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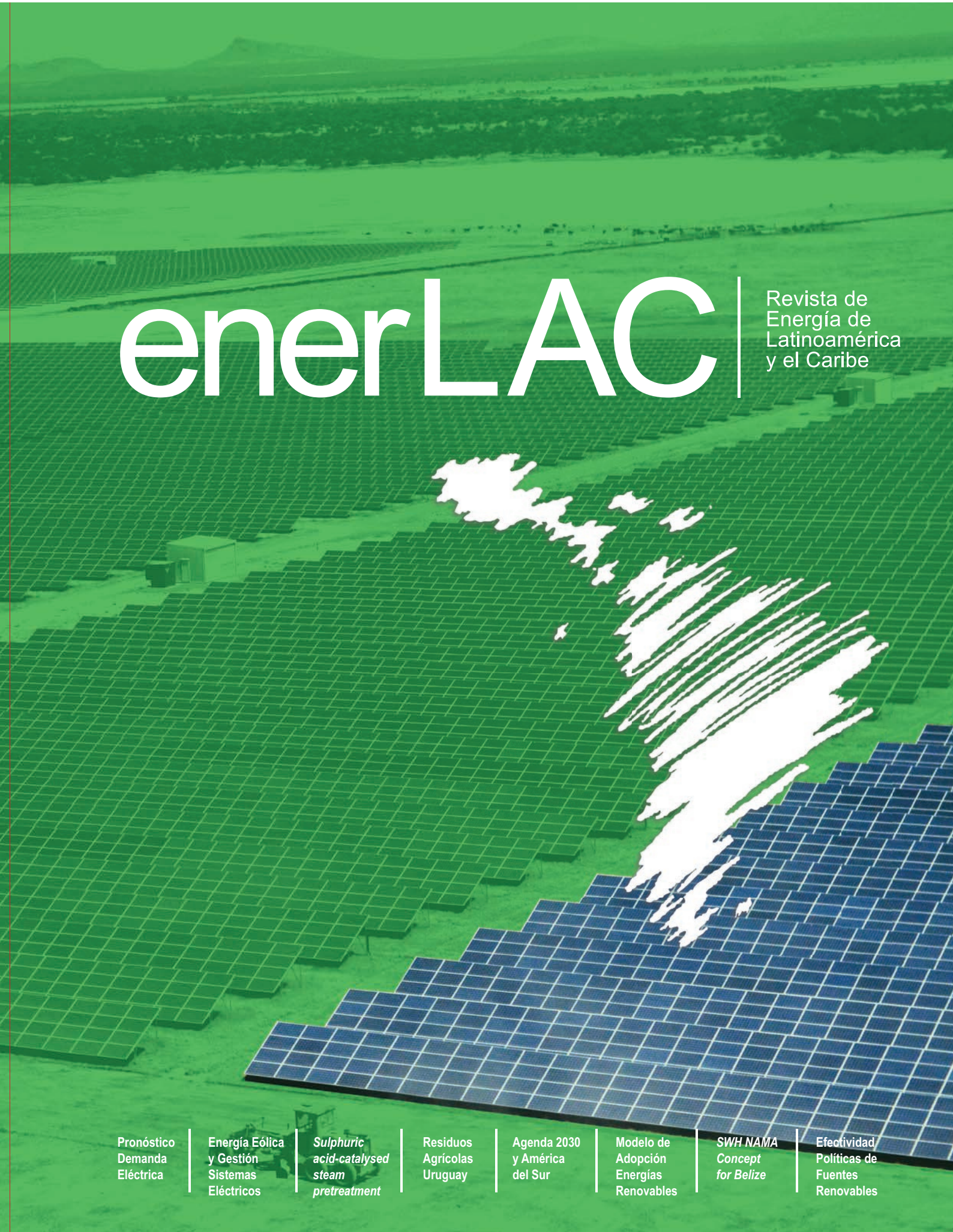

