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Renewable Energy Technology for Smallholder Farmers

Collaboration with Local Companies for Adaptive Agriculture in Cambodia

PROJECT FULL NAME	COUNTRY & REGION	EXECUTING AGENCIES	IMPLEMENTING AGENCY
Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies in Rural Cambodia (S-RET)	Cambodia 	Ministry of Agriculture Forestry and Fisheries (MAFF), Cambodia	International Fund for Agricultural Development (IFAD)
GEF PROJECT ID: **9103**		**FOCAL AREAS**	**IMPACT AREAS**
PROJECT TYPE: **FSP, SCCF**		▪ Climate Change	▪ Climate Change Mitigation ▪ Climate Change Adaptation ▪ Poverty Reduction ▪ Women's Empowerment
GEF PERIOD: **GEF-6**		GEF Project Financing **$ 4,600,000**	Co-financing Total **$ 21,092,000**

Summary

Climate change projections show Cambodia becoming hotter with increased rainfall in the wet season and reduced rainfall in the dry season. These changes will make it difficult for farmers, who have already reported that the climate has become less predictable, to select the optimal time to plant rice and other crops. The Scaling-up of Renewable Energy Technologies (S-RET) project targeted 8,000 smallholder farmers in five provinces comprising 980 villages, particularly women and poor households in remote areas, who lack access to modern, affordable, and reliable energy sources. Building on strong collaboration with and learning from existing projects, engaging small and medium sized enterprises through a Call for Proposal, and active women's participation with innovative ideas from private sector, the project succeeded in introducing appropriate and affordable RET for smallholder agriculture in rural areas of Cambodia.

As a result, the project contributed to reducing greenhouse gas (GHG) and improved climate resilience for the rural communities by investing in economically viable RET for agriculture production, processing, and post-harvest activities. Key lessons learned from this project are transparent grant mechanism for small and medium sized enterprises, scaling up and strengthening sustainability of RET by private sector initiatives, and knowledge sharing for awareness raising of RET.

Figure 1: Ms. Khat Sa Em uses a portable solar pump to grow vegetables in Ponleu village, Takeo province. @IFAD

Results, Global Environmental Benefits and Adaptation Benefits

The project has achieved the following global environmental benefits as well as direct adaptation benefits for local communities as of June 2020:

- 5,233 direct and indirect small farmer beneficiaries (34 percent female)[1] adopted sustainable and environmentally friendly RETs at farm level for agricultural production, processing, and post-harvest activities such as irrigation, drying, cooling, and storage (65 percent of target goal).
- The project has installed 1,192 RETs (non-biodigesters) to date, of which 309 units (20 percent of total) are owned by female-headed households.
- The project was able to identify various appropriate and affordable RET options for smallholder farmers, including solar dryers for processing food, portable solar water pumps to irrigate crops, biochar briquettes for heating chicks, solar poultry incubators, solar cricket incubators, and others.
- The National Biodigester Programme (NBP) has installed 1,961 biodigester plants,[2] of which female-headed households own 882 plants (45 percent). Biodigester plants directly benefited women who are responsible for collecting firewood and cooking (65 percent of target goal).
- Biodigester plants reduced 15,120 tons of CO_2 emissions and saved 9,594 tons of fuelwood[3] from 2018 to 2020.

1 Indirect beneficiaries include farmers along the value chain that benefit indirectly i.e. by renting RET (e.g. portable solar pump) or buying outputs from a direct beneficiaries' use of RET (e.g. farmers buying chicks and selling them after fattening through the GIC solar incubator).

2 NPB installed 265 biodigesters in 2017, 646 in 2018, 749 in 2019 and 301 in 2020. NPB also initiated and tested biogas to run irrigation pumps, rice milling machines and heaters for warming chicks. These pilots aim to expand the scope of NBP to support medium and large-scale biodigesters for commercial applications i.e. slaughterhouses and lagoons.

3 These net environmental benefits are calculated with the methodology subscribed under the Gold Standard based on the assumption that a biodigester has reduction in workload of 2.5 hours per day, and reduction of 4-6 kg of firewood per day or 50 litters of kerosene saved over a duration of 10 years. Emission factor of 71.9 tCO_2/TJ for kerosene was applied.

- Every kilogram of the Sustainable Green Fuel Enterprise (SGFE)'s Biochar briquettes[4] saves 6.5 kilogram of wood that is not cut from Cambodian natural forests. To date, the company has saved a forest area in Cambodia equivalent to 165 football fields, thus reducing (absorbing) about 28,000 tons of CO_2 emissions.

Environmental Challenge

Cambodia is a least-developed country and highly vulnerable to the impacts of climate change. Around 80 percent of the population live in rural areas and are dependent on agriculture for their livelihoods. Climate change projections show that Cambodia is becoming hotter, with increased rainfall in the wet season and reduced rainfall in the dry season. These changes will make it difficult for farmers, who have already reported that the climate has become less predictable, to select the optimal time to plant rice and other crops.

