Environmental sustainability of solar water pumping in Sub-Saharan Africa

Terms of Reference

I. Background

The 'Environmental sustainability of solar water pumping in Sub-Saharan Africa' research project has been commissioned by the Low Energy Inclusive Appliances (LEIA) programme. The research project will be made possible through funding from UK aid and IKEA Foundation.

The UK aid funded LEIA programme aims to accelerate the availability, affordability, efficiency and performance of a range of low energy inclusive appliances. The programme is coordinated and convened by the Efficiency for Access Coalition, which aims to accelerate global energy access through energy-efficient appliances and is jointly managed by Energy Saving Trust (www.energysavingtrust.org.uk) and CLASP (www.clasp.ngo).

II. The Problem

Solar water pumps (SWPs) are one of the four near-to-market technologies that the LEIA programme focusses on, as it plays a critical role in improving incomes and livelihood resilience to largely agrarian rural households. Approximately 95% of farmed land in Sub-Saharan Africa relies solely on seasonal rainfall for water needs. Currently the substantial majority of irrigation schemes in Sub-Saharan Africa (SSA), both large and small-scale, use surface water. Only 20% of schemes use groundwater resources. At the same time, harnessing groundwater resources for irrigation has the potential to increase irrigation by 120 times across 13 countries namely Nigeria, Tanzania, Ghana, Zambia, Burkina Faso, Ethiopia, Niger, Kenya, Mali, Mozambique, Rwanda, Uganda, and Malawi (Malabo Montpellier Panel, 2018 as cited in Efficiency of Access Coalition, 2019). While surface water will continue to be a key resource for irrigation needs, the expansion of groundwater resources will be critical to unlock the true irrigation market in SSA.

There are clear potential benefits to such a trend, were it to materialise. In drinking water supply, a transition from handpumps to solar pumping would save considerably on human energy and effort. In agriculture, the benefits of having a reliable groundwater supply for irrigation, both during increasingly erratic rainy seasons and in seasonal dry periods, are obvious. The application of solar energy may result in more reliable and cost-effective water pumping (especially compared to unreliable grid power or increasingly expensive fossil fuels). Over-abstraction of groundwater in many regions of the world has been well documented. In India for example, growing demands for 'green revolution' crops, combined with unsustainable energy subsidies led to widespread over-abstraction in several states, to the detriment of both agriculture itself and the drinking water supply. There are fears that uncontrolled

expansion of groundwater irrigation in Africa could lead to similar results, if only initially in particular hotspots.

III. Objectives

The LEIA programme has a research mandate that includes consumer, market, technical and impacts research activities. The impacts research component includes a mandate to estimate environmental impacts, maximize positive impacts and understand and make recommendations for mitigating negative impacts of our interventions.

Therefore, Energy Saving Trust (EST) proposes to launch this research with the objective of bridging the knowledge gap related to potential negative impacts on groundwater tables as we expand access to SWPs in Sub-Saharan Africa. This research will also aim to make recommendations on how interventions for expanding access to solar water pumps can be made using environmentally sound principles.

IV. Scope of work[1]

Many African countries are characterised by weak governance and inadequate regulatory systems, making it incumbent on private sector players and external development partners to evaluate those risks and take socially and environmentally responsible voluntary measures to mitigate identified risks.

Geographical focus: The analysis will document a big-picture risk assessment at the Sub-Saharan Africa level, with a deeper dive in East and West African countries.

This research will outline potential environmental impacts that may unfold in line with the market projections of solar water pump uptake in SSA in the years to come in published literature. The degree of risk may vary with the rate of adoption of solar water pumping technology. The research will evaluate environmental threats in line with few different scenarios of expected market projections and will include the following three work components.

1. **Review available estimates of market potential**. Numerous projections of the potential for expansion of irrigated agriculture and drinking water supply in SSA have been made. More specifically, the magnitude of the market potential for solar water pumps in SSA has been estimated. The first part of the work will provide a critical analysis and synthesis of these estimates and projections, in particular highlighting and challenging questionable assumptions and gaps in evidence.

