RESEARCH BRIEF:

ASSESSMENT OF RENEWABLE ENERGY AND ENERGY EFFICIENCY SOLUTIONS FOR RURAL WATER SUPPLY IN VIET NAM

1. Introduction

This research, conducted from March-July 2023, is part of a five-year partnership between the Ministry of Agriculture and Rural Development (MARD) and UNICEF that is exploring the application of renewable energy (RE) and energy efficiency (EE) for rural water supplies in Viet Nam. The study – commissioned by UNICEF, National Centre for Rural Water Supply and Environmental Sanitation (NCERWASS) and conducted by the Green Development Centre – assesses the current status and potential of EE-RE solutions for rural water systems with a view to promoting use of clean energy and reducing clean water production costs in rural areas. The findings will also underpin development of EE-RE guidelines for rural water projects.

Importantly, this study explores climate-resilient technologies for green development and enhanced delivery of clean water supplies to rural populations against the backdrop of the climate crisis. UNICEF is committed to supporting Viet Nam to strengthen its water, sanitation and hygiene (WASH) sector through a holistic approach that ensures effective, innovative and sustainable responses at scale.

2. Methodology

The research applied a combination of qualitative and quantitative methods. Information was collected from: (1) legal documents of central and provincial agencies, reports from other organizations and agencies in Viet Nam and internationally, (2) interviews

Central water plant of Ham Thuan Bac district, Binh Thuan province.

with representatives of relevant central agencies and six provinces/cities, solar power and EE service providers, financial institutions-banks, and experts, (3) site surveys of 25 rural water supply systems (RWSSs) that have applied solar power and EE solutions at different scales and (4) a national consultation workshop on the research results and comments from stakeholders[1] on 6 April 2023 in Ha Noi.

3. Key findings

3.1 Overview of Viet Nam's rural water supply sector

Viet Nam's rural population represented nearly 63 percent of the total national population in 2022 (62.37 million people). While nearly 70 percent of rural people can access clean water, supplies do not reach all rural areas, with the northern mountainous, north central and Central Highlands among regions with lower coverage than the national average.

According to the National Centre for Rural Water Supply and Environmental Sanitation (NCERWASS), by 2022 Viet Nam had a total of 18,109 RWSSs across all 63 cities and provinces, with gravity water supply systems[2] accounting for 61 percent and others comprising 39 percent (7,000 systems), primarily electricity-powered hydraulic pumps.

Overall, small- and medium-sized RWSSs (production capacity of <500m^3/day) accounted for more than 94 percent.

Centralized water supply system in Thanh An, Thanh Thang-Thanh Loi commune, Can Tho province.

[1] Including the Ministry of Industry and Trade, Ministry of Science and Technology, Ministry of Agriculture and Rural Development, Provincial Centre for Rural Water Supply and Sanitation experts and international organizations.

[2] Gravity water systems use gravity to transport water from a source located at a higher elevation to users located at a lower elevation.

Centralized water supply station in My Huong commune, Soc Trang province.

Cognizant of the sector's importance, the Government of Viet Nam has set ambitious targets for the water sector, particularly for clean rural supplies. The National Strategy for Rural Water Supply and Environment Sanitation to 2030, with a vision to 2045 (NSRWSS) targets 65 percent of the rural population to access clean water that meets quality standards with a minimum quantity of 60 litres/person/day by 2030 and by 2045, 100 percent of the rural population will use safe and sustainable clean water and sanitation.[3] To strive for the sustainable development of the rural water supply sector, in addition to financial, technological and communication solutions to enhance water supply capacity, the NSRWSS recommends the application of RE solutions such as solar, wave and wind energy to produce clean water.

3.2 Potential and opportunities for RE-EE solutions in RWSSs

Opportunities for EE solutions

The EE potential and opportunities for RWSSs were found to be significant:

- Survey results from 25 RWSSs[4] indicated that effective implementation of EE solutions could lead to energy cost savings of 20-35 percent depending on the system.
- RWSSs mostly use low-efficiency pump technology compounded by poor maintenance, inefficient operating procedures and limited energy management policies that result in high and inefficient electricity consumption.
- The percentage of non-revenue water from RWSSs is high. Depending on the systems, water losses fluctuate at 13-33 percent on average. Reducing such water losses will help drive down energy costs for pump operations to boost system-wide EE.
- The government has policies to promote EE.
- According to current policies, grid electricity prices are projected to increase, while the capacity of RWSSs is expected to continuously rise through expansion or construction of systems to meet growing demands. Therefore, EE is imperative to ensure RWSSs can meet rural communities', especially children's, WASH needs and in a climate-friendly way.

