HYDROGEN INTEGRATION IN POWER-TO-GAS NETWORKS

Jaron Whalley | Principal Mechanical Engineer | Fyfe

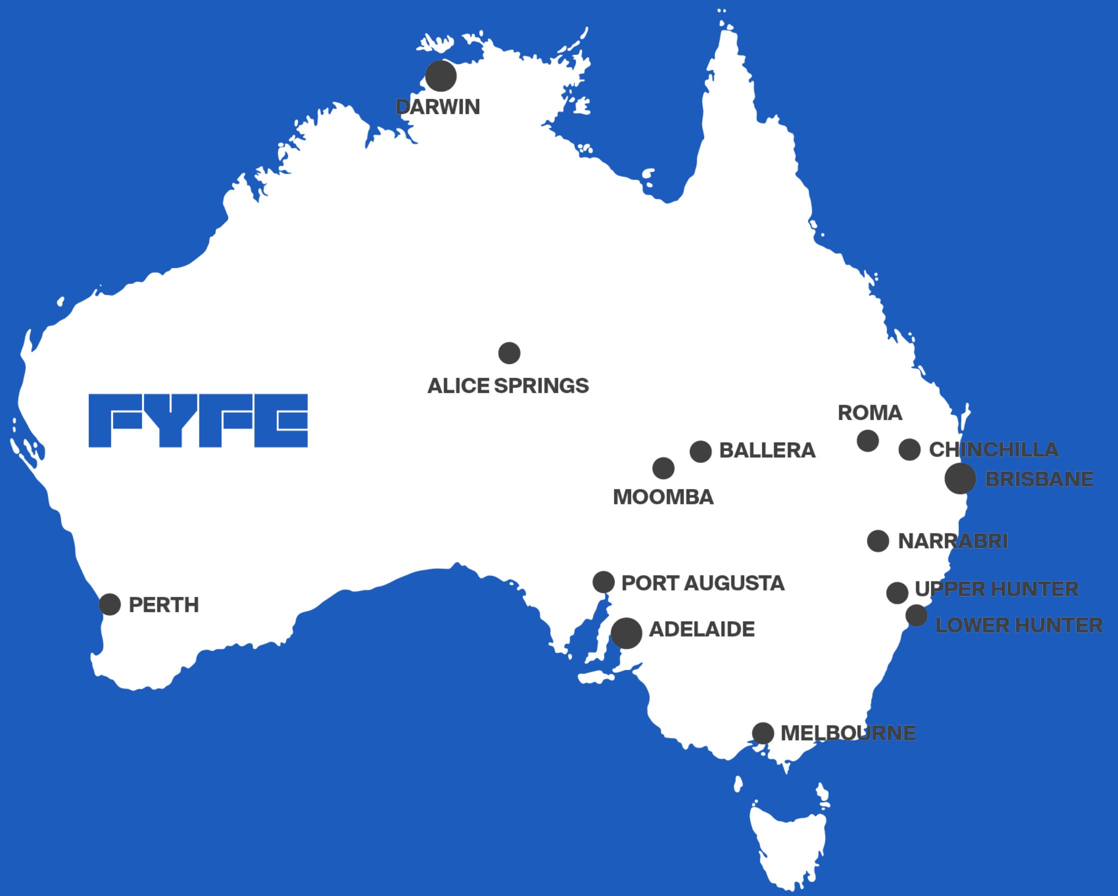
APGA Brisbane Conference

Overview

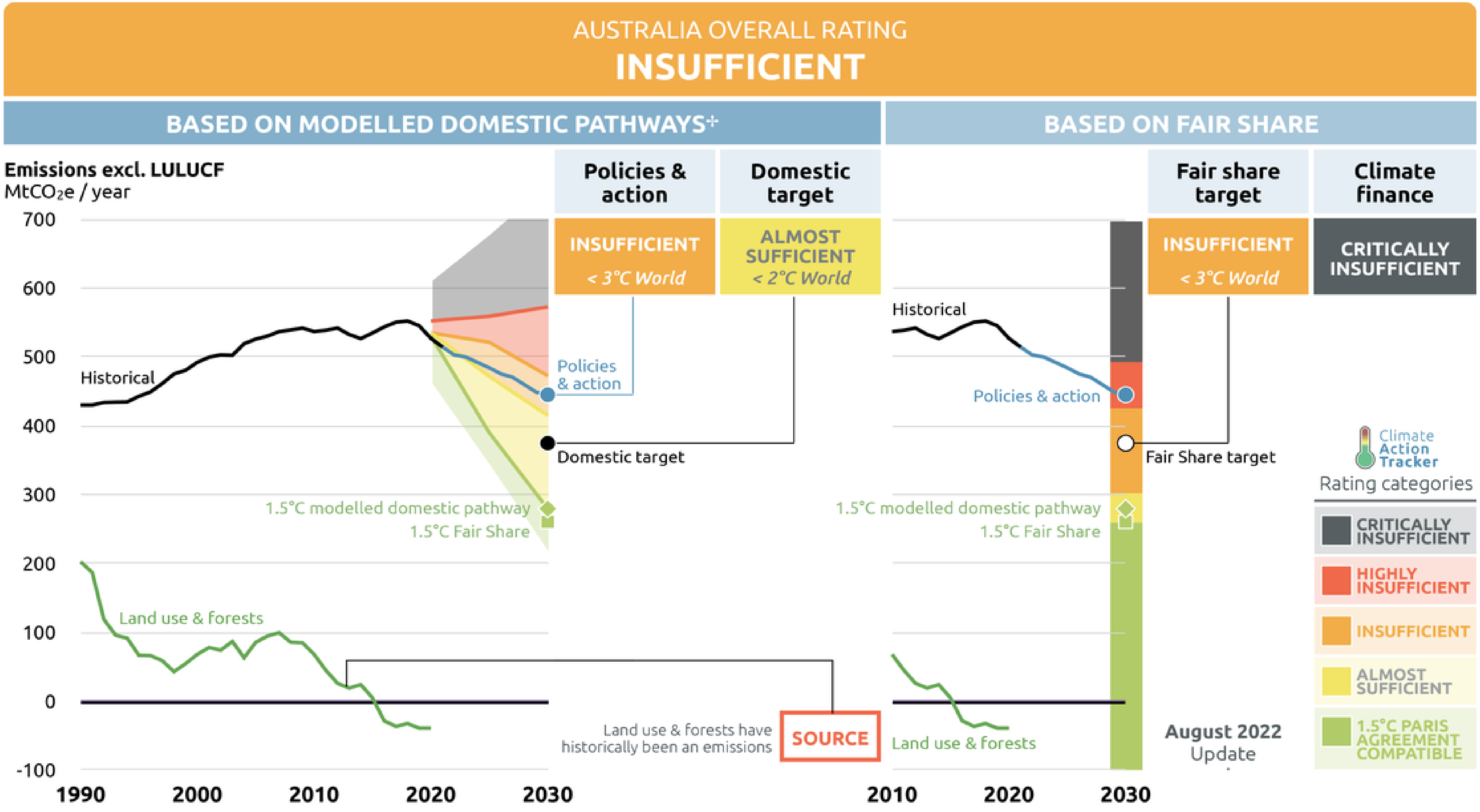
- Australian decarbonisation trends
- What is power-to-gas (P2G)
- Electrolyser comparisons
- P2G in Australia, UK, Germany & Micro Grids
- Risks with hydrogen
- Hydrogen embrittlement of steels
- ASME B31.12
- Cost of P2G
- P2G Hydrogen Refuelling Stations

About us

Fyfe is an Australian professional project services firm delivering value through integrated engineering, environment, planning and survey. We deliver high value projects in the energy, resources, property and infrastructure sectors.

