

# UK embraces hydrogen-fuelled future as transport hub and train announced

Trials of UK's first hydrogen-powered train begin.

Published 30 September 2020  
From: [Department for Transport](#) and [The Rt Hon Grant Shapps MP](#)



- Britain's first hydrogen train to revolutionise rail with trials beginning in the Midlands

BUSINESS HQ

14th October

## Scotland set for hydrogen-powered train and rail revolution - BOC



Exclusive by Brian Donnelly | [@BrianDonnellyHT](#)  
Business Correspondent



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# Hydrogen Rail Revolution?

By applying this approach to the 15,400 single track kilometres (STK) of unelectrified rail network in Great Britain, we have calculated a need to provide:



11,700 STKs of electrification.



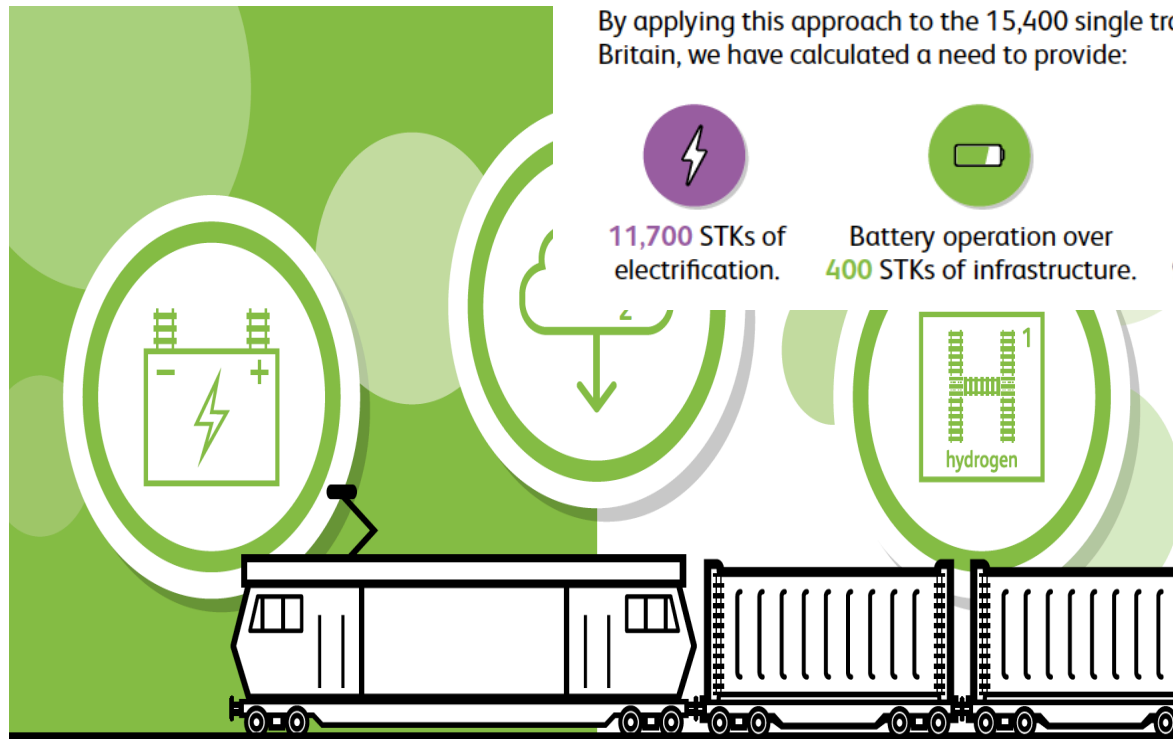
Battery operation over 400 STKs of infrastructure.



Hydrogen operation over 900 STKs of infrastructure.



2,300 STKs where there is no clear technical choice.



## TRACTION DECARBONISATION NETWORK STRATEGY

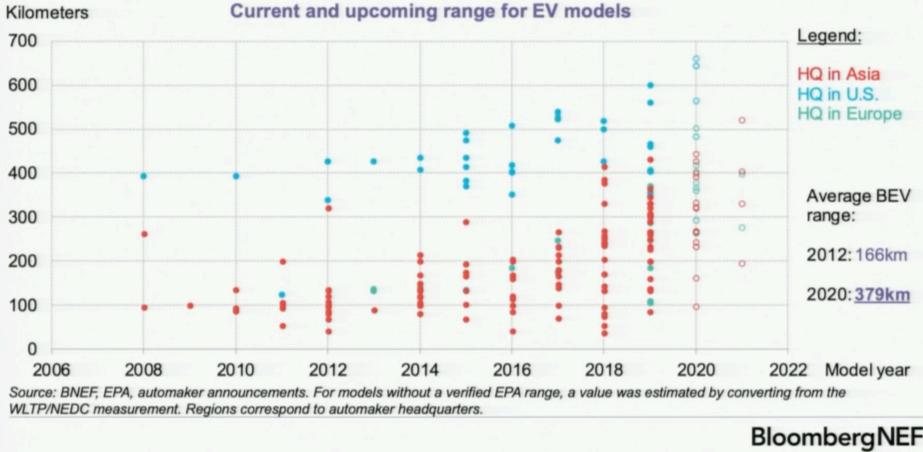
INTERIM PROGRAMME BUSINESS CASE

Executive Summary

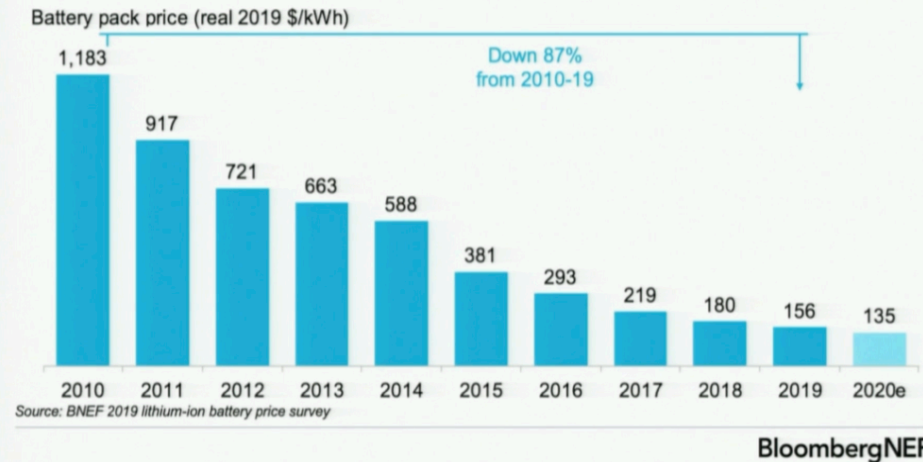
# Rail

<https://www.networkrail.co.uk/wp-content/uploads/2020/09/Traction-Decarbonisation-Network-Strategy-Interim-Programme-Business-Case.pdf>

