

International opportunities LNG/Hydrogen

1st December 2021 EIRIK MELAAEN

Credit Harald Pettersen, Equinor -



Combining Norwegian competence with international energy needs



Hydrogen and LNG:

Norwegian Energy Partners

Market Update Hydrogen

Report

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Network meeting Workshop Webinar Seminar

INTERNATIONAL ENERGY FORUM 202





Norwegian Energy Partners Annual Offshore Oil & Gas Market Report 2021-2024

RYSTAD ENERGY

Report prepared by Rystad Energy

August 2020

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Natural gas demand

Utviklingen i kraftsektoren fra i dag til 2050 (TWh) i Lavutslippsscenarioet



IEA – Natural gas demand in the Stated Policies Scenario in the World Energy Outlooks 2021, 2020 and 2016



Equal split between fossil and non-fossil energy in 2050 DNV – Energy Transition Outlook 2021



Hydrogen in the global race to net zero



Country with Hydrogen strategies

- Hydrogen used in:
- Industry
- Power
- Transport

Hydrogen use sectors Image: Constraint of the sector	✓ ✓	✓ ✓	(~)	х	×		
Industry \checkmark	✓ ✓	~	(~)	х	х	~	12
Power (\checkmark) (\checkmark) \checkmark	~	1					(*)
		~	~	~	~	~	(~)
Transport (*)	(~)	(*)	~	~	~	~	~
Buildings (✓) (✓) (✓) (✓) 𝔅 𝔅 (✓) 𝔅 𝔅 (✓) (✓)	(~)	(~)	~	~	ж	(~)	(~)
$\Longrightarrow \text{Export} \qquad \qquad \blacktriangleright \mathbf{x} \mathbf{x} \mathbf{x}^{1} \mathbf{x} \mathbf{v} \mathbf{x} \mathbf{x}^{2} \mathbf{x} \mathbf{v}$	~	~	х	ж	ж	~	ж

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1) Hydrogen imports transit to other countries (e.g. Germany) considered.

2) For Norway, hydrogen is not targeted for direct export, but indirectly through the export of NG with local CCS.



LNG – The big picture

- Natural gas is the cleanest burning and fastest growing fossil fuel
- LNG demand will almost double by 2035 (US, Mozambique, Russia, Canada and Qatar)
- Natural gas/LNG will be an important premise for the green shift.
- Increased trading of LNG require massive development and create opportunities
- Norway's advantages are established maritime/onshore supply chain for LNG and offshore competence
- Alternative to coal is LNG and small-scale LNG solutions
- LNG projects are typically EPCI contracts, module deliveries and assemblies on site
- LNG projects are more than cryogenic equipment!



Hydrogen – The big picture

- A booming market High focus on hydrogen as the energy carrier of the future
 - Many countries with hydrogen strategy and road maps. Europe- Japan, Korea, Australia etc.
 - Large funding are allocated requirements for local content
 - High focus on green hydrogen Blue hydrogen will play an important role in the transition to renewables
 - Nobody wants to talk about it, but forecasts show that this is the reality
 - Costs need to go down, especially on green hydrogen. Scale up solutions!
 - Large dynamics in the markets and many project are planed, but large uncertainty about the timeline and realism
- Uncertainty about what will be the fuel of the future in long-distance transport, marine, power production, etc.
 - Ammonia will probably play an important role in the future



Green shift - Norway/Europe



- Project types:Renewable/H2 productionLow-carbon H2
- production/CCS
- Infrastructure/distribution
- EU open grid
- Ammonia
- Power to X/efuel
- End users (process industry, transport, maritime, power etc.)
- Value chain/Supply chain

Not only hydrogen competence/technology required for the green shift

2021 Hydrogen Projects in Scotland

End User

01 Cloverhill's Aberdeen Hydrogen First 02 Eden Mill distillery 03 Glasgow Hydrogen Gritters 04 HECTOR project 05 HyDIME 06 HyFlyer 07 HySeas III 08 HySpirits 09 Hytransit Project -Aberdeen Hydrogen Busses 10 Hytrec 11 JIVE 2 - Dundee Hydrogen Transport 12 Kirkwall Airport Decarbonisation 13 Liquid Organic Hydrogen Carriers (LOHC) for the transportation of hydrogen 14 Project HyLaddie 15 Scottish Hydrogen Train project 16 TimberLINK 17 Uist Distilling Company