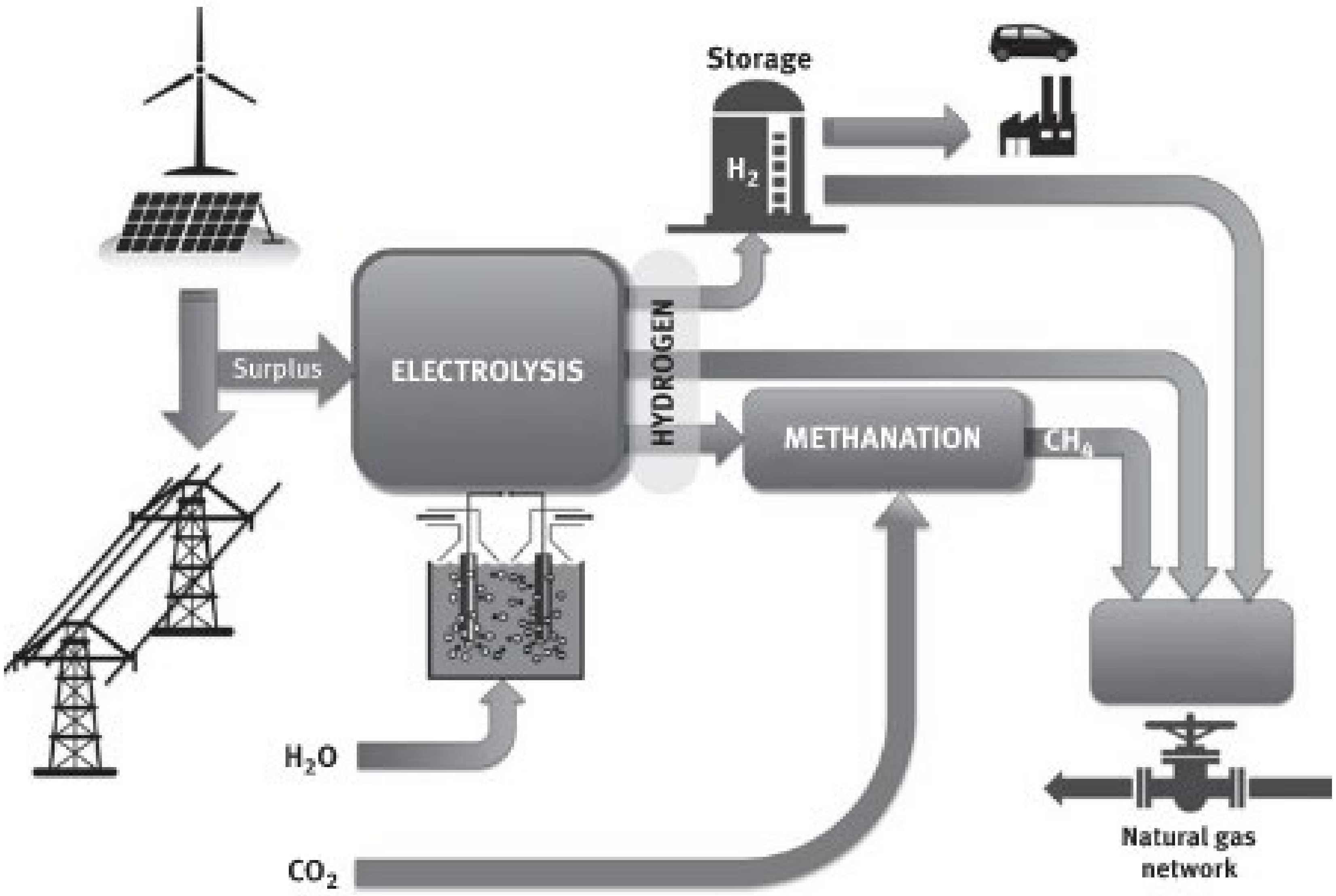


Australian decarbonisation trends



https://climatSactiontracker.org/

What is power-to-gas (P2G)