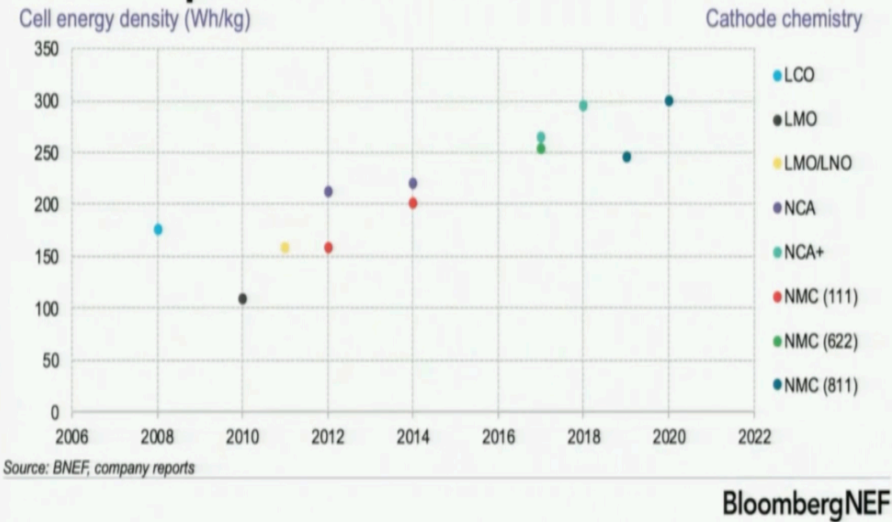
# Average EV range is rising



# Lithium-ion battery prices keep falling



# Battery-cell energy densities have almost tripled since 2010



Batteries can only get better





*The Chemical Engineer*

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Tuesday 25th February 2020

Powering the future: the lithium battery that doesn't get thrown away

**Design battery with end of life recycling in mind.**

**Environmental Concerns – Lithium and rare metal extraction**





Story



## So. Africa: Report says platinum mines have serious health, safety risks for workers, host communities

# Geothermal project in England secures funding to help pilot lithium-extraction technology

## Harvesting Vital Lithium From Sea Water

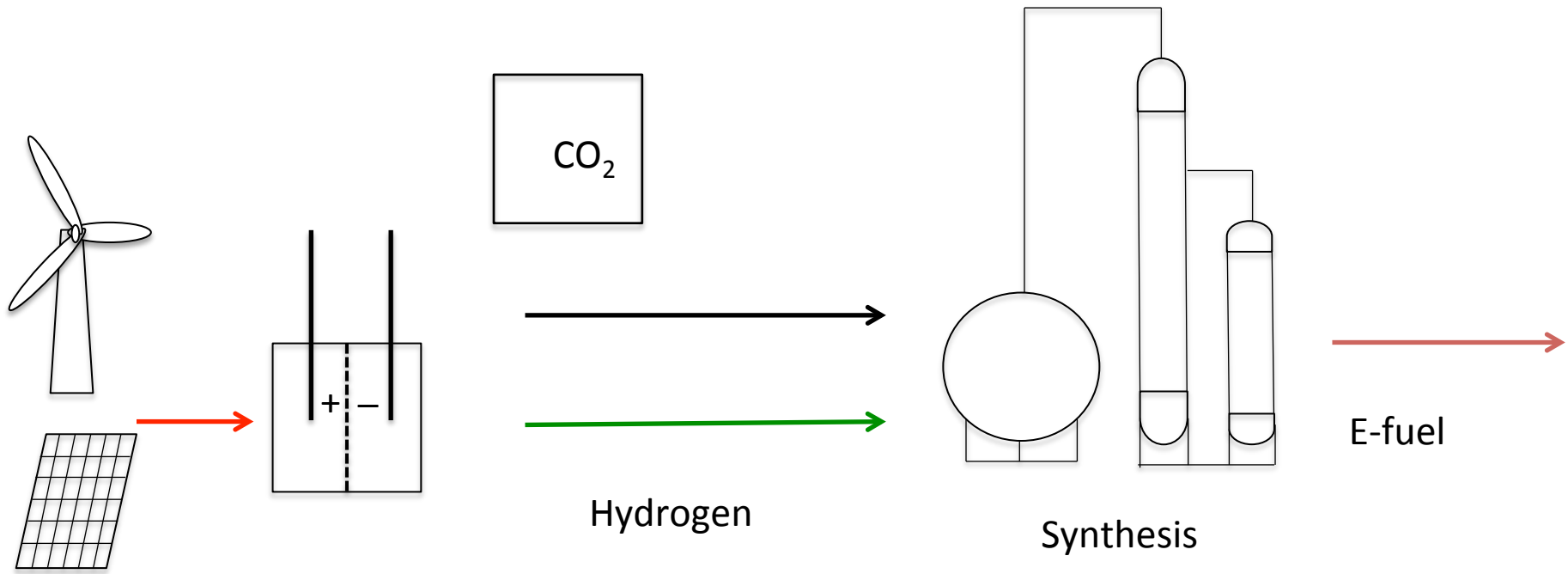
NEWS © Jan 21, 2020 | Original story from the Iran University of Science and Technology



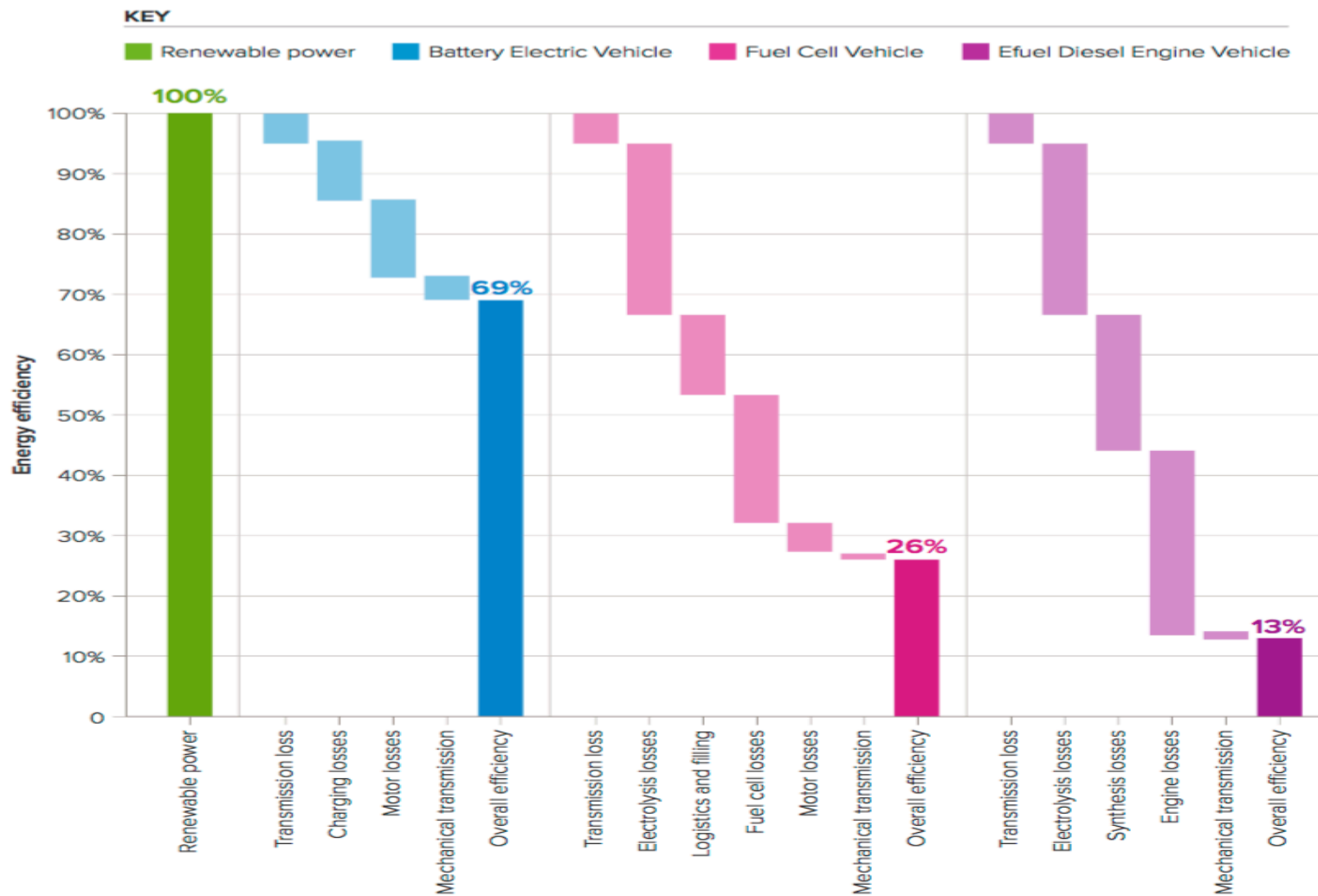
## Tesla to make EV battery cathodes without cobalt

