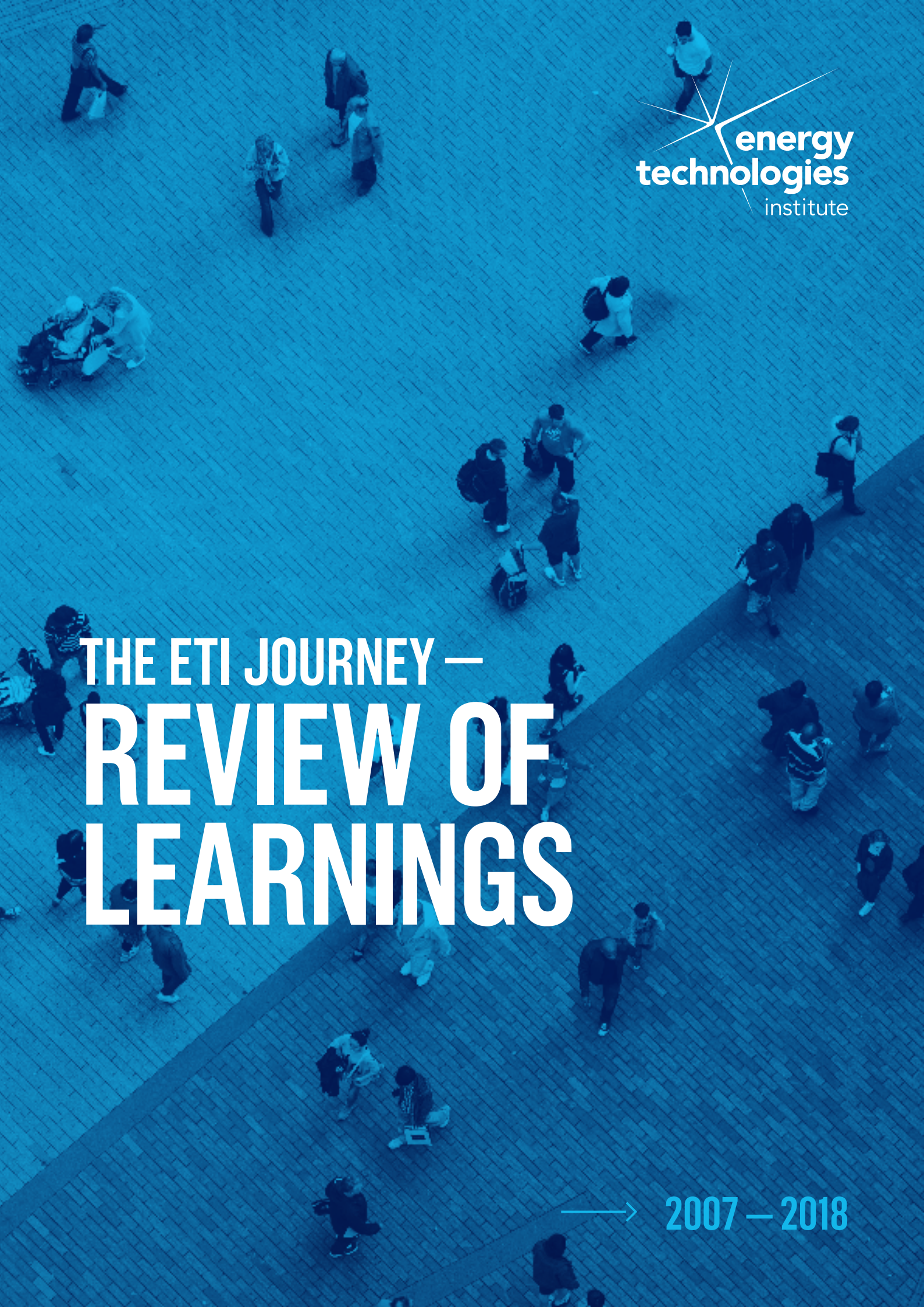

energy technologies institute

THE ETI JOURNEY — REVIEW OF LEARNINGS

2007 — 2018

CONTENTS

REPORT CONTEXT

→ **The ETI was created in 2007** with the 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.**

The ETI operating model was untested in the UK previously – a ten-year public-private partnership (PPP) focused on delivering energy sector innovation in the Technology Readiness Levels of 3-6 (sometimes referred to as the "valley of death"). As the ETI approaches the end of its operational life, it is appropriate to capture the learnings not just from the technical output of the ETI but from how the organisation has operated over the last decade.

This review has therefore been undertaken to identify learnings that future innovation delivery bodies in the UK may wish to take note of. It is not intended to assess whether the ETI as a concept was good or not, and it needs to be understood that it is focused on the organisation as a whole and not on the actions of individuals.

The report is written by ETI employees and is based upon interviews with past and present staff together with stakeholder interviews and analysis undertaken by The School of Business and Economics at Loughborough University.

The review highlights a series of recommendation themes that cover:

- The establishment of a new energy related innovation organisation
- The successful operation of an organisation that delivers innovation
- How to maximise the legacy and learnings from the ETI's experience

It is important that this piece of work should be viewed in the context of what we learnt from the OPERATION of the ETI and not the outputs of the organisation.

Aspects of the ETI experience and learnings have already informed the establishment and growth of the Energy Systems Catapult as well as informing the operating model for the Oil and Gas Climate Initiative, a voluntary CEO-led initiative of ten major oil and gas companies who aim to lead their industry's response to climate change through a billion-dollar investment vehicle.

For further information on the successes of the ETI and its legacy please visit www.eti.co.uk.

SUMMARY OF LEARNINGS –

→ The ETI was established in December 2007 with a ten-year remit to **accelerate the development, demonstration and deployment of low-carbon energy technologies in the UK.** It was the first time that a partnership model comprising major multi-national companies and the UK Government had been tested in the energy sector as a means of **driving innovation.** It was positioned to focus on the so-called "valley of death" between early stage research and development and commercial deployment.

The external context in which the ETI has operated over its life has shifted considerably. The national and global drive to decarbonisation has accelerated, and the UK has remained in the vanguard. At the same time however, domestic economic policy has increased political and societal concerns about the cost of decarbonisation, and particularly affordability for those in fuel poverty. The ETI's industrial sector members have also witnessed a challenging period since 2007, and each has seen at least one significant corporate strategy refresh driven by the global economic cycle or one-off corporate shocks. In short, the interests of the ETI members shifted over the life of the ETI, but the ETI's long-term mission did not.

For the most part, the ETI has been very successful, and is generally considered to have made a strong contribution to the UK's decarbonisation efforts. How effective specific technology interventions have been has yet to be seen. The ETI's work has been valued highly by its members and there is some regret that it is not continuing.

As ETI approaches the end of its operational life (2019), a staff and stakeholder review has been undertaken to identify the lessons that can be learnt from the ETI's operation (reported in this document) with a view to sharing this experience to inform UK energy innovation activity in the future. Some of these lessons are specific to the ETI, but some have been seen elsewhere in other innovation models such as The Carbon Trust. There is a body of academic research already available on the topic, such as the work of Dr Mark Winskel of Edinburgh University in 2018 (The pursuit of interdisciplinary whole systems energy research: Insights from the UK Energy Research Centre) and 2007 (Renewable Energy Innovation: Collaborative Learning and Intellectual Property).

The ETI review is not academic. It is clearly introspective and, by its nature, self-critical. In fact, it could be argued that any of the issues identified are as much a consequence of a changing external context as they are from issues within the ETI's own control – nonetheless, even those issues which where externally driven could have been dealt with better.

The key learnings from the ETI operation are summarised as follows:

- The ETI has delivered upon its ten-year mission and has been recognised as having made a significant contribution to low-carbon energy innovation in the UK. The ETI has also delivered impact in areas that were unforeseen when the organisation started, such as the creation of its in-house low-carbon energy system modelling and analytical capability, now transferred to the Energy Systems Catapult.
- The ETI has successfully developed an evidence-based 'whole systems approach' to understanding the impact of its interventions and to inform energy system transition thinking. This has been recognised as highly valuable. Having a strong, independent evidence base and analytical capability (such as that developed within the ETI) reduces the risk associated with prioritising innovation spending.

THE EXTERNAL CONTEXT IN WHICH THE ETI HAS OPERATED OVER ITS LIFE HAS SHIFTED CONSIDERABLY

- Innovation that supports the low-carbon energy system transition takes time and stamina, and even a ten-year life is not long enough for an organisation like the ETI to fully maximise the value of its operations and answer the challenges it was set.
- Whilst constancy of purpose is essential, it is also critical for organisations delivering longer-term innovation to demonstrate and communicate (visible) progress on a regular basis to maintain stakeholder engagement, recognising that stakeholder priorities may shift independently.
- The ETI has provided valuable insight into the real-world operation of a PPP innovation funding model that was unique in the energy sector. The funding model brought significant benefits to the ETI operation including:
  - Providing long-term stability and vision in an area of key strategic value to the UK.
  - Delivering effective risk management and an appropriate level of funding capacity to deliver impact.
  - Enabling access to a broad range of skills within the industry and within market participants.
  - Creating a respected and independent knowledge and evidence base and its dissemination.
  - A range of unexpected beneficial consequences, not least providing the organisation with the time and resources to think about, and analyse, the key strategic issues associated with the low-carbon energy transition.

  However, using a PPP model for innovation delivery also creates challenges which should be reflected on. In the context of the ETI these were:
  - The complexity of relationships and governance that it created.
  - Managing within the constraints of a multi-party limited liability partnership agreement (LLPA) that established the organisation and which was agreed before the ETI began operating.
  - Managing the expectations and needs of a diverse membership – whose expectations varied over time.
  - Managing external expectations, particularly among SMEs and the academic community of the organisation's intention and purpose.
  - Managing the (sometimes negative) perceptions surrounding a large-industry based PPP which potentially acted as a barrier to engagement, particularly with SMEs.
- When setting up any organisation, culture matters. Culture develops early and can be difficult to change. In the early days of the ETI there was a significant focus placed on IP protection, consistent with member expectations of where the ETI would deliver value. This led to governance approaches and the development of processes that ultimately reduced the external impact of the organisation and to some extent reduced its perceived value to external stakeholders. There is a strongly-held view among those consulted that the LLPA was instrumental in defining this initial culture, which gave challenges later on.
- Openness and transparency has a very positive impact on the delivery of innovation. Sharing knowledge about successes and failures, within the constraints of confidentiality, is highly valuable to the wider innovation community. Any over-emphasis on intellectual property (IP) protection by a funding organisation can frustrate knowledge exploitation and lead to a consequential loss of value and impact.
- Accelerating technology towards commercialisation is however a different knowledge challenge to that of early stage academic research. Commercialisation needs to create competitive value and to position technologies to achieve investor returns. This constrains knowledge-sharing and reinforces the need for appropriate IP management and governance. Getting the balance right between strong IP governance and sharing knowledge is important to engender trust and to be effective.
- The importance of skilled communications resources to deliver external messages effectively, and to manage and reinforce the market positioning of the organisation with the wider stakeholder community was only recognised in the second half of the operational life of the ETI.
- Delivering effective innovation requires a focus on "outcomes" rather than a narrow focus on delivering

SUMMARY OF LEARNINGS –

Continued »

sequential tasks or "outputs". This is especially the case in the energy sector where innovation activity can take a long time, and where the context for innovation evolves continuously. Creating impact from innovation requires active monitoring of the energy landscape and requires outcome-focused programmatic and theme leadership as well as conventional technology project investments.

- Delivering impact from interventions and investments requires an understanding of a broad range of disciplines, and is much more than simply developing and demonstrating technologies. Commercialisation challenges also arise through policy or regulatory framework

FLEXIBILITY IS KEY TO DELIVERING INNOVATION

constraints, or through the lack of experience or abilities in the organisation leading the commercialisation activities. Scale-up requires investment, and investors demand acceptable delivery risk. Having a broad diversity of disciplines and experience within the leadership team of an innovation funding organisation (like the ETI) is likely to increase the impact of the organisation's activities, particularly in respect of identifying problems and helping participants to commercialise and deploy innovations.

- Flexibility is key to delivering innovation – "one size fits all" contractual approaches to funding innovation are unlikely to provide the agile environment needed to maximise impact. Furthermore, governance processes and the culture these can drive need to be appropriate to the size and mission of the organisation that is being established.
- Convening capital for demonstration projects, and delivering a level of financial return from these projects that would be acceptable to commercial investors, is hugely challenging. The ETI created a vehicle for delivering the scale, ambition, risk-sharing and financing for such early stage demonstration-scale activities, but even then they were difficult to deliver. It remains unclear how this void in the innovation landscape will be filled once the ETI closes, i.e. the delivery of projects which require majority or full funding but which are at a pre venture capital stage of maturity. What is clear though is that there remains a hugely significant role for the public sector providing capital support in the future.
- Although the ETI's relationship with the SME community has at times been challenging, there are a number of examples of where the capacity and technical capability of the ETI, and its networks – in addition to financing – have been successful in supporting SME growth. ETI support for innovation has helped develop UK skills and capacity as well as delivering low-carbon technology progression. The availability of investment is a necessary but insufficient condition for technology acceleration.
- Many SMEs face similar scale-up challenges which can hold back further investment and commercialisation. SMEs often don't know what they don't know, and challenging and supporting them as they attempt to grow and scale is as important to their success as technology demonstration. Areas such as robust engineering quality systems, supply chain management, business development, health and safety management, cost control and forecasting and investor relations are common weaknesses that need to be addressed before further scale-up investment will flow. Given the natural blind spot many SMEs will have, in contrast to grant funding or traditional venture capital investment management, an interventionist project assurance approach backed with a network of support expertise, as deployed by the ETI, can be very effective.

