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Lessons learnt

The environmental impact of promoting access to green energy through inclusive finance

The case of a solar farming system in Bangladesh

Results of the greenhouse gas emissions impact assessment of an agricultural system consisting of a solar-powered water pump, thresher and dryer.

Background

ADA promotes access to green energy for vulnerable populations by helping its local partners develop tailored financial services for acquiring solar or energy-efficient equipment for domestic or productive use.

The positive socio-economic impact resulting from the use of this equipment, particularly in terms of improving living conditions and reducing fuel expenditure, are undisputed. Nevertheless, in view of the pressing climate situation, it is becoming necessary to estimate the environmental impact of this type of initiative, in particular in terms of reducing greenhouse gas emissions. While the priority for vulnerable populations remains to adapt to the consequences of climate change, ADA considers itessential to ensure that the solutions it promotes are consistent with a sustainable development objective, particularly in terms of low carbon.

ADA has therefore partnered with the Luxembourg Institute of Science and Technology (LIST) to carry out an impact assessment of the greenhouse gas emissions of various types of equipment promoted through its projects.

Case study: implementation of a solar agricultural system in Bangladesh

Background to the initial project

“Chars” are unstable alluvial islands located on Bangladesh’s main rivers that today are threatened by climate change. The populations that have settled on them depend on agriculture and fishing and live without running water, electricity, transport or other public services or infrastructures, making them particularly vulnerable.

One of the major challenges facing the communities living on the chars of the Brahmaputra River is managing water for agricultural production throughout alternating periods of drought and flooding.

Objectives

In order to enable the populations of the Chitulia Digha char to better manage irrigation for rice production in dry periods, ADA and the NGO Friendship Luxembourg and Bangladesh teamed up from July 2022 to October 2023 to install a solar agricultural system composed of two water pumps, a rice thresher and a dryer powered by electricity produced by a system of 48 photovoltaic panels and 45 batteries.

The use of this system enables the char’s populations to cut their rice production costs compared to a system based on diesel pumps. At the same time, the solar system reduces their activity’s environmental footprint, particularly by reducing the risk of diesel pollution.

SUBJECTS

Access to basic services

Agricultural and forestry value chains

PROJECT NAME

Multi-usage solar mobile equipment

OBJECTIVE

Enable smallholder farmers in Bangladesh to adapt to climate change with low-carbon solar equipment

PROJECT DURATION

From July 2022 to October 2023

REGION COVERED

Bangladesh, Asia

BUDGET

EUR 14,000

STAKEHOLDERS

Project funder
Luxembourgish Ministry of Foreign Affairs

Project partner
Friendship Luxembourg and Bangladesh (NGO)

Author of study
Luxembourg Institute of Science and Technology (LIST - research institute)

CONTRIBUTION TO THE SDGs

2 ZERO HUNGER · 7 AFFORDABLE AND CLEAN ENERGY · 13 CLIMATE ACTION

2.4 Sustainable food production and resilient agricultural practices

7.1 Access to energy

13.1 Strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries

Key results

- **Identification, purchase and installation of the most appropriate equipment** (two water pumps, a thresher and a dryer, powered by solar electricity) in terms of price, accessibility and quality of maintenance services
- **Production costs reduced** by replacing old diesel-powered water pumps by two solar-powered electric pumps
- **Reduction of noise pollution** from the old diesel pumps
- **Improved agricultural production efficiency and reduced crop losses** thanks to the new solar farming system

50
producers were trained
in good rice production and irrigation practices and use the equipment

35
producers use the solar irrigation system
as well as the thresher and dryer thanks to the introduction of a rotation system

40
households supplied with electricity
for four hours a day during the irrigation period and 24/7 outside this period, thanks to the surplus electricity produced by the photovoltaic system

Main objectives of the environmental impact assessment

In addition to this initiative's positive economic impact (reduction of diesel consumption costs and increase in productivity) and the improvement of living conditions (reduction of noise pollution and access to lighting), **a positive environmental impact in terms of reducing greenhouse gas emissions was also expected and was the subject of this assessment.**

This project was selected as it introduces a complex system that makes it possible to **promote the use of green energy both for productive use (agriculture) and for domestic use (household lighting), on a community and not just individual scale.** The expected impact, both socio-economic and environmental, is therefore potentially greater than for other projects and deserves specific analysis, especially as **Friendship has planned to replicate the installation of this system in other communities.**