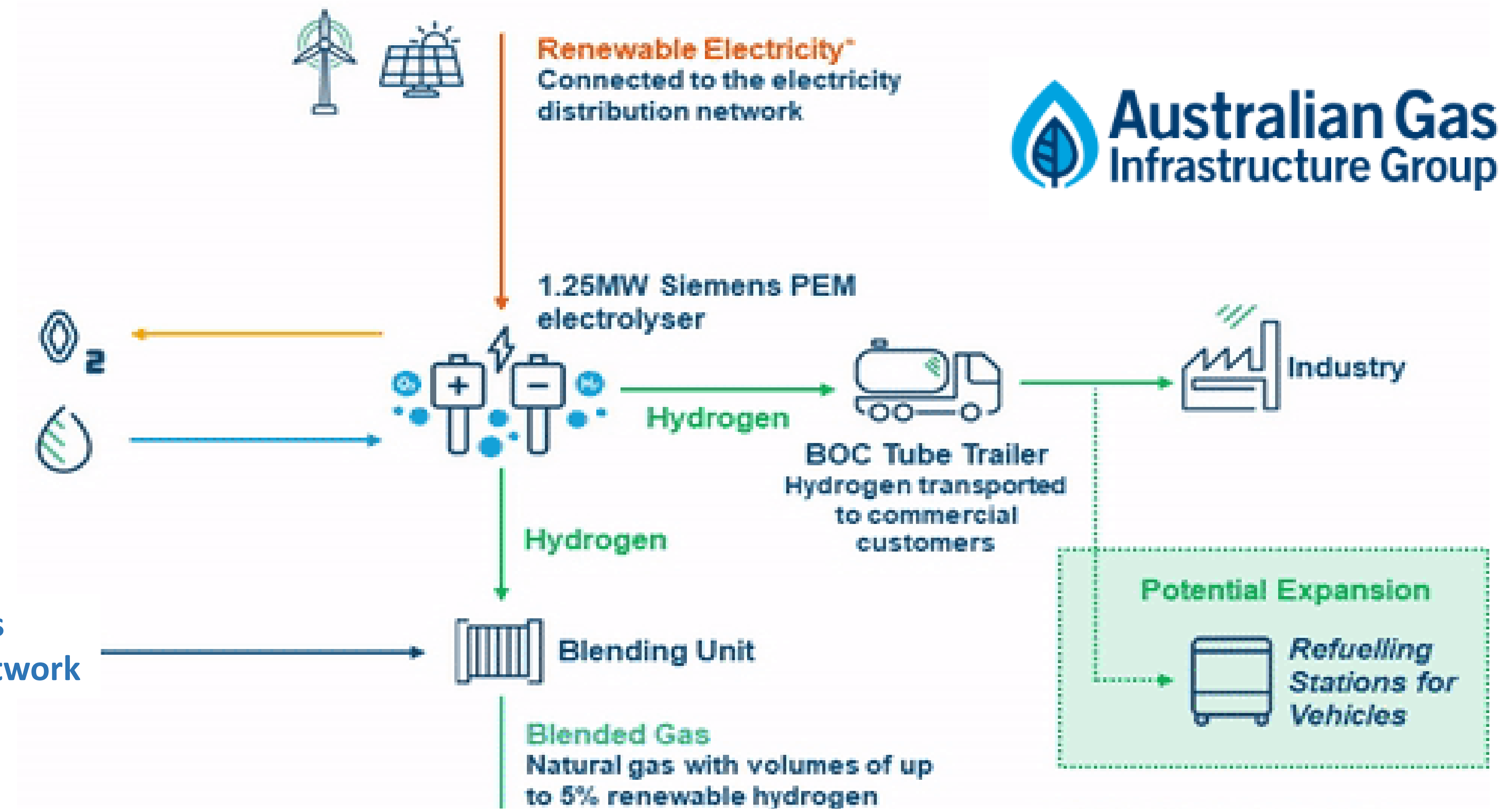
Electrolyser comparisons

Type of technology	Low Temperature					High Temperature	
	Liquid Alkaline			Membrane		O_2-SOEC	H^+-SOEC
	Ambient	Pressurized	ETAC	AEM	PEM		
OEMs	Aqualyzer, stargate hydrogen, nel	HYMETH, Hydrogen Optimized, Hysata, Hydrogen pro, McPhy, sunfire, LONGi, nel, John Cockerill, Peric, metacon, stargate hydrogen, AQUAHYDREX	H_2PRO	Enapter, HydroLite	ITM POWER, nel, SIEMENS, hystar, plug	sunfire, ceres, Bloomenergy, FuelCell Energy, TOPSOE, DynElectro, convion, elcogen, SERONICS	CoorsTek

Water Electrolysis for Hydrogen Production

Type of technology	Low Temperature					High Temperature	
	Liquid Alkaline			Membrane		O_2-SOEC	H^+-SOEC
	Ambient	Pressurized	ETAC	AEM	PEM		
Main advantage	Low CAPEX and long track record	Smaller footprint and higher flexibility than ambient	High efficiency	Low CAPEX	Smallest footprint	Highest efficiency	Lower temperature
R&D direction	Increase current densities while using unexpensive components		Scalability, durability and track record	Scalability, durability and track record	Replacement of expensive components	Scalability, durability and track record	