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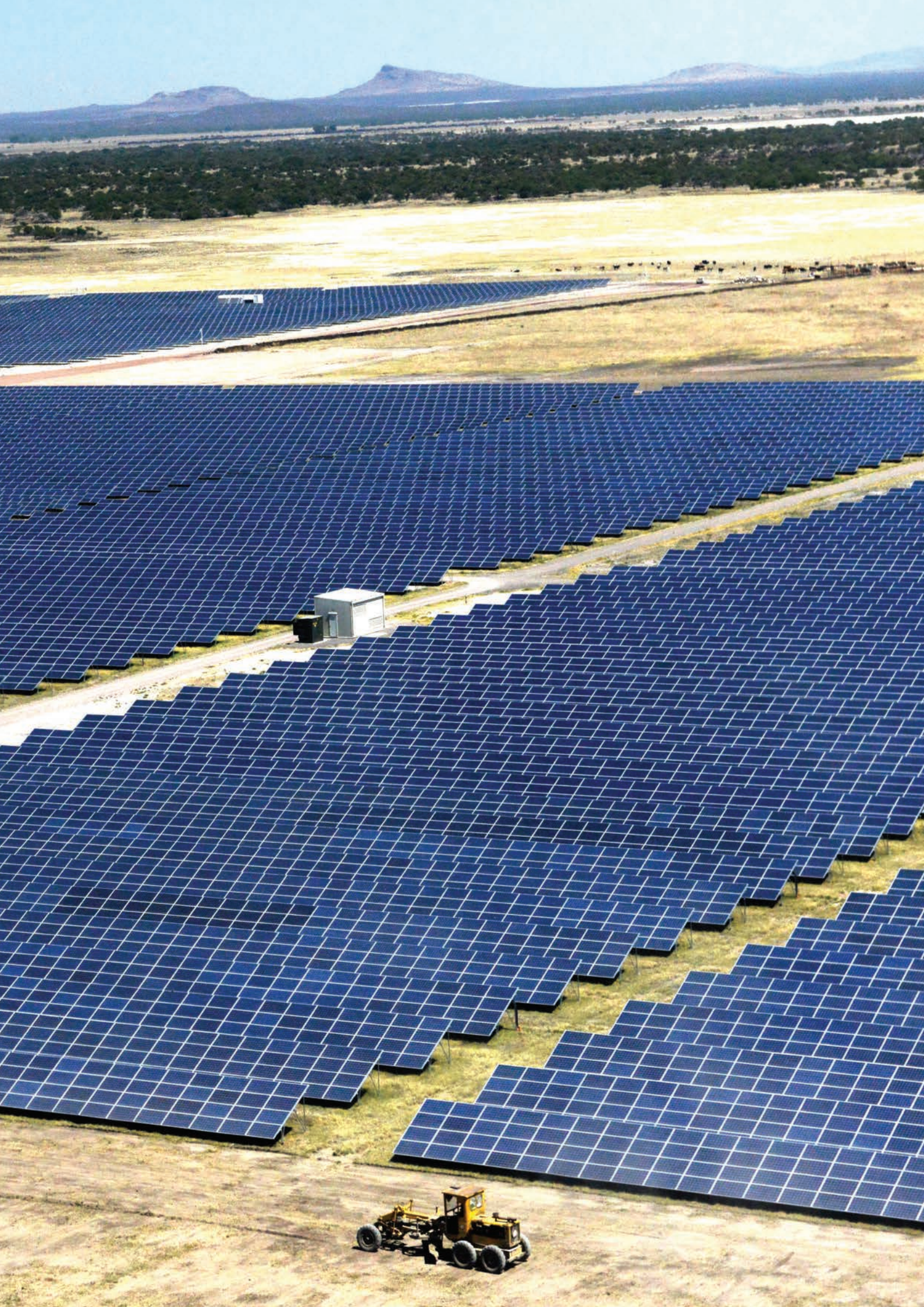

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SOLAR WATER HEATING (SWH) NAMA CONCEPT FOR THE INDUSTRIAL, COMMERCIAL AND RESIDENTIAL SECTORS IN BELIZE

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Executive summary is written by OLADE, drawn from the consultancy work of María Luz Farah, of the consulting firm POCH by WSP.

