

# SR The Road to Renewable Transport Solutions Seminar



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# Charging Ahead: Delivering Transport Decarbonisation



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# Claire Mack

Chief Executive  
Scottish Renewables



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# **Stuart Greig**

Assistant Director Low Carbon Economy  
Transport Scotland





**TRANSPORT  
SCOTLAND**  
CÒMHDHAIL ALBA

# SCOTTISH RENEWABLES

# ROAD TO RENEWABLE TRANSPORT

LOW CARBON ECONOMY DIRECTORATE

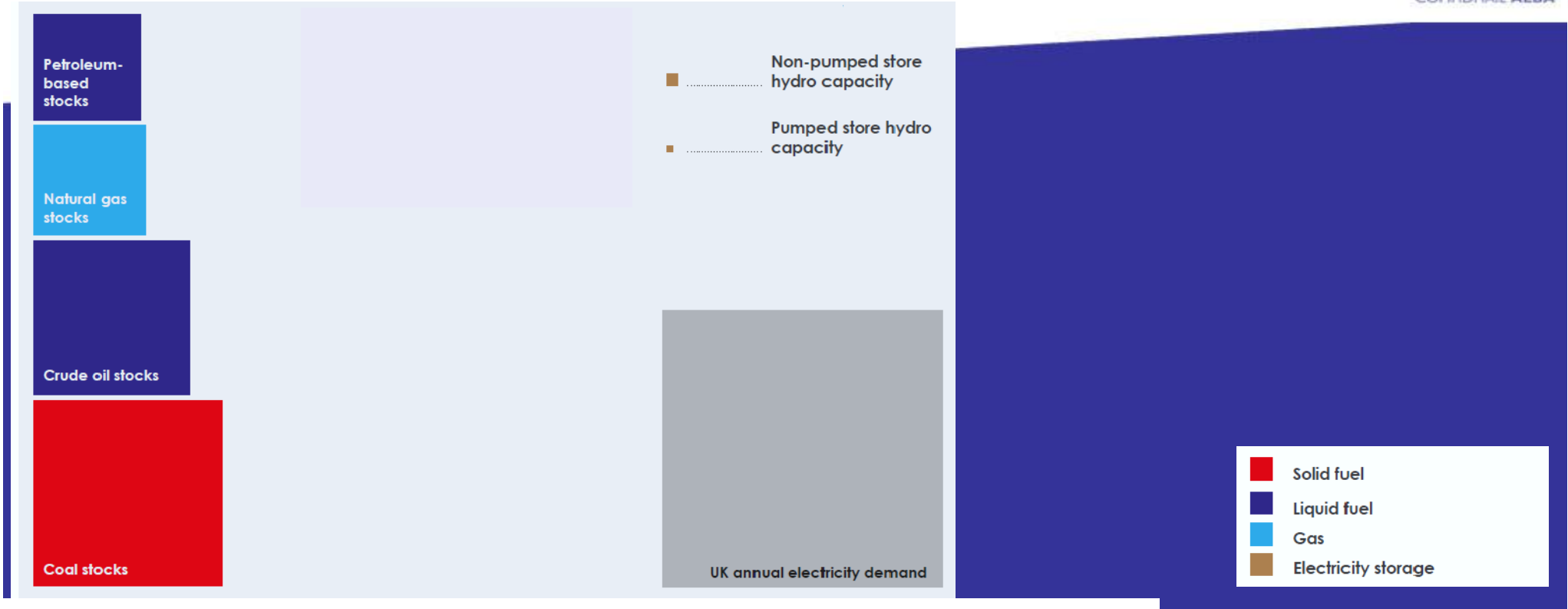
Assistant Director (Transport Scotland)



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# Energy Storage in UK, 2014

The area of each coloured square indicates the energy stored



- Solid fuel
- Liquid fuel
- Gas
- Electricity storage

# A NATION WITH AMBITION

THE GOVERNMENT'S  
PROGRAMME FOR SCOTLAND  
2017-18



year of young people  
bliadhna na h-òigridh  
2018



**WE WILL PHASE OUT THE NEED  
FOR NEW PETROL AND DIESEL  
CARS AND VANS BY 2032**



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## MISSION

**“Phase out the need for new petrol and diesel cars and vans by 2032”**

### Priority 1

**Support a user focused,  
state-of-the-art network  
of charge points  
supporting Scotland’s  
energy needs**

### Priority 2

**Embed new skills and  
capabilities into the  
Scottish workforce**

### Priority 3

**Scottish business  
engaged in and  
benefiting from the shift  
to ULEVs**

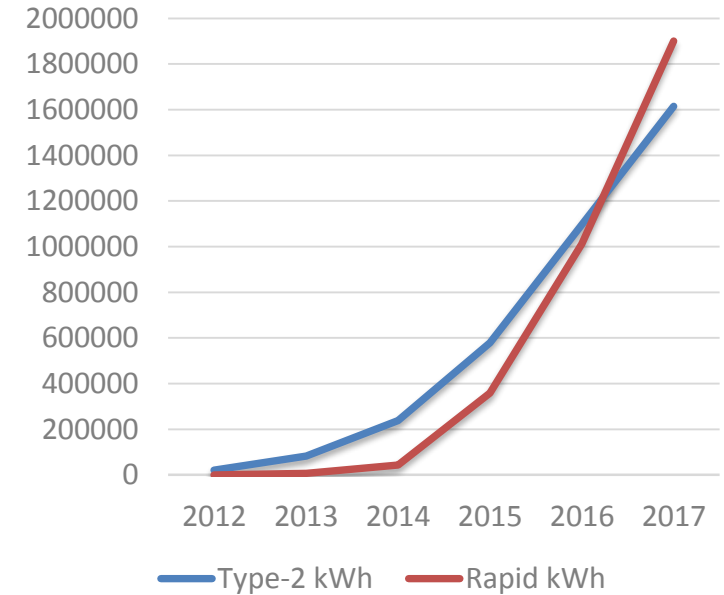
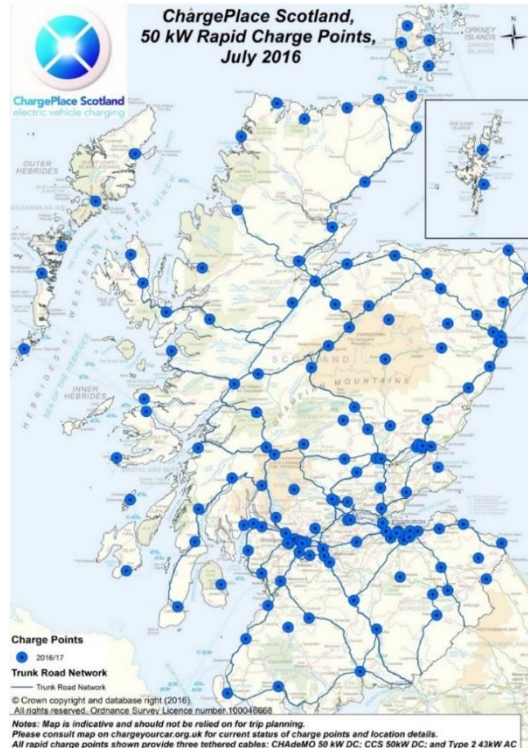
### Priority 4

**Incentivised consumers  
making informed choices  
on the purchase, access  
and use of ULEVs**

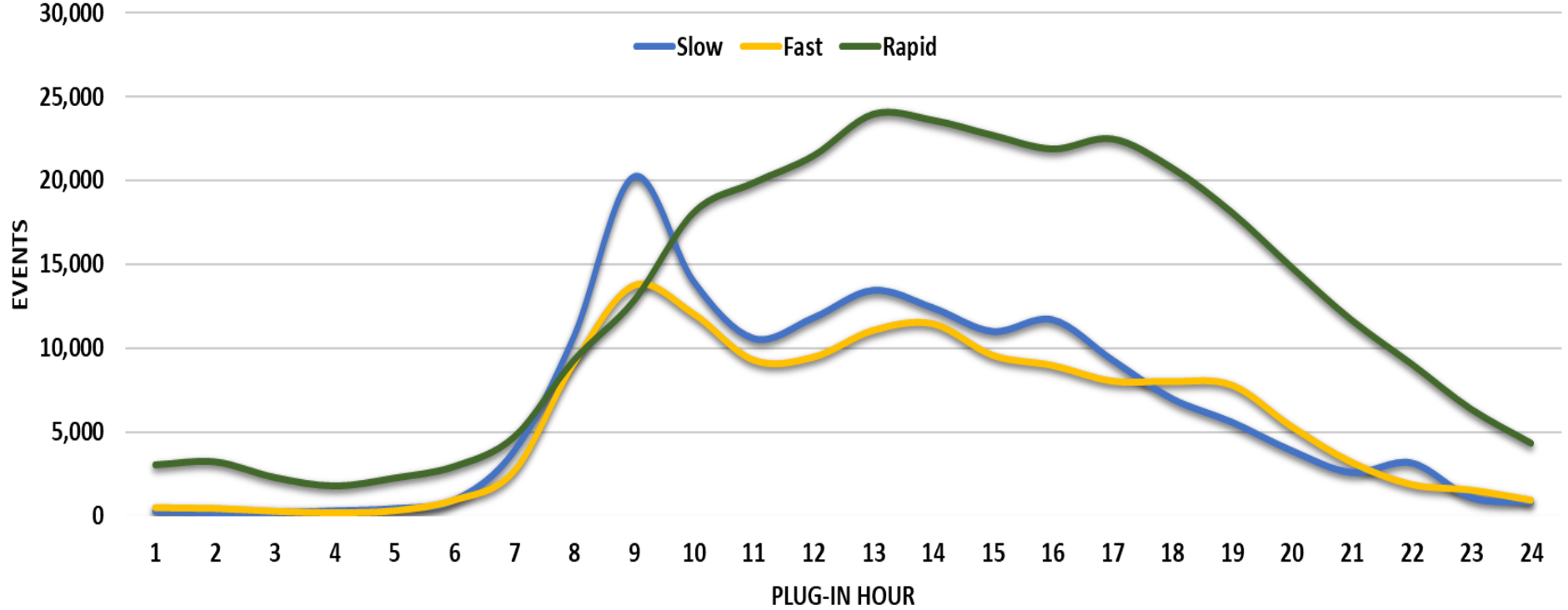
## OUTCOMES

**Scotland at the forefront of growth in ULEV markets.  
A fair distribution of investment costs, benefiting all consumers.  
Business benefitting from new markets and technologies**

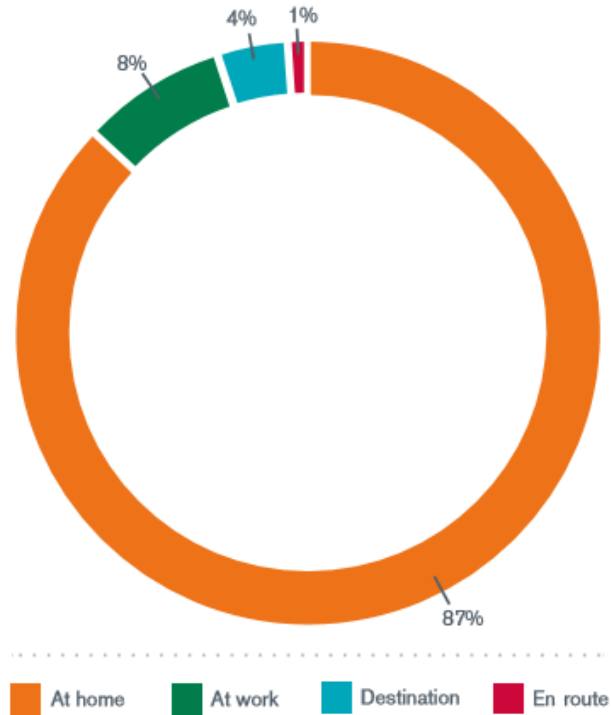
# Charge Place Scotland Network Growth



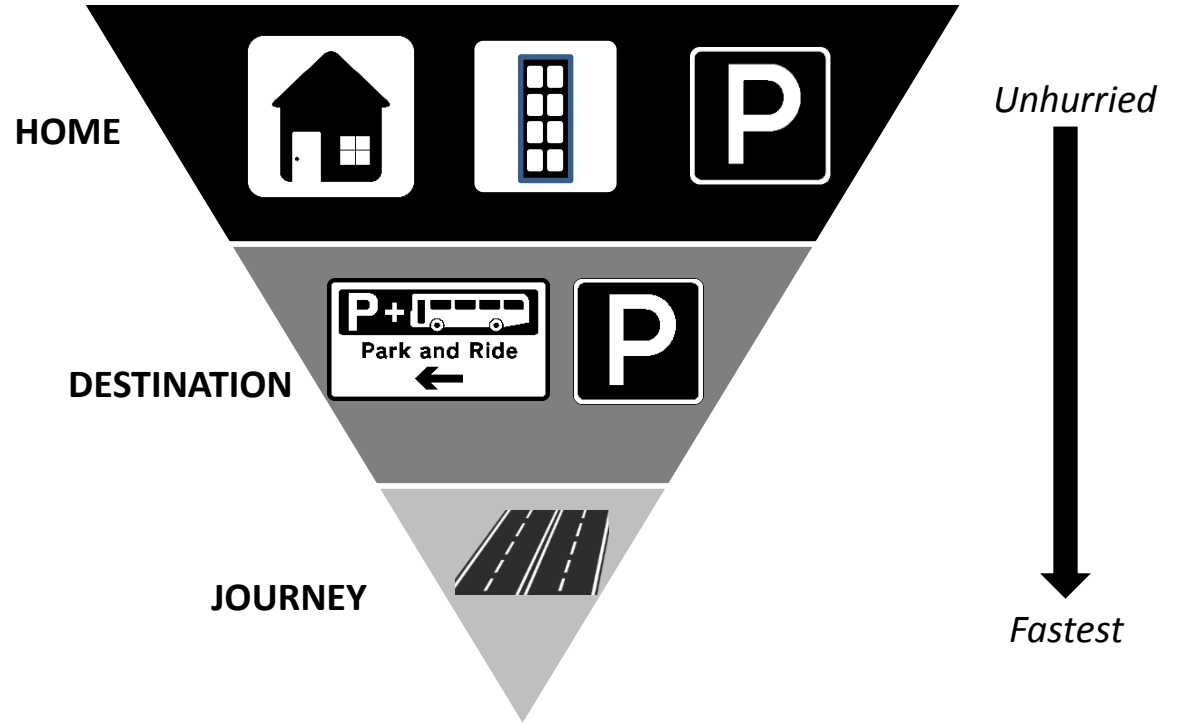
# CPS: Hour of Charging



EV charging activity by location



# Charging hierarchy





# VISION



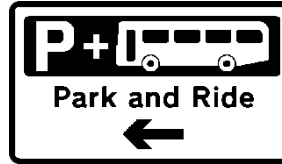
## HOME

All households have easy access to home or local charging solutions

Charging opportunities part of the fabric of urban areas

Chargers integrated into SMART, distributed network with V2G capability

Informed consumers benefiting from SMART charging



## DESTINATION

Charging opportunities part of the fabric of urban areas

Chargers integrated into SMART, distributed network with V2G capability

Informed consumers benefiting from flexible charging tariffs

Opportunities for local generation and storage maximised



## JOURNEY

Targeted at locations of maximum demand

Locations support local economic activity

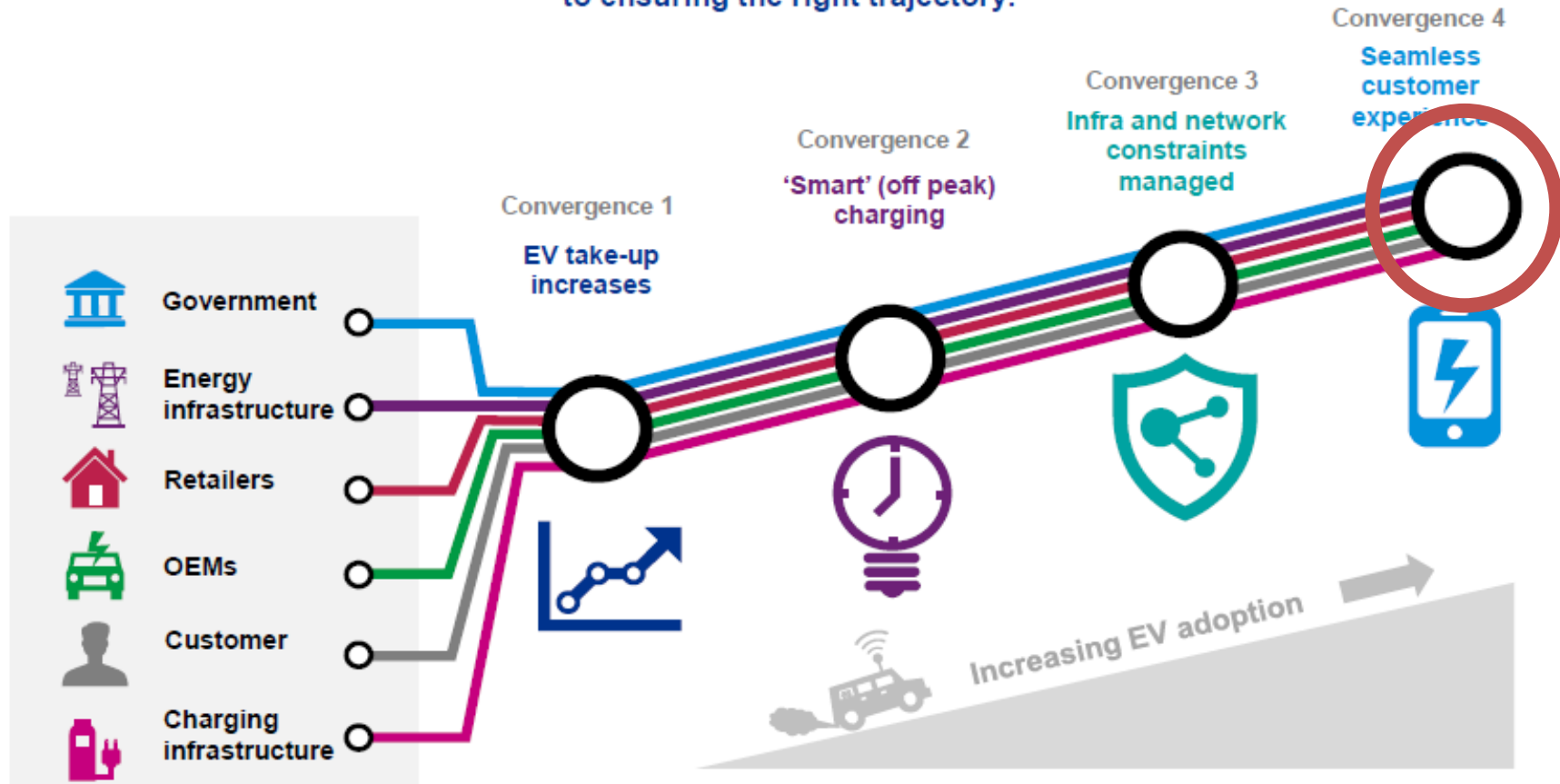
Locations integrated into trunk road master planning

Opportunities for local generation and storage maximised



# The EV adoption journey has 4 key milestones

This journey will require an unprecedented level of coordination and collaboration between ecosystem participants. Having the right interventions at the first convergence point will be crucial to ensuring the right trajectory.