2. **Refine the conceptual risk framework for the study.** The next task will be to organise a conceptual framework that will identify the potential threats to the environmental sustainability of groundwater supplies from growth in the solar water pumping market. A suitable approach to the assessment of risk, and to the determination of the confidence with which conclusions can be drawn, will be identified. Some of the risks this research will investigate include:

[1] The scope of work has been drafted by Richa Goyal, Energy Saving Trust and Richard Carter, Independent Consultant.

2.1 ***Risks related to over-abstraction and falling water tables*****:** This phenomenon has been experienced widely in North America, China and India, as well as in North Africa. So far this has generally not been the case in SSA, although the risk is real. What is the risk of over-abstraction of the groundwater table via solar water pumps leading to situations where adequate irrigation or drinking water supply may itself be threatened? This research will consider contributions to over abstraction of GW tables from the following sources:

- Risks from climate change, deforestation and encroachment: Climate change is altering the global water cycle and water availability is likely to become more variable and unpredictable. Climate change poses a threat to water resources, although its impact on renewable groundwater resources is not straightforward. Intuitively, it may be thought that in areas where climate change leads to reduced rainfall, this would be accompanied by reduced groundwater recharge. However, a recent paper in Nature (Cuthbert et al, 2019) suggests, among other things, that the increased rainfall intensities associated with anthropogenic climate change may lead to more, not less, groundwater recharge. Likewise Cobbing (2020) challenges 'the discourse of [groundwater] shortage in Sub-Saharan Africa', suggesting that the dominance of such discourse 'may retard progress towards a much-needed structural change in economic activity enabled by increased agricultural production, resilience and water security'. This research will review the existing evidence of threats to groundwater resilience from climate change.
- Risks from increased demand - In SSA especially, populations are projected to rise rapidly to and beyond the end of the 21st century. Urbanisation is taking place in many countries at twice the annual average national rate of increase (with rural growth rates still positive but slowing). Water demands are increasing faster than population. There are additional risks to groundwater supplies from land use change. Country contexts and global and national trends are leading to increasing demands for food and water. Demographic trends are already leading to degradation of land and water resources as farming households and national governments attempt to address their burgeoning food, energy, and water demands. This research will analyze the experience in India and other places where solar water pumping has taken off in order to understand elements that have resulted in environmental sustainability issues, particularly with respect to groundwater use.
- Risks from introducing inappropriate technologies: Inappropriate attempts to introduce pumps with higher discharge ratings to boreholes and wells which cannot sustain high abstraction rates may inadvertently lead to rejection of pumping technologies, including solar. Many areas of Africa are underlain by aquifers which have inherently low yields. A further risk concerns the introduction of more sophisticated (and more expensive) technology than used hitherto (solar pumps replacing handpumps or treadle pumps) into low-income countries and fragile contexts with very weak institutional capacities and maintenance / repair infrastructure.
- Risks from pandemics: There has been an increase in number of zoonotic or diseases that jump from humans to animals due to increased animal habitat loss with approximately one new infectious disease appearing every four months (Smith et al., 2014 as cited in Cooper, 2020). It is clear that the water demands for public health will increase during a pandemic for combatting and treatment purposes. Increased demand for domestic water and water for healthcare settings could lead to trade-offs in competing demands for supplies from agriculture and other sectors (Joshi & Nicol, 2020 as cited in Cooper, 2020). Added stress on groundwater levels in the years to come from unsustainable water

abstraction via SWPs can add to the balance between requirement of water for agriculture and food production, and water in cities to combat pandemics.

2.2 ***Negative impacts on water quality and soil condition*****:** This risk is expected to be more profound in coastal areas and in areas where fresh groundwater is found in proximity to saline water. In such regions increased salinization of wells and boreholes is an obvious risk. The application of irrigation water in quantities insufficient to leach salts from the soil may lead to salt build-up in the crop's root zone. Groundwater abstraction may mobilise nuisance chemical species such as iron, and toxic species including manganese, fluoride and arsenic. The latter is especially serious as it affects both drinking water and food, and it is highly poisonous in low concentrations if consumers are exposed for extended periods. This research will look at published literature on this topic to summarize expected risks on water quality and soil condition as the expected market potential of solar water pumps is realised in the years to come in SSA.

