



H₂MEET

Conference 2024

Ramping up Hydrogen Economy with Cutting-Edge Technology

Program Book

Country Day

Global Hydrogen Dynamics

25-26 September, 2024

Room 305, 307, KINTEX I, KOREA







Fueling today and tomorrow.

That's *Energy in Progress*



Learn more:



CONTENTS

Country Day I Australia	12p	• Australian Hydrogen Policy • Opening Comment: New South Wales • The Optimization of Wind Energy Supply Chains • Port of Newcastle Clean Energy Precinct • The NSW Advantage: World-class infra meets nation-leading incentives • Opening Comment: Queensland • Queensland Hydrogen and Future Fuels Update • Dalrymple Bay – A Queensland Export Terminal for New Energy Products • H₂-Hub™ Gladstone – Export-class Green Hydrogen and Green Ammonia • Production Cost and Carbon Intensity of Hydrogen and Methanol from Residual Wastes Using the MIHG Technology • Energy Estate – Innovation in Large Scale Hydrogen Project in Australia • Opening Comment: West Australia • An opportunity to rethink commercial hydrogen production • Introduction to InCapture and Greenhouse Gas Assessment Permit Area G-15-AP NWS Australia • Opening Comment: South Australia • Green Cement: Achieving Net Zero in Regional South Australia • South Australia's Great White Kaolin Project • Green Hydrogen Supply Chain Masterplan between Australia and Korea • South Australia – State Prosperity Project
--	------------	---

CONTENTS

Country Day I Canada	125p	• Keynote Speech 1: Clean Energy in British Columbia • Keynote Speech 2: Canada's Hydrogen Landscape • Pitching Session - Alberta's Industrial Heartland Association • Pitching Session - Ballard Power Systems • Pitching Session - Greenlight Innovation • Pitching Session - Momentum Materials Solutions • Pitching Session - Powertech Labs Inc. • Pitching Session - TesTneT Canada
Country Day I Norway	205p	• The low carbon value chain in Norway – CCS, green and blue hydrogen and ammonia • Norwegian Research Collaboration and Future Opportunities • Green hydrogen production by alkaline electrolysis system • Cost-effective, Safe and Light Weight Storage and Transportation of Hydrogen • Beyond Limits: Innovating Cryogenic Fluid Storage with the Lattice Pressure Vessel • Challenges in establishing hydrogen and ammonia transport • Zero Loss of Lives – no injuries or damages caused by fire & gas

CONTENTS

Country Day II International	290p	• [Colombia] Colombia, Hydrogen towards a just energy transition • [Australia] Regulating market barriers and market failures in the hydrogen sector • [Switzerland] Opportunities of collaboration with Swiss hydrogen innovation ecosystem • [Greece] Hydrogen: Our Work and Impact • [Chile] Chilean Experience in Mobility and Safety for H₂ Projects • [USA] U.S. Hydrogen Program Overview • [India] Developing a Reliable & Scalable Green Hydrogen Supply Chain • [Spain] Current situation of the deployment of the Hydrogen Economy in Spain • [Egypt] Hydrogen in Egypt
Country Day II Chile	442p	• Chile's Green Hydrogen Action Plan 2023-2030 • Investment Attraction Policy of Chile – Highlights for Energy Industry • The Future of Global Hydrogen Trade: Implications for Chile and South Korea
Country Day II USA	499p	• U.S. Hydrogen Landscape and Policy Updates • Strategic Role of U.S. Hydrogen Development (TBD) • Indiana: The Land of Hydrogen Opportunities in the Midwest • Ohio's Hydrogen Industry • Energy-Enabled Economic Development Opportunities in Pennsylvania

Timetable

September 25 (Wed)
Country Day I : Australia Day

Time	Program	Title
Opening		
13:30 - 14:00	Registration & Networking	
14:00 ~ 14:02	Opening Comment by MC	Dane Richmond (Trade & Investment Commissioner, Australian Trade and Investment Commission (Austrade))"
14:02 ~ 14:10	Opening speech	Jeff Robinson (Australian Ambassador, Australian Embassy)
Speech		
14:10 - 18:00	Speech 1	Australian Hydrogen Policy
		Catherine Zerger (Branch Head, Hydrogen Strategy, Department of Climate Change, Energy, the Environment and Water)
	Speech 2	Opening Comment: New South Wales
		Yoojin Kim (Director, Investment NSW Seoul)
	Speech 3	The Optimization of Wind Energy Supply Chains
		Tony Noske (Director, Wind SCS)
	Speech 4	Port of Newcastle Clean Energy Precinct
		Craig Carmody (CEO, Port of Newcastle)
	Speech 5	The NSW Advantage: World-class infra meets nation-leading incentives
		Yoojin Kim (Director, Investment NSW Seoul)
	Speech 6	Opening Comment: Queensland
		Luke Shim (Commissioner, Trade & Investment Queensland Seoul)
	Speech 7	Queensland Hydrogen and Future Fuels Update
		Mark Stone (Executive Director, Department of Energy and Climate, Queensland Government)
	Speech 8	Dalrymple Bay – A Queensland Export Terminal for New Energy Products
		Michael Riches (CEO, Dalrymple Bay infrastructure)

Timetable

September 25 (Wed)
Country Day I : Australia Day

Time	Program	Title
14:10 - 18:00	Speech 9	H2-Hub™ Gladstone – Export-class Green Hydrogen and Green Ammonia
		Attilio Pigneri (CEO, The Hydrogen Utility (H2U))
	Speech 10	Production Cost and Carbon Intensity of Hydrogen and Methanol from Residual Wastes Using the MIHG Technology
		Greg Perkins (CEO, Wildfire Energy)
	Speech 11	Energy Estate – Innovation in Large Scale Hydrogen Project in Australia
		Vincent Dwyer (CEO, Energy Estate)
	Speech 12	Opening Comment: West Australia
		Jess Ahn (Investment and Trade Director, Government of Western Australia, Seoul Office)
	Speech 13	An opportunity to rethink commercial hydrogen production
		Conrad Mulherin (CCO, Vytas Ltd.)
	Speech 14	Introduction to InCapture and Greenhouse Gas Assessment Permit Area G-15-AP NWS Australia
		Julia Davies (General Manager, Incapture)
	Speech 15	Opening Comment: South Australia
		David Connolly-Hay (Department of State Development (Invest SA), Business Development Manager, Government of South Australia)
	Speech 16	Green Cement: Achieving Net Zero in Regional South Australia
		Craig Cresp (General Manager Operations, Hallet Group)
	Speech 17	South Australia's Great White Kaolin Project
		Joe Ranford (Andromeda Metals: Chief Operating Officer / Andromeda Technologies: Executive Director)
	Speech 18	Green Hydrogen Supply Chain Masterplan between Australia and Korea
		Robert Saunders (Managing Director, MIEAust CPEng NER APEC Engineer IntPE (Aus), Elecseed)
	Speech 19	South Australia – State Prosperity Project
		David Connolly-Hay (Department of State Development (Invest SA), Business Development Manager, Government of South Australia)

Timetable

September 26 (Thu)
Country Day I : Canada Day

Time	Program	Title
Opening		
10:30 - 11:00	Registration	
11:00 - 11:05	Welcome Remarks	Derrick Kim (Managing Director, Trade and Invest British Columbia in South Korea)
Speech		
11:05 - 12:30	Speech 1	Keynote Speech 1: Clean Energy in British Columbia
		Aron Kim (Trade Commissioner, Global Affairs Canada)
	Speech 2	Keynote Speech 2: Canada's Hydrogen Landscape
		Ivette Vera-Perez (President and CEO, Canada Hydrogen Association)
	Q&A	
	Speech 3	Pitching Session - Alberta's Industrial Heartland Association
		David Howe (Strategic Projects Manager, Alberta's Industrial Heartland Association)
	Speech 4	Pitching Session - Ballard Power Systems
		Norman Chor (Account Manager of Asia Pacific, Ballard Power Systems)
	Speech 5	Pitching Session - Greenlight Innovation
		Greig Walsh (Chief Commercial Officer, Greenlight Innovation)
	Speech 6	Pitching Session - Momentum Materials Solutions
		Arlene Ai (Co-founder and CEO, Momentum Materials Solutions)
	Speech 7	Pitching Session - Powertech Labs Inc.
		Ben Skillings (Division Manager, Powertech Labs Inc.)
	Speech 8	Pitching Session - TesTneT Canada
		Young-min Choi (Sales Representative of Korea, TesTneT Canada)
	Q&A	

Timetable

September 26 (Thu)
Country Day I : Norway Day

Time	Program	Title
Opening		
13:00 - 13:20	Registration & Coffee	
13:20 - 13:25	Welcome Remarks	Per Christer Lund (Energy Counsellor, The Royal Norwegian Embassy)
Speech		
13:25 - 17:35	Speech 1	The low carbon value chain in Norway – CCS, green and blue hydrogen and ammonia
		Per Christer Lund (Energy Counsellor, The Royal Norwegian Embassy)
	Speech 2	Norwegian Research Collaboration and Future Opportunities
		Christine Mee Lie (Counsellor for Higher Education, Research and Innovation, The Royal Norwegian Embassy in Seoul)
	Speech 3	Green hydrogen production by alkaline electrolysis system
		Nuno Bernardino Rodrigues (Tender Manager, Nel Hydrogen Electrolyser)
	Speech 4	Cost-effective, Safe and Light Weight Storage and Transportation of Hydrogen
		Yngve Schrøder Tufteland (International Sales Manager, Umoe Advanced Composites)
	Speech 5	Beyond Limits: Innovating Cryogenic Fluid Storage with the Lattice Pressure Vessel
		Yonghwan Cho (R&D Engineer, Lattice International)
	Speech 6	Challenges in establishing hydrogen and ammonia transport
		Robert Judd (Group Leader - Hydrogen/Low Carbon Fuels and CCUS / H ₂ & CCS, DNV Energy Systems)
	Speech 7	Zero Loss of Lives – no injuries or damages caused by fire & gas
		Damian Tan (Global Projects & Account Manager, Autronica Fire & Security)
	Panel Discussion	

Timetable

September 25 (Wed)
Country Day II : International Day

Time	Program	Title
Speech		
13:00 ~ 16:30	Speech 1	[Colombia] Colombia, Hydrogen towards a just energy transition
		Shirley Vega (Commercial Counsellor, Embassy of Colombia in Korea)
	Speech 2	[Australia] Regulating market barriers and market failures in the hydrogen sector
		Zubin Bilimoria (University of Sydney)
	Speech 3	[Switzerland] Opportunities of collaboration with Swiss hydrogen innovation ecosystem
		Antoine Jourdan (Director SIP West EPFL, Switzerland Innovation)"
	Speech 4	[Greece] Hydrogen: Our Work and Impact
		Nikolaos Ntavos (Co-Founder & Manager of CluBE, Cluster of Bioeconomy & Environment of Western Macedonia (CluBE))
	Speech 5	[Chile] Chilean Experience in Mobility and Safety for H2 Projects
		Dr. Eduardo Salamanca (CEO, HYDROSHEN – U. de Chile)
	Speech 6	[USA] U.S. Hydrogen Program Overview
		Christine Watson (Technology Manager, U.S. Department of Energy)
	Speech 7	[India] Developing a Reliable & Scalable Green Hydrogen Supply Chain
		Anirudh Vuyyala (Lead International Business, Adani New Industries Ltd (ANIL))"
	Speech 8	[Spain] Current situation of the deployment of the Hydrogen Economy in Spain
		Dr. Javier Brey (Chairman, Spanish Hydrogen Association (AeH2))
	Speech 9	[Egypt] Hydrogen in Egypt
		Khaled Nageib (CEO, Hydrogen Egypt)

Timetable

September 26 (Thu)
Country Day II : Chile Day

Time	Program	Title
Opening		
09:45 - 10:15	Registration & Welcoming Coffee Break	
10:15 - 10:20	Welcome Remarks	Mathias Francke (Ambassador of Chile to the Republic of Korea, Embassy of Chile in Republic of Korea)
Speech		
10:20 - 12:00	Speech 1	Chile's Green Hydrogen Action Plan 2023-2030
		Alex Santander (Head of the Strategic Planning and Sustainable Development Division, Ministry of Energy)
	Speech 2	Investment Attraction Policy of Chile – Highlights for Energy Industry
		Catalina Pérez (International Network Manager, InvestChile: Investment Promotion Agency of Chile)
	Speech 3	The Future of Global Hydrogen Trade: Implications for Chile and South Korea
		Prof. Younkyoo Kim (Dean of Graduate School of International Studies of Hanyang University, Hanyang University)
	Q&A	

Timetable

September 26 (Thu)
Country Day II : USA Day

Time	Program	Title
Opening		
13:00 - 13:30	Registration and Networking	
13:30 - 13:40	Opening Remarks	Michael Kim (Commercial Officer, U.S. Embassy Seoul)
Speech		
13:40 - 15:30	Speech 1	U.S. Hydrogen Landscape and Policy Updates
		Christine Watson (Technology Manager, U.S. Department of Energy)
	Speech 2	Strategic Role of U.S. Hydrogen Development (TBD)
		Sally Sun (Vice President for International Business Development, Tallgrass Energy)
	Speech 3	Indiana: The Land of Hydrogen Opportunities in the Midwest
		Narai Kim (Director of Korea Office, Indiana Economic Development Corporation (IEDC))
	Speech 4	Ohio's Hydrogen Industry
		Jiyun Choi (Consultant, JobsOhio)
	Speech 5	Energy-Enabled Economic Development Opportunities in Pennsylvania
		Adam Walters (Senior Energy Advisor, Pennsylvania Dept. of Community and Economic Development (DCED))

Country Day I

Australia Day

Country Day I : Australia Day

Opening

Country Day I : Australia Day

Opening Comment by MC



Dane Richmond

Trade & Investment Commissioner,
Australian Trade and Investment Commission
(Austrade)

Bio

Mr Dane Richmond, Austrade Trade and Investment Commissioner, and Counsellor (Commercial) at the Australian Embassy in Seoul, South Korea.

Dane joined Austrade from the Department of Resources, Energy and Tourism. He worked in the Tourism Division of Austrade prior to taking a posting in Shanghai where he served as Trade and Investment Commissioner from 2017-2022. Previously he worked for the Department of Finance and Deregulation and prior to that he worked for Australian water tech start up in Shanghai.

He holds a bachelors in Asian Studies from the Australian National University (ANU) and a master's degree in strategic and Defence Studies from the ANU. He has undertaken further studies in technology leadership at the Massachusetts Institute of Technology (MIT) and is a 2023 Asialink Leader. He speaks Mandarin and Korean.

Dane leads the Resources,

Country Day I : Australia Day

Opening speech



Jeff Robinson

Australian Ambassador,
Australian Embassy

Country Day I : Australia Day

Australian Hydrogen Policy

Country Day I : Australia Day

Australian Hydrogen Policy



Catherine Zerger

Branch Head, Hydrogen Strategy, Department of
Climate Change, Energy, the Environment and Water

Catherine Zerger is the Branch Head, Hydrogen Strategy in the Department of Climate Change, Energy the Environment and Water and leads work on the National Hydrogen Strategy, the Guarantee of Origin Scheme and Hydrogen Headstart. Catherine has over 20 years' experience in government, largely focused on energy and climate change policy, programs and regulation. This has included work on energy efficiency and clean energy technologies.

Ms Zerger has a Bachelor of Arts (Hons) and Bachelor of Science from Monash University and a Masters of Public Policy from the Australian National University.

Country Day I : Australia Day

Opening Comment: New South Wales

Country Day I : Australia Day

Opening Comment: New South Wales



Yoojin Kim

Director, Investment NSW Seoul

Education

- 2002 Master's Degree of International Management at Yonsei University Graduate School of International Studies
- 1995 Bachelor's Degree of Mass Communication at Yonsei University in Seoul

Professional Career

- 2014 – Current, Austrade (InvestmentNSW) – NSW Trade & Investment Director for Korea
- 2013-2014, SoftForum – Head of Marketing
- 2010-2013, Truston Asset Management Singapore, Director
- 2010-2010, New Zealand Trade & Enterprise, Manager
- 2002-2007, Korea IT Industry Promotion Agency, Manager
- 2001-2002, Daum Solution, Manager
- 1005-1999, Hyundai Information Technology, Associate

Speech Title

The NSW Advantage: World-class infra meets nation-leading incentives

Speech Summary

NSW combines its natural advantages and extensive industrial infrastructure with world-leading incentives to create a clear pathway to cost-competitive hydrogen and projects of global scale. As Australia's largest economy, NSW's advantage is based on its large, skilled workforce and strategic infrastructure, including deep water ports and major highways. These strong fundamentals are boosted by a nation-leading \$3 billion Hydrogen Strategy that provides industry support and strong incentives of up to \$5/kg to achieve cost-competitive green hydrogen production.

Company Introduction

InvestmentNSW is the commercial arm of New South Wales (NSW) State Government to boost NSW economy by facilitate the partnership between NSW organizations and foreign organization. InvestmentNSW Korea team assist NSW companies to go global and attract foreign direct investment from Korean organizations.

Country Day I : Australia Day

The Optimization of Wind Energy Supply Chains

Country Day I : Australia Day

The Optimization of Wind Energy Supply Chains



Tony Noske

Director, Wind SCS

Education

- 1969 - Completed Secondary Education (Yr 12) Hamilton & Western District College Victoria Australia
- 1971 - 1973, Mechanical Design & Drafting Course Warrnambool
- 1990 - 1991, Melbourne Business School, Leadership
- 1992 - Harvard USA, Business Culture
- 1998 - Business Administration Course INSEAD France

Professional Career

- 2023 - Present - Wind Logistic Alliance, Chair.
- 2023 - Present - Wind SCS Holdings Pty Ltd, Director Supply Chain Solutions and Optimization.
- 2021-2022 - Blue Water Shipping, Managing Director/ Head of Wind Energy Australia.
- 2019-2022 - McCol's Transport, Consultant / Strategic Advisor - Fleet Optimization.
- 2019-2021 - N10 Project Solutions Pty Ltd, Director Supply Chain Solutions and Optimization.
- 2015-2018 - Kelly Logistics Pty Ltd, Consultant / Operations / Business Development.
- 2008-2012 - Noske Wind, Founder / Director Supply Chain Solutions and Optimization.
- 2005-2015 - Noske Logistics Group, Founder / Director Supply Chain Solutions and Optimization.
- 1982-1999 - Kalari Transport Holdings, Founder / Director Supply Chain Solutions and Optimization.
- 1980-1982 - Boral Resources Limited, Regional Manager South West Victoria.
- 1973-1980 - Southwest Quarrying & Asphalt - Manager South West Victoria.
- 1972 - Trainee E Stewart Mitchell Baltimore Maryland.
- 1971 - Trainee ConRoc Los Angeles California.

Research Interest

1980 - Present, Supply Chain Optimization and the pursuit of culture, safety and improved operational systems for delivery of supply chain solutions and projects.

Speech Summary

Wind SCS was formed to chair and establish the Wind Logistics Alliance (WLA) in conjunction originally with, the leaders of key wind energy supply chain companies.

This alliance has the capability to deliver the total Onshore / Offshore wind energy supply chain from POM to Turnkey Installation.

The focus of the Wind Logistics Alliance (WLA) is to eliminate the traditional interface friction and risk between the multiple scopes of the wind turbine supply chain.

These interfaces come with inherent risks, inefficiencies and misalignments which lead to higher costs and disruptions. WLA's now has additional parties to further enhance its capabilities to have linkage with the Hydrogen production industry.

Company Introduction

Validating a sound ability to deliver wind energy projects is vital to any license application.

WindSCS and Wind Logistics Alliance partner relationships bring together every niche required to deliver optimized wind project supply chain services in Australia that can be of high value to the Hydrogen production supply chain.

Capabilities include:

International shipping, Stevedoring, AQIS Inspections, Customs clearance, Port Operations & Marshalling Services, Oversize inland transport expertise including route approvals, transport, lifting, offloading, escorts and project management.

Supply of Port machinery including specialized heavy lift cranes, reach stackers, SPMT and handling tools, Installation services including pre-assembly, turbine erection, HV/ LV voltage cabling, lifting operations and installation activities, Mechanical and electrical maintenance, component exchange and blade inspection and repair

Country Day I : Australia Day

Port of Newcastle Clean Energy Precinct

Country Day I : Australia Day

Port of Newcastle Clean Energy Precinct



Craig Carmody

CEO, Port of Newcastle

Education

- 2004, Master in Industrial and Employment Relations, Monash University, Melbourne, Australia
- 2007, Executive Masters in Public Administration, Public Policy, Australia

Professional Career

- 2018 – Present, Chief Executive Officer, Port of Newcastle, Australia
- 2014 – 2018, Director, Svitzer, Australia
- 2013, Director of Policy, Officer of the Prime Minister of Australia
- 2010 – 2013, Deputy Chief of Staff, Office of the Minister for Infrastructure and Transport
- 2008 – 2010, Senior Policy Advisor Employment and Workplace Relations, Office of the Deputy Prime Minister of Australia
- 2005 – 2008, Director, Strategic Policy and Implementation, Department of Employment and Workplace Relations
- 1995 – 2005, Lieutenant Colonel, Australian Army

Speech Summary

Port of Newcastle's Clean Energy Precinct will enable the production, storage, domestic distribution, transmission, and international export of clean energy, including hydrogen and green ammonia.

Located on a 220-hectare parcel of land on Kooragang Island, the Clean Energy Precinct aims to position Australia as a major global player in hydrogen production and exports, and that the Hunter Region is considered a clean energy powerhouse by 2030.

Port of Newcastle's Clean Energy Precinct has received a \$100 million funding grant from the Australian Government, administered by the NSW Government.

With the Clean Energy Precinct, Port of Newcastle will be a catalyst for employment, growth, and diversification, including energy to support future growth and reduce reliance on coal.

Company Introduction

Port of Newcastle is more than a port. It exists to build Australia's prosperity with responsible, integrated and innovative supply chain solutions.

With trade worth about \$48 billion to the national economy each year, Port of Newcastle enables Australian businesses to successfully compete in international markets.

The port has capacity to handle 10,000 ship movements and over 200 million tonne of cargo annually. With a deepwater shipping channel operating at 50% of its capacity, significant port land available and enviable access to national rail and road infrastructure, Port of Newcastle is positioned to further underpin the future prosperity of the Hunter, NSW and Australia.



ABOUT PORT OF NEWCASTLE





CLEAN ENERGY **PRECINCT**



CLEAN ENERGY PRECINCT

PILLARS FOR DELIVERY



Australia's clean energy's one-stop-shop for:

- Production
- Storage
- Domestic Distribution
- Transmission
- International Export

Port of Newcastle's Clean Energy Precinct has received a \$100 million funding grant from the Australian Government, administered by the NSW Government.



VISION OF THE PROJECT

> \$4.2 BILLION

added to the gross regional product in the Hunter Region by 2040⁽¹⁾

660,000 TONNES

ANNUAL REDUCTION IN DOMESTIC CARBON EMISSIONS⁽²⁾, EQUIVALENT TO TAKING ABOUT 143,476 PETROL-FUELLED CARS OFF THE ROAD FOR A YEAR

+5,800

NEW HUNTER REGION JOBS BY 2040⁽¹⁾

~1 million tonnes annual reduction in export carbon emissions⁽²⁾, equivalent to taking about 217,391 petrol-fuelled cars off the road for a year

PRODUCTION OF AND EXPORT DEMAND FOR GREEN AMMONIA >600,000 KTPA FROM 2030 ONWARDS

Use of 1.6 gigawatts of electricity and 22 megalitres of recycled water with no impact on utilities or our community

Support ~1.6 gigawatts in renewable energy generation⁽²⁾, equivalent to powering about 1.7 million average Australian households for a year

RE-SKILLING 16,000 EXISTING MINING EQUIPMENT TECHNOLOGY SERVICES (METS) WORKERS

WHAT THE CLEAN ENERGY PRECINCT WILL DO:

Drive decarbonisation

Capture export opportunities

Production and export, all in one precinct

Proper diversification

Support Australia's clean energy economy and the Hunter Region's future prosperity

Provide common use, open access, and shared infrastructure, reducing costs

Create new low carbon job pathways

PROPOSED PROJECT DEVELOPMENT



Ancillary and civil works

- Site buildings
- Office and administration facilities
- Internal roads
- Car parking
- Warehousing
- Laydown areas
- Storage yards
- Staging areas
- Clean energy storage facility
- Associated pipeline infrastructure



Electrical

- Grid connection
- Transmission infrastructure
- Substation
- Switchyard



Water and recycled water

- Network connection
- Supply contracts

VISION OF THE PROJECT



PORT OF NEWCASTLE: CLEAN ENERGY PRECINCT FULL PHASE COMPLETION





CLEAN ENERGY PRECINCT

Partners

CLEAN ENERGY PRODUCERS



SKILLS AND TRAINING



ELECTRICITY



WATER



INTERNATIONAL PARTNERS



TRANSPORT / STORAGE



TECHNOLOGY



Government



THANK YOU



 +61 2 4908 8200

 energy@pon.com.au

 www.pon.com.au

Country Day I : Australia Day

**The NSW Advantage:
World-class infra meets nation-leading incentives**

Country Day I : Australia Day

The NSW Advantage: World-class infra meets nation-leading incentives



Yoojin Kim

Director, Investment NSW Seoul

Education

- 2002 Master's Degree of International Management at Yonsei University Graduate School of International Studies
- 1995 Bachelor's Degree of Mass Communication at Yonsei University in Seoul

Professional Career

- 2014 – Current, Austrade (InvestmentNSW) – NSW Trade & Investment Director for Korea
- 2013-2014, SoftForum – Head of Marketing
- 2010-2013, Truston Asset Management Singapore, Director
- 2010-2010, New Zealand Trade & Enterprise, Manager
- 2002-2007, Korea IT Industry Promotion Agency, Manager
- 2001-2002, Daum Solution, Manager
- 1005-1999, Hyundai Information Technology, Associate

Speech Title

The NSW Advantage: World-class infra meets nation-leading incentives

Speech Summary

NSW combines its natural advantages and extensive industrial infrastructure with world-leading incentives to create a clear pathway to cost-competitive hydrogen and projects of global scale. As Australia's largest economy, NSW's advantage is based on its large, skilled workforce and strategic infrastructure, including deep water ports and major highways. These strong fundamentals are boosted by a nation-leading \$3 billion Hydrogen Strategy that provides industry support and strong incentives of up to \$5/kg to achieve cost-competitive green hydrogen production.

Company Introduction

InvestmentNSW is the commercial arm of New South Wales (NSW) State Government to boost NSW economy by facilitate the partnership between NSW organizations and foreign organization. InvestmentNSW Korea team assist NSW companies to go global and attract foreign direct investment from Korean organizations.

Investment NSW

The NSW Hydrogen Advantage

Yoojin Kim

NSW Trade & Investment Director for Korea

H2MEET - Sept 2024



NSW: the premier destination for hydrogen investment



With **8.2 million people**, we have Australia's largest population and represent its largest state economy.



31% share of Australia's GDP

Source: Australian Bureau of Statistics - Australian National Accounts: State Accounts, 2021-22 financial year.



Leader in Renewable Energy Attractiveness

Highly rated for future investment opportunities.

Source: MinterEllison, Australian Renewables Report 2023



AAA credit rating.

Source: Moody's and Fitch



2 universities in the world's top 20 located in NSW.

Source: QS University World Rankings 2025



THE UNIVERSITY OF
SYDNEY



UNSW
SYDNEY

Investment NSW

Ready infrastructure and a deep talent pool

The NSW Hydrogen Advantage



Largest economy & skilled workforce



World-leading renewable energy development



Existing steel and ammonia production & export



Extensive road, rail, port and grid infrastructure

World-leading policy and targeted incentives

The NSW Hydrogen Advantage



NSW Hydrogen Strategy

Our state's plan to become a hydrogen superpower.

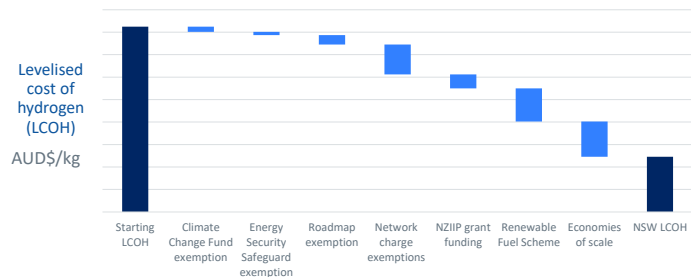
60 actions

\$3 billion total incentives

Up to \$5 per kilo cost reduction

Clear policy pathway to reduce production costs

\$3 billion in incentives to reduce the cost of green hydrogen by up to **\$5 per kilo**.



NSW's unique policy measures

Building gigawatt-scale around today's demand

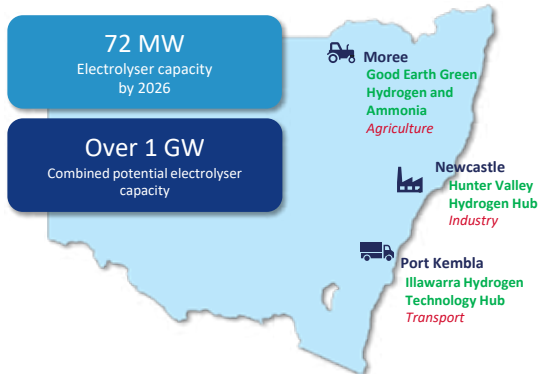
The NSW Hydrogen Advantage



Hydrogen Hubs

\$109 million

Co-locating supply and demand to drive scale, reduce costs, focus innovation and grow workforce capability



Investment NSW

Port of Newcastle

\$100 million Commonwealth grant



Net Zero Manufacturing Initiative

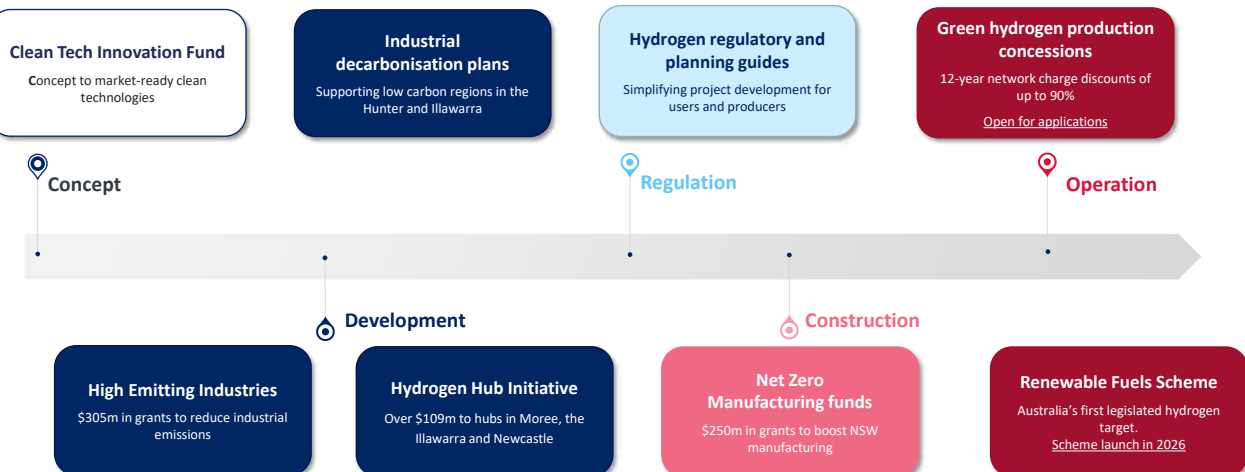
\$275 million



5

Support all along the value chain

The NSW Hydrogen Advantage



Investment NSW

6

Join us in Sydney next year...

2025 Asia-Pacific Hydrogen Summit



Join us and over +3000 industry professionals at the region's largest and most senior Hydrogen Summit.

In Partnership With:



Supported By:



**ASIA-PACIFIC
HYDROGEN**

SUMMIT & EXHIBITION

20-21 November 2025

ICC SYDNEY, AUSTRALIA



2023 APAC Hydrogen Summit, Sydney



The Hon. Penny Sharpe
Minister for Climate Change and Energy

Investment NSW

7

Thank you

Visit investment.nsw.gov.au to find out how NSW can help grow your business in Australia and the Asia Pacific.

Yoojin Kim

NSW Trade & Investment Director for Korea
Investment NSW

yoojin.kim@austrade.gov.au

Justin O'Connor

Senior Project Officer - NSW Hydrogen Strategy
NSW Department of Climate Change, Energy, the Environment and Water

justin.oconnor@dpie.nsw.gov.au





© 2024 State of NSW and Department of Climate Change, Energy, the Environment and Water

With the exception of photographs, the State of NSW and Department of Climate Change, Energy, the Environment and Water (the department) are pleased to allow this material to be reproduced in whole or in part for educational and non-commercial use, provided the meaning is unchanged and its source, publisher and authorship are acknowledged. Specific permission is required to reproduce photographs.

Learn more about our copyright and disclaimer at dceew.nsw.gov.au/copyright

Country Day I : Australia Day

Opening Comment: Queensland

Country Day I : Australia Day

Opening Comment: Queensland



Luke Shim

Commissioner, Trade & Investment Queensland Seoul

Country Day I : Australia Day

Queensland Hydrogen and Future Fuels Update

Country Day I : Australia Day

Queensland Hydrogen and Future Fuels Update



Mark Stone

Executive Director, Department of Energy and Climate,
Queensland Government

Education

- 1999 Master of Engineering, Petroleum Engineering, Heriot-Watt University, Scotland
- 1994 Bachelor of Engineering (Honours), Minerals Engineering, Camborne School of Mines, UK

Professional Career

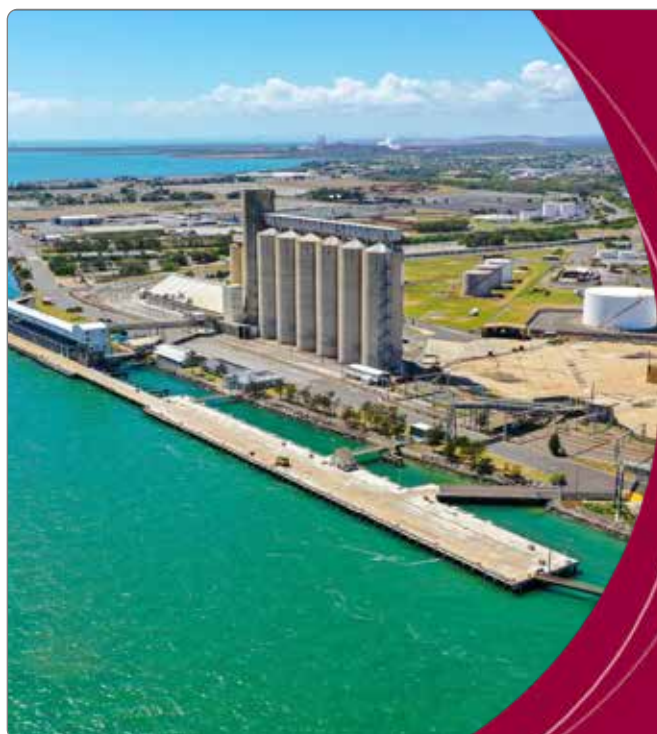
Mark Stone is the Executive Director for Hydrogen and Future Fuels, within the Queensland Department of Energy and Climate. An engineer by training, Mark joined the department having spent 30-years in private and public sector roles, spanning international petroleum development and the regulation of safety and health in high-hazard industry. In his current role, he's responsible for progressing the hydrogen and future fuels components of government's policy under the Queensland Energy and Jobs Plan. This involves stakeholder engagement and consultation, policy development and the administration of related state government programs.

Speech Title

Queensland Hydrogen and Future Fuels update

Speech Summary

As Australia's 'Sunshine State' Queensland has the potential to produce more than 10 million tonnes per year of renewable hydrogen and is working to deliver domestic and export partners with a reliable supply. Learn about Queensland's hydrogen and future fuels vision to secure a net zero future.



Renewable Hydrogen Queensland – The zero carbon hydrogen leader

Mark Stone

Executive Director
Hydrogen and Future Fuels
Department of Energy and Climate



Acknowledgement of Country

I would like to respectfully acknowledge the Traditional Owners of the lands from which I'm speaking today the Turrbal and Yuggera Peoples and acknowledge Elders both past and present.

I also recognise those whose ongoing effort to protect and promote Aboriginal and Torres Strait Islander cultures will leave a lasting legacy for future Elders and leaders.



BuildingCommunities
Art by Casey Coolwell-Fisher, Chaboo Designs



Queensland's 2035 Clean Economy Pathway

Queensland's
emissions
reduction targets

30%
below 2005
levels by 2030

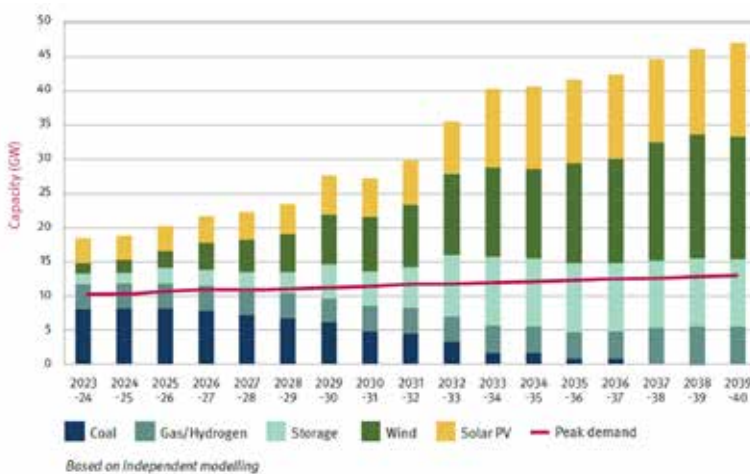
75%
below 2005
levels by 2035

Net zero
by 2050

**Why do we need to
decarbonise Queensland's
economy?**

- ✓ Climate action is a jobs opportunity for all Queenslanders
- ✓ Decarbonisation generates investment throughout the economy
- ✓ Creating the jobs of the future economy
- ✓ Diversification and community resilience
- ✓ Protecting the environment.

Changing generation mix



Queensland's generation mix will transform over time to include more wind, solar and storage to ensure we always have enough energy to meet Queensland's energy demand including at peak times.



The Enabling Queensland's hydrogen production and export opportunities report:



- ✓ Demonstrates Queensland's unique opportunity to create an internationally significant renewable hydrogen export industry.
- ✓ Identifies and evaluates each of Queensland's key export regions including existing infrastructure and its potential role in local supply chains.
- ✓ Gives strategic insight for proponents into Queensland's hydrogen production potential as they plan, develop and secure capital, partners and off-take for their projects.
- ✓ Provides industry and government partners a platform for future planning and provides a reference to guide industry to grow sustainably, while balancing economic, social, environmental and cultural values.

Queensland's Hydrogen Competitive Advantages

- ✓ Significant wind and solar resources.
- ✓ Large transmission network and established industrial hubs in Northern Queensland.
- ✓ 14 ports, 5 priority ports - majority public owned.
- ✓ Experience and an energy exporter and capability in export of bulk commodities out of multiple ports.
- ✓ Publicly owned generators, ports and transmission network.
- ✓ Plenty of land including State Development Areas (SDAs) and Infrastructure Corridors.
- ✓ Large regional population and highly skilled workforce

Image: Queensland ports and renewable energy zones

Thank you



Mark Stone

Executive Director, Hydrogen and Future Fuels

Department of Energy and Climate

www.energyandclimate.qld.gov.au/hydrogen



Queensland
Government

Country Day I : Australia Day

**Dalrymple Bay – A Queensland Export Terminal
for New Energy Products**

Country Day I : Australia Day

Dalrymple Bay – A Queensland Export Terminal for New Energy Products



Michael Riches

CEO, Dalrymple Bay infrastructure

Education

- 1987-1992 Bachelor of Commerce, University of New South Wales
- 1987-1992 Bachelor of Laws, University of New South Wales

Professional Career

- 1993-2004 Minter Ellison Lawyers; partner from 2000-2004
- 2004-2010 Partner, Clayton Utz Lawyers
- 2011-2016 Director, Corporate Services and General Counsel, Alinta Energy
- 2017-2019 Executive Director, Network, Aurizon Holdings Ltd
- 2020-2022 Chief Executive Officer, Axicom Pty Ltd
- 2023-2024 Board Chair, Altogether Group Pty Ltd
- 2024-Present Chief Executive Officer, Dalrymple Bay Infrastructure Ltd

Research Interest

Transport infrastructure for new energy products

Speech Title

Export of New Energy Products through Dalrymple Bay Terminal

Speech Summary

Dalrymple Bay Infrastructure in partnership with three global energy market participants has undertaken detailed studies on the capability of the Dalrymple Bay Terminal (DBT) to export new energy products in conjunction with, and ultimately in replacement, of coal exports.

The characteristics of the terminal:

- Deep water priority port that is less than 2 weeks sailing to Asian markets
 - Existing port infrastructure that can be readily added to for the export of ammonia or other new energy products in a very short time horizon
 - Close proximity to high quality renewable energy zones in Queensland
 - Extensive land at the port that is owned by one of our consortium partners and available for development
 - More than 30km from a major population centre,
- make DBT an ideal location for the development of a new energy facility.

This speech will elaborate on the work undertaken to date and the key benefits DBT offers to any party seeking the most cost efficient and effective location to produce and export new energy products

Company Introduction

Dalrymple Bay Infrastructure Limited is the largest metallurgical coal export terminal in the world with a capacity of 84.2mtpa servicing over 20 mines and more than 10 customers in the central Bowen Basin of Queensland, Australia. A component of our transition planning is to develop the terminal to have the ability to export new energy products



Dalrymple Bay Terminal (DBT) and the Port of Hay Point



- ✓ DBT is the world's largest metallurgical coal export terminal
- ✓ DBT is located within the Port of Hay Point - one of only five designated priority ports in Queensland¹
- ✓ Significant available industrial land within the Port of Hay Point¹
- ✓ 3.8 km jetty and 4 deepwater berths with further expansion possible
- ✓ Minimal structural modifications required to install a green ammonia pipeline on existing marine infrastructure²
- ✓ Located within the Isaac renewable energy zone³
- ✓ Catchment and infrastructure study completed by Aurecon confirming suitability of DBT and Hay Point for exporting up to 25Mtpa of green ammonia²
- ✓ Up to 4 Mtpa of green ammonia exports alongside 84.2Mtpa of contracted coal exports²
- ✓ Experienced consortium includes Dalrymple Bay Infrastructure, Brookfield, Itochu and North Queensland Bulk Ports

1. Queensland Dept of Transport and Main Roads, <https://www.tmr.qld.gov.au/business-industry/transport-sectors/ports/sustainable-port-development-and-operation/sustainable-ports-development-act-2015> (2022)

2. Dalrymple Bay Hydrogen Port and Catchment Study (October 2023)

3. Source: Queensland Government – Department of Energy and Climate – REZ Roadmap (May 2024)

Country Day I : Australia Day

**H2-Hub™ Gladstone – Export-class Green
Hydrogen and Green Ammonia**

Country Day I : Australia Day

H2-Hub™ Gladstone – Export-class Green Hydrogen and Green Ammonia



Attilio Pigneri

CEO, The Hydrogen Utility (H2U)

Education

- 1994-2000, M.Sc. Mechanical Engineering (Energy), Politecnico di Milano, Italy
- 2004-2005, Visiting Researcher, Hydrogen Pathways Program, University of California, Davis
- 2002-2006, PhD Energy and Environmental Systems, Università del Salento, Italy

Professional Career

- 2019 - Present, Founder and CEO, H2U – the Hydrogen Utility®, Australia
- 2012 - 2019, Managing Director, TWE, Australia
- 2010 - 2011, Technical Director – Energy, Green Collar Climate Solutions, Australia
- 2007 - 2011, Associate Director, Centre for Energy Research, Massey University, New Zealand
- 2004 - 2005, Visiting Researcher, Hydrogen Pathways Program, University of California, Davis
- 2002 - 2007, Founder and Managing Director, Energia ESCO, Italy
- 2001 - 2002, Lieutenant, Technical Corps, Italian Navy, Italy
- 2000 - 2001, Researcher, end-Use Efficiency Research Group, Politecnico di Milano, Italy

Research Interest

Renewables and Hydrogen Systems Integration
Energy Integrated Systems Planning
Hydrogen Delivery Infrastructure
Greenhouse Gas Abatement Strategies

Speech Summary

H2-Hub™ Gladstone is a greenfield industrial-scale development for the production and export of green hydrogen and green ammonia, proposed to be in Gladstone Queensland, Australia.

The Project is planned for a staged implementation, up to 4 million tonnes of green ammonia per year established initially to deliver import replacement options for existing domestic ammonia customers and later scaled up to support export market expansion.

Company Introduction

The Hydrogen Utility® (H2U®) is a specialist developer of hydrogen-energy infrastructures for sustainable mobility and renewable energy storage. H2U is based in Australia and operates throughout the Asia-Pacific.

Country Day I : Australia Day

**Production Cost and Carbon Intensity of
Hydrogen and Methanol from Residual Wastes
Using the MIHG Technology**

Country Day I : Australia Day

Production Cost and Carbon Intensity of Hydrogen and Methanol from Residual Wastes Using the MIHG Technology



Greg Perkins

CEO, Wildfire Energy

Education

MBA, Global Executive MBA for Asia Pacific
University of California, Los Angeles
National University of Singapore

Doctor of Philosophy
Materials Science and Engineering
University of New South Wales, Sydney

Thesis: "Mathematical modelling of underground coal gasification".

Bachelor of Science (Mathematics & Computers)
Bachelor of Mechanical Engineering (1st Class)
Monash University, Melbourne

Professional Career

2016-Present | Wildfire Energy Pty Ltd, Brisbane
Managing Director and CEO
Greg is co-founder of Wildfire Energy.

2009-2016 | ASX 200 Energy Company, Brisbane
Chief Technology Officer

Greg led and managed a team of up to 35 engineers and scientists in the development of technology and execution of projects for coal gasification. The technology development led to licensing and engineering deals worth more than 30 million USD in upfront payments and engineering fees. Greg delivered design packages for integrated projects in capex range up to \$1.5 billion and supported start up, commissioning and operations of the technology for more than four years.

2008-2009 | Shell International, Malaysia
Senior Process Engineer Gasification

Greg was seconded to Malaysia to commission and start up a new \$100 million gasification unit within an integrated refinery. Greg was responsible for process engineering, site training and support for day to day operations.

2003-2008 | Shell International, The Netherlands
Process Engineer Chemicals and Fluid Flow

Greg worked at Shell's global research and technology centre in Amsterdam, where he was a consultant to numerous Shell engineering groups on oil and gas flow modelling, optimization of catalytic systems and novel process design. He designed critical cooling systems in seven projects totaling over \$3 billion USD of investment.

Research Interest

• Gasification • Biofuels • Waste management

Greg is a former Adjunct Professor in Chemical Engineering at the University of Queensland, where he helped direct and supervise research into cleaner energy technologies until January 2024.

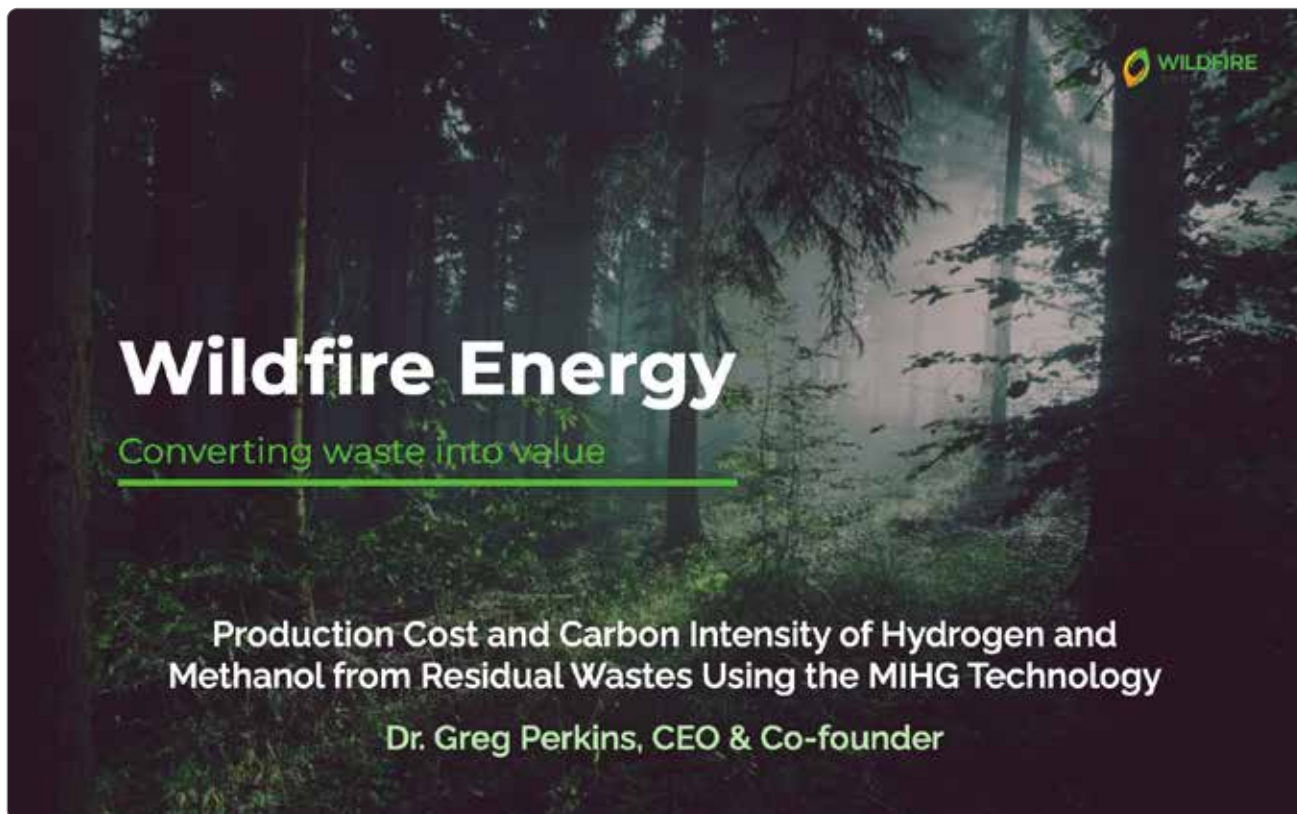
Speech Summary

The speech will:

- Outline Wildfire Energy's Moving Injection Horizontal Gasification (MIHG) technology
- Describe how the MIHG technology can be used to produce hydrogen and methanol from residuals wastes
- Describe pilot plant operations and hydrogen production to date
- Summarise the levelized cost of hydrogen and levelized cost of methanol from commercial plants with specific relevance for South Korea
- Summarise the carbon intensity of hydrogen and methanol produced from residual wastes
- Provide an overview of commercial plants

Company Introduction

Wildfire Energy's purpose is to create a more sustainable planet. Wildfire aims to convert wastes destined for landfill and incineration into higher value energy products. Using its proprietary MIHG technology Wildfire can convert residual wastes into renewable electricity, hydrogen and methanol with lower emissions and with low cost. Wildfire Energy also supports improved waste recycling and the transition to circular economy principles in order to have a more sustainable planet.



 **Wildfire Energy**

Converting waste into value

Production Cost and Carbon Intensity of Hydrogen and Methanol from Residual Wastes Using the MIHG Technology

Dr. Greg Perkins, CEO & Co-founder



 **Wildfire Energy**

Problem

Waste growing to 3 billion tonnes per annum



3.4 Billion

-  Only 30% of waste is recycled or converted into energy
-  Nearly 70% of waste is landfilled, producing 5% of global GHGs
-  Solid waste emissions forecast over 2.4 billion tonnes CO₂eq

Problem

Insufficient supply of sustainable fuels



Renewable hydrogen and renewable natural gas for mobility and general industry



Bio-methanol for chemicals, shipping and aviation



Renewable diesel and gasoline for trucks, buses and cars



The Solution

MIHG - Moving Injection Horizontal Gasification

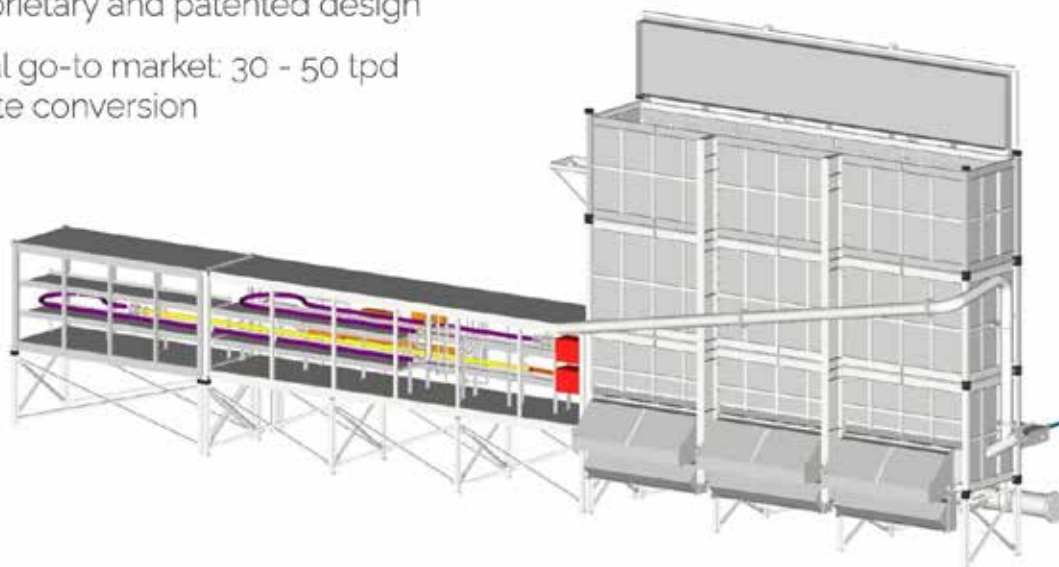




The MIHG Reactor

Proprietary and patented design

Initial go-to market: 30 - 50 tpd
waste conversion

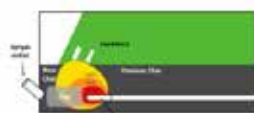


How It Works



Loading

- Batch loading via conveyor
- No sorting required



Conversion into Syngas

- Ramp up
- Moving injection process for 24 hr
- Ramp down



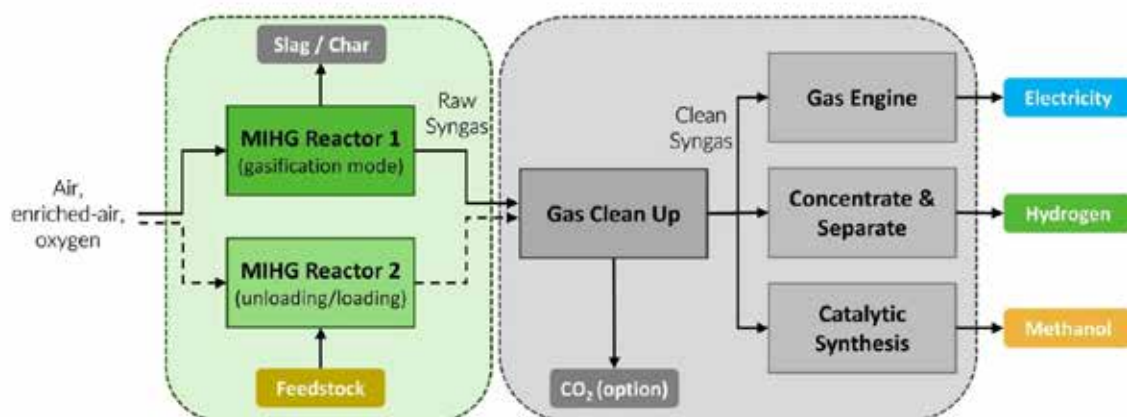
Unloading

- Cool down
- Unloading slag & biochar into bins
- Slag recycled



Project Integration

MIHG is the heart of any project



Solid feedstock is converted into syngas continuously by alternating operations between MIHG reactors 1 and 2



The MIHG Pilot Plant

Proven conversion of waste into electricity and hydrogen



OPTIONAL SLIDE

Key Benefits



No waste sorting



Low utilities usage



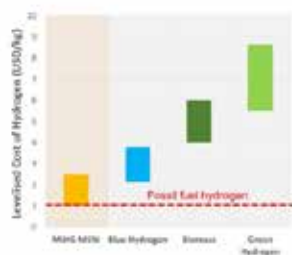
Low cost materials



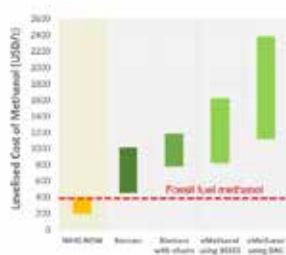
Modular design

Production Cost

Lowest cost option for sustainable fuels



Hydrogen 1 - 2 USD/kg



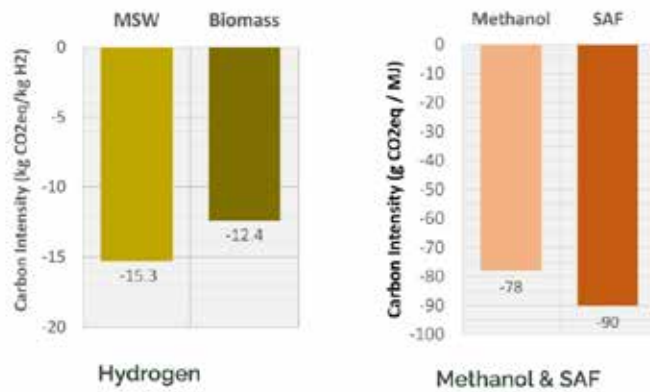
Methanol 200 - 400 USD/t

MIHG can produce sustainable fuels at levelised costs comparable with fossil fuels



Carbon Intensity

Net Negative Emissions



MIHG can produce sustainable fuels with net negative emissions



Bulwer Island Energy and Hydrogen Recovery Facility

- Process 40 - 50 ktpa waste into 4 - 5 MWe electricity, 3 MWt heat and 1 - 2 tpd of H₂
- Hydrogen for heavy mobility
- >30 ktpa of CO₂eq reduction



Partners

BOC
A Member of The Linde Group

ITOCHU



PURM
Bitumen





Bio-Methanol and Sustainable Aviation Fuel Project

- Distributed production of methanol and hydrogen from wastes
- Transport to centralised upgrading facility near Brisbane Airport
- Methanol converted into SAF
- Methanol could be used for shipping fuel as well



Partners



Conclusions



Hydrogen
1 - 2 USD/kg



Methanol
200 - 400 USD/t

Use MIHG technology to convert residual wastes into hydrogen and methanol at competitive costs with net negative emissions.



Country Day I : Australia Day

**Energy Estate – Innovation in Large Scale
Hydrogen Project in Australia**

Country Day I : Australia Day

Energy Estate – Innovation in Large Scale Hydrogen Project in Australia



Vincent Dwyer
CEO, Energy Estate

Education

- Bec, LLB, LLM USYD 1984-1988

Professional Career

- Senior Associate: Allens Arthur Robinson Sydney 1990 – 1994
- Senior Associate: Allens Arthur Robinson Singapore 1994 – 1998
- Partner: Gilbert + Tobin 2000 – 2010
- Partner, Head of Energy – Asia Pacific: Norton Rose Fullbright 2010 – 2018
- Co-Founder & CEO: Energy Estate 2018 - Current

Research Interest

Emerging Renewable Energy Technology & Systems.

Speech Title

“Energy Estate – Innovation In Large Scale Hydrogen Projects In Australia”

Speech Summary

An outline of the key hydrogen projects currently being developed by Energy Estate in Australia and elsewhere

Company Introduction

Energy Estate was established in early 2018 to accelerate the transformation of the energy sector and the decarbonisation of industry, and to be a vehicle to deliver global scale decarbonisation. 6 years later, with a deeply experienced and multi-disciplined team, we have established a portfolio of over 30GW of renewable energy, storage and green hydrogen projects with a strategically diversified range of technologies and industry partners. We have a portfolio of projects in Australia, NZ, US and Europe with teams in Sydney, Melbourne, Brisbane, Hong Kong and London

Energy Estate was one of the first renewable energy developers to put communities and regional economic development at the centre of our development principles



Energy Estate - Overview

Our team has a unique combination of a clear vision, with core competencies and skills, decades of experience and knowledge across the energy value chain. Our approach is to start with a customer driven analysis and to utilise a diverse range of technologies and infrastructure to create enduring net zero outcomes. We strongly value partnerships which help us achieve and accelerate our development goals

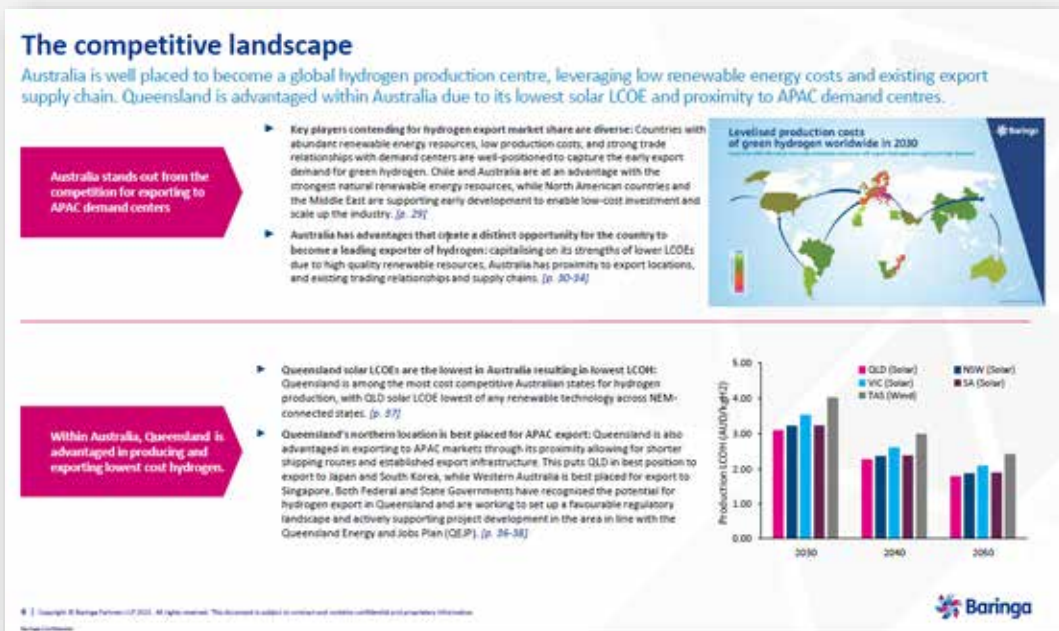
 Vertically integrated zero carbon energy portfolio focused on decarbonisation of the industrial supply chain and transition of the globe towards net zero	 Over 20GW of generation projects ¹	 Over 8.4GW of long-term duration storage projects ¹
 Extensive industry alliances and partnerships providing depth and breadth of technological and execution expertise, and accelerating and broadening route to market options for portfolio	 Over 8GW of electrolysis projects ¹	 Downstream end product optionality
 Unique multi-disciplined development team with intimate knowledge of renewable energy, infrastructure and hydrogen markets, and commitment to improving digital engagement and outcomes during the development, construction and operation life cycle	 4 large scale hubs	 Multiple additional development opportunities
 Customer-driven development methodology focused on meeting industry demands and achieving customer product needs, now and into the future		
 Recognised for putting local economic development outcomes at the heart of project development cycles and ensuring development principles embed the Sustainable Development Goals in all aspects of our business		
 Founded in 2018, and headquartered in Sydney, Australia , with teams in Sydney, Melbourne, Brisbane and London, and projects spanning across Australia and New Zealand. We have recently added team members in Hong Kong, Japan and the US.		

 **energy estate**

Queensland opportunities

 **energy estate**

Queensland - Globally competitive



HyNQ Project

The North Queensland Clean Energy Project (HyNQ) is a large-scale integrated renewable energy and hydrogen production project being developed by Energy Estate together with joint venture partners Idemitsu Renewable Developments Australia and IHI Engineering Australia and in collaboration with CS Energy. Located at the Port of Abbot Point the HyNQ project plans to produce circa 285 tpd of green hydrogen to support an export target of 500ktpa of green ammonia, with a target to commence operation prior to 2030. As a first moving project within the Abbot Point State Development Area HyNQ seeks to accelerate the clean energy transition in the region.

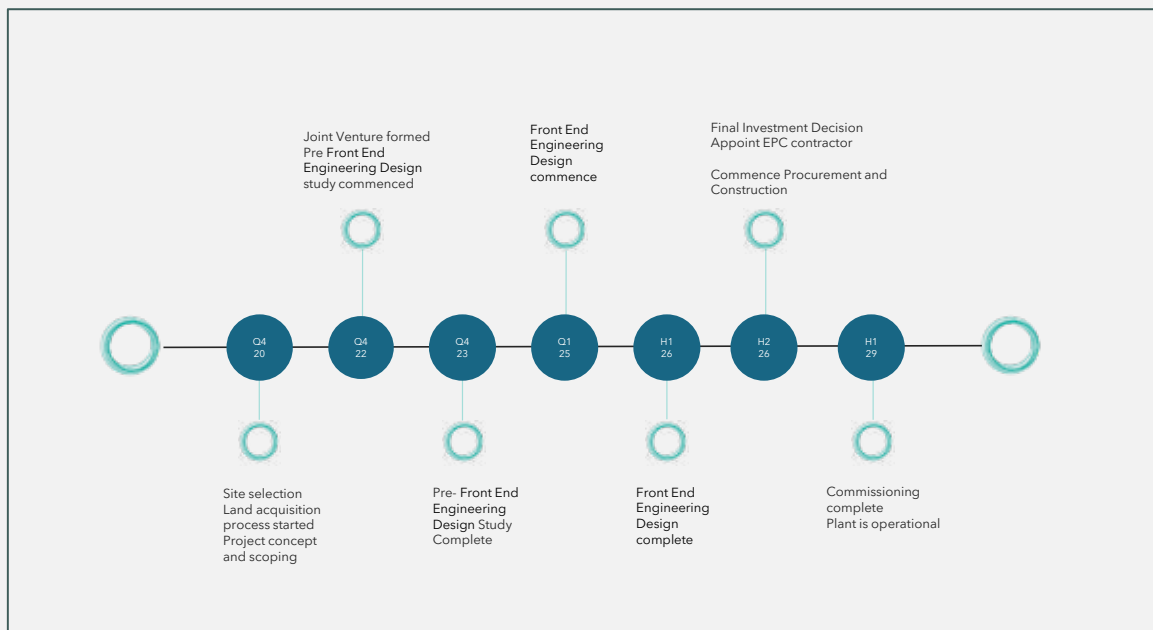


HyNQ - Project Layout

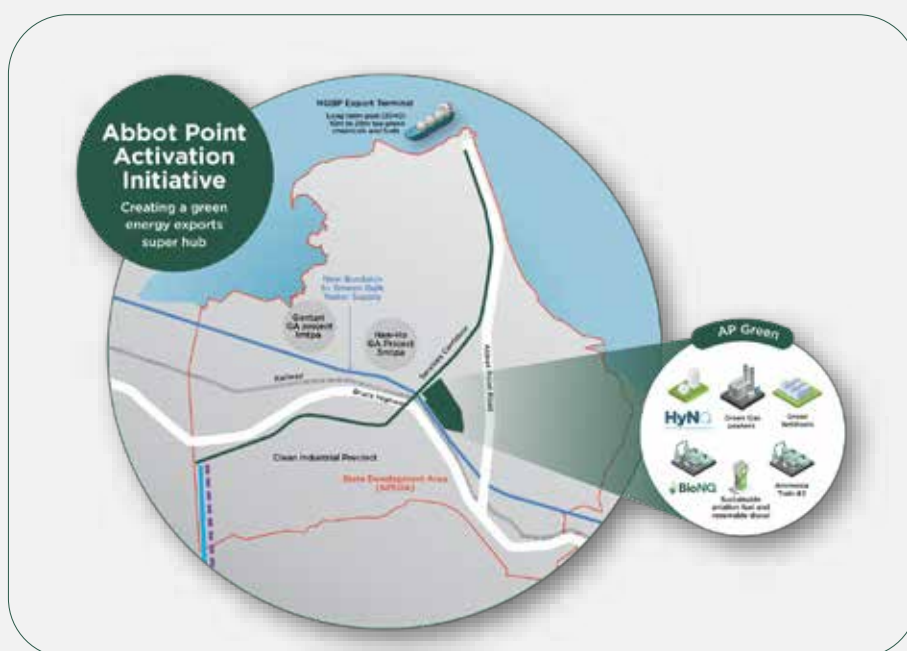


HyNQ
North Queensland Clean Energy Project

Indicative Project milestones

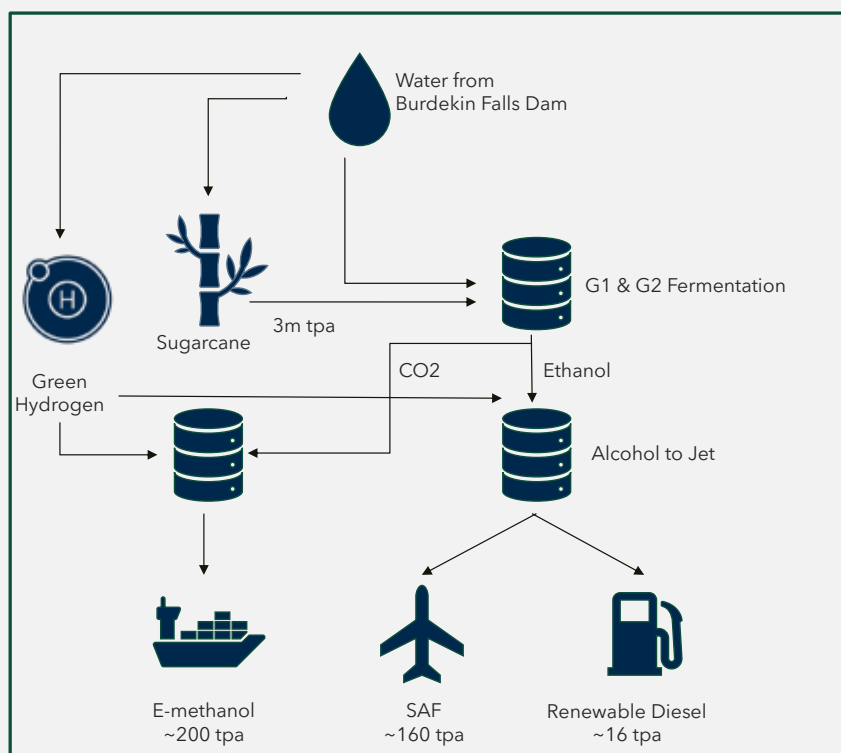


HyNQ
North Queensland Clean Energy Project



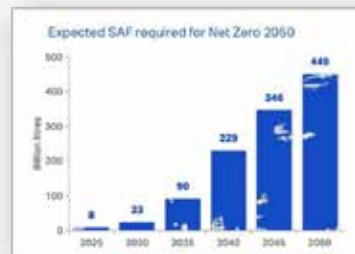


BioNQ – access to water creates industry



Advantages of BioNQ

	Production of large-scale biomass for use in producing high value energy products for the domestic Australian market and export markets.
	Large-scale existing infrastructure and biomass logistics for moving sugar cane for further processing to high value added SAF, methanol and/or urea.
	High-quality and reliable water from the Burdekin Dam/River for use in biomass production, industrial use and potable water supply
	Provision of cost-effective power and water for the hydrogen production required to support the production of SAF from biomass and the methanol plant operations with the benefit from the excellent behind the meter renewable power supply at Abbot Point.
	Flexible delivery of SAF and renewable diesel by train for local distribution and methanol via the Port of Abbot Point. The Bruce Highway and the main north coast railway line to both Townsville and Cairns are the important arteries adjacent to the Abbot Point biorefinery location



Country Day I : Australia Day

Opening Comment: West Australia

Country Day I : Australia Day

Opening Comment: West Australia



Jess Ahn

Investment and Trade Director,
Government of Western Australia, Seoul Office

Country Day I : Australia Day

**An opportunity to rethink commercial
hydrogen production**

Country Day I : Australia Day

An opportunity to rethink commercial hydrogen production



Conrad Mulherin

CCO, Vytas Ltd.

Education

- 2012, M.Sc., Resources Management, University College London, London & Australia
- 2010, B.Sc., Geologic Sciences, Queen's University, Canada

Professional Career

- 2024 - Present, Chief Commercial Officer, Vytas Ltd. Perth & Melbourne, Australia
- 2021 – 2023, Director, Critical Minerals & Energy Transition, PwC, Melbourne, Australia
- 2016 – 2021, Investment Manager, Pacific Road Capital, Sydney, Australia
- 2013 – 2016, Equity Research Analyst, Stifel / GMP Securities, Sydney, Australia

Research Interest

Alternative methods of hydrogen production
Heat capture and recycling
Materials recycling
Circular economy

Speech Title

Vytas presents an opportunity to rethink commercial hydrogen production

Speech Summary

Introduction to Vytas:

- Company background
- Overview of projects and products

Vytas' method of hydrogen production:

- Silicon hydrolysis: how it works and how it is differentiated from electrolysis
- Technology background

The advantages of on-demand hydrogen:

- Opportunities for deployment
- Opportunities to produce at lowest quartile costs
- Opportunities for energy security

Concluding remarks

- Next steps for Vytas
- Partnering opportunities

Company Introduction

Vytas is a founder-led, innovative Australian business commercialising production of multiple processing technologies that have the potential to disrupt the status quo and materially lower carbon footprints. Vytas is scaling production of nanoporous silicon and production of green hydrogen, using alternative and low-cost process methods.



Forward Looking Statements & Disclaimer



These presentation materials and any accompanying verbal presentation are confidential and have been prepared by Vytas Ltd (the Company). By receiving the Presentation Materials, you acknowledge and represent to the Company that you have read, understood and accepted the terms of this disclaimer. It is the responsibility of all recipients of these Presentation Materials to obtain all necessary approvals to receive these Presentation Materials and receipt of the Presentation Materials will be taken by the Company to constitute a representation and warranty that all relevant approvals have been obtained.

NOT AN OFFER

These Presentation Materials are for information purposes only. The Presentation Materials do not comprise a prospectus, product disclosure statement or other offering document under Australia law (and will not be lodged with the Australian Securities and Investment Commission). The Presentation Materials also do not constitute or form part of any invitation, offer for sale or subscription or any solicitation for any offer to buy or subscribe for any securities nor shall they or any part of them form the basis of or be relied upon in connection therewith or act as an inducement to enter into any contract or commitment with respect to securities.

NOT INVESTMENT ADVICE

The Presentation Materials are not investment or financial product advice (nor tax, accounting or legal advice) and are not intended to be used for the basis of making an investment decision. Recipients should obtain their own advice before making any investment decision.

SUMMARY INFORMATION

The Presentation Materials do not purport to be all inclusive or to contain all information about the Company or any of the assets, current or future, of the Company. The Presentation Materials contain summary information about the Company and its activities which is current as at the date of the Presentation Materials. The information in the Presentation Materials is of general nature and does not purport to contain all of the information which a prospective investor may require in evaluating a possible investment in the Company or that would be required in a prospectus or product disclosure statement or other offering document prepared in accordance with the requirements of Australian law or the laws of any other jurisdiction. The Company does not undertake to provide any additional or updated information whether as a result of new information, future events or results or otherwise.

FORWARD LOOKING STATEMENTS

Certain statements contained in the Presentation Materials, including information as to the future financial or operating performance of the Company and its projects, are forward looking statements. Such forward looking statements:

- Are necessarily based upon a number of estimates and assumptions that, while considered reasonable by the Company, are inherently subject to significant technical, business, economic, competitive, political and social uncertainties and contingencies.
- Involve known and unknown risks and uncertainties that could cause actual events or results to differ materially from estimated or anticipated events or results reflected in such forward-looking statements, and
- May include, among other things, statement regarding estimates and assumptions in respect of prices, costs, results and capital expenditure, and are or may be based on assumptions and estimates related to future technical, economic, market, political, social and other condition.

The Company disclaims any intent or obligation to publicly update any forward-looking statement, whether as a result of new information, future events or results or otherwise. The words 'believe', 'expect', 'anticipate', 'indicate', 'contemplate', 'target', 'plan', 'intends', 'continue', 'estimate', 'may', 'will', and similar expressions identify forward looking statements.

All forward looking statements contained in the Presentation Materials are qualified by the foregoing cautionary statements. Recipients are cautioned that forward looking statements are not guarantees of future performance and accordingly recipients are cautioned not to put undue reliance on forward looking statement due to the inherent uncertainty therein.

NO LIABILITY

The Company has prepared the Presentation Materials based on information available to it at the time of preparation. No representation or warranty, express or implied, is made as to the fairness, accuracy or completeness of the information, opinions and conclusions contained in the Presentation Materials. To the maximum extent permitted by law, the Company, its related bodies corporate (as that term is defined in the Corporations Act 2001 (Commonwealth of Australia) and the officers, directors, employees, advisors and agents of those entities do not accept any responsibility or liability including, without limitation, any liability arising from fault or negligence on the part of any person, for any loss arising from the use of the Presentation Materials or its content or otherwise arising in connection with it.

CONFIDENTIAL

The contents of these Presentation Materials are confidential. These Presentation Materials are being provided to you on the condition that you do not reproduce or communicate them or disclose them to, or discuss them with, any other person without the prior written consent of the Company.

CONFIDENTIAL

2

Introduction to Vytas



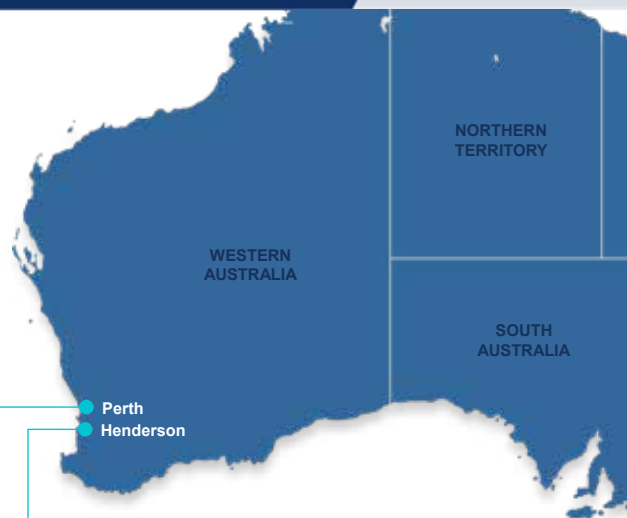
- Innovative Australian-based business commercialising production of multiple technology materials that have the potential to lower costs and decarbonise production of silicon, silane and hydrogen, accelerate the global energy transition and race to net zero
- 100%-owns +3,000km² of tenements hosting unique geological deposits of high-purity quartz

1. ULTRA HIGH PURITY QUARTZ (UHPQ) & SYNTHETIC SILICA
2. CARBON FREE NANOPOROUS SILICON & SILANES
3. GREEN HYDROGEN ON-DEMAND

- Vytas has developed its processes at its in-house lab in Perth, Western Australia
- Currently commercialising and scaling process technologies
- Actively seeking development partners across Silicon, Silane and Green Hydrogen strategies

Vytas Head Office and Lab

Pilot & Testing Facility



CONFIDENTIAL

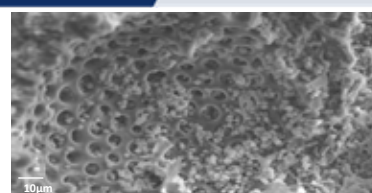
3

Multiple industrial and green technology products



GEOLOGICALLY UNIQUE SOURCE MATERIAL OPENS UP NOVEL PROCESSING PATHWAYS:

- Vytas 100% owns multiple deposits along the west coast of Western Australia having unique geological characteristics, **notably naturally occurring nanoporosity**
 - A 3cm sphere of 'lumpy' quartz (traditional feedstock material) has an approximate surface area of 28cm². The surface area of Vytas' nanoporous material averages 250m² per gram and is up to 500m² per gram – **orders of magnitude difference**
- Vytas holds largest tenement packages that it believes equates to multiple decades of production
- Vytas's silica resources are the source material for multiple product lines at varying stages of commercialisation



Scanning electron microscope (SEM) image of Vytas' nanoporous silica to silicon material

HPQ & UHPQ		Synthetic Silica		Silicon (battery grade)		Silane		Green Hydrogen	
Product:	Traditional HPQ and UHPQ product	Product:	Low cost, low carbon, high-purity synthetic silica	Product:	Low cost, low carbon nanoporous silicon (powered, battery grade 2N)	Product:	SiH ₄ gas	Product:	Low-cost hydrogen produced "on-demand", at point of use
Market:	Targeting crucible manufacturers in China and other Asia; optical fibre; solar industry	Market:	Sodium and potassium silicate industrial markets; crucibles; solar industry	Market:	Silicon battery anodes for Li-ion batteries; source material for H ₂ production	Market:	Polysilicon, solar cell, semiconductor supply chain; miscellaneous industrial	Market:	Green hydrogen industry
Status:	Batch-scale production, offtake discussions	Status:	Lab-scale production; process flow sheet engineering	Status:	Pilot plant development, product qualification with offtakers; fundraising	Status:	R&D	Status:	Lab-scale production; commercialisation; fundraising; industry discussions

CONFIDENTIAL

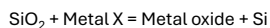
4

Low-cost, low-carbon processing technologies are a potential game-changer



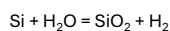
METALLOTHERMIC REDUCTION TO PRODUCE SILICON:

- Silicon (Si) is produced from nanoporous silica (SiO₂) in a furnace, whereby the silica is mixed with a metal reagent and the metal bonds with the O₂ forming a new metal oxide, isolating Si.



SILICON HYDROLYSIS OF HYDROGEN: TECHNOLOGY BACKGROUND

- Silicon hydrolysis to produce green hydrogen is the process whereby nanoporous silicon is added to water in a reactor causing the Si to bond with O₂, isolating H₂ which is released as a gas.



- Silicon material **must have** high nanoporosity
- The reaction is **highly exothermic** and produces ample heat
- The obstacle to wider adoption in the 1900's of "on demand" hydrogen was the cost of silicon production from the traditional carbothermic silicon process, and reaction times of Si in H₂O to produce hydrogen.

➤ VYTAS' NANOPOROUS SILICON OVERCOMES THESE CHALLENGES

¹ – Brack et al (2015), Energy Science & Engineering, An old solution to a new problem?

CONFIDENTIAL

Silicon production



Metallothermic Reduction

- 300 - 650°C (lower energy requirements)
- Metal reductant required (e.g. not a carbon input)
- No carbon by product
- Metal-oxide can be recycled and reused
- Significantly reduced carbon footprint of silicon product

Current industry standard:

Carbothermic Reduction

- 2000 – 3000°C (very high energy requirement)
- Carbon input required (low ash coal, or charcoal)
- Carbon byproduct (CO₂)

Hydrogen production



Silicon hydrolysis of water

- Green hydrogen produced 'on-demand', eliminating storage and transport logistics of H₂
- Established technology with US military application
- Highly exothermic reaction, creating circular opportunities

Current industry standard:

Electrolysis

- Complexity with storage and logistics
- Endothermic reaction
- High capex

5

Vytas' process is built on established technology



PROVEN PROCESS OF HYDROGEN PRODUCTION FROM SILICON

- Hydrogen production from nanoporous silicon is a well-established chemical process, with +100-year proven track record

VYTAS HYDROGEN PRODUCED AT LINCOLN LABORATORIES

- Lincoln Laboratories at the Massachusetts Institute of Technology (MIT) on behalf of the Office of Naval Research (ONR) have pursued a similar hydrogen-production technology using nano-porous aluminium
- Vytas worked with Lincoln Laboratories to optimise the Vytas process using nano-porous silicon



https://www.youtube.com/watch?v=TYRiJU_lo0

<https://www.youtube.com/watch?v=EZIWQIQwvBI&t=1063s>

CONFIDENTIAL



Green Hydrogen On Demand from a simple process flow sheet



Nanoporous silicon

- Vytas is producing nanoporous silicon (2N) which is feedstock for hydrogen production
- Vytas is developing a Nanoporous Silicon Pilot Plant in Henderson, WA



Hydrogen Reactor (Si Hydrolysis of H₂O)

- Hydrogen reactor equipment is 'off-the-shelf' and adaptable to a variety of project sizes
- 1 tonne Si powder produces ~140kg of H₂ at 100% utilisation



*Representative example of hydrogen reactor that could be used in Vytas' hydrogen production.

Hydrogen Fuel Cell (H₂ to energy)

- Vytas has initially pursued application with fuel cells but recognises there is potential with other industrial and energy generation applications
- 1kWh and 5kWh fuel cell sizes in first instance



CONFIDENTIAL

7

Vytas's Green Hydrogen production vs. Electrolysis



Vytas On-Demand Green Hydrogen		Electrolysis
✓ Whole-of-system energy requirements of 50KWh/kg H ₂ . Vytas is working to lower this. Theoretically 4.1KWh/kg can be achieved. Can be initiated by electricity or waste heat.	⚡	- Whole-of-system energy input of 90-100KWh/kg H₂. - Must be electrical input.
✓ No PFAs ✓ No strong acids/bases ✓ No carbon	☠	- PFAs in electrolyser construction that break down with use. - Potassium hydroxide in the water (strong base) - Conflict minerals for the electrodes
✓ H ₂ produced immediately prior to consumption. Removing challenges with pressure, temperature or volatile gas.	⚓	- High temperature, high pressure - Volatile gas - Ammonia method of storage can be harmful to marine environment
✓ Hydrogen is not required to be stored as it can be created immediately before use. ✓ 210kg of hydrogen equivalent can be stored in 1m³ of Si at room temperature and pressure.	🏠	- Hydrogen requires specialised materials for storage and transport at specific temperature and pressure. - Life cycle loss of H₂ from transport/storage is estimated to be 2-5% daily.
✓ With minimal management, any quality water can be used as an input.	💧	Nearly all commercial electrolysis operations require ultra-pure water.
✓ Lowest quartile production costs	💰	Highly varied depending on electricity supply and Balance of Plant (BoP).

CONFIDENTIAL

8

Vytas' hydrogen production creates circular economy outcomes



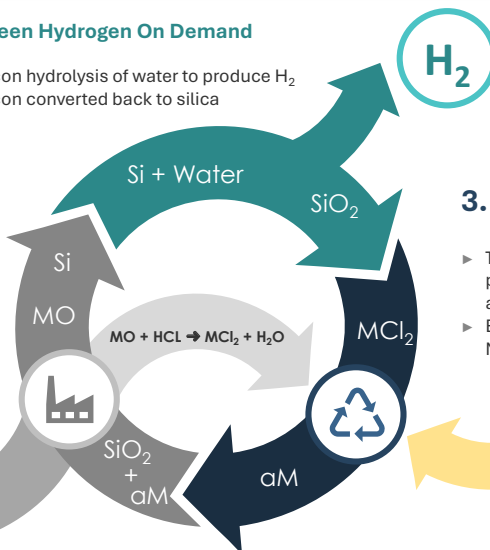
2. Green Hydrogen On Demand

- Silicon hydrolysis of water to produce H₂
- Silicon converted back to silica

1. Metallothermic Reduction

- Silica (SiO₂) to Nanoporous Silicon (Si)
- Exothermic reaction (recovered energy supplies all the energy required for the reaction)
- Key reactant is an activate Metal (aM)
- Activate Metal is Oxidized to metal oxide (MO)

Silica extracted from Vytas' deposits



3. Metal Oxide Circular Economy

- The Metal Oxide is leached from the product of the Metallothermic Reduction as Metal Chloride Crystal (MCl₂)
- Electrical Reduction of Metal Chloride to Metal using green electrical energy

CONFIDENTIAL

9

Time to engage is now



Vytas is at an exciting company juncture: ground-breaking process technology has been developed with commercialisation accelerating the potential to disrupt the status-quo and cost profiles of nanoporous silicon and green hydrogen

NANOPOROUS SILICON

- ✓ Nanoporous silicon pilot plant in development
- ✓ Product qualification processes underway with anode industry and National Battery Testing Centre

HYDROGEN SCALE-UP

- ✓ Moving beyond lab-scale production, scoping 50kW demonstration plant, deployable prototype in development
- ✓ Continued R&D around heat capture and recycling and other cost optimisation areas
- ❖ Vytas's H₂ production generates significant waste heat that can be re-purposed. Vytas's reactor technology partner is designing a system to produce potable water as a by-product

ACCELERATING COMMERCIAL-SCALE PRODUCTION THROUGH STRATEGIC INDUSTRY PARTNERSHIP

- ✓ Vytas is actively engaged in commercial discussions in Australia and international markets, while continuing to seek technology and development partners to scale production
- ✓ Vytas believes its unique method of hydrogen production will be a leading, low-cost method in a variety of production methods as the world moves to a hydrogen economy.
- ✓ **NOW** is the opportune time to partner

CONFIDENTIAL





Vytas Ltd:

Conrad Mulherin
Chief Commercial Officer

E: conrad@vytas.com.au
M: +61 450 440 720

Country Day I : Australia Day

**Introduction to InCapture and Greenhouse Gas
Assessment Permit Area G-15-AP NWS Australia**

Country Day I : Australia Day

Introduction to InCapture and Greenhouse Gas Assessment Permit Area G-15-AP NWS Australia



Julia Davies

General Manager, Incapture

Education

- 2010 Executive MBA, Lausanne Switzerland
- 1987-1989; MSc., Geology, Birkbeck University London. UK
- 1981-1984; BSc., Geology, University College Cardiff. UK

Professional Career

2020-Present; Carbon Capture & Storage, InCapture, Australia.
2016-2020; Exploration Oil & Gas, Discover Geoscience, Australia.
2006-2015; Oil & Gas Exploration & Business Development, OMV, Europe, FSU & Middle East.
2000-2006; Oil & Gas Exploration, Woodside, Australia & Libya.
1995-2000; Oil & Gas Exploration & Operations, Australia.
1984-94; Exploration Geoscience Oil & Gas Operators UK, Africa & SE Asia.

Research Interest

Carbon Capture Technologies, Legislation & Transportation

Speech Title

Introduction to InCapture and Greenhouse Gas Assessment Permit Area G-15-AP NWS Australia

Speech Summary

G-15-AP has recently been awarded to InCapture Pty Ltd and their Joint Venture Partners SK Earthon of Korea and CCQ of Western Australia. The Permit Area lies 120kms offshore the Burrup Peninsula, considered a prime future industrial and green energy corridor.

The technical work carried out to date is considerable and initial results indicate the area allows a rapid assessment program which if carried out effectively and supported by the required and legislated regulatory approvals may allow an early 2030's operational timeframe for sequestration and permanent storage. The Joint Venture Partnership considers the Permit Area offers global-scale storage sites with the potential for considerable upside. InCapture and their partners proudly consider this project one of Australia's' first "Green CCS Projects"

Company Introduction

InCapture Pty Ltd (InCapture) is a privately owned company based in Western Australia. InCapture forms part of the Longreach Capital Investment Group.



Disclaimer & Copyright



- This Presentation has been prepared by InCapture
- Forward looking statements
 - This Presentation contains certain “forward-looking statements”. The words “expect”, “should”, “could”, “may”, “predict”, “plan” and other similar expressions are intended to identify forward-looking statements. All statements in this presentation other than statements of historical fact, are forward-looking statements, which are subject to a number of risks, uncertainties, and assumptions that are difficult to predict and are based upon assumptions as to future events that may not prove accurate. These factors include InCapture’s reliance on a cyclical industry and principal customers; InCapture’s ability to continue to expand markets for licensing of data, and InCapture’s ability to acquire and process data products at costs commensurate with profitability. Actual results may differ materially from those expected or projected in the forward-looking statements. InCapture undertakes no responsibility or obligation to update or alter forward-looking statements for any reason.
- Copyright
 - The presentation, including all text, data, photographs, drawings and images (the “Content”) belongs to InCapture Pty Ltd and/or its subsidiaries (“InCapture”) and may be protected by Australian, U.K., and international copyright, trademark, intellectual property and other laws. Accordingly, neither the whole nor any part of this document shall be reproduced in any form nor used in any manner without express prior written permission by InCapture and applicable acknowledgements. In the event of authorized reproduction, no trademark, copyright or other notice shall be altered or removed. © 2024 InCapture Pty Ltd. All Rights Reserved.

Project Highlights

- First mover advantage on one of Australia's first green CCS project
- Burrup Peninsula location – prime future industrial and green energy corridor
- Rapid assessment program with potential early 2030s operational timeframe
- Global-scale storage sites with >3 million tonnes of CO₂ storage per annum and considerable upside potential
- Successfully awarded G-15-AP on 6th August 2024 with a 3 Year Primary Work Program



Our project is Australia's first potential carbon sequestration site that does not promote, rely, nor prolong oil and gas projects



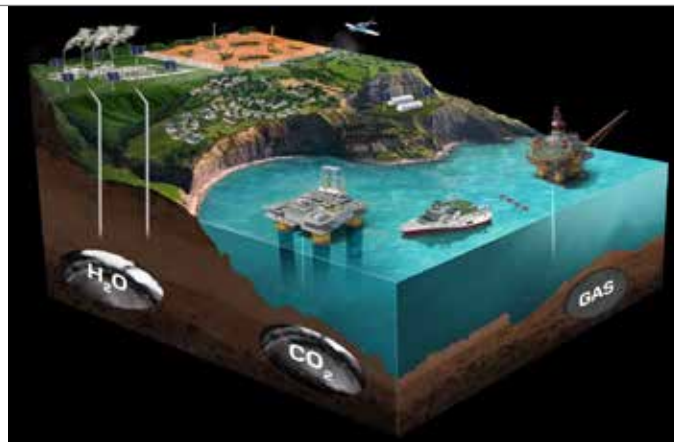
Our project is located in a prime future industrial and green energy corridor with access to South-East Asian region emissions sources



Project trajectory for rapid maturation to meet emitter's 2030 and 2050 climate objectives

Corporate Overview

InCapture: a privately owned company based in Western Australia, forming part of the Longreach Capital Investment group.



~ 53% shareholder



Publicly listed ASX energy exploration company with a strong reputation as an efficient and successful explorer in Australia and UK.



Beagle No. 1 is the operator of petroleum exploration permit WUK-540-F on the North West Shelf, WA.



InCapture engages for and develops carbon sequestration sites around Australia and the world to help the world achieve its net-zero goals.



Theia Energy's vision is to produce affordable clean energy, ensuring energy security and a sustainable economy in the northwest of Australia.



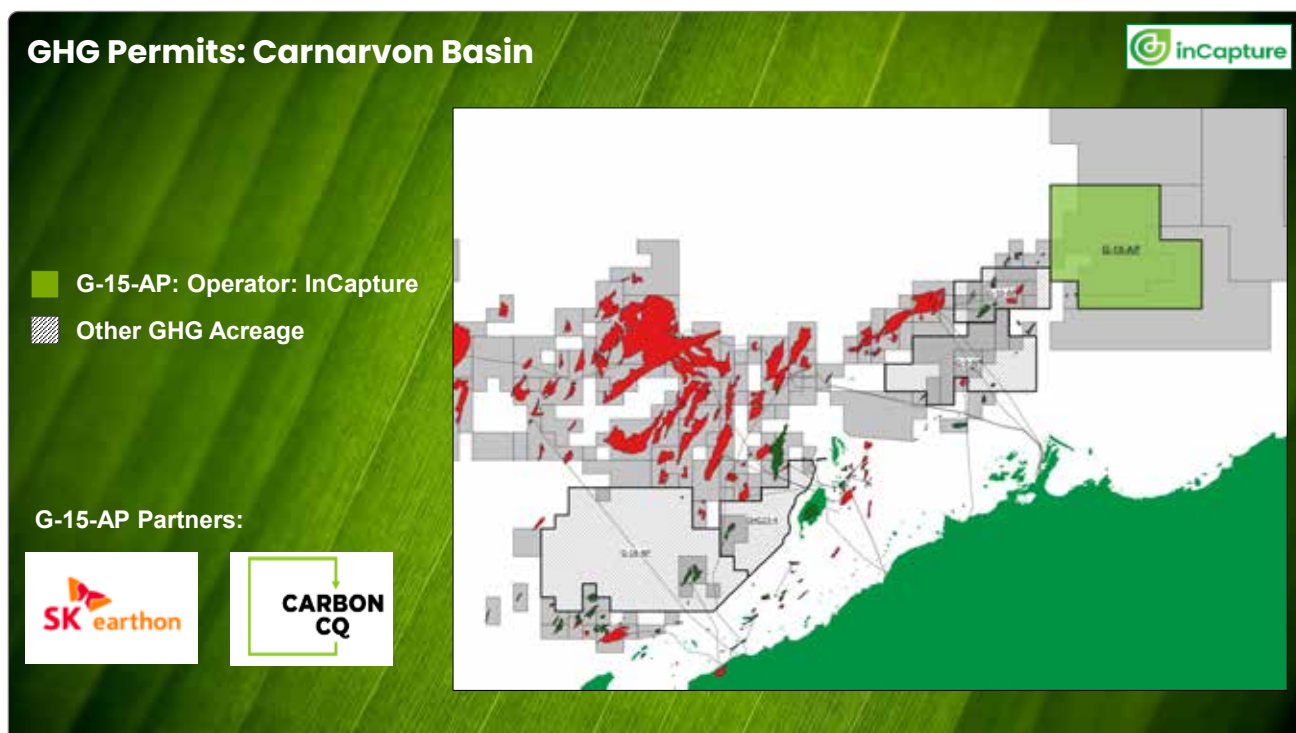
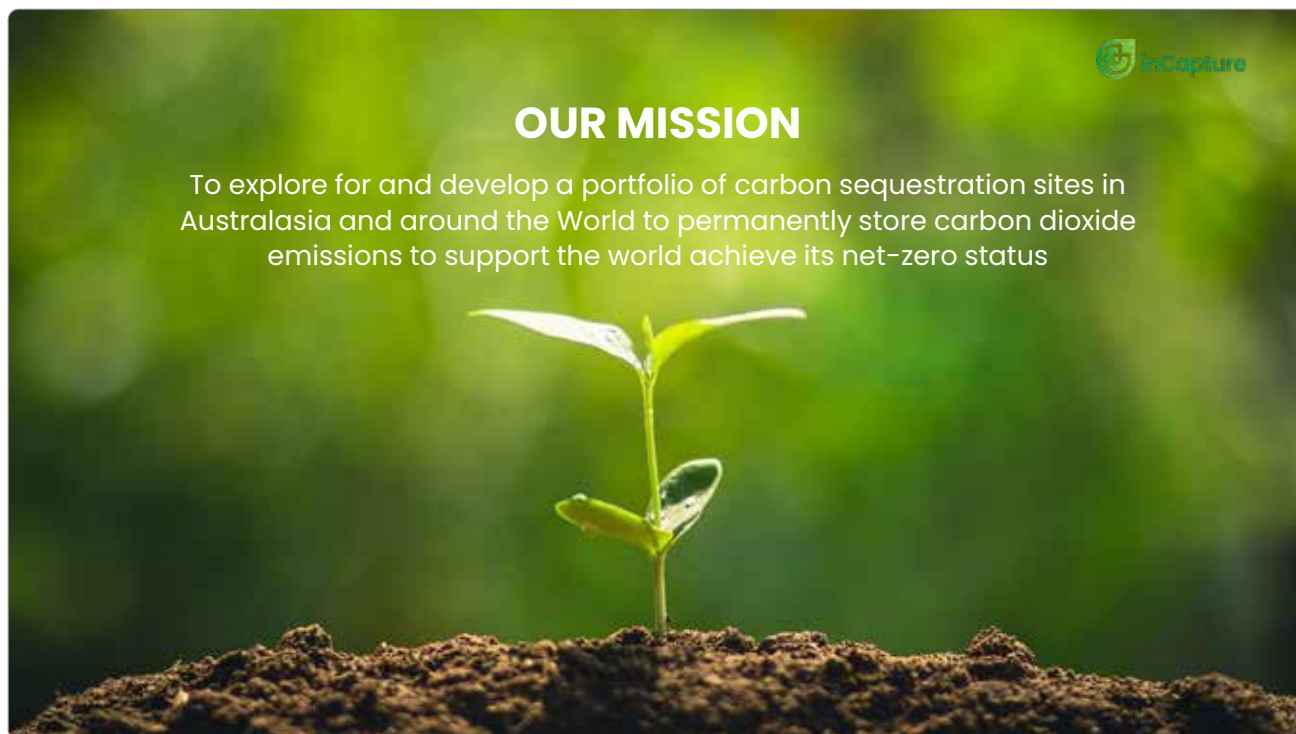
Creating value through innovative exploration for Critical Metals in Australian frontier basins.



