strategy&

Unlocking South Africa's Hydrogen Potential

pwc

Unlocking South Africa's Hydrogen Potential – Key takeaways

Hydrogen is critical to achieving global decarbonisation

"As the world becomes more reliant on renewables as its primary source of energy, Hydrogen offers an unparalleled solution for the transport, storage and efficient utilisation of clean energy"

The time is now

"Hydrogen is receiving an unprecedented level of international traction as the cost of renewables decline and carbon emissions are increasingly penalised"

SA has the competitive advantage to produce and export green energy

"South Africa has world class renewable potential that can be leveraged to supply clean energy to the world and transform the domestic economy"

Hydrogen means more than just Fuel Cells

"Hydrogen has the ability to revolutionise the entire energy space. For South Africa, focussing on Fuel Cells alone is missing the bigger opportunity"

Investing in Hydrogen is necessary to diversify the SA economy

"As part of SA's economic recovery plan, the country needs to develop new competitive industries in the global markets. Hydrogen can fulfil that role and in a complementary manner to other initiatives and sectors"

Regulation is key for SA to successfully capitalise

"Coherent government policy will be necessary to support the pace of hydrogen development and correctly incentivise the move towards fully Green hydrogen"

The Global Energy Transition

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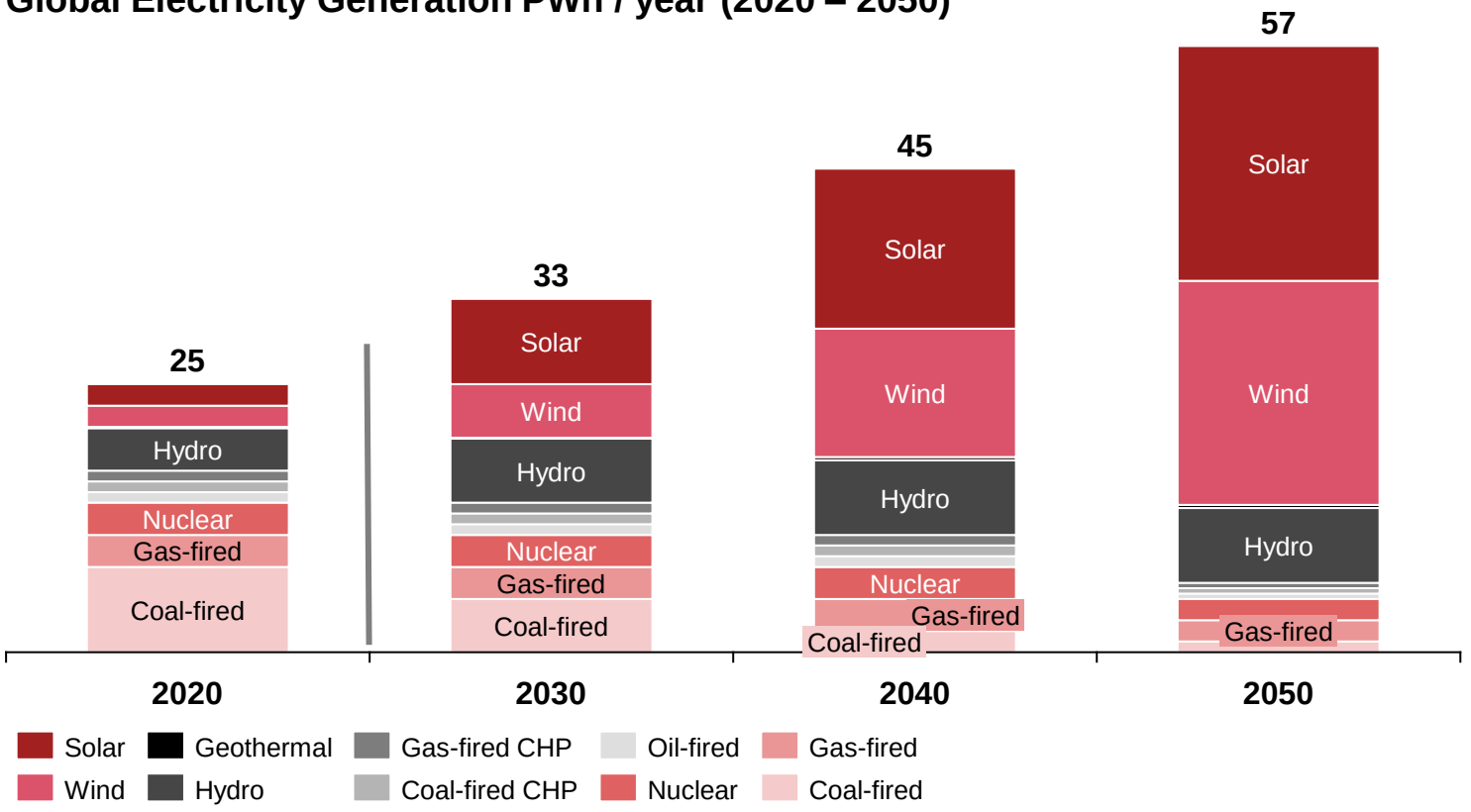
Global Electricity Generation PWh / year (2020 – 2050)



Key Insights

- It is estimated that by 2050, renewables will account for **85%** of Global Electricity production. Sectors such as transport, building heat and power and industrial processes will take longer.
- Despite this, it is expected that the Global Energy Mix will be **50%** powered from renewable sources by **2050**
- **As the world moves towards renewables as the primary energy vector, production will become increasingly geographically constrained, necessitating increased cross-border transportation and storage of green energy**