DELIVERING IMPACT FROM INTERVENTIONS AND INVESTMENTS REQUIRES AN UNDERSTANDING OF A BROAD RANGE OF DISCIPLINES, AND IS MUCH MORE THAN SIMPLY DEVELOPING AND DEMONSTRATING TECHNOLOGIES

- Impact from innovation activities are delivered through the creation of benefits that are then exploited by various stakeholders, and it is important to identify these exploitation routes at the outset. These must be kept under continuous review as exploitation routes may change, and it is usual for new beneficiaries of innovation activities to materialise over time.

These learnings have led to a number of recommendations for consideration in the context of delivering energy-related innovation in the future:

When setting up a new energy-related innovation delivery organisation, it is recommended that:

- The organisation is set up recognising that a broad range of disciplines are needed to deliver innovation successfully. At a portfolio level, knowledge management, communications, policy advice and business development capabilities are examples of what is also required. This experience should be reflected within the organisation's leadership team.
- The organisation also needs the breadth of skills necessary to be able to recognise the organisational and scaling issues in its participants and then have the commercial tools to be able to act – providing additional engineering, quality, HSE support etc. to improve success rates and impact. Technology needs to be made "investor ready", and many organisations lack the experience, ability and self-awareness to achieve this.
- The organisation is created in such a way as to act in an open and transparent manner as is possible within commercial constraints. This should be reflected in the organisation's mission and operational philosophy.
- The organisation is established to ensure external expectations and perceptions are pro-actively managed from inception to ensure that genuine engagement from a broad range of stakeholder groups is achieved throughout its life.
- The cultural impact of the organisation's legal and operational frameworks on its ability to deliver its mission is considered during the establishment phase.
- The organisation's governance structures and operational processes are developed from the outset with due regard to the size and mission objectives of the organisation. These should be continuously reviewed to ensure they remain fit for purpose.
- The organisation is set up recognising that delivering impact requires knowledge to be shared as well as IP to be protected.

During the operational phase of an energy-related innovation delivery organisation, it is recommended that:

- The organisation focuses on delivering overall "outcomes" rather than simply task-oriented project outputs to maximise the chances of delivering innovation impact. This recognises that in many cases the outputs expected at the start of an innovation activity are often not those that deliver most value by the end.
- The ongoing analysis and mapping of the external technology and innovation landscape is embedded within the activities of the organisation to ensure that its innovation activities align and respond to changes in the external landscape, whilst also remaining focused on long-term goals. This is especially valuable for energy-related innovation activities (including demonstration projects) which are subject to policy changes and can often take several years to deliver.
- The organisation's appetite for risk is aligned with its mission and is clearly and consistently communicated to internal and external stakeholders on an ongoing and regular basis.

SUMMARY OF LEARNINGS –

Continued »

- A business plan is maintained to support and promote the organisation's technology and strategy focus. This plan should be complemented by an organisational development plan, identifying the capability needs and shortcomings of the organisation to deliver its mission.
- Through its governance, the organisation continually challenges itself:
  - Organisational culture is regularly assessed to ensure continued alignment against mission objectives.
  - All stakeholders internal to the organisation are continuously challenged to support the organisational mission and reflect on how well it is being delivered. This will reduce the risk of deviating from the mission in response to short-term external pressures.
  - Business improvement processes are focused on the performance of the organisation as a whole and its ability to deliver its mission – minimising "silo" effects.
  - Ensuring investment is "outcome" focused – delivering goal oriented programmes of work not only discrete interventions.
  - Ensuring technology demonstration investment is tied to clear business outcomes not simply technology outcomes, especially where the future commercialisation of the technology and the future of the recipient are synonymous. This requires active project assurance and an ability to intervene and provide support and advice. This is more interventionist than grant funding.
  - The creation and availability of a respected and independent knowledge and evidence base that can contribute to the UK energy debate and inform the choices and decisions associated with the low-carbon energy transition.
- All stakeholders recognise that delivering impact from energy innovation takes time and long-term commitment. Organisational longevity is key when creating or developing new organisations operating in the UK energy innovation arena.

To maximise the legacy and learnings from the ETI experience, it is recommended that:

- The public sector recognises and reinforces its critical role in delivering energy demonstration projects in the UK and that it has an active role to support commercialisation. The departure of the ETI from the energy innovation landscape leaves a potentially very significant gap in this area.
- The benefits delivered by the ETI's PPP model are carried through into future innovation delivery vehicles in the UK. Most notably these include:
  - Providing long-term stability and vision in an area of key strategic value to the UK.
  - Fostering an innovation environment that enables risk sharing and the right level of funding capacity and funding intensity to deliver impact.
  - Enabling access to a broad range of skills within the industry and within market participants.

ALL STAKEHOLDERS RECOGNISE THAT DELIVERING IMPACT FROM ENERGY INNOVATION TAKES TIME AND LONG-TERM COMMITMENT. ORGANISATIONAL LONGEVITY IS KEY WHEN CREATING OR DEVELOPING NEW ORGANISATIONS OPERATING IN THE UK ENERGY INNOVATION ARENA

INTRODUCTION –

The ETI was established in December 2007 with a ten-year remit to **accelerate the development, demonstration and deployment of low-carbon energy technologies in the UK.**

The context to this was the UK's ambitious long-term carbon reduction targets, and the aim of enhancing UK knowledge and capability in the low-carbon energy sector. It was the first time that a partnership model comprising major multi-national companies and the UK Government had been tested in the energy sector as a means of driving innovation with a focus on the so-called "valley of death" between early stage R&D and commercial deployment.

As the end of the ETI's operational life approaches (the end of 2019), now is an appropriate time to reflect on the ETI journey so far and to assess what this might mean for UK energy innovation in the future. In that context, this document has two key purposes:

1. To identify the key learnings from the operational experience of the ETI; and
2. To assess how these learnings might objectively inform energy innovation delivery vehicles in the UK in the future.

This document has been authored from within the ETI, using a broad set of evidence gathered from ETI staff and external stakeholders. Loughborough University delivered the external stakeholder insights through its School of Business & Economics (SBE). Their role was to develop and implement a method of independently ascertaining the views and experiences of a range of external stakeholders that have engaged with the ETI in different ways and at different times since 2007. The significant contribution that SBE has made to this work is therefore gratefully acknowledged.

> **NOW IS AN APPROPRIATE TIME TO REFLECT ON THE ETI JOURNEY AND TO ASSESS WHAT THIS MIGHT MEAN FOR UK ENERGY INNOVATION IN THE FUTURE**

THE ENERGY TECHNOLOGIES INSTITUTE LLP (THE ETI) –

← **Flettner Rotors**
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. The rotor sails will be fitted during the first half of 2018, before undergoing testing and data analysis at sea until the end of 2019.

↓ **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.

ETI PURPOSE

→ The ETI is an industry and government funded research institute into **low-carbon energy system planning and technology development** to address UK energy and climate change targets. It was set up to act as **a conduit between academia, industry and the government** to accelerate the development of low-carbon technologies.

It has done this by bringing together engineering projects that develop affordable, secure and sustainable technologies to help the UK address its long-term emission reduction targets, as well as delivering near-term benefits. Over the last ten-years it has made a series of targeted commercial investments approaching more than £400m in technology programmes across heat, power, transport and the infrastructure that links them.

The ETI has delivered innovation from strategic planning to technology demonstration in the following ways:

Knowledge building

- Informing industry decision-making through the use of robust, shared evidence and commercially available project outputs
- Building a better understanding of the decarbonisation potential in developing industries
- Informing the policy debate

Developing technology

- Building supply chain capability
- Creating new economic opportunities
- Exploiting UK technology knowledge and skills

Demonstrating technology

- De-risking new systems
- Focusing on accelerating low-carbon innovation
- Building investor and industry confidence

Strategic analysis and planning

- Developing an internationally peer-reviewed national energy system design and planning capability
- Identifying the lowest-cost decarbonisation pathways for the UK energy system out to 2050
- Producing technology and industry sector insights and developing a whole system modelling capability

HISTORY

In 2006 when the UK Government first announced its support for the ETI, it committed to providing up to £500m in matching funding, creating the potential for a £1bn institute over a lifetime of 10 years.

At the time support for the ETI was provided by senior executives of four of the world's leading international energy companies (E.ON UK, Shell, EDF Energy and BP). They recognised that accessing the best research and technology was of vital importance in providing the products and services

SHARING KNOWLEDGE ABOUT WHAT DOES NOT WORK IS AS VALUABLE – IF NOT MORE VALUABLE – THAN DELIVERING KNOWLEDGE ABOUT "SUCCESSFUL" PROJECTS

↑ **Pre-saturated Core Fault Current Limiter**
The Fault Current Limiter, developed during this project by GridON, was commissioned into service in May 2013 at a UK Power Networks main substation in Newhaven. During more than three years in service it demonstrated excellent performance.

THE ENERGY TECHNOLOGIES INSTITUTE LLP (THE ETI) –

Continued »

that would enable their companies to thrive through a century in which they expected fundamental changes to the business and environmental context in which they operate. The government also succeeded in attracting two other 'core industry partners' to join them, Caterpillar and Rolls-Royce. All six companies committed to making an equal contribution of up to £5m per year for the ten-year period. It was this funding, matched by government, that has allowed the ETI to invest more than £400m over the last ten-years.

When the prospectus for the ETI was launched in September 2006, the then Secretary of State for Trade & Industry (Alistair Darling, MP) said...

'Not since the 1970s has energy been so high on political and media agendas, and a matter of public interest and debate. In just a few decades we must radically transform our energy but also the efficiency with which we use it and how we manage its transport and storage. The drivers for this are powerful ones, as we strive to assure the secure and sustainable energy that is fundamental to our prosperity and to our way of life, both now and for the long term. There can be no doubt that the challenge we face is a major one, in the UK and globally. But I believe it is also an exciting one, with huge opportunities to be grasped by those with the ingenuity and drive to take advantage.

Research excellence and innovation are central to achieving our energy goals. ...By bringing together the efforts and investments of both public and private sectors, and by focusing on key challenges with a new level of scale and ambition, we have the potential to achieve step change advances.'

Previous investment in energy, science and technology had demonstrated that low-carbon energy sources could be employed and that energy efficiencies could be achieved, but it was recognised that there was an urgent need to accelerate the pace and the volume of innovation activity directed towards the eventual deployment of the most promising technologies. In response, the ETI was set up to provide the UK with a pre-eminent, world-class means of delivering low-carbon energy technology research to underpin eventual deployment, by connecting the best scientists and engineers working in academic and industrial organisations both within the UK and overseas.

The work of the ETI deliberately occupied the middle ground between the longer-term research funded by the UK's Research Councils and the market deployment of proven technologies – the so-called "valley of death".

THE PPP

The ETI was designed to be inclusive, developing projects and partnerships with whoever could undertake the world's best R&D. It was recognised that some low-carbon focused research excellence exists within smaller companies (SMEs), and the aim was to structure the ETI to welcome and encourage the involvement of such firms in its project work, recognising the particular funding and other challenges that they face.

To achieve this, the core funding of the ETI was established as a 50:50 PPP, governed through a LLPA. The Institute became a Legal Entity in December 2007.

Six industrial members committing up to £5M per annum each, all matched by Government, provided an investment of up to £60m per year into UK-based low-carbon energy research. This matched funding approach meant that the Institute was able, where necessary, to provide 100% funding for projects it procures and still remain compliant with EU State Aid rules. This represented a significant increase in spend on energy R&D in the UK and it was designed to both build on and complement previous investments in academic energy research.

THE ETI'S CORPORATE STRATEGY

The core industry partners played a key role in shaping the initial research agenda for the ETI, ensuring that it accelerated low-carbon energy technology solutions in critical areas for industry. Together with Government, they set the following objectives for the Institute:

- To increase the level of funding devoted to R&D to meet the UK's energy policy goals, both domestically and internationally.
- To deliver R&D that facilitates the rapid commercial deployment of cost-effective, low-carbon energy technologies.

THE ETI WAS DESIGNED TO BE INCLUSIVE, DEVELOPING PROJECTS AND PARTNERSHIPS WITH WHOEVER COULD UNDERTAKE THE WORLD'S BEST R&D

- To provide better strategic focus for commercially applicable energy related R&D in the UK.
- To connect and manage networks of the best scientists and engineers, both within the UK and overseas, to deliver focused energy R&D projects and to accelerate their eventual deployment.
- To build R&D capacity in the UK in disciplines relevant to delivering the UK's energy policy goals.