New solar-powered rice thresher with photovoltaic system

Methodology

Life Cycle Assessment

The method used by LIST to assess the environmental impact of the project described above is the Life Cycle Assessment based on the international standard ISO 14040, which describes the protocol to be followed for assessing environmental impacts throughout the life cycle of a product, from the purchase of raw materials to **its production, use, end-of-life treatment, recycling and disposal.**

This methodology involves the following steps:

: Definition of the assessment scope

This step consists in describing in detail the service provided by the new system being assessed, the assessment scope (or system life cycle phases taken into account) and the system being replaced, which will then make it possible to **estimate the difference in greenhouse gas emissions between the new and the old system for providing the same service.**

The assessment compares a new agricultural system to an old one that produces the same amount of rice over a year of use:

The new agricultural system *consists of:*

- **2** electric water pumps
- **1** electric rice thresher
- **1** electric dryer

all powered by a photovoltaic system composed of 48 solar panels connected to 45 Li-ion batteries

The old agricultural system *consists of:*

- **8** diesel-powered water pumps
- **4** diesel-powered threshers

no dryer, rice being dried naturally in the sun

Several assessment scopes were considered in the study, corresponding to **four scenarios**:

1. **Comparison of the old agricultural system and the new system,** without taking into account the surplus electricity produced by the photovoltaic system in place

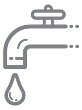
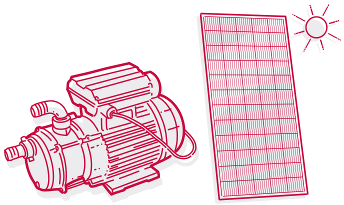
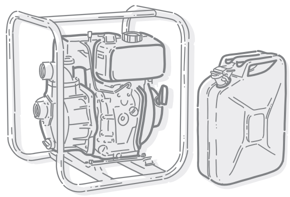
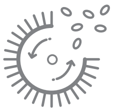
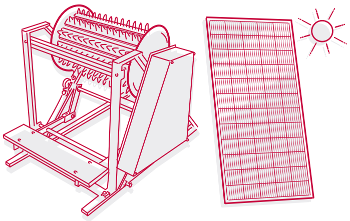
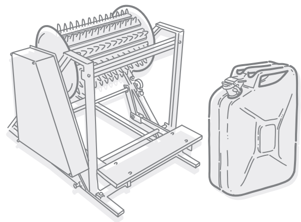
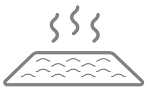
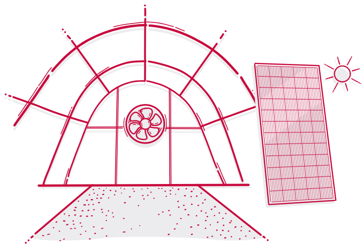
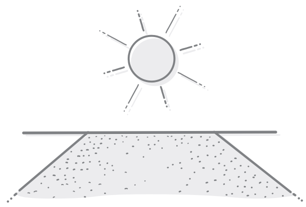
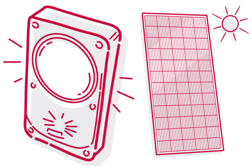
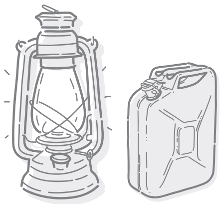
2. **Scenario 1** + solar lamps powered by the surplus electricity produced by the photovoltaic system, compared to kerosene lamps, used by 40 households

3. **Scenario 1** + total surplus electricity produced by the photovoltaic system compared to the same amount of electricity produced by diesel

4. **Scenario 1** + total surplus electricity produced by the photovoltaic system compared to the same quantity of electricity produced by the Bangladeshi electricity grid

Scenario 2 is the baseline scenario presented in this document, as it is the one that is actually in place. This reflects the fact that prior to the new system's implementation, the community did not use the equivalent of the surplus electricity produced by the photovoltaic system, either from diesel, which would represent much too high a cost, or from the national electricity grid, which cannot serve the area in question for technical reasons. Scenarios 3 and 4 are therefore unrealistic. Nevertheless, they are included in the assessment to take into account the total surplus electricity produced by the photovoltaic system while following the method that requires comparing similar uses between the new and the old system.