# Scottish Charging Network: Draft Guiding Principles

- **Strategic.** Investment in the charging network should be strategically organised to reduce the need for electricity network upgrades, and the associated costs and disruption.
- **Enabling.** The network should support the emergence of new business models, local investment, commercial opportunities and wider energy and transport system benefits.
- **Comprehensive.** The network should enable EV owners to confidently journey throughout Scotland.
- **Responsive.** The network should be responsive to shifting patterns of demand and capable of keeping pace with technology developments.
- **Accessible.** The network should be accessible to the widest possible range of consumers, while reflecting the different needs of consumers in urban and rural areas.
- **Reliable.** The network should be resilient and well maintained.



# How

- Step change in quality of modelling and data systems
- New partnerships- industry, DNOs, academia (User Forum)
- Clearly communicated frameworks and evidence to support investment
- Innovation, Innovation, Innovation



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**Thank you**

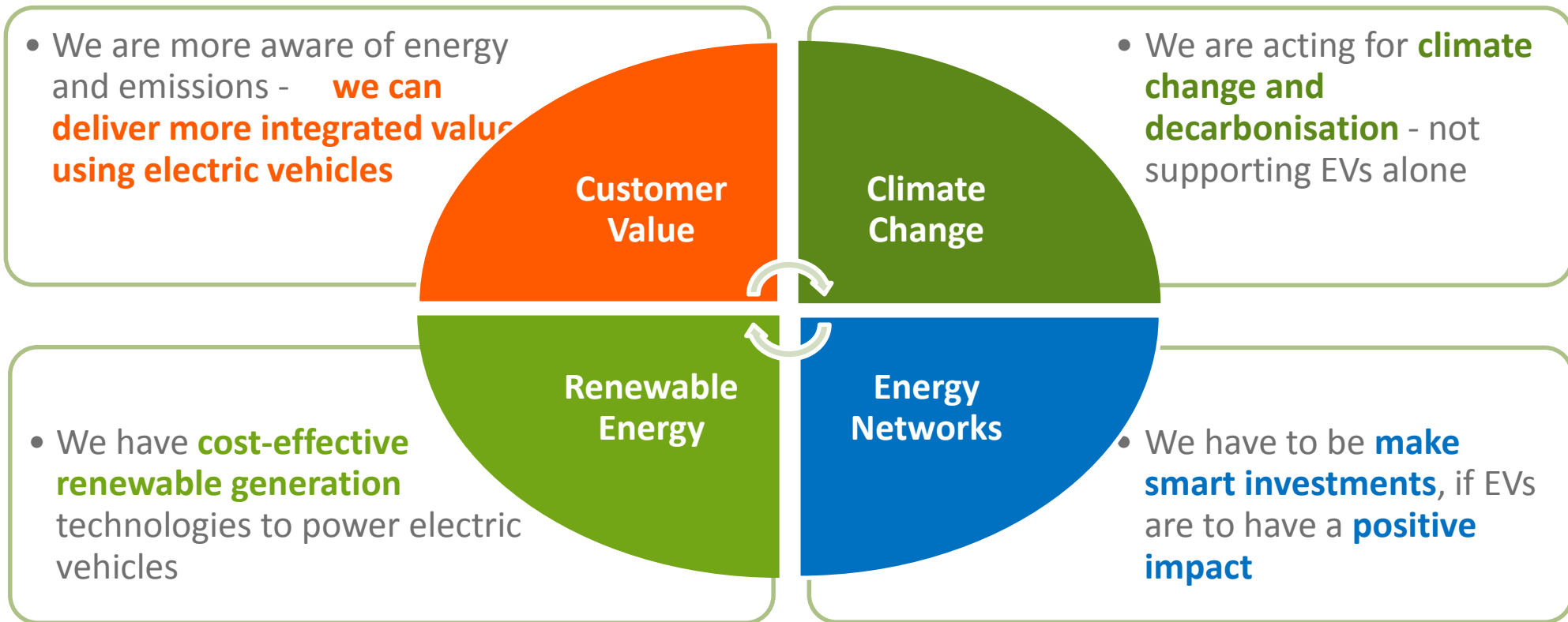


# **Barry Carruthers**

Head of Innovation, Sustainability & Quality  
ScottishPower

# Renewables & Transportation – Global and UK Perspectives

## Multiple Perspectives to Consider





## ScottishPower - Walking the Walk...

Iberdrola to install **25,000 chargers** in Spain by 2021  
>400 Fast Chargers **every 100km** in key routes

**EV Employee Programme** supports >80 private cars  
**Replaced >50% ICE Staff pool cars** by end of 2018

**SP Energy Networks** trials EV van & 4x4 options  
**SP Renewables** orders EVs and 4x4 PHEVs

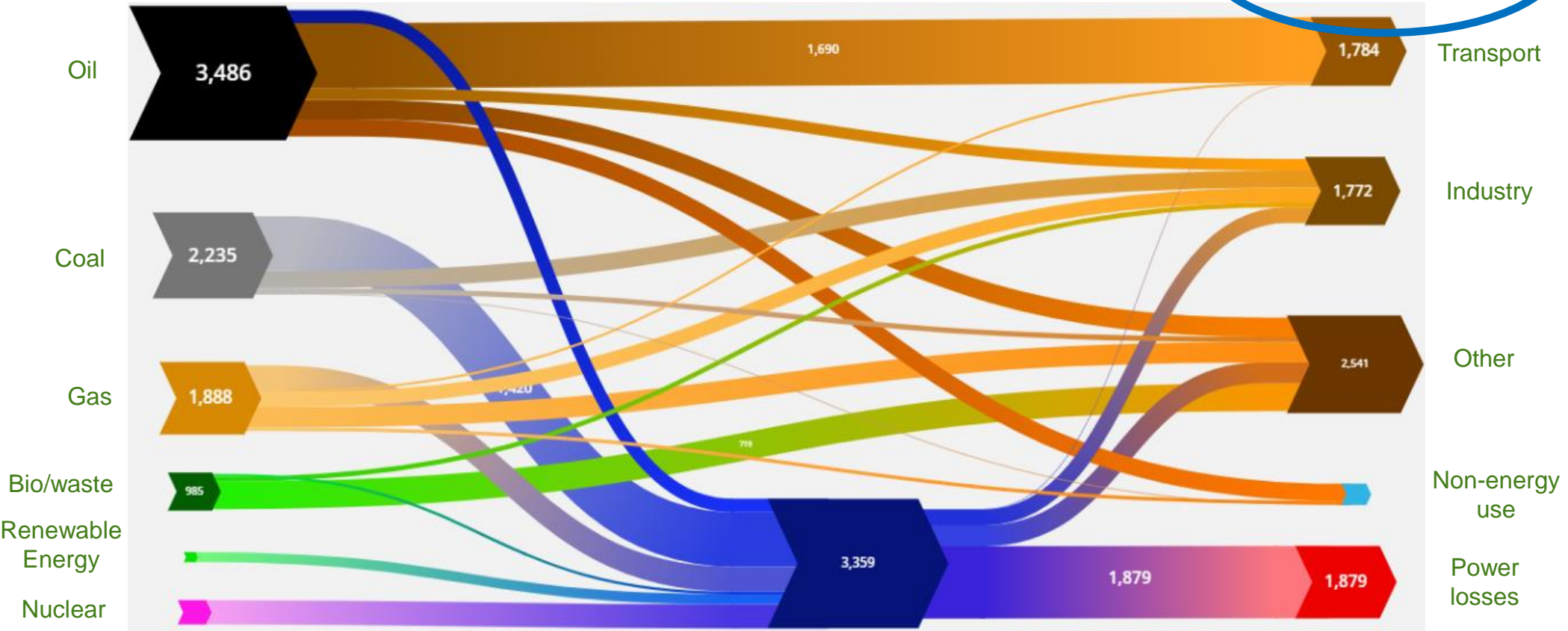
**SP Retail** offering 100% Renewables EV Time-of-Use Tariffs, Chargepoint Finder app, Smart Home Charger



# Zooming Out – The World Balance (1996)

**Production**  
(~9485 Mtoe)

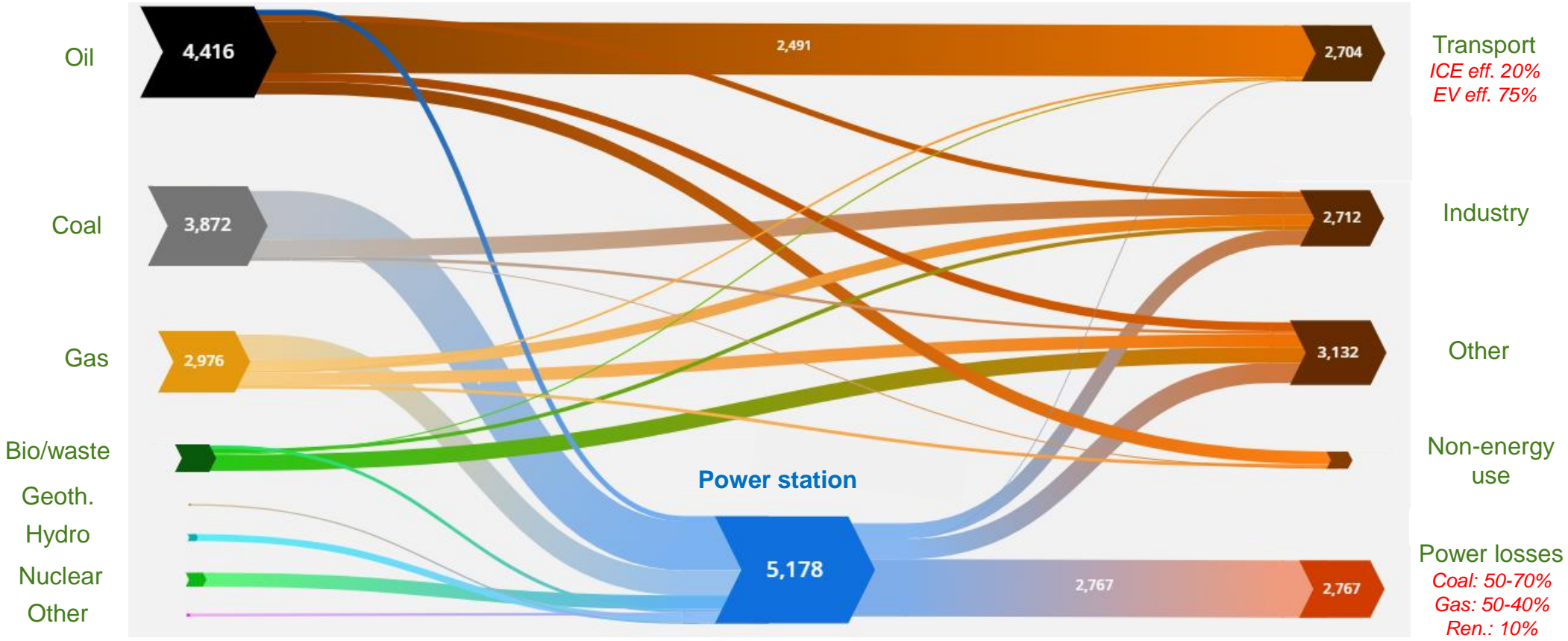
**Total final consumption**  
(~6654 Mtoe) *~30% losses*