This was interpreted by the organisation's leadership into a vision statement which described the ETI as providing

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

with a mission statement

> 'To accelerate the development 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.'

bp · CATERPILLAR · EDF ENERGY · Rolls-Royce · Shell · EPSRC Pioneering research and skills · Department for Business, Energy & Industrial Strategy · Innovate UK

THE ENERGY TECHNOLOGIES INSTITUTE LLP (THE ETI) –

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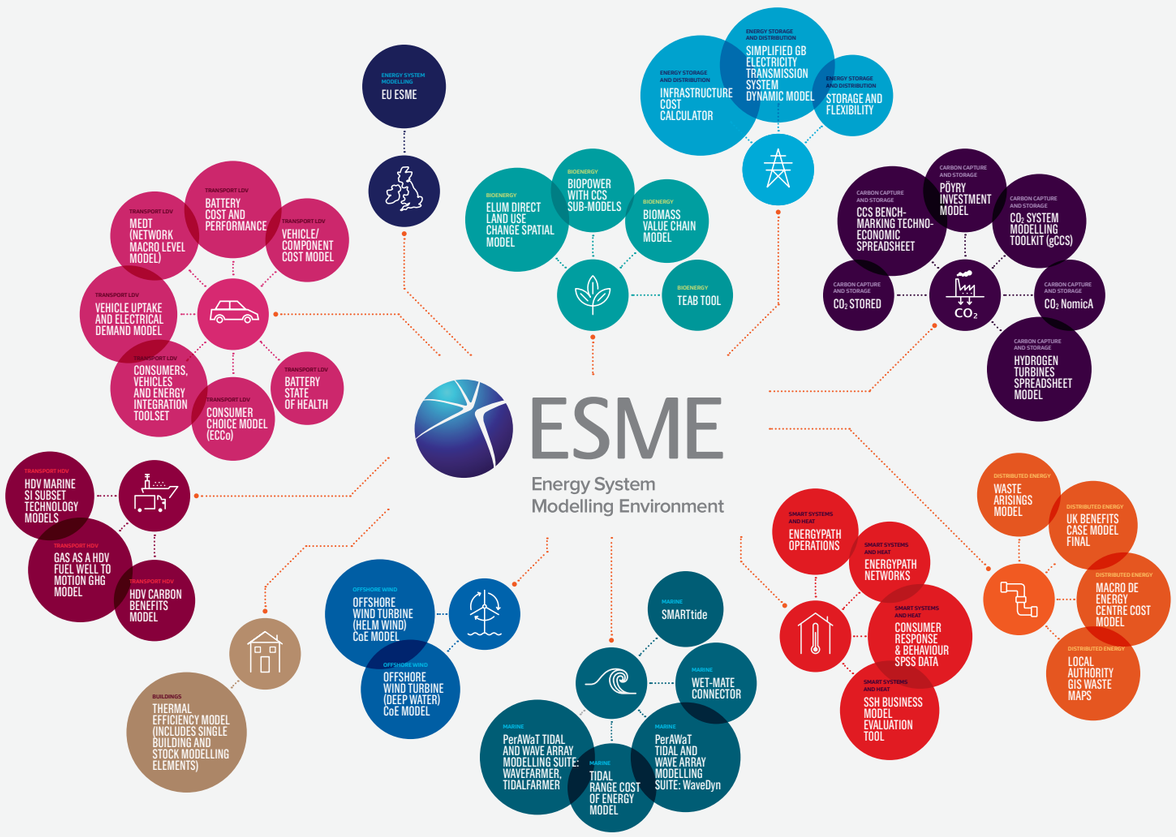
THE DEVELOPMENT OF A DETAILED TECHNOLOGY STRATEGY BECAME A CORE PART OF THE ETI'S OPERATIONAL PRACTICE



It also led to the definition of a set of specific outcomes for the ETI:

- Creating a major impact on policy development – project outputs which inform future policy / regulation / legislation, particularly around climate change and economic development.
- Supporting the development of critical supply chains – investment in the capability that leads to commercial development of key services, systems and component technologies for use in the UK and globally.
- Building investor and industry confidence – system and sub-system demonstrations that deliver market confidence and encourage future investment.
- Providing value to Members – knowledge and capability which is recognised by Members (both public and private) as improving their ability to deliver their own objectives within the energy sector.

MODUS OPERANDI

The operational structure of the ETI was established to enable it to select, commission, fund, manage and undertake, where appropriate, the delivery of defined R&D programmes. A significant proportion of the funding was focused on investments in a small number of key technology areas where the ETI could add value and where there was the greatest promise of deployment on the basis of their eventual contribution to low-carbon, secure energy supplies.

The development of a detailed Technology Strategy became a core part of the ETI's operational practice. This was based on the creation of a national energy system design and planning capability, which could deliver a whole system analysis through a suite of software models.

Not only did this capability create a highly effective Technology Strategy for the organisation, it also provided evidence and data that has informed the UK Committee on Climate Change and the Department for Business, Energy and Industrial Strategy and other government departments to support policy recommendation. It has also helped to influence industry groups targeting future investments.

Competitive mechanisms (with appropriate peer review for quality and for commercial relevance) have been used to procure specific innovation projects as part of this ETI Technology Strategy. These were carried out in centres of excellence across the UK and, where essential to the objectives of the Institute, overseas. Collaborative project teams were drawn from both large and small industries, and from academia. These collaborations benefited from the opportunity to leverage their own investment in R&D with that of the core funding, and having access to the ETI's infrastructure, network and capabilities.

Specific technology programmes were established with individual plans, milestones and timelines in order that the ETI could monitor progress towards specific objectives. Together, these programmes across heat, power, transport and the infrastructure that links them created a portfolio of engineering projects researching, developing and demonstrating new low-carbon technologies. By working together, sharing resources, knowledge and expertise, these low-carbon technology programmes were designed to accelerate the creation of innovative and commercially viable products and processes.

EVIDENCE GATHERING –

In order to **reflect on the impact achieved by the ETI,** the findings and observations contained in this document have been **developed using evidence gathered from the following sources:**

- ETI staff (past and present) – inputs were provided via a small number of facilitated workshops. These workshops explored aspects of the ETI's processes and operating model that were considered by staff to have added value to, or had hindered, the delivery of the ETI's mission. A summary of the key findings from these workshops can be found in Annex 1.
- ETI external stakeholders – to obtain an independent perspective from external stakeholders on their experiences of interacting with the ETI, a team from the School of Business and Economics at Loughborough University were commissioned to perform a series of 30 stakeholder interviews. These stakeholders included representatives from Government, ETI Industrial Members, academia and SMEs. A summary of the key messages derived from these interviews can be found in Annex 2.

Alongside these sources we have also drawn upon conclusions from a PhD study (funded by the ETI) and focused on knowledge management which used ETI as a case study and from which a number of academic presentations have been made. A summary of the insights arising from this research can be found in Annex 3.

This evidence was also supplemented with operational performance data from ETI records.

FINDINGS AND OBSERVATIONS

The evidence gathered from these sources was subjected to critical analysis from which a number of key findings and observations have been derived. For ease of reading these findings and observations have been grouped into the following four themes:

- Organisational Culture
- Operations
- The Public-Private Partnership
- Accelerating Innovation

Taking each of these in turn:

ORGANISATIONAL CULTURE

The ETI's strong leadership drove the organisation to achieve in a way that has been widely welcomed and recognised by external commentators. It was very effective at building a culture with strong values and a desire to deliver. This was reinforced by the LLPA that established the organisation and set some very clear expectations from the membership.

In any new organisation, culture forms quickly but is then very difficult to change. Continuous improvement requires deliberate and reflective management, and since an organisation's culture will generally reflect its leadership, there is a need to ensure that the leadership experience has a diverse range of backgrounds.

THE EVIDENCE GATHERED FROM THESE SOURCES WAS SUBJECTED TO CRITICAL ANALYSIS FROM WHICH A NUMBER OF KEY FINDINGS AND OBSERVATIONS HAVE BEEN DERIVED

The ETI has a rich engineering identity. This provides significant benefits, but also dominated the organisation's culture in a way which at times did not act to its advantage. The predominant behaviours delivered a task-oriented approach typical of engineers, and some non-technical staff struggled to contextualise their specific responsibilities. Also, at times during the partnership some non-engineers reported feeling under-valued and under-represented.

In some ways these issues were exacerbated by the operational processes used within the ETI. To streamline these processes, a 'by exception' approach to project reporting was adopted. This drove a culture of focusing more on problems rather than successes.

An organisation's structure is also important in the creation of its culture. In the ETI, a 'matrix management' structure was established, in which most staff simultaneously belonged to functional departments and smaller inter-departmental programme teams. This helped to provide focus as well as creating value, but it did not avoid the development of a "silo mentality" which in some cases impacted on the ability to maximise fully the organisational capability through skills transfer etc. There was recognition of a need to create the natural interactions between teams that lead to cross-functional working, but in practice these were not always fully effective.

The need to protect the IP of the organisation and its project partners became a dominant issue within the ETI and at times limited effective knowledge-sharing. Consequently, the ETI gained an external reputation for being an intellectual property 'protector' not a 'knowledge sharer', leading to inaccurate perceptions that this was what all the membership wanted. Positive endorsement of knowledge-sharing was needed to counteract the established culture of taking a cautious approach to IP protection. This was realised too late in the organisation's life.

A key learning from this analysis is that both internal and external perceptions of an organisation need to be acknowledged, understood and, where appropriate, addressed proactively. 'Listening' should be a key cultural objective for an organisation like the ETI, and the issues identified by such listening should be addressed through effective communication activities and a reflective approach to organisational improvement that addresses the whole organisation and its culture not just its business processes.

EVIDENCE GATHERING –

Continued »

OPERATIONS

The early establishment of a recognised culture, membership expectations and the organisation's strong leadership team led to the early establishment of the culture of the ETI. This culture then set the governance practices and operational responses employed by the ETI.

Whilst the success of the organisation in delivering against its original objectives for the full ten-years can be attributed in no small part to the way in which it was governed and operated, a number of salient lessons can still be drawn from this experience:

- Since the private sector members of the ETI were all large companies, there was a tendency for them to expect large organisation style governance and practices within the organisation. When applied to a small organisation like the ETI, these expectations impacted its agility and responsiveness, creating a level of bureaucracy described as 'onerous' by many external stakeholders. Specific examples of this included protracted contractual negotiations over IP and onerous detailed internal reporting requirements.
- Delays created by IP protection and approval processes resulted in some missed opportunities for delivering impact and a perception externally that the industrial Members were restricting knowledge-sharing to preserve commercial advantage – which was not the case.
- In business, contract negotiations would normally be led by "contract managers" supported by lawyers. In the ETI, contract negotiations were generally led by lawyers which led to some unintended consequences. For example, utilising an approach to contracting which involves a 'one size fits all' basic contract which is then negotiated on a case-by-case basis did not offer the ETI sufficient flexibility when funding many projects with different scales of activity.
- The deliverable review processes adopted by the ETI were seen as onerous by some project participants. There were strong project assurance reasons for doing this, but the organisation was often seen by external stakeholders as lacking in both flexibility and pragmatism in the way these processes were implemented.
- Adopting more agile and flexible operating processes from the outset would have been beneficial, since the nature of innovation requires a willingness to vary projects and contracts in response to changing circumstances.
- The ETI established a strong capability for project assurance which was seen as having significant value. This relied on employing individuals with exceptional project management skills.
- Innovation takes time, but stakeholders want visible action and momentum. Creating visibility and being open about early learnings requires communications capability and resources, since early successes secure a longer lasting legacy. Until its Communications function was restructured and strengthened in 2012 the ETI did not tell its story competently, nor did it share insights from 'failures' sufficiently to ensure that learning was maximised.
- During its early years the ETI was focused on setting up and delivering innovation projects. As a consequence there was insufficient early focus on impact and/or knowledge-sharing. On reflection it would have been beneficial for these to have been a more central part of the organisation's practices and processes from the start, with a much wider understanding of how project deliverables could be converted into outcomes and impact. This requires greater understanding of the needs of users of the knowledge created and project outputs that are subsequently shaped to meet these needs. It would have been beneficial for stakeholder identification, prioritisation, management and engagement to have been a more explicit element of the organisation's operations. The tacit assumption was that this was covered by engagement with the membership, but in reality this proved not to be the case. The external stakeholders and context for projects need to be kept under constant review – they change.
- The ETI developed a clearly stated, evidence-based and mutually agreed technology strategy which was hugely beneficial in terms of setting technology and project procurement priorities. A similar clear statement of the overall business strategy would also have been beneficial, most notably in terms of addressing the difficult task of managing varied and changing stakeholder expectations.
- Communication style is an important factor in the way an organisation is perceived. Perceptions of the ETI were improved when investment in communications activity increased. A focus on internal communication was also shown to be needed to address the issues created by the changing expectations of the membership and other stakeholders.
- The ETI has been successful in employing staff who believe in and are committed to its vision. Experience has shown that effective 'talent management' is needed throughout the life of an organisation to unlock the full potential and skills even from very committed staff.

THE PPP

There is broad agreement that implementing a PPP to deliver innovation in low-carbon energy was worthwhile. It delivered value and provided a useful learning experience for a range of partners. At the organisation's mid-term review point (2012) the membership wanted the organisation to continue, but the lack of a clear articulation of why the ETI will not continue beyond 2019 due to an uncertain economic environment influencing investment decisions has led to some external perceptions of failure.

PPPs provide stability and effective risk-sharing for long-term investments and the model creates good access to pertinent organisations and knowledge sources. They can take commercial risks that would be unacceptable for other investors, although this requires governance that is supportive and is not risk averse. The ETI model has also overcome some of the short-termism associated with normal political and business cycles.

The ETI's membership, naturally, had different expectations and needs, and these varied over time. The recession understandably had a major impact on these, creating a desire for additional financial returns from private sector members and an increased focus on wealth/job creation from the public sector. Whilst the ETI responded to these requirements, they were not the prime focus of the ETI at the start of its life (i.e. its mission was about developing and deploying low-carbon technologies to meet the UK's Climate Change goals). The impacts of these expectations led to changes in the operating model that naturally took some time to embed.

The value that has been delivered by the ETI has been much broader than anticipated and in some cases from areas that were not expected. Examples of this include the development of the strategic analysis capability and tools including ESME (Energy Systems Modelling Environment) a national energy system design and planning capability; the strategy development support provided to the ETI membership; and specific projects like the CO_2 Storage Appraisal Project (which produced the UK's first online CO_2 storage atlas). There has been less technology demonstration activity than was originally expected by some stakeholders, but it is the unbiased knowledge and evidence delivered by the ETI that has been identified as the most valuable return on investment it created. The ETI has established itself as a respected source of advice and evidence.

PPPs do, however, create complex relationships and governance expectations which can be hard to deliver and can stifle organisational performance. The legal agreement that establishes the organisation sets the context and can constrain operation and performance. Timing and relationships with the membership needs careful management, and subsequent changes in the membership can create IP issues that can have major implications for the operation. Open innovation and collaboration can be problematic for some large organisations.

Whilst the use of a PPP model helped overcome EU State Aid issues and allowed for 100% funding of SMEs and academia, this came with 'strings' that weren't fully understood by the project participants. An organisation set up by large organisations will most likely work for large organisations, but may not fit with smaller organisations – SMEs sometimes found the ETI's large organisation culture difficult to manage. The perception of ETI as a large industry-focused organisation undoubtedly created a barrier to some SME participation.