Opportunities for RE solutions

With more than 18,100 RWSSs in rural Viet Nam, of which more than 7,000 use electricity to operate, there is great potential for application of solar power, based on the following factors:

[3] Decision No.1978/QD-TTg of the Prime Minister to approve the National Strategy for Rural Water Supply and Environment Sanitation to 2030, with a vision to 2045.

[4] Located in the provinces of Nam Dinh, Thai Nguyen (north), Binh Thuan (centre), An Giang, Can Tho and Soc Trang (south).

Solar power system installed at the centralized water supply system in Thanh An, Thanh Thang-Thanh Loi commune, Can Tho province.

RWSSs are interested and have sites appropriate for installation of solar power systems: Most leaders of surveyed RWSSs reportedly planned to install solar power systems. Most RWSS sites are suitable for small-and medium-capacity solar-powered water systems.

Raw water suction pipe at the central water plant of Ham Thuan Bac district, Binh Thuan province.

Viet Nam has favourable natural conditions for solar power development: With its sub-equatorial location and the highest average total number of sunshine hours is more than 2,600 hours annually, the average total annual radiation is about 3.2-5.5kWh/m^2/day and is gradually increasing in the southern region. This RE source is an advantage for Viet Nam to exploit and serve industrial production, services and living demands of the population, including RWSSs.

The trend from fossil energy to RE: The move to RE is growing momentum worldwide amid the climate emergency. Development of RE sources is playing an important role in national sustainable economic development as it exploits infinite natural resources (such as wind, sun), as well as helps reduce impacts of greenhouse gas emissions and climate change. Viet Nam is no exception to this trend.

The Vietnamese Government strongly encourages RE development, particularly solar power: The National Power Development Plan for 2021-2030, vision to 2050 (PDP8) targets solar power systems to deliver 24,100MW by 2030 and 178,944MW by 2050.[5] The proportion of solar power system electricity will increase from 6.3 percent in 2030 to more than 20 percent in by 2050. Thus, from 2030, the solar power sector in Viet Nam is poised for explosive growth with an average annual increase of 7,750MW (32 percent).

The investment cost in solar power is decreasing, while electricity prices are increasing: Today, the average investment cost in Viet Nam for ground solar power is about VND 23 million/kWp and for rooftop solar power it is VND 15 million/kWp. Decreasing investment costs and rising electricity prices will shorten payback periods and drive more RWSSs to utilize solar power.

Solar power has many advantages: It provides clean and free-of-charge electricity, its design, installation and operation are simple, safe, reliable and

[5] By the end of 2020, the total operating capacity of solar power in Viet Nam was 16,640MW.

Source: Internet

fast, while maintenance is simple and inexpensive. The current price of solar power is comparative to the price of fossil electricity. Any RWSS can install and apply solar power.

Energy service companies (ESCO) are investing in solar power: Currently in Viet Nam, numerous ESCOs are investing in installation of solar power systems to sell electricity to entities with suitable premises and demand for electricity at prices lower than national grid ones. This is an opportunity for non-financed RWSSs to cooperate with ESCOs to develop solar power.

3.3 Relevant policies and regulations

Renewable energy

Viet Nam is committed to enforcing policies for RE development, especially solar and wind energy. By the end of 2020, the total operating capacity of solar power in Viet Nam was estimated at 16,640 MW, generating an electricity output of 12,084 MW.

PDP8 targets that by 2030 and 2050 solar power will contribute 6.3 and 19.3 percent, respectively of total commercial electricity production in Viet Nam. Furthermore, by 2030, 50 percent each of public buildings and residential houses will have rooftop solar power.

Energy efficiency

Viet Nam has set up a variety of policies to encourage EE solutions. The Law on "Economical and Efficient use of Energy" passed by the National Assembly in 2010, is a breakthrough in leveraging an environment for EE development in Viet Nam.

At present, the government is executing the National Energy Efficiency Programme for 2019-2030 (VNEEP3) with the goal of saving 5-7 percent of total energy consumption during 2019-2025 and 8-10 percent during 2026-2030.[6]

Greenhouse gas emission reduction

Being one of six countries hardest hit by natural disasters and climate change, Viet Nam's government is taking aim at greenhouse gas emission reductions and has set ambitious targets. By 2030, Viet Nam aims to reduce total greenhouse gas emissions nationwide by 9 percent and with international assistance by 27 percent.[7] At the 26th UN Climate Change Conference of the Parties (COP26), Viet Nam committed to net zero emissions by 2050.