P2G in Australia

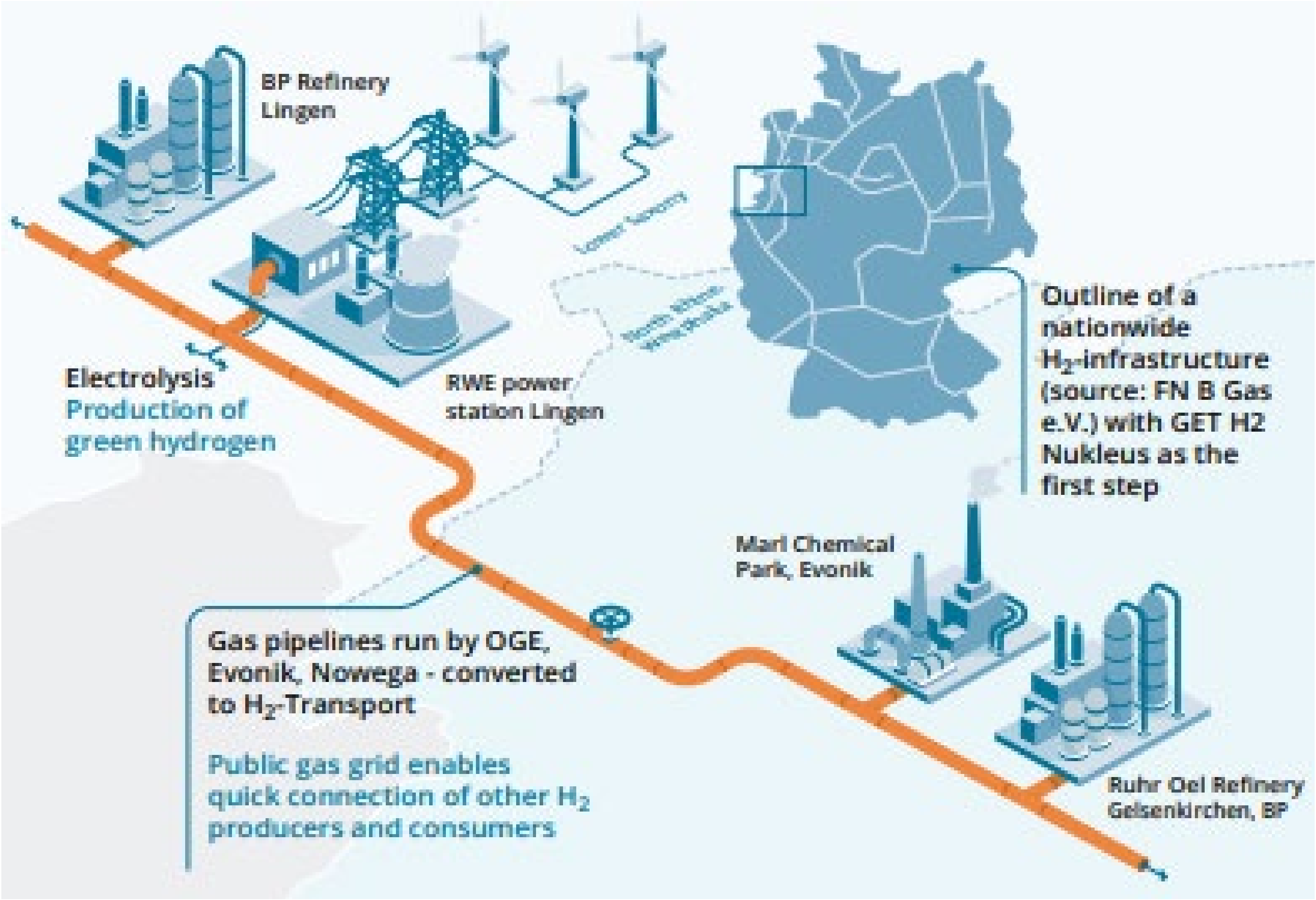


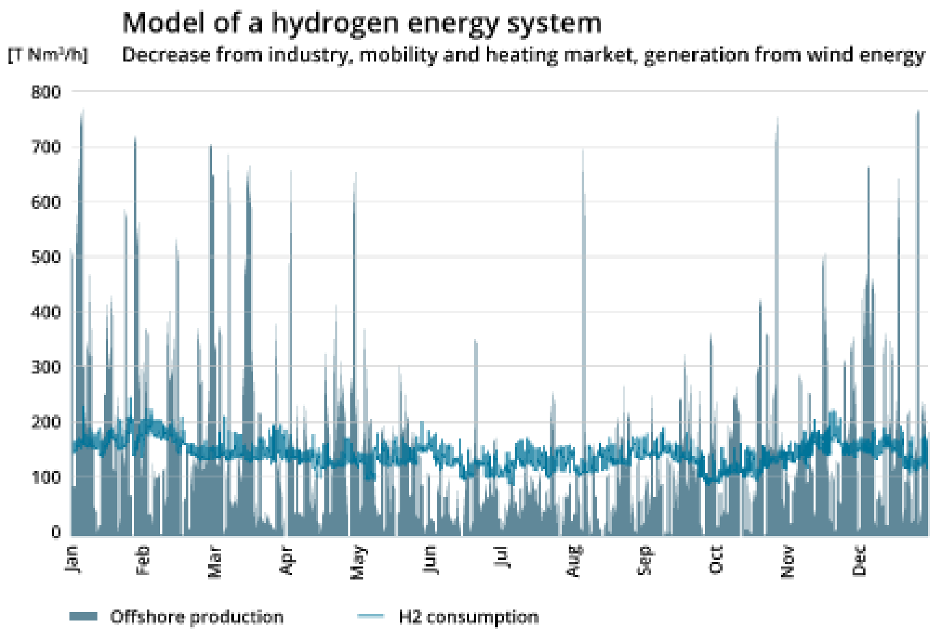
Gas Network

P2G in UK

