Statement of requirement

Techno-economic analysis of the prospects and costs of replacing (reducing) fossil fuel generator use in emerging economies with energy solutions incorporating novel battery technologies

Introduction:

The Faraday Institution is the UK's independent institute for electrochemical energy storage science and technology, supporting research, training, and analysis. We bring together scientists, industry partners, and government funding with a common goal. We invest in collaborative research to reduce battery cost, weight, and volume; to improve performance and reliability; to develop scalable designs; to improve our manufacturing; to develop whole-life strategies from mining to recycling to second use; and to accelerate commercialisation.

Bringing together expertise from universities and industry, and as part of the Faraday Battery Challenge, the Faraday Institution endeavours to make the UK the go-to place for the research, development, manufacture and production of new electrical storage technologies.

With respect to this call for proposals, the Faraday Institution has received funding from UK aid to research new battery technologies and conduct relevant techno-economic and related studies into battery-based solutions that have the potential to increase the uptake of cheaper, cleaner and more reliable energy in Overseas Development Assistance (ODA)-eligible countries. The UK aid support is provided as part of the Transforming Energy Access (TEA) programme, which supports early stage testing and scale-up of innovative technologies and business models that will accelerate access to affordable, clean energy based services to poor households and enterprises, especially in Africa.

Overview

A recent Faraday Insights publication highlighted issues surrounding the use of fossil fuel generators in developing countries and emerging economies, where many people and businesses do not have access to grid electricity or where the electricity supply is unreliable. Global fossil fuel generator capacity is estimated currently to be 350 GW (equivalent to 700 large coal power stations) and, with growing demand in India, sub-Saharan Africa and China, it is projected to reach 560 GW over the next ten years.

The World Bank Group's International Finance Corporation (IFC) estimate that this fleet of diesel and petrol generators in developing countries serves 20 to 30 million sites and costs an estimated $40 billion per year to run, eight times the cost of the generators themselves, see "The Dirty Footprint of the Broken Grid". Alongside the financial implications of using generators, there are the associated noise, air quality, climate, pollution and health impacts. The IFC estimate that energy storage technologies could save up to 100 million tonnes of CO_2 emissions per year (excluding China) by replacing 25 million diesel and petrol generators in developing countries.

The growth in demand for battery technologies globally and particularly those used in electric vehicles, is fuelling considerable technical and economic progress in electrochemical energy storage. This progress, in turn, is contributing to the potential of energy storage technologies (when integrated with complimentary technologies such as efficient appliances, smart controllers, renewable generation as well as innovative business models) being a viable replacement for, or significantly reducing the use of, generators for energy applications in emerging economies.

Enabling fossil fuel generator replacement solutions for energy access in emerging economies is an area of focus for DFID's TEA programme. It is now working with the Faraday Institution to establish how energy access solutions comprising novel energy storage technologies and complimentary technologies can be viable and competitive for deployment in Africa and how the full potential of such solutions can be realised.

Last year, the Faraday Institution commissioned a scoping study "Rapid market assessment of energy storage in weak and off-grid contexts of developing countries", conducted by Vivid Economics, to help inform the direction of this call. The outputs of the report include identifying the market potential of battery and other energy storage technologies and identifying some of the leading technological solutions which offer high potential impact. This call focusses on the potential for batteries to enable energy solutions that replace fossil fuel generators and seeks a greater level of understanding and analysis of the opportunity.

The Objective

Energy storage systems such as batteries, whether standalone or grid-charged backup behind-the-meter, coupled with renewable energy and/or efficient appliances and Pay-as-you-Go technologies, or as part of a renewable energy-battery-genset hybrid, can deliver some of the services that diesel and petrol generators provide today. However, whilst the cost competitiveness of storage has been proven in specific contexts, a lack of data and detailed analysis of the factors that lead to a continued preference for diesel and petrol generators, is contributing to the slow progress of realising this commercial and social development opportunity.

DFID and the Faraday Institution have identified a number of technical and economic unknowns and challenges that need to be better understood and addressed in order to establish the potential and inform associated RD&D and innovation activities.

