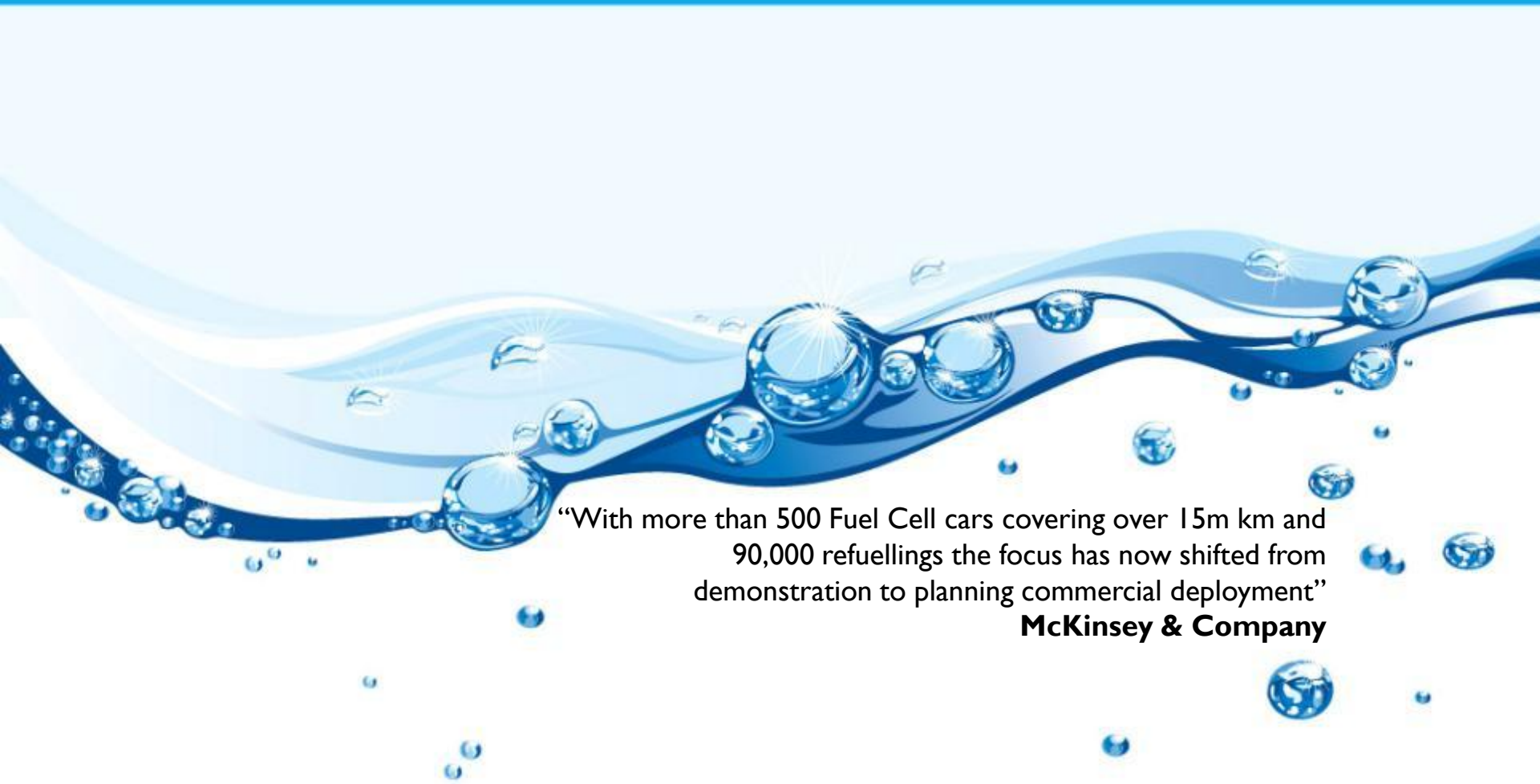
ITM Power plc

Hydrogen as a Sustainable Energy Carrier, 13th April 2011

Dr Graham Cooley, CEO



"With more than 500 Fuel Cell cars covering over 15m km and 90,000 refuellings the focus has now shifted from demonstration to planning commercial deployment"

McKinsey & Company

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Essential Technology & Systems

- Harnessing Renewable Energy
- Producing Green Hydrogen
- Regeneration of Power
- A Zero Carbon Footprint Fuel

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ITM Power has designed hydrogen systems technology for integration into the built environment and transport to provide energy security and zero-carbon energy solutions for early adopters.

Harnessing Renewable Energy

Here's the problem: renewable energy such as wind and solar are unpredictable and need storage technology to be fully utilised. How do you store electricity for long periods of time? The answer is Hydrogen produced by electrolysis enabling you to:

- Use your renewable power whenever you need it
- Keep the lights 'on' during a power cut
- Replace your electricity and natural gas supply

Green hydrogen is produced in an electrolyser by splitting water using renewable energy. It therefore has a zero carbon footprint. All other fuels produce carbon somewhere in the supply chain.

- You can produce your own fuel
- When you produce Green Hydrogen the only by-product is oxygen
- When you burn it; no carbon in means no carbon out
- Once you've paid for the equipment your ongoing fuel is free

About ITM Power

ITM has systems design and integration expertise covering the production, storage, compression and dispensing of high pressure gaseous hydrogen. To find out more visit our website: **www.itm-power.com**

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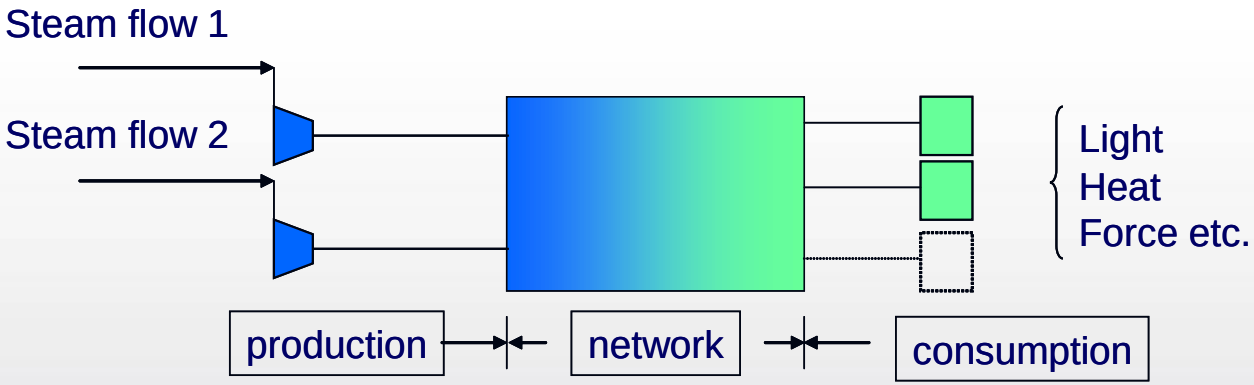
The Case for Energy Storage

Energy Storage

Production and Consumption are dynamically coupled

- Sub second response
- Energy storage today is from the inertia in bid rotating plant
- Intermittent renewable power makes the situation worse
- Energy storage is key