EVIDENCE GATHERING –

Continued »

ACCELERATING INNOVATION

The ETI has achieved the outcome it was seeking of accelerating low-carbon energy innovation, although ten-years has arguably not been long enough to extract the full potential value from the partnership. Specific examples of where this acceleration has occurred include:

- Taking a novel and transformational approach to the delivery of low-carbon heat in a retrofit environment through its 'Smart Systems and Heat' Programme.
- Carbon Capture and Storage – providing evidence to support the potential for CO_2 storage around the UK and supporting important underpinning developments in this technology.
- Support for the development of a more effective supply chain in the offshore renewables sector through interventions such as funding the Industrial Doctorate Centre in Offshore Renewable Energy (IDCORE) with Engineering and Physical Sciences Research Council (EPSRC) and leading the debate around the potential for delivery from specific technologies.
- Establishing the importance of and developing an evidence base for taking a whole systems approach to the delivery of low-carbon energy innovation.

and there are many more.

The whole systems perspective that the ETI has adopted is highly respected. There is significant value in undertaking evidence-based strategic thinking to inform interventions and to understand the impacts of these post-project completion. The ETI has challenged conventional thinking and has done this with detailed evidence-based analysis.

Innovation takes time, but stakeholders, particularly funders, often want visible action and momentum. However, chasing 'quick wins' does not necessarily deliver expected long-term value, although it can provide unexpected benefits.

Transparency becomes an expectation for an innovation organisation that is publicly funded. The Government requires published evidence for use in policy making and the concept of 'open innovation' sets expectations among all external stakeholders. This can sit at odds with the expectations of project participants who are seeking to create commercial opportunities from their involvement in collaborative projects, leading to some (but not all) being less open in their approach.

The upcoming end of the ETI will result in the cessation of an important funding stream that has had the ability to deliver significant funding to large-scale projects. With the ability to sometimes fund up to 100% of project costs this has been an important part of the way that the ETI has contributed to the acceleration of low-carbon energy innovation in the UK.

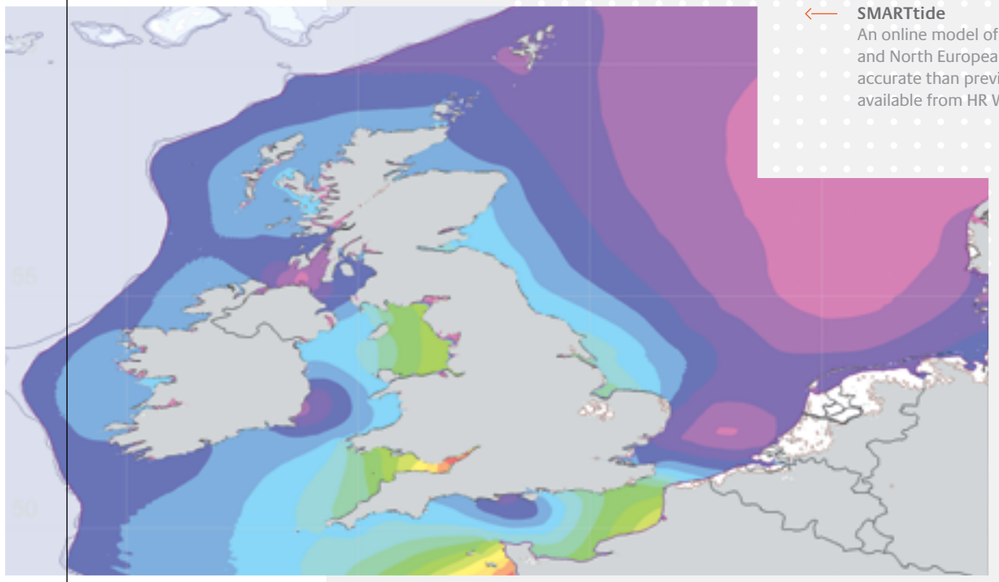
Capitalising on the value of demonstration projects is very difficult. The risks involved in large-scale engineering demonstrations mean that public sector support is crucial, but then so is committed and patient private sector investment. They need to work together to 'pick (potential) winners' based on strong evidence, whilst also recognising that if they are taking exaggerated risks then not all projects will deliver the hoped for outcomes. But whatever the outcome many valuable lessons will be learnt along the way.

The ETI proposition has not just been finance-led, it has provided engineering capability too. And when SMEs have embraced this model it has worked well and the ETI has been able to fund the development of significant skills and supply chain capacity in the UK. These successes have been most apparent where significant effort was put in to setting clear expectations on all sides. Effective innovation requires a focus on 'outcomes' not just the task-focused delivery of 'outputs'. Sharing knowledge about what does not work is also as valuable as delivering successful projects.

Innovation can be difficult for large organisations set up to deliver resilient services, and yet many such organisations in the energy sector are currently having to re-learn what it means to deliver successful new commercial offerings. The ETI has provided a pipeline of venturing opportunities and knowledge of where solutions were not ready for commercial deployment. However, it has also learnt that an organisation set up to share the risks and costs of demonstration activity is not necessarily the right vehicle for venturing.

The low-carbon energy landscape has evolved during the ETI's lifetime and the ETI has not always responded as quickly to this as it could have. The nature of innovation is that delivered outcomes and the stakeholders through whom they are delivered are not necessarily predictable at the start of a project. When developing an innovation programme technical issues should not be the only consideration.

THE UPCOMING END OF THE ETI WILL RESULT IN THE CESSATION OF AN IMPORTANT FUNDING STREAM THAT HAS HAD THE ABILITY TO DELIVER SIGNIFICANT FUNDING TO LARGE-SCALE PROJECTS



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

KEY LEARNINGS AND RECOMMENDATIONS –

→ The findings and observations summarised in the previous section have been **further developed to extract a number of key learnings** and to **identify a number of recommendations** that we feel are relevant to future energy innovation delivery bodies in the UK. These are summarised as follows:

THE ETI'S PPP MODEL

In the context of the ETI, the key benefits that a PPP has delivered are:

- Providing long-term stability and vision in an area of key strategic value to the UK.
- Delivering effective risk management and an appropriate level of funding capacity to deliver impac.
- Enabling access to a broad range of skills within the industry and within market participants.
- The ability to create a respected and independent knowledge and evidence base and disseminate it.
- A range of unexpected beneficial consequences, not least providing the organisation with the time and resources to think about, and analyse, the key strategic issues associated with the low-carbon energy transition.

However, adopting a PPP model to deliver innovation also created issues which need to be recognised. In the context of the ETI these were:

- The complexity of relationships and governance that it created.
- Managing the expectations and needs of a diverse membership which varied over time.
- Managing external expectations, particularly those among SMEs and academic institutions of the organisation's purpose.
- Managing the (sometimes negative) perceptions surrounding a large-industry based PPP which potentially acted as a barrier to engagement, particularly with SMEs.
- The constraints that were placed upon ETI operations by the legal agreement LLPA that established the organisation and which was agreed before the ETI began operating.

In conclusion, the PPP model has delivered significant benefits to the delivery of low-carbon energy innovation in the UK, and there is a clear ongoing need for innovation vehicles that deliver these benefits beyond the life of the ETI. This includes the need to maintain an ongoing UK analytical capability that can provide an independent knowledge and evidence base around low-carbon energy innovation and the longer-term low-carbon energy transition.

However, managing the expectations and perceptions of a PPP – especially one with a heavy industry focus – provides challenges that can act as a potentially significant barrier to engagement with particular stakeholder groups, most notably SMEs.

It is recommended that:

- Actions are put in place to ensure that the benefits delivered by the ETI's PPP model (and described above) are carried through into future innovation delivery vehicles in the UK.
- Future innovation delivery vehicles are set up in a way that ensures that external expectations and perceptions are pro-actively managed from the organisation's inception to deliver genuine engagement from a broad range of stakeholder groups.

CULTURAL IDENTITY

When setting up a new organisation, culture matters – and it needs to be developed early, nurtured and actively managed. Experience suggests that regular communication of a clearly stated set of 'values' can help to shape organisational culture, and celebrating success is an important part of building a shared vision and delivering effective outcomes.

In the ETI, the operational focus on IP protection (particularly in the organisation's early days) established a culture whereby some behaviours, governance and processes evolved that discouraged knowledge-sharing, reducing the external impact of the organisation, and therefore reducing its perceived value. There is a strongly-held view that the construction and wording of LLPA that established the ETI was instrumental in defining this culture.

It is recommended that:

- When new innovation delivery bodies are being established (or are in the early stages of their operational life) the cultural impact of their legal and operational frameworks on the organisation's ability to deliver its mission must be a prime consideration.
- When in operation, the organisational culture of innovation delivery bodies are regularly assessed to ensure continued alignment against their mission objectives.

ORGANISATIONAL EFFECTIVENESS

The ETI has benefited from strong and very effective leadership. This has driven the successful delivery of an organisation that is recognised by many external stakeholders as having made a significant contribution to low-carbon energy innovation in the UK.

The organisation and its leadership has been dominated by individuals with engineering / technical backgrounds. On reflection, it has become clear that an organisation like the ETI needed to be able to call on a much broader diversity of disciplines and experience to increase the impact of its innovation activities, particularly within its leadership team.

Effective talent management is needed to unlock the full potential and skills of staff and to increase organisational effectiveness. If an organisation is primarily delivering innovation project assurance then engineering project management is not the only skill set that will be needed.

Maximising the value of the skills and capability that do exist within a matrix organisation requires an organisational structure that delivers natural interactions between smaller project-focused teams. This was recognised in the organisational design of the ETI, but the organisation was still described as having a 'silo mentality' by some, particularly between ETI programme areas.

Significant emphasis was placed upon organisational improvement within the ETI, but this tended to focus on business process improvements. A more holistic ("mission focused") improvement approach would have helped to address some of the significant cultural and operational issues encountered earlier in the organisation's life.

KEY LEARNINGS AND RECOMMENDATIONS –

Continued »

The natural response of the large organisations that came together to create the ETI was to focus heavily on governance and processes. In the case of the ETI this created an overhead burden that was too great for an organisation of circa 100 individuals which was set up to be small, innovative, agile and responsive. Governance processes and the culture these can drive need to be appropriate to the size and mission of the organisation that is being established.

Arguably, the ETI misinterpreted the needs of its membership with regard to IP protection, leading to the creation of a risk-averse culture that did not deliver the required levels of pragmatism with contract agreements. This also limited the visibility of the progress that the organisation was making with external stakeholders, particularly early in its life. The ETI learned the importance of skilled communications resources too late in its operational life and was less effective than it could have been at integrating these skills into the organisation and ensuring that they were listened to.

The operating environment of the ETI was inevitably complex. There were many types and scales of project with many different types of delivery partners. Managing this complexity requires flexibility in the legal agreements that are applied. Added to this, the legal frameworks for delivering innovation will inevitably differ from those required for standard business services. The approach taken at the start of the ETI to establish a standard 'technology contract' agreed by the membership that could then be applied to all projects did not provide the flexibility that was needed.

Agility and flexibility are needed when delivering innovation projects. Empowerment and trust of individuals is as important in a small organisation as it is in a large organisation, particularly with regard to financial decision making. This is because delivery of large-scale innovation activity always requires project assurance processes that are flexible and responsive, which is not possible if every decision has to be referred "up the line".

The ETI did a very good job of creating a Technology Strategy that was clearly stated, evidence-based and mutually agreed with its membership. There was less evidence of the same level of rigour being applied to the creation and/or subsequent communication of a wider business strategy. This omission was to the ETI's detriment.

It is recommended that:

- When new innovation delivery bodies are being established, their governance structures and operational processes should be developed with due regard of the size and mission of the organisation. This includes considering a broad (not just technical) skill set within its leadership team. Additionally, more 'holistic' business improvement activities are likely to deliver additional value over and above a simple focus on improving business processes.
- An innovation delivery organisation's appetite for risk should be aligned with its mission and should be clearly and consistently communicated to stakeholders on an ongoing and regular basis. This includes staff to ensure that an appropriate approach to risk management becomes embedded within the culture of the organisation.
- As well as being clear on technology strategy, innovation delivery bodies should also be required to produce and maintain an over-arching business plan which defines the outcomes and impact that are being sought at the organisational level and the approach to their delivery. This will help set and manage external expectations around knowledge-sharing, communication and commercialisation objectives. Knowledge Management and Communications should be integral parts of this business plan.
- Once an innovation-delivery organisation's mission is established, all internal stakeholders (including the funders of the organisation) should be continuously challenged to support that mission and reflect regularly on how well it is being delivered. This will reduce the risk of deviating from the mission in response to short-term challenges.

EFFECTIVE INNOVATION REQUIRES A FOCUS ON OUTCOME RATHER THAN A NARROW FOCUS ON DELIVERING SEQUENTIAL TASKS AS 'OUTPUTS'

DELIVERING INNOVATION

The ETI experience has shown that delivering innovation in the energy sector requires a broad range of disciplines and is much more than simply about developing technologies. For example, having a clear eye on how new ideas might be commercialised, or understanding how policy might need to be evolved in new areas, are as critical to the innovation process as the technology itself.

Effective innovation requires a focus on 'outcomes' rather than a narrow focus on delivering sequential tasks or "outputs". This is especially the case in the energy sector where meaningful innovation activity can take several years, and where the context for innovation evolves continuously. Creating impact from innovation requires active monitoring of the energy landscape.

Sharing knowledge about what does not work is as valuable – if not more valuable – than delivering knowledge about "successful" projects. For innovation to succeed it is absolutely necessary to accept that some innovation projects will fail, and that the learning derived from these "failures" is widely shared.

Openness and transparency has a very positive impact on the delivery of innovation. An over emphasis on IP protection (which appeared to occur within the ETI) can lead to misperceptions by external stakeholders and a subsequent loss of value.

Capitalising the value of demonstration projects, and developing the level of financial returns from such projects that would be acceptable to commercial investors, is highly challenging. The ETI's PPP model created a vehicle for delivering the scale, ambition, risk-sharing and financing for demonstration-scale activities, but even then it was not easy. It remains unclear as to how this void in the innovation landscape will be filled once the ETI closes. There remains a hugely significant role for the public sector to play in de-risking these types of projects in the future.

