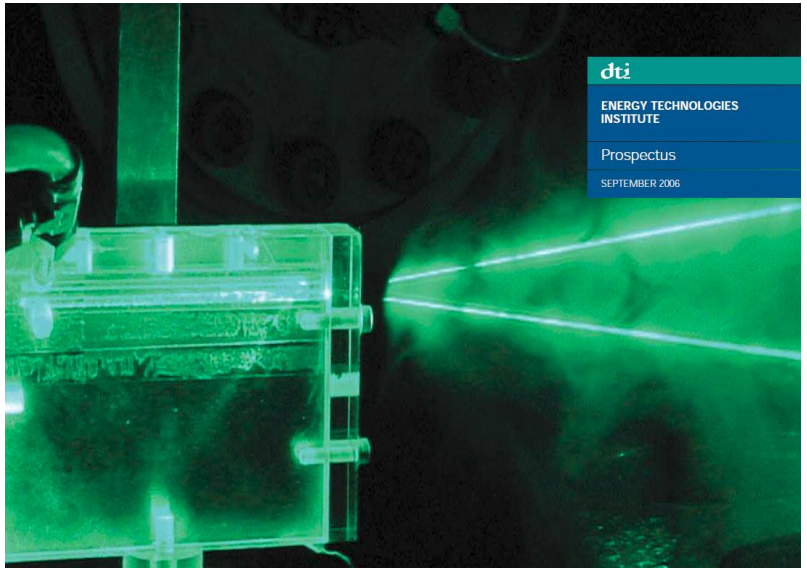
ETI 10 TEN YEARS OF INNOVATION 2007 — 2017

Jonathan Wills

Chief Executive Officer

In the Beginning…



- A No. 10 Initiative to help to tackle the energy trilemma
- Headline c. £500m investment
- Matched funding model
- Limited Liability Partnership

- EU wide drive to renewables
- Approaching Kyoto implementation period

Partnership Agreement – December, 2007

energy technologies institute

Our mission

To accelerate the development, demonstration and eventual commercial deployment of a focused portfolio of energy technologies, which will increase energy efficiency, reduce greenhouse gas emissions and help achieve energy and climate change goals.

Our vision

Secure, sustainable and affordable energy for present and future generations.

Department for Innovation, Universities & Skills

Technology Strategy Board
Driving Innovation

EPSRC
Pioneering research and skills

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Constancy of Purpose – ETI today

Our mission

To accelerate the development, demonstration and eventual commercial deployment of a focused portfolio of energy technologies, which will increase energy efficiency, reduce greenhouse gas emissions and help achieve energy and climate change goals.

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Secure, sustainable and affordable energy for present and future generations.