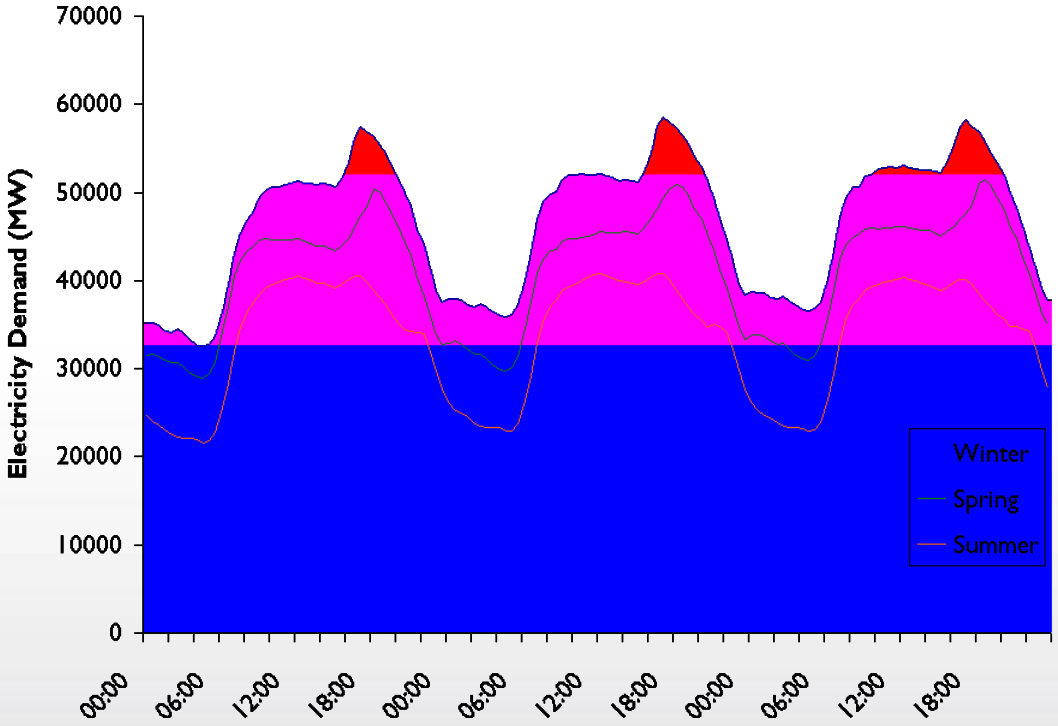


At any time : $\Sigma P_{cons} = \Sigma P_{prod}$

UK Electricity Demand

Demand varies daily, weekly, seasonally:

- Winter peak is 60 GW
- Base load plant
- Mid merit plant
- Peaking plant

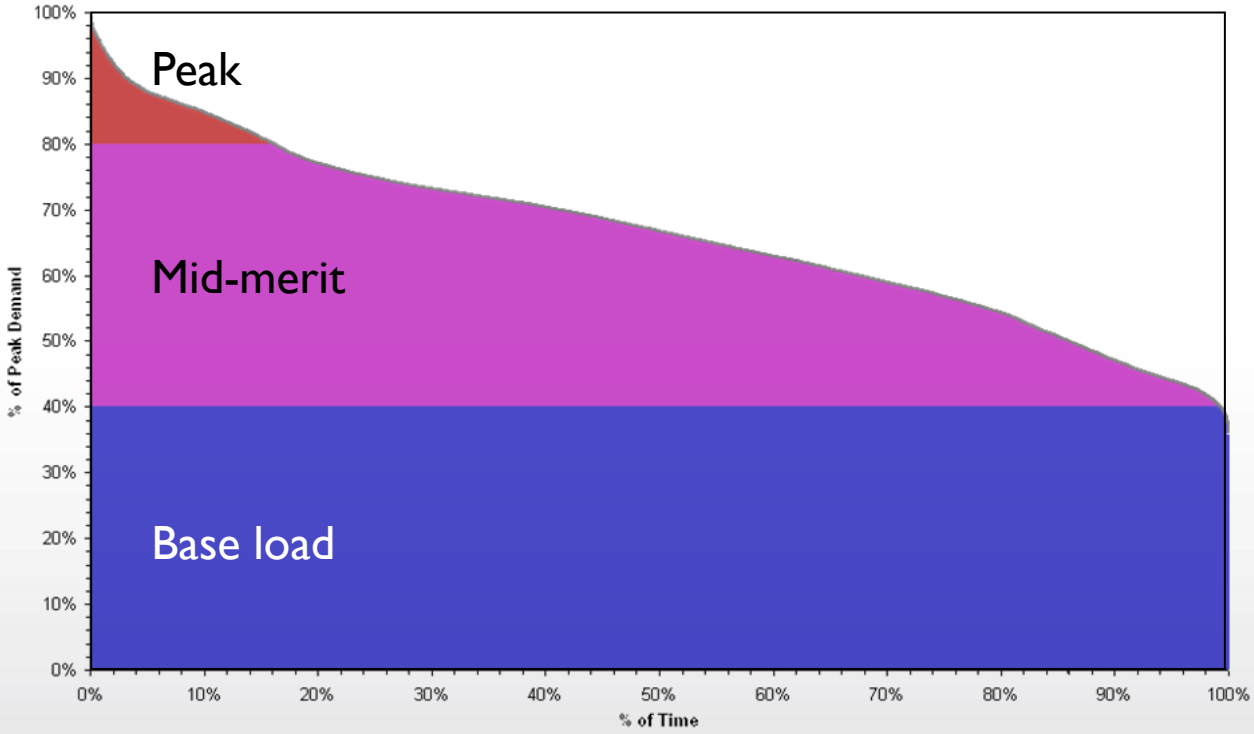


Data from National Grid

UK Load Duration Curve

Plant utilisation over time:

- Huge utilisation of inefficient plant
- 40% fully utilised

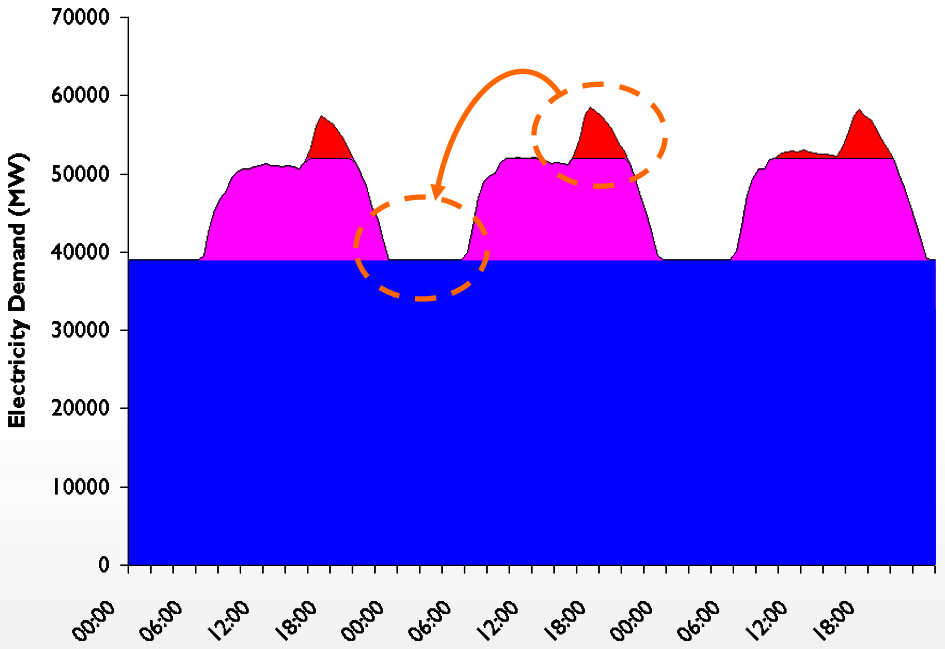


Data from National Grid

Bulk Commodity Storage

Shifting the peaks to fill the troughs:

- Turns mid merit in base load
- Reduces the need for peaking
- Increases system efficiency
- Day night arbitrage!