Cambodia's GHG emissions are low but rising and the agriculture sector is estimated to produce 80 percent of national carbon-dioxide equivalent (CO_2e). The contribution of domestic livestock to the total emissions was 48 percent followed by rice cultivation and agricultural soils—hence the rationale for increasing the adoption of biodigesters.[5] There is high potential for introduction of appropriate and cost-effective renewable energy technologies (RETs) for smallholder agriculture. However, actual adoption rates are low, with only biodigesters and solar home lighting systems in rural Cambodia due to limited knowledge of RET; limited range of proven technologies; underdeveloped marketing, financing, installation, and after-sale services for RET; high costs relative to the resources of smallholders; and an inadequate policy environment.

Integrated Approach and Key Features

While promoting RETs for smallholder agriculture to reduce GHG emission and adapt climate change, delivery of RETs also helped to address cross-cutting themes including private sector engagement, youth capacity building, technologies and knowledge transfer, and women's empowerment, which were objectives under the new National Strategic Development Plan (NSDP) 2019-2023.

Strong synergy among other projects to maximize benefits

The project has been built upon key achievements and strong collaboration with the other successful renewable energy and agricultural development projects in Cambodia, namely the National Biodigester Programme (NBP), Project for Agriculture Development and Economic Empowerment (PADEE), and Agriculture Services Programme for Innovation, Resilience, and Extension (ASPIRE), both implemented by IFAD. Building on 984 Improved Group Revolving Fund (IGRF) groups established from PADEE, the project provided a subsidy (max $150) to IGRF members when RET is purchased and add $50 to the IGRF revolving fund for each RET installation. IGRF groups have established capacity and provided their members with access to credit which can be applied to financing RET installations. Model farmers are supported to facilitate peer-to-peer learning and this has improved beneficiary's participation and interest in RET. At least half of the IGRF members are female household representatives and through the testing of technologies, women are empowered to take up alternative livelihoods and trainings.

Collaborating with the National Biodigester Programme (NBP), the S-RET project was able to scale up PADEE's tested pro-poor biodigesters as well, which are smaller and cheaper than the standard biodigester models, thus suitable for farmers with few livestock. With the S-RET project, existing social capital and empowerment of local communities have been further strengthening by providing RET solutions that help them improve agricultural productivity and reduce energy costs. After the end of PADEE in 2018, the project has now migrated under ASPIRE and has a scope for nation-wide outreach and application.

4 Biochar Briquettes made from coconut husks are a clean alternative to firewood for cooking. The residue can also be used to improve soil fertility.
5 Agricultural emissions are largely in the form of CH4 (methane) and N2O (nitrous oxide) which have much higher greenhouse effects than CO_2.

Active private sector engagement through a Call for Proposal

The entire project relies on the effectiveness of partnering with private sector renewable energy companies to deliver RETs in target areas. Results have been generated in terms of leveraging partnerships with the private sector. To get innovative and affordable RET for smallholder agriculture, the project instituted a Call for Proposal to private companies which awards testing grants (maximum $80,000) to support testing RET under smallholder farm conditions (i.e. testing carried out on-farm, not at a research facility) and roll-out grants (maximum $160,000) to establish supply chains and after-sales service networks allowing grantees to scale-up their production and reduce high transaction costs in rural areas.

Out of 30 proposals, the project signed 12 agreements with local private companies (one international) for implementation of RETs to validate the technical, economic, and sociocultural acceptability of RET. As a result, the project was able to identify various appropriate and affordable RET options for smallholder farmers including solar dryers for processing food,[6] portable solar water pumps to irrigate crops,[7] making and using biochar briquettes to heat newly hatched chicks,[8] solar poultry incubator to heat eggs, solar cricket incubators, solar hydroponics for growing vegetable with less water,[9] and solar animal feed processing machines in addition to biodigesters. After an independent expert conducted an in-depth evaluation of the testing phase, seven grantees with active roll-out grants are currently ongoing to scale-up their RET.

Figure 2: A portable solar pump to grow vegetables @IFAD

6 Traditional methods of sun drying expose fish and meat to flies, dust, and other contaminants. Thus, the product is perceived to be higher in value due to quality of drying process. More hygienic drying method allows drying during the rainy season as well.
7 Switching from diesel to solar water pumps can save up to $2,110 per year. The pump costs $600 with a 200W panel and a flow rate capacity of 2.4m^3/hour.
8 Biochar Briquettes made from coconut husks are a clean alternative to firewood for cooking. The residue can also be used to improve soil fertility.
9 Hydroponic systems can reduce water use by 82%. Around 400 plants can fit on a bed surface of 13.5m2. Each bed contains 1,755L of water which is changed every three cycles.

