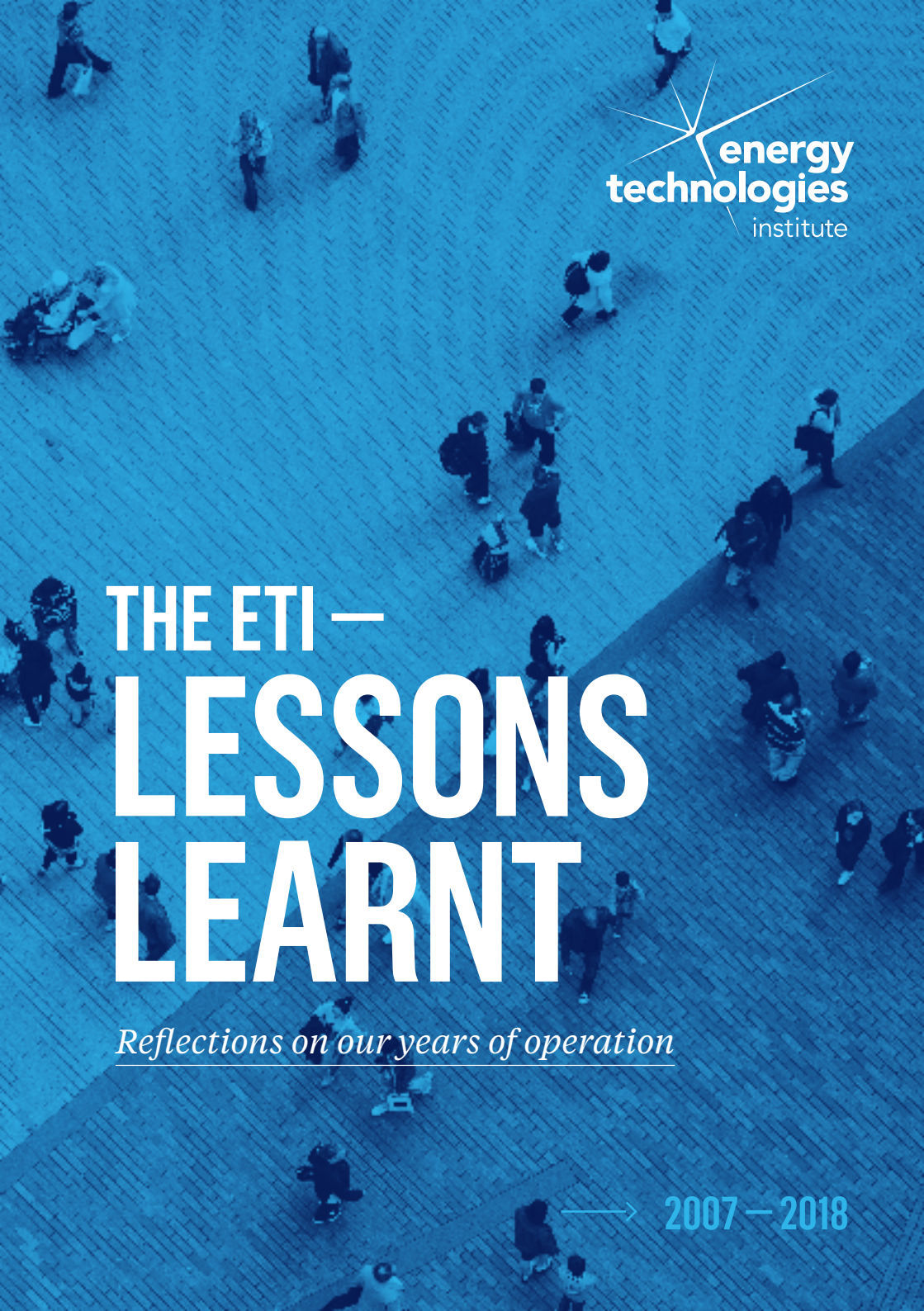


energy technologies institute

# THE ETI — LESSONS LEARNT

*Reflections on our years of operation*

2007 — 2018

*An overview of our learnings*

# THE ENERGY TECHNOLOGIES INSTITUTE (ETI) IS A £400M INDUSTRY AND UK GOVERNMENT PARTNERSHIP INTO LOW CARBON ENERGY SYSTEM PLANNING AND TECHNOLOGY DEVELOPMENT.