A leading subsurface consultancy which provides expert subsurface information to the global energy industry through its O&G team of highly experienced geoscientists.



Multiphase service company providing subsurface data and leading edge tech to the global energy & resource industry.



G-15-AP: CO₂ Sequestration Project

Offshore Australian Commonwealth Waters site location:

- Regulatory frameworks in place
- Close to multiple emitters across the Pilbara
- Close to Asian emitters
- Located within a geological basin identified by Geoscience Australia as being "highly suitable" for geological storage of CO₂

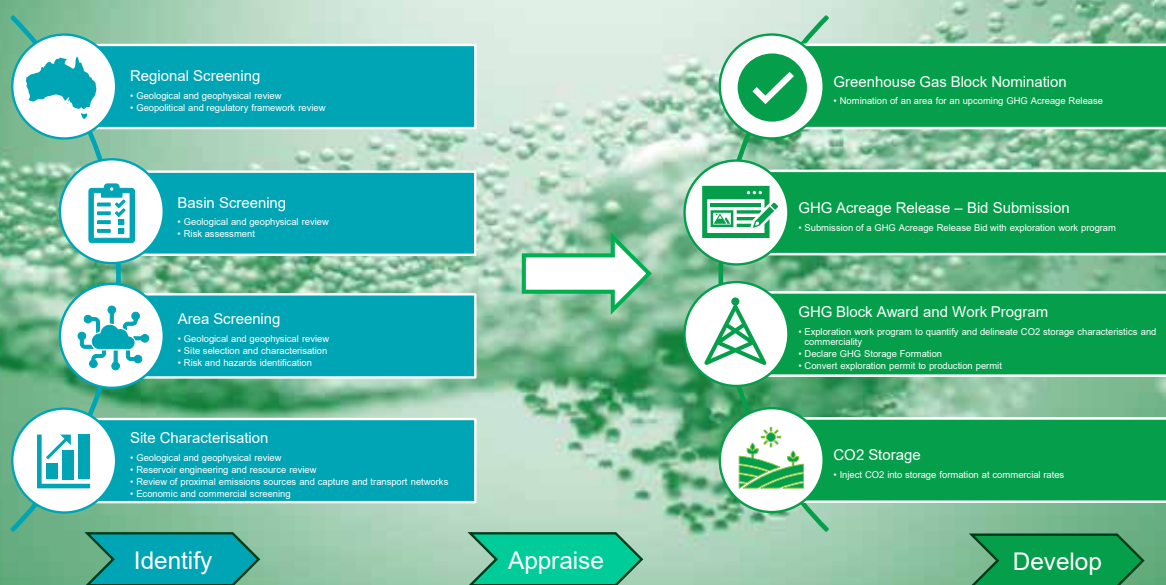


InCapture has:

- An extensive geological and geophysical database over the area of interest
- Decades of working geological expertise in the area
- Proven experience:
 - Exploration
 - Operations
 - Permit management

- Highly Suitable for geological storage
- 2D Seismic
- 3D Seismic
- G-15-AP

Our CCS Screening Workflow



G-15-AP Work Program and Project Milestones



Primary Term Work Program by Category	
2D Seismic Reprocessing	
2D Seismic Interpretation	
Regional Geological Review	
Core Analysis	
Petrophysics	
Geomechanics	
Static Geological and Plume Modeling	
Reservoir Engineering studies	
Dynamic Geological and Plume Modeling	
Well Engineering and Planning	
Risk and Uncertainty Management	
Measurement, Monitoring & Verification Planning	
3D Seismic Acquisition Planning	
Development Concept Engineering	
Project Technical and Engineering Studies integration	

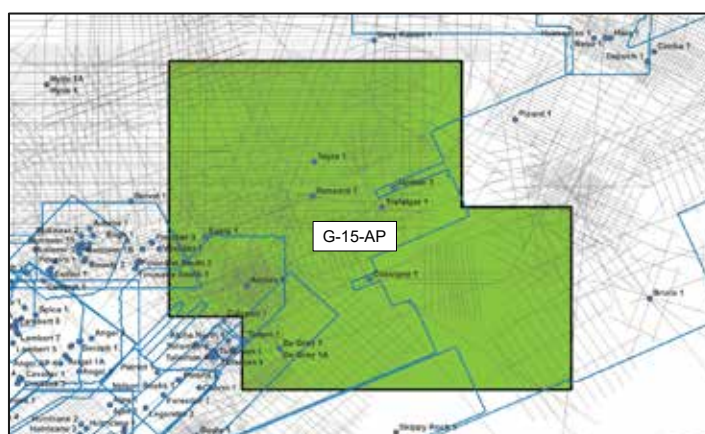
Contingent Work Program by Category	
Drilling of One Appraisal Well and Two Appraisal Well Injection Tests	
License 1000 km ² 3D seismic data and processing	
Seismic and Drilling Environmental Planning and Stakeholder Consultation	
Technical Supporting studies	

Well and Seismic Coverage



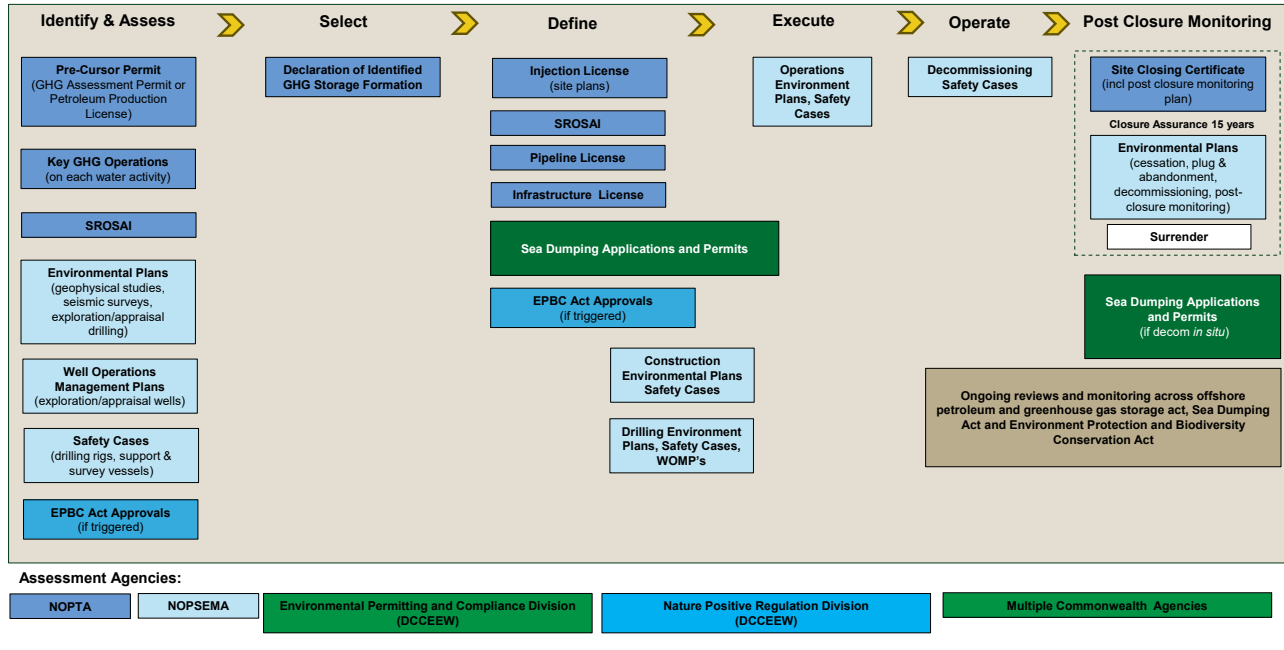
- Legacy 2D (1969 - 2001) ~10,000 km
- Legacy 3D (1997 - 2013) ~3000 km²
- 10 petroleum exploration wells within the permit
- Considerable analogue wells and fields

Year	Well Name	Operator	Water Depth (m)	TD (mMDKB)	Age at TD	Well Result	Additional Information
1971	De Grey-1	BOCAL	95	2088	Early-Mid Triassic	Dry	No shows
1972	Cossigny-1	BOCAL	113	3203	Early-Mid Triassic	Dry	No shows
1972	Sable-1	BOCAL	11	3971	Late Triassic	Dry	Minor shows and fluorescence in Early Jurassic
1973	Ronsard-1	BOCAL	160	2848	Early Jurassic	Dry	No shows
1978	Jarman-1	Woodside	134	2906	Mid Jurassic	Dry	Weak fluorescence near TD
1988	Trafalgar-1	AmpolEx	124	2743	Mid Jurassic	Dry	No shows
1990	Aurora-1	Marathon	113	3022	Mid Jurassic	Dry	No shows
2001	Teyra-1	Woodside	198	2907	Mid Jurassic	Gas Show	Minor gas in Legendre Fm



Excellent coverage of 2D/3D seismic and well data

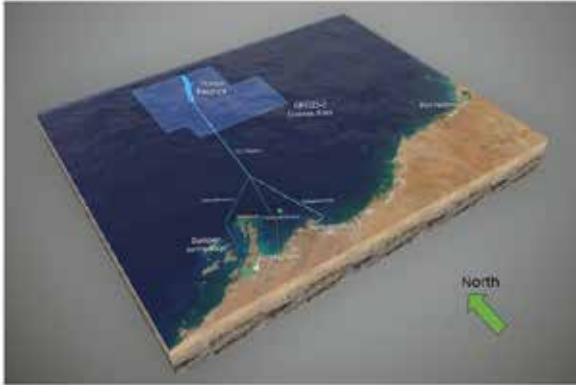
Offshore CCS Commonwealth Regulatory Approvals Mapping



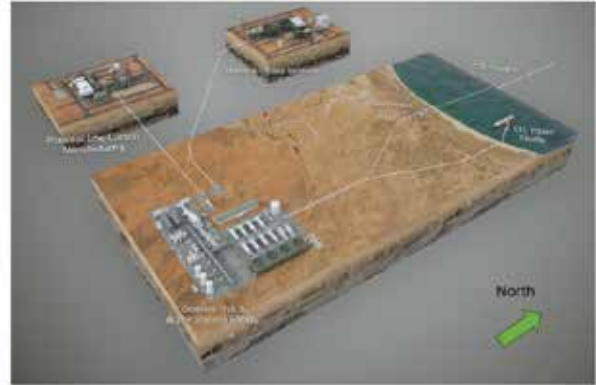
Burrup CCS Hub Concept



Hub Concept Development Design Concept



Project Overview Schematic with Pipeline Concept



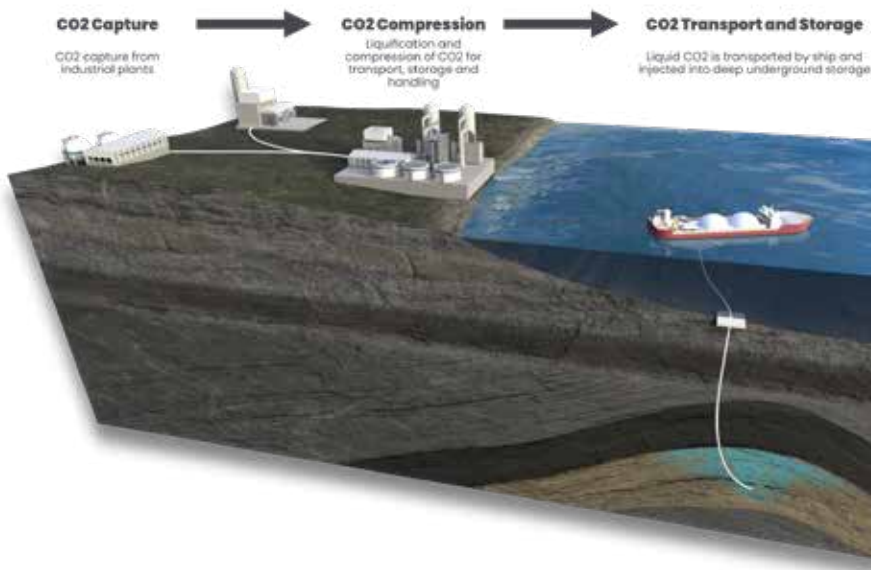
Schematic of Onshore facilities for the Hub Concept with CO₂ Import Terminal

Capture of GHG	- Local emitters require GHG capture - Imported CO₂ will be received at shore via either a Jetty or Pipeline End Termination (PETM)
Processing and Compression	- Onshore processing and storage - Compression to pipeline inlet pressure
Transport	- Subsea pipeline from shore to a location over the storage target - Pipeline is likely to be in Carbon Steel
Injection	- Direct injection via either: - Offshore minimum facility NUI platform, or - Subsea wellhead(s)

Summary of Very High-Level Reference Case Development Design Concept

Consultant Case Studies

Liquid CO₂ Carrier Shipping Option



Cross Border Transportation

High Level Concept



The Vision

- Investment in one of Australia's green CCS projects located within a future industrial and green energy growth corridor.
- Potential early 2030's operational timeframe.
- Access to APAC library of Geoscience datasets allowing us to build a portfolio of CO₂ Sequestration Sites.
 - World-class CO₂ sequestration site.
- Engaging with Australia and Asian emitters.
- Aligned with Industry & CCS specialists who bring expertise, ability and a need to sequester CO₂ emissions.



Contact: info@incapture.com.au

Country Day I : Australia Day

Opening Comment: South Australia

Country Day I : Australia Day

Opening Comment: South Australia



David Connolly-Hay

Department of State Development (Invest SA),
Business Development Manager, Government of
South Australia

Education

· 2011-2014, Bachelor of Management, University of South Australia

Professional Career

2008 – current: Working across multiple sectors within the South Australian Government, David is a career business development professional assisting project proponents deliver successful outcomes in South Australia. This includes the provision of bespoke case management, consultancy and advocacy. David works in multiple sub-sectors of renewable energy and mining, focusing on resources, fuels and clean technologies.

Speech Title

South Australia – State Prosperity Project

Speech Summary

South Australia's renewable energy transition and green hydrogen ambitions.

Company Introduction

Leading the clean energy transition, the South Australian Government has a dedicated team of investment and business professionals that can connect you with opportunities, industry networks, and other agencies to assist in the delivery of successful projects delivery.

The South Australian Government is committed to delivering sustainable economic growth, and a resilient economy through the development of innovative and productive businesses and industries in South Australia.

Country Day I : Australia Day

**Green Cement:
Achieving Net Zero in Regional South Australia**

Country Day I : Australia Day

Green Cement: Achieving Net Zero in Regional South Australia



Craig Cresp

General Manager Operations, Hallett Group

Education

- 2010 – Diploma of Project Management
- 2004 – Diploma of Civil Engineering (Design)

Professional Career

- Nov 2022 – Current: General Manager Operations, Hallett Group
- Mar 2019 – Nov 2022: Head of Capital Projects, Liberty Primary Steel
- Jan 2018 – Mar 2019: Senior Project Manager, McMahon Services
- Aug 2012 – Dec 2017: Project Superintendent SCM
- Jan 2002 – Aug 2012 – Various Engineering Design Roles, regional South Australia, Adelaide and London, UK

Research Interest

Regional economic growth

Speech Title

Green Cement: Achieving Net Zero in Regional South Australia

Speech Summary

Achieving Net Zero is a goal for many industrial sectors and the Hallett Group is no different. Our focus is to be Net Zero by 2050. Our Green Cement Processing Hub in Port Augusta, South Australia is a regional location with a population of 14,000 people. We are uniquely positioned with our abundance of land, sun and wind, coupled with well-established Transmission infrastructure that was first constructed in 1950's with the first power station in Port Augusta, Playford A Power Station. Through multiple expansions, the Port Augusta Power Station assets generated base load electricity for South Australia for over 60 years when it was closed in 2016. One legacy it left was 20 million tonnes of Fly Ash, left dormant in the Ash Storage Area, a 276-hectare site. The Hallett Group are building a Green Cement Processing Hub adjacent the storage area and will reclaim the full 20 million tonnes of fly ash over a 40 year period creating a locally manufactured supplementary cementitious material for use in cement, providing a lower carbon cementitious material to the market. Couple the manufacture of the SCM with renewable energy and alternate fuel sources like Hydrogen, we intend to operate green and manufacture green.

Company Introduction

Hallett Group is the largest integrated supplier of building, construction and mining materials in South Australia. With a history going back 40 years, employing over 500 people, we are deeply engaged in the communities we operate in.



Green Cement Transformation Project

Port Augusta, South Australia

September 2024



The Hallett Group



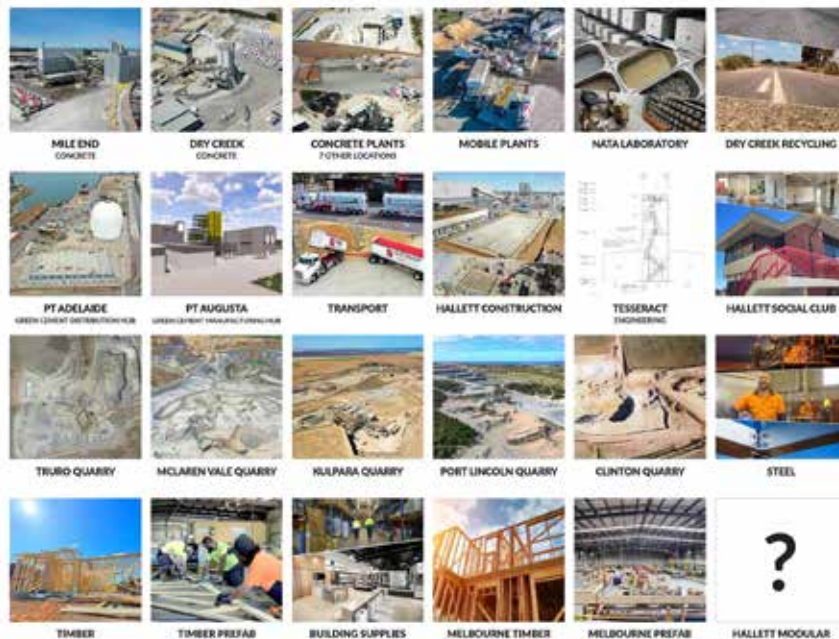
Hallett Group

Hallett Group is an integrated supplier of building, construction and mining materials and services.

With a history going back 40 years, we are proudly 100% SA owned and operated employing over 500 South Australians.



Hallett Operations



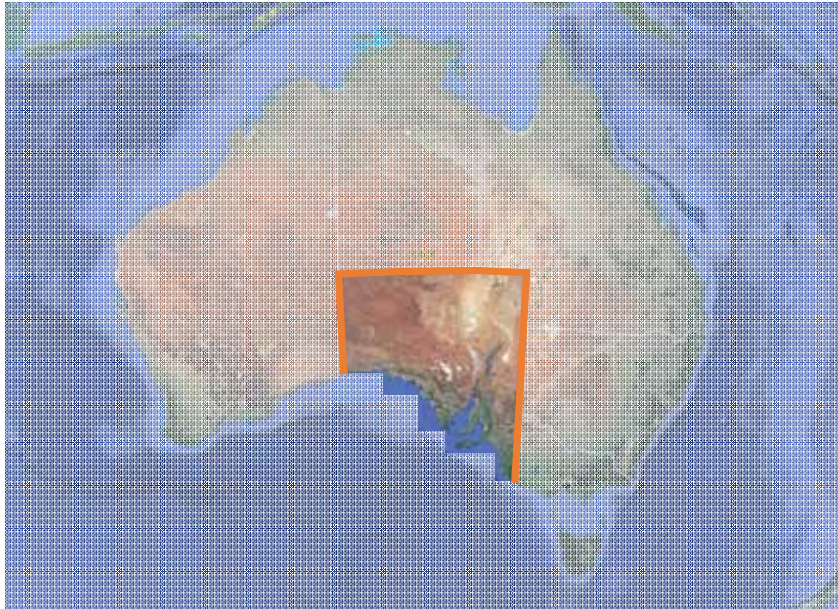
Green Cement Processing Hub Port Augusta, South Australia



Australia



South Australia



Port Augusta, South Australia



The City of Port Augusta



- Population of ~14,000 people
- Uniquely located at the top of Spencer Gulf
- Also, the Crossroads of Australia for Road and Rail
- With the incredible backdrop of the Flinders Ranges



The City of Port Augusta



The City of Port Augusta – Energy History



Photo provided By Government of South Australia

- Playford A Power Station commissioned in 1954 (90MW)
- Playford B Power Station commissioned in 1963 (240MW)
- Northern Power Station commissioned in 1985 (520MW)



The City of Port Augusta – Energy History

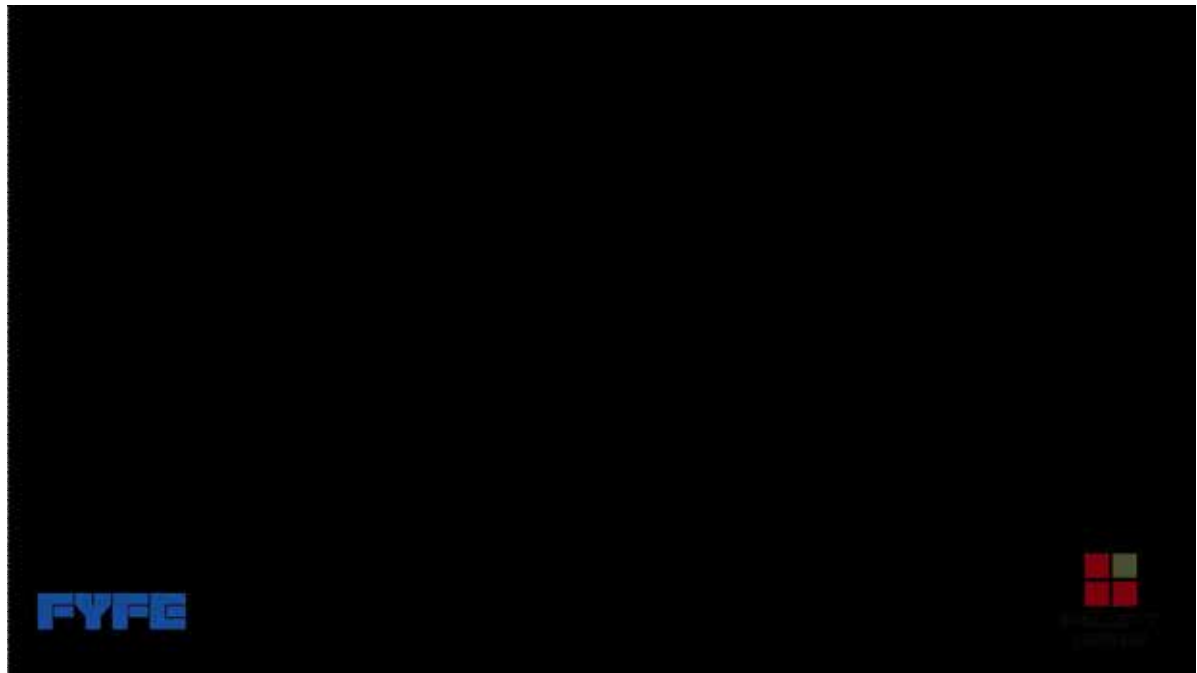
- During the 62 years of operation, the power stations provided 40% of states base load power
- The fuel for these three power stations was Brown Coal, mined from the Leigh Creek mine 280km north of Port Augusta
- Close to 100Mt of Brown Coal was mined from Leigh Creek during its 72-year operational life
- Post closure of the power stations and mine, the sites were remediated to the acceptable standard defined by the relevant authorities
- However, the legacy of 60+ years of operation of the power stations is still evident on the landscape

The City of Port Augusta – Energy History

- One residual outcome of burning coal is the production of Flyash
- In most cases, this Flyash is deposited into tailings dams or ash storage areas
- For Port Augusta, this is in the form of a 276-hectare ash storage area leaving a dormant legacy containing 20Mt of Flyash
- Hallett intend to now make use of the ash and manufacture Green Cement



Green Cement Processing Hub Port Augusta, South Australia



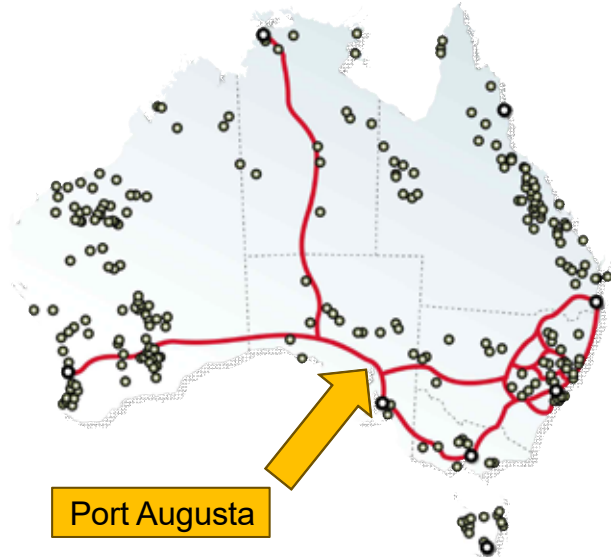
Green Cement Flow Sheet



Green Cement Processing Hub



Port Augusta Rail Network



Port Augusta

National Rail Network & Operational Mines

Green Cement Benefits

Comparative Carbon Emissions of regular GP Cement and Optimised Green Cement

500ktpa
Cementitious

82%
Reduction on
emissions or
314kt CO₂

GP Cement
384kt CO₂
Emissions

Optimised
Green Cement
70kt CO₂
Emissions



Achieving Net Zero in Regional South Australia

Australia's Net Zero Plan 2050

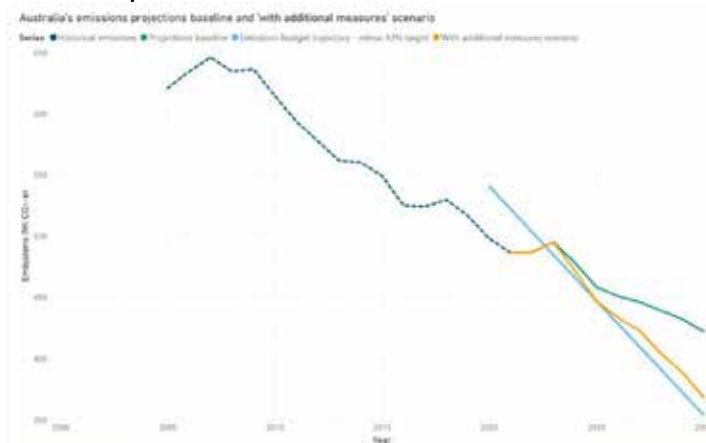
- Australia and the world are undergoing the biggest and fastest economic transformation since the industrial revolution. ¹
- Action to reduce emissions will help prevent the worst impacts of climate change but will also create a boom in new jobs and new industries. ¹
- The Federal Government's Net Zero Plan will guide our transition to the legislated target of net zero greenhouse gas emissions by 2050. ¹
- Alongside the Federal Government, South Australia is intending to be a net 100% renewable energy generator by 2027. ²

¹ <https://www.dcceew.gov.au/climate-change/emissions-reduction/net-zero>

² <https://www.ohpsa.sa.gov.au/projects/hydrogen-jobs-plan>

Australia's Net Zero Target 2050

- Our Green Cement project will reduce Australian CO₂ emissions by **300,000** tonnes per annum immediately, growing to a **1 million** tonnes in



- In context, Australia's emissions Projections **Baseline** for year 2026 is a 7.6MtCO₂-e reduction on the previous year

Hallett's Net Zero 2050

- From the outset of our Green Cement Transformation Project will support other businesses achieve their Net Zero goals
- For the Hallett Group we intend to achieve Net Zero by 2050
- We achieve this by:
 - Reviewing our current processes, for example:
 - Plant and Equipment; fuel type, where they are manufactured
 - Procurement Strategies; power (energy), fuel source locations
- However, we recognise that opportunities to reduce emissions further are here today and that's why we have commenced Project Helios

Project Helios

- Project Helios will provide a Hydrogen fuel to our Green Cement Processing Hub
- This can, in the future, provide us with a 100% Green fuel source to dry our product: our final step to a fully Green Processing Facility



Project Helios

- However, we don't intend to stop at our Green Cement Processing Hub
- We will investigate further options on the use of Hydrogen in our transport fleet and energy generation options for our remote mining and quarry operations
- Support other operations with their decarbonisation journey using Hydrogen through trials but also energy generation options that are available today
- Port Augusta is well position to support many trials in the transport and logistics space as the crossroads of Australia for Road and Rail

Project Helios



However, this isn't done without partners and support

**Government of
South Australia**



elecseed



KHNP
KOREA HYDRO & NUCLEAR POWER CO., LTD



Project Helios





**HALLETT
GROUP**

Thank you



Country Day I : Australia Day

South Australia's Great White Kaolin Project

Country Day I : Australia Day

South Australia's Great White Kaolin Project



Joe Ranford

Andromeda Metals: Chief Operating Officer /
Andromeda Technologies: Executive Director

Education

- 1989 - 1993, Bachelor of Engineering (Mining), University of South Australia, Adelaide, Australia
- 2013-2015, Masters Degree., Business Administration, The University of Adelaide, Adelaide, Australia
- Fellow Australian Institute of Mining and Metallurgy (AusIMM),

Professional Career

Joe Ranford is a mining engineer with 25 years' senior management experience across both domestic and international mining companies. Joe has significant experience operating and bringing mining operations into production within sensitive communities with considerable knowledge of the South Australian mining approval process and stakeholder landscape. Most recently, he held the role as Chief Operating Officer for Nordic Gold Inc., a Canadian based company which was the previous owner of the Laiva Gold Mine in Finland, where he re-established mining operations and brought the project back into production from care and maintenance.

Prior to his role at Nordic Gold Inc, Joe was Operations Manager for Terramin Australia Limited where he managed all operational and technical aspects of the Angas Zinc mine and undertook the evaluation and approval processes for the Tala Hamza Zinc Project in Algeria.

Joe is focused on bringing the deposits of the Great White Kaolin Project on South Australia's Eyre Peninsula project into production.

Research Interest

Activated clay, rheology modifying concrete admixtures application for low carbon concretes
Manufacturing HPA from Al rich kaolin feed stock

Speech Title

South Australia's Great White Kaolin Project

Speech Summary

Andromeda Metals is developing South Australia's Great White kaolin deposit. The Great White kaolin clay deposit is high in aluminium and ISO brightness and low in impurities, making it a high quality industrial mineral for use in porcelain and ceramics applications. Being a remote site, establishing basic services requires clever solutions and transportable energy is required. Andromeda is looking to co-generate electricity with its drying requirements to meet market demands and develop new products such as High Purity Alumina.

Company Introduction

Andromeda Metals Limited ('Andromeda') is a South Australian company with the vision of leading the world in the supply of superior quality industrial minerals.

The Great White Project (GWP) contains several high-value deposits containing a naturally occurring blend of halloysite tubes and kaolinite plates.

GWP is located near the community of Poochera on the Eyre Peninsula in South Australia.

We aim to develop the deposit into a world-class mining operation and produce high quality kaolin products that meet the exacting needs of our customers.

Our planned development of GWP includes energy optionality, enabling the Project to leverage the South Australian Government's investment in green hydrogen.



Andromeda

South Australia's Great White Kaolin Project

H2Meet Presentation
September 2024

Joe Ranford
Chief Operating Officer

joe.ranford@andromet.com.au
+61 8 7089 9800
Level 10, 431 King William Street, Adelaide, South Australia 5000



Disclaimer and Qualifications

This presentation contains summary information about Andromeda, and its activities current only at the date of this presentation. This presentation is for information purposes only. The information in the presentation is of a general nature only and does not purport to be complete. This presentation should be read in conjunction with Andromeda's most recent financial report and other periodic and continuous disclosure announcements lodged with the Australian Securities Exchange (ASX) which are available at www.asx.com.au and also available on Andromeda's website at www.andromet.com.au.

Investment risk

You should have regard to the risk factors outlined at the end of this presentation headed "Summary of Key Risks". This summary of key risks should be considered in the context of previous disclosures made by the Company in accordance with its periodic and continuous disclosure obligations. It is not intended to be an exhaustive list of the risk factors to which the Company is exposed.

No investment or financial product advice

The information contained in this presentation does not constitute investment advice or financial product advice (nor taxation or legal advice) and is not intended to be used as the basis for making an investment decision or as a recommendation to acquire securities in Andromeda. The information contained in this presentation should not be relied upon as a recommendation or forecast by Andromeda (including as to the performance of Andromeda or its share price). Readers should obtain their own professional advice and carry out their own independent investigations and assessment of the information in this presentation (including any assumptions) before acting.

This presentation has been prepared without taking into account any particular person's objectives, financial situation or needs; does not purport to identify the nature of specific market or other risks associated with any investment in the Company and does not constitute any legal, taxation, investment or accounting advice. An investment in Andromeda's securities is subject to investment and other known and unknown risks, some of which are beyond the control of Andromeda, including loss of income and principal invested. The Company does not guarantee any particular rate of return or the performance of the Company nor does it guarantee any particular tax treatment. Any investment decision should be based only on a person's own due diligence, inquiry, assessment and professional advice.

Forward-looking statements

This presentation contains or may contain certain forward-looking statements and comments about future events, that are based on Andromeda's beliefs, assumptions and expectations and on information currently available to management as at the date of this presentation.

Often, but not always, forward-looking statements can generally be identified by the use of forward-looking words such as "may", "will", "expect", "plan", "believes", "estimate", "anticipate", "outlook", and "guidance", or similar expressions, and may include, without limitation, statements regarding plans, strategies and objectives of management, anticipated production and production potential, financial forecasts, product quality estimates of future Mineral Resources and Ore Reserves.

Such statements are only expectations or beliefs and are subject to inherent risks and uncertainties which could cause actual values, results or performance achievements to differ materially from those expressed or implied in this presentation. Where Andromeda expresses or implies an expectation or belief as to future events or results, such expectation or belief is expressed in good faith and on a reasonable basis. No representation or warranty, express or implied, is made by Andromeda that the matters stated in this presentation will in fact be achieved or prove to be correct. Except as required by law, Andromeda undertakes no obligation to provide any additional or updated information or update any forward-looking statements, whether on a result of new information, future events, results or otherwise.

Readers are cautioned against placing undue reliance on forward-looking statements. These forward-looking statements are not guarantees of future performance and involve known and unknown risks, uncertainties, assumptions and other important factors, many of which are beyond the control of Andromeda, the directors, and management of Andromeda. These factors include, but are not limited to difficulties in forecasting expected production quantities, the potential that any of Andromeda's projects may experience technical, geological, metallurgical and mechanical problems, changes in market prices and other risks not anticipated by Andromeda, changes in exchange rate assumptions, changes in product pricing assumptions, major changes in mine plans and/or resources, changes in equipment life or capability, emergence of previously underestimated technical challenges, increased costs, and demand for production inputs.

Not an offer

This presentation is for information purposes and is not, and does not purport to be, a prospectus, product disclosure statement or any other offering document under Australian law or the law of any other jurisdiction. The information does not and will not constitute or form part of an offer, invitation, solicitation or recommendation in relation to the subscription, purchase or sale of securities in any jurisdiction. The distribution of this presentation in jurisdictions outside Australia may be restricted by law and you should observe any such restrictions.

No warranty

While care has been taken in preparing the information in this presentation, no representation or warranty, express or implied, is made as to the currency, accuracy, reliability, completeness or fairness of the information, opinions and conclusions contained in this presentation. The information in this presentation has been obtained from or based on sources believed by Andromeda to be reliable. This includes references to test results and reports completed by external parties.

Information in this presentation which is attributed to, or derived from, a third-party source has not been independently checked or verified by Andromeda. No representation or warranty is made as to the accuracy, completeness or reliability of such information.

To the maximum extent permitted by law, neither Andromeda nor its related corporations, Directors, officers, employees, advisers or agents, nor any other person, accepts any liability, including, without limitation, any liability arising from the use of this presentation or its contents or otherwise arising in connection with them, nor guarantees or makes any representations or warranties, express or implied, as to or takes responsibility for, the currency, accuracy, reliability, completeness or fairness of this presentation nor the information, opinions and conclusions contained in this presentation.

Assumptions and Notes for Financial Information on 2023 DFS and Stage 1A+ in this presentation:

Further details on the 2023 DFS and the assumptions and notes for the 2023 DFS (and risk factors applicable to the Company) can be found in the Company's ASX Announcement "2023 Definitive Feasibility Study Results" released on 24 August 2023. This should be read together with ASX Announcement dated 6 May 2024 "Andromeda expansion plans for The Great White Project" and "Clarification of expansion plans for The Great White Project" and the ore reserve estimate previously announced to ASX on 6 April 2022, "Great White Kaolin Project—Definitive Feasibility Study and Updated Ore Reserve".

Andromeda confirms that it is not aware of any new information or data that materially affects the information included in the original market announcements and that all material assumptions and technical parameters underpinning the estimates and financial information continue to apply and have not materially changed.

Currency

Unless otherwise stated, all cashflows in this presentation are in Australian dollars, are undiscounted and are in real terms (not subject to inflation/escalation factors).

Mineral Resources and Ore Reserve Estimates

Information that relates to Ore Reserve Estimate has been previously announced to ASX on 6 April 2022, "Great White Kaolin Project – Definitive Feasibility Study and Updated Ore Reserve. Andromeda confirms that it is not aware of any new information or data that materially affects the information included in the original market announcement and that all material assumptions and technical parameters underpinning the estimates continue to apply and have not materially changed.

Information that relates to the other kaolin deposit Mineral Resource Estimates in this presentation have been previously announced to ASX as follows:

1. ADN ASX dated 26 November 2020, Updated Mineral Resource for the Great White Kaolin JV Deposit
2. ADN ASX dated 16 November 2023, Chairlift Kaolin Deposit Mineral Resource Estimate.
3. ADN ASX dated 29 September 2020, New mineral resource estimate for Hammerhead Halloysite-Kaolin Deposit.
4. ADN ASX dated 23 March 2022, Maiden Tiger Kaolin Resource and Regional Rare Earth Element Potential. Halloysite reported with kaolinite.
5. ADN ASX dated 11 August 2020, New Mineral Resource for the Mount Hope Kaolin project.

Andromeda confirms that it is not aware of any new information or data that materially affects the information included in the original market announcements and that all material assumptions and technical parameters underpinning the estimates continue to apply and have not materially changed.

Competent Person's Statements

The data in this presentation that relates to Mineral Resource estimates for The Great White Deposit, the Chairlift Deposit, the Hammerhead Deposit, the Tiger Deposit and Mount Hope Deposit is based on information evaluated by Mr Eric Whittaker who is a Member of the Australasian Institute of Mining and Metallurgy (MAusIMM). Mr Whittaker is the Chief Geologist of Andromeda Metals Limited and has sufficient experience relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the "JORC Code"). Mr Whittaker has over 30 years of experience in the mining industry. Mr Whittaker consents to the information in the form and context in which it appears. Mr Whittaker is entitled to participate in Andromeda's employee incentive plan.

The data in this presentation that relates to Mineral Reserve estimates for The Great White Deposit is based on information evaluated by Mr John Millbank who is a Member of the Australasian Institute of Mining and Metallurgy (MAusIMM). Mr Millbank is the Director of Proactive Mining Solutions Pty Ltd, an independent mining consultancy, and has sufficient experience relevant to the style of mineralisation and type of deposit under consideration, and to the activity which he is undertaking, to qualify as a Competent Person as defined in the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the "JORC Code"). Mr Millbank consents to the information contained in this presentation being used in the form and context in which it appears. Mr Millbank, or any of the entities he directly controls, has no financial interests in Andromeda Metals Ltd or any of its subsidiaries.

Third party data from consultants and government agencies

Andromeda has relied on information provided by specialist consultants and government agencies in preparing this presentation. Andromeda has reviewed all information to the best of its ability but does not take responsibility for its accuracy or completeness, or reliability of such information.

Third party data on markets and pricing

The 2023 DFS (and hence this presentation) uses information from third parties pertaining to the kaolin industry, forecast pricing, market segments and end-markets in which Andromeda intends to operate (**Market Data**). This information has been substantially derived from market research prepared by third parties.

The Market Data includes assumptions, estimates and generalisations that the Company believes to be reliable, but no representation or warranty is made as to the accuracy, completeness or reliability of such information. Due to the forward looking nature of the Market Data, it may not necessarily reflect actual market conditions and there is no guarantee that any forward looking statements in the Market Data will prove to be correct or will be achieved. Andromeda has not independently verified the Market Data and the Company cannot give any assurances to the accuracy or completeness of this information or the underlying assumptions used in generating this information. Industry assumptions, forecasts and estimates involve risks and uncertainties and are subject to change based on various factors, including those discussed in the risk factors set out in this presentation.

Additional authorisations/certification

- Additional authorisations or certification is required for certain activities described in this presentation, including:
- the current Program for Environment Protection and Rehabilitation (PEPR) covers a 13 year mine life, with processing of 300,000 tonnes per annum of kaolin ore, so any increase or change to this will require a new PEPR;
 - the sale of sand products as extractive minerals, which is not currently authorised under Mining Lease 6532 (and will require a change in operations) or under the PEPR (which would need to be updated and approved by the regulators accordingly);
 - the sale of Great White HRM™ outside of Australia, which may require certification for use in concrete applications.

Andromeda has no reason to believe that such additional authorisations and certifications will not be forthcoming, but no guarantee can be given on this, including as to timing.

Other permits and authorisations may also be applied for in the ordinary course of development and operations and will be applied for as and when required.

Photographs, images, diagrams, charts and maps

Photographs, images, diagrams, charts and maps used in this presentation are illustrative only and may not be drawn to scale. Unless otherwise stated, all data contained in the charts, graphs and tables is based on information available at the date of this presentation.

Andromeda Metals

Developing the Great White Project in South Australia



Characteristics

- ✓ High-grade 15.1 Mt Ore Reserve¹ supporting a 28-year mine life
- ✓ Low complexity operation - simple mining with a low strip ratio
- ✓ Low sovereign risk jurisdiction

Kaolin is an aluminosilicate ($\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$) clay:

- ~ 50% coarse silica sand – <3 mm natural angular construction sand
- ~ 50% kaolinite – aluminosilicate clay – 60% < 2 µm



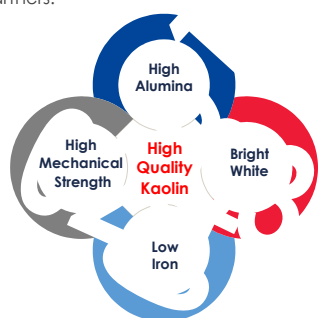
1. Refer ADN ASX dated 6 April 2022, "Great White Kaolin Project – Definitive Feasibility Study and Updated Ore Reserve. The total 15.1Mt Ore Reserve contains 5.2Mt Proved Reserve and 9.9Mt Probable Reserve. Andromeda confirms that it is not aware of any new information or data that materially affects the information included in the original market announcement and that all material assumptions and technical parameters underpinning the estimates continue to apply and have not materially changed.

What makes a premium kaolin?



Andromeda delivers high "value in use" to customers

- **Value in use** is the pricing basis for industrial minerals. It quantifies the profit realised through converting a raw material into a finished product.
- Andromeda has established high value in use and premium price point with Spain's **Institute of Ceramic Technology** and offtake partners.



Characteristics of high value in use kaolin products



- Concrete Decarbonisation with Great White HRM™
- High Purity Alumina (HPA) with Andromeda's high-quality kaolin
- Zircon replacement with Andromeda's ultra fine kaolin

5

Focused on safe and sustainable operations With the aim of being a supplier, partner and employer of choice



Andromeda recognises that to establish a sustainable development it will require integration of these three elements, and a focus on Environment, Social and Governance (ESG) with a view to reducing carbon.



Environment

- Recycling of water via reverse osmosis system
- Gas used to co-generate heat and electricity for processing operations
- Planned reduction of operational carbon footprint as production expands



Social

- Active stakeholder engagement – landholders, First Nations, businesses, community groups and employees
- Work health and safety (WHS) managed through risk-based approach



Governance

- Comprehensive framework of Company policies to ensure consistent and coordinated management of ESG matters
- Active approach to risk management, mitigated as far as practicable



Andromeda recognises the Wirangu as the traditional custodians of the land on which our project sits.

6

The Great White Project

Delivery of a High-Value Project



Drivers for development of the Project

- ✓ Market opportunity: growing supply deficit for high-quality kaolin
- ✓ Large global market: ~30Mtpa, US\$4.4 billion characterised by consistent, low-volatility growth of 4.7% CAGR¹
- ✓ Products are used in a diverse range of sectors and applications, e.g. as fillers, additives and pigments in industrial, electronics, nanotechnology, medical, cosmetics and consumer products



Challenges

- ✓ Remote location
- ✓ Baseload energy solution
- ✓ Thermal requirement for product drying



1: Fortune Business Insights, "Global Kaolin Market Analysis, Insights and Forecast, 2024-2032" (2024).

7

The Great White Project

Remote site – require transportable energy solution



Requirement

Power and Thermal Energy

Site based generation of electricity

Fluid Bed dryer for product moisture removal



Current Solution

Micro turbines provides flexible power solution

Liquid Petroleum Gas trucked supply

Co-generation provides excess heat via exhaust for drying requirements



Partnership Opportunities

PV, battery, electrolyser

Low CO₂ energy solutions

South Australia state government hydrogen initiative



8

Products in Development

Andromeda's focus on green solutions



Concrete Decarbonisation with Great White HRM™

A kaolin concrete additive that will deliver cost-effective concrete decarbonisation.

- **Value in use and pricing strategies driven by material commercial benefits:**
 - Cement industry has very few options to reduce CO₂ emissions.
- **Clear commercialisation pathway**
 - Production ready: processing using planned TGWP flowsheet, no additional capital required, lower C1 cost than Great White CRM™
 - Certified: for use in concrete under Australian Standards (AS 1478.1 – 2000)
 - Strategic Alliance Agreement for commercialisation of Great White HRM™ signed with Hallett Group¹, a significant SA construction firm – targeting critical end user validation.

HPA with Andromeda's high-quality kaolin²

High Purity Alumina (HPA) is listed as one of Australia's Critical Minerals with a growing demand.

- **HPA's use:**
 - HPA is used in the manufacturing of LED lights, synthetic sapphire glass, semiconductors and lithium-ion batteries.
- **Great White kaolin ideally suited to make HPA:**
 - Test work carried out by external consultants confirmed that kaolin from TGWP is ideally suited for making HPA, due to its high aluminium content and low levels of alkali and alkaline earth metals.
 - The lab scale tests undertaken have produced HPA to 99.99% purity (4N HPA).

1. Refer ADN ASX dated 16 November 2023 titled Strategic Alliance Agreement signed with Hallett Group.
 2. Refer ADN ASX announcement dated 20 June 2024 titled Andromeda progresses HPA product development.

Thank you



Partnership Opportunities:

- Low carbon energy solutions
- Kaolin offtakes
- HPA users
 - ✓ synthetic sapphire glass
 - ✓ battery manufacturers
 - ✓ LED, phosphors, semiconductors



Andromeda

The Great White
Mineral Company

For more information about the Company, please
visit our website, www.andromet.com.au or contact:

Joe Ranford
Chief Operating Officer
T: 08 7089 9800
E: joe.ranford@andromet.com.au



Country Day I : Australia Day

**Green Hydrogen Supply Chain Masterplan
between Australia and Korea**

Country Day I : Australia Day

Green Hydrogen Supply Chain Masterplan between Australia and Korea



Robert Saunders

Managing Director,
MIEAust CPEng NER APEC Engineer IntPE (Aus),
Elecseed

Education

- (1991 – 1996) - B.Eng (Hons) Energy Engineering, London South Bank University (UK)
- (2022 – 2022) - Circular Economy and Sustainability Strategies, University of Cambridge (UK)

Professional Career

- 2022 – Present, Managing Director Elecseed Pty Ltd (Australia/Korea)
- 2017 – 2022, General Manager Renewables, Calibre Group (Australia)
- 2016 – 2017, General Manager Renewables, BG Group (Australia)
- 2015 – 2016, National Manager Buildings, Calibre Group (Australia)
- 2012 – 2015, National Manager, Buildings, WSP Opus (Australia)
- 2008 – 2012, Chief Operating Officer, Ashburner Francis (Australia)
- 1996 – 2007, Managing Director, Saunders Specialised Services Ltd (UK)

Research Interest

Green Hydrogen Supply Chain
Albedo Effect of Bi-Facial Solar Panels

Speech Title

Green Hydrogen Supply Chain Masterplan between Australia and Korea

Speech Summary

Elecseed are part of a Korean – Australian consortia completing research for the supply chain of green hydrogen between Australia and Korea including the end to end production, logistics and liquefaction process. The project is based upon green hydrogen production in Australia.

The speech will provide a summary of the work done to date, the outcomes, the challenges and the next steps in this work. Project partners include the Korean Advanced Institute of Science and Technology (KAIST), Korea Gas Corporation (KOGAS Tech) Korea Maritime Consultants (KOMAC) and Lattice Technology.

Company Introduction

Elecseed is a progressive Renewable Energy Developer and Consultancy providing innovation, technical eminence, funding, and multifaceted solutions to deal with the paradigm shift in how we generate, manage, and consume energy. With offices in Seoul Korea and Brisbane Australia, Elecseed identifies and leads specific market needs, not only to propel our drive to a greener future but also satisfy the immediate economic needs and demands. We have experience across the Asia Pacific in bringing the right partners to develop solutions across renewables including Photovoltaics, Wind, Hydrogen and Battery Storage technology, leveraging off strategic financial and engineering expertise.

elecseed.

Basic Design of Transportable Standardized 75,000 m³ Liquid Hydrogen (LH₂) Export and Import Terminals for Green Hydrogen Import

Robert Saunders
25th September 2024
Seoul

Driving future energy



Presenting Today



Robert Saunders

Managing Director
Elecseed

robert.saunders@elecseed.io

B.Eng (Hons) Energy Engineering
London South Bank University (United Kingdom)

Welcome to Elecseed

We are living in a significant time as nations and companies decarbonise their assets to meet aligned global targets and provide for a cleaner future.

Elecseed is a progressive Renewable Energy Developer and Consultancy providing innovation, technical eminence, funding, and multifaceted solutions to deal with the paradigm shift in how we generate, manage, and consume energy.

With offices in Seoul Korea and Brisbane Australia, Elecseed identifies and leads specific market needs, not only to propel our drive to a greener future but also satisfy the immediate economic needs and demands.

We have experience across the Asia Pacific in bringing the right partners to develop solutions across renewables including Photovoltaics, Wind, Hydrogen and Battery Storage technology, leveraging off strategic financial and engineering expertise.

Join us in our tenacious journey to a more sustainable and responsible world, driving the future of renewable energy solutions.



elecseed

The Study Explained

elecseed



The Study

This project is entitled “Basic Design of Transportable Standardized 75,000 m³ Liquid Hydrogen (LH₂) Export and Import Terminals for Green Hydrogen Import”.

It proposes a liquid hydrogen-based maritime supply chain for intercontinental hydrogen transportation from Australia to Korea.

The supply chain, consists of:

- Hydrogen Production Location in Australia
- Logistics between the production location and the Port
- A barge-type LH₂ Export Terminal
- An LH₂ Carrier / Tank
- A barge-type LH₂ Import Terminal

It provides the advantage of reducing onshore construction, enabling stable quality control, and shortening the delivery period.

Funded thus far by Korean Energy Technology Evaluation and Planning (KETEP, the R&D Arm of MOTIE) as well as contributions from the Study Consortia Members



Ministry of Trade,
Industry and Energy



elecseed

Study Consortia Members and Key Responsibilities



Overall Research and LH₂ Tank and Pipeline Design (Korea)



Liquid Hydrogen Tanks and Commercialisation (Korea)



Liquefaction (Korea)



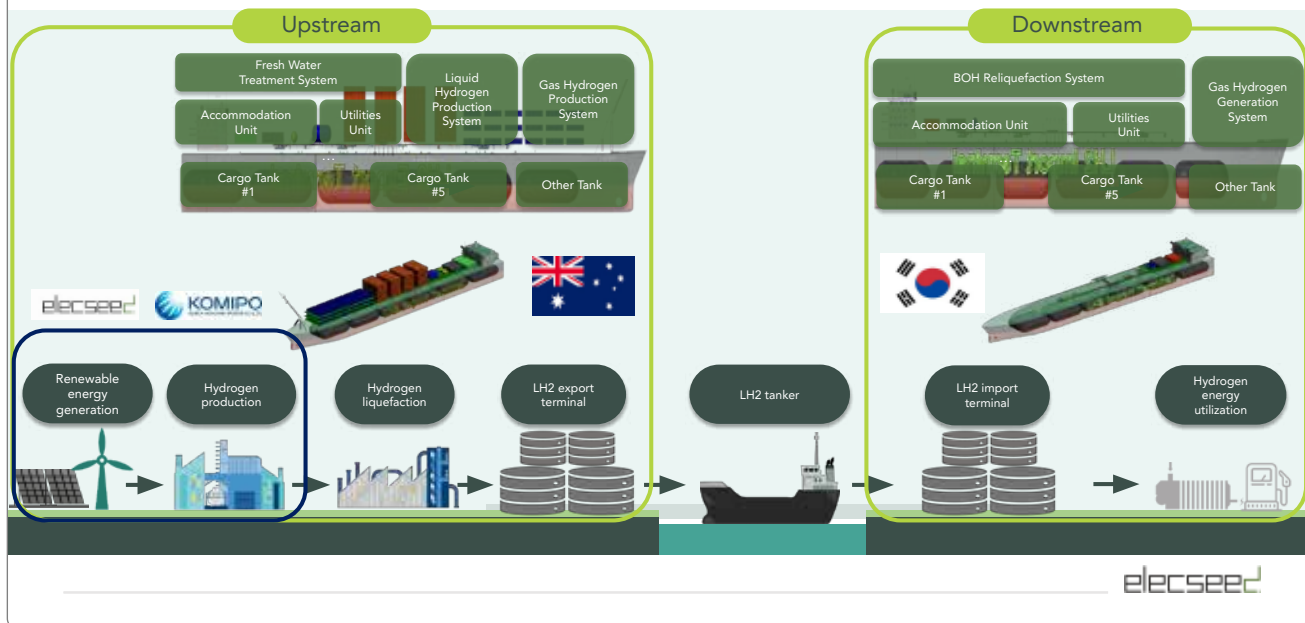
Barge / Terminal Design (Korea)



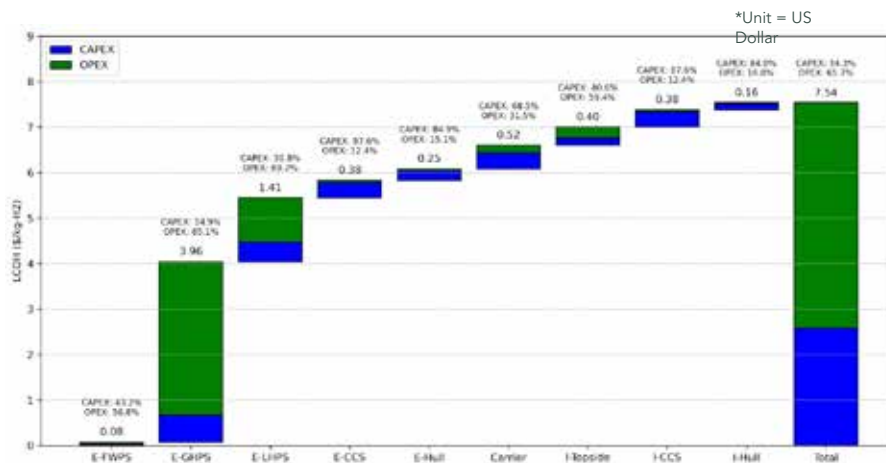
Renewable Energy / Hydrogen Production (Australia)

elecseed

Masterplan – Upstream and Downstream



Metrics Outcome – Supply Chain Door to Door



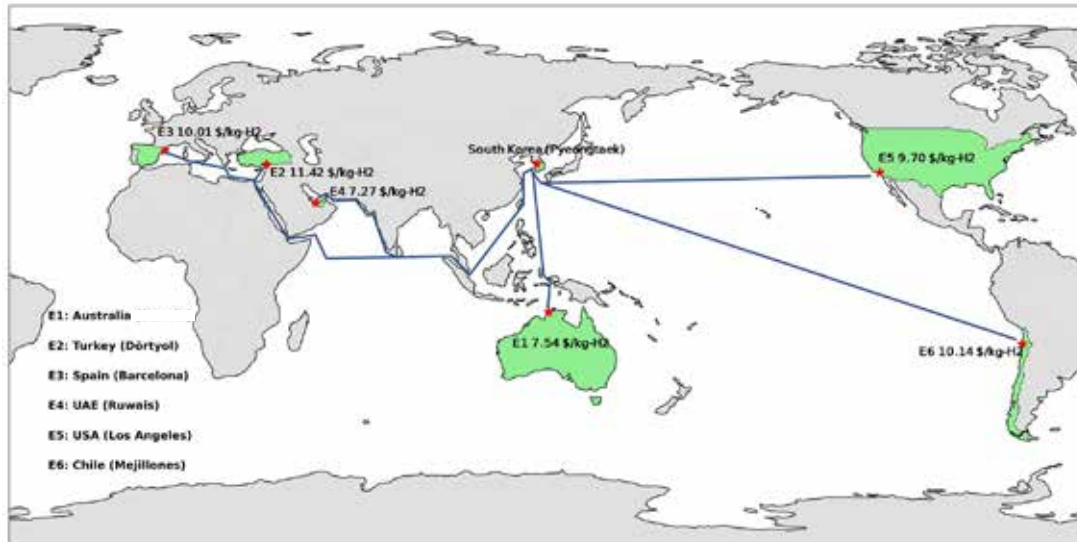
- FWPS Fresh Water Production System / - GHPS Gas Hydrogen Production System / - LHPS Liquid Hydrogen Production System
- CCS Cargo Containment System / - CHS Cargo Handling System / - HMS Hull and Marine System

World 1st CAPEX & OPEX National Research for whole supply Chain of Green Hydrogen

- Professor Alan Finkel - National Hydrogen Strategy 2019
- A\$2/kg (Production) Gate Price Only (US\$1.4)
- Our Masterplan study looks at the total overall price including logistics, which to our knowledge is the first of its kind in the World.



Summary of Australia Position Globally



elecseed

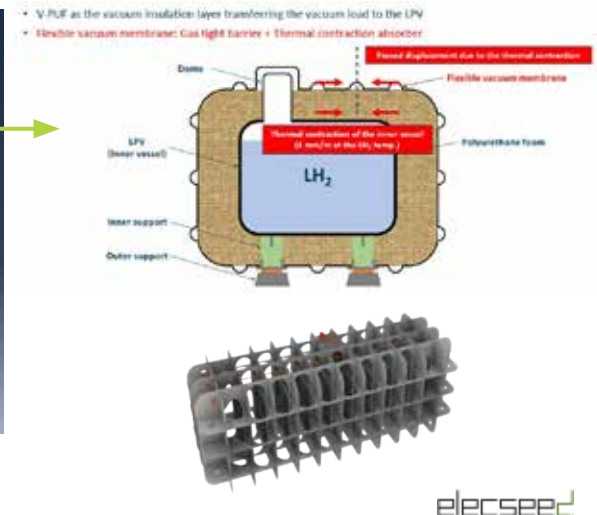
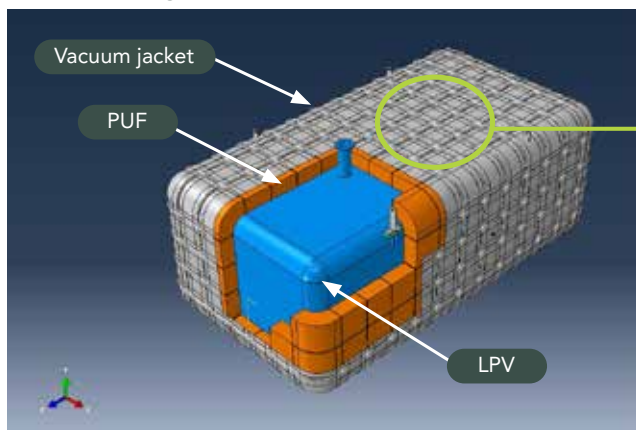
The Key Technology

elecseed



Liquid Hydrogen Tank

General Design



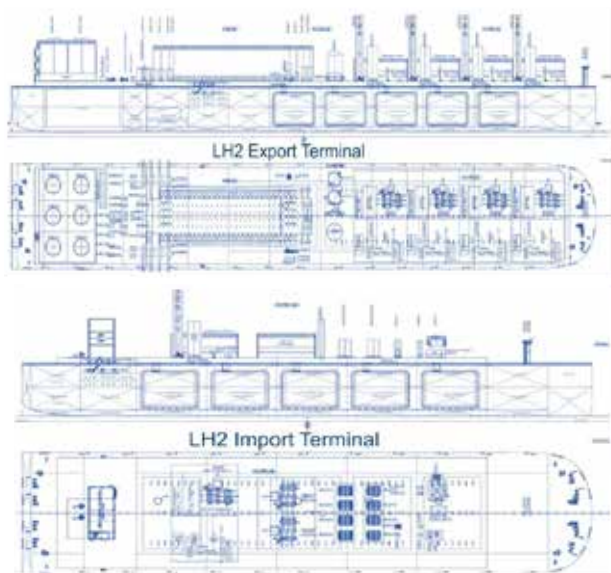
Liquid Hydrogen Tank



- The Tanks have been constructed
- Several Patents Registered
- Paris-La Défense, France – September 7, 2023: Bureau Veritas (BV), a World leader in testing, inspection, and certification, has delivered an Approval in Principle (AiP) to LATTICE Technology Co., Ltd. (LATTICE) for its innovative design and development of a 75,000 CbM floating liquified hydrogen (LH₂) import terminal.

elecseed

The Barge / Terminal Design



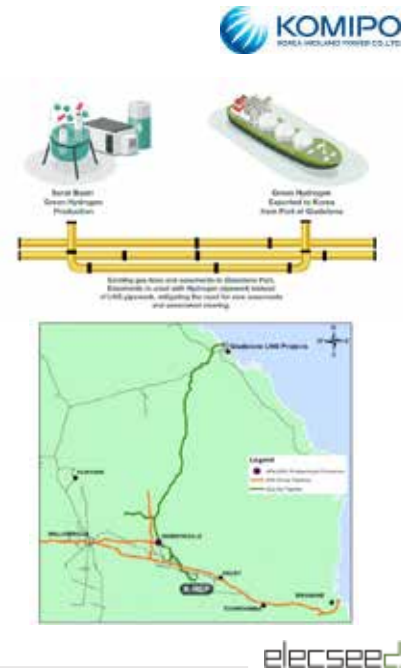
elecseed

From Production to Port

elecseed



Original Reference Site for Study

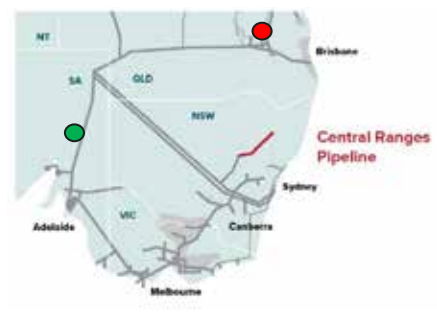


elecseed

Option 1 Inland Location – Hydrogen Gas Line Infrastructure to Port



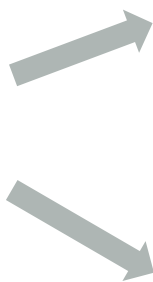
Option in Southern States



- Approximately 2,500 Kilometres of hydrogen pipelines are currently operating in the United States
- Certain parts of Australia has gas similar gas line infrastructure that could be transitioned to Hydrogen, using existing easements and skills, whilst mitigating environmental impact
- The first hydrogen gas line in Australia is currently in design / planning (43km), owned by APA, located in WA

elecseed

Option 2 Traditional Road and Rail Transportation Methods to Port



LPV LH2 ISO containers transported by trailers



LPV LH2 ISO containers transported by trains

elecseed

Option 3 Adjacent to Deep Sea Port Location



Government of South Australia



- Currently consulting with the Government of South Australia regarding development site locations and export points
- Cape Hardy or Port Bonython are possible export Hubs as examples
- Detailed Design and Construction is now ready to commence to the next stage.

elecseed

The Next Steps

- The Basic Design completed at the end of 2024
- The Detailed Design Commences in 2025
- A location within Australia is currently being sought for detailed design and construction to commence in 2025 with government support
- Funding being concluded to move to the next stage of the study and start construction of the project



elecseed

Consortia Summary Video (Courtesy of Lattice Technology)



elecseed

elecseed.

Driving future energy

Thank you
감사합니다

International Offices

Elecseed have offices in both the Republic of Korea and Australia. We work closely together and bridge the two nations, connecting investment, technology, skills, common goals, research and overall collaboration. We work from central modern facilities and welcome you to contract or visit our offices in Brisbane and Seoul.

Australian Office

310 Edward Street
Brisbane City
QLD, 4000
Australia

T: +61 (0)416 029160
brisbane@elecseed.io

Korean Office

9-4 Dongpangyo-Ro 52 Gil
Seongnam, 13535
Korea

T: +82 10 9045 7413
seoul@elecseed.io

Driving future energy

elecseed.

Country Day I : Australia Day

South Australia – State Prosperity Project

Country Day I : Australia Day

South Australia – State Prosperity Project



David Connolly-Hay

Department of State Development (Invest SA),
Business Development Manager, Government of
South Australia

Education

· 2011-2014, Bachelor of Management, University of South Australia

Professional Career

2008 – current: Working across multiple sectors within the South Australian Government, David is a career business development professional assisting project proponents deliver successful outcomes in South Australia. This includes the provision of bespoke case management, consultancy and advocacy. David works in multiple sub-sectors of renewable energy and mining, focusing on resources, fuels and clean technologies.

Speech Title

South Australia – State Prosperity Project

Speech Summary

South Australia's renewable energy transition and green hydrogen ambitions.

Company Introduction

Leading the clean energy transition, the South Australian Government has a dedicated team of investment and business professionals that can connect you with opportunities, industry networks, and other agencies to assist in the delivery of successful projects delivery.

The South Australian Government is committed to delivering sustainable economic growth, and a resilient economy through the development of innovative and productive businesses and industries in South Australia.

State Prosperity Project South Australia

David Connolly-Hay

Business Development Manager
Resources, Fuels and Clean Technologies
Department of State Development (Invest SA)

25 September 2024

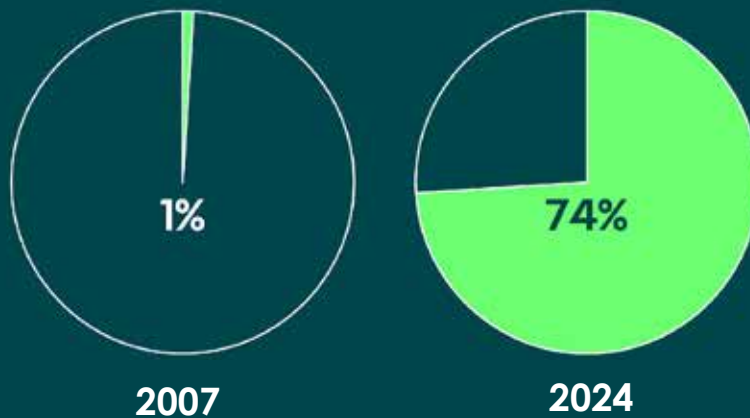


South Australia on the World Map

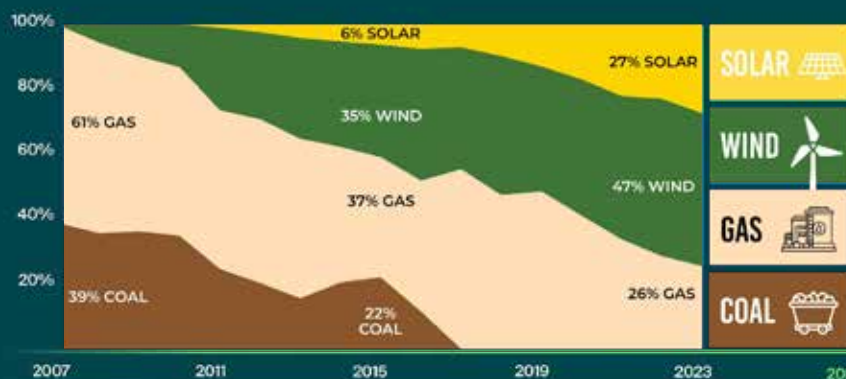


Source: GISGeography

South Australia's Renewable Share



Global leader in renewable electricity



► stateprosperity.sa.gov.au



The energy transition

Upper Spencer Gulf and surrounds

- C Copper
- S Smelters & Steelworks
- H Hydrogen
- Northern Water
- Solar & Wind
- Magnetite Iron Ore
- Port Facilities



South Australia's hydrogen journey

2017



2019



2020



2021



2022



2023



2024



2026



Hydrogen Jobs Plan

- ✓ 250MWe of electrolyzers
- ✓ 200MW hydrogen power generation
- ✓ 100 tonnes of hydrogen storage
- ✓ Stabilise grid by using excess renewable energy
- ✓ Improve grid security through new dispatchable electricity
- ✓ Operational from 2026



Early contractor involvement (ECI)

Preferred delivery partners

End-to-end solution encompassing:

- 250MWe electrolyzers
- 100% hydrogen-operated fast-startup turbines
- On-site storage

Dual purpose storage and transmission pipeline providing infrastructure connections for hydrogen production expansion and industrial offtake.



ATCO

Energising SA: An ATCO & BOC Hydrogen Collaboration

BOC
A Linde company

 **epic energy**



The Copper Opportunity



South Australia has

69%

of Australia's
copper resource

Source: Department for Energy & Mining



Northern Water



Northern Water

A new, reliable and secure water supply.

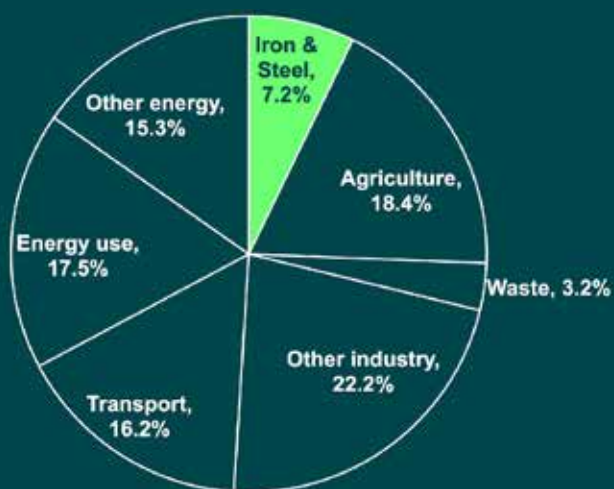
- 260ML/day sea water desalination plant in the Spencer Gulf
- Approximately 600km pipeline to the Upper Spencer Gulf and Far North South Australia
- Unlocks hydrogen and critical mineral opportunities



The green iron opportunity



Global CO₂ emissions



Source: Climate Watch, the World Resources Institute



Hydrogen & Renewable Energy Act

- Legislated in 2023
- Consultation on Regulations closed April 2024
- Australia's first legislation to coordinate hydrogen and renewable energy supply
- Streamlines processes
- Government auctions to develop renewable projects on Crown Land – proposed Release areas - Hydrogen and Renewable Energy Act | Energy & Mining (energymining.sa.gov.au) feedback closes 22 October 2024



South Australia The green energy transition



Renewables and land

World-class renewables and available land



Minerals and metals

Vast, nation-leading copper and iron deposits



Water

Governments and industry partnering on sustainable supply to unlock net-zero industries



Industry

Existing industry, assets and infrastructure



Hydrogen

SA Government investing in world-leading facility providing early-mover hydrogen supply



Enablers

- Skilled workforce
- Strong working partnerships
- Best-in-class legislation and regulation

For more detailed project
information, please visit our
interactive map via;



investinprosperityprojects.sa.gov.au



Thank you

David Connolly-Hay

Business Development Manager
Resources, Fuels and Clean Technologies
Department of State Development (Invest SA)



Country Day I

Canada Day

Country Day I : Canada Day

Welcome Remarks

Country Day I : Canada Day

Welcome Remarks



Derrick Kim

Managing Director,
Trade and Invest British Columbia in South Korea

Country Day I : Canada Day

**Keynote Speech 1:
Clean Energy in British Columbia**

Country Day I : Canada Day

Keynote Speech 1: Clean Energy in British Columbia



Aron Kim

Trade Commissioner, Global Affairs Canada

Education

- 2009-2015 Finance Bachelor of Commerce, University of British Columbia
- 2017-2018 Economics Master of Food and Resource Economics, University of British Columbia

Professional Career

Aron (Seong Soon) Kim is a Canadian Trade Commissioner who has worked with Global Affairs Canada (GAC) for five years. He is the clean energy specialist at the Regional Office of GAC in Vancouver where he works closely with clean energy (including hydrogen) companies to help them grow internationally. He has led various clean energy delegations from the Indo-Pacific to Canada to advance collective decarbonization efforts between Canada and other Asian countries.

Research Interest

Clean Energy

Speech Title

Clean Energy in British Columbia

Company Introduction

Global Affairs Canada (GAC) is the department of the Canadian government responsible for the country's foreign affairs, international trade, and development assistance. It plays a key role in shaping Canada's interactions with other countries, promoting Canadian values and interests abroad, and supporting international peace and security.



The graphic features the Canadian flag and the text "Government of Canada / Gouvernement du Canada" in the top left. The "Canada" wordmark is in the top right. The "Trade Commissioner Service" is written in a large, blue, sans-serif font. The main title "CANADA: A GLOBAL LEADER IN CLEAN TECHNOLOGY" is in a bold, blue, sans-serif font. A large, stylized "CANADA" is on the right, with a red maple leaf and a blue and white geometric shape. Below the "CANADA" text, it says "Do business with Canada" and "Faites affaire avec le Canada".

Government of Canada / Gouvernement du Canada

Canada

Trade Commissioner Service

CANADA: A GLOBAL LEADER IN
CLEAN TECHNOLOGY

Do business
with Canada
Faites affaire
avec le Canada

1



The graphic features a large, stylized "CANADA" on the right, with a red maple leaf and a blue and white geometric shape. Below the "CANADA" text, it says "Do business with Canada" and "Faites affaire avec le Canada".

Agenda

- ☐ Trade Commissioner Service
- ☐ Overview of Hydrogen Sector of Canada and BC
- ☐ Key companies and projects
- ☐ Government programs for H₂ and CCUS

2



THE CANADIAN TRADE COMMISSIONER SERVICE (TCS) NETWORK

We are Canada's global team of Trade professionals abroad. An unbeatable network with offices across Canada and around the world.

125+ YEARS SUPPORTING CANADIAN SMEs

10,000+ CLIENTS EACH YEAR

1,000+ TRADE COMMISSIONERS

160+ LOCATIONS WORLDWIDE

6 REGIONAL OFFICES IN CANADA

Let our team of professionals help you at:

tradecommissioner.gc.ca



Do Business with Canada



INNOVATE WITH CANADA

As a world leader in science and technology we can connect you with the right R&D partners in Canada



BUY FROM CANADA

There are many Canadian organizations available to meet your needs for high-quality products, services and technologies



INVEST IN CANADA

Benefit from a stable economy with competitive business costs and a safe and inclusive environment

5

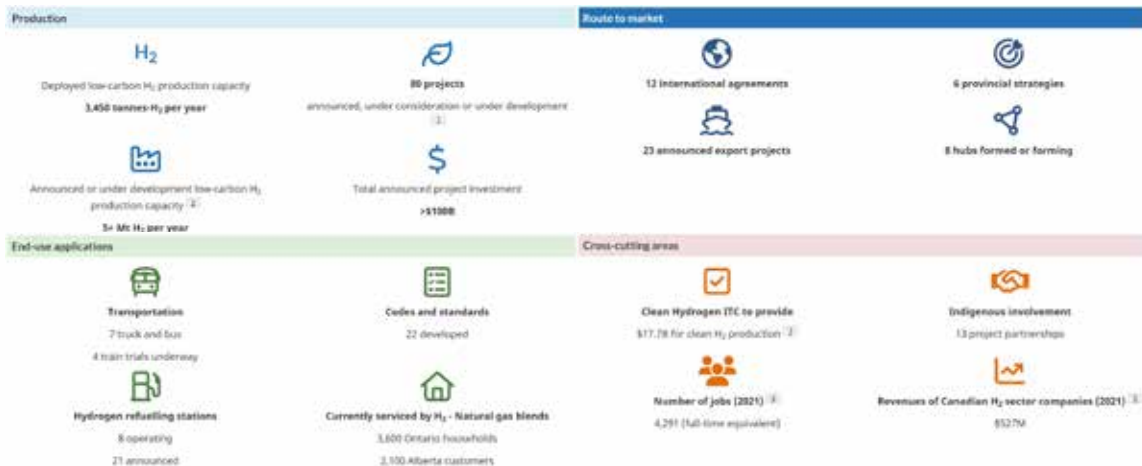
CANADA

OVERVIEW OF HYDROGEN SECTOR OF CANADA

6

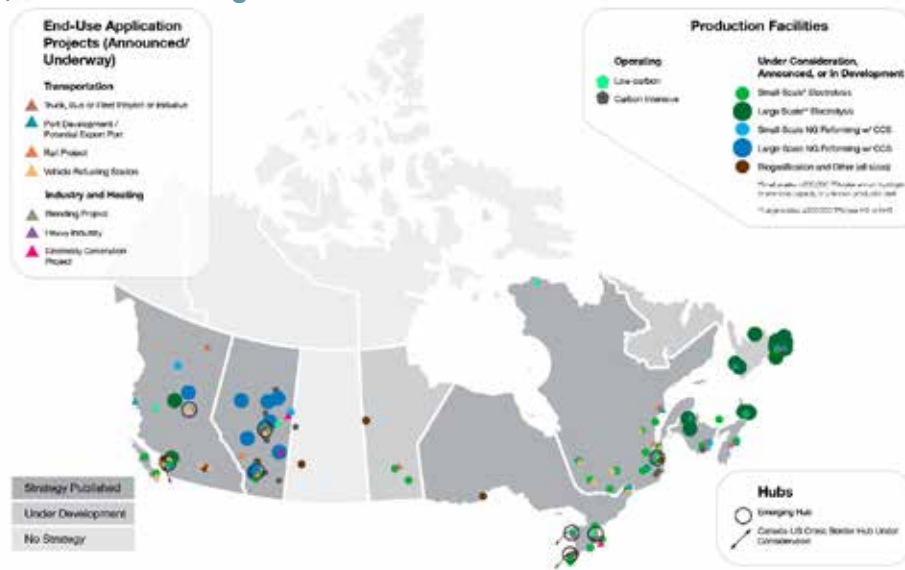
CA

Canada's Hydrogen Production Potential



7

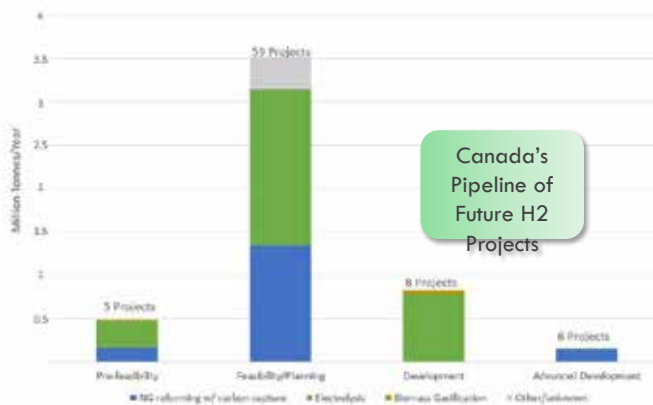
Summary map: Hydrogen developments in Canada since 2020 – Production, end-use, hubs and strategies



8

Canada's Key Hydrogen Production Projects

- ◆ **13** low-carbon hydrogen production projects in operation
- ◆ **80** low-carbon hydrogen production projects announced, across all production pathways, representing **CAD\$100 billion** in potential investment, **5 MT H₂** production capacity

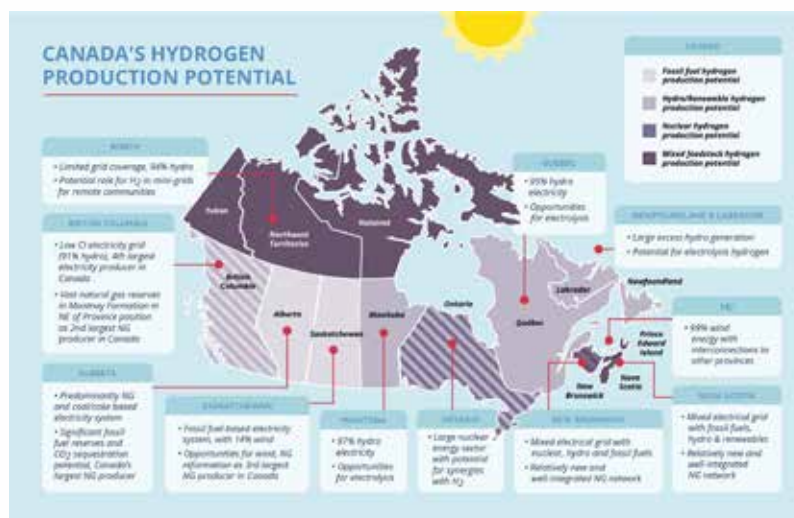


A colourful reminder
While hydrogen is often referred to as "green," "blue," or other colours based on how it is produced, Canada's focus remains on the carbon intensity of the hydrogen, including with regards to hydrogen derivatives such as ammonia.

Any production pathway, as long as it is low carbon, is equally part of Canada's Hydrogen Strategy

9

Canada's Hydrogen Production Potential



10

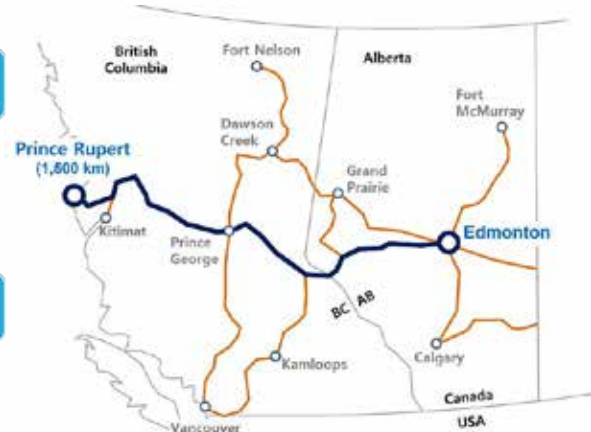
Western Canada Hydrogen/Ammonia Export Opportunity

Western Canada offers advantages as a supplier of low-carbon ammonia to Asian markets

- Cost friendly natural gas feedstock
- High ESG standards
- Shorter shipping times to Asian markets than US Gulf Coast or Qatar
- Existing, efficient infrastructure network
- Robust federal and provincial support for hydrogen industry

Most projects are in Alberta - ammonia must be shipped by rail to the pacific coast (British Columbia).

- Government and industry are working to remove barriers to safely transporting ammonia by rail



11

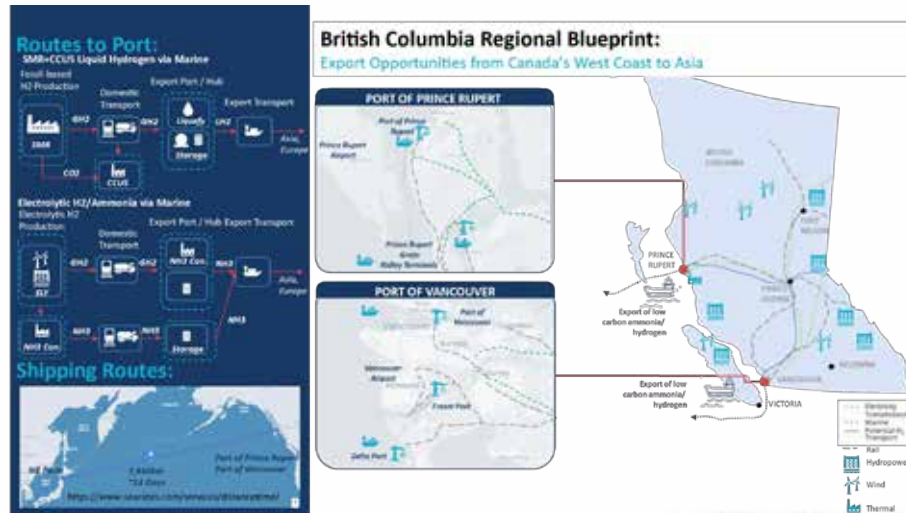
BC's hydrogen sector

BC's Hydrogen Strategy implementation framework

- The BC Ministry of Energy, Mines and Low Carbon Innovation (EMLI) released in 2021 its Hydrogen Strategy that includes 63 actions to undertake over the short term (2020-2025), medium term (2025-2030) and long term (2030-beyond).
- A dedicated hydrogen concierge service: Clean Energy and Major Projects Office (CEMPO) – a proponent's one-stop shop for all things hydrogen funding, regulatory, permitting, engagement, etc.
- **Home to a fuel cell cluster**
 - Cellcentric: A JV between Volvo Group and Daimler to accelerate the use of hydrogen-based fuel cells. Cellcentric opened their new manufacturing and research and development (R&D) facility in Burnaby. The facility produces hydrogen fuel cells stacks for the medium- and heavy-duty truck market and will develop manufacturing technologies to support at-scale series production.
 - AVL & Greenlight: April 2018 - Austria-based AVL established a global competence center for proton exchange membrane fuel cell for the burgeoning global market in long-haul transportation applications. The R&D center will develop fuel cell technology and digital technology development tools that will dramatically accelerate the at-scale deployment of robust and custom fuel cell technologies.

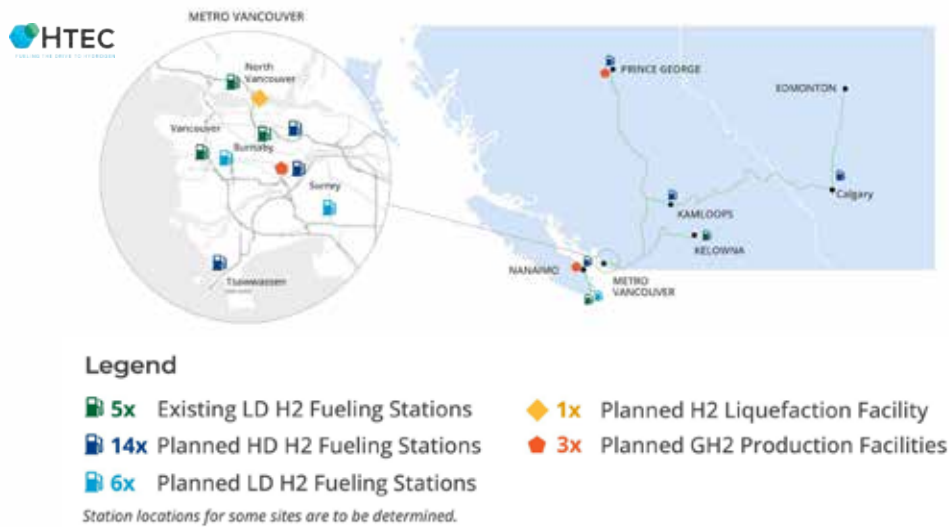
12

BC's hydrogen sector



13

H2 Gateway Project



14

BC's key H₂ & CCUS players

Low-Carbon Hydrogen Production	Hydrogen Distribution	Fuel Cell Products and Services	Academia-Consulting	CCUS, Recycling/End-of-life
Producers & Project Developers	Distributors		Academia	
 		       	 	 
Production Equipment	Distribution Equipment		Consulting	
 Purification & liquefaction Equipment  	    		 	

15

GOVERNMENT PROGRAMS FOR H₂ AND CCUS

16

Government Policy supporting hydrogen and CCUS

- ❑ On March 28, 2023, the Government of Canada tabled a budget that bolstered its ongoing commitment to building one of the cleanest economies in the world with new support measures:
- ❑ **1) Investment Tax Credit for Clean Electricity** - A 15% refundable tax credit for eligible investments in non-emitting electricity generation systems (wind, solar, hydro, wave, tidal and nuclear). Companies can receive this tax credit on the day of Budget 2024 as long as the project did not begin before March 28, 2023. Timeline: The Clean Electricity Investment Tax Credit would be available as of the tabling of the 2024-25 budget for projects that did not begin construction before March 28, 2023. The Clean Electricity Investment Tax Credit would not be available after 2034.
- ❑ **2) Investment Tax Credit for Clean Technology Manufacturing** - A refundable tax credit equal to 30% of the cost of investments in new machinery and equipment used to manufacture or process key clean technologies, and extract, process, or recycle key critical minerals. Timeline: The credit would apply to property that is acquired and becomes available for use on or after January 1, 2024. The phase-out will begin in 2034 (previously 2032) and will not be available thereafter.
- ❑ **3) Investment Tax Credit for Clean Hydrogen** - The levels of support will vary between 15-40% of eligible project costs, with the projects that produce the cleanest hydrogen receiving the highest levels of support. Will also extend a 15% tax credit to equipment needed to convert hydrogen into ammonia, in order to transport the hydrogen. Timeline: The Clean Hydrogen Investment Tax Credit is available for investments made as of March 28, 2023. It will be phased out after 2030.

17



Government Policy supporting hydrogen and CCUS

- ❑ **Clean Fuel Regulations (CFR)**, released in mid 2022, requires fossil-based transportation fuels to reduce carbon intensity by 15% (compared to 2016) by 2030. The regulations establish a credit market for regulated parties (producers and importers). Credits are proportional to the carbon intensity of the hydrogen that is used.
- ❑ **Clean Technology Investment Tax Credit – \$185 million**: Following the 2022 Fall Economic Statement announcement, the refundable investment tax credit of 30% is expanded to include geothermal systems.
- ❑ **Reduced Tax Rates for Zero-Emission Technology Manufacturers – \$1.3 billion**: Following the 2021 budget, which reduced corporate income tax rates by half for zero-emission technology manufacturers, this budget proposes to extend these reduced tax rates by three years to 2034, with phase-out beginning in 2032.
- ❑ **Carbon Capture Utilization and Storage Investment Tax Credit – \$520 million**: Extension of the tax credit to dual use heat and/or power equipment and water use equipment.
- ❑ **Strategic Innovation Fund – \$500 million**: Applied to the development and application of clean technologies.
- ❑ **Canada Infrastructure Bank**: An increased mandate to invest in clean power and green infrastructure. Impact assessment and permitting processes for major projects: A commitment to outlining a concrete plan for improving efficiency
- ❑ **Recapitalization of the Smart Renewables and Electrification Pathways Program (SREP)**: SREP provides up to a maximum of \$25M to eligible renewable energy and grid modernization projects during the construction phase. Projects must use market ready technologies and apply workplace equity, diversity, and inclusion components. Details to be released in the coming months.

18



Thank you

Contact:

Seongsoonaron.kim@international.gc.ca

Country Day I : Canada Day

**Keynote Speech 2:
Canada's Hydrogen Landscape**

Country Day I : Canada Day

Keynote Speech 2: Canada's Hydrogen Landscape



Ivette Vera-Perez

President and CEO,
Canada Hydrogen Association

Education

- Master of Applied Science from the University of British Columbia
- MBA from McGill University.

Professional Career

Before joining the Canadian Hydrogen Association, Ms. Vera-Perez was the National Team Lead for Mitacs's industry business development group and directed a multidisciplinary team across Canada with the mandate of helping industry secure top talent to advance innovation. She also previously served as the Manager for the Greenhouse Gas Reduction programs at the Ontario Centres of Innovation, where she managed over \$275 million in program funding. Ivette is a founder of the Ontario Clean Technologies Industry Association, and serves on the board of the Atlantic Hydrogen Alliance.

Research Interest

Ivette Vera-Perez has over 15 years of experience in the cleantech and environmental technologies sector. Her expertise spans from business development to site engineering, operations, and financing.

Speech Title

Canada's Hydrogen Landscape

Company Introduction

The Canadian Hydrogen Association (CHA) is a national, non-profit association that represents industry, academia, end-users and other stakeholders in Canada's hydrogen sector. As the Voice of the Sector, the CHA's mission is to strengthen Canadian leadership, raise awareness of the benefits of clean hydrogen and hydrogen technologies, and accelerate the adoption of its members' products and services to help create a prosperous low-carbon world. The CHA supports nearly 200 members across Canada and provincial affiliates in British Columbia, Alberta and Ontario. You can also follow CHA on LinkedIn, X (@PoweringNow) or visit www.canadah2.ca to learn more information.

State of Canada's Hydrogen Sector

Ivette Vera-Perez
President and CEO

H2MEET Seoul
September 2024



Canadian
Hydrogen
Association

Association
Canadienne de
L'hydrogène

UNCLASSIFIED | NON CLASSIFIÉ



About the Canadian Hydrogen Association (CHA)

www.canadah2.ca

UNCLASSIFIED | NON CLASSIFIÉ

About the CHA



- Leading **national** association for the hydrogen sector in Canada
- 50 years of history
- **200+** members
- **Regional affiliates** in BC, Alberta, and Ontario. Partnered with Quebec and Atlantic associations.
- **Voice of the Sector**
 - Advocacy
 - Government relations
 - Communications
 - Networking



www.canadah2.ca

About the CHA



UNIFIED VOICE FOR THE CANADIAN HYDROGEN SECTOR

→ Advocacy & Government Relations

- Ottawa (Fall 2024)
- Victoria (Spring 2024)
- Edmonton (Spring 2024)
- Ontario (Fall 2024)

→ Awareness and Education

→ Networking and Trade Missions

- 8 international events during 2023 calendar year
- 5 international events 2024 YTD



UNCLASSIFIED | NON CLASSIFIÉ

The Canadian H₂ value proposition



- Leading energy exporter
- Top-10 hydrogen producer
- 40+ years of expertise in hydrogen fuel cell technologies and products
 - Canadian fuel cell products exported to 40+ countries
 - Powering 8,000 trucks and buses
- 100+ years of expertise in electrolyzer technology & products
- Hydrogen production expertise (electrolysis, biomass gasification, pyrolysis, reforming)
 - Large-scale projects in Atlantic Canada for export to Europe
- CAD \$500MM sector revenues
- Diverse industrial ecosystem spanning the entire value chain from H₂ production, fuel cell stack development, components & materials, testing and certification, research, engineering)
- 4,000+ highly skilled professionals



www.canadah2.ca

UNCLASSIFIED | NON CLASSIFIÉ

Canada's hydrogen ecosystem



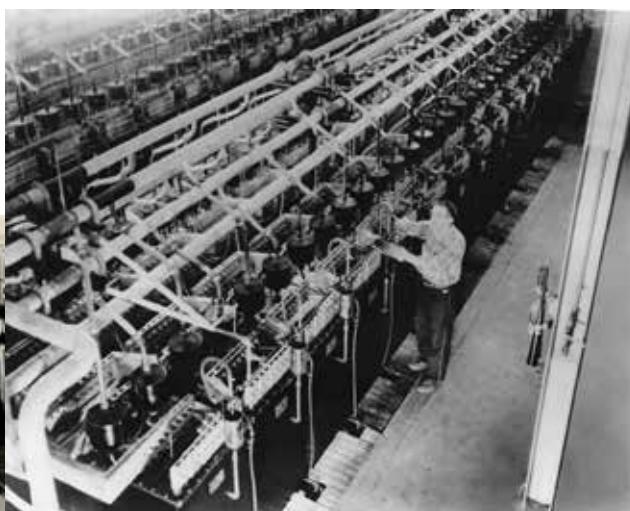
Sponsoring	Canadian Nuclear Laboratories Hydrogen Optimized National Research Council Canada Conseil national de recherches Canada TC Energy
Executive	Air Liquide PRODUCTS ATCO Atura Power BC Hydro Bruce Power accelera ENBRIDGE FASKEN HATCH
Industry	AVL calcentric CEM CERTARUS dynamCERT GREENFIELD GREENLIGHT INNOVATION HATCH HTEC HYUNDAI ILF INNERGEX intertek IVYS LAKESIDE Marsh MESSER North Atlantic PacifiCorp Quinterra SACRI ENERGY SFC
Small Business/End User	AECOM EIA FURANO FirstEnergy HYDRA HYDROGEN IN ACTION HYZON ARCADIS IONMR NIRD ITD LOOP ENERGY VOLVO Cavendish CH2M ECRESEARCH PERMASCAND SSES SPARTAN CONTROLS SEUS Teck solestis TERRESTRIAL ENERGY TEST Thomas Thor UTILITY
Academic/Consultant	BCIT C2CAN CARON HAWCO GROUP INC CNA DALHOUSIE UNIVERSITY Lambton MCHBANK OntarioTech RRC SAIT University of Alberta University of British Columbia University of Calgary University of Toronto L3Harris Whitson62 ZZ SMRT Ltd.
Start-up	Aurora Hydrogen AVRION CARIBOO CRATOS D77 QEKONA OPJULE AUTONIC CICE Coquitlam OWEN SOUND H2GO CANADA MOMENTUM MATERIALS SOLUTIONS GHPOWER HYDROFUEL HYZON HYDROGEN CANADA TERALTA THOR TRIPLE POINT INVEST FRIEDOUVE
Associate	Aurora Hydrogen AVRION CARIBOO CRATOS D77 QEKONA OPJULE AUTONIC CICE Coquitlam OWEN SOUND H2GO CANADA MOMENTUM MATERIALS SOLUTIONS GHPOWER HYDROFUEL HYZON HYDROGEN CANADA TERALTA THOR TRIPLE POINT INVEST FRIEDOUVE

UNCLASSIFIED | NON CLASSIFIÉ



Canadian hydrogen retrospective

From 1905 to today



Canada's Hydrogen Journey

Establishing pioneering leadership



1905 - 1913

The beginning

1905 – Dominion Coal Company used hydrogen in the production of synthetic fuel from coal.

1905 – A.T. Stuart presented the opportunity for electrolysis of water in Niagara Falls.

1913 – A.T. Stuart develops the "Stuart Cell."

1940-1950

Initial R&D

1940s-1950s – The National Research Council (NRC) began exploring hydrogen's potential in various industrial processes.

1948 – A.T. Stuart founds The Electrolyser Corporation & starts manufacturing and direct sales.

1970s

The oil crisis

1973 – The oil crisis led to renewed interest in hydrogen. Canada's government and private sectors started investing in hydrogen research to reduce dependence on imported oil.

1970s – The Canadian Hydrogen Association (CHA) was founded.

1980s

Advancements in fuel cell technology

1983 – Ballard Power Systems is founded.

1986 – World Energy Conference was a major success.

1987 – Major installations were provided to a Hydro-Québec-Air Liquide joint venture in Bécancour, QC.

1987 – Hydrogen National Mission for Canada is published.

Canada's hydrogen journey

Competing in a world that has embraced hydrogen



1990s

Commercialization Efforts

1990s – Ballard developed FC buses and other applications. Their technology was showcased at the 1993 World's Fair in Vancouver.

1993 – World's Fair in Vancouver established Canada's leadership in hydrogen technology.

2000s

Government support

2000 – Hydrogen & Fuel Cells Canada (H2FCC) is established in BC.