Applied to scenario 2 of the project in question, this step produces the following information:

Service provided assessed	*New system assessed*	*Old system assessed*
Water pumping  1 season of use (12 hours per day for 90 days)	 **Electric water pump powered by solar energy produced by the photovoltaic system**	 **Diesel water pump**
Rice threshing  1 season of use (8 hours per day for 15 days)	 **Solar-powered electric thresher**	 **Diesel thresher**
Rice drying  1 season of use (8 hours per day for 300 days)	 **Solar-powered electric dryer (with fan)**	 **Natural sun drying**
Lighting  One year for 40 households (4 hours per day during the 90 day irrigation period, 24 hours a day the rest of the year)	 **Solar lamps**	 **Kerosene lamps**

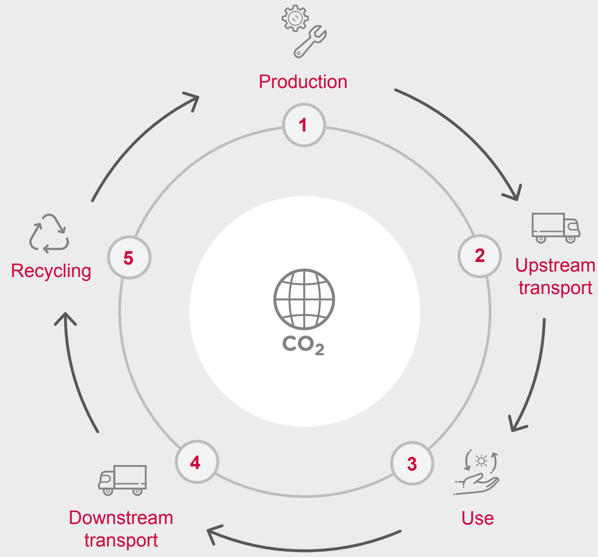
Life Cycle Inventory and Life Cycle Impact Assessment

This step consists of **identifying and listing all the elements** (equipment components, production process, mode of transport, etc.) that can generate greenhouse gas emissions at each stage of the life cycle of the new and the old system, identifying each element's emission factors and then quantifying the greenhouse gas emissions from the assessed systems' life cycle.

The data used in this step comes from the assessed systems' technical documentation, the relevant scientific literature if there is no documentation (particularly for replaced systems) and – to model the components and processes of the different systems assessed – the Ecoinvent database, the leading global database for life cycle assessments.

The greenhouse gas emissions generated at each stage of the assessed systems' life cycle were calculated using the Environmental Footprint 3.1 method developed by the European Commission.

Applied to the project in question, this step produces the following results:



	New system *powered by solar energy*				Old system *powered by diesel*			
For 1 season / year of use								
Total emissions	1,276 kg CO_2 eq.				16,000 kg CO_2 eq.			
Details of system components	2 electric water pumps *(58% of total emissions)*	1 electric thresher *(27% of total emissions)*	1 dryer with electric fan *(3% of total emissions)*	40 solar lamps *(12% of total emissions)*	8 water pumps *(51% of total emissions)*	4 thresher *(12% of total emissions)*	Natural drying *(0 emissions)*	40 kerosene lamps *(37% of total emissions)*
Production *(% of emissions per system component)*	**94.3%**	**94.3%**	**93.3%**	**99%**	0.9%	1.5%	0%	0.8%
Upstream transport[1] *(% of emissions per system component)*	5%	4.1%	2.2%	0.9%	0.1%	0.1%	0%	0%
Use *(% of emissions per system component)*	0%	0%	0%	0%	**99%**	**98.4%**	0%	**99.1%**
Downstream transport[2] *(% of emissions per system component)*	0.5%	1.9%	1.2%	0.2%	0%	0%	0%	0%
Recycling / End of life *(% of emissions per system component)*	0.2%	- 0.3%	3.3%	- 0.1%	0%	0%	0%	0%

Note that emissions related to the production, transport, use and end of life of the photovoltaic system and the battery are reallocated to each element of the new agricultural system based on the amount of energy produced by the system and consumed by each element. This allocation makes it easier to compare the elements of the new and the old system.

1 Upstream transport corresponds to the transport between the place of production of each piece of equipment and the project site. The production site assumptions are as follows: the solar panels of the photovoltaic system are produced in China, the battery, thresher and dryer are produced in Bangladesh (in Dhaka), the electric water pump is produced in India and the solar lamps are produced in France.

2 Downstream transport corresponds to the transport from the project site to the recycling centre in Dhaka, Bangladesh.

Comparing the new and the old system shows very clearly that while the vast majority of emissions related to the new system come from the equipment production phase, **the vast majority of those generated by the old system come from the equipment use phase, notably due to the combustion of oil during this phase.**

The transport phase, whether upstream or downstream, remains negligible compared to the other phases.