Source: DNV GL's Energy Transition Outlook

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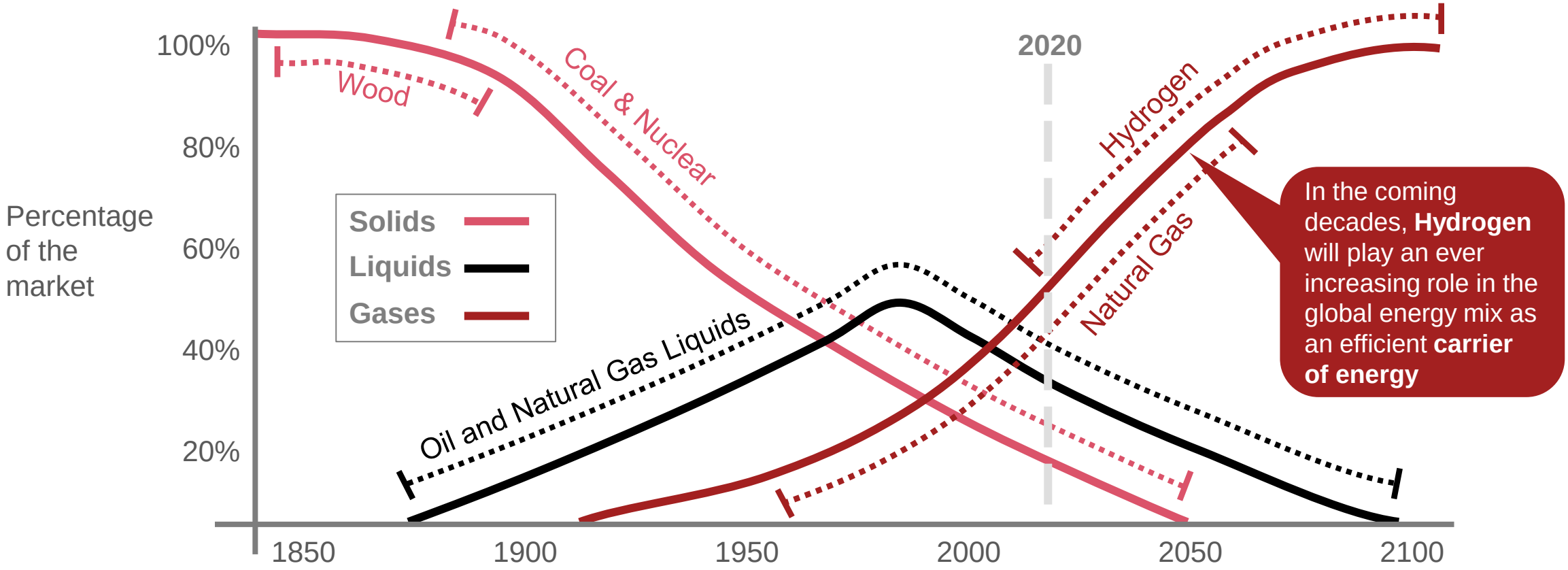

Source: 'The Geography of Transport Systems' 5th Edition (Jean-Paul Rodrigue) 2020

Hydrogen energy content

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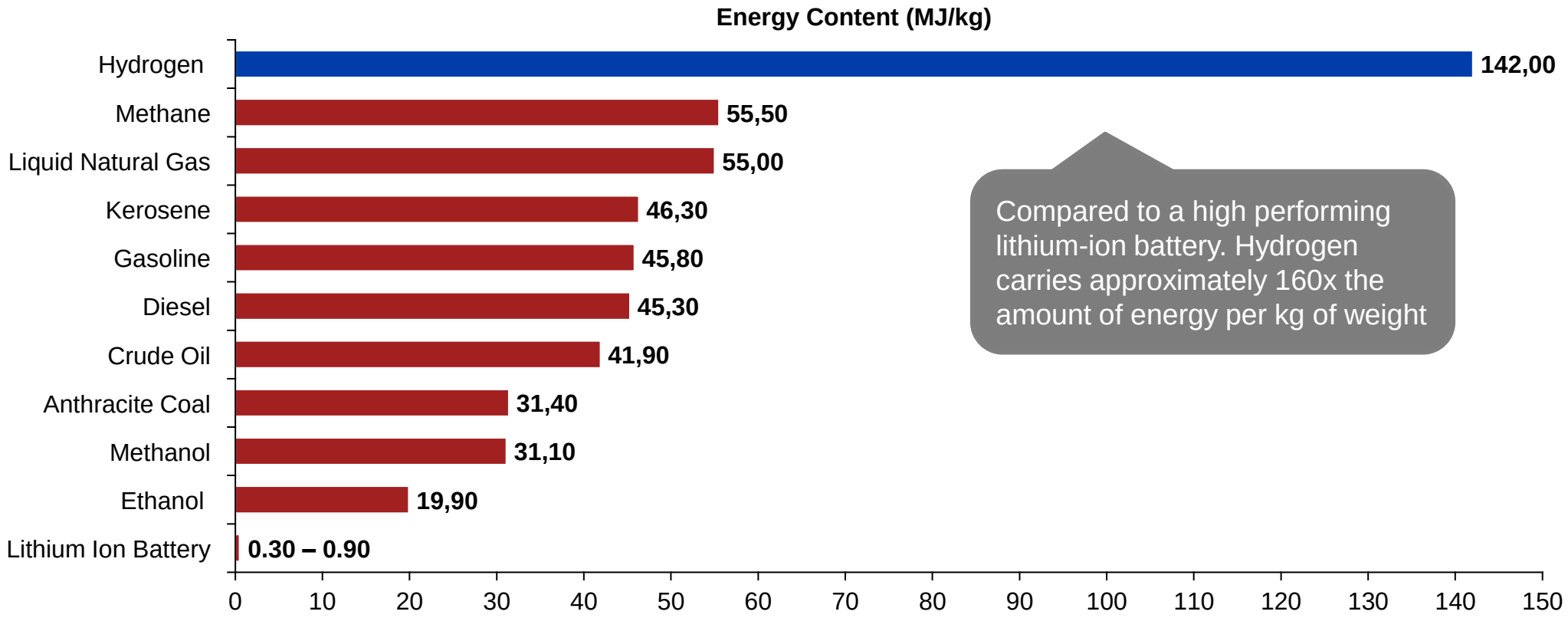