2000 – The Canadian government launched the Hydrogen Early Adopters (H2EA) program.

2004 – Vancouver hosted the 15th World Hydrogen Energy Conference.

2009 – Largest FC bus fleet introduced for Winter Olympics.

2009 – The CHA and H2FCC merge to form CHFCA.

2010s

Strategic Developments

2010 – NRC initiated a hydrogen and fuel cell program, focusing on advanced R&D.

2016 – Hydrogenics partnered with Alstom to develop hydrogen-powered trains.

2020s

Accelerating towards a hydrogen economy

2020 – Canada's "Hydrogen Strategy for Canada" is released.

2022-2024 – Numerous projects were announced, including the development of hydrogen hubs in AB, SK and ON, and increased investments in electrolyzers and FC.

2024 – CHFCA rebrands to a more inclusive, all encompassing, CHA.

Canada's present hydrogen landscape

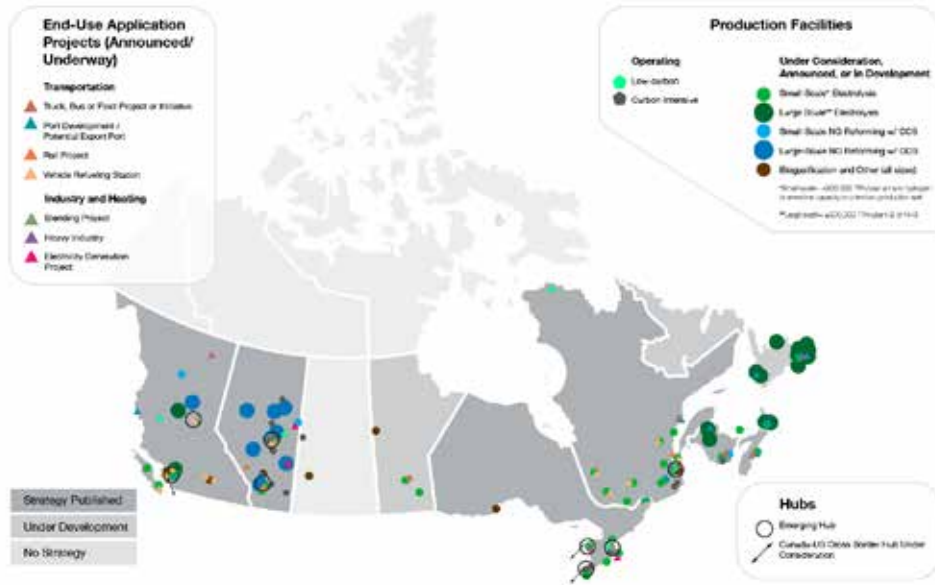
Cross country hydrogen developments

UNCLASSIFIED | NON CLASSIFIÉ



Participation from all provinces

UNCLASSIFIED | NON CLASSIFIÉ

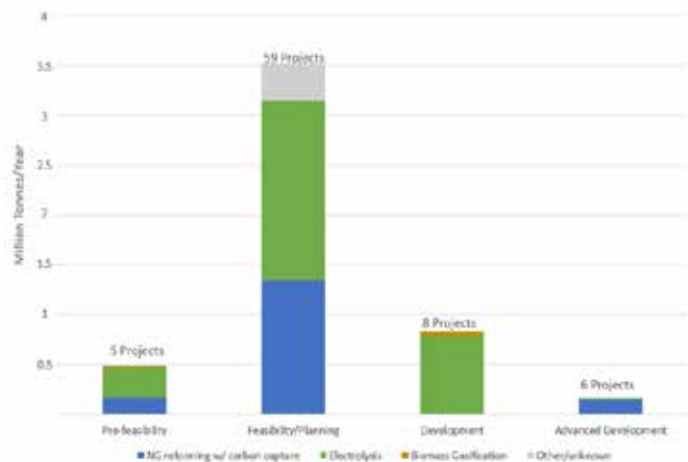


Canadian Projects in 2024

UNCLASSIFIED | NON CLASSIFIÉ



- 13 low-carbon hydrogen production facilities in operation.
 - 6 electrolytic & 7 natural gas + CCS
 - The Air Liquide 20 MW electrolyser in Bécancour, QC, began operating in 2021
- 80 production projects have been announced since 2020.
 - 5 million tonnes of annual low carbon hydrogen production capacity
 - \$100+ billion in potential investment.



UNCLASSIFIED | NON CLASSIFIÉ

Canadian government support



- **Hydrogen Strategy for Canada update: strategic priorities for 2024-26):**
 - De-risk high-impact production projects of low-carbon hydrogen
 - Achieve scalable hubs and strategic corridors, targeting end-uses with greatest potential
 - Codes and standards development
 - Awareness and market data
- **Regulatory measures**
 - Clean Fuel Regulations (CFR)
 - Carbon Pollution Pricing
 - Methane Regulation
- **Funding programs**
 - Clean Fuels Fund (CFF), Strategic Innovation Fund – Net Zero-Accelerator (SIF-NZA), Canada Growth Fund (CGF), Canada Infrastructure Bank (CIB), Zero Emission Vehicle Infrastructure Program (ZEVIP)
- **Investment Tax Credits**
 - Clean Hydrogen Investment Tax Credit (CHITC)
 - Clean Electricity Investment Tax Credit or the Clean Technology Investment Tax Credit
 - Clean Technology Manufacturing Investment Tax Credit
 - The Investment Tax Credit for Carbon Capture, Utilization and Storage



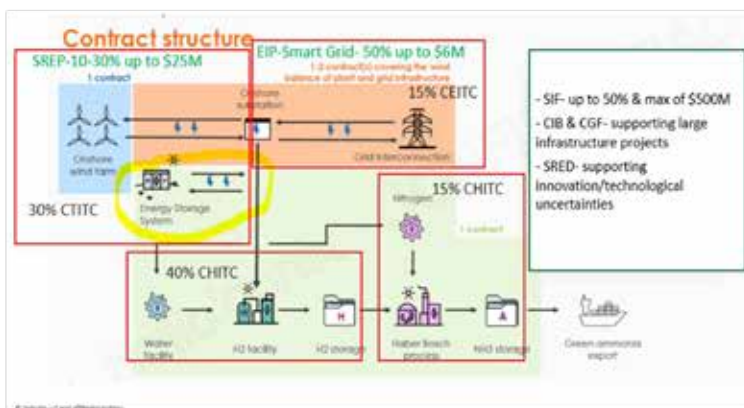
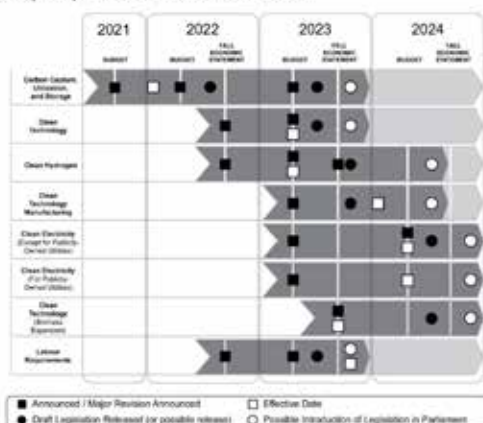
www.canadah2.ca

UNCLASSIFIED | NON CLASSIFIÉ

Canadian investment tax credits



Figure 3.3
Delivery and Implementation Timeline for Investment Tax Credits



www.canadah2.ca

UNCLASSIFIED | NON CLASSIFIÉ



Opportunities for collaboration with Canada

www.canadah2.ca

UNCLASSIFIED | NON CLASSIFIÉ



Collaboration opportunities

Research and Demonstration

- Industry academic collaboration
- Academic-Academic collaboration

International Supply Chains

- Equipment and technology for low-carbon hydrogen production & distribution (e.g. electrolyzers)
- Fuel cell stacks, components & materials
- Hydrogen vehicles and components
- Hydrogen fueling stations
- Hydrogen export corridors

Stakeholder engagement

- Webinars
- Networking events
- Conferences
- Roundtables/workshops
- B2B matchmaking



Support mechanisms

- Updates on policy and funding/financing instruments

Certification and regulations

- Sharing of best practices regarding codes and standards
- Facilitating meetings between government to address regulatory barriers

Hydrogen Hubs (Valleys)

Scaling up clean H₂ produced from low-cost energy resources

- Capitalizing on infrastructure
 - Rail, pipeline, ports

www.canadah2.ca

Thank you

Ivette Vera-Perez
President and CEO
iveraperez@canadah2.ca



Canadian
Hydrogen
Association

Association
Canadienne de
L'hydrogène

Country Day I : Canada Day

Pitching Session
- Alberta's Industrial Heartland Association

Country Day I : Canada Day

Pitching Session - Alberta's Industrial Heartland Association



David Howe

Strategic Projects Manager,
Alberta's Industrial Heartland Association

Research Interest

David has deep-rooted experience in economic development and is leading the development of Alberta's first Designated Industrial Zone project, a regulatory streamlining initiative that increases development readiness and available cluster infrastructure for new projects

Speech Summary

David looks forward to speaking about the endless opportunities available to project developers in the Heartland region, particularly in Hydrogen

Company Introduction

Alberta's Industrial Heartland Association is a non-profit association of five municipal partners. It guides industrial development for a 582 square kilometre region of land in proximity to northeast Edmonton using an eco-industrial philosophy that reflects the interests of the community, industry and environment.



Alberta's Industrial Heartland Association H2 Meet



IndustrialHeartland.com  

UNCLASSIFIED | NON CLASSIFIÉ

ABOUT US

Alberta's Industrial Heartland Association (AIHA) is a municipal government supported economic development association. AIHA's mandate is to attract industrial assets into Alberta's Industrial Heartland.

AIHA is a 25-year partnership of five municipalities and three associate members. AIHA is non-profit and does not seek any financial reward from project developers.

CITY OF
FORT SASKATCHEWAN
FORTSAK.CA

Lamont County

STRATHCONA
COUNTY

Sturgeon
COUNTY

Edmonton



2

Industrialheartland.com  

UNCLASSIFIED | NON CLASSIFIÉ

ALBERTA'S INDUSTRIAL HEARTLAND

Alberta's Industrial Heartland is Canada's largest hydrocarbon processing region, consisting of over \$45 billion in industrial investments. AIH is home to 40+ companies in a variety of sectors, including producing and processing oil, gas, and petrochemicals, as well as advanced manufacturing



3

Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

AIHA ORGANIZATION

BUSINESS DEVELOPMENT

Works with project sponsors to efficiently and effectively develop projects in AIH

GOVERNMENT RELATIONS

Advocates for industry friendly policies and regulations

COMMUNICATIONS AND COMMUNITY RELATIONS

Connects the communities and stakeholders with relevant association and development activities



4

Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

BUSINESS DEVELOPMENT SERVICES

INVESTOR OUTREACH

Travelling globally to present development opportunities to potential project sponsors

BUSINESS CASE DEVELOPMENT & STUDIES

Conduct business cases and studies relevant to developing in AIH

PROJECT DEVELOPMENT PARTNER

Act as an extension of project development team to advance projects

SITE SELECTION

Work with project sponsors to find co-location and greenfield sites in AIH

GOVERNMENT ENGAGEMENT

Introductions to relevant government and regulatory stakeholders

MATCHMAKING

Finding potential project partners and partners for collaboration



HOSTING

Coordinating corporate visits to Alberta and AIH



ALBERTA'S
INDUSTRIAL
HEARTLAND

5

Industrialheartland.com



ALBERTA'S
INDUSTRIAL
HEARTLAND

6

Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

EXISTING INDUSTRY

CHEMICALS & FUELS

- Ethylene – 1,300 KTA
- Polyethylene – 850 KTA
- PG propylene – 115 KTA
- Polypropylene – 550 KTA
- MEG/EO/EG– 800 KTA
- Iso-octane – 521 KTA
- Styrene monomer – 450 KTA
- Urea – 1,400 KTA
- Ammonium sulphate – 355 KTA
- Ammonia – 376 KTA
- Hydrogen – 821 KTA
- Refined fuels – 447 Kbpd
- Bitumen upgrading – 270 Kbpd
- Benzene – 370 KTA
- Aromatics
- Petcoke



MIDSTREAM & UTILITIES

- NGL fractionation – 485 Kbpd
- Over 40 Salt cavern storage
- Oil, natural gas, and NGL pipelines
- Water and industrial gas systems
- Two operating world-scale CCUS systems
- Rail storage and loading

DIVERSIFIED PRODUCTS

- High-purity nickel
- High-purity cobalt
- Nickel composite powders
- Cobalt powders
- Hydrogen peroxide
- Prilled sulfur
- Renewable power



Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

CURRENT PROJECTS - SANCTIONED



Project: Path2Zero
Description: Path2Zero is Dow's, and the world's, first net-zero integrated ethane cracking complex which will utilize hydrogen as a clean fuel and third-party CCS. The project will add a total of 1.8 MMTPA of ethylene and polyethylene in two phases.

Project Type: Ethylene and derivatives
Capacity: 1.8 MMTPA
Status: Under construction



Project: Hydrogen / Industrial Gas Complex
Description: Linde is investing more than US\$ 2 billion to build, own, and operate an integrated clean hydrogen and atmospheric gas complex. The project will supply hydrogen from Linde's ATR to Dow's Path2Zero project

Project Type: Blue Hydrogen and Atmospheric Gas
Capacity:
Status: Sanctioned



Project: Polaris
Description: Polaris is a carbon capture project which will capture ~650 thousand tonnes of CO₂ from Shell's Scotford Refinery and Chemical Complex

Project Type: Carbon Capture
Capacity: 650 KTPA
Status: Sanctioned



Project: Atlas
Description: Atlas is a multi-phase, open-access carbon storage hub located east of Alberta's Industrial Heartland. The initial phase is underpinned by CO₂ volumes from Shell's Polaris project

Project Type: PDH & PP
Capacity: 550 KTA
Status: Sanctioned



Project: Fort Sask Expansion
Description: Plains Midstream Canada sanctioned an expansion of their fractionation facility at Fort Saskatchewan.

Project Type: NGL Frac
Capacity: 30 kbbbl/d
Status: Under construction



Project: RFS IV
Description: Pembina is constructing its fourth fractionator in AIH. The C3+ frac will add 55 kbbbl/d, bringing total frac capacity to 256 kbbbl/d on site

Project Type: NGL Frac
Capacity: 55 kbbbl/d
Status: Under construction



Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

RECENT ANNOUNCEMENTS - UNDER STUDY



Project: Blue Hydrogen and Ammonia
Description: Shell and Mitsubishi have signed a MOU relating to the production of low-carbon hydrogen/ammonia through the use of carbon capture and storage (CCS).

Project Type: Hydrogen and ammonia
Capacity: 165 KTA hydrogen
Status: Under Study



Project: Blue Ammonia and Blue Methanol
Description: Itochu Corp., Petronas Canada and Inter Pipeline announced a partnership to evaluate the development of a world-scale integrated blue ammonia and blue methanol production facility.

Project Type: Ammonia and Methanol
Capacity: 1.8 MMTPA
Status: Under Study



Project: Blue Ammonia
Description: Pembina and Marubeni announced an MOU to jointly develop a low carbon ammonia facility utilizing CCUS. The ammonia will be produced to serve the Asian market

Project Type: Low-carbon ammonia
Capacity: 1.0 million mt/year
Status: Under Study



Project: Hydrogen Canada Ammonia
Description: Hydrogen Canada and E1 are collaborating on a blue ammonia facility in AIH.

Project Type: Blue ammonia
Capacity: 1.0 MMTPA
Status: Under Study



Project: Clean fuel export
Description: ATCO and Kansai are collaborating to develop a clean fuels supply chain, producing clean hydrogen and derivatives for Asia.

Project Type: Hydrogen and derivatives (ammonia)
Capacity:
Status: Under Study



Project: AIH Waste-to-Energy
Description: Varne signed an MOU with a major industrial partner in AIH to pursue the development of a waste-to-energy facility with integrated carbon capture in AIH.

Project Type: Waste-to-energy
Capacity:
Status: Under Study



Project: Greenlight
Description: Kineticor is proposing a 1,400 MW combined cycle, gas fueled power plant utilizing CCUS.

Project Type: Low carbon power (CC + CCUS)
Capacity: 1,400 MW
Status: Under Study



Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ



OPPORTUNITIES

Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

TARGETED INDUSTRIAL OPPORTUNITIES IN AIH

PETROCHEMICALS

DIVERSIFICATION



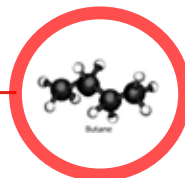
METHANE
Methanol
Fertilizer
Fuel Ammonia
Animal Nutrition
Hydrogen
Hydrogen Carriers



ETHANE
Ethylene
EO / EG
Chlor Alkali -> EDC
DMC



PROPANE
Propylene
PO / PG
SAP
IPA
Methionine
2EH



BUTANE
Maleic Anhydride
Iso-butane
Butadiene



HEAVY INDUSTRY
Renewable Fuels
Synthetic graphite
Critical Mineral Refining
Low-carbon Power
Waste-to-energy
Industrial Biotech



Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

Immense Natural Resources



VAST NATURAL GAS AND NGL RESERVES

- Over 1,100 TCF of natural gas reserves, representing over 200 years of production at current demand
- Over 25 billion barrels of NGL representing over 100 years of production

PROVEN PRODUCTION

- Approximately 17 bcf/d of gas production with significant volumes flowing through AIH
- Over 500 kbpd of fractionation capacity in AIH

OPTIONALITY ON SUPPLY

- TC Energy's NGTL pipeline system extends over 24 thousand kilometers connecting producers, marketers, and aggregators across western Canada to downstream users in AIH
- At peak, NGTL moves ~14.3 bcf/d of natural gas

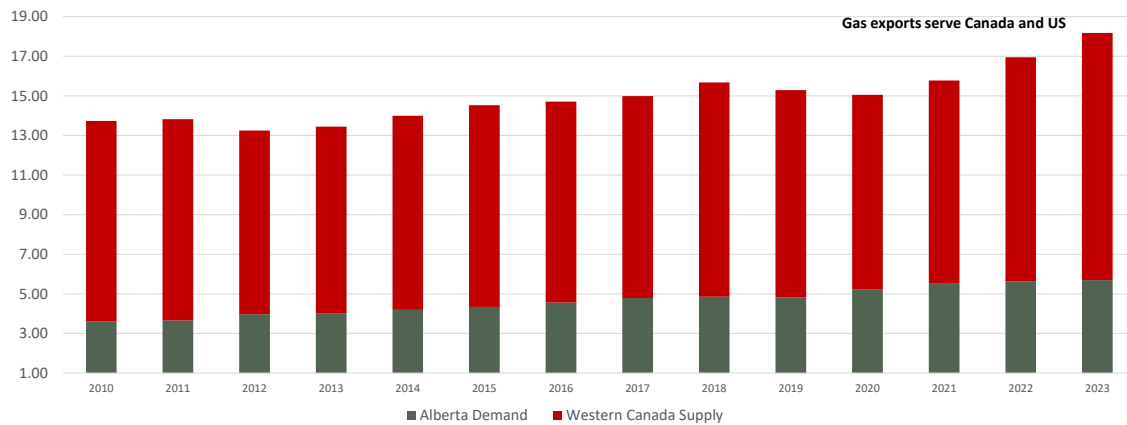
Industrialheartland.com



NATURAL GAS

Abundant and available

UNCLASSIFIED | NON CLASSIFIÉ



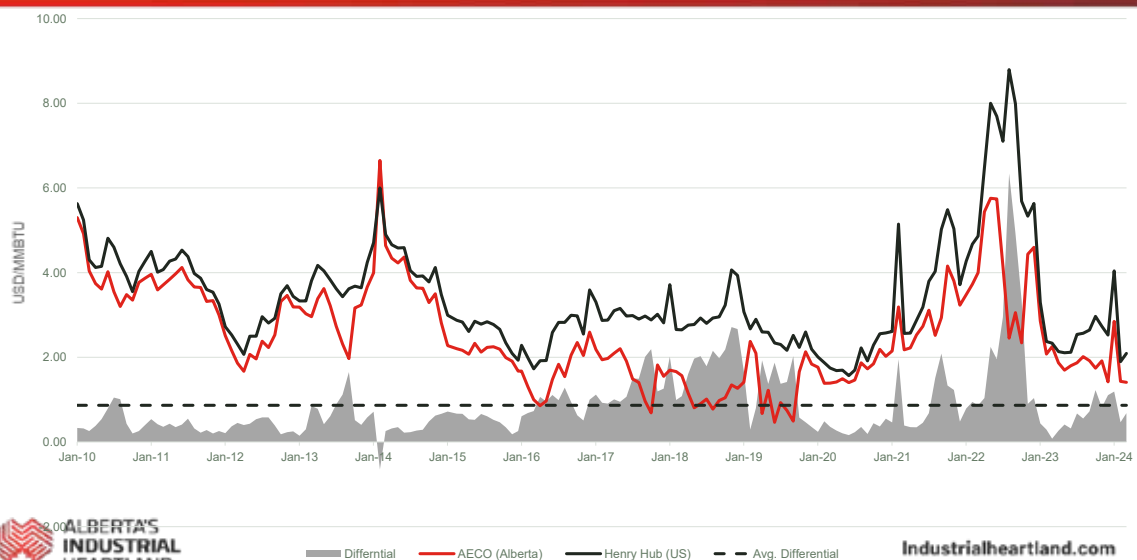
Industrialheartland.com



NATURAL GAS

Low cost and secure

UNCLASSIFIED | NON CLASSIFIÉ



Industrialheartland.com



EXISTING CCUS INFRASTRUCTURE

UNCLASSIFIED | NON CLASSIFIÉ



- A world-class capture project designed to capture and store over 1 million tonnes of CO₂ per year
- Quest began operations in 2015 and, to date, has captured and stored more than 4 million tonnes of CO₂

QUEST



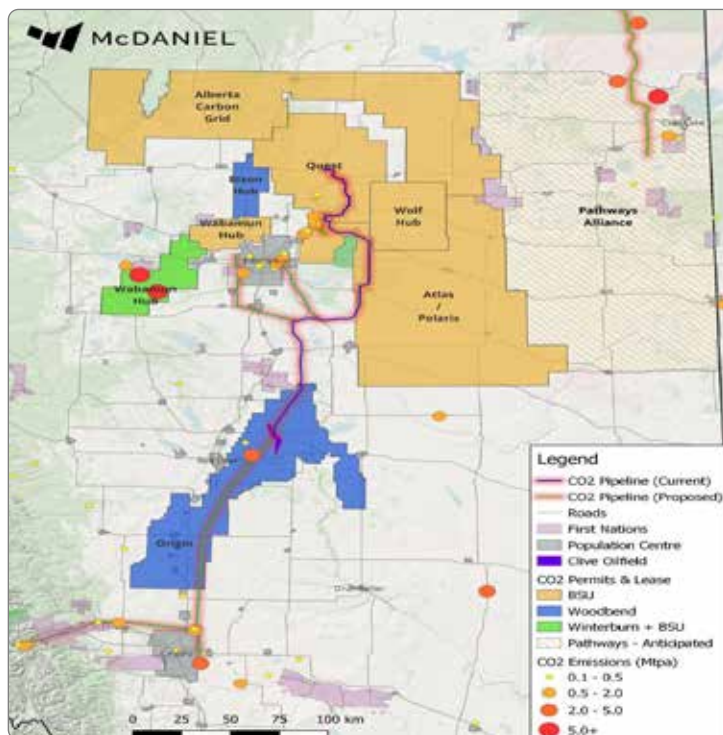
ACTL



- Alberta's first large-scale carbon capture utilization and storage project
- Consists of a 240-kilometre pipeline collecting and transporting up to 14.6 million tonnes per year of CO₂ for enhanced oil recovery and storage



Industrialheartland.com



UNCLASSIFIED | NON CLASSIFIÉ

NEW CCUS OPERATORS

Alberta has moved to a regulated sequestration market when certain parties have been granted the exclusive right to sequester CO₂ emissions in Alberta.

- This allows new emitters to work with a designated number of companies that have proven technical proficiency in sequestering emissions.
- New emitters have options to negotiate the commercial value of their emissions and cost of transportation / sequestration services
- In AIH, 6 companies/partnerships were granted exclusivity to sequester emissions:

Atlas Carbon – Shell Canada, ATCO, & Suncor
Meadowlark – Bison Low Carbon Ventures
Alberta Carbon Grid – Pembina & TC Energy
Wabamun Hub – Enbridge
Wolf Hub – Wolf Midstream
Origin Hub – Enhance Energy

16

GLOBAL MARKET ACCESS West Coast to International Markets

UNCLASSIFIED | NON CLASSIFIÉ

Gateway to Asia

- Quickest marine times from North America to access Asian markets through uncontested waters.
- Deepwater ports with active expansion from the likes to DP World and Vopak.



heartland.com

COMPREHENSIVE GOVERNMENT SUPPORT

UNCLASSIFIED | NON CLASSIFIÉ

Federal Incentives

Strategic Innovation Fund – Funding envelopes for strategic projects

Scientific Research and Experimental Design – Tax credits for research and design in Canada

Clean Technology Investment Tax Credit (ITC) – 30% refundable tax credit for 'clean technologies'

Carbon Capture Utilization and Storage ITC – Refundable tax credits for CCUS; 60% for DAC, 50% for carbon capture (other than from ambient air), and 37.5% for carbon transpiration, sequestration, and utilization

Clean Hydrogen ITC – 15-40% refundable tax credit for projects that produce hydrogen (based on CI)

Provincial Incentives

Alberta Petrochemical Incentive Program – Grants for 12% of capital cost of petrochemical projects

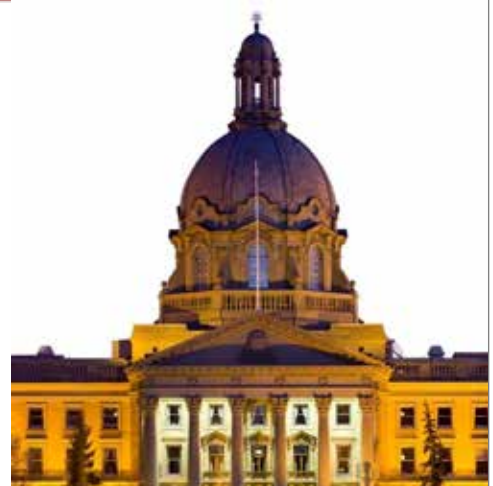
Alberta Carbon Capture Incentive Program – Grants for 12% of capital cost of carbon capture projects

TIER – Heavy emitter regulation in which new facilities can generate monetizable carbon credits for facilities which have better emission profiles than stated benchmarks

Municipal incentives

Heartland Incentive Program – Property tax abatement up to 2.5% of capital cost of project

Designated Industrial Zone – Regulatory streamlining for projects in Alberta's Industrial Heartland (fast tracked environmental permitting in region)

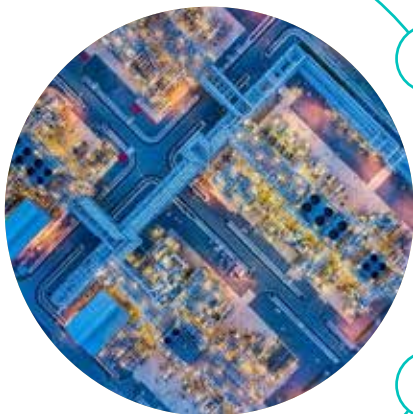


18

Industrialheartland.com

UNCLASSIFIED | NON CLASSIFIÉ

Alberta's Only Designated Industrial Zone (DIZ)



Regulatory Streamlining

- Reduced requirements for EPEA renewals
- Fast tracked regulatory approvals
- Facilitating harmonization of municipal permitting
- Developed the Applicants Advisory Service for new investments

Cluster Infrastructure Development

- Improved access to water that will support future hydrogen and petchem developments. (Feasibility study 21/22, grant supporting regulatory ready applications 2023/24, grant for water infrastructure 24/25)
- Improved topsoil management
- AIHA Master Drainage Plan for zone (submitted for Water Act approval)

Environmental Outcomes

- Air Emissions management (policy development and implementation)
- Developing cumulative load-management approach for wastewater
- Zone-wide assessment underway

Capital Investments

- Biannual working sessions across GOA departments co-lead with Jobs Economy and Trade with support from Alberta's Industrial Heartland and the Northeast Capital Industrial Association

[Industrialheartland.com](https://industrialheartland.com)



Thank you

David Howe

+1-780-232-7610

davidh@industrialheartland.com

Chris Malayney

+1-780-232-6784

Chris@industrialheartland.com



Country Day I : Canada Day

**Pitching Session
- Ballard Power Systems**

Country Day I : Canada Day

Pitching Session - Ballard Power Systems

Norman Chor

Account Manager of Asia Pacific,
Ballard Power Systems

Country Day I : Canada Day

**Pitching Session
- Greenlight Innovation**

Country Day I : Canada Day

Pitching Session - Greenlight Innovation



Greig Walsh

Chief Commercial Officer,
Greenlight Innovation

Professional Career

Greig Walsh is the co-founder and Chief Commercial Officer of Greenlight Innovation. He is a Mechanical Engineer and has been in the hydrogen and fuel cell industries for more than 25 years. His mission is to provide Greenlight's customers with the tools they need to commercialize hydrogen technologies.



COMPANY OVERVIEW



Mission

'Enabling the development and commercialization of advanced energy technologies to benefit society and the planet'





Company Facts

- Founded in 1992
- Leader in Fuel Cell and Electrolyzer testing equipment
- Global sales and service
- Equipment install base of ~2000 test stations
- Current manufacturing capacity: 150 – 200 test rigs per year
- 300 engineers, technicians, and staff



3



Greenlight Location

Located in the heart of the Vancouver fuel cell and battery community, with sales and service offices in Europe and Asia





Secondary Manufacturing Facility



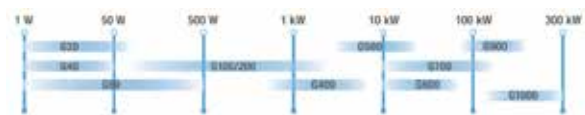
- 3700m² additional manufacturing facility



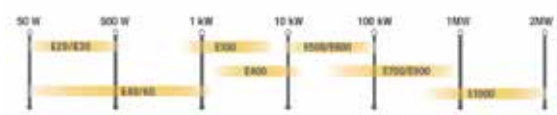
Our Products



Fuel Cell Test Stations



Electrolyser Test Stations



7



PEM Fuel Cell Testing



G20



G40/60



G100/200



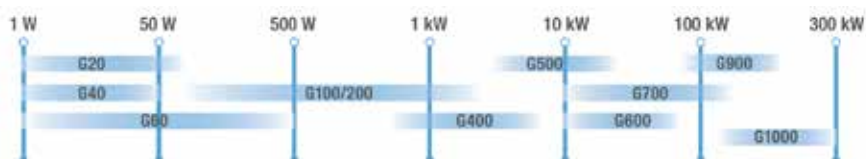
G400



G500/600



G700/900/1000



8



Fuel Cell System Development



9



Electrolyser Testing



10



Electrolyser Testing

Turn-key PEM and Alkaline Electrolyser test station:

- Anode and cathode DI liquid supply with metering pumps, including recirculation for cooling
- Power supply up to 1000A, 1000V, 1MW+
- Optional test hardware available

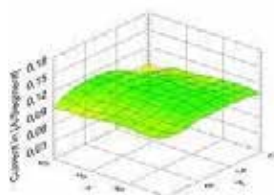


11



Integrated Diagnostic Tools

- Fully integrated Electrochemical Impedance Spectroscopy (EIS) instruments
 - Industry-leading instrument manufacturers (Gamry, Biologic, etc.)
 - Cyclic and linear sweep voltammetry
 - Built-in plotting of Lissajous, Bode, and Nyquist plots
- AC impedance / High Frequency Resistance
- Current Interrupt
- Current density distribution



12



Fuel Cell & Electrolyser Balance of Plant

Greenlight offers:

- procurement, assembly and testing of serial production BOP skids and systems



13



Primary Facility



- 5000m² facility

14



Secondary Facility



- Additional 3,700m² facility; large and small machine lines

15



Secondary Facility



- Additional 3,700m² manufacturing building

16



Sample Equipment Installations



17



Global Customer Service

- Service locations in Europe, North America, China, Korea, Japan and India
- Parts warehoused in China, NA and Europe
- Calibration, repair, upgrades and training
- Extended warranties & service contracts available
- Factory training available for test engineers or maintenance team



Photo: ZSW Germany

18



Country Day I : Canada Day

Pitching Session
- Momentum Materials Solutions

Country Day I : Canada Day

Pitching Session - Momentum Materials Solutions



Arlene Ai

Co-founder and CEO,
Momentum Materials Solutions

Education

Master's degree in Chemical Engineering from the University of Calgary.

Professional Career

Following graduation, she joined Momentum Materials, a start-up co-founded by her colleague.

Research Interest

With a strong focus on innovation in the field of hydrogen fuel cells, she has successfully secured three significant grants, enabling the development of cutting-edge membrane electrode assembly technology. In addition to her technical expertise, she has also taken on responsibilities in marketing and customer acquisition, helping to position Momentum Materials as a leader in the sustainable energy sector.

Speech Title

Momentum Materials

Speech Summary

Momentum Materials Solutions is a Calgary-based startup commercializing novel carbon technology with applications in catalyst and MEA products for PEM fuel cells. The team has developed carbon supports and catalysts that have demonstrated improved performance and durability during bench scale fuel cell testing. These patented materials can more than double the operational lifetime of fuel cell stacks while increasing rated performance.



MOMENTUM MATERIALS



WHO WE ARE

Innovative Carbon Materials for a Sustainable Future



200%+ Improvement

In durability for PEM fuel cells

13+ Customers

In 7 countries have tested the products



20+ Patents

Filed or applied around the core technology and products

12+ Awards

Received across Canada and China

www.momentummaterials.ca

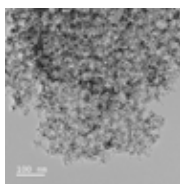
3

OUR PRODUCTS + SERVICES



CATALYST SUPPORT

- Momentum Materials proprietary NCP Supports™.
- Multiple pore size choice (10-100 nm)
- Enhanced carbon corrosion resistance



CATALYSTS

- Pt on NCP catalysts for PEM fuel cells, H₂ production, and more.
- Pt content options ranging from 20% to 50%.
- Superior catalyst durability



ANODE MATERIALS

- Momentum Materials proprietary MCP materials for Si-C anodes.
- Increased energy density and capacity
- Customizable properties



SERVICES

- R&D services for new material development in energy areas.
- Technical support to help customers succeed.

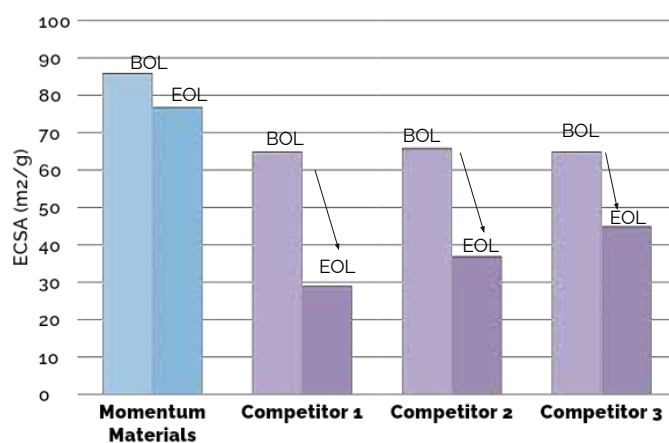
www.momentummaterials.ca

4

NCP Support



◆ Good Catalyst Durability



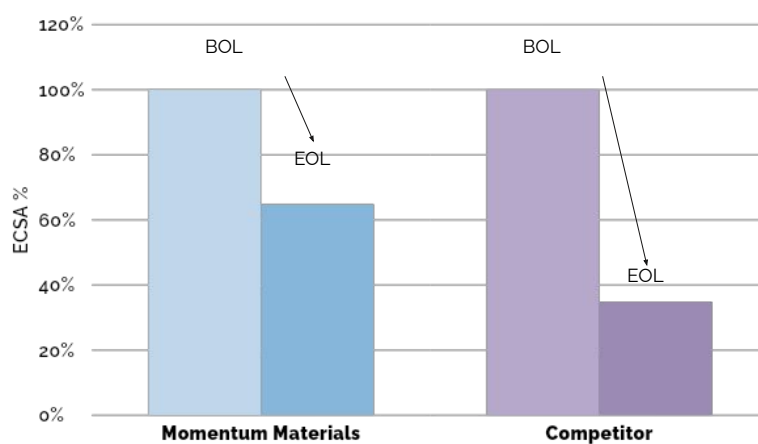
www.momentummaterials.ca

5

NCP Support



◆ Good Carbon Durability



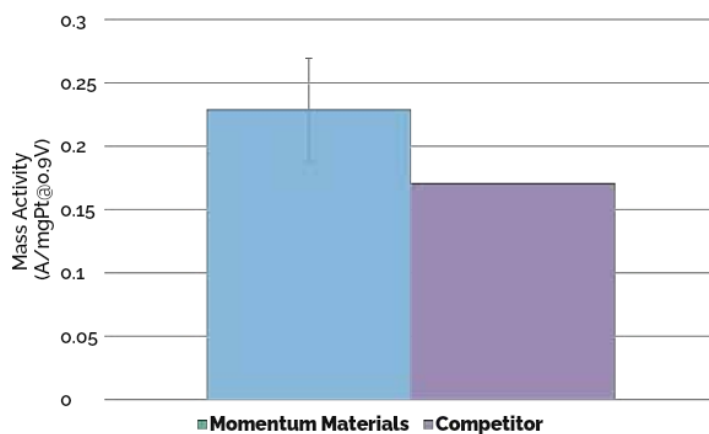
www.momentummaterials.ca

6

NCP Support



◆ Good Catalyst Performance



www.momentummaterials.ca

7

NCP Product Traction

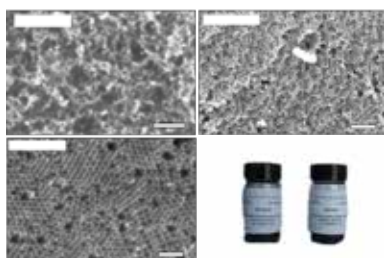


13+ Customers

In 7 different countries

300+ Kilograms

Annual manufacturing capacity



Higher Efficiency

Longer Lifetime

Lower Total
Lifetime Cost

www.momentummaterials.ca

8

Contact Us

❖ 253147 Bearspaw Road, Calgary, AB, Canada T3L2P5



Contact: Arlene /

EMAIL arlene@momentummaterials.com

WEB momentummaterials.com

www.momentummaterials.ca

9

Country Day I : Canada Day

**Pitching Session
- Powertech Labs Inc.**

Country Day I : Canada Day

Pitching Session - Powertech Labs Inc.



Ben Skillings

Division Manager, Powertech Labs Inc.

Company Introduction

Powertech Labs is recognized worldwide as the leading authority for the testing and certification of high-pressure hydrogen fuel storage components and systems. A wholly owned subsidiary of BC Hydro, Powertech Labs is made up of 200 scientists, technicians, engineers and specialists who are pioneers in the development of high-pressure hydrogen technology for both vehicles and refueling infrastructure. Since 2001, Powertech has designed and constructed 12 turnkey, compressed hydrogen fueling stations which are installed across North America. Powertech offers a one-stop-shop approach for businesses that require technical engineering expertise, standards and code testing, as well as quality testing and failure analysis services. We provide specialized testing and investigation services to support electrical utilities' capital assets: generation, transmission and distribution, OEMs, automotive manufacturers, government and research organizations

HYDROGEN TESTING & SOLUTIONS OVERVIEW

September 2024
Ben Skillings
H2 Meet Seoul, Korea

Powertech
The Power of Trust. The Future of Energy.



ABOUT POWERTECH

We are **catalysts** in the global transition to a **sustainable energy future** offering services for testing, engineering, and hydrogen infrastructure solutions.

- One of the largest testing and research labs in North America
- 15 different testing labs
- Specialty industries:
 - Power utilities
 - Automotive
 - Industrial manufacturing
 - Hydrogen

COMPANY OVERVIEW

Powertech

COMPANY OVERVIEW

LABORATORIES

MULTIDISCIPLINARY LAB FACILITY

Hydrogen Infrastructure



High Voltage



Stator Aging



Chemistry Research



High Power



Power Systems



Materials Solutions



Mechanical Testing



Grid Automation



3

COMPANY OVERVIEW

HYDROGEN INNOVATION

Since **1983**, Powertech has provided the **technical expertise** to support the complex and changing needs of the compressed gas industry, including hydrogen. Many of Powertech's most recent innovations are contributing to the **advancement of the industry**.

TESTING | HYSTEP | FUELING STATIONS | TRANSPORT | MOBILE REFUELING



COMPANY OVERVIEW

HYDROGEN TESTING SERVICES

Trusted by automotive OEMs and their Tier 1 and 2 suppliers/integrators for over 20 years

Cylinders



Components



Fuel Systems



Customized



5

COMPANY OVERVIEW

HYDROGEN TESTING SERVICES

World leader in performing **customized** and **destructive testing** of high-pressure components and systems

Hydrogen Release



Crush/Impact



Damage Tolerance



Hydrogen Ignition



H₂ Embrittlement



Vehicle Fire



6

COMPANY OVERVIEW

HYDROGEN TESTING SPOTLIGHT

DESTRUCTIVE CYLINDER TESTING

GUNFIRE TEST



BONFIRE TEST



7

COMPANY OVERVIEW

HYDROGEN INFRASTRUCTURE INNOVATION

GLOBAL FIRSTS IN HYDROGEN

Canada's leading hydrogen station equipment provider

We develop, integrate, and deliver safe and reliable next-generation hydrogen infrastructure.



2001: Canada's first 35 Mpa hydrogen fueling station



2002: World's first 70 Mpa hydrogen fueling station

Today: Amongst the highest performing hydrogen stations in operation



COMPANY OVERVIEW

HYDROGEN INFRASTRUCTURE SOLUTIONS

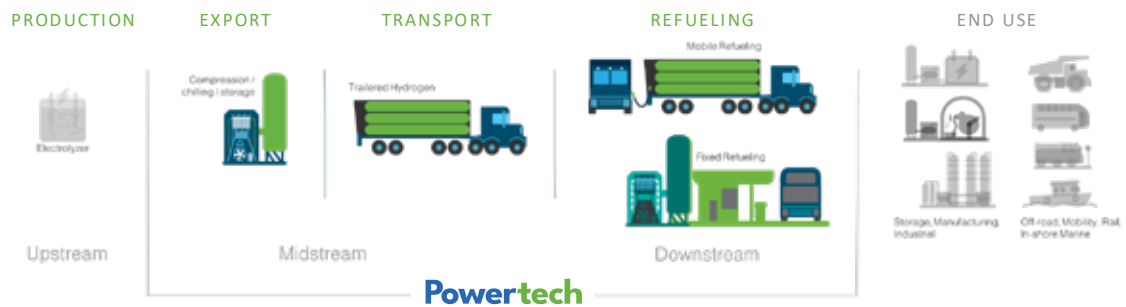
Powertech is enabling the transition to hydrogen by providing **integrated transport and fueling infrastructure solutions** – from production outlet to vehicle inlet – with **wrap-around support services**.

PRODUCTS

- Fixed Fueling
- Mobile Refueling
- High-Capacity Trailer
- Export systems

SERVICES

- Engineering (Pre-FEED, FEED, TEA)
- Operations & Maintenance



9

COMPANY OVERVIEW

HYDROGEN INFRASTRUCTURE

TRANSPORT AND FUELING EQUIPMENT

Infrastructure solutions that **link supply to demand**

Fixed Fueling Stations



Mobile Refuelers



High-Capacity Trailer



Export Systems



COMPANY OVERVIEW

HYDROGEN INFRASTRUCTURE SUPPORT SERVICES

WRAP-AROUND SUPPORT SERVICES

Engineering



Testing



Operations & Maintenance



COMPANY OVERVIEW

HYDROGEN INFRASTRUCTURE SPOTLIGHT

UNIVERSITY OF BRITISH COLUMBIA RENEWABLE ENERGY HUB



- City-scale “living laboratory”
- Solar array on the parkade roof
- Electrolyzer producing up to 60 kg/day of green hydrogen
- Hydrogen compression and storage in enclosure
- Dispenser for 700 bar light- and 350 bar heavy-duty vehicle fills





Powertech
The Power of Trust. **The Future of Energy.**

Country Day I : Canada Day

**Pitching Session
- TesTneT Canada**

Country Day I : Canada Day

Pitching Session - TesTneT Canada



Young-min Choi

Sales Representative of Korea,
TesTneT Canada

Company Introduction

TesTneT Canada Inc. is a subsidiary of TesTneT Engineering GmbH of Munich. TesTneT is an ISO 17025: 2017 registered organization, performing the high pressure testing of components used in hydrogen fuel systems. TesTneT can conduct various tests involving hydrogen gas pressure cycling, hydraulic pressure cycling, and destructive tests (fire testing, gunfire penetration) on all elements of hydrogen fuel systems, including fuel containers, pressure regulators, valves, fittings, hoses, etc.

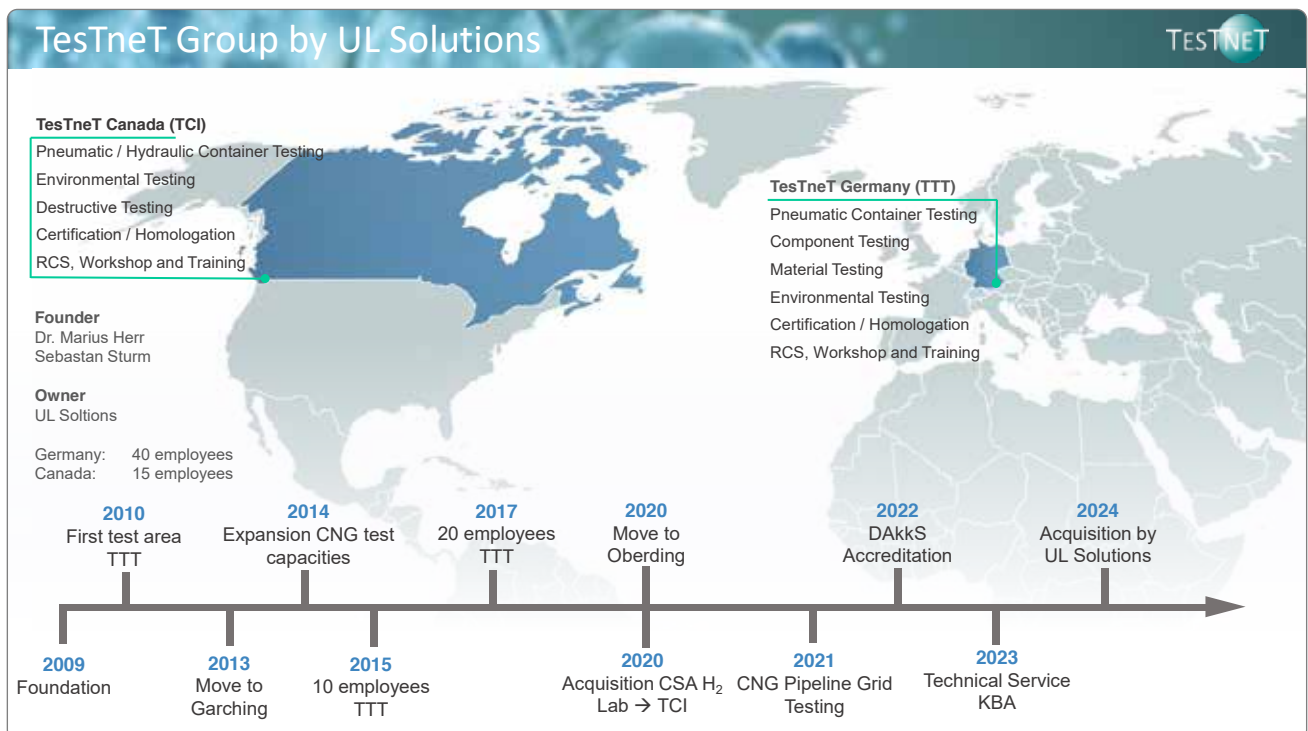


TESTNET

The HYDROGEN Testing Group
by UL Solutions

DIN EN ISO/IEC 17025 accredited by DAkkS / IAS
Tech. Service Category A, B and D (KBA Germany)



TesTneT Group by UL Solutions


TesTneT Germany

TesTneT Engineering GmbH
Eschenallee 11
85445 Oberding (Schwaig)



3

TesTneT Group by UL Solutions




TesTneT Canada

TesTneT Canada Inc.
9669-201 St.
Langley, British Columbia



Activities

TESTNET



Testing Services

- Extensive in-house testing capabilities
- Network of partner laboratories
- Individual design and set up of test stands
- Communication, documentation and reporting
- Validation and certification

Facility Design

- Conceptual design
- Engineering and construction
- Safety concepts
- Approval
- Commissioning
- Operation

Technical Service

- In-house Type Approval via KBA / Germany for certification of automotive components
- Strong cooperation with Notified Body for PED/TPED components

RCS, Workshop and Training

- Committee activities
- H₂ safety
- H₂ storage & transport
- Custom Workshops
- Individual Trainings

8

Testing Services: Components

TESTNET



Specimen

- OTV
- Pressure regulator
- Manual valves
- Pressure / Temperature sensors
- Nozzles / Receptacles
- Injectors
- Connectors
- Tubings / Fittings / Hoses
- TPRD
- Breakaway coupling

Flow

Parameter

- up to 150 g/s
- up to 300 g/s (coming soon)

Pressures

- up to 250 MPa (gas)
- up to 700 MPa (hydr.)

Temperatures

- -60...180 °C (static / cyclic)
- ≥ LN₂ temp. (cryogenic testing)
- up to 600 °C (TPRD benchtoping)

Types

- Cycle testing
 - Hydraulic cycling (water, oil)
 - Gas cycling (H₂, N₂, CNG)
- Leak test
- TPRD activation
- Corrosion
- Mechanical forces
- Chatter tests
- Function tests
- Coupling / uncoupling

14

Testing Services: Containers

TESTNET



Subscale

Liner material selection

- Permeability
- f(mat., T, p, gas, geometry)
- Moisture
- H₂ / CNG compatibility
- Blistering

Boss material selection

- H₂ compatibility
- Corrosion

Design

- Liner boss connection
- Boss-connector geometry



Single Tanks

Hydraulic testing

- Burst pressure
- Ambient & extreme temperature pressure cycling

H₂ gas tests

- Permeation / leakage
- Gas cycling

Destructive

- Localized fire / bonfire / penetration
- Chemical exposure

Other tests

- Mechanical testing
- Customized tests



Storage Systems

- Customized tests
- Liner buckling
- Extreme climate corrosion
- Filling & defueling procedures
- Crash
- Computer tomography

15

Testing Services: Containers

TESTNET



Gas Pressure Testing

H₂ gas cycling acc. RCS-requirement like

- EC79 2009 / EU406 2010
- GTR 13 / ECE R134 and others

Custom filling tests like

- PRHYDE - dynamic refueling simulation

Safe chamber

- Unsafe containers
- Pre-damaged containers
- Refueling station error-case simulation



Hydraulic Pressure Testing

Hydraulic tests acc. RCS requirement like

- GTR 13 / ECE R134
- ANSI/CSA HGV 2 – Hydrogen Vehicle Tanks
- ISO 19881: 2018 – Gaseous Hydrogen – Land Vehicle Fuel Containers and others

Most common tests

- Hydraulic burst
- Pressure Cycle (ambient, extreme temperature)
- Accelerated stress rupture



Destructive Testing

Destructive tests acc. RCS requirement like

- EC79 2009 / EU406 2010
- GTR 13 / ECE R134
- EN 12245

Most common tests

- Bonfire test
- Gunshot test
- Penetration / Impact test

16

Testing Services: Containers

TESTNET

Destructive Test – Fire Resistance & Penetration



Pipe for fire testing
(cylinder placed inside)

Pipe for gunfire testing
(cylinder placed inside and shot through hole)

Test trailer
(DAQ)



Bonfire Test



Gun Fire / Penetration test

17

Testing Services: Materials

TESTNET



H₂ Compatibility

- Metallic (ISO 11114-4)
- Non-Metallic (ANSI CSA CHMC2)



Blistering

- Static
- Dynamic
- Rapid decompression
- Custom profiles



Mechanical Testing

- Tensile test
- Melting Point analysis
- Shear properties
- Density



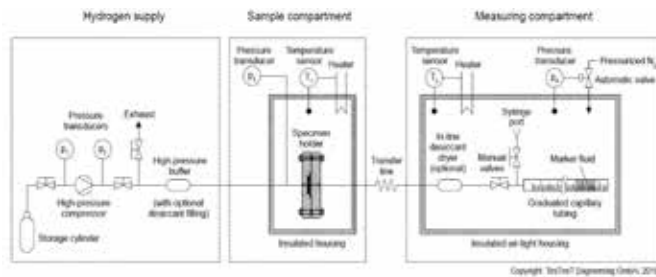
Plate Permeation

- Polymers, Elastomers, Compounds
- Different test media
- Up to 105 MPa
- -40...100 °C

18

Testing Services: Materials

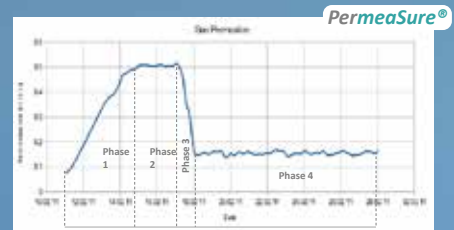
TESTNET



Innovative Permeation Rate Measurement

Acc. ANSI CSA CHMC2

- Permeation rate measurement on raw material level
- Customer is not required to provide full-size test sample (pressure container)
- Lean test setup, fast and adjustable permeation build-up rates
- Precise, fast and cost-efficient



19

Testing Services: Environmental

TESTNET



Thermal Tests

- Temperature cycle
- Temperature shock
- High temperature duration test
- Steam / heat cycling

Chemical Tests

- Salt spray corrosion
- Oxygen & ozone aging
- Automotive fluid exposure
- Moist ammonia exposure

Others

- Vibration
- Noxious gases
- Dust
- Impact
- Classification waterproofing

20

Testing Services: Special

TESTNET



Two independent protective environments to cover custom test demands

- Pneumatic overpressure / burst test of low volume components
- Pressure cycling of large scale components (volume reduced) with unclear safety level
- Hydrogen ignition testing

Reference Project

Benchmark testing of CNG pipeline components, taken out of the Germany CNG pipeline grid

- Leakage behavior comparison testing (CNG vs. H₂ vs. N₂ Leakage)
- Leakage behavior during cyclic hydrogen cycling



Zertifizierungsprogramm
Ergänzungsprüfungen für Armaturen für gasför-
mige Brennstoffe für einen Wasserstoffgehalt von
bis zu 100 Vol.-%
DVGW CERT ZP 4110

Doc.-Art.	ZP
Verfasser	DVGW CERT GmbH
Stand	01.12.2012

21

Certification & Type Approval

TESTNET



Toyota



Linde



TesTneT

Automotive

GCH₂ storage systems

- Tanks and components
- Fuel cell system components
- Fuel cell systems (*planned*)

Transportable

GCH₂ storage systems

- Single vessels and bundles
- System components (valves)

Stationary

Refueling station components

- Dispenser system components (hoses, breakaways, nozzles)
- Electrolyzers and FC components

22

Certification & Type Approval

TESTNET

TesTneT Homologation Matrix				
Application	Automotive		Transportable	Stationary
Standard	European Union	Others	TPED	PED
Service	Type Approval Letter of Attestation Certificate of Conformance	Letter of Attestation Certificate of Conformance	Test + Certificate	
Testlab	TESTNET			
Certifier	Technical Service TESTNET	e.g. NRTL (North America) TESTNET Partner	Notified Body (via TÜV RL)	TESTNET Partner







23

RCS, Workshops and Training

TESTNET



RCS

- Validation
- Certification
- Homologation
- Committee activities
- H₂ safety
- H₂ storage & transport

Workshops

- Hydrogen Academy (HyAc GmbH) powered by LIFTE H₂ and TesTneT
 - H₂ knowledge modules
 - Qualification modules
 - Customized offer
- Certificate of participation

Training

- Conceptual design
- Engineering and construction
- Safety concepts
- Approval
- Commissioning
- Operation

24

Regulations, Codes and Standards

TESTNET

United Nations (UN, UNECE)

- UN GTR 13 Phase II/Task Force 3: Test Procedures
- UNECE R134: Safety related Performance of H₂-fueled Vehicles

International Organization for Standardization

- ISO TC 197: H₂-Technologies German National Committee
- ISO 19887: Fuel System Components for H₂-fueled Vehicles

Canadian Standards Association

- CHMC 1: Hydrogen Compatibility of Metallic Materials
- CHMC 2: Hydrogen Compatibility of Non metallic Materials
- HGV 2: Compressed Hydrogen Gas Vehicles Fuel Containers
- HGV 3.1: Components for Hydrogen Vehicles
- HGV 4.2: Hydrogen Refueling Stations Hoses
- HGV 4.4: Hydrogen Refueling Stations Breakaway Devices
- HGV 4.6: Hydrogen Refueling Stations Manual Valves
- HGV 4.10: Hydrogen Refueling Stations Fittings

Deutscher Verband des Gas und Wasserfaches (DVGW)

- G PK 2 5 6 Project Group for Hydrogen Refueling Stations

Sino-German Electro Mobility Innovation & Support Center (SGEC)

- German/Chinese Hydrogen Mobility RCS Cooperation Group



25

Expansion Germany

TESTNET

Cryogenic Hydrogen Test Infrastructure



LH₂-storage systems (permission given)

- Filling / pressure increase measurement / boil off
- Component flow test
- Cryogenic pump testing
- Fuel cell system testing
- Electrolyzer testing



27



TESTNET

The HYDROGEN Testing Group
by UL Solutions

For more information please contact
sales@h2-test.net

GERMANY	CANADA
Dr. Marius Herr	Craig Webster
m.herr@h2-test.net	cwebster@h2-test.net

 TesTneT Group

 Hydrogen Academy

Country Day I

Norway Day

Country Day I : Norway Day

**The low carbon value chain in Norway
– CCS, green and blue hydrogen and ammonia**

Country Day I : Norway Day

The low carbon value chain in Norway – CCS, green and blue hydrogen and ammonia



Per Christer Lund

Energy Counsellor, The Royal Norwegian Embassy

Education

PhD in Chemical Engineering from Norwegian University of Science and Technology (1986-1991)

Professional Career

With an PhD in chemical engineering from the Norwegian University of Science and Technology, Per Christer engagement in the maritime and energy industries spans over 30 years, including research institute (Institute of Energy Technology in Norway); software company (director for OMX/HandelScandinavia - now Nasdaq OMZ) in Canada; energy market consultancy (Nordpool Consulting) (advisory on global energy markets) and a Japanese nuclear power company (Power Reactor and Nuclear Fuel Development Corporation).

Research Interest

Renewable energy – offshore wind, solar, geothermal
Energy efficiency
Energy markets and systems
Low carbon energy value chain – CCS, hydrogen, ammonia
Nuclear energy

Speech Title

The low carbon value chain in Norway – CCS, green and blue hydrogen and ammonia.

Speech Summary

The speech presents the background and status for Norwegian low carbon energy value chain. From early mover on offshore CCS in the 1990s, Norway is very well positioned as a major producer and exporter of blue hydrogen to Europe and beyond. Also founded on Norway's excessive hydro power the country also have significant potential for green hydrogen and ammonia.

The strong cooperation between government and industry is reflected in an clear hydrogen strategy supported by the industry – now seeing around 80 projects and initiatives on hydrogen and ammonia production, transport and usage.

Company Introduction

Innovation Norway is the Norwegian Government's most important instrument for innovation and development of Norwegian enterprises and industry. In Korea, Innovation Norway is the commercial section of the Norwegian Embassy, supporting Norwegian companies for business development, export and internationalization.

The low carbon value chain in Norway – CCS, green and blue hydrogen and ammonia

Norway Day - H2Meet Conference 2024 - Seoul Sept. 26, 2024

Dr. Per Christer Lund
Energy and Technology Counsellor
Norwegian Embassy / Innovation Norway
perlu@innovationnorway.no



[Hydrogen from Norway \(businessnorway.com\)](https://businessnorway.com)

PEXELS, S. E.
Liland

Norway – a unique energy nation

A petroleum major

- World's 4th largest exporter of natural gas, 7th largest exporter of crude oil
- Petroleum industry is 25 % share of total GDP and employs ~200 000 people directly and indirectly (out of 5.5 million population).
- Norway has built up the world's largest Sovereign Wealth Fund 1.568 billion Euro (three times Norway's GDP)
- Norway exports 10 times more energy than domestic consumption

A renewables major

- 98% electricity produced by green hydro power
- A major exporter of green electricity and storage/balancing services to Denmark, UK, EU
- World's first and world's largest floating offshore wind farms
- Huge potential for offshore wind energy, ambition to develop 30 GW floating by 2040
- Global leader on floating offshore technology and maritime operations

A green energy export major?

- Increased electricity export – grid expansion
- Green hydrogen producer and exporter – from offshore wind..?
- Blue hydrogen/ammonia producer and exporter – from natural gas with CCS



The Norwegian Hydrogen Landscape

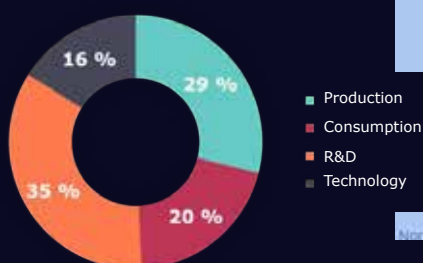
Number of
projects in total

212

.....
Projects in 82
municipalities

Different types of projects

Production	75
Consumption	52
R&D	90
Technology	41



Planned production volume in tonnes

Number of projects	Year	Planned production (tonnes)		
		Total	Renewable	Low-carbon
75	2025	14 300	10 500	3 800
	2030	1 300 000	1 070 000	230 000
	2035	2 500 000	1 300 000	1 200 000
	2040	4 785 000	1 300 000	3 485 000



SKREI/HEGRA – Herøya Green Ammonia



HEGRA – Herøya green ammonia
www.hegra.no/

Key points:

- Electrifying Yara's ammonia plant with renewable power; PEM electrolysis (450 MW)
- 400,000 tons green ammonia per year
- Reducing CO₂ emission by 800,000 tons per year
- Operational by 2026-28

Technical data

Hydrogen technology: Oxyfuel ATR
[SynCOR Ammonia™]

CO₂ capture technology: pre-combustion

Gas feed: 2.8 MSm³/d

Renewable electricity: 10 MW

Blue hydrogen capacity: 600 ton/d

Blue ammonia capacity: 3000 ton/d

Annual output: 1 million ton/yr

CO₂ capture rate: above 99%

CO₂ injection: 2 million ton/yr

Legend:

- Equinor ASA: 40%
- Horisont Energi AS: 30%
- Vår Energi AS: 30%

Key points:

- Replacing coal by hydrogen as reduction agent for ilmenite (FeTiO_3)
- Reducing CO2 emissions by 82%
- Funded by ENOVA through IPCEI (ca 30 mill USD)

Tizir project

Pioneering Sustainability

Selected hydrogen maritime projects in Norway

Lofoten-Bodø Hydrogen Ferry from 2025



Public Procurement Lofoten-Bodø Hydrogen ferry



Pioneering Sustainability

HYDRA Ferry

Hydra hydrogen ferry

TOPEKA



Topeka hydrogen vessels

Two of the world market leaders of electrolyzers have their HQ in Norway

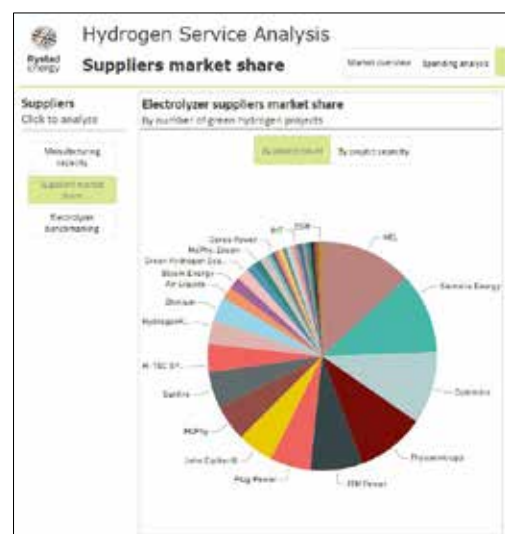


NEL production plants:

- Norway
- USA



HydrogenPRO production plants:	Hystar production plants:
- China	- Norway
	- USA tbc



Source Rystad Energy 2023



Photo NEL



Photo Hexagon



Photo Eidesvik



Ongoing Nor



2007: Snøhvit LNG
0,7 mill ton/yr

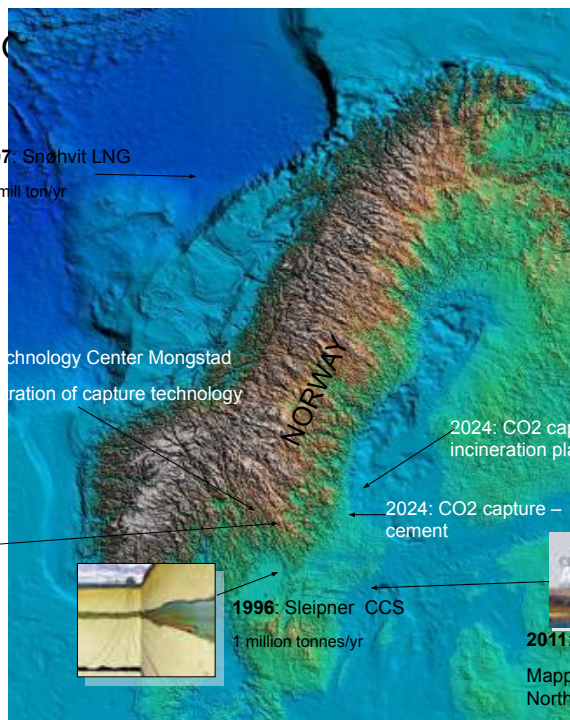


Technology Center Mongstad
Integration of capture technology

2022: Northern Lights



1996: Sleipner CCS
1 million tonnes/yr



Norwegian Enabling CCS Value Chain

Capture

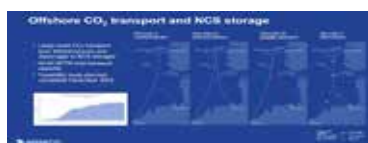


Source: Rystad Energy - Your Energy Knowledge House
Print screen made Jan 24



Transport

Exploring CO₂ pipelines – Gassco CO₂ study



COD Northern Lights – 2024/2025



Source: Northern Lights JV DA_EU
Project Common Interest

NOR CO₂ Storage – Saline Aquifers



Source: Rystad Energy - Your Energy Knowledge House
Print screen made Jan 24

13

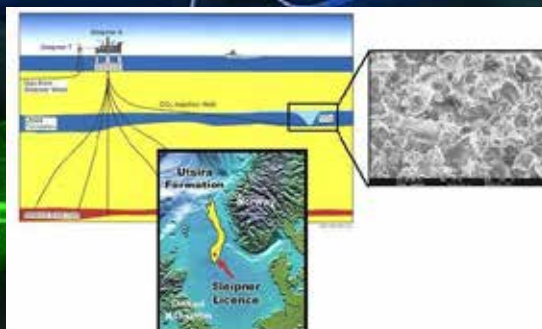


Pioneering Sustainability

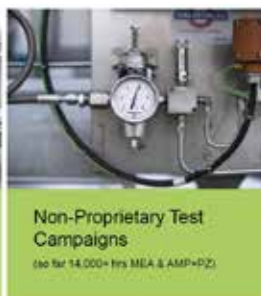
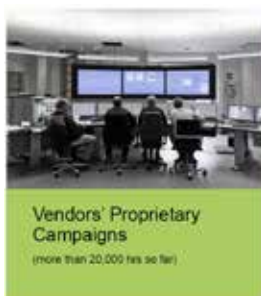


The starting point – Sleipner CCS (1996)

- First industrial scale offshore CCS project – Norwegian sector of the North Sea
- In operation by Norwegian energy major Equinor since 1996
- CO₂ source: reducing CO₂ content in natural gas from 9 – 2.5 %. Offshore/topside capture.
- Financial driver: introduction of CO₂ tax of ~45 US\$/ton in 1991
- Injection into saline aquifer 800-1000 m below seabed (above gas field)
- Capacity ~1 million ton/year – accumulated > 20 million ton injected (45% of Norway's annual emission)
- Comprehensive monitoring for integrity and leaks – observed creation of carbonate seals



Technology Centre Monstad (TCM) – world largest open access test center for CCS



Key points:

- Main objective to test, verify and demonstrate different cost-efficient, industrial scale CO₂ capture technologies
- In operation since 2012 at Equinor processing plant
- Owned 73.9% by Norwegian Government, remaining between Equinor, Shell, Total
- Competence center for world-wide CO₂ capture projects

Technology Centre Monstad - TCM



Pioneering

15



Full scale CCS value chain - Northern Lights & Longship projects

Northern Lights HUB terminal



Northern Lights main partners



Northern Lights



Key points:

- Demonstration of full scale open-source infrastructure for CO₂ capture, (ship) transport and storage
- 1.5 mill ton CO₂ storage per year (by 2024)
- Longship includes CO₂ capture from industrial sources in Norway (cement and **waste to energy**)
- Liquid CO₂ shipment
- Total investment estimation 2 bill USD) with Norwegian Government support



Pioneering Sustainability

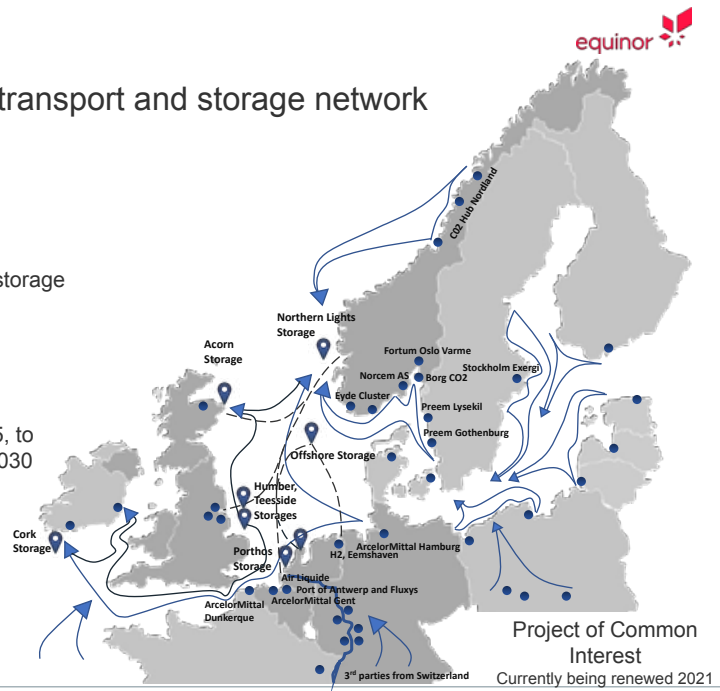
16



European eco-system for CCS I towards and integrated European transport and storage network

Full cycle carbon removal and storage

- Create eco-system for CCS – a community
- Emitters as well as integrated network with other storage locations - safe, secure and cost efficient
- Position for CEF funding (under TEN E)
- A specific, concrete solution for industry by 2024/5, to maintain jobs and reach emission reductions by 2030
- Flexible to scale up as market develops



Country Day I : Norway Day

**Norwegian Research Collaboration and
Future Opportunities**

Country Day I : Norway Day

Norwegian Research Collaboration and Future Opportunities



Christine Mee Lie

Counsellor for Higher Education,
Research and Innovation,
The Royal Norwegian Embassy in Seoul

Education

- 2017, R&D Policy evaluation: Methods, Experiences and New Approaches, University of Twente, Enschede, Netherlands.
- 2013-2017, Ph.D., Technology and Innovation studies, University of Oslo, Oslo, Norway.
- (also guest researcher as part of Ph.D. at Korea Development Institute, Sejong, Korea)
- 2010-2012, M.S., Economics, University of Oslo/Yonsei University, Oslo/Seoul, Norway/Korea.
- 2007-2010, B.S., Public Administration and Management, University of Oslo, Oslo, Norway.

Professional Career

- 2022-present, Counsellor for Higher Education, Research and Innovation, The Royal Norwegian Embassy, Seoul, Korea.
- 2019-2022, Senior Economist/Consultant, Menon Economics AS, Oslo, Norway.
- 2017- 2019, Advisor, Norwegian Ministry of Education and Research, Oslo, Norway.

Speech Title

Norwegian research collaboration and future opportunities

Speech Summary

The speech will introduce ongoing Norwegian research collaboration and discuss the impact of this and future opportunities, including relevant national funding opportunities and opportunities through Horizon Europe (in which Korea will become an associated member country from 2025).

Company Introduction

The Royal Norwegian Embassy in Seoul.

 Norwegian Embassy

Norwegian Research Collaboration and Future Opportunities

Christine Mee Lie, PhD
Counsellor for Higher Education, Research and
Innovation
Norway Day at H2Meet Conference, KINTEX, September 26th
2024 – «Norway enabling low carbon & renewable hydrogen
value chains»



Norwegian **Hydrogen Strategy** and **Hydrogen Roadmap**

- **Hydrogen Strategy** launched 2020
 - **Hydrogen Roadmap** launched 2021 as part of the White Paper “**Putting Energy to Work**”
-
- Overall goal: *Support **technology development through the whole innovation chain** from research to piloting and demonstration of production and use of clean hydrogen.*
 - Ambitions towards 2030: ***Hydrogen as an energy carrier has been established as a real alternative** in the maritime sector and matures further as a good alternative in industry.*



Norwegian Embassy



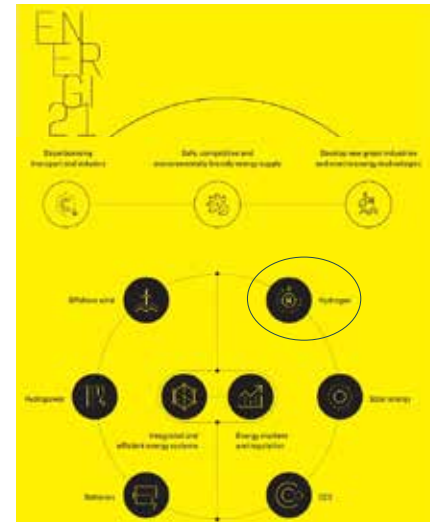
2

Energy21 Strategy: Hydrogen 1 of 6 Focus Areas

- Norwegian strategy for **research, development and commercialization** of new climate friendly energy technologies.

• Overall goal: Contributing to a **coordinated, efficient and goal-oriented focus** on research and technology efforts, where **increased commitment from the energy industry is key**.

- Prepared by **industry, research institutions, academia and the authorities**.
- The **government-appointed board** is tasked with **following up** the strategy and giving **advise** on R&D funding allocations.



Funding and Support for Hydrogen

- Considerable funding schemes** supporting the development of hydrogen today - **from basic research to innovation projects**.

- A key element of the mentioned Roadmap was the **coordination of hydrogen-relevant funding agencies** - which led to the establishment of HEILO.

And we see that overall:

- The public funding level for research, demonstration, and market introduction within hydrogen has **increased significantly in recent years**.
- Key energy companies and industries in Norway have committed to **several large hydrogen projects**.

HEILO

- Funding mechanisms for hydrogen, from basic research to innovation projects and investments in environmentally friendly technologies
- Cooperation between
 - The Research Council of Norway (R&D)
 - Innovation Norway (R&D)
 - Enova (R&D and investments)
 - Gassnova (R&D CO₂ capture and handling)
- Website: www.enova.no/heilo



Two Centres for Environment-friendly Energy Research (FME) on Hydrogen Established

HYDROGENi – Norwegian centre for hydrogen and ammonia research and innovation.

- NOK 200 mill NOK/Year 5-8 year 2022-2030
- Host SINTEF Energy
- Research partners; SINTEF, SINTEF Ocean, NTNU, IFE, UiO, USN, UiT
- 50+ user partners

HyValue – Norwegian centre for hydrogen value chain research.

- NOK 120 mill NOK/Year 5-8 year 2022-2030
- Host NORCE
- Research partners; UiB, UiS, NHH, Western Norway University of Applied Science, SNF, FNI, TØI
- 45 user partners



Norwegian Embassy



5

HYDROGENi & HyValue Partners



Norwegian Embassy

6

...Norway also Collaborates in Several International Arenas for R&D within Hydrogen

Why?

- **International collaboration on R&D is key** to solving the world and Norway's energy need for the future.

• Norway participates in:

- Clean Hydrogen Partnership
- Clean Energy Transition Partnership
- Hydrogen Europe
- IEA Technology Collaboration Programme
 - (Korea also a participant)



Norwegian Embassy

7

Relevant for **Future Research Co-operation** between Norway and Korea

- **MoU signed between MSIT & Norwegian ministry of Education and Research nov 2019**
 - *The basis for fostering and furthering our co-operation in R&D.*
 - *First JCM to take place in Seoul this October – renewable energy on the agenda.*
- **MoU between KETEP and RCN signed nov 2019.**
 - *Several projects already established.*
- **Korea becoming 1st Asian country to be associated to Horizon Europe from 2025**
 - *Norway been an associated member for 30 years – and are performing very well in the fiercely competitive program.*

(...RCN & NRF working on a bilateral  Norway -  Korea research call that will include hydrogen research projects - BUT this is still under development/negotiations – stay tuned for more details later!)



Norwegian Embassy

8

Korea a Prioritized Country for Norway

- **PANORAMA-strategy:** the Norwegian Government's strategy for co-operation with strategic partner countries outside the EU
 - **Purpose:** *To increase the quality and relevance of Norwegian higher education, research and innovation through internationalisation, and through cooperation with industry.*

- **Korea was included as new strategic partner country in 2021!**

...this means that it's a priority for Norway to increase R&D collaboration with Korea in *general* – not only related to hydrogen. Which is an important take away as well, to keep in mind 😊



(Co-operation with Russia on hold)



Norwegian Embassy

9



Norwegian Embassy

Thank you for the Attention!



Christine Mee Lie, PhD

Counsellor for Higher Education, Research and Innovation, Royal Norwegian Embassy in Seoul

Christine.mee.lie@mfa.no

www.linkedin.com/in/christinemeelie



Country Day I : Norway Day

**Green hydrogen production
by alkaline electrolysis system**

Country Day I : Norway Day

Green hydrogen production by alkaline electrolysis system



Nuno Bernardino Rodrigues

Tender Manager, Nel Hydrogen Electrolyser

Education

Post-graduation in digital business | by Emeritus, Columbia business school and MIT – 2019/20
Digital strategy and transformation, platforms, and digital marketing
Msc. Mechanical Engineering equivalent | Instituto Superior Técnico, Lisbon, Portugal – 1994-1999

Professional Career

TENDER MANAGER – Nel Hydrogen Electrolysers AS, Norway June 2022 to Present
MANAGER C&A AFTERMARKET AND PROJECT EXECUTION – TechnipFMC, Norway Oct 2021 to May 2022
DEPUTY SYSTEM PROJECT MANAGER – TechnipFMC, Norway Oct 2018 to Sept 2021
PROJECT MANAGER – Development of next Generation of Controls systems - FMC Technologies Norway 2016-2018
PRODUCT PROJECT MANAGER – Controls, IWOCS and Connections - FMC Technologies / TechnipFMC, Norway Feb 2011 to Oct 2018
OWNER | Create Solid LDA, Portugal 2005 to 2011
MECHANICAL ENGINEER | CERN, Switzerland 2003 to 2005
TEAM LEADER | Jorge Honório da Silva e Filho Lda, Portugal 2001 to 2003
JUNIOR ENGINEER | LEMAC-PT, Portugal 1999 to 2001

Research Interest

Particle physics
New product development

Speech Title

A century of Norwegian electrolyzers focused safety, efficiency and reliability

Speech Summary

When Sam Eyde started Norsk Hydro aiming to produce hydrogen from the plentiful hydro power to produce ammonia, triggered a chain of events that led to the creation of several industrial powerhouses, including what would become NEL today.

That technology that started in the early XX century has been improved with the contribution of generations of Norwegian engineers to bring it to what it is today and will continue to be further developed in terms of safety, efficiency and reliability for the decades to come.

Company Introduction

As the world leading hydrogen technology company, Nel is a pure-play technology company. We are independent and dedicated to delivering the best technology solutions for hydrogen in the market.

With a long track record, our technology has been refined and improved over almost 100 years.

We have the most energy-efficient water electrolyzers, with a robust and proven technology but we are looking into the future by pushing the boundaries of efficiency.

nel•

A century of Norwegian
electrolysers focused on safety,
efficiency and reliability

Nel's solution for large scale
green hydrogen



NEL IN BRIEF

A fully dedicated electrolyser technology company

A century of
electrolyser innovation
and pushing for new
technologies

One focus:
Delivering the most
energy-efficient and
reliable electrolysers

World-class partners
for delivering best-in-
class turn-key systems

NEL IN BRIEF

A fully dedicated electrolyser technology company



3

nel

Nel's founding father

- Sam Eyde represents the beginning of the Norwegian industrial adventure
- His visions resulted in companies such as Hydro, Elkem, Yara ... and Nel
- Sam Eyde's big idea was to produce fertilizer for a world that needed more food
- Nel's big idea is to make electrolyser equipment for companies that wants to cut emissions



4

nel

NORWAY

Almost a century of electrolyser innovation in Norway

- Nel's history begins in 1927 when Norsk Hydro, Nel's parent company, started testing its first electrolyser
- Hydro also built the world's two largest hydrogen production plants: Rjukan (167 MW) and Glomfjord (135 MW)
- The electrodes manufactured at Herøya today are a further improvement of Hydro's technology
- The facility at Herøya was the world's first fully-automated electrolyser facility
- At the research center in Notodden we are developing next-generation pressurized alkaline electrolysers



1953: A 135 MW electrolyser system in Glomfjord, Norway

nel

5



nel

Excess of power at Rjukan

- Use of available 'green' power 167 MW
- Six floors of electrolyzers
- H₂ for ammonia and fertilizer
- Operating from 1929 – 1971
- World war II
- Hollywood



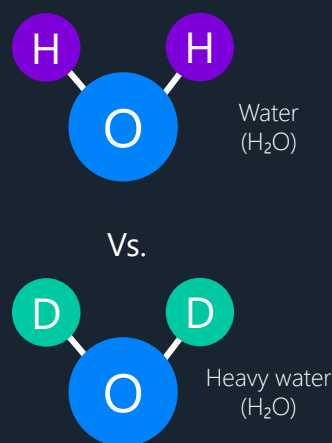
7

STRICTLY PRIVATE AND CONFIDENTIAL – ©2024 Nel – All rights reserved

nel

Heavy water at Rjukan

- Normal concentration: 1 out of every twenty million molecules is heavy water
- The water return has a higher concentration
- Until 1940 secret heavy water production for the French, delivery through Scotland
- April 1940. Germans occupy Rjukan
- 1943 Norwegian Resistance forces supported by the allies bomb the cellar
- February 1944 Ferry with electrolyte barrels containing 1% heavy water is sunk



8

STRICTLY PRIVATE AND CONFIDENTIAL – ©2024 Nel – All rights reserved

nel

The Electrolyser building was demolished in 1977



The Electrolyser building was demolished in 1977

Glomfjord

- Hydropower 135 MW
- Electrolysis for ammonia
- Urea and Fertilizer
- 1953 – 1988
- Why did it end ?



11

STRICTLY PRIVATE AND CONFIDENTIAL – ©2024 Nel – All rights reserved

nel

Electrolyser plant at Glomfjord



nel

Glomfjord

- Hydropower 135 MW
- Electrolysis for ammonia
- Urea and Fertilizer
- 1953 – 1988
- Why did it end ?



13

STRICTLY PRIVATE AND CONFIDENTIAL – ©2024 Nel – All rights reserved

Never forget “the why”

- Fight climate change by decarbonizing hard-to-abate industries that cannot be electrified directly
- Help bring energy from where it can be produced to where it will be consumed and improve energy security



14

When Nel's parent company started hydrogen production, they did it to provide fertilizer for a hungry world. Now, we face a new challenge:

15

STRICTLY PRIVATE AND CONFIDENTIAL – ©2024 Nel – All rights reserved

nel



– António
Guterres,
UN Secretary
General

"The climate-bomb is ticking. Humanity is on thin ice – and the ice is melting fast"

nel

RENEWABLE HYDROGEN

A must for industries that are hard to electrify

- While some companies and industries can easily decarbonize by switching to clean electricity, industries that are hard to electrify, such as refineries, steel, ammonia, and heavy transport must use renewable hydrogen to end their dependency on fossil fuels
- Our customers are pioneering the transition to a renewable society. Nel has the experience and know-how to make the transition as smooth and predictable as possible



17

nel

Some of our pioneering customers and partners



18

nel

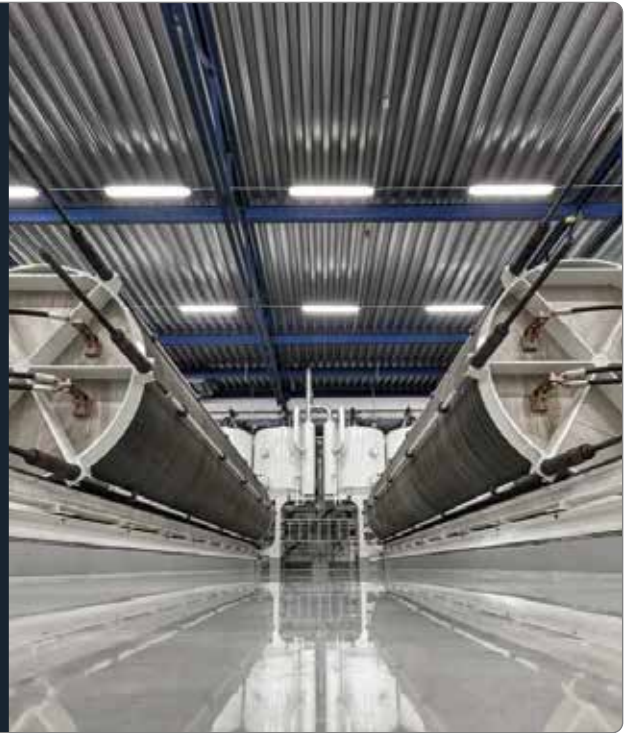




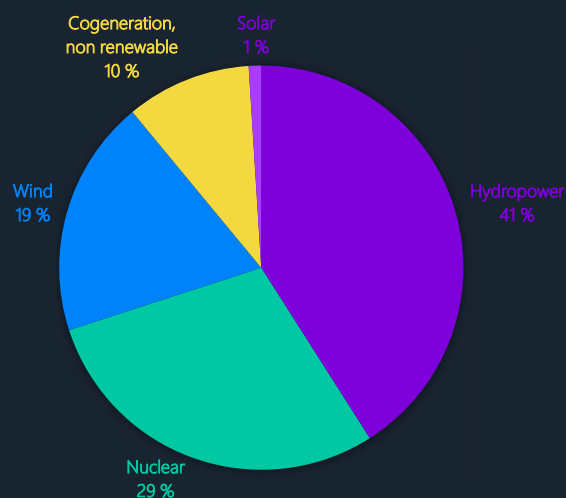
Ovako: Swedish pioneers

- Sweden's, and one of Europe's, largest electrolyser plant in Hofors
- The world's first fossil-free hydrogen plant to heat steel prior to rolling
- Replacing coal by clean hydrogen
- Cements Ovako's position as the industry leader in sustainable steel production
- Massive global potential in decarbonization

23



Swedish power mix and the colours of hydrogen



24

STRICTLY PRIVATE AND CONFIDENTIAL – ©2024 Nel – All rights reserved

nel

OCIM Sarawak

- 25 MW Hydropower
- Polysilicon
- Operating since 2013
- Owned, operated and maintained by the end user

25

STRICTLY PRIVATE AND CONFIDENTIAL



COMMERCIAL DEVELOPMENTS - SUBSEQUENT

10 MW order from Samsung C&T



27

- Client: Samsung C&T
- Size: 10 MW
- Value: EUR ~5 million
- Location: South Korea
- This is the clients first off-grid green hydrogen production project
- Samsung C&T will do the EPC work internally
- Samsung C&T has a significant pipeline of electrolyser projects

nel

COMMERCIAL DEVELOPMENTS – Q4 2022

Woodside Energy H2OK project, Nel's largest contract so far



28

Picture source: Woodside Energy

- Client: Woodside Energy
- Delivery: 2024
- Value: NOK 600 million
- Liquid hydrogen production in Oklahoma for major transport companies
- Contract includes stack, BoS, and engineering

nel

Unparalleled track-record

- **Tested and proven technology**
 - We have almost a century of experience developing electrolyzers that are tested and proven by our clients across the world
- **Electrolysers for the future**
 - Building on our unparalleled track record, we are shaping the future of electrolyser technology
- **Pioneering customers**
 - Our customers are pioneering the transition to a renewable society. We have the experience and know-how to make the transition as smooth and predictable as possible

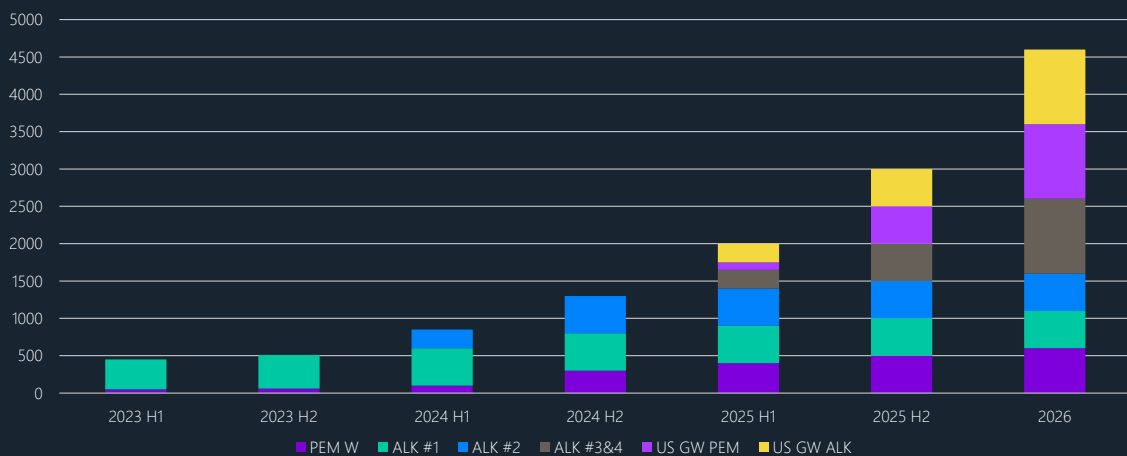


29

AUTOMATION AND MANUFACTURING SCALE-UP

PEM & ALKALINE capacity plan

Annualized current capacity plan/[MW]



30 Strictly private & confidential. Cannot be distributed without Nel's prior approval.

nel



number one by nature

Country Day I : Norway Day

**Cost-effective, Safe and Light Weight Storage
and Transportation of Hydrogen**

Country Day I : Norway Day

Cost-effective, Safe and Light Weight Storage and Transportation of Hydrogen



Yngve Schrøder Tufteland

International Sales Manager,
Umoe Advanced Composites

Education

- 2024, Course in Hydrogen Technology, Vestland University College, Norway
- 2008-2010, M.A., Political Science, University of Oslo, Norway
- 2008, Exchange Semester, Universidad Complutense de Madrid, Spain
- 2004-2007, B.A. Political Science, University of Oslo, Norway

Professional Career

- 2024 – Present, International Sales Manager, Umoe Advanced Composites, Norway
- 2023 – Chief Analyst, Oxford Research AS, Norway
- 2021-2022 – Senior Analyst, Oxford Research AS, Norway
- 2017-2021 – Senior Advisor, Norwegian Ministry of Trade, Industry and Fisheries – maritime department
- 2011-2017 – Advisor/Senior Advisor, Norwegian Ministry of Trade, Industry and Fisheries, R&I Department
- 2011 – Higher Executive Officer, Norwegian Directorate for Education and Training
- 2010 – Intern, The Royal Norwegian Embassy in Paris, France

Research Interest

Hydrogen Technology
Decarbonization
Energy Transisiton
Composites material

Speech Title

Cost-effective, safe and light weight storage and transport of hydrogen

Speech Summary

Umoe Advanced Composites leads in large type IV glass fiber pressure vessels and storage modules, offering low CAPEX, low OPEX, lightweight materials, and unparalleled safety. They provide cost-effective, non-toxic solutions for hydrogen and gas storage and transportation, excelling in various sectors.

Company Introduction

Umoe Advanced Composites is the global leading provider of large type IV glass fiber pressure vessels and storage and transportation modules bundled in containerized solutions.

Safe and Cost-effective Storage and Transportation of Hydrogen

Yngve Schrøder Tufteland
yst@uac.no
International Sales Manager



The future is **LIGHTER**.



Low Capex
and Opex
over lifetime



Lightweight



Ultimate
Safety



25+ years
lifetime



High
capacity

Leading global producer and supplier of large type IV glass fiber pressure cylinders and transportation modules for Hydrogen, Biogas CNG, Flare gas and Helium



Selected customers

SIEMENS
energy

MAXIMATOR
HYDROGEN

Gasum

pluTM

HYDROSPIDER

WOLSKA

Everfuel^o

CNG
FUELS

WOIKOSKI

EUROPEAN
ENERGY

SSC

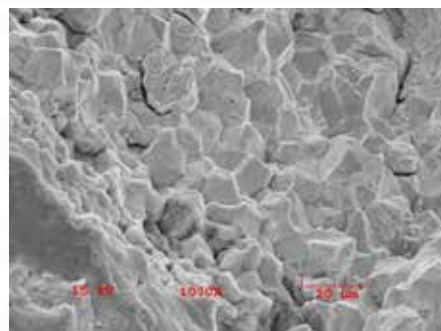
ENERGY

The future is **LIGHTER**.



Complexity and Cost

- Complexity and Cost:
 - Hydrogen storage is a complex and costly part of the hydrogen supply chain.
- Material Degradation:
 - Hydrogen causes embrittlement in steel, leading to material degradation.
 - Hydrogen can easily escape from containers due to its small molecule size.
- Low Natural Density
 - Efficient storage requires compression or alternative storage methods.



Hydrogen Embrittlement – Magnified Image.
Source: [Industrial Metalurgists, LLC](#)

The future is **LIGHTER**.



Storage Solutions for Hydrogen

- Compression:
 - Compression of hydrogen is a well-developed methodology.
 - Higher storage pressures are continuously being researched.
- Steel and Composite Tanks:
 - Traditional steel tanks can store hydrogen at pressures up to 170 bar.
 - Carbon fiber tanks can store hydrogen at pressures up to 1,000 bar.
- Cost vs. Efficiency:
 - Full carbon fiber tanks are expensive.
- **Ideal solutions combine high pressure storage without high costs.**

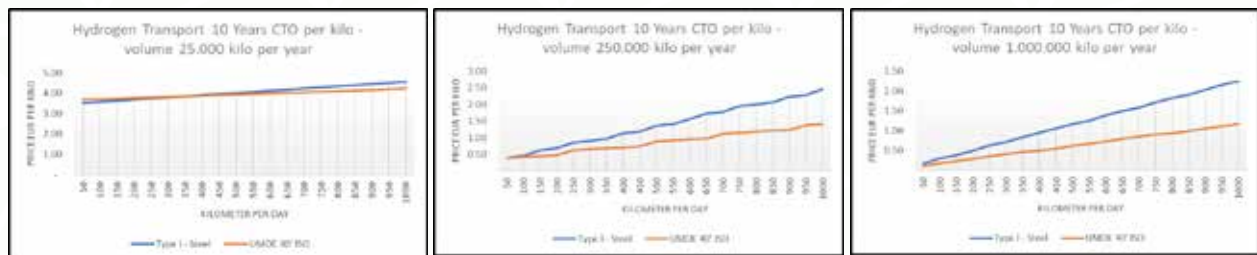


UM
OE
ADVANCED EYE
COMPOSITES

Kilo per year	km per day																				Kilo per day		
	0.88	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950		1000	
	25,000	3.68	3.71	3.74	3.77	3.80	3.83	3.86	3.89	3.91	3.94	3.97	4.00	4.03	4.06	4.09	4.12	4.14	4.17	4.20		4.23	68
	50,000	1.86	1.88	1.91	1.94	1.97	2.00	2.03	2.06	2.09	2.12	2.14	2.17	2.20	2.23	2.26	2.29	2.32	2.35	2.37		2.40	137
	100,000	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.14	1.17	1.20	1.23	1.56	1.58	1.61	1.64	1.67	1.70	1.73	1.76		1.79	274
	150,000	0.64	0.67	0.70	0.72	0.75	0.78	0.81	1.04	1.07	1.09	1.12	1.15	1.18	1.21	1.24	1.46	1.49	1.52	1.55		1.58	411
	250,000	0.39	0.42	0.45	0.48	0.63	0.66	0.69	0.71	0.74	0.89	0.92	0.95	0.98	1.12	1.15	1.18	1.21	1.24	1.39		1.42	685
	500,000	0.21	0.24	0.33	0.36	0.45	0.47	0.56	0.59	0.62	0.71	0.74	0.82	0.85	0.94	0.97	1.00	1.09	1.12	1.20		1.23	1,370
	750,000	0.15	0.22	0.25	0.32	0.38	0.41	0.48	0.55	0.58	0.65	0.71	0.74	0.81	0.88	0.91	0.98	1.05	1.07	1.14		1.21	2,055
	1,000,000	0.12	0.18	0.24	0.30	0.35	0.41	0.47	0.50	0.56	0.62	0.67	0.73	0.79	0.85	0.91	0.94	1.00	1.05	1.11		1.17	2,740
2,500,000	0.09	0.14	0.19	0.25	0.30	0.36	0.42	0.47	0.52	0.57	0.63	0.69	0.74	0.79	0.85	0.90	0.95	1.02	1.07	1.12	6,849		
5,000,000	0.07	0.12	0.18	0.23	0.29	0.35	0.40	0.45	0.51	0.56	0.61	0.67	0.72	0.78	0.84	0.89	0.94	1.00	1.05	1.10	13,699		
1,600,000	0.10	0.15	0.22	0.26	0.31	0.38	0.43	0.49	0.54	0.59	0.65	0.70	0.76	0.81	0.86	0.92	0.97	1.02	1.09	1.13	4,384		
7,500,000	0.06	0.12	0.17	0.23	0.28	0.34	0.39	0.45	0.50	0.56	0.61	0.67	0.72	0.77	0.83	0.88	0.94	0.99	1.04	1.10	20,548		
10,000,000	0.06	0.12	0.17	0.22	0.28	0.34	0.39	0.44	0.50	0.55	0.61	0.66	0.72	0.77	0.83	0.88	0.93	0.99	1.04	1.10	27,397		
25,000,000	0.06	0.11	0.17	0.22	0.28	0.33	0.38	0.44	0.49	0.55	0.60	0.66	0.71	0.77	0.82	0.88	0.93	0.98	1.04	1.09	68,493		

- Total cost of ownership over lifetime
- Example case Steel Type 1 versus UAC Type 4. Korean transport costs
- Steel Type 1 only favorable for short transport distances and low volume

UMOE
ADVANCED E&E
COMPOSITES



- Outcome dependent on volume, km per day and country specific costs (driver, fuel)

UAC | MEGC Configurations

H₂

The future is **LIGHTER**.



20ft ISO STD or HC



40ft ISO STD or HC



Pressure range: 250, 300, 350, 425 & 450 bar

H₂ Capacity
at 350 bar:

20ft: 8 to 11 (ea1666 L) Cylinder capacity

440 KG

30ft: 18 to 22 (ea1200 L) Cylinder capacity

630 KG

40ft: 18 (ea1666 L) Cylinder capacity

720 KG

Key Attributes:

- Highly Customized manifold solutions
- Minimized potential leak point design
- Leak before burst feature
- 25+ years design life
- No corrosion
- Class leading Safety properties (Impact, Collision & Fire).
- Premium product performance during operation.