*Cutting cobalt makes batteries cheaper*

**Environmental Concerns – Lithium and rare metal extraction**



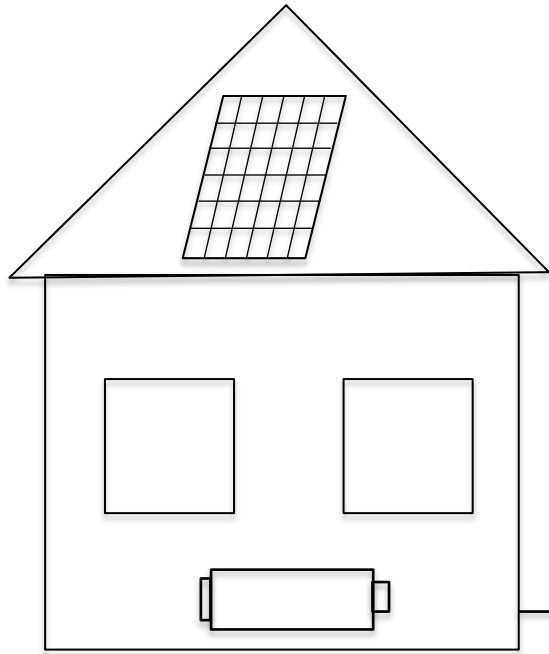
**E-fuel production**



## Passenger car comparison

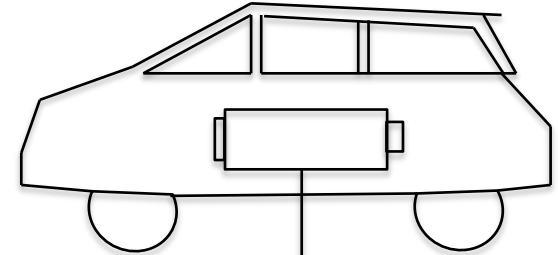
<https://royalsociety.org/-/media/policy/projects/synthetic-fuels/synthetic-fuels-briefing.pdf>



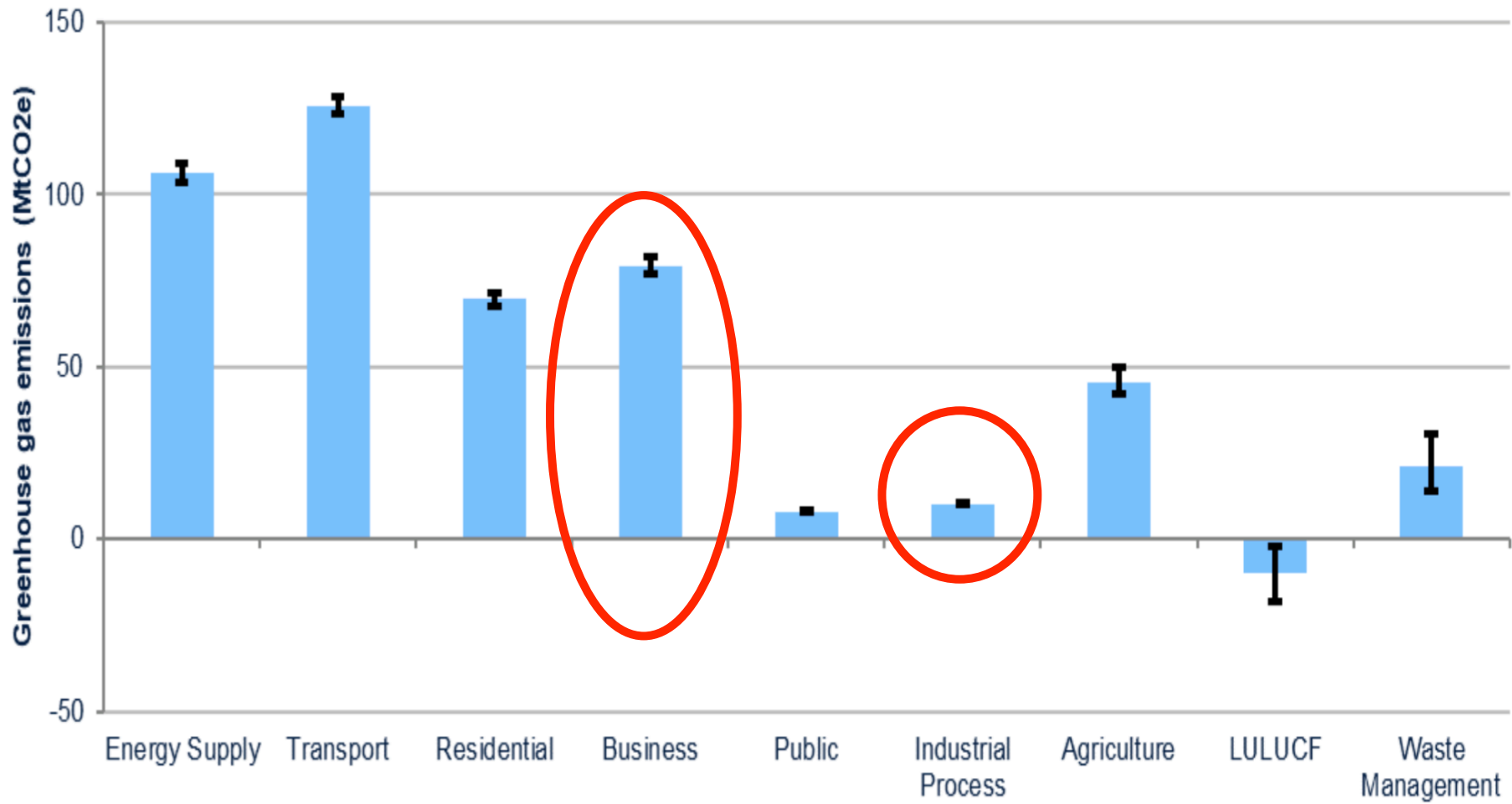


Grid

SET



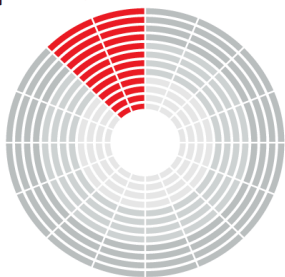
## Renewable Intermittency and Storage



**Decarbonising Industry**

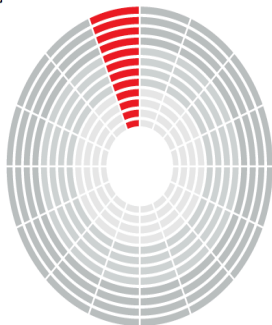
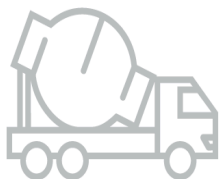
**Steel.**