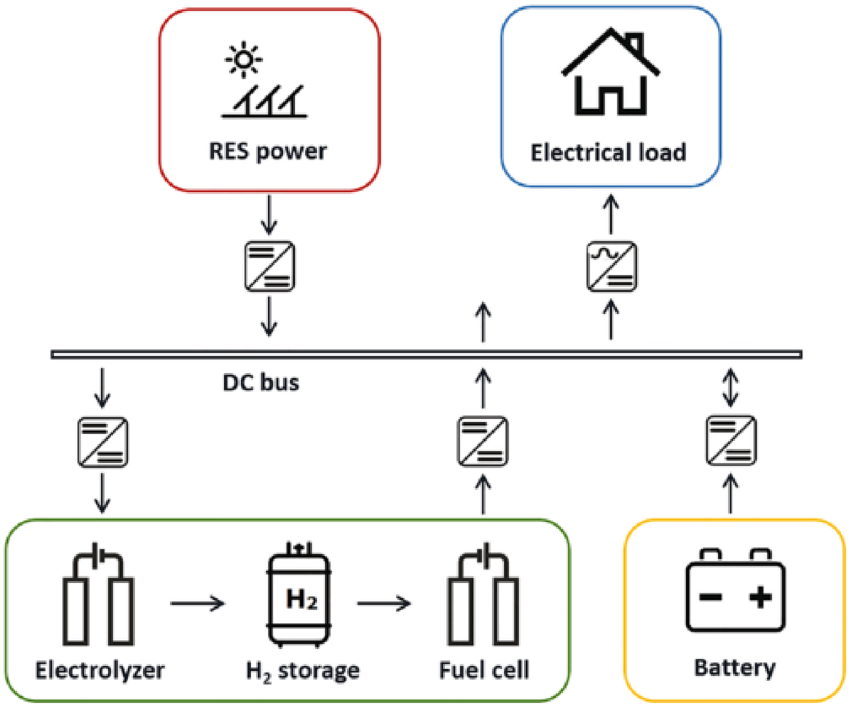
Winlaton, Gateshead

P2G in Germany - GET H2 nucleus





Power-to-gas used for micro-grids



