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EMPOWERING WOMEN AND DELIVERING ELECTRICITY ACCESS TO THE OFF-GRID POPULATION IN VIET NAM

TECHNICAL BRIEF

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This technical brief was prepared by Morgane Rivoal (UNDP), Bui Viet Hien (UNDP), in collaboration with GreenID (Khanh Nguy and Ha Nguyen). Contributors to the technical brief include: Jenty Kirsch-Wood (UNDP), Koos Neefjes (independent reviewer), Irene Dankelman (independent reviewer), Verania Chao (UNDP), Yen Nguyen Thi (CARE). It benefited from consultations with UN Women, SNV, GIZ, WWF and the Center for Sustainable Rural Development (SRD). It was edited by Kayleigh Swanson (UNDP), and designed by Merran Eby (UNDP).

For more information, please contact bui.viet.hien@undp.org.

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EMPOWERING WOMEN AND DELIVERING ELECTRICITY ACCESS TO THE OFF-GRID POPULATION IN VIET NAM

TECHNICAL BRIEF

KEY MESSAGES

1. **Viet Nam has good opportunities to develop gender-sensitive climate policies and development programmes that can foster mitigation strategies in the energy sector.** There are already numerous successful pilots which have delivered encouraging results in providing the off-grid population with access to electricity through renewable energy technologies. Besides providing energy for lighting and cooking, off-grid solutions could be deployed to support the delivery of public services (e.g. education, health care) and the development of livelihoods by enabling productive end-uses (e.g. tailoring, agriculture).

2. **In Viet Nam, 1.3 million people still lack access to electricity.** As the costs of renewable energy technologies are falling, they become more affordable. Solar PV systems can cost-effectively bring electricity to rural provinces and do not rely on imported fuels.

3. **Providing electricity access to the poor has far-reaching socioeconomic impacts that would benefit the country as a whole.** Upgrading to solar powered lighting solutions holds big health, development and climate benefits. It triggers economic opportunities for beneficiaries and employment in the commune.

4. **Women largely benefit from access to electricity** as they bear the brunt of household chores, including the provision of food and fuel – tasks which may become more challenging and time-consuming as climate change contributes to resource scarcity. Switching to electric appliances thus enables women to spend more time on non-household tasks. Access to electricity positively impacts 'empowerment enablers' such as education, free time, and access to information programmes through television and radio (Winther, 2017). These enablers further contribute to closing the gender gap.

5. **Rural households are able and willing to contribute to the costs of Solar Home Systems**, a fact that has been demonstrated by local NGOs, such as the Vietnamese pioneer GreenID (Nguy, 2018). However, they need financial support to help them overcome the initial costs of capital. In this regard, different mechanisms exist that could be scaled up. They include collaborating with the Vietnamese Women's Union (VWU), Viet Nam Farmer's Union (VFU) and People Credits Fund (PCFs).

6. Increasing the penetration of small-scale solar PV technologies **supports the country's ambition under SDG 7** (*Affordable and Clean Energy*) while contributing to its mitigation and adaptation efforts, laid out in the Nationally Determined Contributions (NDC) document.

7. **This note showcases a private Cost-Benefit Analysis (CBA) in An Giang province**. The results of the CBA are unequivocal; the Net Present Value of investing in a Solar Home System (SHS) is positive, delivering over 20 million VND after five years and the benefit-cost ratio reaches 3.5.

It is essential to promote women's initiatives in designing renewable energy technologies in electrifications for the off-grid population in the rural remote areas as well as promoting women's participation in household solar rooftop and energy efficiency initiatives in Viet Nam by 2030.

RECOMMENDATIONS

- **Defining gender equality as an explicit outcome of rural electrification.**

  This would lead to more sustainable outcomes for climate-compatible development, as gender blind electrification processes may reproduce structures of inequality. By training women in producing, commercialising and using renewable energy technologies, the Government of Viet Nam will ensure that the benefits of electrification are leaving no one behind.

  Enhancing women's capacities, including in male-dominated sectors, will further contribute to changing the way women are perceived — this change can support a shift from traditional gender roles to more inclusive ones, and also increase women's economic empowerment.

- **Adopting a gender-sensitive approach in electrification projects and research.**

  This includes, for instance, uncovering the extent to which women have effective access to credit and possess enough financial literacy to make informed decisions about electricity access. Further, discriminatory social norms may exist that would prevent women from accessing financial services fully.

  Where possible, depending on the availability of information, an intersectional approach should be taken to examine the variation of women's situations depending on factors including their age, socioeconomic and ethnic background, and location. Economic opportunities for women, leveraged through access to electricity and lighting should be embedded into both national gender equality and climate change strategies, plans and policies.