Its mission is 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.

# INTRODUCTION —

**Most stakeholders agree that the ETI has made a significant contribution to low carbon energy innovation over the last 10 years. As it approaches the end of its operational life in 2019 when its funding finishes, we feel there is a rich legacy to the ETI's operation in addition to its projects and insights. We have undertaken a staff and stakeholder review to identify the lessons learnt and to share the knowledge we have accumulated over the last decade to help inform the development of innovation bodies in the future.**

Since 2007 ETI has made investments totalling almost £400m in research and development activity across heat, power, transport and the infrastructure that links them – delivering innovation from strategic thinking through to technology demonstration. It has created a project portfolio that has built knowledge and has developed and demonstrated new technology alongside undertaking whole system strategic analysis and planning.

In 2012, the ETI underwent a detailed Mid Term Review conducted by Technopolis, a research and innovation specialist consultancy in collaboration with management, engineering and development consultancy Mott MacDonald. This review assessed the performance of the ETI in the first half of its life drawing on the lessons learnt for its second period of operation.

As we now come to the end of the ETI's operational life we wanted to reflect on the full experience. This summary report of that final review (based on the views of its management and detailed interviews with staff and stakeholders) should be viewed in the context of what we have learnt from the operation of the ETI and not the outputs of the organisation. It does not assess whether the ETI as a concept was good or not and is focused on the organisation as a whole and not on the actions of individuals. It concludes by highlighting a series of recommendations. These recommendations cover three themes – what to consider in the establishment of a new energy related innovation organisation; the factors to consider in order to successfully run an innovation organisation; and how to maximise the legacy and learnings from the ETI's experience.



**£400m**

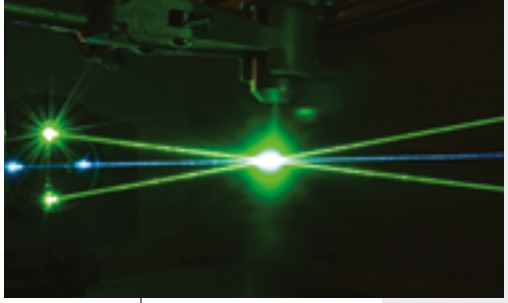
**Since 2007 ETI has made investments totalling almost £400m in research and development activity across heat, power, transport and the infrastructure that links them**

These key findings reflect the context of the external environment the ETI has operated within. The last decade has coincided with significant changes in the UK macroeconomic context for energy investment. The ETI was created at a particular time for a particular purpose – to accelerate UK efforts in low carbon innovation. The years 2007/08 were marked by a confidence and enthusiasm in relation to energy sector innovation. It was also a period of sustained macroeconomic growth with strong political consensus around energy and climate policy. Following the financial crisis originating in late 2008 and the resulting recession, the economic and subsequent political context changed profusely with increased emphasis on the cost of decarbonisation to the consumer.

Recession also affected the ETI's ability to expand its industrial membership from the initial six to the planned 10 members. The Institute's overall financial resources over its life were therefore around half of those projected at its inception.

The ETI's existence also coincided with major UK political changes. There were three general elections in the ETI's lifetime. ETI was originally conceived by a Labour government but was for the majority of its time overseen by a coalition government and then the Conservative government. It also outlived the establishment and the winding up of the Department for Energy and Climate Change, which was a natural home for a lot of its work. And it was only at the end of its lifetime that the Government's Industrial Strategy which placed Clean Growth as a grand challenge was launched. A lot of the ETI's analysis is reflected in the supporting Clean Growth Strategy which is positioned to help deliver on the wider UK Industrial Strategy's aims.