Interpretation

This step consists of **comparing the quantity of greenhouse gas emissions** generated by the two systems in providing the same service and of **drawing a conclusion as to the environmental impact** of replacing one system with another. It is the subject of the following section.

Limitations

The life cycle assessment method is based on the **comparison of the same service provided by different systems,** and does not take into account any rebound effect. The rebound effect occurs when a given system becomes more efficient and less costly to operate, resulting in longer or more intensive use than the previous system and potentially negating some of its benefits.

Moreover, a certain number of uncertainties appear at each stage of the assessment, for example relating to the primary data used concerning the production of photovoltaic panels, the generic data from the Ecoinvent database representing the average industrial processes, emissions factors, etc.. Although the magnitude should not differ in the results below depending on the various assumptions made, this limitation should be considered when interpreting the results.

Irrigated rice field
in the project area in Bangladesh

Results of the assessment: environmental impact

NEW AGRICULTURAL SYSTEM WITH SOLAR LAMPS VS OLD SYSTEM WITH KEROSENE LAMPS (SCENARIO 2)

- 92% **GHG emissions**

- 14,724 KG CO_2 eq. **over 1 year**

i.e. more than 5 return flights from Luxembourg to Bangladesh[1]

For the same service provided, i.e. for one year of use of the agricultural system and lighting for 40 households, the new system combined with solar lamps **reduces greenhouse gas emissions by 92% compared to the old agricultural system** combined with kerosene lamps.

The results of the assessment for the **four scenarios** considered are depicted below:

Emissions avoided over 1 year under different scenarios

While scenario 4 is not realistic in the region of the project concerned, the results are nevertheless interesting as Friendship plans to replicate the implementation of such systems in other regions of Bangladesh, which are or could be connected to the national electricity grid. The assessment of this scenario shows that even taking into account the total surplus electricity produced by the photovoltaic system, **using the new system reduces greenhouse gas emissions by 88%.**

Thus, in addition to the gain in terms of improving the living conditions of populations who now have access to energy thanks to the photovoltaic system, there is a significant reduction in emissions compared with an equivalent consumption of electricity produced via the grid.

1 Estimate carried out with MyClimate, based on flights with a stopover in Istanbul on both outward and return legs.

Conclusion

The use of solar-powered equipment has **a considerable positive impact in terms of greenhouse gas reduction** when the equipment replaces traditional diesel-powered equipment and is used in a similar way.

Oil combustion is the source of the vast majority of greenhouse gas emissions in traditional systems, just as it is the source of harmful effects on the health of users of these systems, and of soil pollution from leaks.

Although environmental impact is not always the priority impact sought by this type of development project, since the main objective of which remains to improve populations' living conditions, the assessment shows that promoting this type of equipment remains entirely consistent with a more general objective of contributing to sustainable development in all its dimensions, whether social, economic or environmental.

Outlook

The NGO Friendship plans to replicate the initiative in other parts of Bangladesh by installing several dozen solar-powered water pumps and electrical agricultural equipment.

Similarly, ADA continues to experiment with solutions aimed at facilitating access to green energy to meet the basic needs of vulnerable populations and develop income-generating economic activities in various regions of the world.

These solutions target both individuals and communities, and include the search for sustainable business models for mini-solar networks in rural areas that would allow households and micro- and small entrepreneurs to consume decarbonised electricity.

These initiatives will continue to be the subject of environmental impact assessments such as this one, while considering the socio-economic effects on the populations concerned.

ADA, expert in inclusive finance, driver of partnerships and innovation

ADA (Appui au Développement Autonome – "support for autonomous development") is a Luxembourgish non-governmental organisation that has been increasing the autonomy of vulnerable people in Africa, Central America and South-East Asia with inclusive finance since 1994, thereby contributing to achieving the Sustainable Development Goals.

ADA leverages its resources and expertise to innovate, support local partners, implement technical support programmes, give investment advice and manage knowledge to positively and sustainably impact targeted populations.

ADA's activities focus on three main topics: youth entrepreneurship, agricultural and forestry value chains as well as access to basic services. These activities take into account three transversal priorities: climate change, gender and the use of digital technologies.

www.ada-microfinance.org/en

Expert in inclusive finance, driver of partnerships and innovation

ADA (Appui au Développement Autonome) is a Luxembourgish non-governmental organisation that strengthens the autonomy of vulnerable people by leveraging inclusive finance to improve their living conditions.

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