THE FARADAY INSTITUTION

A Method to Prioritise and Accelerate the Commercial Value of Research

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The Faraday Institution has developed an analytical methodology to assess early-stage commercialisation potential for each of its research projects. The assessment results in a bespoke approach to commercialisation tailored to each project, the prioritisation of limited resources and the development of consortia that are investment ready. The approach can be implemented by any organisation with limited resources and a portfolio of research projects.

Introduction

Part of the Faraday Institution's mission is to use fundamental battery science to sustain and advance the UK's manufacturing industry, in particular to commercialise scientific discoveries in a way that gives UK manufacturing industry a competitive advantage. Some of the Faraday Institution's research projects have been conducting research for nearly four years, some have been in progress for more than two years and some are on the verge of creating a path to commercialisation. The successful commercialisation of these projects has the potential to have a substantial impact on the UK economy. However, realising these economic opportunities will require different levels of expenditure and commercialisation effort.

The high-quality research being carried out across the Faraday Institution research programme is part of a global race to advance energy storage technology. Without effective management, there is a risk that discoveries remain in the laboratory or businesses using the new technology locate the resulting manufacturing outside the UK. To prevent these things from happening, early engagement with industry and careful and thoughtful management is needed to accelerate successful commercial exploitation in the UK.

The Faraday Institution has therefore developed an approach named TSCAN to prioritise and direct the activities of its internal commercialisation team to the research areas that are likely to have the most substantive impact on the UK economy. TSCAN is not a tool to measure the value of the research, but a methodology to assess where additional resources should be directed to advance commercialisation. The aim is to enable the Faraday Institution to make an informed judgement and decision, based on the best available evidence, on which of its programmes or parts of programmes it should seek to commercialise to strengthen the UK battery industry.

The TSCAN assessment is led by the Faraday Institution commercialisation team, with the substantial input and support of the academic research teams. Industrial partners also input into the process where relevant. The methodology has so far proven valuable for making informed commercialisation decisions, leading for example to the establishment of a UK-based consortium to develop prototype solid state batteries.[1]

Overview of the TSCAN Assessment

The TSCAN assessments are 20- to 30-page analytical reports that provide the Faraday Institution with a robust

[1] UK-based consortium established to develop prototype solid-state batteries (19 August 2021).

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way of making and presenting rational judgements about the best use of scarce commercialisation resources. TSCAN assessments are not just undertaken on one single occasion but are refreshed and updated on a rolling basis to ensure that the Faraday Institution's commercialisation strategy keeps up to date with the global race in battery research, fast-moving battery markets and developments within the research projects.

The TSCAN assessments are used to evaluate each research project at a specific point in time in terms of the likelihood of successful commercialisation, the balance between public investment and commercial returns, and whether the project and HQ teams have the combined skills, time, expertise, knowledge and infrastructure capabilities to move the technology through a commercialisation process. The assessment is made up of the five components as defined in the figure below.

Figure 1: Summary of the TSCAN methodology

	Component	Description	Category
T	Technology	Probability of a discovery being available at a given time	Impact
S	Significance	Significance of the breakthrough for the UK economy and manufacturing industry	Benefit
C	Competition	Potential competition, including cost and performance criteria	Impact
A	Action	Activity required to move the discovery to the next stage of commercialisation	Activity
N	Investment	Public and private investment required to reach the next stage	Cost

These components can be further categorised into impact, benefit-cost analysis and action.

- The impact assessment reflects the likelihood of successful commercialisation of the research, based on the **(t)echnology** research breakthroughs required, the **(c)ompetition** in the marketplace and whether any competitors could get to the market more quickly than a Faraday Institution-led consortium;
- The benefit-cost assessment that balances the public sector **i(n)vestment** required to commercialise the research against the **(s)ignificance** of the future UK economic impact; and
- The **(a)ction** required to move the technology through a commercialisation process and the required skills, expertise, knowledge and infrastructure capabilities in the Faraday Institution, university or consortium.

Description of each TSCAN Component

This section describes the analysis undertaken for each of the five components of the TSCAN assessment in more detail. The outcome of the assessment is a bespoke approach to commercialisation tailored to each project that enables the Faraday Institution to prioritise commercialisation resources and convene consortia that are investment ready.