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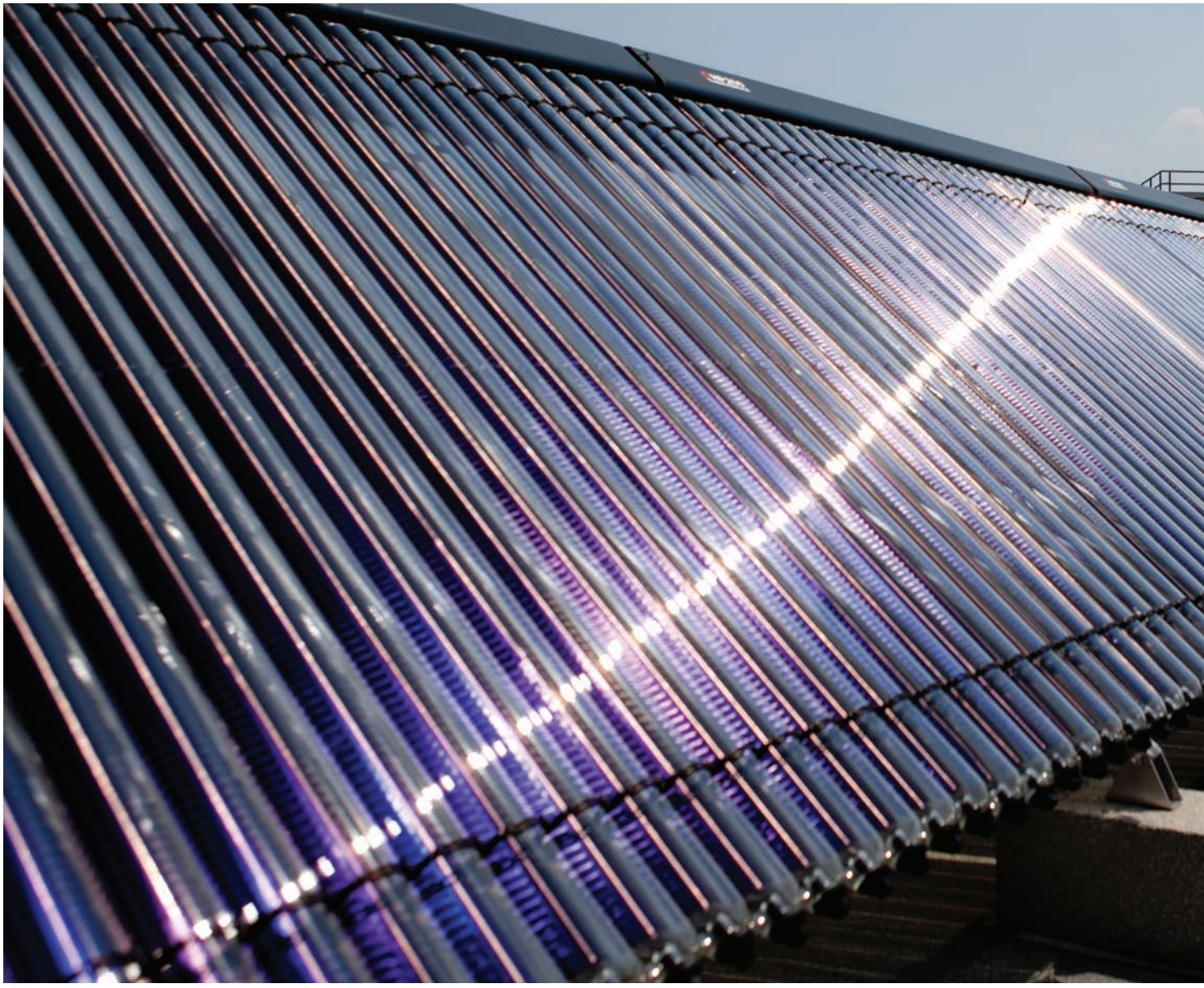

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ABSTRACT

The SWH NAMA in Belize aims to implement the solar water heating technology for the industrial, commercial and residential sectors, with the objective of reducing the emission of greenhouse gases from the use of fossil fuels for water heating through the installation and use of solar collectors and storage tanks. It includes an estimation of the GHG emission reductions expected for the implementation of the project, considering several scenarios according to the current situation and using appropriate methodologies to assess these estimations; and an analysis of the financial and technical support required and estimation of the financial and technological resources needed for the proper development of the SWH NAMA.

Keywords: Climate Change, Solar Water Heating, Nationally Determined Contributions, National Appropriate Mitigation Action, Belize

RESUMEN

El NAMA SWH en Belice tiene como objetivo implementar la tecnología de calentamiento solar de agua para los sectores industrial, comercial y residencial, con el objetivo de reducir la emisión de gases de efecto invernadero por el uso de combustibles fósiles para el calentamiento de agua a través de la instalación y uso de colectores solares y tanques de almacenamiento. Incluye una estimación de las reducciones de emisiones de GEI esperadas para la implementación del proyecto, considerando varios escenarios de acuerdo a la situación actual y utilizando metodologías apropiadas para evaluar estas estimaciones; y un análisis del apoyo financiero y técnico requerido y una estimación de los recursos financieros y tecnológicos necesarios para el correcto desarrollo del NAMA SWH.