Compared to a high performing lithium-ion battery. Hydrogen carries approximately 160x the amount of energy per kg of weight

Source: C. Ronneau – Universitaires de Louvain

Hydrogen production methods

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	Grey Hydrogen	Blue Hydrogen	Green Hydrogen
Summary	Hydrocarbon feedstock (coal, natural gas, oil) with all CO_2 from the production process emitted into the atmosphere	Same hydrocarbon feedstock as grey hydrogen with carbon capture and storage (CCUS) technology integrated	The electrolysis of water from a renewable power source (wind, solar, etc.) or through a bioreactor
Market Share	**90%**	**6 - 7%**	**3 – 4%**
Outlook	Decline as the world tightens carbon emissions and 'blue' and 'green' alternatives become less expensive	Positive outlook for the short to medium term as it is a viable 'Green' transition for existing Grey Hydrogen production sources	Highly positive with of production to decline sharply due to cheaper renewable energy, scale and electrolysis improvements
Carbon Emissions	**9kg - 20kg** of carbon per 1kg Hydrogen	**1kg – 2kg** of carbon per 1kg Hydrogen	**0kg** of carbon per 1kg Hydrogen

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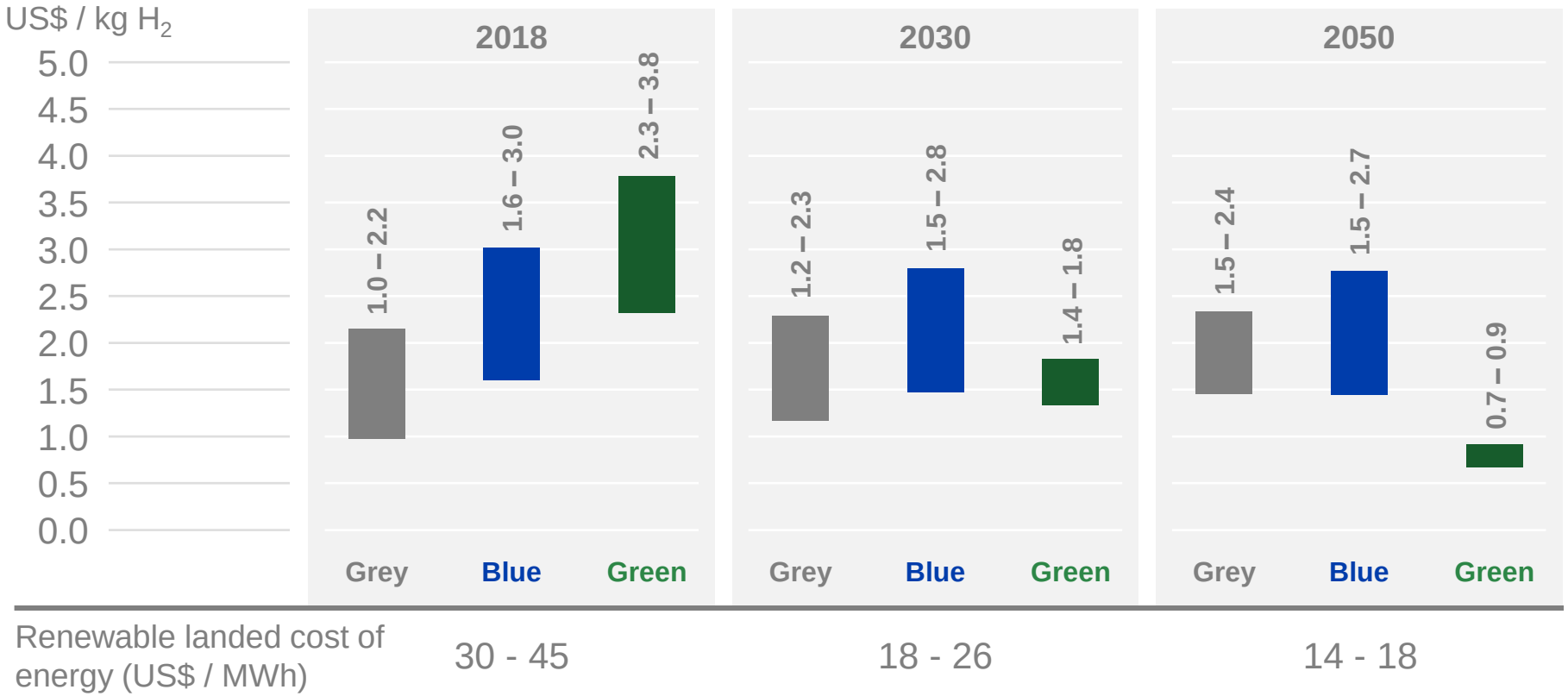

Source: International Energy Agency, "The Future of Hydrogen: Seizing today's opportunities," June 2019 (https://www.iea.org/reports/the-future-of-hydrogen); Strategy& "The dawn of green hydrogen – Maintaining the GCC's edge in a decarbonized world