As far as data, literature and expert opinion allow, the study will disaggregate its analysis of identified risks by country or sub-region, by scale of technology (pump size) and irrigation, scale of adoption, by water use (e.g. agriculture, animal husbandry, and in drinking water), and/or by other relevant categories which emerge from the review.

3. Recommendations for risk mitigation that speak to different stakeholders.

This work will include a range of recommendations for sustainability of solar water pumping in small farmer irrigation and community drinking water supply in SSA. Consideration will be given to areas such as technological solutions, crop selection, farming and irrigation methods, conservation agriculture, rainwater harvesting and enhancing aquifer storage, and appropriate business models. See suggested lines of inquiry below.

I. The role of information and communication technology and sensors for water resource monitoring.
II. The implications of different farming systems, crop selections and irrigation application methods on water demands in agriculture.
III. The complementary activities related to water conservation which solar water pump users can undertake, and which appropriate government policy and business models can incentivise to enhance sustainability.

The study is expected to be useful to the following stakeholder groups and initiatives. Recommendations will be addressed to each of the following groups:

3.1 Policy makers. The potential threats analysed, and the recommendations arising from this research, are expected to inform national governments and development partners undertaking bulk procurement of technology or implementing subsidy programmes and other policy incentives to expand access to solar water pumps.
3.2 Investors. Insights from this study are expected to inform responsible environmental, social and corporate governance decisions made by those investing in solar water pumping programmes.
3.3 Manufacturers, distributors and retailers. The identified risks may also have implications for the viability of solar pump markets. If for example over-abstraction or water quality deterioration occur

within the product purchase repayment period, this could affect the user's ability and willingness to complete payment terms. Incorporating such environmental risks in the business strategies of pump manufacturers and others is expected to enhance the resilience of the private sector.

3.4 **Energy / water access programmes such as LEIA**. Programmes such as LEIA and others within the portfolio of the Efficiency for Access coalition include goals to expand access to solar pumps. These programmes and coalitions are uniquely positioned to influence the design of such interventions in a more environmentally sustainable direction. This study will review the LEIA programme theory of change and other related materials and provide appropriate recommendations that a programme like LEIA can directly undertake. It will also offer insights and implications for the development of impact metrics around sustainable solar water pumping.

3.5 **Solar pump users**, both farmers (of crops and animals) and communities of drinking water consumers. The study is expected to provide straightforward guidance to users on selection of pumping solutions taking into account any environmental impacts from unsustainable abstraction of groundwater. The LEIA programme is expected to undertake a consumer awareness campaign in a region in SSA with the aim of increasing awareness of end-users about appropriate SWP technology. This research recommendations are expected to feed into this consumer awareness campaign.

IV. Approach

The work will be delivered with the help of an external consultant, contracted specifically for this project. The consultant should have strong experience on topics such as farmer-managed irrigation, groundwater resources and water management with a focus on low income countries in Africa. The consultant should have demonstrable knowledge of different water pumping technologies being used in rural regions in developing countries. This research should be informed by key informant interviews with knowledgeable individuals from a range of companies representing manufacturing and distributors, and a similar number of experts from research institutions, relevant INGOs, governmental institutions and donors.

V. Deliverables

The study will lead to the following deliverables:

1. A peer reviewed **main report** (30-40 pages plus Annexes) containing
    a. an executive summary written for non-specialists;
    b. a critical analysis and synthesis of estimates and projections of the market potential for solar pumps in SSA;
    c. a detailed review of the threats to the environmental sustainability of the anticipated solar water pumping market set within a clearly formulated conceptual framework;
    d. bespoke recommendations for the various identified stakeholder groups;
    e. a full reference list and select bibliography.
2. A blog post explaining the objectives and key findings of the study.
3. An infographic explaining key findings.
4. A Powerpoint presentation consolidating the key findings.
5. A webinar organised by Energy Saving Trust and presented by the contractor.