Active women's participation with innovative ideas from private sector

Innovative ideas from the private sector also made the active participation of women in the project possible. Most women in rural areas had no financial record of borrowing, but testing grantees had extended flexibility to pilot innovative financial schemes. For example, one of the testing grantees, EcoSun, sells portable solar water pumps and has ventured into "Pay As You Go" rental/lease models, for a portable solar pump purchased as a group investment. According to the data from EcoSun's field testing of portable solar pumps, annual operational cost for solar pumping is $50, including maintenance. This is much lower compared to the annual operational cost of diesel pumps, which is $493 for fuel, oil, and maintenance. On average, farmers can save between 2-3 litres of gasoline per day ($1.50 – $2.30). The initial capital cost to install solar pumps remains higher compared to diesel pumps (for the same pumping capacity, solar pumps cost $600 versus $160), but with saving from gasoline, it is possible to pay back the initial investment. Portable solar water pumps are easy to use and suitable for vegetable producers, especially for women who are growing off-season high-value crops (fruits and vegetables). EcoSun had installed 192 units, of which 59 owned by women headed households (31 percent).

Solar egg incubators became another popular RET for women, because a company made a solar egg incubator package and provided training on how to operate the incubators. The package includes a cage, chicken house, healthy breeds, feed, and the solar incubator system for 300 or 500-egg production capacity. Training on chicken hatching, raising, vaccination, breeding, feeding, cage construction, treatment and operation, and maintenance of the RET have been provided and directly benefitted women as well. As a result, solar incubators are proving as a suitable and easy-to-use RET securing high hatching rates. Hatching rates of 95 percent are being achieved with solar incubators, compared with only 20 percent with traditional methods.[10] Chick hatching for mostly women beneficiaries has currently become a main source of income for many families, providing $350 to $400 per month. Green Innovet Cambodia (GIC) has installed 50 solar egg incubators, of which women own 32 units (64 percent).

Figure 3: Solar powered poultry incubators with 300-500 egg-capacity @IFAD

Lessons Learned

Transparent grant mechanism in order to reap more benefits

In order to ensure active engagement of the private sector, it was critical to get agreement on a transparent grant mechanism. While it took time to develop and agree on a transparent grant mechanism for RET through the Call for Proposal, providing more appropriate and affordable RET for smallholder farmers in Cambodia became possible only with active engagement of the private sector and integration of their innovative ideas in the project. For example, one

10 Access to solar energy overcomes the need for intermittent electricity access - a reason for higher chick mortality rates due to more frequent storms and rains causing higher frequency of electricity cuts in rural areas.

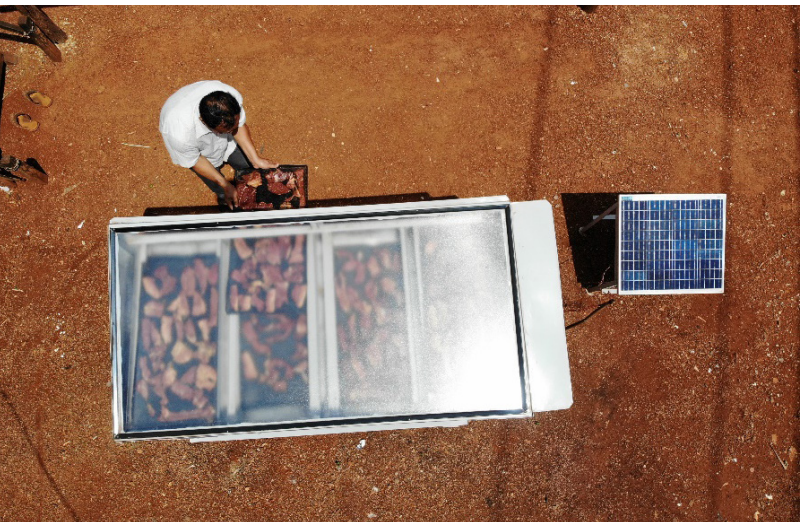

Figure 4: More hygienic drying method which allows drying during the rainy season @IFAD

of the grantees, Kosol/LES, which sells solar dryers for fish and meat, has set-up innovative finance schemes where 30 percent of the total RET cost ($950) is paid up front; the remaining 70 percent is paid in the form of dried beef/fish directly to the company (approximately 6kg per day and making a profit of $20/day[11]). Kosol/LES has set up e-commerce/mobile platforms and is working with retailers.

This business model is promising as it allows farmers to break even within six months from investment and increase production capacity with secure marketing and sales networks. With this model, the company could reduce risks of default payment as well. To date, there are 107 units of solar dryers installed in six provinces, of which 50 are female owned (47 percent). With the testing and roll-out grant, the cumulative amount of disbursement to grantees to date is $2,568,501: $1,779,980 in project grants and $788,521 from private companies. This grant mechanism also encouraged an investment from private companies to RET.

