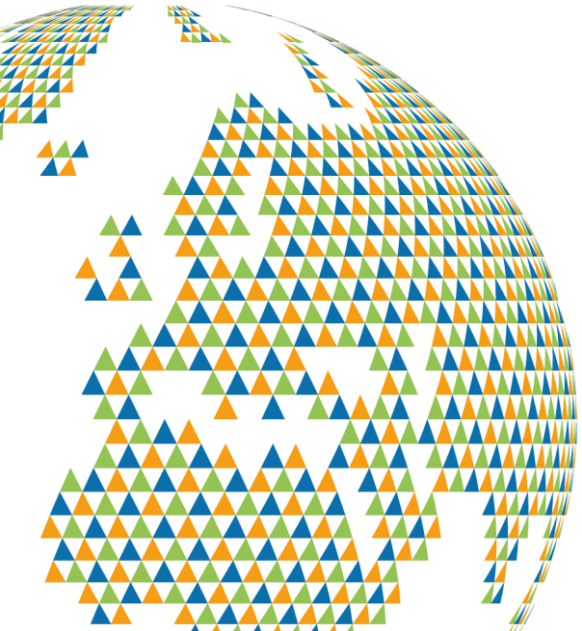
STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Hydrogen and the Energy Trilemma

Deb Pal- deb.pal@stopford.co.uk



HYDROGEN TECH EXPO

March 2023

Mere Hall Farm Business Centre, Bucklow Hill
Mere
Knutsford
Cheshire
WA16 6LE
Tel +44(0) 1565 758 764
www.stopford.co.uk

Registration Number: 01630328 (England & Wales)
VAT Number: 388 107 726

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Contents

- Introduction to Stopford
- World Trilemma Index
- Energy Security
- Energy Equity
- Environmental Sustainability
- Impact of hydrogen
- Stopford case studies
- Summary

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Our Service Groups

TECHNOLOGY & INNOVATION

Stopford has a proven track record in developing innovative process technologies and process solutions, for commercially successful innovation.

CONSULTANCY

Stopford's consultants bring together experts in health, safety, and the environment. Trusted by our clients and partners to manage their most challenging safety and environmental issues.

PROJECTS

Bringing together a dedicated project team, of multi-disciplinary engineers, procurement specialists and construction managers with responsible and creative leadership