$95 billion hydrogen pipeline at beginning of 2020

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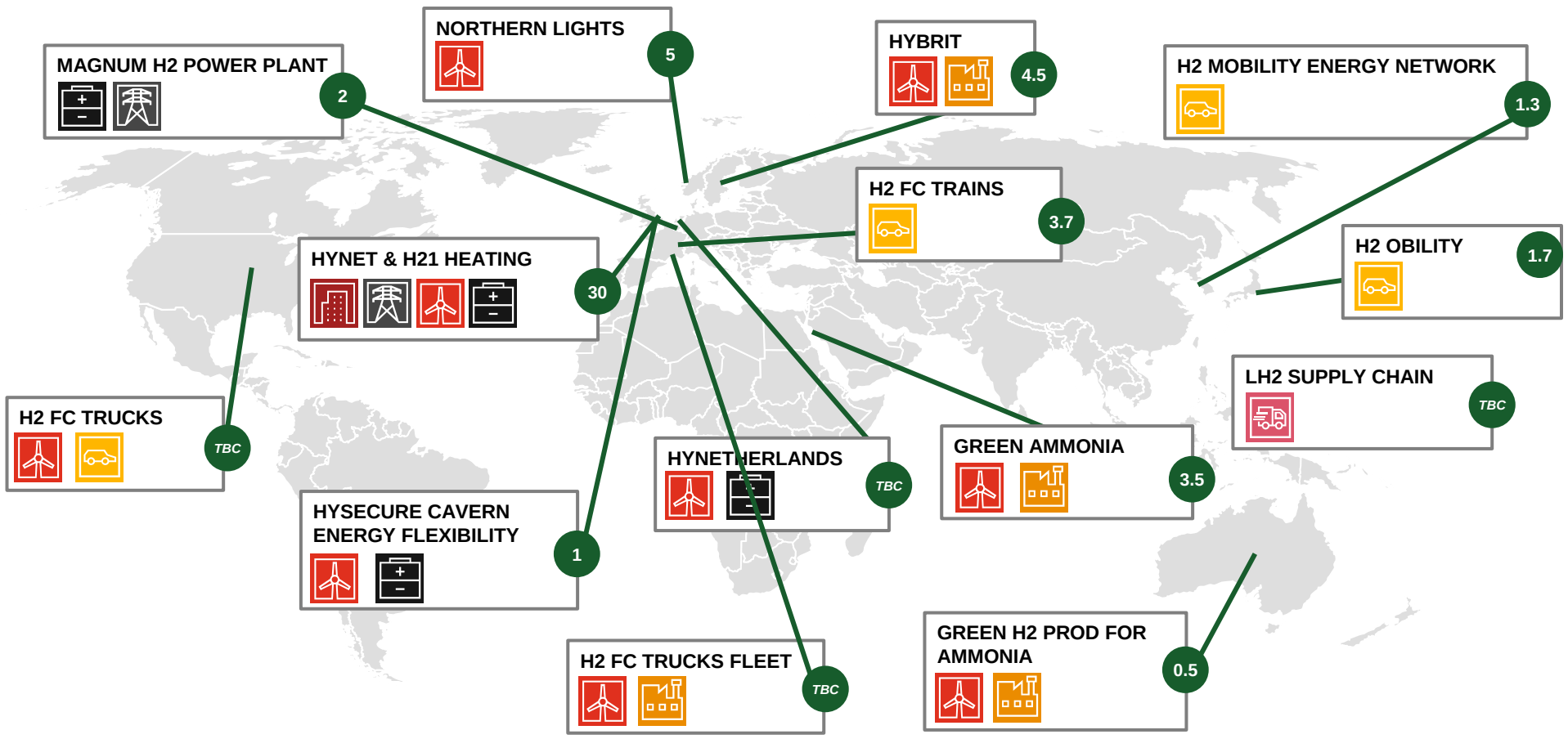
- Production
- Distribution
- Storage
- Mobility
- Power Generation
- Feedstock
- Building heating

Approximate CO_2 abatement of project at scale (Mt / year)



Source: Bloomberg Green, Strategy& analysis

Rapid increase in national hydrogen strategies and funding

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	Production	Utilisation	Technology	SA Potential
National Hydrogen Strategy release in November 2019. Government funding of **AUD 370 million** to back new hydrogen projects	✓	✓		
In 2019, Saudi Arabia earmarked the NEOM region to be the leading **global hub for renewable energy.** In June 2020, it secured a **~ € 4.5 billion green ammonia production facility**, producing **1.2mtpa**	✓			
In 2019, New Zealand launched **"a Vision for Hydrogen in New Zealand",** which sets out the role of Hydrogen in its commitment to be carbon neutral by 2050	✓	✓		
In June 2020, the U.S. Department of Energy announced intentions to invest **$100 million** into two DOE National Laboratory-led consortia for **fuel cell and hydrogen R&D.**	✓	✓	✓	
The government released **#mission2030 - Austrian Climate and Energy Strategy,** which included boosting infrastructure for hydrogen and a flagship project centred on renewable hydrogen	✓	✓		
In 2019, the Dutch government Climate Agreement included a substantial hydrogen development program to accommodate **large-scale production and storage of renewable electricity with hydrogen technology**	✓	✓	✓	
Launched a Industrial Decarbonization challenge, committing **GBP 170 million** towards deploying technologies like carbon capture and hydrogen networks in industrial clusters, supporting the Industrial Clusters Mission to establish the world's first net zero industrial cluster by 2040		✓	✓	
In June 2020, Germany announced a **€9 billion stimulus package** allocated to expand the role of green hydrogen to help end the country's reliance on coal as the country revealed its Hydrogen strategy		✓	✓	
JPY 26.3 billion (~ €215 million) was approved to establish a **hydrogen supply chain** and offer subsidies toward public hydrogen station development for fuel-cell vehicles		✓	✓	
In January 2019, the government announced **its Hydrogen Economy Roadmap** and Ulsan's Future Energy Strategy, focussing on leading the hydrogen vehicles and fuel cell industry. Furthermore, the government announced it plans to build three hydrogen-powered cities by 2022		✓		
In 2018, the Government presented the **Hydrogen Deployment Plan for Energy Transition** to the key players in the sector. One of the objectives is to put 5000 hydrogen vehicles on the road by 2023 and to install 100 refuelling stations for those vehicles		✓		