Multi-vector

18 Aberdeen Hydrogen Hub
19 Aberdeen Vision
20 BIG HIT
21 East Neuk Power to Hydrogen
22 GENCOMM - AD
23 ITEG - Integrating Tidal Energy into the European Grid
24 North of Scotland Hydrogen Programme
25 OHLEH - Outer Hebrides Local Energy Hub



Transmission/distribution

47 H100 Fife project



First Round – IPCEI Hydrogen project Netherland



- 1: Air Liquide Rotterdam Hytrucks
- 2: Air Liquide Terneuzen 200 MW
- 3: Air Products Rotterdam Import and distribution for mobility
- 4: Bosch Tilburg Electrolyser Stacks
- 5: Chemgas Shipping Rotterdam inland shipping fleet
- 6: DAF Trucks Eindhoven- Hydrogen Powered Trucks
- 7: Engie Eemshaven 100 MW
- 8: HBR Rotterdam A European shipping corridor
- 9: HBR/BP/Nouryon Maasvlakte 250 MW

10: HBR – Maasvlakte – Conversionpark

- 11: HBR Infrastructure Maasvlakte to Pernis
- 12: Hydron Energy Noordwijkerhout- PEM electrolyser technology
- 13: Lukoil/Total Vlissingen 150 MW
- 14: GasUnie Groningen Backbone
- 15: GasUnie Zuidwending Hydrogen storage
- 16: NedStack Arnhem Fuel Cell Giga Factory
- 17: Nouryon/PoA/Tata A'dam Port 100 MW
- 18: Province South Netherlands Rotterdam – RH2INE
- 19: Shell Maasvlakte 200 MW
- 20: Uniper Maasvlakte 50/500 MW
- 21: Vattenfall Maasvlakte 100 MW

- 22: VDL Eindhoven Energy Systems for mobile and stationary applications
- 23: Vopak Rotterdam H₂ Imports in
 - Europe
- 24: Yara/Ørsted Sluiskil 100 MW

Green: H₂ production Orange: H₂ Infrastructure Purple: H₂ Import/export Blue: H₂ use in mobility Red: H₂ Enabling technologies



Hydrogen Prospects – The Netherlands



Projects – Australia

- LNG; 10 projects operating, 21 trains, 84mtpa capacity
 - 1 new train planned (Pluto2) Bechtel EPCI (pending FID)
- FSRU; 6 proposed projects east coast (NSW/VIC) and South Australia
 - Hoegh LNG secured 1 project most advanced
- Hybrid Energy Solutions; Hydrogen
 - multiple hydrogen projects announced
 - small scale powering rural communities and remote mine sites replacing diesel fired power;
 - E.g. Denham hydrogen pilot, Horizon Power (state utility company)
 - large scale (major power generation)
 - E.g. Port Kembla gas-hydrogen co-fired power station, Squadron Energy
- Hybrid Energy Solutions; Batteries
 - Multiple large scale battery projects (SA, VIC, NSW)
 - Support large growth in onshore wind / solar
 - Grid stabilization and back up power

New LNG project has been approved - The Scarborough and Pluto second train development



Source: Department of Industry, Science, Energy and Resources

Norwegian Energy Symposium: H2 & CCS Solutions and <u>Technology</u> 9-10 Nov. 2022 Day 1: HYDROGEN, please click <u>HERE</u> Day 2: BLUE HYDROGEN/CARBON CAPTURE & STORAGE, CCS, please click HERE.

Projects – Brazil

Location map of LNG regasification projects in Brazil

Table presents the status of LNG regasification terminal projects listed from North to South Regions which was not under commissioning and/or operating until this document's publication



4°N

2°N

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2.5

so.

8°5

S°S

Capacity Final Initial Environmental Under Project (million State Investiment studies Licensing Construction m³/day) Decision* CELBA Terminal 15 PA AM/ Uirapuru Amazonica Energy PA Geramar III thermoeletric power plant (associated MA N.A. terminal) São Marcos I/II Thermoeletric power plants MA 21 (associated terminal) Suape PE 21 Central Port 20 ES ES N.A. Imetame Port Norte Fluminense Terminal RJ 21 TEPOR RJ 21 TRSP 14 SP TGS SC 15

Notes: N.A. - not available; terminals already built (commissioning or in operation) were not cited. Source: EPE.

Latin America

Green hydrogen put on the agenda, at the starting point!



Brasil - Small scale LNG project developed by ENEVA, an E&P company operating in onshore fields. Natural gas will be provided by Azulão field.