The Challenge - 80% GHG for the UK

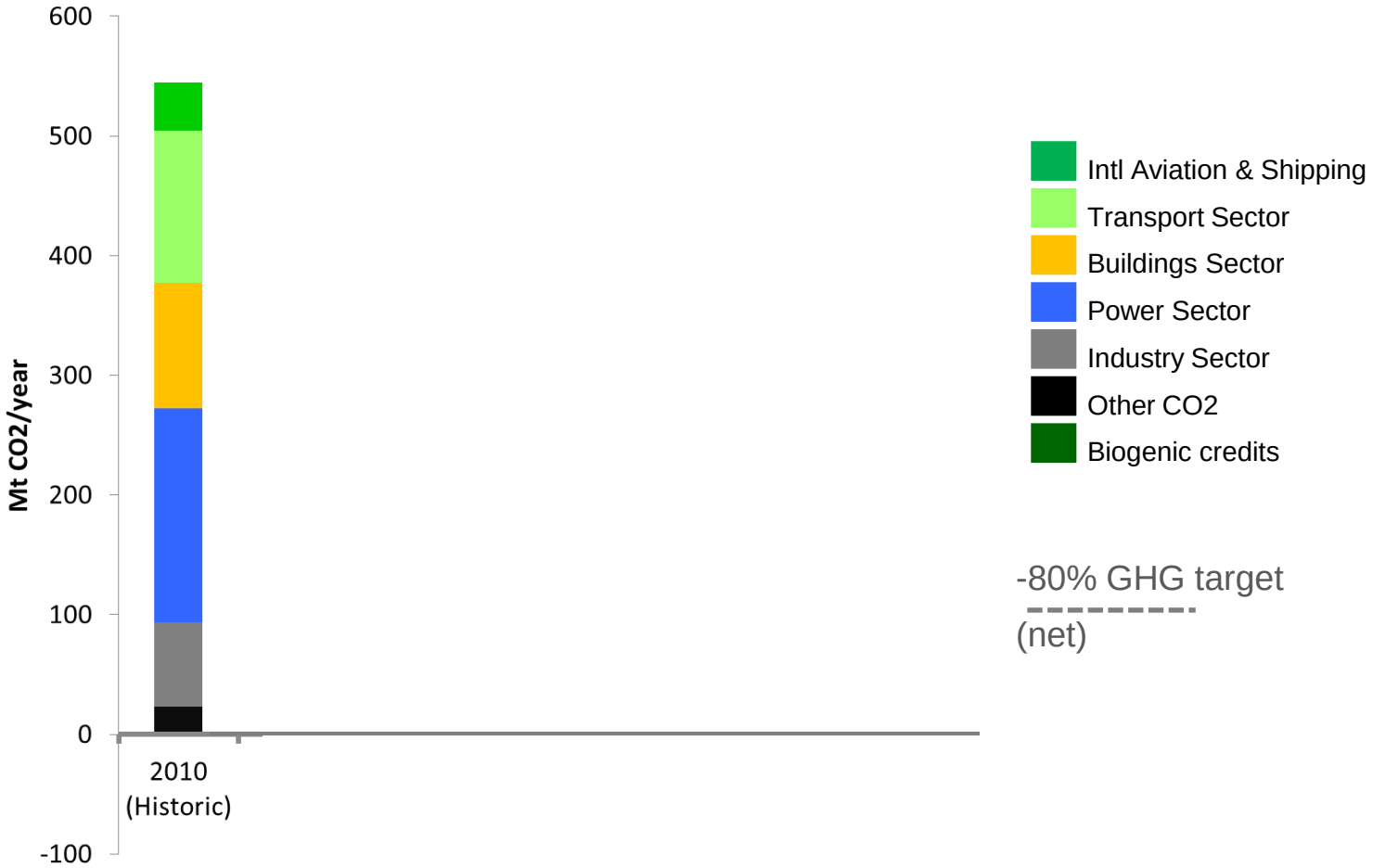


Chart data from base case v4.3

A route to meeting - 80% GHG for the UK

Power now, heat next, transport gradual – cost optimal

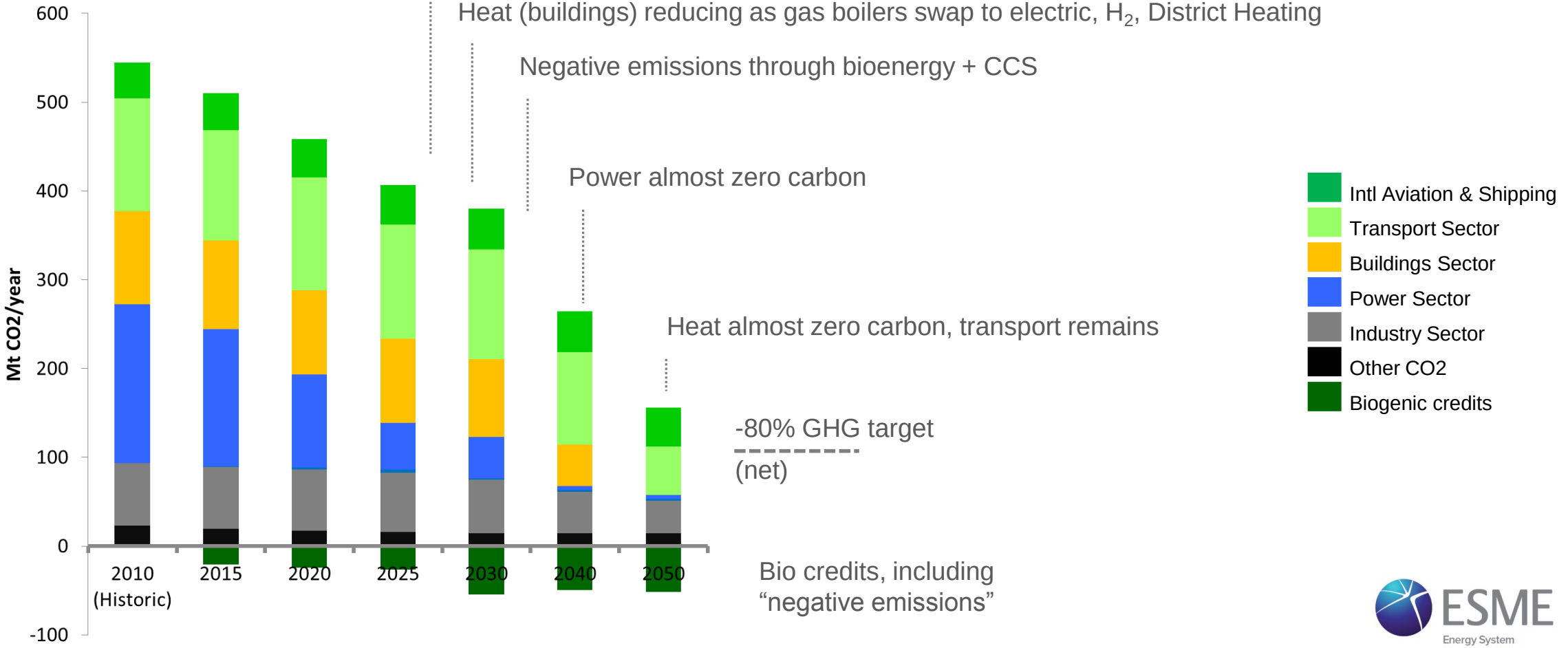
CCS commercialised, renewables & nuclear deployed