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

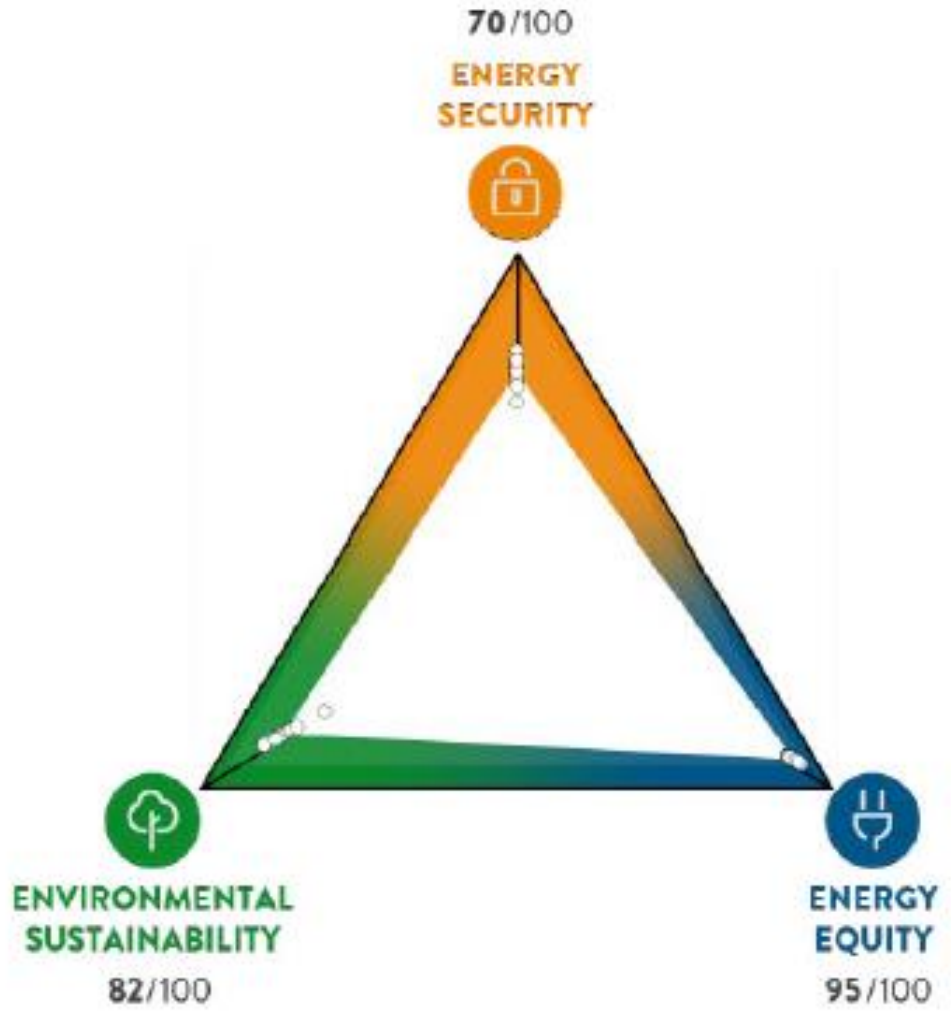
WORLD ENERGY TRILEMMA INDEX 2022

In partnership with Oliver Wyman

Energy Security reflects a nation's capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks with minimal disruption to suppliers

Energy Equity assesses a country's ability to provide universal access to affordable, fairly priced and abundant energy for domestic and commercial use

Environmental Sustainability represents the transition of a country's energy system towards mitigating and avoiding potential environmental harm and climate change impacts



Note: The IEA definitions are more comprehensive

Source: World Energy Council in partnership with Oliver Wyman

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Overall rankings

Grade X Y Za

Energy Security

Energy Equity

Environmental Sustainability

a-countries context – quartile where the country's scores falls

Comparative index

Reflects data from 1998 to 2021, not fully reflective of recent price shocks

Rank		Grade	Score
1	Sweden		84.3
2	Switzerland		83.4
2	Denmark		83.3
3	Finland		82.7
4	United Kingdom		82.4
4	Canada		82.3
5	Austria		82.2
6	France		81.1
6	Norway		81.0
7	Germany		80.6
8	New Zealand		80.3
9	Slovenia		78.8
9	Estonia		78.7
10	United States		78.5

Source: World Energy Council in partnership with Oliver Wyman

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Energy Security

Rank	Country	Energy Security Score
1	Canada	76.9
2	United States	74.1
3	Finland	73.8
4	Sweden	73.1
5	Czech Republic	72.9
6	Germany	72.5
7	Latvia	72.4
8	Hungary	72.1
9	Austria	71.6
10	United Kingdom	70.8

Source: World Energy Council

- Resource-rich countries top the list
- Diversified energy mix is key
- Anomaly with ranking of Germany – lagging data not fully reflective of current energy crisis
- Baltic nations have a low dependence on natural gas

Source: World Energy Council in partnership with Oliver Wyman-World Energy Trilemma Index | 2022 | World Energy Council

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Energy Equity

1	Luxembourg	100
2	Qatar	99.9
3	Kuwait	99.8
3	UAE	99.8
4	Oman	99.6
4	Iceland	99.6
5	Bahrain	99.5
6	Ireland	98.6
7	Trinidad & Tobago	98.4
7	Switzerland	98.4
8	Israel	98.3
9	United States	97.3
10	Saudi Arabia	97.2
10	Norway	97.2

Source: World Energy Council

- Government subsidies? Should they be included?