# KEY LEARNINGS FROM THE ETI OPERATION —



← **High Efficiency Selective Catalytic Reduction**
A project that designed and developed a system that operates effectively over a wide range of operating conditions and produces low levels of greenhouse gases when co-optimised with an engine

**AN INNOVATION ORGANISATION LEARNS THROUGH DOING. KNOWLEDGE IS THEREFORE ONE OF ITS KEY PRODUCTS**

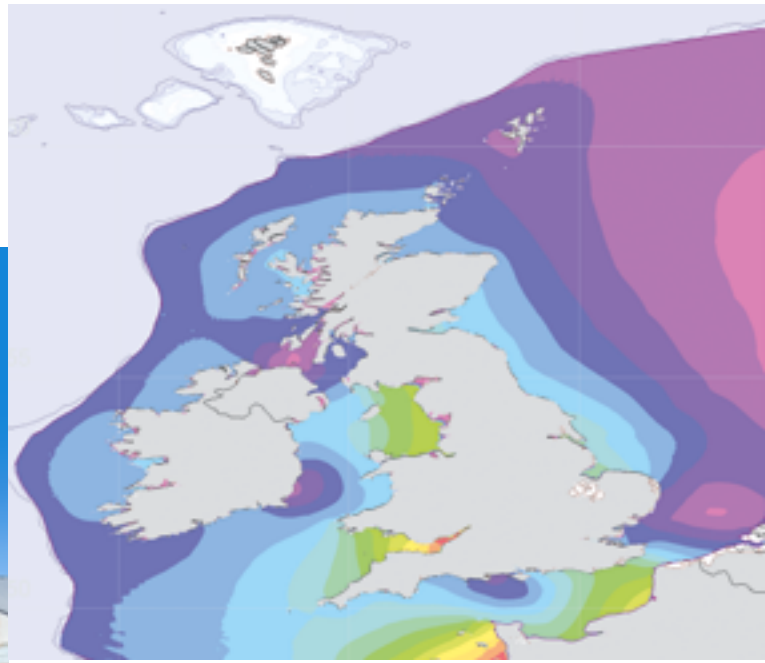
- The establishment of a Public Private Partnership (PPP) model to deliver low carbon innovation has provided both long-term stability and vision in an area of key strategic importance to the UK. The partnership model has delivered significant benefits to the delivery of low carbon energy innovation and has demonstrated that there is a clear ongoing need for new and different innovation vehicles to deliver these benefits beyond the ETI's lifetime.
- A consistent long term focus is necessary to reinforce that innovation must be outcome driven and more than a set of discrete tasks. A whole system approach is fundamental to success.
- Future innovation vehicles should pro-actively manage external expectations and perceptions from their inception. They need to be clear what they are and what they are not so as not to allow misconceptions to perpetuate. A collegiate approach is needed to solve such an enormous challenge as decarbonisation.
- When establishing new innovation bodies great thought needs to be given to the nature of the operational and legal constraints it is given. These constraints have a high cultural impact on the organisation and can act as a brake if they are mismatched with the organisation's mission. A constant comment about the ETI was that it was very regimented and inflexible in its operation in relation to its size of operation.
- The governance structures and operational processes of an innovation organisation should be developed with due regard to the size and mission of the organisation itself. Likewise an organisation's risk appetite should be closely aligned to its mission and clearly communicated to stakeholders, including its membership. Agility and flexibility are needed when delivering innovation projects especially when operating in a constantly changing environment which the ETI did.
- Most innovation bodies will fall under the definition of an SME enterprise (less than 250 employees and a turnover under £50m). The ETI needed to be able to draw on its membership's experience, but also needed to be able to call on a much broader diversity of disciplines and experience. Whilst engineering project management skills are essential, much more is needed to mature technology concepts into investable and impactful innovations.
- An innovation organisation learns through doing. Knowledge is therefore one of its key products. The organisation should therefore be open (within commercial constraints) to sharing the knowledge it has generated. Sharing knowledge about what does not work is as valuable (if not more valuable) than sharing knowledge about successful projects. This requires investment in time and effort to share such knowledge effectively and to develop a professional capability which will help maximise the value and impact of innovation delivery organisations.
- It is important to consider the organisational longevity when creating or developing energy innovation organisations. This should match the scale of the challenge they are seeking to answer and recognise that organisations need time to become effective.