A strong, independent evidence base and analytical capability (such as that developed within the ETI) reduces the risk associated with prioritising innovation spending and the necessary government role of "picking winners".

Positioning the ETI as a funder of demonstration activity provided improved 'line of sight' to commercial opportunities which delivered significant value and benefits to the membership and external organisations. However, an organisation set up to deliver development and demonstration activity is unlikely to be effective at commercial venturing.

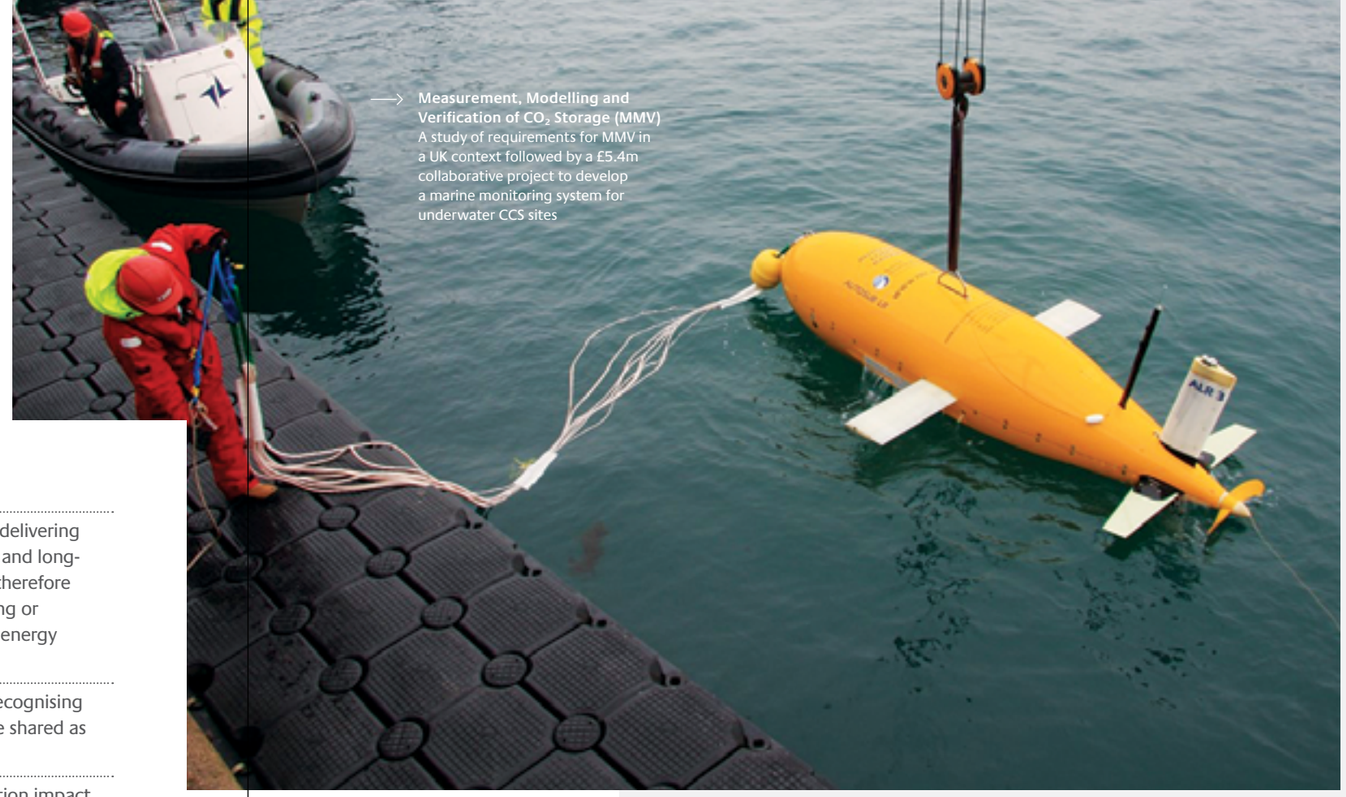
Organisations that are more familiar or are more comfortable with an open innovation approach have engaged more successfully with the ETI model.

It is recommended that:

- Innovation delivery organisations are created in such a way that they act and are seen to act in ways that are open and transparent. This should be reflected in their mission and their operational philosophy.
- Innovation delivery organisations within the energy sector should be set up recognising that a broad range of disciplines are needed to deliver this innovation successfully. It is more than just about developing technologies. Commercialisation, communications knowledge management, policy, and business development capabilities are all examples of other skills that are required. Holistic capability across these disciplines will maximise the value and impact of innovation delivery organisations.
- The public sector reinforces its critical role in delivering energy demonstration projects in the UK in terms of commercial risk mitigation. The loss of the ETI in the energy innovation landscape leaves a hole in this area.

KEY LEARNINGS AND RECOMMENDATIONS –

Continued »



→ **Measurement, Modelling and Verification of CO_2 Storage (MMV)**
A study of requirements for MMV in a UK context followed by a £5.4m collaborative project to develop a marine monitoring system for underwater CCS sites

DELIVERING IMPACT

The ETI has successfully challenged conventional thinking with evidence based on a 'whole systems approach' to understanding the impact of its interventions and to inform energy system transition thinking. This has been recognised as unique and highly valuable.

The ETI has delivered impact in areas that were unforeseen when the organisation started. The development of its in-house energy system modelling and analytical capability is a good example of this.

A ten-year life for an organisation like the ETI is not enough time for it to fully maximise the value of its operations. Innovation that supports the low-carbon energy system transition takes time and stamina, but key stakeholders also want to see visible progress and nearer-term benefits.

There is a need to be continuously aware of – and responsive to – the perceptions of internal and external stakeholders. Impact from innovation activities are delivered through the creation of benefits that can be exploited by specific stakeholders. It is important to be clear what these ultimate exploitation routes are at the start, but they should be kept under continuous review as they often change and there are often additional beneficiaries that materialise over time.

Delivering impact requires knowledge to be shared as well as IP to be protected. The ETI was observed to focus more on the latter which was seen potentially as detrimental to its value. There was a widely-held view that the ETI did not actively pursue or consider benefits realisation ("exploitation") early enough in its operational life. A focus on outcome and impact delivery needs to be embedded in organisational culture from the start.

Although the ETI's relationship with the SME community has overall been challenging, there are examples of where the capacity and technical capability of the ETI – in addition to financing – has been successful in supporting SME growth. ETI support for innovation has helped develop UK skills and capacity as well as delivering technology progression.

It is recommended that:

- Recognition is made by the Government that delivering impact through energy innovation takes time and long-term commitment, and that consideration is therefore given to organisational longevity when creating or developing organisations operating in the UK energy innovation arena.
- Innovation delivery organisations are set up recognising that impact delivery requires knowledge to be shared as well as IP to be protected.
- To maximise the chances of delivering innovation impact within the energy sector, innovation delivery organisations should be structured to focus on delivering overall "outcomes", through the creation of benefits for specific stakeholders, rather than simply task-oriented project outputs. The issue here is that the outputs expected at the start of an innovation activity are often not those that deliver most value by the end. Furthermore, the external landscape changes all the time so innovation activities must be aware of – and responsive to – these changes.
- Recognition is made by innovation funders that in many cases the biggest impacts arising from innovation activities can be delivered in areas that were unforeseen at the start. Approaches to innovation project selection and prioritisation other than those based solely on financial return should be explored to maximise the chances of unforeseen benefit realisation.

"THE ETI HAS DELIVERED IMPACT IN AREAS THAT WERE UNFORESEEN WHEN THE ORGANISATION STARTED. THE DEVELOPMENT OF ITS IN-HOUSE ENERGY SYSTEM MODELLING AND ANALYTICAL CAPABILITY IS A GOOD EXAMPLE OF THIS

ANNEXES –

ANNEX 1 – SUMMARY OF ETI STAFF INPUTS AND OBSERVATIONS

→ This Annex **summarises the observations made by ETI staff** during workshops sessions. These observations – and the insights they provide – have been grouped into the themes below. They are not in any order of priority. Some similar observations appear across a number of the different themes, but these have been left as-is and have not been rationalised further in this Annex.

Key themes:

1. Clarity of targeted outcomes is critical
2. There is a misalignment between delivering long-term impact and having to deliver "quick wins"
3. Culture forms early and is hard to change
4. The choice of organisational structure influences culture and mission delivery
5. Sharing knowledge is as important as creating and protecting it
6. Energy innovation takes time and ambition
7. Organisational strategy needs to be clear and process and procedures should be appropriate to the objectives
8. A clear and well-communicated operating model is needed
9. An organisation that is set up to take risks will have "failures"
10. External reputation is important and requires careful management

Considering each theme in turn:

1. CLARITY OF TARGETED OUTCOMES IS CRITICAL

Clarity of targeted outcomes – and remaining focused on delivering these outcomes – is critical to the successful delivery of innovation, especially in areas with longer-term emphasis (e.g. the low- carbon energy transition). Many ETI projects have involved the development and demonstration of new technology and system concepts. This involves taking risks that would not normally be considered acceptable to commercial organisations. By their nature these projects are challenging, can take several years to complete, and they require a range of skills and capabilities that are generally not found within a single organisation.

To this end, the ETI staff consultations highlighted the following:

- A focus on project outcomes should be part of all project, programme and organisational design.
- Delivering the ultimate outcomes and impact of a project are more important than delivering the individual outputs and deliverables within the project.
- Exploitation needs to be part of organisational culture from the start – any project should be set up with an understanding of how its outcomes are likely to be used after the completion of the project. This will increase the likelihood of longer-term impact.
- Large organisations are not necessarily the best at delivering innovation – one of the expectations of the ETI's public-private partnership model was that the inclusion of large industry players would provide a natural vehicle for high-value innovations to be pulled through and accelerated to commercialisation. Examples of this within ETI were limited.
- Culture develops quickly and is then very hard to change – instilling an outcome-focused culture within all project stakeholders (including the funding organisation) needs to happen from the outset.
- Given the (typically) long duration of large-scale innovation projects within the energy sector, the ultimate beneficiaries and vehicles that deliver a project's outcomes are often different to those anticipated at the start. Having an understanding of this is critical for long-term project success.
- Long-term demonstration projects are inherently risky. Market requirements evolve and change on similar timescales, and this can affect a project's impact. So it is important to be aware when delivering energy innovation projects that changes and developments in the external landscape will occur, and that the influence of these changes are reflected in the flexible design and evolution of a project.
- Careful selection of project participants with an outcome and impact focus is highly valuable. It is also important that project funding organisations are clear in setting their expectations of project participants at the start of a project, and that they provide support to project teams during project delivery when issues (inevitably) arise.

2. THERE IS A MISALIGNMENT BETWEEN DELIVERING LONG-TERM IMPACT AND HAVING TO DELIVER "QUICK WINS"

It is recognised that delivering impactful innovation in the energy sector is challenging, time consuming, and expensive. This is particularly the case given the usual expectation of significant at-scale demonstration before new technologies and systems become accepted by market participants.

In this context, the ETI staff consultations have highlighted the following:

- Delivering successful long-term innovation requires committed stakeholders with a long-term vision; but stakeholder commitment is often reliant on delivering early success or at least some early perceived value.
- There is a misalignment between quick wins and long-term impact – chasing quick wins may not necessarily deliver the anticipated long-term value, although it can sometimes deliver value that can provide benefits (and be exploited) elsewhere.
- Political cycles and business pressures do not encourage long-term thinking – a view was expressed that neither Government or industry appear comfortable at looking more than 10 years ahead. This remains a significant barrier to the successful delivery of innovation in the energy sector.

ANNEXES –

Continued »

3. CULTURE FORMS EARLY AND IS HARD TO CHANGE

In general ETI staff observed that although organisational processes took time to evolve, the underlying organisational culture was established quickly following the ETI's creation. And after this had happened, the organisational culture was hard to change – in fact there was little evidence of any significant change over the 10 years of its operation.

In this context, the ETI staff consultations highlighted the following specific points relating to ETI organisational culture and its impact on mission delivery:

- The culture of an organisation is important and should not be left to chance – it needs deliberate and reflective management rather than an approach based on allowing it to grow organically.
- When establishing the culture of an organisation, it is important to reflect on how to get the most out of people. Talent management (as opposed to performance management) within the ETI could have been implemented much earlier. It was felt that although the ETI attracted highly skilled and capable people, these skills were not used to the maximum extent because of a 'siloed' (programme-driven) organisational structure and culture.
- To enable staff empowerment the leadership team needed to be able to articulate what was to be delivered and what their expectations were. In the case of the ETI, the PPP model meant that the membership requirements seemed to change regularly (for example in financial value return expectations). This made the clarity/consistency of expectations on staff a challenge.
- Leadership style has a major impact on organisational culture and performance. The ETI was seen to have had strong leadership from the start which has many positives, but it can also stifle individuals within the organisation.
- Innovation and organisational leadership needs a broad range of skills, not just engineering – there was an argument that there was insufficient diversity in the ETI leadership team in terms of skill sets and experience.
- It is important that all functions within the organisation feel equally valued. The ETI had a very strong engineering and analytical culture which in some cases led to non-engineering staff and functions feeling undervalued.
- In addition, the strong engineering and analytical culture within the ETI failed to fully recognise that decisions are taken and options are chosen for a vast range of reasons, not just engineering or commercial optimisation. Consumer preference was given as an example, although it was recognised that this had received greater emphasis within the ETI in the last three to four years of its operation.
- The articulation of ETI messages externally to the organisation has tended to 'tell' rather than 'engage' – this improved over time, but remained an underlying feature of how the organisational culture manifested itself. Was the ETI therefore too focused on communicating the "right" answer rather than providing options and implications?
- The ETI staff have demonstrated a high level of commitment / engagement throughout the life of the ETI, reflecting their belief and alignment with the ETI mission. This has been maintained even during the wind-up process of ETI operations.
- ETI established a culture of taking time to analyse, reflect and understand the full impacts of intervention options in the context of the energy system as a whole rather than jumping in to make rapid (un-evidenced) decisions. This has been seen as a significant strength.
- A culture of openness, transparency and consistency are hugely important both internally and externally if innovation impact is to be delivered successfully. Staff commented that the culture established within the ETI was generally focused on protecting membership value over and above external transparency, and this has only recently started to change significantly.
- Having a programme team – the Smart Systems & Heat team (subsequently transferred to the Energy Systems Catapult in 2015) based at a different location to the rest of the ETI created barriers that proved hard to manage and reconcile. It was suggested that this may have been a consequence of a different culture/mentality having grown organically in the remote location.