3.3 Gt ~9% of total GHG



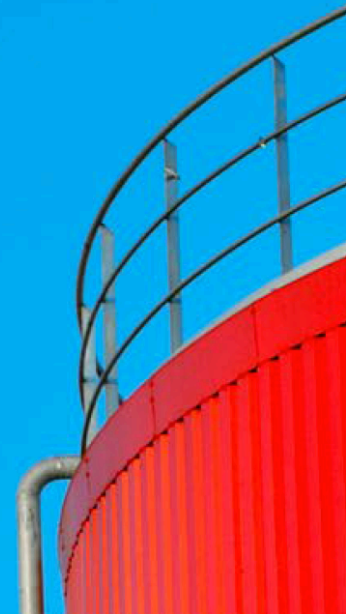
**Cement.**

2.7 Gt ~7% of total GHG



# Hydrogen for the future:

## Delivering zero-carbon in heavy industry



## Decarbonising Industry



<b>Business</b>	<b>million tonnes CO2 equivalent</b>	<b>%</b>
	<b>79.0</b>	<b>17.51</b>
Incidental lubricant combustion in engines	0.0	0.00
Refrigeration and air conditioning	10.7	2.37
Closed foams	0.5	0.10
Firefighting	0.3	0.07
Solvents	0.0	0.00
One component foams	0.0	0.00
Iron and steel - combustion and electricity	8.8	1.96
Industrial combustion and electricity (excl. iron and steel)	45.7	10.12
Commercial and miscellaneous combustion and electricity	11.7	2.60
Electronics, electrical insulation, scientific research, military applications and sporting goods	0.6	0.14
Non energy use of fuels	0.0	0.01
Accidental fires	0.0	0.00
N <sub>2</sub> O use as an anaesthetic	0.6	0.13

#### Industrial processes

million tonnes CO2 equivalent	10.2	2.27
Sinter production	1.3	0.28
Cement production	4.4	0.97
Lime production	1.1	0.24
Soda ash production & use	0.2	0.04
Glass production	0.4	0.08
Fletton brick production	0.0	0.00
Ammonia production	0.8	0.18
Aluminium production	0.1	0.02
Nitric acid production	0.0	0.01
Adipic acid production	0.0	0.00
Other - chemical industry	0.3	0.06
Halocarbon production	0.0	0.01
Magnesium cover gas	0.2	0.04
Iron and steel production	1.0	0.23
Titanium dioxide production	0.2	0.04
Bricks production	0.3	0.07
Non ferrous metal processes	0.0	0.00
Use of N <sub>2</sub> O	0.0	0.01

## Decarbonising Industry

Almost half of fuel consumed for energy can be electrified with technology available today.

Share of total estimated fuel consumption for energy, 2017, %

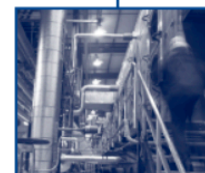
		Examples of processes	Technology status
Other (potential not assessed <sup>1)</sup> )	19		
Very-high-temperature heat (>1,000°C)	32	Melting in glass furnace, reheating of slab in hot strip mill, and calcination of limestone for cement production	Research or pilot phase
High-temperature heat (400–1,000°C)	16	Steam reforming and cracking in the petrochemical industry	Available today
Medium-temperature heat (100–400°C)	18	Drying, evaporation, distillation, and activation	Available today
Low-temperature heat (≤100°C)	15	Washing, rinsing, and food preparation	Available today



**A BestPractices  
Steam Technical  
Brief**



## Industrial Heat Pumps for Steam and Fuel Savings

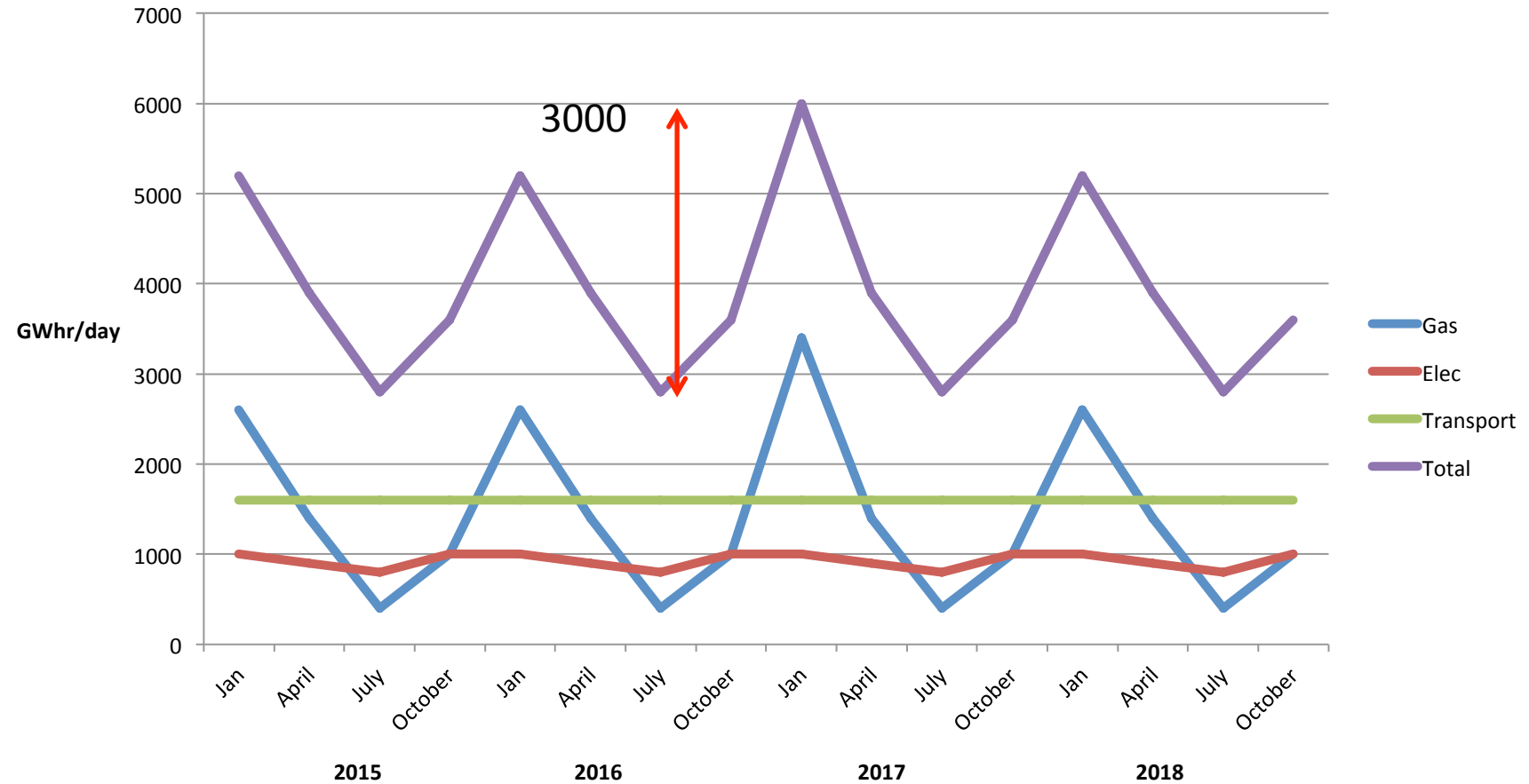


U.S. Department of Energy  
**Energy Efficiency and Renewable Energy**  
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