# Zooming Out – The World Balance (2016)

**Production**  
(~13,809 Mtoe)

**Total final consumption**  
(~9558 Mtoe) *~30% losses*



Transport  
*ICE eff. 20%*  
*EV eff. 75%*

Industry

Other

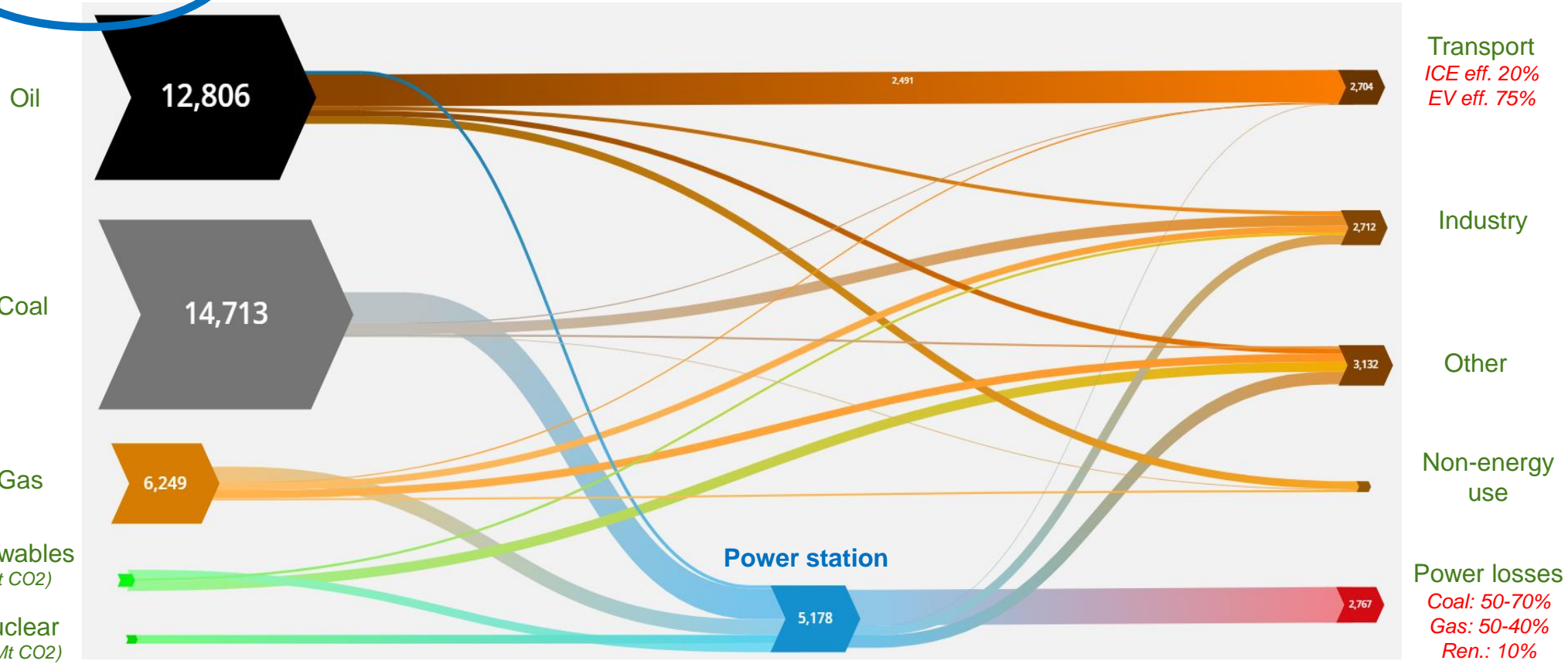
Non-energy use

Power losses  
*Coal: 50-70%*  
*Gas: 50-40%*  
*Ren.: 10%*

# Zooming Out – The World Balance – Emissions to Consumption (2016)

**Production**  
(~34,000 Mt CO<sub>2</sub>)

**Total final consumption**  
(~9558 Mtoe) ~30% losses

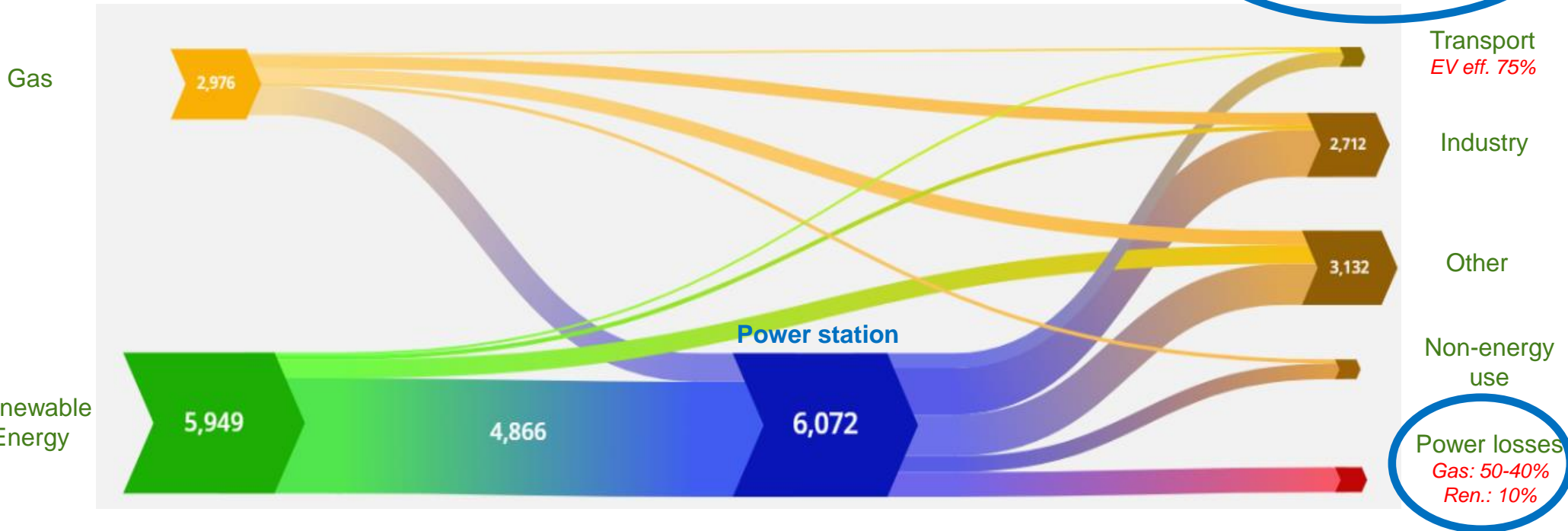




# Zooming Out – The World Balance – Restrictions in Oil & Coal

**Production**  
(~8925 Mtoe)

**Total final consumption**  
(~7509 Mtoe) ~15% losses



**Opportunity for a low carbon future in more efficient system**

## Zooming In – Achievements and Challenges

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> 80% of coal removed from the energy system

~ 30GW of renewable energy connected – substantial shift in system dynamics

~ 2% vehicles all charge simultaneously (price-driven perhaps)

=

4GW peak demand (equivalent to max. winter demand in Scotland)

- ✓ Invest ahead of time, in the right places, for maximum benefit, lowest cost
  - ✓ Design pricing and technical systems to drive optimal behaviour
- ✓ Deliver the energy system for low carbon generation & low carbon transport

## Remember...

All parts working together will deliver: **Better Future, Quicker for everyone**

- We are more aware of energy and emissions - **we can deliver more integrated value using electric vehicles**

Customer Value

- We are acting for **climate change and decarbonisation** - not supporting EVs alone

Climate Change

- We have **cost-effective renewable generation** technologies to power electric vehicles

Renewable Energy

- We have to be **make smart investments**, if EVs are to have a **positive impact**

Energy Networks

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**Barry Carruthers**  
**Head of Innovation, Sustainability & Quality**

[bcarruthers@scottishpower.com](mailto:bcarruthers@scottishpower.com)







**Councillor Lynne Short**  
Convenor City Development  
Dundee City Council



# THE ROAD AND THE MILES TO DUNDEE'S RENEWABLE TRANSPORT SOLUTIONS

# CLLR LYNNE SHORT





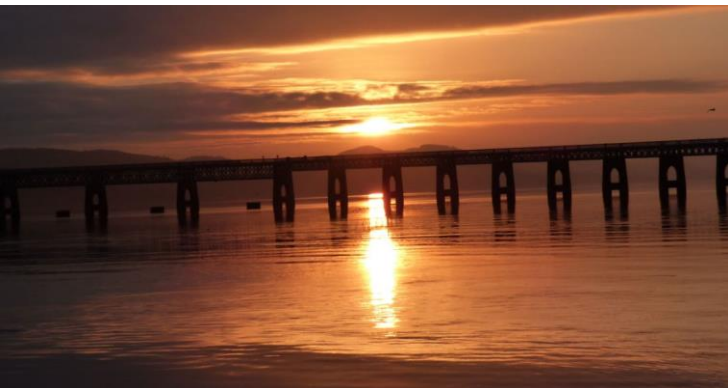
# DUNDEE'S TRANSPORT CHALLENGES

Size

Terrain

Location

Cleaner Air!



# PART OF A SUSTAINABLE MIX

Leading the international charge on EV use

Piloting hydrogen powered buses

Cycling/walking infrastructure

The MILL

20mph streets

Low Emission Zone



# IN NUMBERS

12 Hydrogen



Cycle/foot...



114 EV charging points 94 publicly available



Largest council EV fleet in UK



CO2 Tonnes



2014/15 - 47,761

2012/13 - 65,693

2015/16 - 45,555

2016/17 - 41,131

# THREE WAYS TO SUCCESS

Integrated

Easily accessible

Different modes

# NEXT STEPS

Support to make good choices

Greater partnership working

Integrated, accessible and multi-modal transport







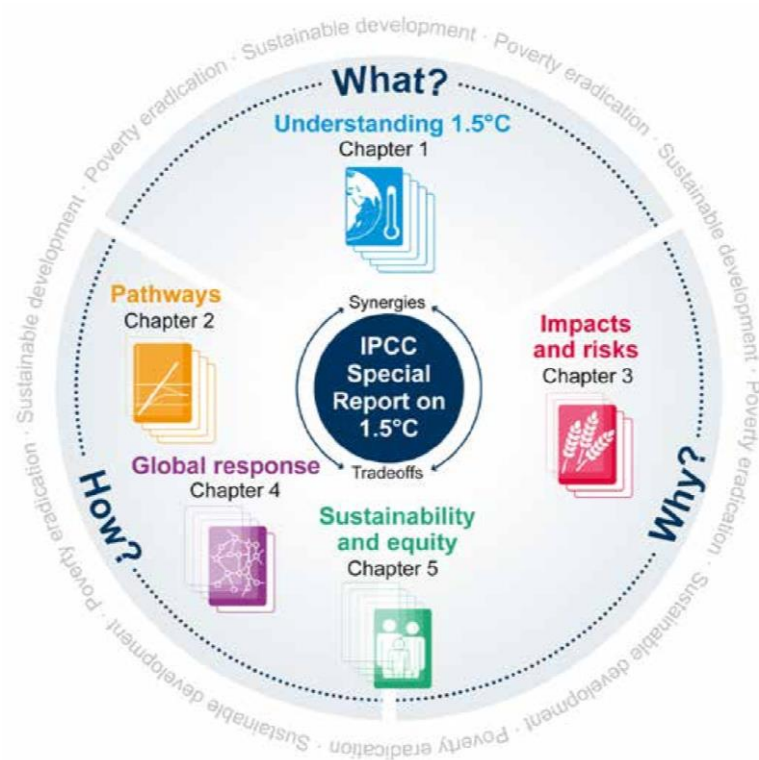
**Dr Moira Nicolson**  
Senior Behavioural Insights Practitioner  
Ofgem

## Applying behavioural insights to electric vehicle 'smart' charging

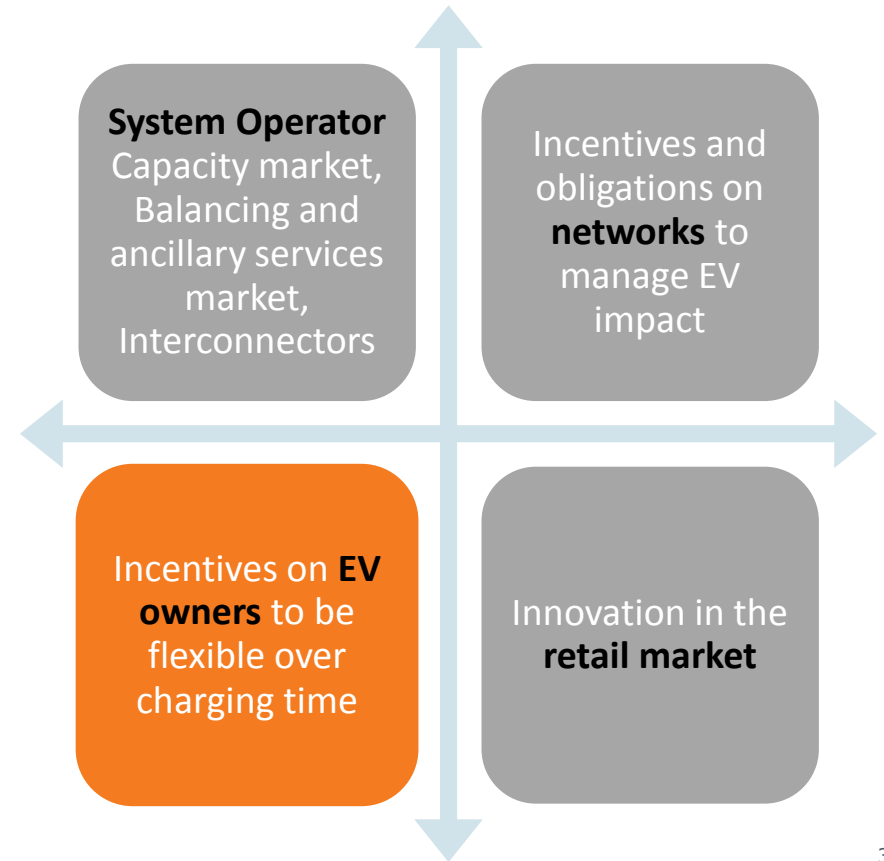
A case for effective but selective nudges?



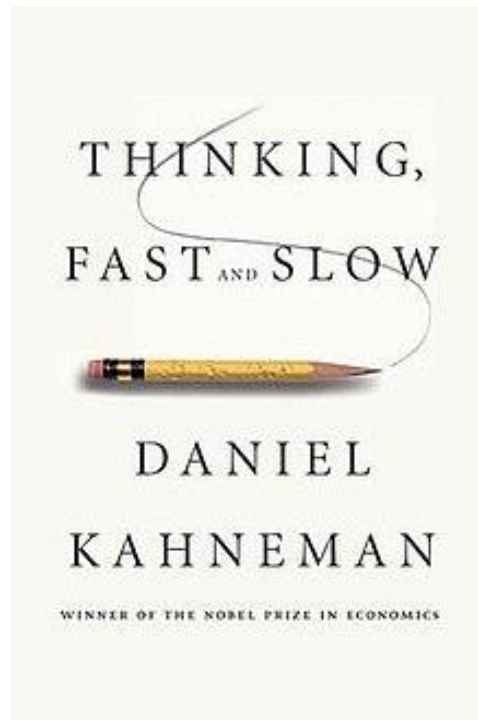
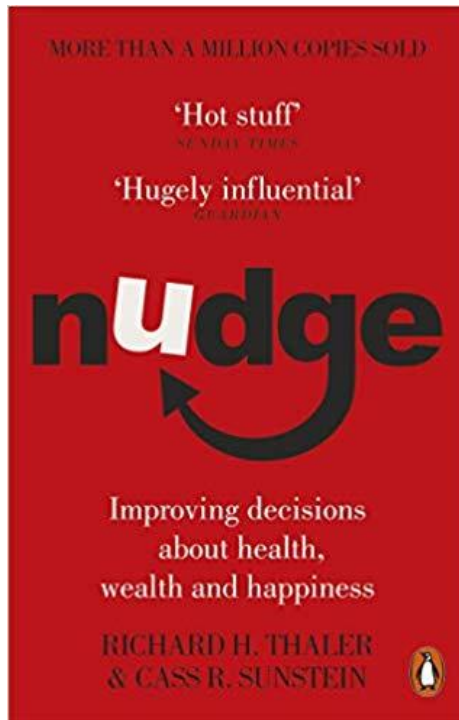
## Demand side management crucial for limiting warming to 1.5°C

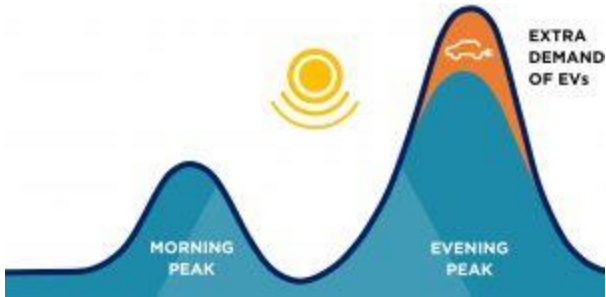


## Tools for managing increased electricity demand from EVs

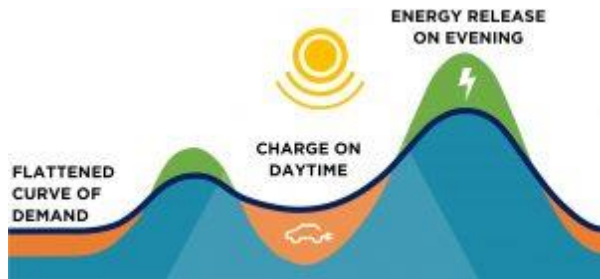


**Nudges** influence behaviour without affecting the underlying incentives and whilst respecting freedom of choice – in contrast to taxes, subsidies and mandates





What EV owners do now



What EV owners are  
'expected' to do

Two key behavioural changes:

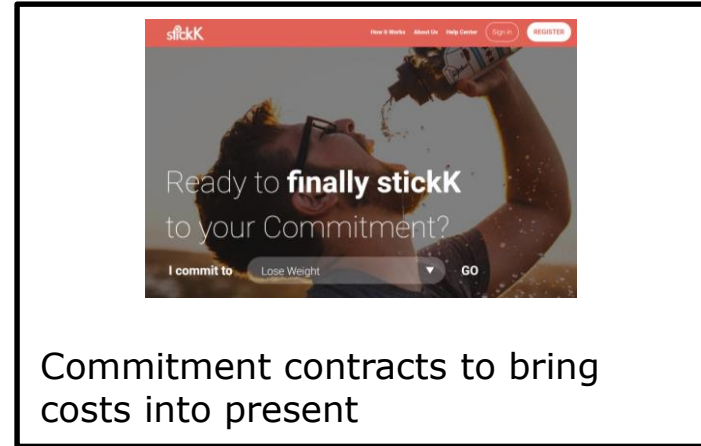
- 1. Adopt** a smart charging tariff or service
- 2. Respond** to the price signals by adjusting the timing of their charging or not overriding automated current curtailment

**Focused on specific decision errors/biases that do not apply in all cases:**



Enjoy now      Pay later

Error/bias:  
Time inconsistent preferences  
"self control issues"



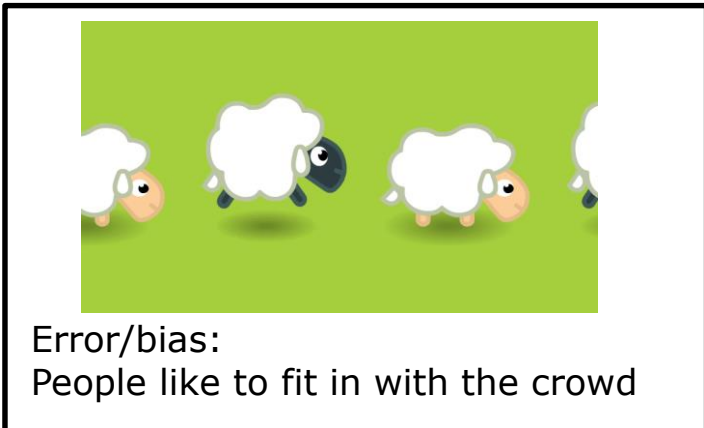
Ready to **finally stickK** to your Commitment?