Heat (buildings) reducing as gas boilers swap to electric, H_2, District Heating

Negative emissions through bioenergy + CCS

Power almost zero carbon

Heat almost zero carbon, transport remains



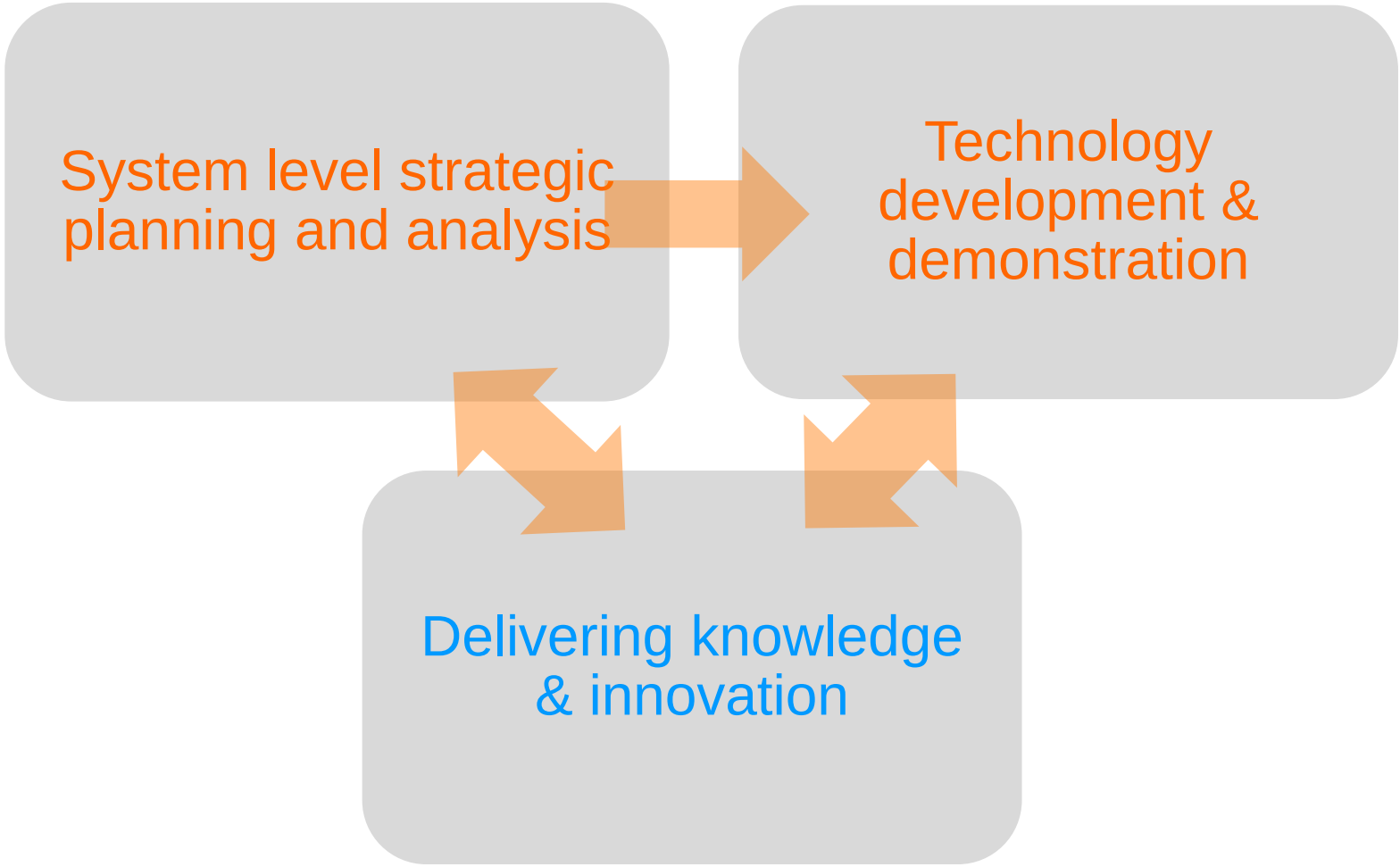
-80% GHG target (net)

Bio credits, including "negative emissions"