- **Increasing political attention and support to bring attention to the 1.2 percent of off-grid Vietnamese households** (GSO, 2017).

  The *One Million Solar Rooftops* project has brought together donors, energy experts, banks and ministries including the Ministry of Industry and Trade (MoIT). This initiative shall be put forward as the primary outreach platform.

  A statement at the highest level supported by key evidence and options for implementation would help to enforce policies and regulations, of which Feed-In-Tariffs are a crucial component. For instance, when the grid is extended to rural areas, it should be ensured that the electricity generated from solar could be sold to the grid and EVN. Hence the initial capital investment would still be viable.

- **Leveraging the energy economic empowerment nexus.**

  NGOs and practitioners should continue to collect quantitative evidence that demonstrates the global economic value of bringing electricity to poor households. They should jointly establish the link between access to electricity and entrepreneurship. Policy makers should support women in gaining access to electricity and stimulate the creation of cooperatives, businesses and training (e.g. added value products, marketing) as a double dividend.

- **Offering adequate financial solutions.**

  Existing partnerships with state banks, Vietnamese Micro Finance Institutions (WVU, TYM) and NGOs should be leveraged to aggregate finance at scale and offer tailored financial mechanisms to unelectrified households in remote areas. Policy makers should design energy subsidies that facilitate access to loans for women and the poor population and remove the need for collateral and/or position solar home systems as productive use investments.

- **Encouraging the private sector to work in remote areas.**

  The numerous barriers to off-grid electrification (investment and operational costs, lack of available infrastructure to transport material, lack of local capacities) could be overcome with the right partnerships and policies in place. As the market for off-grid solar is still at an early stage in Viet Nam, it could benefit from the support of donors and partners to continue expanding. This support could take the form of impact investing and results-based financing, for instance.

- **Keeping an eye on industry innovations.**

  Prices of renewable energy technologies are falling drastically and new products are being introduced to the market. Policy makers and development partners should stay up-to-date with these new technologies to offer the latest quality products available. Similarly, high-quality standards should be promoted, because the lack thereof has led to deficient material being used in past instances, thereby creating distrust among the consumers (Nguyen, 2014).

INDICATORS

This brief suggests using the following indicators to measure progress toward mainstreaming gender in mitigation measures of the electricity sector, of Viet Nam's revised Nationally Determined Contribution (NDC):

Proposed key gender-sensitive indicators	Responsibility	Source	Frequency
Gender Marker[1]: Energy policies should include gender equality as part of their objectives	MOIT	• New data, should be part of MOIT Plan/PDP8 to implement NDC and PIPA	Annually
# of local Women's Union groups and MFI who have received a training on RE technologies, district level	Women's Union	• PIPA • MOIT M&E system for national/targets programmes on RE	Annually
# of women and # of men who holds leadership positions in the RE sector	MOIT & GSO	• National Gender Development Statistical Indicators Circular No. 1/2019/TT-BKHDT • (0301)	Every 2 years
# of women and # of men who work in the RE sector	MOIT & GSO	• New data, should be part of MOIT Plan/PDP8 to implement NDC and PIPA	Every 2 years
# of off-grid households who have access to RE technologies # of female-headed off-grid household who have access to RE technologies	MOIT and Women Union 1 million solar rooftops initiative	• New data, should be part of MOIT Plan/PDP8 to implement NDC and PIPA	Annually
# of women headed and # of men headed business who have installed a solar rooftop	1 million solar rooftops initiative	• New data, should be part of MOIT Plan/PDP8 to implement NDC and PIPA	Annually

Other Indicators (optional)

1. # of women headed business who have aligned their business plan considering their environmental footprints
2. # of courses on Renewable Energy Technologies (RET)
3. # of women students and # men students who are studying RE

[1] The Gender Marker measures how much a project invests in gender equality and women's empowerment. Select one for each output: GEN3 (Gender equality as a principle objective); GEN2 (Gender equality as a significant objective); GEN1 (Limited contribution to gender equality); GEN0 (No contribution to gender quality)

I. Background & Rationale

1. **The Vietnamese government has set an ambitious objective to achieve a 100 percent electrification rate by 2020, under SDG 7 (*Affordable and Clean Energy*).**

   In 2016, 98.8 percent of Vietnamese households had access to electricity for lighting, cooking and heating, with a median consumption of 100 kWh per month (Ha-Duong, 2017). However, approximately 1.1 million Vietnamese still lacked access to electricity to satisfy this basic human need (GSO, 2016).