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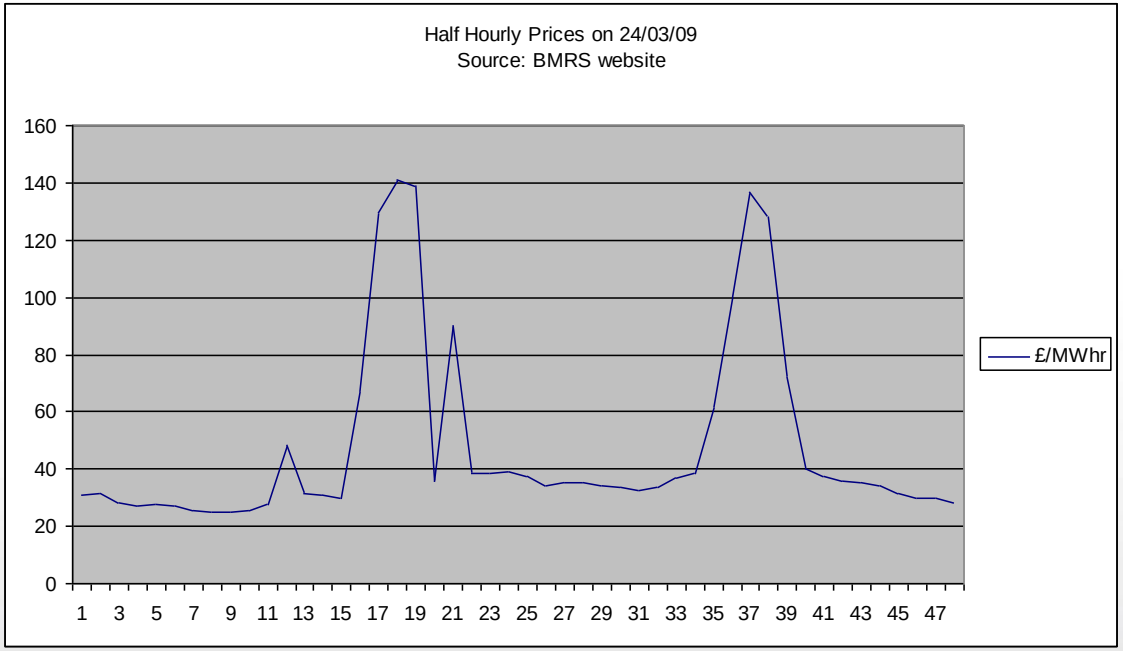
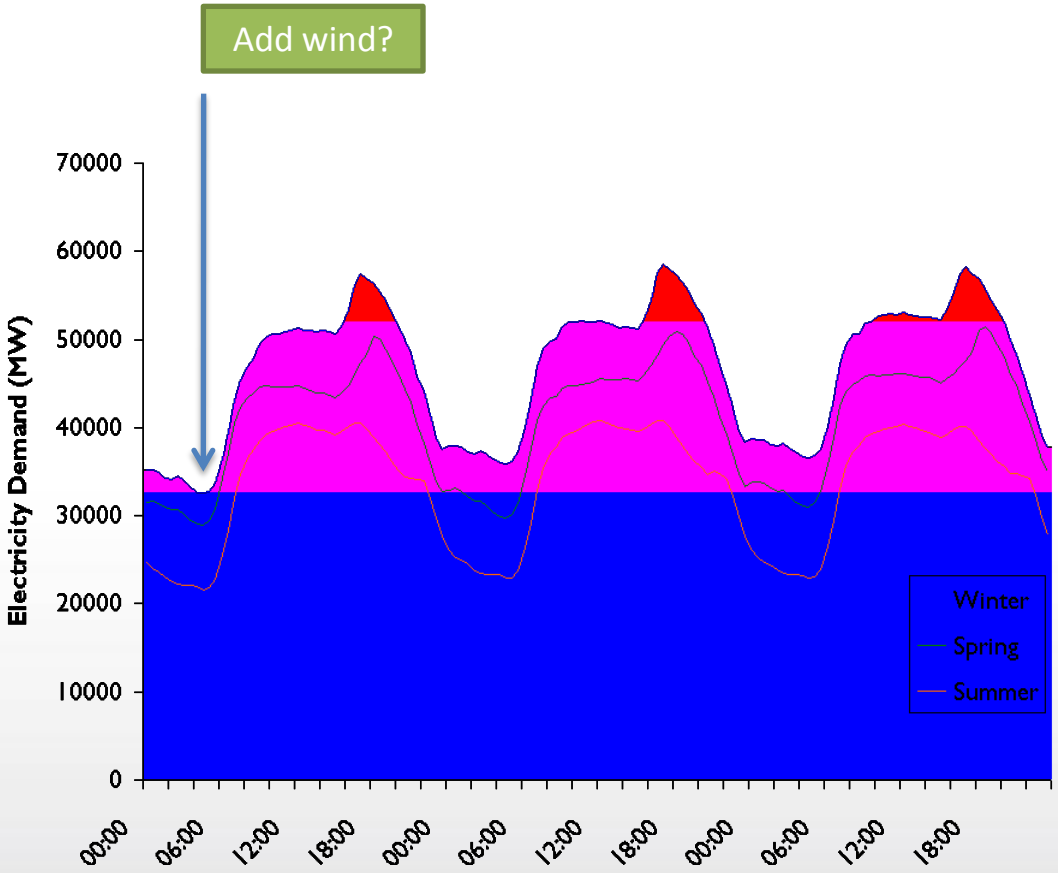


The Balancing Mechanism Reporting System (BMRS)
The BMRS website provides near real time and historic data about the Balancing Mechanism which is used by the National Grid (System Operator) as a means of balancing power flows on to and off the electricity Transmission System in the UK.

UK Electricity Demand

Adding Intermittent Power:

- Need take or break decisions
- Undermines Base load
- Increased need for spinning reserve
- Pushes you back down merit order