Viet Nam aims to join the carbon market. Decree No.2022/ND-CP (dated 7 January 2022) sets a timeline for the pilot carbon business in 2025 and to be fully operational by 2028.

Accordingly, policies enacted have created an important legal framework

[6] Decision No. 280/QD-TTg on approval for National Programme for Thrifty and Efficient Use of Energy for the Period of 2019-2030

[7] Nationally Determined Contribution of Viet Nam, updated in 2022.

Centralized water supply system in Thanh An, Thanh Thang-Thanh Loi commune, Can Tho province.

for managers of RWSSs to apply RE-EE solutions in clean water production and supply to promote use of clean energy, reduce energy costs and greenhouse gas emissions and contribute to environmental protection.

3.4 Current energy usage in RWSSs

For RWSSs that use hydraulic pumps, national grid electricity is the main energy source to supply water to consumers. Pumps are the most energy-intensive equipment, accounting for 95-98 percent of electricity consumed by surveyed RWSSs.

Although the power load of most RWSSs is small averaging between 40kW-60kW, electricity is a key operating expense. Of surveyed RWSSs, more than three-quarters spend between 15-35 percent of total budgets on electricity, 15 percent lays out more than half, and less than 10 percent spends approximately 10 percent on electricity.

Water pump system at the central water plant of Ham Thuan Bac district, Binh Thuan province.

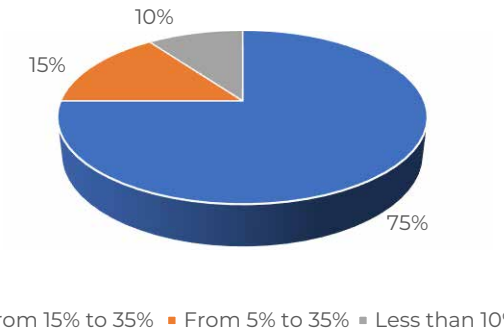

Figure 1. Ratio of electricity costs in total operating costs of RWSSs

The high cost of electricity consumption for RWSSs is mainly caused by:

- Numerous RWSSs were built more than 10 years ago using old pumping technology, that consumes large amounts of energy, now considered inefficient
- High percentage of clean water leakages
- Designed capacity of pump systems may not be suitable
- Lack of an effective energy management system/ policy for RWSSs
- Low water tariffs applied on rural clean water
- Managers and operators of RWSSs lack knowledge and experience in application of EE solutions.

The average specific energy consumption (SEC) of surveyed RWSSs is 0.465kwh/ m^3, however, energy consumption per volume of water produced widely differs depending on water supply capacity (Figure 2).

Treatment water pipeline in the centralized water supply system of Thanh An, Thanh Thang-Thanh Loi commune, Can Tho province.

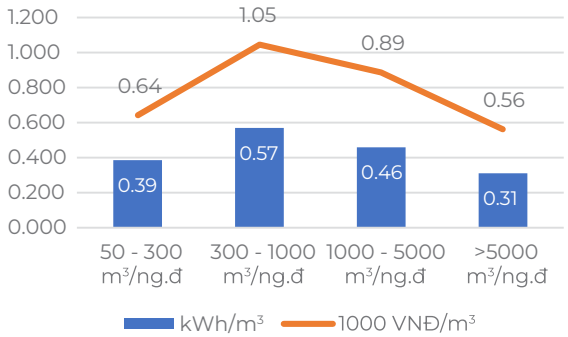

Figure 2. Average specific energy consumption (in 2022) assessed in surveyed RWSSs based on water supply capacity

3.5 Current status of RE & EE in RWSSs

Current RE applications

Although Viet Nam has the potential to develop other RE sources such as wind, tidal waves, hydro and biomass, only solar power is active in RWSSs. This is because it is cheaper, more suitable for rural water supply sites and easier to install and operate.

The first solar power systems used for RWSSs were installed from 2013-2015, however, development has slowed. By 2022, more than 40 solar power systems were operational at RWSSs, with more than 80 percent having small generation capacity (less than or equal 12kwp). All solar power systems installed were funded by foreign sources or the State budget.