   In addition, some households face regular power cuts, as they live in disaster-prone areas which disrupt the network leaving them with no access to electricity for long periods. Delivering access to a reliable, affordable, and clean source of electricity underpins socio-economic development.

2. **The prices of Solar Photovoltaic (PV) technologies in South-East Asia have plummeted, from $4,000/kW in 2012 to $2,000/ kW in 2016.**

   The average Levelised Cost of Electricity (LCOE) fell by 39 percent over the same period, from $0.31/ kWh to $0.19/ kWh, becoming more competitive than fossil fuel power (IRENA, 2018). Viet Nam possesses untapped potential in terms of solar energy – the country experiences daily solar irradiation between 3.36-5.23 kWh/m2 across all provinces (Cooper, 2019).

   The Red River Delta, the Northern Central, the Central Highlands, the Southern Central, and south of Viet Nam are the most suitable areas to install solar power (Nguyen,2014). Currently, for rooftop projects, the net-metering rate is $0.0934/kWh (Decision 11/2017/QD-TTg). This rate applies to power generated in excess from rooftop solar projects that began their operations prior to July 2019. Carbon Tracker estimated that by 2020 it will be cheaper to invest in new solar PV than new coal in Viet Nam (Carbon Tracker, 2019).

3. **The off-grid population living in rural areas has a very low demand for electricity services, estimated at 1 kWh per day, as many households cannot afford appliances that require high watt power (Nguy, 2018).**

   Such a load would cover basic services such as lighting, phone charging, radio and TV. In 2009, 4 percent of the Vietnamese population was still relying on kerosene lamps as their primary source of lighting (Lam, 2012). These expenditures constitute a significant share of a low-income household's budget, and adversely affect their welfare. Moreover, they leave them dependent on fluctuations in the prices of fuels.

4. **Rural men and women are both affected by the lack of energy; however, underlying inequality means that women are impacted disproportionally (IRENA, 2018).**

   Women traditionally lag behind men in terms of their access to new technologies, however, previous experiences in the region have demonstrated that women are excellent advocates of RE technologies (Sharma, 2014). For instance, the programme *Lighting a Billion Lives* in India which included women in the value chain – from production to sales and maintenance – demonstrated high adoption rates.

   When enabling conditions are met, women drive the demand for renewable energy for lighting, cooking and productive use solutions and increase and diversify livelihoods at the individual, household and community level.

5. **The potential benefits of access to electricity for women are manifold**.

   These include a reduction of time spent on household chores, the development of new skills, increased economic opportunities, increased income, and improved quality of life induced by access to health information and services disseminated through radio and TV programs.

6. **There is a striking correlation between unelectrified households and poverty status.**

   Moreover, there is an interplay between electricity access and topography in Viet Nam. The off-grid population is concentrated in rural and remote areas (Midlands and Northern Mountains) and is largely composed of members of ethnic minorities.

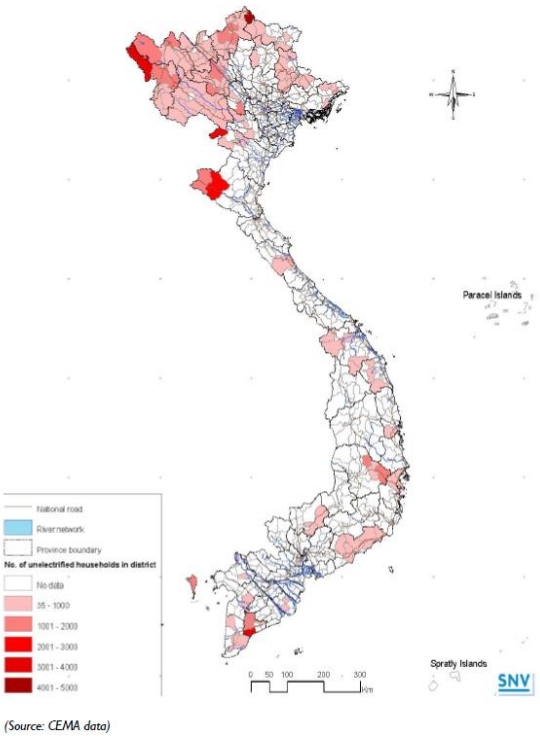


Figure 1 GIS Map of un-electrified households by district (SNV, 2014)