# CONTEXT —
# THE ETI'S PURPOSE

The ETI was set up to help address UK energy and climate change targets by helping to accelerate the development (and ultimate deployment) of low carbon technologies. Over its operational phase it will have made investments near to £400m in innovation activity that stretches across heat, power, transport and the infrastructure that links them.

It has done this through a framework of strategic thinking to identify project selection through to physical technology demonstration. This has resulted in a portfolio of over 150 projects building knowledge, developing and demonstrating technologies complemented by strategic analysis and planning activities on the impact of such innovation on the whole energy system.

**Consumers, Vehicles and Energy Integration (CVEI)**
A mass market field trial to understand changes required to energy supply systems to encourage wider adoption of electric vehicles



**SMARTtide**
An online model of the UK continental shelf and North European Waters, 100x more accurate than previous data. Commercially available from HR Wallingford

**Very Long Blades**
The ETI commissioned Isle of Wight SME Blade Dynamics to develop a technology platform to build blades in excess of 100m for use on the next generation of large offshore wind turbines

**150**

**A portfolio of over 150 projects building knowledge, developing and demonstrating technologies complemented by strategic analysis and planning activities.**

# CONTEXT —
# THE ETI'S HISTORY

2007

Following the launch of a prospectus for investment from the then Department of Trade and Industry, six industry members were recruited to co-invest in the ETI operation. These were all large global energy and engineering companies BP, Caterpillar, EDF, EON, Rolls-Royce and Shell. E.ON left in November 2014 due to a change in their corporate research and development strategy.

The ETI was established because it was recognised that there was an urgent need to accelerate the pace and volume of innovation activity in low carbon energy. ETI was designed to occupy the ground between fundamental research funded by the UK research councils and the market deployment of proven technologies. This has often been described as the "valley of death" for innovation. The ETI's aim was to share risk and provide funding to pull through low carbon innovations.

The ETI was established as a 50:50 PPP. Funding consisted of up to a maximum of £5m per annum from each individual industry member which was then match funded by the government. This provided a maximum budget of £60m per annum for research activities. Government funding was channelled through formerly the Technology Strategy Board – now Innovate UK – and the Engineering and Physical Sciences Research Council (EPSRC).

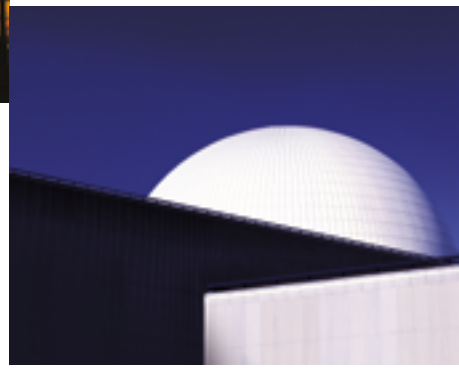
Public sector oversight has always resided with business department which is currently the Department for Business, Energy and Industrial Strategy.

**£5m**

**The maximum contribution per annum from each individual industry member which was then match funded by the government**



**THE ETI WAS ESTABLISHED BECAUSE IT WAS RECOGNISED THAT THERE WAS AN URGENT NEED TO ACCELERATE THE PACE AND VOLUME OF INNOVATION ACTIVITY IN LOW CARBON ENERGY**



**Storage and flexibility modelling**
A model to calculate the future fixed energy and infrastructure costs and performance. Used by government and utilities in their scenario planning

# ETI OPERATION — CORPORATE STRATEGY

The ETI began life with a vision to help provide "secure, sustainable and affordable energy for present and future generations". This vision remained unchanged throughout the lifetime of its operation.

The successful outcomes outlined for the organisation were: to have a major impact on policy development; support in the development of critical supply chains; help to build investor and industry confidence and provide value to its members.

Others will interpret the extent to which ETI has delivered against these stated outcomes, but it should be noted that most informed observers believe the ETI has delivered on all of these outcomes.