4. THE CHOICE OF ORGANISATIONAL STRUCTURE INFLUENCES CULTURE AND MISSION DELIVERY

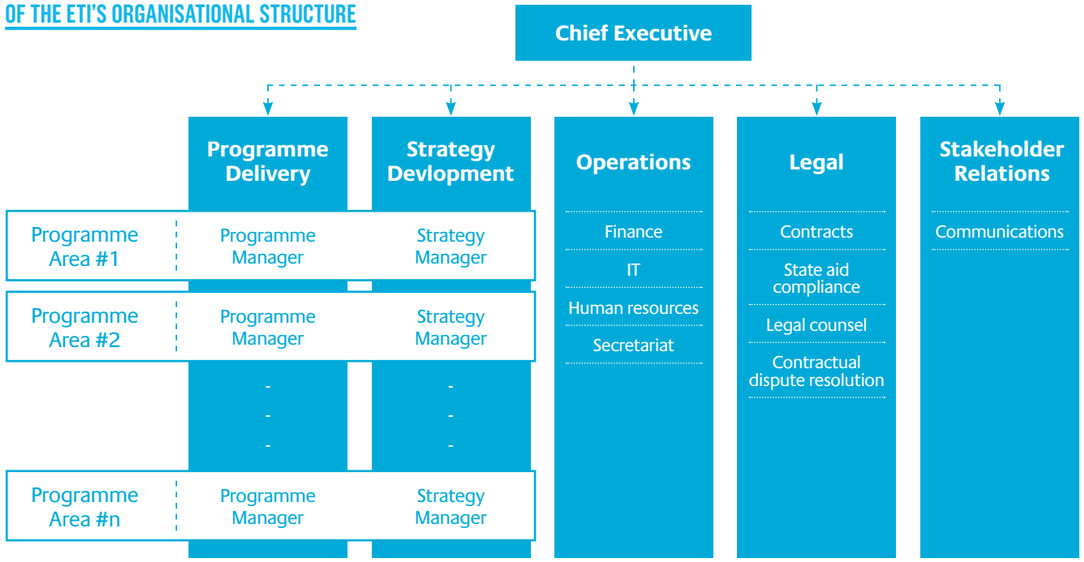
Even in small organisations (such as the ETI) 'siloed' working is common and difficult to overcome. This was seen as a barrier to delivering successful innovation. Creating and encouraging cross-functional project teams, and recognising this in organisational structure, is most likely to deliver successful innovation outcomes.

The organisational structure implemented by the ETI is shown schematically in Figure 1. This comprised five traditional functional Directorates reporting to the Chief Executive.

Operationally, projects were delivered under a number of thematic Programme Areas (e.g. Offshore Wind, Distributed Energy, Bioenergy, etc). Each programme area comprised a Programme Manager responsible for the delivery of the portfolio of projects within the programme, and a Strategy Manager responsible for identifying, defining and providing technical oversight to those projects. Each programme "team" also included a number of project managers to deliver specific projects, and strategy analysts to support the Strategy Manager in technical and impact analysis. In some cases lawyers were also allocated to specific programme areas although, this arrangement was generally less formal than in the case of the Programme and Strategy Managers.

A key part of the ETI's work focused on "whole energy systems thinking". This was delivered by regular interactions between the Strategy Managers, in conjunction with other members of the Strategy Development Directorate, to bring programme-level insights together at a system level.

FIGURE 1 - SCHEMATIC REPRESENTATION OF THE ETI'S ORGANISATIONAL STRUCTURE



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The ETI staff consultations have highlighted a range of issues in relation to organisational structure. It is clear from the staff feedback that the approach adopted by the ETI has had both positive and negative consequences in terms of mission delivery. Furthermore it is clear that there is no "right" organisational structure from the perspective of the individuals who have worked in the ETI; individuals have a range of preferences and this was borne out in staff responses:

- It was observed that the evolution of small programme teams provided focus and had a positive impact in terms of ensuring project delivery within the particular programme area. This also created a culture of common purpose within those small teams.
- However, it was also observed that the programme structure created artificial silos both within the Programme Delivery function itself (i.e. between programme areas) but more broadly within the overall organisational structure of the ETI. This led to weak integration across teams and reduced the opportunities for cross-team working. Individuals were expected to build detailed sector-specific knowledge, but to a much lesser extent develop skills that could be transferred across sectors. Furthermore some individuals felt that the programme-focused structure also led to their pre-ETI skills and experience not being exploited as well as they could have been in other areas of the organisation. In some cases it was also noted that different ways of working had evolved between staff working in the different programme areas as a result.
- The boundary between the Programme Delivery and Strategy Development Directorates (as project delivery and technical functions respectively) was seen as somewhat artificial; in some cases it reduced the sense of cohesion within programme areas.
- The organisational structure is not the be-all and end-all of success. Creating a sense of "one team" through, for example, whole-organisation team building events (with purpose, not artificially-created) and more "management by walking about" are critical to delivering success.

5. SHARING KNOWLEDGE IS AS IMPORTANT AS CREATING AND PROTECTING IT

Two key objectives of the ETI were to accelerate the development of affordable low-carbon technologies in the UK and to inform the energy transition debate through evidence-based analysis. Delivering both of these objectives has led to the generation of huge quantities of knowledge. Some of this knowledge has taken the form of "traditional" technology-related Intellectual Property (IP). Other knowledge has included (for example) developing insights into the strategic options for delivering the low-carbon energy transition through whole energy system analysis, understanding how market and technology development might interact, and supply chain development opportunities.

Staff consultations have highlighted that striking the right balance between protecting IP and sharing knowledge is critical to delivering the innovation mission of an organisation like the ETI. It was the widely held view amongst staff that in the early years of the ETI the organisational culture was heavily focused on protecting and managing IP rather than sharing knowledge and exploiting the ETI's activities outside of the organisation. On reflection, it appears that there were a number of reasons for this:

- A lack of clarity and consistency internally on the IP ownership/licensing strategy of the organisation and how it should be applied.
- An over-emphasis on commercial risk mitigation – the ETI was set up to take risks, but behaved in a risk-averse manner from a legal perspective.
- ETI's communications, knowledge management and exploitation activities not being integrated into the organisational culture from the start.
- A misunderstanding of the external stakeholder environment.

It was also observed, however, that there had been a significant change in emphasis within the ETI over the latter half of its lifetime towards a much more open and willing-to-publish approach which had delivered significant impact as a result. There was a widely shared view amongst staff that the ETI should have focused much earlier on the external communication of its activities to the wider stakeholder audience.

Specific staff observations included:

- External communications and knowledge management are key to delivering the mission of an organisation like the ETI and should be embedded in organisational culture from the word go. This requires skilled resources and appropriate levels of funding.
- The ETI's exploitation activities should have been thought-through and embedded in the organisation's way of doing things from the start.
- Some of the ETI's external publication material was over-complicated. There could have been more emphasis placed on delivering simplified messages – this is a cross-organisation responsibility.
- There is a need for a common understanding of what "effective" Knowledge Management means from the start. The ETI did not share knowledge outside its membership early enough and there is evidence that this was interpreted outside the organisation as a lack of transparency and/or over-protectionism. This may have been the result of over-analysis to get the "right" answer in relation to energy system insights, or simply down to over-zealous protection of IP in relation to technology projects. Good knowledge management is not just about protecting IP.
- There is a cultural dimension to this – technical people / engineers are often familiar with (and understand) IP protection, but are not so good at sharing knowledge.
- There was a tacit assumption when the ETI started that the ultimate beneficiaries of project outputs were primarily the ETI membership and project participants. It became clear as time progressed that there was a much broader range of external stakeholders that could benefit from ETI project outputs.
- It would have been advantageous for the ETI to be more open to sharing data earlier, thereby allowing it to be used on other projects at earlier stages.
- Building in an "obligation to publish" into ETI contracts may have helped in making the ETI's activities more visible.

6. ENERGY INNOVATION TAKES TIME AND AMBITION

The energy sector has historically been characterised as being highly risk-averse. The ETI was set up in recognition of the fact that delivering a transition to a low-carbon future will challenge the conventional industry norms. The ETI was positioned to focus on the so-called energy innovation "valley of death" between early stage development and commercialisation. This generally comprises pre-commercial technology or system-level demonstration activities (TRLs 3-6), and in the context of low-carbon energy systems this normally means near commercial scale trials. Activities of this type are often high-cost (several £m) and can take several years to complete. This makes them challenging both in terms of financial investment but also in terms of technology risk. Long-term commitment is therefore critical for success.

ETI staff have been working in this area for the last ten years and have made some very insightful observations about their experiences:

- Getting a new innovation organisation going and operating effectively is a long-term process. It takes several years. Opting for the "obvious" choices at the start does not mean they will be the right choices, so providing a new organisation with the flexibility to change tack when necessary will be highly valuable.
- Choosing appropriate operating processes from the outset would have been highly valuable to delivering early successes. Staff felt that the operating processes that were implemented by the ETI during the first couple of years were overly complex ("large company processes imposed on a small organisation") and led to inefficiencies that took some time to rectify. Adopting agile and flexible operating processes from the outset would have been beneficial.
- Evidence-driven priority setting is something ETI has done well. Making large investments in demonstration activities requires very careful consideration of options and risk. The ETI's evidence-driven approach to assessing investment opportunities using in-house whole system modelling and analysis capability, and the targeted project investments arising from this analysis, were seen as highly beneficial.
- In the current financial environment the public sector has an increasingly critical role to play in the financing

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of large-scale energy demonstration activities. The ETI experience has shown that capitalising on the value of demonstration projects is extremely difficult, and these projects seldom provide commercial returns in their own right. Even with the significant financial backing provided by the ETI membership, developing the business cases for large-scale demonstration projects has proven to be highly challenging. Public sector financial risk mitigation therefore remains crucial. And the scale of financing required to make it happen means that "picking winners" is inevitable and should not be avoided.

- Innovation cycles are very long in the energy sector, and delivering innovation with lasting impact takes time. Long-term commitments are needed to deliver long-term innovation processes. The view of staff was that the ten year life span of the ETI was not long enough to deliver its full value (indeed it feels like the rug was pulled from underneath the organisation just as its true value was starting to emerge), but it has focused the minds of those involved on learnings and legacy which can only be positive.
- Given the long timeframes for demonstration projects, the stakeholders and beneficiaries for the final "product" are not always those that were initially expected. It is therefore important to continuously appraise the changing external landscape and question whether a project's initial objectives remain valid to ensure that demonstration activities remain relevant and appropriate to the markets that will facilitate commercialisation.
- Although much energy innovation is focused on the long-term, it is important (where possible) to deliver nearer-term value along the way to keep stakeholders engaged and to help shape the longer-term innovation pathway.
- Technology development can often only be a relatively small part of successful innovation. Balancing technology, business models, supply chains and other aspects collectively is likely to deliver greater success overall.
- Planning and identifying potential next steps for innovation projects can often take longer than expected. But do it well and it can deliver significant value.
- "Mistakes" will inevitably be made when delivering long-term energy innovation activities, but these mistakes are absolutely necessary for learning and should not be seen as negative. There can be too much focus on delivering project "successes" rather than making the most of the highly valuable lessons learnt from "mistakes".

7. ORGANISATIONAL STRATEGY NEEDS TO BE CLEAR AND PROCESS AND PROCEDURES SHOULD BE APPROPRIATE TO THE OBJECTIVES

The ETI's PPP model was in many ways an experiment in the energy innovation arena with no known precedent. Its governance structure was agreed by the prospective industrial and public sector members during the partnership negotiation phase which took place during 2006 and 2007. The ETI commenced operations in December 2007. The organisational structure of the ETI was developed and implemented in early 2008. Many of the ETI's operational processes were developed in similar (rapid) timescales via consultants external to the organisation. This structure and these processes defined the way ETI operated throughout much of its operation.

