The Faraday Institution – Written evidence (STS0031)

Introduction to the organisation:
The Faraday Institution (FI)[1] is the UK's independent institute for electrochemical energy storage research, skills development, market analysis and early-stage commercialisation. It is a key delivery partner for the Faraday Battery Challenge to bring forward bold and transformational change in application-inspired battery research. The core intention underlying the FI's establishment is to give prominent leadership and a strong national strategic focus on electrochemical research, with close proximity to industry.

Funded through EPSRC-UKRI, the FI serves as the UK's flagship battery research programme to build and manage focused, substantial and impactful research projects in areas of fundamental science and engineering that have significant commercial relevance and potential, defined at a high level by industry and delivered by consortia of universities and businesses. The FI delivers PhD training to the next generation of battery scientists and engineers, who will be future leaders in both academia and industry, facilitating the transition of new technologies to market.

Since the launch of its research programme in 2018, the FI has assembled a unique community in a nationally distributed model — 490+ university researchers from a multitude of fields from 24 (currently) UK universities, committed industry partners, technology business development specialists. Together they bring a diversity of perspectives and are united in their efforts to overcome tough scientific challenges: to reduce battery cost, weight, and volume; improve performance, efficiency, and reliability; develop scalable designs; improve manufacturing abilities; develop whole-life strategies; and accelerate the outputs towards commercial outcomes.

Q1) What would it mean for the UK to be a "science superpower?"
A science superpower is one where investment in R&D is the top 10 countries globally as a percentage of GDP and ideally within the top 5. But success is not just about investment levels, which are principally "input". A science superpower will produce results ("output") and turn this investment into scientific value and economic benefits in terms of intellectual property development, creation of spinouts and new companies, the development of skills and capability and ultimately new employment and industries. In a science superpower, government investment in R&D should be consistent from year to year thus sending a strong signal to the private sector about funding commitments which, in turn, will stimulate and grow the UK economy. A superpower will also be the global leader in at least several high-profile and high-growth areas, whether that is in life sciences or by inventing the new technologies to support the push to Net Zero.

These ambitions and principles will be embedded throughout the research ecosystem and community, with practical application in research councils, research institutions and research projects, as well as being widely used by the

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[1] See the Faraday Institution Annual Report for a full description of programmes and impacts.

researchers themselves. In the context of the FI, for example, this means a research organisation that:

- Attracts, nurtures, & invests in a diverse, multidisciplinary research base across the UK;
- Catalyses the research community to work on a national mission with a clear focus;
- Creates new scientific knowledge as evidenced through high quality, highly-cited publications of international relevance;
- Enables permeable boundaries between industrial and academic efforts, where breakthrough research in the laboratory is put on the path for commercial development;
- Improves the international ranking and prestige of UK universities and facilities;
- Generates a critical mass of IP that will support the UK's long-term position to become a global leader in battery technologies; and,
- Secures sovereign capability which in turn will create more higher paid, green jobs and economic, environmental, and social benefit for the UK.

Whilst the OSTS's focus on science and technology capabilities covers important key areas for the UK – sustainable environment, health and life sciences, national security and defence, and a digitally and data driven economy – the FI recommends "energy" be added to provide a prominent focus, especially considering the UK's ambition for energy independence, and which will be necessary to achieve Net Zero.

The effects of a frequently changing science policy are well understood. Hard stop of funding and short-term commitments for research and innovation projects results in suboptimal decision making, adds great stress to universities and uncertainty to the research base, and distracts research organisations from their mission. This is particularly challenging for organisations working in long-term areas of strategic importance for the UK where longevity and consistency of research planning is essential. It increases the risk of loss of researchers, particularly early-career researchers, to international competition, which both impedes a programme's ability to deliver in the immediate term and imperils the future. Seeking year-on-year funding extensions is a resource intensive and unsustainable practice for any major research programme with serious strategic intent and does not reflect Government's commitment to making the UK a science superpower.

To address this, the FI recommends taking learnings from other international competitors that provide longer-term funding in areas of strategic importance. The FI's review of international research organisations (US, Japan, Germany) suggests that a cohesive strategy, which links fundamental research (known as basic research in the US) directly to the relevant industrial challenges is seen to realise much richer benefits than current research practices. Other best practice and learning points identified from the review of global and UK research institutes include the following:

- Organisations with longer term views and funding (i.e. 5-10 years) were more successful in securing patents (Fraunhofer, NEDO, MRC, NIMS).
- Institute based programmes were more effective for producing patents than university-based programmes (Fraunhofer, NIMS, MRC).

- Organisations that operate research out of universities deliver results faster when directly managed by a technical programme manager (with the ability to terminate the project) from the parent organisation rather than from the university (DARPA); and
- Industrial collaborations are successful in realising commercial products, when the project explicitly aims to produce a specific process or a demonstrator device (Fraunhofer, NEDO) and when the companies are involved from the planning stage of the research project.

These learnings have been taken into the FI model for the operation of its research programme.

Q3) Does the introduction of a science and technology strategy challenge the Haldane principle and UKRI's commitment to fund outstanding research?