**SECURE, SUSTAINABLE AND AFFORDABLE ENERGY FOR PRESENT AND FUTURE GENERATIONS**

TECHNOLOGY PROGRAMME AREAS

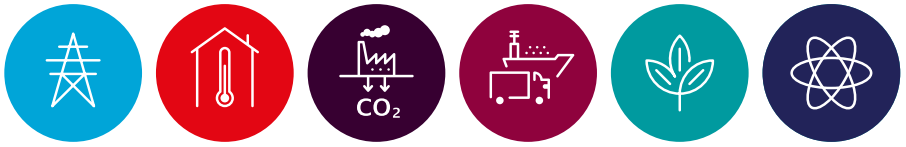
OFFSHORE WIND | MARINE | DISTRIBUTED ENERGY | BUILDINGS



# ETI OPERATION — A FOCUSED PORTFOLIO

ETI's funding model has focused on making commercial investments across a number of key technology areas where it was identified that the ETI could add significant value. In contrast to a number of other bodies, the ETI has not provided research grants. This new approach to funding led to the development of a detailed technology strategy for the ETI based on a national energy system design and planning capability that the ETI created called ESME (Energy System Modelling Environment). Originally ESME was intended only to identify the investments ETI should make, but it eventually became a powerful energy system modelling tool in its own right and has been used to inform the activities of external organisations such as the Committee on Climate Change in the setting of UK carbon budgets. ESME has been recognised across the energy system modelling community as having played an important role in the UK decarbonisation debate.

ETI's technology programmes have included a portfolio of over 150 engineering projects researching, developing and demonstrating new low carbon technologies. The technology programmes covered – Offshore Wind, Marine, Distributed Energy, Buildings, Energy Storage & Distribution, Smart Systems and Heat, Carbon Capture and Storage, Transport Efficiency (covering both light duty (cars) and heavy duty (land and marine), Bioenergy and Nuclear. Alongside this the strategy development directorate (now transferred to the Energy Systems Catapult) delivered energy system planning analysis and modelling capability.




ENERGY STORAGE & DISTRIBUTION | SMART SYSTEMS & HEAT | CARBON CAPTURE & STORAGE | TRANSPORT | BIOENERGY | NUCLEAR

# ETI OPERATION — ORGANISATIONAL CULTURE

The ETI has a rich engineering identity and this has provided significant organisational benefits to deliver the project portfolio, but it has also dominated the organisation's culture. Staffed by people passionate about the challenge of a low carbon transition, the ETI gravitated to an engineering task oriented and evidence based bias. This rigid approach to the delivery of "a task" and focus on the long term goals helped to foster a culture that sometimes focused more on problems that had to be solved as opposed to celebrating and profiling the successes of the organisation.

With two dominant directorates, strategy development and programme delivery inputting to the technology programme portfolio, a "silo mentality" developed on occasion between both the programme areas themselves and the work of the directorates. This was felt more inside the organisation than noted outside.

The investment in technology acceleration via third party participants and the shared investment risk approach of the ETI funding model, drove a need to protect intellectual property. This was both for the benefit of the project participants and for the ETI and its members. Strong IP management discipline became an important focus for the ETI and its contracting approach, particularly at the start of the organisation. At times this led to limited knowledge sharing from the outcomes of ETI project work, particularly in the early part of the ETI's life. The majority of IP generated from ETI projects is actually owned by the participating project partners themselves and was not shared in order to protect their commercial positions. Suspicion of the ETI's contracting approach and rigorous IP management were left unchallenged and some innovators were undoubtedly reticent to engage.

> STAFFED BY PEOPLE PASSIONATE ABOUT THE CHALLENGE OF A LOW CARBON TRANSITION



The ETI developed a strong governance and quality model which at times was inflexible. The ETI is a small organisation – its maximum staff numbers of c100 includes itself in the classic definition of an SME. Those interviewed for this report believe it was impacted to some extent by its lack of agility and responsiveness because of its large organisational scale of governance – developed to mirror some of the large organisations that were its membership.