ADR-TPED/PED/RID - Certified

UAC | The UMOE pressure vessels – Type IV

The future is **LIGHTER**.

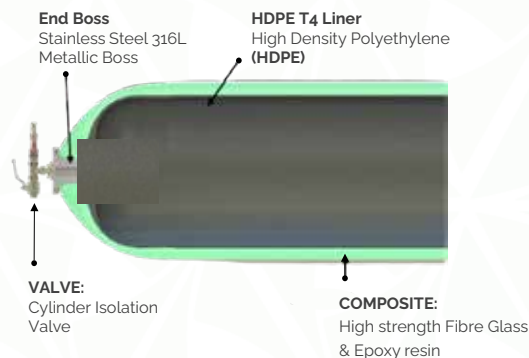


⇒ High Density Polyethylene (HDPE) inner tube (Plastic Liner protected and heavily reinforced).

- High strength glass fibers
- Epoxy resin.

⇒ Stainless Steel (SS316) leak proof endbosses embedded with possible customized manifold configurations.

- «Leak before burst» design – safety.

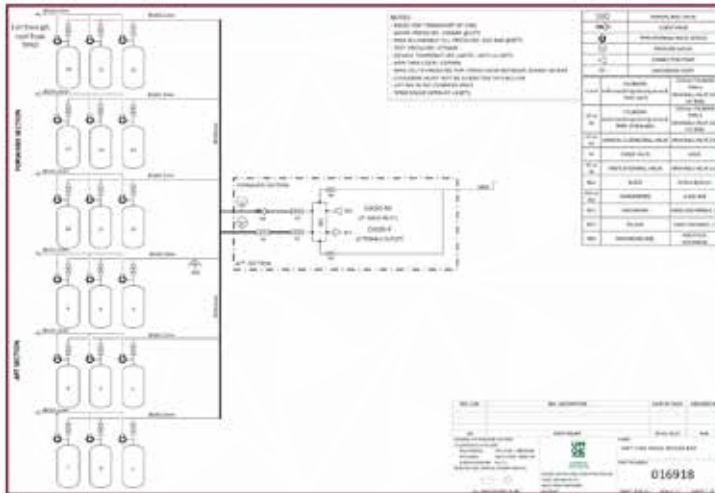


The future is **LIGHTER**.



UAC | The UMOE container P&ID – Best Practice

Example Piping & Instrumentation Diagram (PID)



UAC | Reference cases

The future is **LIGHTER**.



H₂ Project Hydrogen distribution Switzerland

⇒ **Customer: HydrosSpider**

Developing the hydrogen ecosystem in Switzerland

video



- 50 Hyundai FCEV trucks in service (1600 per 2025)
- 24 H₂ containers modules delivered per Q1 2022 (200 per 2025)



- 10 HRS fuelling – 7-8 t of H₂ every week.
- 3 MW electrolyser capacity
- Performed more than 1500 container swaps at HRS/electrolyser with connection/de-connection inlet/outlet.



- Centralized (electrolysis plant) Production

UAC | Reference cases

The future is **LIGHTER.**



H₂ Project Hydrogen distribution New Zealand

⇒ Project Description: Hirlinga Energy

Storage from Decentralized Production
of Green Hydrogen

[video](#)



- H₂ containers modules delivered -
- 350 bar - 40FT and 20FT

UAC | Reference cases

The future is **LIGHTER.**



H₂ Project Hydrogen distribution Norway

Customer: HYDS

HYDS develops and operates green
hydrogen plants and distributes green
hydrogen to the end user in various
forms.



- H₂ 350 bar 40 FT containers delivered

UAC | Reference cases

Bus Fuelling Stations reference project



vimeo

⇒ Project Description

- UAC supplied Ryse Hydrogen the 40ft units used for transport of Hydrogen from Power Source to Bus Depots (350BAR) where the Ryse fueling stations are deployed.
- EU-program «H2Bus» deploying 600 Hydrogen London busses



The future is **LIGHTER**.



Hydrogen for Short Sea Shipping

The future is **LIGHTER**.



Hydrogen fuelled ships – and transportation

H2 retrofit of LNG-vessel



Transportation of H2 containers



H2 fuelled CSOV



H2 Passenger Ferry



Hydrogen for Short Sea Shipping

*The future is **LIGHTER**.*



- Weight and volumetric energy density are important for maritime projects
- For sailing longer than 15-20 nautical miles, battery solutions are usually not relevant
- Compressed hydrogen is the most cost-effective alternative for zero-emission coastal and regional shipping
- Hydrogen must be available throughout the shipping network (for instance a container feeder route or at offshore energy base ports)
- Regular port calls
- Reserve more energy consuming (ex. Ammonia) solutions for deep sea transportation

Local Production and Bunkering for Hydrogen Ferry

*The future is **LIGHTER**.*



599 PAX
17 Knots – Appx. 100 Km

Bunkering straight from the facility to the ferry



UAC | Reference cases

Containerized Stationary Storage of Hydrogen

5 Ton H₂ storage at 200 BAR

Large-scale production and storage
Facility of green hydrogen

Scalability

3 phase project:

- 1) 5 TON – 20MW Established
(635 kg storage containers)
- 2) 300 MW per 2025
- 3) 1 GW per 2030



The future is **LIGHTER**.

**UM
OE**

ADVANCED
COMPOSITES

The future is **LIGHTER**.

UAC | Worldwide Partners and Customers -H₂



McPhy

**NILSSON
ENERGY**

**NIPPON
GASES**
The Gas Professionals

Hitachi Zosen
INOVA

HYDROSPIDER

H₂energy

WOIKOSKI

RYSE

Linde

Everfuel

Gasum

**MAXIMATOR
HYDROGEN**

**Transport
for London**

ORLEN

ORKAN

ELEMENT 2

MIMU
Carbon Tracking

NanoSUN

Air Liquide

EUROMEKANIK

HyNion

Country Day I : Norway Day

**Beyond Limits: Innovating Cryogenic Fluid
Storage with the Lattice Pressure Vessel**

Country Day I : Norway Day

Beyond Limits: Innovating Cryogenic Fluid Storage with the Lattice Pressure Vessel



Yonghwan Cho

R&D Engineer, Lattice International

Education

- 2012-2020, B.S., Mechanical Engineering, University of Waterloo, ON, Canada
- 2020-2022, M.S., Mechanical Engineering (Welding and joining technology), University of Waterloo, ON, Canada

Professional Career

- 2018, Project Engineer, Co-op, Bend All Automotive ULC, ON, Canada
- 2019, Quality Control engineer, Co-op, Toyota Motor Manufacturing Canada, ON, Canada
- 2022-Present, Research & design Engineer, Lattice International AS, Seoul Korea

Research Interest

- Prismatic type pressure vessel for cryogenic fluid storage application
- Finite element method for static and thermal analysis
- Welding and joining technology

Speech Title

Beyond limits: Innovating cryogenic fluid storage with the Lattice Pressure Vessel.

Speech Summary

- Introduction of company and lattice pressure vessel (LPV)
- Applications of LPV
- Case study and comparison between LPV and cylindrical pressure vessel
- References and on-going projects of LPV technology

Company Introduction

Lattice International AS

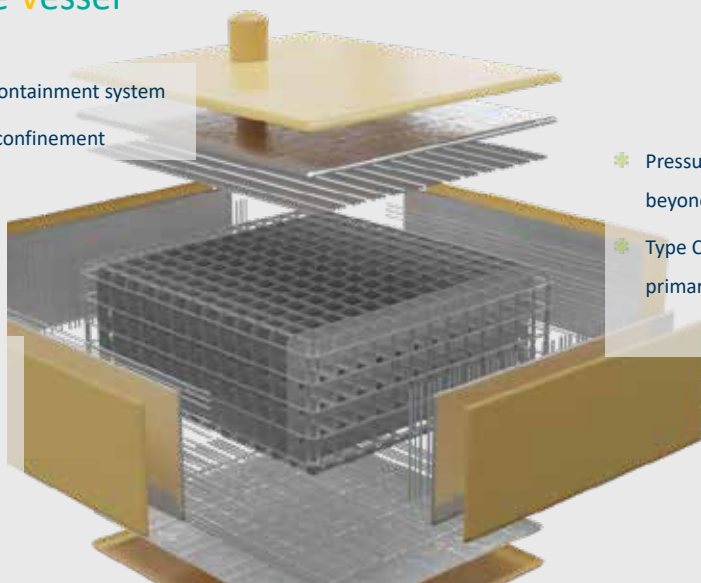
- Established by Prof. Pål G. Bergan and Daejun Chang in 2012 at KAIST, South Korea.
- Provides engineering solution for cryogenic fluid containment.



Lattice Pressure Vessel

- * Fully scalable, free-shape containment system
- * Designed for any space or confinement

- * Handles all liquefied gases:
LH₂, LN₂, LCO₂, and LNG
- * Ambient to cryogenic temperatures

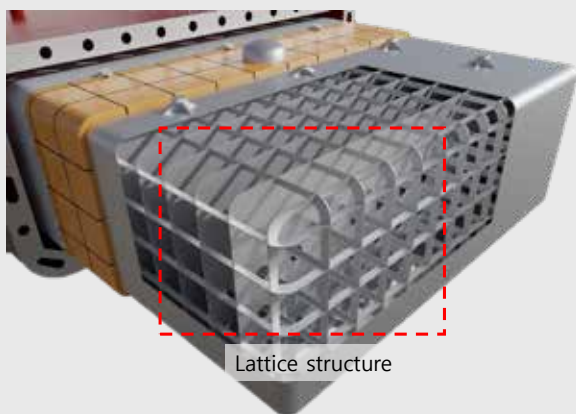


- * Pressure loads from 1 to 30 bar and beyond
- * Type C tank equivalent – leak tight primary barrier

Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com

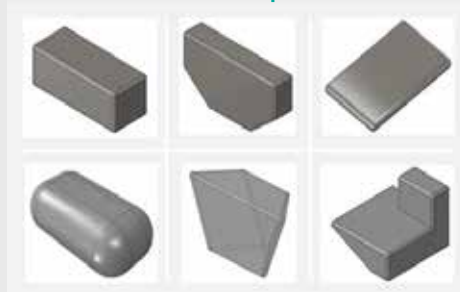


Lattice Pressure Vessel - Technology

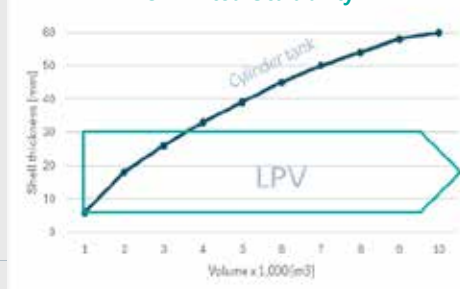


Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com

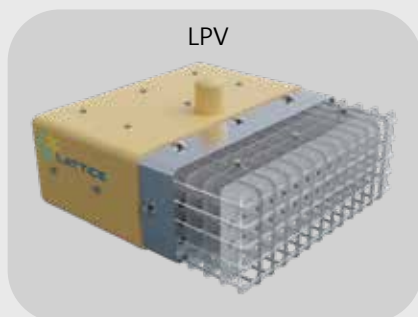
Free-Shape



Unlimited Scalability



Lattice Pressure Vessel - Technology



Large-scale pressure vessel

All cargo types

Holding time

Maintenance

OPEX saving

Free-shape Pressure vessel

Space utilization

Applicability

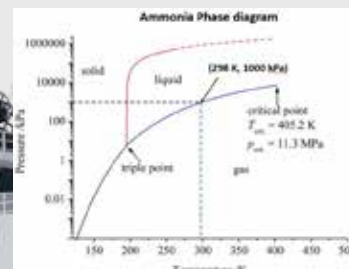
CAPEX saving

Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com

LATTICE

LNH₃ Storage Solutions

- ✱ Ammonia exists in liquid state at room temperature above **10 bar** pressure
- ✱ LPV design allows LNH₃ to be stored in a large-scale **without the need for insulation**
- ✱ For both **fuel application** and **storage/transportation application** LPV offers most volume-efficient and easy- to-operate solution

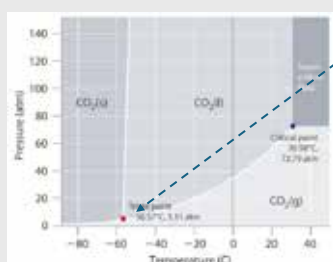


Tank Volume: > 30,000 m³
Design Pressure: > 10 bar

Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com



LCO₂ Storage Solutions



- ✱ LCO₂ must be stored **above 5.1 bar** pressure condition to avoid formation of dry ice
- ✱ Due to impurities and holding time, design pressure above 12 bar is preferred
- ✱ Large scale (>20,000m³) medium pressure vessel is only possible with LPV
- ✱ Reduction in CAPEX & OPEX

Tank Volume : > 30,000 m³
Pressure range : 8 – 20 barg



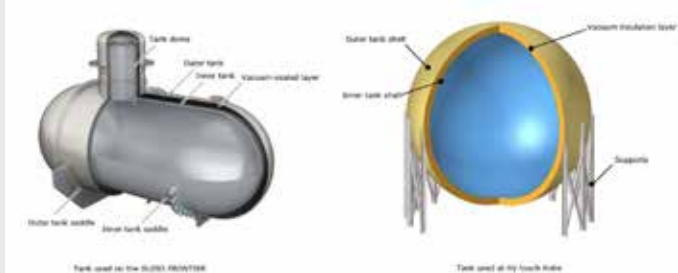
Carbon capture, Utilization and Storage value chain

Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com



LH2 Storage solutions

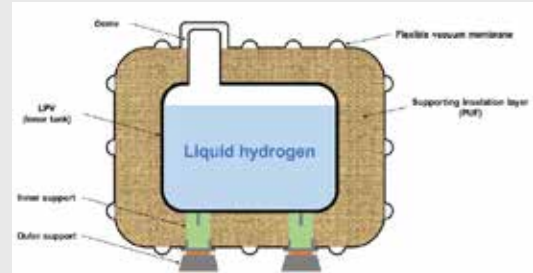
Conventional



Source: News & Events, Kawasaki Heavy Industries, Ltd. https://global.kawasaki.com/en/corp/newsroom/news/detail/?f=20231211_8742

- * LH2 storage require double-wall vacuum insulation
- * Very heavy outer jacket
- * High fabrication difficulty

LPV V-CCS



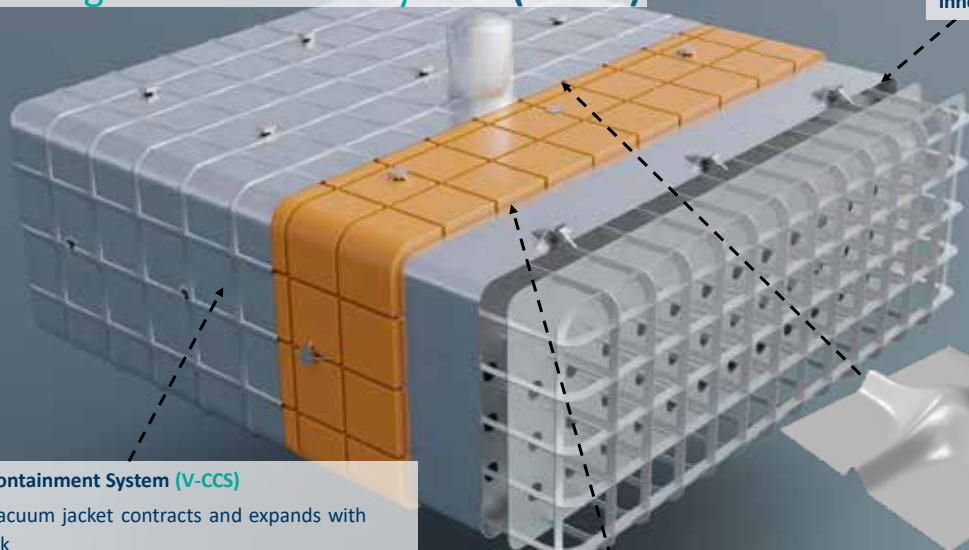
Source: Hyunjun Park et al., Structural design of flexible vacuum insulation system for large-scale LH2 storage. Int J Hydrogen energy 2022

- * Flexible vacuum membrane used for outer jacket
- * Thin metal sheet with corrugation
- * Lighter, cheaper, and easy fabrication

Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com



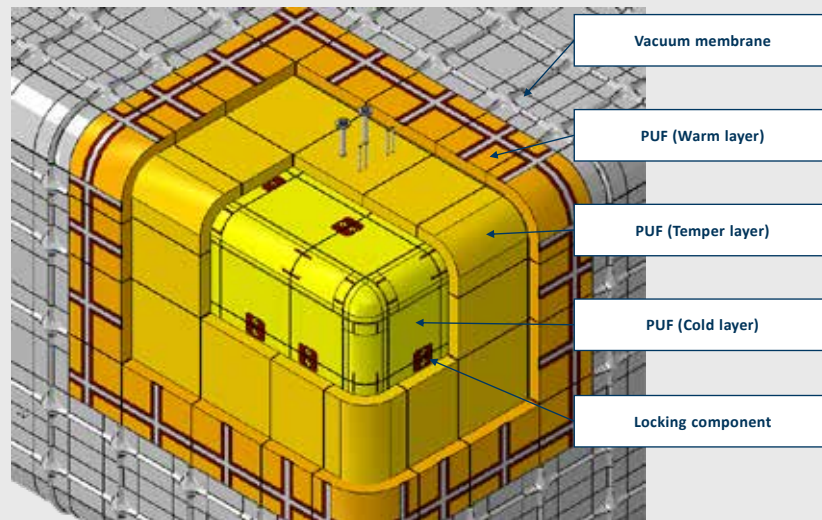
Vacuum Cargo Containment System (V-CCS)



Vacuum Cargo Containment System (V-CCS)

- * Corrugated vacuum jacket contracts and expands with LPV inner tank
- * Unlimited scalability along with LPV

Vacuum Cargo Containment System (V-CCS)



Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com



Lattice Pressure Vessel – 200 m³ V-CCS



200 m³ LH₂ Tank
Available for showcase: Pohang / Jan – June 2025



Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-international.com



STORAGE TANK (Land/Onshore)

- Large volume **cylindrical tanks** have long horizontal length due to its restriction in diameter
- The fabrication of **spherical tanks** are very difficult and expansive and loss of space utilization is inevitable
- LPVs offers superior **space utilization** for storage on land due to its unlimited scalability and height



Lattice Pressu
www.lattice

Real-life comparison: Cylinder (24 m3) and LPV (22 m3)



Source: How one of the largest pressure vessels in the world was made. 8 Dec. 2023.
www.thefabricator.com/thefabricator/article/arcwelding/how-one-of-the-largest-pressure-vessels-in-the-world-was-made.



Source: Nasa-Ksc, Adam Swanger. World's Largest Liquid Hydrogen Tank Nears Completion.
www.cryogenicsociety.org/index.php?option=com_dailyplanetblog&view=entry&year=2022&month=05&day=05&id=48:world-s-largest-liquid-hydrogen-tank-nears-completion.

LATTICE

Summary

- LATTICE is **REDEFINING** the pressure vessel technology
- LATTICE **CUSTOM-DESIGNS** pressure vessels to meet customer's needs
- LATTICE creates **ECONOMIC VALUE** by enhancing space utilization
- LATTICE serves as a catalyst for the acceleration of **RENEWABLE ENERGY** industry



Lattice Pressure Vessels for Any Shape, Any Size, and Any Pressure
www.lattice-technology.com

LATTICE



Norway office:
Strandveien 15, 1366 Lysaker, Norway

Rep. of Korea office:
Rm910, TBC, 593 Daedeok-daero, Yuseong-gu, Daejeon, Rep. of KOREA

www.lattice-international.com

Country Day I : Norway Day

**Challenges in establishing hydrogen and
ammonia transport**

Country Day I : Norway Day

Challenges in establishing hydrogen and ammonia transport



Robert Judd

Group Leader - Hydrogen/Low Carbon Fuels and CCUS
/ H₂ & CCS, DNV Energy Systems

Education

- 1977-1980, BSC (Hons), Chemistry with Physics, Queen Mary University of London, London, UK
- 1980-1985, Ph.D., Surface Chemistry and Catalysis, Queen Mary University of London, London, UK

Professional Career

- Jan 1984 - Mar 1988, Post Doctoral Research Fellow, Cambridge University, Cambridge, UK
- Mar 1988 - June 1996, Senior Consultant / Scientist / Engineer, British Gas Research BG Technology, London, UK
- Jun 1996 - Jun 2012, Principal Consultant, Advantica, GL, Loughbrough, UK
- Jul 2012 - Present, Secretary General, GERG (European Gas Research Group)
- Apr 2022 to Present - Technical Director Hydrogen and Low Carbon Fuels, DNV, Singapore

Research Interest

Enabling the Energy Transition through integration of hydrogen and gaseous / molecular supply chains into the energy system

Speech Title

Challenges In establishing hydrogen and ammonia transport

Speech Summary

The presentation will examine the current status of hydrogen introduction into the energy system and the work being done by DNV to enable supply chains by understanding and mitigating gaps in current knowledge.

Company Introduction

DNV Energy Systems : As the world's leading resource of independent energy experts and technical advisors, we provide assurance to the entire energy value chain.





WHEN TRUST MATTERS

Challenges in Developing a Hydrogen / Ammonia Supply Chain An Asian Case study

26th September 2024

Industries and governments are focusing on four key areas to scale the hydrogen and ammonia economy



The scale of the future hydrogen society will be determined by success in managing safety



Hydrogen behaves differently to natural gas and will require new or adapted infrastructure



Hydrogen can be produced in several ways, but if it is to help in the battle with climate change, the process will have to be decarbonised



Long-term policy commitments will be essential to building demand for hydrogen, and companies will need effective, long-term strategies

DNV in the Hydrogen and Derivatives Segment

15,000 experts

across the Maritime, O&G, Renewables & Power markets providing local access to global best practice

160 years

serving the maritime & energy industries, including early engagement in the oil and gas, wind and solar, hydrogen & CCUS sectors

5%

total revenue invested in R&D each year to support the development of next generation technologies

170+

industry standards, guidelines and recommended practices

30+

joint industry projects per year collaborating with industry and our customers to develop the next generation of standards

24

laboratories and test centres including the World's first full-scale hydrogen testing facility supporting safety, infrastructure and policy

200+

carbon capture and utilisation projects delivered in the past 10 years including development of the first international standards

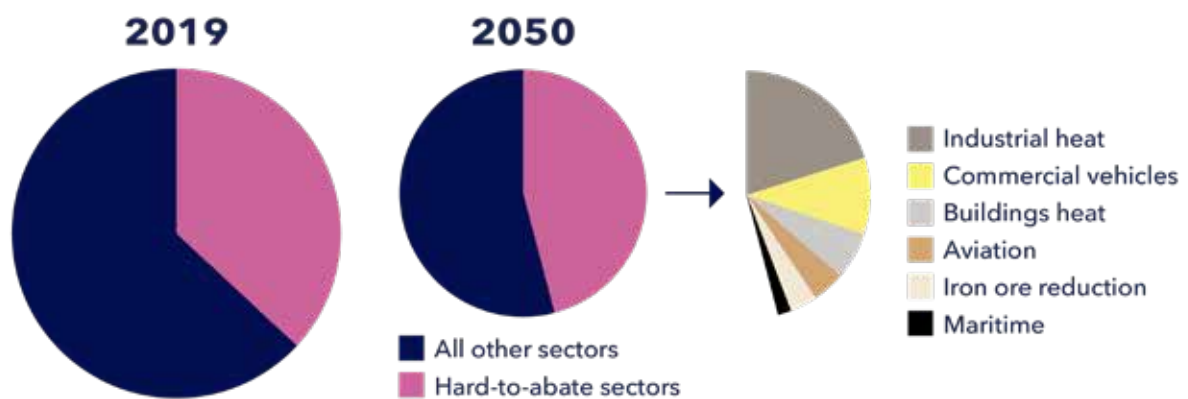
200+

hydrogen projects delivered in the past 12 months spanning production, transportation, utilisation and policy

3 DNV © 06 APRIL 2023



urgent need to address hard-to-abate sectors



DNV © 06 APRIL 2023



Blending and Pipelines

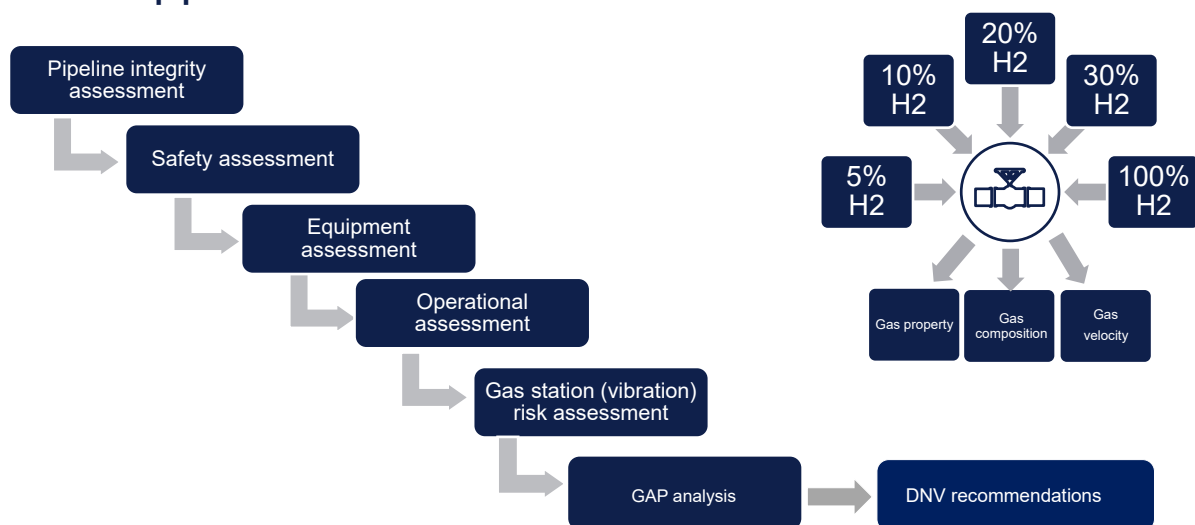
- Addition of hydrogen increases volumes of gas transported due to the lower energy density of hydrogen.
- This increases the velocity of gas in the pipeline, which will lead to a higher pressure drop for the same compressor duty.
- At some blending percentage a need to reduce the maximum allowed operating pressure – this will in turn lead to increased velocities and pressure drops.
- Existing compressors could be re-used for blend up to 10-15%.
- Subject to the ability of the end user to accept the blend



5 DNV © 06 APRIL 2023



Hydrogen network readiness DNV approach



6 DNV ©



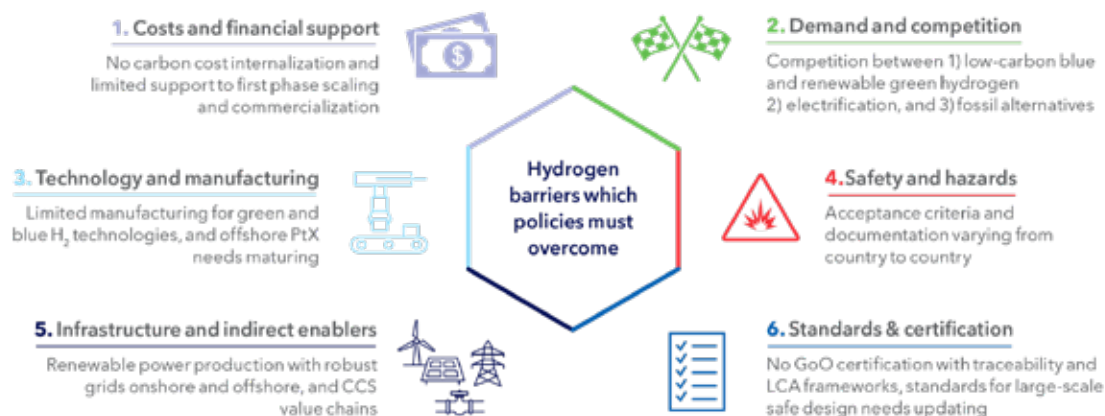
Considerations in Establishing a Supply Chain – Singapore Case Study

- Singapore H₂ strategy – 50% H₂ in Power Generation by 2050 and substantial use in other sectors
- Ammonia pathfinder project – to understand the challenges of establishing an ammonia supply chain using a 40MW pilot project

Issues –

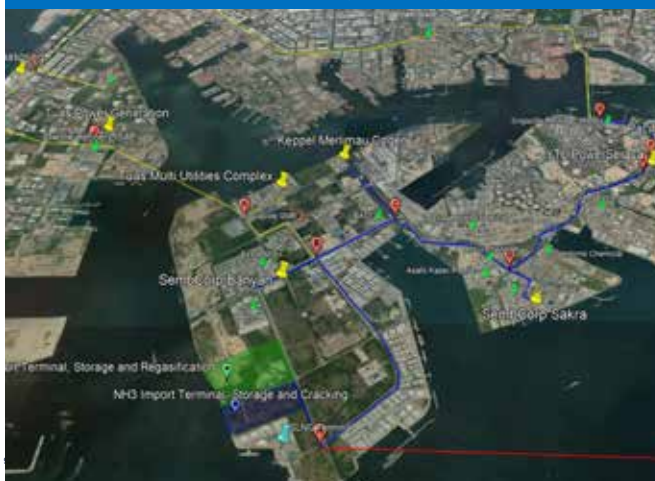
- optimising production and transport for the lowest LCOA / LCOH
- Developing infrastructure to import ammonia and / or hydrogen and to store and transport and use it in country
- Ensuring safety given the potentially large volumes to be stored and transported
- Develop new regulatory and policy frameworks to minimise risks and incentivise demand

Breakdown of barriers for policies to overcome



Implications for Singapore's hydrogen roadmap

Meeting the Challenges of the Singapore Hydrogen Strategy while maintaining security of supply requires careful and detailed analysis and planning involving all stakeholders



1. Singapore has substantial potential use cases across industry, maritime, aviation and power but significant variation in timelines, scale and cost sensitivity
2. Multiple potential import/production pathways exist to supply hydrogen but landed cost depends on end use application and economies of scale
3. Significant constraints on infrastructure options due to space and safety considerations
4. Extensive existing import and distribution infrastructure has potential to be repurposed but maintaining security of supply through this process is key

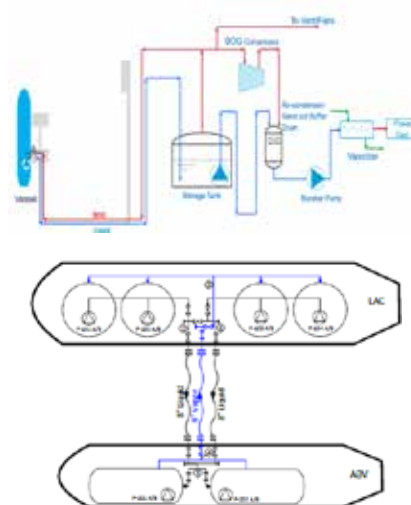
Ammonia Safety Considerations for Singapore

Developing end-to-end ammonia pilot for ammonia utilization in Singapore:

- QRA and risk based analysis for conversion of existing tank for Ammonia Storage with supporting system
- Safety Studies for Ammonia Bunkering transfer operations for the Pilot phase considering 4 pilot concepts
- QRA and Site Selection assessment for commissioning of Ammonia Powered Vessel

DNV's role

- Presented state of the art information on safety of Ammonia & Hydrogen with case studies of Ammonia related plants
- Case studies of Ammonia related plants & capability of Spadeadam test site for full scale release assessment
- Identify optimal NH₃ tanks configuration, safety systems for NH₃ turbines, power plants, tanks, jetty operations
- Provide input on ammonia/hydrogen related design standards
- Identify and quantify the risks related to Ammonia transfer and Jetty selection
- Coarse QRA for ammonia bunkering operations and commissioning in Singapore water
- Site selection assessment for commissioning in Singapore Water



QRA and Site Selection for Commissioning of Ammonia Powered Vessel

Fortescue Green Pioneer converted and tested in Singapore

DNV carried out a Quantitative Risk Assessment (QRA) for ammonia bunkering operations (shore to ship) and for commissioning in Singapore waters. A site selection assessment for the Green Pioneer sea trials in Singapore waters was performed through relevant considerations and detailed screening of the marine conditions surrounding the selection of a site for the Green Pioneer commissioning

The location selection also takes into account - distance from sensitive receptors, access to emergency departure routes, access by SAR vessels of SCDF, navigational safe access and egress etc.

- Coarse QRA for ammonia bunkering operations (shore to ship)
- Coarse QRA for the Green Pioneer commissioning in Singapore water
- Site selection assessment for the Green Pioneer commissioning in Singapore water
- Support and Facilitation with Key Local Stakeholders (MHD, MPA)



12 DNV © 06 APRIL 2023

DNV

SEA Genco: Hydrogen Readiness assessment

- Assessment of hydrogen deployment readiness on current power generation assets
- Technical assessment of hydrogen as a fuel for the power generation fleet
- Risks associated with hydrogen adoption
- Safety, technical, regulatory economic



Type	Risk description	Risk
Safety	Non-compliance with these standards may lead to safety hazards, legal liabilities, fines, and potential reputational damage. It could also undermine public trust and security confidence.	High
Safety	Lack of coordination may lead to delayed response, inadequate containment of incidents, and increased risk to personnel and the community.	High
Economic	While gas turbines can theoretically achieve 50% H ₂ (on-firing, the current OEMs) maximum agreed upon baseline rate of 1%. Higher percentage of mixture will require further research and validation from the OEMs. The limited feasibility of higher H ₂ on-firing may hinder long-term carbon capture plans and affect the overall cost-effectiveness of the solution.	Medium
Process	The integration of H ₂ on-firing across various turbine models, including Siemens SGT5-8000H, GE S9A-E2, Siemens V94.2, GE S9A, and M901F, introduces significant technical challenges. Without specific guidance and cost estimations from OEMs, there may be uncertainties in identifying the right technical solutions, leading to potential delays, cost overruns, operational inefficiencies, and safety concerns.	High

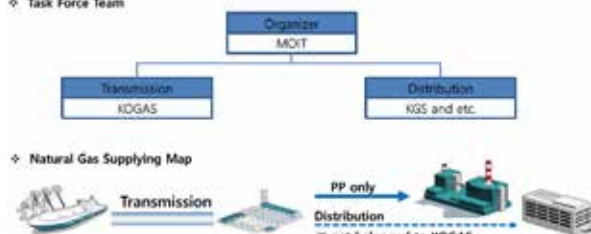
Turbine model	Upgrade package	0%	30%	50%	100%
GE S9A-E2	DLN	Today (grower)	Today (1)	Start today	Future
SGT5-8000H	DLN	Today	Today	2030	2030 (10)
SIEMENS 2000E	DLN	Today	Today (2)	2030	2030 (10)
ABB GT13	Unknown	...	...	...	...
M901F	DLN	Today	Today (1)	Start today	2030 (10)
GE M9000FA	DLN	Today	Today	Scheduled (1)	2030 (10)

14 DNV © 06 APRIL 2023

DNV

Repurposing infrastructure Hydrogen Blending – a regional example of the approach - Kogas

Task Force Team



- Technical advisory in hydrogen blending
- Test Bed design advisory
- Validation of pipeline and assets
- Benchmarking of hydrogen blending projects
- Technical advisory in KOGAS demonstration project
- Standards and technology benchmarking

Demo project in Jeju island

Blending gas supply for Power Plant ('23.7. ~)



DNV

Choices for Singapore

- Pipeline repurposing vs. new pipelines
- Blending vs. direct move to full H₂ or NH₃
- Phased rollout vs. concurrent rollout
- Centralised vs. decentralised infrastructure
- Single carrier vs. multi-carrier imports
- NH₃ cracking vs. direct use

Challenges for Singapore

- Loss of energy capacity of existing infrastructure due to lower energy density
- Space constraints for new pipelines and supporting infrastructure
- Storage of H₂ and NH₃ requires substantially more space than LNG
- TRL and scale of ammonia generation and cracking technologies is still low
- Safety requirements and risk contour size differ from traditional fuels

WHEN TRUST MATTERS

Thank You

Robert.judd@dnv.com

www.dnv.com

17 DNV © 06 APRIL 2023



Country Day I : Norway Day

Zero Loss of Lives

– no injuries or damages caused by fire & gas

Country Day I : Norway Day

Zero Loss of Lives – no injuries or damages caused by fire & gas



Damian Tan

Global Projects & Account Manager,
Autronica Fire & Security

Education

· 1989 – 1993 BSc Electrical Engineering, Wichita State University (USA)

Professional Career

· Mar 2023 to Present

Spectrum Safety Solutions

Global Projects and Accounts Manager

April 2007 to Feb 2022

MSA S.E. Asia

Business Development Manager (APAC)

Jan 2009 – Jan 2016

Det-Tronics Singapore

Regional Sales Manager

April 2007 – Dec 2008

Kidde Asia

Regional Sales Manager

Research Interest

Fire and Gas Detection Systems and Solutions

Company Introduction

Autronica Fire & Security are a leading innovator, manufacturer and supplier of fire and gas safety worldwide. Through entrepreneurial spirit and expertise our products have for more than 60 years, ensured safety in applications on land, sea and in renewables, petrochemical, oil and gas sectors.



26th September 2024

Hydrogen

Fire & Safety Solutions to Mitigate Hydrogen Hazards

PRESENTED BY: DAMIAN TAN

Global Projects & Accounts Manager

Autronica Fire and Security A/S

CONFIDENTIAL AND PROPRIETARY | 2024



CONTENT

- | | |
|-----------------------|--------------------|
| 1 Autronica | 7 Gas Detection |
| 2 Science | 8 Systems Solution |
| 3 Applications | |
| 4 Codes and Standards | |
| 5 Our Capabilities | |
| 6 Flame Detection | |

CONFIDENTIAL AND PROPRIETARY | 2024



AUTRONICA

YOUR FIRE & SAFETY SYSTEMS SOLUTION PROVIDER

CONFIDENTIAL AND PROPRIETARY



Meet Det-Tronics & Autronica

Det-Tronics Headquarters, Bloomington, MN, USA



Systems Center, Bloomington, MN, USA



Engineering Test Center, Savage, MN, USA



CONFIDENTIAL AND PROPRIETARY

Autronica Headquarters, Trondheim, Norway



Clean Energy Headquarters, Stavanger, Norway



Engineering Test Center, Savage, MN, USA



Local Offices:

- Houston
- Denmark
- London
- Korea
- Dubai
- France
- Brazil
- Singapore

Sales Presence:

- Canada
- Norway
- India
- Saudi Arabia
- Scotland
- Germany
- Italy

Representative Offices:

- Partners across
- USA, Canada
 - Latin America, Africa
 - Europe, Middle East, Asia Pacific
 - South Asia, Central Asia, Australasia

Engineering Test Center

- Technology research and design validation
- 100% post production flame testing and verification
- Approvals testing
- Customer training
- Competitive benchmarking
- Customer applications testing
- Customer live video broadcasting

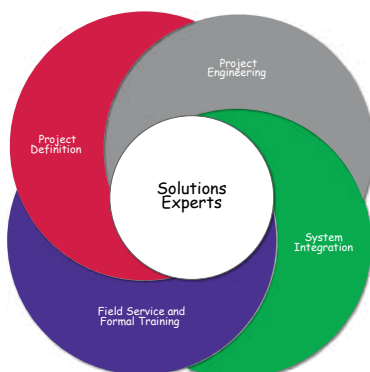


CONFIDENTIAL AND PROPRIETARY

5

Solution Experts

More than five decades, we have been meeting the needs of customers around the world with solutions that protect people, property and processes.



Understand what you need, We do!
 Project definition, We do!
 Project engineering, We do!
 System Integration, We do!
 Proposal development, We do!
 Project management, We do!
 Factory and Site Acceptance services, We do!
 System manufacturing, We do!
 Field Service, We do!
 Training, We do!

#1 Choice in Industrial High Hazardous Detection Globally!

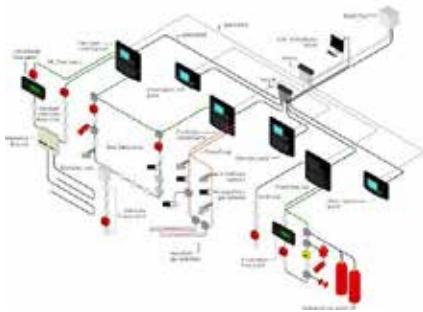
CONFIDENTIAL AND PROPRIETARY



6

Autosafe – All In One Solution

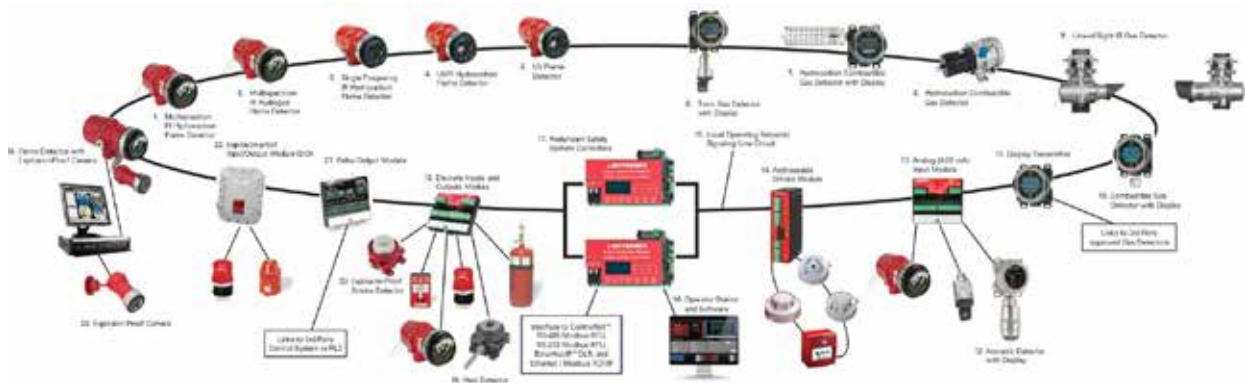
- Reliable - Approved according to IEC 61508 – SIL 2
- Always available with Dual Safety and Short Circuit Isolators in each detector
- Accurate with DYFI+ digital filter technology
- Always same sensitivity and pollution reports with SelfVerify (*calibrated selftest*)



CONFIDENTIAL AND PROPRIETARY

7

Eagle Quantum Premier™ SIL2 – All In One Solution



CONFIDENTIAL AND PROPRIETARY

8

SCIENCE

CONFIDENTIAL AND PROPRIETARY

Hydrogen Facts

Chemical Formula = H₂

Wide range of flammability:

- LFL/LEL = 4% by volume
- UFL/UEL = 74% by volume
- If a leak occurred in a confined space with poor ventilation, the hydrogen concentration could easily reach the lower flammability limit (4%)
- Hydrogen-air mixtures can ignite with 1/10 the effort of igniting gasoline-air mixtures!

Relative Vapor Density = 0.07

- Hydrogen is approximately 13 times lighter than air
- If hydrogen collects under a roof or overhang, it could quickly form an explosion hazard
- A leak outdoors will tend to rise quickly and simply diffuse



Hydrogen

CAS RN: 1333-74-0

NFPA Hazard Classification

Hydrogen



CONFIDENTIAL AND PROPRIETARY

10

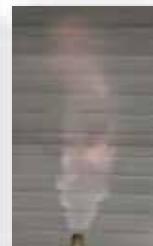
Hydrogen Facts

Hydrogen fire is a pale blue color and is largely invisible to the human eye in daylight conditions

A pure hydrogen fire produces no smoke and very little radiant heat

It is hard to tell if there is a hydrogen leak because hydrogen has no odor to it

- Hydrogen is a very light gas and there are no known odorants that are light enough to diffuse at the same rate as hydrogen
- In other words, if odorants that are available today were to be added to hydrogen, by the time a worker could smell it, the hydrogen concentration may likely have already exceeded its lower flammability limit



Low Ambient Light H₂ Flame



Hydrocarbon A

Hydrogen

Hydrocarbon B

No Ambient Light

CONFIDENTIAL AND PROPRIETARY

11

APPLICATIONS

CONFIDENTIAL AND PROPRIETARY

Hydrogen Applications

- Hydrogen Process Production
- Storage
- Transportation
- Electrolyser Production



CONFIDENTIAL AND PROPRIETARY

13

Hydrogen Applications & Use Cases



Turbine Fuel Additive



Automotive



Aviation



Process



Aerospace

<https://hydrogen-central.com/nasa-kennedy-space-center-large-scale-liquid-hydrogen-tank-development/>

CONFIDENTIAL AND PROPRIETARY

14

CODES & STANDARDS

CONFIDENTIAL AND PROPRIETARY

Codes, Standards, and Resources for H₂ Safety

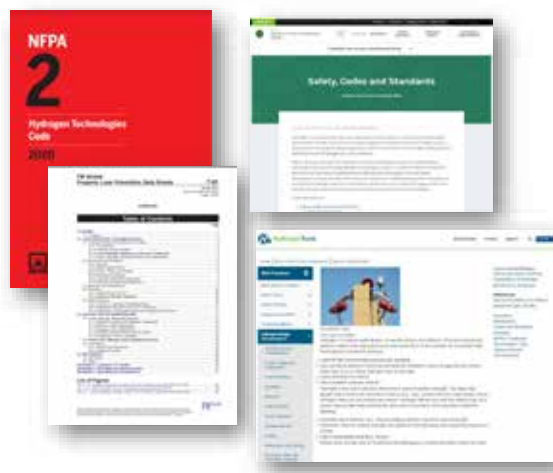
- ✓ **NFPA 2** – Hydrogen Technologies Code
- ✓ **FM Global** Property Loss Prevention Datasheet 7-91
- ✓ **U.S. Department of Energy:**

<https://www.energy.gov/eere/fuelcells/safety-codes-and-standards>

<https://h2tools.org/bestpractices/use-detectors>

<https://hydrogen-central.com/>

<https://go.nfpa.org/hydrogen-dispersion-screening-tool>



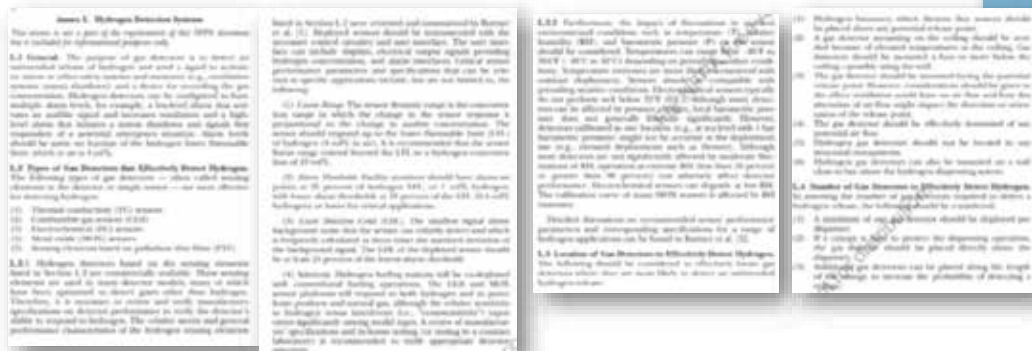
CONFIDENTIAL AND PROPRIETARY

16

Codes, Standards, and Resources for H2 Safety

NFPA 2 – Hydrogen Technologies Code

- Note that the guidance is less than a page long, so seeking additional application advice is high priority for safety systems



CONFIDENTIAL AND PROPRIETARY

17

Codes, Standards, and Resources for H2 Safety

NFPA 2 – Hydrogen Technologies Code

DUE FOR UPDATE IN 2026

Key Points

- Annual certification required for approved original performance-based design criteria.
- The equipment used for Gas detection shall be listed or approved.
- Hydrogen detection systems should be designed, installed, tested, inspected and maintained as per Manufacturer's requirements.
- Trained staff must perform maintenance, inspection, calibration, and testing.
- For gaseous hydrogen, testing shall be conducted at least annually.
- Hydrogen systems shall be designed by persons competent in such design.
- For liquefied hydrogen equipment related to safety, gas detection, and fire protection must be checked or inspected every 6 months
- When maintenance activities are carried out, then proper procedure to be followed so that minimum disruption occurs to the life safety systems.
- Gas detection equipment and alarms shall be listed or approved.
- For electrolyzers, thermal detectors shall be provided in gasifier area to activate the fire protection system and shutdown.
- NFPA 72 approved system shall be provided.
- UV/IR Flame detection to be used near the gasifier vessel.
PROPOSED TO BE UPDATED TO "RADIANT ENERGY FLAME DETECTORS"



CONFIDENTIAL AND PROPRIETARY

18

OUR CAPABILITIES

| CONFIDENTIAL AND PROPRIETARY |

FLAME DETECTION

| CONFIDENTIAL AND PROPRIETARY |

Hydrogen Flame Detection Solutions

X3302 Multispectrum IR

- Detects fires that produce super-heated water vapor and little to no Carbon Dioxide (CO₂)
- Fires are typically invisible to the human eye



CONFIDENTIAL AND PROPRIETARY

21

Hydrogen Flame Detection Solutions

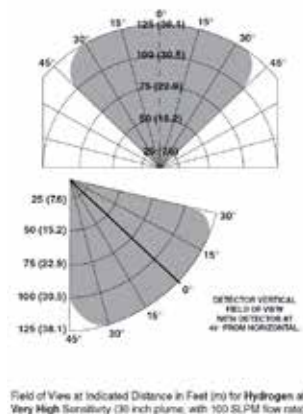
X3302 Multi-spectrum infra-red flame detector

Range (m)	Very High	High	Medium	Low
On-Axis	38	33.5	21	11
Off-Axis	30.5	24.5	15	7.5

X3302 Detection Range in Meters to 750mm hydrogen plume fire (100 SLPM) listed by sensitivity



- Multiple approved sensitivities provide application flexibility
- Multiple detection algorithms, including an optional Sustained Fire Mode
- Multiple fuels approved
 - Hydrogen
 - Syngas
 - Methane/NG
 - Methanol



CONFIDENTIAL AND PROPRIETARY

22

Hydrogen Gas Detection Solutions

FlexVu® Model UD10 with Catalytic Bead Sensor

- 0-100% LFL/LEL H₂ detector
- Proven catalytic bead technology
- FlexVu UD10/CGS is certified as a Gas Detector
- One piece design with integral thermal barrier
- Sinter bonded flame arrestor provides superior EMI protection
- Extended operating temperature range (-55°C to +125°C)
- Backlit, Liquid Crystal Display (LCD) indicates gas type and concentration
- 4-20 mA output with HART
- Configurable relay outputs
- Explosion-proof aluminum or stainless-steel housing
- Sensor can be remotely located using a sensor termination box (STB)
- Non-intrusive calibration



CONFIDENTIAL AND PROPRIETARY

25

Hydrogen Gas Detection Solutions

GT3000 Series H₂

- Electrochemical sensing cell detects hydrogen in parts per million (ppm)
- Detection range of 0-1000ppm (0 - 0.1% by volume)
- Response time T50 = 8 seconds, T90 = 60 seconds
- Operating temperature range -20°C to +40°C
- Temperature compensated for consistent performance
- IP66 allows installation outdoors
- Magnetic switch for non-intrusive calibration
- 4-20 mA output with HART communication
- Durable 316 stainless-steel transmitter housing and carbon filled polyphthalamide (PPA) sensor module
- Ideal for battery charging rooms (batteries expel hydrogen as they are charged)



CONFIDENTIAL AND PROPRIETARY

26

Hydrogen Gas Detection Solutions

H₂ Acoustic gas tests

- Use pressure comparative tests rather mass/second tests
- Due to H₂ volumes compared to mass
- Use of mA linear outputs with regard to dB acoustic signatures does not offer analytic capability for assessing gas leakage alarm condition. Det-Tronics approach is as analytical as with our flame detectors.

[Hydrogen Acoustic Test](#)

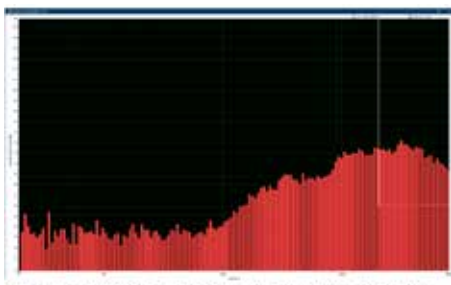


Figure 3: FlexSonic Acoustic Detector output 25 feet from 6 Bar (87 psi) Hydrogen (H₂) through 2mm round orifice.

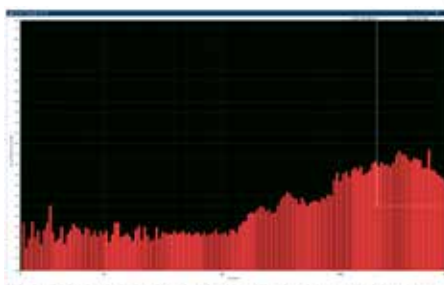


Figure 4: FlexSonic Acoustic Detector output 20 feet from 6 Bar (87 psi) Methane (CH₄) through 2mm round orifice.



CONFIDENTIAL AND PROPRIETARY

27

SYSTEM SOLUTIONS

CONFIDENTIAL AND PROPRIETARY

Questions

| CONFIDENTIAL AND PROPRIETARY |

Country Day II

International Day

Country Day II : International Day

**[Colombia] Colombia,
Hydrogen towards a just energy transition**

Country Day II : International Day

[Colombia] Colombia, Hydrogen towards a just energy transition



Shirley Vega

Commercial Counsellor,
Embassy of Colombia in Korea

Professional Career

Shirley Vega, the Executive Director of ProColombia in the Republic of Korea, first came to Korea in 2009 through the Korean Government Scholarship Program. She holds a degree in Industrial Engineering from Ajou University. Fluent in Korean, Shirley brings over a decade of expertise in corporate strategy, market expansion, start-ups, and business development, with a strong focus on the Asian market, particularly Korea.

Her career includes roles at prominent companies such as Samsung SDS, AmorePacific, and Intralink Group. Before joining ProColombia, she served as the Country Manager for Procomer (Costa Rican Trade and Promotion Agency). Since June 2022, Shirley has led ProColombia Korea with a mission to enhance Colombian investment, trade, and tourism in Korea. She is committed to fostering partnerships with organizations that share the vision of strengthening economic ties between Korea and Colombia.

Speech Title

Colombia, Hydrogen towards a just energy transition

Speech Summary

Colombia is committed to driving energy transition towards a greener, more sustainable economy. We actively promote investment opportunities in renewable energy, with a particular focus on green hydrogen, clean energy technologies, and the broader energy transition. As the global demand for clean energy surges, Colombia is positioning itself as a hub for sustainable energy production, leveraging its abundant wind and solar natural resources and ambitious government initiatives to reduce carbon emissions.

We invite you to consider Colombia as the ideal destination for hydrogen production and development. With its vast renewable energy potential, including strong wind and solar resources, along with a strategic location and firm commitment to sustainability, Colombia is poised to become a global leader in green hydrogen production.

Our government supports energy transition projects with favorable policies and incentives, creating a business-friendly environment for foreign investors. Moreover, Colombia's proximity to key global markets and its well-established port infrastructure provide seamless export routes to Asia, Europe, and North America, further enhancing its appeal as an investment destination.

By choosing Colombia, your company will not only gain access to a rapidly growing and competitive market but also contribute to a sustainable global energy future. We invite you to join us in shaping the clean energy revolution and position your business at the forefront of the hydrogen industry.

Company Introduction

ProColombia is the national agency in charge of promoting Colombia's international trade, foreign investment, tourism, and exports. Operating under the Ministry of Commerce, Industry, and Tourism, its mission is to drive Colombia's economic growth by positioning the country as a key player in global markets, attracting foreign direct investment, and showcasing Colombia as a prime destination for tourism and business ventures.



SOUTH KOREA STRATEGIC ALLY FOR HYDROGEN DEVELOPMENT IN COLOMBIA



Double Taxation Agreement in force since 2014.

Free Trade Agreement in force since 2016.
Preferential access for:

- Hydrogen – HS 28.04.10 – 0% Tariff
- Ammonia – HS 28.14.10 – 0% Tariff
- Methanol – HS 29.05.11 – 0% Tariff



Competitive maritime transit times to South Korea (Pusan) from **24 days** to export hydrogen and derivatives.

KOICA
한국국제협력단

kotra
무역투자24



The Republic of Korea and Colombia have strengthened their cooperation channels. **KOICA** and **KOTRA** have presence in Colombia.



By 2030, Colombia aims to meet 1% of the **hydrogen export demand** to **South Korea, Germany, and Japan** with an expected increase to 3% by 2050.*

*Just Energy Transition Roadmap, Draft Documents.

SOUTH KOREA STRATEGIC ALLY FOR HYDROGEN DEVELOPMENT IN COLOMBIA



MOU: Colombia and Korea sign alliance for environmental protection. (August 2021)



MOU: Hydrogen Colombia joins the Global Hydrogen Industry Association Alliance (GHIAA) and signs a collaboration agreement to promote hydrogen on a global scale. (May 2022)



MOU: H2 Korea and Procolombia strengthened international ties by signing an MoU for the development of hydrogen. (September 2023)



HYDROGEN FOR A JUST AND SUSTAINABLE TRANSITION



5 REASONS TO INVEST IN HYDROGEN

1

Colombia has a **green energy matrix** mainly with renewable resources and a competitive energy mix with high availability of sources, allowing the development of large-scale of low-emission hydrogen projects.

2

Colombia will provide the **world's fourth - lowest hydrogen production cost** and the second lowest in Latin America by 2050*.

*IRENA, 2022

3

The National Hydrogen Strategy sets by 2030, there will be an electrolysis capacity of 1-3 GW, with **estimated investment of USD 5.5 billion** in hydrogen production and demand projects for mobility and refineries.

*Hydrogen Roadmap, 2021

4

An **ideal export platform** to the main hydrogen and derivatives importers in Asia, Europe and North America.

5

Robust institutions and a sector-specific regulatory framework that includes incentives to promote long-term investments to achieve the decarbonization and reindustrialization targets.

DIVERSE GEOGRAPHY AND FAVORABLE CLIMATE CONDITIONS



SOLAR



Colombia surpasses the world average solar radiation by 60%, reaching **4.5 kWh/m²**.

WIND



Potential of **50 GW Onshore** and **50 GW Offshore**. In La Guajira, wind speeds are between **9 – 12 m/s**, double of the world average.

HYDRO



More than 740,000 watersheds and a multiannual flow of 52 m³/s. **65 GW** hydropower potential capacity. **67%** of the energy is produced by hydroelectric power.

BIOMASS



Potential of more than **500,000 TJ** of biomass per year.

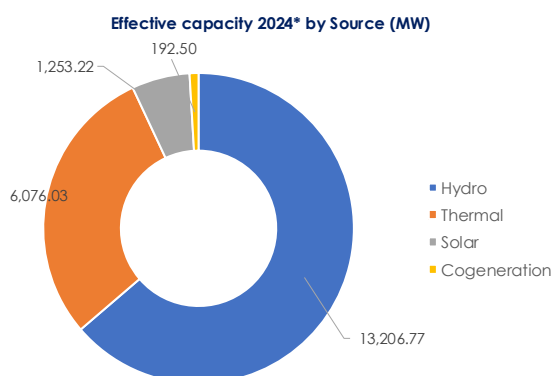
GEOHERMAL



Potential of more than **1.5 GW**.

Source: Ministry of Mines and Energy

COLOMBIA HAS A GREEN ENERGY MATRIX



Total 2024* effective capacity was **20,728.52 MW**, of which more than **70.7%** was green, mainly with hydropower plants, and the remaining **29.3%** is non-renewable (thermal).

* August 8, 2024
Source: [XM Expert Advisors](#)

THE WORLD'S FOURTH-LOWEST PRODUCTION OF GREEN HYDROGEN BY 2050



LEVELISED COST OF HYDROGEN RANGE IN 2050
DERIVED FROM SUPPLY-DEMAND ANALYSIS
(USD/KgH₂)

- 1 | China
- 2 | Chile
- 3 | Morocco
- 4 | Colombia
- 5 | Australia
- 6 | Mexico

Ranging between
USD 0.8/ kgH₂ and USD
1.1/kgH₂



Source: [International Renewable Energy Agency \(IRENA\)](#)

*LCOH: The levelised cost of hydrogen. Notes: Levelised cost of hydrogen derived from supply-cost curves of individual countries and regions based on their estimated hydrogen demand for 2050. Water availability for electrolysis is considered in the hydrogen supply-cost curves

LATAM'S TOP 3 IN RENEWABLE HYDROGEN SECTOR IN 2024



Overall scoring of the 2024 H₂LAC Index

- 1 | Chile – 73.25
- 2 | Brazil – 72.75
- 3 | Colombia – 72.25
- 4 | Uruguay – 54.75
- 5 | Costa Rica – 54.70
- 6 | Argentina – 51

Source: [H2LAC](#)

Colombia remains in the top 3 of the renewable hydrogen sector in Latin America and the Caribbean. It has a high level of regulatory development and policies that enable the adoption and development of renewable hydrogen



USD 5.5 BILLION OF INVESTMENT IN H₂ PRODUCTION AND DEMAND PROJECTS BY 2030



GOALS 2030

PRODUCTION



1-3 GW*

Electrolysis capacity between

1.5 - 4 GW of NCRE

1.7 USD/kg LCOH* green



50 kt* H₂ – 2.4 USD/kg

Blue hydrogen production



DEMAND



1,500 – 2,000

Light-duty fuel cell vehicles



50 – 100

Public access hydrogen fueling stations



40% low carbon H₂ (Green and blue) of total industry consumption



Demand 2030: 120 kt per year

Demand 2050: 1,850 kt per year

CROSS-SECTORIAL



Between **7,000 - 15,000** direct and indirect jobs



0.7 Mton CO₂ avoided annually



The main trade destinations will be **South Korea, China, Japan, and the United States.**

Source: Ministry of Mines and Energy

NCRE: Non-Conventional Renewable Energy *LCOH: The levelized cost of hydrogen. Kt: kilotons, a unit of energy

30-YEARS ROADMAP



Scan to download

- With the support of the Interamerican Development Bank – IDB and the UK Government the Colombia's hydrogen roadmap, launched in 2021.
- Colombia is updating its strategy in alliance with GIZ – German Cooperation.

HYDROGEN PERSPECTIVES IN THE JUST ENERGY TRANSITION ROADMAP (DRAFT DOCUMENTS)



2023- 2030

Regulation for hydrogen production, storage and distribution.

International cooperation agreements to facilitate the export of green hydrogen.

Investments in infrastructure and hydrogen production.



Electrolysis capacity



Renewables



H₂ National Demand



H₂ Exports

2030

2.5 GW

2040

10 GW

2050

25 GW

120 GW

1,569 MT/Y

Start of exports to countries with International Agreements

885 KT/Y

Mobility: 872kt (220,000 Vehicles)

Refineries: 412kt (50% Green H₂)

Industries: 285kt

MT/Y: Million Tons per Year

KT/Y: Thousand Tons per Year

Source: Ministry of Mines and Energy. [Just Energy Transition Roadmap, Draft Documents](#). (In Spanish)



Source: GIZ – German Cooperation



INFRASTRUCTURE AND EXPERIENCE FOR FUTURE DEVELOPMENTS



6 hubs for the development of hydrogen corridors and valleys that enable a network for production, distribution, and transportation.



10 Port Zones with access to the Atlantic and Pacific coasts. **The ports of Barranquilla and Cartagena** already have infrastructure for handling ammonia and liquid fuels exports and imports.



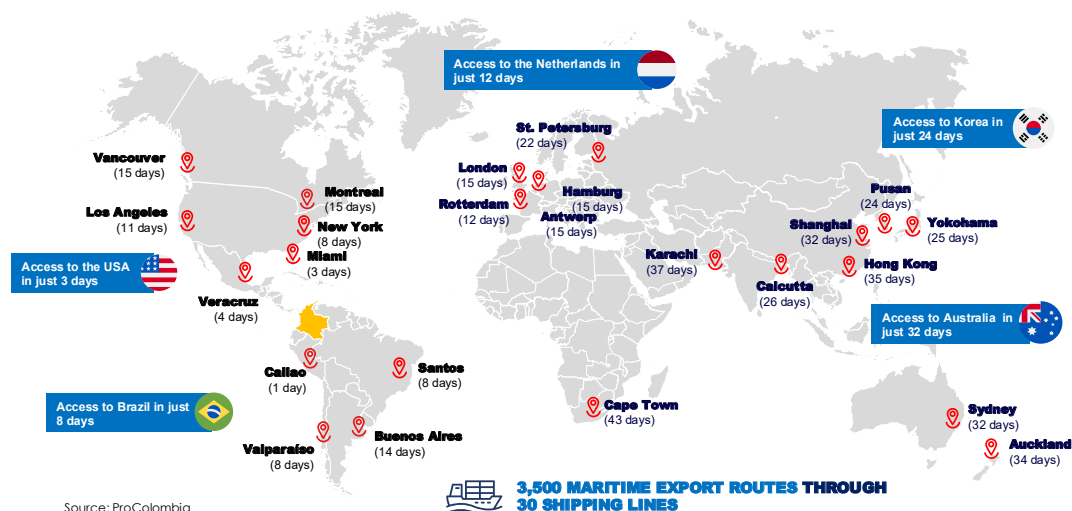
2 Refineries, 1 Regasification Terminal, and 7,500 kms natural gas pipeline.



Skilled workforce and productive capabilities in goods and services for the electric sector.

[GIZ HUBS OVERVIEW](#)
[GIZ EXECUTIVE SUMMARY \(IN SPANISH\)](#)

WE CONNECT TO MORE THAN 750 PORTS IN 140 COUNTRIES AROUND THE WORLD



Source: ProColombia



3,500 MARITIME EXPORT ROUTES THROUGH 30 SHIPPING LINES

HYDROGEN AND PTX INITIATIVES AND PERSPECTIVES



FIRST PILOT PROJECTS			NEXT STEPS		Cartagena	Barrancabermeja
	Industrial feedstock (Refinery)			Refineries (large-scale Green H ₂) 60 MW each (COD: 4Q 2025 – 1Q 2026)	 \$137-155 MUSD	 \$135-152 MUSD
	Injection into the natural gas network			PTX Production Pilots Ammonia, methanol and e-fuels (2025)		
 	 Fanalca  TOYOTA	Sustainable Mobility		Blue Hydrogen Residue Gasification (2030)	Barrancabermeja \$143 MUSD 55% Refinery Consumption	2.3 Mton/Year CO ₂ Captured, available for long-term sequestration 93% CO ₂ Capture rate
		First Hydrogen Hub (Launched in July 2023)		- Distributed H₂ - Centralized H₂ - LOHC - Ammonia - E-fuels	Waste to Energy: - H₂ - SynGas - Liquid Fuels	

Source: ProColombia, National press release.



COLOMBIA IS YOUR NEXT INVESTMENT DESTINATION FOR



	Greenfield low-emission hydrogen projects.
	Greenfield Power-to-X projects. Domestic and international market applications: Fertilizers, sustainable mobility, refineries, e-fuels.
	International private equity funds and cooperation.
	Potential for new manufacturing/assembly of electrolyzers: a hub for the region.
	Strategic alliances with key local and international players.

HYDROGEN AND PTX PROJECTS



TOTAL PROJECTS



27

STATUS



Concept: 10
Feasibility Study: 10
FID/Construction: 3
Operational: 4

PRODUCT



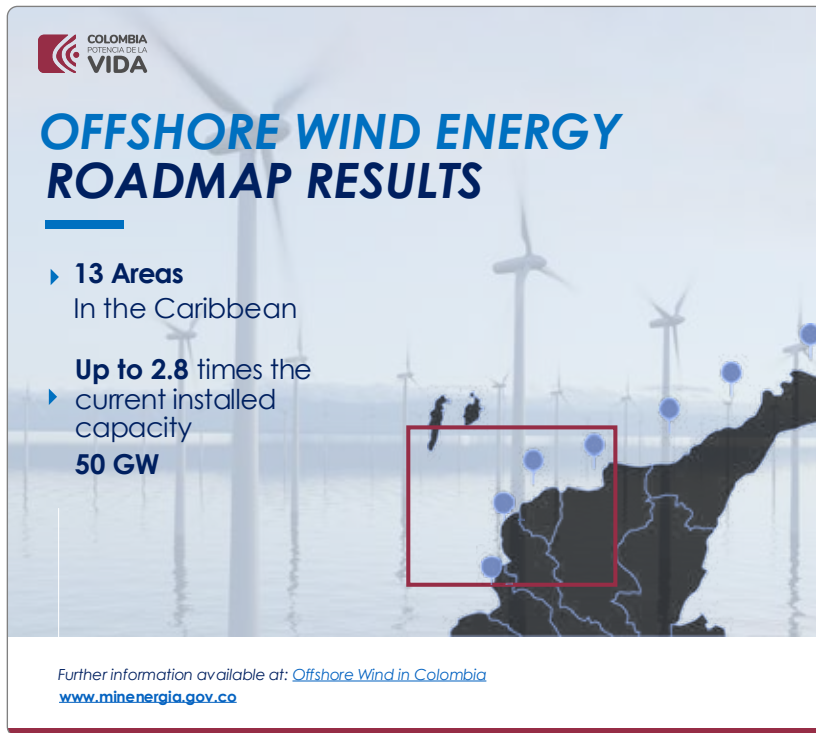
H₂: 13
Ammonia: 5
Various: 9

COMPANIES



To download full report
[International Energy Agency - IEA](#)





COLOMBIA
POTENCIA DE LA
VIDA

OFFSHORE WIND ENERGY ROADMAP RESULTS

- ▶ **13 Areas**
In the Caribbean
- ▶ **Up to 2.8 times the**
current installed
capacity
- ▶ **50 GW**

Further information available at: [Offshore Wind in Colombia](https://www.minenergia.gov.co)
www.minenergia.gov.co



FIRST COMPETITIVE PROCESS IN LATIN AMERICA AND THE CARIBBEAN

4th quarter 2023

- Socialization **first round auction** rules in the Caribbean coast
- Auction's specifications and conditions.

3rd quarter 2024

- Qualification process for interested parties.

At the end of 2025

- Winning bidders and Temporary Occupancy Permits.





REGULATORY FRAMEWORK AND INCENTIVES

COLOMBIA CO
THE COUNTRY OF BEAUTY

THE COUNTRY HAS A WELL-ESTABLISHED INSTITUTIONAL FRAMEWORK



GOVERNMENT ENTITIES



H2 ASSOCIATIONS



PRIVATE AND SERVICE PARTNERS*



*View our full Private Sector investment Services Directory: [Link](#)

ENERGY TRANSITION POLICY AND LEGAL FRAMEWORK



Law 2099 of 2021 establishes public policy guidelines for the country's energy transition and strengthens the incentives of **Law 1715 of 2014**.



Green, blue and white hydrogen and geothermal are considered as Non-Conventional Sources of Energy (NCSE). (Law 2099, 2021 and Law 2294, 2023)



The **Reindustrialization Policy** (2023) included among its main commitments the Energy Transition, which encourages decarbonization and the reduction of economic dependence on oil and coal.

Energy Transition policy was approved through **CONPES 4075 of March 29, 2022**.

The policy creates the energy transition path to develop new technologies such as wind energy, geothermal energy, and **hydrogen production**.



Source: National Planning Department and ProColombia

REGULATORY FRAMEWORK

- | | | | |
|---|--|---|--|
| <p>1 Law 697 of 2001
Declare the rational and efficient use of energy to be of social and public interest</p> | <p>2 Law 1964 of 2019 "Electric Mobility Law"
Promote the use of electric and zero-emission vehicles in the country.</p> | <p>3 Law 2169 of 2021
Declares of public utility and social interest the projects that produce and store green hydrogen.
Decree 1537 of 2022
Establishes a procedure for the issuance of the administrative act of public utility for projects of green hydrogen.</p> | <p>4 Law 2099 of 2021 (Energy Transition Law)
Defined green and blue hydrogen and adopted mechanisms for the promotion</p> |
| <p>6 Decree 1475 of 2022
Defines conditions and incentives to promote local development, storage, distribution and use of hydrogen</p> | <p>7 Decree 1537 of 2022
It regulated the administrative procedure for green hydrogen production and storage projects</p> | <p>8 Law 2294 of May 19, 2023
The National Development Plan introduced the white hydrogen</p> | <p>9 Decree 2235 of 2023
Regulate Article 235 of Law 2294 of 2023 in relation to the development of White Hydrogen projects within the framework of the Just Energy Transition in Colombia.</p> |

AN ATTRACTIVE FRAMEWORK FOR HYDROGEN INVESTMENTS

Incentives for investments in Non-Con Efficient Energy Management Sources of Energy (NCSE) and Efficient Energy Management (GEE)



INCOME TAX DEDUCTION



VAT EXEMPTION



CUSTOM DUTIES EXEMPTION



ACCELERATED DEPRECIATION

Deduction from income tax, in a 15-year period, 50% of investments in research, development, production of electricity with Non-Conventional Sources; and / measures for Efficient Energy Management; including smart

VAT exemption for elements, machinery, services for production and use of energy from renewable sources; actions/measures for energy efficiency, including smart metering. Automatically excluded: energy inverters, solar panels, charge controllers, for solar energy systems with panels.

Custom duties exemption for machinery, equipment, smart metering, materials, supplies, for generation with renewable sources, and actions/measures for energy efficiency. Only for machinery, equipment, materials, and supplies without national production.

Accelerated depreciation, up to 33.33% annually for machinery, equipment, civil works for generation with renewable energies, energy efficiency actions/measures. This incentive can be obtained simultaneously with the 50% income tax deduction for the same investments.

*GEE: Efficient Energy Management.
Source: Ministry of Mines and Energy



COLOMBIA LAUNCHED ECOH2 A COMPREHENSIVE INFORMATION MANAGEMENT SYSTEM



Explore **EcoH2** to learn more about hydrogen development in Colombia, register projects and find relevant information to understand and further promote the hydrogen value chain.

PROCOLOMBIA IS READY TO ASSIST YOU



Scan to
download the
PPT

SHIRLEY VEGA

ProColombia Korea Executive Director
E-mail: svega@procolombia.co

Office: +82 (2) 7201 318 Ext. 64502
Address: Kyobo Building Fl.11,
1 Jongno, Jongno-gu, Seoul, South Korea.

<https://investincolombia.com.co/en>

#TheCountryOfBeauty



Country Day II : International Day

**[Australia] Regulating market barriers and
market failures in the hydrogen sector**

Country Day II : International Day

[Australia] Regulating market barriers and market failures in the hydrogen sector



Zubin Bilimoria
University of Sydney

Education

- 2023 – 2026, Ph.D. Candidate, University of Sydney Law School, Sydney, Australia
- 2013 – 2027, Bachelor of Laws (University Medal and First Class Honours), University of Sydney Law School, Sydney, Australia
- 2013 – 2015, Bachelor of Commerce, University of Sydney Business School, Sydney, Australia

Professional Career

2020 – Present, Investment Manager, Palisade Investment Partners, Sydney, Australia. Specialising in investment across clean energy technologies, including traditional renewable energy technologies (wind and solar) and emerging technologies (BESS, hydrogen)

2018 – 2020, Investment Banking Analyst, Goldman Sachs, Sydney, Australia. Analyst in the Financing Group, providing acquisition financing and solutions for corporate clients and financial sponsors

2016 – 2019, Sessional Academic, University of Sydney Business School, Sydney, Australia. Taught courses for undergraduate finance students, covering Financial Valuations, Mergers & Acquisitions, and Investments & Portfolio Management

Speech Title

Regulating market barriers and market failures in the hydrogen sector

Speech Summary

My speech will focus on international developments within the hydrogen sector. First, I plan to outline the theoretical justification for why government's intervene in certain markets – which under the economic theory of regulation is to address market failures. There are three main market failures in the hydrogen sector: (i) Positive spillovers and learning effects, which arise when knowledge produced from the research and development procedures of one company spills over to the benefit of other firms. This leads to innovation failures, caused by under-investment as there is a 'first mover disadvantage'. The second market failure refers to externalities, where economic participants fail to consider all the costs and benefits associated with their actions. For hydrogen, negative externalities include the greenhouse gas emissions from 'grey' hydrogen, and positive externalities include the environmental benefits and increased energy security from 'green' hydrogen, which may not be reflected in the price differential. Finally, information asymmetries exist, which result in an inefficient allocation of resources. For example, information asymmetry is evident in the purchasing and selling of clean hydrogen, due to the absence of an internationally standardised certification regime.

After discussing market failures, I will analyse the extent to which National Hydrogen Strategies address these market failures, or whether they go beyond correcting market failures, for example to achieve industrial policy objectives such as increased employment and economic activity.

Finally, my speech will analyse case studies of real-life hydrogen projects, and how market failures and market barriers have affected their completion and development.

Company Introduction

Palisade Investment Partners is based in Sydney, Australia, and is an independent, global infrastructure manager. In March 2023, Palisade established Intera Renewables, which is a renewable energy platform, aggregating five of Palisade's operational renewable energy assets. In addition, I am a PhD candidate at the University of Sydney Law School, completing a PhD focused on international developments in the hydrogen regulatory sector and implications for Australia. reliable, affordable and accessible for all Chilean citizens.

Country Day II : International Day

**[Switzerland] Opportunities of collaboration
with Swiss hydrogen innovation ecosystem**

Country Day II : International Day

[Switzerland] Opportunities of collaboration with Swiss hydrogen innovation ecosystem



Antoine Jourdan

Director SIP West EPFL, Switzerland Innovation

Education

- HEC Lausanne
- Executive MBA in Corporate Finance (2013)
- Swiss Federal Institute of Technology (EPFL)
- Master in Computer Science and Telecommunication (2004)

Professional Career

- Swiss Federal Institute for Technology – Vice Presidency for Innovation
World-class research institute and university - www.epfl.ch (since November 2017)
- Director “Switzerland Innovation Park West EPFL”
<https://www.switzerland-innovation.com/network-west/>
- Co-Head of Industry relations @ Vice Presidency for Innovation
<https://www.epfl.ch/innovation/industry/>
- Director “Alliance-Innovation”
<https://alliance-innovation.ch/>
- Senior Business Manager (+15 years in private sectors)
TESSI Solutions – Business Process Outsourcing
Informatique-MTF SA – Compliance Banking & Anti-Money Laundering
Altran – Engineering consulting
- Startup Founder and Associate (8 years)
AgriVerde Sàrl - Agritech Startup
Iventis Sàrl – Sporttech startup

Research Interest

Academia Industry Collaboration
Public private partnership

Speech Title

Opportunities of collaboration with Swiss hydrogen innovation ecosystem

Speech Summary

Switzerland is often recognized as a leading country in term of Innovation.

What is the magic recipe and how can companies take advantage of the Swiss ecosystem?

This short presentation will give participants with an initial overview of the Swiss innovation ecosystem related to Hydrogen. Both the fields of research and the startups ecosystem will be showcased.

Moreover tangible opportunities for collaboration will be presented.

Company Introduction

Switzerland Innovation forms an ecosystem for domestic and international companies allowing them to further their research activities in partnership with universities and higher-education institutions. The sharing of ideas between researchers, talented individuals, and innovative entrepreneurs creates breeding grounds for innovation.



SWITZERLAND
INNOVATION
PARK NETWORK WEST EPH



Hydrogen: A world of opportunities

Antoine Jourdan

September 2024

H₂ is indispensable for hard-to-abate sectors



In 2050
600M tonnes
1000B USD
For producing green H₂

Source: www.precedenceresearch.com
IRENA – International Renewable Energy Agency

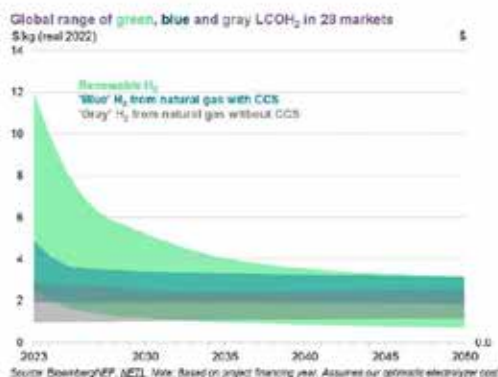
Here is the catch...



The good news is

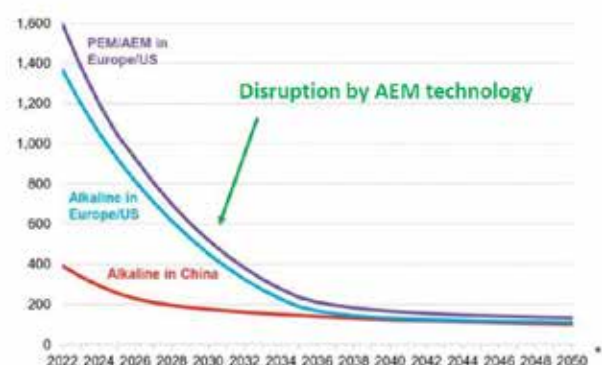


Green hydrogen will eventually undercut blue and gray in all markets



BloombergNEF

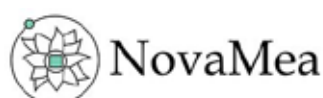
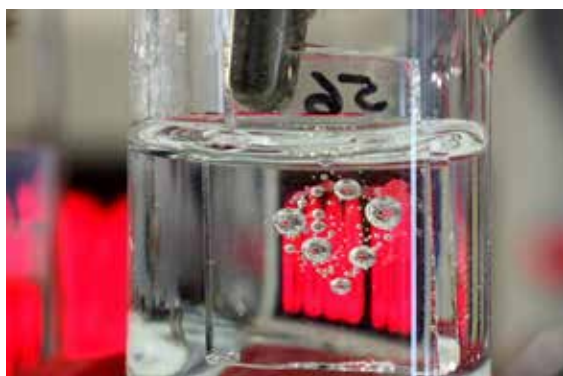
If electrolyzer cost can go like:



Lab of Inorganic Synthesis and Catalysis – Prof Xile Hu

Develop catalysts that are made of Earth-abundant elements for chemical transformations that are related to synthesis, energy, and sustainability.

With a focus on base metal catalyzed C-C bond forming reactions, C-H bond functionalization, (electro)catalytic water splitting, activation of small molecules such as CO₂, H₂, O₂, as well as the development of synthetic models for the active site of metalloenzymes



Patented anion exchange membranes (AEM)

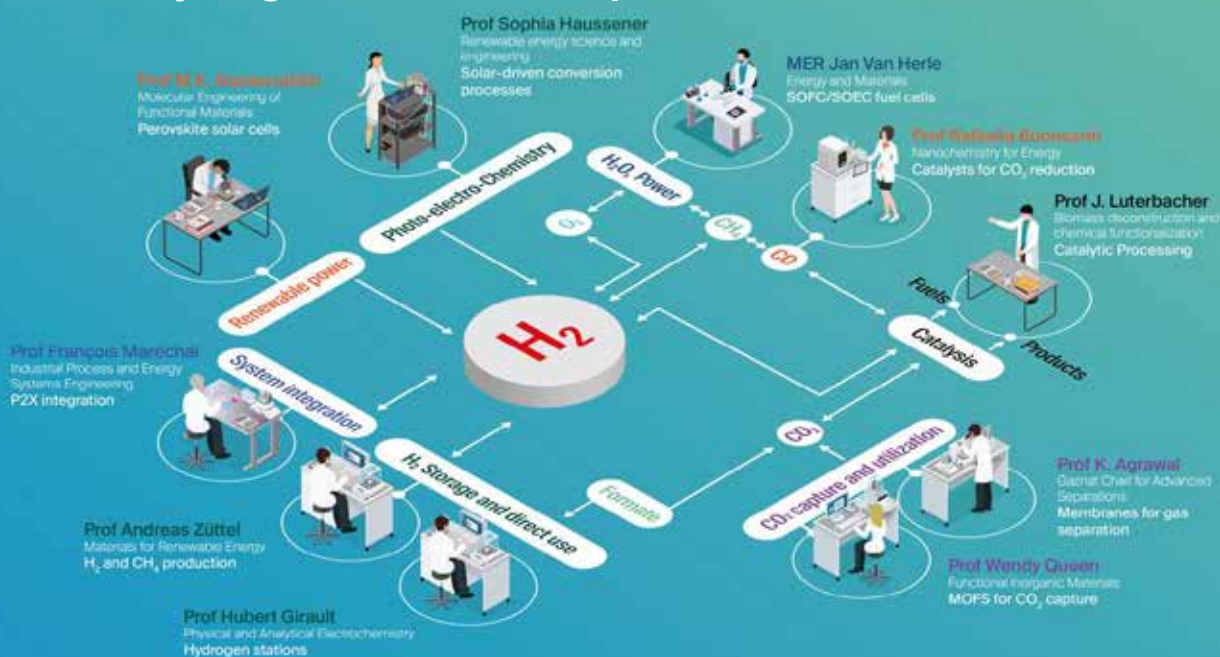
- most advanced in the world
- providing the performance and durability of water electrolysis process.

Patented electrodes

- from earth-abundant metals
- affordable and efficient.



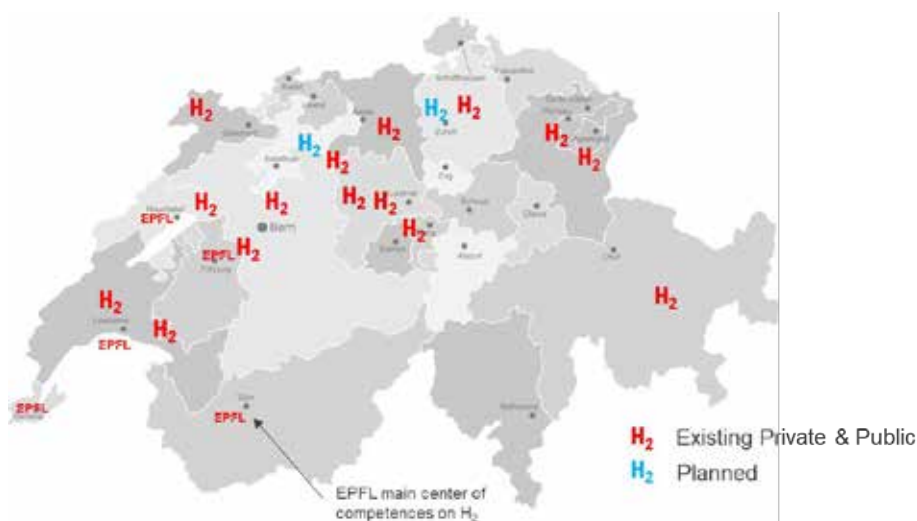
P2X Hydrogen Research Campus



An inspiring continuous engine for disruptive innovation



17 H₂ refueling stations in Switzerland



Hyundai Motor's XCIENT Fuel Cell Trucks Achieve Record of 10 Million km Total Driving Distance in Switzerland (June 14 2024)



Your swisstech discovery program



“A tailor-made program to discover the potential of academia in innovation, maximize impact of opportunities, and benefit from a vibrant & unique ecosystem”



Partner with other corporates and SMEs



Partner with startups



Launch innovation projects with academia



Test talents and ideas

+ Benefit from financial & governmental support of Switzerland's Unique Business Environment

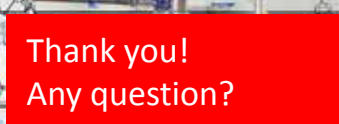
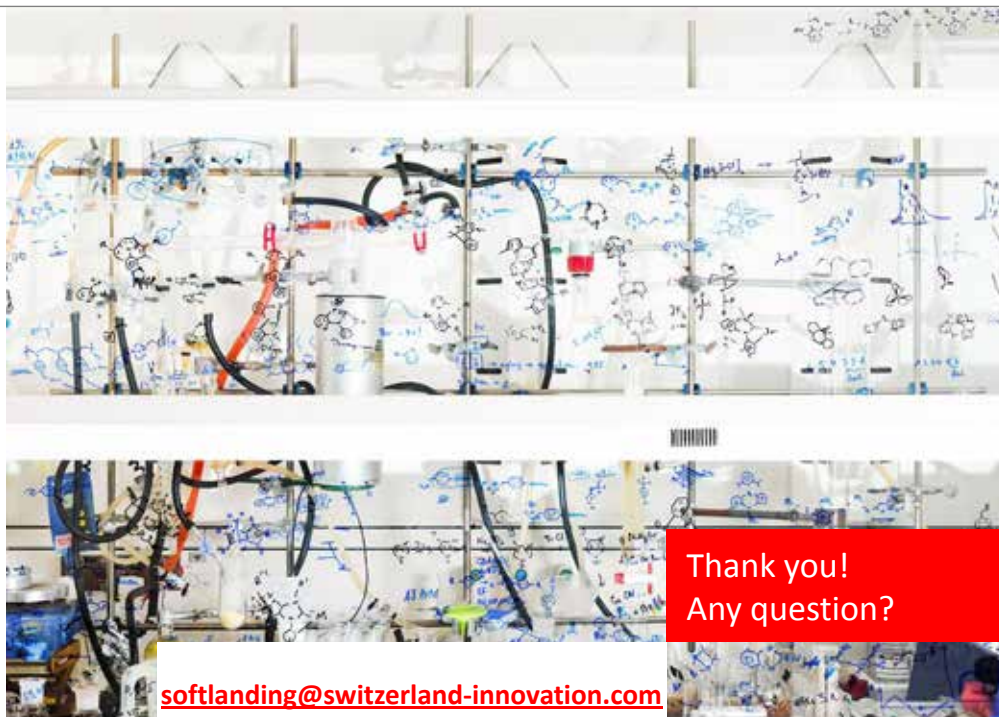
Switzerland position on H₂



- **Government supports research, innovation, and demonstrators** with the objective to contribute to energy & environmental transition ...
- ... and to position Switzerland strongly in the **Hydrogen research, startups to pre-industrial-scale**
- Rapid growth in demand for green hydrogen in Switzerland is expected but **Switzerland needs to accelerate its rollout of renewable energy production capacity** (especially PV)
- Expectations of **real and considerable opportunities in Europe** with (Green) Hydrogen market and sector to grow fast







softlanding@switzerland-innovation.com

Country Day II : International Day

[Greece] Hydrogen : Our Work and Impact

Country Day II : International Day

[Greece] Hydrogen : Our Work and Impact



Nikolaos Ntavos

Co-Founder & Manager of CluBE, Cluster of Bioeconomy & Environment of Western Macedonia (CluBE)

Education

- 2000-2006, Diploma, Energy Engineer, University of Western Macedonia, Kozani, Greece
- 2022-2024 MSc in "Hydrogen Science and Technology" University of Western Macedonia, Kozani, Greece

Professional Career

- 07/04/2014–Present, Co-Founder & Manager, CluBE – Cluster of Bioeconomy & Environment of Western Macedonia
- 01/01/2007–Present, Energy Engineer (Freelance)
- 25/11/2016–31/12/2019, Project Manager/Additional Staff, Waste Management Company of Western Macedonia, Greece. (DIADYMA S.A.)
- 31/07/2012–31/03/2016, EU External Programme Project Manager, Regional Development Fund of Western Macedonia, Greece.

Research Interest

- Sustainable use of biomass resources and boosting regional competitiveness
- Intelligent technologies in the energy sector
- Bioenergy optimization and regional biomass action plans
- Social responsibility in SMEs and sustainable practices
- Bioeconomy potential and development strategies in EU regions
- Hydrogen production and integration in energy systems
- Urban biowaste reduction and transformation into value-added products
- Energy efficiency in public buildings
- Sustainable forest value chain and digitalization in forestry
- Innovative storage solutions and energy grid resilience

Speech Title

Hydrogen: Our Work and Impact

Speech Summary

Nikolaos Ntavos will present CluBE's hydrogen projects, emphasizing the transition from coal in Western Macedonia, Greece. Key projects will include GreenSkills4H2, Hy2Market, 24/7 ZEN, H2Marine, i-STENTORE, InnoAGRIVET, and GREENH2ORN. The LIFE GREENH2ORN project will aim for climate neutrality with a 500-kW electrolyzer, a hydrogen refueling station, and municipal fleet fueling in Kozani and Thessaloniki.

Company Introduction

The Cluster of Bioeconomy and Environment of Western Macedonia (CluBE) is a non-profit company established among local actors and stakeholders of the Region of Western Macedonia in Greece. CluBE emerged since early '00s from the continuous collaboration of regional players during previous projects, analysing regional bioenergy and biomass potentials, the core cluster structures, and the regional innovation systems devoted to the energy sector.

CluBE is developing R&D and business activities in the fields of bioeconomy, bioenergy and environment, in order to reinforce green, smart and circular economy in the region and the neighbouring areas, namely through: energetic exploitation of biomass for household and industrial use and especially for district heating systems for small, medium or large cities, mobilisation of regional biomass supply chains, development of the green hydrogen economy, increase of the share of biofuels in the energy mix of transportation fuels, co-firing biomass with lignite in existing power stations and/or future heating plants, optimisation of heating systems, improvement of energy efficiency for households, public and private buildings, promotion of the concepts of smart cities and villages, support of the entrepreneurship in the field of circular bioeconomy.



Hydrogen: Our work and impact

Nikolaos Ntavos, Co-Founder & Manager, CluBE

Establishment of CluBE

- ❖ **Initially founded in 2014 as Bioeconomy and Environment Cluster**
- ❖ **Not-for-profit company**
- ❖ **Bottom-up approach**
 - **Development of common business and R&D in Bioeconomy and Environment**
 - **Mobilize resources to bridge the gap**



Areas of activity

Promotion of **Bioeconomy** as a major decarbonization pillar for the regional **Exploitation of renewable energy, clean technologies and energy storage**

Development of the **green hydrogen economy**

Promote **climate neutrality in cities**

Promote **smart cities & villages** initiatives

Support digital transition

Biomass exploitation and optimization of local biomass supply chains

Increasing the share of **biofuels in the energy mix** of transportation fuels

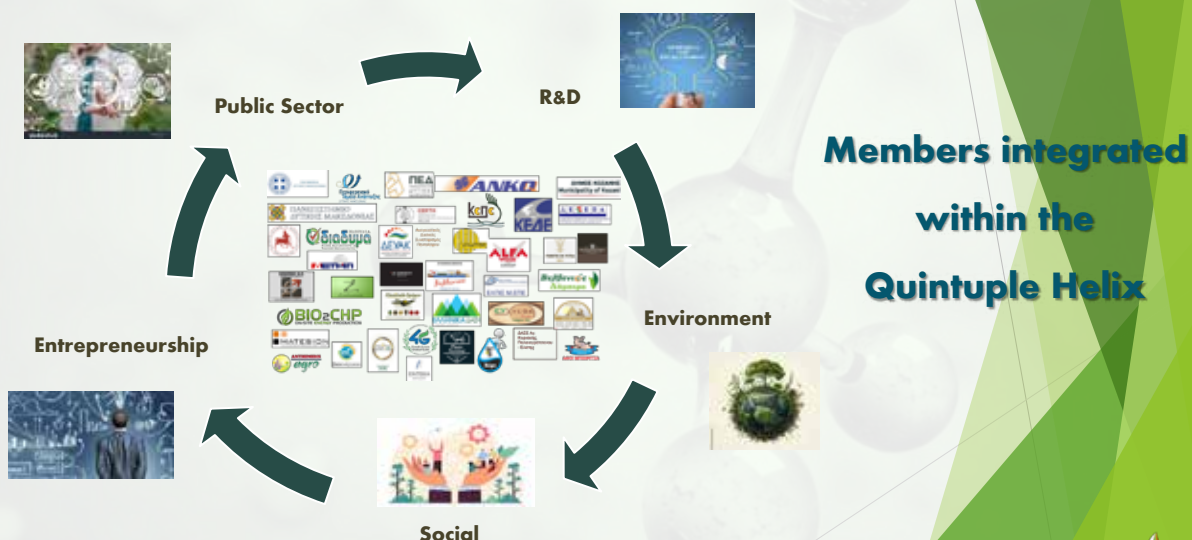
Energy efficiency in industry, services, households / collective models

Sustain the **New European Bauhaus** initiative

Shaping a **circular and symbiotic** industrial ecosystem and supporting **life-cycle thinking**

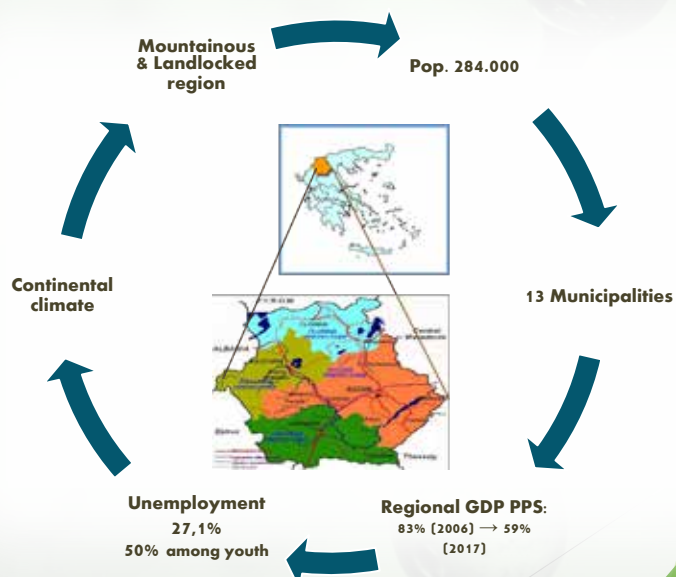


Our Power = Our Members





The Region of Western Macedonia - Greece



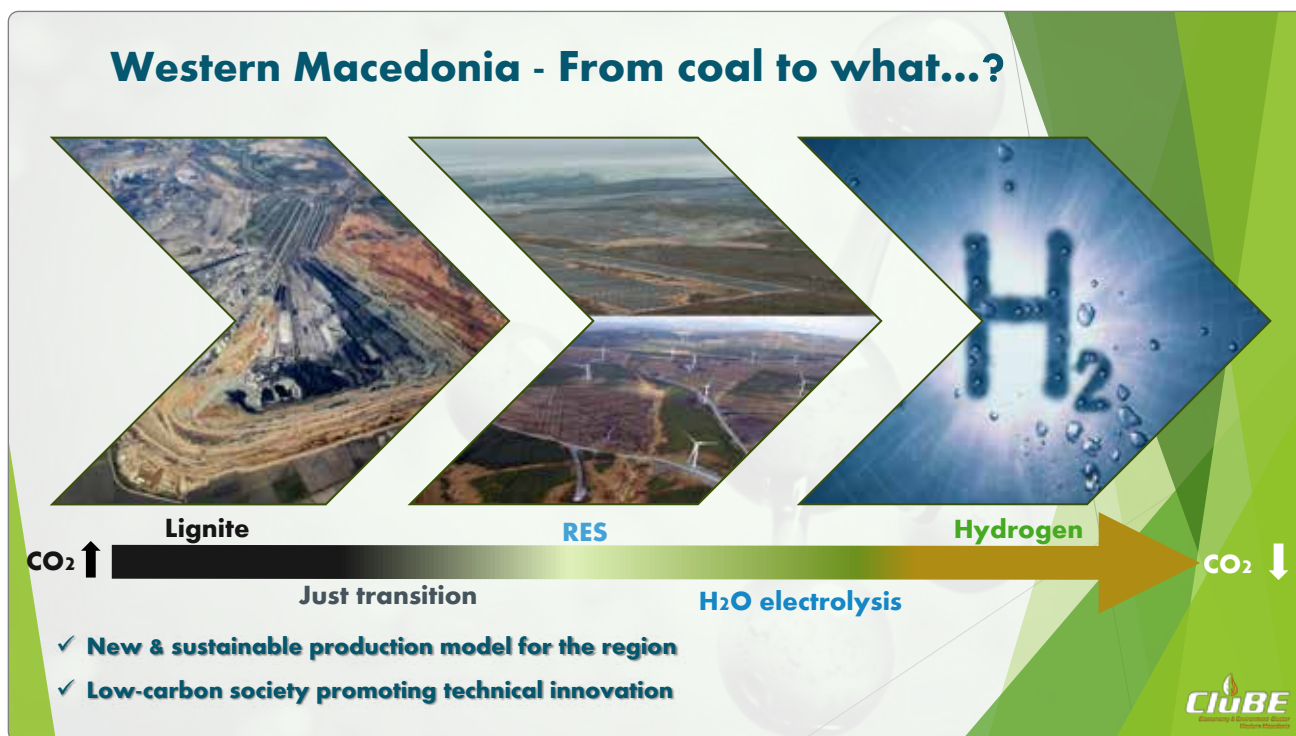
Lignite industry in Western Macedonia



- Supply of low-cost grid electricity since 1960
- Energy pillar of national economic growth
- 4 lignite-fired power plants → 40% of the electrical and 20% of the total demand in Greece
- DH provision to ~100.000 citizens in Kozani, Ptolemaida and Amyntaio



Western Macedonia - From coal to what...?