Chart data from base case v4.3

A SUMMARY OF 10 YEARS OF INNOVATION

The ETI Model



ETI viewed from 2019 - Breadth

Offshore wind

Blade Dynamics

Test Rig

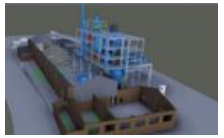
Floater

Bioenergy

Land use change

UK Strategy

Value chain model

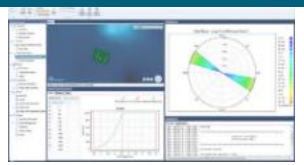


Waste Gasification

Marine

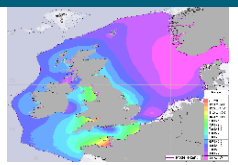
REDAPT

PERAWAT



TidalFarmer

IDCORE



SmartTide

Wet Mate

StreamTec

CCS

UK Strategy

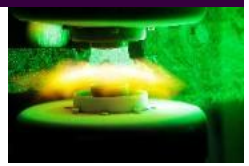
CO2 stored

Store appraisal

gCCS

MMV

Hydrogen

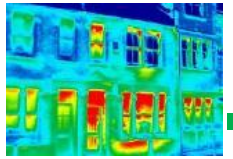


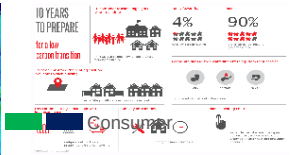
Hydrogen

Smart Systems and Heat

SSH

Energypath – network planning





Consumer

Product / Service
Training / People
Data / Knowledge

ETI viewed from 2019 - Breadth

HDV Land

HDV system demo

New platform technologies

New vehicle designs
-30% fuel consumption

HDV Marine

Flettner sail system demo

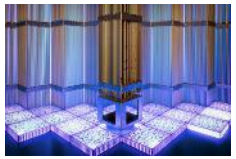
High Efficiency Propulsion

Waste Heat Recovery

Nuclear

Siting and Hazards

Alternative technologies



Nuclear Cost Drivers

Energy Storage / Distribution

GridON Fault Current Limiter

Newcastle University
Energy Storage

Electric vehicle
charging infrastructure

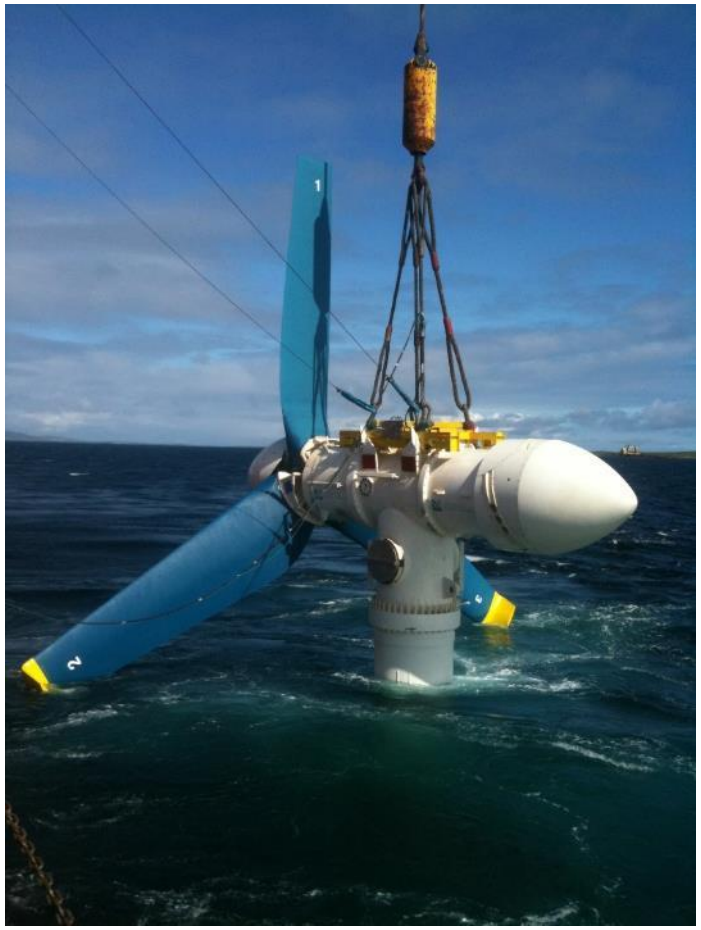
Heat Infrastructure
Development

Energy systems Strategic Analysis Function
Key in-house legacy - people and knowledge

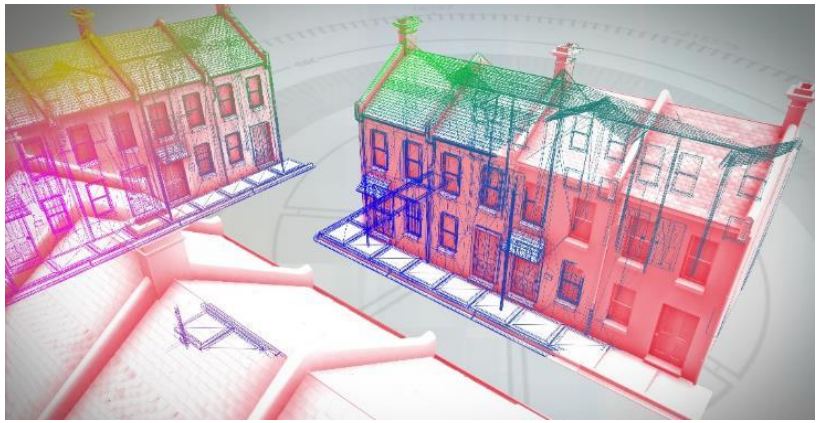
Insights across the whole UK energy system – publications, presentations, conferences, roundtables, knowledge dissemination