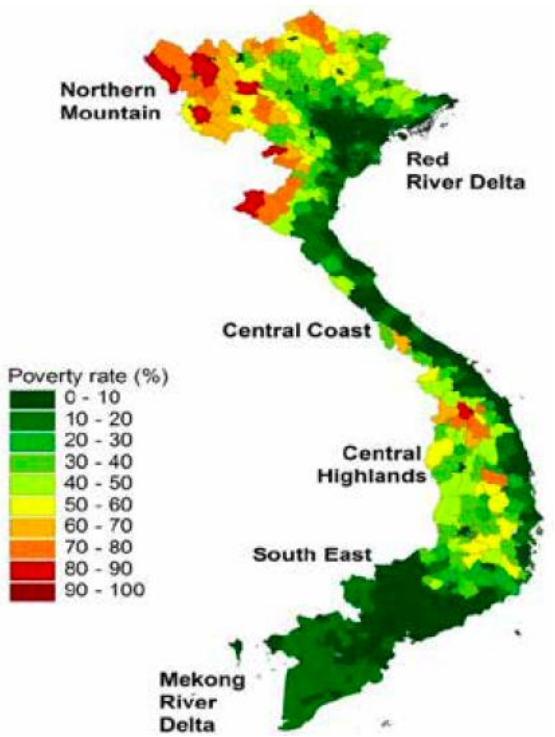


Figure 2 Poverty rate by district, 2014 (World Bank, 2018)

II. Gender Inclusion – Main Entry Points

It is now widely accepted that differences in access to and use of energy exist between women and men; renewable energy technologies are not gender-neutral.

In fact, programmes that do not consider gender, or tend to adopt a gender-neutral approach, will likely be dominated by men, because men and women will experience benefits of electricity in different ways, and men are often the final decision-maker in the household (Winther, 2018).

Accordingly, there is a growing body of evidence demonstrating the benefits of rural electrification for women. For instance, Dinkelman (2011) found that electrification in South Africa reduces the time spent cooking and doing general household chores, thereby freeing up time for women who are predominantly in charge of these activities. Therefore, it is necessary to put in place special incentives to target women as beneficiaries of electrification, and involve women in the design, production and distribution of energy value chains.

In the Vietnamese context, the delivery of electricity through solar energy can positively affect women in at least four different ways.

These include:

1) employment and capacity building;
2) increased income due to time savings;
3) improved social status; and
4) well-being (including health security).

Social status and well-being cannot be monetised, therefore they have not been integrated into the CBA.

III. The Benefits of Electrification

There are many co-benefits of rural electrification, spanning health improvement to economic opportunities, gender equality, and education.

There are numerous ways by which access to lighting improves income.

Households may allocate their labour differently across distinct activities, progressively shifting from (or adding to) their traditional farming practices to include more profitable ones, generating surplus income.

Secondly, lighting positively affects the total number of working hours for households. Khandker (2012) found that households in Bangladesh have increased their income by an average 21 percent after electrification had taken place.

Lastly, enabling women to do more household tasks in the evenings gives women more time for paid work during the day, leading to an increase in labour supply and in-home business activities (Dinkelman, 2011). A study in El Salvador found that men spend more time conducting non-agricultural activities in the evening, leading to an increase in household income (Barron and Torero, 2014).

Besides the increase in income, electrification may result in additional employment opportunities.

In fact, an essential condition for an off-grid programme to succeed is the availability of sales and maintenance services, ideally performed by locals. In addition to guaranteeing the sustainability of the project, sales and maintenance services create job opportunities and enhances the locals' understanding of environmental issues.

Deliberately targeting women at this stage is a very promising way to improve their lives and foster gender equality. Creating entrepreneurship and employment opportunities for women in the renewable energy sector, for instance, can be an effective climate compatible development strategy that simultaneously reduces emissions and generates economic benefits for women. Several projects in India successfully introduced solar home systems in remote villages by specifically training women in installing, repairing and maintaining solar panels, thereby creating employment opportunities (Sharma, 2014).

Because women are less likely than men to migrate to urban areas in search of work, a program designed to engage women guarantees that expertise stays within the commune. Involving women may also help reduce the stigma associated with electrification as a traditionally 'male-sector'. This outcome is important as the country transitions toward Industry 4.0, not to leave any women behind.

Establishing technical skills among women may have a positive spillover effect, as outlined by Winther (2018) in Kenya.

Her case study showed that before electrification, women were not considered able to climb roofs or assemble electronic devices. Winther notes that after the intervention, the perception of the women's ability and capacity had changed – women technicians were enjoying the highest consideration among their community, which contributes to gender equality. She further describes the influence of these women as role models for young girls raised in the village.

In remote rural areas, literacy rates among ethnic minorities are much lower[2] than the national average (UNDP, 2018). Thus, access to a radio and TV are extremely valuables means of accessing information.

Radio and TV play a significant role in economic development (Mala, 2009). Furthermore, improved access to information services, provided by extension workers, for instance, can foster access to markets and boost entrepreneurship.