***Palabras Clave**: Cambio Climático, Calentamiento Solar de Agua, Contribuciones Determinadas a Nivel Nacional, Acciones Nacionales Apropiadas de Mitigación, Belice*

INTRODUCTION

The SWH NAMA in Belize is a project that aims to implement the solar water heating technology for the industrial, commercial and residential sectors, with the objective of reducing the emission of greenhouse gases from the use of fossil fuels for water heating through the installation and use of solar collectors and storage tanks.

The development of an efficient and effective Solar Water Heating NAMA concept for the industrial, commercial and residential sectors in Belize requires, the evaluation of institutional stakeholders in order to define the specific roles for the NAMA implementation. Also, estimations of the GHG emission reductions expected for the implementation of the project, considering several scenarios according to the current situation and using appropriate methodologies to assess these estimations, were elaborated. Followed by a barriers analysis that has the objective of identifying and analyzing the way and the level in which the barriers would affect the implementation of the SWH NAMA. Furthermore, the analysis of the financial and technical support required and estimation of the financial and technological resources needed, allows the identification of the most relevant requirements for the proper development of the SWH NAMA. It also helps with the establishment of the main planning priorities, before and during the SWH NAMA operation. Finally, the development of an MRV framework is also key step for a NAMA since the results of this process enables the country to consistently track the performance of the project.

RELEVANT INFORMATION FOR THE SWH NAMA

The following is a summary of the relevant information for the SWH NAMA concept, showing important data available in the consulted documents.

National context

Population

According to the 2010 census, Belize has a population of 322,453 and a density of 14.1 (Pop/km2). Urban population corresponds to 52%, with a 3.1% urbanization rate estimated between 2005 and 2010. Poverty rate in Belize is 41.3% (The Statistical Institute of Belize, 2017).

Economy

Belize has a small economy, based primarily on agriculture, commerce, tourism and construction. Agriculture represents 30% of the GDP and provides 70% of the importations incomes. The most relevant products are bananas and sugar cane. The most developed industries are textile, agri-food, tourism and construction.

According to the Central Bank of Belize, in 2015 the tertiary sector represented 61% of the country's GDP, of which the wholesale and retail trade is the most relevant sub sector (Central Bank of Belize, 2017).

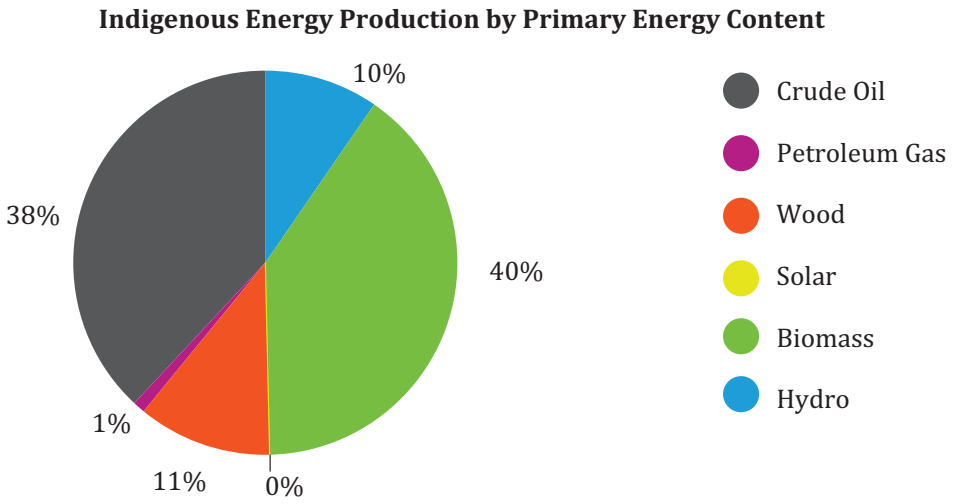
The travel and tourism sector in Belize has grown considerably in the recent years, and it has become an important industry of the nation, with a direct contribution of 495.5 BZDmn in nominal prices in the year 2015 (14% of the GDP) and a total contribution of 1,309.1 BZDmn in nominal prices in the same year (40% of the GDP), including other impacts in the domestic supply chain, capital investment, other related incomes (Central Bank of Belize, 2017) & (World Travel and Tourism Council, 2017).