(T) Technological Breakthrough

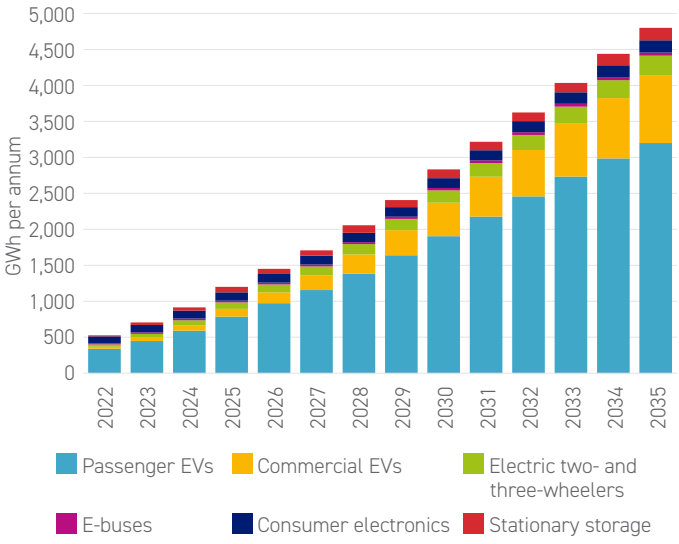
This component involves assessing the difficulty of a particular technological breakthrough being targeted by the research project and the incremental intellectual property that can be created. It covers the following steps:

- Identify technological breakthroughs, discoveries and know-how in Faraday Institution projects in the short and medium-term;
- Identify the technical requirements of different energy storage applications;
- Set out how the technology breakthroughs contribute to addressing the industry requirements in existing or new products, markets and services; and
- Assess the extent to which existing intellectual property is available or can be made available.

(S) Market Significance

This is the economic significance of the breakthrough technology for the UK manufacturing industry and UK economy. This component starts by examining the potential market opportunities for the specified technology at the global and European level and then sizes up the value of the market for research project discoveries over the short, medium and long term. A useful starting point for lithium-ion battery applications is the level of global demand by application. BNEF forecasted global annual lithium-ion battery demand to increase from 500 GWh in 2022 to nearly 4.8 TWh per annum in 2035 split by application in Figure 2.

Figure 2: Global lithium-ion battery demand to 2035



Source: Long-Term Electric Vehicle Outlook 2021 (BNEF, June 2021).

The economic significance assessment also covers:

- The opportunity to deliver significant UK economic impact, measured in terms of the GDP impact or the number of high value jobs created or safeguarded;

- Whether a successful version of the technology provides the UK manufacturing industry with a competitive advantage. In particular, whether an advantage over competitors is sufficient to give the UK manufacturing industry a significant and sustainable market;
- The market revenues and commercial returns available when the product or service reaches a mature market; and
- The global and UK supply chain and whether it is deficient or needs to be developed to maximise the benefits for the UK economy.

(C) Competition

This component looks at the chance that another rival group of researchers in academia or industry will get to the same or an equivalent result before the relevant Faraday Institution project does. A detailed review of the market competition is at the heart of this assessment, along with the identification of commercial and industrial issues, and the UK stakeholders involved in the market.

A first step is to identify the research competition around the world. One way of achieving this is to analyse the patent and academic publication landscape for a given technology across geographic regions and identify the leading companies and research organisations competing within the technology space. Two examples of the type of patent landscape analysis performed for competition analysis of 'lithium-sulfur batteries' are provided in Figures 3 and 4. News articles and company press releases are also monitored. The competition is monitored on a rolling basis, as new technological breakthroughs and commercial developments arise continually.

Comparing the performance of businesses or consortia is more difficult than academic groups, as public information is much more limited, but the purchase of custom market intelligence or interviews with experts could help with the assessment. Assessing competition would also look at whether there are any non-technical reasons why the technology has not been commercialised yet. These could include barriers around, for example, cost, intellectual property, supply chain issues, environment issues, safety, regulation and competing technologies.

(A) Activities

This component covers the activities and actions required to move the technology to the next stage. It covers an assessment of the skills, capability, knowledge and infrastructure required and whether this is within the current capacity of the Faraday Institution and the research project team or whether additional capabilities are required. For example, in the case of the solid-state battery project (SOLBAT), a consortium was developed with organisations in battery research, development and manufacturing. Along with the Faraday Institution and Oxford University that has led the research, partners included Johnson Matthey, Britishvolt, UK