Product / Service
Training / People
Data / Knowledge

Case Study - Wind, Wave and Tidal

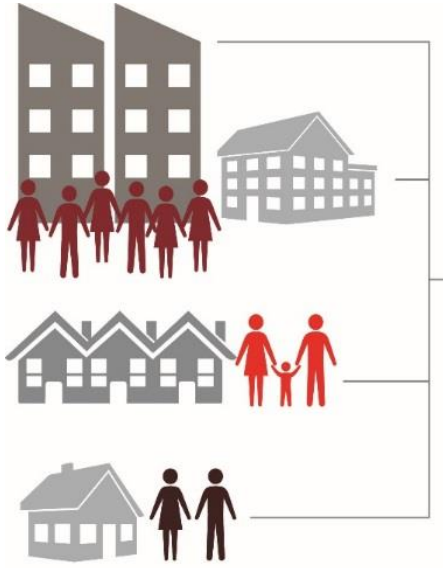


Case Study - Decarbonising the home



Delivered by CATAPULT Energy Systems

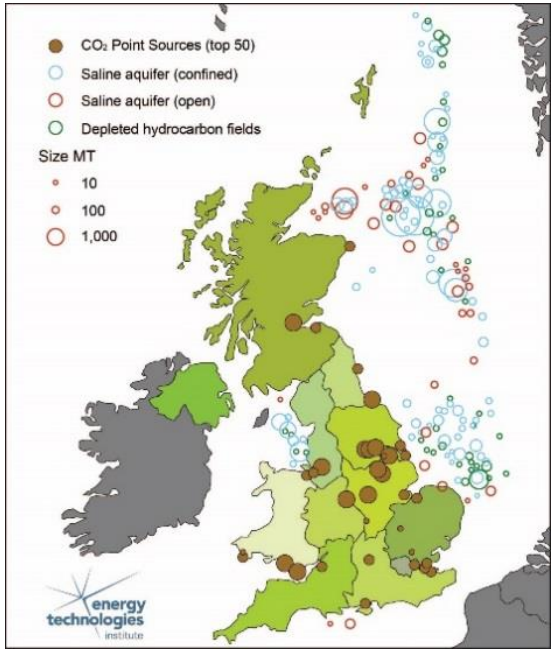
People and buildings

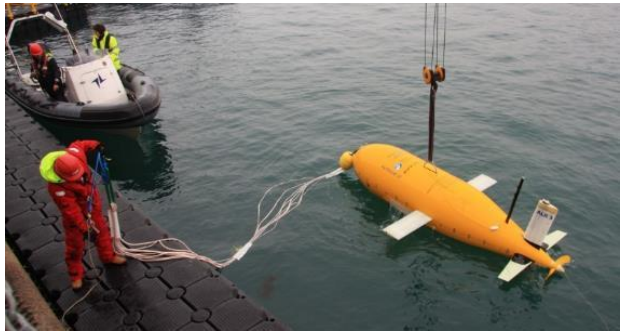


Networks

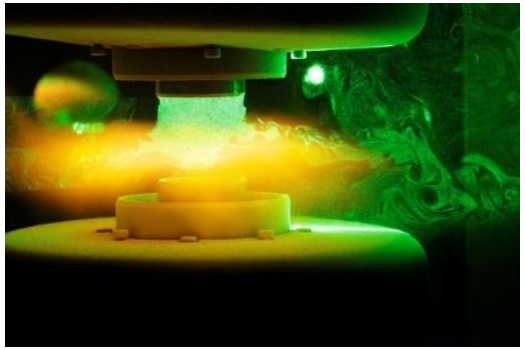
Integration

Case Study - Carbon Capture and Storage

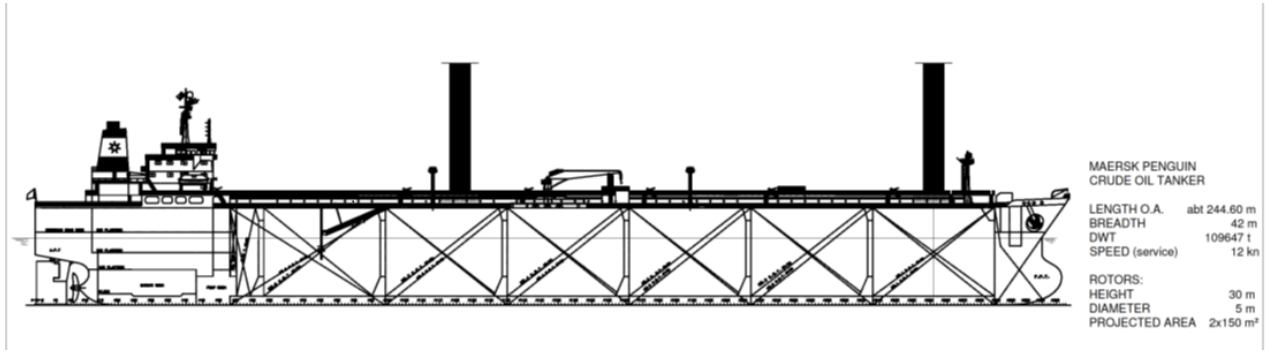


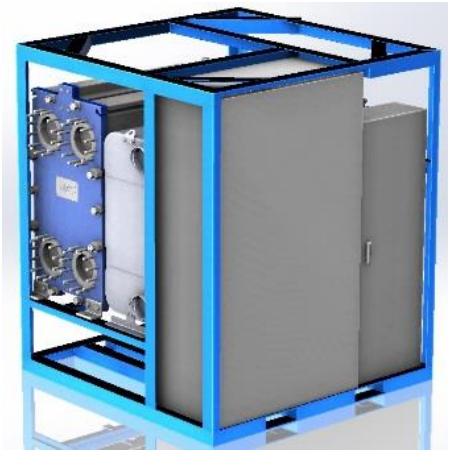


OIL AND GAS CLIMATE INITIATIVE

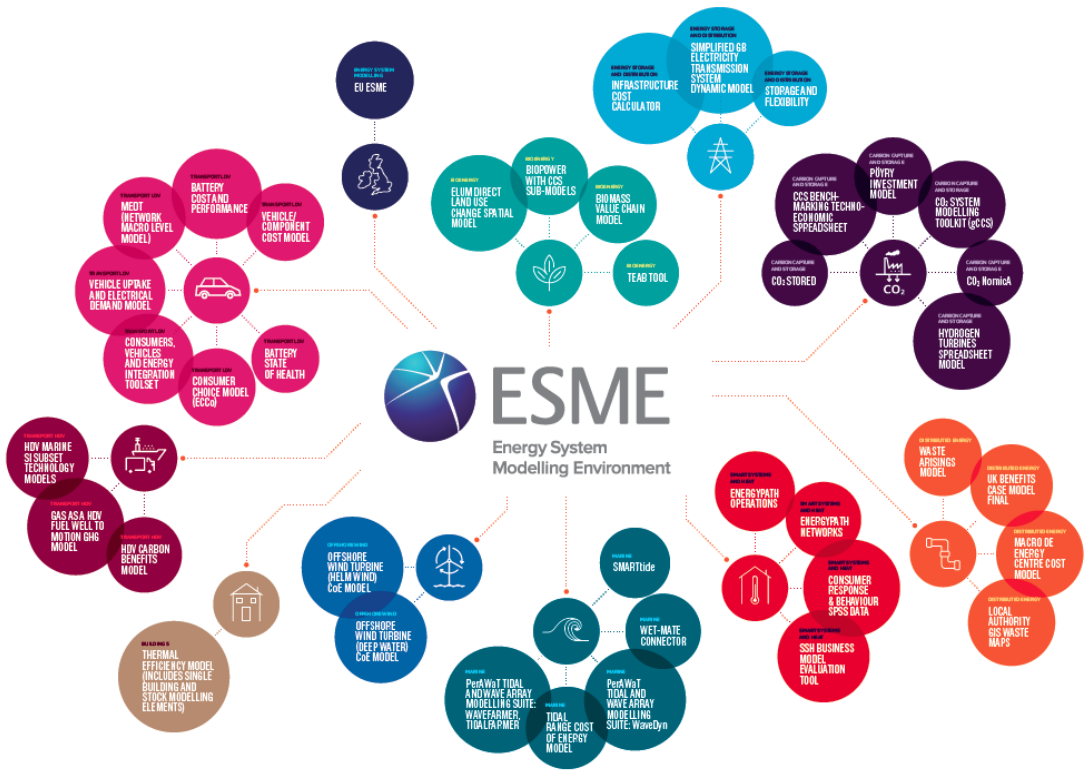


Case Study – HDV Marine

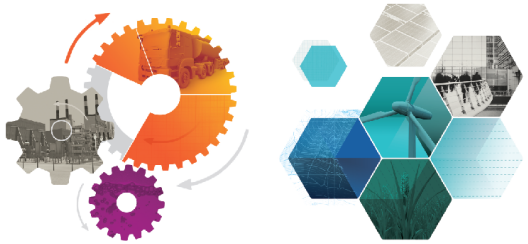