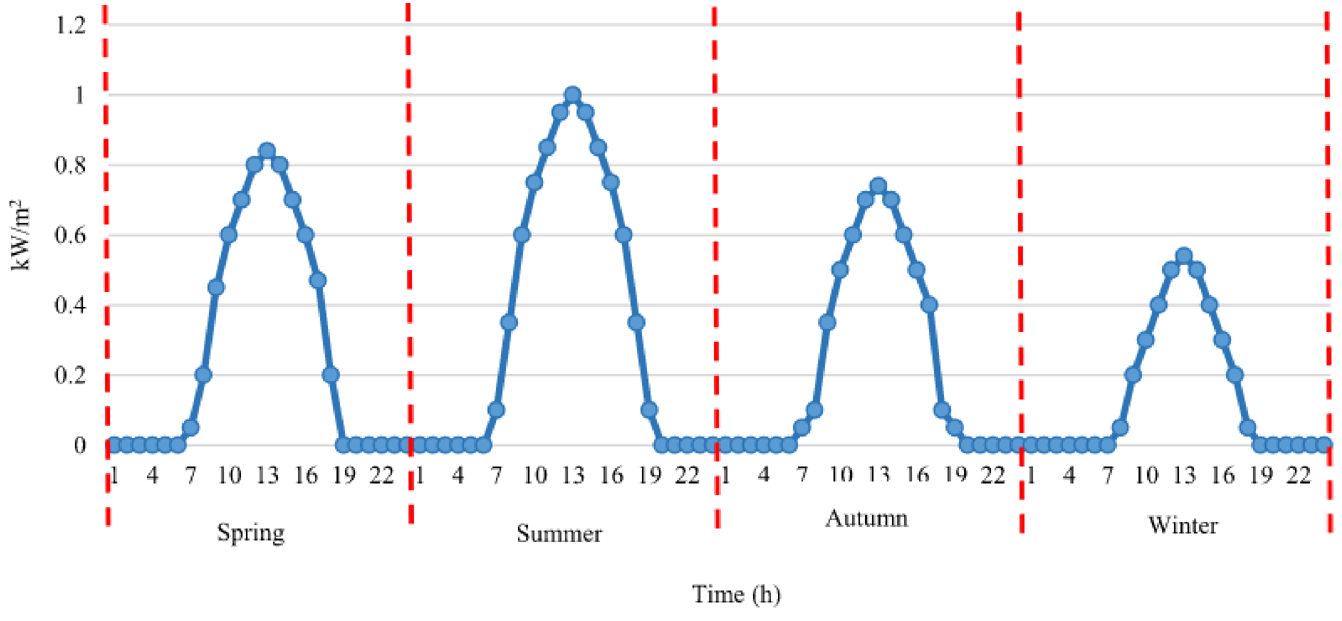
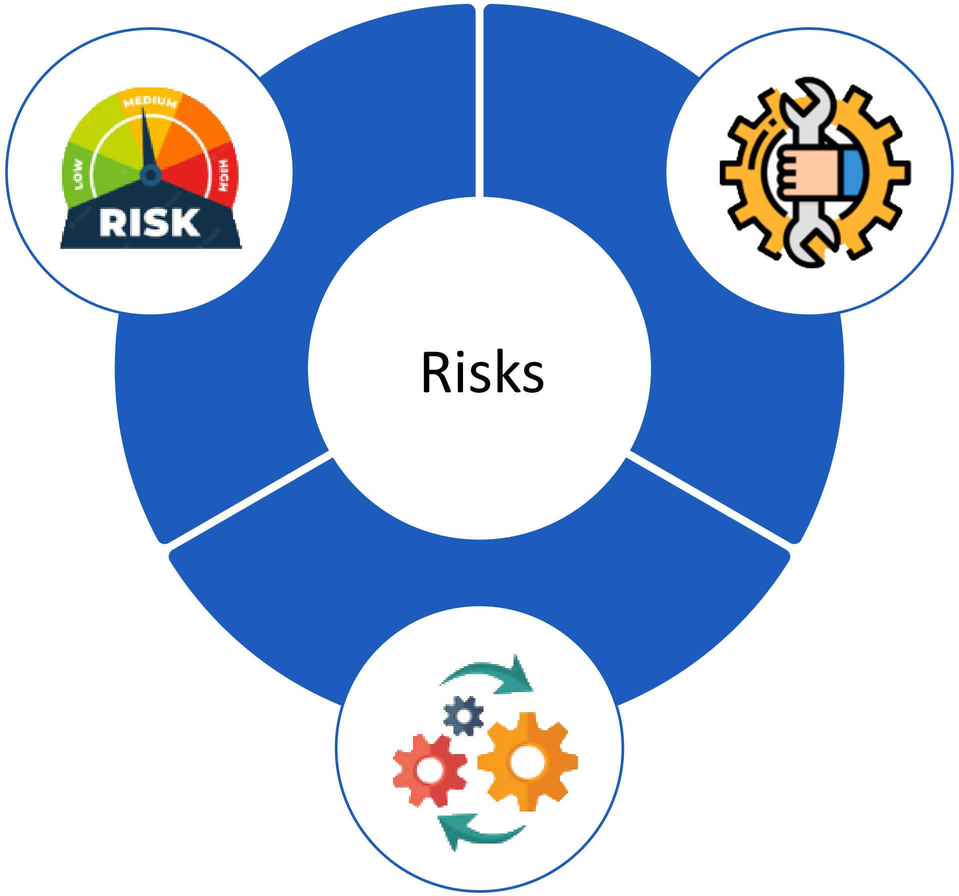


Fig. 7. Solar radiation for different seasons.