The Limited Liability Partnership Agreement (LLPA) did not allow for the ETI to take significant contractual risk through its project contracts and the ETI's ability to hold contractual risk on project investments was significantly low. The ETI built its own in-house legal function which took the lead on all contract negotiations. Many observe that the availability of three lawyers to work across a portfolio that numbered 150 projects at its maximum operation, coupled with a reluctance to hold contractual risk led to a long process of contract negotiation.

The ETI was recognised by its peers as establishing a strong capability for project assurance. This brought significant value to the organisation itself but sometimes it was viewed by project partners as lacking in flexibility and pragmatism when it came to its operational processes, treating each project irrespective of value to the same detailed governance procedures. This changed as the ETI evolved, but a more agile approach would have been welcomed by many project partners.

> THE ETI WAS RECOGNISED BY ITS PEERS AS ESTABLISHING A STRONG CAPABILITY FOR PROJECT ASSURANCE

It was not until mid-way through the ETI's life that it increased investment in its communications output to establish it as a professional function in its own right. Given that knowledge has become one of the key outcomes from the ETI operation, the wider dissemination strategy developed from 2012 onwards including the ETI becoming a publisher of reports in its own right resulted in increased positive perceptions of the ETI and helped to improve its impact on the low carbon agenda.

# ETI OPERATION —
# PUBLIC PRIVATE PARTNERSHIP

The partnership model which underpinned the ETI helped it deliver value and provides a useful learning experience for others as a first of its kind funding model for delivering large scale energy innovation in the UK. The structure of the partnership provided stability and effective risk-sharing to enable long-term investments. The model also provided access to a wide pool of knowledge from across the member organisations to address issues through the ETI's strategic advisory and programme advisory groups. This stability helped the ETI to take investment risks that would have been unacceptable to single investors.

The external context for the ETI changed significantly over the course of ten years not least driven by the global financial crisis and the subsequent recession. Changes of government, shifts in policies and changes to corporate strategies and priorities meant the needs and expectations of the ETI from its members shifted over the life of the partnership. This created a managerial challenge to meet everyone's requirements but reaching and maintaining a consensus is important in a partnership and this had to be carefully navigated by the ETI executive. Nevertheless, the partnership proved remarkably robust, with all partners recognising the value they were receiving.

The value delivered by the ETI partnership was actually broader than had been originally anticipated. In particular the strategic analysis and planning capability that was created and has now transferred to the Energy Systems Catapult. Both government and industry members extracted significant value from this capability, informing and challenging their own analysis and thinking. Some have argued that the most valuable return on the ETI investment is the unbiased knowledge and evidence base it has created on low carbon energy system planning and technology development. For many, the ETI became a respected source of evidence and advice. However, the ETI undertook less technology demonstration activity than some had originally envisaged, with this element only accelerating in the final few years of the ETI's life.



> **BOTH GOVERNMENT AND INDUSTRY MEMBERS EXTRACTED SIGNIFICANT VALUE FROM THE PARTNERSHIP, INFORMING AND CHALLENGING THEIR OWN ANALYSIS AND THINKING**

## OUR MEMBERS

bp

CATERPILLAR

EDF ENERGY

Rolls-Royce

EPSRC
Pioneering research and skills

Department for Business, Energy & Industrial Strategy

Innovate UK

## ETI PROGRAMME ASSOCIATE

HITACHI
Inspire the Next

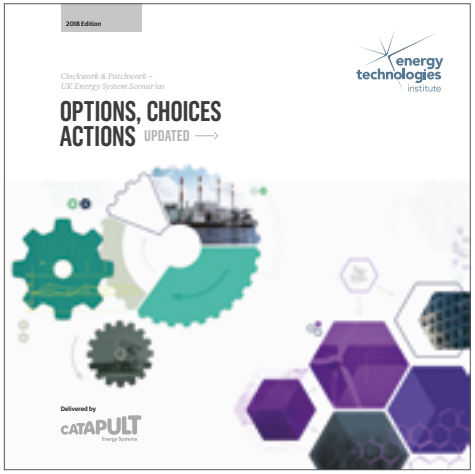
# ETI OPERATION —
# ACCELERATING INNOVATION