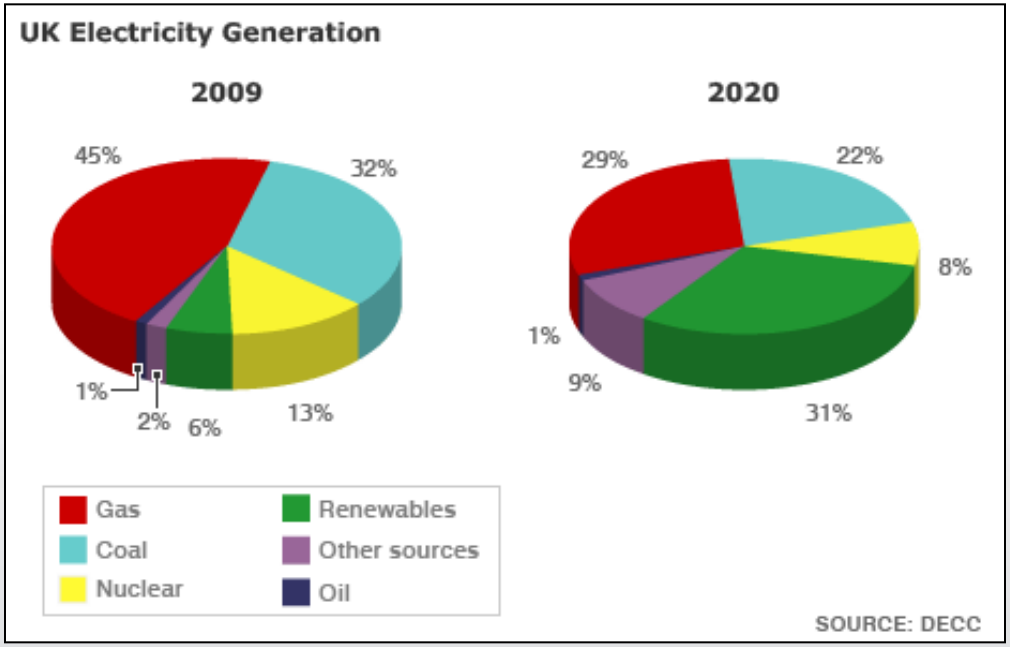


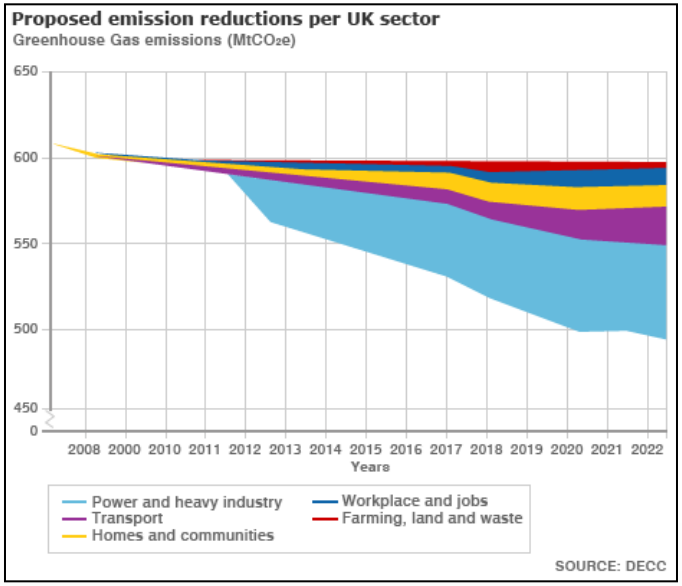
Data from National Grid

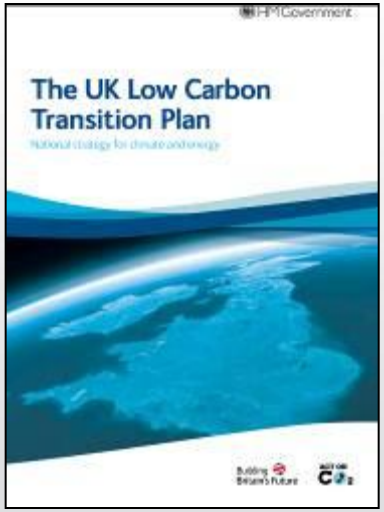
UK Generation

CO_2 targets to be met by power & heavy industry:

- 16% reduction in GG emissions by 2020
- 31% renewable generation by 2020
- This cannot be achieved without energy storage!



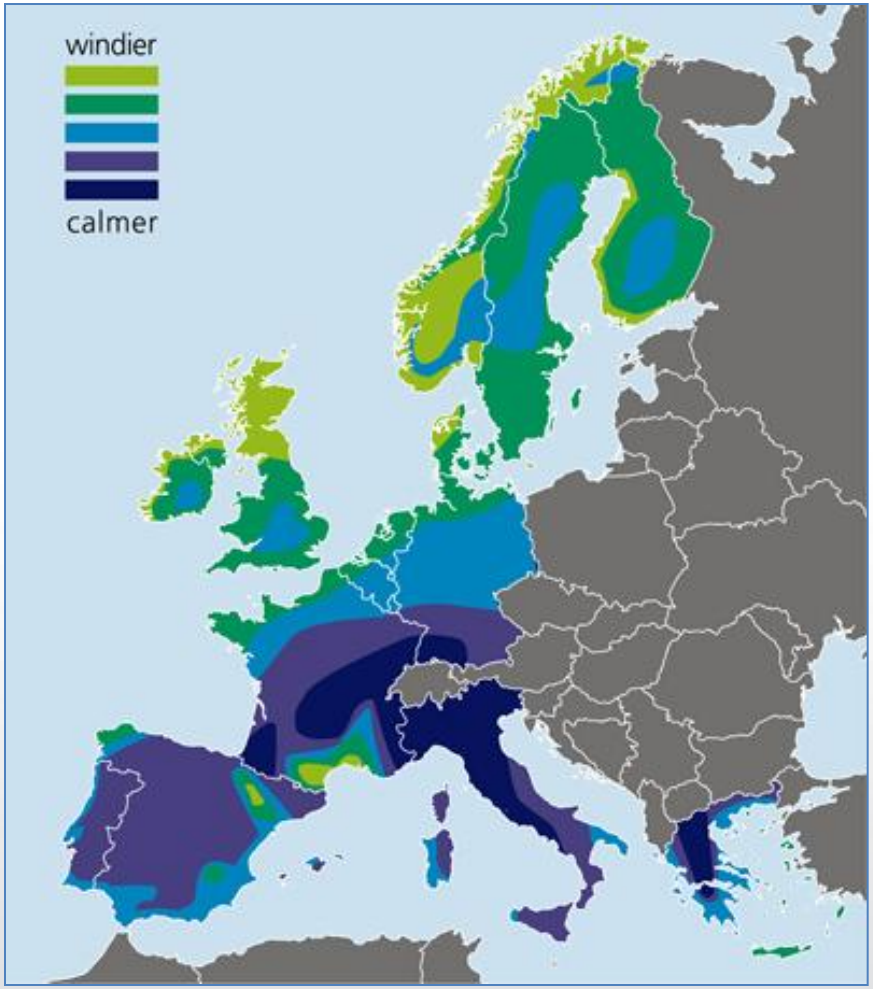




Wind Energy: The UK

A plentiful resource?

- Best Wind resources in Europe
- Entering Phase Three of construction in UK
- Onshore capacity factor 30%, offshore 40%



Wind Energy: The Case for Denmark

Study by CEPOS Sept 2009

- 20% of its generating capacity is wind
- Only 5% of demand is met by wind
- Negative electricity prices
- 50% is exported
- Sweden and Norway used as energy storage

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Storing Renewable Energy

Supply Chain Logistics

Adding energy storage to the logistics:

- Five elements are dynamically balanced
- Adding energy storage would lead to:
  - New business models
  - New service strategies
  - New pricing structures

Bulk Energy Storage

Fuel → Generation → Transmission → Distribution → Customer Services

Distributed Energy Storage

Demand Side Management

Summary:

Energy storage offers:

- Improve operational efficiency
- Integrate intermittent renewables
- Support base load nuclear
- Join the dots between power & energy
- Decarbonisation