Private sector can initiate scaling up and strengthening sustainability of RET

The private sector played a vital role for scaling up and strengthening sustainability of RET. The private sector itself could initiate scaling up their RET business outside of the original project areas, and strengthen the sustainability of their RET business through ensuring their maintenance system. The project originally targeted five provinces. However, the companies are reaching out to other provinces to seek further business opportunities. The anticipated integration of S-RET into a nation-wide ASPIRE further enhanced the potential for scaling up and allowed the private sector to establish supply chains throughout Cambodia. IMB Cambodia and NBP are already scaling up their activities to provinces in ASPIRE.

In order to strengthen sustainability of RET, IMB Cambodia who scale-up solar has established and trained six existing suppliers to develop commercial supply chains for RETs to assure that the RETs installation are well maintained, including after-sale services and availability of spare parts at the local suppliers. These six suppliers installed 316 solar pumps, 62 of them (20 percent) with female headed households as a part of roll-out grant. Entrepreneurs Du Monde (EDM) scaled up solar micro-grids, which allowed for remote troubleshooting and monitoring, thus addressing the challenge of poor after-sales services at the village level. EDM is the second roll-out grantee to scale-up a solar Okra network and agricultural equipment for income generation activities such as solar cricket incubators, cooling system for crops and vegetable storage. Okra is an award-winning Australian company, which pioneered the smart solar-power micro grids technology. EDM installed 75 solar poultry incubators in the project areas so far.

Knowledge products and their dissemination were crucial to improve awareness of RET

Various knowledge products and training were vital to improve awareness of local and national governments and local communities. Collaborating with the Royal University of Agriculture, the project produced various knowledge products to share RET information including project briefs, training curriculum for PADEE Commune Extension Workers (CEWs),[12] newsletters, brochures, calendars, posters,

11 Dried beef sells at $25/30 per kg.

12 The 3-day Training of Trainers (ToT) were conducted by RUA team in each PADEE province. All CEWs were invited to participate, as trainees intend to become lead trainers for IGRF members, as well as, other farmers in their communities. Using the knowledge and understanding together with training materials getting from TOT, CEWs organized RET awareness campaigns in their respective IGRFs and other outstanding farmers within their communities.

Figure 5: More hygienic drying method which allows drying during the rainy season @IFAD

and simple handouts with basic information on RETs. The project also developed two short videos and a case study of the use of solar energy for chicken hatching and breeding. In addition, each grantee has produced a short video which is launched through social networks such as Facebook and YouTube. In collaboration with grantees, the project also produced seven technical booklets of RET in Khmer.13 These booklets are used during training and promotional events, and have been disseminated to all Provincial Departments of Agriculture, Forestry, and Fisheries (PDAFFs), ASPIRE programme support unit, CEWs, and other stakeholders.

These products carried an important message to share knowledge on RET options to strengthen interest of national and provincial level staff, S-RET team, and CEWs working closely with smallholder farmers. The project's public extension system, namely CEWs and PDAFFs, played a particularly active role in strengthening knowledge dissemination from national to provincial and village levels. As a result, beneficiary farmers have gradually increased their knowledge on RET including aspects on life-cycle costs compared to conventional energy sources (diesel versus solar pumps), and health benefits (i.e. smoke from combustion of firewood/charcoal). At the same time, improved policy dialogue with the Ministry of Mines and Energy (MME) is also necessary to address critical aspects such as Value-added Tax reduction on solar equipment, feed-in tariffs, and net-metering policies. However, MME has a big expectation for large-scale hydro power projects in the Mekong region; thus, gaining more interest in small-scale renewable energy from MME is still a challenge and it takes longer to convince them about benefits of renewable energy.

13 These are about solar hydroponic systems, biochar briquette for heating chicks, solar animal feed processing machine, solar egg incubator, solar water pumps, solar dryers and solar hot water dip. The project is in the process of translating the technical booklets into English.

Figure 6: Women farmers are using solar dryers for fish and meat drying @IFAD

References and multimedia

- **Mid Term Review**, https://www.thegef.org/project/mainstreaming-ecosystem-based-approaches-climate-resilient-rural-livelihoods-vulnerable
- **Project Design Report Document**, https://publicpartnershipdata.azureedge.net/gef/PMISGEFDocuments/Climate%20Change/Cambodia%20-%20(9103)%20-%20Building%20Adaptive%20Capacity%20through%20the%20Scaling-up/Final_PDR_20March2016_Clean.pdf
- **S-RET Annual report 2020 Cambodia** (photo book), https://www.dropbox.com/sh/qezzd3nhd8wc23v/AADU0CoQUmzz68n0HLNaSfMia?dl=0
- **Video program about the S-RET project** (in Khmer with English subtitle), http://aspirekh.org/s-ret/

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