This call is focused specifically on:

1. Better understanding the existing applications and the techno economics associated with decision making for fossil-fuel generator-based energy solutions being used in sub-Saharan Africa for:
    - Micro-grid (includes mini-grids) applications, e.g. off-grid villages/towns, off-grid or weak grid commercial/industrial/agri-processing/use, off-grid or weak grid power for critical infrastructure (e.g. clinics, schools, telco infrastructure and banking)
    - In-building, unreliable-grid-connected, backup power applications e.g. housing, offices, hotels, telecommunications networks, ATMs and hospitality industry
    - Larger scale grid back-up utility and grid balancing applications

    and the prospects for energy storage to replace or supplement fossil fuel-based generators for these applications in the future; including estimating of potential uptake based on detailed cost analysis

2. Developing a data intensive, bottom-up techno economic model(s) to:

- determine the market-driven economic feasibility of
- support requirements analysis and generation for
- inform applied research activity for

novel energy storage technology-based energy solutions (integrated with complimentary technologies) seeking to displace existing fossil fuel-based generator solutions or existing energy storage technologies such as lead acid and Li ion. The model(s) should be designed to manage the techno economic analysis of multiple energy storage technologies including, but not limited to, Na-ion, Zn-based technologies, flow batteries and thermal storage. The model should be dynamic enough to manage inputs that are likely/expected to change over time e.g. battery material costs, manufacturing costs, fuel costs and enable different scenarios to be modelled. It should be able to manage 'right-sizing' in terms of matching power demand and peak loads with appropriate supply. The model's uses will include identifying the economic case for replacing fossil fuel generators with viable solutions in the short term (low hanging fruit), medium term and longer term.

3. Understanding current value and supply chains (including the organisations involved) associated with fossil-fuel generator-based energy solutions addressing the applications above in sub-Saharan Africa or a selection of regions in Africa

4. Understanding the current and emerging value and supply chains (including organisations involved) for battery technology-based solutions addressing the applications above in sub-Saharan Africa or for a selection of regions in sub-Saharan Africa

The Scope

This is expected to be primarily desk-based research, analysis and modelling, including online interviewing, but we are open to tenders that offer innovative suggestions for meeting the requirements.

The Requirements

1. Understanding of the techno economic analysis used to support decisions to procure fossil fuel generator based energy solutions in sub-Saharan Africa (noting that the Faraday Institution will be commissioning an additional piece of work to look into the behavioural and political economic aspects that also influence demand and decision making later in 2020).

The detailed market assessment of existing applications being serviced with petrol and diesel generators should include:

- Customer requirements and profiles: e.g. expected services and benefit
- Technical requirements e.g. power load, generator performance, integration with other appliances and legacy systems and future proofing
- Business model requirements
- Installation and commissioning requirements/constraints
- Operations and maintenance requirements
- End-of-life requirements
- Skills, capability and capacity constraints
- Regional policy and regulation requirements / incentives

The associated analysis should include the costs and prospects for storage technologies (alone and in conjunction with different energy supply inputs, appliances and payment strategies/business models) to out-compete diesel and petrol generation in a range of developing country use cases and contexts. It should include:

- Deep dive, quantitative analysis of costs of competing, storage technologies including upfront costs, operations and maintenance, and end-of-life costs
- Comparison of storage technologies with petrol and diesel generation, both in terms of upfront costs and use over an extended use period, including secondary market and end of life considerations
- Analysis of the costs associated with different technologies in different applications. Cost analysis for different use cases; domestic, productive use, mini-grids, grid back-up and/or grid scale
- Estimate of time after which battery technology costs will out-compete initially cheaper alternatives (lifetime cost analysis, LCOE, total cost of ownership)
- Prospects for energy storage in future, estimate of potential uptake based on detailed cost analysis, also generating corresponding estimated impacts in terms of e.g. $ savings, fossil fuel savings, climate and health impact
- Short case-studies and vignettes to further clarify and illustrate. For example, setting out the business case for storage options in countries with high use of diesel generators such as Nigeria, for the different applications and comparing with other potential competitors for those markets.