Case Study – Analysis



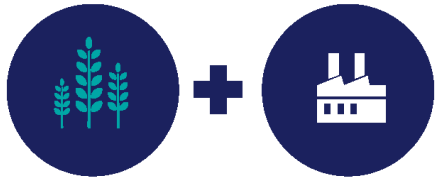
ENERGY TRANSITION ANALYSIS - KEY LESSONS LEARNT



The UK can afford a 35 year transition to a low carbon economy - the cost of transition is in the range of

1-2% GDP in 2050

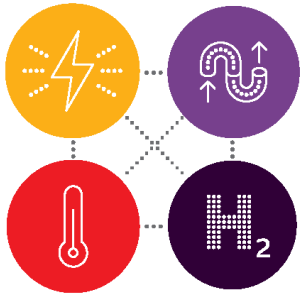
CCS and Bioenergy are especially valuable



Negative emissions create headroom for difficult to abate sectors

High levels of intermittent renewables requires flexibility across entire system

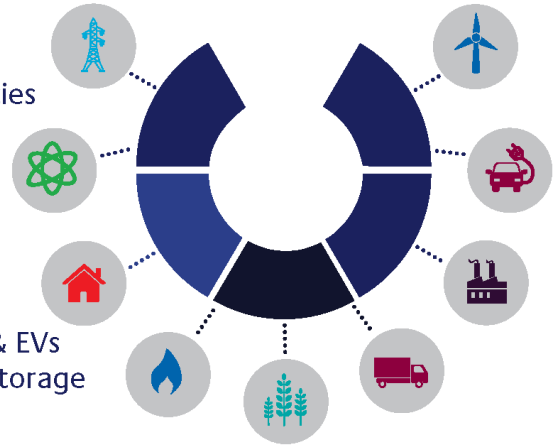
Energy infrastructure has to be adapted and enhanced, new networks created and integrated