- Developing countries? Infrastructure development is key, increasing access to energy

- Trinidad & Tobago
  - Exports 80% energy (oil & gas)

Source: World Energy Council in partnership with Oliver Wyman

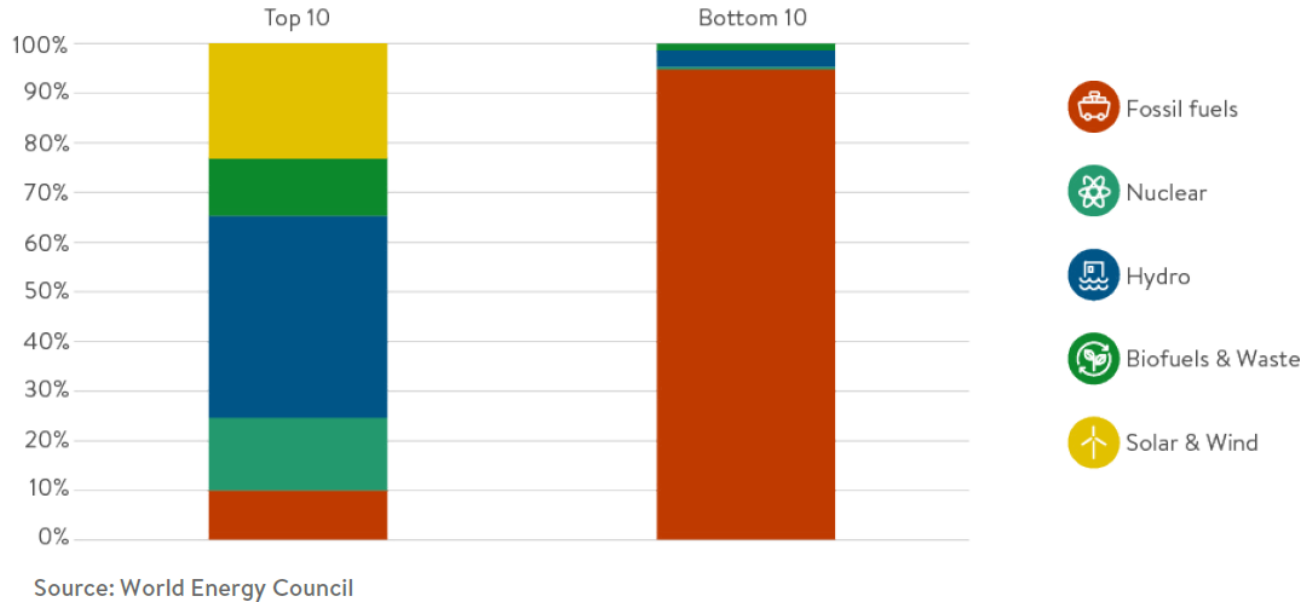
STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Rank	Country	Sustainability Score
1	Sweden	87.5
2	Switzerland	87.1
3	Norway	85.8
4	Denmark	84.7
5	Uruguay	84.0
6	France	83.4
7	United Kingdom	83.2
8	Brazil	82.8
9	Albania	82.7
10	Luxembourg	82.1

Environmental Sustainability

- Reflects low carbon electricity generation
- Uruguay generates significant amount from solar, wind and hydropower