I commit to Lose Weight GO

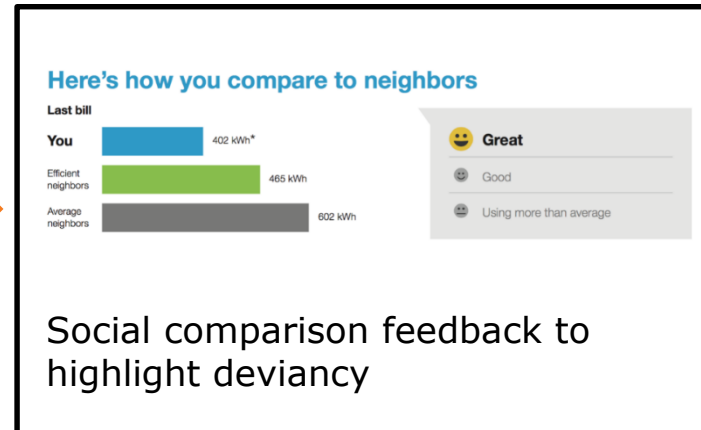
Commitment contracts to bring costs into present

Charging at peak is not a failure of self control

**Focused on tried and tested solutions that cannot be generalised to all situations:**



Error/bias:  
People like to fit in with the crowd



Here's how you compare to neighbors

Category	Value
You	402 kWh*
Efficient neighbors	465 kWh
Average neighbors	602 kWh

Great  
Good  
Using more than average

Social comparison feedback to highlight deviancy

Off-peak charging isn't the norm (yet)



**Focused on 'one size fits all' solutions to inertia:**



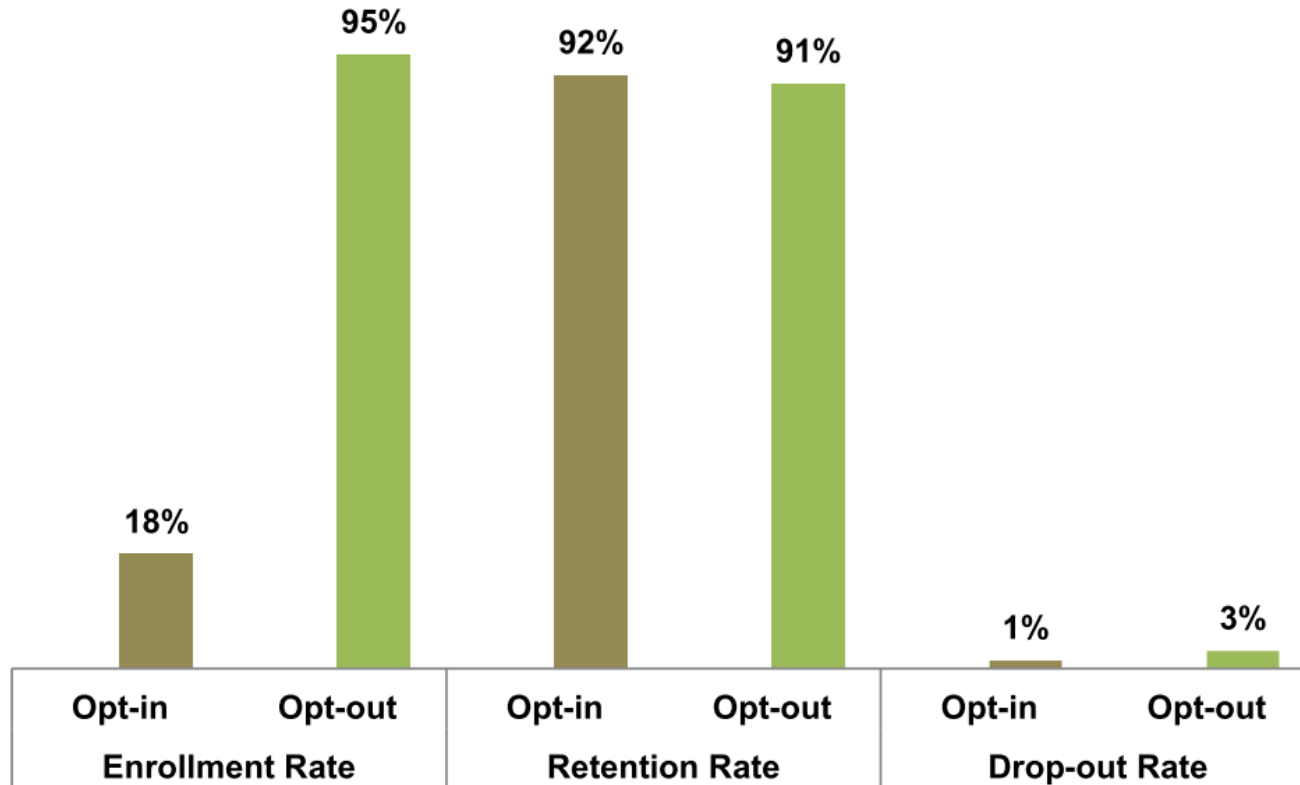
Inertia affects pension and organ donation enrolment as well as switching to cheaper energy deals



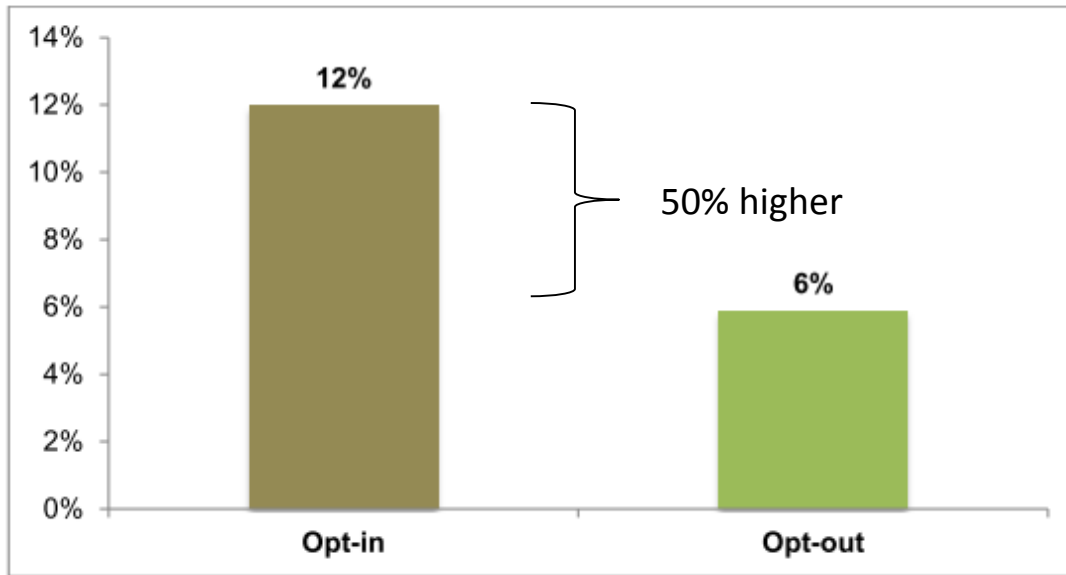
Opt-out enrolment

Opt-outs don't account for variation in 'flexibility capital'

## **Enrolment, retention and drop-out rates amongst US Consumer Behaviour Smart Grid trials of time of use tariffs**





### Peak load reduction across opt-in and opt-out groups (Sacramento Municipal)



US Department of Energy, Interim Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies, p 31.



Choice architecture should be about getting people 'into the right box' by being effective and selective (Johnson, 2016)

		<b>Population sub-group</b>	<b>Tariff A Smart charging tariff</b>	<b>Tariff B Flat-rate tariff</b>
Increase adoption amongst them		Have flexibility capital	X	
Not them		No flexibility capital		X

Nudge options	Description	Evidence base/questions
<i>Personalised defaults</i>	Automatically enrol EV owners on to smart charging tariffs if analysis of their consumption data shows they have flexibility potential.	Successful at influencing online purchasing decisions e.g. Amazon and Netflix personalised recommendations but relies on ability to predict flexibility and might raise questions about privacy and informed choices.
<i>Tailored prompts</i>	Prompt Government EV grant recipients to adopt a smart charging tariff/service.	<a href="#">One study</a> shows that EV grant recipients would engage with tariff switching prompts, especially if sent within 3 months of purchasing their EV.
<i>Bundling of smart charging tariffs/services with EV</i>	EV owners are offered a tariff & EV packaged when they purchase their vehicle.	No specific evidence to date, bundling is effective in online retail context e.g. 'Similar items purchased with' options.

- Maintaining energy affordability and security in a low carbon world relies on behavioural change as well as technological change
- The electrification of transport, and smart charging in particular, is a good example of the type of behaviour change expected considering low levels of consumer engagement in the energy market
- Opt-out enrolment onto smart charging schemes is not a straightforward solution to consumer inertia
- Alternative options such as personalised defaults and tailored prompts could be better alternatives – but real world testing is required, and solutions would require retail market innovation



Ofgem Behavioural Insights Team

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**Our core purpose is to ensure that all consumers can get good value and service from the energy market. In support of this we favour market solutions where practical, incentive regulation for monopolies and an approach that seeks to enable innovation and beneficial change whilst protecting consumers.**

**We will ensure that Ofgem will operate as an efficient organisation, driven by skilled and empowered staff, that will act quickly, predictably and effectively in the consumer interest, based on independent and transparent insight into consumers' experiences and the operation of energy systems and markets.**



**Niall Riddell**  
Electric Vehicles Lead  
EDF Energy



blueelab

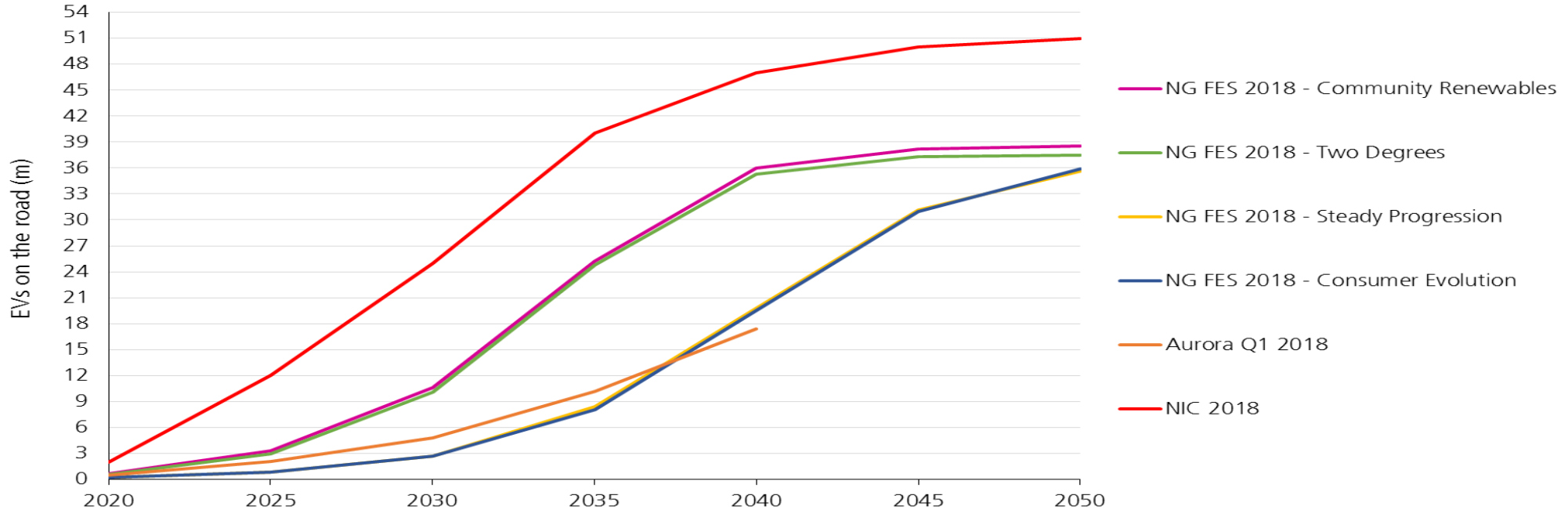
Niall Riddell, Electric Vehicle Lead, EDF Energy  
EDF electric vehicle plan

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# Electric Vehicles represent a major opportunity

Growth in electric vehicles driven by declining costs and increasing regulation

## Forecast growth in UK plug-in vehicles



Electricity demand from EVs is typically expected to reach **3-5TWh by the mid 2020's**, rising rapidly

# EDF to be the leading e-mobility provider in Europe

Leading provider by 2022 in our four main markets; France, UK Italy, Belgium



Leading power supplier for electric vehicles, equating to 30% of market share

Biggest charging network operator, n°1 on the market

Europe's "smart charging" leader



# EDF Energy's current EV activity

EDF Energy has a long history in EV with a range of current projects

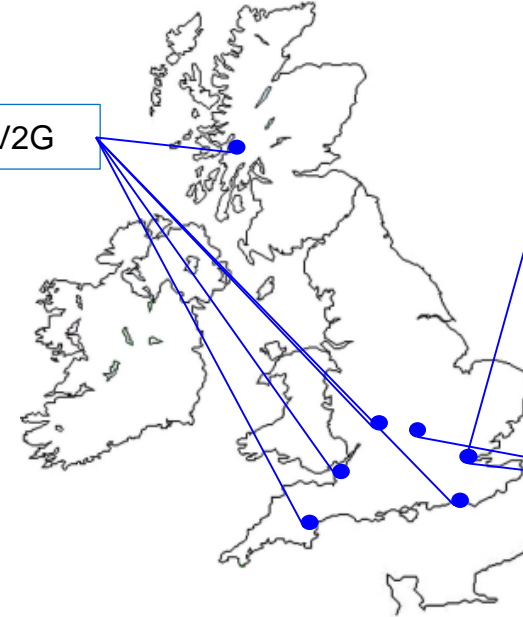
## National projects

- Building on legacy
- Business charging solutions
- Domestic charging solutions
- Working with Nissan
- Nuvve & Powershift;

Own sites; EV100 & V2G

Ubitricity

V2GO & V2 Street



## Stronger UK partnerships



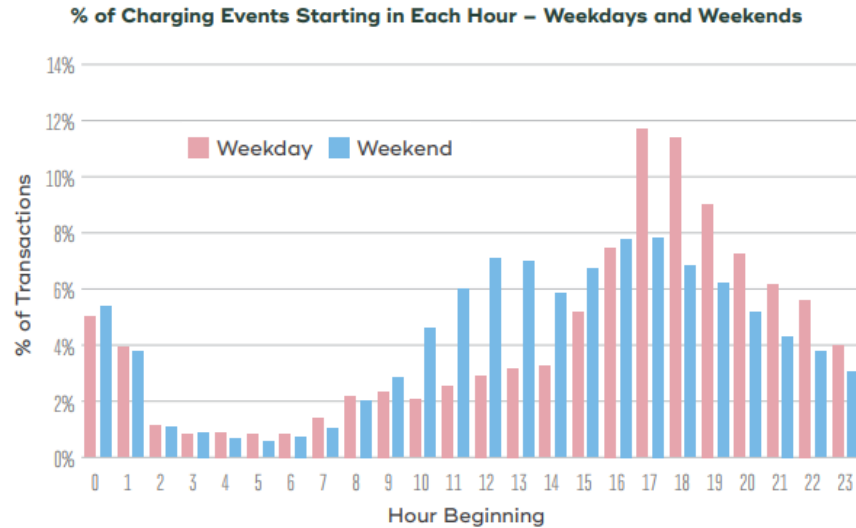
DriveElectric

# Smart charging is critical: solutions are on a spectrum

Avoiding a high cost, high CO2 evening peak

## What is smart charging?

- What item is smart?
- At what level does the smart system operate?
- Who controls the smart?



**Smart charging spectrum**  
Increasing sophistication...increasing complexity

Government

Dumb

No control

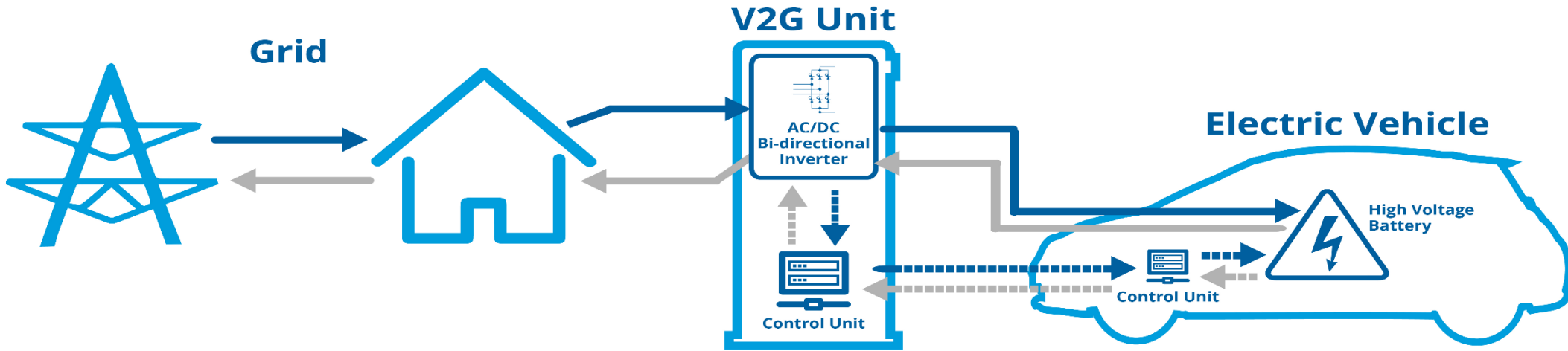
Uni-directional power flow  
Fixed shape Dynamic shape

Smart

Bi-directional power  
(Vehicle-2-Grid)

# Vehicle-to-grid

Enabling two way flow of power from your car and additional asset value



**Vehicle-to-grid (V2G)** chargers allows a two-way flow of electricity between the car and the charger and the electricity grid. This enables cars to return unused electricity back onto the charger and subsequently return it back to the grid opening up the potential for electric vehicles to become portable energy storage.