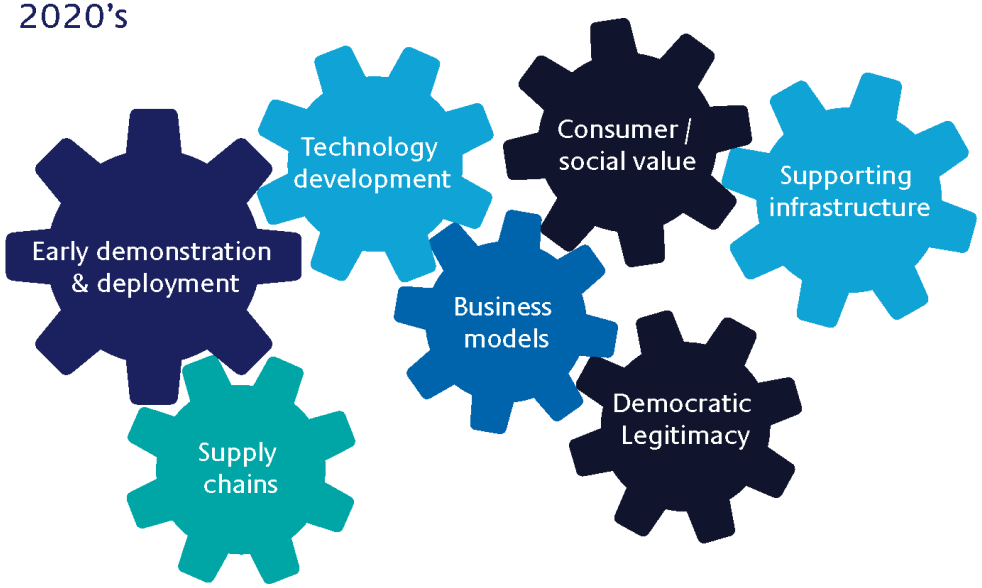
Develop and prove a basket of promising solutions

Key Technology Priorities

Bioenergy
New nuclear
Offshore wind
Gaseous systems
Low carbon heating
Efficiency of vehicles & EVs
Carbon Capture and Storage
Efficiency in buildings



Preparing for scale up and wide scale deployment by mid 2020's



Priorities to 2030

Decarbonising electricity

- Nuclear
- Offshore Wind
- Bioenergy
- Gas (CCS)
- Smart Systems

Proving CCS in UK context

- Power
- Heat
- Industry
- Hydrogen
- Negative emissions

Developing & testing ‘next step’ options

- CCS (gas / biomass)
- Bioenergy
- Hydrogen
- Small Modular Reactors
- Low carbon heat solutions

+ efficiency
+ flexibility

IMPACT AND LEGACY

Has anyone taken notice?
Has the ETI had any impact?

ETI in numbers

£320m Including ~£15m of income

£300m in the UK

146 projects

19 Demonstrations **27** Technology developments **103** Knowledge building

56 Led by SME's **35** Led by research organisations

ETI in numbers

63 ETI publications by 2019

131 staff employed (averaging ~60)

42 consultation responses

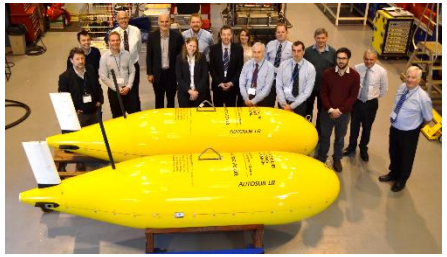
41 models and tools developed

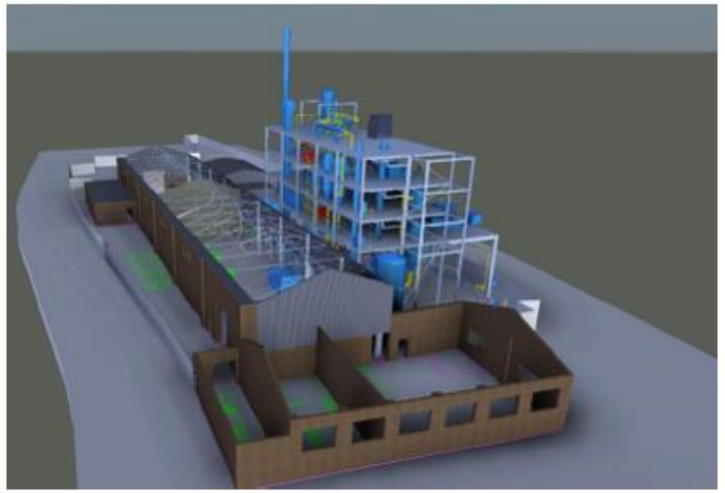
929 citations of our work over 4 years

537 documents and data sets made public

12 select committees

Legacy - assets and test rigs





Legacy – knowledge, capability

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OGCI OIL AND GAS CLIMATE INITIATIVE

CATAPULT Offshore Renewable Energy

Loughborough University

Newcastle University

Imperial College London

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

SRF

62 PhDs sponsored

21 student placements

Marine

Accelerating innovation to harness the UK's vast natural wave and tidal resources.

Search 118 deliverables for Marine >

Carbon Capture and Storage

Helping to accelerate the implementation of CCS in the UK.