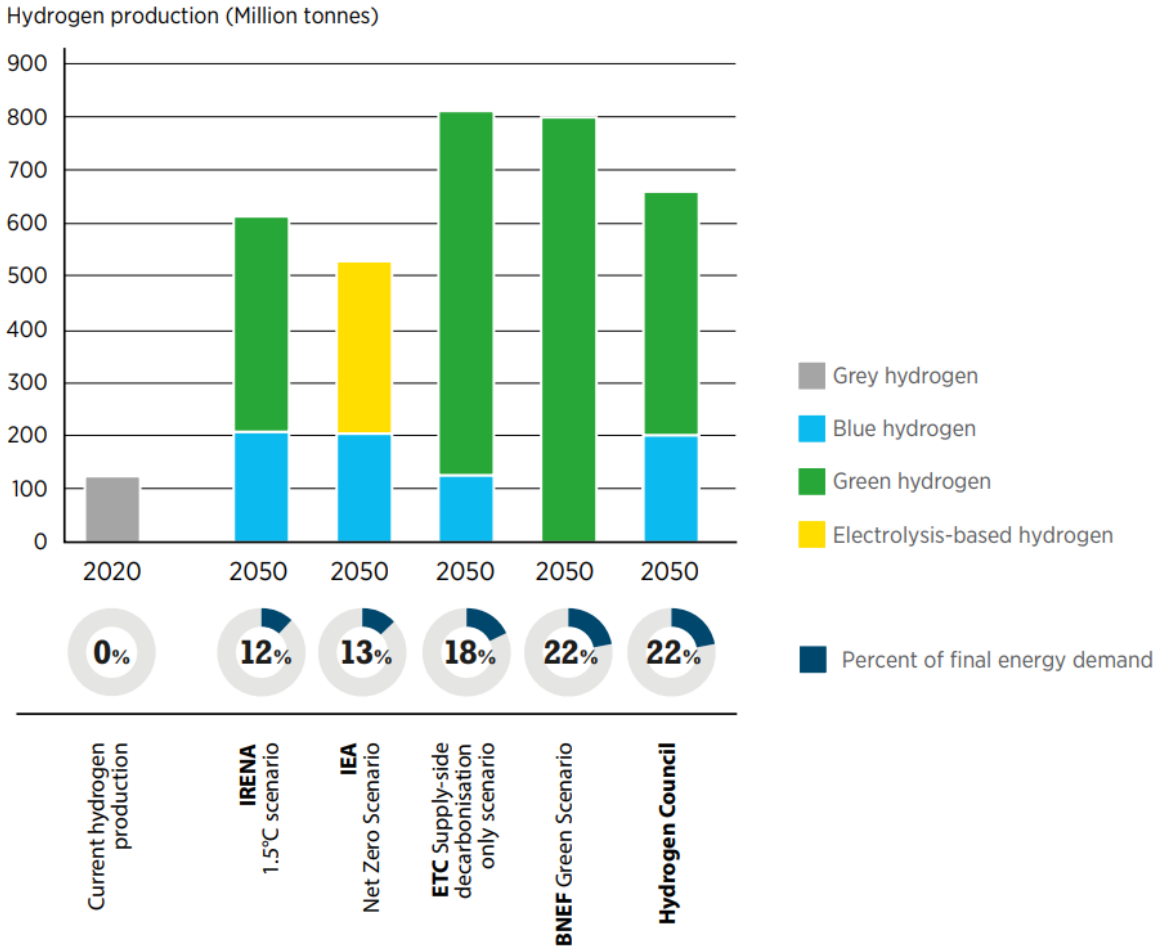
Figure 15: Average electricity generation mix for the top 10 and bottom 10 countries



Source: World Energy Council

Source: World Energy Council in partnership with Oliver Wyman

Outlook for hydrogen



Sources: BloombergNEF (2021a); ETC (2021); Hydrogen Council (2021); IRENA (2021a); IEA, (2021a).

UK Hydrogen Strategy analysis suggests 250-460TWh of hydrogen could be needed in 2050, making up 20-35 per cent of UK final energy consumption

Source: UK Hydrogen Champion Report-Hydrogen Champion Report: Recommendations to government and industry to accelerate the development of the UK hydrogen economy (ecitb.org.uk)

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Impact of hydrogen on the Trilemma