# Electrified Industrial Heating

<https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/plugging-in-what-electrification-can-do-for-industry>  
<https://www.energy.gov/sites/prod/files/2014/05/f15/heatpump.pdf>

## UK Historical Energy Usage



**Renewable Intermittency and Storage**



## Hydrogen: The future fuel today

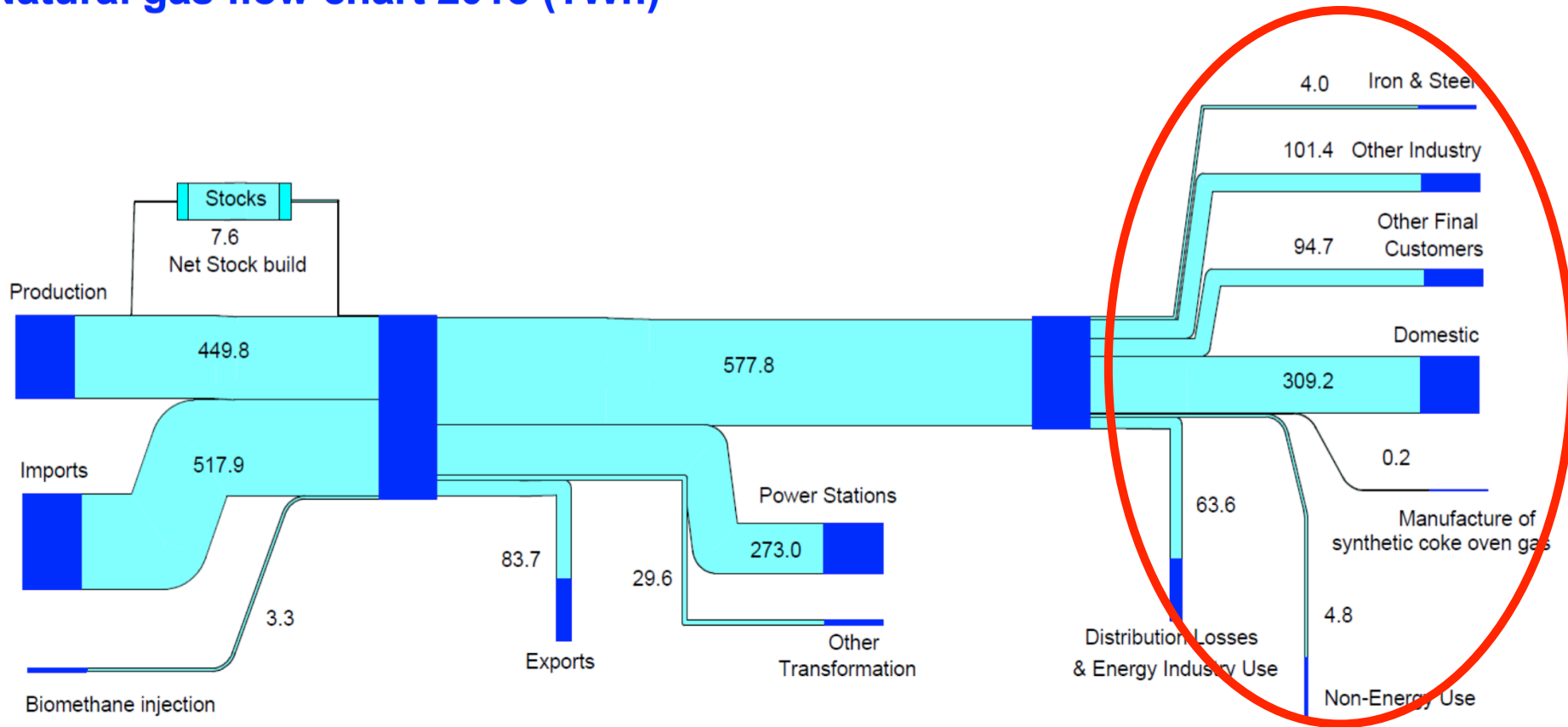
A collection of articles on generation, storage, transport and utilisation



“UK’s electricity demand is the smallest of the three, annual transport demand is 1.4 times electricity, and heat is 2.7 times electricity. Therefore, to electrify these demands with intermittent electrical supply would be predicated on building generation, transmission and distribution assets equating to four more grids along with industrial levels of battery deployment to transfer summer power to winter heat.”