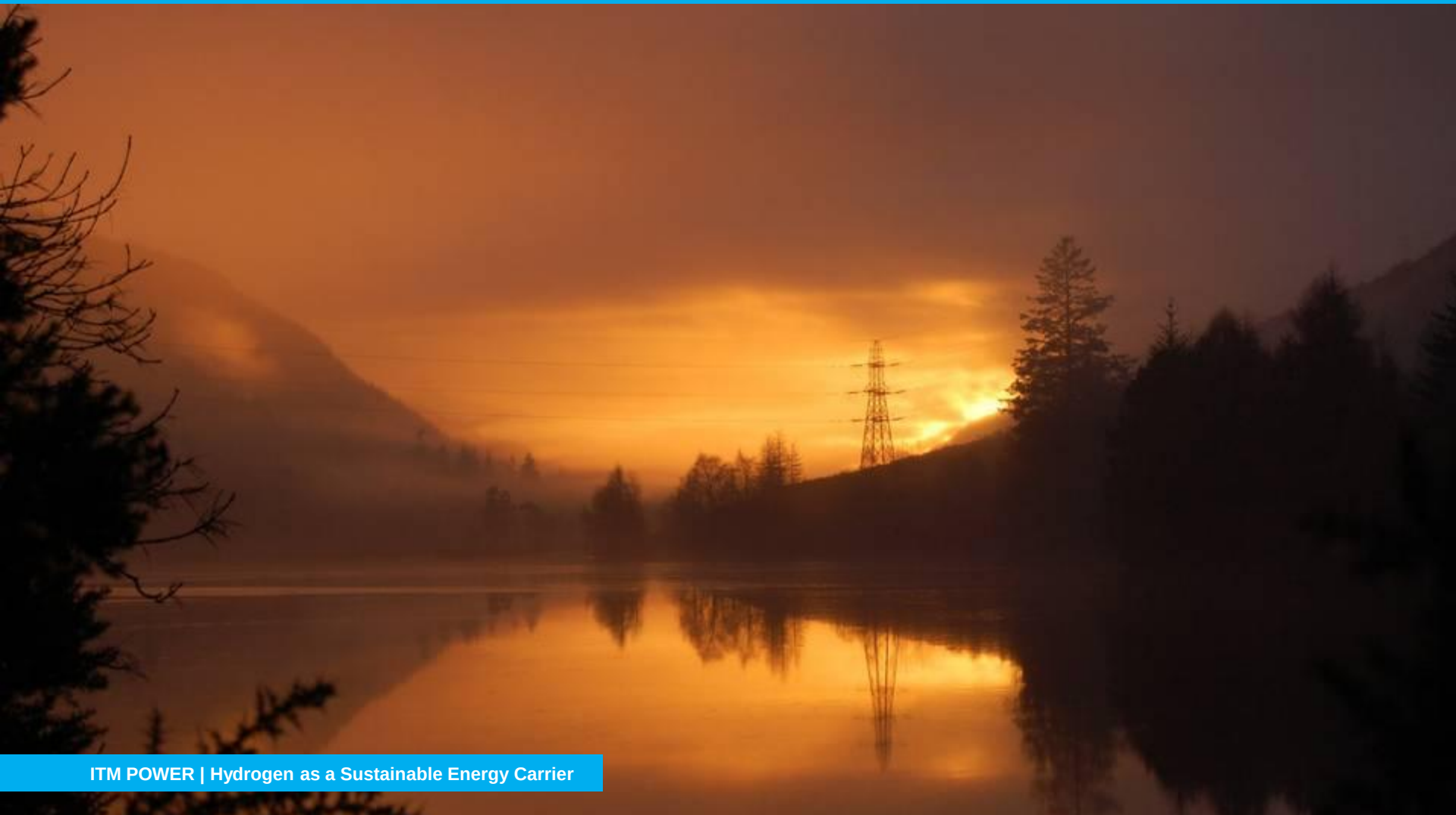
However:

- Many technologies are unproven
- Cost targets are difficult to define
- Engineering scale poses a technology risk

Sector Export:

- Ready to implement
- Addresses the needs of both the power and transport industries

Sector Export

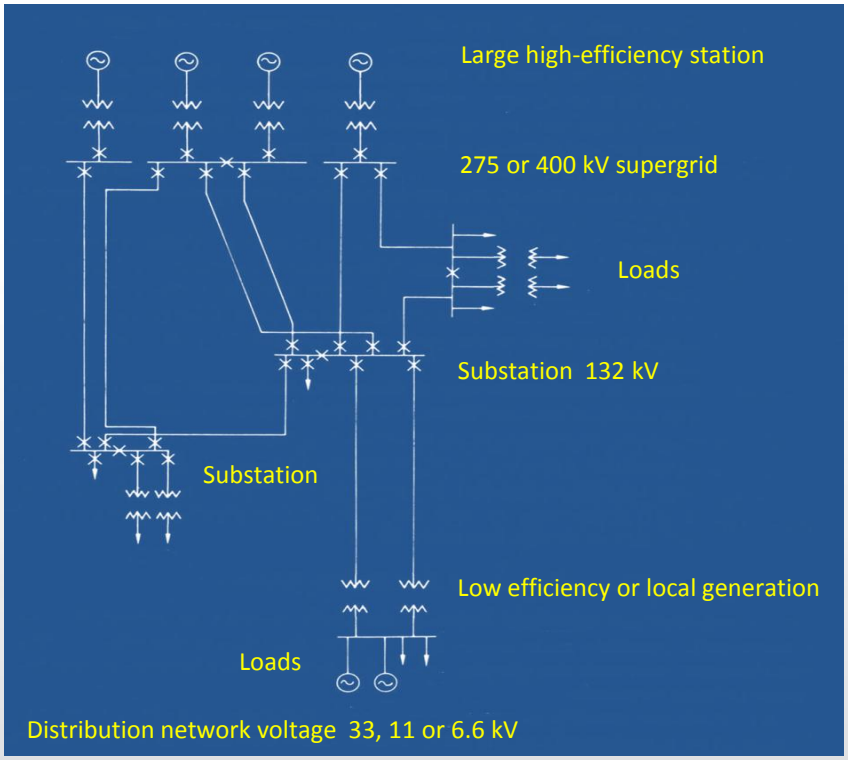


Power Sector Export

Dumping power to high value applications

Supply/Demand mismatch can be alleviated by exporting power

- Power in | Power Out (Conventional Energy Storage)
- Power in | Fuel Out (Sector Export Energy Storage)