Search 103 deliverables for Carbon Capture and Storage >

David Clarke Fellowships – Post Doctorate

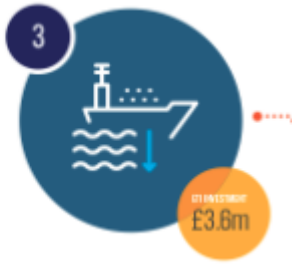
- Applied energy related research with clear industrial application
  - Research of national importance and potential for creating significant impact on the delivery of a low carbon energy system.
  - Clear benefits – with stakeholder pull.
  - Multi-disciplinary, not just technical solutions but broader - system, market and societal.
- Each award is for 3 years
- At least 1 award each year for at least 3 years
- Managed through the EPSRC Post-Doctoral Research Fellowship awards

Still to come… 30 projects, 10 insights…

WASTE HEAT RECOVERY PHASE 3

FEBRUARY 2017

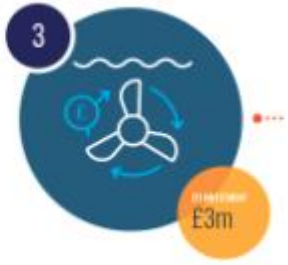
A project which aims to develop and demonstrate a Waste Heat Recovery System for ships that could deliver fuel efficiency savings of at least 8%



HIGH EFFICIENCY PROPULSION SYSTEM FOR SHIPS PHASE 3

FEBRUARY 2017

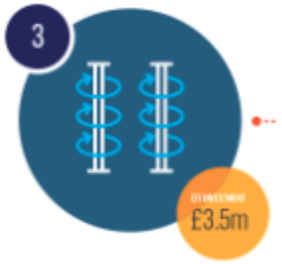
A project to develop and demonstrate a High Efficiency Propulsion System for ships which aims to reduce fuel consumption by around 8%



FLETTNER ROTOR SAILS PHASE 3

FEBRUARY 2017

The project will be the first installation of wind-powered energy technology on a product tanker vessel, and will provide insights into fuel savings and operational experience



ON-HIGHWAY SIMULATION SUPPORT PHASE 3

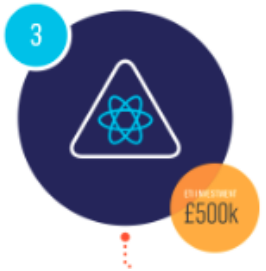
APRIL 2017

This project will build and develop on-highway heavy goods vehicle models using an industry recognised platform to verify the integrated system concepts developed in the Land Phase 1 project

NATURAL HAZARDS REVIEW PHASE 3

MAY 2017

Preparation of guideline document to describe the characterisation of natural hazards relevant in the UK. Case studies at 5 locations to be used to demonstrate methodologies



WASTE GASIFICATION PHASE 2 – COMMERCIAL PLANT DEVELOPMENT

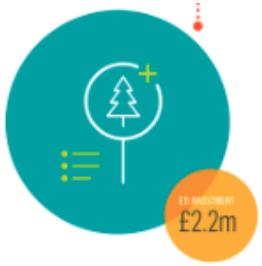
APRIL 2017

A 1.5 MWe waste gasification power plant capable of high efficiencies and reliability

BIOMASS FEEDSTOCK IMPROVEMENT PROCESS

MARCH 2017

A demonstration project which aims to show how the removal of impurities and contaminated material from sustainable biomass could make bioenergy cheaper, more efficient, and deliver greenhouse gas savings



CATAPULT Energy Systems

THE ETI EXPERIENCE

The ETI Experience

A perspective on the ETI model

- The 10 year agreement held the partnership together – but it is cumbersome
  - Legalistic – result of multi party negotiation
  - Drove risk averse contracting and IP approach - “difficult to contract with”
  - A great deal of stakeholder management; high governance burden
  - Little emphasis on early dissemination - perceived as a “Members only” club
- **Operations evolved over time**
  - The organisation found its position in the landscape
  - Members understood what they valued
  - The model allowed shared risk and flexibility (debt, equity, all within State Aid rules)
  - Reputation for objectivity and quality became established – a strong brand to be associated with
  - Challenging but supportive to SME capability development
  - Increasing focus on exploitation and deployment challenges
  - The organisation found its voice – increasingly trusted voice

The ETI Experience

A perspective on the ETI impact

- Has the ETI “accelerated technology”?
  - Yes – but too early to say with what impact
  - Yes – but the “valley of death” is alive and well!
- Has the ETI influenced UK direction?
  - Shift in low carbon narrative over 10 years (ETI role?)
  - Power, Heat, Transport – a joint challenge
  - Better clarity over what’s important – and what’s not!
  - Better informed member strategies and investments
  - Foundation for Energy Systems Catapult
  - Informing the model for Oil and Gas Climate Initiative.

OIL AND GAS CLIMATE INITIATIVE

CATAPULT Energy Systems

SRF

CATAPULT Offshore Renewable Energy

10 Years of Innovation - Conclusions

- Transitioning to a low carbon energy system is a system problem; technology innovation is an enabler to the solution - not the solution in itself.
- Innovation takes time – a 10 year mission has brought a constancy of purpose. ETI has covered a lot of ground - but there is still much to do.
- A model where (objective) analysis informs project selection which informs analysis is very powerful - especially if it engages a wide stakeholder base.
- A public-private partnership has its draw backs but it does create a mutually beneficial "sticky" relationship
  - learning together and sharing risk
  - resilient to changes to corporate strategy/Govt priorities
  - Neither would act without the other!
- There is a rich legacy from the ETI's work – and most of it is available to the follow on organisations – and we haven't quite finished yet!
- There are clear "no regrets" pathways – we need to plan deployment, not just research.

ETI members

bp

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Department for Business, Energy & Industrial Strategy

EPSRC Pioneering research and skills

Innovate UK Technology Strategy Board

ETI programme associate

HITACHI Inspire the Next