Through the development of its ESME model, the ETI's whole energy systems perspective has become highly respected across the energy landscape in the UK and beyond, with ETI staff invited to speak and present at a number of energy conferences. A number of people interviewed for this review identified that they felt the ETI had challenged previously held conventional thinking on a low carbon transition of the energy system. But ten years is arguably not long enough to extract the full potential value from the partnership. The first solid test for the UK in meeting its emissions commitments occurs in 2020. It will probably only be in the mid-2020s when big energy infrastructure decisions are taken that it will be possible to judge the full success or otherwise of the ETI.

Sharing of knowledge and learning should be a core component of an innovation organisation. We have noted that it was in the second part of the ETI's life that the organisation addressed this issue. It is hoped that the volume of published material ETI will leave behind alongside access to its underlying data via its "knowledge zone" will be used by the government and other actors as evidence for their future decision making.

The ETI proposition and operation provided significant engineering capability to the UK in the field of low carbon development and through its advisory groups acted as a catalyst for discussion and debate. There is significant value in undertaking evidence based strategic thinking to inform interventions and to understand the impact of these post-project.

→ **Energy System Modelling Environment**
An internationally peer reviewed national energy system design and planning capability – to identify the lowest cost decarbonisation pathways for the UK energy system




← **Options, Choices, Actions**
Clockwork & Patchwork —
Two plausible scenarios for meeting the UK's 2050 climate targets

**THROUGH THE DEVELOPMENT OF ITS ESME MODEL, THE ETI'S WHOLE ENERGY SYSTEMS PERSPECTIVE HAS BECOME HIGHLY RESPECTED ACROSS THE ENERGY LANDSCAPE**

ESME
Energy System
Modelling Environment

# SUMMARY OF LEARNINGS –

Innovation to support *any low carbon transition takes time and stamina* and a 10 year lifespan has arguably not been long enough to extract the full potential value from the ETI partnership. The Mid Term Review of the ETI noted that the organisation was established from scratch with large ambitions but that ETI's set up took too long. There is a natural tension between the focus on the long term goals of the organisation – in this instance – addressing 2050 climate change targets – and the need to demonstrate short term benefits from the organisation's operations. Establishing the organisation, setting its strategy and launching the initial projects took time and it was five years before the ETI approached its maximum funding capacity of £60m per annum and was therefore acting as it had been originally envisaged. By the time the benefits of the ETI partnership were becoming clear and the organisation was demonstrating its abilities to identify and accelerate the candidate technologies needed to support the energy transition in the mid-2020s, the organisation was already planning for its closure. The final impact of the ETI's work and how effective specific technology interventions have been will not be fully realised until the make-up of the UK energy system in 2025 or 2030 is known. The question remains one of what could the ETI have achieved if it had remained operational to these timescales.

The ETI has operated as a PPP and its existence has provided valuable insight into how this type of funding model operates in an energy environment. Again the Mid Term Review noted that the partnership pooled a cross-section of widely different yet complementary experiences mobilising a considerable depth of financial and intellectual resource. However the PPP operating model produces both benefits and challenges. While it created a structure where industry and government could come together to commit to major investments and risk-sharing activities in a way few others could, it also brought with it heavy governance, especially in its early years. The ETI governance evolved as the organisation matured but it is clear that *flexibility in operation is key to delivering innovation*.



→ **Offshore Wind Test Rig**
Indoor turbine test rig designed to allow the whole offshore wind drivetrain to be tested onshore before deployment offshore

# FLEXIBILITY IN OPERATION IS KEY TO DELIVERING INNOVATION

As with any organisation *culture is very important*. The ETI's over-arching LLPA – the legal agreement that created the ETI – defined quite clearly how the ETI would operate and therefore helped to define the ETI culture at the outset. The ETI shows how a LLPA can provide a strong governance model for an organisation. But it should also be recognised that this can lead to an unintended stifling of some of the innovative thinking the organisation was put in place to support.