Hydrogen Initiatives & Europe

Production Goals:

- Produce 10 Mt/yr of renewable hydrogen annually by 2030.
- Import an additional 10 million tonnes by 2030

Infrastructure Development:

- 6 GW of renewable hydrogen electrolyzers by 2024.
- Scaling up to 40 GW by 2030



EU Hydrogen Strategy:

- ## REPowerEU Plan:

- ### Important Projects of Common European Interest (IPCEI):

- Fit for 55 Package:**

- ### Regulatory Frameworks:

- ### Clean Hydrogen Partnership:

- European Clean Hydrogen Alliance:**

- ### Hydrogen Observatory:

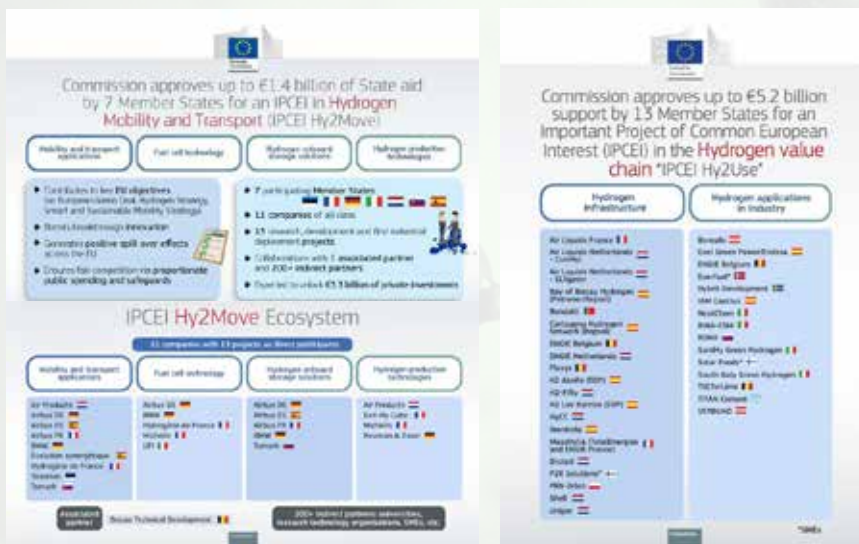
- Part of the EU's broader hydrogen strategy.
- Provides up-to-date information on the status and trends of hydrogen deployment across Europe.
- Supports the monitoring and analysis of the hydrogen market and the implementation of the EU hydrogen strategy ([Energy](#)) ([World Economic Forum](#)).

Commission approves up to €5.4 billion support by 15 Member States for an important Project of Common European Interest (PCEI) in the **Hydrogen Technology value chain** "PCEI Hy2Tech"



Electrolysers	Pipelines	Storage	LONG Hauling terminals	Cross-workstream collaboration
AIR LIQUIDE Energie Salzgitter ENERTRAG EWE HYDROGEN Fusion Fuel GRO HCH Hydrotub Ferne Hyfly Unile Uniper Polenvergas Reckw EnergyPort RAU SAPPHI Wissener 	AquaChem Cress Eurostream EWE H2T Gasnetz Hamburg Gasunie Nanterra OGE Oxitras SNAM ThyssenGas 	EWE GASSPEICHER RAE Gas Storage VNG 	Hydrogenius Vopak 	Facilitating future interconnections - Common agreement on interoperability - Joint recommendations on operational rules - Contribution to standardisation

H2-related IPCEIs (2/2)



European Hydrogen Bank

These are the selected projects.

Project	Coordinator	Country	Bid volume (kt H ₂ /10 yrs)	Bid capacity (MW _e → Mega-watts electric)	Expected GHG avoidance (kt CO ₂ /10 yrs)	Bid price (EUR/kg)
eHVG Lahti	Nordic Ren-Gas Oy	Finland	122	90	836	0.37
EI Alamillo H2	Benbrós Energy S.L.	Spain	65	60	443	0.38
Grey2Green -II	Petrogal S.A.	Portugal	216	200	1477	0.39
HYSENCIA	Angus	Spain	17	35	115	0.48
SKOGA	Skiga	Norway	169	117	1159	0.48
Catalina	Sanato Huelva	Spain	480	500	3204	0.48
MP2X	Madoquepo wter 2x	Portugal	511	500	3494	0.48

► What is the European Hydrogen Bank: An EU initiative to support renewable hydrogen production, funded by the EU Emissions Trading System.

► Goals/Targets: Promote renewable hydrogen, reduce CO₂ emissions, boost innovation, and meet 2030 production targets.

► Scope of the Auction: Allocated €720 million to seven EU projects to produce 1.58 million tonnes of hydrogen over ten years, with premiums of €0.37 to €0.48 per kg/H₂.

► Summary of the Results: Seven projects funded, avoiding over 10Mt of CO₂ emissions, with grant agreements due by November 2024 and production starting within five years.

► Outlooks: High industry participation suggests the need for a larger budget in future auctions, with the next auction planned for the end of the year to refine regulatory and funding schemes.

Hydrogen Initiatives & Greece

Production Goals:

- Produce 1 TWh of renewable hydrogen by 2030.

Infrastructure Development:

- 300 MW of renewable hydrogen electrolyzers by 2030.



Hydrogen Projects in Greece

Linde switches on 1-MW green hydrogen production plant in Greece



Image by Linde Group
The green hydrogen production facility of Linde Hellas is located in the town of Kozani, West Macedonia. The electrolysis process is powered with electricity from renewable energy plants.

ADVENT
Greece: Advent Technologies Spearheads Green Hydrogen Plant in Kozani with €24 Million Grant

By FuelCellworks March 15, 2024 3 min read 22 views



B&T Composites joins R&D project to develop novel composite hydrogen storage tanks

As part of the Green-based H2Cat project, the company's new tanks will be developed and installed with embedded sustainable health monitoring (SHM) systems.

Research and Pilot Projects

Only two units for electrolytic hydrogen production have been built, with some pilot/commercial hydrogen production and refueling station projects seeking European funding

Approved Hydrogen Equipment Projects

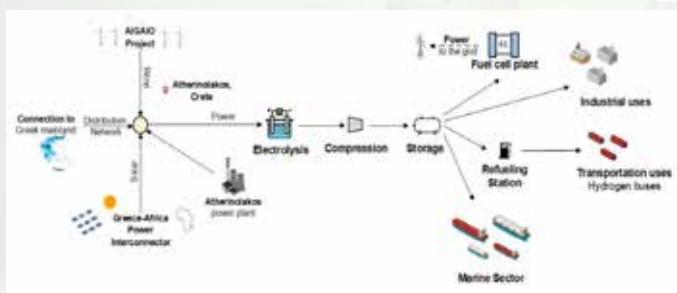
Two projects, one for electrolyzer and fuel cell production and one for synthetic material hydrogen tank production, have been approved for funding and will be installed in Western Macedonia, a coal phase-out region

16

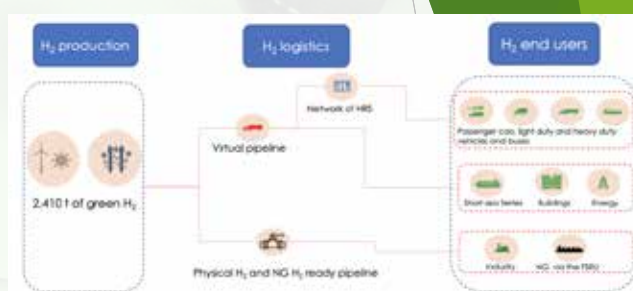
Project examples – CRAVE-H2

- ✓ 100-MW green H₂ plant in Atherinolakos, Crete, aimed at boosting Cretan and European economies
- ✓ Serving four key end-markets: Public Mobility, Navy, Export & Power Generation
- ✓ Supported by various institutions

Partners



Project examples – TRIERES



5	26
Countries	Partners
2,410	23
Tons of green H ₂ produced per year	Different applications
10,492,431	
Total budget in euros	

- ✓ Small-scale initiative with significant expansion potential to the Balkans, South-Eastern Europe and Eastern Mediterranean
- ✓ Centered around Motor Oil's refinery in Corinth
- ✓ Green H₂ use in mobility, energy, and industry sectors
- ✓ Successful implementation ensured by local & regional government participation

CluBE as a strategic partner in EU hydrogen network

- Greenovatel Europe – Full member
- European Bioeconomy Stakeholders Panel – DG RTD European Commission – Member
- Biobased Industries Consortium (BIC) – Associate Member
- **European Clean Hydrogen Alliance – Member**
- Innovawood – Full member
- Hellabiom (Hellenic Biomass Association) – Full member
- **Hydrogen Europe – Member**
- **Fuel Cells and Hydrogen Joint Undertaking (FCH JU) – Hydrogen Valleys Partnership – Member**
- **National Contact Point of EU Hydrogen Observatory**
- **Member of Hydrogen Valleys S3 Partnership**
- European Circular Economy Stakeholder Platform – Leadership Group Member
- ENRD Mainstreaming the Bioeconomy Thematic Group – Member
- S3 Bioenergy Partnership – Member
- Greek Bioeconomy Forum – Founding member
- Local Governments for Sustainability – Member
- Hellenic-German Chamber of Commerce and Industry
- American-Hellenic Chamber of Commerce
- European Biogas Association
- AMWAJ Alliance
- World Bioeconomy Forum
- European Federation of Agencies and Regions for Energy and Environment



CluBE portfolio on hydrogen projects

Strategic initiatives on hydrogen

- GreenSkills4H2, Erasmus+ Project 
- Hy2Market, I3 instrument/ERDF Project 
- i-STENTORE, Horizon Europe Project 
- 24/7_ZEN, Horizon Europe Project 
- H2MARINE 
- Pilot Positive Energy Building – InnoAGRIVET
(The case of the Agri-Vet Centre as a Living Lab in Western Macedonia)
- Management of Urban Sewage Sludge to Hydrogen Fuel for Transportation
- LIFE GREENH2ORN – GREEN Hydrogen mObility for the tRansition to climate Neutrality



CluBE portfolio on hydrogen projects

GreenSkills4H2 – The European Hydrogen Skills Alliance

33 Partners in 15 countries

-  5 Industry Stakeholders
-  11 Higher Education, Research organisations & 4 VET Providers
-  6 National and European networks
-  3 Local / Regional stakeholders
-  2 Clusters
-  Communication/Digital Experts
-  Market analysis and Skills Experts
-  Transitioning regions represented by stakeholders



greenskillsforhydrogen.eu/

Funded by the European Union



CluBE portfolio on hydrogen projects

GreenSkills4H2 – The European Hydrogen Skills Alliance



CluBE portfolio on hydrogen projects

GreenSkills4H2 – The European Hydrogen Skills Alliance

Educational training programs at UoWM

Masterclass: One-Day Hydrogen

- Topics: Hydrogen value chain & its role in the energy transition in Western Macedonia
- Target audience: key stakeholders, policymakers, engineers and students
 - Event response: ≥ 70 participants



1st & 2nd Hydrogen Summer Sch2ools

- Topics: Electrolyzers, fuel cells, safety issues, injection, distribution & mobility
- Target audience: under/postgraduate engineering students
 - Event response: ≥ 80 participants



CluBE portfolio on hydrogen projects

GreenSkills4H2 – The European Hydrogen Skills Alliance

Training with the Technical Chamber of Greece/ Department of Western Macedonia

Engineering our Future: Developing Hydrogen Skills

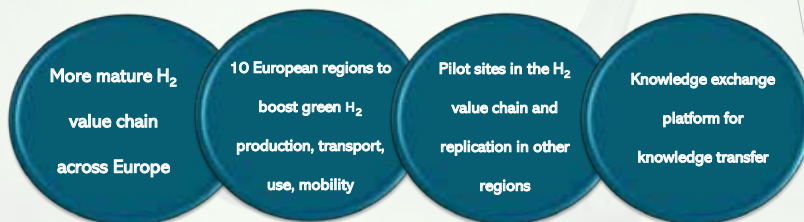
- Topics: Hydrogen economy & technologies
- Target audience: Engineers, technicians, students
- Event response: ≥ 30 participants



CluBE portfolio on hydrogen projects

Hy2Market - HYdrogen TO enter MARKets reducing carbon Emissions Footprint

Creating the hydrogen market for Europe



Hy₂Market



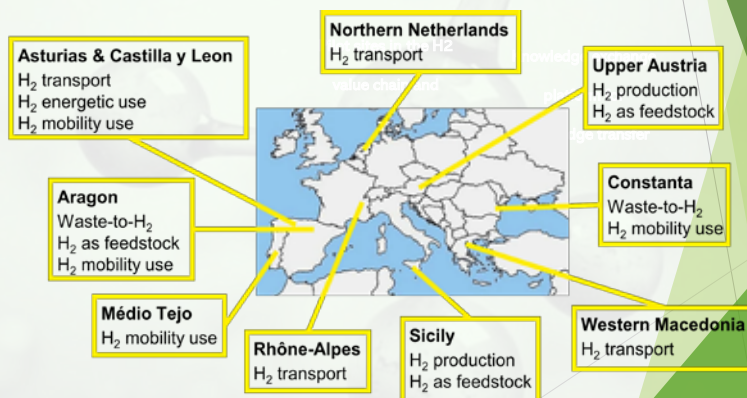
CluBE portfolio on hydrogen projects

Hy2Market - HYdrogen TO enter MARKets reducing carbon Emissions Footprint

Pilot regions

Hy₂Market

- Production
- Transport
- Industrial usage
- Mobility usage
- Knowledge exchange



CluBE portfolio on hydrogen projects

24/7 ZEN – Reversible SOEC/SOFC system for a zero-emissions network energy system



- ✓ Scalable and replicable
33/100 kWp rSOC operation
- ✓ Optimization & feasible deployment
in different scenarios



CluBE portfolio on hydrogen projects

24/7 ZEN – Reversible SOEC/SOFC system for a zero-emissions network energy system



Partners



CluBE portfolio on hydrogen projects

24/7 ZEN – Reversible SOEC/SOFC system for a zero-emissions network energy system



24/7 ZEN – Reversible Solid Oxide (rSOC) systems



CluBE portfolio on hydrogen projects

H2MARINE – Hydrogen To Marine



Hydrogen PEM-FC stack for marine applications



PEMFC Validation
in relevant environment
and industrial data



PEM Lifetime:
40.000h-80.000h



PEMFC Validation
in relevant environment
and industrial data

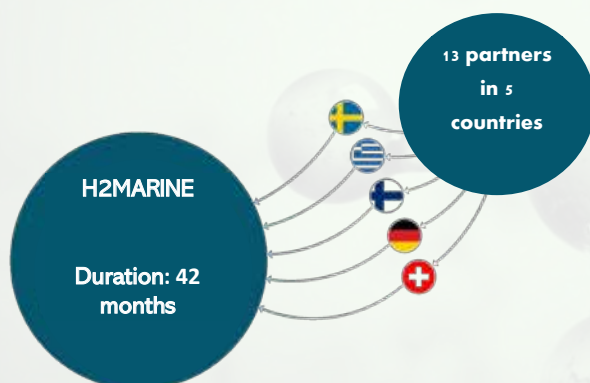


PEMFC CAPEX:
2024:<1,500 €/KW
2030: 1,000 €/KW



CluBE portfolio on hydrogen projects

H2MARINE – Hydrogen To Marine



CluBE portfolio on hydrogen projects

i-STENTORE – Innovative Energy Storage Technologies Towards increased Renewables integration and Efficient Operation

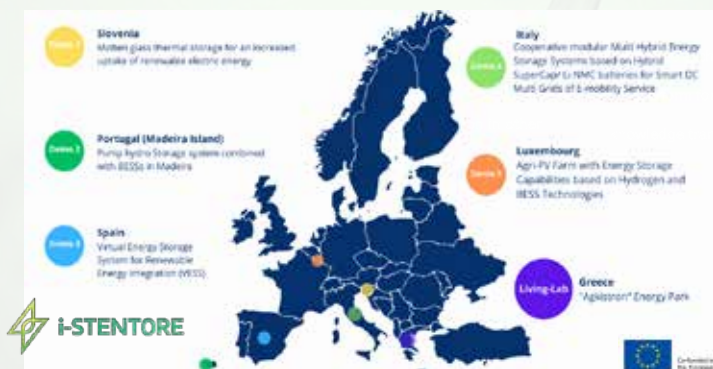
Project objectives



CluBE portfolio on hydrogen projects

i-STENTORE – Innovative Energy Storage Technologies Towards increased Renewables integration and Efficient Operation

Demo & Living lab sites



CluBE portfolio on hydrogen projects

InnoAGRIVET – Pilot Positive Energy Building

The Case of the Agri-vet Centre as a Living Lab in Western Macedonia



✓ Savings of 246 kWh/m² ~83%

Energy measures

- Use of air-cooled heat pump
- Installation of PV system
- Use of H₂ for excess RE storage
- Use of excess H₂ for fueling 2 H₂-FC cars

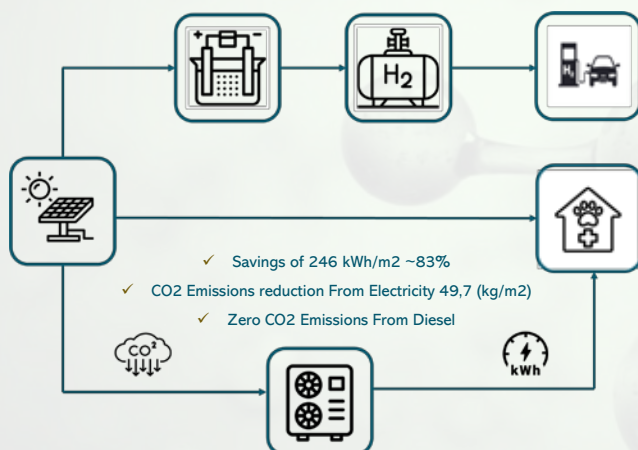
Energy Source	Fuel consumption (kWh/m ²)	CO ₂ Emissions (kg/m ²)	Fuel consumption (kWh/m ²)	CO ₂ Emissions (kg/m ²)
Electricity	50,3	49,7	143,4	141,8
Diesel oil	0,00	0,00	158,7	41,9
Total (kWh/m²)	50,3		296,3	
Total		49,7		183,7



CluBE portfolio on hydrogen projects

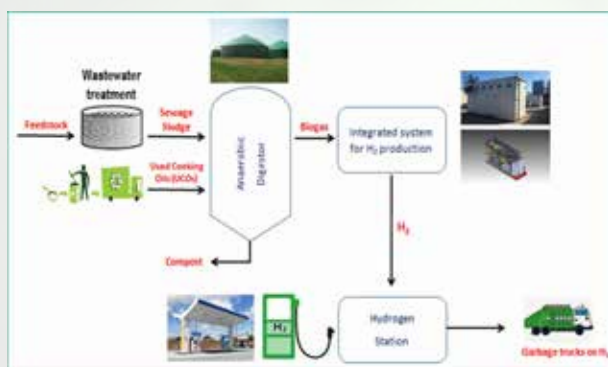
InnoAGRIVET – Pilot Positive Energy Building

The Case of the Agri-vet Centre as a Living Lab in Western Macedonia



CluBE portfolio on hydrogen projects

Management of Urban Sewage Sludge to Hydrogen Fuel for Transportation



Main Objectives:

1. Anaerobic digestion of sewage sludge and UCOs into biogas
2. Consequent conversion of biogas into H₂ in an integrated system
3. The produced H₂ will be delivered to hydrogen refueling stations in order to power fuel cell garbage trucks, currently operating on diesel

CluBE portfolio on hydrogen projects

H2Meet B2B meetings for the LIFE GREENH2ORN Project



CluBE portfolio on hydrogen projects

LIFE GREENH2ORN – GREEN Hydrogen mObility for the tRansition to climate Neutrality

Title GREEN Hydrogen mObility for the tRansition to climate Neutrality GA: 101158215	Goal Demonstrate the potential for local production, distribution and use of green H ₂ in mobility	Location Kozani / Thessaloniki
Duration 60 months	Funding LIFE Subprogramme Climate Action Total EU grant: ~ 3 M€	



CluBE portfolio on hydrogen projects

LIFE GREENH2ORN – GREEN Hydrogen mObility for the tRansition to climate Neutrality

GREEN HYDROGEN PRODUCTION

ESTABLISH A 500-KW ELECTROLYZER POWERED BY A GREEN PPA



HYDROGEN REFUELING STATION

CREATE A 200/350/700 BAR HRS WITH A CAPACITY OF 210 KG H₂/DAY



SUSTAINABLE MOBILITY

FUEL MUNICIPAL FLEETS*

- 1 GARBAGE TRUCK
- 1 ROAD SWEEPER
- 5 PASSENGER CAR
- 6 SCOOTERS

*FUNDED FROM THE PROJECT



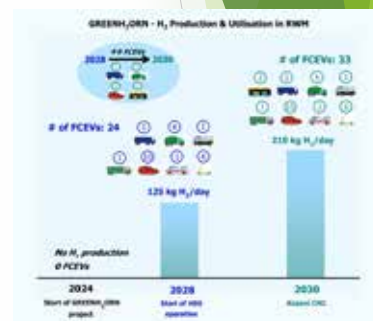
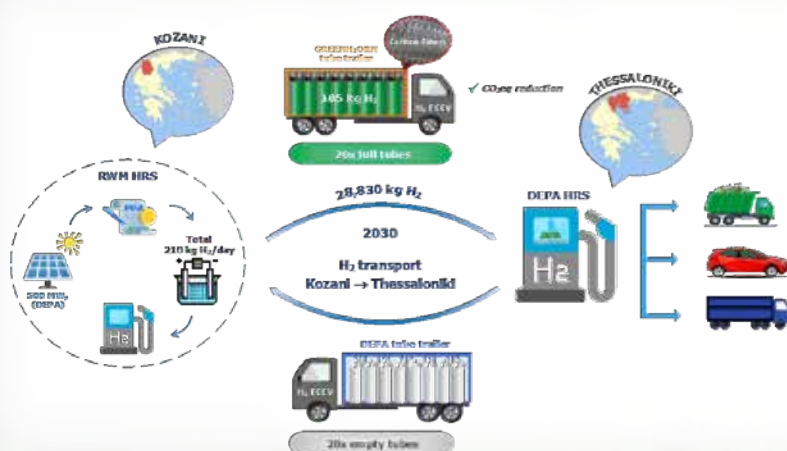
IT PLATFORM

DEVELOP AN IT PLATFORM FOR CENTRALIZED DATA MANAGEMENT TO OPTIMIZE OPERATIONS AND SUPPORT REPLICATION



CluBE portfolio on hydrogen projects

GREENH2ORN – GREEN Hydrogen mObility for the tRansition to climate Neutrality



Thank you!

Nikolaos Ntavos, CluBE
Tel.: +30 6979774457
Email: n.ntavos@clube.gr



Country Day II : International Day

**[Chile] Chilean Experience in Mobility and
Safety for H2 Projects**

Country Day II : International Day

[Chile] Chilean Experience in Mobility and Safety for H2 Projects



Dr. Eduardo Salamanca

CEO, HYDROSHEN – U. de Chile

Education

- 2000-2004, Dr., Mechanical Engineer, University of Concepción, Concepción, Chile
- 2002-2003, Researcher for Dr., Mechanical Engineer, Technical University Munich, Munich, Germany
- 1998-2001, M.S., Mechanical Engineer, University of Concepción, Concepción, Chile
- 1991-1996, B.S., Mechanical Engineer, University of Concepción, Concepción, Chile

Professional Career

- 2010-Present, Professor, Mechanical Department, FCFM, University of Chile, Santiago, Chile
- 2007-Present, CEO, SHENRE Group (SHEN Reliability www.shen-re.cl, SHENSORS www.shensors.cl & HYDROSHEN www.hydroshen.cl), Chile
- 2005-2007, Reliability Engineer, Spence Mine, BHP, Sierra Gorda, Chile
- 2004-2005, Consultant Reliability Engineer, Chuquicamata Smelting Division, Codelco, Calama, Chile
- 2004-2004, Consultant Reliability Engineer, Perfor Drill Ltda., Concepción, Chile
- 2000-2002, Project Engineer, "Development of aeronautical design capacities in Chile through the implementation of a tolerant damage model to increase the service life of aircraft". FONDEF project, Chile
- 1998-2000, Reliability Engineer, Escondida Mine, BHP, Antofagasta, Chile

Research Interest

- Reliability and Risk
- Condition Monitoring
- Vibration Analysis
- Safety in H2 Systems

Speech Title

Chilean Experience in Mobility and Safety for H2 Projects

Speech Summary

In the 15-minute presentation, the Hydroshen company will show the developed projects, current projects and future initiatives that make it one of the leading companies in the development of hydrogen technologies in Chile. The purpose of the presentation is the search for collaborating and allied companies for the development of these and future H2 technological projects.

Firstly, the development of the Pan American Games torch will be shown. The objective of this successful project was the development and implementation of a blending between propane gas and hydrogen, where H2 was produced on site through photovoltaic panels. Photovoltaic panels were installed and through an inverter, powered an electrolyzer to produce green hydrogen from water. A special mixer and burner were developed to feed the torch.

The second project shown is the design and implementation of an H2-powered electric pickup truck for off-road use (70 kW for mining operation). This project, already completed, was carried out in collaboration with the National Hydrogen Institute (INH2) and the Federico Santa María Technical University. As requested by the mining industry, a diesel truck was converted to electric and then a supercapacitor (40kW), Li batteries (15kW) and fuel cell (15kW) were installed to power the engine with electrical power. This first project allowed us to gain experience in development and gain the trust of the mining industry.

The third project in development is the Retrofit (diesel to electric) of a backhoe for use in the industry. This project, which has partial financing from Corfo, is being carried out in collaboration with INH2 and is expected to be completed by November 2025. The purpose is the conversion to electric, feeding earth-moving machinery with H2. For the development, an 80kW fuel cell was purchased and tested, this FC will be installed in hybrid operation with lithium batteries and a customized control system that considers fuel savings. In the last stage of the project, improvements will be implemented aimed at the comfort, automation and operational safety.

Below are 2 initiatives that are being applied for public-private co-financing, these are the conversions to hydrogen (using FC) of a garbage collection truck and a passenger train. In the case of the garbage collection truck, it is expected to retrofit from diesel to electric and fuel it with hydrogen. On the other hand, in the case of the passenger train, given that it is already an electrical application, it is desired to make it autonomous through the use of H2 and thus eliminate the catenary connection. Both initiatives demand a custom power design and a custom power control system.

Finally, a collaborative initiative for the manufacturing and assembly of electrolyzers is shown. This is an ongoing application that will receive co-financing of 10.000.000 US\$ for its implementation. The objective of this project is part of the national policy to strengthen the hydrogen industry in Chile and aims to meet the future demand and spare parts for electrolyzers in our country.

Company Introduction

HYDROSHEN is a Chilean company dedicated to equipment and solutions in hydrogen generation, applied to a wide range of uses, both residential and industrial.

HYDROSHEN is part of SHENRE Group.



HYDROSHEN

Practical solutions for complex problems

Introduction

2024

 Visit Our Website
Hydroshen.cl




HYDROSHEN

About Us




HYDROSHEN is a Chilean company dedicated to equipment and solutions in hydrogen generation, applied to a wide range of uses, both residential and industrial.

2024

2



Some of our solutions

Succes Cases

2024



Implementation of Pan-American Games' Hydrogen Flame



Hydrogen was produced with solar energy and was burned directly in the flame of the Pan American Games (2023) in a collaborative project along with SHEN-RE and USM.



2024



4



Implementation of Pan-American Games' Hydrogen Flame



2024

5



Pick-up truck H₂ Retrofit with fuel cells



- During 2022, a pick up truck was successfully retrofitted to Hydrogen fuel cell technology.
- FC+Battery+SC+Electric Motor



2024

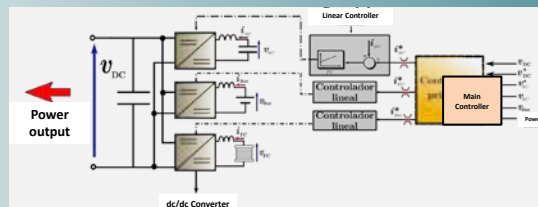
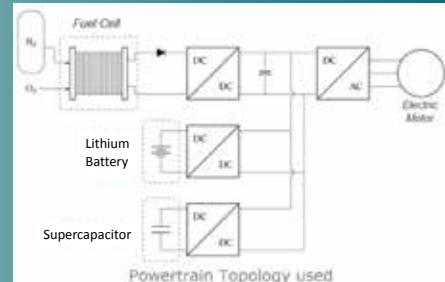
6



Pick-up truck H₂ Retrofit with fuel cells

Developments:

- Custom control strategies
- Fuel saving strategies
- Custom power converters
- Algorithms for reliable operation



2024

7



Mining Vehicle H₂ Retrofit



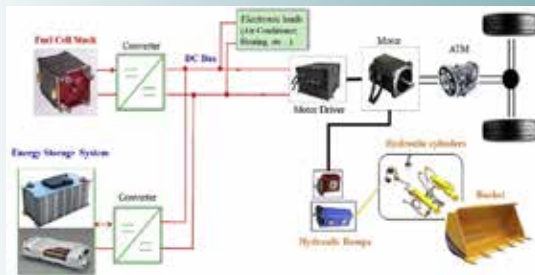
- Currently being developed
- Engine: 216 [HP]
- Operational weight: 19,400 [kg]
- Rated load 11,360 [kg]
- Loading Hydraulic System
- Flow: 326 [l/min]
- Maximum pressure of 250 [bar]
- Bucket: 3.5 [m³] fuel tank 215 [l]

2024

8



Mining Vehicle H₂ Retrofit



Developments:

- Custom powertrain design
- Design and development of power converters
- Support in standard compliance (SEC processing)
- Damage Tolerance analysis
- Semi-active vibration isolation

2024



9



Project: Use of Green Hydrogen in Urban garbage trucks



- Helps with decontaminating the city
- Development of new standards and regulations
- Promotion of the advantages of H₂ as an energy vector
 - Power: 210 [kW]
 - Weight: 10 [Ton]

2024

10



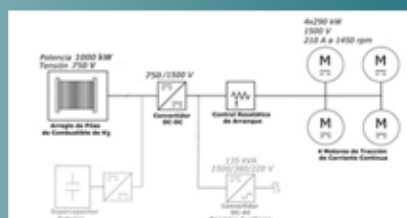
Hydrogen-powered Passenger Trains



The agreement between EFE, National Institute of Hydrogen, and the Ministry of Transport is being renewed to continue with the project.

- 1.2 MW
- 13 KV
- 4 CC Electric Motor (300 kW)

2024



11



Hydroshen is currently looking for partners

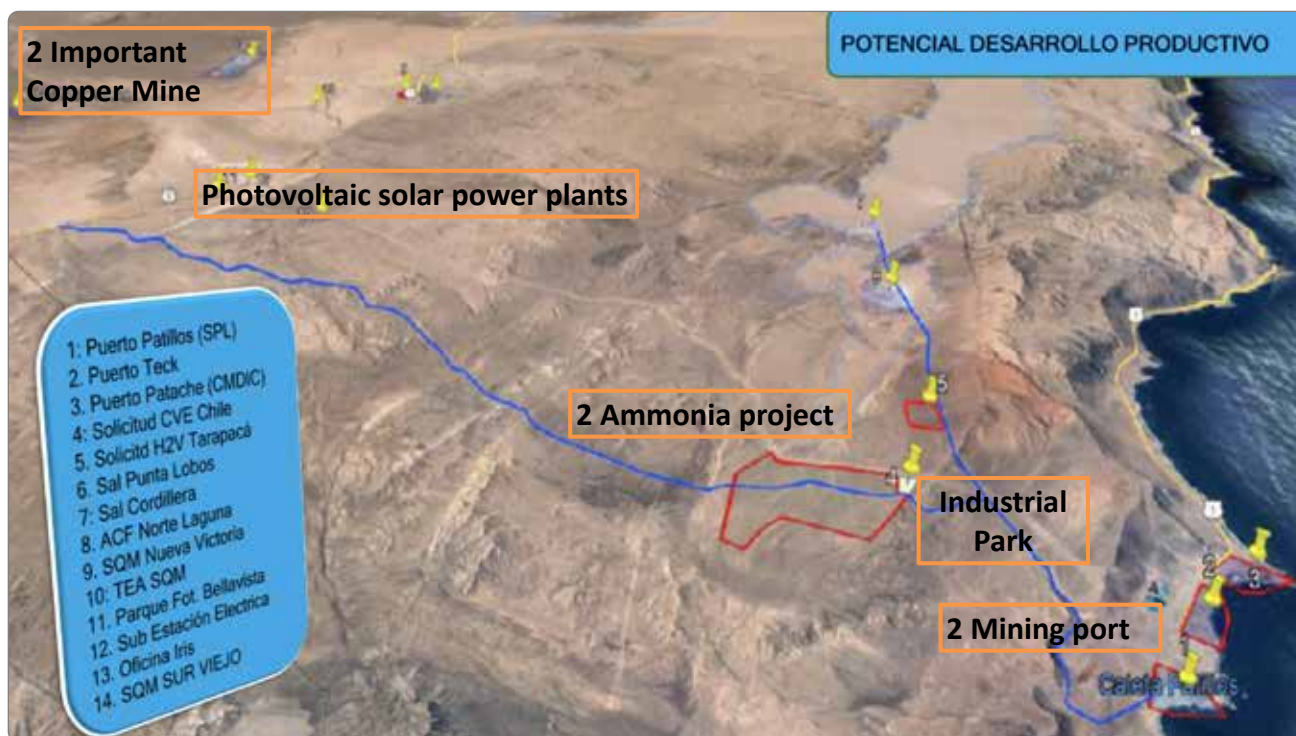
Manufacturing and/or assembly of Electrolyzers and their components in Chile

The call "Projects for the Manufacture and/or Assembly of Electrolyzers and their Components in Chile", aims to contribute to sustainable productive development and to enable the green hydrogen industry in the country, by facilitating the creation of industrial and commercial partnerships between domestic and foreign companies along the green hydrogen value chain, and contributing to the local and international supply of electrolyzers in order to reduce delivery times within Chile and the region, ensuring qualified personnel for electrolyzer maintenance services in the national territory, while contributing to the economic development of the country.

2024

Up to USD\$10 Million for the 60% of the project

12



Amount of investment in ammonia projects in Tarapacá

PROYECTOS	INVERSIÓN (US\$M)	M.O. ETAPA CONSTRUCCIÓN	M.O. ETAPA OPERACIÓN
CVE PROYECTO 51	2.500	1.700	500
GH ENERGY I	1.800	750	130
GH ENERGY II	1.800	750	130
TOTAL	4.300	3.200	760



CHILEAN FINANCING MECHANISMS FOR GREEN HYDROGEN

www.corfo.cl

Calls that are or will be available during 2024 from CORFO to receive projects from the Green Hydrogen and its derivatives value chain (updated on June 28, 2024)



01

Green Hydrogen Facility

It will seek to catalyze private investment in production projects, demand and actors in the H₂V value chain, through instruments that mitigate risks and reduce costs.

Reference: Under development

USD 1,000 million in total

Q4 2024

02

Green Credit

Financing program with competitive conditions to promote the development and execution of projects that mitigate the effects of climate change

Reference: In the following [Corfo link](#)

USD 20 millions per project

Open

03

Technological Program for hydrogen demand

Seeks to increase the rate of innovation in companies of the H₂V industry, through the execution of technological project portfolios and coordination of consortiums.

Reference: In the following [Corfo link](#)

USD 3.5 millions per project

Open

2024

15



CHILEAN FINANCING MECHANISMS FOR GREEN HYDROGEN

www.corfo.cl

Calls that are or will be available during 2024 from CORFO to receive projects from the Green Hydrogen and its derivatives value chain (updated on June 28, 2024)



04

R&D tax incentives law

Up to 35% tax credit against the First Category Tax on the amount invested in R&D and the remaining 65% may be considered an expense necessary to produce the income.

Reference: In the following [Corfo link](#)

Up to USD 1.2 million/ year per RUT (chilean company ID)

Open

05

High Technology Innovation

Support R&D-intensive innovations that face high technological uncertainty and point to scale-ups with high potential for national or global commercialization.

Reference: In the following [Corfo link](#)

USD 1.1 million per project

Open

06

Create and Validate

Development of new or improved products (goods or services) and/or processes, requiring R&D, from the prototype phase, to the technical validation phase at a productive or commercial scale.

Reference: In the following [Corfo link](#)

USD 220,000 per project

Open

2024

16



CHILEAN FINANCING MECHANISMS FOR GREEN HYDROGEN

www.corfo.cl

Calls that are or will be available during 2024 from CORFO to receive projects from the Green Hydrogen and its derivatives value chain (updated on June 28, 2024)

2024

17

	07	Manufacturing and/or assembly of electrolyzers Process that seeks to contribute to the implementation of the first manufacturing and/or assembly plant(s) of electrolyzers and their components in Chile. Reference: In the following Corfo link	USD 10 millions per project Open
	08	Human Capital for Innovation Strengthening of R&D&I capabilities in national companies, through the insertion of highly qualified professionals and technicians. Reference: In the following Corfo link	USD 42,000 per project Open
	09	Technology Absorption for Innovation Program To contribute to improving the systematic innovation capabilities of a group of companies, by strengthening their technological absorption capabilities, co-financing the incorporation of new knowledge, best practices and/or technologies. Reference: In the following Corfo link	USD 375,000 per project Open



CHILEAN FINANCING MECHANISMS FOR GREEN HYDROGEN

www.corfo.cl

Calls that are or will be available during 2024 from CORFO to receive projects from the Green Hydrogen and its derivatives value chain (updated on June 28, 2024)

2024

18

	10	Call25 Eurogia2030 - Eureka Network EUREKA-driven program focused on low-carbon technologies. It is oriented to promote collaborative, international and close to the market R&D&I projects that are framed within the SDs: Decarbonization; Democratization; Digitalization; Deregulation; and Decentralization. Reference: In the following Corfo link	To be defined Open
	11	Technological program for the manufacture of components for the H2V industry Seeks to promote the transformation of the national industry to achieve high technological manufacturing sophistication and linkage with the value chain of the H2V industry. Reference: in the following Corfo link	USD 3.5 millions per project Open
	12	Green Hydrogen Technology Center in Magallanes Development and implementation of a Technology Center focused on the value chain of Green Hydrogen and its derivatives in Magallanes region. Reference: in the following Corfo link	USD 6,3 millions Open



HYDROSHEN

Practical solutions for complex
problems

2024



Visit Our Website
[Hydroshen.cl](https://hydroshen.cl)

Country Day II : International Day

[USA] U.S. Hydrogen Program Overview

Country Day II : International Day

[USA] U.S. Hydrogen Program Overview



Christine Watson

Technology Manager, U.S. Department of Energy

Education

- 2019-2021, M.S., Materials Science and Engineering, Oklahoma State University, USA
- 2004-2009, B.S., Chemical Engineering, North Carolina State University, USA
- 2004-2009, B.S., Physics, North Carolina State University, USA

Professional Career

- 2023-Present, Technology Manager, Safety Codes and Standards, Hydrogen and Fuel Cell Technologies Office, U.S. Department of Energy, USA
- 2021-2023, ORISE Science and Technology Fellow, Safety Codes and Standards, Hydrogen and Fuel Cell Technologies Office, U.S. Department of Energy, USA

Research Interest

Hydrogen Safety, Codes and Standards

Speech Title

U.S. Hydrogen Program Overview

Speech Summary

The U.S. Department of Energy's Hydrogen and Fuel Cell Technologies Office focuses on research, development, and demonstration of hydrogen and fuel cell technologies across multiple sectors enabling innovation, a strong domestic economy, and a clean, equitable energy future.

Company Introduction

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Hydrogen and Fuel Cell Technologies Office.



U.S. DOE Hydrogen Program Safety Overview

Christine Watson – Safety, Codes & Standards Subprogram

H2Meet

September 25, 2024 – Kintex, South Korea

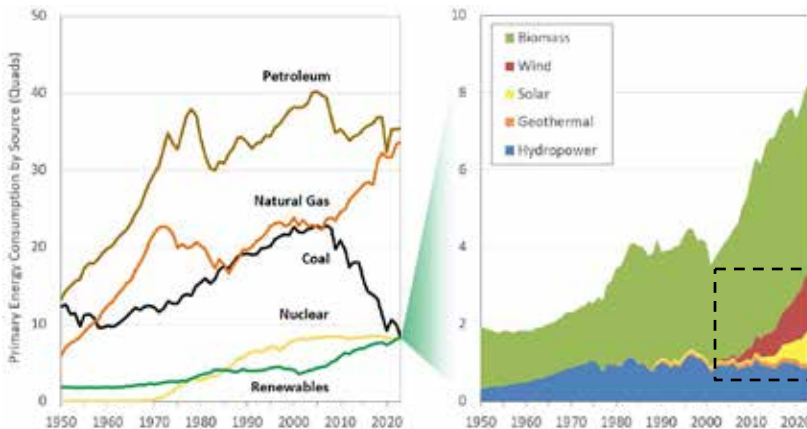


U.S. Energy Landscape and Key Goals

U.S. Primary Energy Consumption by Energy Source

Total = 93.6 quads

Renewable Total = 8.2 quads



Administration Goals include:

- Net-zero emissions economy by 2050 and 50–52% reduction by 2030
- 100% carbon-pollution-free electric sector by 2035

Priorities: Ensure benefits to all Americans, focus on jobs, Justice40: 40% of benefits in disadvantaged communities

Quad= quadrillion British thermal units (Btu)

Source: Melaina, Chilton, et al, DOE HFTO, based on data collected from U.S. Energy Information Administration, Monthly Energy Review, April 2024, Table 1.3. <https://www.eia.gov/totalenergy/data/browser/?tbl=T01.03#/2f=A>

President Biden Signs Key Bills into Law – Examples of Policies and Activities

Bipartisan Infrastructure Law (BIL) provides \$9.5B for clean H₂ and Inflation Reduction Act (IRA) includes significant tax credits



President Biden Signs the Bipartisan Infrastructure Bill into law on November 15, 2021. Photo Credit: Kenny Holston/Getty Images

BIL Required National Clean Hydrogen Strategy and Roadmap

Examples of policies & activities across the H₂ value chain

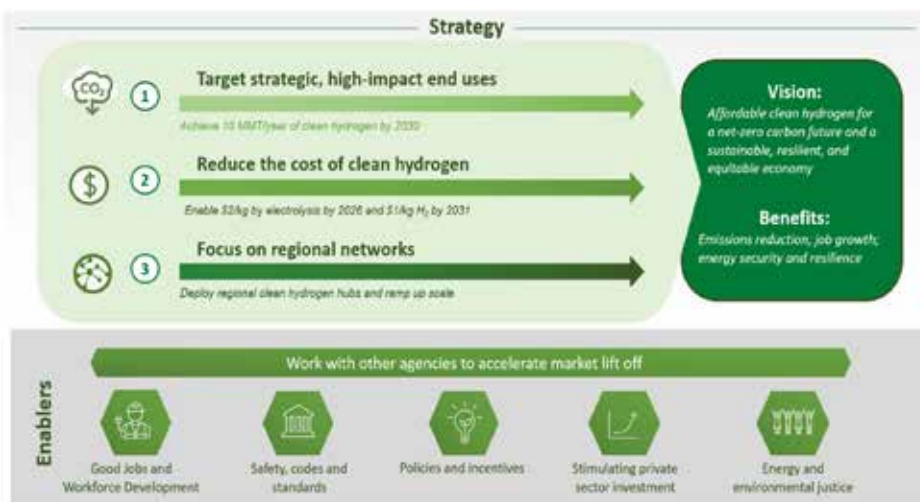
Supply	Midstream	End Use Demand
Production Tax Credit 45V, 45Q (Treasury)	Fueling Corridor Grants (DOT/JO)	Vehicle Tax Credits, Clean Fuels Credits, 48C (Treasury)
Electrolyzer RD&D BIL (DOE)	Bipartisan PIPES Act NPRM (DOT PHMSA)	State Policies (ZEV Mandates, H2 PTC) ¹
Manufacturing Tax Credit 48C (Treasury/DOE)	Manufacturing Tax Credit 48C (Treasury/DOE)	Clean Power Rule NPRM (EPA)
H2 Hubs, BIL (DOE)	H2 Hubs, BIL (DOE)	Buy Clean Standards (EOP)
		Agency offtake (DOD, USPS, USDA, DOT, EPA, etc.)
		H2 Hubs, BIL (DOE)

JO: Joint Office of Energy and Transportation; EOP: Executive Office of the President; NPRM: Notice of proposed rulemaking
1: ZEV Mandates see: <https://www.c2es.org/document/us-state-clean-vehicle-policies-and-incentives/>; State example <https://leg.colorado.gov/bills/hb23-1281>

U.S. National Clean Hydrogen Strategy and Roadmap



www.hydrogen.gov
Released June 5, 2023



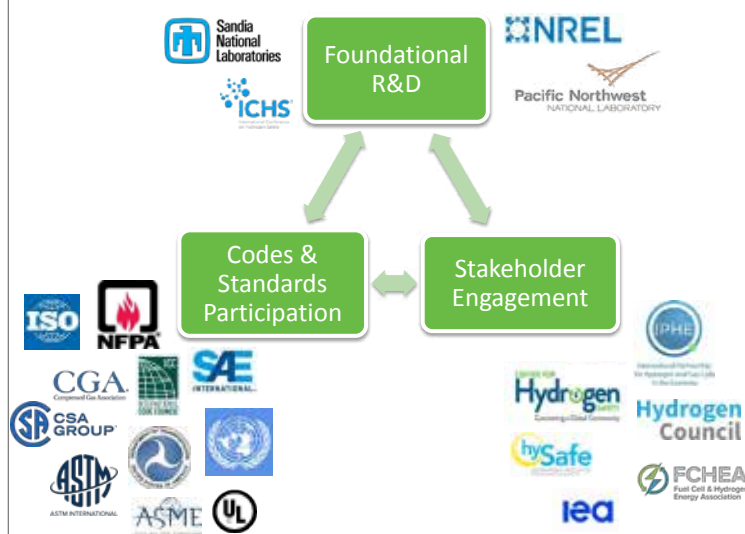
U.S. Opportunity: 10MMT/yr by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050. ~10% Emissions Reduction. ~100K Jobs by 2030.



Enabling Safety

Safety, Codes, and Standards Subprogram Activities

Collaborative Ecosystem



Enabling the Safe Deployment of Hydrogen and Fuel Cell Technologies

- Conduct **RD&D** to provide **scientific basis** needed to define requirements in developing and revising codes and standards.
- Enable improvements to **permitting process**.
- Support **best safety practices** for hydrogen and fuel cell deployments.
- Develop and enable **widespread sharing** of **safety-related information resources** and lessons learned.
- Conduct **workforce development** activities with an emphasis on safety practices and culture.

HIT WG – Infrastructure, Siting, and Permitting (ISP)

Goal: Address federal regulatory barriers to infrastructure deployment, siting, and permitting to enable national goals of 10 MMT/year supply and end use by 2030, 20 MMT/year by 2040, 50 MMT/year by 2050

WG Scope	Actions and Milestones (from National Clean Hydrogen Strategy & Roadmap)	Near Term Objectives
- Siting, permitting, pipelines, storage, and infrastructure* - Harmonized codes and standards - Interoperability and global standardization* - Safety, emissions (including secondary), sensors, risk mitigation, environmental impact* - Environmental review and best practices (NEPA, etc.)* - Pipeline and blending test facilities	2023 – 2025 - Lay regulatory groundwork for large-scale clean hydrogen deployments * - Develop streamlined guidance on hydrogen pipeline and large-scale project permitting.* 2026 – 2029 - Enable international harmonization of codes and standards. - Address regulatory challenges to increase electrolyzer access to renewable and nuclear energy. - Develop national guidance for hydrogen blending limits.* * In partnership with Workforce, Equity and Justice Team	- Identify regulatory requirements and responsibilities for deployment across local, state, and federal levels and any gaps. – Complete January 2024 - Hold forum on pipeline safety R&D. Document results of PHMSA's, DOE's, other federal agencies, and international R&D on hydrogen and hydrogen blends. – Complete October 2023 - Develop lessons learned and best practices on siting, permitting, safety, and infrastructure. – Ongoing – End CY 2024 - Identify potential and existing standards and regulatory requirements for hydrogen and blends for pipelines, storage, and infrastructure. – Expected September 2024 - Develop interagency plan to address access restrictions for FCEVs in tunnels, bridges, and other enclosed public infrastructure. – Ongoing – End CY 2024
Membership Co-Leads: DOE HFTO, DOT PHMSA Members: DOC (ITA, NIST), DOD (USCG), DOE (EJE, FECM, HFTO, OCED, OP), DOI (BOEM), DOL (OSHA), DOT (FAA, FHWA, FRA, FTA, MARAD, NHTSA, PHMSA), EPA, FERC, NASA, WH-CEQ, NRC		

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

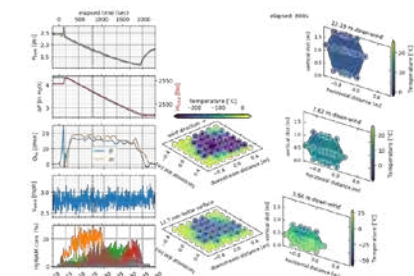
HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

7

LH2 Pooling Experiments Enable Model Development & Validation

Unique LH2 pooling experiment enables validated models to justify needed safety requirements without unnecessary restrictions for larger liquid hydrogen systems in emerging technologies

- **16 tests over 4 days**
- Variations in wind speed, substrate, LH2 release rate
- Utilized **IR and Visible cameras** coupled with temperature and concentration sensors
- **NREL's Hydrogen Wide Area Monitor (HyWAM)** monitored hydrogen concentrations, correlated with temperature



Substrate Release point Thermocouples and concentration sensor intakes



U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

8

Hydrogen Safety Codes and Standards Applicability Navigator (HySCAN)

- Enable **new hydrogen stakeholders** to identify current codes and standards to move quickly and safely into the hydrogen market
- Current focus on NFPA 2 and ASME B31.12

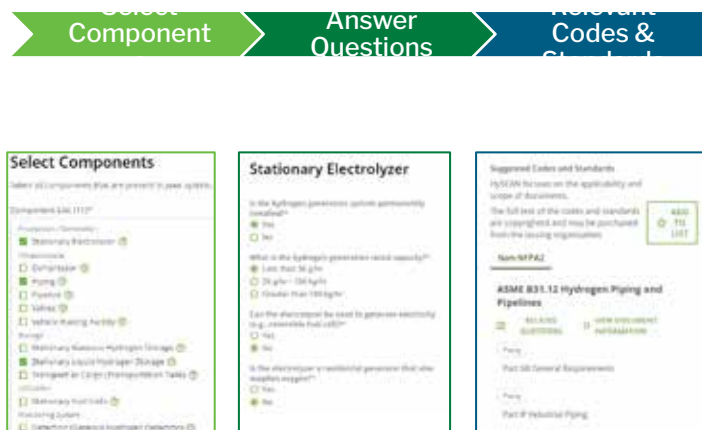
HySCAN
Hydrogen Safety Codes & Standards
Applicability Navigator

Pacific Northwest
NATIONAL LABORATORY

Sandia
National
Laboratories

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

How It Works:



Visit now at
<https://h2tools.org/hyscan>

U.S. DEPARTMENT OF ENERGY

11

>20 Years of the Hydrogen Safety Panel

By The Numbers...

32 panel members since 2003

637 safety reviews

300+ global safety presentations

>600 combined years of experience

>10,000 first responders trained

1 hydrogen tools portal



*HSP recognized with a
Hydrogen Program Special
Recognition Award at 2023
Annual Merit Review!*



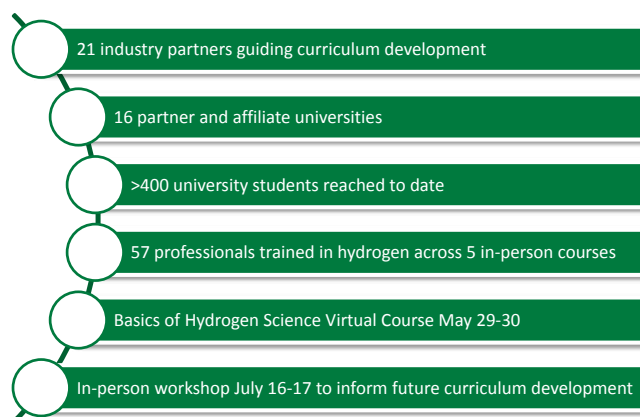
U.S. DEPARTMENT OF ENERGY | OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

12

H2EDGE – Hydrogen Education for a Decarbonized Global Economy

Training engineering professionals and university students for career opportunities in hydrogen



Hydrogen Workforce Acceleration CRADA

*A well-prepared workforce to enable hydrogen's success across the U.S.
– safely, efficiently and equitably*



Mission: Produce essential resources and serve as a Central Hub to develop the middle-skilled Hydrogen Workforce

Team:



The last coal power plant in Washington State is scheduled to shut down in 2025. Credentials and training are needed to help displaced workers secure jobs in the emerging clean hydrogen economy.

Phase I

- Perform needs assessments to inform curriculum and credential development
- Examine viable career pathways with a focus on disadvantaged communities
- Produce a framework for curriculum and credentials

Phase II

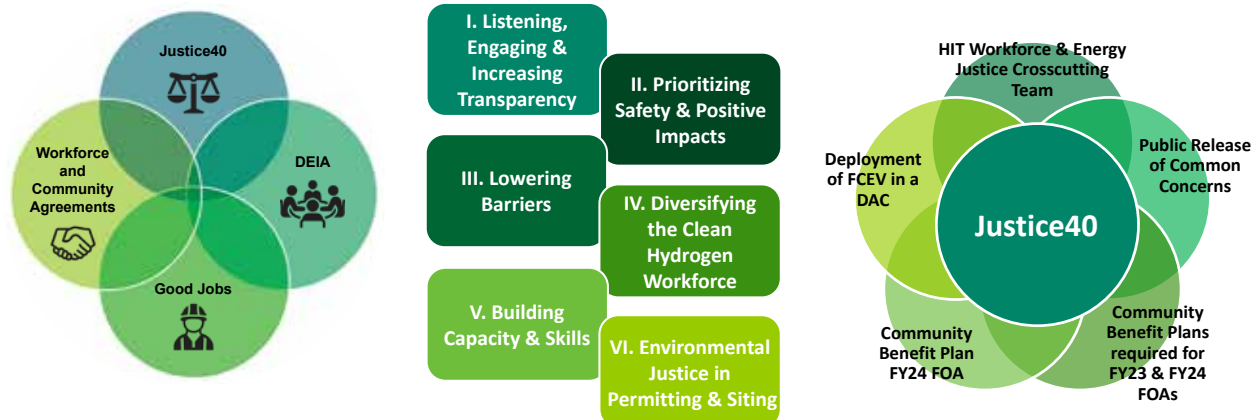
- Develop middle-skilled credentials for testing and deployment
- Integrate expertise in hydrogen safety
- Provide high-quality AR/VR experiences to accentuate learning objectives
- Ensure quality and safety (Accreditation Panel)
- Improve accessibility of materials

Phase III

- Deploy and assess middle-skilled credentials
- Expand nationwide with additional educational partners and stakeholder input (e.g., unions, tribes)
- Enable complementary joint deployment
- Ensure long-term sustainability

Building the pathway to match skills to needed jobs

Environmental Justice Initiatives



Draft Responses to Frequently Asked Questions and Common Concerns About Clean Hydrogen

<https://www.energy.gov/eere/fuelcells/draft-responses-frequently-asked-questions-and-common-concerns-about-clean-hydrogen>

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

15

Examples of International Collaborations



Regulations, Codes, Standards, and Safety Working Group Task Forces:

- **Bulk Storage:** Risk, gaps and deployment barriers – **new report published!**
- **Permitting:** Identifying permitting processes and lessons learned – **newly launched!**
- **Maritime:** Gaps and risk analysis underway



U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

16

Resources and Opportunities for Engagement

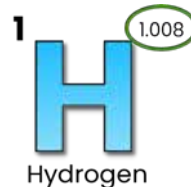
Key Publications



www.hydrogen.energy.gov

Hydrogen and Fuel Cells Day October 8

- Held on hydrogen's very own atomic weight-day



Join Monthly
H2IQ Hour Webinars

Download
H2IQ For Free



Visit H2tools.Org For
Hydrogen Safety And
Lessons Learned

<https://h2tools.org/>



Sign up to receive hydrogen and fuel cell updates

www.energy.gov/eere/fuelcells/fuel-cell-technologies-office-newsletter

Learn more at: energy.gov/eere/fuelcells AND www.hydrogen.energy.gov

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

17

Thank You

Christine Watson

Technology Manager - Safety, Codes & Standards

Hydrogen & Fuel Cell Technologies Office

Christine.Watson@ee.doe.gov

www.energy.gov/fuelcells

www.hydrogen.energy.gov

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

18

Country Day II : International Day

**[India] Developing a Reliable &
Scalable Green Hydrogen Supply Chain**

Country Day II : International Day

[India] Developing a Reliable & Scalable Green Hydrogen Supply Chain



Anirudh Vuyyala

Lead International Business, Adani New Industries Ltd (ANIL)

Education

- 2007-2011, B.Tech., Mechanical Engineering, VIT Vellore, India
- 2014-2016, MBA, NMIMS, Mumbai, India

Professional Career

- 2022-Present, Lead International Business, Adani New Industries
- 2019-2022, BD Head, Paras Energy, West Africa & Dubai
- 2015-2019, International Business, Suzlon Energy

Speech Title

Developing a Reliable & Scalable Green Hydrogen Supply Chain

Speech Summary

ANIL is spearheading Adani group's green H2 business vertical, integrating advanced technology and renewable energy to produce green H2 and derivatives. Our complete control over the green H2 ecosystem—from equipment manufacturing and renewable energy to green H2 production and port logistics—ensures unmatched reliability and efficiency.

Company Introduction

Adani New Industries Ltd (ANIL) drives Adani group's global green hydrogen and derivatives initiatives.



Disclaimer

CONFIDENTIAL


By accepting this presentation, recipients acknowledge that they have read, understood and accepted the terms of this disclaimer. This presentation is subject to the confidentiality provisions set forth in the recipients' applicable non-disclosure agreements. This presentation is the property of and contains the proprietary and confidential information of Adani Group, Inc. and its Affiliates (collectively, the "Company").

This presentation is being provided for informational purposes only and is intended solely to facilitate a discussion with the recipient. No representation or warranty, express or implied, is or will be given by the Company or its affiliates, directors, officers, partners, employees, agents or advisers or any other person as to the accuracy, completeness, reasonableness or fairness of any information contained in this presentation and no responsibility or liability whatsoever is accepted for the accuracy or sufficiency thereof or for any errors, omissions or misstatements, negligent or otherwise, relating thereto. No information included in this presentation constitutes, nor can it be relied upon as, legal, tax, investment or other advice.

This presentation is confidential and is intended among other things to present a general outline of the Company. The contents are not to be reproduced or distributed to the public or press. Each person who has received a copy of such presentation (whether or not such person is an intended recipient or not) is deemed to have agreed: (i) not to reproduce or distribute this presentation, in whole or in part, without the prior written consent of the Company, other than to legal, tax, financial and other advisors on a need to know basis (ii) if such person is not an intended recipient, to return this information to the company (iii) without the prior written consent of the company not to disclose any information contained in this presentation except to the extent that such information was (a) previously known by such person through source (other than the company) not bound by any obligation to keep such information confidential (b) in the public domain through no fault of such person, or (c) lawfully obtained at a later date by such person from source (other than the company) not bound by any obligation to keep such information confidential and (iv) to be responsible for any disclosure of this presentation, or the information contained herein, by such person or any of its employees, agents or representatives.

CONFIDENTIAL

adani

Adani Group - Demonstrated & Unmatched Infrastructure Expertise



India's largest port operator handling ~607 MMTPA capacity, presence at 15 locations



India's Largest private conventional power portfolio 16,850 MW with operating capacity of 15,250 MW



One of world's largest Solar & Wind Developer: ~22 GW (under operation + construction) & RE Capacity of 50 GW by 2030



India's Largest private transmission company ~20,422 ckt km ; ~54,661 MVA



Pumped Storage: 3.5 GW under construction/development with 20 GW pipeline under pre-development



India's Largest Integrated Solar Manufacturer 4.0 GW Capacity with planned expansion to 14 GW

3

CONFIDENTIAL

adani

Adani Group - Demonstrated & Unmatched Infrastructure Expertise



Adani Total Gas Limited: Gas Distribution Presence across 52 Geographical Areas, covering 14% of the population



Owens and operates LNG terminal, with peak capacity of 6.5 MMTPA (expandable up to 10) at Dhamra Port



India's 2nd Largest Cement Manufacturer (capacity of 89 MMTPA)



India's Largest airport infrastructure company, handling India's 25% passenger footfall (7 airports) & 1/3rd cargo traffic



Data Center: 1 GW planned capacity over the next decade



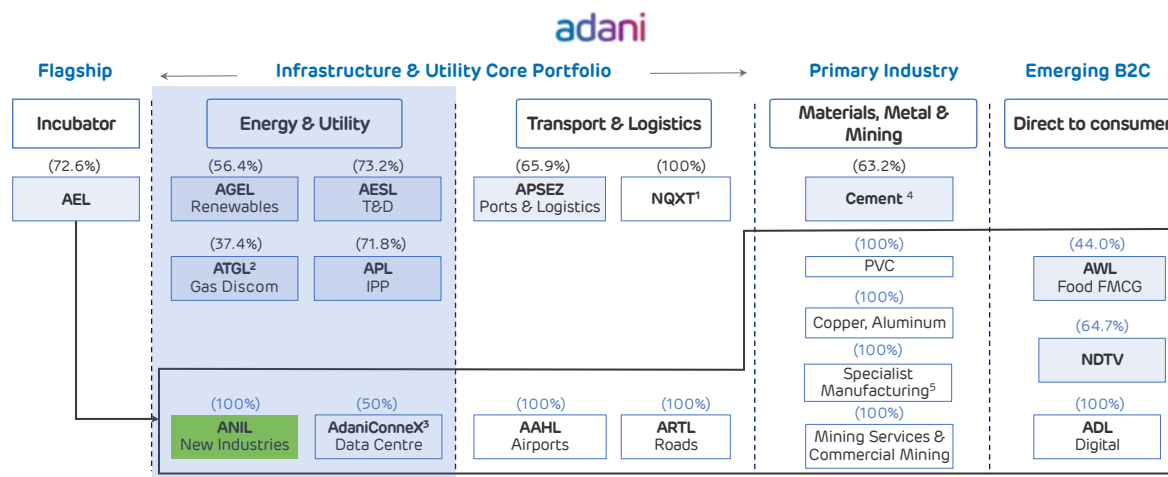
Kutch Copper: will be world's largest single location smelter with 1 MMTPA planned capacity (Operational capacity 0.5 MMTPA till date)

4

CONFIDENTIAL

Adani Group: A World Class Infrastructure & Utility Portfolio

adani

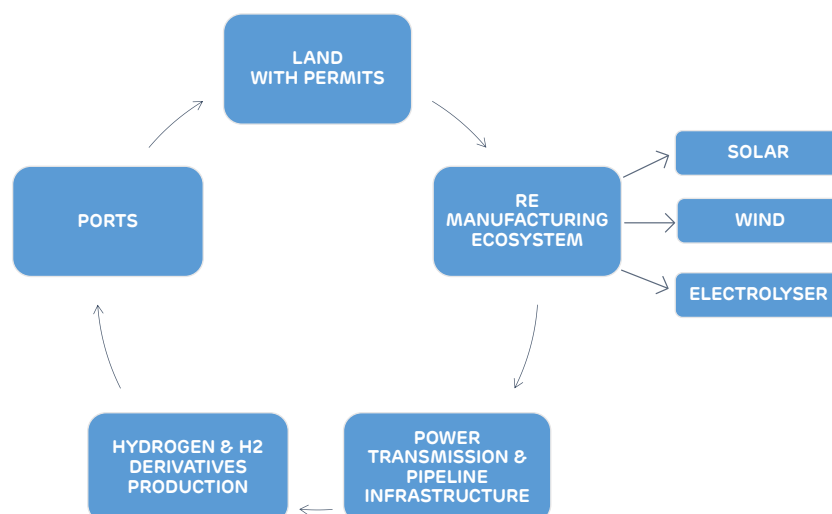


A multi-decade story of high growth centered around infrastructure & utility core

1. NQXT: North Queensland Export Terminal | 2. ATGL: Adani Total Gas Ltd, JV with Total Energies | 3. Data center, JV with EdgeConnex, AEL: Adani Enterprises Limited; APSEZ: Adani Ports and Special Economic Zone Limited; AESL: Adani Energy Solutions Limited; T&D: Transmission & Distribution; APL: Adani Power Limited; AGEL: Adani Green Energy Limited; AAHL: Adani Airport Holdings Limited; ARTL: Adani Roads Transport Limited; ANIL: Adani New Industries Limited; AWL: Adani Wilmar Limited; ADL: Adani Digital Limited; IPP: Independent Power Producer; NDTV: New Delhi Television Limited; PVC: Polyvinyl Chloride. 4. Cement business includes 63.19% stake in Ambuja Cement which in turn owns 50.05% in ACC Limited. Adani directly owns 6.64% stake in ACC Limited. 5. Includes the manufacturing of Defense and Aerospace Equipment. Promoters holding are as on 30th September 2023.

5

ANIL's approach in developing a reliable and scalable Green Hydrogen Supply Chain

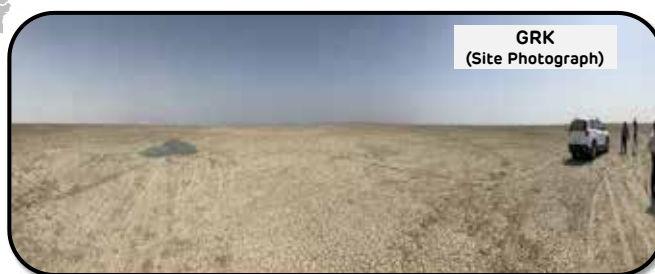
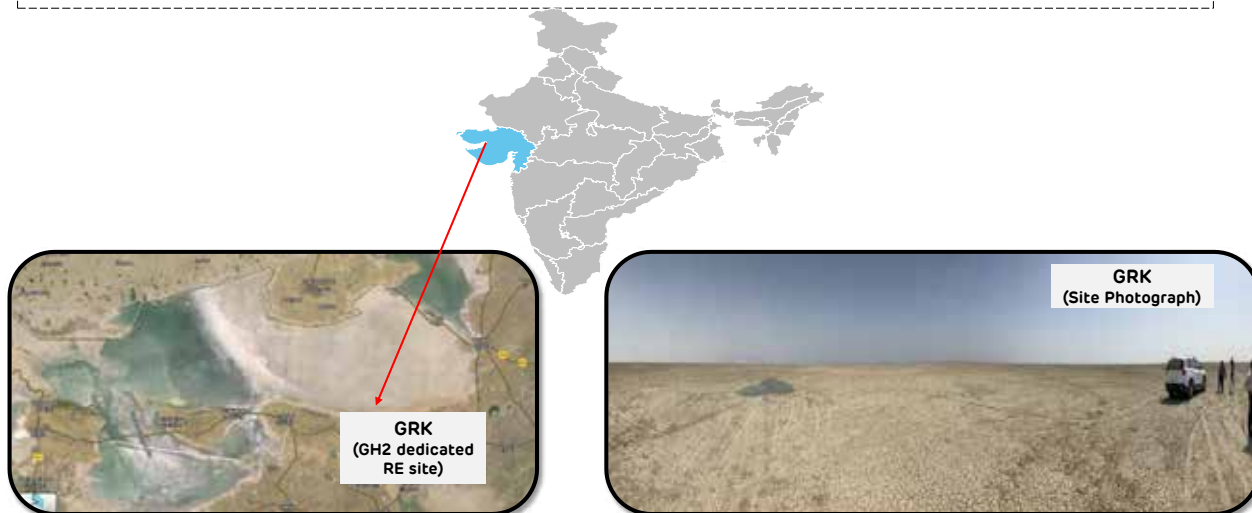


CONFIDENTIAL

adani

ANIL's Approach – Land (1/5)

- Allocated land in **GRK, Gujarat**, Capacity ~ **84,486 Hectare** ; RE Generation Capacity ~ **45 GW**
- Green Hydrogen Production Capacity ~ **2 MMTPA** , equivalent to **10 MMTPA** Green Ammonia



GRK: Great Rann of Kutch

7

CONFIDENTIAL

adani

AGEL – RE Park Development

- World's largest single location Hybrid RE Plant in **Khavda, Gujarat** ~ **53,000+ Hectares**
- RE Generation Capacity ~ **30 GW**



GRK: Great Rann of Kutch; *Dedicated RE Site for ANIL | AGEL" Adani Green Energy Limited (Adani group company) is India's largest renewable energy producer

8

CONFIDENTIAL

adani

ANIL's Approach – Renewable Manufacturing Ecosystem (2/5)



Wind Turbine Manufacturing – 5.2 MW WTG
1.5 GW/annum (expanding to 5 GW/Annum)



Manufacturing Cluster - Mundra



Wafer, Ingot & glass manufacturing



Automated Solar Module Manufacturing
4 GW/annum (additional 10 GW under progress)



Electrolyser manufacturing

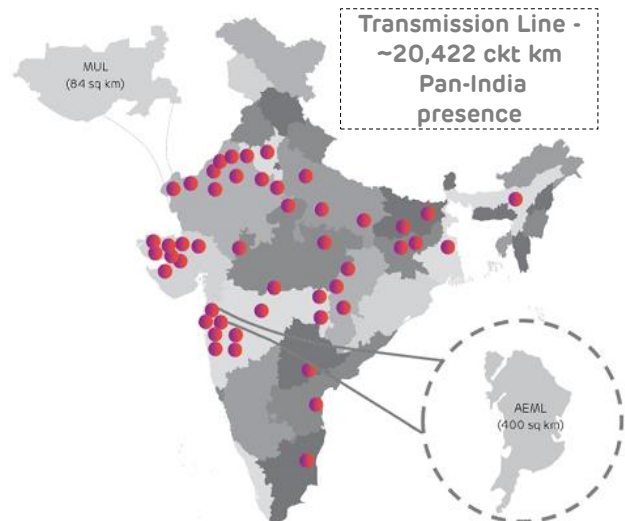
9

ANIL's Approach– Power Transmission & Pipeline Network (3/5)

CONFIDENTIAL

adani

- Largest private sector transmission company in India; O&M for first privately owned HVDC
- Substation: **~54,661 MVA** transmission capacity
- Phase I : Power transmission through grid
- Phase II : **~215 Km H₂ pipeline** for transportation & storage



Transmission Line -
~20,422 ckt km
Pan-India
presence

Pipeline
Infrastructure (ATGL)
7500+ km of pipeline

10

CONFIDENTIAL

adani

ANIL's Approach – Electrolyzer (4/5)



Technology development

Multiple tie-ups with Electrolyser technology providers namely **Cavendish Renewable Technology (Australia)** and **Hydep (Italy)**

Alkaline

5 MW size Electrolyser Pilot in progress

AEM

Prototype stage in progress

C-Cell

Prototype stage in progress

Preferred Technology

Alkaline

- Proven technology for 100 years.
- Lower initial CAPEX

Anion Exchange Membrane (AEM)

- High operational flexibility
- Lower CAPEX compared to PEM
- Better efficiency than Alkaline

Product development

- Establishing **Electrolyser Testing Lab** to drive performance improvement
- Won 198.5 MW Capacity under PLI scheme (Tranche 1)
- Establishing **Electrolyser Manufacturing Facility**; to be commissioned by 2025
- **Supply chain development for achieving 90% indigenization of Electrolyser**

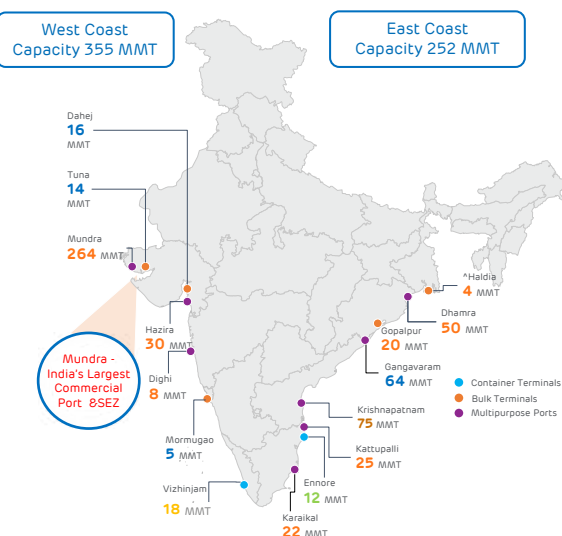
PLI: Production Linked Incentive; PEM: Polymer electrolyte membrane; AEM: Anion Exchange Membrane;

11

ANIL's Approach – Ports (5/5)

CONFIDENTIAL

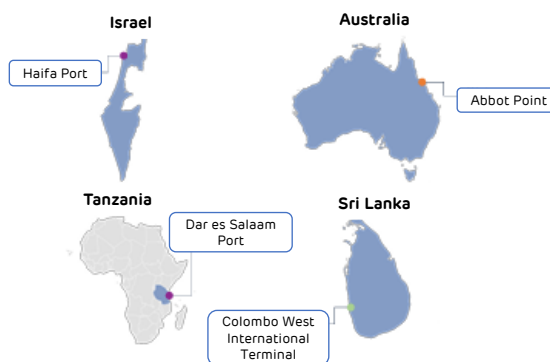
adani



15 ports with capacity of ~607 MMT
Achieving east-west coast parity

^ Under Construction | MMT : Million Metric Ton

Overseas Ports/Terminals



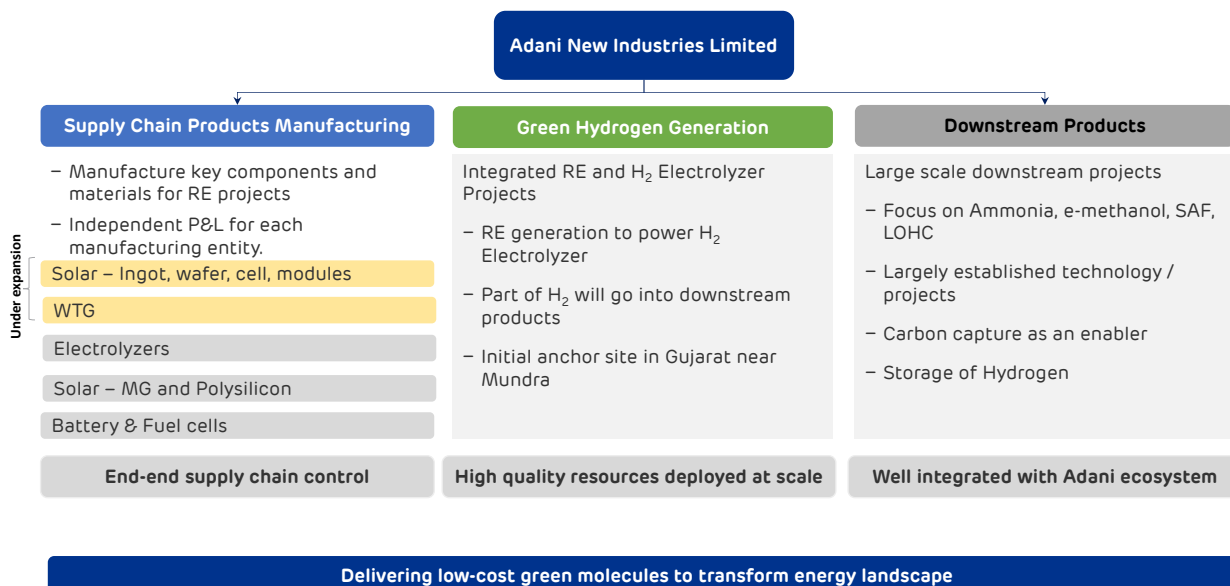
- Operating Israel's largest port, Haifa Port, handling 50% of the country's total cargo
- O&M contracts at ports in Australia and Tanzania
- Building a container terminal at Colombo, Sri Lanka

12

CONFIDENTIAL

adani

ANIL: Business Segments

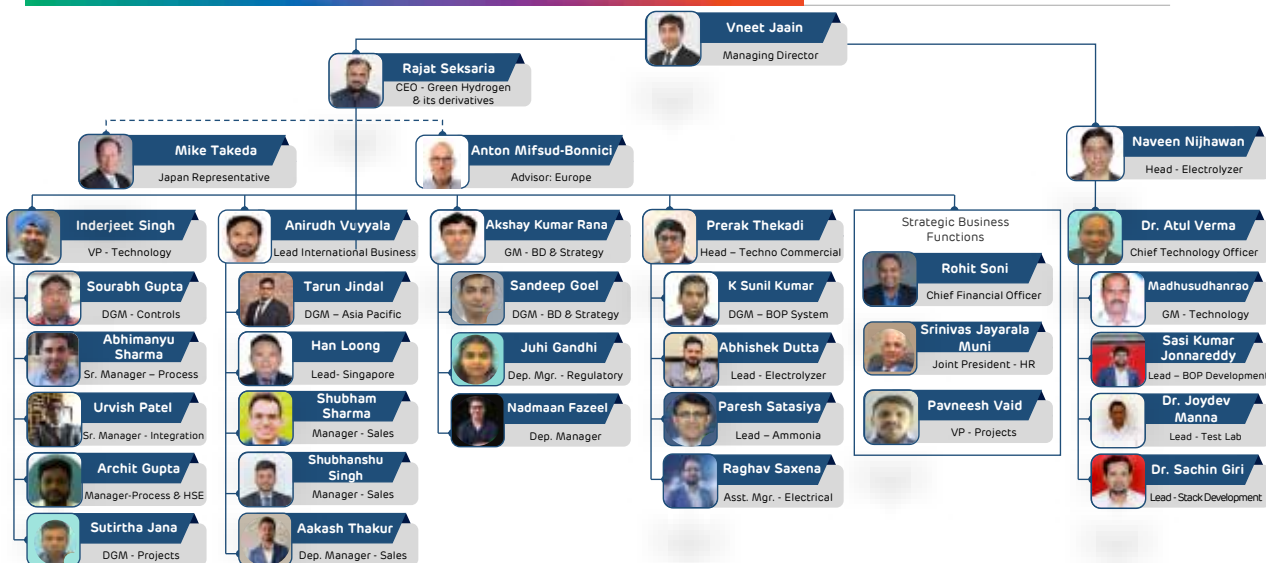


13

CONFIDENTIAL

adani

ANIL: Hydrogen BU Organization Structure



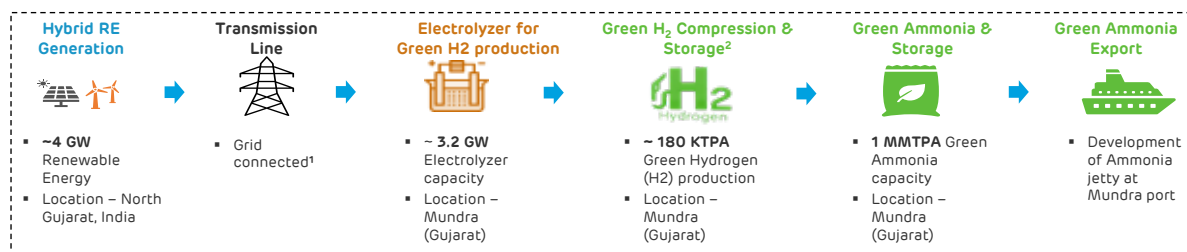
Dedicated workforce of 100+ for Green Hydrogen

14

CONFIDENTIAL

adani

ANIL Green Ammonia Project Phase I - 1 MMTPA Capacity

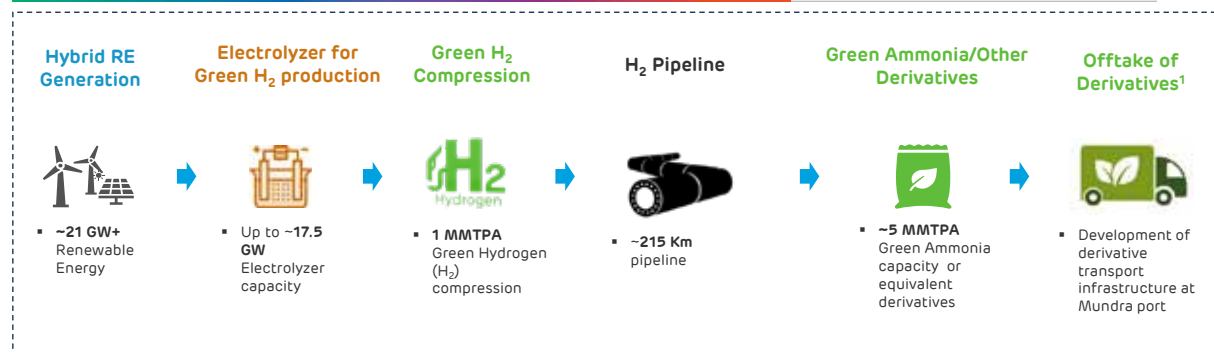


15

CONFIDENTIAL

adani

ANIL Green Hydrogen – 1 MMTPA Capacity



Hydrogen Pipeline Features
▪ 24x7 availability of GH ₂
▪ Pipeline acts as a storage medium
▪ Improved Carbon footprint



1. Ecosystem Optionality includes Urea, methanol, LH₂, SAF, and others
GH₂ : Green Hydrogen; GRK: Great Rann of Kutch

16

CONFIDENTIAL



ANIL: RFNBO - Compliant with Global Guidelines

Particulars	Highlights
Additionality	All renewable capacities catering to Green Hydrogen are new
Temporal Correlation	RE generation and electrolyzer power consumption are matched on hourly basis
Global Standards	- Adhering with EU RED II/ RED III Norms - Adhering with Indian, Korean, Japanese and Global Standards
Carbon Intensity	- Less than 3.38 Kg CO₂/Kg of H₂ (specific CI as per customer requirement) - Less than 0.45 kg CO₂/Kg of NH₃ (specific CI as per customer requirement)

17



CONFIDENTIAL



Project Development | Global Engineering Partners

Project Activities	Partners
Hydrogen Pipeline	 ENGINEERS INDIA LIMITED A Navitas Company
Off-grid integration	 Worley energy chemicals resources
Hydrogen Storage	 FICHTNER
Pilot Project Detailed engineering	 TATA CONSULTING ENGINEERS LIMITED
Owner's engineering	 TRACTEBEL ENGIE
Site Studies (Geotech study, contour mapping, water resource, etc.)	Studies Ongoing
Feasibility Study of 1 MMTPA Green Ammonia	 TOYO ENGINEERING
Ammonia Licensor	Final discussions Ongoing

Multiple partnerships and engagements with global entities to develop the largest green hydrogen hub in Mundra

18



CONFIDENTIAL

adani

Pilot Projects at a Glance



Clean Energy Transition utilizing state of art technology

Location	Unit 1 – 330 MW, Mundra Thermal (Coal) Power Plant
Description	- Feasibility study on potential modification in Mundra Power Plant to achieve 20% liquid ammonia co-firing - Phase 1 and Phase 2 is supported by Japanese Government Agency NEDO



Hydrogen Fuel Cell Electric Trucks

- Adani Enterprises Limited (AEL) is the first in Asia and among the first in the world to adopt hydrogen fuel cell operated trucks for mining
- AEL signed an agreement to launch a pilot project to develop a hydrogen fuel cell electric truck (FCET) for mining logistics and transportation with **Ashok Leyland (India), and Ballard Power (Canada)**



Description

- Weight: 55 Tons
- 3 Hydrogen Tanks
- 200 Kms working range
- Powered by Ballard's 120 kW PEM fuel cell technology



ATGL Green Hydrogen Blending Pilot Project

- Aims to assess the adaption of green hydrogen as an alternative energy source for City Gas Distribution consumers
- To blend green hydrogen with natural gas for over 4,000 Home and Commercial PNG customers during the pilot phase

Description

- As per studies, an upto 8% hydrogen blend can reduce emission by upto 4%
- Project will enhance existing infrastructure, diversify energy mix, develop hydrogen ecosystem and reduce CO2 emission by upto 4%



19

CONFIDENTIAL

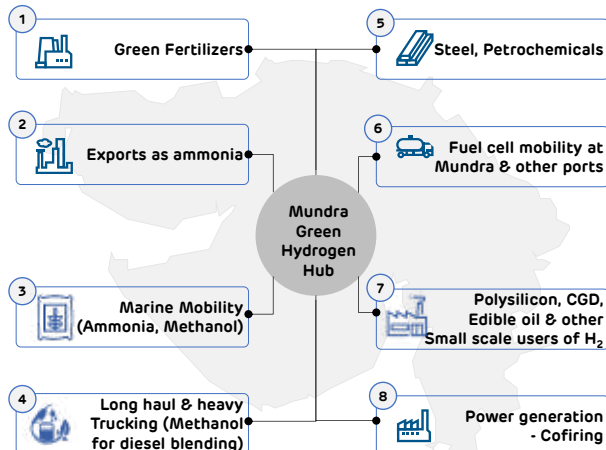
adani

Mundra – World's Largest Green Hydrogen Ecosystem

ANIL Master Plan

RE capacity	~45 GW
Green Hydrogen	Upto 2 MMTPA
Green Ammonia	Upto 10 MMTPA
e-Methanol	Upto ~2 MMTPA
Hydrogen Compression & Storage	Supports 2 MMTPA ecosystem
LH ₂ & Other derivatives (SAF, LOHC)	Available as required

... For multiple end uses including substantial captive use in Adani Portfolio businesses* ...



RE: Renewable Energy; PVC: Polyvinyl chloride; MMTPA: Million Metric Tons Per Annum; LH₂: Liquid Hydrogen; MCH: Methyl Cyclohexane; LOHC: Liquid Organic Hydrogen Carrier; CGD: City Gas Distribution; KMTA: Kilo Metric Tons Per Annum; GW: Gigawatt; MOU: Memorandum of Understanding; SEZ: Special Economic Zone
* Currently expected configuration and under finalisation

20

A Reliable, Scalable & Cost-Effective GH₂ Supply Chain

Reliability

Successful track record in delivering multi-billion dollar infrastructure projects

Scalability

2.0 MMTPA Green Hydrogen ecosystem being developed with multiple Ammonia & Methanol trains

Cost-Effective

End-to-end integration with complete supply chain control ensures cost-competitiveness

Thank You



Country Day II : International Day

**[Spain] Current situation of the deployment
of the Hydrogen Economy in Spain**

Country Day II : International Day

[Spain] Current situation of the deployment of the Hydrogen Economy in Spain



Dr. Javier Brey

Chairman, Spanish Hydrogen Association (AeH2)

Education

- 2005-2015, Ph.D., Economy, Universidad Pablo de Olavide, Seville, Spain
- 2008, MBA, IESE, Universidad de Navarra, Madrid, Spain
- 1992-1998, B.S. & M.S, Engineering, University of Seville, Seville, Spain

Professional Career

- 2009-Present, Chairman, Spanish Hydrogen Association (AeH2), Madrid, Spain
- 2016-Present, CTO & Founder, H2B2 Electrolysis Technologies, Sevilla, Spain
- 2016-Present, Tenured Professor, Engineering Dept., Universidad Loyola, Sevilla, Spain
- 2013-2016, CEO, Abengoa Hidrógeno, Sevilla, Spain
- 2003-2012, General Manager, Hynergreen Technologies, Sevilla, Spain
- 2001-2003, General Manager, Greencell, Sevilla, Spain
- 2000-2001, R&D Engineer, Instalaciones Inabensa, Sevilla, Spain

Research Interest

- Hydrogen Economy
- Deployment of Hydrogen Infrastructure
- Electrolysis Technologies & Processes

Speech Title

Current situation of the deployment of the Hydrogen Economy in Spain

Speech Summary

With a Roadmap established in 2020, and a “Strategic Project of Renewable Hydrogen” established in 2021, Spain has made renewable hydrogen a “national project”. Currently, the Government has allocated a budget of more than 3 billion euros to the deployment of hydrogen capacities, and set goals such as having 11 GW of electrolyzers deployed by 2030.

Company Introduction

Founded in 2002, AeH2 currently has 450 members, representing the entire hydrogen value chain in Spain.

Spanish Hydrogen Association

AeH₂
ASOCIACIÓN ESPAÑOLA
DEL HIDRÓGENO

Hydrogen Economy in Spain: Advancing Policies
and Projects

H2MEET 2024

Javier Brey
President AeH₂

25th September 2024

AeH₂
ASOCIACIÓN ESPAÑOLA
DEL HIDRÓGENO

The AeH₂ | Regulation | Funding | Projects | Capabilities

The Voice of the Hydrogen sector in Spain Since 2002



400+ members
+ 37% growth since 2021
+ 20 years supporting the sector
+ 15 years of international collaborations

MISSION

Promote and encourage the development and growth of hydrogen technologies in Spain, with the aim of strengthening and enhancing the national industrial fabric.

VISION

Hydrogen is a key energy vector in the decarbonization of the Spanish economy to achieve climate neutrality in 2050. Hydrogen allows for reactivating, redefining and transforming the national economy, through the creation of a technological and productive industrial fabric, and the generation of highly qualified employment.



3

The AeH₂ | Regulation | Funding | Projects | Capabilities

BOARD OF DIRECTORS



President

D. Javier Brey Sánchez



Vice-president

D. Antonio González García- Conde



Secretary

D. Miguel A. Peña Jiménez

Sectoral vocals

- Industrial Gases Sector.
- Renewable Gases Sector.
- Fuel Gas Sector.
- Energy Sector.
- Engineering and Construction Sector.
- Electrolyzers Sector.
- Technology Centers Sector.
- Testing, Inspection and Certification Sector.
- Public Research Organizations Sector.
- Scientific Facilities and Singular Technologies Sector.
- Industrial Development Sector.
- Demand Integration and Renewable Sector.



4

The AeH₂ | Regulation | Funding | Projects | Capabilities

Members



5

January 2024

AeH₂
Asociación Española de Hidrógeno

The AeH₂ | Regulation | Funding | Projects | Capabilities

Our promoting members



6

December 2023

AeH₂
Asociación Española de Hidrógeno

The AeH2 | Regulation | Funding | Projects | Capabilities

Objectives



CLUSTER

To be the gathering place of the sector, bringing together companies, institutions, technology and research centers and, universities with activity in hydrogen and fuel cells.



R&D&i

To promote research and innovation in hydrogen and fuel cells, as well as the promotion of startups and technological knowledge.



DEVELOPMENT

To support the development, promoting the production, storage, and distribution applications of hydrogen, and its use in fuel cells.



EDUCATION

Offering professional education through specific courses already consolidated with various universities and training centers.



LEGISLATION

Promoting laws and rules for the regulation of hydrogen as an energy vector.



DISSEMINATION

To make hydrogen acknowledged as an energy vector by our society.



7

The AeH2 | Regulation | Funding | Projects | Capabilities

International collaboration



8

The AeH2 | Regulation | Funding | Projects | Capabilities



European Hydrogen Energy Conference

EHEC is the European conference of reference in the hydrogen sector. Held every two years, it is organized by the Spanish Hydrogen Association (AeH2) and brings together experts, researchers and industry leaders in the field of hydrogen, providing a platform to share the latest advances, innovations and developments in hydrogen technologies.

- Showcase advances in R&D projects and products.
- Bring the latest advances in research and business to a worldwide audience of interested parties.
- Find strategic business opportunities and collaborations.



4
PLENARY
SESSIONS

250+
PARALLEL
SESSIONS

3000+ m2
EXHIBING
SPACE

**B2B &
Networking
Activities**

50+
SPONSORS

80+
EXHIBITORS

1300+
ATTENDEES
+ 35 COUNTRIES

Next edition

Seville
March 2026



9

The AeH2 | Regulation | Funding | Projects | Capabilities

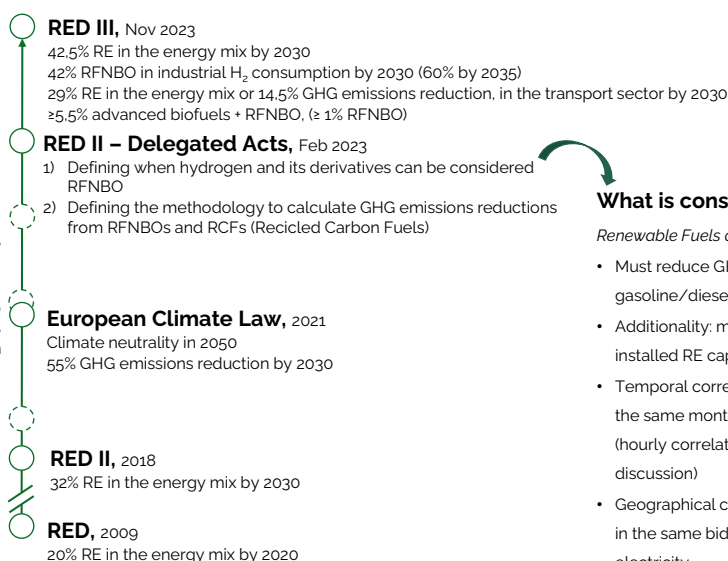
Europe drives regulation



2022, **RePower EU**
After the invasion of Ukraine

2021, **Fit for 55**
Proposals to reach 55%
GHG emissions reduction

2019, **European
Green Deal**
Climate neutrality in 2050
40% RE by 2030



What is considered RFNBO?

Renewable Fuels of Non-Biological Origin

- Must reduce GHG emissions by ≥ 70% from gasoline/diesel (3,38kg CO₂/kg H₂)
- Additionality: must be produced with newly installed RE capacity
- Temporal correlation: must be produced in the same month as the renewable electricity (hourly correlation from 2030 currently under discussion)
- Geographical correlation: must be produced in the same bidding zone as the renewable electricity

10

The AeH2 | **Regulation** | Funding | Projects | Capabilities

Europe drives regulation

RED III, Nov 2023

42.5% RE in the energy mix by 2030

42% RFNBO in industrial H₂ consumption by 2030 (60% by 2035)

What counts towards this target?



29% RE in the energy mix or 14.5% GHG emissions reduction, in the transport sector by 2030
≥5.5% advanced biofuels + RFNBO, (≥ 1% RFNBO)

What counts towards this target?

- Substitution of fossil-based H₂ in the refineries producing fuels for transport
- Consumption of H₂ and/or its derivatives* in road/maritime/aviation transport
*e- gasoline, e- diesel, e- methane, e- kerosene, ammonia, methanol ...
- x2 multiplier for RFNBO use in transport
- x1.5 multiplier for RFNBO use in maritime/aviation transport

Currently Spain is in the transposition period

Preliminary public consultation (closes 20th Sep)

Draft regulation texts

Public consultation

Official processing of new Laws and Decrees by the Parliament

Transposition deadline
21st May 2025



The AeH2 | **Regulation** | Funding | Projects | Capabilities

Europe drives regulation

Regulation on the deployment of alternative fuels infrastructure - AFIR

Sep 2023

By 2030, HRS in the EU will...

- Have a minimum cumulative capacity of 1ton/day (500kg for roads with low traffic)
- Have at least a 700 bar dispenser to ensure inter-operability
- Be located on the TEN-T road network or within 10 km driving distance from the nearest exit of a TEN-T road
- Be in every urban node along the TEN-T road
- Be deployed with a maximum distance of 200 km between them along the TEN-T core network



Every Member State needs to define a clear trajectory towards AFIR 2030 target in their national policy, including a clear indicative target for 2027

Spain still needs to do this

ReFuel EU Aviation Regulation

Sep 2023

- Mandatory shares of sustainable aviation fuels (SAFs) to be available at EU airports: 2% of overall fuel supplied by 2025 and 70% by 2050
- Mandatory RFNBO subquotas of 1.2% in 2030 and 35% in 2050

FuelEU Maritime

Sep 2023

- Applicable to ships with a gross tonnage (GT) above 5000, with several exemptions (e.g. warships, fish catching ships...)
- Progressive target for GHG emissions reduction, 2% in 2025, 80% in 2050 (RFNBO will benefit from double counting)
- Subtarget for RFNBO use of 2% by 2034

All three are direct application
do not need to be transposed

The AeH2 | **Regulation** | Funding | Projects | Capabilities

Spain has growing ambitions for renewables and hydrogen

Under the Regulation on the governance of the energy union and climate action (EU)2018/1999, all Member States must have a 10-year plan addressing decarbonization, energy efficiency, energy security, international energy market, and research, innovation and competitiveness, known as NECP (National Energy and Climate Plan, PNIEC in Spanish).



The Updated PNIEC (draft) includes **15 new measures** to promote hydrogen development in Spain

	First PNIEC (published 2020)	Updated PNIEC (draft published June 2023, final document pending, values might change)
GHG emissions reduction by 2030	23%	32%
RE in total energy consumption by 2030	42%	48%
RE in electricity generation by 2030	74%	81%
RE in the transport sector by 2030	15%	25%
Advanced biofuels + RFNBO in transport by 2030	2,1%	11%
RFNBO in industrial hydrogen consumption by 2030	25 % (set in the Roadmap, not PNIEC)	74%
Energy efficiency (reduction of primary energy consumption) by 2030		44%
+ climate neutral by 2050		
+ 100% renewable electricity by 2050		

The AeH2 | **Regulation** | Funding | Projects | Capabilities

Spain has growing ambitions for renewables and hydrogen



"Hydrogen Roadmap: a commitment to renewable hydrogen"

6th October 2020 - Approved by the Council of Ministers

To be updated every 3 years (currently delayed) to:

- Evaluate the progress made.
- Assess the degree of implementation of the implemented measures.
- Quantify its impact.

Includes **60 actions** to promote the development of hydrogen in Spain, divided in 4 blocks

1. **Regulatory instruments.** E.g. Modify the classification of on-site renewable hydrogen production at HRS as an industrial activity.
2. **Sectoral instruments.** E.g. Establish a national statistical system on hydrogen consumption and production in Spain.
3. **Cross-cutting instruments.** E.g. Adapt the profiles to deal with work related to hydrogen technologies with specific training, such as training for fire fighters.
4. **Boosting R&D.** E.g. Promote the national development of high-power electrolyzers.

2030 GOALS



The AeH2 | Regulation | **Funding** | Projects | Capabilities

IPCEIs – Important Projects of Common European Interest

Enable state-aid to commercial projects if they represent a significant contribution to economic growth, jobs, the green and digital transition and competitiveness for the Union industry and economy. They must have positive spillover effects to the whole Union.