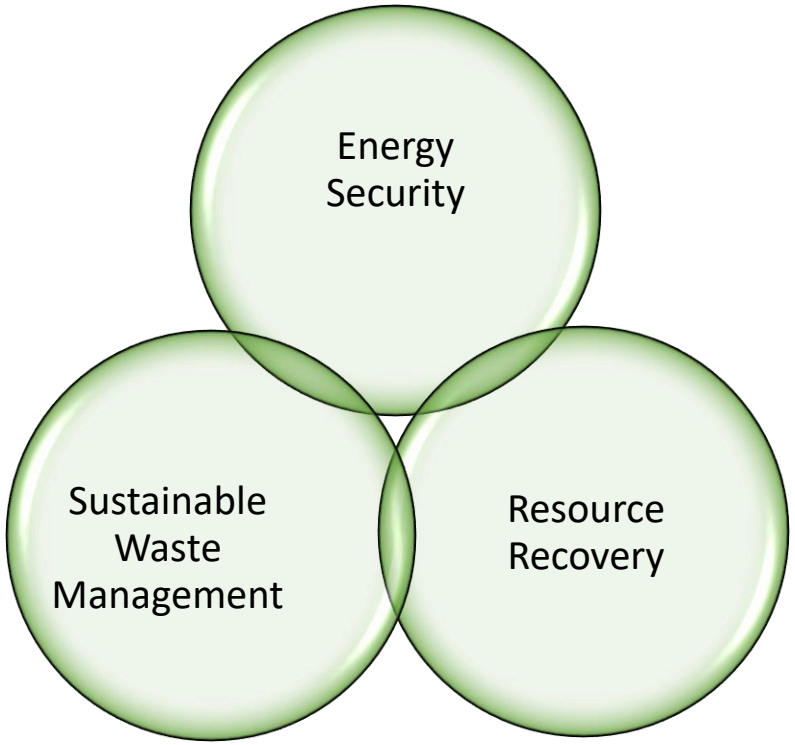
- Hydrogen is a manufactured product and not a raw material.
- Hydrogen will level out the fossil fuel geopolitics; greater competition. It will have to be more cost competitive compared to fossil fuels.
- Countries with cheap renewable energy have the potential to be exporters of green hydrogen.
- Existing fossil fuel suppliers have the necessary infrastructure and people resource to remain significant energy exporters.
- Green hydrogen has the ability to increase energy independence, unlike blue hydrogen, which will be exposed to fossil fuel market.
- Constraints on supply chain: electrolysers, geological supplies of minerals & metals.

Impact of hydrogen on the Trilemma

- Will it “level” out the geopolitics that fossil fuel has created or will it create new areas of tension?
- Skills/numbers gap
- State Subsidies
- US Congress passed the Inflation Reduction Act of 2022. Among the incentives in the act: $430 bn on energy infrastructure, $15 bn tax credits
- REPowerEU – EU’s initiative to reduce dependence on Russian gas, state aid?
- Overall impact on equity

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Project Reference: Plasmergy ™



"Plasmergy presents an opportunity to enable the waste management sector to transition to more sustainable operations, whilst enabling the generation of low-carbon energy and low carbon hydrogen"

Energy Security

Environmental Sustainability

Project Reference: Fuel Switching

Mineral sector

- Successfully carried out blending hydrogen with natural gas, providing 6% of the thermal value up to 100% substitution of hydrogen on an existing kiln
- Acceptable lime quality produced

Cement

- **Cement Production; World's first use of a net zero carbon fuel mix**
- **Mix: Meat & bonemeal, Glycerine (by-product from Bio-diesel production) and Hydrogen**

Environmental Sustainability

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Summary

- Hydrogen provides an opportunity for countries to better manage the Energy Trilemma
- Hydrogen should reduce tensions due to geopolitics?
- Hydrogen helps diversify the energy mix and hence improves energy security, the use should be selective
- Rapid scale up of green H2 should improve environmental sustainability –limited by geological supplies of minerals & metals?
- Energy equity – low cost renewable electricity, solar, wind – Impact of state subsidies?

STOPFORD
CONSULTANCY TECHNOLOGY & INNOVATION PROJECTS

Thanks for listening

Questions?

See us at Stand G07

CONTACT US

Mere Hall Farm Business Centre
Bucklow Hill Lane
Mere
Knutsford
Cheshire
WA16 6LE

Tel +44(0) 1565 758 764
www.stopford.co.uk

Registration Number: 01630328 (England & Wales)
VAT Number: 388 107 726

@STOPFORDLTD