The introduction of an S&T strategy does not necessarily challenge the Haldane principle. From the outset, the FI's research programme has world-leading excellence at its core. Its programme supports the Haldane principle's focus on "quality, excellence and likely impact of science and research programmes" and follows a rigorous peer review processes in the selection of major projects. To ensure impact, however, the FI also places research excellence in the context of needing to compete in a strategically important global race. The FI therefore developed an analytical methodology[2] 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. This approach does not sacrifice research excellence – that must remain core – but seeks to accelerate aspects of a programme where new knowledge can be created and commercial impact exploited.

Q4) Is the UK realising the potential of its research investment?

It is inevitably the case that fair and transparent allocation of public research investment is accompanied by a proper process to determine which research programmes are most likely to succeed. However, it should also be recognized that the criteria for success may be different dependent on the nature of the research and the problems to be addressed. For example, a policy decision to electrify the automotive sector has already been made for the near horizon (2030) and decarbonisation of all mobility in the progress to Net Zero 2050 will be required, the latter being a global need as well as a national imperative. It is certainly necessary, therefore, to undertake intensive research around the needs of these goals both now and on the 50-year horizon nationally to place the UK in a position to thrive and prosper from the Net Zero transition.

Having accepted this premise, it is essential both to be agile in making funding available in the right research areas and to be prepared to commit to the top researchers and projects on 5–10-year horizon without the over-bureaucratic urge to review on a constant basis. Research programmes need to be given some time to deliver. Researchers need to have some assurance that their funders have some faith in their abilities. The constant "review mentality" is

[2] "A Method to Prioritise and Accelerate the Commercial Value of Research" https://www.faraday.ac.uk/get/insight-13/

better channelled into pro-active and productive management of the research programmes by technical programme managers, such as in the FI, the US model already referred to earlier in this document and, potentially, ARIA.

Q6) What more should be done to encourage private-sector investment in research and development in the UK?

Private sector investment could be encouraged by ensuring that a substantial proportion of government R&D funding is directed towards the markets and sectors that the private sector are interested in. The private sector will invest if there is commercial potential, and they see that they could eventually benefit from capturing a share of new markets. This focus on opportunities and challenges is termed mission-driven research and is the approach adopted by the FI.

The work of research institutions and research programmes should be actively reviewed, influenced and challenged by the private sector. This link between research and industry should be formalised, where possible, in governance terms. The FI, for example, has an international panel of industry experts who actively and regularly engage the academic investigators. Industry has worked from day one with researchers in the setting of technical targets and to offer regular, expert advice to our academic research teams. This builds trust, ensures industrially relevant questions are interrogated, and enables the natural opportunities for collaboration and acceleration to occur.

The programme of work, research projects and strategy of the FI are all undertaken with close proximity to industry. This has led to increased industrial-academic engagement, more meaningful research questions pursued, and the acceleration of commercially viable technologies. This active management across industrial and academic partners is expertly managed within the FI's mission to develop intellectual property for the economic benefit of the UK, an activity given leadership and focus by dedicated professionals in the HQ team.

Another policy to incentivise private sector research spending is to actively embed commercialisation into the objectives of research institutions. This is the approach adopted by the FI. After its first four years, FI's commercialisation efforts are now supporting 8 spin-outs, 16 industrial fellowships and 8 industry sprint projects and enabling 26 identified inventions move along the path for patenting. In 2021, the FI launched a consortium of 7 UK organisations (including Oxford University, Britishvolt, Johnson Matthey) to develop world-leading prototype solid-state battery technology, targeting automotive applications.

In terms of the pipeline and problems commercialising discovers, a gap often exists in the UK between research discoveries and the commercial application of those discoveries for the benefit of the UK economy. Academic teams often find it challenging to identify the routes to market and may not have the right skills or incentives to deliver commercial outcomes compared to other academic objectives. This issue was recognised when the Faraday Battery Challenge was established where research funding is provided to three stages to market: research, innovation and scale-up. For example, the FI focuses on research at lower technology readiness levels (TRL) whereas the UK Battery Industrial Centre is tasked with scale-up and works at the higher TRL levels.

Q7) How well does the UK collaborate on research with international partners and what can it learn from other countries?
The long-term approach taken by the US, Japan and Korea to research and commercialisation is a key learning point for the UK. In the area of energy storage, for example, these countries have understood that research into developing new energy storage technologies needs to be considered over at least a 10-year time horizon and that long-term research projects (5-to-10 years each) are required compared to short-term funding for commercialisation.

The UK already has research strengths in next generation technologies such as sodium-ion, solid-state and lithium-sulfur batteries. Taking a long-term approach gives the UK the opportunity to compete with other countries, commercialise technologies, capture significant economic benefits and become a global leader in next-gen battery technology.

International collaboration is most useful at lower TRLs in fundamental or basic research. At lower TRL, research is at higher risk and therefore typically undertaken by academics. Strong collaboration domestically and internationally across academia and different universities and institutions is useful at this stage because the risks are pooled and it is difficult to capture specific techniques, IP and knowledge from the research as it spills over into other sectors. For example, the US and UK share a long history of S&T collaboration, reconfirmed with the signing of the new Atlantic Charter by President Biden and Prime Minister Johnson last year. Long-term collaborative planning with such key allies will enable the UK to both strengthen its own hand whilst enabling scientific exchange.

At higher TRLs, businesses typically get more involved in the research, as the risk and reward ratio is more commensurate with investment decisions in the private sector. At these higher TRL, it is more appropriate that the research is undertaken behind closed doors and in competition with other institutions.

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