# A complete electric vehicle solution – made easy

With free expert advice and access to a range of products and services under one roof, the transition to electric vehicles has never been easier.



Vehicles

+



Charging

+



Energy supply

[Find out more >](#)

**Claire Mack**  
Chief Executive, Scottish Renewables

**Stuart Greig**  
Assistant Director Low Carbon Economy, Transport Scotland

**Barry Carruthers**  
Head of Innovation & Sustainability, ScottishPower

**Councillor Lynne Short**  
Convenor City Development, Dundee City Council

**Dr Moira Nicolson**  
Senior Behavioural Insights Practitioner, Ofgem

**Niall Riddell**  
Electric Vehicles Lead, EDF Energy

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**Helen Wylde**  
Chief Engagement Officer  
Transport Systems Catapult



# Fuelling the Future: Alternative Transport Fuels



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**Emil Rangelov**  
CEO  
HV Systems

An aerial, semi-transparent view of a highway with several trucks. In the upper left, there is a building with solar panels and three tall chimneys. The background shows a lush green forest.

**HV Systems**  
Zero Emissions Vehicles

**HVI ENERGY**  
Fuelling The Future

**Emil Rangelov**  
CEO HV Systems

Perspective on transport decarbonisation, the opportunities and challenges of bringing new technology to this emerging market



**HV Systems**  
Zero Emissions Vehicles

**HVI ENERGY**  
Fuelling The Future

**Air pollution kills  
40,000 people a year  
in the UK**

**One in three people  
live in an area with  
dangerously high  
levels of air pollution**

**Asthma alone costs  
the NHS £1bn a year**

**If you breath air, you should care!**



**HV Systems**  
Zero Emissions Vehicles

**HVI ENERGY**  
Fuelling The Future

**40% of GHG is  
transportation & up to  
half of that is from  
Heavy Goods  
Vehicles.**

**Whilst the focus is  
currently on cars, we  
ought to pay more  
attention to cleaning  
up large vehicles like  
trucks and buses.**





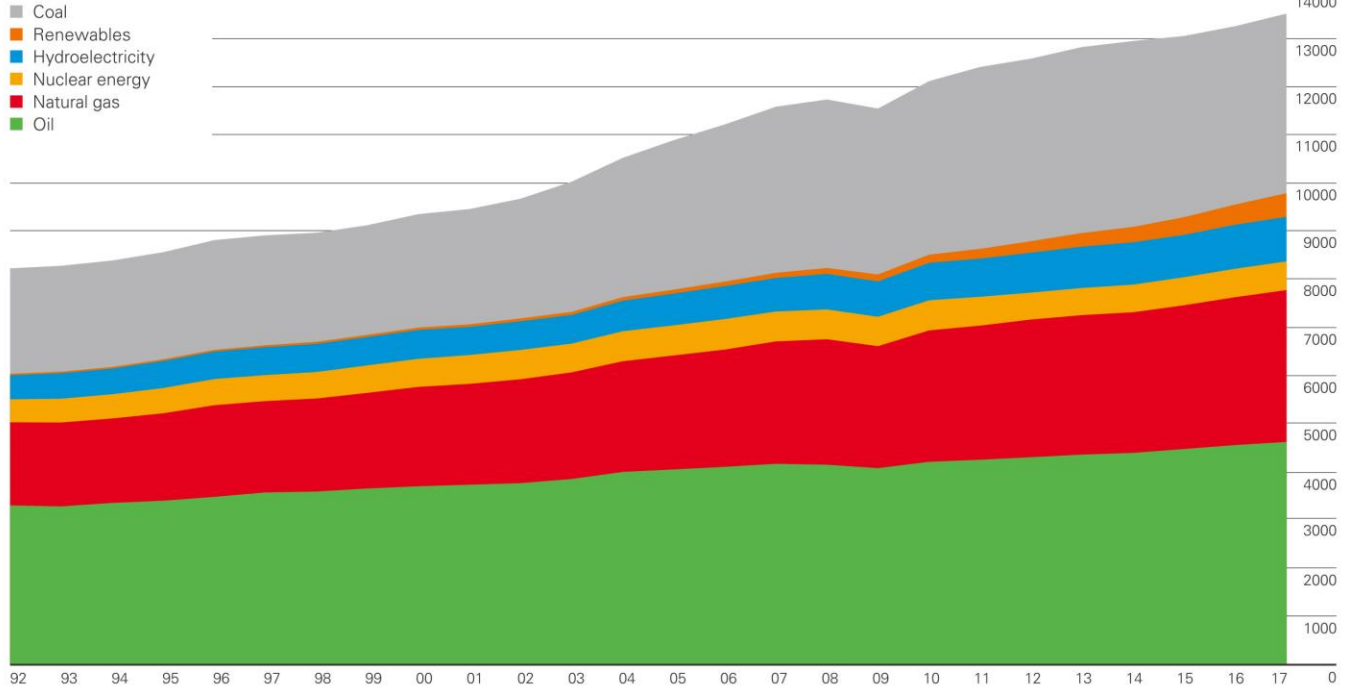
Subsidies for solar, wind & even bio-mass began in 1975

Fossil fuels contributed 85.2% of global energy in 2017

The use of fossil fuels have more than doubled since 1975

**World consumption**

Million tonnes oil equivalent



World primary energy consumption grew by 2.2% in 2017, up from 1.2% in 2016 and the highest since 2013. Growth was below average in Asia Pacific, the Middle East and S. & Cent. America but above average in other regions. All fuels except coal and hydroelectricity grew at above-average rates. Natural gas provided the largest increment to energy consumption at 83 million tonnes of oil equivalent (mtoe), followed by renewable power (69 mtoe) and oil (65 mtoe).

1975		
Fossil Fuels	5,318.3*	92.8%
Low Carbon Fuels	82.4*	1.44%
Renewable	328.5*	5.73%

It was estimated in 1975 that the percentage of global energy consumption from fossil fuels in 2015 would be approximately 85%.

2017		
Fossil Fuels	11,509.4*	85.18%
Low Carbon Fuels	596.4*	4.41%
Renewable	1405.4*	10.40%

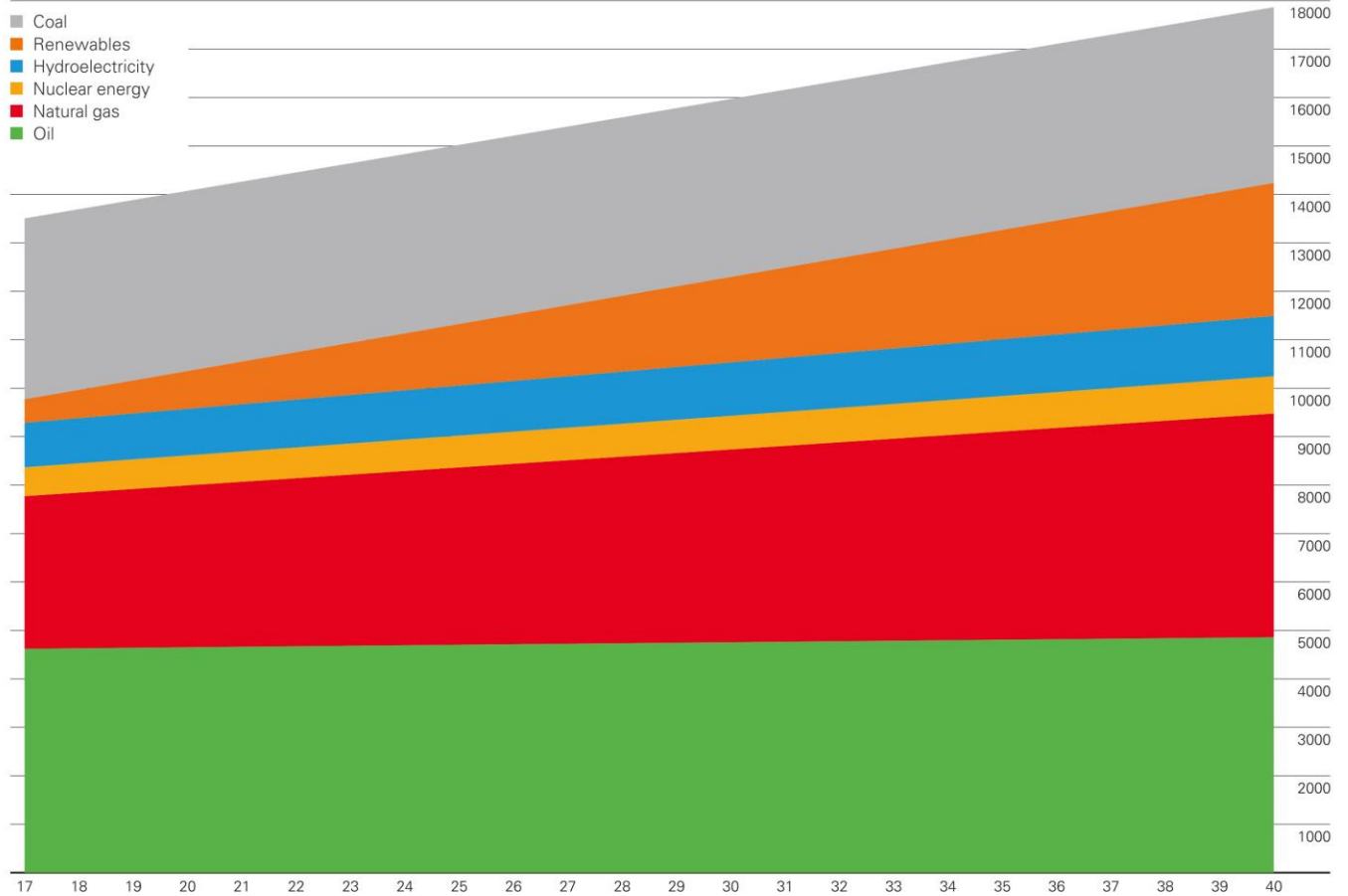
\*Million tonnes oil Equivalent

Sources: www.bp.com | www.forbes.com



2040 Evolving Transition		
Fossil Fuels	13,102*	73.34%
Low Carbon Fuels	770*	4.31%
Renewable	3,993*	22.35%
Total	17,865*	

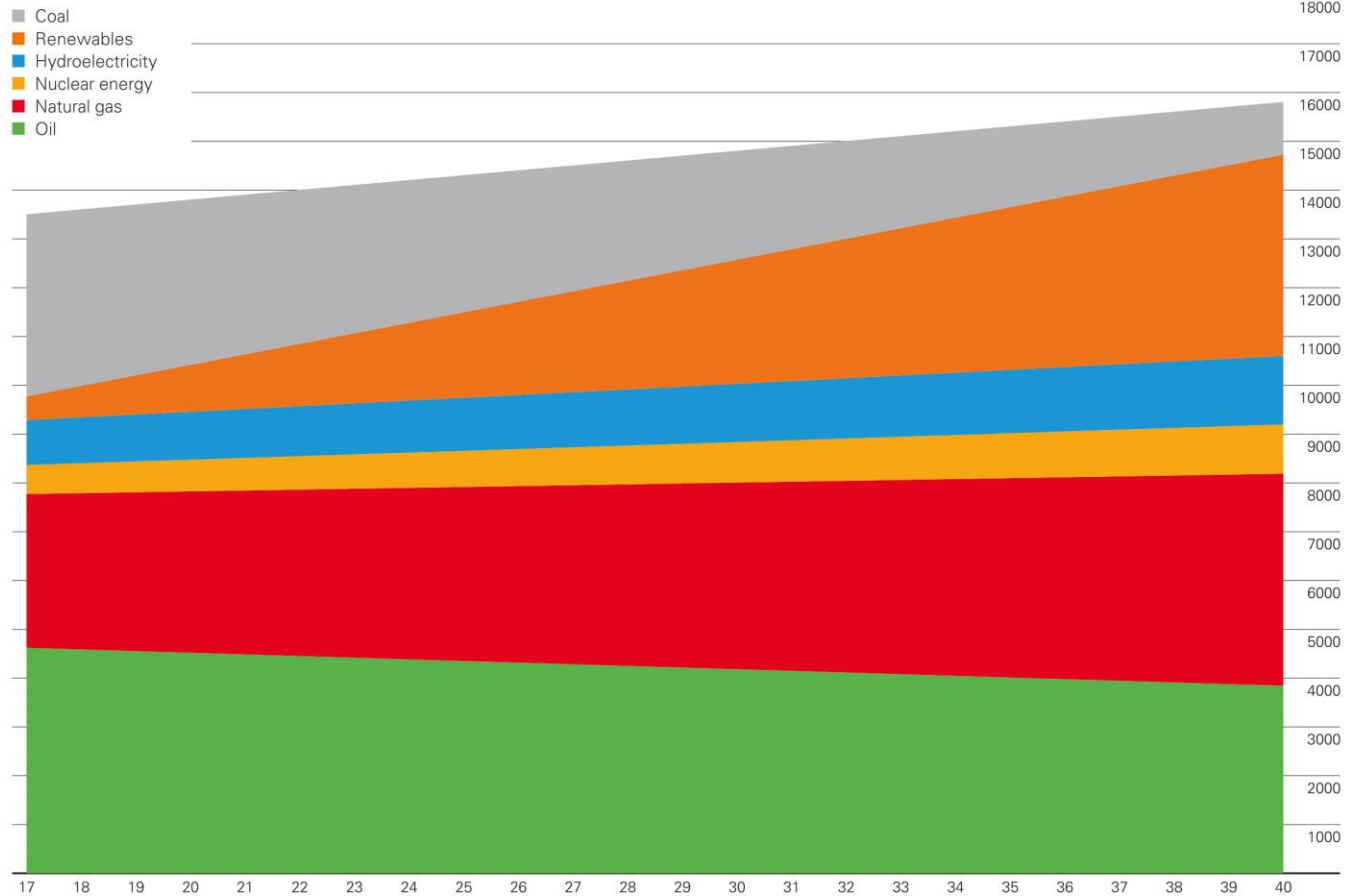
**World consumption**  
Million tonnes oil equivalent



2040 Rapid Transition		
Fossil Fuels	9,267*	56.54%
Low Carbon Fuels	1,012*	6.17%
Renewable	6,111*	37.28%
Total	16,390*	

**World consumption**

Million tonnes oil equivalent





# Change: Challenges and solutions

High cost  
Lack of OEM product  
Infrastructure  
Hydrogen for HGV



**Transition: What are the next steps?**



## **In Conclusion**

**Sustainable transport is not going to be easy,  
but it is achievable.**

**Time, money and collaborative commitment  
from the industry, government and society to  
secure change.**

**And change we must.**



# **Paul Minto**

Partner, Infrastructure Projects Energy  
Addleshaw Goddard

# Scottish Renewables - Transport Fuels

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Paul Minto

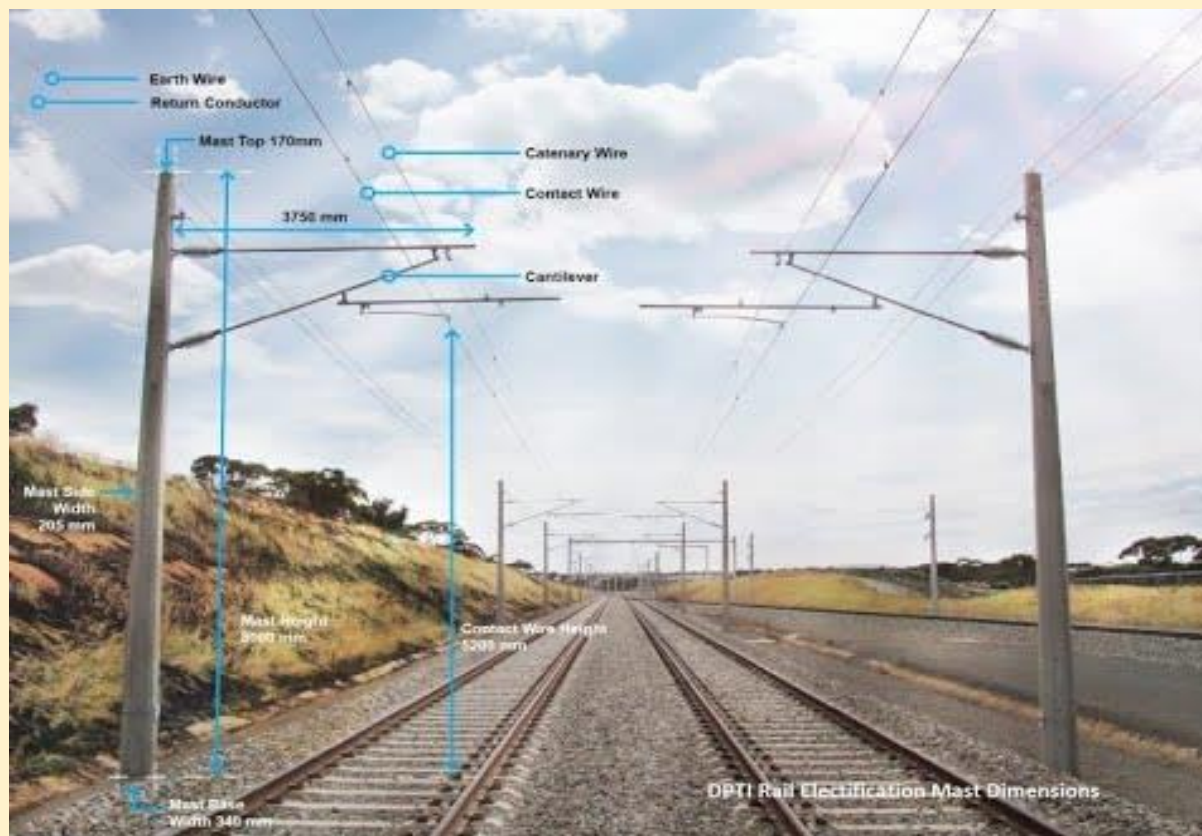
Partner

[paul.minto@addleshawgoddard.com](mailto:paul.minto@addleshawgoddard.com)