Similarly, information regarding health, nutrition, early warning systems (e.g. hurricanes, flooding) and family planning becomes accessible, with clear benefits for women's well-being (Kabir, 2017).

Electricity access also has a positive effect on literacy rates and school enrolment (Lipscomb, 2013).

In Viet Nam, Khandker (2013) found that in the wake of an electrification programme, school enrolment and total years of schooling increased. In Bangladesh, the same author (2012) was able to measure the increase in time spent studying: 22 additional minutes for the boys and 12 minutes for the girls.

When the time spent after nightfall reading and doing homework increases, it positively influences the family's investment in education. Because lack of electricity deprives rural poor women of access to education during their youth, they are correspondingly deprived of access to Income-Generating Activities (IGA) later in life.

Eliminating the emissions associated with the use of kerosene lamps would mean reducing five gigatons of C02 over 20 years (Jacobson, 2013).

Kerosene lamps are a significant source of Black Carbon (BC), emitting over 270,000 tonnes of BC into the atmosphere annually (Jacobson, 2013). They also produce substantial amounts of carbon monoxide (CO), nitric oxides (NOx), and sulphur (Lam, 2012). In addition, the use of kerosene lamps generates harmful levels of air pollutants, which in turn increase the risk of respiratory diseases.

Because fuels are often stored in plastic bottles similar to water bottles, they put family members, especially children, at risk of unintentionally inhaling toxic kerosene, with severe health effects. Moreover, fires, burns and explosions are common among users (Lam, 2012). A study in El Salvador found that using a cleaner source of energy for lighting reduces the concentration of pollutants up to 63 percent (Barron and Torero, 2014).

In this case, health benefits have not been included in the private CBA, as households are still cooking with firewood and charcoal in open burning stoves, which generates high levels of smoke and PM 2.5.

[2] In Lai Chau province, the literacy rate is 62.5 percent, while in Ha Noi it reaches 98.7 percent (GSO, 2018).

IV. Description of the Case Study

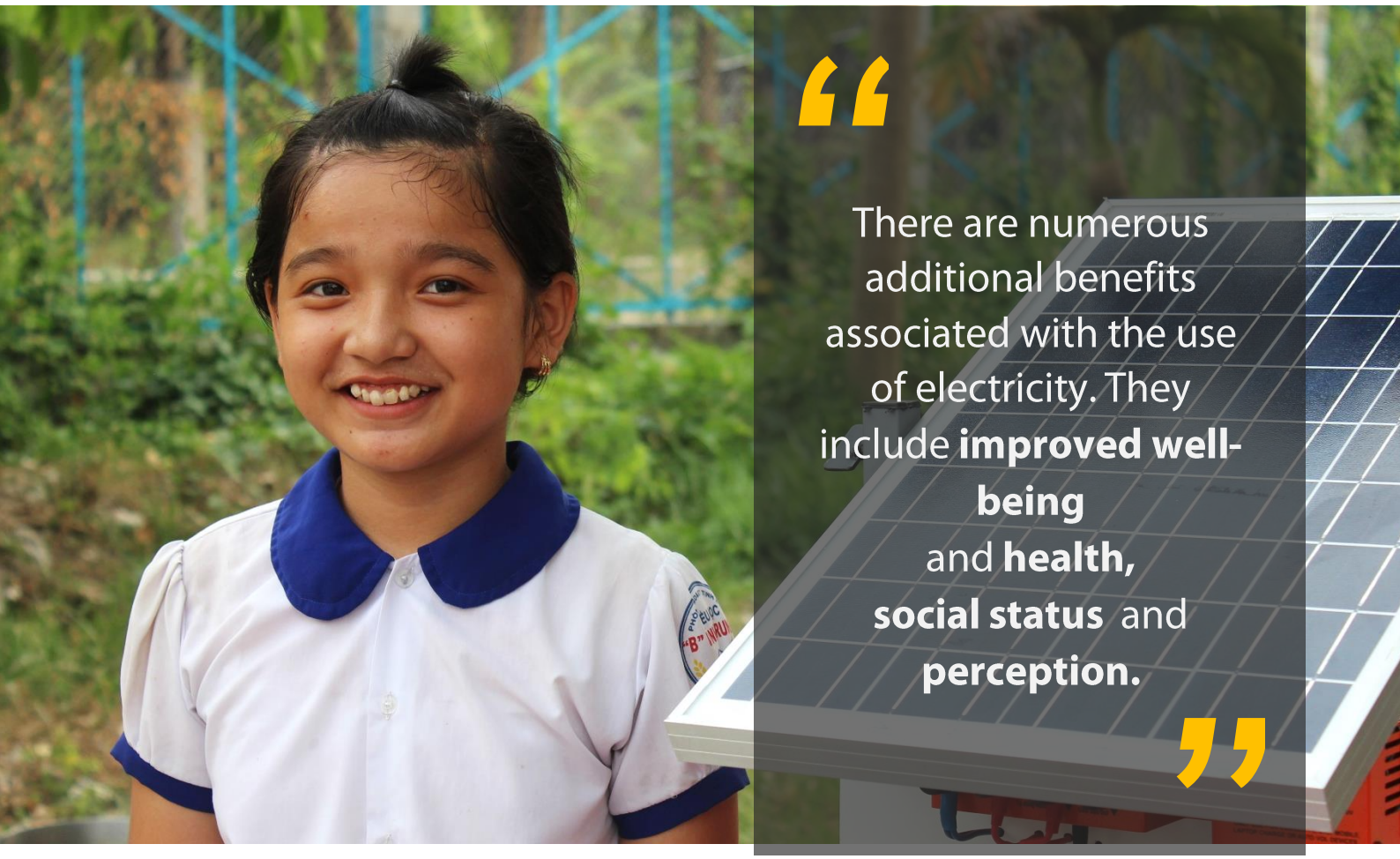
In collaboration with GreenID, a Vietnamese grassroots organisation, a case study was chosen based on the following criteria: sustainability of the intervention, access to baseline data, and potential for scale-up.