Belize has high energy dependence because of the percentage of imported energy, which leads to high costs and inadequate energy data; although the energy sector is a main source of government revenue (e.g., fuel taxes, license fees and royalties) (REEP, 2011).

Energy sector

The Energy Report 2015 (Ministry of Public Service, Energy and Public Utilities, 2015), made by the Ministry of Public Service, Energy and Public Utilities, presents the general data of the energy sector, showing the total consumption and production in Belize during 2015. According to the report, the energy generation in Belize during 2015 was 8,592 TJ, comprising of:

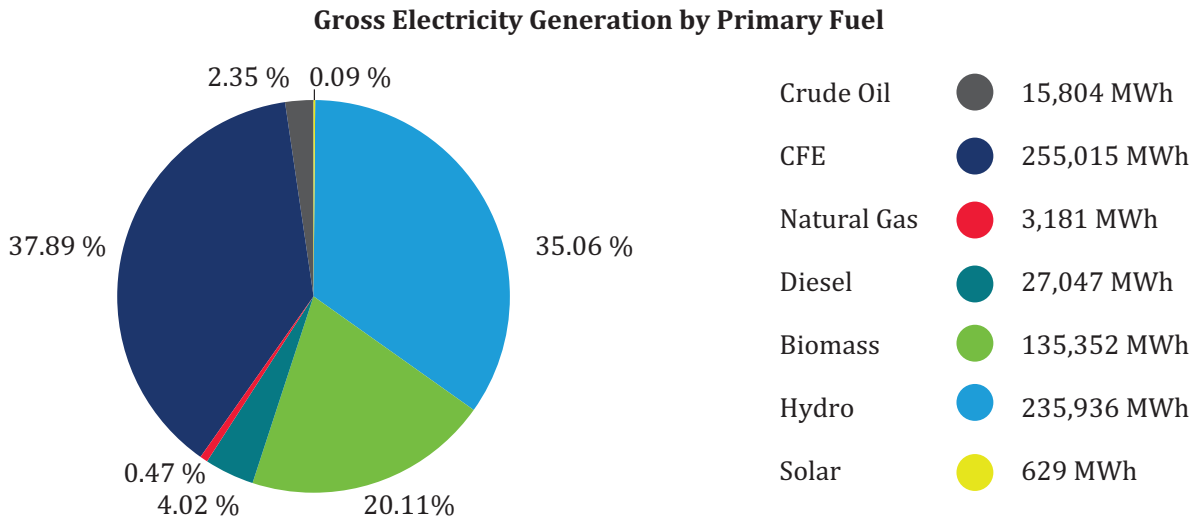
Figure 1. Domestic Energy Production by Primary Energy Content in 2015



Source: Ministry of Public Service, Energy and Public Utilities, 2015

On the other hand, Belize imported 9,822 TJ, most of its total energy supply. In the case of electricity generation, during 2015, a total of 656,530 MWh were produced with a total installed capacity of 141.78 MW. The fuel distribution of this generation is shown in figure 2.

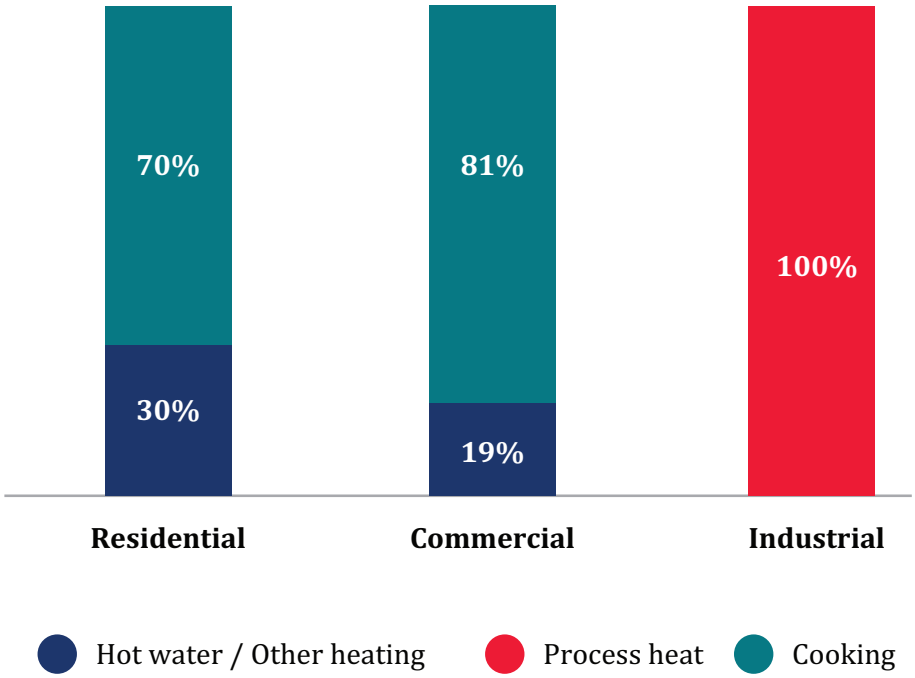
Figure 2. Breakdown of electricity generation output by primary fuel in 2015