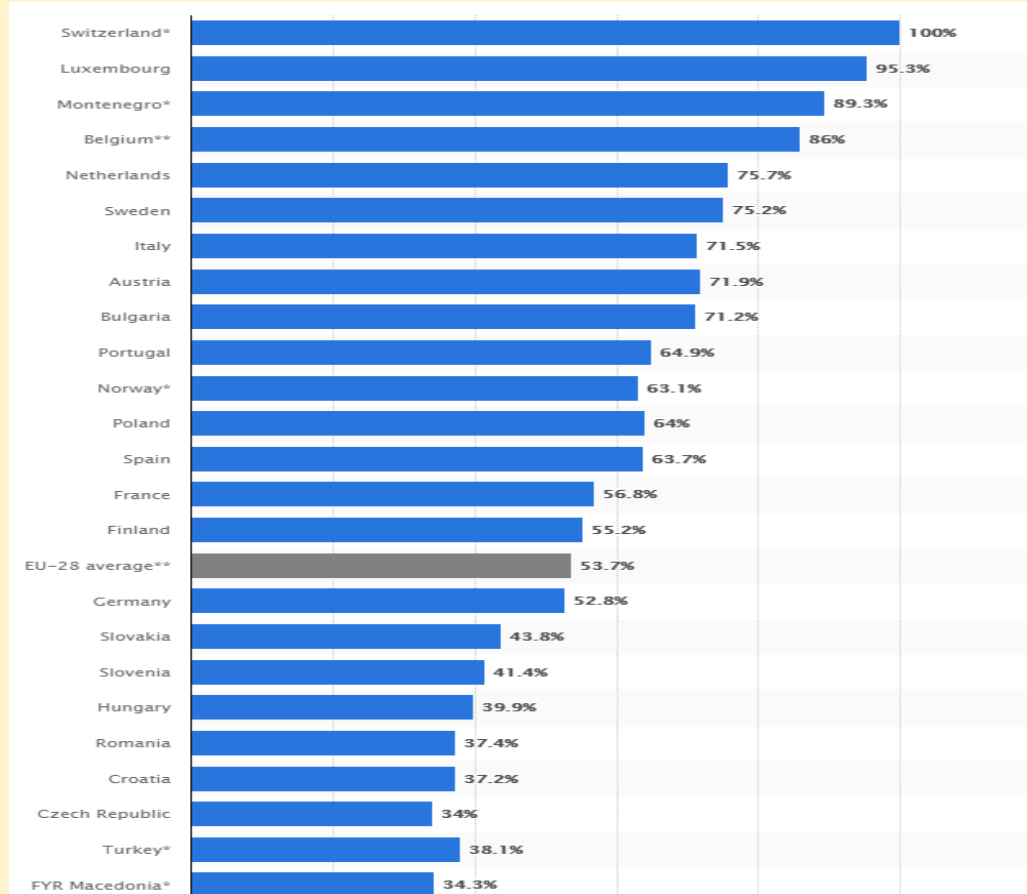
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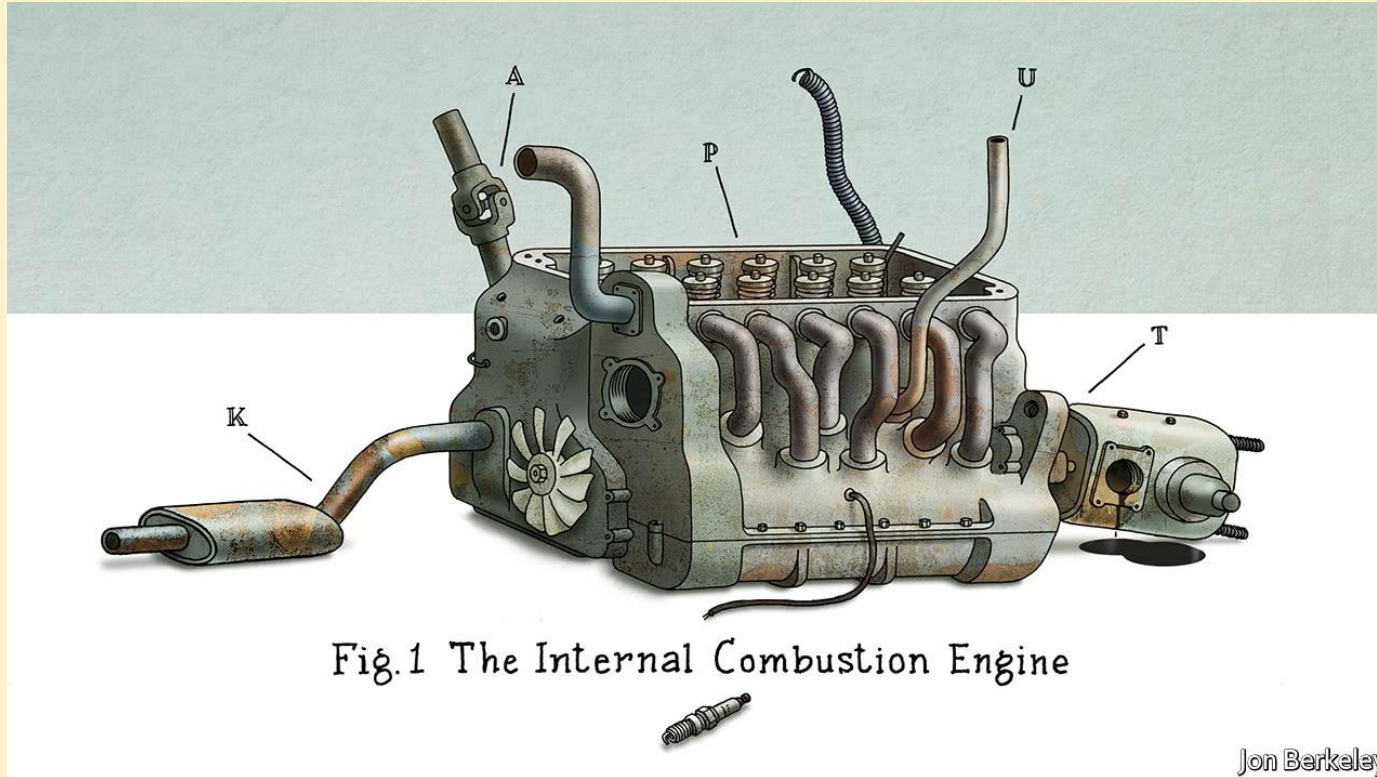
# Rail Transport



# Electrification in Europe



# The Economist - Roadkill



# Renewable Transport Fuels Obligation

- RTFO applies to large fossil fuel suppliers – approx 60 in UK.
- Electricity suppliers earn GreenHouse Gas Credits for electricity used to charge vehicles.
- GHG Credits can be traded with fossil fuel suppliers to meet their RTFO quota.

# A9 corridor





**Chris Dunn**  
Chief Naval Architect  
Ferguson Marine





*Blending modern technology and innovation with  
Clydebuilt craftsmanship*





Ferguson Marine  
Engineering Limited  
Newark Works  
Port Glasgow  
Scotland, UK



**STRATEGICALLY LOCATED**



# 360 Ships and counting...



# Leading the way with Innovation

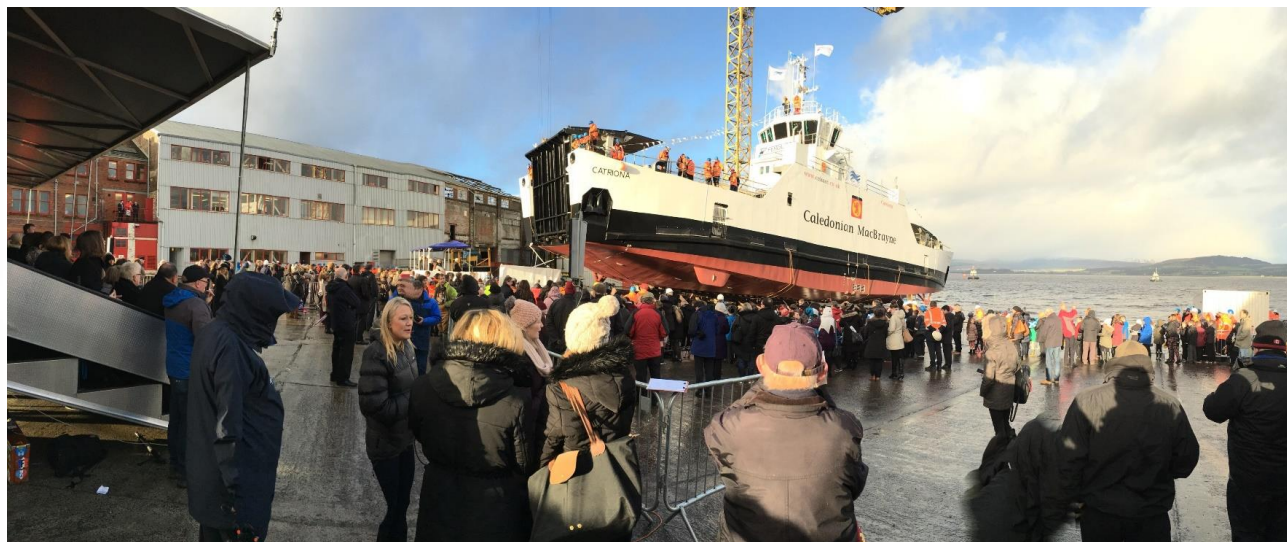


MV Hallaig – the World's first Hybrid Battery ferry



MV Lochinvar – 2<sup>nd</sup> Hybrid

MV Catriona 727 - launched December 2015



**THE WORLD'S FIRST HYBRID FERRY**



# Leading the way with Innovation



MV Glen Sannox  
UK's first LNG/MGO ferry



**THE UK'S FIRST LNG POWERED VESSEL**

# Challenges facing us in 2019

## Climate change



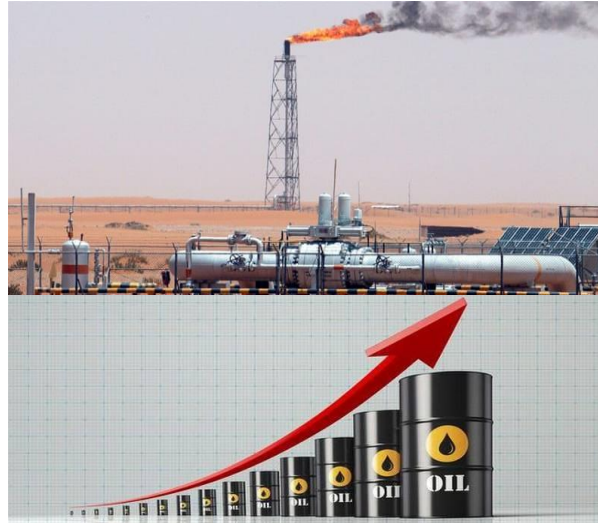
### True scale of CO2 emissions from shipping revealed

Leaked UN report says pollution three times higher than previously thought

In 2019, CO2 emissions by the global marine fleet will reach almost 2 billion tons, 7% of the global total.

The 15 largest ships emit as much NOx & SOx as the world's 760 million cars.

## Unstable fuel prices



Wild crude oil price swings may be new normal for markets as US, Russia and Saudis vie for influence

## Curtailed renewables



Some 1.49 million megawatt hours or 3% of wind power generated in 2017 was 'wasted'. Constraint payments to wind farms (to stop generation) reached a total of **£108,247,860** in 2017, rising to the record level of **£124,649,106** in 2018.

**THERE IS A NEED FOR CHANGE**



# HyDIME

**FERGUSON**  
marine



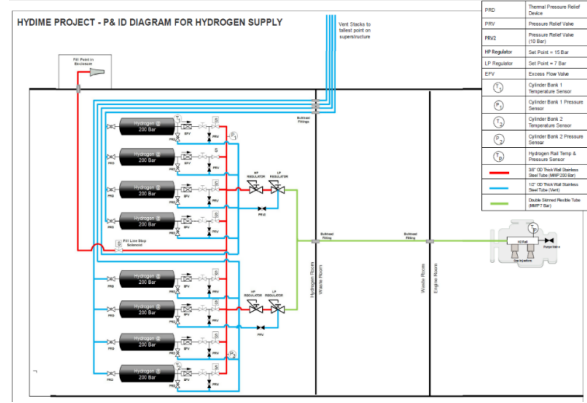
**THE UK'S GROUND-BREAKING MARINE HYDROGEN PROJECT**

- Hydrogen Diesel Injection in a Marine Environment
- Conversion of existing APU to run on Hydrogen and Diesel
- Utilising existing, proven technology
- Build on Orkney 'Hydrogen Economy'
- Application to a lifeline service



**Funding boost for ferry fuel project**  
 Hydrogen diesel injection system to run on renewable island energy

EMEC is looking at ways to use wind and wave energy to generate electricity for the island of Orkney. The project is a joint venture between EMEC and Orkney Islands Council. The project is a joint venture between EMEC and Orkney Islands Council. The project is a joint venture between EMEC and Orkney Islands Council.