Figure 3: Lithium-sulfur battery patents by region of origin and protection

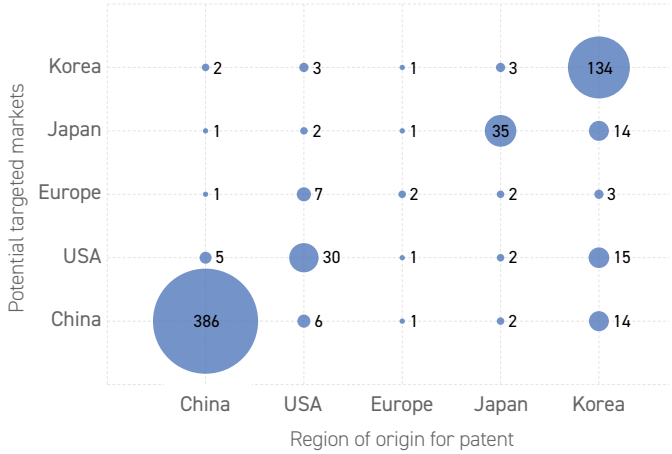
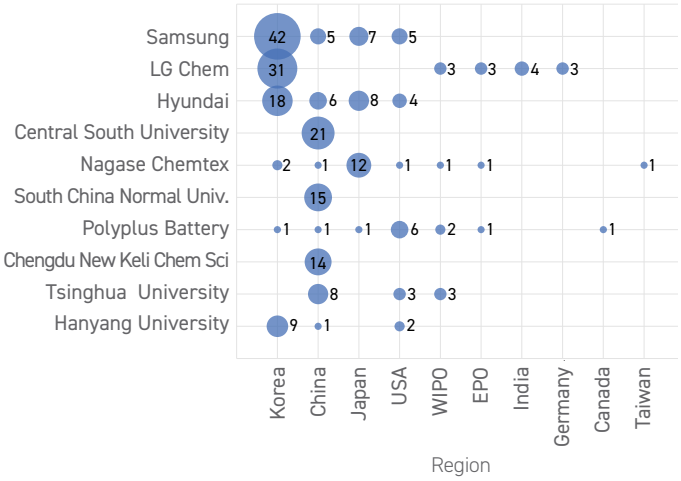


Figure 4: Lithium-sulfur battery patents for major companies by region of protection



Source: Technology Key Report produced by the Faraday Institution for 'lithium-sulfur battery', generated by Patsnap Insights (2022).

Note: WIPO (World Intellectual Property Organization) and EPO (European Patent Office)

Battery Industrialisation Centre, Emerson & Renwick and the University of Warwick.[2]

As well as assessing the actions required by the research project, a number of project tools are developed to facilitate commercialisation including:

- Description of the plausible pathways for the first step to market;
- Delivery plan, which sets out the plan, activities and timescale;
- Identification of the partners and stakeholders that need to come together to deliver the technical requirements;
- Description of the commercial arrangements for each of the collaborators and whether to set up a special purpose vehicle; and

[2] UK-based consortium established to develop prototype solid-state batteries (19 August 2021).

- Assessment of the resources required in terms of equipment, facilities and talent.

(N) Investment

The final component considers the ability to attract the public and private sector investment required to deliver the first step along the commercialisation path. The private sectors willingness to participate in the venture is also considered as this provides a soft-market test and determines market viability.

TSCAN Fit with the Objectives of the Faraday Institution

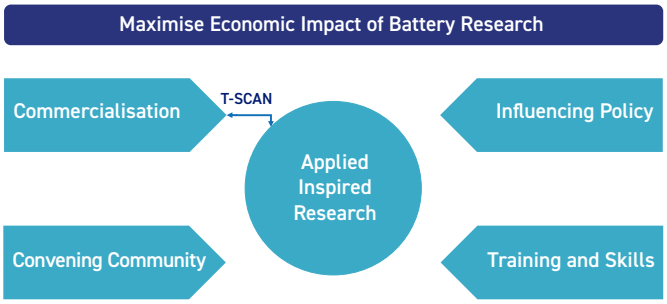
The Faraday Institution's overall mission is to lead the UK's efforts in energy storage research and maximise the impact of battery research on the manufacturing sector and the UK economy. Activities undertaken to achieve this mission are summarised in Figure 5. The core activity is application-inspired research, which is carried out at scale in universities in collaboration with industry. The research aim is to reduce battery cost, weight, and volume; improve performance and reliability; and develop whole-life strategies including safety, recycling and reuse.

Training and skills development is undertaken to ensure that the next generation of battery scientists and engineers have the capabilities to work in academia and industry. The policy development function helps to ensure that the public, public bodies, policymakers and public institutions are well-informed about the energy transition. The Faraday Institution also acts as a convener of the battery research community, bringing together research scientists and 50 industry partners to work on projects with commercial potential and by holding conferences, seminars and events. The commercialisation team actively manages intellectual property generated by the projects and looks at how to take the research along a commercialisation path to market and to create real value for the UK economy.

TSCAN provides a tool and assessment methodology to link application-inspired research being conducted in universities to the Faraday Institution commercial team and its objective to maximise the impact on the UK economy.