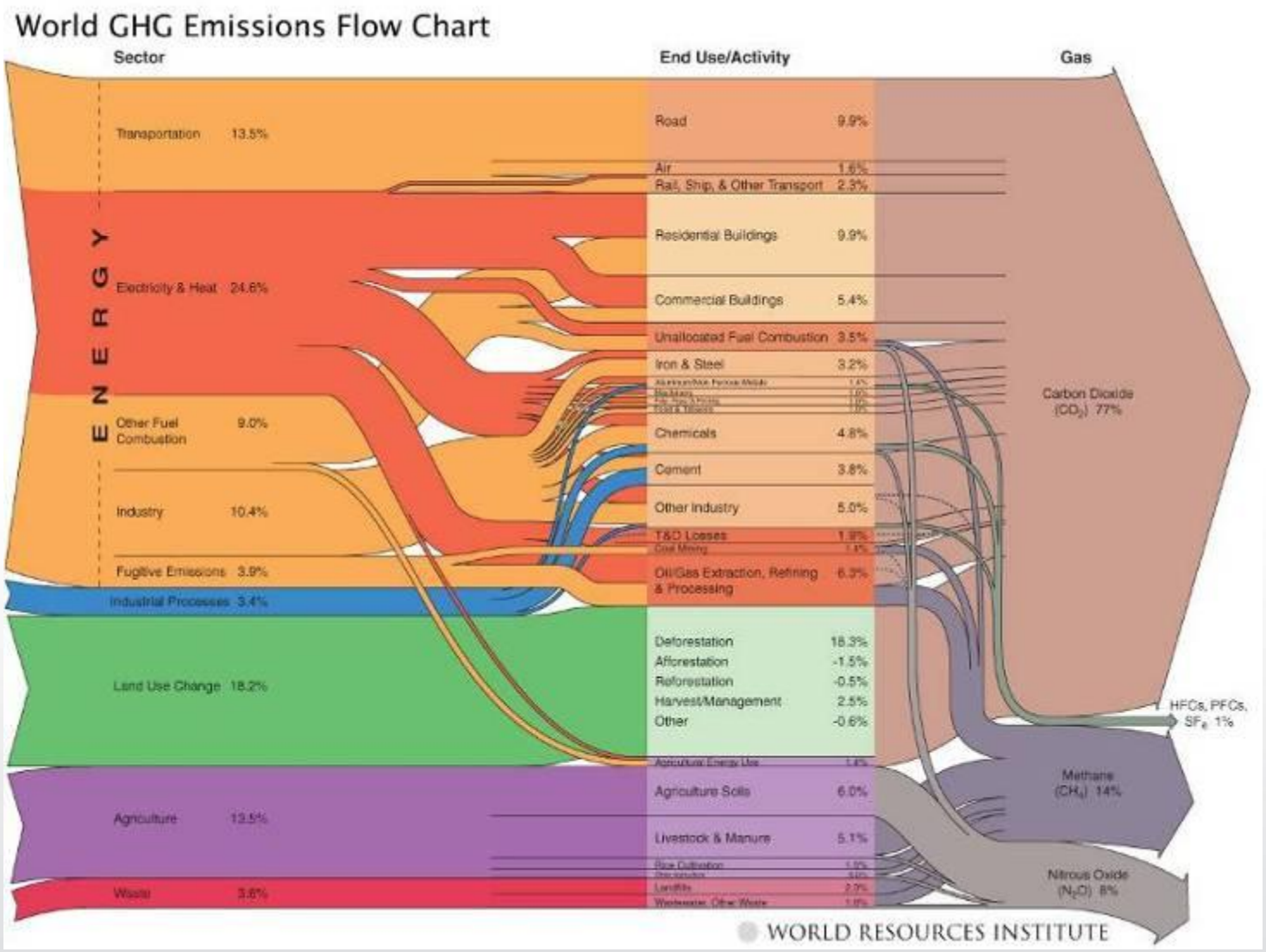


Dumping power to high value applications

Supply/Demand mismatch can be alleviated by exporting power

- Fuel is a huge sector
- Needs decarbonising
- Improve air quality
- Reduce dependence on fossil fuels

Power Sector Export



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Oil Prices

Oil and gasoline prices are steadily rising

- Crude oil approaching $120 a barrel
- The age of cheap oil is over

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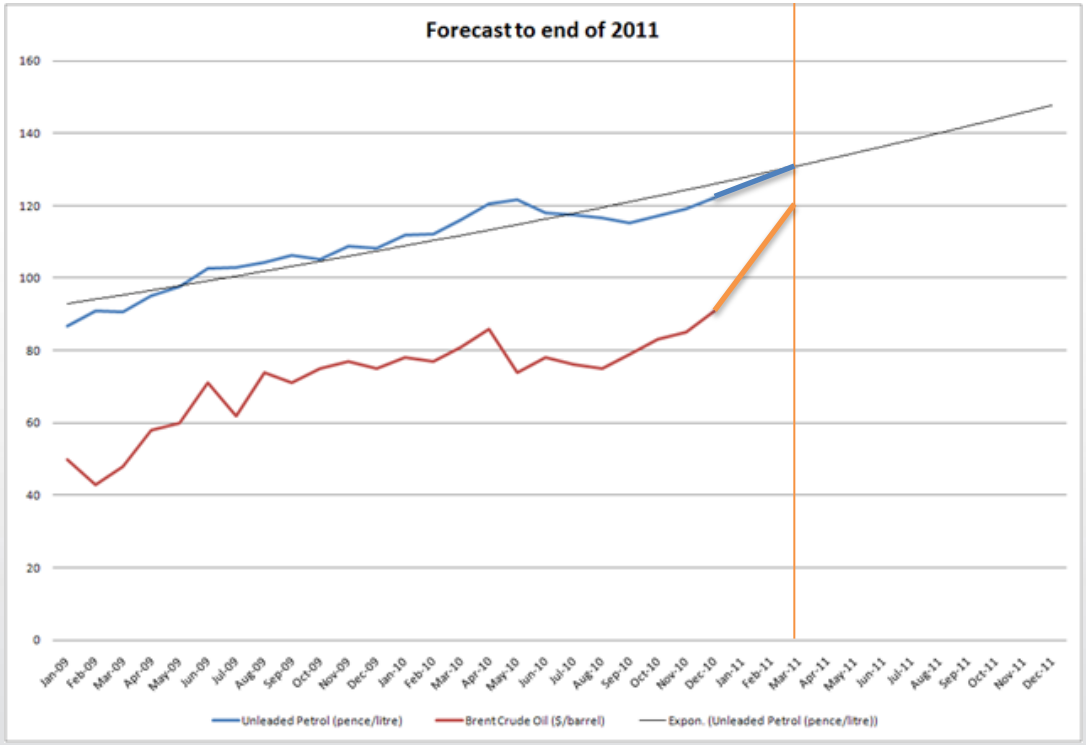
UK Pump Prices

Price of petrol and diesel now a national issue

- Petrol £1.30 per litre
- Trend indicates £1.45 per litre by end 2011



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What's the Solution?

Hydrogen made from renewable power

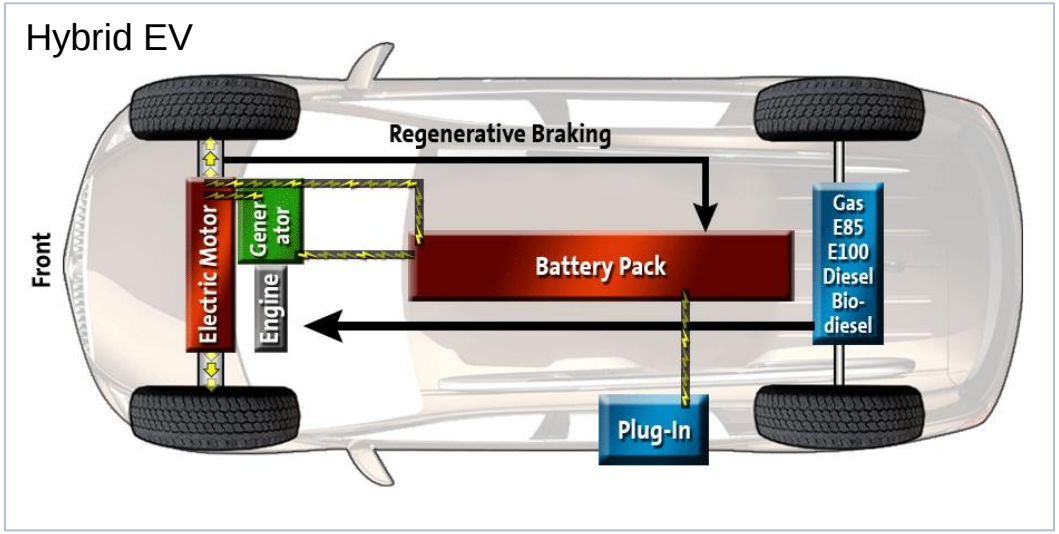
- Replaces a revenue cost with a capital item
- Reduces the need for fossil fuels
- Decarbonises transport
- Improves air quality
- A demand side managed load