Source: Ministers for the Department of Industry, Science, Energy and Resources, Fuel Cell and Hydrogen Energy Association, Baker McKenzie, French Government, New Zealand Ministry of Business, Innovation and Employment, European Commission, Strategy& analysis

Global renewable energy potential

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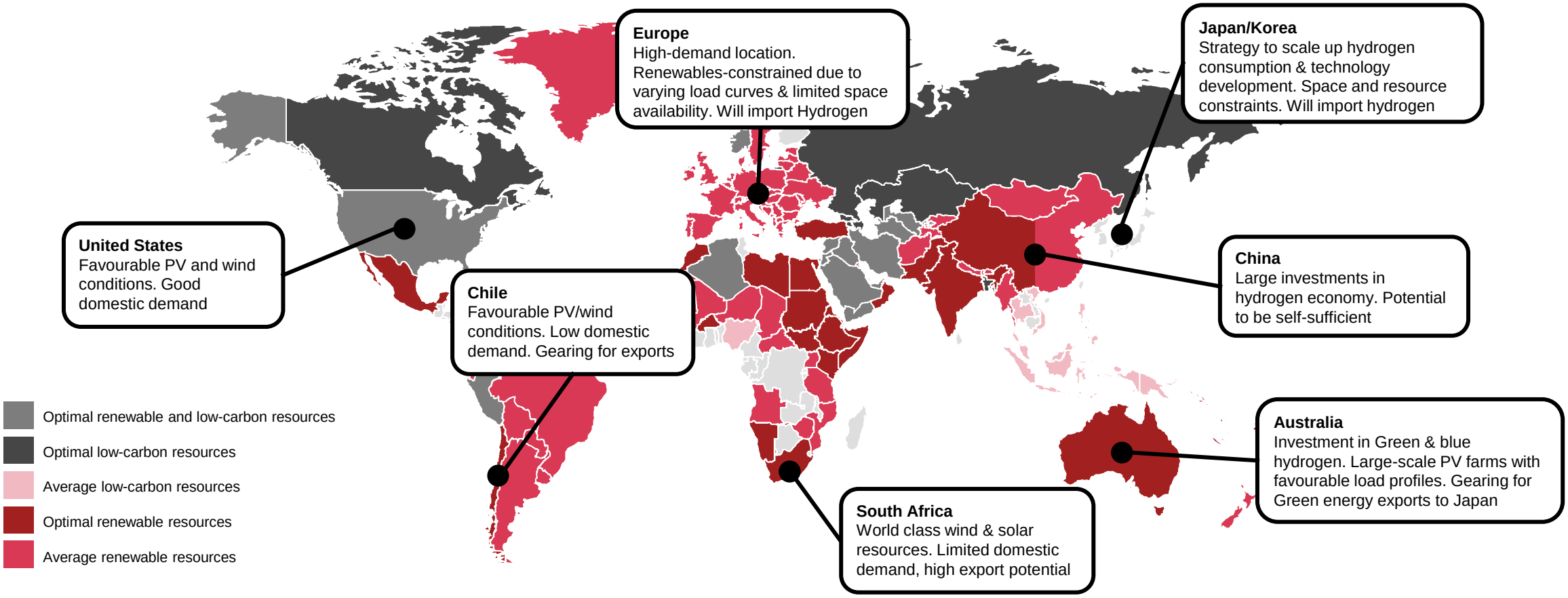