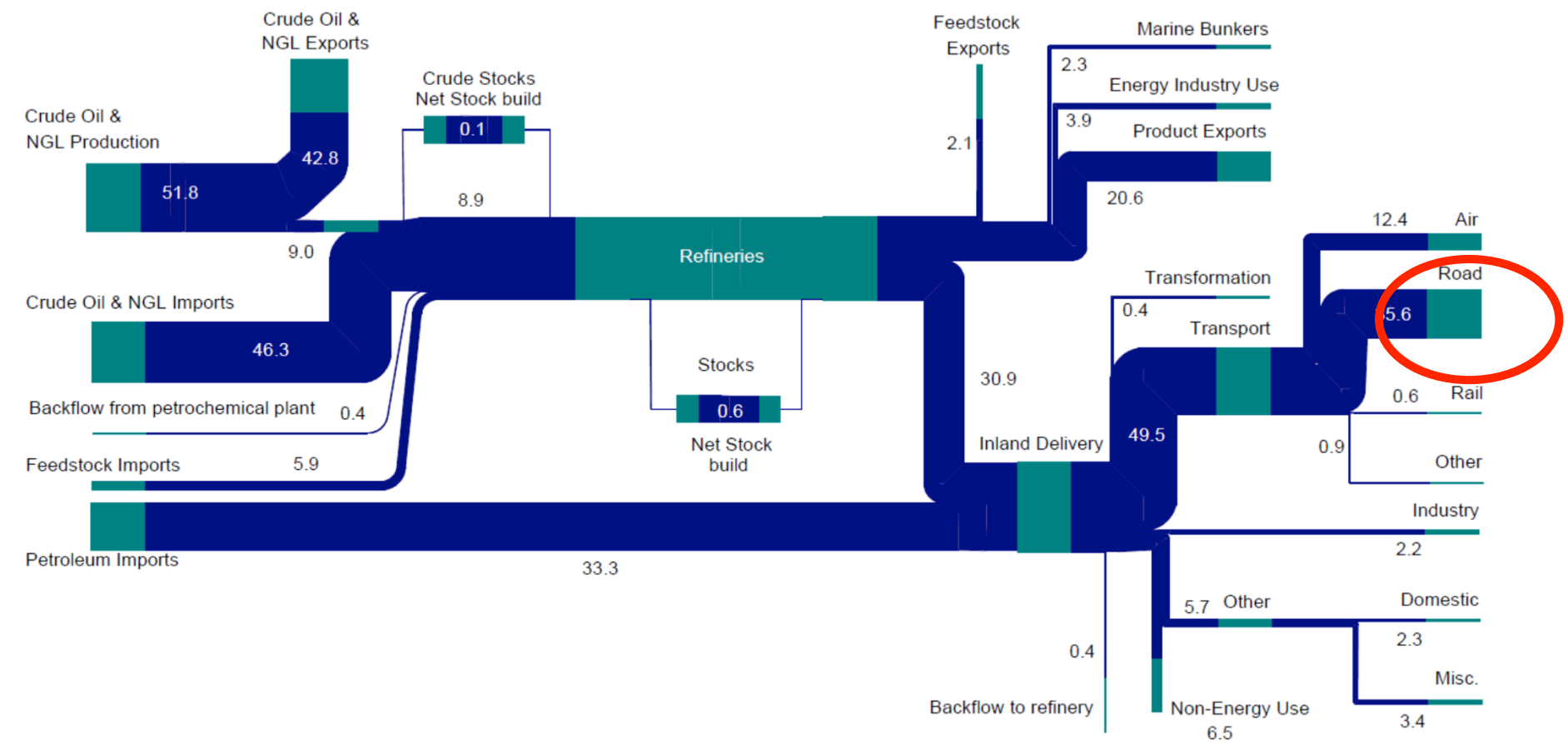
## Renewable Intermittency and Storage

## Natural gas flow chart 2018 (TWh)



## Renewable Intermittency and Storage

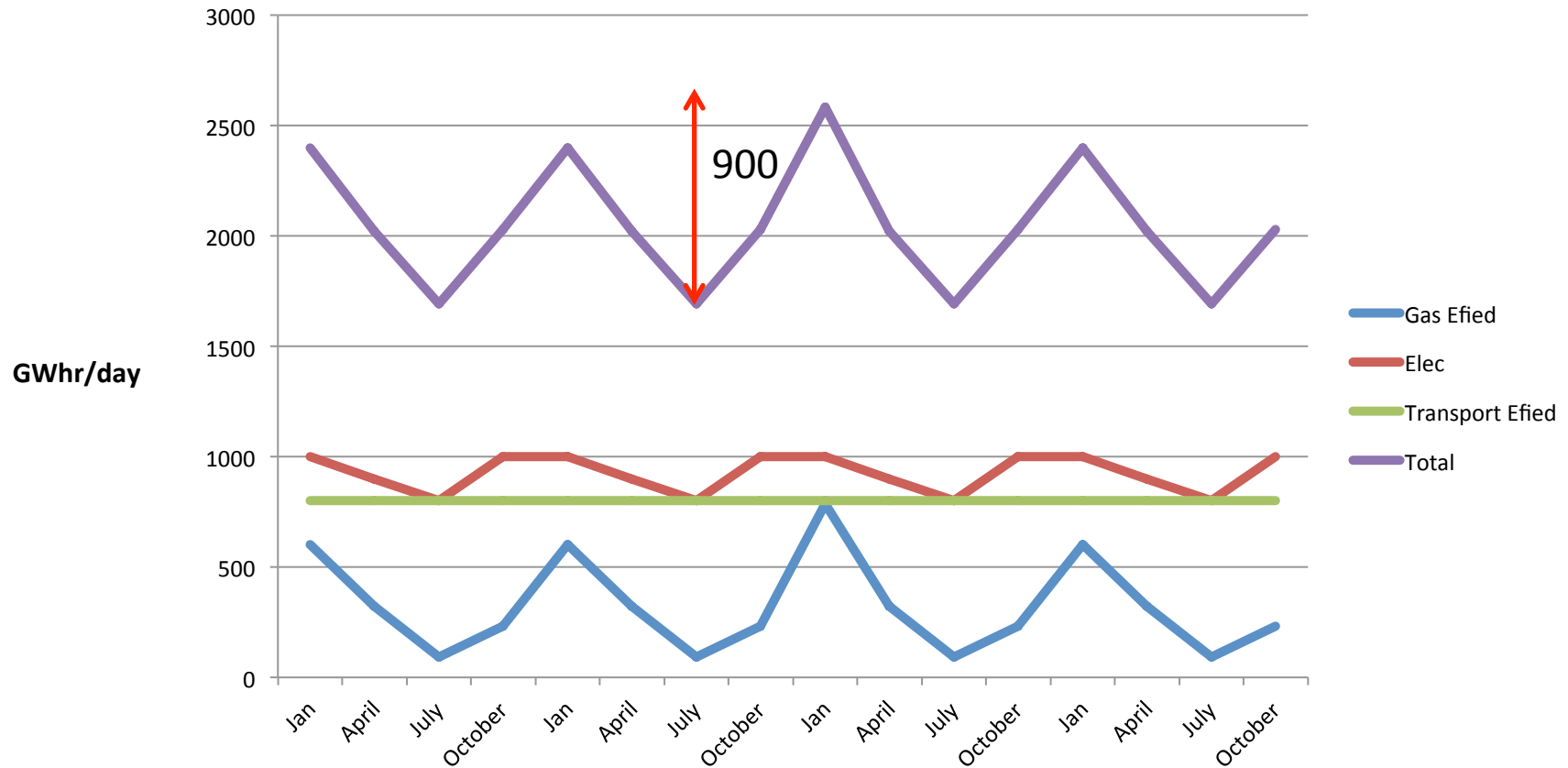
# Petroleum Flow Chart 2019 (million tonnes)