Source: Ministry of Public Service, Energy and Public Utilities, 2015

The document "Overcoming barriers EE and RE" (Castalia, 2014) presents a series of graphics with information that explains the energy consumption by several classifications, as the ones below:

Figure 3. Purpose of heat energy by sector



Source: Castalia, 2014

The graphic shows the uses of the heat consumption in the Residential, Commercial and Industrial sector. Hot water for sanitary purposes is only used in the residential and commercial sector; and cooking is the main use in these sectors. In the other hand, the industrial sector uses heat for several processes.

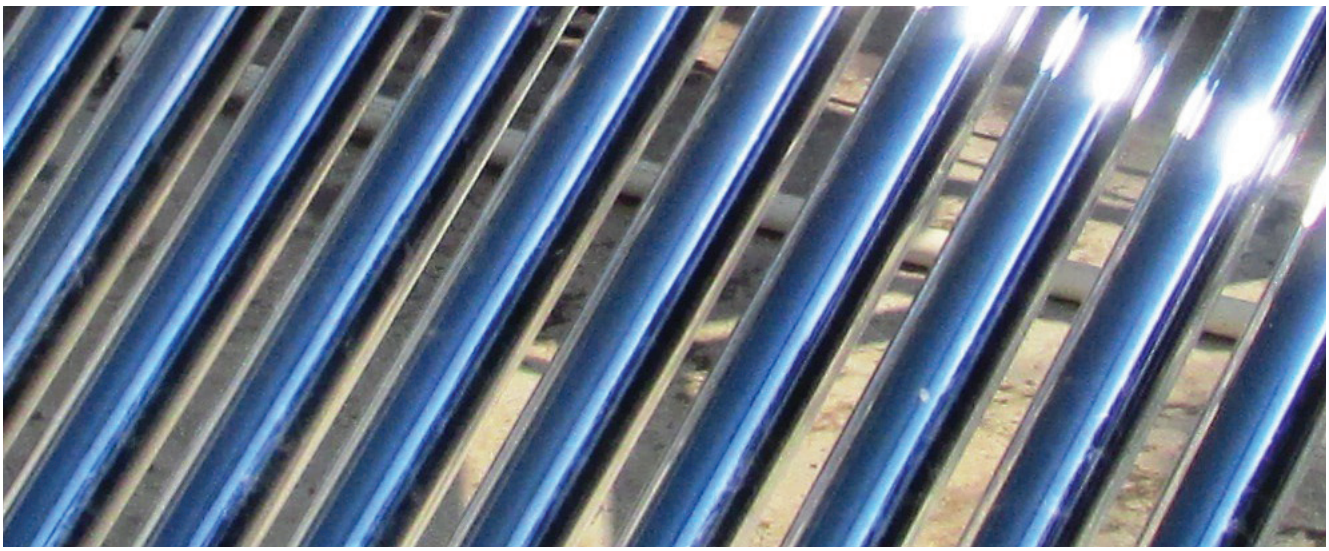
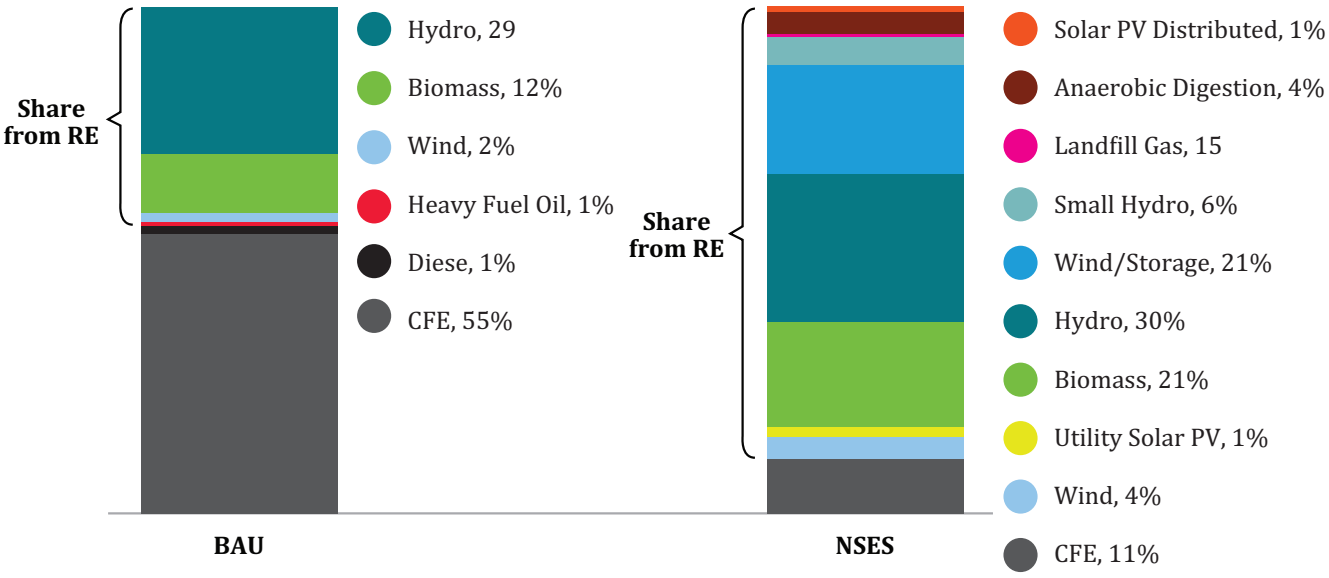