VI. Available budget and submission requirements

Interested parties are required to submit the following documents for submission:

1. Financial proposal: This should include a detailed budget estimate in US Dollars outlining fees and expected expenses for the duration of the project. Detailed budget should include all direct and indirect cost estimates for executing the project, detail specifically a break-down (in days) of the level of effort associated with the activities.
2. An outline of the breadth and depth of the consultant's relevant experience, and the level of expertise to be able to deliver on this scope of work. [up to 500 words]
3. An outline of the consultant's experience in working in the field overseas, particularly in the context of developing countries. This should include consultant's experience in being able to deliver quality outputs in a short space of time that can be shown to have had a significant impact. [up to 500 words]
4. Any other information [Up to 250 words]
5. Two recent relevant publications
6. Contact details of two referees whom Energy Saving Trust can reach out to
7. Submissions from individual consultants, research organizations or consulting firms are encouraged. A consortium of consultants and/or consulting firms is allowed. Detailed CVs of all expected individuals working on the project should be submitted. A hired consultant can sub-contract other parties as needed. In such cases please include details of expected sub-contracted parties as part of submission process.

Please feel free to attach other materials as appendices as needed to strengthen your application.

The deadline for submission is 17:00 BST, 23 July 2020. Proposals must be emailed to Richa Goyal at richa.goyal@est.org.uk. All questions can also be addressed to Richa Goyal at richa.goyal@est.org.uk. We request all inquiries to be made by email and not by phone.

EST Team will evaluate proposals received from respondents. Selection of the candidate will be based upon the following criteria:

1. The breadth and depth reflected in consultant's relevant experience from submissions under points 2. – 6. highlighted above under 'documents for submission'.
2. Relevant qualifications, including working knowledge of types of pumping technologies, broad technical knowledge of sustainable water management, and understanding of holistic approaches in water conservation.
3. Total cost and value for money.
4. A due diligence process performed by EST on both financial and safeguarding.

Available budget

The range of available budget is USD $28,000 - $34,000. This does not include budget for professional design of the report which will be covered by EST separately.

VII. Expected research timeline

We expect the research to commence in the week of 11 August 2020, submission of a draft report in early October 2020 and the peer reviewed final report by November 2020.

VIII. Sustainability

To promote environmental best practice, Energy Saving Trust will place emphasis on the environmental credentials of its contractors. Each respondent is therefore required as part of their proposal to provide details of their environmental certification relating to ISO140001 and ISO50001 (if appropriate), environmental policy or any other relevant information regarding their approach to sustainability. Responses should outline the organisation's commitment to minimize negative environmental impacts and reducing energy consumption when delivering this contract.

IX. Terms and conditions and invoicing

Contractors will be expected to sign Energy Saving Trust's standard terms and conditions (available on request). Payment schedule will be agreed at the stage of contract signing.

X. Conflict of Interest

In order to ensure that research is of maximum benefit to the wider community, it must be impartial and seen to be impartial. Bidders must be free of any conflicts of interest regarding which direction the market for off-grid appliances might take. This means that bidders must not have commercial interests in the market taking any particular direction. The types of situation that could lead to conflicts of interest include if the bidder is:

- A manufacturer or supplier of off-grid appliance equipment or components;
- A current or recent past contractor to a single manufacturer or to a small number of manufacturers of a particular type of appliance;
- An economic operator with a commercial interest in the market moving in a particular direction.

Bidders must declare if any such conflict exists or if it could be perceived to exist based on their status and work history and, if so, how this would be managed to guarantee impartiality.

XI. Freedom of Information Act

Pursuant to the Freedom of Information Act 2000 Energy Saving Trust may be required to disclose certain information to third parties and/or the public. Respondents must notify Energy Saving Trust in writing when submitting their proposals which parts of the proposal are considered to be commercially sensitive. Please note that it is not possible to classify the whole document as non-disclosable. Failure to notify Energy Saving Trust indicates that no commercially sensitive information has been submitted.

XII. References

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