TSCAN does not measure the value of the research conducted by project teams nor does it consider the contribution the Faraday Institution projects could make to other elements of the Faraday Institution mission such as generating new knowledge, skills development, building up the UK's battery science base and helping to deliver Net Zero. Instead, TSCAN looks at the research projects through the lens of the commercialisation potential and to help prioritise the use of these limited commercialisation resources across the research portfolio.

Figure 5: Faraday Institution's mission and objectives

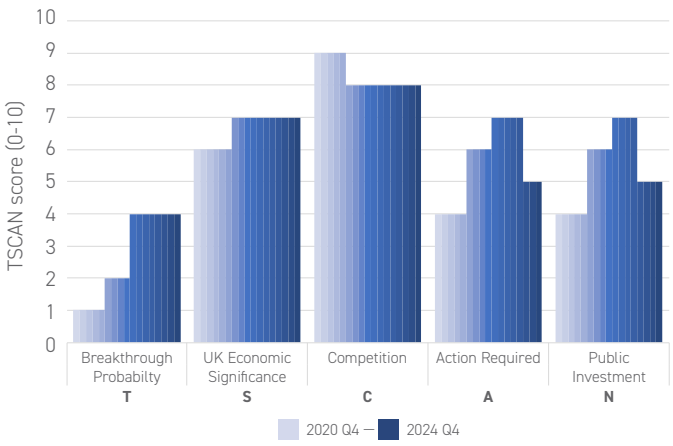


Application of the TSCAN to an Example Research Project

The TSCAN methodology enables the Faraday Institution and the commercialisation team to identify the key challenges and barriers to commercialisation, and to develop strategies for getting to market. Resources need to be carefully directed as the current level of resource of the commercialisation team in the Faraday Institution is limited.

The TSCAN assessment is updated on a rolling basis to reflect changes in the market, breakthroughs, strategic refocussing of direction and wider technology developments in the market. Changes in the assessment can be plotted to illustrate how the commercialisation opportunity may change over time and when commercialisation resources need to be deployed. This illustration in Figure 6 shows that the breakthrough probability for technology has increased over the period, while the economic significance and competition remains essentially constant. The chart boils down complex judgements into a simple assessment to prioritise the timing of when commercialisation resources need to be deployed, identifying the specific action and public investment that is required just before the end of the period examined. The TSCAN assessments are updated regularly with the picture changing as battery research and battery markets evolve.

Figure 6: TSCAN assessment over time



Application of TSCAN to the Faraday Institution Research Portfolio

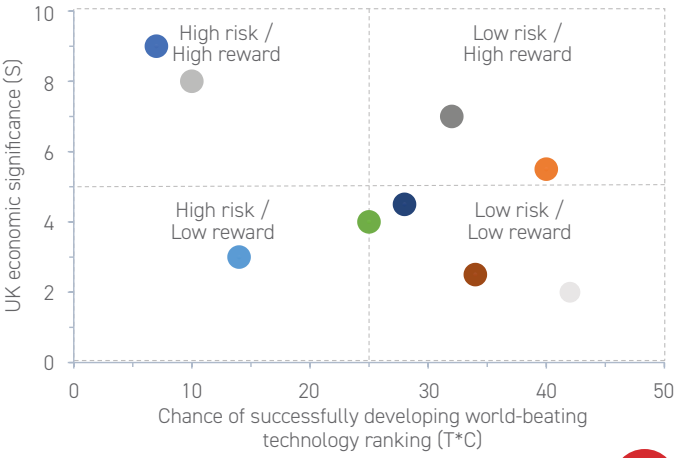
TSCAN can be used to assess how the research portfolio of the Faraday Institution looks as a whole, informing the selection of future projects. A useful tool is to plot each of the projects on a risk and reward chart to visualise the whole portfolio.

The reward indicator is defined as the commercialisation potential or significance of the technology to the UK economy, while risk is defined as the chance of successfully developing a world-beating technology. This risk measure is created by combining the likelihood of a technological breakthrough (technology) part of the TSCAN with the inverse of the chance that other institutions or companies will get there before a Faraday Institution-led consortium (competition).

An illustration of the results from undertaking the TSCAN assessment across the Faraday Institution's portfolio of main projects is shown in Figure 7. This tool can be used to inform future project selection decisions based on the objective of having a balanced portfolio, with a mix of projects balancing risk and reward.

The four quadrants illustrate different combinations of risk and reward. Academic research is typically higher risk as it is often undertaken at low technology readiness levels (TRL) of 1 to 3 compared to commercial research which is focused at higher TRL and relatively lower risk. The diagram also illustrates that projects with high economic significance are loosely correlated negatively with the chance of developing world-beating technology.