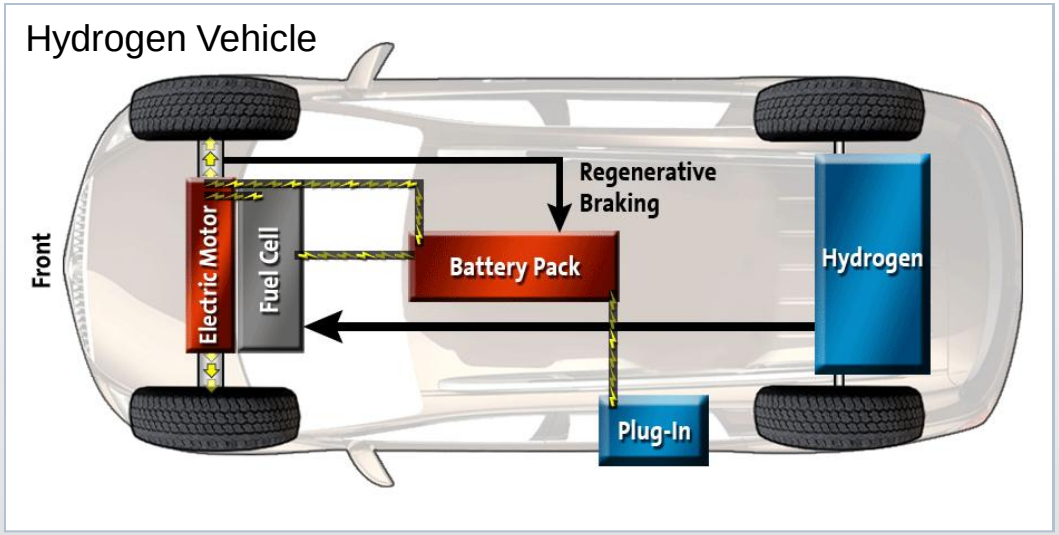
Hydrogen Fuel Cell Electric Vehicles

EV and Hydrogen Cars

Hydrogen vehicles are EV's but with some significant advantages:

- Refuelling time (3mins)
- Range of over 400 miles
- Well to wheel efficiency
- Grid demand side management

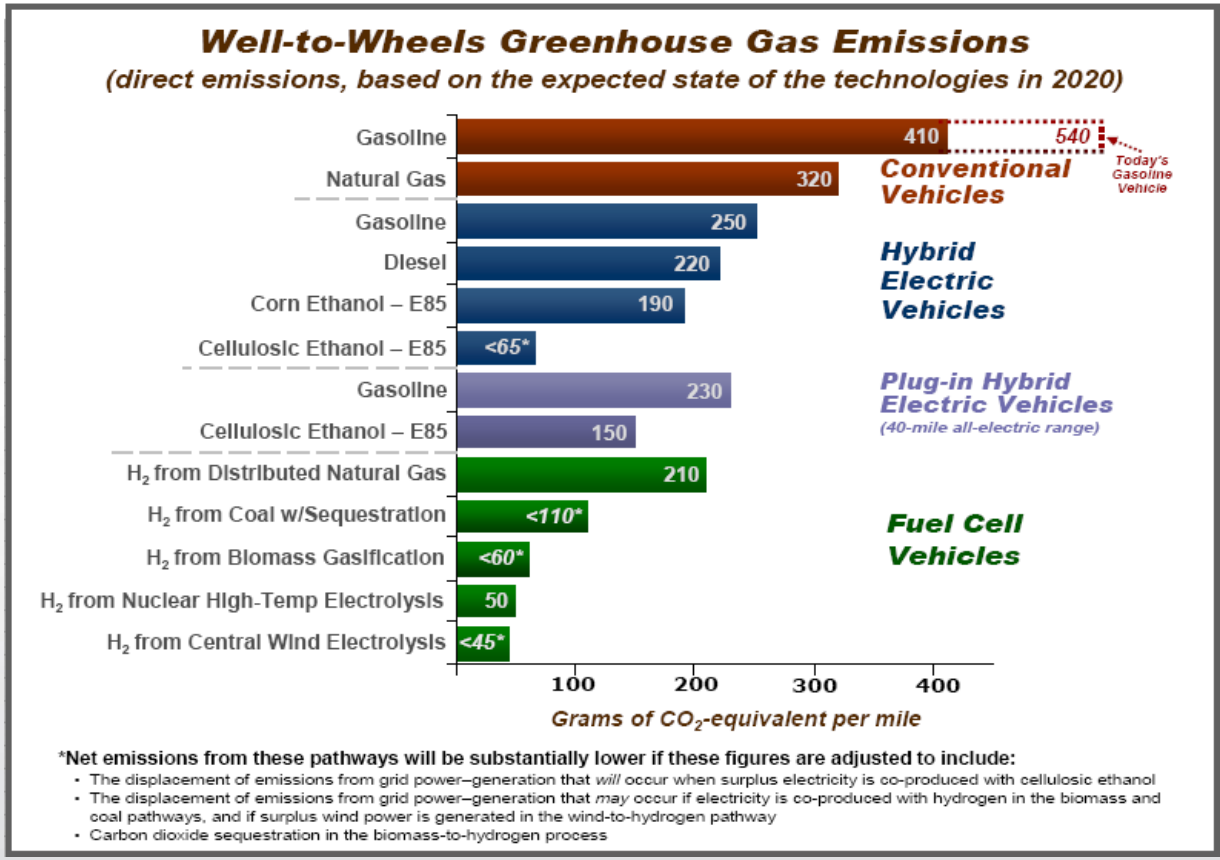




Well to Wheel Emissions

DoE analysis agrees with the major car companies

- Hydrogen from centralised wind
- On site hydrogen even better
- "A triple zero fuel"



U.S. DEPARTMENT OF ENERGY

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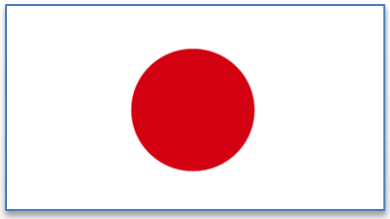
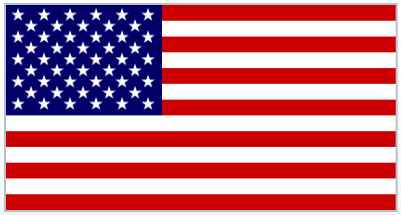
Japan, US & Germany Adopt Hydrogen

Toyota, Honda and Nissan join forces to promote hydrogen

- Total of 100 hydrogen refuelling stations planned in Japan
- 1000 refuelling stations in Germany in 4yrs ($2.6bn)
- 150 planned in California (30 already built)





The Clean Fuel Conundrum

A chicken and egg type situation

- The vehicles need somewhere to refuel for large scale deployment
- The infrastructure is expensive and needs customers for the business case
- Vehicle and refuelling infrastructure technologies need to be compatible

Breaking the Chicken and Egg

Some joined up thinking is required

- The vehicles need somewhere to refuel for large scale deployment
- The infrastructure is expensive and needs customers for the business case
- Vehicle and refuelling infrastructure technologies need to be compatible