The two solar power configurations applied are: (1) off-grid (independent, 85 percent) and (2) on-grid (15 percent).

Off-grid solar power water systems supply electricity directly to pumps to deliver water to consumers. This type of system actually works effectively in the first five to seven years of operation. However, after this period, most systems in surveyed provinces had stopped working or were expanded to connect to the grid. The main reasons are:

- The solar power configuration is an independent solar power source, used for small capacity submersible pumps, but does not have electricity storage systems. This type of pump is suitable for small-capacity solar power and has good water pumping performance. However, the solar power source is unstable due to changes in solar radiation intensity, causing most pumps to breakdown after five-seven years of operation. When a pump fails to work, RWSSs typically switch to AC (alternative current motor) pumps connected to the national grid, with installed solar power systems becoming redundant.
- Due to increased capacity, RWSSs have switched to national grid electricity which now reaches all localities.
- Staff and technical workers operating RWSSs are not well trained in solar power systems. Hence, they lack knowledge to operate, maintain and repair systems, resulting in solar equipment becoming damaged.

Pumping water from the reservoir at Giao Thuy Water Plant, Nam Dinh province.

Solar power system in Thanh An, Thanh Thang-Thanh Loi commune, Can Tho province.

On-grid solar power systems receive DC (direct current) power from solar panels converted into alternating current through the inverter power converter. If the RWSS does not use all electricity produced by the solar power system, the electricity is wired to the national grid and sold to the electricity company. At the time of survey, all on-grid solar power systems installed in RWSSs were operating efficiently, meeting 15-30 percent of total electricity demand of each RWSS, helping to reduce electricity costs and increasing revenue for RWSSs.

Current EE solutions

As a result of the government promulgating a variety of policies to promote economical and efficient use of energy and escalating electricity costs for production and supply of water, RWSSs are increasingly applying EE solutions. All 25 surveyed RWSSs have applied EE solutions, however, investment levels and the number of applied solutions significantly differ. Medium- and large-scale RWSSs have implemented more effective EE solutions, in contrast to small-scale RWSSs.

EE solutions applied by surveyed RWSSs with respective adoption rates are as follows: (1) use of high-performance lighting devices (LED & compact bulbs): 100 percent, (2) use of variable frequency drives for pumps: 76 percent, (3) installation compensate capacitors for transformer substations: 36 percent, (4) use of high-efficiency motors IE2/IE3: 28 percent and (5) installation of pressure sensors: 8 percent.

Most such EE solutions save 10-25 percent of energy, with an average payback period of less than five years.

In addition to these solutions, a small number of RWSSs have applied energy management solutions, such as adjusting pumping hours to avoid paying high electricity prices during peak hours, installing soft startup systems, Supervisory Control and Data Acquisition (SCADA) systems and contracting monthly norms for electricity usage.

Filtering tank at water plant Giao Thuy, Nam Dinh province.

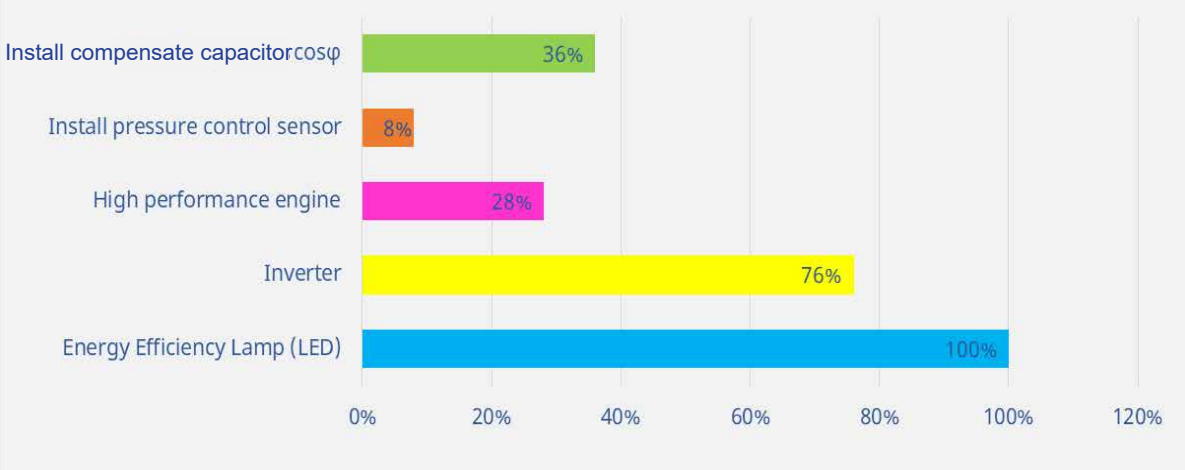

Figure 3. Percentage of EE solutions applied by surveyed RWSSs

3.6 Challenges for RE-EE solutions in RWSSs

Although the application of solar power and EE in the RWSSs brings significant economic, social and environmental benefits and has great potential, it still faces challenges.