Source: IEA, McKinsey

South Africa has world class renewables

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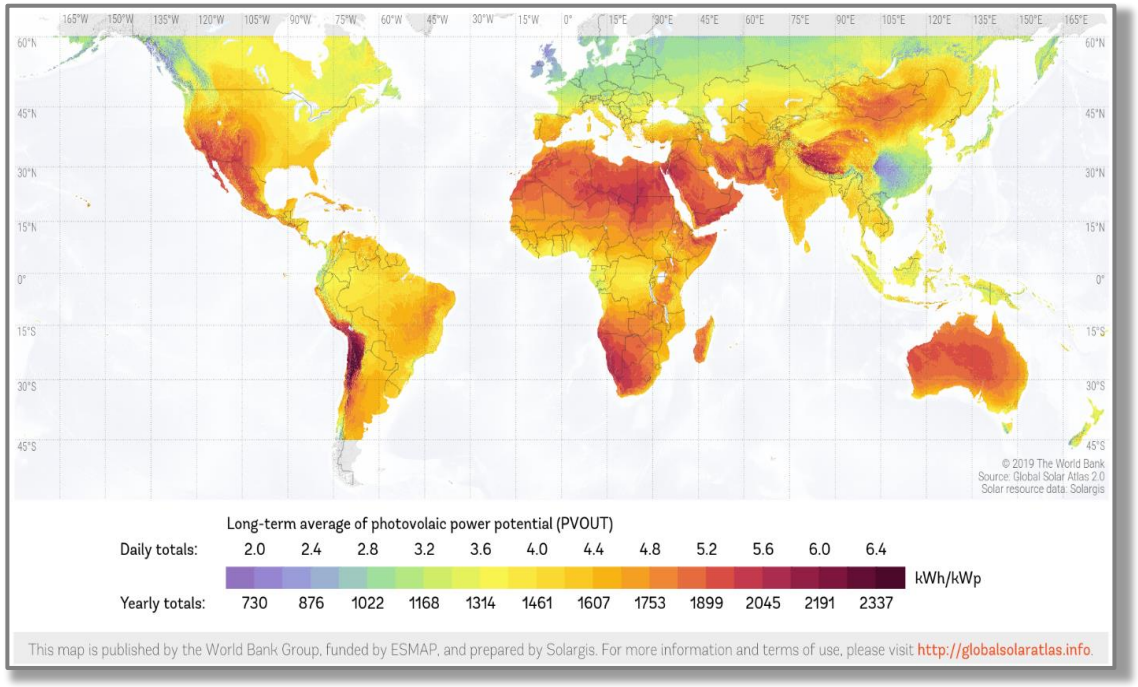
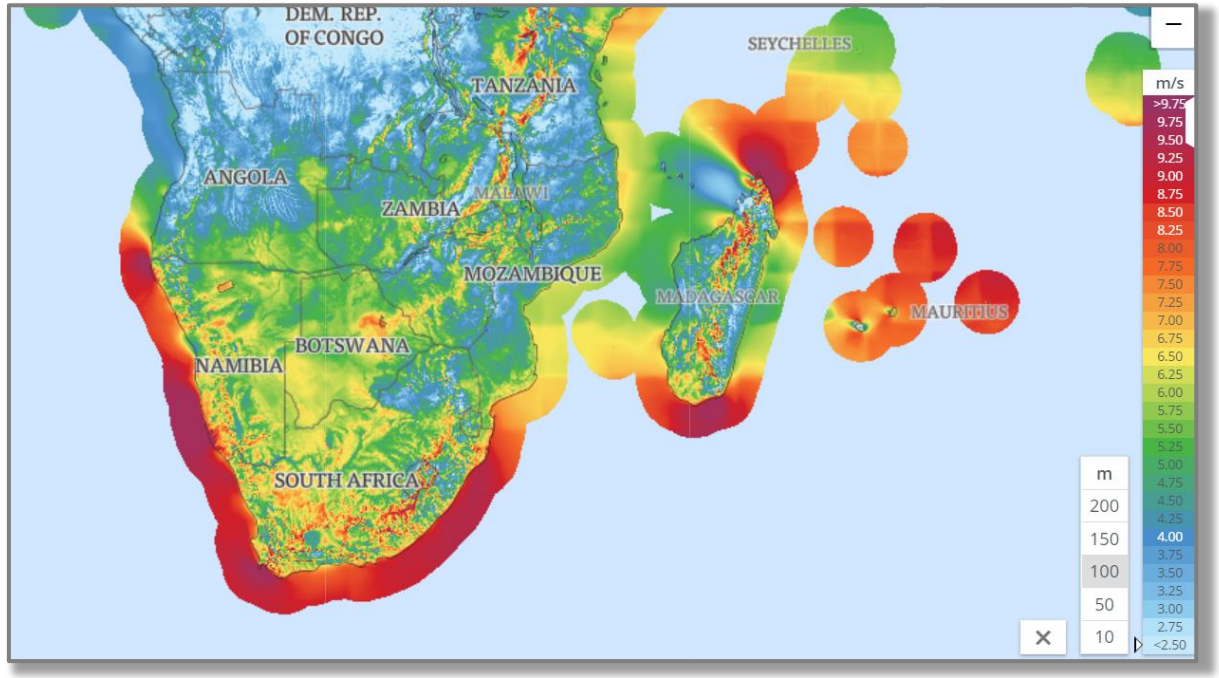


Source: Global Solar Atlas, World Bank

"South Africa has near perfect wind conditions across almost all of its 3000km coastline, along with pockets of high capacity onshore wind in the Western and Eastern Cape"

"South Africa's solar in the Northern Cape has the potential to not only generate energy for the domestic economy but also to export this clean energy through the West Coast Ports"



Source: Global Wind Atlas 2020

SA is ideally positioned to be a exporter of green energy to the world

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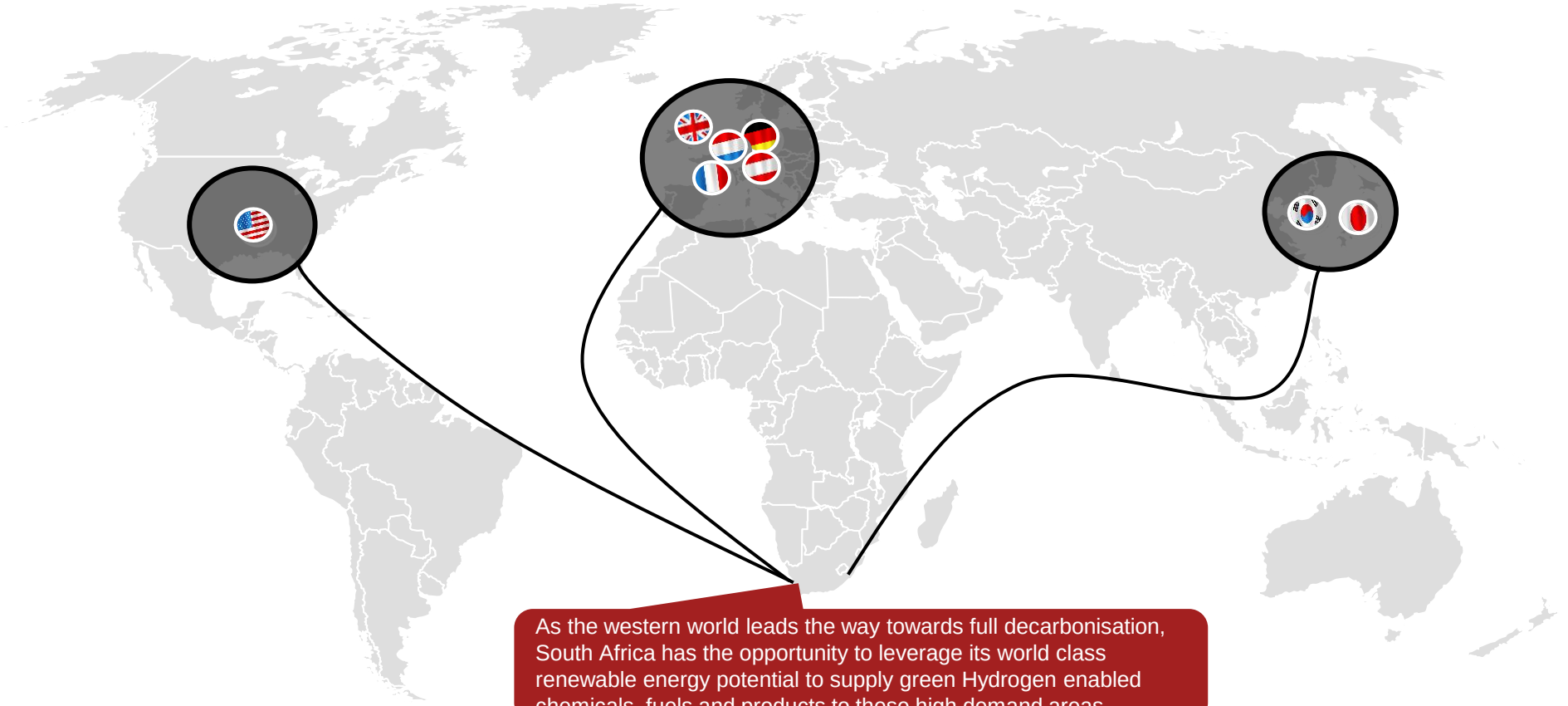