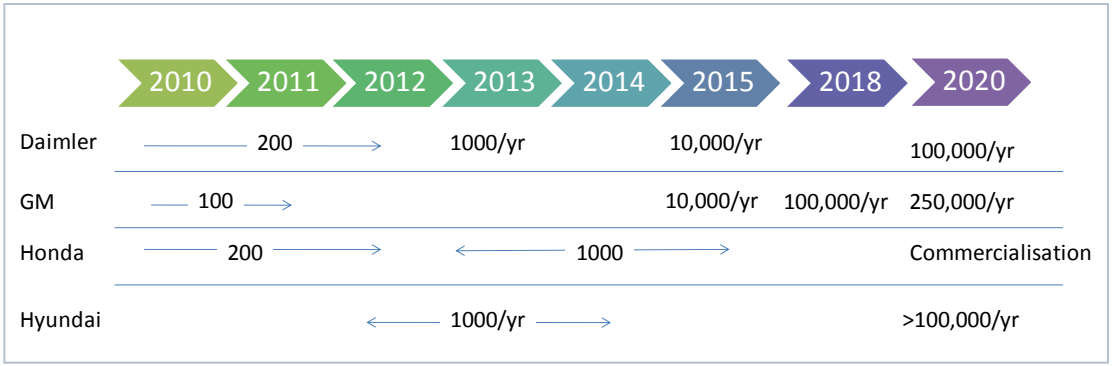
HONDA RENAULT NISSAN TOYOTA
DAIMLER Ford GM OPEL KIA

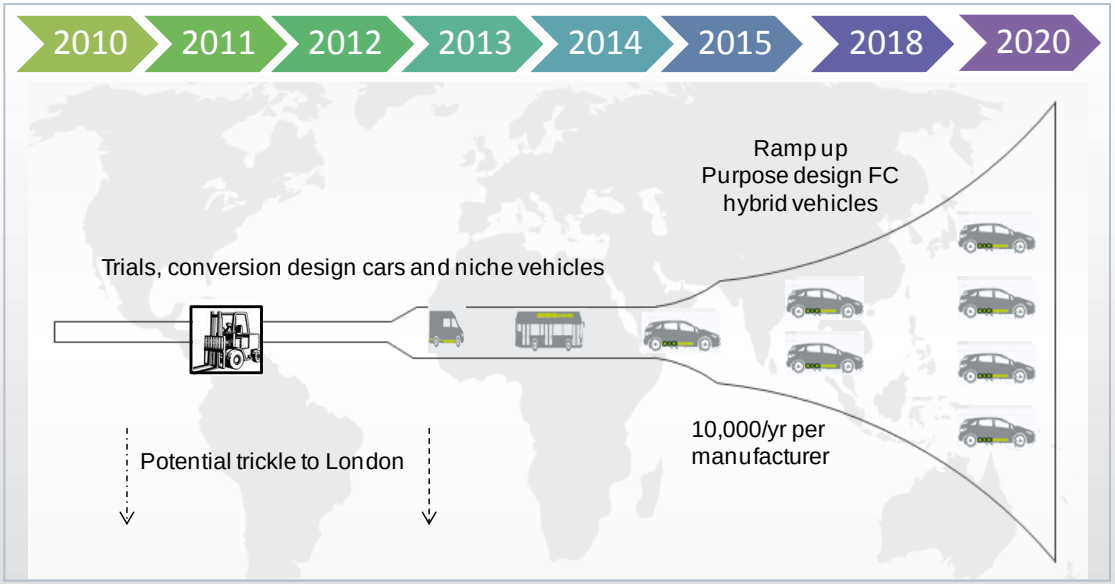
DAIMLER EnBW THE LINDE GROUP
OMV VATTENFALL TOTAL NOW

Hydrogen Vehicles

Serious traction envisaged around 2015

- Air quality may drive early adoption
- Commercial fleet early adoption
- Return to base refuelling
- Perfect for embedded electrolysis

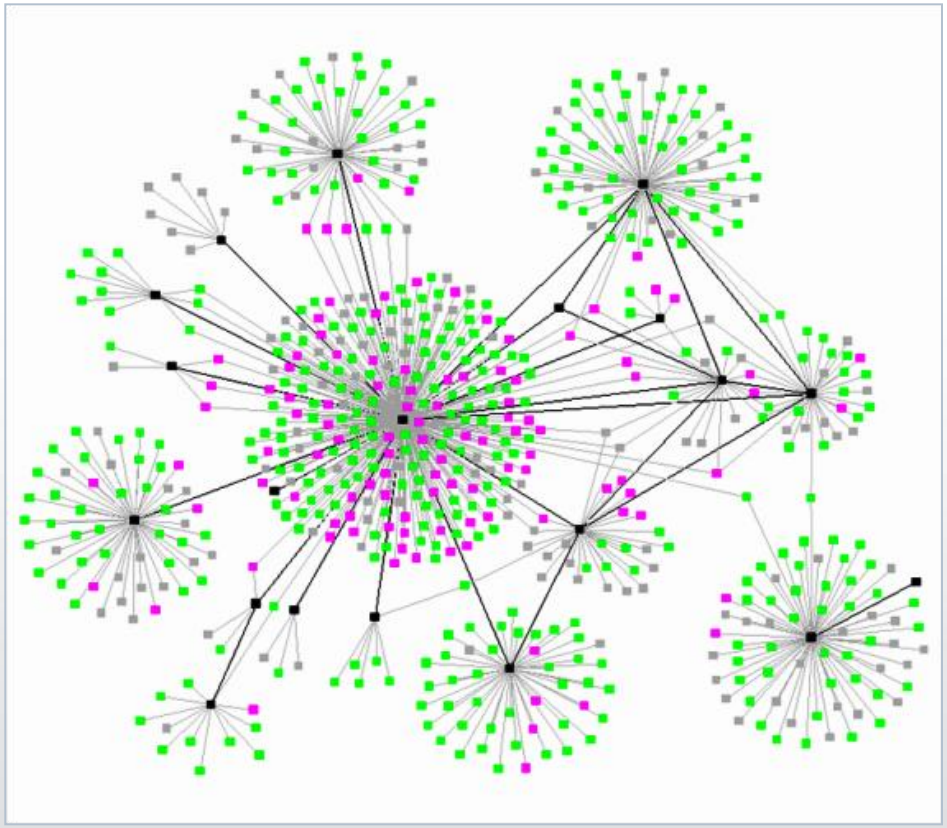




Return to Base

Early adoption from commercial fleets

- Scheduled routes
- Sophisticated fuel procurement
- Sophisticated environmental impact models
- Carbon footprint targets
- Air quality targets



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Hydrogen on Site Trials

Trials to establish commercial benefits and environmental impact models

Center Parcs www.centerparcs.co.uk	DHL Supply Chain www.dhl.co.uk	RAC www.rac.co.uk	Scottish Water www.scottishwater.co.uk	Sheffield City Council www.sheffield.gov.uk	Scottish & Southern Energy www.scottish-southern.co.uk	Isle of Man Government www.gov.im
The Forestry Commission www.forestry.gov.uk	London Borough of Camden www.camden.gov.uk	Commercial Group www.commercial.co.uk	Vestas Wind Systems www.vestas.com	Tarmac www.tarmac.co.uk	May Gurney www.maygurney.co.uk	Autoglass www.autoglass.co.uk
London Stansted Airport www.stanstedairport.com	Scottish Police Services Authority www.spsa.police.uk	Southampton City Council www.southampton.gov.uk	VolkerHighways www.volkerhighways.co.uk	Amey www.amey.co.uk	Enterprise www.enterprise.plc.uk	UPS www.ups.com

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What's the Solution?

Hydrogen made from renewable power

- Via the grid as a demand side managed load
- Direct coupling to renewables
- Joined up thinking between the Power & Transport sectors

Summary

- Renewable power needs energy storage
- Sector export a great solution
- Transport is a large enough sector
- Green hydrogen is a zero carbon footprint fuel
- Early adoption is from commercial fleet operators
- HOST trials to establish economics and business models