All IPCEIs are expected to be completed by 2031 (timelines varying in function of the individual projects and the companies involved). Around 3,600 direct jobs across the EU are expected to be created, 18,9b€ of public funding mobilized and 24,5b€ of private investments expected. Four "waves"

1. **Hy2Tech** – July 2022
 - 15 countries: Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Netherlands, Poland, Portugal, Slovakia and **Spain**
 - 41 projects, 35 companies (**4 Spanish projects/companies**)
 - 5,4b€ in public funding (state aid) – **Spain 74M€**
 - + 8,8b€ in private investments (*expected*)
2. **Hy2Use** – September 2023
 - 13 countries: Austria, Belgium, Denmark, Finland, France, Greece, Italy, Netherlands, Poland, Portugal, Slovakia, **Spain** and Sweden
 - 35 projects, 29 companies (**7 Spanish projects/companies**)
 - 5,2b€ in public funding (state aid) – **Spain 794M€**
 - +7b€ in private investments (*expected*)
3. **Hy2Infra** – February 2024
 - 7 countries: France, Germany, Italy, the Netherlands, Poland, Portugal, and Slovakia
 - 33 projects, 32 companies
 - 6,9b€ in public funding (state aid)
 - +5,4b€ in private investments (*expected*)
4. **Hy2Move** – May 2024
 - 7 countries: Estonia, France, Germany, Italy, Netherlands, Slovakia and **Spain**
 - 13 projects, 11 companies (**2 Spanish projects/companies**)
 - 1,4b€ in public funding (state aid) – Spain TBC
 - + 3,3b€ in private investments (*expected*)

 The AeH2 | Regulation | **Funding** | Projects | Capabilities

PERTE ERHA – Spanish Recovery and Resilience Transformation Plan

Next Generation EU provides grants and loans to support reforms and investments in the EU Member States through the Recovery and Resilience Facility.

With this funds Spain created the funding figure 'PERTE' (Acronym in Spanish for 'Strategic Projects for Economic Recovery and Resilience') to promote high-priority projects that are especially complex or for which the current private sector motivation is insufficient.

In 2021, the Spanish Ministry for the Ecological Transition and the Demographic Challenge (MITERD) published the first PERTE ERHA grants: renewable energies, renewable hydrogen and storage.

- Creation of 280,000 jobs (direct and indirect expected)
- Public investment: 6920 M€
- Private investment (expected): 9450 M€



H2 Pioneros

- Hydrogen production + distribution + use
- 0,5MW – 20 MW electrolysis capacity
- 1st call - 2022, 150 M€
- 2nd call – 2023, 150 M€

H2 Cadena de Valor

- Manufacturing and testing capabilities – 2022, 30 M€
- Design, demonstration and validation of hydrogen vehicles – 2022, 80M€
- Electrolysis demonstrators – 2022, 100M€
- Fundamental research, innovative pilots, enabling technologies – 2022, 66,6M€

H2 Valles y clústeres

- 2024, 1200M€
- Min 100MW electrolysis (can be split between several locations within the valley but min 50MW each, max 100km distance)

The AeH2 | Regulation | Funding | Projects | Capabilities

Spain fosters H2 technology development and innovation



CDTI is a Business Public Entity under the Ministry of Science, Innovation and Universities that promotes innovation and technological development of Spanish companies. CDTI provides applications assistance and support to R & D & I projects of Spanish companies at both state and international levels.

National point of contact for coordination of Horizon Europe + Clean Hydrogen Partnership Calls
Included H2 line in their national funding program "Misiones", their 2022 Call funded eight hydrogen projects with 35 M€



AEI is a public entity under the Ministry of Science, Innovation and Universities, managing programs, instruments and actions that are awarded within the framework of the State Plans for Scientific and Technical Research and Innovation

It has financed low TRL hydrogen projects through some of its calls such as 'Proyectos en líneas estratégicas' or 'Transmisiones'

It also funds the activities in the Spanish Technological Platform for Hydrogen since 2005, one of AeH2's main projects



The Spanish technological Platform for Hydrogen (PTeH2) brings together stakeholders from the Science-Innovation-Technology network of hydrogen in Spain to gather valuable information, recommendations and action lines for R&D in hydrogen technologies.

The AeH2 | Regulation | Funding | Projects | Capabilities

Spain conquers first European Hydrogen Bank auction

First auction results and conclusions

- **720 M€**
- **7 projects** (3 in Spain)
- **1.58 Mt de H₂** RFNBO
- **0.37-0.48 €/kg**, OPEX support
- **8.35GW** electrolysis to be installed

46 proposals (out of 130 received) located in Spain with..

- 5.8 LCOH
- 4800h average electrolyser usage at max capacity per year

Out of the 130 proposals received ..

- 2.9 years – average time to start operation
- 82 would have an industrial offtaker while 37 will have a mobility offtaker
- 30 would buy the electrolyzers only outside the EU (20 in China), + 40 from "EU + non-EU countries"

What's next?

Q4 2024 second round of auction
Final T&C pending, the draft includes:

- Max bid 3.5 €/kg H₂
- Max 3 years to start operations
- Two budget buckets (general and maritime transport)
- More information on electrolyser supply strategy
- Min 5 MW electrolysis (single location)
- MoU/Lol for ≥60% of electricity to be consumed
- MoU/Lol for ≥60% of H₂ to be produced

Companies	Country	Bid (€/kg)	Volume (kt H ₂ - 10 years)	Beginning operations	Final use
Lahti Nordic, Ren Gas Oy	Finland	0.37	122	2027	E-Methane
Benbros Energy S.L.	Spain	0.38	65		Undisclosed
Petrogal S.A., Galp	Portugal	0.39	216		Refinery
Angus, Dhamma Energy	Spain	0.48	17	2026	Mobility + Others
Skiga, EnBW, Fuella	Norway	0.48	169	2026	Ammonia
Renato PtX Holdco, Enagas Renovable, CIP, Fertiberia	Spain	0.48	480	2028	Ammonia + Refinery
Madoqua Power 2X, CIP	Portugal	0.48	511	2028	Ammonia (maritime)

The AeH2 | Regulation | Funding | **Projects** | Capabilities

AeH2's Project Census

Started in 2023...

Gathered TRL>7 projects led by AeH2's Members or in which they participate

- 123 projects
- From 46 AeH2's Members
- Most of them were in preliminary stages ("planned projects")
- Wide range of applications; substituting existing fossil-based hydrogen use with renewable hydrogen being the most common, followed by the production of hydrogen derivatives

If all these projects were developed that would mean...

- **11 GW** installed capacity
- **21• b€** in investments



Interactive map and results report (*in Spanish*) available in AeH2's website

2024 Update (map + report in November)

Currently collecting and processing project data

The AeH2 | Regulation | Funding | Projects | **Capabilities**

Hydrogen potential in Spain



Allows greater penetration of renewable energies in the mix



Transversality: transport, industry, electricity production and buildings decarbonization



Key to the "coupling sector" and the circular economy



Huge potential for renewable hydrogen production. Strategic geographical position.



Self-sufficiency and potential to become a reference hydrogen exporter

Great opportunity for economic and technology development

The AeH₂ | Regulation | Funding | Projects | Capabilities



Updated monthly
www.aeh2.org



Updated yearly
2024 edition coming soon
www.pteh2.org

Hydrogen Economy in Spain: Advancing Policies and Projects

H2MEET 2024

Javier Brey
President AeH₂

25th September 2024

AeH₂
ASOCIACIÓN ESPAÑOLA
DEL HIDRÓGENO

Spanish Hydrogen Association



www.aeh2.org



info@aeH2.org



[@AeH2_ENG](https://www.linkedin.com/company/AeH2_ENG)



AeH2 Asociación Española del Hidrógeno

AeH₂
ASOCIACIÓN ESPAÑOLA
DEL HIDRÓGENO

Country Day II : International Day

[Egypt] Hydrogen in Egypt

Country Day II : International Day

[Egypt] Hydrogen in Egypt



Khaled Nageib
CEO, Hydrogen Egypt

Always looking to unlock innovations!

Summary of experience

"Over 30 years' experience across the value chain of energy, petrochemical and ports/maritime and recently renewables and hydrogen Covering engineering construction, operations, management, finance, policy and regulations."

- Over 25 years of experience with emphasis on Ports transportation, CNG, LNG, LPG and Maritime shipping and logistics.

Areas of expertise

- Viability analysis of a new port terminal
- Commercial model development
- Experienced in international finance and equity
- Deepwater port evaluation
- Port strategy development Port terminals growth strategy
- Supported multiple green field ports in Egypt and Middle East and west Africa Terminal management experience and operations around the world, new ports, design build and operations. East Marine services and supported other marine developments including navigation and towage.
- Also advised on ports in Nigeria and Mozambique. Advised on river transport projects and new river terminal design in Egypt

WORK EXPERIENCE

CEO, Founder and initiator

Hydrogen Egypt (H2EG)

2022-present · Founder, initiator and Managing Director

- Developing hydrogen ecosystems and Hydrogen Valley's
- Strategic advisory services for hydrogen and energy transition propositions
- Creating fit for purpose coalitions
- Supporting lobby and strategic positioning

LinkedIn page <https://www.linkedin.com/showcase/mena-hydrogen-to-egypt-hub-h%C2%B2eg/>

<https://www.linkedin.com/in/dalia-samir-49428646>

Our others SOCIAL LINKS

<https://www.linkedin.com/company/egyptian-ports-development-group-epdg/>

<https://youtube.com/@hydrogenegypt> <https://www.facebook.com/profile.php?id=100088959387965&mibextid=LQQJ4d> <https://twitter.com/hydrogenegypt?s=11&t=fsDEE0z2P-p-H2fujUanBA> <https://instagram.com/hydrogenegypt?igshid=YmMyMTA2M2Y=>

CEO, Founder and initiator

Egyptian Ports Development Group EPDG www.epdg-eg.com www.epdg.org

2015- present · Structuring LNG/CNG/PLG activities

- Ports mobility, maritime shipping and logistics
- Demand forecast demand for container traffic.
- EPDG have through its team and partners exceptional experience in designing, building and operating terminals and ports. Our strengths lay within our ability to understand the client and offer bespoke maritime consulting service, in a local market with international solutions.
- EPDG bring in a blend of long-term experience of working in Egypt, Africa and the Middle East, working in infrastructure and port projects.

CEO

Global Projects Services www.gpscorp.net

2012 - 2019 · Manpower services

- Premier manpower solutions for engineering industry

General Manager

Bechtel

1991 - 1997 · Commercial and Operations management of civil, power, and pipeline projects USA and Algeria





Hydrogen in Egypt





1. **Our Company EPDG** was established under Egyptian Laws and has interest in introducing services in two main activities; Ports Services & Oil/Gas Requirements Supplies.
2. **Oil/Gas Market in Egypt** has long history and is currently very promising specially with the current available large facilities;
 1. Oil & Gas Upstream activities with latest huge Gas discoveries – considered to be the biggest in the Mediterranean Sea.
 2. 14 Refineries (one of them is recently constructed and is about to start production and will be one of the biggest Refineries in the middle East).
 3. 4 Petrochemical Factories. 2 are currently under establishment, to be 6 factories.
 4. LNG Facilities for Gas export (Egypt is planning to export again by 2020 as they stopped export since 2011).
 5. Egypt is currently planning to be Regional Energy Hub.
 6. Petroleum Sector includes 2 Giant State owned Companies, One of them is Engineering Company named “ENPPI” and other is Construction Company named “Petrojet” and both are leading many EPC mega Projects (inside and outside Egypt).



الهيدروجين الأخضر طاقة المستقبل النظيفة





Introduces GREEN HDROGEN in Egypt



Green Energy Reintented

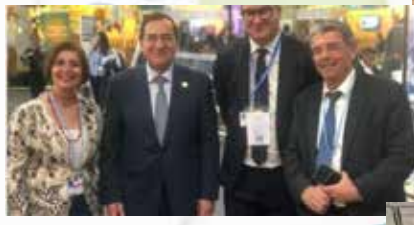







WHO IS HYDROGEN EGYPT (H2EG)?










WHO IS HYDROGEN EGYPT (H2EG)?

Hydrogen Egypt (H2Egypt) objective is to serve the Egyptian corporate community, in close cooperation with partner Hydrogen Europe, by focusing in first phase on the European Union as the first destination of Egyptian green hydrogen and ammonia, therefore understanding and directly connecting with the EU cascade of regulations, specifications, legislation, technology, infrastructure of ammonia shipping, LOHC, future pipelines connecting Egypt EU, offtake opportunities and financial support mechanisms for research, pilot projects, capacity building, and grants.



Our Association Hydrogen Egypt in partnership with H2 Europe, is promoting Egyptian green hydrogen and ammonia to the EU market, working with regulations, legislation, technology, infrastructure of ammonia shipping, and future pipelines connecting Egypt with the EU. We are the voice of industry and helping developers to accelerate the offtake agreements. We are always waiting for the narrative to come from the EU. Why don't we have our own narrative? Hydrogen Egypt (H²Egypt) with Hydrogen Europe helps to project Egypt and Africa's policies & regulations/specifications and securing offtake commitments.

Our aim is Mobilizing Private Capital for Nature to Meet Climate and Nature Goals and meet SDGs 2030.



Introduces GREEN HDROGEN in Egypt



WHO IS HYDROGEN EGYPT (H2EG)?

H2Egypt Corporate Services:

- International and EU regulations and policy and export opportunities are key to Egyptian companies, H2EU and H2EG are a voice and Platform for connecting, unpacking and having direct communication to EU for Egyptian companies to secure opportunities and have input into regulations and legislation.
 - >Hydrogen Europe is the bridge into EU committees, legislators to convey Egypt priorities. H2EU is also focusing on International policy and regulations.
- B2B services for Egyptian and European and International companies and investors.
 - >Hydrogen Europe +400 members are connected to Hydrogen Egypt. H2Egypt is connected to all major International companies and associations.
- Connecting Egyptian production with European and International off takers.
 - >Hydrogen Europe has organized platform to connect its off takers to Egypt market.
- H2Egypt will host Conferences, webinars, workshops, newsletters. Bringing together the top companies, investors, experts and organizations.
- H2Egypt aims to serve and assist as a voice for the Egyptian hydrogen community to Egyptian stakeholders, EU, and internationally.
- Leveraging Hydrogen Technology to Accelerate the Just Transition to a Clean Power Future for All 🇪🇺 We look at women working to capitalize on hydrogen technologies to democratize the energy sector, especially in the Middle East, Northern and sub-Saharan regions of Africa, where the opportunity to leverage surplus solar power to produce green hydrogen can boost economic growth while producing additional and more diverse and equitable employment opportunities, at the same time making hydrogen fuel available for resilient, stable, zero-emission local power solutions and accelerating the just transition to a clean power future for the region and the world.



Introduces GREEN HDROGEN in Egypt





WHO IS HYDROGEN EGYPT (H2EG)?

SEGMENTS:

- General Public
- Small and medium scale production and applications
- Large production, export, trading, applications
- Heavy industry towards decarbonization
- Current producers and consumers of all types of hydrogen and ammonia

Objectives Serving the Egyptian Hydrogen community:

- Awareness Demonstrate
- Technology transfer
- Local industrialization
- HR Capacity building
- Women and Youth
- Education, consultations, skills/capacity building and vocational training
- Create local market for applications and off takers
- Technology and applications pilots
- Hydrogen technology and applications awareness in Egypt.
- Launching Hydrogen pilot projects in Egyptian in cooperation with European partners.







Introduces **GREEN HDROGEN** in Egypt



HYDROGEN EGYPT (H2EG)'S VISION

EDUCATION & AWARENESS






Introduces **GREEN HDROGEN** in Egypt



WHO IS HYDROGEN EGYPT (H2EG)? ⚡

How we can cooperate and support, hereinafter our SOW:

Hydrogen Egypt areas of cooperation:

- International Off Take
- Project Studies
- Plant EPC + Network/Grid +Port infrastructure
- Electrolyzers
- Project location Plant Renewables and Land
- General Project Services
- Unpacking/Overview/Analysis Egypt

- Local offtake and applications
- Capacity building

and International policies and regulations







FORUM HYDROGEN BUSINESS FOR CLIMATE



HYDROGEN TECHNOLOGY OF THE YEAR 2023 (WINNERS)



COP28: meet with all global Leaders







COP28 climate summit under way in Dubai

DIG NEWS



UAE COP28 guest list led by bankers, lobbyists – and housekeeping

Total attendance at climate change conference in Dubai is estimated at about 80,000



Mark Carney and Michael Bloomberg at an opening day reception for the COP28 in Dubai on Thursday in Dubai at COP28 via Getty Images





MEMBERS OF HYDROGEN EGYPT

WELCOME TO THE H2 EGYPT PARTNERSHIP



Introduces GREEN HDROGEN in Egypt



WHO IS HYDROGEN EGYPT (H2EG)?

We

are proud to be part of [TRIÈRES - Greek Hydrogen Valley](#) of the [EU Programs Coordination Initiative](#) that is launched in [#Greece](#) and [#Egypt](#) is a part with Hydrogen Egypt [#togetherforimplementation](#) [#greenhydrogen](#) [#nocarbonfootprint](#) [#greenenergy](#) [#decarbonization](#) [#togethertosaveourplanet](#) [#ValleyOfRa](#) [#Egypt Clean Hydrogen Partnership](#)

The Clean Hydrogen Partnership- funded project [TRIÈRES - Greek Hydrogen Valley](#) took up its activities this July. Beginning as a small-scale Valley, the project aims to use the refinery of project lead [Motor Oil](#) in Corinth, gr as a Hydrogen generator and use the created Green Hydrogen in the production of low and no Carbon footprint energy and industrial products.







Introduces GREEN HDROGEN in Egypt





WHO IS HYDROGEN EGYPT (H2EG)?

We are also members of the World Bank Partnership programme called **Hydrogen for Development (H4D)**



Dolf Gielen • 1st
Senior Energy Economist and Hydrogen Lead World Bank
Smo •

#hydrogen
#H4D
#ESMAP
#worldbank
#hydrogenegypt
#khalednageib
#daliasamir









We are delighted to welcome Hydrogen Egypt as a new partner in the Hydrogen for Development Partnership. Realizing Egypt's ambitious hydrogen plans is an important task of global significance and the insights gained will help the energy transition worldwide.



Always looking to unlock innovations!





VALLEY OF RA

 Egypt eg - The oldest human civilization becomes a cradle of [#hydrogen](#).
 eg Egypt played a very special role in human history, as the country is considered the origin of human civilization.
 🇪🇬 Now it is returning to its role as a pioneer of great civilizational developments.

→ The rise of hydrogen is equally important with the move away from fossil fuels.
 ✓ With hydrogen we can end the Anthropocene and begin a new e can be called the Cyclocene. ☀️ Sun, wind and hydrogen are the es elements of this development. We will therefore meet the Egyptian RA often in the near future. [#ValleyofRa](#) ✨

With Hydrogen our Ancient Egyptians preserved Mummies.
 Thousands of year ago recycling and [#ZEROWASTE](#) were a way of life to [Cope with the environment and climate change](#)

Let's build together the Valley of Ra.
[this complete value chain, the new cluster of hydrogen projects](#)
[the Egyptian supply chain, the new cluster of hydrogen projects](#)
[the Council of Antiquities](#)




Introduces **GREEN HDROGEN** in Egypt







Egypt: a unique location

Egypt is an important location when discussing decarbonizing ammonia production. It boasts a combined ammonia production capacity of 6 million tonnes per annum, all based on natural gas. Globally, Egypt is the 6th largest urea fertilizer producer, and the 5th largest urea exporter. Furthermore, Egypt had one of the last operational electrolysis-based ammonia plants in the world: this one fed with hydropower. The KIMA plant operated with alkaline electrolyzers and hydroelectricity from the Aswan Dam, and was closed down in 2019.

Location



Egypt's geographical position is at crossroads between Europe, the Middle East and Africa



Egypt is very well placed geographically as a major shipping hub, with easy access to the Mediterranean and red sea (Europe – Asia shipping trade route) via Suez Canal



The second largest signatory of multilateral trade agreements in the world



3



Egypt has one of the largest economies in the Middle East and North Africa (MENA) region and several of its key industries (fertilizers, steel, refining and petrochemicals) are among the region's largest consumers of unabated grey hydrogen.

Hydrogen in Egypt



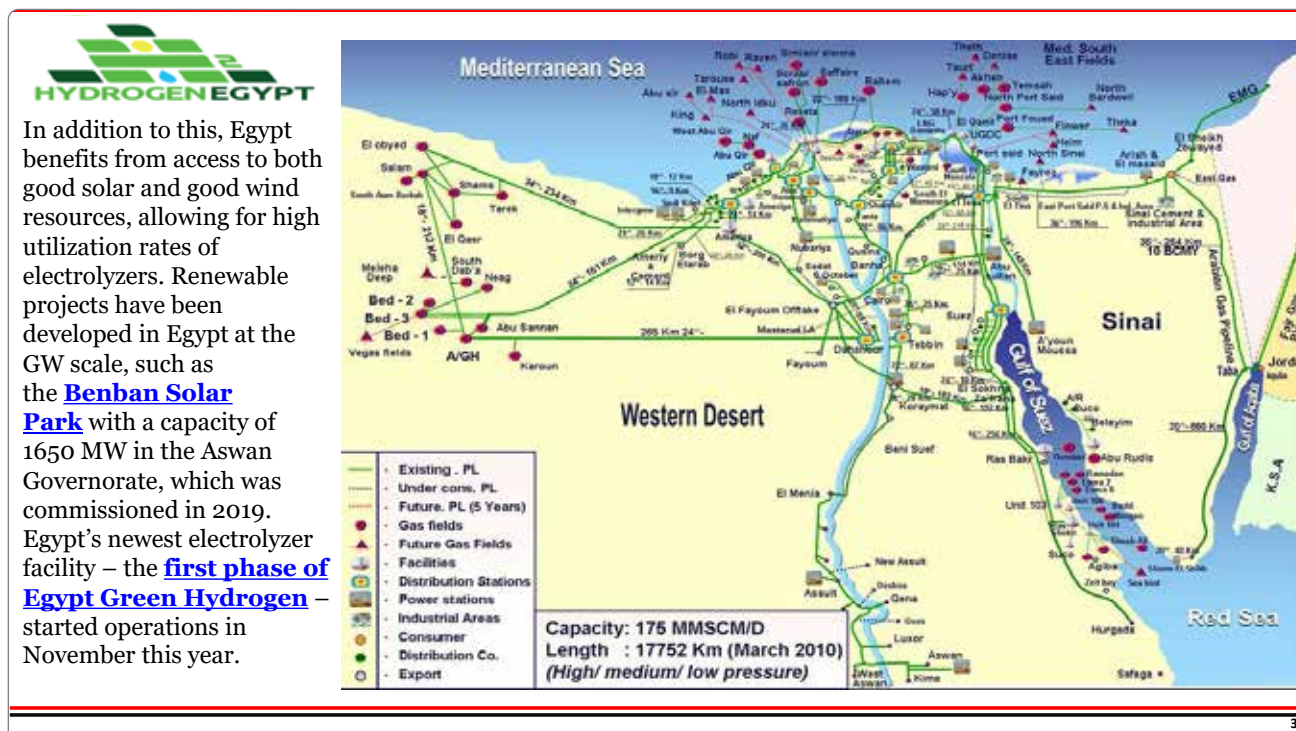
Hydrogen is currently produced from natural gas using the steam methane reforming (SMR) process. Almost for captive production



Average annual consumption of gray Hydrogen is around 1.8 to 2 MT/year

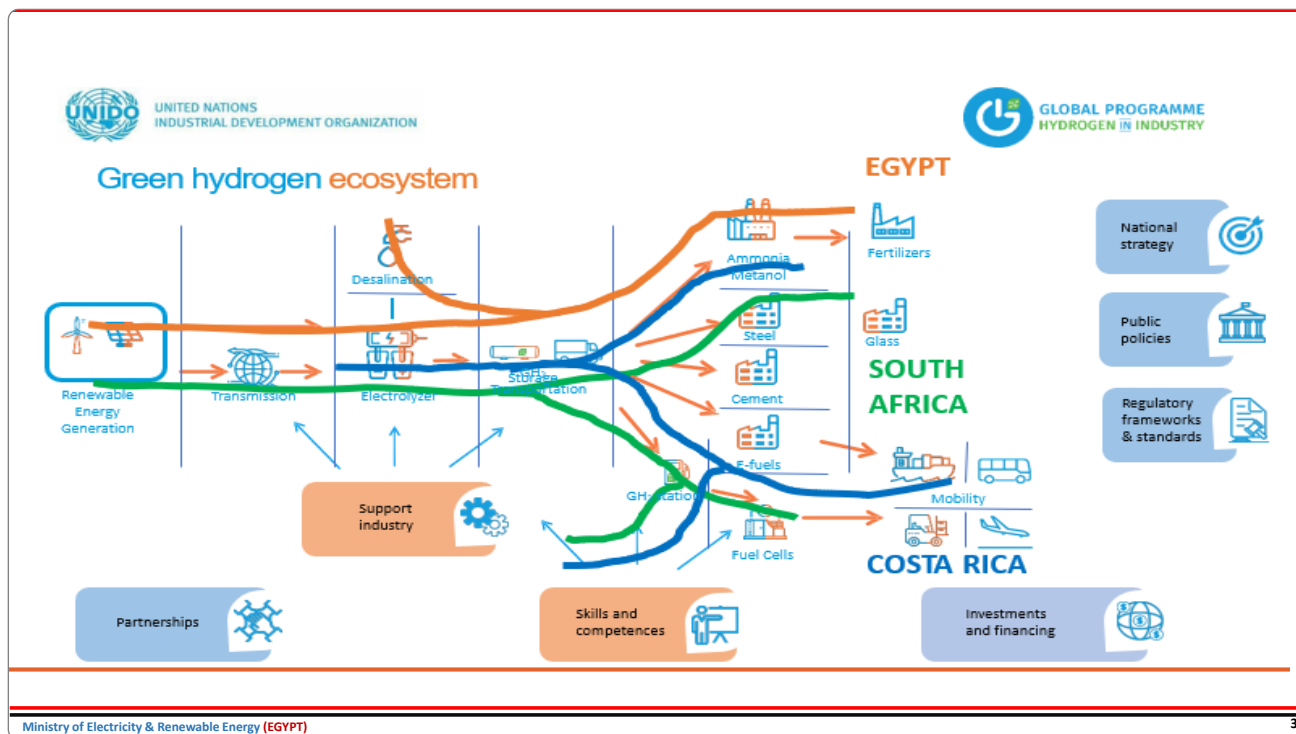


3



3

In addition to this, Egypt benefits from access to both good solar and good wind resources, allowing for high utilization rates of electrolyzers. Renewable projects have been developed in Egypt at the GW scale, such as the [Benban Solar Park](#) with a capacity of 1650 MW in the Aswan Governorate, which was commissioned in 2019. Egypt's newest electrolyzer facility – the [first phase of Egypt Green Hydrogen](#) – started operations in November this year.



3

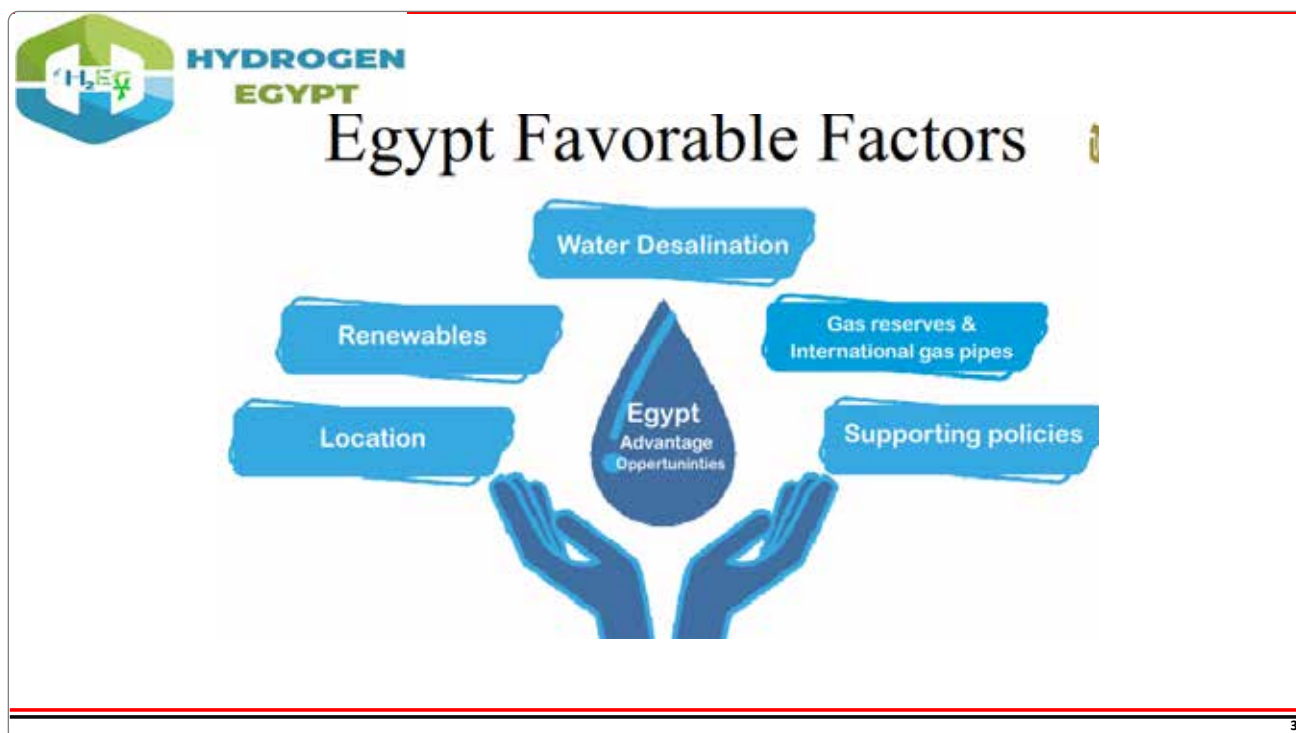


Environmental Sustainability

Since the Earth is a very complex system, sustainability includes many different aspects. Materials, electricity, fuel and water use, emissions and effluents, waste & recycling; all are relevant to companies.



3



HYDROGEN EGYPT

Policies / Framework to Support Green Hydrogen in Egypt

The Egyptian government has regulated an energy diversification policy known as the "Integrated and Sustainable Energy Strategy of 2035"

Expansion of the Egyptian Investment Law No. 72 of 2017 (the "Investment Law") so as to grant the stipulated incentives and guarantees to local and foreign investments in green hydrogen project and the incentives associated with the golden licenses

The Law of Special Economic Zones No. 83/2002 and its amendments by the virtue of law No. 27/2015, SC Zone is entitled to grant investors more competitive financial incentive package

3



Ammonia and Fertilizers



3



Egypt's future potential

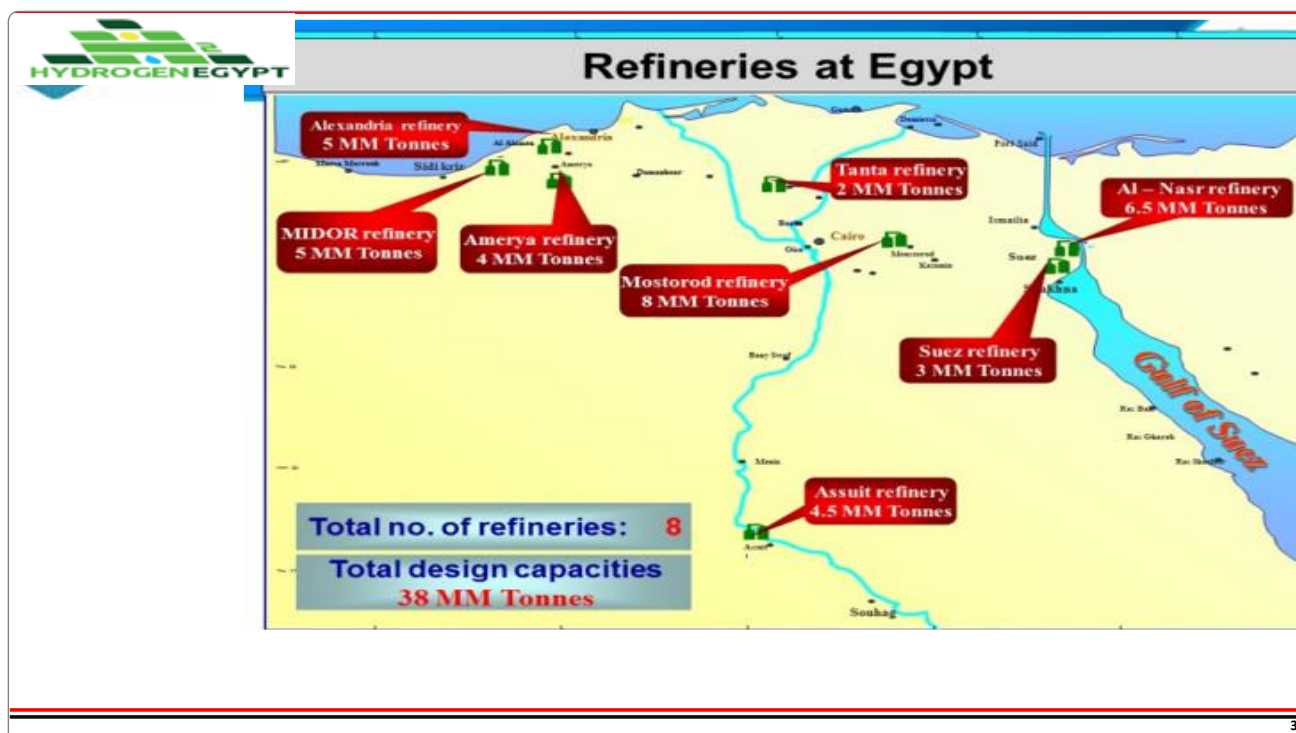
There is substantial interest in renewable ammonia production in Egypt, as follows from the numerous announced projects in the SCZONE, as well as the availability of suitable financing in the country. However, long-term offtake security & clarity on certification rules is still required before these projects can reach FID.



Click to enlarge. The six ports (red dots) and

With regards to clarity, it is evident that rules regarding what is considered "green" are far from settled. Once aspects such as temporality, additionality and grid-connected hydrogen production have been figured out, certification must be implemented to allow for differentiating between carbon intensities of ammonia

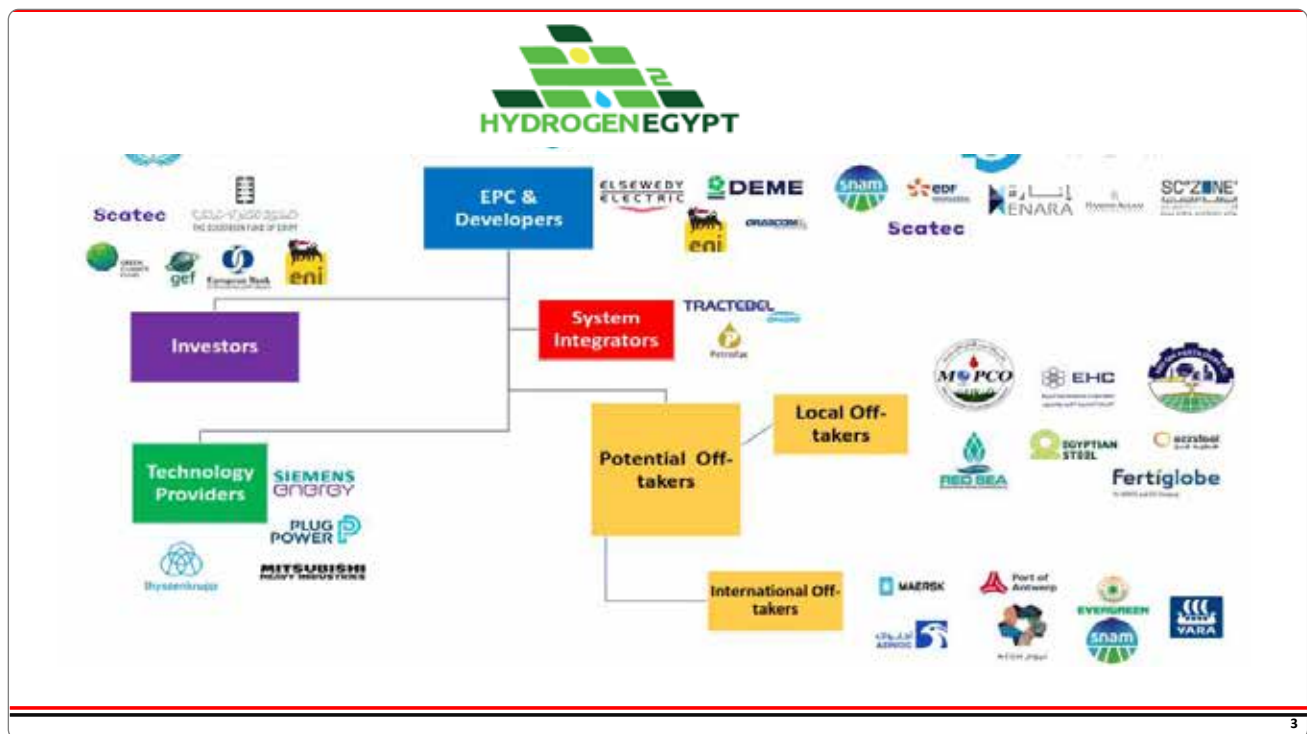
3



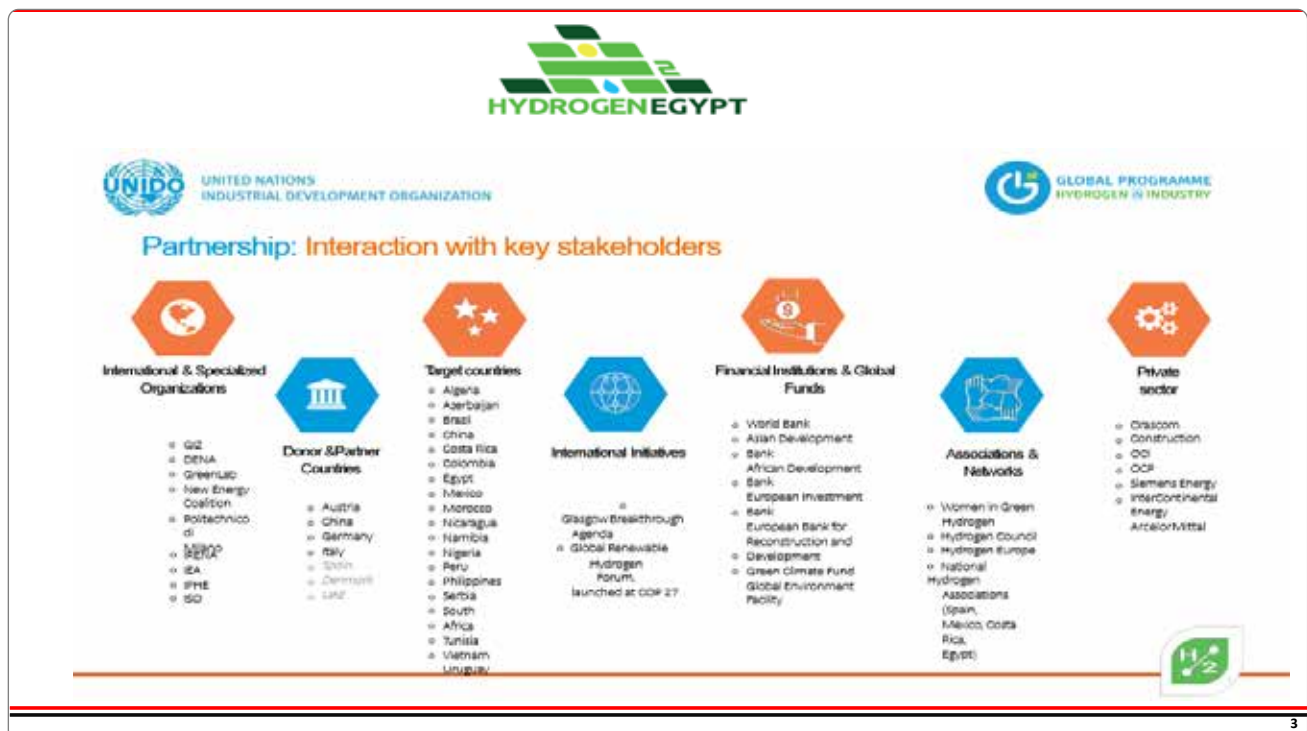
3



3



3



3

What is Egypt's role in the global green hydrogen economy?

- Due to its unique location at the meeting point between Europe, Africa and Asia and between the Mediterranean and Red Seas, with highly developed sea ports, pipelines and of course the Suez Canal, Egypt has a key role in the global transport of energy in every form including hydrogen, which must not be developed in isolation and will be central in energy trade, as ammonia & via pipeline trade.
- Blessed with abundance of sun, wind, hydroenergy and natural gas, Egypt is an optimal energy hub. We have developed extensive infrastructure for energy generation, fertilizer production & have enormous potential for producing green hydrogen & ammonia which we can export to EU and FE. To this end, Hydrogen Egypt has worked with government and commercial entities to reach agreements such as the MOU on Hydrogen with the EU to realize this potential
- Egypt cooperates with international bodies on standards and certification and follows framework roadmaps from IEA, IRENA & the EU.
- Egypt recognizes that advancing renewable energy & green hydrogen in developing countries is critical for global decarbonization & will contribute to global equity and stability
- COP27 in Sharm el Sheikh was a great catalyst driving the Egyptian government to achieve ambitious targets for clean energy and cooperate with private and public energy initiatives around to meet these targets.
- Going forward, as EU, US and other global leaders tighten regulations and taxation on carbon emissions, the need for hydrogen rises, impacting relative pricing and making the case for export of Egyptian green hydrogen even more attractive.
- Egypt can take a leadership role in an Africa-EU partnership to develop green hydrogen for mutual benefit of all parties



Green Hydrogen Recent signed MoUs



Today's signing reflects the growing interest of companies to join the Egyptian Green Hydrogen Program, which reflects the country's progress in the right path through the establishment of a clear and fully formed program supported by all state agencies, noting that this is reflected in the investment incentives that were approved last January to enhance the competitiveness of projects established in Egypt.

- MoUs were signed between the Suez Canal Economic Zone (SCZone), the Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company (EETC), the New and Renewable Energy Authority (NREA) with Bash Global, Smart Energy, the Gamma Construction and Meridium Alliance, SK Eco Plant-Sea Sec North Africa Alliance, Al-Tawakkol Gila, AMM Power and United Energy Group
- the signing of the MoUs represents a new step for the Fund in a series of investment partnerships with major international companies to establish projects in the field of green hydrogen in the Suez Canal Economic Zone, where the memorandums of understanding signed with 7 developers add expected investments for the pilot phase of about \$ 12 billion, in addition to about \$ 29 billion for the first phase, bringing the total investments to about \$ 40 billion within 10 years.





Green Hydrogen

Recent signed MoUs










19



Green Hydrogen

Siemens



Partnership has to manage the scale up of a new industry
- H2 Roadmap for Egypt until 2030



Pilot project

- 100-200 MW project for early technology deployment
- Establish partner landscape
- Establish and test regulatory environment and certification schemes
- Setup off-take relations and logistics concepts

Start early 2022
24-36 months implementation

Scale-up

- 400-800 MW project size to maximize scale effects on existing (proven) technology
- Proof competitiveness for large scale export in global market
- Leverage large scale investment to foster local know-how build up
- Establish long term off-take relations

Start late 2024
24-36 months implementation

Industrialization

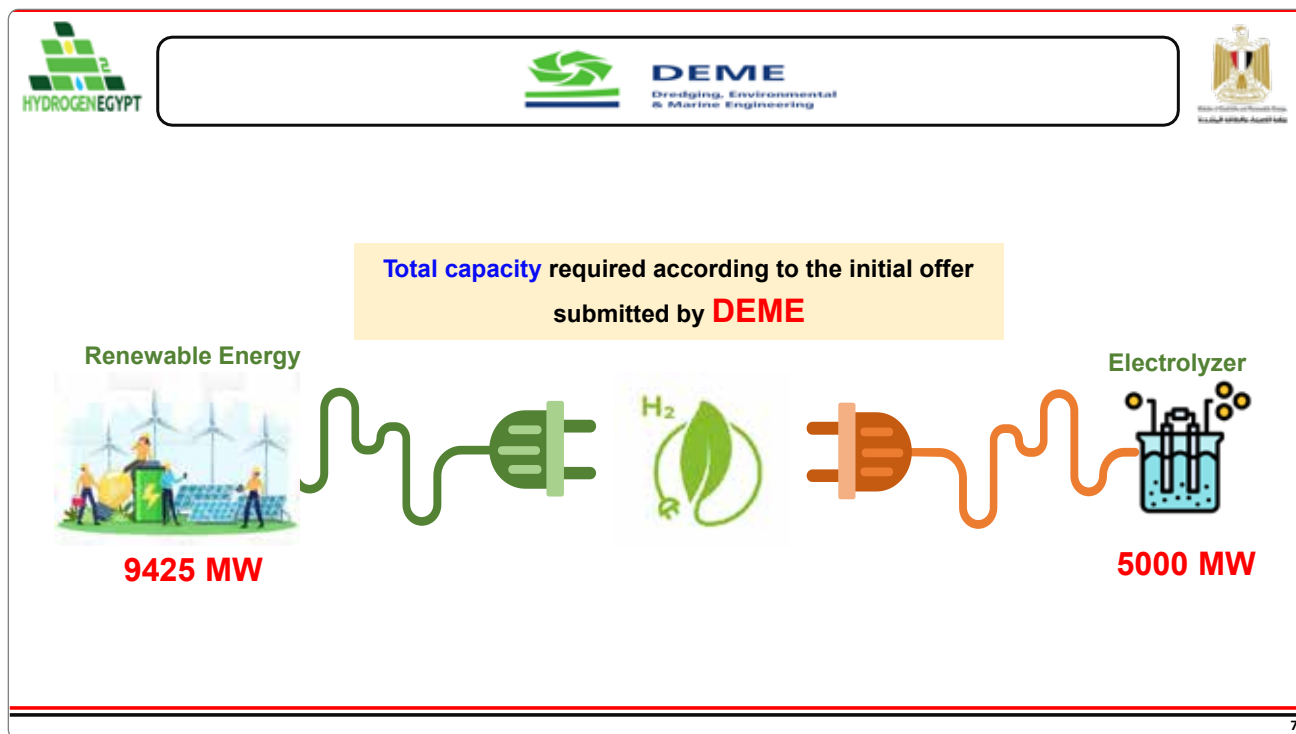
- 1.5 - 3 GW project size to establish large scale local industry
- Achieve cost competitiveness against conventional energy carriers based on Next-GEN technology and
- Leverage local value addition

Start 2027+
24-36 months implementation

Siemens Presentation (Egypt Hydrogen) about the Hydrogen Road Map for Egypt until 2030

Ministry of Electricity & Renewable Energy (EGYPT)

6

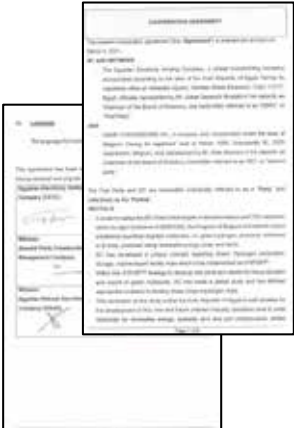




Green Hydrogen

Belgian Consortium **DEME, FLUXYS, PORT OF ANTWERP**





March 2021 a cooperation agreement was signed between

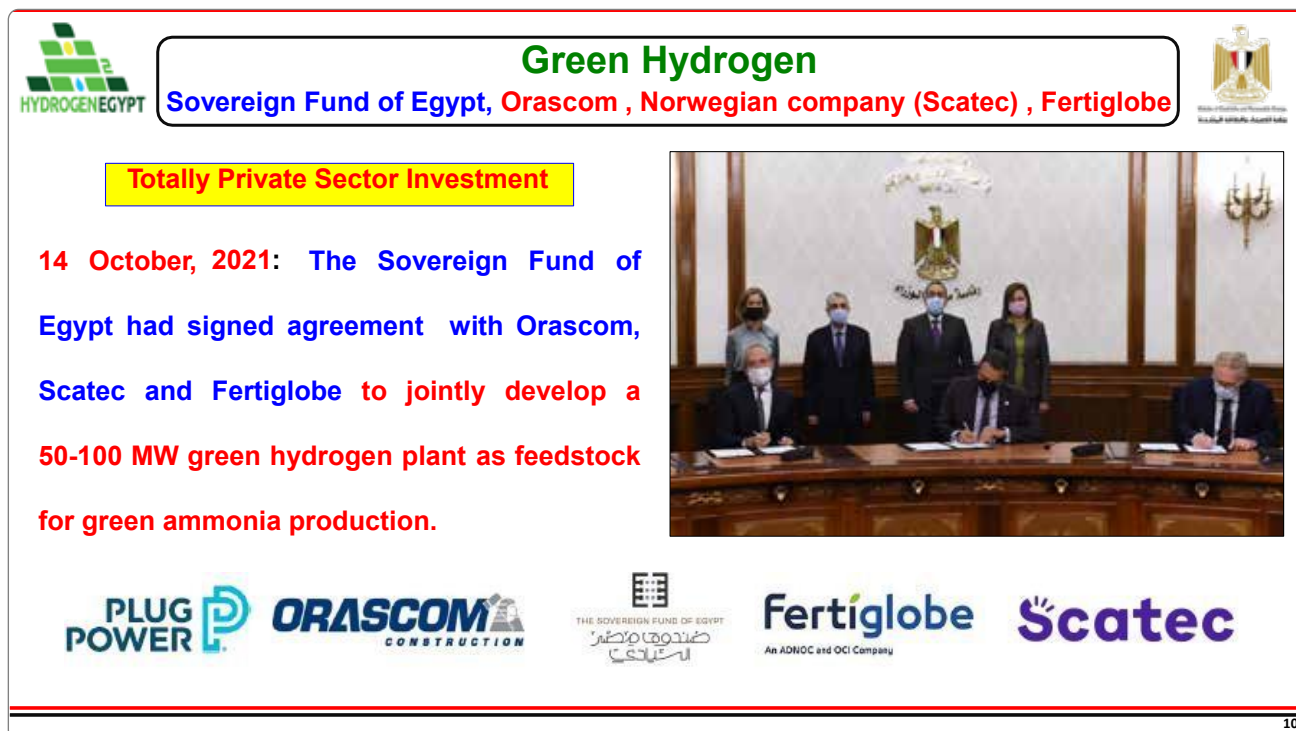
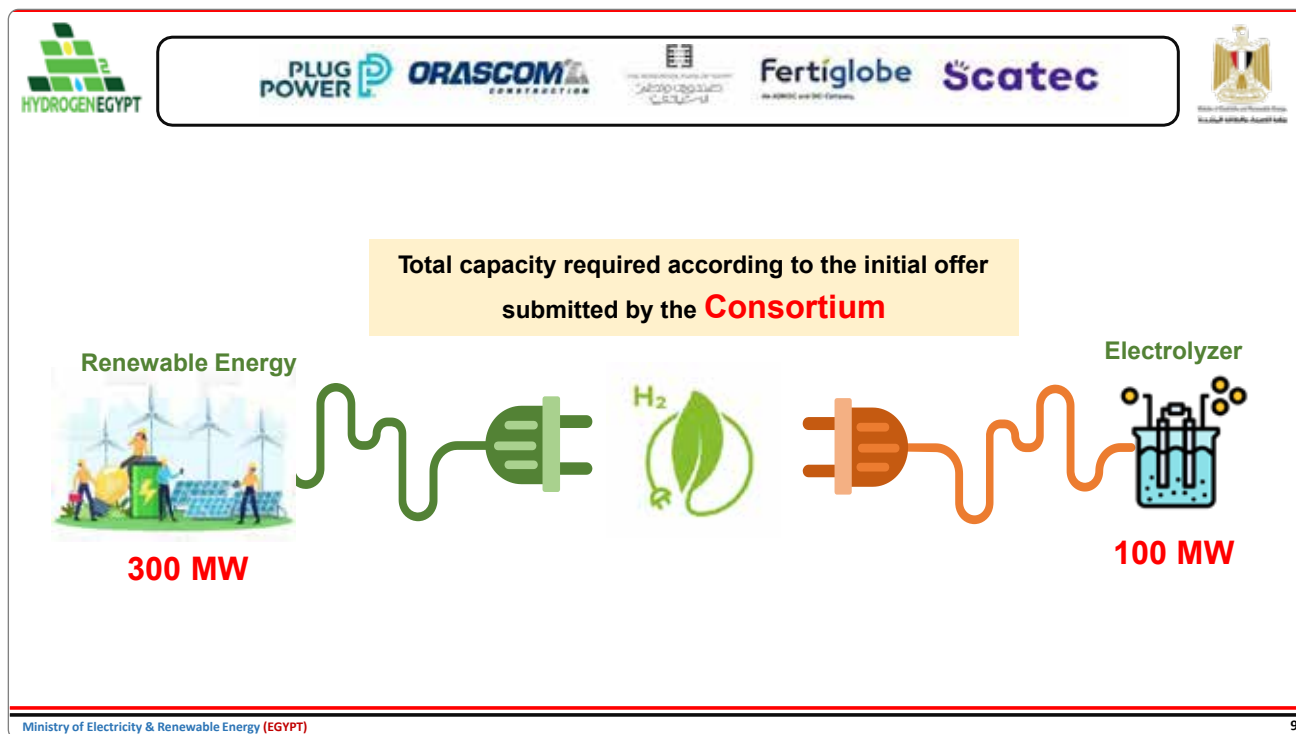
- **Egyptian electricity holding company .**
- **Aboukir ports construction and Management company**
- **Egyptian National gas Holding company.**
- **Belgian Consortium **DEME, FLUXYS, PORT OF ANTWERP****

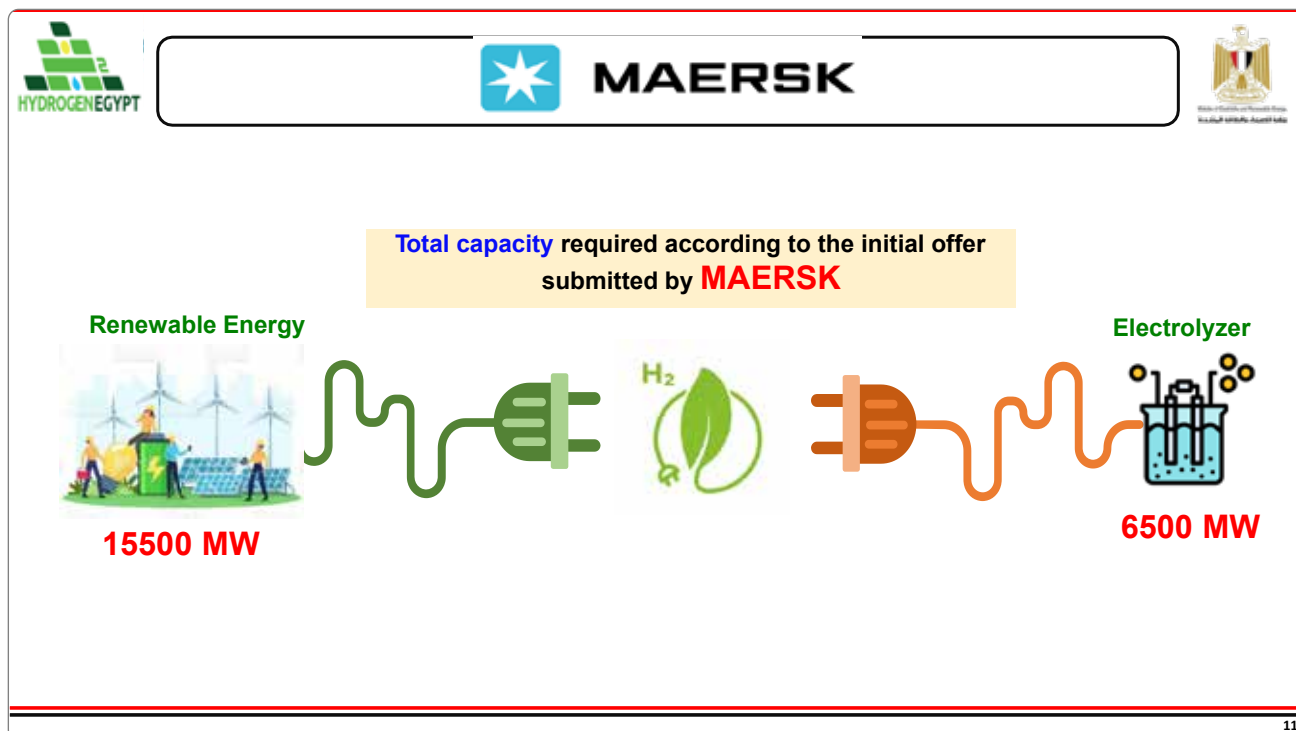
To prepare a feasibility study in different locations in Egypt to establish a green hydrogen production project (HYPOR-EGYPT).

A pilot project with a capacity of 200 megawatts will be launched to produce green hydrogen, after which it will enter the commercial scope.

Ministry of Electricity & Renewable Energy (EGYPT)

8





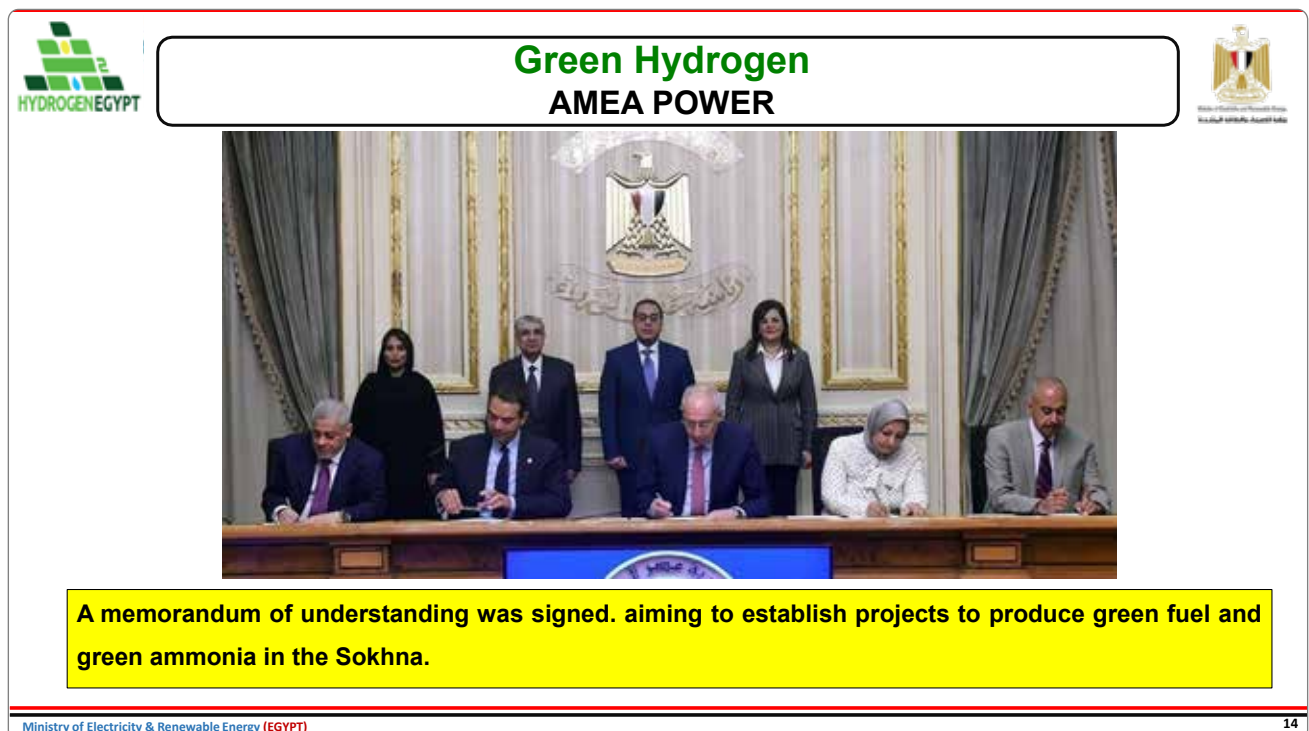
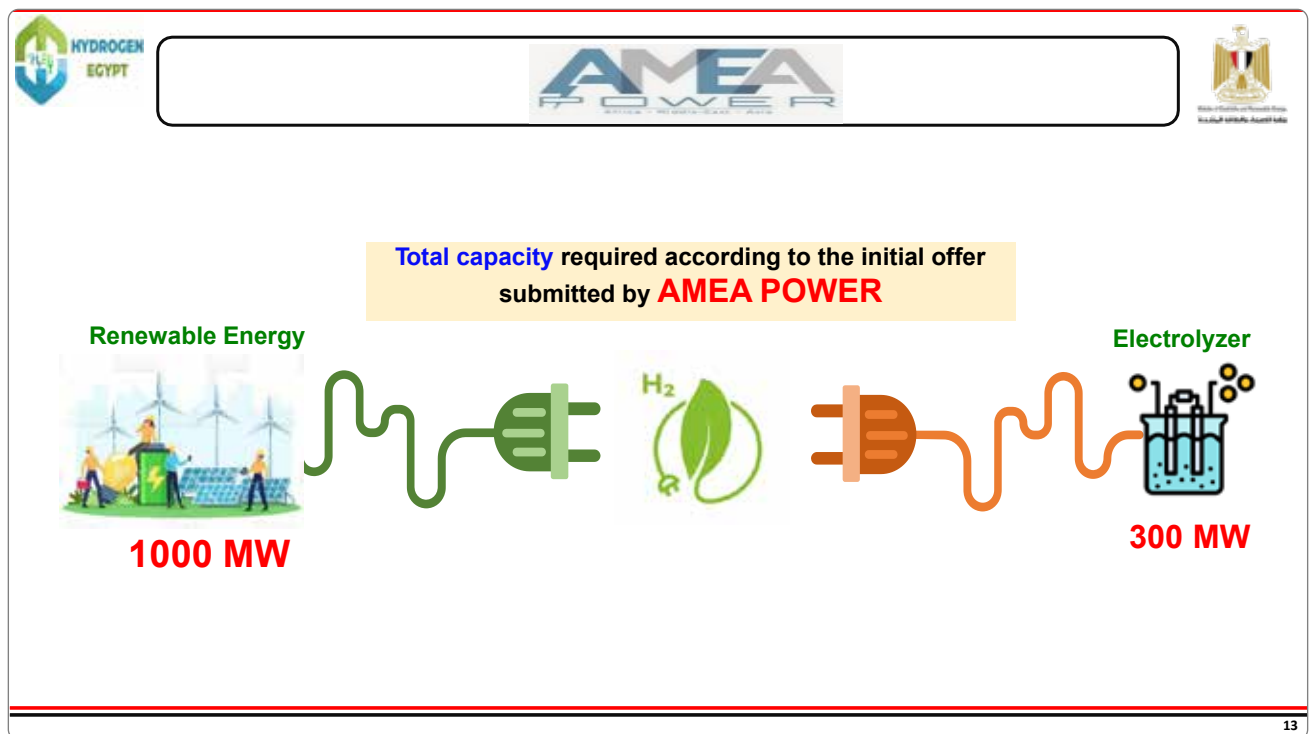
11

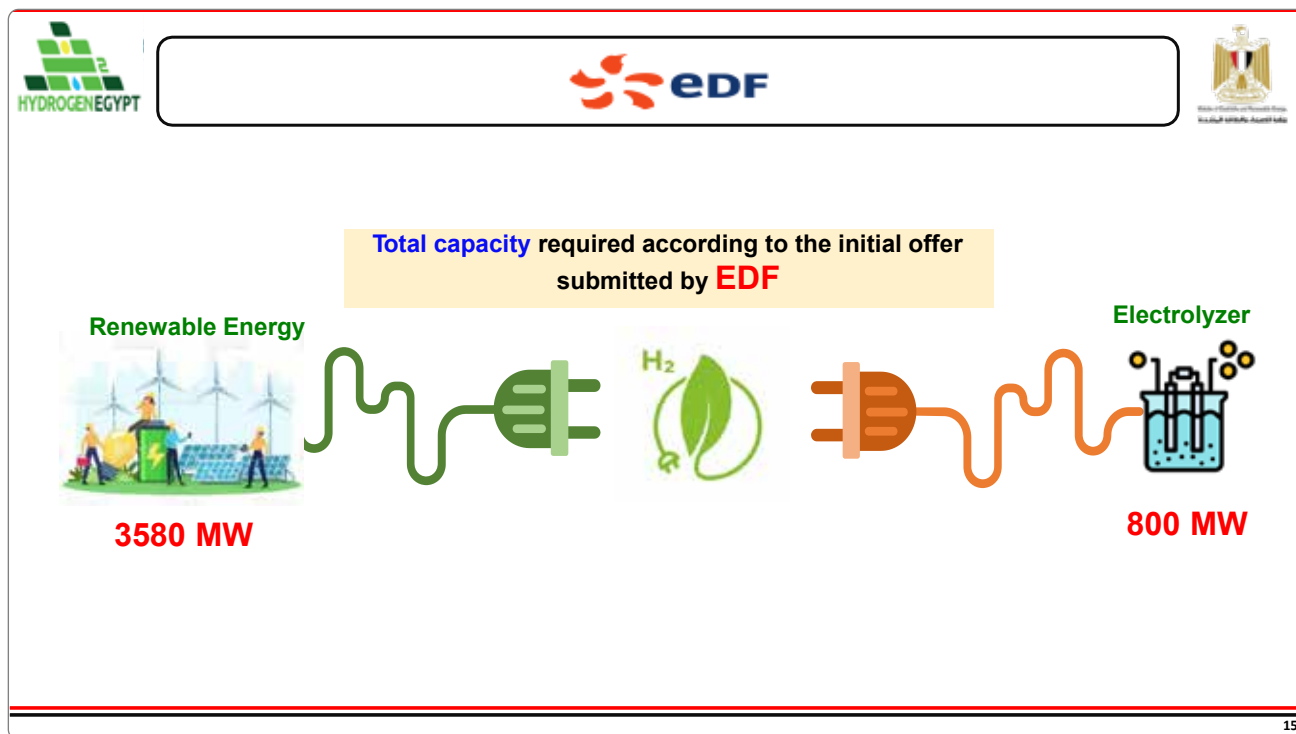
Green Hydrogen
MAERSK

A memorandum of understanding was signed between the General Authority for the Economic Zone of the Suez Canal, the Sovereign Fund of Egypt, the New and Renewable Energy Authority, the Egyptian Electricity Transmission Company, and Maersk International to establish a project to produce green fuel for ship bunkering supplies in the Suez Canal Economic Zone.

Ministry of Electricity & Renewable Energy (EGYPT)

12





BEBA

Green Hydrogen
EDF

An agreement concerns EDF Renewables. The subsidiary of the giant Electricite de France (EDF) intends to collaborate with the General Authority of the Suez Canal Economic Zone (SCZone), the Sovereign Wealth Fund of Egypt (TSFE), the Egyptian Electricity Transmission Company (EETC), the New and Renewable Energy Authority (NREA) and the Zero-Waste Egypt Alliance. The agreement signed in the presence of several members of the Egyptian government aims to produce hydrogen and its derivatives from the port of Ain Soukhna in the Gulf of Suez.

16



Green Hydrogen EDF



Project Description : Project phases and Timelines



Phase 1

- Export agreement for 100% of total production until 2030.
- Paving the way for decarbonization of maritime industry.

Electrolysers: 200 MW
NH₃ prod.: ~600 mt/day
PV: 350 MWdc
Wind: 280 MW
NH₃ storage: 7,000 MT
Operation date: Q1 2025



Phase 2

- Scale up to fulfil the maritime market initial growing demand of green fuel.
- Investment in the bunkering terminal.

Electrolysers: up to 500 MW
NH₃ prod.: ~1,600 mt/day
PV: 650 MWdc
Wind: 400 MW
NH₃ storage: 15,000 MT
Operation date: Q1 2030



Phase 3

- Commercialization of green fuel for ships bunkering.

Electrolysers: up to 1,000 MW
NH₃ prod.: ~3,000 mt/day
PV: 1,100 MWdc
Wind: 800 MW
NH₃ storage: 30,000 MT
Operation date: Q1 2035




CONFIDENTIAL 7

Ministry of Electricity & Renewable Energy (EGYPT)

17








Total capacity required according to the initial offer submitted by the **Consortium**

Renewable Energy

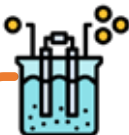


3430 MW





Electrolyzer



2000 MW

18



Green Hydrogen Masdar, Hassan Allam Utilities



- The first MoU was signed between the Suez Canal Economic Zone (SCZone), the Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company (EETC), the New and Renewable Energy Authority (NREA), the UAE's Abu Dhabi Future Energy Company (Masdar), and Hassan Allam Utilities Company
- The second MoU was signed between the Sovereign Fund of Egypt, EETC, the New and Renewable Energy Authority, Masdar, and Hassan Allam Utilities Company

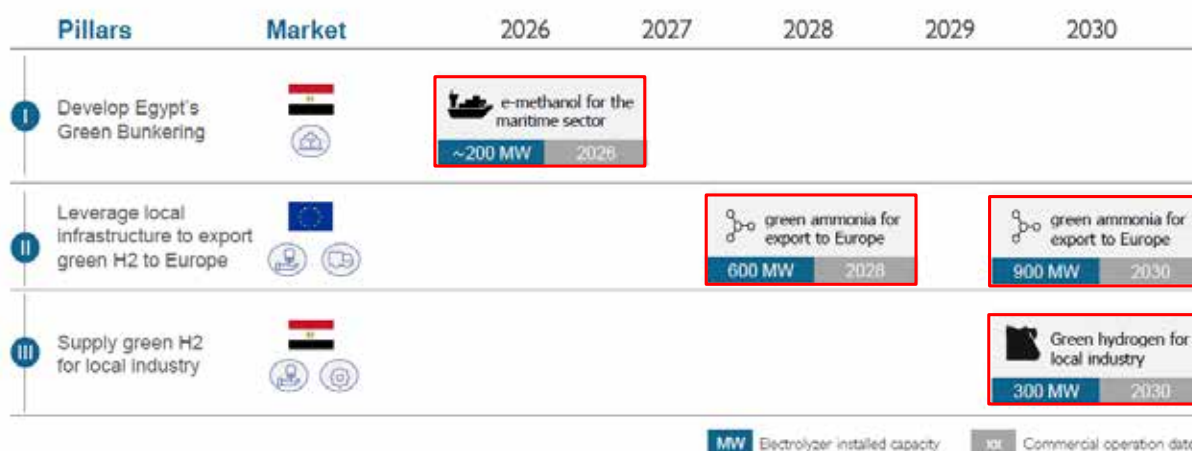
19



Green Hydrogen Masdar, Hassan Allam Utilities



Masdar – HA Utilities proposed Roadmap for 2 GW electrolyser capacity by 2030



20



Green Hydrogen Masdar, Hassan Allam Utilities



The offer submitted by the MASDAR includes the implementation of a 4 gigawatt electrolyzer in the Suez Canal Economic Zone by 2030 and aims to achieve three objectives:

- Supplying ships with green fuel .
- Exporting green ammonia to Europe.
- Providing green ammonia for local industry



Proposed Capacities & Capacities of MOU Renewable Energy & Electrolyser



Available lands for establishment Renewable Energy projects (Wind / Solar)

Ministry of Electricity & Renewable Energy (EGYPT)

25



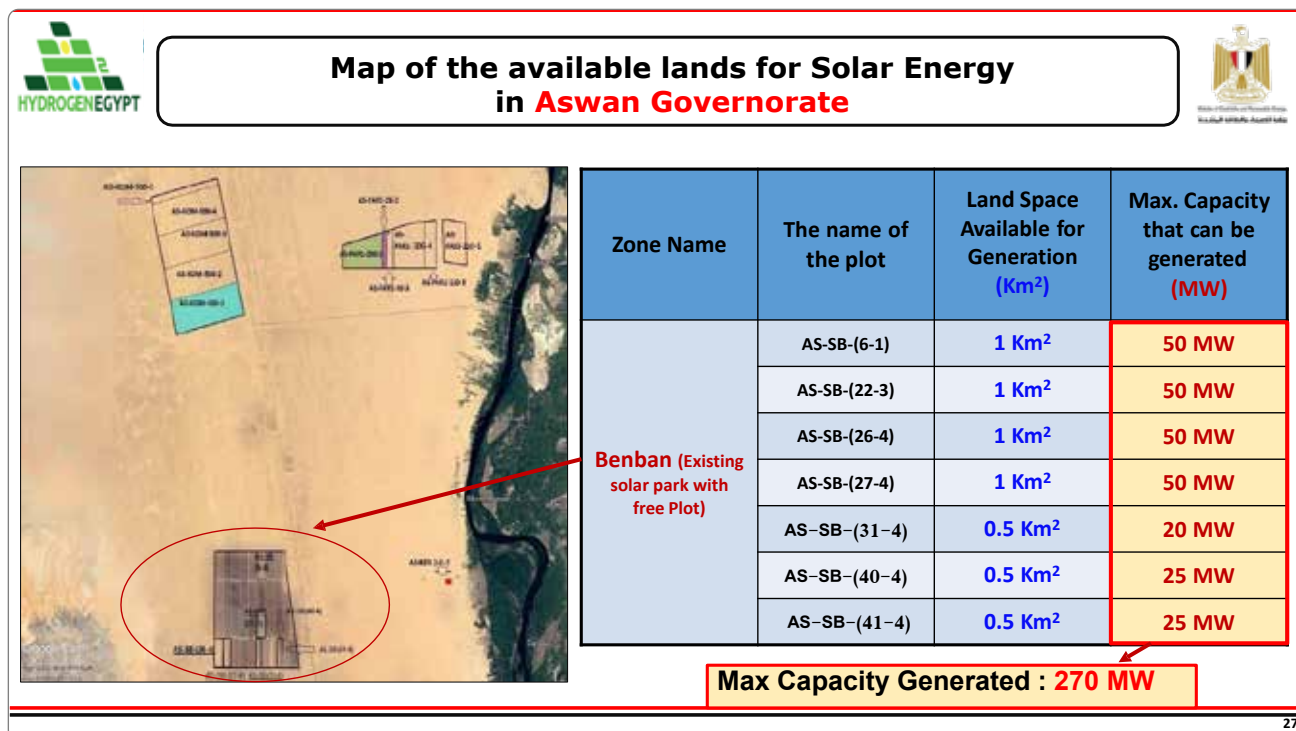
Map of the available lands for Solar Energy in **Aswan Governorate**



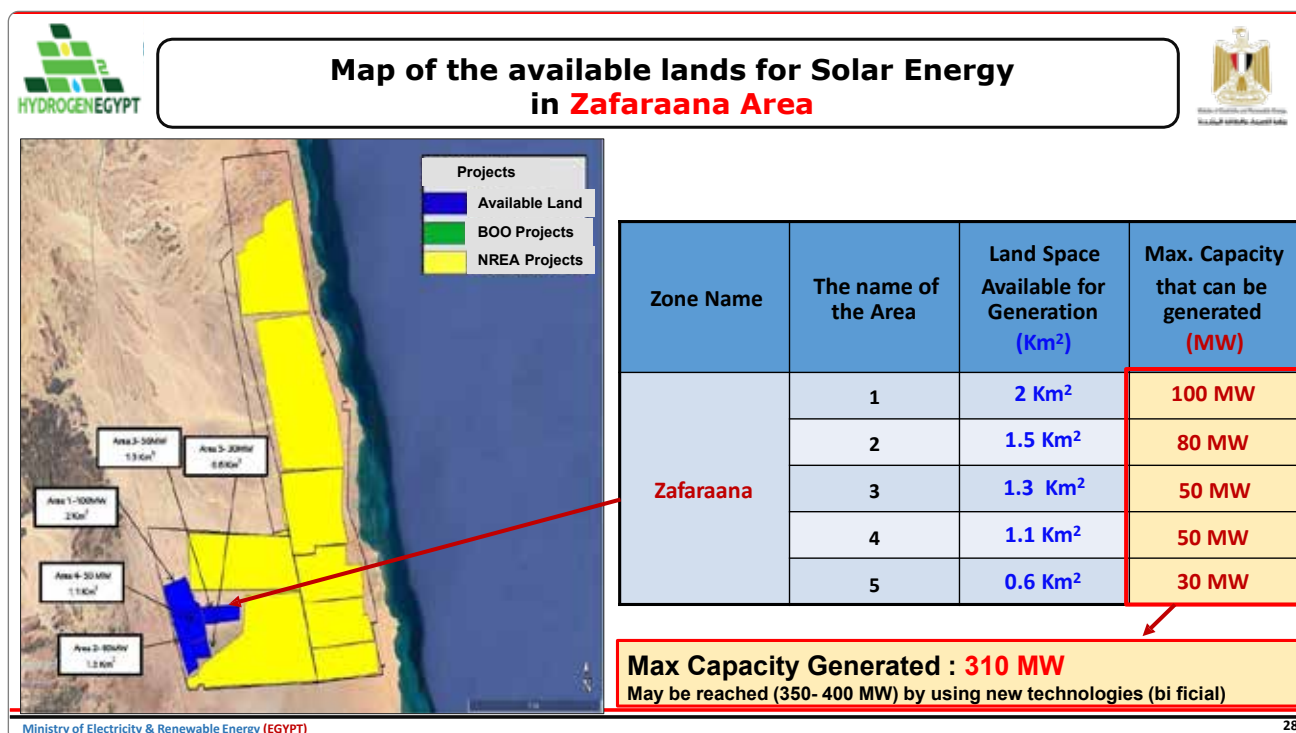
Zone Name	The name of the plot	Land Space Available for Generation (Km ²)	Max. Capacity that can be generated (MW)
Fars 1	AS-FAR1-50-3	1 Km ²	50 MW
	AS-FAR1-300-4	6 Km ²	300 MW
	AS-FAR1-120-5	2.4 Km ²	120 MW
Fars 2	AS-FAR2-210-1	4.2 Km ²	210 MW
Kom Ombo	AS-KOM-500-2	10 Km ²	500 MW
	AS-KOM-500-3	10 Km ²	500 MW
	AS-KOM-500-4	10 Km ²	500 MW
	AS-KOM-100-5	1.9 Km ²	100 MW

Max Capacity Generated : 2280 MW

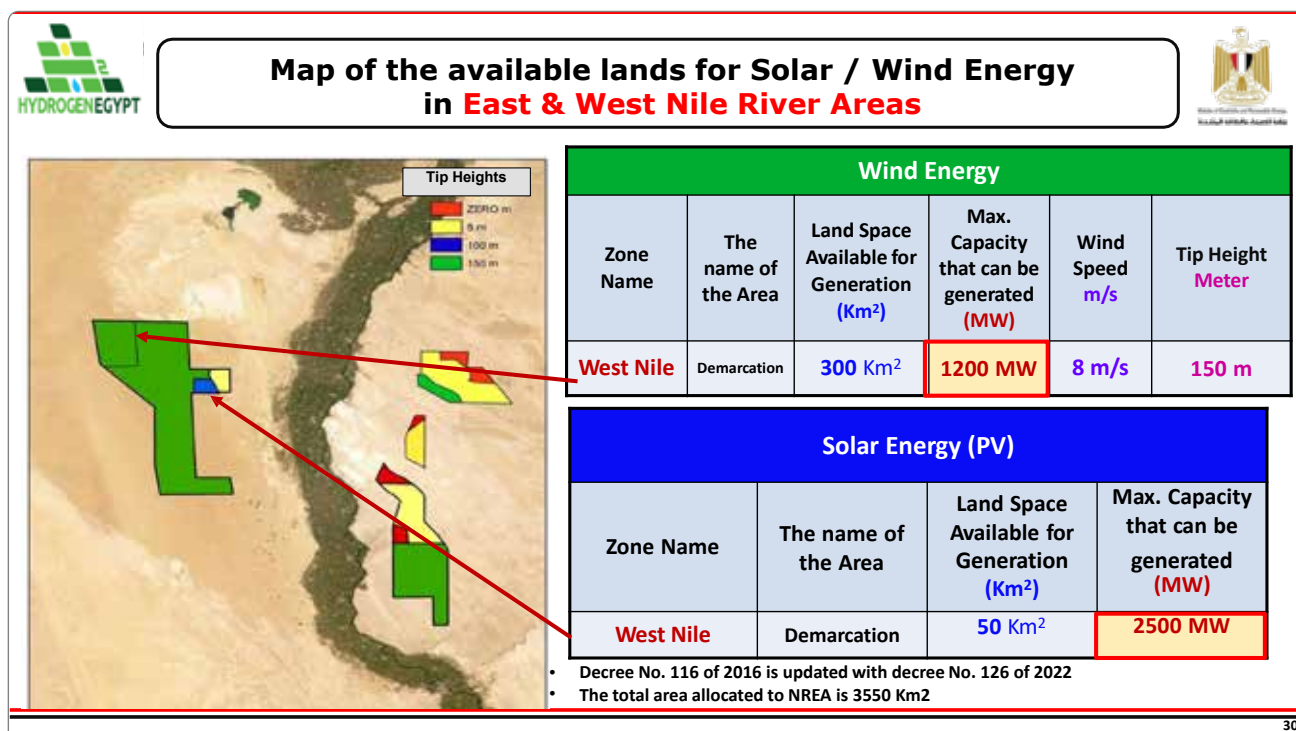
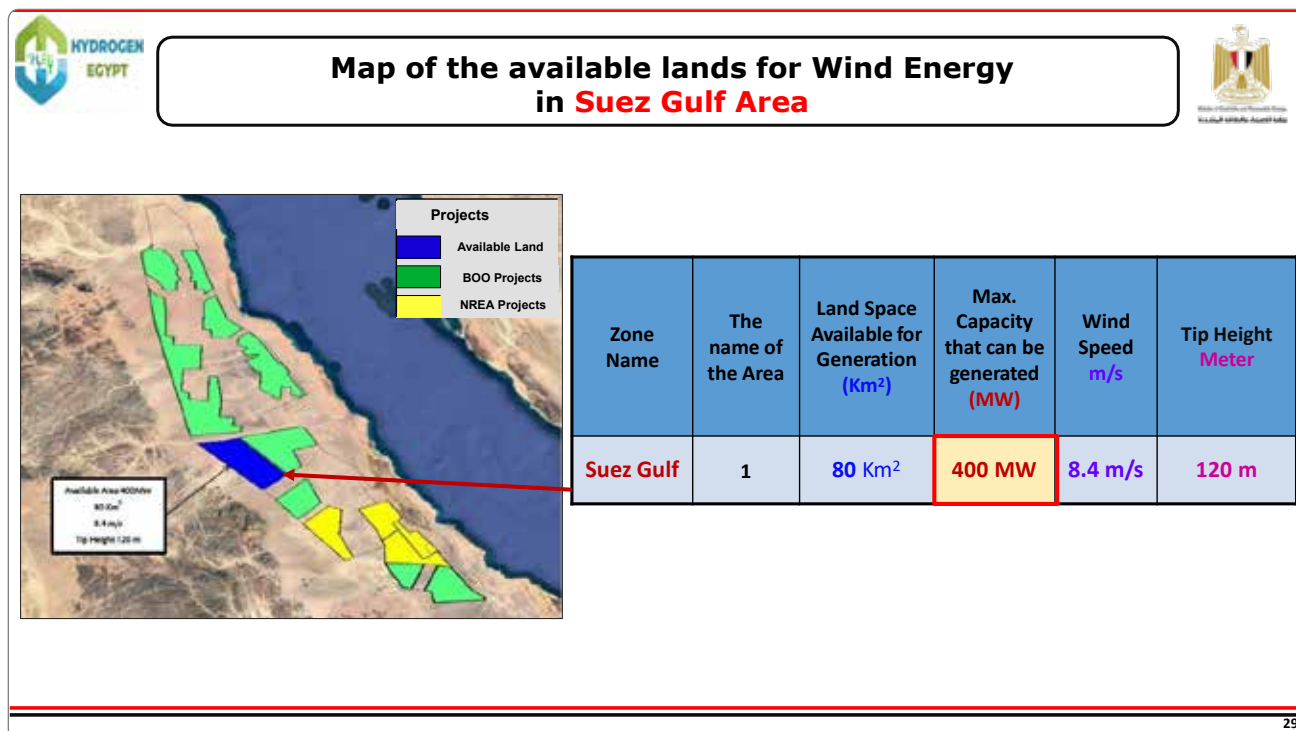
26



27



28





**Available lands for the establishment of projects
to generate electricity from Renewable Energy (Wind / Solar)**



Region	Available Areas (Km ²)			Capacities that could be Generated (MW)		
	Wind Energy Projects (Km ²)	Solar Energy Projects (Km ²)	Total (Km ²)	Wind Energy Projects MW	Solar Energy Projects MW	Total MW
Suez Gulf 9 – 9.5 m/sec	80	-----	80	400	-----	400
West Nile 8 m/sec	1807	66	1923	9035	5800	14835
East Nile 7 – 7.5 m/sec	645	981	1626	3225	49050	52275
Fares 1	-----	7	7	-----	350	350
Fares 2	-----	4	4	-----	200	200
Kom Ombo	-----	32	32	-----	1600	1600
Benban	-----	5.5	5.5	-----	270	270
Zafarana 7 – 7.5 m/sec	-----	6.5	6.5	-----	300	300
Total	2532	1102	3684	12660	57250	70230

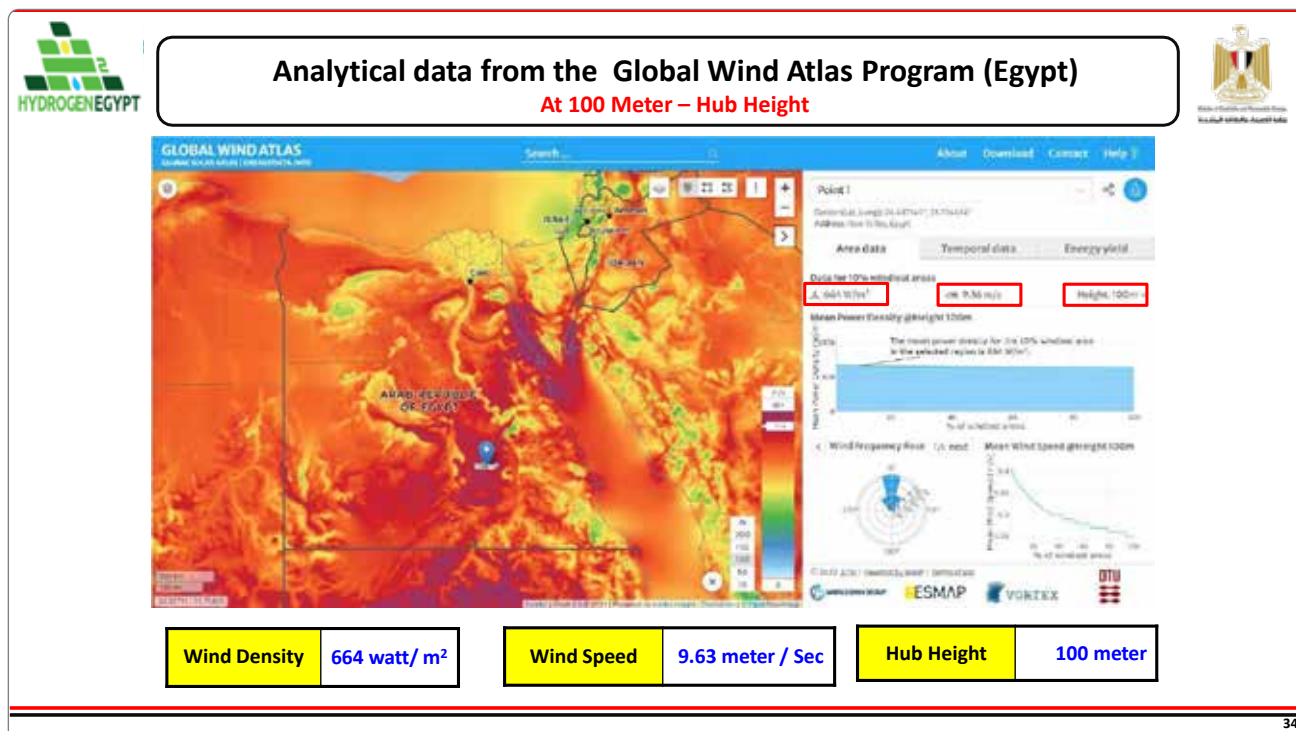
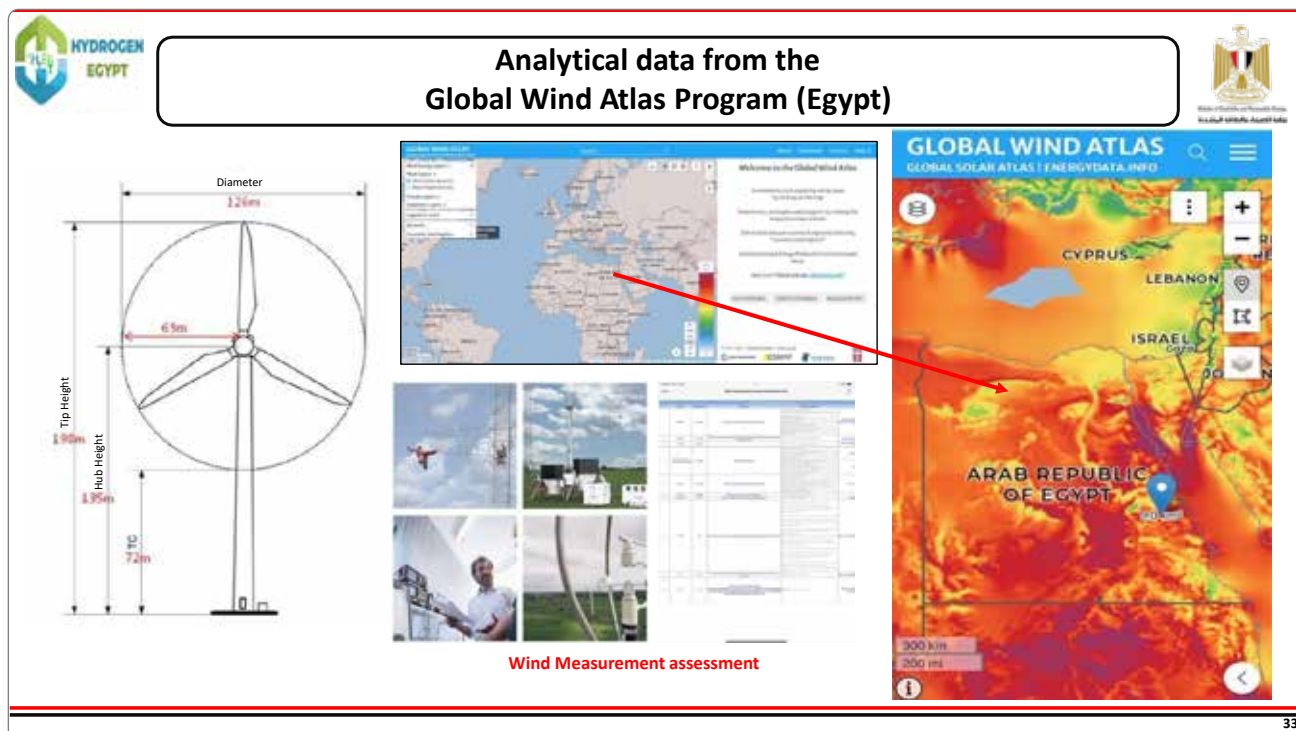
31

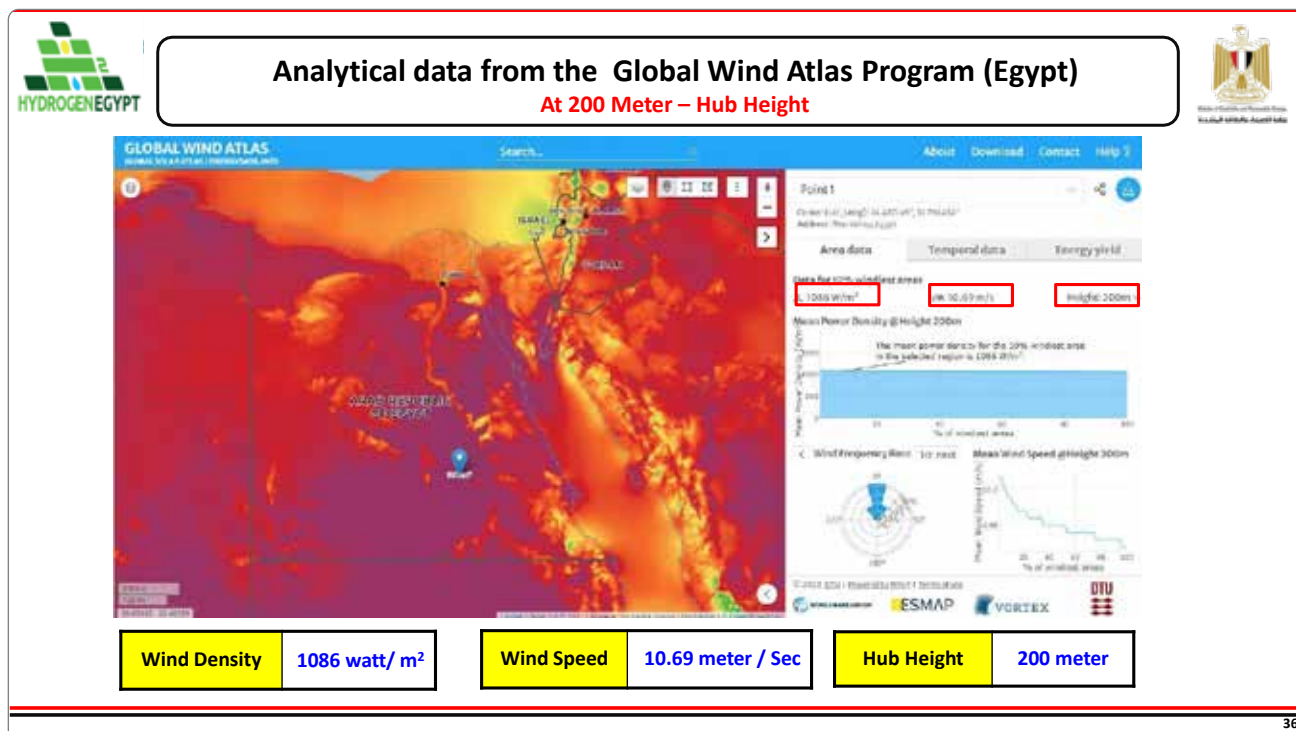
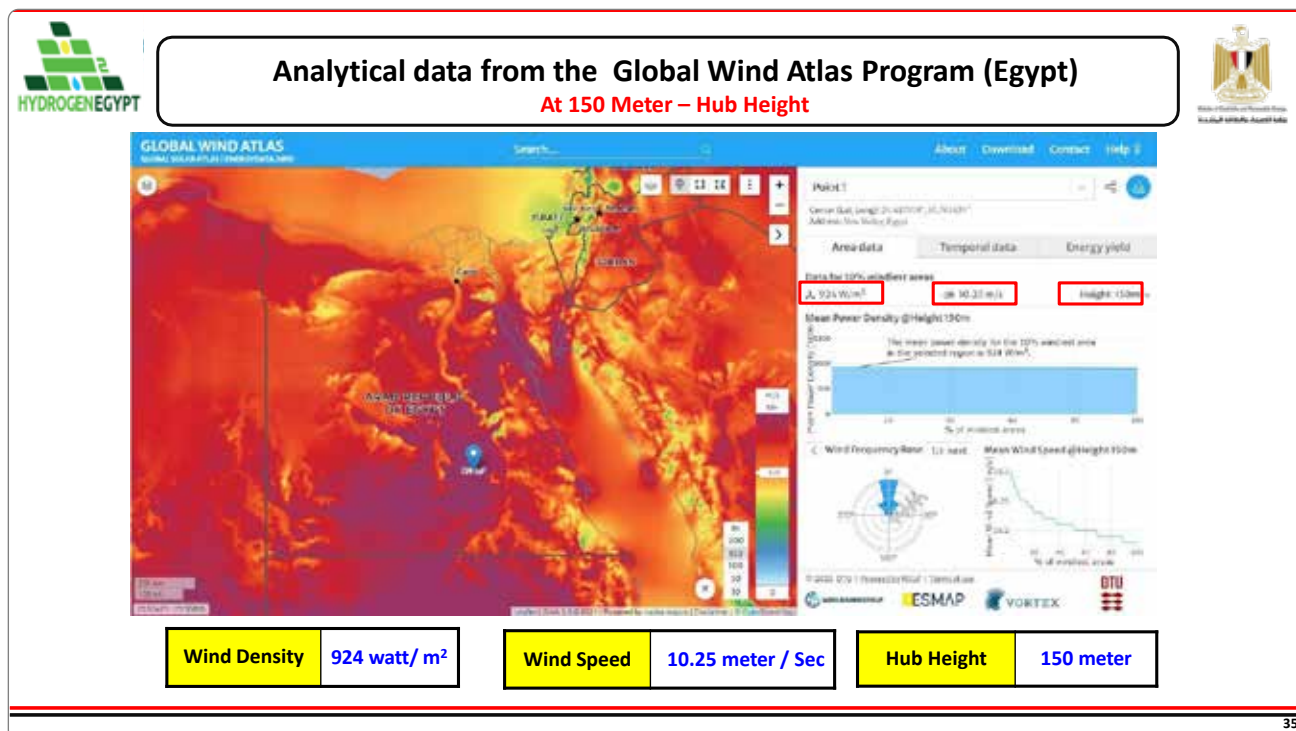



Analytical data from the

Global Wind Atlas Program (Egypt)

32







Preliminary Study for Additional Areas for wind power

37



Preliminary Study for Additional Areas for wind power

Additional Areas for wind power from rang 1 m/sec a 1 m Hub height)					
Zone		Location	Average Wind Speed (m/s)	Potential Area (km2)	Min. expected Wind Capacity (MW)
1	Onshore	West of Minia	8	1807	3614
2	Onshore	East of Minia 1	7.5	555	1110
3	Onshore	East of Minia 2	7.5	90	180
4	Onshore	Gulf of Zayt	11	1190	2380
5	Onshore	Zafarana	10	30	545
6	Onshore	Elkharga 1	8.5	2563	5106
7	Onshore	Elkharga 2	8.5	1730	3460
8	Onshore	Fayoum	7	201	402
9	Onshore	East of Sohag	8	15430	75832
10	Onshore	West of Sohag	8	6700	172948
11	Onshore	West of Nile near Aswan	9.2	37916	13400
12	Onshore	Western desert, South of Wahaat Region	8.5	86474	30860
13	Onshore	East of Suez Gulf, Ras Sedr region	9	1680	3360
14	Onshore	West of Aqaba Gulf, Dahab region	9.5	540	1080
15	Onshore	Berenice	8.8	830	1660
16	Offshore	Inside Suez Gulf, From South of Ain Sokhna to Gulf of Zayt	10.5	4500	9000
17	Offshore	Inside red sea, from Gulf of Zayt to Safaga	9.8	10890	21780
Total				173116	346717

Ministry of Electricity & Renewable Energy (EGYPT)

38



Preliminary Study for Additional Areas for wind power



Additional Areas for wind power from rang 1 m/sec a 1 m Hub height)			
Zone	Location		Average Wind Speed (m/s)
1	Onshore	West of Minia	8
2	Onshore	East of Minia 1	7.5
3	Onshore	East of Minia 2	7.5
4	Onshore	Gulf of Zayt	11
5	Onshore	Zafarana	10
6	Onshore	Elkharga 1	8.5
7	Onshore	Elkharga 2	8.5
8	Onshore	Fayoum	7
9	Onshore	East of Sohag	8
10	Onshore	West of Sohag	8
11	Onshore	West of Nile near Aswan	9.2
12	Onshore	Western desert, South of Wahaat Region	8.5
13	Onshore	East of Suez Gulf, Ras Sedr region	9
14	Onshore	West of Aqaba Gulf, Dahab region	9.5
15	Onshore	Berenice	8.8
16	Offshore	Inside Suez Gulf, From South of Ain Sokhna to Gulf of Zayt	10.5
17	Offshore	Inside red sea, from Gulf of Zayt to Safaga	9.8



- Total Potential Area (km²) : 173 thousand Km²
- Total of Min. expected Wind Capacity (GW) : 347 GW



EGYPT Green Energy Corridor

Due to expansion of Green Projects



EGYPT Green Energy Corridor





EGYPT Green Energy Corridor aims to facilitate integration of large scale Renewables into the Grid to Supply:

- **National Development projects.**
- **Green Hydrogen projects.**
- **Water Desalination Projects.**
- **Interconnection Projects.**

41



ATOMEAXPO 25-26 APRIL 2024







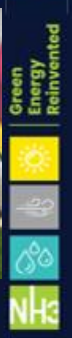


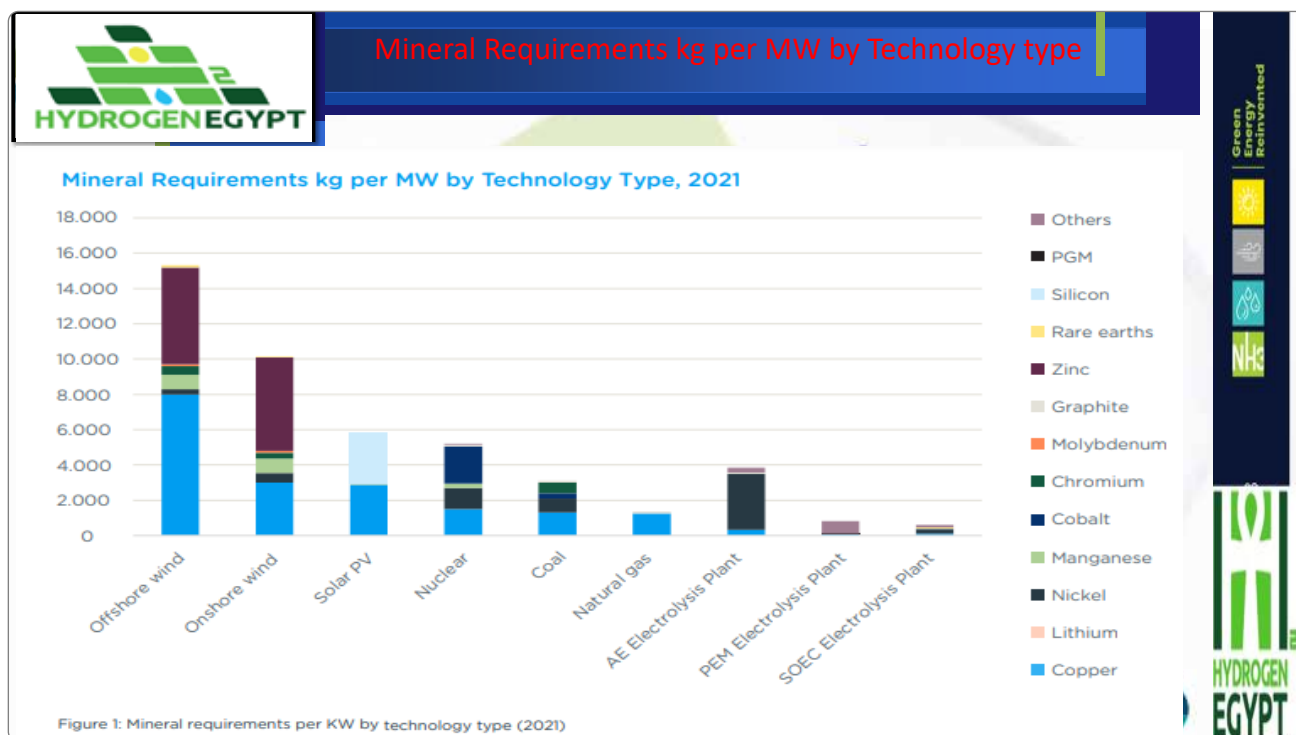
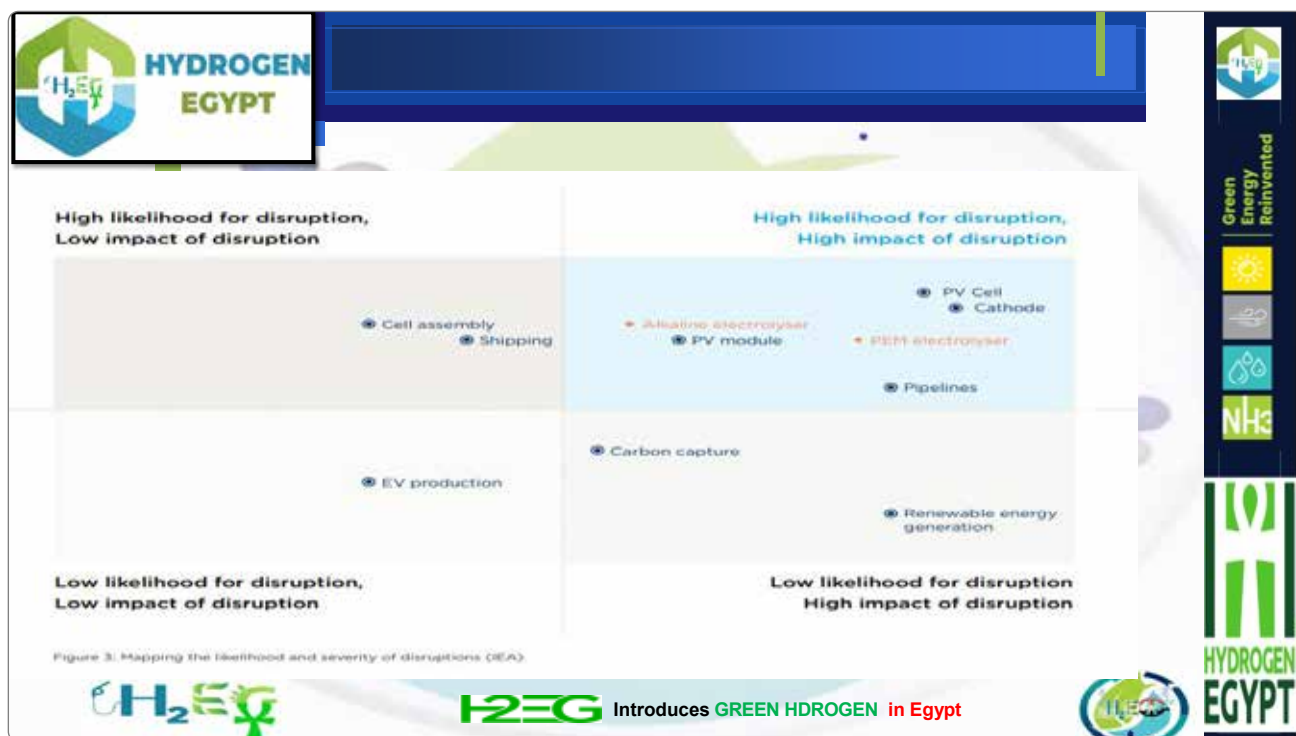


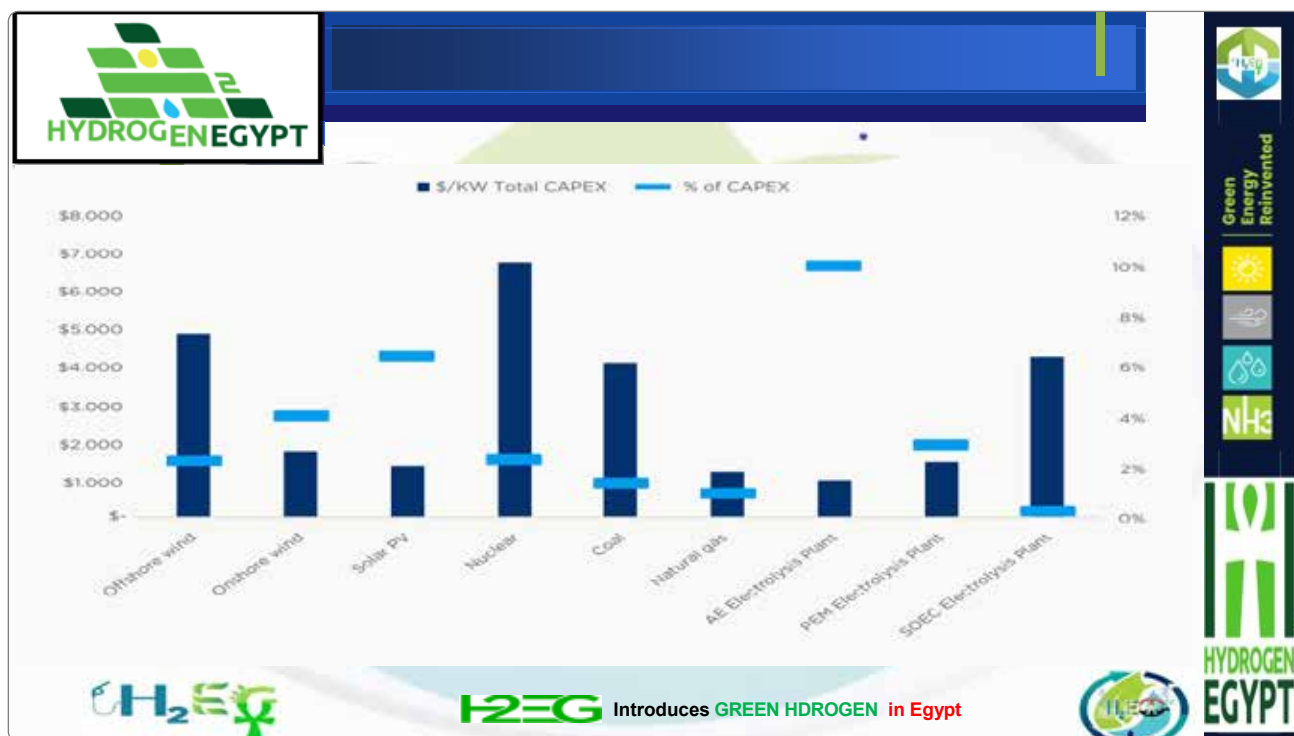

H₂EG Introduces **GREEN HDROGEN** in Egypt



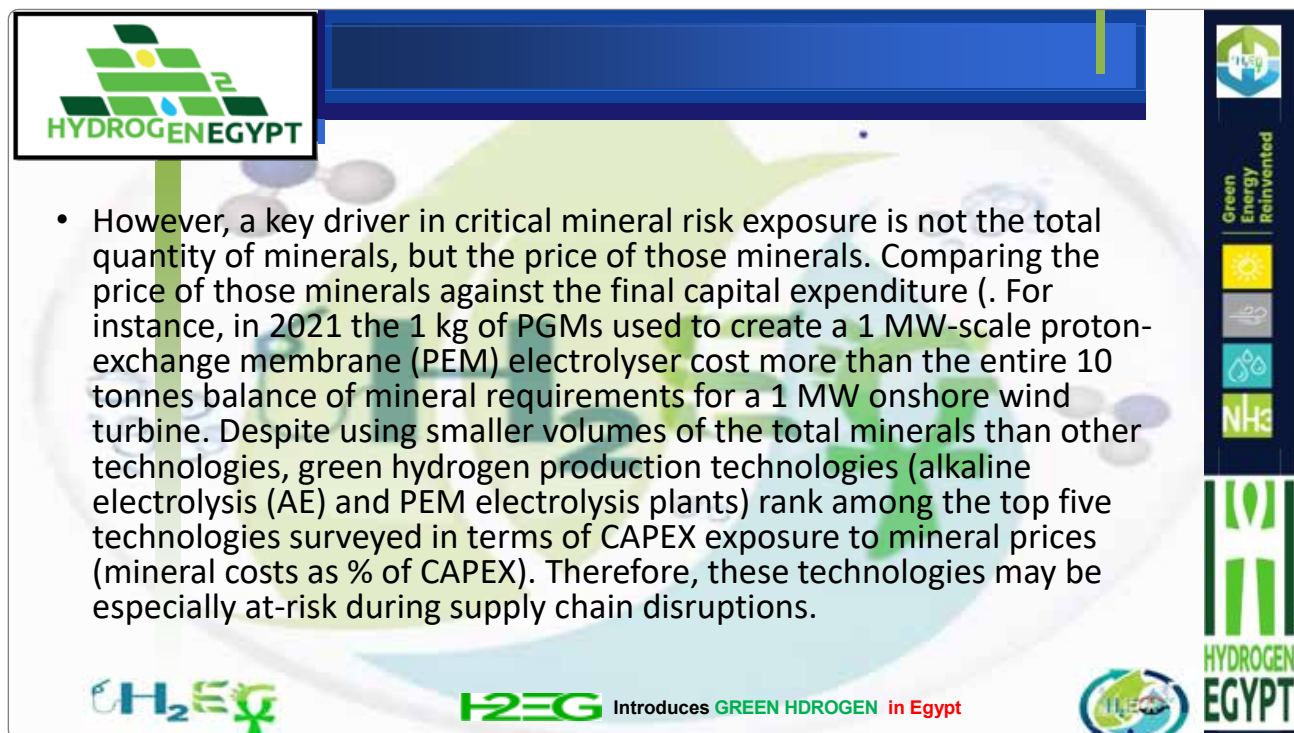
Green Energy Reinvented





- However, a key driver in critical mineral risk exposure is not the total quantity of minerals, but the price of those minerals. Comparing the price of those minerals against the final capital expenditure (CAPEX). For instance, in 2021 the 1 kg of PGMs used to create a 1 MW-scale proton-exchange membrane (PEM) electrolyser cost more than the entire 10 tonnes balance of mineral requirements for a 1 MW onshore wind turbine. Despite using smaller volumes of the total minerals than other technologies, green hydrogen production technologies (alkaline electrolysis (AE) and PEM electrolysis plants) rank among the top five technologies surveyed in terms of CAPEX exposure to mineral prices (mineral costs as % of CAPEX). Therefore, these technologies may be especially at-risk during supply chain disruptions.