Figure 4. Generation share in Belize



Source: Castalia, 2014

As shown above, BAU scenario for Generation share includes a high dependence on electricity imports (CFE, 55%), which is expected to change with the introduction of renewable energy technologies to Belize's grid.

The document "Toward a national energy policy. Assessment of the energy sector in Belize" (REEP, 2011) presents information about the characteristics of energy generation in Belize and the main fossil fuels that are used in the country for lightning and cooking. Furthermore, it also includes the actual description of the renewable energies share.

The National Energy Policy Framework (Government of Belize, 2012) presents estimated comparative costs for the electricity sources which includes the installation of solar water heaters. This – as opposed to solar PV - makes sense in Belize's context because the per-KWh cost of solar thermal ($0.11 USD per KWh on average) is lower than grid electricity ($0.12 USD per KWh); but the cost of solar PV is much higher than grid electricity".

The same document also presents some projections to 2040, for lightning and water heating. The predictions are as follows:

a) Shift away from electric to solar lighting. By 2040: electric lighting (75%) and solar lighting (25%).

b) Shift towards using solar and geothermal technologies for cooling. By 2040: electric cooling (50%), geothermal cooling (25%) and solar cooling (25%).

c) Total phasing out of electric water heating. By 2040: LPG water heating (10%), solar water heating (70%) and geothermal water heating (20%).

Furthermore, it includes potential policies for the implementation of SWH systems, which are presented in the Policy section below.

Climate Change

The following paragraphs show the information included in Belize's INDC and National Communications.

Belize has submitted its INDC to the UNFCCC during the COP21, and its NDC in April 2016, in matters of mitigation in the energy sector, the NDC shows that the Sustainable Energy Strategy and Action Plan states the goal of becoming a low carbon economy by 2033, improving energy efficiency and conservation, with an energy intensity reduction of at least 30% by 2033 and a fuel imports dependency reduction of 50% by 2020 due to increasing renewable energies.

The specific goal is to increase the share of renewable energies up to 85% by 2030 by implementing hydropower, solar, wind and biomass, and reduction of transmission and distribution losses.

Furthermore, Belize has submitted three National Communications to the UNFCCC. The Third Communication presents Belize's national inventory of anthropogenic emissions by sources and removals by sinks. Key source assessments for reference years 2003, 2006 and 2009 were conducted and sought to capture new sources and sinks in addition to those described in the Initial and Second National Communications that might have arisen because of recent developments in the country.