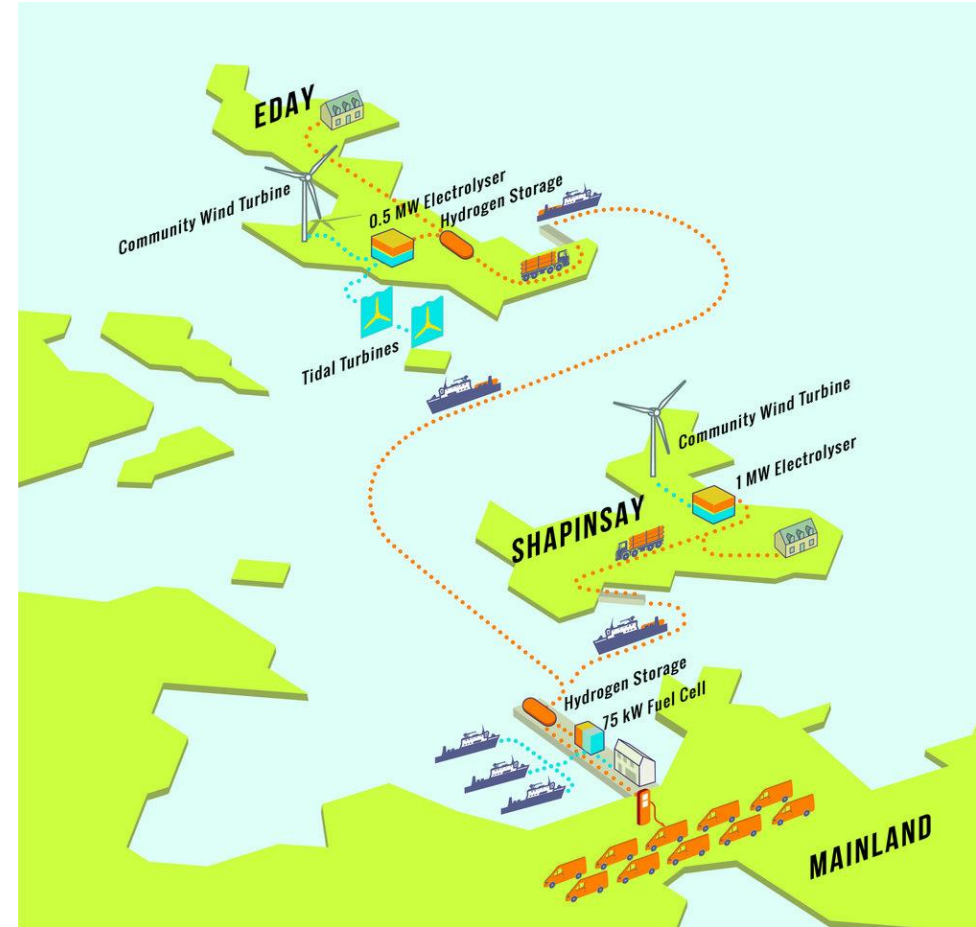


# H<sub>2</sub> in Orkney – The Hydrogen Islands

Advanced ‘Sustainable Energy Strategy’

Home of EMEC - European Marine Energy Centre

Ongoing projects: Surf ‘n’ Turf  
Big Hit  
Dual Ports



**ADVANCED INFRASTRUCTURE**

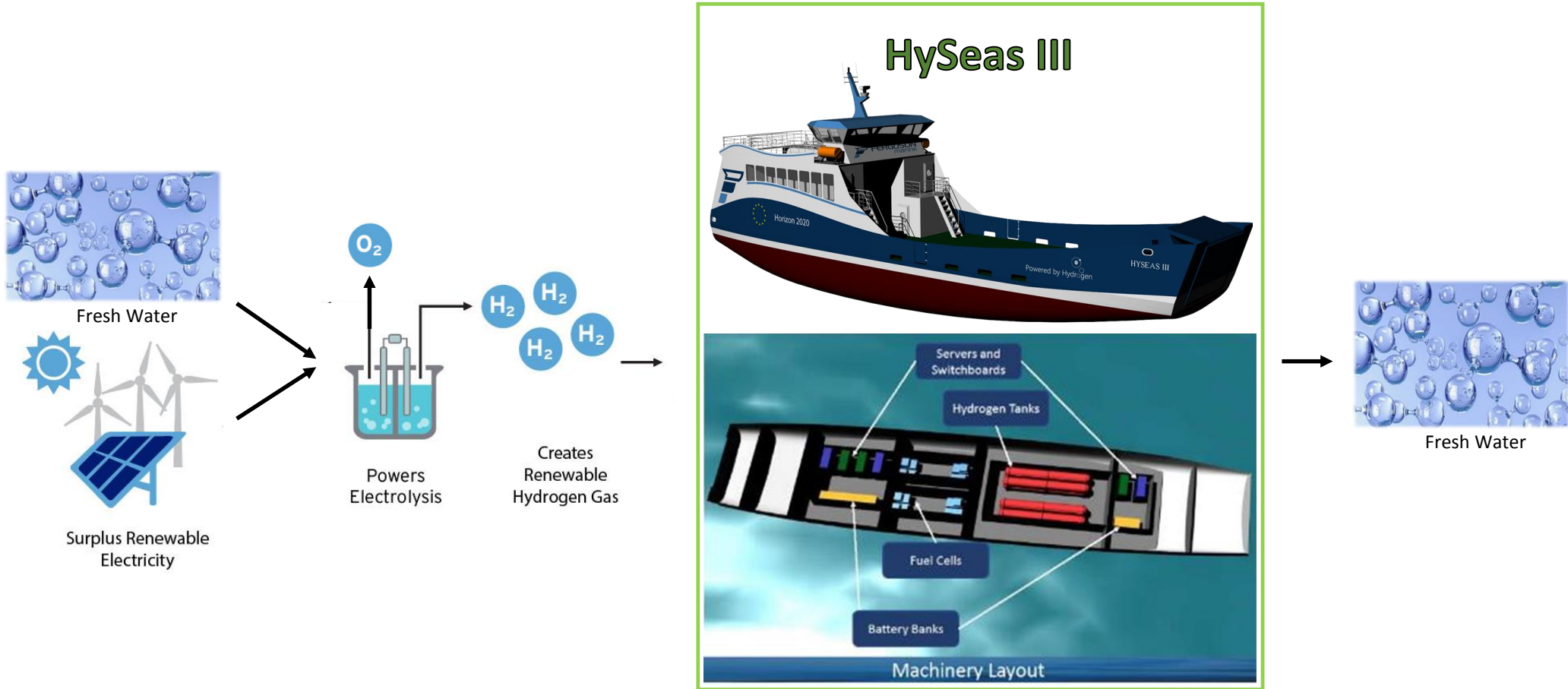
# Hydrogen power



23 January, 2018  
European Commission awarded  
**HySeas III**  
consortium €9.7 Million

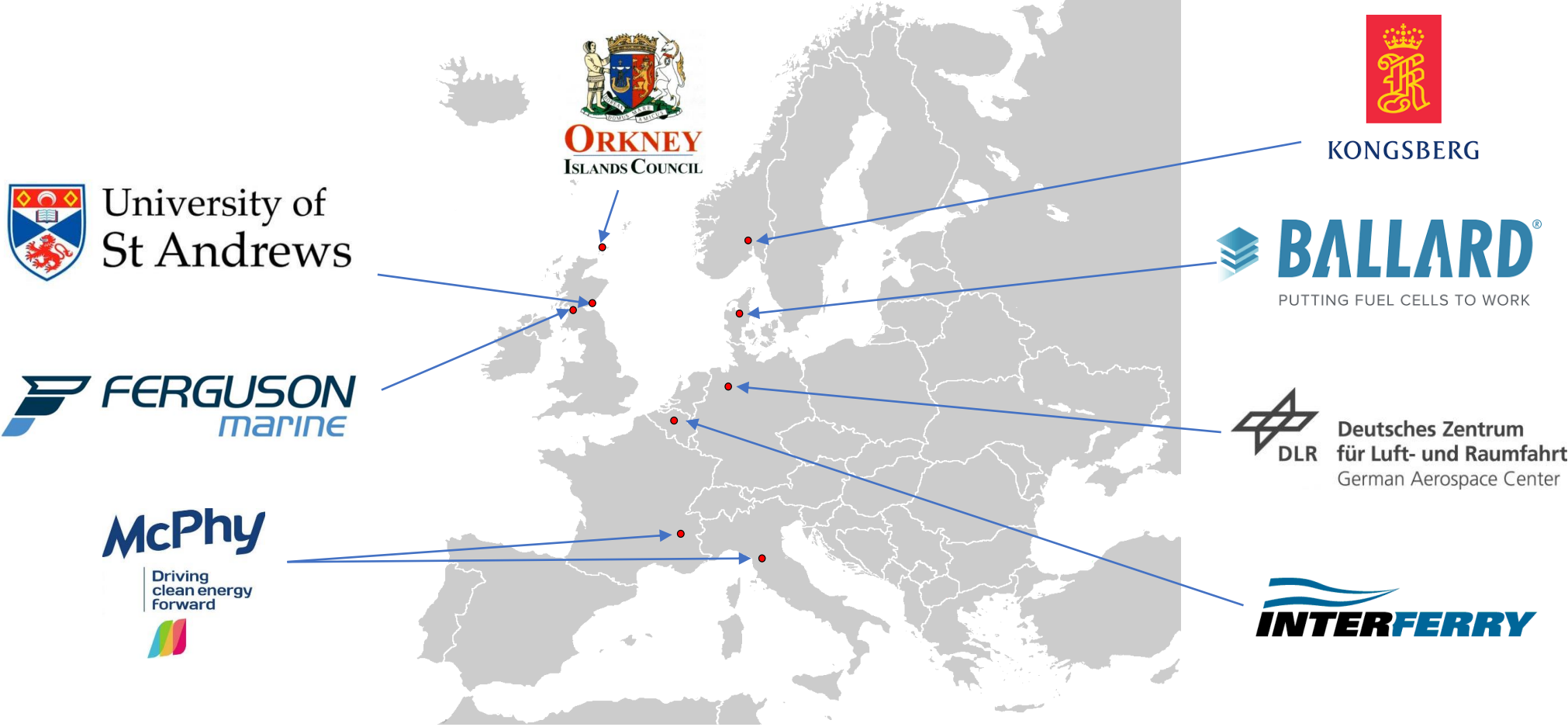
**THE WORLD'S FIRST SEAGOING HYDROGEN FERRY**

# Zero Emission – powered by renewables



**A 100% CLEAN PROCESS**

# HySeas III Consortium



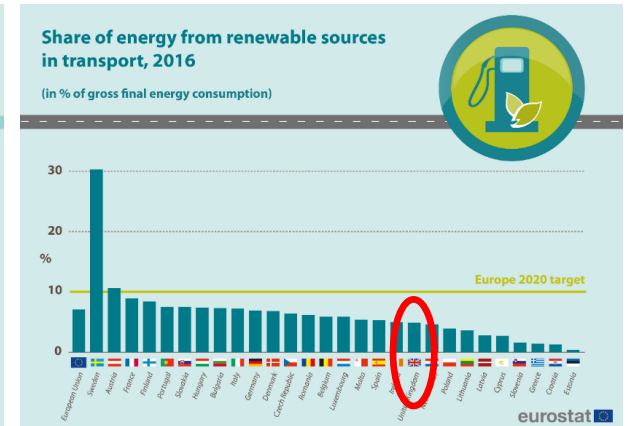
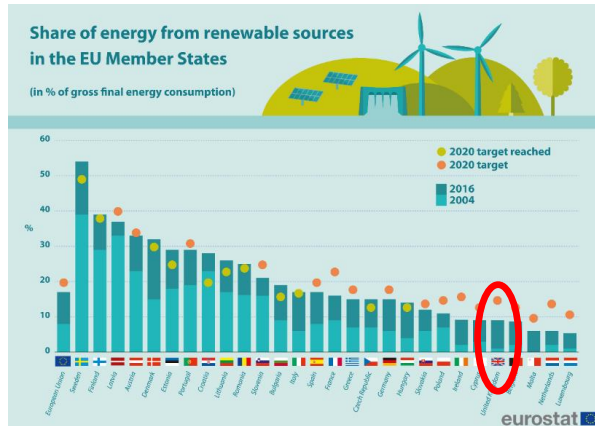
**A WORLD-BEATING TEAM**

# The Opportunity

- Creation of a ‘Hydrogen Economy’
- Exploit renewable resource
- Emissions reduction
- Promotion of corporate vision and values
- Fuel independence
- Local economic prosperity
- World-leading Intellectual Property

Global estimates suggest ships are responsible for 15% of NO<sub>x</sub> and 8% of SO<sub>x</sub> worldwide.

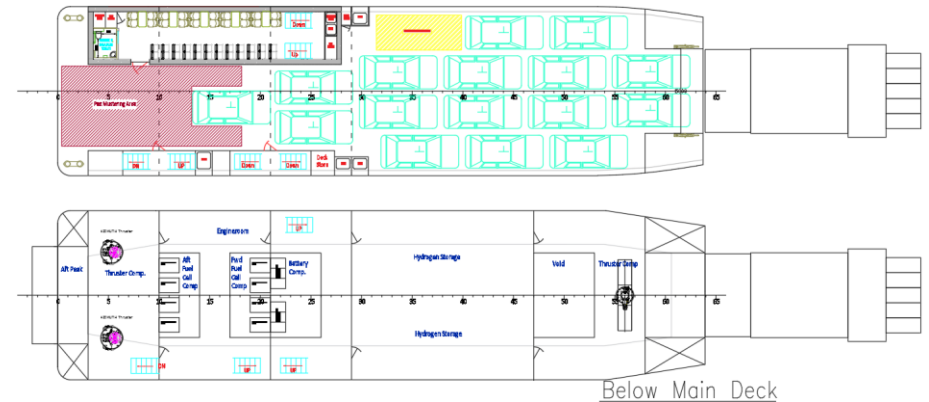
International shipping produces around 3% of human greenhouse gas emissions – roughly double that of aviation.





# HySeas III Project Risks

- Legislation and regulation
  - Lack of Hydrogen-specific rules
  - Risk based design process
  - Suitability of the IGF Code
- Commercial justification / viability
  - Capital investment
  - Market price for hydrogen - projection
  - Through life costing / O&M
- Customer perception
  - Hindenburg and H-Bomb
  - Inefficient and complicated
  - **The Future !!**





*Delivering the future...*







**Fergus Tickell**  
Senior Consultant  
Wood

**wood.**

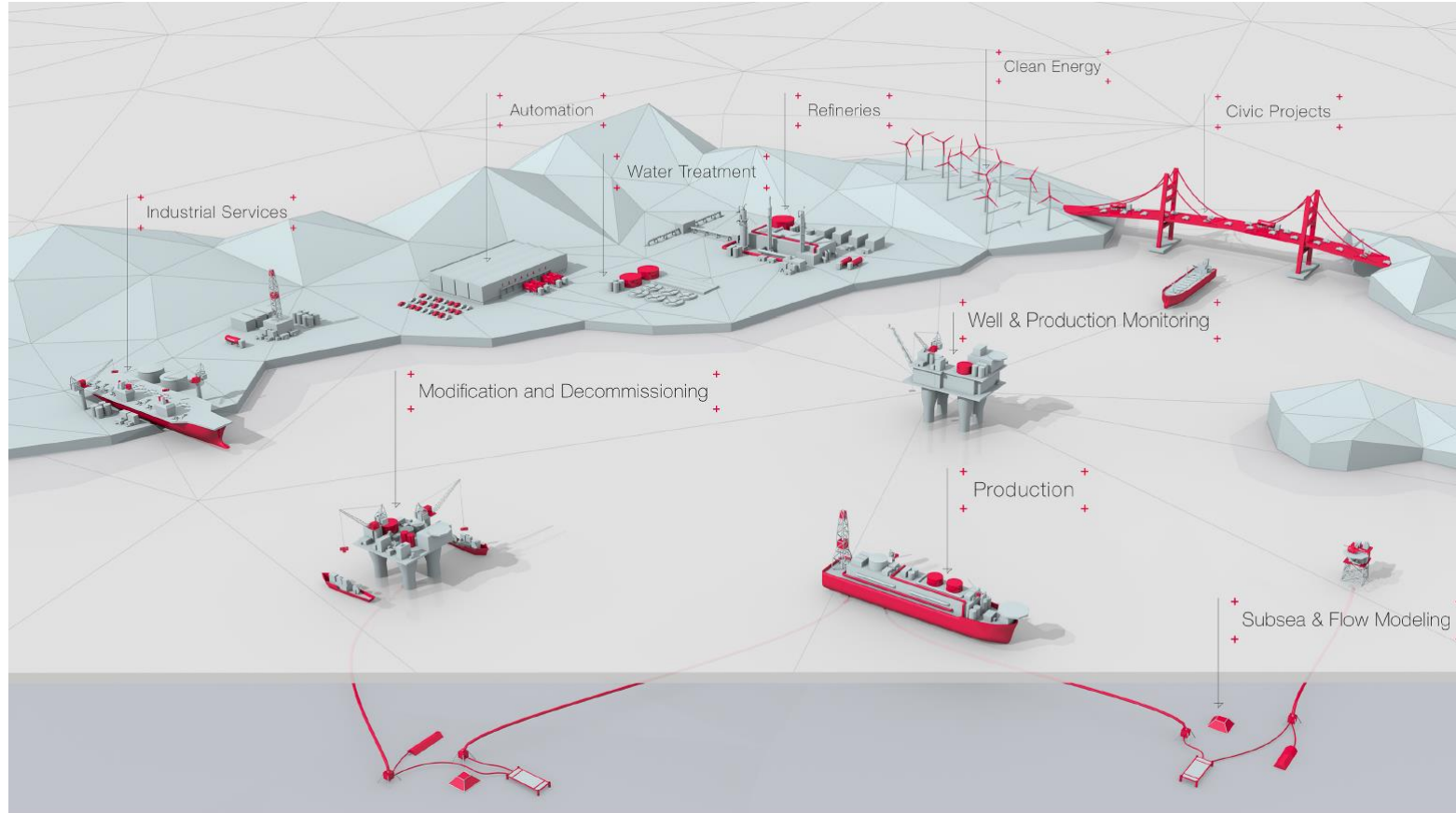
# Hydrogen Transport

February 2019

[woodplc.com](http://woodplc.com)

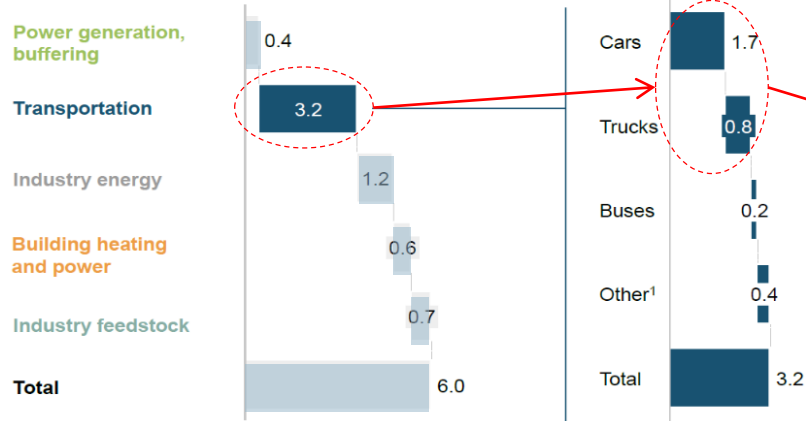


# Wood capabilities

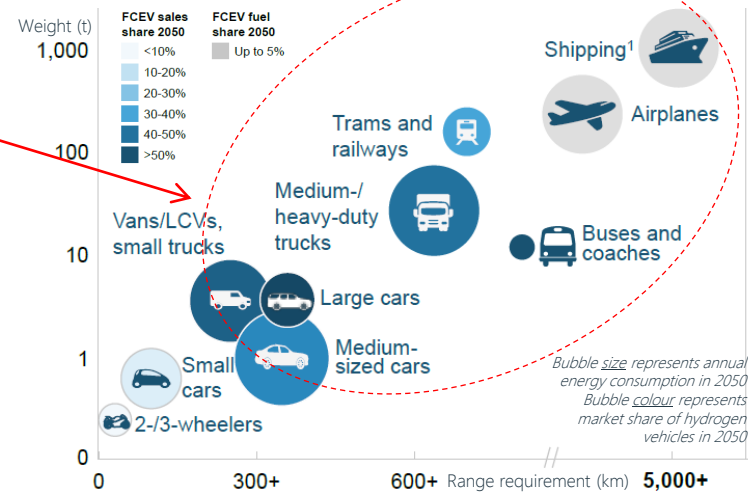


# A natural solution for heavy transport

## Targeting 6GT of annual CO2 reduction by 2050



## Larger cars & trucks ripe for hydrogen displacement



Back in 2015, the COP21 (Conference of the Parties) meeting in Paris secured a landmark agreement between **195 countries** to keep global warming “well below 2° Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5° Celsius” within this century. 76% of annual global greenhouse gas emissions are due to CO<sub>2</sub>. Even though the US is now looking to pull out of the agreement, the momentum created by this agreement shows no sign of stopping.