As the western world leads the way towards full decarbonisation, South Africa has the opportunity to leverage its world class renewable energy potential to supply green Hydrogen enabled chemicals, fuels and products to these high demand areas

Four pillars of the Global Hydrogen Economy

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Transport

- **Road –** High efficiency, zero emission Fuel Cell Electric Vehicles
- **Aviation –** Liquid hydrogen drones, VLOTs and synthetic fuels
- **Rail** – Fuel Cell Electric Locomotives
- **Shipping –** Green Hydrogen based ammonia fuel

Building Heat and Power

- **Off-grid / backup power systems**
- **Natural Gas Replacement / blending**
- **Combined heat and power systems (CHP)**

Hydrogen

Industrial Feedstock

- **Industrial Heat** – Zero emission efficient heat
- **Feedstock** – Moving carbon heavy feedstock to green ones
- **Carbon Sequestering –** capturing carbon (CC) using hydrogen
- **Synthetic Fuels –** CC from fossil fuels and air scrubbing

Energy Sector

- **Renewable Energy Intermittence** – Store of energy
- **Efficient Energy Transport** – Cross border
- **Cost effective gird buffering and cross sector coupling**
- **Multi-use** – Direct combustion and fuel cells

Six key benefits of South Africa investing in Hydrogen

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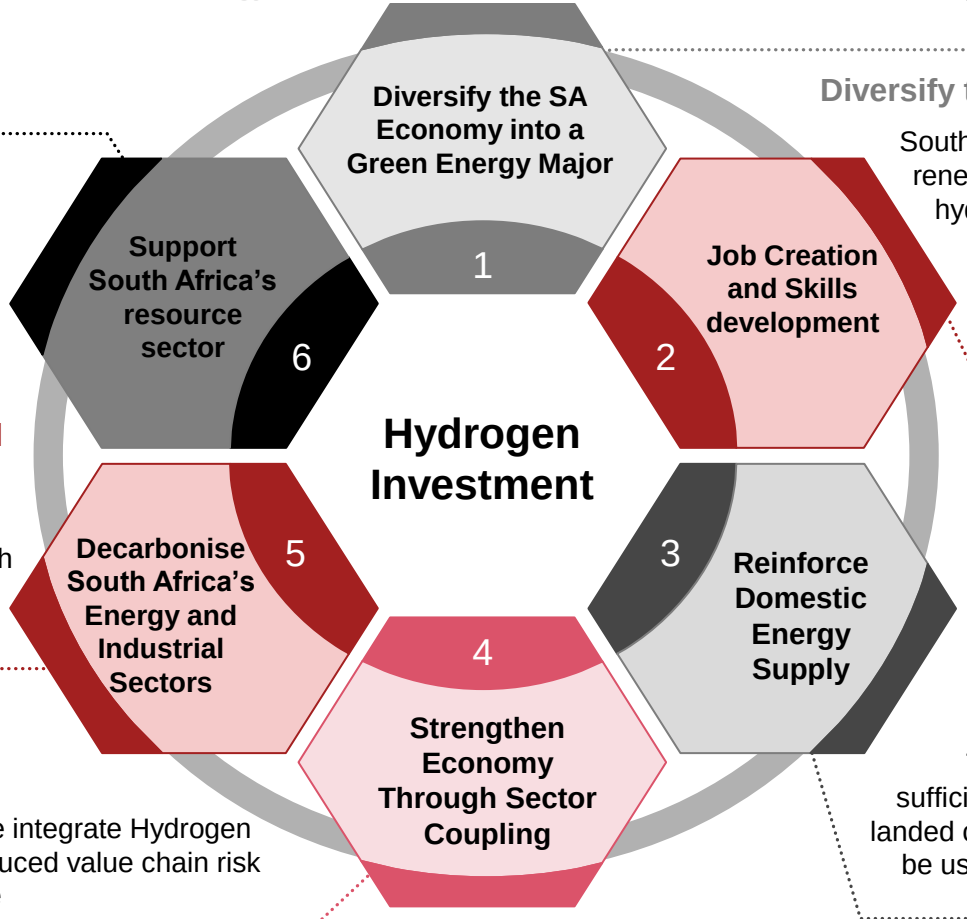