Policies on grid connection

The policy on electricity connections to the grid was suspended: New solar power system installations have been suspended from grid connections since the end of 2020[8], with no regulations or roadmap for implementation to resume.

Regulations on public-private cooperation lack specific guidelines and consistency among localities: Three key aspects need to be clarified: the mechanism for leasing public property (mainly rooftops for installing solar panels), renting equipment (solar power systems) and the mechanism for purchasing electricity from energy service companies (ESCO). In reality, State-funded RWSSs cannot lease space to other entities to install solar panels, rent solar panels or purchase electricity from solar power systems installed by ESCOs.

Viet Nam has no regulations on energy consumption norms for the rural water supply industry. This prevents RWSSs from having a basis or standard to evaluate the efficiency of their systems.

Access to resources and finance

RWSSs lack initial investment for installing solar power and implementing EE solutions: The application of solar power and some EE solutions requires initial investment, which is quite large compared to the financial ability of RWSS management units, which are mostly

[8] Decision No.13/2020/QD-TTg on the mechanism to encourage the development of solar power in Viet Nam.

Clean water tank at the water plant Lien Bao commune, Nam Dinh province.

State entities. Hence, the main investment source is from limited State coffers which cannot stretch to solar power or EE solutions.

Difficulty accessing financial sources: Market financial sources for RE-EE are diverse, including loans from commercial banks and investment funds. However, RWSSs have difficulty accessing these funds due to: (1) lack of collateral and (2) relatively small investment levels required for solar power and EE solutions of RWSSs. Hence, financial institutions and banks commonly do not prioritize loans or financial assistance to this sector.

Awareness and implementation capacity

Awareness of RE-EE within RWSSs is generally limited: RWSS management entities lack capacity to assess the feasibility, effectiveness and benefits of solar power and EE solutions, both technically and financially.

RWSS staff lack knowledge about solar power and EE: While staff operating production and water supplies are concurrently responsible for managing and operating solar power systems and EE solutions, they have not received specialized training on solar power or energy management. Therefore, RWSSs' capacity to manage and operate solar power projects and energy-consuming equipment is weak.

4. Conclusions and recommendations

4.1 Conclusions

Over the past decade, Viet Nam has shown a keen interest in EE-RE technologies: Numerous policies have been enacted and implemented at central and local levels to promote EE-RE.

While EE and RE solutions have been applied within the rural water supply sector, momentum has slowed and investment is limited: Solar power is the only RE source applied in RWSSs. Of the two types of installed solar power, on-grid power systems were found to be working efficiently, while the majority of off-grid solar power systems were no longer working or already integrated with the on-grid power system.

EE and solar power solutions have brought about positive economic, social and environmental effects and impacts: The applications of solar power and EE have helped RWSSs reduce electricity costs, reduce greenhouse gas emissions, and contribute to protecting the environment. Most technical measures commonly used to address EE problems produce EE levels of 10-25 percent from each measure and have a payback period of less than five years.

The need and potential to apply solar power and EE in RWSSs is significant: Many PCERWASSs plan to install solar power systems in their RWSSs.

Water treatment area at Xuan Truong Water Plant, Nam Dinh province.

Scaling-up of solar power and EE in RWSSs faces obstacles that require policy, finance, communications, awareness raising and capacity building solutions: (i) rooftop solar power has no grid connection policy, (ii) public-private cooperation lacks guidelines, (iii) current financial mechanisms do not encourage owners of RWSSs and ESCOs to invest in RE-EE, (iv) financial sources are difficult to access and (v) awareness and implementation capacity of RWSSs is limited.