Staff consultations highlighted the following:

- The way the LLPA was negotiated had a profound long-term impact on the organisation. The LLPA agreement was primarily created by lawyers from the ETI membership. The ETI's management team therefore joined the new organisation with its governance structure already agreed. Having to deliver in line with the pre-defined governance requirements had a profound impact on the shaping of organisational culture.
  - From a governance perspective, staff felt that delivering the requirements of the LLPA had the (unintended) effect of imposing "big company" processes and governance on the much smaller ETI organisation. In the early days especially, this led onto significant levels of bureaucracy which limited the organisation's agility and ability to be responsive. In addition, there was a view that the private sector members' need for the ETI to remain a good news story (e.g. could not afford H&S incidents, etc) – whilst entirely understandable – led at times to conservative / over-burdensome operational processes.
  - The implementation of the ETI's governance requirements seemed to drive a focus on reporting. The time spent on producing reports to satisfy the perceived needs of the governance process led to significant demands from the ETI and from project participants. It was unclear whether the level of detail provided in ETI governance reports was actually needed or whether this had been tested.
  - The shape of the ETI evolved over time, but this often appeared to be in response to changing direction from the ETI Board. An example of this was the (relatively short-lived) change in emphasis around 2012 towards delivering tangible financial value return from projects in addition to accelerating the deployment of affordable low-carbon technologies.
  - Consistency of mission is crucial – and also how it is applied across the organisation. Whilst the ETI's mission statement has never changed, the (apparent) changing directional emphasis from the ETI Board at certain points in time led to uncertainty about how best to deliver this mission. On reflection, staff noted that it would have been helpful to have been provided with clarity on (and provided continuous reinforcement of) the organisation's:
    - Intended outcomes
    - Position in the innovation landscape
    - Interactions with other stakeholders
    - Definition of success
  - The decision to locate the Smart Systems & Heat programme team away from Loughborough, whilst understood to be partially a response to office capacity constraints, also appeared to be a mechanism to satisfy membership expectations in respect of IP management. This had significant organisational repercussions that ultimately led to the unintended fragmentation of the ETI into two separate groups. Separation of location is not in itself an issue, but the operational barriers put in place (in this case) to manage IP did create issues.
  - Getting the right balance of risk and reward during contract negotiations is always a challenge. ETI staff observed that in many cases, detailed contract negotiations were led by lawyers rather than the project managers. This had very significant resource and performance implications (e.g. very long contract negotiation times). It was recommended by several staff that a more pragmatic approach to contract negotiation would have been highly beneficial, e.g. led by Programme Managers supported by qualified Contracts Managers who can call on lawyers as required, rather than driven by lawyers.
  - There was a widely held staff view that the ETI's organisational strategy has been primarily driven by "technology" rather than by the delivery of the broader ETI outcomes. Broader outcome delivery also requires an effective "business" strategy as well as a robust technology strategy.
  - The ETI experience has shown that an effective innovation process will not deliver fixed (pre-defined) outputs but will deliver "outcomes" which can often be unintended. Having to manage innovation projects that deliver a range of pre-defined outputs at the start is not necessarily conducive to delivering successful innovation and valuable outcomes. Flexibility and agility is therefore required to respond to changing circumstances.
  - Having a strong in-house whole system modelling and analytical capability to provide insights into where innovation opportunities exist and what project interventions are required was considered by staff to be a highly valuable ETI asset. Additionally, the ETI's in-house ability to deliver broader contextual insights from project outputs and outcomes (i.e. answering the "so what?" question) was also seen as being highly valuable. The ETI's experience has shown that project teams / innovators themselves are unlikely to be able to deliver this context.
  - The contractual frameworks used to deliver long-term innovation need to be flexible to changes in circumstances. The ETI often used fixed-price contracts to reduce financial risk, but this in itself may have introduced unintended constraints to the innovation process. Managing innovation projects through more agile approaches in order to introduce greater flexibility will be more appropriate in many cases.

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8. A CLEAR AND WELL-COMMUNICATED OPERATING MODEL IS NEEDED

- The ability of the ETI to provide 100% funding for projects was seen to be well-aligned with the needs of the SME community who often find it hard to provide the match funding required in publicly funded projects. However, this very different model of innovation funding did create issues of expectations – it was not grant funding but nor was it a strict commercial proposition.
- Experience of running this funding model suggests that both its structure and the implications of that structure need greater clarity and far better communication from the start. Project participants need a better understanding of what is expected of them and issues of alignment of objectives need to be addressed early in the procurement process.
- More broadly, the level and type of support offered by the ETI to innovators has been noticeably different to other funding bodies. In addition to offering higher levels of financial support, the organisation has delivered market interventions with examples of project engineering support and the support in the development of new product introduction processes that have proved invaluable to the SMEs involved.
- Whilst a number of organisations have benefited from this engagement, the mismatch of expectations has led to others rejecting the ETI model. These issues have been compounded by the struggle that the membership have had with how to deliver value from the PPP. At one stage, a short-lived emphasis on financial value return to the membership led to a change in strategic emphasis for the ETI, which had a severe impact on its relationships with other stakeholders.

9. AN ORGANISATION THAT IS SET UP TO TAKE RISKS WILL HAVE "FAILURES"

- Despite it having been set up as a means of sharing investment risk between industry and government, a risk-averse culture had been established within the ETI. The pressure to be seen to be successful as a project management organisation mitigated against its ability to derive and publish knowledge from projects that had not delivered positive commercial outcomes.
- Reflecting on this issue, staff concluded that the appetite for risk within the ETI was too low for an organisation set up as a PPP that could take commercial risks that would be unacceptable to other investors. The culture that became established within ETI was one in which a 'successful project' was one that reached completion on time and on budget. Very few projects were stopped midway through. However, a delivery driven culture of this kind does not reflect the needs of an organisation set up to accelerate innovation, one in which it is necessary to accept that some projects will fail and that the learning derived from such 'failures' is as important as the knowledge created from the organisation's successes.
- Open communication and transparency were seen as key to this process. Publishing results, lessons and identified pitfalls earlier would have enabled external stakeholders to learn from projects that did not work as much as from the 'success' stories. To achieve this, it was even suggested that rewarding an organisation's leadership for delivering greater openness should be considered.
- Staff also observed that the risk averse culture was reflected in the organisation's procurement processes, with an apparent inability, particularly early in ETI's life, to vary contracting approaches to meet the needs of different sizes of project. This was coupled with insufficient pragmatism around the way in which contracts were negotiated, especially for smaller projects, leading to unnecessarily long negotiation periods.
- From the perspective of the organisation's strategy, a paradox was noted within ETI between undertaking work that was in the national interest and delivering value to both public and private sector members. The membership was seeking a value return on their investments (which was not measured purely in financial terms) and also had varying strategic needs (both temporally and between the membership). This added to the issues around the approach to risk within the organisation, as did the changing energy markets and economic conditions that prevailed throughout the lifetime of the ETI.
- The long-term nature of the ETI investments created the potential for a more strategic and potentially higher risk strategy to be adopted, but there was still a tendency for the organisation to be reactive in its responses to changing membership interests and market conditions.

10. EXTERNAL REPUTATION IS IMPORTANT AND REQUIRES CAREFUL MANAGEMENT

- Staff were aware that the ETI has been seen as a 'tough client'. Questions were raised about how well this message had been listened to or reflected upon, with a suggestion that the ETI had not responded to it in either its operations or its external communications. This may have led to disengagement and a reluctance of potential partners to engage with the ETI.
- The ETI's rigorous approach to project definition, commissioning, delivery and exploitation was seen by staff as a strength of the organisation but, since this approach is not common in the innovation space, its benefits were not very well understood and it was not always sold as a benefit. There was a perception that the ETI needed to create greater clarity about its expectations through broader and more effective communication to project participants at the outset of projects.
- There was also some confusion apparent over the role of the ETI. Staff identified rigorous project management as a core value of the organisation, with well-established processes, success criteria and reporting protocols. However, they also questioned whether this level of process was needed when the main role of the ETI had been to deliver 'project assurance' of innovation investments.
- The focus on effective project management had led to a belief within the organisation that it existed to deliver engineering projects which in turn created culture and processes with time/cost implications that were at odds with a project assurance role. If the role of the ETI was to support others to deliver innovation, staff questioned whether there were other ways of achieving these same outcomes.

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ANNEX 2 – SUMMARY OF EXTERNAL STAKEHOLDER INPUTS

→ To establish an **external and independent perspective on the ETI experience,** a team from the School of Business and Economics at Loughborough University were contracted to provide an **evaluative project** in which a sample of ETI stakeholders were interviewed to help **identify key learnings from the ETI's operational life.**

Interviewees were selected to be representative of the ETI's external stakeholders, including those from government, industrial members, academia and SMEs. Around 30 interviews were conducted.

The following text captures a summary of the responses received from the external stakeholder group.

THE ETI HAS DELIVERED AMBITION, CAPACITY AND SKILLS...

From an analysis of the views expressed by our external stakeholders, it is clear that the ETI has indeed delivered a unique focus and created a necessary capacity to fund demonstration activities that bridge the gap between the development of low-carbon solutions and their subsequent commercial deployment. By their nature these carry commercial risks that the ETI's funding was designed to manage.

The way in which the ETI was set up and funded meant that it had the capacity to make larger investments than other public funding bodies, and the involvement of industrial members added important expertise – through risk management and commercialisation skills.

These capabilities were further reflected in the staff that ETI was able to recruit, who were seen by the respondents as professional, skilled and knowledgeable, providing good project leadership, and always keen to listen, learn and challenge.

There is now real concern about where the funding for significant low-carbon energy demonstration activities will come from in the future.

THE ETI HAS CREATED AN EFFECTIVE AND WIDE-RANGING LEGACY THAT WILL SHAPE THE FUTURE OF ENERGY IN THE UK ...

- The innovation funding delivered by the ETI has developed skills that were not previously available in the low-carbon energy sector. In particular, project participants noted that their capabilities had increased through their involvement with the ETI, and that having the ETI as a client is a marketable asset.
- The oversight of projects and their progress provided by the ETI was welcomed and seen as constructive. Some even went as far as to describe the organisation's project management skills as 'excellent'.
- Key elements of the legacy created by the ETI include the funded programmes and their outputs, and the modelling work delivered through ESME and the other detailed sub-system models that the ETI has created.
- The value delivered by ESME has been much broader than expected, supporting a technology strategy development process that has proved beneficial to all those who participated in the funding decisions made by the ETI (both internal staff and external advisors). This approach has been emulated, and ESME outputs have been used to inform strategy development outside of the ETI as much as they have to set the agenda for the interventions ETI has made through its funding of specific innovation activity.
- The capacity developed through the creation of ESME and the associated strategic analysis capability within the ETI is another important legacy of the organisation. Respondents were pleased to see this being transferred to the Energy Systems Catapult. They were also pleased to see the ordered way in which the activities of the ETI were being wound up and the efforts that were being given to learning lessons from the organisation's experiences (something that is not typically done for organisations delivering R&D or innovation).
- In general, involvement in the ETI has been a useful learning experience for a range of partners. In itself, the organisation's operating model has provided a useful case study to government, and other organisations (e.g. the Oil & Gas Climate Initiative) are seeking to emulate the more positive aspects of the model. Also, the network of participants that has been built around the ETI has nurtured other beneficial collaborations.

THE ETI HAS MADE A RESPECTED, EVIDENCE-BASED CONTRIBUTION TO THE DEBATE AROUND THE TRANSITION TO A LOW-CARBON ENERGY SYSTEM IN THE UK...

The ETI has achieved recognition for delivering a broadly based and balanced portfolio of innovation activity, covering diverse technology interests but very firmly within a systems context. The strategic approach taken to establishing this programme mix has been effective, with a stated strength of the organisation being the approach it has taken to defining potential low-carbon futures and associated innovation needs.

> **THE INNOVATION FUNDING DELIVERED BY THE ETI HAS DEVELOPED SKILLS THAT WERE NOT PREVIOUSLY AVAILABLE**

In this way, the ETI has successfully fostered and accelerated low-carbon energy innovation.

In reflecting on what the ETI has achieved, it was clear that stakeholders valued the knowledge more than any financial return they might have received from the ETI. The ability to support and promote innovation in both technology and policy were recognised as ETI skills, and the ETI is clearly seen as a non-partisan expert in its field, providing rigorous, evidence-based and influential analysis of the sector. For these reasons it has become a respected source of advice and evidence for policy makers, providing an important perspective on the options for a future low-carbon energy system. A key aspect of this advice has been the way in which, throughout its lifetime, the organisation has continued to promote the idea that an 80% reduction in greenhouse gas emissions by 2050 is achievable and affordable.

In conclusion, the ETI has clearly influenced the debate around the transition to a low-carbon energy system. However, some respondents did feel that more could have been achieved.

THE ETI'S LACK OF OPENNESS LIMITED THE IMPACT THAT IT ACHIEVED...

When the ETI was established expectations were set about the way it would operate, delivering large-scale demonstrations of low-carbon energy solutions, and driving these through to the point where the solutions were being commercially deployed. Whilst some respondents recognised that this approach would create 'back-end loading' in the outputs from the organisation, there was some disappointment expressed in the lack of visibility of large-scale demonstration impact from the ETI. There was also less evidence of commercialisation in the ETI's work than many had originally expected, and further disappointment that significant commercial success was not a visible part of the ETI's legacy.

At the beginning of the ETI there was a belief that it needed to move quickly into a delivery mode to demonstrate the value that the organisation could create. The respondents felt that this should have resulted in some 'quick wins', which were not achieved. Neither had the organisation been sufficiently open about what it had learnt from the projects that had not worked.

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Whilst the whole systems approach that the ETI adopted was recognised as having significant value, there was a sense that this thinking, and the associated focus on technical solutions, had dominated at the expense of a broader economic, industrial and consumer perspective. In addition, the ETI's system model ESME was not seen as 'open source', limiting its usefulness within government. It was even suggested that ESME and its benefits could have been 'sold harder'.

The mid-term review of the ETI identified that external communications from the organisation needed to be stronger. Whilst significant efforts had been made to address this, respondents still felt that the ETI could have achieved greater impact through wider IP dissemination. Greater openness and sharing of knowledge could have happened much earlier in the life of the ETI, making the outputs of the work more widely available and securing a more effective and lasting legacy for the organisation.

There was a feeling that the ETI should have been less concerned about IP and more focused on the influence it was achieving. It could have been better at promoting and championing the issues associated with delivering effective low-carbon energy innovation. The poor visibility of the ETI's work beyond its immediate circle of associates led to it being seen as the 'Bletchley Park of energy innovation'.

It was also clear that additional expectations had built up around what the ETI would deliver. Respondents felt that it should have had a stronger role in wealth creation, and the lack of continuation funding for the organisation was seen as an indication that the membership had not been convinced of the value it was delivering.

THE ETI'S OPERATING MODEL – A PUBLIC-PRIVATE PARTNERSHIP – PROVIDED STABILITY BUT CREATED CHALLENGES...

There is no doubt that the use of a PPP has provided balance and stability, ensuring that the ETI was able to operate successfully for ten-years and deliver an unprecedented level of financial risk-sharing between government and private enterprises operating in the energy sector.