## Renewable Intermittency and Storage

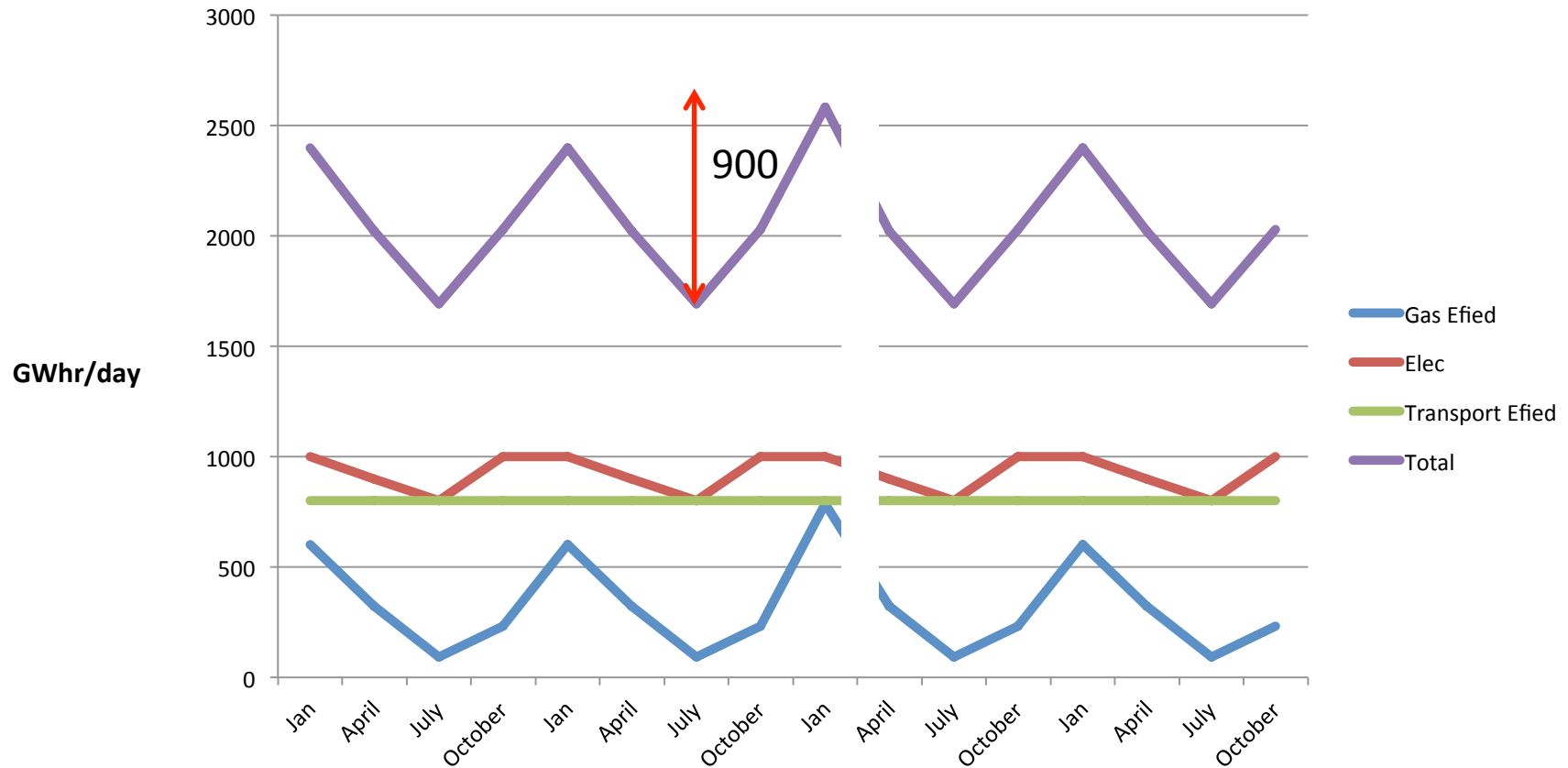


## Electrification and Energy Efficiency Usage



## Renewable Intermittency and Storage

## Electrification and Energy Efficiency Usage



## Renewable Intermittency and Storage

Hydrogen storage seems to be accepted in the absence of analysis of alternatives and combinations.

Gas no CCS – accept short term emissions  
Gas with CCS  
Thermal  
Batteries  
Hydro  
Nuclear  
Imports  
Bio-fuels  
E-fuels  
Tidal  
Geothermal  
Gravitricity

**Energy Storage – a compelling case for hydrogen?**



## Heating in Great Britain: An incumbent discourse coalition resists an electrifying future

Richard Lowes<sup>a,\*</sup>, Bridget Woodman<sup>b</sup>, Jamie Speirs<sup>c</sup>

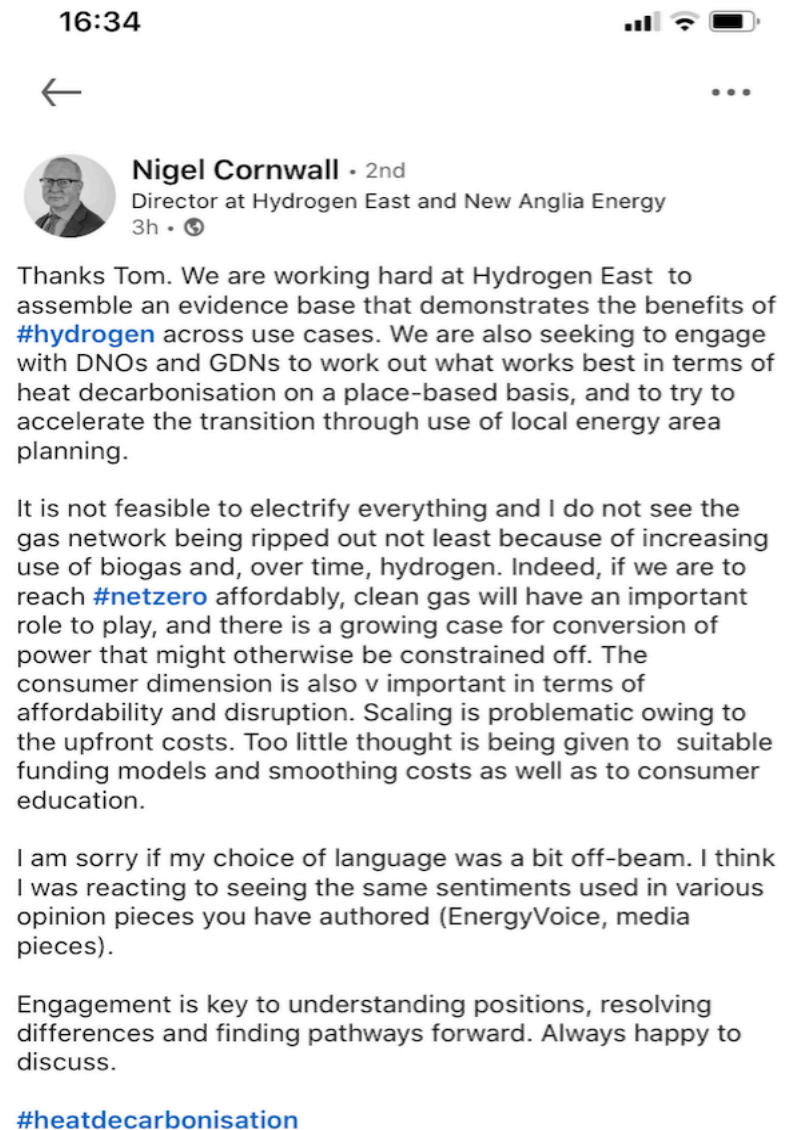
<sup>a</sup> Fellows Office, Stella Turk Building, University of Exeter, Penryn Campus, Penryn, TR10 9FE, UK

<sup>b</sup> B051-033, Stella Turk Building, University of Exeter, Penryn Campus, Penryn, TR10 9FE UK

<sup>c</sup> 537, Chemistry, South Kensington Campus, Imperial College London, SW7 2AZ, UK