4.2 Recommendations

To promote and realize renewable energy solutions focused on solar power and energy efficiency in RWSSs, towards the common goals of meeting rural communities' and children's WASH needs in a climate-friendly way, the following actions are essential:

Ministries and departments

Develop and implement financial mechanisms to realize RE-EE solutions for RWSSs: While investing in solar power sources and EE solutions in RWSSs requires a moderate budget, it is still difficult for RWSSs due to limited financial capability. As RWSSs urgently need to borrow capital to invest in solar power and EE technology, the government should enact a policy to prioritize capital for RE and develop dedicated financial mechanisms for EE-RE water supply sector projects. These would include low interest-bearing and long-term loans, guarantee funds or risk-sharing mechanisms.

Develop regulations and guidelines for solar power grid connections for RWSSs: Regulations and guidelines for solar power grid connections to RWSSs are essential because: (i) solar power sources in RWSSs are mainly rooftop ones with small capacity that will not cause overloading of transmission systems unlike large solar power stations (tens to hundreds of MW), (ii) the rural clean water industry is a priority sector for development, (iii) it is consistent with Viet Nam's net zero emissions commitment by 2050.

Promulgate guidelines on public-private partnerships for solar power and EE in RWSSs: The government and provinces need to provide specific guidance on the public-private partnership mechanism for implementation of RE-EE projects for RWSSs, specifically: (1) guide State-invested RWSSs' management entities to lease premises (roofs of headquarters, water surfaces of reservoirs, vacant land) where solar power systems can be installed and (2) provide a mechanism for leasing equipment (solar power system, EE equipment) to be installed in RWSSs.

Develop and enact regulations on energy consumption norms for RWSSs: The Ministry of Agriculture and Rural Development (MARD) is encouraged

Filtering tank of Hoa Thuong water plant in Thai Nguyen province.

to study, develop and promulgate regulations on energy consumption norms for the rural water supply sector as a reference for RWSSs to invest and improve EE measures.

Strengthen communication activities to raise awareness and achieve capacity building in the development, management and operation of solar power systems and EE equipment in RWSSs: Raising awareness on the benefits of applying RE and solar power and implementing EE solutions for RWSS staff and relevant agencies (project approval agencies, investors and stakeholders) is key. Therefore, MARD should assign NCERWASS to: (1) implement awareness-raising campaigns for PCERWASSs, rural clean water supply companies about EE-RE, (2) organize trainings for PCERWASS technical staff on the operation and maintenance of solar power sources, EE solutions and technologies applied in RWSSs to build teams of trainers for provinces, (3) develop and issue technical guidance documents and standards on RE-EE applications, (4) guide provinces on inventory, assessment and synthesis of greenhouse gas reductions from application of solar power and EE solutions and technologies in RWSSs to prepare for carbon trading in the near future and (5) build demonstration models and organize dissemination and replication.

Provincial level

Develop and implement a plan to apply RE-EE solutions for RWSSs in provinces: A plan and mechanism to encourage RWSSs to seek RE-EE solutions in provinces is necessary. To achieve this, Provincial People's Committees and departments of Agriculture and Rural Development should assign a unit for each province (PCERWASS) to develop a plan for solar power and EE application for RWSSs in the province and specifically define goals, roadmaps, resources and solutions to promote solar power as well as EE application for RWSSs.

Organize training to strengthen capacity and raise awareness about solar power and EE application for officials and technicians of RWSS management entities in provinces, especially for staff and technicians who directly manage and operate RWSSs.

RWSS owners

Develop and implement plans to apply RE-EE solutions in RWSSs. It includes five-year period plans and annual plans to promote adoption of clean energy sources, contribute to reducing greenhouse gas emissions, and enhance overall efficiency of clean water production and distribution.

Raw water suction pipe at the central water plant of Ham Thuan Bac district, Binh Thuan province.

Provide capacity building and increase awareness of solar power and EE for technical staff of entities, especially technical staff who directly manage and operate RWSSs. Improve the capacity to access new technology, evaluate the effectiveness of EE solutions for RWSS management and operation teams.

Develop and enforce internal regulations on: (i) energy management: energy usage monitoring and reporting regimes, periodic assessments to detect energy losses and take timely remedial solutions and (ii) processes for operating, repairing and maintaining solar power equipment, and using energy efficiently.

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Ha Noi Office:
Address: 304 Kim Ma, Ba Dinh, Ha Noi, Viet Nam
Tel: +84 (0) 243 850 0100

HCMC Office:
Address: Room 507, Sun Wah Building, 115 Nguyen Hue, District 1, Ho Chi Minh City
Tel: +84 (028) 3 821 9413

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