2. The conceptual technoeconomic model should be spreadsheet based, able to manage multiple energy storage technologies and to deliver outputs that can be compared to fossil fuel based and other competing technologies. It should establish a taxonomy of variables that include:
    - <u>technical requirements</u>: storage capacity, system power, 'emergency' power capability, autonomy, discharge duration, energy and power density, round trip efficiency, ramp rate, charge rate, self-discharge and energy retention, power quality, power factor, voltage stability, waveform, harmonics
    - <u>practical requirements</u>: space requirements, operating costs including maintenance and replacement, durability, lifetime, reliability, response time, transportability, , modularity, feasibility and adaptation to generating source, adaptation to application type, harmonisation with network, operational constraints, especially safety, environmental aspect including temperature, decommissioning and disposal, ease of install and maintenance, integration with other hardware and software to develop turn key solutions and enable innovative business models

    The model should be dynamic in that it will be able to manage variable inputs and enable scenario planning over time. For example, variable inputs might include fuel pricing, but also the impacts of regulation that might accelerate/reduce demand overtime e.g. regulating emission and air quality.

3&4. The assessment of application associated value chains and supply chains should be in the form of an annotated report and take an end-to-end view, from upstream manufacturing through to last mile developer, installer and operator. It should seek to identify key organisations and stakeholders.

Deliverables

The output of the work will be a report, a supporting slide deck and the techno economic model. All three are expected to be published widely and should be formatted to support ease of publication and communication, including graphics and images where they support clarity. All three will be used by the Faraday Institution and others third parties, including the Department for International Development (DFID) to develop further opportunities for ODA-funded RD&D and innovation support in the area of fossil fuel generator reduction and replacement.

The model will need to be useable, editable and updatable by the Faraday Institution team. The associated data and code will need to be transparent and editable by the Faraday Institution team. Any IP associated with the model needs to be open source and unencumbered for use.

The model should come with a basic user introduction, with associated notes. Proposals should include resources for training up to 6 members of the Faraday team (including third parties invited to the training session by Faraday Institution) to be expert users of the model. To help set expectations this should be no more than a half day of training for an already competent Excel spreadsheet user.

Indicative Budget

Our indicative budget for this activity is up to £100k inc VAT. Any bids proposing costs higher than this will be expected to provide evidence within the methodology including any robust justification for the additional funds.

Reporting

- An annotated outline of the report and should be presented within 4 weeks of the start of the contract
- An illustrative version of the model including architecture, data inputs, assumptions and outputs should be presented within 8 weeks of the start of the contract
- A draft final report and model should be presented a month before the agreed completion date, where the findings will be shared with representatives of the Faraday Institution team and relevant stakeholders, who will provide feedback to inform the final version of the report and associated slides
- The final report, PowerPoint slides and model, updated following comments from stakeholders, the Faraday Institution and collaborating government bodies, will be delivered and presented at a funders meeting at the completion of the project.

Timeframe

The aim is to complete the project, with the outputs being fit for publication and wide communication by 31st December 2020.

Contact points

Successful projects will report directly to the Programme Manager at the Faraday Institution. For questions about this opportunity, please contact ian.ellerington@faraday.ac.uk or nick.smailes@faraday.ac.uk

Competition Criteria

The assessment criteria will be:

- Proposed methodology (20%)

- Expertise in developing/emerging economy energy markets, especially diesel/genset markets (20%)
- Technical expertise on energy storage / battery technologies for storage applications (20%)
- Economic modelling expertise, approach and track record (20%)
- Value for money / price (20%)

Each criterion will be scored through a paper sift. The assessors may invite one or more bidders for a clarification interview prior to making a final decision. The proposals will be re-scored after the interview. Scoring below a set hurdle rate in any criterion will eliminate the proposal.

The closing date for proposals is 31st July 2020.

The highest scoring proposal will be invited to agree final contract terms and start work, as soon as possible after but no later than September 2020 with a view to completing the work by 31st December 2020.