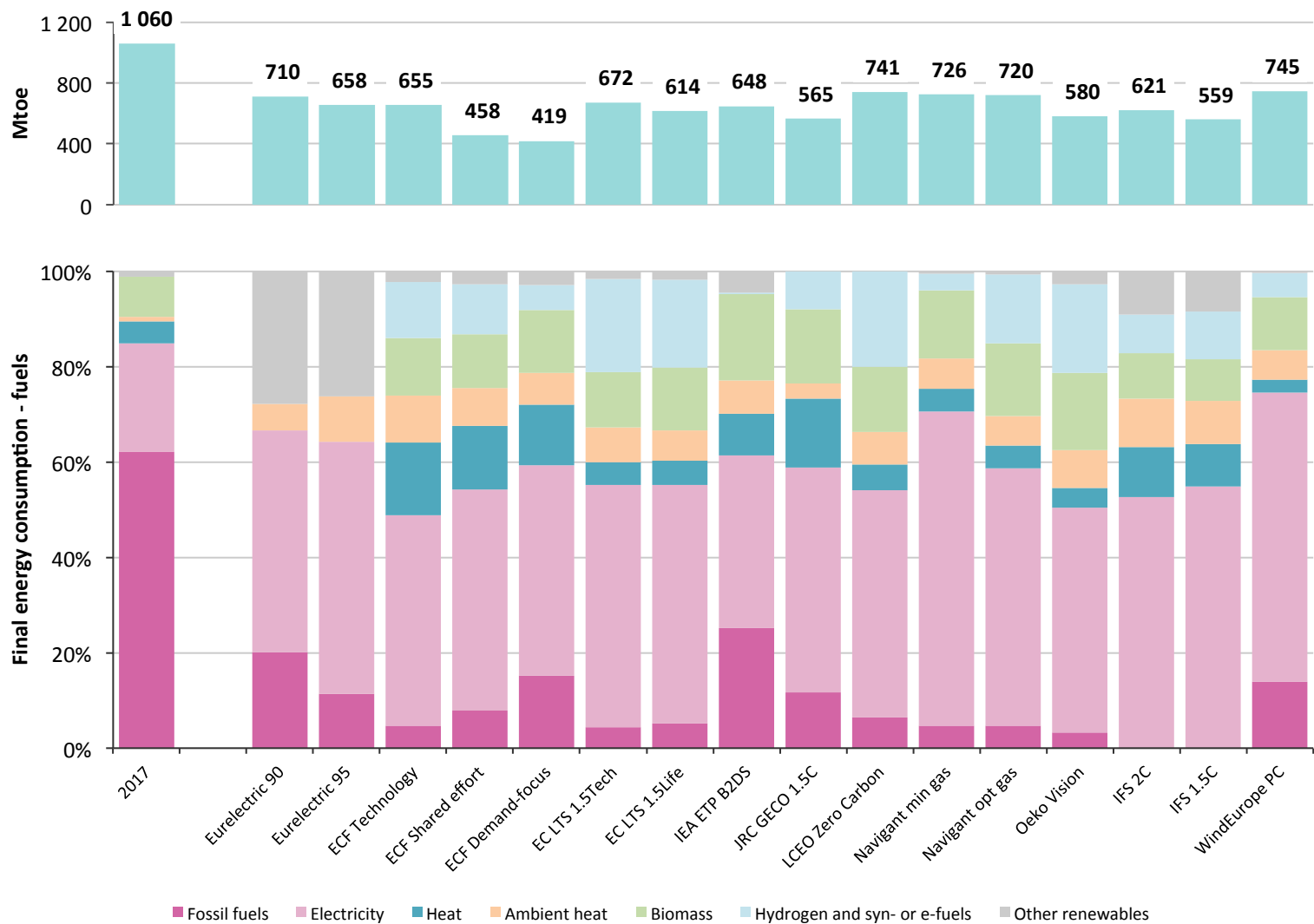
major uncertainties with a decarbonised gas pathway. Incumbents are over-selling 'green-gas' to policy makers in order to protect their interests and detract from the importance and value of electrification. Policy and research recommendations are made.

## Institutionalised Hydrogenism



It gets personal

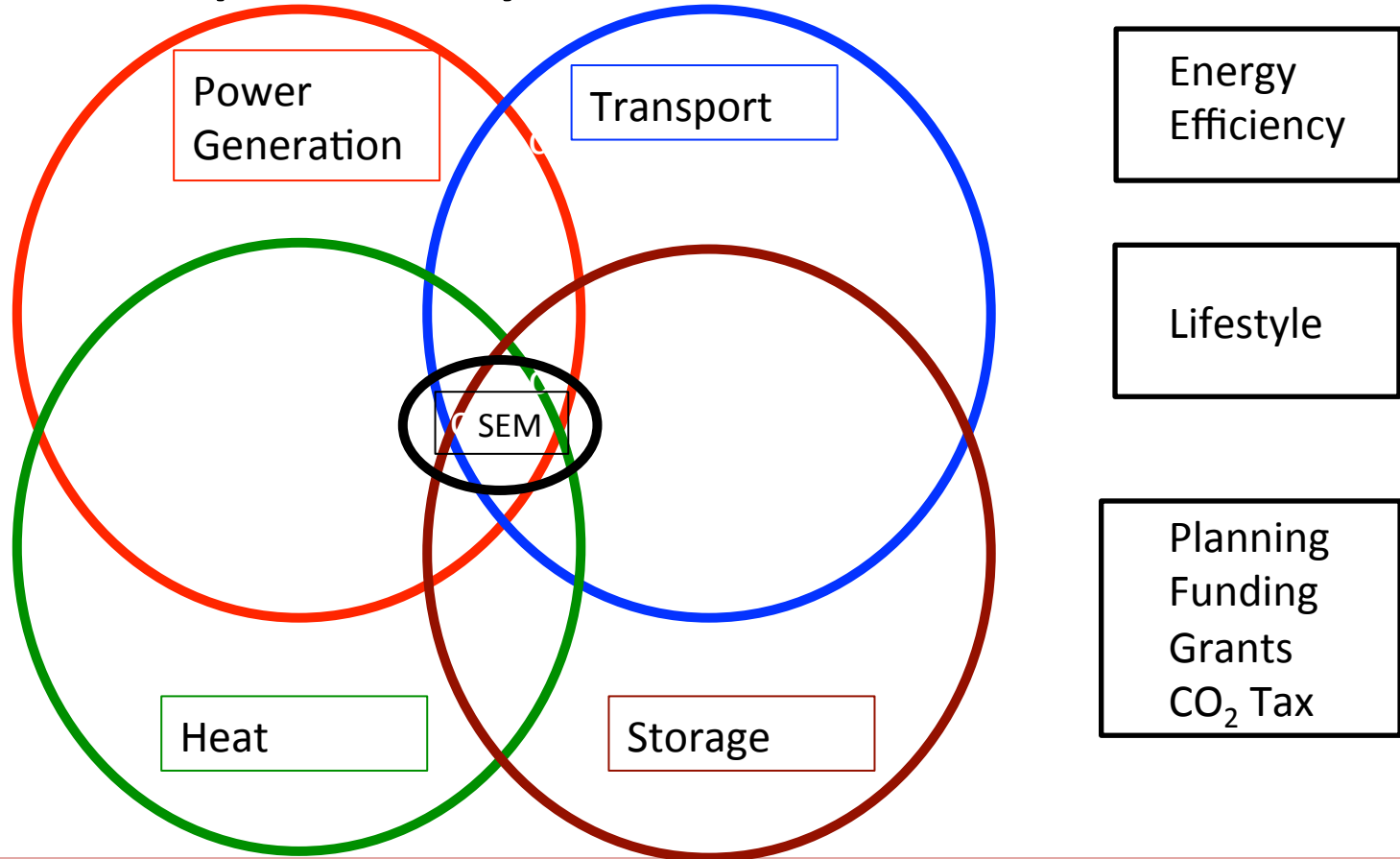




## EU Pathways

[https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118592/towards\\_net-zero\\_emissions\\_in\\_the\\_eu\\_energy\\_system\\_-\\_insights\\_from\\_scenarios\\_in\\_line\\_with\\_2030\\_and\\_2050\\_ambitions\\_of\\_the\\_european\\_green\\_deal\\_on.pdf](https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118592/towards_net-zero_emissions_in_the_eu_energy_system_-_insights_from_scenarios_in_line_with_2030_and_2050_ambitions_of_the_european_green_deal_on.pdf)

# Where is the holistic evidence for the UK's potential pathways to net zero?



**Conclusion**

The background of the slide is a composite image. The top half shows a deep blue night sky filled with numerous small, bright stars. A large, detailed full moon is positioned in the upper right quadrant. The bottom half of the image shows a view of Earth from space, with a thin white atmospheric layer separating the dark blue of the sky from the green and brown landmasses of the planet below.

# **Over-selling Hydrogen in the UK**

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