Figure 7: TSCAN assessment across the Faraday Institution's research portfolio of main projects



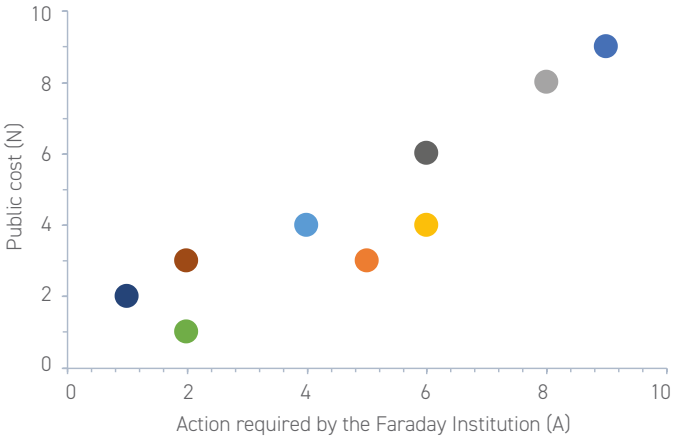
The Faraday Institution's TSCAN portfolio assessment is similar to the strategy advocated from the lessons learnt review of the Vaccine Taskforce: "We must be prepared to invest at risk, with a portfolio mindset... with the knowledge that value for money could not be assessed at the individual spending decision level."[3]

Assessing Cost and Action across the Faraday Institution Research Portfolio

The TSCAN assessment can also be used to look at how resource requirements are spread across the portfolio in terms of both effort required and the public sector investment. This can also be used as a tool to allocate Faraday Institution resources and project managers, particularly as some research projects will necessarily have a much longer gestation than others. Key lessons for future industrial policy learnt from the vaccine development process was to "choose a small number of clear measurable missions" and "provide long-term investment at scale".[4] Applying the TSCAN methodology across the whole Faraday Institution portfolio captures these learning points.

Figure 8 shows that projects with high economic potential will often need higher public investment and higher levels of capacity and capability from the Faraday Institution. This can help with the allocation of project managers to organise the commercialisation process and develop consortia for relevant projects as required.

Figure 8: TSCAN assessment across Action and Investment



Summary

TSCAN gives the Faraday Institution a clear and robust way of making and presenting rational judgements about the best use of scarce commercialisation resources. The methodology enables roadmaps to be developed to accelerate the commercialisation of research to the specific advantage of the UK manufacturing industry and the UK economy. In particular, TSCAN helps the commercialisation team to:

- Accelerate the commercialisation of electrochemical research;
- Ensure research is addressing the right challenges, with application inspired targets;
- Transition research from the laboratory to the real world; and
- Create UK employment and UK economic impact.

TSCAN will be particularly important to the next phase of

[3] UK Innovation Strategy (July 2021). Leading the future by creating it, Department for Business, Energy & Industrial Strategy.
[4] Industrial Strategy Council (March 2021). UK Lessons for industrial policy from development of the Oxford/AstraZeneca Covid-19 vaccine.

work of the Faraday Institution, which will increasingly be focused on commercialisation activities; such as moving the technology from a laboratory prototype to a pre-commercial demonstrator and through to mass manufacturing. A gap often exists in the UK between the making of new discoveries and the commercial application of those discoveries for the benefit of the UK economy.

Commercialisation plans have now been developed for each of the Faraday Institution's research projects together with a prioritisation of resources across those projects. More resources will be deployed in the next few years to translate discoveries from the laboratory to the business world in ways that promote the competitive advantage of the UK manufacturing industry. The TSCAN methodology continues to develop as the Faraday Institution's research programmes evolve and deliver scientific and industry-relevant impacts.

Other public and private sector organisations undertaking mission-inspired research may find the TSCAN method useful for managing their commercialisation resources. Please contact Stephen Gifford at the Faraday Institution for more information on how to utilise TSCAN for your research organisation.

About the Faraday Institution and Faraday Insights

The Faraday Institution is the UK's independent institute for electrochemical energy storage research, skills development, market analysis, and early-stage commercialisation. We bring together academics and industry partners in a way that is fundamentally changing how basic research is carried out at scale to address industry-defined goals.

Our 'Faraday Insights' provide an evidence-based assessment of the market, economics, technology and capabilities for energy storage technologies and the transition to a fully electric UK. The insights are concise briefings that aim to help bridge knowledge gaps across industry, academia and government. If you would like to discuss any issues raised by this "Faraday Insight" or suggest a subject for a future Insight, please contact Stephen Gifford.

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