PPP's are also, however, renowned for creating operational complexity (ref needed), and the ETI was no exception, at least in terms of the perceptions stakeholders had of the way in which the organisation had balanced an 'open innovation', public funding model with the more closed commercial environment of its private sector members.

The use of public funding to support the development of IP clearly set an expectation of greater transparency and led many to conclude that the ETI would have benefited from a more open and less restrictive model. There was a commonly held perception of the ETI as an 'exclusive partnership' for the benefit of its membership.

The perceived benefits of partnering with the ETI clearly varied with the level of involvement. Respondents from the membership and other large industry players reported an ease of access that was not reflected in the responses from SMEs. Respondents from large organisations found the ETI approach to projects rigorous and beneficial, whereas SMEs often found their engagements with the ETI to be time consuming, reducing the value of the relationship. In some cases SMEs expectations of access to ETI membership was not fulfilled, and the issues they encountered were often compounded by their concerns about the ETI's position on IP.

The ETI needed to deliver to a broader stakeholder community than just its membership, and it is clear that the perceptions that some of those stakeholders have of the ETI and its operating model have prevented this engagement from being as successful as it might have been.

EXTERNAL PERCEPTIONS OF THE ETI'S FOCUS ON IP HAVE HINDERED SUCCESS...

In general, from the responses received, it was clear that the ETI membership found it easy to engage with the ETI. Others did not, citing onerous bureaucracy and the restrictive use and ownership of intellectual property as hindering the success of the ETI.

There was a commonly held view that the dominance of the ETI's private sector members and their need to secure return/value from their investment had limited the ETI's effectiveness, the perception being that they had restricted knowledge-sharing to preserve commercial advantage. However, this was not the only perceived issue. Cumbersome processes and protracted contractual negotiations over intellectual property rights were found by SMEs in particular to be time consuming and resource intensive, destroying the value of participating in an ETI funded project. Overall, this reduced the value of ETI investments, not least because it decreased the time available to deliver projects.

The ETI's apparently complex bureaucracy was seen as having been set up to protect private members' interests, but this reduced the public benefit derived from the government's funding of the organisation. In one extreme case a respondent reported a widely held belief that the government had finished up paying twice for access to ETI knowledge (due to a confusion over IP licences).

From an operational perspective, the ETI's approach to IP protection also made it more difficult than it should have been to ensure effective external review of work as it happened.

Regardless of the complexities around the cause of these problems, there is no doubt that commercial IP considerations reduced the ETI's effectiveness when it came to knowledge-sharing.

WE NEED TO LEARN FROM THE ETI 'EXPERIMENT'...

Whilst the ETI is generally regarded by its stakeholders as having been successful in its stated aim of accelerating low-carbon energy innovation, there are clearly a number of important lessons that can be learned from external stakeholders' perceptions of the ETI and the experience that has been gained from operating this experimental approach to shared funding and risk taking. Specific lessons highlighted by those stakeholders included:

- The purpose and overall strategic objectives of the ETI needed to be expressed more clearly and transparently.
- Where governance and operational models were seen to be 'restrictive', alternatives should have been sought or more done to manage stakeholder perceptions and expectations.
- There were apparent inconsistencies in the application of the ETI's processes and project management frameworks that needed to be addressed, whilst recognising that securing desired outcomes requires greater flexibility in adapting the scope and approach to individual project circumstances.
- Issues with deliverable review processes needed to be addressed sooner to avoid the detrimental reputational impact of inappropriate reviewer responses.
- The ETI's failure to align itself with others in the sector was seen as detrimental to the objectives of both the ETI and the sector as a whole.
- The ETI was not always agile enough to adapt to an evolving low-carbon energy landscape.
- Management of perceptions and expectations with regard to IP and knowledge-sharing are key.

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ANNEX 3 – SUMMARY OF INSIGHTS FROM CASE STUDY PHD

As part of a PhD research project, Loughborough University based student Ghosia Ahmed undertook **an empirical study of the conflict that arises in an organisation like the ETI** between the need to **share knowledge** and the requirement to provide appropriate management of **IP.** The study used an 'action learning' methodology, working with three separate groups of ETI staff over an extended six month period.

The following sections summarise the key findings drawn from this empirical study and makes recommendations to the way that issues could have been addressed and practices improved. The findings are set out under eight key themes that emerged during the research and were identified as most important to the ETI's knowledge-sharing and information security practices.

DISTINCT MEMBERSHIP STRUCTURE – PPP

The ETI's distinct membership structure had a significant influence on the organisation, particularly on its knowledge-sharing and information security practices.

The membership structure had provided good access to pertinent organisations and knowledge sources, and being associated with large and reputable organisations built the ETI's reputation and profile – which were also recognised as strengths for knowledge-sharing.

The intricacy of the governance in such a structure had created a unique set of challenges. For example, there were complex, and sometimes conflicting, confidentiality requirements from the membership, who were in some cases commercial competitors and driven by their own organisational interests and expectations.

Having to work within such complexity, created a behaviour of great caution amongst the employees, and sometimes led to 'knowledge withholding' behaviours.

MANAGEMENT SUPPORT AND COMMUNICATION

Management support and communication were perceived as integral parts of knowledge-sharing and information security practices. Employees expectations were high in this regard and this was seen to have been an influencing factor for employee behaviour.

Moreover, for knowledge-sharing, the research participants expressed the need for clear direction from management. However, the role of management in a complex and knowledge-intensive PPP was recognised as challenging. The dynamic and fast-paced nature of an organisation running various projects meant that internal communication was, at times, inconsistent.

OPERATIONAL AND LEGAL PROCESSES

The ETI's comprehensive operational and legal processes played an important role in the organisation.

Operating in a complex membership structure, it was a high priority for the ETI to ensure that the knowledge it produced met the various confidentiality requirements of its membership and project partners and was well-protected from external security threats. Whilst this satisfied information security requirements, the legal and approval processes that developed were described by staff as excessive and time-consuming, sometimes leading to delays in processing time-sensitive IP and missed opportunities for exploitation.

> THE MEMBERSHIP STRUCTURE HAD PROVIDED GOOD ACCESS TO PERTINENT ORGANISATIONS AND KNOWLEDGE SOURCES

The central role and dominance of these processes was reported as having impacted the organisational culture as well as having a detrimental effect on external engagement.

AWARENESS AND CLARITY

Significant emphasis was placed on the role of awareness and clarity about knowledge-sharing and information security requirements at the ETI.

The research participants wanted greater clarity about existing knowledge-sharing activities in the organisation and more direction on target audiences for their work. Insufficient awareness and clarity about knowledge-sharing and security requirements were seen to have hindered knowledge-sharing, with employees following a general presumption of knowledge protection when engaging externally, and refraining from taking the risk of sharing knowledge without clear instructions.

PROTECTIVE CULTURE AROUND KNOWLEDGE

From an information security perspective, the ETI had implemented a comprehensive multi-layered protection approach and its knowledge was sufficiently protected from internal and external threats. However, due to the complex contractual requirements of its membership and project partners, the knowledge-intensive environment and the nature of innovative projects, the ETI was described as having a protective culture around its knowledge. This, combined with the reported lack of awareness about knowledge-sharing requirements, resulted in employees following a presumption of protection, rather than openness, where at times knowledge was being unnecessarily withheld from external sharing.

ENGINEERING CULTURE

The ETI has a rich engineering culture, which has significantly influenced the organisational knowledge-sharing practices.

The integral positions, high calibre and expertise of its engineering staff has been given a great deal of respect as they played a critical role in implementing strong knowledge creation and management processes within the ETI. On the other hand, the need for greater visibility for other disciplines and more interdisciplinary collaboration within the organisation was raised – particularly to facilitate the translation of complex technical knowledge and increase external knowledge dissemination.

It was also reported that the ETI was intrinsically taking engineering approaches to issues of organisational culture, for example, by developing technological solutions to address cultural or humanistic knowledge-sharing problems.

ORGANISATIONAL IDENTITY AND STRATEGIC AIMS

Being a knowledge-intensive organisation, focusing on various project areas, alongside operating as a PPP with a unique identity, generated complexity for the ETI in managing its knowledge.

Whilst the ETI was essentially a knowledge creating and disseminating organisation, some research participants felt that it had incorrectly perceived itself as an engineering organisation. This was attributed to the engineering influences within the organisation's leadership structure, coupled with the organisation's immersion in project development and its active management of a network of stakeholders.

Greater clarity was needed around the organisation's identity and aims, and this was seen to have had an impact on the organisation's knowledge-sharing practices.

ANNEXES –

Continued »

SILO MENTALITY

Effective collaboration and knowledge-sharing across the ETI and with its various stakeholders was recognised as an important requirement for the organisation to succeed and achieve its goals. To facilitate this, the ETI had developed and implemented a knowledge-management strategy and subsequent initiatives to encourage knowledge-sharing. However, the research found evidence that the ETI was lacking the required level of collaboration, communication and knowledge-sharing across the organisation, particularly between project teams and departments.

Despite the matrix structure of the organisation, a hierarchical approach to leadership and decision-making was still apparent. When combined with the specialist nature of the projects being delivered, and the geographical separation of some teams, this reduced the effectiveness of internal communication and knowledge-sharing.

The research participants recognised the need for more collaboration and social ties, and expressed the desire to eliminate the 'silo mentality' within the organisation.

RECOMMENDATIONS

Based on these findings, the following recommendations were made to the ETI in order to generate greater efficiency in its knowledge-sharing and information security practices, and achieve better balance between both practices.

1. NURTURE A CULTURE OF TRANSPARENCY AND KNOWLEDGE-SHARING

The protective culture around its knowledge had hindered the ETI's knowledge-sharing.

Since organisational culture is a reflection and the outcome of the way an organisation operates, in order to change the culture, practices and mindsets need to be changed first. The ETI needed to shift its strategic and operational focus from knowledge protection to knowledge-sharing i.e. allowing a general presumption of knowledge openness, with the exception of cases where explicit knowledge needed to be protected.

In addition, the culture of the organisation emulates the practices of senior management, thus it would be beneficial for management to provide support and transparency, and foster trust in employees as this can nurture confidence and increase knowledge-sharing behaviour.

2. PROVIDE GUIDANCE AND CLARITY

Employee awareness and clarity about which knowledge is permitted to be shared and which needs to be protected was recognised as a weakness that hindered the ETI's knowledge-sharing practices.

The ETI needed to address this issue more effectively. An option for achieving this would be to create a clear set of guidelines for both knowledge-sharing and information security, which could be communicated consistently throughout the organisation. Alternatively, following an assumption of openness and sharing, it may be simpler and more beneficial for the ETI to define which knowledge needs to be treated confidentially, and allow all other knowledge to be treated as 'open' for sharing.

Increasing awareness about the organisation's target audiences and creating transparency about existing external knowledge-sharing activities were additional approaches suggested to give employees more opportunities to engage, and serve as a motivation for knowledge-sharing behaviour.

3. PROVIDE CLEAR AND COHERENT COMMUNICATION

Due to the dynamic and fast-paced nature of being a project-based organisation, management support and guidance in the form of clear communication was an important factor in employees' external knowledge-sharing. Lack of guidance led to 'knowledge withholding' behaviours.

Opportunities were identified for ETI to review and enhance its existing internal communication strategy – particularly top-down communication – and provide more frequent, clear and coherent communication regarding organisational strategic messages, decisions and changes.

Being regularly informed and reminded about the strategic aims of the organisation is likely to increase employee engagement and reinforce positive knowledge-sharing behaviour.

DUE TO THE DYNAMIC AND FAST-PACED NATURE OF BEING A PROJECT-BASED ORGANISATION, MANAGEMENT SUPPORT AND GUIDANCE IN THE FORM OF CLEAR COMMUNICATION WAS AN IMPORTANT FACTOR IN EMPLOYEES' EXTERNAL KNOWLEDGE-SHARING

4. INCREASE INTERDEPARTMENTAL COLLABORATION

The ETI could have usefully increased interdepartmental and interdisciplinary collaboration in order to bridge the gap between engineering and non-engineering staff, increase knowledge dissemination and identify more opportunities for exploiting time-sensitive IP.

For such collaboration to also reduce the 'silo mentality' of some teams, it needed to be voluntary and reciprocal – as opposed to being a formal requirement. Thus, it was recommended that the ETI supported informal initiatives to create an environment that is conducive to informal knowledge-sharing, to help nurture social ties and begin to shift the organisational culture towards voluntary collaboration and knowledge-sharing.

5. STREAMLINE LEGAL AND OPERATIONAL PROCESSES

Whilst the ETI's legal and operational processes are necessary for legal, contractual and confidentiality compliance, as well as ensuring accuracy and credibility of knowledge outputs, the complexity and comprehensive nature of these processes caused delays and a hindrance to knowledge-sharing.

To reduce the delays and prevent missed opportunities for timely knowledge-sharing, particularly concerning time-sensitive IP, it was recommended that the ETI should review its legal and approval processes and seek to make them more streamlined and efficient where possible.

6. IMPROVE CONFIDENCE IN PRODUCT INTERNALLY

The ETI's knowledge is of a scientific nature, and the organisation has various contractual agreements and expectations from its stakeholders to comply with, as well as maintaining its professional reputation in the energy industry. Consequently, the organisation had a strong sense of concern and responsibility ensuring its product was of a high quality, accurate and robust.

However, this has led to greater effort and importance being placed on quality control than knowledge dissemination. The ETI could have usefully increased its internal confidence and trust in its product by eliminating the fear of mistakes and reputational risk, and improving the balance between quality control and timely product dissemination.

7. ENHANCE KNOWLEDGE AND INFORMATION MANAGEMENT STRATEGY

A more holistic and strategic approach to 'knowledge and information management' would have created a better balance and efficiency between the ETI's knowledge-sharing and information security practices. There were benefits to be gained by connecting these two practices and identifying the overlapping areas.

Adopting this approach in future initiatives would not only increase resource efficiency and reduce potential duplication of effort, but also reduce the conflict between knowledge-sharing and protection, helping the organisation to achieve its knowledge-sharing goals.

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