Because the number of beneficiaries surveyed is limited, the financial analysis does not intend to be representative; rather it proposes a methodology that could be replicated to extrapolate results in the future.

Case Study: Installation of 237 Solar Home Systems (SHS) in An Hoa Village

An Hoa is located in the district of Tinh Bien, An Giang province, in the south of Viet Nam. Most of the inhabitants depend on income from small-scale farming (avocado, tangerine) and tourism. The average monthly income in the village is 5,300,000 VND with variations between 2,000,000 VND and 10,000,000 VND.

Before the intervention, numerous technologies were put forward by GreenID: solar lanterns, improved cookstoves, LED bulbs, solar street lamps and biogas. Among these solutions, the villagers elected Solar Home Systems (SHS) as the most suitable technology for their needs. To explain this choice, the beneficiaries mentioned the sense of ownership that the SHS brings to the household, the simple installation, the fact that it removes the need to make monthly payments, the affordability, and the ability to expand the system capacity once their income increases. After the SHS was installed, beneficiaries started producing chopsticks, earning on average 1,150,000 VND monthly.



V. Cost-Benefit Analysis

Definitions of Terms

The Net Present Value (NPV): All costs and benefits over the lifespan of the project are converted to their present value, using a social discount rate. If the NPV >0, we can assume that the project makes a positive contribution to society's welfare.

The Benefit-Cost Ratio (BCR): If the BCR >1, it means that the discounted benefits exceed the costs. The project is cost-effective and therefore viable.

The Internal Rate of Return (IRR): Represents the theoretical discount rate where the NPV equates 0. Indicates the strength of the project, irrespective of the discount rate used.

Private CBA: The private CBA only considers the monetary costs and benefits assumed by a single household.

Social CBA: A Social Cost-Benefit Analysis (SCBA) or economic CBA considers the outcome for the 'society as a whole', by allowing for the quantification of non-market costs such as environmental degradation and considering the public at large (rather than a single entity) (Barbier, 2009). The SCBA aims to appraise the efficiency of a specific project based on its overall net benefits.

Given the data available, it was decided to conduct a private cost-benefit analysis in An Giang to respond to the following question: **what are the costs and benefits for a household to invest in a Solar Home System?** The data and assumptions available are presented explicitly and transparently in the calculation sheet, therefore they could be used to perform a social CBA in the future.

Private CBA – Initial Results

Case 1: Solar Home Systems in An Hao commune, An Giang province

Capital Cost (current and in the next five years if market potential is high)

The overall cost of purchasing two solar panels equivalent to 270Wp and the equipment was 6,600,000 VND (283 USD) in 2017. The installation cost was 86 USD. The solar equipment (battery, inverter and controller) was purchased in Viet Nam and manufactured by Vu Phong solar company. Replacement costs of the battery, inverter and controllers were also included.

Costs	Value	Stakeholders
Capital cost	6,600,000 VND	50 % is supported by GreenID
Replacement costs	Varies across the years	
Credit facility (t=2%)	3,366,000 VND	50% is paid by the family

Benefits	Value/ year	Source
Adverted fuel expenditure	2,400,000 VND	GreenID survey
Time savings	5,460,000 VND	GreenID survey
Increase in income	13,800,000 VND	GreenID survey

Averted fuel expenditure

Before the intervention, households reported using batteries, for which they were spending on average of 150,000 VND (6 USD) per month. They also used kerosene lamps and consumed on average 8 litres of kerosene per month, which corresponds to a total monthly cost of 200,000 VND (9 USD).