Support South Africa's Resource Sector

Increased demand for Hydrogen Fuel Cells will stimulate demand for South Africa's PGMs and the massive increase in domestic Solar and Wind resources will help support the wider commodities sector

Decarbonise South Africa's Energy and Industrial sectors

South Africa can not only help decarbonise its own power sector through large scale renewable investment, but through access to green hydrogen can decarbonise its other industrial sectors such as steel production and mining

Strengthen Economy Through Sector Coupling

Hydrogen has the unique capability to be a carrier of energy across a multitude of different sectors. If the economy is able integrate Hydrogen technology across multiple sectors they can benefit from reduced value chain risk and benefit from cost reductions through economies of scale

Diversify the SA Economy into a Green Energy Major

South Africa has the opportunity to leverage its world class renewable energy resources to produce and export green hydrogen and green hydrogen enabled fuels, chemicals and products. Generating large export revenue and attracting foreign investment

Job creation and Skills Development

Development of a new hydrogen export industry will create numerous jobs along the value chain and enhance the specialised skills pool in the country

Reinforce Domestic Energy Supply

The large renewables investment needed to generate sufficient quantities of Hydrogen for export will bring the SA landed cost of energy down and a portion of this capacity can be used to support our domestic grid. Potentially at a lower cost to consumers

Important regulatory questions remain

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Investing in Hydrogen can be a win for the entire economy

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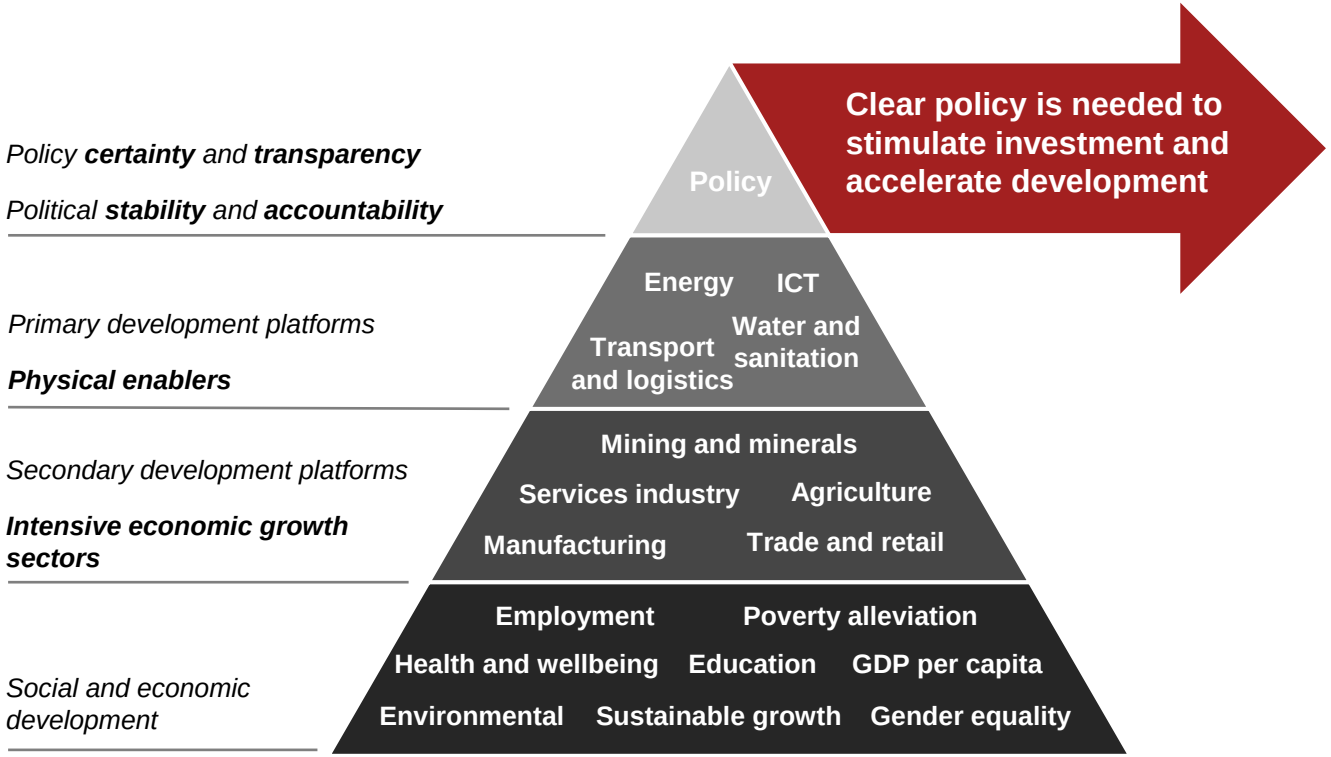
Hydrogen can be a key enabler of economic growth



7 Point Policy Plan for South Africa

- Finalise the SA Hydrogen strategy and roadmap – where to play, how to start, how we support and incentivise ***(Currently under development)***
- Clear Ministerial direction around which government department will champion Hydrogen ***(e.g. Energy or Trade and Industry)***
- Assesses the need for regulation in enabling a competitive market ***(regulatory hurdles need to minimised and processes streamlined)***
- Incentivise early investment and just transition from Grey, to Blue, to Green Hydrogen ***(e.g. sector specific SEZ's, tax credits, policy certainty)***
- Fast tracking of renewable energy licensing used for Hydrogen production
- Review and strategy for local content and local skills development
- Signing of collaboration agreements between hydrogen producers, off takers and technology players ***(similar to the Japan-Australia and Germany-Morocco MoUs signed in recent years)***

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