Egypt Hydrogen Projects



Egypt Hydrogen Valley of Ra

Hydrogen Egypt H2EG develops hydrogen value chains in a geographic region, based on the needs and opportunities of that region. It is from this vision and experience that Impact Hydrogen sees the opportunity to accelerate hydrogen production for domestic use and export in Egypt. Egypt has wonderful hydrogen opportunities to turn the industrial area around the Suez Canal into the first Hydrogen Valley in the Middle East and North Africa. This region could become the world's "Central green hydrogen corridor". A green hydrogen zone that covers more than just the Suez Canal and the economic zone, but also contributes to further regional development. A green hydrogen zone that offer more than hydrogen projects and unlocks a prosperous future for Egypt.

Hydrogen export opportunities.
Several European countries are looking for hydrogen import opportunities and a lot of ports are working on the development of global strategic locations where the low-emission ships of the future can transport green hydrogen, or its derivatives, all over the world. The routes through which these ships pass are called green shipping corridors. Examples are the Port of Rotterdam, Shanghai and Los Angeles. Based on its strategic location, it is to be expected that the Suez Canal will become such a corridor. Developing a Hydrogen Valley will help enable Egypt to claim this unique position.

Development opportunities
Egypt wants to play an important role in the hydrogen economy but to reach 2030 goals, acceleration is needed. By organizing value chains and unlock investments, hydrogen can contribute to socio-economic development if it's used to decarbonise industry and mobility, to contribute to agricultural development, and to a new energy system. This will create more jobs and prosperity and as such, contribute to the Sustainable Development Goals.
Hydrogen Egypt offer to organize a Hydrogen Valley called *Valley of Ra*: by organising the enabling ecosystem and developing the blueprint for the economic and sustainable regional impact. It will be a new cluster of hydrogen projects with a complete supply chain from Cairo to Alexandria.



H2EG Introduces **GREEN HDROGEN** in Egypt



Green
Energy
Reinventd














Egypt Hydrogen Projects



Egypt Hydrogen Valley of Ra

2-1 Valley of RA
With hydrogen we can end the Anthropocene and begin a new era that can be called the Cyclocene.

 Sun, wind and hydrogen are the essential elements of this development. We will therefore meet the Egyptian Sun God RA often in the near future. [#ValleyofRa](#) Let's build together the Valley of Ra. 

  this complete value supply Chain 

  **TOP** Congratulations to the launch of our Valley of Ra at our HES 2023 **the new cluster of hydrogen projects, let's build it together with local use of small scale production applications, let's build the hydrogen village.** FYI We have arranged our first Hydrogen summit HES2023 in Egypt last September 2023 and we are looking forward to your participation at the upcoming version of HES2024 and our Hydrogen Egypt Congress HEC the Mediterranean Forum that will take place next November 2024 grouping all Med ports all over the world to discuss CBAM, offtake, export, transport, mobility, etc. fantastic lineup which is proof of a strong Cooperation between Egypt  and the EU  our next Summit will be tackling the local Hydrogen demand off-takers, due to CBAM and lack of gas, there's a surge in green H2. This whole eco system will be at our conference, in addition to presence of H2 mobility, marine +++ companies, South global ports (Sud Sud). Let's scaling up the hydrogen cooperation in the Mediterranean. covering Hydrogen geopolitics, policies, regulations, demand, supply, infrastructure, shipping, finance, EPC, technology, small scale local applications, **hydrogen village and hydrogen valley #hydrogen #africansolutionstoaficanproblems**



H2EG Introduces **GREEN HDROGEN** in Egypt



Green
Energy
Reinventd














Egypt Hydrogen Valley of Ra



2. Hydrogen Valley of Ra

The Hydrogen Valley concept is internationally embraced as a solution to the "chicken and egg" problem for hydrogen: large scale production needs guaranteed off take and large off takers will only convert their business to green hydrogen if supply is guaranteed.

Organizing the hydrogen value chain in one region, integrally, and with an ecosystem of relevant stakeholders, ensure a match between demand supply, and the enabling environment. Impact Hydrogen provides the vision, the models, the know-how, as well as the project coordination that is required to orchestrate the development and operation of such Hydrogen Valleys.

And we take it one step further: the Hydrogen Valley is tailored to regional opportunities and needs, engaging local stakeholders, and contributing to the UN Sustainable Development Goals. This way, the Hydrogen Valleys create value for all stakeholders across the value chain and the wider socio-economic system in the region.

In Egypt, this means the Hydrogen Valley of Ra can play a major role in the development of Hydrogen in Egypt. Supported by EU Clean Hydrogen Partnership, the Hydrogen Valley of Ra can play a leading role in accelerating hydrogen production and export.



3. Hydrogen for domestic use and export

The Hydrogen Valley of Ra can be developed as a Hydrogen Valley with supply to various end sectors in Egypt and in the EU.

As such, we make a roadmap for the region: map existing and potential green hydrogen initiatives and plans and the growth potential for the region and investigate what the socio-economic and environmental needs are. In this way the transformation to green hydrogen can secure, and adapt to, a region's core business.

We also connect green hydrogen plans in Egypt to users of green hydrogen in the EU: this unlocks funding.

We do this together with local stakeholders: companies in the value chain (including SME), knowledge institutes, civil society and national and local governments.

In co-creation we develop a *Hydrogen Valley Roadmap* including skills needed.

The Hydrogen Valley approach combines not only projects, knowledge and opportunities, but also makes a region investor-ready and attracts new business and jobs.

To let this contribute to economic development, we skill people with the Hydrogen Learning Platform



Green
Energy
Reinvent

HYDROGEN
EGYPT

Egypt Hydrogen Valley of Ra



4. Our approach to develop the Hydrogen Valley of Ra
Hydrogen Egypt has developed a model for the development of Hydrogen Valleys, consisting of four phases. In the initiation phase, Impact Hydrogen works with the initiator, which could be a company or a government, on bringing together interested partners and defining the preliminary goals for the Hydrogen Valley. In the next phase, a multidimensional assessment is carried out to map the technical and market context of the value chain, the enabling environment such as the policy framework, investment climate, labour market and availability of required knowledge and education centres. This phase is concluded with a roadmap.

In the third phase, the business case is worked out in detail, and scoping decisions are made for the different streams of hydrogen within the Valley. Based on this, the final project plan is designed, and then implemented in the final phase: the engineering and building phase. Communication, long term goals and short-term visibility our part of our work.

Regional impact and trade



Central to our approach is the active involvement of local stakeholders, including local SMEs and knowledge institutes, in the analysis and design around how the new hydrogen economy can contribute to local prosperity and socio-economic development. This means that in addition to hydrogen export, opportunities for local use of renewable energy and hydrogen are integrated in the design, resulting in stable trade relationships with mutual benefits.

Project development
We can lead by providing knowledge, capacity, partnerships and quality control to implement the model. We do this in collaboration with our partners, including knowledge institutes, human capital agencies and our global network of hydrogen value chain partners.



Introduces GREEN HDROGEN in Egypt



HYDROGEN
EGYPT

Green
Energy
Reinvent



Egypt Hydrogen Projects



Egypt is actively Performing as part of Global Community related climate change , and Green Energy transaction for best approach of low imitations , and/or de-carbonization.

Additionally, power availability , in correlation with economy , is a vital concern to comply with several international regulations , and agreements , aiming de-carbonization , and lowering imitations.

Agriculture , Transportation , and other aspects are main ranges to contribute Hydrogen as a green , clean source of power to approach all those global activities and coop-up aimed progress.

2- Projects on demand to currently Focus on :

2.1 Agriculture , and Farming

2.2 Motorized vehicles upgrade

- We recently received several inquiries about various types , and scales of Hydrogen projects demands ,
- However , our deep technical , economical vision that most feasible applicability , go for those 2 types of Demands , which will be described in terms of inquires headlines , and our proposed solution to work on.





Introduces GREEN HDROGEN in Egypt



Green Energy Reinvented





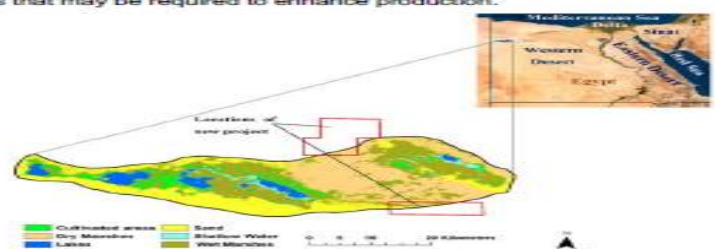
Egypt Hydrogen Projects



2.1 Hydrogen For Agriculture , and Farming :

2.1.a. Abstract:

- 2015 , Egyptian government initiated a development project in to reclaim 1.5 million acres with primary goal to increasing agricultural production.
- Siwa is one of these areas in Western Desert of Egypt, with 30,000 acres using groundwater from the Nubian Sandstone Aquifer System (NSAS).
- investigate studies planned that government goals are achievable in the next 20 years to secure food and water needs of the Siwa region.
- Results show that total required crop areas are 7154 and 6629 acres in winter and summer, respectively.
- These areas are less than 17,010 acres of available area for cultivation (Av). The estimated total water use is 40.6 million cubic meters (MCM), which is less than the 88 MCM that is considered available groundwater in the Nubian Aquifer System (NAS).
- Due to available capacity in Siwa, an optimization model is used to maximize crop production considering government policies.
- The Autoregressive Integrated Moving Average (ARIMA) model was applied to predict production costs and sell prices of cultivated crops.
- Analysis included deferent scenarios beyond government-recommended approaches to identify ways to further expand agriculture production under sustainable conditions.
- Results provide valuable insights to the ability to achieve government goals from the project and changes that may be required to enhance production.







Introduces GREEN HDROGEN in Egypt



Green Energy Reinvented





Egypt Hydrogen Projects



2.1.b. Project's Area Description :

- Siwa region is located in the northwest of Western Desert in Egypt.
- Natural depression area of 0.28 million acres and an example of a closed basin where groundwater is the only source of water.
- Climate is arid to semiarid, where average annual rainfall is 13 mm and evaporation ranges from 5.2 to 17 mm/day
- climatic Tabulation is shown for the proposed project in Siwa, which are away from the salty lakes and marshes.
- determined the groundwater potential from both aquifers in Siwa has been reported that, to ensure sustainability for the next 100 years, annual groundwater withdrawal should not exceed 60 and 88 million cubic meters (MCM) respectively, where these values are small compared to the available groundwater in storage.
- **Important to notice Monthly Sunshine hours , where Solar power Systems are commonly used, and will be vital Power source for Hydrogen Utilization .**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Record high °C (°F)	29.3 (84.7)	34.6 (94.3)	41.5 (106.9)	44.9 (112.6)	48.0 (118.4)	48.2 (118.8)	45.2 (113.4)	42.2 (108.0)	42.3 (108.1)	41.9 (107.4)	37.5 (99.5)	29.0 (84.2)
Mean daily maximum °C (°F)	19.3 (66.7)	21.5 (70.7)	24.5 (76.1)	29.9 (85.8)	34.0 (93.2)	37.5 (99.5)	37.0 (98.6)	34.6 (94.3)	30.5 (86.9)	25.0 (77.0)	20.5 (68.9)	
Daily mean °C (°F)	12.1 (53.8)	14.0 (57.2)	17.3 (63.1)	21.9 (71.4)	26.8 (79.4)	29.2 (84.6)	29.9 (85.8)	29.4 (84.9)	27.1 (80.8)	22.8 (73.0)	17.3 (63.1)	13.2 (55.8)
Mean daily minimum °C (°F)	5.6 (42.1)	7.1 (44.8)	10.1 (50.2)	13.7 (56.7)	17.8 (64.0)	20.4 (68.7)	21.7 (71.1)	21.4 (70.5)	19.5 (67.1)	15.5 (59.9)	10.2 (50.4)	8.5 (47.3)
Record low °C (°F)	-2.2 (28.0)	-1.3 (29.7)	0.3 (32.5)	5.7 (42.3)	7.5 (45.5)	14.0 (57.2)	17.5 (63.5)	15.9 (60.6)	11.7 (53.1)	7.8 (46.0)	2.9 (37.2)	-0.7 (30.7)
Average precipitation mm (inches)	2 (0.1)	1 (0.0)	2 (0.1)	1 (0.0)	1 (0.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0.1)	1 (0.0)
Average precipitation days (≥ 1.0 mm)	0.3	0.1	0.1	0.2	0	0	0	0	0	0	0.1	0.2
Average relative humidity (%)	56	50	46	38	34	33	37	41	44	50	56	59
Average dew point °C (°F)	2.8 (37.0)	2.7 (36.9)	4.7 (40.5)	6.5 (41.9)	7.5 (45.5)	9.8 (49.6)	12.5 (54.5)	13.5 (56.3)	13.2 (55.8)	11.5 (52.7)	7.7 (45.9)	4.4 (39.9)
Mean monthly sunshine hours	230.7	248.4	270.3	289.2	318.8	338.4	353.5	363.0	315.6	294.0	265.5	252.8





Introduces GREEN HDROGEN in Egypt



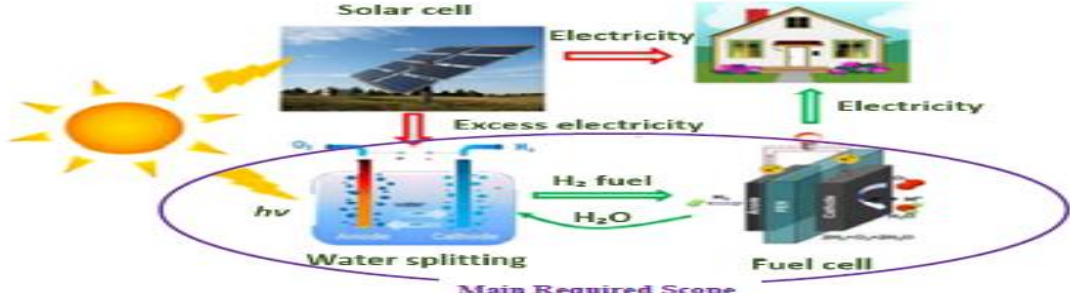


Egypt Hydrogen Projects



2.1.c. Project's Demand / inquiry Agriculture , & Farming :

- Group of farms on Siwa region is located in the northwest of Western Desert in Egypt.
- Farms owners are using solar panels to get electrical power , as they are not connected to local electricity network.
- According to their description , they are in full dark up-on reaching sun set , and they are **looking for 24/7 power availability , by using Hydrogen** .
- Generated power , will be mainly for Pumps operation to get underground water for irrigation , as well daily domestic use and any else aims would be reached .
- Owners, focus on Hydrogen , with availability of solar power permanently , regarding it will be more economical , if compared to costs of getting connected to local network , and also power / fuel costs for future.
- *Other farming & agriculture complexes are available all over Egypt , and such type of demand is a mass production business model , to be utilized successfully .*



Main Required Scope





Introduces GREEN HDROGEN in Egypt





Egypt Hydrogen Projects



2.1.d. Main Scope required :

- The scope required , will focus on Hydrogen Generation , which is mainly Electrolysis with convenient limited sizing to operate machinery related to farming use.
- Main purposes will be pumps operation for irrigation , Limited generator for lighting , domestic use (Cooking , Airconditioning , ...etc.,)
- Generated Hydrogen , is to be 24/7 sustainable to operate & fulfill demands.
- System would be either for each farm use , and/or as central generator serves several farms.
- Therefore :
Design options to be considered for sustainability & economical considerations as follows :

Option 1 :

Hydrogen is continuously generated through Electrolysis & injected directly as H₂ Fuel for a convenient sized Generator

Considering :

- Solar power Storage system to maintain operation after sunset
- Ground Water , must be subjected to necessary filtration to guarantee compliance to electrolysis safety & efficient functioning.
- Suitable adjustments for Domestic devices (Oven , boilers , ...etc.,)

Engineering will be include recommendations for relevant issues related to system , while details will focus on Electrolyzes & Hydrogen processioning

Option 2 :

Hydrogen generated through Electrolysis & Stored within most applicable technique into limited tank(s) , then to be circulated as H₂ Fuel for a convenient sized Generator

Considering :

- Solar power Storage system to maintain operation after sunset
- Ground Water , must be subjected to necessary filtration to guarantee compliance to electrolysis safety & efficient functioning.
- Suitable adjustments for Domestic devices (Oven , boilers , ...etc.,)

Engineering will be include recommendations for relevant issues related to system , while details will focus on Electrolyzes & Hydrogen processioning

Economic feasibility will be vitally needed




Introduces GREEN HDROGEN in Egypt




Green Energy Reinvented






Egypt Hydrogen Projects



2.2 Motorized vehicles upgrade :

2.2.1. Project's Demand / inquiry

- Main scope required is to develop the most convenient dual injection System using Hydrogen injection for vehicles with old Motors / engines
- Dual injection Engine (Hydrogen / Fuel) will be widely used for various scopes of vehicles (cars , Buses , Trucks , earthworks equipment , Cranes ...etc.,)
- Also Same Demand will be for Marine units (Tugboats , OSV, Ferry boats , ...)
- Engines subjected to such upgrade , will not imply any liability , as it is no longer in warranty by manufactures







Introduces GREEN HDROGEN in Egypt




Green Energy Reinvented






Hydrogen test for an old diesel engine



Our Hydrogen demo/test for an old diesel engine

Our report
approved
by Alexandria
University

Figure (5) improvement of exhaust emissions during idle with hydrogen

4- The emission rate improved with the use of hydrogen by 100% and the prevention of carbon monoxide, carbon dioxide, and sulfur dioxide. Figure (5)



Figure (5) percentage of CO2 emissions during diesel fuel.

Figure (2) instrumentation device

The engine was run on diesel fuel first, and environmental readings and emissions were taken. After that, hydrogen issuance equipment was installed, which is a flashback arrester, a hydrogen temperature gauge, and a measurement of the flow rate of hydrogen and the value of hydrogen pressure before the hydrogen enters the engine, using a hydrogen cylinder with a capacity of 40 liters and a pressure of 100 bar, and then the hydrogen at a pressure of 3 PSI and 5 PSI environmental measurements were also taken.

The results were as follows:

- 1- Emission rates with diesel fuel are high, especially carbon dioxide, as shown in Figures (3,4)
- 2- An improvement in emissions occurred when hydrogen was mixed with diesel, Figure (5)
- 3- Operating the engine with 100% hydrogen fuel.

Figure (6) operates the engine with pure hydrogen

5- Increasing the rate of improvement in emissions with increasing hydrogen pressure.





HHO DESCRIPTION

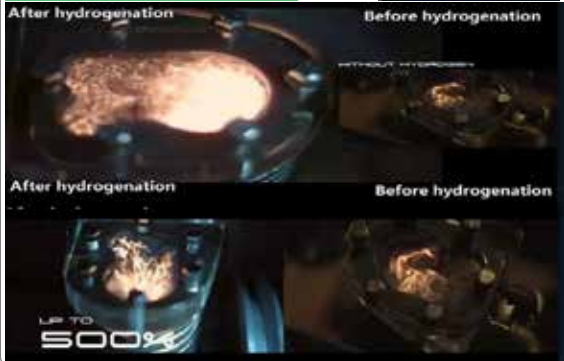
Advantages of HHO gas as a fuel in Diesel engine

- HHO gas mixture burns nearly 10 times faster compared to gasoline air mixture.
- HHO ignition limits are much wider than gasoline. So it can burn easily and give considerably higher efficiency.
- High self ignition temperature but very little energy is required to ignite it.
- Its clean exhaust is the most attractive feature of all.
- No green house effect.

Improved fuel consumption

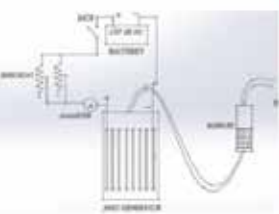


Increased flammability of fuel

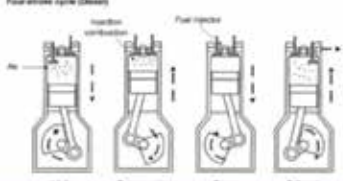


Equipment Description

The main equipment used in this investigation was the diesel fuelled electrical generator and the electrolysis cell. The electrolysis cell separates hydrogen from oxygen in the water molecule. This mixture of hydrogen and oxygen is then sent to the air intake of the diesel generator.



Gasoline combustion effects



Operating temperature	H ₂ : 850 °C, Diesel: 550 °C
Flammability limit	H ₂ : 4 to 75% per volume Diesel: 0.75%
flame velocity	H ₂ : 325 cm/second Diesel: 30cm/second
The increase in flame speed	causes increasing cylinder pressure, hence greater power and efficiency
characteristics of hydrogen can significantly reduce	dust and GHG emissions, such as NOx and CO, from the diesel engine



HHO

Hydrogen/oxygen Electrolytic cell (Hydrogen Generator)

Generator engine	4 cylinders, 2.5
current	7-8 Amps
output	.33 L/min
Electrodes	two stainless steel threaded electrodes
Produced gas Pressure	atmospheric vacuumed in the air intake of the engine.
DC power supply to convert the household AC to DC for use by the electrolyzer.	Hyundai 3020E 6-55A 0-30V

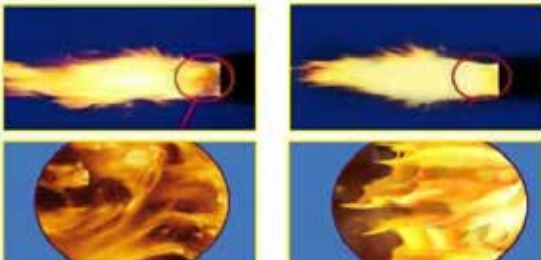


Cleaner engines due to water vapour

Removing The Carbon Deposits



Achieves more complete combustion of fuel



(Before)
combustion insufficient

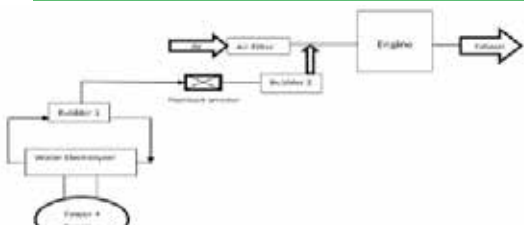
(After)
complete combustion



HHO

Set up

Experimental setup (Engine, Second bubbler)
Schematic for the experimental apparatus





Optimization of oxyhydrogen gas flow rate as a supplementary fuel in compression ignition combustion engines, the University of Jordan, 2027

1. Load measurement device connected to genset and load
2. DC power supply connected to electrodes on electrolyzer
3. Scale placed on platform
4. Fuel container filled to safe level
5. Fuel container placed on scale



Fuel Saving and process efficiency calculation in H₂/O₂ injection

$$\% \text{ fuel savings} = \frac{SFC_{Baseline} - SFC_{H_2/O_2 \text{ Injection}}}{SFC_{Baseline}} \times 100\%$$

specific fuel consumption (SFC)

$$E_{input} = (SFC_{Baseline} - SFC_{H_2/O_2 \text{ Injection}}) P_{AC} \Delta t \left[38.6 \frac{MJ}{L} \right] \left(\frac{L}{846g} \right) \left(\frac{1000Wh}{3.6MJ} \right)$$

$$E_{used} = P_{DC} \Delta t$$

$$\text{Process efficiency} = \frac{E_{input}}{E_{used}}$$

the energy content of the diesel fuel was 38.6 MJ/L and the density was 846 g/L



HHO

Comparison of Baseline and Minimum H₂/O₂ injected SFC

Fuel Saving and efficiency in 20 Amps

gasoline engine	4 cylinders, 1.1L
current	74 Amps
output	311 L/min
Electrodes	two stainless steel threaded electrodes
Produced gas Pressure	atmospheric (occurred in the air intake of the engine)
DC power supply to convert the household AC to DC for use by the electrolyzer	Hitachi 1000W 0-10A 0-30V
Rated Frequency	60 Hz
Revolution speed	2800 rpm
Turn	Single cylinder, vertical, air-cooled
Bore x stroke (mm)	70 x 94
Displacement	305 cc

As a 10-millimetre inter-plate gap in the HHO cell and 2000 rpm

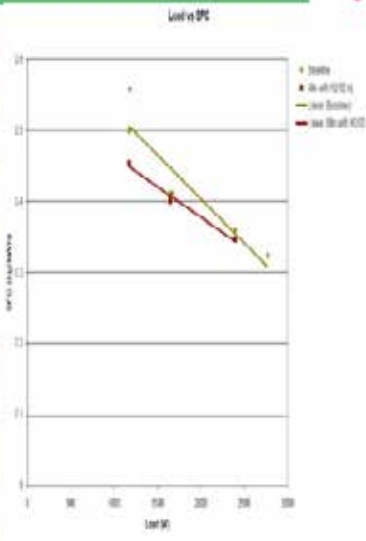
Values derived from 20 Amps load test (includes temperature interference)		
DC Power W	% fuel savings	Process efficiency (%)
0 (beginning)	0	0
0 (end)	44.26	Unstable
9.72	43.89	694.64
20.24	42.01	320.76
30	46.63	240.76
40.15	41.86	158.20
48.91	34.34	107.34

SFC Improvement 18.53%

Hydrogen Injection into Diesel Engines for Fuel Efficiency Improvement, Murdoch University, 2008

Comparison of Baseline and Minimum H₂/O₂ injected SFC

gasoline engine	4 cylinders, 1.1L
current	74 Amps
output	311 L/min
Electrodes	two stainless steel threaded electrodes
Produced gas Pressure	atmospheric (occurred in the air intake of the engine)
DC power supply to convert the household AC to DC for use by the electrolyzer	Hitachi 1000W 0-10A 0-30V
Rated Frequency	60 Hz
Revolution speed	2800 rpm
Turn	Single cylinder, vertical, air-cooled
Bore x stroke (mm)	70 x 94
Displacement	305 cc





HHO

Fuel Saving

Assuming a 10% increase in fuel economy for diesel applications, the resulting fuel savings would amount to 451800 barrels of diesel fuel per day in the United States alone (based on EIA consumption estimates for diesel fuel).

Unipqua Energy, an Oregon company	Canadian Hydrogen Energy Company
Fuel Saving	Fuel Saving
in the 3-12% in transport applications	10%

El kassaby et al.: gasoline engine efficiency and the fuel consumption by the oxy-hydrogen addition.

Fuel Saving	34%
Thermal efficiency improvement	10%

4-stroke single cylinder diesel engine (kimlookat)

Sl No.	Load Wt. (N)	Speed N. (RPM)	Time for 10% of fuel consumption t. (sec)	Advantage reading h. (m)	BP (KW)	TPC (kg/hr)	BSEC (kg/Whr)	BSMEP (bar)	η _m %	η _{th} %	% of diesel saved
1	0	1500	89	0.049	0	0.3347	0	0	0	0	3.2
2	4	1500	73	0.049	0.98	0.408	0.4137	0.6891	19.18	23.00	1.2
3	8	1500	48	0.049	1.97	0.620	0.3185	0.1783	25.20	37.40	2.1
4	11	1500	33	0.047	2.712	0.902	0.3336	0.245	23.84	43.10	6
5	13	1500	31	0.047	3.205	0.9600	0.2008	0.2898	26.47	49.27	19.3

Nabil and Dawood tried 150 cc and 1300 cc engines with oxy hydrogen

improvements in the thermal efficiency by	7% and 13.1%
Fuel consumption reduction	14.8% and 16.3% for the two engines

Hydrogen Injection into Diesel Engines for Fuel Efficiency Improvement, Murdoch University, 2008



HHO

Environmental benefits Emission Reduction

Potential to decrease emissions based on Unipqua Energy claims:

Emission	Percent Reduction
NO _x	Up to 60
Carbon Monoxide	Up to 100
Hydrocarbons	Up to 100
Particulates	Up to 95
Capacity (Barrel/day)	Up to 70

Bari and Emswael tested a four cylinder, direct injection water cooled diesel engine by using on board hydrogen oxygen generator in order to produce H₂-O₂ mixture through water electrolysis.

Emissions	Percent Reduction
CO	15.4
HC	18.2

Sa'ed A. Mirmar and Ammar A. Al-Rouman integrated a 197 cc single cylinder SI engine

Emissions	Percent Reduction	Emissions	Percent Reduction
CO	20	NOx	50
HC	18.2	Fuel saving	20-30 %

Hydrogen Injection into Diesel Engines for Fuel Efficiency Improvement, Murdoch University, 2008

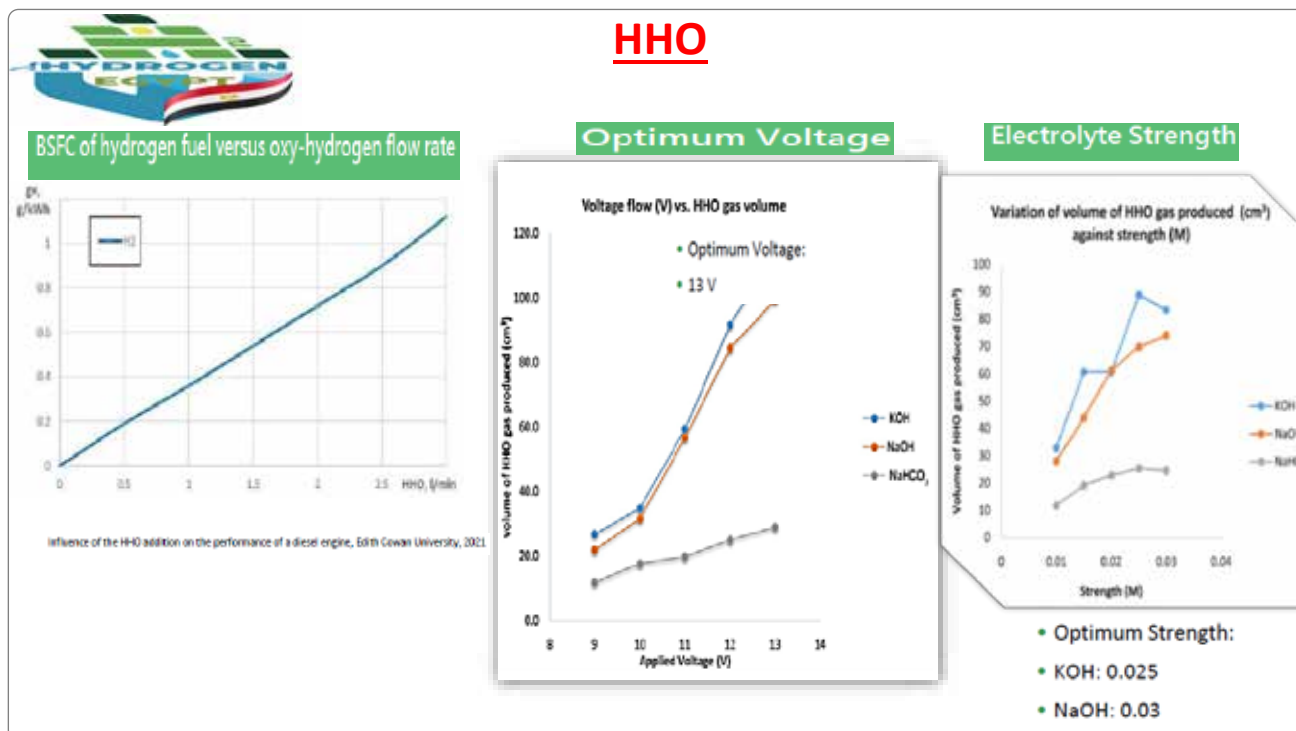
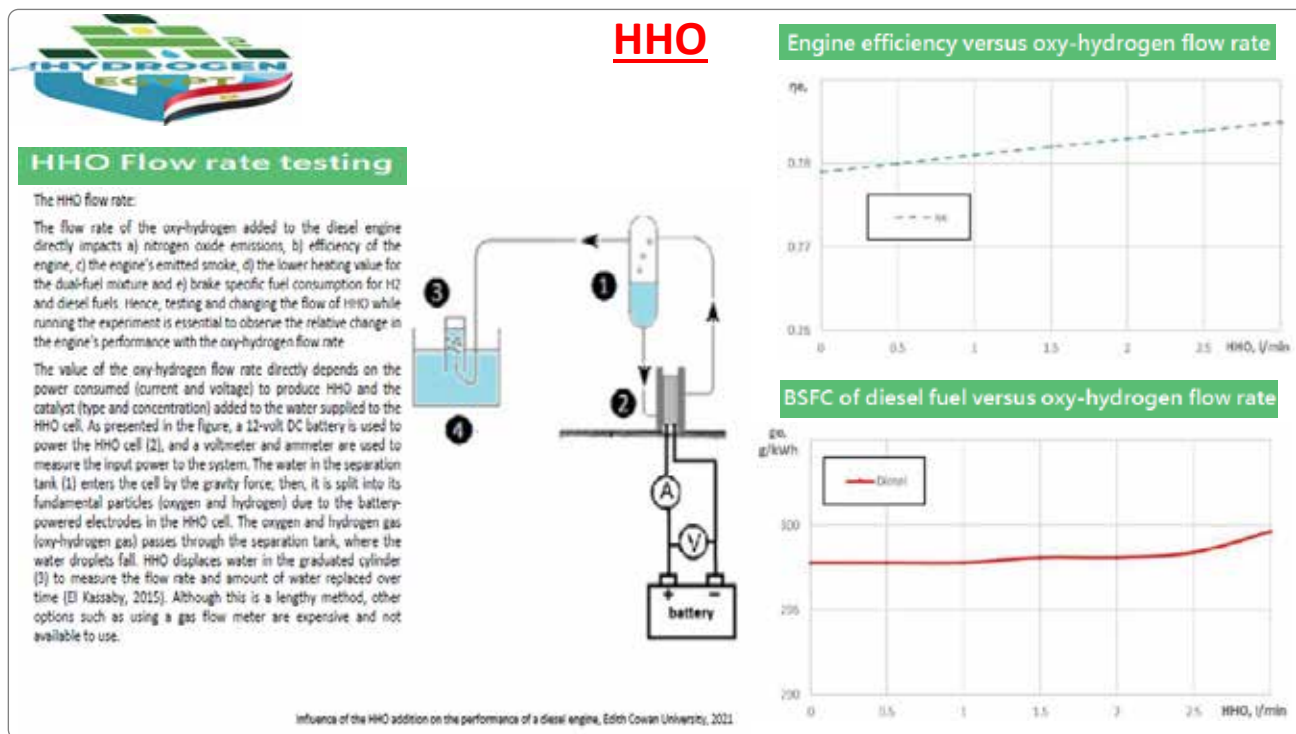
Optimization of oxyhydrogen gas flow rate as a supplementary fuel in compression ignition combustion engines, the University of Jordan, 2017

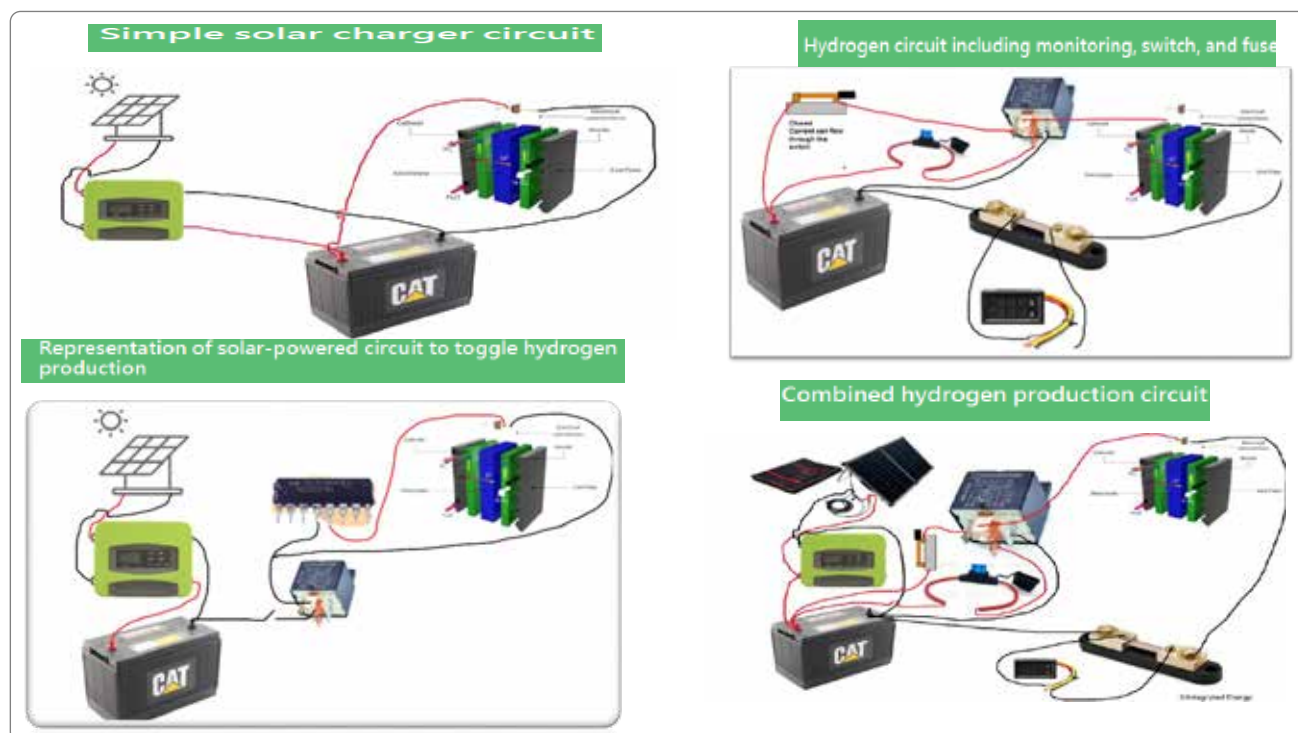
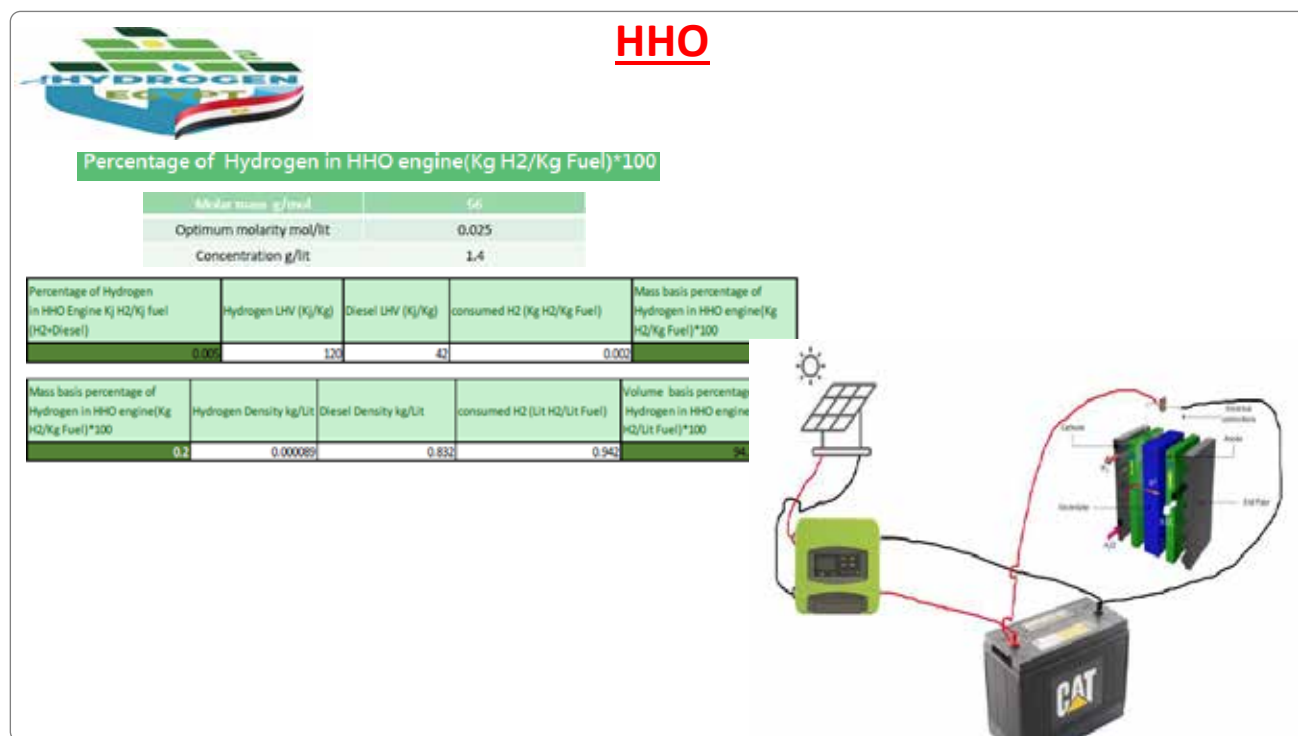
At a 10-millimetre inter plate gap in the HHO cell and 2000 rpm

CO reduction	8%
HC reduction	10%

Nabil and Dawood tried 150 cc and 1300 cc engines with oxy hydrogen

CO reduction	33% and 24.5%
HC reduction	27.4% and 21%



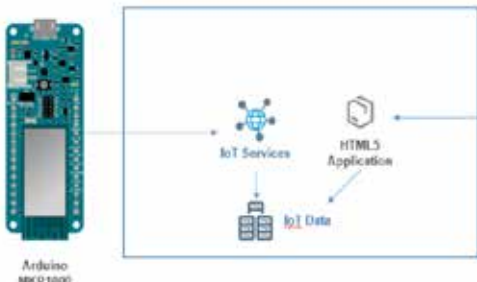




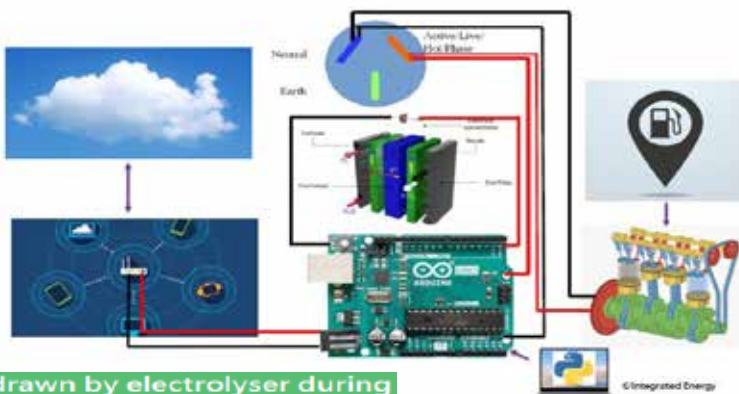
HHO

Overview of online monitoring circuit for engine

Simplified circuit for online monitoring



Arduino MKR1000



Comparison of voltage and current drawn by electrolyser during production vs. no production respectively






Egypt Hydrogen Projects



2.2.2. Hydrogen Generation & Re-filling :

Design options to be considered for sustainability & economical considerations as follows :

Option 1 :

Hydrogen is continuously generated through Electrolysis & injected directly as H₂ Fuel into, Diesel / gasoline engine .

Considering :

- Electrolyzes is powered by Batteries or Vehicle Generator
- Suitable adjustments for applicable Hydrogen Amount

Engineering will be include recommendations for relevant issues related to system , while details will focus on Electrolyzes & Hydrogen processioning

Option 2 :

Hydrogen generated through Electrolysis & Stored within central tank or portable cartridges , while all system is mounted on truck OR centralized as filling station (Future Expansion) .

Considering :

- Electrolyzes is powered by Batteries or Vehicle Generator

Engineering will be include recommendations for relevant issues related to system , while details will focus on Electrolyzes & Hydrogen processioning

Economic feasibility will be vitally needed







Introduces GREEN HDROGEN in Egypt






Egypt Hydrogen Projects



3- Finally :

Will be required to present technical solutions with options that :

- Fulfill clients' demands
- Demonstrate feasibility in economic perspective

Please provide your appreciated offers (Technical / Financials) , explaining your valued contribution .

Collaboration Criteria , will be discussed ,

Please don't hesitate to contact Us , for any further necessary issues may come up , and we shall do our best to respond with pleasure .

Looking forward to getting your soonest valued feedback

All thanks & respects





H2EG Introduces **GREEN HDROGEN** in Egypt



Green Energy Reintented




▶▶▶▶▶▶▶▶




[Www.hydrogenegypt.com](http://www.hydrogenegypt.com) or LinkedIn page <https://www.linkedin.com/showcase/mena-hydrogen-to-egypt-hub-h%C2%B2eg/>

<https://www.linkedin.com/in/dalia-samir-49428646>

<https://www.linkedin.com/in/khaled-nageib-034832219>

Our other SOCIAL LINKS

<https://www.linkedin.com/company/egyptian-ports-development-group-epdg/>

<https://youtube.com/@hydrogenegypt> <https://www.facebook.com/profile.php?id=100088959387965&mibextid=LQQJ4d> <https://twitter.com/hydrogenegypt?s=11&t=fsDEE0z2P-p-H2fujUanBA> <https://instagram.com/hydrogenegypt?igshid=YmMyMTA2M2Y=>

42



Thank You



42



HHO

Country Day II

Chile Day

Country Day II : Chile Day

Welcome Remarks

Country Day II : Chile Day

Welcome Remarks



Mathias Francke

Ambassador of Chile to the Republic of Korea,
Embassy of Chile in Republic of Korea

Country Day II : Chile Day

Chile's Green Hydrogen Action Plan 2023-2030

Country Day II : Chile Day

Chile's Green Hydrogen Action Plan 2023-2030



Alex Santander

Head of the Strategic Planning and Sustainable Development Division, Ministry of Energy

Education

- Electrical Engineer and Master of Science in Electrical Engineering, Universidad Técnica Federico Santa María, Valparaíso.
- Diploma in Business Management, Universidad de Chile.

Professional Career

More than 12 years of professional experience in different areas of the energy sector, mainly in: consulting, operation and planning of electricity systems, expansion of electricity transmission systems, energy planning and evaluation of new technologies, citizen participation processes, development of emission mitigation and carbon neutrality plans, analysis of resilience and adaptation to climate change, people management and innovation in different areas, public policy and sectoral regulation. Current Head of the Strategic Planning and Sustainable Development Division of the Ministry of Energy of Chile. Active member of IEEE and CIGRÉ, with several publications

Speech Title

Chile's Green Hydrogen Action Plan 2023-2030

Speech Summary

Chile's natural energy resource potential, international commitments regarding carbon neutrality, and the presence of critical minerals such as copper and lithium, position the country as a key player in the global energy transition.

In 2020, Chile published its National Green Hydrogen Strategy, with the aim of transforming the country into the lowest cost GH2 producer globally, betting on the export of large volumes of GH2 and derivatives, while contributing to a 25% reduction in current national GHG emissions.

This strategy was ratified by the current government, through the publication of the Green Hydrogen Action Plan 2023-2030, developed through a participatory process. It is a roadmap for the sustainable development of the industry through coordinated actions between government portfolios and related agencies, in accordance with regional and local authorities.

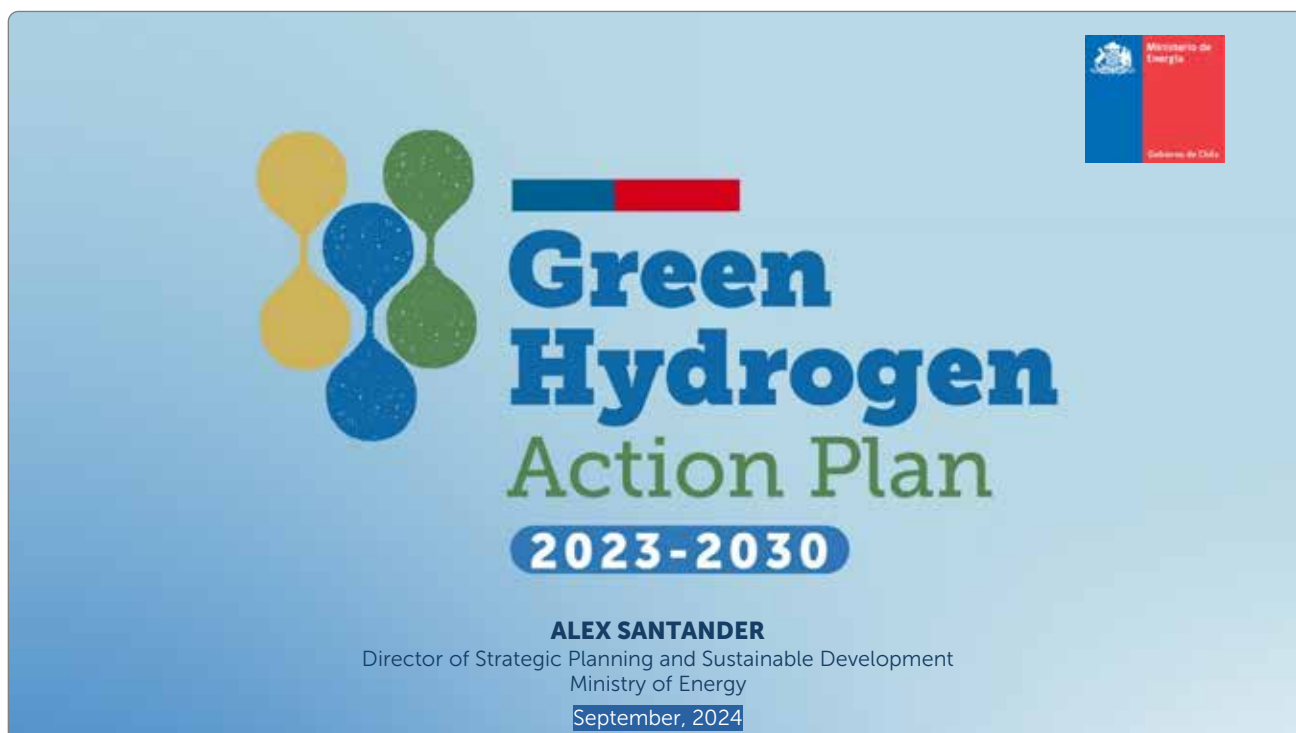
The Action Plan contemplates lines of work with short- and medium-term milestones and clear responsibilities that will allow the deployment of the green hydrogen industry and its derivatives in our country and thus facilitate investments.

Company Introduction

Founded on February 1, 2010, the Ministry of Energy of Chile is the governmental entity in charge of developing and coordinating, in a transparent and participative manner, the different plans, policies and norms for the development Chile's energy sector.

Its mission is to create and maintain an energy sector in Chile that supports a thriving society and a healthy economy. This is not only a technical challenge but a social and economic challenge as well.

Its goal is to have an energy sector resilient to climate change by providing a diverse, balanced and sustainable electric grid that is reliable, affordable and accessible for all Chilean citizens.



POLITICAL AND LEGAL FRAMEWORK



Climate Change Law (2023)
Ministry of Environment



Long-Term Climate Strategy (2021)
Ministry of Environment

Chile's international commitment and legal mandate goal:

Chile aims to be carbon-neutral and resilient economy before 2050



STRATEGIC-POLITICAL

Main goals for electrical power system

100% Zero-emissions energy by 2050

70% Zero-emissions fuels in non-electric energy end-uses by 2050

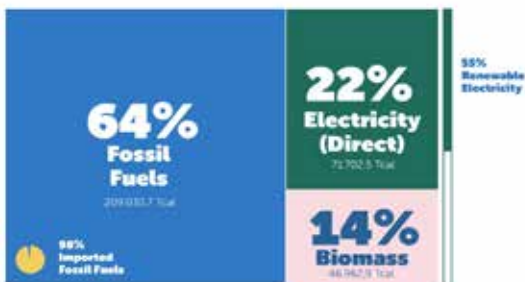
+80% Renewable energy by 2030

+2 GW Storage by 2030
(*) +6 GW by 2050

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 3

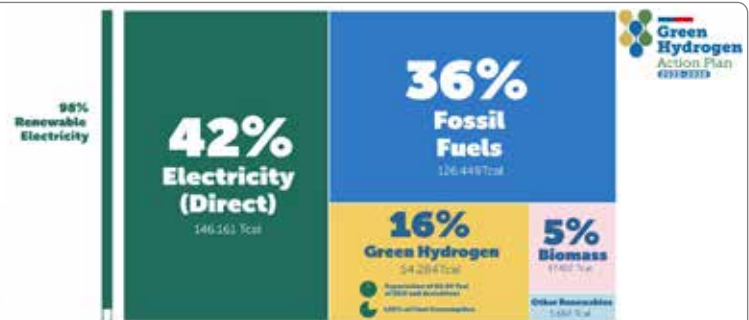
ENERGY MIX

Chile



Energy National Balance, 2022

Historical
2022



LTEP, Carbon Neutrality, 2050



LTEP, Accelerated Transition, 2050

Projected
2050

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 4

**MID-TERM CONSENSUS
BUILDING IS REQUIRED**

2050

2030

2023

We know **where we're headed...**
...we're building **how to get there**

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 5

SECTORAL INSTRUMENTS

NATIONAL ENERGY POLICY

NEW PRODUCTIVE IDENTITY FOR CHILE

"Green hydrogen and its derivatives represent a historic opportunity to transform Chile into one of the leading producers of clean energy globally. This will enable job creation and foster new industries that will contribute to local development and decarbonization."

2030 Chile is an exporter of energy in the form of Green Hydrogen.

2050 70% of zero-emission fuels is non-electric energy and uses

NATIONAL STRATEGY FOR GREEN HYDROGEN

2020 Establishing the Foundations of the Industry
2025 Attracting the Industry
2030 Conquering Global Markets

ACTION PLAN 2020-2023

PILLARS:

1. Establish market and export platforms
 2. Economic, policy, regulatory, financial
 3. Social and institutional foundations
 4. Capacity building and innovation
- 5. B.2023: Finalize all requirements to export hydrogen
 - 6. 2024: Establish capacity building and export development
 - 7. 2025: Implement pilot projects in all base load fuels
 - 8. 2026: Establish "Green Hydrogen" export routes
 - 9. 2027: Utilize all relevant laws
 - 10. 2028: Implement pilot projects of GH2 for decarbonization

GREEN HYDROGEN ACTION PLAN 2020-2023

2021 A.2024

Investment, projects, incentives, support

2027 A.2030

Production, challenges, and decarbonization

2027 A.2030

Production, challenges, and decarbonization

2027 A.2030

Production, challenges, and decarbonization

2027 A.2030

Production, challenges, and decarbonization



Plan de Mitigación y Adaptación al Cambio Climático del Sector Energía

energia.gob.cl/cambioclimatico



Plan de Acción Hidrógeno Verde

planhidrogenoverde.cl



energia.gob.cl/panel/plan-de-descarbonizacion

TACTICAL

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 6

GH2 NATIONAL STRATEGY



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 7

GH2 ACTION PLAN PARTICIPATORY PROCESS



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 8



A GH2 ACTION PLAN WITH A STATE VISION

STRATEGIC COMMITTEE

The Strategic Committee aims to provide strategic and policy guidance, with broad consensus among participants, to constitute a high-level framework for the Green Hydrogen Action Plan and build a policy narrative that communicates, nationally and internationally, the country's hydrogen guidelines.



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 9



DISCUSSED TOPICS BY STRATEGIC COMMITTEE

DATE	SESSION 1 JULY 31 2023	SESSION 2 AUGUST 22 2023	SESSION 3 SEPTEMBER 4 2023	SESSION 4 OCTOBER 12 2023	SESSION 5 OCTOBER 19 2023	SESSION 6 NOVEMBER 14 2023
Topics Discussed	• Introduction to the exercise of desired future boundaries and attributes. • Initial discussion of Human Capital and Environmental dimensions.	• Discussion on the Environmental dimension.	• Conclusion of the objective image for the Environmental dimension. • Discussion on the International dimension.	• Conclusion of the objective image for the International dimension. • Discussion on the Economic dimension. • Further discussion on the Economic dimension.	• Continuation of the discussion on the Economic dimension. • Discussion on the Human Capital and Citizenship dimensions.	• Conclusion of the discussion on Citizenship, Human Capital, and Economic dimensions.

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 10



STRATEGIC COMMITTEE

Environmental dimension

"The green hydrogen industry will develop within a unique window of opportunity for the country, demonstrating how an industry can be deployed as a pillar for national economic growth, while moving towards the highest international environmental standards for the protection of ecosystems, mitigation, compensation and/or repair of its impacts, contributing to local development and improving the quality of life of local communities.

The State will provide conditions to increase certainty in the viability of the green hydrogen industry and its value chain, through the development and implementation of different instruments, consistent with each other, such as the development of environmental baselines, the development of regulations and sustainability standards, institutional strengthening, response capacity for the review and monitoring stages, environmental responsibility on ecosystems, quality of life, communities, among others.

Considering a transition period towards regulatory adaptation, the State should accompany projects that are in the development stages during this period, so that they can incorporate these challenges early on through public-private agreements or other mechanisms of voluntary origin".



STRATEGIC COMMITTEE

International dimension

"Considering the international character of the green hydrogen industry and its derivatives, established in two of the pillars of the National Green Hydrogen Strategy, it will be developed with a diversity of partners and commercial actors, promoting neutrality abroad and competition in the sector. Full compliance with international trade rules and commitments assumed by our country is key to build stable policies.

International openness will allow the State to promote global relations and the positioning of Chile in the establishment of green corridors and productive linkages. Likewise, the State will generate the conditions for the process of internationalization of hydrogen and its derivatives to leverage for Chile the development of innovation, technology transfer, the generation of local capacities associated with the sector and promote global trade in a context of sustainability through certification or other mechanisms that promote progress in all its dimensions".



STRATEGIC COMMITTEE

Economic dimension

"The green hydrogen and derivatives industry represents a window of opportunity for the economic transformation of the country and its regions, through productive and energy diversification within the framework of global decarbonization.

The State will offer a favorable environment for this industry in terms of investment, research and innovation, thus boosting its competitiveness in the short term and consolidating it as a strategic sector contributing to the country's economic growth and development. To take advantage of the window of opportunity, an enabling regulation will be implemented according to its temporary and structural challenges, which will allow moving towards a permit processing system that will provide certainty and improve efficiency.

The national production of green hydrogen and derivatives will be prepared for the demands of international markets and will promote the development of productive chains in the regions of the country, encouraging the participation of different productive agents throughout the value chain.

The State will promote the internal demand for green hydrogen and derivatives for the deployment of the industry, promotion of decarbonization and competitiveness of the national economy."



STRATEGIC COMMITTEE

Human capital and technological development dimension

"The green hydrogen and derivatives industry opens a window of opportunity in the formation of knowledge and skills in the country, through a development that will diversify and generate value in the territories and their communities.

The public policy will promote a continuous transfer of knowledge, national and international, that will allow the formation of competencies in a timely manner according to market demands. This is achieved thanks to the harmonious articulation between human capital formation, research and innovation institutions, and industry.

The State has the role of generating the enabling conditions for effective processes of innovation and technological development, as well as, together with the industry, promoting labor reconversion, aiming to improve labor standards and formal training at all levels that have an impact on its development. Research in green hydrogen and its value chain will contribute to broad and cross-cutting country development objectives."



STRATEGIC COMMITTEE

Citizenship dimension

"The green hydrogen and derivatives industry will be characterized by the clear, timely and transparent delivery of information on projects to citizens and local public opinion, establishing channels of communication, evaluation of alternatives and effective accountability among the different actors.

The State will have the role of promoting early participation, adapting and/or strengthening the institutional framework and ensuring the existence of a multi-stakeholder governance that allows reaching agreements between the parties to minimize the impacts and maximize the benefits of the projects, promoting local development and the welfare of the people living in the territory where they are located, tending to guide their location through formal instruments of management and territorial planning.

The new green hydrogen industry, together with the State, will ensure decent work and promote fair and equitable participation in the benefits derived from its activities with the communities. Benefit sharing will be promoted through various mechanisms, such as: support to local companies to participate in the supply chain, provision of services and/or urban infrastructure, community participation in some dimensions or benefits of the projects, interventions that promote the rooting of workers in the territory, among others."

GREEN HYDROGEN INSTRUMENTS



GH2 NATIONAL STRATEGY



6 strategic pillars

STRATEGIC COMMITTEE



5 objective targets

GH2 ACTION PLAN 2023-2030



81 actions
177 milestones

GREEN HYDROGEN TIMELINE



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 17

GOVERNANCE



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 18

GOVERNANCE



MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 19

GOVERNANCE

18

ministries and
CORFO

+14

other organisms

international
cooperation

Ministry of Energy
Ministry of Economy, Development and Tourism
Ministry of Finance
Ministry of Science, Technology, Knowledge and Innovation
Ministry of National Assets
Ministry of Public Works
Ministry of Environment
Ministry of Foreign Affairs
Ministry of Transportation and Telecommunications
Ministry of Agriculture
Ministry of Social Development and Family
Chilean Economic Development Agency (CORFO)
--
Ministry of Defense
Ministry of Education
Ministry of Women and Gender Equity
Ministry of Health
Ministry of Labor and Social Security
Ministry of Housing and Urban Development

MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 20

CONTROL AND ACCOUNTABILITY



18

action lines



81

Actions with milestones
during 2023-2030
(40 MEN)

174

control milestones (81 MEN)

 MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 21

DISTRIBUTION OF MEASURES



- | | |
|--|--|
| 1. Governance and multi-stakeholder participation (6, 14) | → Strategic Planning and Sustainable Development Division. |
| 2. Information, dissemination and public education (4, 5) | → Fuels and New Energy Division |
| 3. Economic and financial leverage mechanisms (10, 19) | → Strategic Planning and Sustainable Development Division |
| 4. Environmental management (3, 11) | → Project Development Division |
| 5. Sustainability of the industry (4, 7) | → Project Development Division |
| 6. Regulatory clearance (2, 6) | → Fuels and New Energy Division |
| 7. Permitting system (5, 8) | → Project Development Division |
| 8. Compatibility and land embedding for projects (4, 17) | → Strategic Planning and Sustainable Development Division |
| 9. Enabling infrastructure and development (4, 13) | → Strategic Planning and Sustainable Development Division |
| 10. Demographic challenge of the energy transition (3, 4) | → Strategic Planning and Sustainable Development Division |
| 11. Electricity transmission and energy costs (4, 7) | → Strategic Planning and Sustainable Development Division. |
| 12. Uses to decarbonize the national economy (5, 18) | → Fuels and New Energies Division. |
| 13. Demonstrative projects (2, 4) | → Fuels and New Energies Division |
| 14. Promoting productive linkages (3, 5) | → Fuels and New Energies Division |
| 15. Strengthening and development of human capital (6, 10) | → Gender and Human Rights Office |
| 16. Gender perspective in the industry (4, 8) | → Office of Gender and Human Rights |
| 17. Promoting research, development and innovation (5, 8) | → Fuels and New Energies Division |
| 18. Opening up international markets (7, 13) | → International Affairs Office |
| PMO CONTROL | → Office of Planning and Management Control |

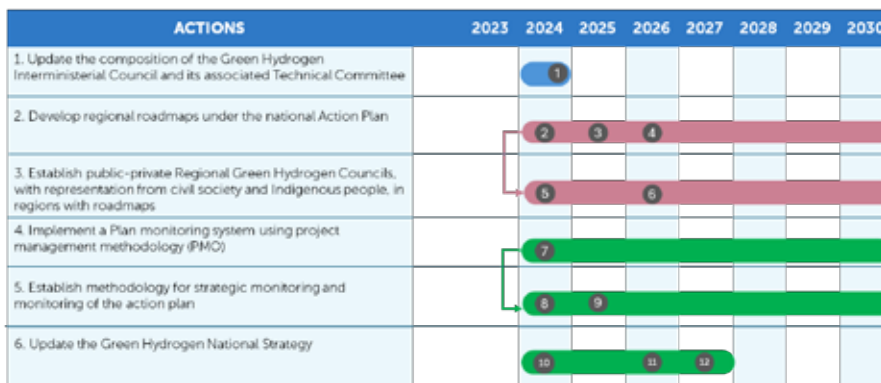
 MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 22



1

DPEDS

LINE OF ACTION 1: GOVERNANCE AND MULTI-STAKEHOLDER PARTICIPATION



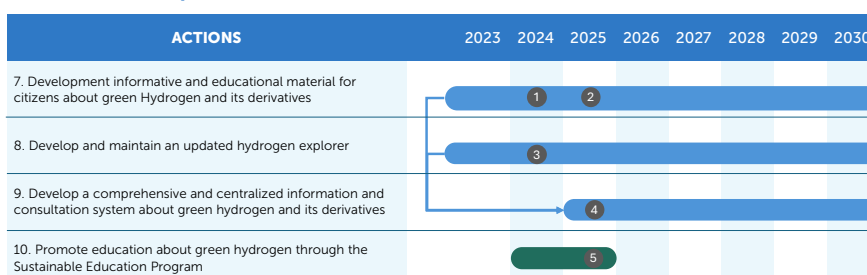
MILESTONES

- Modification of Ex. Res 60 by CORFO, from 2022
- Elaborated documents: in Biobío (2); in Antofagasta (3); in Valparaíso (4)
- Establishments of Councils in Magallanes and Chilean Antarctic, Biobío and Antofagasta
- Publication of improvements observation documents for respective roadmaps from multi-stakeholder councils
- Platform loaded with milestones and responsible parties
- Definition of monitoring indicators for the commitments of this Plan
- First analysis of Plan progress and recommendation for action updates
- Validation and update of commitments of the current GH2 National Strategy
- Update of the GH2 National Strategy aligned with a Sustainable Industrial Development Policy of the country
- Review of the GH2 Action Plan according to the updated GH2 National Strategy

2

DCNE

LINE OF ACTION 2: INFORMATION, DISSEMINATION AND CIVIC EDUCATION



MILESTONES

- Material available in the first region of the country
- Material developed and available nationwide
- Launch of the Green Hydrogen Explorer
- First version of the platform
- Educational material developed and available



LINE OF ACTION 3:

ECONOMIC AND FINANCIAL MECHANISMS TO BOOST THE INDUSTRY

3
DPEDS



MILESTONES

1. Closure of the first process of allocation of state lands ("Ventana al Futuro")
2. Publication of the call for the second process of allocation
3. Annual call for each CORFO instrument
4. Design of the pilot ETS programme for the energy sector
5. Implementation of the pilot ETS programme
6. Submission of the Bill to Congress (specific for each case)
7. Approval of the Bill (specific for each case)
8. Update and operation in the first semester of 2024
9. Prospecting work for Green Credit placement
10. Contribution of the Green Hydrogen Guarantee Fund
11. Formal opening and start of the "Facility GH2 Desk" with Green Credit
12. Opening of the FSA call (Financial Assistance Mechanism)
13. Start of public-private working group sessions
14. Closure of the first call of the financing round intended in 2023
15. Evaluation of opening new financing rounds

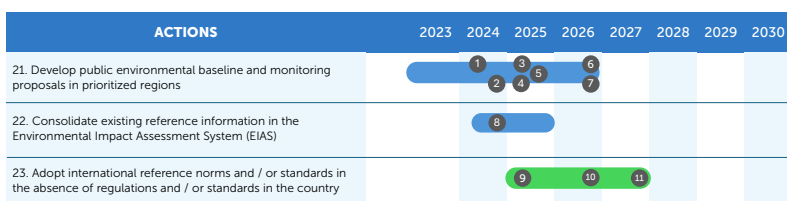
MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 25



LINE OF ACTION 4:

ENVIRONMENTAL MANAGEMENT

4
DDP



MILESTONES

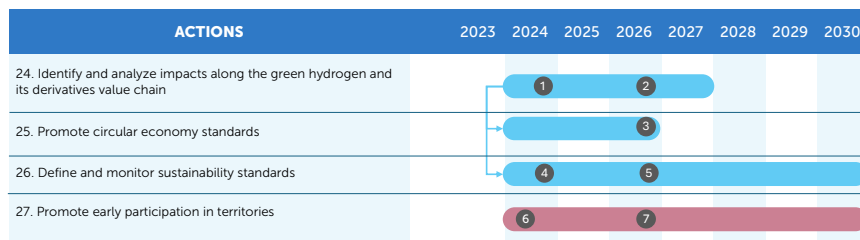
1. Magallanes public environmental baseline available on the Platform (with existing secondary information)
2. Launch of a technological platform with baseline and other information
3. Antofagasta public environmental baseline available on the Platform (with existing secondary information)
4. Metropolitan Region public environmental baseline available on the Platform (with existing secondary information)
5. Magallanes public environmental baseline available on the Platform (with primary information collected from the field)
6. Antofagasta public environmental baseline developed and available on the Platform (primary information collected from the field)
7. Metropolitan public environmental baseline available on the Platform (with primary information collected from the field)
8. Study conducted by the end of 2024 to standardize EIAS reference information
9. Document prepared with a selection of international reference norms and standards
10. Analysis of applicability and standardization applicable in project evaluation
11. Start of the procedure to adopt norms into the national legal framework

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 26



LINE OF ACTION 5: INDUSTRY SUSTAINABILITY

5
DDP



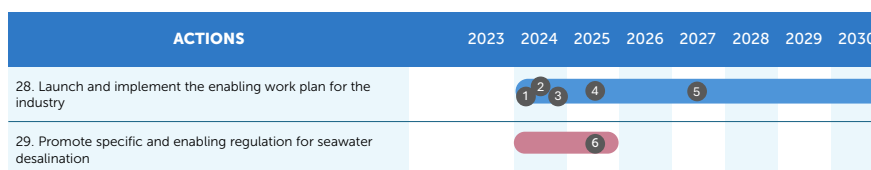
MILESTONES

- 1 Published study on the identification of socioeconomic impacts derived from renewable hydrogen projects in Chile
- 2 Develop and publish study about on life cycle analysis of the green hydrogen industry
- 3 Guide on best practices in circular economy associated with the green hydrogen and its derivatives industry and value chain
- 4 Identification of critical processes in the green hydrogen value chain
- 5 Document outlining key performance indicators for the green hydrogen industry, derivatives, and its value chain
- 6 At least two projects have initiated the early participation process
- 7 At least two projects have completed their early participation processes



LINE OF ACTION 6: REGULATORY ENABLEMENT

6
DCNE



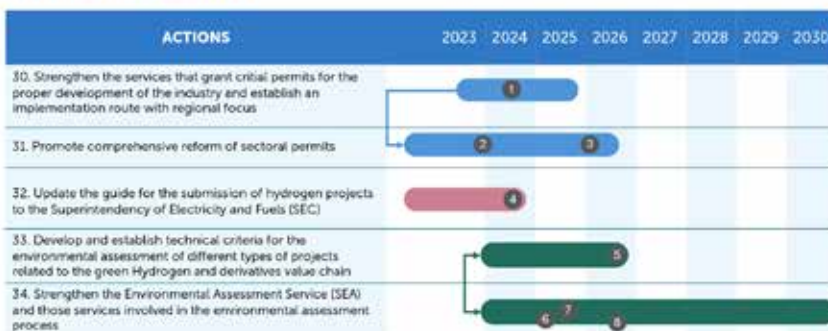
MILESTONES

- 1 Launch of the Regulatory Work Plan
- 2 Registration of the Hydrogen Installation Safety Regulation
- 3 Start of the study to generate a proposal for Hydrogen quality regulation and Hydrogen refueling station regulations
- 4 Presentation of the regulatory strategy for hydrogen derivatives
- 5 Update of the regulatory work plan
- 6 Advocacy for a Bill on seawater desalination for publication

7

DDP

LINE OF ACTION 7: PERMITTING SYSTEM



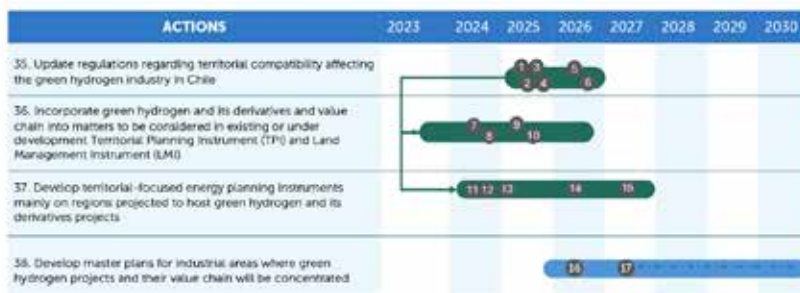
MILESTONES

1. Services linked are trained
2. Bill is submitted
3. Bill is approved
4. Update of the guide is published
5. Technical criteria are published
6. Projection of staffing strengthening requirements
7. Progressive implementation of strengthening and modernization of services
8. Services are trained in strategic regions

8

DPEDS

LINE OF ACTION 8: TERRITORIAL COMPATIBILITY AND INTEGRATION FOR PROJECTS



MILESTONES

1. Update Circular N° B12/D4 of 2020 - Instruct technical criteria for the qualification of productive activities and infrastructure
2. MINVU DDU Circular on land use applicable to destination projects for industrial use
3. Methodological design study for the development of "Energy Infrastructure Studies" of TPI
4. Base study for the update of the GOUC (General Ordinance of Urbanism and Construction) regarding Energy Infrastructure
5. Update of the GOUC regarding energy infrastructure
6. Modification of MINVU DDU Circular N° 481 instructing on the methodology for Energy Infrastructure Studies in TPIs
7. Registration of RLUP (Regional Land-Use Plan) Regulation
8. Working group on TPI for areas with projected development of the GH2 industry and its derivatives
9. Zoning of the coastal edge of the Magallanes Region
10. RLUP Methodological Guide
11. L.TEP Decree with Tocopilla and Antofagasta EG2P
12. Publication of SEPR Magallanes with SEA (Strategic Environmental Assessment)
13. Publication of SEPR Biotbio
14. Publication of SEPR Antofagasta with SEA
15. Publication of SEPR Valparaiso
16. Evaluate application areas
17. Start to develop the first Master Plan



9

DPEDS

LINE OF ACTION 9: ENABLING INFRASTRUCTURE DEVELOPMENT

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
39. Addressing the challenges of enabling infrastructure within the framework of intersectoral coordination		1 2 3						
40. Planning the enabling infrastructure development for the green hydrogen and derivatives industry		4 5 6 7						
41. Developing investment plans in enabling infrastructure for the green hydrogen and derivatives industry		8 9 10						
42. Tendering state-owned lands for the development of infrastructure for the value chain of the green hydrogen and derivatives industry		11 12 13						

MILESTONES

- 1 Incorporation of Ministry of Energy into the National Commission for the Use of Coastal Border (NCUCB) of the Ministry of Defense
- 2 Incorporation of the Ministry of Energy into the National Commission for Logistics Development (NCLD)
- 3 Incorporation of Regional Energy Secretariats into Regional Coastal Use Commissions
- 4 Integrated planning study of green hydrogen and derivatives infrastructure
- 5 Study of social evaluation methodologies for projects associated with the green hydrogen industry
- 6 Design of Logistics Development Plan in the Magallanes Region
- 7 Design of Logistics Development Plan in the Northern Macrozone
- 8 Criteria for Sustainable Public Infrastructure (Ministry of Public Works)
- 9 Bid awards for reinforcement of Mardones Pier, Magallanes Region (Austral Port Company)
- 10 Sustainable Public Infrastructure Criteria (Ministry of Public Works)
- 11 Study for identification of state-owned lands for disposal
- 12 Agreement between the Ministry of National Assets and the Ministry of Energy for the Land Tender Plan
- 13 Tendering of state-owned lands for the development of shared infrastructure for the value chain of green hydrogen and derivatives



10

DPEDS

LINE OF ACTION 10: DEMOGRAPHIC CHALLENGE OF THE ENERGY TRANSITION

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
43. Elaborate Territorial Planning Instruments (TPI) addressing human settlement development		1						
44. Review regulations concerning temporary human settlement		2						
45. Review mechanisms for allocating resources for municipal management capacity			3 4					

MILESTONES

- 1 Award of the tender for the Intercommunal Regulatory Plan (IRP) of Magallanes and Tierra del Fuego
- 2 Working group between the Ministry of Energy and the Ministry of Housing and Urban Planning to review applicable regulations regarding temporary human settlements
- 3 Study of alternative mechanisms for local taxation
- 4 Study and proposal for the calculation and allocation of the Municipal Common Fund in the category of floating



11

DPEDS

LINE OF ACTION 11: ELECTRICAL TRANSMISSION AND ENERGY COSTS

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
46. Strengthen the methodology of Long-Term Energy Planning (LTEP)			1 2					
47. Amend regulatory bodies to address the operation of generation-consumption systems defined in the Electrical Law		3 4						
48. Enable residential customers to connect to the transmission of green hydrogen projects		5						
49. Implement the participation of green hydrogen and derivative projects in electricity markets to provide various services			6		7			

MILESTONES

- 1 Document with assumptions about hydrogen
- 2 Incorporation of Magallanes electrical system modelling into LTEP
- 3 Development of consultancy for regulatory proposal
- 4 Regulation sent to the Comptroller
- 5 Isolated Systems bill sent to Congress
- 6 Publication of the Decarbonization Plan roadmap
- 7 Complete regulatory and normative implementation

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 33



12

DCNE

LINE OF ACTION 12: USES FOR DECARBONIZING NATIONAL ECONOMY

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
50. Develop a green hydrogen plant in Cabo Negro, Magallanes		1 2	3 4	5				
51. Mapping of end uses of the national industrial sector for fuel switching		6 7	8					
52. Analyze alternatives to advance in the production of renewable / synthetic fuels by ENAP (Petroleum National Company)			9 10					
53. Promote the conversion of thermal power plants, using alternatives with hydrogen-based fuels		11 12						13
54. Promote energy decarbonization in the medium and isolated electrical systems of the country		14 15	16 17	18 19	20 21	22 23	24 25	26

MILESTONES

- 1 First sod of the plan laid
- 2 Start of operations in Cabo Negro
- 3 Blending of natural gas - hydrogen begins at ENAP facilities
- 4 Use of GH2 in ENAP vehicles
- 5 Applications for partial use in the industrial and / or commercial sector of GH2 or derivatives
- 6 Results of Diagnostic Study
- 7 Continuous updating and annual reports
- 8 Prioritization of applications
- 9 Proposal for progress to implement an alternative renewable / synthetic fuel production
- 10 First analysis of technologies and inputs
- 11 Reconversion study of power plants completed
- 12 Publication of the Decarbonization Plan roadmap
- 13 First coal-fired power generation unit reconverted
- 14 Legislative processing of the bill on social security matters
- 15 Presentation and dispatch of the bill on autonomous communities to Congress
- 16 Legislative processing of the bill on autonomous communities
- 17 Regulatory and normative adaptation for the correct application of laws
- 18 Construction and operation of the first projects based on clean fuels such as green hydrogen and derivatives

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 34



13

DCNE

**LINE OF ACTION 13:
DEMONSTRATIVE PROJECTS**

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
55. Encourage the use of green hydrogen and its derivatives in the local industry through co-financing pilot projects		1	2					
56. Implement a pilot project of green hydrogen bus in public transportation		3	4					

MILESTONES

- 1 Adjudication of projects in the third edition of the green hydrogen accelerator
- 2 Evaluation of continuity of the accelerator
- 3 Purchase of the bus
- 4 Operation start of pilot project



14

DCNE

**LINE OF ACTION 14:
BOOSTING PRODUCTIVE LINKAGES**

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
57. Drive technological transformations in the industry through the "Impulse Technological Transition" short instrument		1						2
58. Identify companies providing services related to the value chain of green hydrogen and its derivatives, and make this information available		3						
59. Promote the establishment of electrolyzer factories in Chile		4	5					

MILESTONES

- 1 First call for the "Impulse Technological Transition" instrument
- 2 Program continuation
- 3 Publication of initiative report
- 4 Publication of Request for Proposal (RFP) call
- 5 Award and contract with selected company / companies



LINE OF ACTION 15:

STRENGTHENING AND DEVELOPMENT OF HUMAN CAPITAL

15
OGDH



MILESTONES

1. Prospective Study on Employment and Vocational Training in Green Sectors: green hydrogen in Chile
2. Second Diagnostic Study of specific profiles for future incorporation into TFC curricula, under the MCTP
3. Proposal for updating curricular grids for Technical Training Centers (TFC) based on the MCTP
4. Delivery of training programs and training material
5. Annual publication of results of allocation to training courses and scholarships, and of work competencies programs
6. First competition for internships abroad and continuity of the program in subsequent years
7. Conducting a technological tour for vocational education instructors (7) and university professors (8) and continued
8. Installation of electrolyzer equipment in high schools, Magallanes Region (9) and in other regions of the country (10)

MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 37



LINE OF ACTION 16:

GENDER PERSPECTIVE IN THE INDUSTRY

16
OGDH



MILESTONES

1. Intersectoral gender working group on green hydrogen
2. Conduct at least one in-person annual meeting of the Network
3. Online GH₂ course with a focus on women
4. Diagnostic study of specific profiles for future inclusion in CFT curricula, under the MCTP
5. First standards validated with the industry
6. Development of a good practice guide for compliance with gender standards for green hydrogen and derivatives projects
7. Implementation, publication and dissemination of the study on gender gaps in the green hydrogen and derivatives industry
8. Development of recommendations for public spaces and human settlements with a gender and security focus

MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 38

17

DCNE

LINE OF ACTION 17: BOOSTING RESEARCH, DEVELOPMENT AND INNOVATION

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
70. Analysis of R&D challenges in green hydrogen projects to complement R&D Law		1	2					
71. Development of R&D&I contest by the National Agency for Research and Development (NARD)		3						4
72. Boosting specialized technological development through Green Hydrogen Technology Development Centers			5	6				
73. Compilation of equipment and scientific infrastructure data for conducting R&D in green hydrogen			7					
74. Generating and disseminating technological information related to the green hydrogen and derivatives value chain		8						

MILESTONES

- Start of working group sessions
- Publication of R&D Guide for the application of projects related to GH₂ and derivatives to the R&D Law
- AN&D contests are held annually throughout the period
- Launch of the Magallanes Technological Center
- Launch of the Technological Development Center for the Maritime and Naval Industry of the Chilean Navy
- Development of a pilot propulsion system fueled by synthetic fuel, by the Technological Development Center for the Maritime and Naval Industry
- Publication of a study on scientific and technological needs and a plan for the enabling infrastructure development
- Publication of the first version of national and international patent indicators

18

ORI

LINE OF ACTION 18: OPENING OF INTERNATIONAL MARKETS

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
75. Position the country's green hydrogen industry abroad		1	2					3
76. Attract foreign investment for the green hydrogen and derivatives industry in Chile		4	5					
77. Subscription and implementation of international cooperation instruments			6					7
78. Promote agreements and / or strategic alliances with governments and multilateral actors for the development of the hydrogen and derivatives industry in the country			8					
79. Develop a strategic proposal for a sustainability certification system for hydrogen			9	10				
80. Strengthen the National Renewable Energy Registry (RENOVA) if the National Electric Coordinator (Chilean SEC) as the base platform for the hydrogen certification system					11	12		
81. Implement green maritime corridors							13	14

MILESTONES

- Participate in the two main annual international meetings / exhibitions of the sector
- Implement through ProChile's commercial offices abroad in focus markets for the industry, promotion activities to maintain Chile's international positioning
- Publication of an e-Book on green hydrogen in Chile
- Launch of this Action Plan in English at the 2024 Investment Forum
- Development of an annual internationalization agenda to prioritize and strategically plan cooperation activities
- Identification of ports in Asia to promote strategic alliances
- Finalize Chile's participation in regional certification frameworks, such as CETHIAC
- Publication of the study and roadmap to establish the requirements to meet international standards of major import hubs
- First enablement of the RENOVA platform for the hydrogen certification system
- Launch of certification platform
- Publication of the results of feasibility studies for the transportation of copper and sulfuric acid
- Publication of the results of the pre-feasibility study for a green maritime corridor for aquaculture in the Aysen region
- Materialize the first green maritime commercial route in Latin America by 2030

CONTROL AND ACCOUNTABILITY

18

action lines



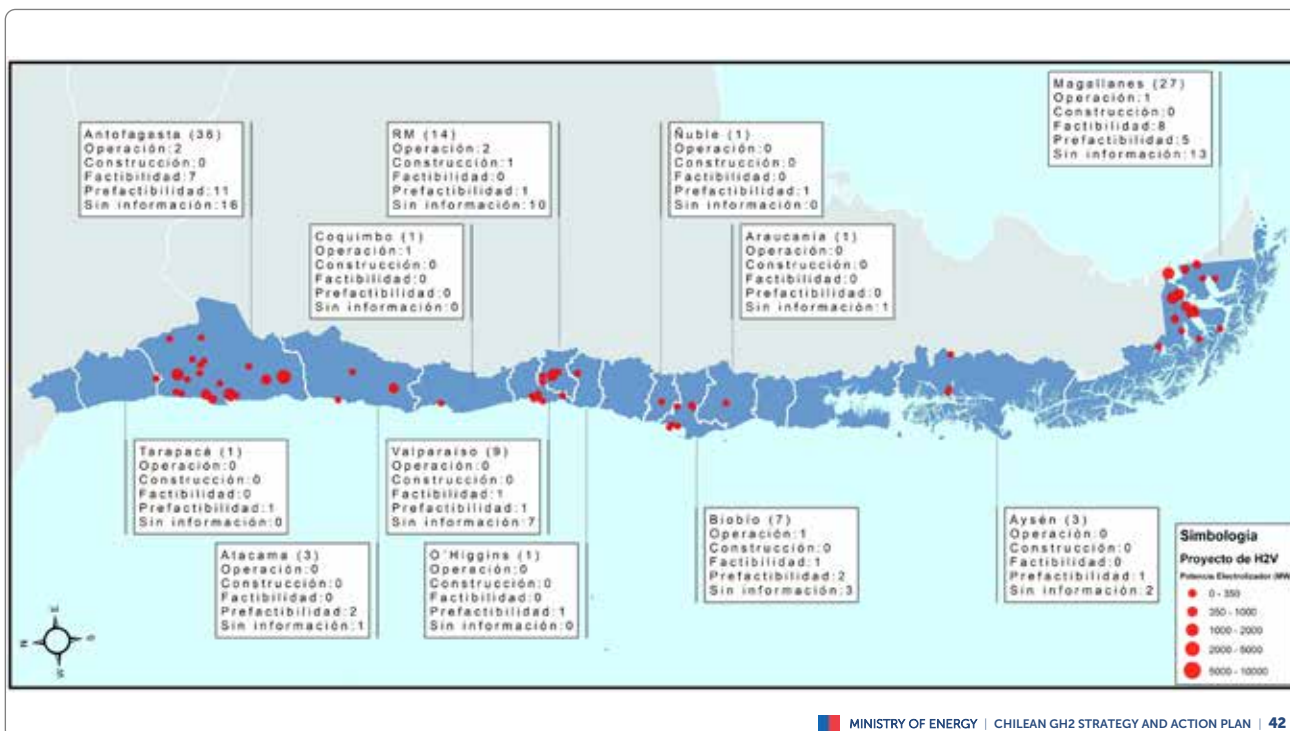
7

finished milestones (4%)

74

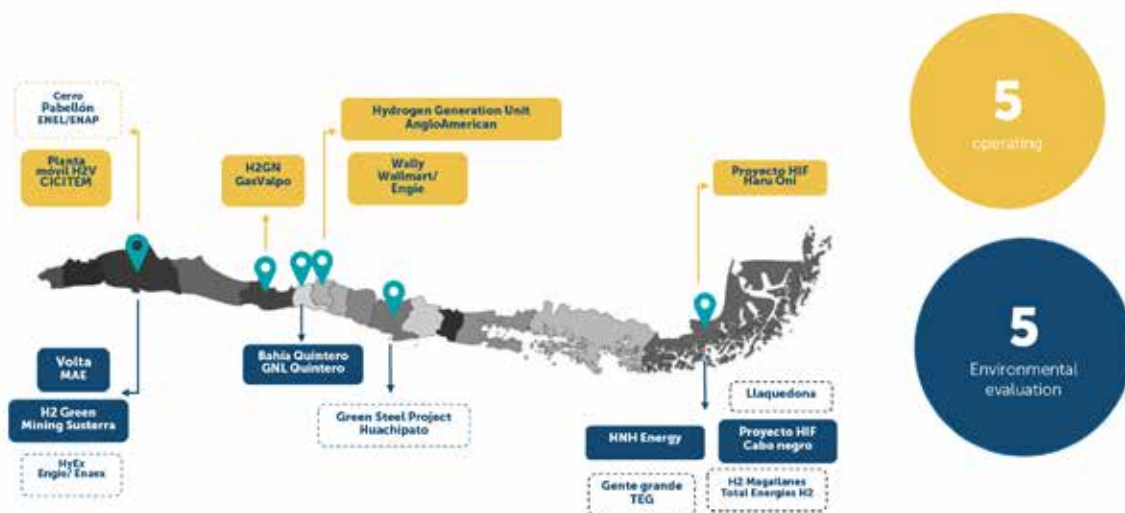
initiated milestones (42%)

MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 41



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 42

H₂/NH₃ PROJECTS UNDER DEVELOPMENT



MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 43

REGULATIONS AND STANDARDS



Ministry of Energy



Ministry of Economy,
Development and
Tourism



Ministry of Health



Ministry of Transport and
Telecommunications



Ministry of Mining

Published on September 12th

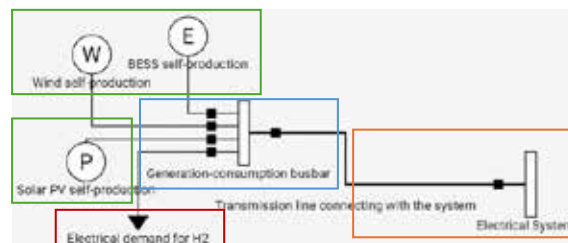
MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 44

ELECTRICAL POWER SYSTEM



• A generation-consumption system

- Is a demand connected to the grid.
- Can produce its own energy with renewable sources.
- Connected in only 1 point to the system.
- Can inject excess of energy to the grid.
- When considering demand charges, it will only pay for the energy and power **taken from the grid**.