Time saved from no longer charging batteries

The installation of SHS allows households to save time. They no longer need to travel to the closest village to charge their battery, saving on average 12 hours weekly. In the CBA, these time savings come

in the form of opportunity costs, defined as 'the value of the marginal output foregone elsewhere in the economy', also called the shadow value of time (Varian, 2010). To estimate the opportunity cost of time, it is assumed that the shadow value is a proportion of the prevailing wage rate among poor Vietnamese households: 2.1 million VND (90 USD monthly). It is then assumed that the beneficiaries would use 50 percent of this extra free time for Income-Generating Activities (IGA). Time savings, therefore, amount for VND 441,000 (19 USD) per month. Beneficiaries have also reported time savings in fetching water, processing crops, cooking and cleaning.

The results of the CBA for An Giang province are presented below.
The results are extremely positive, with an NPV of 21 million VND (using a 10% discount rate) and a BCR of 3.5.
This clearly indicates that investing in an SHS makes economic sense.

Project After 5 Years			
Discount Rates	3%	6%	10%
Discounted Costs	9,491,157	9,010,063	8,447,131
Discounted Benefits	34,569,015	32,225,482	29,479,749
Net Present Value	25,077,858	23,215,419	21,032,618
BCR	3.6	3.6	3.5
IRR	316%		

There are numerous additional benefits associated with the use of electricity, as detailed in section 3.

They include improved well-being and health, social status and perception. Another indirect benefit is that the households' willingness-to-pay (WTP) for energy products and services, will increase over time, thereby creating demand and potentially fostering market creation (Kabir, 2017). If data were available, it would be possible to estimate Black Carbon emission reductions from the displacement of kerosene lamps to solar lighting. These emissions reductions could be valued using the Social Cost of Carbon from the EPA (2017). In 2020, one metric ton of CH_4 will be valued at 540 USD, using a 5% discount rate.

VI. Overview of Potential Financial Mechanisms to Support Poor Households

Target consumers have a need and a willingness-to-pay (WTP) for clean and sustainable lighting solutions.

However, given the fact that unelectrified households represent the poorest segment of the Vietnamese population, there is an affordability gap. Moreover, the use of formal financial services in rural areas remains low. In rural Viet Nam, only 16.5 percent of the population possesses an account in a formal financial institution, compared to 30 percent in urban areas (Nguyen, 2014).

Micro-Finance Institutions[3] (MFI) exist in Viet Nam and could help to fill this gap with low-interest loans if borrowing conditions were adapted to the poor.

Following the nomenclature enacted in in Decision No. 2195/QĐ-TTg '*Building and developing the microfinance system in Vietnam until 2020*', Vietnamese MFI can be divided into three categories. The main and 'official' actors are state development banks: Viet Nam Bank for Social Policies (VBSP), and the People's Credit Funds (PCFs). The Vietnam Bank for Agriculture and Rural Development (VBARD) is not technically a MFI, but it operates in rural areas. Semi-official MFIs consist of mass organisations such as the Viet Nam Women's Union (VWU) and Viet Nam Farmer's Union (VFU), NGOs and programmes operated by development funds. Informal lending from families, neighbours and remittances form the third category of MFIs.

Microcredit is well developed in Viet Nam, with 46 percent of poor households receiving social credit in 2008.

The VBSP reports reaching 5.6 million poor families, while VBARD claims that 4.7 million of its clients are poor (APEC, 2011). The micro-credit sector is regulated by the state which seeks to protect depositors and prevent fraud; thus the Government of Viet Nam has set-up a maximum authorised interest rate of 8-9 percent, depending on the type of institution (Nguyen, 2014). Regarding microsavings, the VBARD and the PCFs largely dominate the market, reporting 5.6 million and 1.5 million depositors, respectively, in 2011.

Households need to meet several conditions to be granted a loan.

First, they must present collateral (land titles, for instance). Second, they must demonstrate their plan for a 'business' – in other words, how they intend to make productive use of the loan. This requirement could represent a challenge for solar PV, as the correlation between solar PV and 'productive use' is not always well understood by the beneficiaries and the MFI actors. Consequently, there is a need for a change in the way solar PV are perceived.