Risks with hydrogen

General risks:

High, medium & low

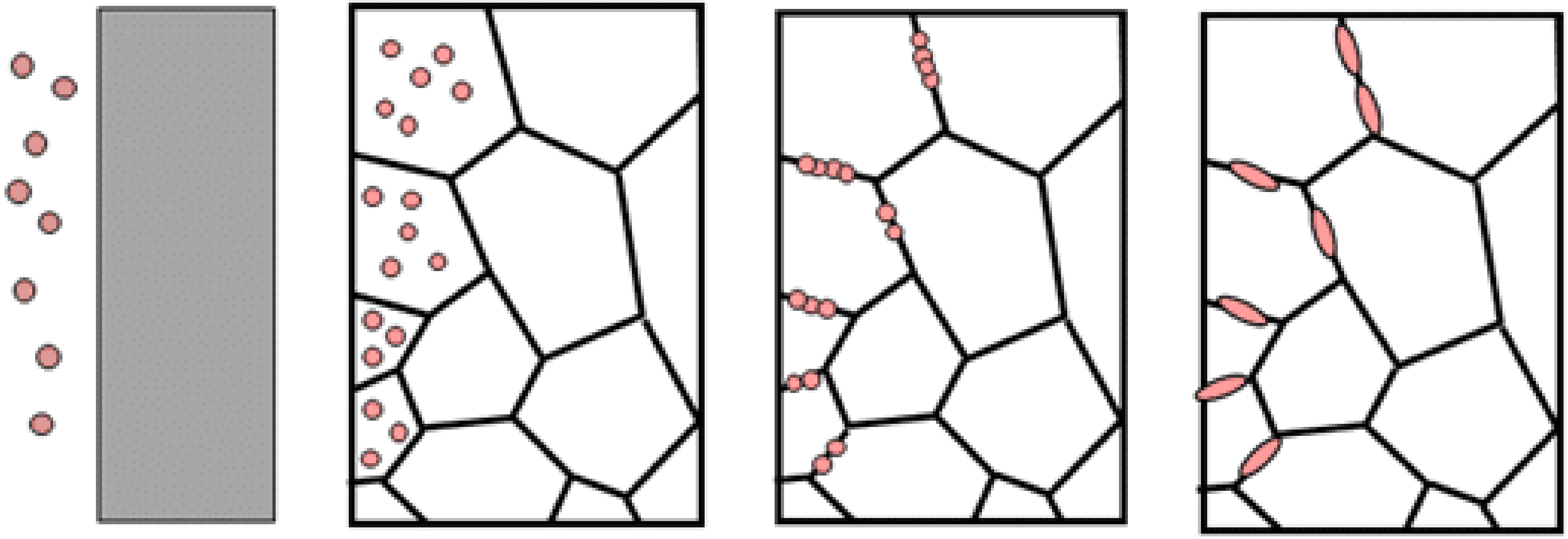


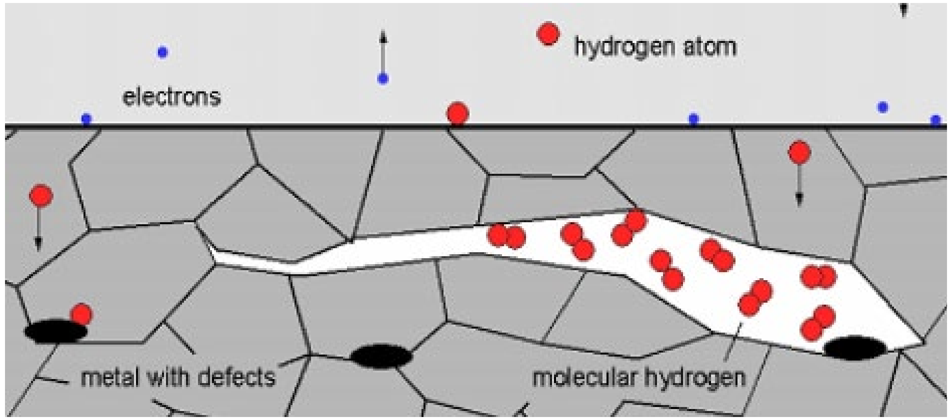
Maintenance risks

Operational risks

Hydrogen Embrittlement of Steels

Hydrogen
Atoms





ASME B31.12

ASME B31.12-2011
(Revision of ASME B31.12-2008)

Hydrogen Piping and Pipelines

ASME Code for Pressure Piping, B31

PL-3.7.1 Steel Piping Systems Design Requirements

(a) *Steel Pipe Design Formula.* The design pressure for steel gas piping systems or the nominal wall thickness for a given design pressure shall be determined by the following formula [for limitations, see (b) below]:

$$P = \frac{2St}{D}FETH_f$$

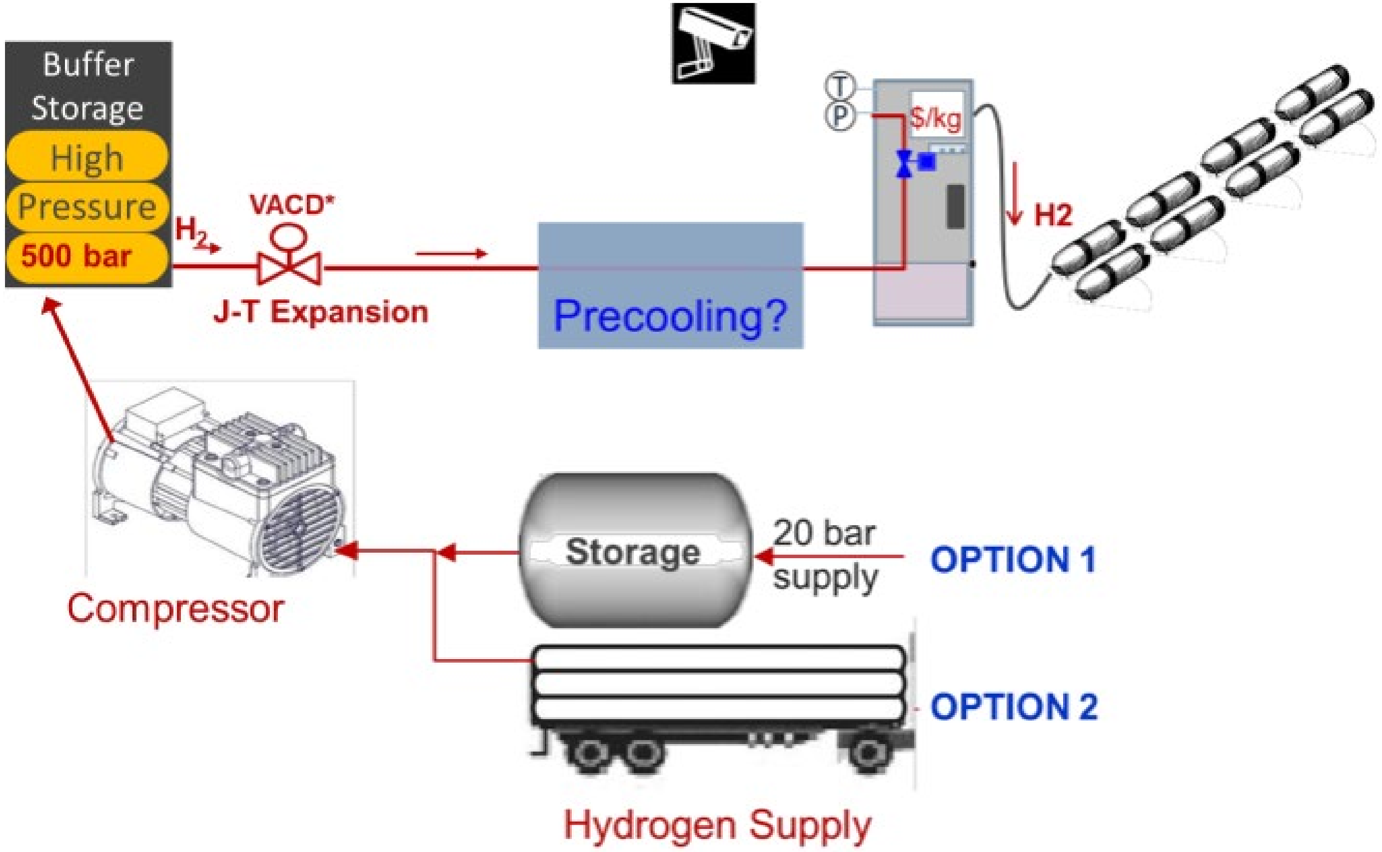
Table IX-5A Carbon Steel Pipeline Materials Performance Factor, H_f

Specified Min. Strength, ksi		System Design Pressure, psig						
Tensile	Yield	≤1,000	2,000	2,200	2,400	2,600	2,800	3,000
66 and under	≤52	1.0	1.0	0.954	0.910	0.880	0.840	0.780
Over 66 through 75	≤60	0.874	0.874	0.834	0.796	0.770	0.734	0.682
Over 75 through 82	≤70	0.776	0.776	0.742	0.706	0.684	0.652	0.606
Over 82 through 90	≤80	0.694	0.694	0.662	0.632	0.610	0.584	0.542

Cost of P2G: 2020, 2026, 2031, 2036

Sub-horizon (y)	(1–5)	(6–10)	(11–15)	(16–20)	Ref.
Installation year (y)	2020	2026	2031	2036	
Li-ion battery ($/kWh)	390	260	210	190	[68]
Thermal storage ($/kWh)	100	95	90	85	assumption
Transformer ($/kVA)	450	427	405	394	[32], assumption
Wind turbine ($/kW)	1466	1370	1246	1172	[41,75]
Solar PV ($/kW)	1720	1255	860	619	[41,71,76]
CHP (CCGT) ($/kW)	1200	1150	1100	1050	[72]
Boiler ($/kW)	450	427	405	394	[32], assumption
Electrolysis * ($/$kW_{el}$)	1170	906	625	508	[67]
Methanation * ($/$kW_{CH4}$)	680	598	519	448	[67]
H_2 storage* ($/$m^3_{H2}$)	52	45	39	26	[44,77], assumption

P2G Hydrogen refueling stations



Questions

- **Fyfe** – projects, partnerships, and collaborations
- **Resources** – fyfe.com.au/hydrogen
- **Connect** – Follow Fyfe on LI for regular hydrogen insights
- **Questions** – Jaron.Whalley@fyfe.com.au

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