2017 emissions were 33.4 Gt, an increase of 1.6% year on year (YoY). In this context, a reduction of **6 Gt represents a significant target**, equivalent to removing the emissions from the **US, Canada and Mexico combined**. Global CO<sub>2</sub> emissions have increased at 1.3% CAGR over the last 10 years, with some countries exceeding double digit increases in 2017 e.g. Turkey increased by 12.7% YoY.

The various methods of transportation have different levels of potential for hydrogen displacement of existing fuels. The **longer the range, the heavier the load and the greater the use** the more attractive hydrogen displacement of existing technology becomes. Early adopters are already in place, with **15,000 forklift trucks** currently using hydrogen around the world, along with **5,000 FCEV cars, 300 buses** and numerous **taxis**. Countries taking the lead in adopting this technology are Japan, Germany, S Korea, Sweden and USA (California).

While **ships** and **planes** are expected to be the last to convert to hydrogen (if they ever do) there is scope for utilising fuel cells to power on board systems.



# Green Hydrogen Example – SWIFTH2 Project

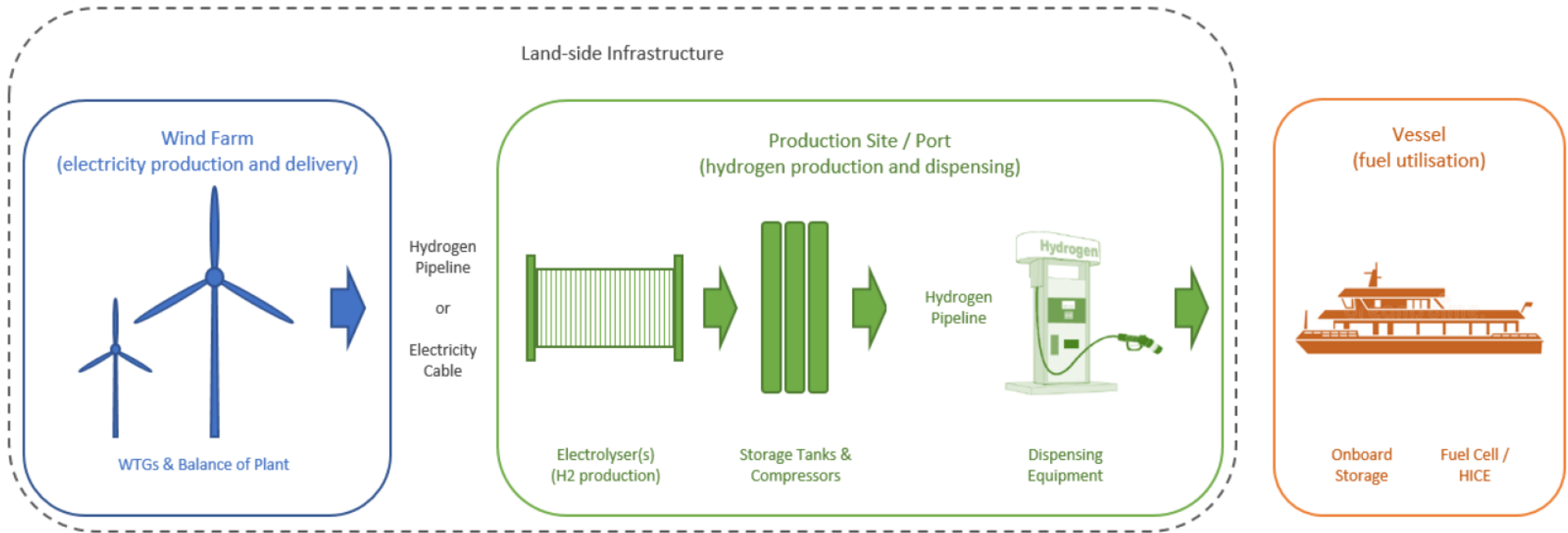
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## Overview

- SWIFTH2 Hydrogen Ferries Feasibility Study
- Involving:
  - vessel design
  - hydrogen generation (electrolysis)
  - storage & pipe infrastructure
  - port infrastructure including dispensing
  - renewables integration (wind)
- First step towards decarbonising shipping sector
- Supporting Scottish Government targets
- Fit with vessel replacement programme

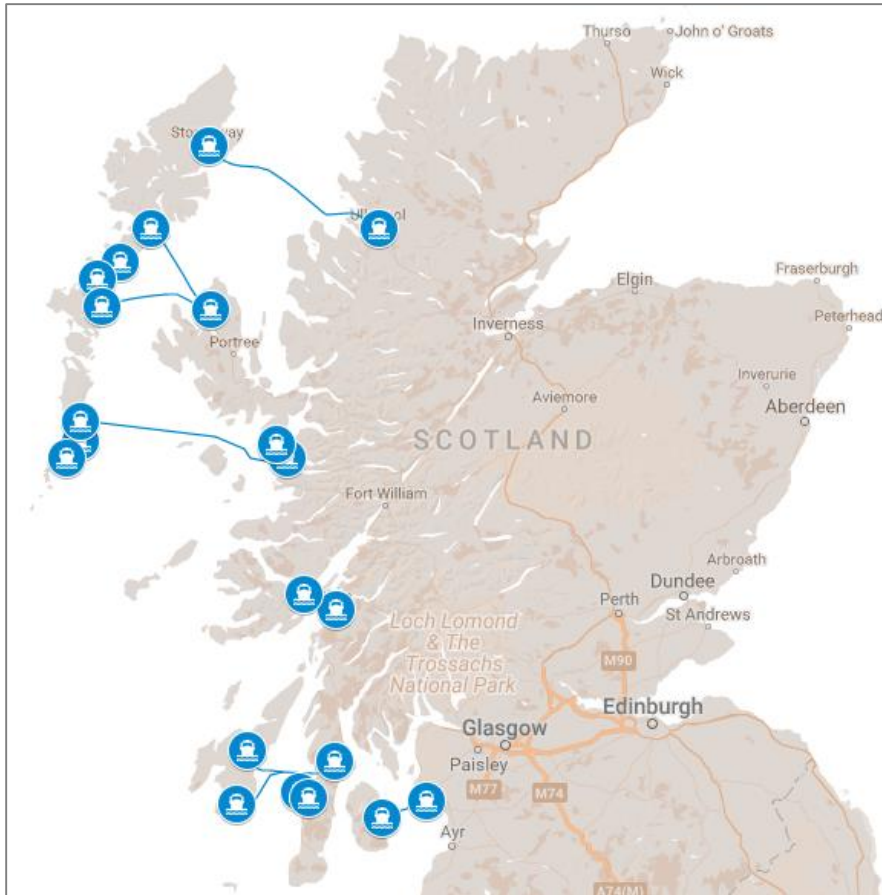


# SWIFTH2 – Proposed Development





# SWIFTH2 - Overview



- CMAL owned vessels operated by CalMac
- 9 mainland and inter-island ferry routes assessed:
  - Ullapool – Stornoway
  - Uig - Tarbert – Lochmaddy
  - Kennacraig - Ports Askaig / Ellen
  - Mallaig - Lochboisdale – Armadale
  - Ardrossan – Brodick
  - Cairnure – Oban
  - Leverburgh – Berneray
  - Barra – Eriskay
  - Gigha - Tayinloan



# SWIFTH2 - Methodology

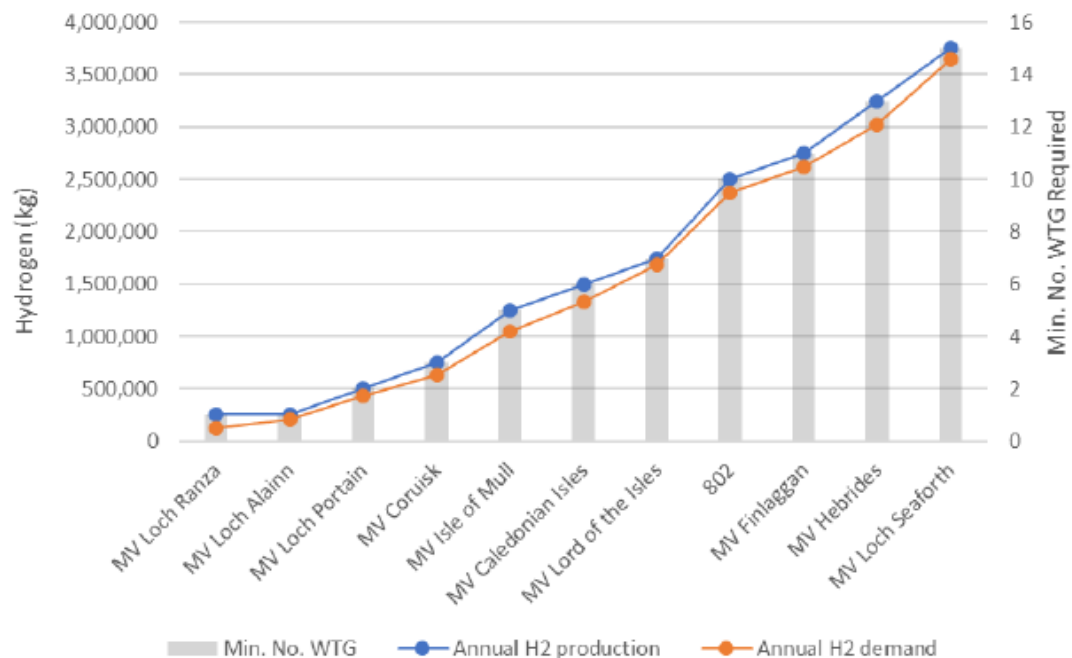
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Activities undertaken as part of the feasibility study:

- Modelling of existing fleet energy demand profiles.
- Sizing and specification of equivalent hydrogen power-train.
- Assessment of islands to determine suitability based on:
  - The size of hydrogen production plant required at port.
  - Wind resource and energy yield assessment.
  - Wind farm land-use and planning review.
  - Wind farm accessibility.
  - Solar resource assessment.



# SWIFTH2 – Wind Farm Sizing

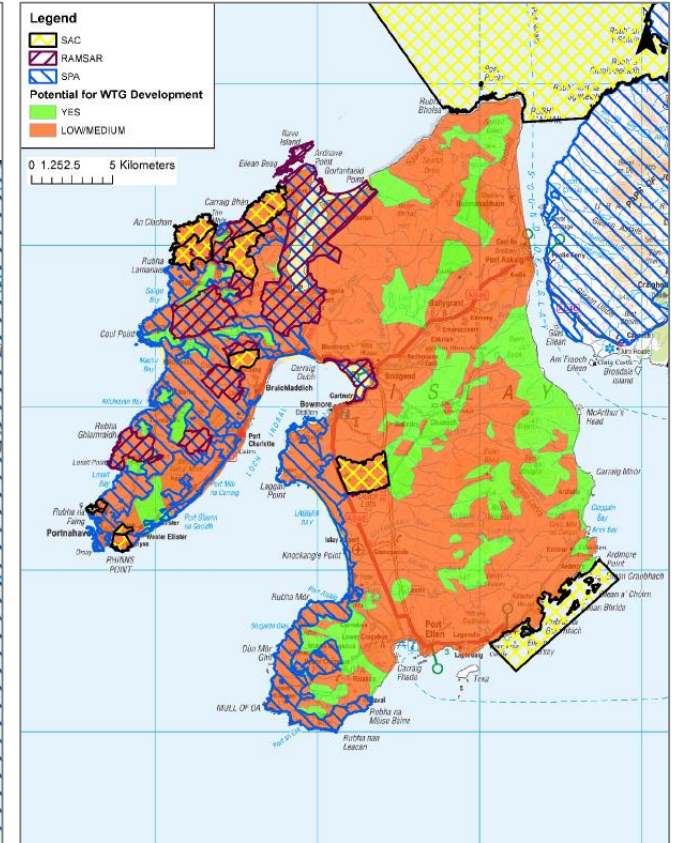
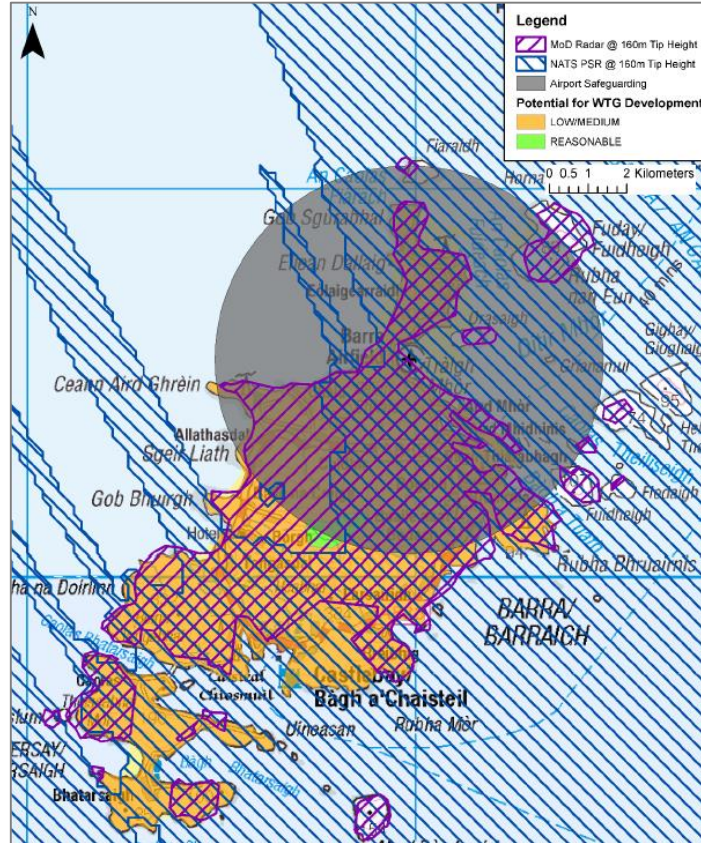


Wood's energy modelling, in collaboration with CMAL and Siemens-Gamesa, has determined the size of wind farm required to produce enough hydrogen for each ship operating the ferry routes.



# SWIFTH2 – Planning Review

Wood's environmental team assessed each island's land-use and planning regime to assess suitability for wind farm construction.





# Green Hydrogen Example - TimberLINK

- Modal shift project
- 100k tonnes timber per annum from:-
  - Ardrishaig
  - Campbeltown
  - Sandbank

To

- Troon
- Ayr
- Girvan

Potential for the timber sector to catalyse de-carbonisation of rural transport.





**wood.**

**[woodplc.com](http://woodplc.com)**



**Claire Mack**  
Chief Executive, Scottish Renewables

**Emil Rangelov**  
CEO, HV Systems

**Paul Minto**  
Partner, Infrastructure Projects Energy, Addleshaw Goddard

**Chris Dunn**  
Chief Naval Architect, Ferguson Marine

**Fergus Tickell**  
Senior Consultant, Wood



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# SR The Road to Renewable Transport Solutions Seminar



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