Convincing case studies that depict access to energy services as the trigger for IGA shall be put forward. This is the case in An Giang province (Page 7), where households started producing chopsticks in the evenings, earning a monthly revenue of 1.1 million VND. However, this productive use is highly dependent on the availability and proximity of markets and potential value chains. Another potential argument to convince MFIs to lend credit to the poor is to present the solar PV, worth over 160 USD (or the batteries worth 100 USD), as collateral.

However, energy subsidies targeting the poor still may face many drawbacks.

If misdirected, these subsidies tend to favour non-poor households. They can also accelerate the creation of a monopolistic market if they only support a few private players. Furthermore, if

[3] We define micro-finance as the activity of providing financial services to the low-income population (credit, savings, insurance).

the subsidy is too high, it may decrease the consumer's willingness-to-pay for the service. Finally, if directed to on-grid electrification, subsidies may discourage suppliers from investing in off-grid projects.

Traditionally, private players (banks) have been reluctant to enter rural markets, because it is less profitable, and the population often lack basic infrastructure to make productive use of electricity services. Other challenges include high costs of distribution, low demand and dependence on public funds. Finally, some experts have been reluctant to push for MFIs entering rural markets because they consider access to formal financial services a right poor people shall be entitled to.

The Government of Viet Nam is committed to gender equality[4] and has made progress on the topic, however some challenges remain for poor women attempting to access credit.

First, loans are made on behalf of the household, not the individual, so there is a resulting lack of sex-disaggregated data. Thus, further studies are needed to determine the intrahousehold dynamics in place when it comes to borrowing and purchasing power. Women's ability to make independent financial decisions, the nature of women's authority over household finances, and requirements for accessing credit should be investigated.

Second, it may be more difficult for women to borrow money because they lack collateral – land titles are often in the husband's or in-law's names (APEC, 2011).

Microcredit funds that specifically target women are well developed in Viet Nam and could be the right vehicle to help women access rural energy technologies.

The VWU has led the process of improving women's access to microfinance by establishing offices in 63 provinces and working with VBSP to provide the bank's female members with access to microfinance credit. VBSP estimates that in some provinces, 95 percent of its borrowers are women (APEC, 2011). The VWU also combines access to microcredit with other services for women, including family planning, business development services, and training on financial literacy, all of which contribute to women's economic empowerment (APEC, 2011).

Cooperation between the VWU and microfinance institutions is key in reaching poor female microfinance borrowers in Viet Nam. Established in 1992 by the VWU, Tinh Thuong Limited Liability Microfinance Institution (also called TYM), is a Vietnamese pioneer. In 2006, the fund became an income-generating unit for social and non-profit purposes. TYM serves low-income households, especially women, and benefits from an excellent reputation in the areas where it operates. Thus, the TYM would be a reliable partner to financially support the delivery of SHS to poor women in rural areas.

[4] The Law on Gender Equality was enacted in 2006.

VII. Conclusions

1. **Solar energy for lighting brings a myriad of economic, social and environmental co-benefits to the off-grid rural poor in Viet Nam.**

   Access to energy is a springboard for social and economic development, linking aspects such as health, education and gender equality. Beyond productive uses, electricity has a strong impact on security, time for leisure, and general standards of living. Consequently, reaching 'the last mile consumer' calls for substantial collaboration between different ministries and developing partners.

2. **The operational costs remain very high for commercial actors to invest in rural areas.**

   Hence, it is necessary to combine government-led educational and awareness campaigns with commercial actor strategies to enable the rapid dissemination of solar products. Delivering energy to 'the bottom of the pyramid' consumers requires the design of robust alliances with provincial/communal authorities, appropriate governance and stable policies. Improving the investment climate to allow a dynamic private sector to emerge will also be a key driver of success.

3. **Various factors affect the adoption of new technologies.**

   Previous studies have shown that households tend to supplement, rather than completely abandon, their old technologies (e.g. firewood cookstoves). It is therefore essential to conduct continued awareness raising campaigns as well as monitoring and evaluation programmes to understand what triggers long-term behavioural changes. Lighting usually exhibits a replacement rate of 50 to 100 percent (Jacobson, 2013).

4. **Finally, women are agents of change and have an important role to play in the widespread adoption of renewable energy technologies**.

   Women should be integrated at every step of the value chain: planning, financing, managing, and operating energy systems. Socio-cultural context and local norms will shape the way electricity provision occurs. Carefully designed systems of electricity access (e.g. Local Energy Planning – LEP promoted by GreenID) can help reduce traditional inequalities and barriers, empowering women and their communities.

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The United Nations Development Programme
304 Kim Ma Street, Ba Dinh District, Ha Noi, Viet Nam
Tel: +84 24 38500100
Fax: +84 24 37265520
http://www.vn.undp.org/