Successful innovation should be seen as *more than simply developing technologies*. A large number of the technologies needed to successfully develop a low carbon energy system are known today but are currently underdeveloped and not investable at scale. The work of the ETI has identified that it is important to fully understand commercialisation challenges and the process of policy making as well as accessing deep and experienced engineering and market knowledge. It is also important to be able to apply these resources and skills to help participants learn and adapt to enable technology adoption at scale, and to inform the policy and regulatory agenda where market barriers hinder the energy transition. It becomes important for the outcomes of the operation that these skills are also represented across the leadership team of such an innovation organisation.

# SUMMARY OF LEARNINGS –

Continued »

Effective innovation *requires a focus on outcomes rather than outputs*. For the ETI this has meant informing policy development, supporting the development of critical supply chains, building investor and industry confidence as well as providing value back to its membership's strategic agenda – across both the private and public sector. It is about the impact of the activity rather than the volume.

*Openness and transparency can have a real impact on innovation*. A PPP model must deliver an element of commercial advantage to those funding it in order to be successful. However, this does not mean the organisation should be closed and opaque. Sharing knowledge about success and failure is highly valuable, but sharing knowledge about what does not work in research and development is as valuable (if not more valuable) than simply sharing knowledge about successful projects. Achieving the right balance between strong IP governance and sharing knowledge is important to engender trust and to be effective.

Throughout its operation, the ETI has challenged conventional thinking in the energy sector by focusing on *a whole systems approach* to decarbonisation. This has created a strong independent evidence base and analytical capability which has helped to reduce the risk associated with prioritising innovation spending. This will be one of the lasting legacies of the ETI as the capability to understand and interpret the interactions and reactions of specific technologies across the energy system has moved to the Energy Systems Catapult.

→ **ReDAPT – Reliable Data Acquisition Platform for Tidal**
Demonstration of a 1MW buoyant tidal generator to increase public and industry confidence in tidal turbine technologies

← **Carbon Capture and Storage**
Over the past ten years the ETI has invested over £28.4m in its CCS programme

**THROUGHOUT ITS OPERATION, THE ETI HAS CHALLENGED CONVENTIONAL THINKING IN THE ENERGY SECTOR BY FOCUSING ON A WHOLE SYSTEMS APPROACH TO DECARBONISATION**

# RECOMMENDATIONS FOR FUTURE INNOVATION BODIES —

## ORGANISATIONAL SET-UP —

- The organisation should be as **open and honest** as is possible within commercial constraints. A PPP has to have some levels of confidentiality – this should be reflected in the mission and philosophy of the organisation
- The organisation's **governance structure should match the size and mission objectives of the organisation** – it should also be regularly reviewed to ensure it remains fit for purpose
- The organisation's structure should recognise that a **broad range of disciplines are needed to deliver innovation** – expertise in these disciplines should be reflected in the make-up of the leadership team
- Delivering impact requires **knowledge to be widely shared** as well as IP to be protected

## OPERATIONAL PHASE —

- The organisation should **focus on delivering overall outcomes rather than simply task-orientated project outputs**
- There should be constant checking of alignment of innovation activities with changes in the external landscape to challenge the organisation's direction – the organisation **needs to be agile and flexible**
- The organisation's **appetite for risk should be clearly communicated** – to avoid any misconception of its operation or purpose

# RECOMMENDATIONS FOR FUTURE INNOVATION BODIES —

Continued »

## MAXIMISING LEGACY —

- The transition to a low carbon future should be constructed in a **whole energy systems approach**
- To deliver innovation through to market adoption requires **access to a broad range of skills** and the ability to bring these to bear on projects and project participants
- There is a need to **consider organisational longevity** when developing new energy innovation organisations
- The **most impactful value of innovation can be unforeseen** at the start of an organisation's operation
- The **public sector has a key role to play** in delivering energy demonstration projects – without it many potential transformational technologies will not attract private sector risk capital and will not reach the market



# FURTHER READING —

For a more detailed analysis of the ETI's operation you can read "The ETI Journey: Review of Learnings" via www.eti.co.uk

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