Hydrogen:

Brasil – Offshore Wind + Hydrogen – 3 states: Ceará, Rio Grande do Norte and Rio de Janeiro.

Chile - global player (ranked amongst top 6). Target to be global export leader. 15 projects.

Colombia and Argentina are in process of implementing new road-maps for green hydrogen

Uruguay is already decarbonized. Hydrogen used in transport sector.

Mexico – Growing interest, Natural gas network could transport blue and green Hydrogen

CANADA'S OPPORTUNI



LNG Project:

- LNG import terminal Canaport (in operation)
- Over a long period 20 LNG facilities/ export licences are proposed but only one real project. LNG Canada/Kitimat BC 50% finalized

LEGEND

 Now reviewing proposal of 18 LNG export facilities from British Columbia to Nova Scotia (e.g. Jean D'Arc Basin project)



Canada

HYDROGEN IN CANADA

Most relevant H2 Projects:

- ATCO, Alberta Hydrogen blending project + CCS (88 MW)
- Suncor and ATCO, Alberta produce clean Hydrogen (300 000 ton/year)
- Hydro Quebec/Thyssenkrupp project green hydrogen

Hydrogen projects and clusters are forming across Canada







Jan Eckhoff, May 19, 2021



USA - Hydrogen

- Major markets California, Louisiana, and Texas
- H2 utilization refining petroleum, treating metals, producing fertilizer, and processing foods
- Lack of H2 policy framework
- Blue H2 linked to oil & gas industry
- Public push to find cleaner energy sources
- Investors are looking for opportunities

Projects & prospects:

- Electrolysis
- Clean hydrogen production
- Fuel cell and similar solutions
- H2 supply chain components and refueling technologies.
- Analyses to assess the cost and performance
- H2 gas turbines
- Blue H2/CCS
- Infrastructure

Asia

Japan and South Korea:

- zero emission 2050
- large import of LNG
- large ambition for green shift and hydrogen

akhstan

Myanma

Indonesia

Malaysia:

- LNG plant capacity about 31 mtpa + 2 regasification terminals
- The next FLNG Tiga is under planning

Indonesia:

- BP Tangguh LNG expansion project Train 3, 3,8 mtpa, start 2022
- INPEX Abadi LNG project, 9,5 mtpa onshore LNG, start 2027

India:

- Kakinada LNG terminal/Crown LNG, GBS, 7.2 MTPA, FID 2022
- Petronet LNG, 4MTPA FSRU + onshore terminal, no timeline
- GAIL launched tender for 10 MW electrolyser, 4.5 Ton H2/day
- NTPC, Technip 5 MW electrolyser contract

China:

- Zero emission 2060?
- large energy importer (LNG) equipment, modul, ship supplier large domestic market
- large investments
- NG solutions
- green shift solutions

Singapore:

Brunei

- LNG bunkering projects (hub)
- ambition for green shift and hydrogen









Middle East - LNG

Saudi Arabia:

- big shale gas development
- use extracted gas to produce hydrogen

Qatar:

- Ras Laffan world's largest LNG export terminal
- QE North field expansion from 77 mtpa to 126 mtpa
- US\$ 50 billion for 6 new LNG trains
- onshore and offshore solutions
- 100-150 new LNG carriers

UAE:

- Most important gas discovery since 2005
- Jebel Ali reservoir/ADNOC
- use extracted gas to produce hydrogen
- 80 trillion cubic feet of gas



Middle East - Hydrogen



- UAE/Abu Dhabi/ADNOC Intention to be a leader in green H2, but also blue
- Oman 20% of power generation from renewables by 2030, and 40% by 2040. H2 production
- Qatar Decarbonizing the LNG export, but no signal of blue H2 production
- Saudi Aramco/Saudi Arabia has committed to converting LNG to hydrogen. Ambition world largest and cheapest H2 supplier. Saudi king pledges 50 per cent clean energy by 2030.



Africa - LNG

Ghana, Nigeria, offshore Mauritania and Senegal etc.:

• Gas and LNG

Opportunities in Africa:

- New projects
- LNG to power
- LNG infrastructure/distribution



Uganda:

 oil and gas resources in the Lake Albert region/Tilenga/Total

Equinor Tanzania



Mozambique LNG Yara – Fertilizer plant? Cabo Delgado province

- Gas to power 3000MW
- FSRU/LNG distribution

solutions for global energy needs



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