- This might be an enabler for green hydrogen projects, as they will count on self-generation at a large scale and take energy and power from the grid during some time blocks or occasionally. Otherwise, they could be charge by the entire demand.
- How do they pay for the energy and power effectively taken from the grid?

ELECTRICAL POWER SYSTEM



- The Ministry of Energy and a consultant, with the support of the GIZ, are developing a study for assessing the payment scheme of the energy and power taken from the grid by generation-consumption systems. This study will asses these payment schemes using a transmission expansion planning model, accounting for a systemic perspective of the issue.
- This study is expected to be finished by late 2024, in accordance with the Action 47 of the 2023 – 2030 Green Hydrogen Action Plan. The results will be a critical input for the generation-consumption regulations that will be included in the regulation for operation and coordination of the electrical system during 2025.

Timeline: 2023-2025

Milestones:

- 2024: Development of specialised consultancy to define regulatory proposal enabling the legal application of generation-consumption systems.
- Mid-2025: Submission of regulatory modification to the General Comptroller's Office.

Responsible Institution: Ministry of Energy.

Action 47: Amend regulatory frameworks to address the operation of generation-consumption systems defined in Article 223 of the General Electricity Services Law

LINE OF ACTION 11:

ELECTRICITY TRANSMISSION AND ENERGY COSTS

ACTIONS	2023	2024	2025	2026	2027	2028	2029	2030
46. Strengthen the methodology of Long Term Energy Planning (PLEP).		1	2					
47. Amend regulatory bodies to address the operation of generation-consumption systems defined in the Electricity Law.		3	4					
48. Enable residential customers to connect to the transmission of green hydrogen projects.				5				
49. Implement the participation of green hydrogen and derivative projects in electricity markets to provide various services.					6			



FINANCIAL MECHANISMS AND INCENTIVES

H2 FACILITY

- **Objective:** Catalyze private investment, mainly by reducing costs and mitigating financial risks, using financial instruments backed by the State.
- It will initially have USD 1 billion at its disposal.
- First milestone: during the fourth quarter of 2024, constitution of the H2V Guarantee Fund (with USD 50 million as first capitalization). It will make H2V hedges available for projects with "Project Finance" or "Structured Finance" as from the start of the Facility's operations.

H2 GLOBAL OR SIMILAR / CFD

- In conjunction with the Uruguayan Ministry of Energy, and following a meeting between the Chilean Minister of Energy and H2Global, we are initiating a joint working group so that green hydrogen projects in Chile and the region can participate in H2Global's tenders.

ARTICLE 6 / CARBON PRICING MARKET

- Climate Change Framework Law instructs the development of economic instruments for climate change management.
- An Emissions Trading System will be implemented, based on a cap & trade scheme in the energy sector. To this end, the Ministry of Energy is about to design and then implement a pilot ETS program for the energy sector.



FINANCIAL MECHANISMS AND INCENTIVES

FISCAL LANDS

- **Objective:** Allocate and manage fiscal land for the development of the green hydrogen industry and its derivatives, considering the territorial compatibility of the requests, within the framework of the "Window to the Future" initiative.
- First allocation process underway; as of August 2024, 3 allocations have been finalized or are about to be finalized, and 17 with a high degree of progress in the pipeline.
- By 2025, the Ministry of National Assets will publish a second call for the allocation of public land.

R&D LAW

- Chile allows the disbursement made under Law No. 20,241 (Law for the Promotion of Research and Development), which establishes a tax incentive for private investment in research and development, to be charged as a credit against the first category tax (up to 35%). The remaining 65% of the investment can be considered a necessary expense to produce income, regardless of the line of business of the company.
- The intention is to strengthen the instrument by increasing the amounts, especially for projects consistent with sustainable development, such as green hydrogen projects.

TAX INCENTIVES

- Tax credit fund, attributable to the first category tax for investments with a high multiplier effect, including the sustainability dimension
- Development tax for investment, tax reduction to incentivize investments that increase business productivity



FINANCIAL MECHANISMS AND INCENTIVES

PERMITTING SYSTEM IMPROVING

- Reforma Integral a la Tramitación de Permisos Sectoriales
- El Ministerio de Economía está actualmente impulsando el trámite en el Congreso de proyecto de ley de reforma integral de permisos sectoriales que simplificará procedimientos de tramitación de proyectos de inversión y reducirá significativamente sus tiempos, resguardando la calidad de ellos y aumentando la certeza jurídica del sistema mediante principios y normas claras, mejor acceso a información, trazabilidad de los trámites

Request for Proposal (RFP) for the manufacture of electrolyzers

- Corfo realizó un llamado a presentar propuestas dirigido a la fabricación y/o ensamblaje de electrolizadores y sus componentes en el país.
- Convocatoria considera un cofinanciamiento por parte de Corfo de hasta un 60% por proyecto, con un máximo de 10 millones de dólares.

Technological Programs (PTEC) Manufacturing and Industrial Use of H₂V

- Buscan incrementar tasa de innovación tecnológica en productos y procesos de empresas asociadas a la cadena de valor del hidrogeno verde y derivados.
- Convocatoria para proyectos de Uso y adopción de H₂ en la industria Chilena
- Convocatoria para fortalecimiento de capacidades locales de manufactura de componentes habilitantes para la industria del H₂V en Chile



RFP FOR ELECTROLYZERS MANUFACTURING

Deadline extension



Proposals for the manufacturing and/or assembly of electrolyzers and their components in Chile

Domestic and foreign companies are invited to form industrial partnerships for the Green Hydrogen value chain, connecting the supply and demand of electrolyzers, their components, and auxiliary systems.

DEADLINE TO
SUBMIT PROPOSALS
22 OCT
12:00 HRS.
www.corfo.cl



Application

Opening:
May 17, 2024
End:
October 22, 2024



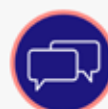
Evaluation

Start:
October 22, 2024
End:
December 26, 2024



Communication of results

Start:
December 27, 2024
End:
January 24, 2025



Contact

Mail:
hidrogenoverde@corfo.cl

<https://www.corfo.cl/sites/cpp/manufacturing-assembly-electrolyzers-components-chile>

TERRITORY AND ENABLING INFRASTRUCTURE

It is addressed at the regulatory level to provide certainty to the location of projects, and instrumentally through territorial planning and management, as well as through energy planning with a territorial focus. The main initiatives under development are:

- Study and work on the modification of the OGUC for territorial compatibility (2024-2025)
- Update Circular No. B32/04 of MINSAL that instructs technical criteria for the qualification of productive activities and infrastructure
- Territorial planning: Mejillones, San Gregorio, etc.
- Energy planning (PELP-PDGE-PEER)
- Industrial Neighborhood Planning and H2V Hub



MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 51

TERRITORY AND ENABLING INFRASTRUCTURE

Plan a portfolio of investments in strategic infrastructure necessary for the promotion and development of the green hydrogen industry, public and private, considering the existing infrastructure as a starting point and considering the possibility of infrastructure sharing. The main initiatives under development are:

- Logistics Development Plan in the Magallanes and Antofagasta Region. (2024-2025)
- ENAP Infrastructure Plan (p.e. Laredo). (2024-2030)
- Investment in public ports such as EPA (p.e. Mardones). (2024-2027)



MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 52



PMO CONTROL AND ACCOUNTABILITY

18 ACTION LINES	→	100% have already begun implementation
81 ACTIONS	→	44% have already started to develop
174 MILESTONES	→	6% are already completed (7 milestones)

Ministry of Energy is **installing follow-up and monitoring mechanisms** for the Plan's commitments, **under the approving decree signed by the president** and ministries involved in the industry:

- follow-up of the fulfillment of each milestone and action
- **PMO project management methodology**
- designation of specific responsible persons per institution
- measurable milestones and clear deadlines

PMO benefits:

- helps to visualize progress in order to prioritize the necessary coordinations
- allows to raise alerts on possible deviations from plans
- helps to better direct efforts and resources

INFORMATION GATHERING

→ **Accountability to the public**

→ **Coordination at different levels**
– Ministers, institutions' teams, public-private work, etc.



GH₂ MID-TERM GOALS

2030

Opening to international markets

First green maritime trade route

Uses to decarbonize the national economy

First coal-fired generation unit reconverted

STRENGTHENING ASIA-PACIFIC RELATIONSHIP



Goal by 2030

Materializing the first green maritime trade route in Latin America

Feasibility studies under development for **copper and sulfuric acid transportation** (2024)

- Gap identification, analysis and ranking for implementation
- Initial estimates of incremental costs compared to fossil routes

Pre-feasibility study for **aquaculture** (2025)



MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 55

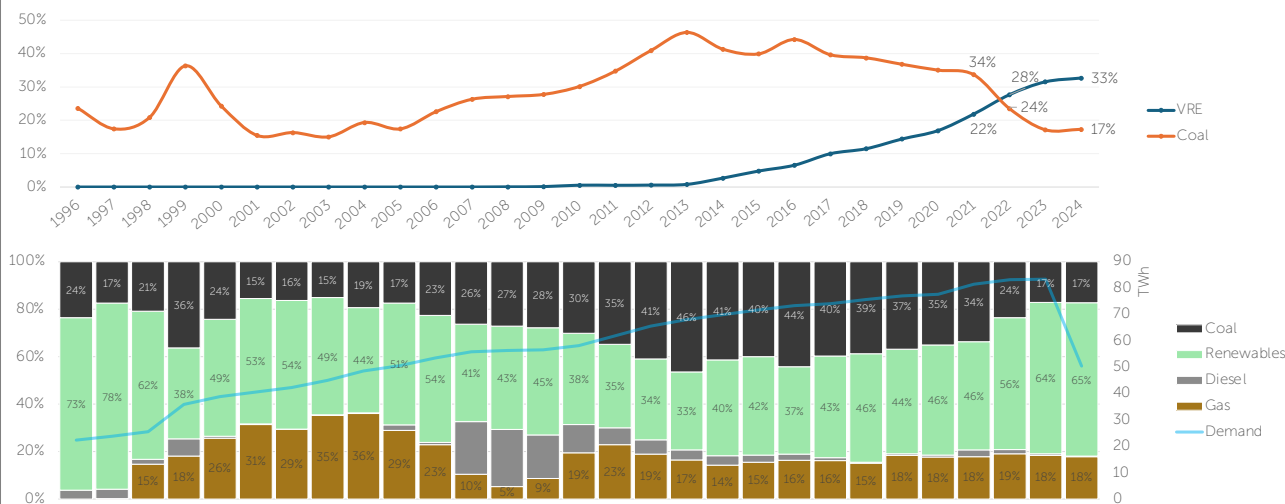
DECARBONIZATION PROCESS IN CHILE



Green hydrogen and ammonia industry will allow to change pollutant **to clean industries**

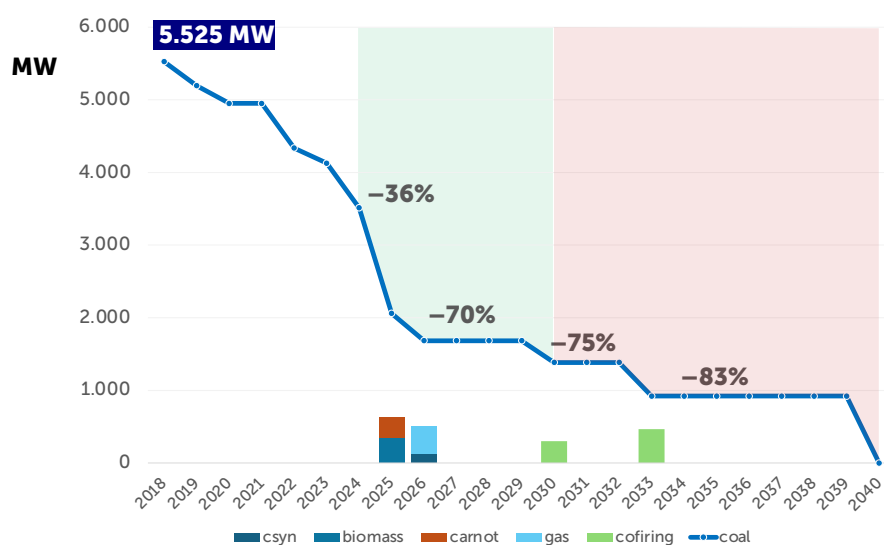
MINISTRY OF ENERGY | CHILEAN GH₂ STRATEGY AND ACTION PLAN | 56

DECARBONIZATION PROCESS IN CHILE



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 57

DECARBONIZATION PROCESS IN CHILE



MINISTRY OF ENERGY | CHILEAN GH2 STRATEGY AND ACTION PLAN | 58

DECARBONIZATION PROCESS IN CHILE

Towards a 100% clean electricity system by 2050



TODAY

Synchronous machines (thermal and hydraulic plants)

Progressive generation growth with digital signals included (CRF, synthetic inertia, etc). Start of analysis and testing

2030

Process of coal retirement and reduction of participation of synchronous machines, leaving mainly hydro and gas, and coal reconverted plants.

Traditional solutions (synchronous condensers, flywheels, reversion, etc).

Quick incorporation of IBRs and GETs, storage

2050

An important percentage of IBR and GET technologies on the grid operating

Digital signals available for use in real time operation

Use of clean fuels (hydrogen and derivatives, CCS-CCU) in some plants

The energy transition must consider different technologies

INVESTMENTS FOR A BETTER FUTURE

Promoting the worldwide energy transition together



1

Renewable energies

Such as solar PV and wind plants, but 24/7 clean energies. Considering utility and distributed scales.

2

Storage projects

Short (transmission) and long (arbitration) duration

3

Reconversion of thermal power plants

Using co-firing and blending technologies, and carbon capture options as CCU (carbon capture and utilization) and/or CCS (carbon capture and storage)

4

Green hydrogen and ammonia value chain

Renewables, electrolizers, ports, pipelines, off-takers. Certification.

5

Modernization of electrical power system

Transmission, Grid Enhancing Technologies, Grid-forming inverters, IBR, digitalization of operation, among others



Experience about

industrialization

economies





ALEX SANTANDER

Director of Strategic Planning and Sustainable Development
Ministry of Energy

asantander@minenergia.cl
+56 9 9557 2088

Country Day II : Chile Day

**Investment Attraction Policy of Chile
– Highlights for Energy Industry**

Country Day II : Chile Day

Investment Attraction Policy of Chile – Highlights for Energy Industry



Catalina Pérez

International Network Manager,
InvestChile : Investment Promotion Agency of Chile

Education

- 2007-2013, Bachelor in Natural Resources, graduated in Agricultural Engineering with a minor in Economics, Pontifical Catholic University of Chile

Professional Career

- 2013 – 2015 : Management Control Assistant, Subsole Export Company - Chile
- 2015 – 2016 : Team Supervisor at Chilean Pavillion, Universal Expo Milano 2015 - Italy
- 2016 – 2019 : Asia Market Manager at ProChile, Ministry of Foreign Affairs of Chile - Chile
- 2019 – present : International Manager at InvestChile - Santiago

Research Interest

Foreign Investment in developing countries
Economic development for the green transition
Critical Minerals
Infrastructure for the climate change mitigation
Renewable energies and green hydrogen

Speech Title

Investment Attraction Policy of Chile – Highlights for Energy Industry

Speech Summary

InvestChile Overview: InvestChile is the state agency responsible for promoting and attracting foreign investment to support Chile's development. It advises over 700 companies annually and manages a project portfolio worth \$33.5 billion.

Investment Strategy: The agency focuses on sustainable and inclusive economic development, targeting high-impact areas like the 4th industrial revolution and sustainable development.

Support Services: InvestChile provides comprehensive support at every stage of investment, from initial prospection to re-investment, including legal advice, public incentives, and conflict resolution.

Economic Highlights: Chile is a leader in digital connectivity and green energy, offering investment opportunities in sectors such as green hydrogen, technological infrastructure, and electromobility.

Company Introduction

InvestChile is the public agency responsible for promoting and attracting foreign investment in Chile. It aims to support the country's economic development by connecting foreign investors with business opportunities in Chile.

H2V Roadshow - September 2024



InvestChile

InvestChile: Investment Attraction Policy of Chile – Energy/H2

Catalina Pérez

International Network Manager
cperez@investchile.gob.cl

FDI Benefits

- Economic growth and competitiveness
- Employment opportunities, human capital development, improvements in productivity, wages increase
- Improvements in the welfare of consumers and workers
- Innovation, trade
- New technologies and processes
- Better environmental standards

...if the host country has appropriate policies and a sufficient level of development for the investment to come to fruition.

investchile.gob.cl

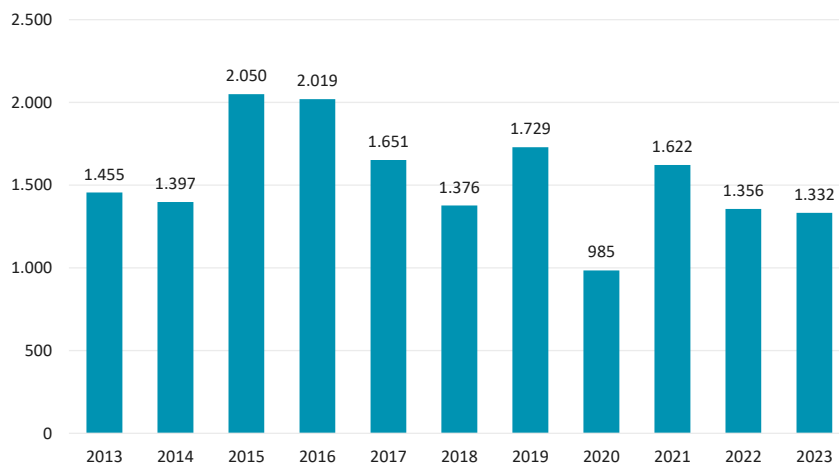
AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

The global flows of foreign investment decreased by 1,8% in 2023 compared to the year 2022.



Global Direct Investment Flows

(Thousands of billions each year)



Fuente: Elaboración propia con base en datos de la OCDE.

Investchile.gob.cl

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

FDI flow in 2023 corresponds to the second year with the highest foreign investment in Chile since 2015.



FDI flows by component

(As of December of each year, in millions of US dollars)

- In 2023, foreign investment reached US\$ 21.7 billion.
- Foreign investment in 2023 represents significant growth compared to 2022
- The figure for 2023 is also 36% higher than the latest five-year average and 50% higher than the average for the 2003-2023 period.



Source: Prepared by the authors with information from the Chilean Central Bank.

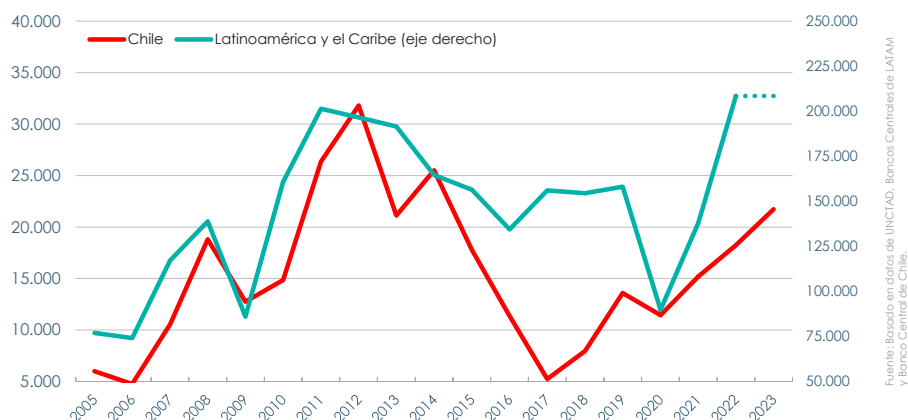
Investchile.gob.cl

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

For 2023, a zero variation in foreign direct investment (FDI) flows is expected in Latin America and the Caribbean. Chile experienced a growth of 19.2% compared to 2022.



FDI flows in Latin America and Chile
(Millions of USD)



Investchile.gob.cl

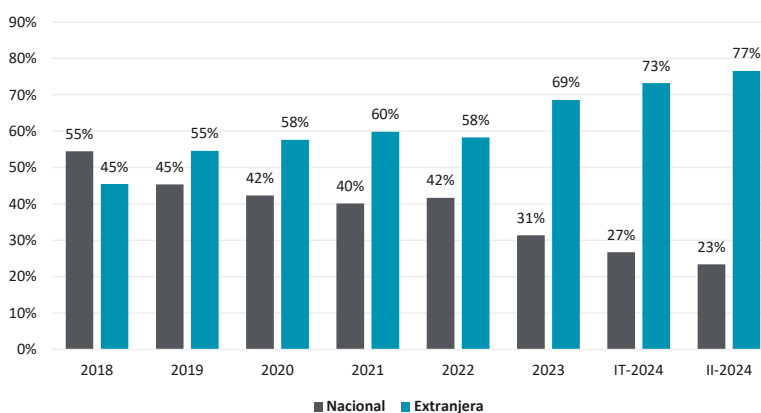
AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

Between 2018 and the second quarter of 2024, foreign private investment increased its share from 45% to 77% of the total investment amount.



CGC Registry Private Investment Participation by National and Foreign Origin

(Percentage)



Investchile.gob.cl

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

InvestChile

450 projects

US\$33.5 billion

Project portfolio
as of December 2023



The State agency that proactively promotes and attracts the foreign investment that Chile needs for its development.

+700 companies
advised each year.

**Services to accelerate
your business**

We offer specific services and key information at each stage of investment project development to support and facilitate decision-making.

Investchile.gob.cl

WHO WE ARE

Foreign Investment Promotion Agency

Purpose

- State agency for the **Promotion and Attraction of Foreign Investment.**
- Increase the realization of quality foreign investments, to:
 - **Diversify and sophisticate** the productive matrix.
 - **Generate quality Jobs**
 - **Promote the transfer** of technologies, capacities, and knowledge
 - **Promote productive linkages** with the local economic network



Committee of Ministers

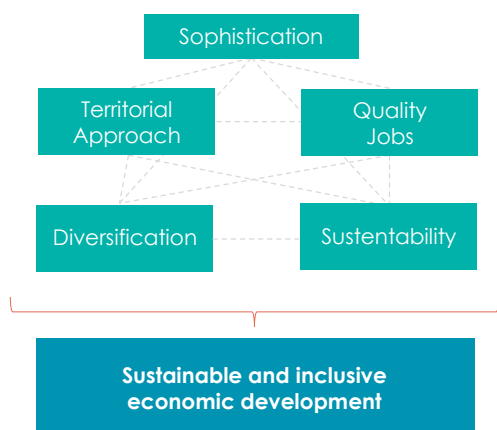
Economy · Finance · Agriculture
Public Works · Mining · Energy · Foreign Affairs

Public-Private Advisory Council

Investchile.gob.cl

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

WHAT INVESTCHILE DOES



- We generate **incremental investment** in the economy with a proactive strategy.
- Investment in areas with undisclosed competitive advantages, of **high impact** for the country's economic development.
- Investment for Chile to be part of the **4th industrial revolution**.
- Investment for **sustainable development**.
- We contribute to increasing the probability of investment materialization.
- We influence and accelerate decision-making.
- We reduce information asymmetries and risk perception.

InvestChile

At every stage of your investment project



PROSPECTION

- General information regarding the investment climate in Chile
- Investment opportunities
- Government programs and public tenders
- Public investment project portfolio
- Specialized reports & publications
- Foreign Direct Investment Statistics



PRE-INVESTMENT

- Meetings Agenda.
- On-site visits & Virtual tours.
- Pool of service providers.
- Industry-specific information.
- Legal advice: setting up a company, taxes, regulations, permits, visas.
- Public incentives: advice & support for application.



LANDING



RE-INVESTMENT

- Support for re-investment & expansion projects
- Contact with key stakeholders in the ecosystem: public, private, academia, industrial associations.
- Support with problem solving, conflict resolution related to operating in Chile

[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

OUR STRATEGY TO PROMOTE FDI

Foreign Investment Promotion Agency



Incentives

- **Tax Incentives:** DTAs – FTAs – VAT refund – VAT exemption for capital goods, R&D law
- **Financial Incentives:** R&D grants, Scholarships IFI Tech, Tax credit extreme zones, Youth Employment subsidy
- **Regulatory Incentives:** Advisory, Visa support

Facilitators

- **Facilitate Permits Processes:** Draft law sectorial permits, Draft law Environmental Assessment, Strengthening of processing services with critical permits.
- **Project Support Offices:**
Ministry of Economy – Projects Office
Ministry of Energy – Projects Support Unit
InvestChile

[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

A Robust Foreign Investment Regime

Equal Treatment

Foreign companies based in Chile enjoy the same rights and obligations as Chilean companies in the country.

Free flow of capital & profits

National legislation allows the entry and repatriation of capital without costs.

Pro-business environment

Simple tax structure /ease to set up companies.

Committed to boost investment

Pro-investment agenda of President Boric's government

[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

KEY INVESTMENT OPPORTUNITIES FOR GLOBAL CHALLENGES



Investment in decarbonization and digital revolution

Our country is not only among the most attractive emerging economies for investment in clean energy, but it also produces minerals that are critical for the energy transition.

H2V; digital infrastructure; global services

Chile has set the goal of becoming the world's cheapest green hydrogen producer (2030); it is a regional technology infrastructure hub (225 projects for 5.6 billion by the first half of 2023); and it is committed to the development of the knowledge-based services sector, to name just a few examples.

Electromobility and clean generation technologies

Chile has the conditions to support the progress of clean energy generation technologies, the widespread use of electromobility, the expansion of electricity grids and the progress towards batteries with higher performance, longer life and higher energy density.

[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

INVESTMENT
OPPORTUNITIES

Green Energy
Mining & Lithium Industry
Food Industry & Recycling Industry
Digital Economy



[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

GREEN ENERGY

Long term Energy Planification Scheme



1st Energy Policy
Published in 2015

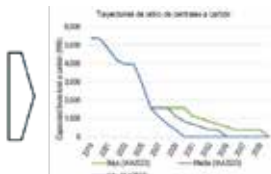


1st update of the Energy Policy
Published in 2022



Initial agenda for a Second Stage of the Energy Transition

Chile is ranked
#3 on the 2023 Bloomberg NEF Climatescope ranking, (#1Latam) attractive emerging markets for clean energy investments.

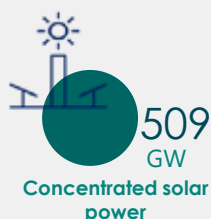
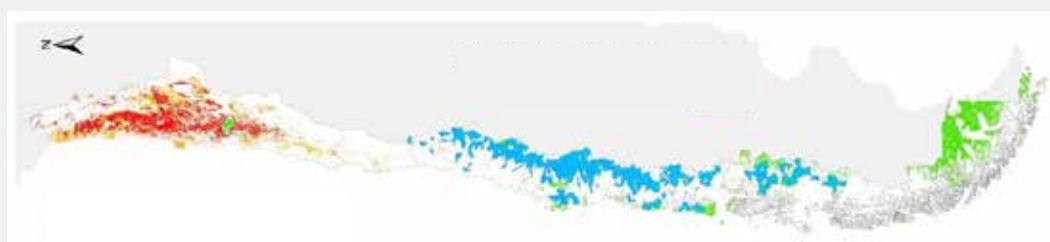


[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA



Chile has massive renewable resources to power the transition to a green energy matrix

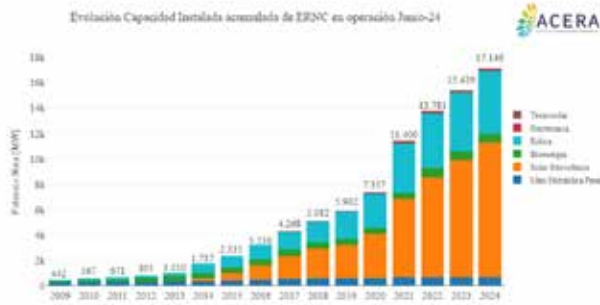


1800+ GW

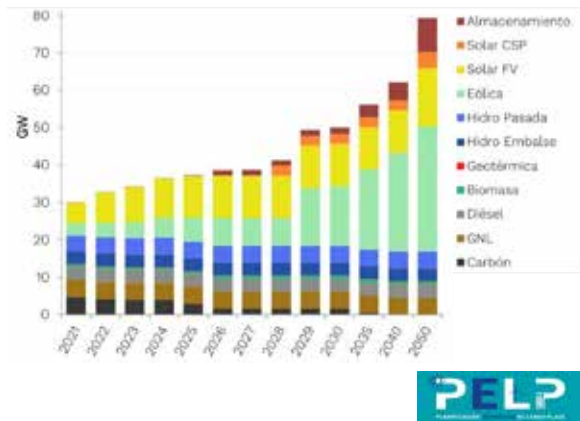
[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

Drivers to invest in Chile's Energy Sector



Installed Capacity Growth projections



Renewable energy potential 70x

Chile's potential in renewable energies is more than 70 times its current installed capacity.

[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

GREEN HYDROGEN



6 strategic pillars.
2020



5 target images
2023



81 actions.
2024



Regulation and permits



Financing and incentives



Local development



Domestic market and international partnerships

[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

GREEN HYDROGEN



Investchile.gob.cl

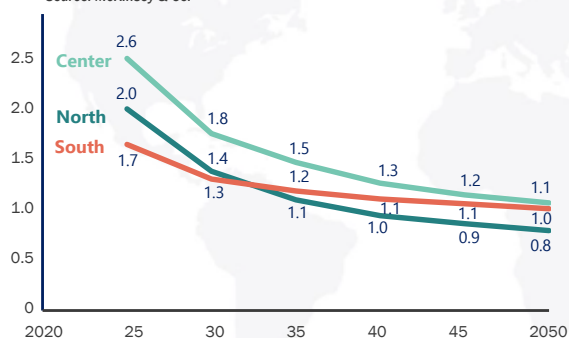
AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

The cheapest green hydrogen on the planet



Levelized cost of green hydrogen (USD/kg H₂)

Source: McKinsey & Co.

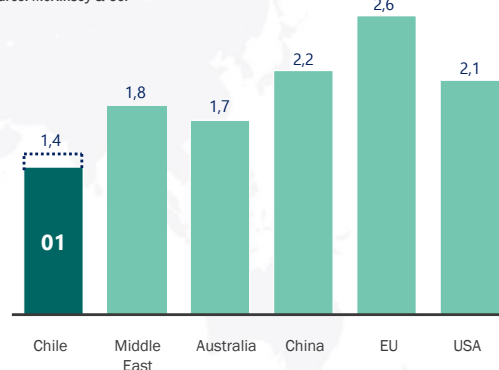


Potential for a 160 Mton yearly green hydrogen production*

*Source: International Energy Agency.

Levelized cost of production by 2030 (USD/kg H₂)

Source: McKinsey & Co.



*Does not consider conditioning, transport, storage nor distribution costs.

Investchile.gob.cl

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

H2V – InvestChile/ Highlights

InvestChile 

- Ministry of Energy & InvestChile working along to promote internationally the **H2V National Strategy**
- InvestChile is currently working with **20 companies on H2V, over US\$15 billion.**
- **H2V Action Plan – H2V e-Book** recently launched.
- **Green Corridors:** Led by the Ministry energy.

Opportunities: - **Investments** (development, loan, debt, equity, etc)
- **Supply Chain:** complement know-how for “multi projects”.
- **Off Takers:** domestic & international.

Investchile.gob.cl

Hydrogen Projects Portfolio

InvestChile 

Investchile.gob.cl

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

#InvestChile Tools to Power up your business



BROCHURE

*中文 – EN - ESP

Our brochure 'Chile, the Place to Build Your Future', as well as, some of the previous tools are available in: Mandarin (* 中文), Spanish, Portuguese, Japanese & German.



INVESTOR'S GUIDE

*中文 – EN- ESP- POR

A complete guide to setting up your business operations. *Steps for landing / Incentives for Foreign Investment / Intellectual Property / Tax structure of Chile / Environmental Legislation / Visas and Foreign Citizens / Personal Data legislation / Labour Laws and Social Security.*



SECTORIAL E-BOOKS

EN - ESP

FDI projections & opportunities regarding food, sustainable packaging, energy, mining, venture capital & Fintech, global services & digital economy in Chile.



INVESTCHILE PORTFOLIO

EN - ESP

This public-private portfolio includes +120 projects in different sectors such as: Infrastructure, tourism, energy & mining.



Investchile.gob.cl

SCAN & DOWNLOAD

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA



E-Book: H2V in Chile



- Comprehensive overview with key information about green hydrogen production in Chile.
- Main actors, projects and incentives
- Climate change and Chile's decarbonization commitments.
- Enabling conditions for the production of GH2 in Chile: Renewable Energy, land, water & infrastructure.



Investchile.gob.cl



InvestChile

Catalina Pérez – International Network Manager - cperez@investchile.gob.cl

[Investchile.gob.cl](https://investchile.gob.cl)

AGENCIA DE PROMOCIÓN DE LA INVERSIÓN EXTRANJERA

Country Day II : Chile Day

**The Future of Global Hydrogen Trade :
Implications for Chile and South Korea**

Country Day II : Chile Day

The Future of Global Hydrogen Trade : Implications for Chile and South Korea



Prof. Younkyoo Kim

Dean of Graduate School of International Studies of
Hanyang University, Hanyang University

Education

- Ph.D. Political Science, Purdue University (Dec. 2000)
- Advisor: Rolf H.W. Theen
- Thesis: Building State Capacity in Russia: A Case Study of Energy Sector Reform, 1992-98
- MALD. Fletcher School of Law & Diplomacy, Tufts University (1996)
- B.A. Russian Language and Literature, Seoul National University (Feb.1988)

Professional Career

- 2005~2011, Assistant Professor, School of International Studies, Hanyang University, Seoul, Korea
- 2011~2015, Associate Professor, School of International Studies, Hanyang University, Seoul, Korea
- 2012~Present, Founding Director, Hanyang Center for Energy Governance & Security
- 2015~Present, Professor, School of International Studies, Hanyang University, Seoul, Korea
- 2023~Present, Director, Hanyang Institute of Energy and the Environment
- 2023~Present, Dean, Graduate School of International Studies, School of International Studies, Hanyang University, Seoul, Korea

Research Interest

- International energy politics and political/economic problems of resource-rich countries.
- Economic Security of Critical Minerals
- Global Supply chain of hydrogen
- Research Articles
 - Younkyoo Kim. 2023. US-China Electric Vehicle Battery Competition and the Role of South Korea, NBR Roundtable for Congressional Affairs, December 2023.
 - Younkyoo Kim. 2022. Rich China, Poor America: Economic Security of Rare Earth Elements. 2022.

Speech Title

The Future of Global Hydrogen Trade: Implications for Chile and South Korea

Speech Summary

The presentation will explore Chile and South Korea's roles within value and supply chains and delve into how Chile's hydrogen export initiatives and South Korea's hydrogen economy policies may reshape the globe's energy and geopolitical relationships. It underscores the importance of a comprehensive understanding of the evolving hydrogen landscape, which promises to reshape energy relations and geopolitics across the Asia-Pacific

Company Introduction

- Hanyang University is a private research university in South Korea. The main campus is in Seoul, and the second one, the Education Research Industry Cluster at Ansan, or ERICA campus, is located in Ansan. Hanyang (한양,漢陽) derives from the former name of the capital Seoul which was used during the Chosun Dynasty. Its motto and educational philosophy is Love in Deed and Truth.
- The university established the nation's first engineering institute (DongA Engineering Institute) in 1939 which became the founding facility of Hanyang University. It also established the first school of architecture and civil engineering in Korea.
- Hanyang University has an alumni network of 330,000 that is not limited to the field of engineering but also to other fields. In 2018, Hanyang was ranked 1st for the number of CEO alumni of venture companies. In 2019, QS World University Rankings ranked Hanyang University 150th.
- The university welcomes over 7,400 foreign students each year and more than 3,000 students study abroad annually. HYU counts the Massachusetts Institute of Technology, University of Cambridge, and Tsinghua University among its 820 partner universities in 88 countries.
- Hanyang University is a private research university in South Korea. The main campus is in Seoul, and the second one, the Education Research Industry Cluster at Ansan, or ERICA campus, is located in Ansan. Hanyang (한양,漢陽) derives from the former name of the capital Seoul which was used during the Chosun Dynasty. Its motto and educational philosophy is Love in Deed and Truth.
- The university established the nation's first engineering institute (DongA Engineering Institute) in 1939 which became the founding facility of Hanyang University. It also established the first school of architecture and civil engineering in Korea.
- Hanyang University has an alumni network of 330,000 that is not limited to the field of engineering but also to other fields. In 2018, Hanyang was ranked 1st for the number of CEO alumni of venture companies. In 2019, QS World University Rankings ranked Hanyang University 150th.
- The university welcomes over 7,400 foreign students each year and more than 3,000 students study abroad annually. HYU counts the Massachusetts Institute of Technology, University of Cambridge, and Tsinghua University among its 820 partner universities in 88 countries.

Future of Global Hydrogen Trade: Implications for Chile and South Korea

September 26, 2024

Younkyoo Kim

Dean, Graduate School of International Studies, School of International Studies, Hanyang University

Director, Hanyang Institute for Energy & Environment (HY-IEE)

Director, HYU-GETPPP



Current State of Green Hydrogen

Global hydrogen demand in 2021 : approximately **94 Mt**

54 Mt in industrial uses
(ammonia or methanol; DRI)

40 Mt in refineries

New industrial uses and applications
(small percentage in transportation, grid injection and power generation)

Estimated Global hydrogen demand by 2030 : more than **200 Mt**



Only 0.6 Mt (less than 1%)
from green or blue
hydrogen (IEA, 2022)



Low-carbon hydrogen will
increase to 70% in 2030
(IEA, 2021)



25% of global hydrogen
demand will be traded
internationally by 2050



Pure hydrogen will be
a 'Regional' business while
Hydrogen derivatives will be
traded worldwide

Chile's Green Hydrogen Strategy

Green hydrogen and its derivatives represent a historic opportunity to transform Chile into one of the leading exporters of clean energy globally.

This will enable job creation and foster new investments that will contribute to local development and decentralisation.

Establishing the Foundations of the Industry

2020

- Action Plan 2020-2023:
- ① Domestic market and export promotion
 - ② Regulation, safety, and pilot projects
 - ③ Social and territorial development
 - ④ Capacity building and innovation

Activating the Industry

2025

- ① 5 B USD: Top 1 of investments in Latin America
- ② 5 GW electrolysis capacity built and under development
- ③ 200 Kton/year production in at least two hubs

• Conquering Global Markets
• An exporter of energy in the form of Green Hydrogen

2030

• Conquering Global Markets
• 70% of zero-emission fuels in non-electric energy end uses

2050

- ① 2.5 B USD/year Global export leader
- ② 1.5 USD/kg cheapest GH₂
- ③ 25 GW global leading producer of GH₂ by electrolysis

18 Lines and 81 Actions

Chile's Green Hydrogen Economy sectors

Production Capacity

Renewable Energy Potential: Chile possesses vast solar and wind resources, with an estimated **annual power generation potential of around 1,800 TWh**, which is about 70 times its current power demand.

Hydrogen Production Goal: The Chilean government aims to achieve at least 5GW of green hydrogen production capacity by 2030.



Export Strategy

Global Market: Aims to export green hydrogen primarily to key markets in Europe and Asia by 2040. The initial annual export target is approximately 200,000 tons of green hydrogen.

However, realizing these goals will depend on several factors, including domestic and international investment, technological advancements, and improvements in the regulatory environment.

Utilization



Hydrogen Fueling Stations: Plans to establish a network of hydrogen fueling stations connecting major cities and transport routes by 2025



Hydrogen Pipelines: Feasibility studies and planning are underway for the long-term development of domestic hydrogen pipelines.

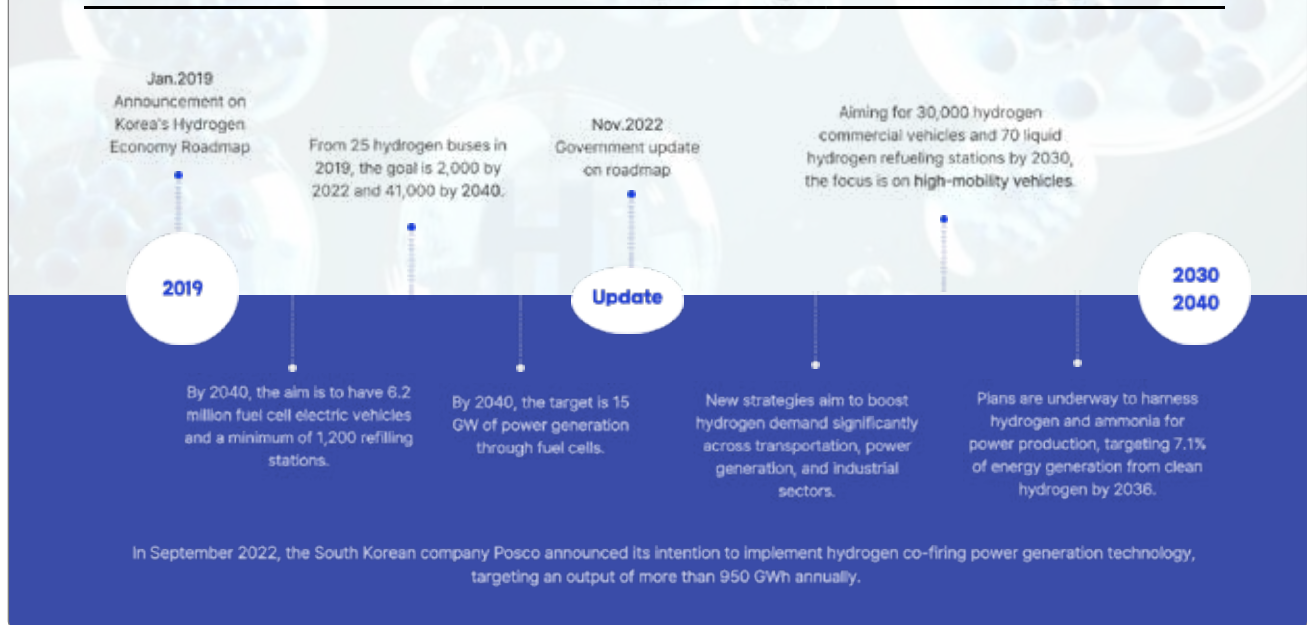


Transport Sector: Target to introduce over 1,000 hydrogen-powered commercial vehicles by 2030

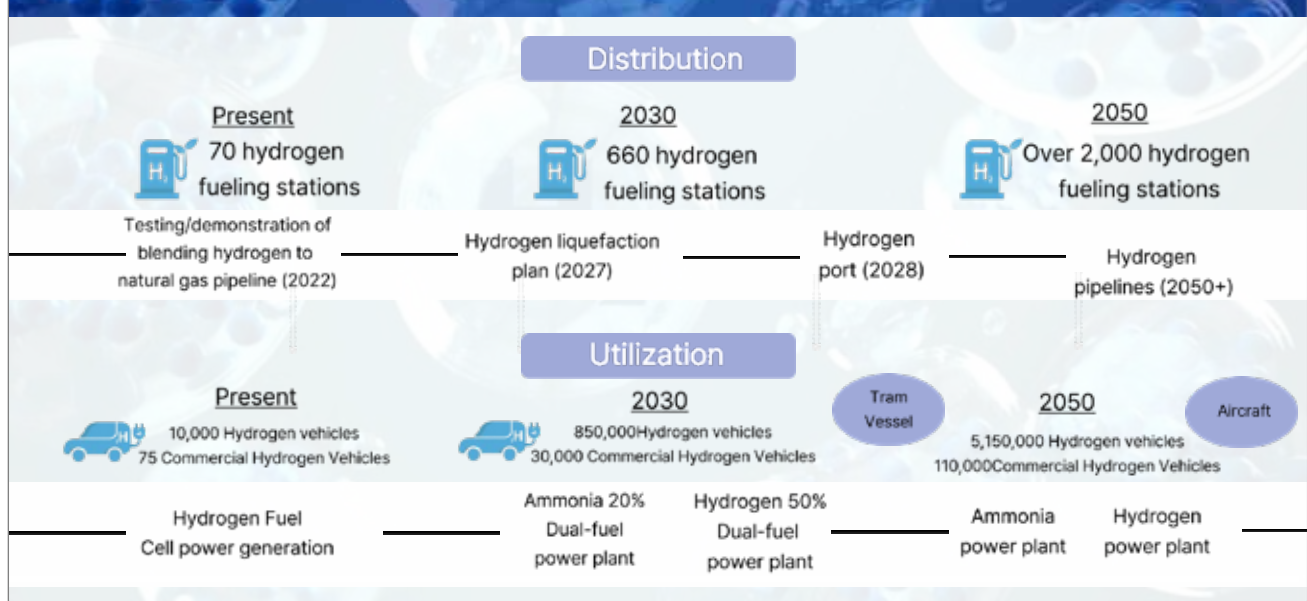


Energy Storage and Generation: Pilot projects for energy storage and generation using hydrogen are ongoing, including trials of hydrogen blending at major power stations.

South Korea's Hydrogen Strategy



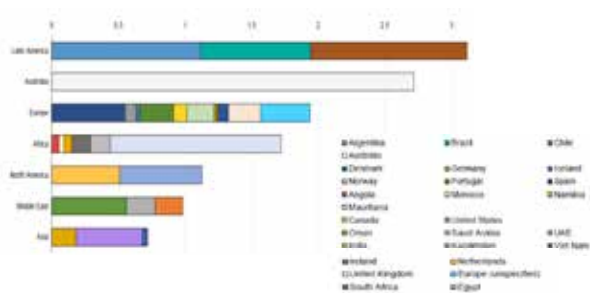
South Korea's Hydrogen Economy Sectors



Future Prospects and Strategic Recommendations

By 2030, 12 Mt of Low-Carbon hydrogen exports per year are expected

Planned hydrogen exports by region/country (2030)
Mt H₂ equivalent per year by 2030



IEA, Global Hydrogen Review 2022, p. 165.

Role of Chile

Hydrogen Production Leader

Chile boasts world-class renewable energy resources. The solar potential in its northern desert regions and strong winds in the south provide ideal conditions for low-cost, high-efficiency green hydrogen production.

Sustainable Development

The hydrogen economy offers an opportunity to reduce reliance on traditional industries such as mining and to foster new economic growth drivers.

Role of South Korea

Investment in Hydrogen Infrastructure

- ✓ Facilitating the development and commercialization of hydrogen fuel cells and related technologies
- ✓ Significant investments are being made by the government and corporations in hydrogen vehicles and fueling infrastructure

Domestic and Export Market Development

Expansion of hydrogen-based transport such as hydrogen buses and hydrogen taxis and export of related technologies such as hydrogen fuel cells

Thank you

Country Day II

USA Day

Country Day II : USA Day

Opening Remarks

Country Day II : USA Day

Opening Remarks



Michael Kim

Commercial Officer, U.S. Embassy Seoul

Education

- M.A. in International Business and Policy, Georgetown University (McDonough School of Business and Walsh School of Foreign Service)
- M.S. in Management of Secure Information Systems (Cyber Security) from George Mason University
- B.A. in Economics, Northwestern University.

Professional Career

- Commercial Officer, U.S. Embassy France
- Advocacy Center in Washington D.C.
- 20 years of public and private sector experience on the defense and ICT sectors

Speech Title

Opening Remarks at the U.S.-ROK Hydrogen Business Forum

Speech Summary

The opening remarks at the US-Korea Hydrogen Business Forum emphasizes the importance of bilateral collaboration in advancing hydrogen technologies, highlighting shared goals in achieving carbon neutrality and fostering innovation and investment opportunities within the hydrogen sector.

Company Introduction

The U.S. Embassy Seoul's Commercial Service is the trade and investment promotion arm of the U.S. Department of Commerce.

Country Day II : USA Day

U.S. Hydrogen Landscape and Policy Updates

Country Day II : USA Day

U.S. Hydrogen Landscape and Policy Updates



Christine Watson

Technology Manager, U.S. Department of Energy

Education

- 2019-2021, M.S., Materials Science and Engineering, Oklahoma State University, USA
- 2004-2009, B.S., Chemical Engineering, North Carolina State University, USA
- 2004-2009, B.S., Physics, North Carolina State University, USA

Professional Career

- 2023-Present, Technology Manager, Safety Codes and Standards, Hydrogen and Fuel Cell Technologies Office, U.S. Department of Energy, USA
- 2021-2023, ORISE Science and Technology Fellow, Safety Codes and Standards, Hydrogen and Fuel Cell Technologies Office, U.S. Department of Energy, USA

Research Interest

Hydrogen Safety, Codes and Standards

Speech Title

U.S. Hydrogen Program Overview

Speech Summary

The U.S. Department of Energy's Hydrogen and Fuel Cell Technologies Office focuses on research, development, and demonstration of hydrogen and fuel cell technologies across multiple sectors enabling innovation, a strong domestic economy, and a clean, equitable energy future.

Company Introduction

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Hydrogen and Fuel Cell Technologies Office.



U.S. National Clean Hydrogen Strategy Perspectives

Christine Watson
Technology Manager, Safety Codes and Standards Subprogram
Hydrogen and Fuel Cell Technologies Office
U.S. Department of Energy

September 26, 2024



U.S. DOE Hydrogen Program Safety Overview

Christine Watson – Safety, Codes & Standards Subprogram

H2Meet

September 25, 2024 – Kintex, South Korea

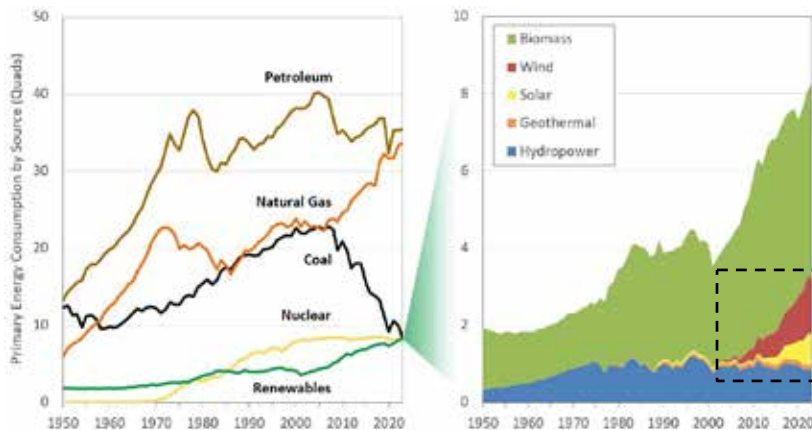


U.S. Energy Landscape and Key Goals

U.S. Primary Energy Consumption by Energy Source

Total = 93.6 quads

Renewable Total = 8.2 quads



Quad= quadrillion British thermal units (Btu)

Source: Melaina, Chilton, et al, DOE HFTO, based on data collected from U.S. Energy Information Administration, Monthly Energy Review, April 2024, Table 1.3. <https://www.eia.gov/totalenergy/data/browser/?tbl=T01.03#/2f=A>

Administration Goals include:

- Net-zero emissions economy by 2050 and 50–52% reduction by 2030
- 100% carbon-pollution-free electric sector by 2035

Priorities: Ensure benefits to all Americans, focus on jobs, Justice40: 40% of benefits in disadvantaged communities

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

2

President Biden Signs Key Bills into Law – Examples of Policies and Activities

Bipartisan Infrastructure Law (BIL) provides \$9.5B for clean H₂ and Inflation Reduction Act (IRA) includes significant tax credits



President Biden Signs the Bipartisan Infrastructure Bill into law on November 15, 2021. Photo Credit: Kenny Holston/Getty Images

BIL Required National Clean Hydrogen Strategy and Roadmap

Examples of policies & activities across the H₂ value chain

Supply	Midstream	End Use Demand
Production Tax Credit 45V, 45Q (Treasury)	Fueling Corridor Grants (DOT/JO)	Vehicle Tax Credits, Clean Fuels Credits, 48C (Treasury)
Electrolyzer RD&D BIL (DOE)	Bipartisan PIPES Act NPRM (DOT PHMSA)	State Policies (ZEV Mandates, H2 PTC) ¹
Manufacturing Tax Credit 48C (Treasury/DOE)	Manufacturing Tax Credit 48C (Treasury/DOE)	Clean Power Rule NPRM (EPA)
H2 Hubs, BIL (DOE)	H2 Hubs, BIL (DOE)	Buy Clean Standards (EOP)
		Agency offtake (DOD, USPS, USDA, DOT, EPA, etc.)
		H2 Hubs, BIL (DOE)

JO: Joint Office of Energy and Transportation; EOP: Executive Office of the President; NPRM: Notice of proposed rulemaking
1: ZEV Mandates see: <https://www.c2es.org/document/us-state-clean-vehicle-policies-and-incentives/>. State example <https://leg.colorado.gov/bills/hb23-1281>.

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

3

U.S. National Clean Hydrogen Strategy and Roadmap



www.hydrogen.gov
Released June 5, 2023



U.S. Opportunity: 10MMT/yr by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050. ~10% Emissions Reduction. ~100K Jobs by 2030.

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

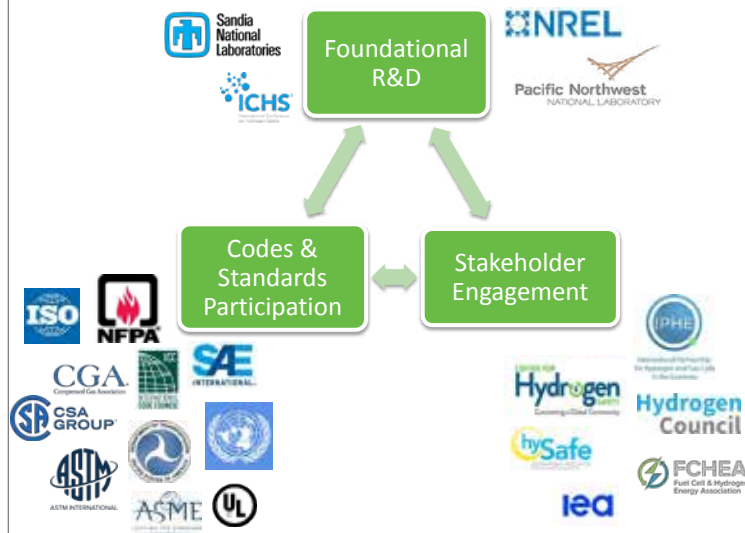
4

Enabling Safety



Safety, Codes, and Standards Subprogram Activities

Collaborative Ecosystem



Enabling the Safe Deployment of Hydrogen and Fuel Cell Technologies

- Conduct **RD&D** to provide **scientific basis** needed to define requirements in developing and revising codes and standards.
- Enable improvements to **permitting process**.
- Support **best safety practices** for hydrogen and fuel cell deployments.
- Develop and enable **widespread sharing** of **safety-related information resources** and lessons learned.
- Conduct **workforce development** activities with an emphasis on safety practices and culture.

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

6

HIT WG – Infrastructure, Siting, and Permitting (ISP)

Goal: Address federal regulatory barriers to infrastructure deployment, siting, and permitting to enable national goals of 10 MMT/year supply and end use by 2030, 20 MMT/year by 2040, 50 MMT/year by 2050

WG Scope	Actions and Milestones (from National Clean Hydrogen Strategy & Roadmap)	Near Term Objectives
• Siting, permitting, pipelines, storage, and infrastructure* • Harmonized codes and standards • Interoperability and global standardization* • Safety, emissions (including secondary), sensors, risk mitigation, environmental impact* • Environmental review and best practices (NEPA, etc.)* • Pipeline and blending test facilities	2023 – 2025 • Lay regulatory groundwork for large-scale clean hydrogen deployments * • Develop streamlined guidance on hydrogen pipeline and large-scale project permitting.* 2026 – 2029 • Enable international harmonization of codes and standards. • Address regulatory challenges to increase electrolyzer access to renewable and nuclear energy. • Develop national guidance for hydrogen blending limits.*	• Identify regulatory requirements and responsibilities for deployment across local, state, and federal levels and any gaps. – Complete January 2024 • Hold forum on pipeline safety R&D. Document results of PHMSA's, DOE's, other federal agencies, and international R&D on hydrogen and hydrogen blends. – Complete October 2023 • Develop lessons learned and best practices on siting, permitting, safety, and infrastructure. – Ongoing – End CY 2024 • Identify potential and existing standards and regulatory requirements for hydrogen and blends for pipelines, storage, and infrastructure. – Expected September 2024 • Develop interagency plan to address access restrictions for FCEVs in tunnels, bridges, and other enclosed public infrastructure. – Ongoing – End CY 2024
Membership Co-Leads: DOE HFTO, DOT PHMSA Members: DOC (ITA, NIST), DOD (USCG), DOE (EJE, FECM, HFTO, OCED, OP), DOI (BOEM), DOL (OSHA), DOT (FAA, FHWA, FRA, FTA, MARAD, NHTSA, PHMSA), EPA, FERC, NASA, WH-CEQ, NRC		

* In partnership with Workforce, Equity and Justice Team

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

7

LH2 Pooling Experiments Enable Model Development & Validation

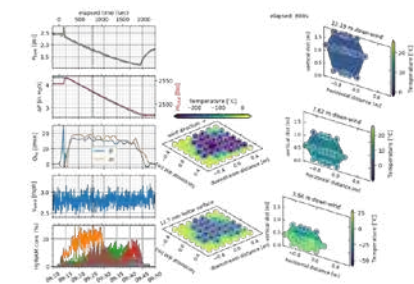
Unique LH2 pooling experiment enables validated models to justify needed safety requirements without unnecessary restrictions for larger liquid hydrogen systems in emerging technologies

- **16 tests over 4 days**

- Variations in wind speed, substrate, LH2 release rate

- Utilized **IR and Visible cameras** coupled with temperature and concentration sensors

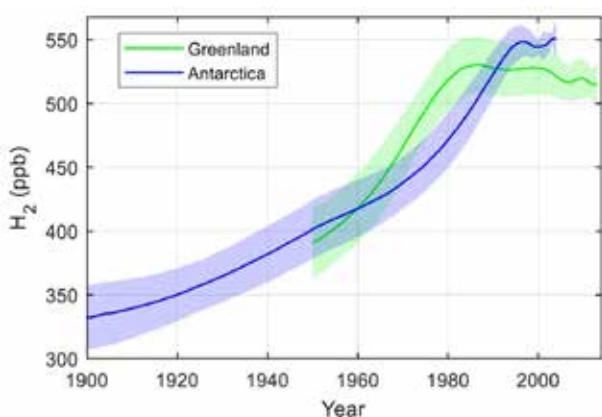
- **NREL's Hydrogen Wide Area Monitor (HyWAM)** monitored hydrogen concentrations, correlated with temperature



Thermocouples Substrate Release point Thermocouples and concentration sensor intakes



Understanding and Addressing Indirect Impacts of Hydrogen Releases



Atmospheric levels of H₂ over the past century based on air measurements using ice samples from Greenland and Antarctica

Patterson et al. <https://cp.copernicus.org/articles/19/2535/2023/>

\$11.4M+ over 3 Years on H₂ Emissions

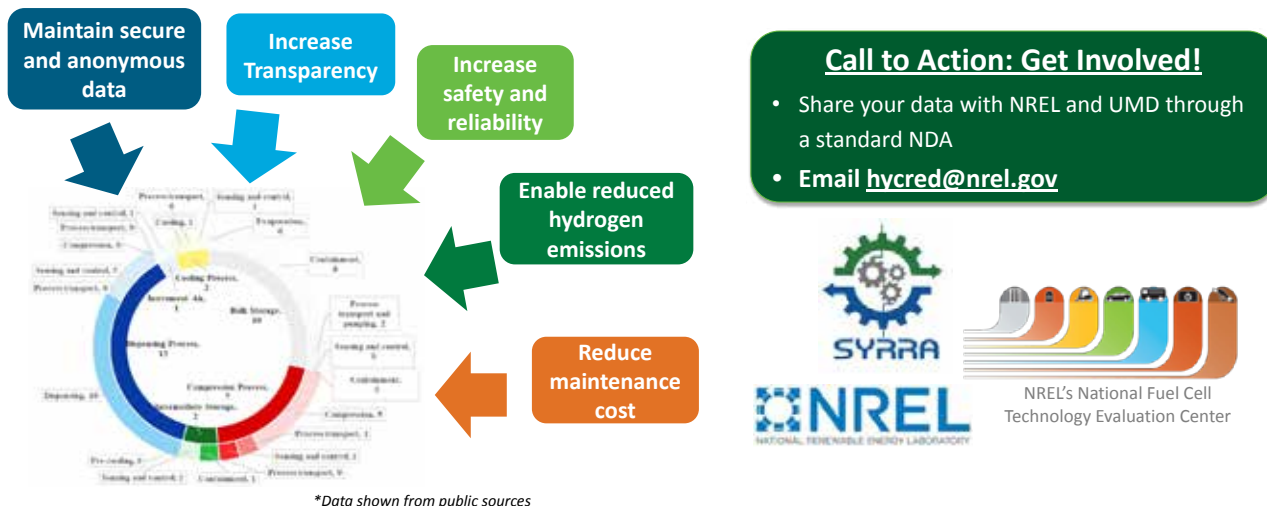
- R&D with NOAA to model atmospheric levels of H₂, understand soil uptake, and inform estimates of the GWP of H₂
- 9 NEW PROJECTS developing ppb-level sensors and quantification technologies
- Continuing national lab R&D on detection, leak rates, and release behavior

ARPA-E Open funding opportunity on detection of hydrogen releases due June 7, 2024:



Collaborative Approach to Address Safety and Hydrogen Emissions

The **Hydrogen Component Reliability Database (HyCReD)** collects high quality data to improve safety, reduce failure rates and maintenance cost, and inform component R&D to enable reduced hydrogen emissions.



U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

10

Hydrogen Safety Codes and Standards Applicability Navigator (HySCAN)

- Enable **new hydrogen stakeholders** to identify current codes and standards to move quickly and safely into the hydrogen market
- Current focus on NFPA 2 and ASME B31.12

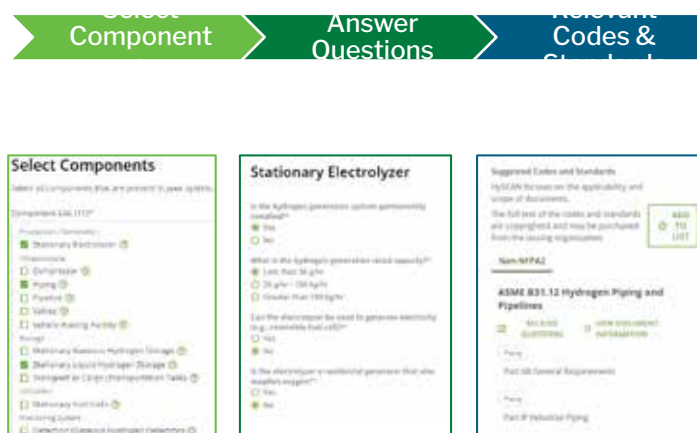
HySCAN
Hydrogen Safety Codes & Standards Applicability Navigator

Pacific Northwest
NATIONAL LABORATORY

Sandia
National
Laboratories

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

How It Works:



Visit now at
<https://h2tools.org/hyscan>

U.S. DEPARTMENT OF ENERGY

11

By The Numbers...

1 hydrogen tools portal



Training engineering professionals and university students for career opportunities in hydrogen

In-person workshop July 16-17 to inform future curriculum development



Hydrogen Workforce Acceleration CRADA

A well-prepared workforce to enable hydrogen's success across the U.S.
– safely, efficiently and equitably



Mission: Produce essential resources and serve as a Central Hub to develop the middle-skilled Hydrogen Workforce

Team:



The last coal power plant in Washington State is scheduled to shut down in 2025. Credentials and training are needed to help displaced workers secure jobs in the emerging clean hydrogen economy.

Phase I

- Perform needs assessments to inform curriculum and credential development
- Examine viable career pathways with a focus on disadvantaged communities
- Produce a framework for curriculum and credentials

Phase II

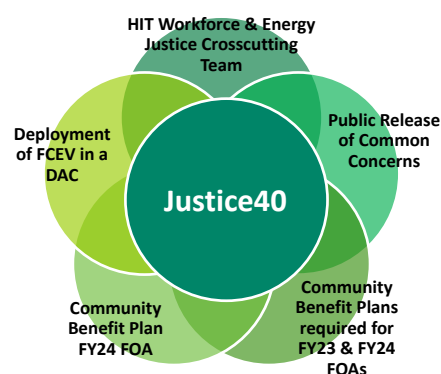
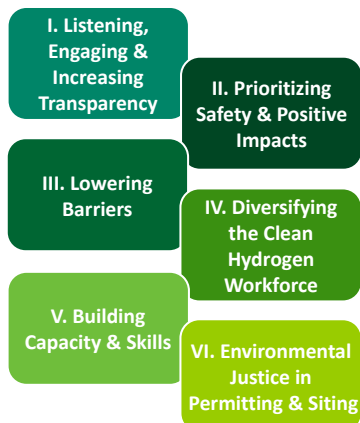
- Develop middle-skilled credentials for testing and deployment
- Integrate expertise in hydrogen safety
- Provide high-quality AR/VR experiences to accentuate learning objectives
- Ensure quality and safety (Accreditation Panel)
- Improve accessibility of materials

Phase III

- Deploy and assess middle-skilled credentials
- Expand nationwide with additional educational partners and stakeholder input (e.g., unions, tribes)
- Enable complementary joint deployment
- Ensure long-term sustainability

Building the pathway to match skills to needed jobs

Environmental Justice Initiatives



Draft Responses to Frequently Asked Questions and Common Concerns About Clean Hydrogen

<https://www.energy.gov/eere/fuelcells/draft-responses-frequently-asked-questions-and-common-concerns-about-clean-hydrogen>

Examples of International Collaborations



Regulations, Codes, Standards, and Safety Working Group Task Forces:

- **Bulk Storage:** Risk, gaps and deployment barriers – **new report published!**
- **Permitting:** Identifying permitting processes and lessons learned – **newly launched!**
- **Maritime:** Gaps and risk analysis underway



U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

16

Resources and Opportunities for Engagement

Key Publications



www.hydrogen.energy.gov

Hydrogen and Fuel Cells Day October 8

- Held on hydrogen's very own atomic weight-day



Join Monthly
H2IQ Hour Webinars

Download
H2IQ For Free



Visit H2tools.Org For
Hydrogen Safety And
Lessons Learned
<https://h2tools.org/>



Sign up to receive hydrogen and fuel cell updates

www.energy.gov/eere/fuelcells/fuel-cell-technologies-office-newsletter

Learn more at: energy.gov/eere/fuelcells AND www.hydrogen.energy.gov

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

HYDROGEN AND FUEL CELL TECHNOLOGIES OFFICE

17

Thank You

Christine Watson

Technology Manager - Safety, Codes & Standards

Hydrogen & Fuel Cell Technologies Office

Christine.Watson@ee.doe.gov

www.energy.gov/fuelcells
www.hydrogen.energy.gov

Country Day II : USA Day

**Strategic Role of U.S.
Hydrogen Development (TBD)**

Country Day II : USA Day

Strategic Role of U.S. Hydrogen Development (TBD)

Sally Sun

Vice President for International Business
Development, Tallgrass Energy

Country Day II : USA Day

**Indiana : The Land of
Hydrogen Opportunities in the Midwest**

Country Day II : USA Day

Indiana : The Land of Hydrogen Opportunities in the Midwest



Narai Kim

Director of Korea Office, Indiana Economic
Development Corporation (IEDC)

Education

- 2019-2020, M.S., Innovation Management, Science Policy Research Unit, University of Sussex, UK
- 2003-2008, B.S., Soongsil University, Seoul, Korea

Professional Career

- 2023-Present, Director of Korea office, Indiana Economic Development Corporation(IEDC)
- 2009-2022, Policy & International affairs researcher, National Academy of Engineering of Korea

Speech Title

Indiana: The Land of Hydrogen Opportunities in the Midwest
미국 중서부 수소 기회의 땅, 인디애나

Speech Summary

Indiana is deeply committed to advancing clean hydrogen production and utilization, especially through our active participation in the Department of Energy's Hydrogen Hub program. The Midwest Hydrogen Hub, MachH2, reflects Indiana's dedication to fostering sustainable development for heavy industries that have been traditionally hard to decarbonize. Indiana will share its valuable experiences and insights from working with heavy industry to promote resiliency in the era of carbon reduction goals. In addition, we will present various opportunities for Korean companies and organizations to engage with and benefit from these advancements.

Company Introduction

The Indiana Economic Development Corporation (IEDC) is responsible for advancing Indiana's economy by supporting business growth, development, and relocation. The IEDC is organized as a public private partnership and manages many initiatives, including performance-based tax credits, workforce training grants, innovation and entrepreneurship resources, public infrastructure assistance, and talent attraction and retention efforts.

INDIANA'S HYDROGEN ECOSYSTEM & OPPORTUNITIES

INDIANA FOR THE BOLD
Economic Development Corporation

Indiana is for the BOLD

- Indiana is where forward-thinking companies are addressing global challenges across a wide range of industry sectors.
- 1,000+ international companies
- Largest per capita automotive industry in the nation and exports **\$55.2 billion in manufactured goods** annually, making advanced manufacturing a defining and critical piece of the state's economy.
- 40+ universities/research institutions across the state
- Top ranked business climate:
 - **2nd** best state to start a business – Forbes
 - **11th** best state for business – CNBC
 - **5th** best infrastructure state – CNBC
 - **Top 10** state business tax climate – Tax Foundation



INDIANA FOR THE BOLD

2

The “Why”:

High-Impact Demand Sectors in Indiana



INDIANA FOR THE BOLD

3

Department of Energy’s Hydrogen Hubs

The Program

- The Regional Clean Hydrogen Hubs Program (H2Hubs) includes up to \$7 billion to establish hubs across America.
- These hubs will create networks of producers, consumers, and local connective infrastructure to accelerate the use of hydrogen as an energy carrier.
- The production, processing, delivery, storage, and end-use of clean hydrogen, including innovative uses in the industrial sector, are crucial to making heavy industry more resilient.



INDIANA FOR THE BOLD

4

MachH2 (Midwest) is one of 7 'selected' hubs



INDIANA FOR THE BOLD

5

The MachH2 Hub is Founded on 4 Pillars

PILLAR 1

a core of **nuclear, renewable, and natural gas** with **carbon capture** for safe clean hydrogen production to support decarbonization in the Midwest

PILLAR 2

a leading **transportation corridor** with a concentration of agriculture, manufacturing, industrial sectors

PILLAR 3

financially strong project sponsors with demonstrated **management and operational excellence**, bringing a robust governance structure that enables a **single, integrated hub**

PILLAR 4

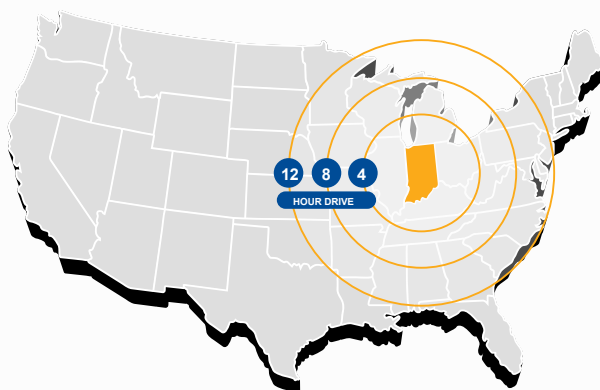
Holistic approach to CBP where EJ opportunities supporting **quality jobs and entrepreneurship** in DACs at regional project sites

- Accelerating the nation's clean hydrogen energy transformation with a market-driven, regional approach

MIDWEST ALLIANCE FOR CLEAN
HYDROGEN

Midwest Alliance for Clean Hydrogen MachH2

- Indiana serves as an anchor site for MachH2.
- 70+ Members and projects across the Hydrogen value chain in Indiana and surrounding states.
- MachH2 will use the rich diversity of existing and new clean generation resources.



INDIANA FOR BOLD

7

Hydrogen Production in Indiana

- BP's Northwest Indiana refinery will serve as an anchor site for the Midwest Hub.
- Positioning BP to integrate hydrogen production into a variety of offtake and input markets in the region.
- Potential blue hydrogen production at or near this facility



"We are thrilled that the U.S. Department of Energy awarded this grant to the MachH2 coalition... Our proposed Midwest hydrogen hub can help decarbonize America's industrial heartland while enhancing Indiana's economy, creating jobs and attracting new businesses and investments to the state."

-BP Vice President of Hydrogen and CCC Tomeka McLeod

INDIANA FOR BOLD

8

Key Indiana Hydrogen Hub Partners



INDIANA FOR BOLD

9

Expanding Hydrogen Opportunities in Indiana

- [Hydrogen Production for Manufacturing](#)
 - Hydrogen-powered manufacturing in steel, glass, and auto parts
- [Blue Hydrogen & Carbon Capture](#)
 - MachH2 at BP's Whiting site, utilizing blue hydrogen production with carbon capture and storage (CCS) technology
- [Hydrogen-powered Mobility](#)
 - Indiana based Cummins announced USD 1 billion in investment for clean energy engines and hydrogen
 - Growing demand for hydrogen-powered trucks, buses, aviation, and logistics
- [Hydrogen Transport](#)
 - Leveraging 1,600 miles (2,574 km) of U.S. hydrogen pipeline and growing demand for tube trailers, storage tanks, and equipment

INDIANA FOR BOLD

10

Riding the Hydrogen Wave: Strategic Plays for Korean Companies in Indiana

• Supply Chain Involvement

- The hydrogen hub project, which involves heavy industries like steelmaking and refining, requires advanced hydrogen storage, transportation technologies, and specialized equipment. Korean companies with expertise in manufacturing hydrogen storage tanks, tube trailers, and related components could contribute to these efforts

• Collaborations with U.S. Firms

- Korean companies that specialize in hydrogen technologies (such as electrolysis, fuel cells, or hydrogen production systems) could form partnerships with U.S. companies like Cummins or Rolls-Royce, both of which are already involved in the project. Such collaborations could help establish a foothold in the U.S. market.

• Research and Development

- Indiana's universities, such as Purdue, are heavily involved in R&D for hydrogen. Korean companies interested in hydrogen innovation could explore joint research projects to develop new technologies in hydrogen production and usage

INDIANA FOR BOLD

11

**THANK
YOU!!!**

인디애나경제개발공사 한국사무소

김나래 대표 Nkim1@iedc.in.gov

김병우 책임 BKim@iedc.in.gov

INDIANA FOR THE BOLD

Country Day II : USA Day

Ohio's Hydrogen Industry

Country Day II : USA Day

Ohio's Hydrogen Industry



Jiyun Choi

Consultant, JobsOhio

Education

· 2017-2022, B.S Economics, Yonsei University, Seoul, Korea

Professional Career

· 2023-Present, Consultant, JobsOhio, Korea

Speech Title

Ohio's Hydrogen Industry

Speech Summary

An Ohio-led initiative, the Appalachian Regional Clean Hydrogen Hub (ARCH2) has been selected by the U.S. DOE to develop a multi-state clean hydrogen hub. ARCH2, led by Columbus-based Battelle, is eligible for up to \$925M in funding across Ohio, Pennsylvania, and West Virginia. JobsOhio looks forward to the development of clean hydrogen business opportunities with the region.

Company Introduction

JobsOhio, the state's unique private economic development corporation, acts as a catalyst for high-growth business investments and job creation.



Ohio's Hydrogen Industry

September 26, 2024

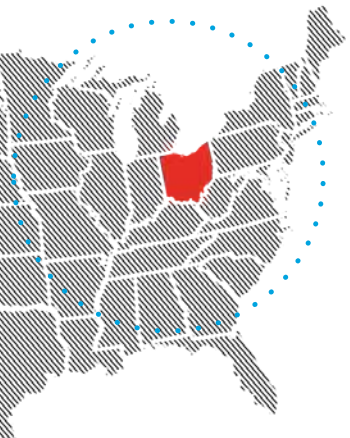
This document is [not](#) a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(bb) and 187.04(C)(1) and (2)




Ohio is the HEART OF THE MIDWEST

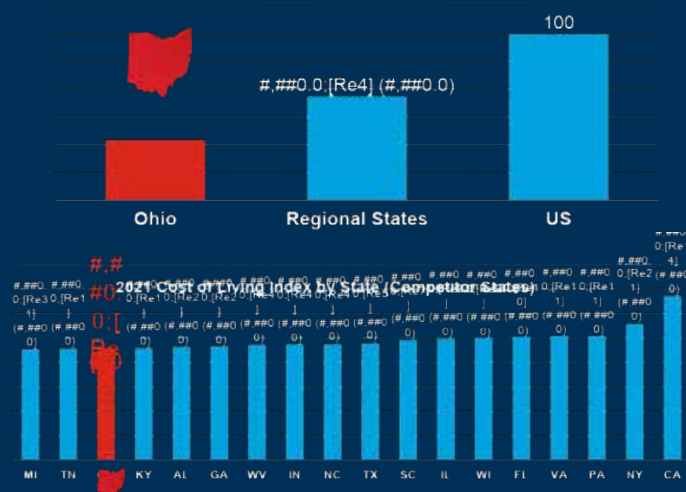
7th Largest U.S. Economy	#7 in USA
Fortune 500 & 1000 HQs	#5 in USA
Fortune 500 Companies	25
Manufacturing GDP	#4 in USA
U.S. & Canadian Population Within One Day Drive (600 miles)	>60%

This document is [not](#) a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(bb) and 187.04(C)(1) and (2)




2

Ohio has a Lower Cost of Living



Source: Lightcast, Council for Community and Economic Research | Regional States: IL, IN, KY, MI, OH, PA, WV
18 Competitor States: AL, CA, FL, GA, IL, IN, KY, MI, NC, NY, OH, PA, SC, TN, TX, VA, WI, WV.
This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 157.04(C)(1) and (2)

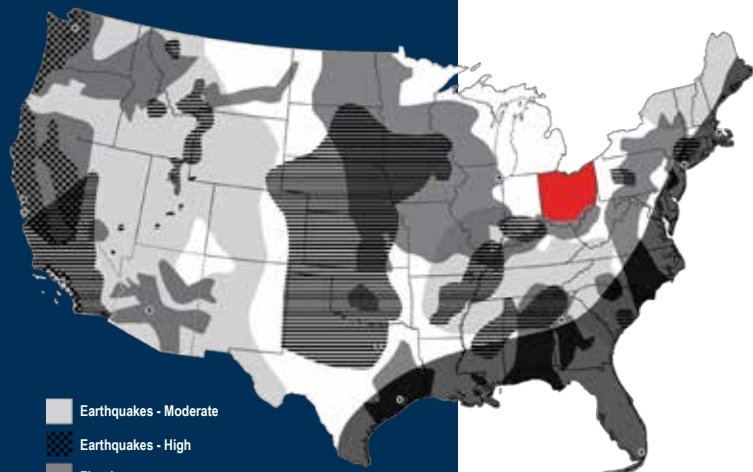


3

Ohio: Low Natural Disaster Risk

**Ohio is
a lower natural
disaster region.***

The map overlays Earthquake (both moderate and high risk), Flood, Tornadoes and Hurricane risks in the continental U.S.



- Earthquakes - Moderate
- Earthquakes - High
- Floods
- Hurricanes
- Tornadoes

*Statewide Disasters from Earthquakes, Hurricanes, Tornadoes and Floods (1953- June 2022)
Data for this map was provided by NOAA.gov and Sperling's Best Places.

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 157.04(C)(1) and (2)



4

Ohio's Tax Advantages

Pro-business State Tax Climate

- NO Corporate Profits or Income Tax
- NO Tangible Personal Property Tax
- NO Inventory Tax
- NO Tax on Products Sold Outside of Ohio
- NO Tax on Machinery and Equipment Investments
- NO Tax on R&D Investments

Single, Low-rate Business Tax

- ONE State Business Tax – Commercial Activity Tax (0.26%)
- No Tax on First \$1 Million in Taxable Gross Receipts
- No Tax on Products Sold to Customers Outside of Ohio

- **Lowest Tax Rate on New Firm Capital Intensive Manufacturing in the Region**
- **#1 Tax Rate in U.S. for New Firm Data & Distribution Centers**



This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 157.04(C)(1) and (2)

5

Hydrogen Overview – Current State & Future Uses



Hydrogen is commonly used today in industrial processes for making steel, cement, oil refining, chemical processing, and other related activities. On a smaller scale, hydrogen is also used as a transportation fuel (bus fleets), fuel cells (forklifts), and power generation.



About 95% of hydrogen worldwide is made from steam methane reformation (SMR) using natural gas as a feedstock (sometimes referred to as "gray" hydrogen).



Currently, Ohio is producing around 161,000 metric tons/year of hydrogen through SMR, using natural gas as its feedstock.



De-carbonization is commonly referenced today and using cleaner hydrogen more broadly is aggressively being pursued.



The cheapest hydrogen made from natural gas costs about \$1.50 per kilogram to produce, while lower-carbon hydrogen can cost anywhere from \$5 to ~\$14 per kilogram.



Ohio has several key advantages over other states in ramping up a hydrogen economy, beginning with its already significant industrial hydrogen market, led by the steel, petrochemical and fertilizer industries.



Ohio can cost-effectively generate, store and deliver large volumes of hydrogen to supply growing industrial markets.



This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 157.04(C)(1) and (2)



Hydrogen Future Projects in Ohio

Projected Ohio Annual Hydrogen Consumption and Production (Metric Tons)
Assuming: No Carbon Dioxide Regulation and Markets Supplied by 15% of Nuclear and Renewable Power, and Remaining Market Supplied by Natural Gas (SMR)

		2030	2040	2050
Hydrogen Consumption	Power generation	31,100	88,400	251,200
	FCEVs	2,900	35,400	430,600
	Forklifts	4,700	8,400	12,700
	Oil refining	188,700	202,400	217,000
	Metal refining	23,900	96,600	391,000
	Ammonia production	114,200	119,600	125,400
	Biofuels	400	7,900	148,000
	Synthetic hydrocarbons	63,600	85,800	397,700
	Other Mfg. markets	8,100	9,100	10,300
	Total Consumption	437,600	653,600	1,983,900
Hydrogen Production	Electrolysis via Nuclear Power	9,300	50,700	59,600
	Electrolysis via Renewable Sources	86,600	112,800	135,900
	Natural Gas (SMR)	341,700	490,100	1,788,400

Note 1: Natural gas production of hydrogen is determined by subtracting the amount of hydrogen generated from repurposing 15% of nuclear and renewable power from the total expected market. Current SMR capacity in Ohio is about 161,000 metric tons annually. Projections assume nuclear power repurposing ramps up to 15% by 2050, using an "S" curve for new products (and assumes overall nuclear power capacity will not grow). For renewable power, we assumed Ohio's growth will follow the EIA national annual growth rate projections for renewable power (3.9% for solar and 0.7% for wind). Currently, repurposing 15% of existing and under construction renewable power would generate about 55,000/yr metric tons of hydrogen.

Note 2: The U.S. Energy Information Administration (EIA) identifies the following as sources of renewable energy: Conventional Hydroelectric Power; Geothermal; Municipal Waste; Wood and Other Biomass; Solar Thermal; Solar Photovoltaic; and Wind. Among these, only solar photovoltaic and wind are included in our renewable projections.

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 187.04(C)(1) and (2)

The Hydrogen Color Spectrum



	Grey H ₂	Brown H ₂	Blue H ₂	Green H ₂	Pink H ₂	Gold H ₂	Turquoise H ₂
Process	Steam methane reforming (SMR) or Autothermal reforming (ATR)	Coal gasification	SMR or ATR + carbon capture and sequestration (CCS)	Renewable electricity and water with an electrolyzer	Nuclear electricity and water (or steam) with an electrolyzer	SMR, ATR + carbon capture and sequestration (CCS)	Methane pyrolysis and sequestration of solid carbon
Source of energy and hydrogen	Natural gas	Coal	Natural gas	Renewable electricity, water	Nuclear generated electricity, water/steam	Biomass or biogas	Natural gas
Equipment	Steam methane reformer (SMR) or Autothermal reformer (ATR)	Gasifier	SMR or ATR and CCS capture, transport, and sequestration	Wind, solar, or hydro and electrolyzer	Nuclear power and electrolyzer	SMR or ATR With or without CCS	Methane pyrolyzer
Emissions	~10	~18	1 - 5	0	0	<0	0
Comments	Current dominant hydrogen production method	About 25% of global H ₂ production, mostly in China	Capture rate ranges from 50% (SMR only) to 90% (full process)	Zero emissions if using 100% renewable electricity	Can be higher efficiency than green H ₂ if waste heat used	Can have negative emissions depending on fuel source	Requires solid carbon to be sequestered without re-emission

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 187.04(C)(1) and (2)

Ohio's Industrial Sector & Related Emissions

JobsOhio

PRELIMINARY

Industrial sector ¹	Market size, \$B ²		Number of Jobs		Emissions (MMT) ⁵		Opportunities to reduce emissions
	Ohio	USA	Ohio	USA	Ohio	USA	
Petroleum Refining	23	555	< 5,000	95,000	4.5	165	Key focus of the next phase: Sector-level analysis of decarbonization opportunities (e.g., existing solutions, level of feasibility and maturity, ROI)
Chemicals ³	3	42	45,000	530,000	4.1	186	
Iron and Steel	13	95	23,000	94,000	11	66	
Food and Beverage ⁴	31	847	61,000	1,840,000	0.6	30	
Cement	2	10	TBD	12,000	0.9	69	

Other areas identified by the NOI incl., steel mill products, aluminium, concrete, glass, pulp, paper, industrial ceramic

Ohio ranks 7th among states in CO₂ emissions in the industrial sector

- According to the DOE's Industrial Decarbonization Roadmap, the "five highest CO₂ emitting sectors where industrial decarbonization technologies can have the greatest impact across the nation"
 - Market size is defined as total annual sector revenue for purposes of this analysis
 - Incl., ammonia, methanol, ethylene, and BTX, as defined by the DOE Industrial Decarbonization Roadmap
 - Incl., wet corn milling, soybean oil, cane sugar, beet sugar, fluid milk, and meat product processing and beer production as defined by DOE
 - Not comprehensive as EPA EIGHT dataset includes large emitters only
- Sources: EPA EIGHT, Energy.gov, US Bureau of Labor Statistics, Ohio.gov, National Institute of Standards and Tech., IBISWorld, Purdue College of Agriculture, Fractracker, Ohio Chemistry Tech. Council, Portland Cement Association

4

9

Emissions Areas in Ohio

JobsOhio

PRELIMINARY

2021 GHG Emissions by facility in Ohio¹



Facility

Sector

MMT CO₂e

A Cleveland-Cliffs (Cleveland)	Iron & Steel	3.64
B Cleveland-Cliffs (Middletown)	Iron & Steel	3.38
C PCS Nitrogen	Chemical	1.73
D Toledo Refining Company	Petroleum Refining	1.51
E Martin Marietta Magnesia Specialties	Chemical manufacturing	1.37
F BP Husky Refining	Petroleum Refining	1.32
G Lima Refinery	Petroleum Refining	1.14
H Haverhill Coke Company	Iron & Steel	0.95
I IronUnits LLC	Iron & Steel	0.78
J Kimble Sanitary Landfill	Waste mgmt.	0.63
K Apex Environmental Sanitary Landfill	Waste mgmt.	0.57
L LINDE INC	Chemical	0.56
M Carmeuse Ohio Inc., Maple Grove Lime Plant	Cement	0.54
N Canton Refinery	Petroleum Refining	0.54
O Fairborn Cement Company	Cement	0.51
P Noble Road Landfill	Waste mgmt.	0.44
Q SunCoke Energy Middletown Operations	Iron & Steel	0.40
R Lafarge Paulding Plant	Cement	0.37
S Globe Metallurgical Inc.	Chemical	0.33
T Beech Hollow Sanitary Landfill	Waste mgmt.	0.33
U Ineos Pigment USA	Chemical	0.32
V North Star Bluescope Steel	Iron & Steel	0.30
W Pixell Specialty Solutions	Paper	0.30
X Carmeuse Lime - Grand River	Cement	0.27
Y Timken Steel Corp.	Iron & Steel	0.25

Takeaways

- The largest cluster of high emitters is in northwest Ohio, largely made up of iron and steel and petroleum facilities
- Cleveland-Cliffs (iron and steel) is the highest emitter overall, with facilities in the Cleveland and Cincinnati areas
- There is a meaningful cluster of emitters in the Appalachian Ohio

1. Excludes emissions from non-manufacturing or cross-cutting industrial sectors that have not been included by the EPA for consideration in the Industrial Decarbonization program (e.g., power plant solutions, oil & gas, coal)

Source: EPA EIGHT

5

Hydrogen Investments & Hydrogen Hub Competition



Parallel Paths with Some Likely Intersection

Private Sector Investments

- Companies are dedicating massive financial resources to de-carbonize and reduce their emissions
- Hydrogen, CCUS, and other related strategies – are opportunities for Ohio as a retention and attraction play
- The planned private sector investments can be counted as private match for the Hub competition, but many investments “will happen regardless” of the Hub outcome
- JobsOhio is seeing projects focused on:
 - Blue hydrogen production
 - CCS
 - R&D related to hydrogen for fleet vehicles
 - Hydrogen fuel cell production
 - Technology providers looking to expand
 - Industrial retrofits to determine CapEx and timing

Hydrogen Hub Competition

- Encouraged by winning ARCH2
- The disbursement of DOE money is likely to take 8+ years
- Private sector is positioning themselves today – **especially within the initial winning hub locations**
- The true benefit will be the federal tax credits aimed at driving down the per kilogram cost of lower-carbon, cleaner hydrogen
- Can these federal subsidies truly reduce the cost to be competitive with traditional “gray” hydrogen?



This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(bb) and 187.04(C)(1) and (2)

11



ARCH2 Overview

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(bb) and 187.04(C)(1) and (2)



Selected Hydrogen Hubs



Note: Selected H2Hubs (small blue circles within each region) are for illustrative purposes only, specific locations to be determined over the next several years

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 187.04(C)(1) and (2)

13

ARCH2 Participants



- Various groups positioned themselves to lead efforts related to landing a hydrogen hub either in Ohio or within the region. Battelle has led ARCH2, which is focused on natural gas produced hydrogen with carbon capture sequestration
 - ARCH2 was formed out of a tri-state consortium among Ohio, Pennsylvania, and West Virginia
- In October 2023, ARCH2 was announced as one of 7 hydrogen hub winners by the USDOE with an award of “up to” \$925 million, which will be disbursed over a several year period.
- Battelle is continuing to work to find partner companies for ARCH2

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 187.04(C)(1) and (2)

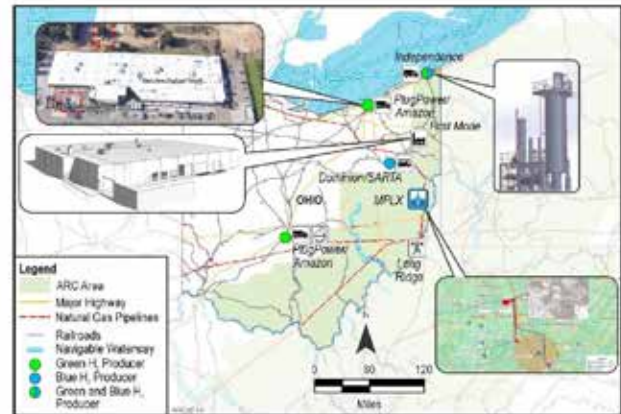
14

ARCH2 Project Summary - Ohio



ARCH2 Project Summaries

- **MPLX:** H₂ storage facility development with connective infrastructure to support ARCH2 producers, storage, and end-users
- **Dominion Energy Ohio:** H₂ production with CO₂ capture to supply H₂ to regional transit (e.g., SARTA)
- **Plug Power/ Amazon:** One distribution center with H₂ fueling MHE; fueling station FCEV delivery trucks.
- **First Mode:** H₂ end-user: Manufacturing facility for retrofitting mining trucks with H₂ fuel cell power system.
- **Independence Hydrogen:** H₂ production facility using industrial off-gas as feedstock in Ashtabula, Ohio to provide clean hydrogen for material handling equipment at distribution centers.



Note: Proposed project locations based on preliminary siting are subject to change during the detailed planning phase (phase 1).

Incentives

*Funding decisions are based on several project factors, including but not limited to: job creation, payroll figures, fixed-asset investment commitment, project location, ability to fund project costs and project return on investment.



This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 187.04(C)(1) and (2)

State Programs



Ohio Job Creation Tax Credit

A refundable and performance-based tax credit calculated as a percent of created payroll and applied toward the company's commercial activity tax liability.

Benefits

- **Value of the credit is 100% reimbursable**
 - The credit is first applied to the company's Commercial Activity Tax value and any amount that exceeds the tax liability is disbursed to the company.
- **The credit is uncapped and performance-based**
 - The more payroll that is created, the more value the company receives over the term of the credit. The value is not capped by job commitments



Roadwork Development (629) Funds

- Available for public roadway improvements, including engineering and design costs.
- Grants are provided to a local jurisdiction and require local participation

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 157.04(C)(1) and (2)

17

JobsOhio Programs



JobsOhio Economic Development Grant

The ED grant is a reimbursement-based grant that provides funding towards fixed asset investments made related to the project such as Land, Building, Infrastructure and Machinery and Equipment.

JobsOhio Workforce Training Grant / Talent Acquisition Services



- The Workforce Training grant is a reimbursement-based grant that provides funding towards employee development and training.
- The grant is reimbursed on the number of hours trained using the jobs created average hourly wage.
- Talent Acquisition Services is a value of services tailored to meet the individual journey gaps of the company.



JobsOhio Growth Fund Loan

The JobsOhio Growth Fund Loan (JOL) promotes economic development, business expansion, and job creation by providing funding for eligible projects in the State of Ohio. The JOL focuses on fixed-asset investment. JOL financing is contingent upon meeting all program guidelines, establishment of appropriate credit enhancement, completion of due diligence, and satisfactory review of the company's financial statements. The Borrower will be responsible for securing financing for the project related costs through loan closing and project completion.

This document is a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(b) and 157.04(C)(1) and (2)

18



JobsOhio Services and Incentives

1. JobsOhio Economic Development Grant (경제 개발 보조금)
2. JobsOhio Growth Fund (성장 기금)
3. JobsOhio Research and Development Center Grant (연구개발 센터 보조금)
4. JobsOhio Revitalization Program (회생 프로그램)
5. JobsOhio Workforce Grant (노동 보조금)
6. Ohio Job Creation Tax Credits (고용창출 세액공제)
7. Talent Services (인력 자원 서비스)
8. Site Selection (임지 선정 지원)
9. Detailed Research (상세 조사 제공)
10. Specialized Assistance (특별 지원)

19

This document is [public](#) a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(bb) and 187.04(C)(1) and (2)



41 S. High Street, Ste. 1500
Columbus, OH 43215

JobsOhio.com

Young Ho Seo

Representative, JobsOhio Korea office

seo@consultant.jobsohio.com

Office: 02 508 8768

Mobile: 010 2364 8766

Jiyeon Choi

Consultant, JobsOhio Korea office

choi@consultant.jobsohio.com

Office: 02 6275 5051

Mobile: 010 5586 5051



20

This document is [public](#) a public record and its content should not be reprinted in any other document. Ohio Revised Code 149.43(A)(1)(bb) and 187.04(C)(1) and (2)



Country Day II : USA Day

**Energy-Enabled Economic Development
Opportunities in Pennsylvania**

Country Day II : USA Day

Energy-Enabled Economic Development Opportunities in Pennsylvania



Adam Walters

Senior Energy Advisor, Pennsylvania Dept. of
Community and Economic Development (DCED)

Education

- 2014 – Bachelor of International Relations, York College of Pennsylvania
- 2016 – Master's of Public Administration, Penn State University

Professional Career

- 2015-2017 – Project Administrator, Downtown Inc
- 2017-2019 – William Penn Fellow, PA DCED
- 2019-present – Senior Energy Advisor, PA DCED

Research Interest

- Energy Transition
- Economic Development
- Hydrogen Technology

Speech Title

Energy-Enabled Economic Development Opportunities in Pennsylvania

Speech Summary

DCED's Sr. Energy Advisor will discuss PA's key strategic advantages for businesses related to abundant energy resources. He will discuss strategic economic development initiatives and show that PA is focused on hydrogen as an emerging technology for business growth and energy transition.

Company Introduction

PA DCED is the lead state agency under the Governor's jurisdiction for economic development.



H₂MEET

Conference 2024

Ramping up Hydrogen Economy with Cutting-Edge Technology