Table 1. Emissions estimates

Reference years	CO_2 Emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NOx (Gg)	CO (Gg)	Total Emissions
2000	11,950	3,862	40	0	10	349	8,487
2003	18,168	9,666	43	0	11	376	8,932
2006	17,375	9,208	41	0	10	361	8,579
2009	13,449	8,778	40	0	10	346	5,067

Source: National Climate Change Office, 2016

SWH information

The document "Overcoming Barriers EE and RE" (Castalia, 2014) includes SWH as one of the proposed technologies to displace electricity consumption as an energy efficiency measure:

Solar water heating	RES, CO1, CO2	Solar water heaters use the heat of the sun to warm water in a roof-mounted system; they can displace over 80 percent of electricity.

And also to displace LPG use in the residential and commercial sectors:

Solar water heating	Residential, Commercial	Solar water heaters use the heat of the sun to warm water in a roof-mounted system; they can displace over 80 to 100 percent of LPG use.

Another report that includes SWH is "Belize's Sustainable Energy Strategy Final (Vol 2)" (Ministry of Energy, 2015). It presents a financial assessment for the installation of SWH systems in the commercial, industrial and residential sectors.

Commercial Solar Hot Water

The main fuel that would be displaced is LPG, with a displacement rate of 95%.

Costs would reach an average of BZ$15,000[1] for the installation of a 5kWth system, which would be paid off in 5.5 years.

Solar Industrial Process Heat

In the industrial sector, the solar heating technology considered was the concentrated solar power with parabolic trough devices; this would result in higher capitals costs for the industrial sector compared with the residential and commercial sector. This application is to produce steam and not hot water, which makes the payback period longer (60 years).

The solar water heating NAMA in Belize is a project that seeks to implement solar water heating technology through the installation and use of solar collectors and storage tanks in the industrial, commercial and residential sectors of the country. In this way it will be possible to reduce the emission of GHG produced by the use of fossil fuels for water heating.

Table 2. SWH in industrial sector

Target sector	Target Fuel	Capital Cost (BZD/TJ)	Incremental O&M Costs (BZD/TJ)	Annualized Cost of Savings (BZD/TJ)	Simple Payback Period (yrs)
Industrial	Crude Oil	160,186	0	160,186	60.0

Source: Ministry of Energy, Science & Technology and Public Utilities, 2015

Residential Solar Hot Water

In the case of residential SWH, the displacement of an 85% of the annual LPG use would mean an average investment of BZ$3,500 which should be paid off in 1.3 years.

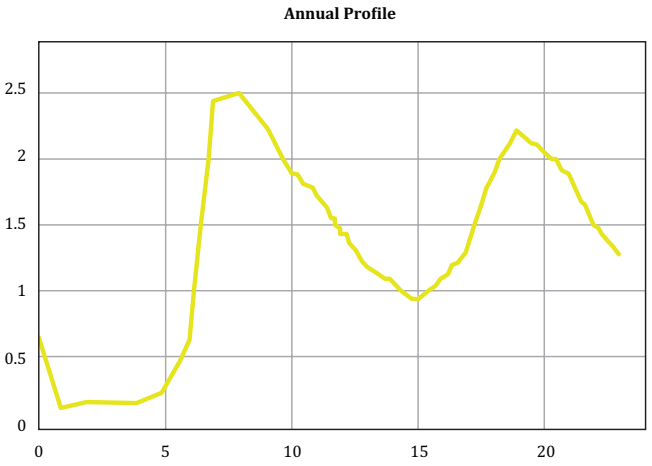
Solar Hot Water Production Potential

The potential of SWH technologies in Belize were assessed for two scenarios, both for a typical residential unit and a commercial user (a hotel). The estimated demand for a US residential building considered for a 12.2 gallons per person per day demand. On the other hand, the hotel demand was estimated considering 24 rooms serving 12,000 persons-day per year.

1 1 USD = 2 BZ

Figure 5 shows the annual average daily load profile for hot water demand in kWth.

Figure 5. Annual profile



Source: Ministry of Energy, Science & Technology and Public Utilities, 2015

The results of the analysis show that for the residential sector the optimum system displaces 94% of the conventional fuel with a 9.9% capacity factor, and for the commercial sector the optimum system displaces 64% of the fuel with a 16.9% of the SWH capacity factor, as shown on table 3.

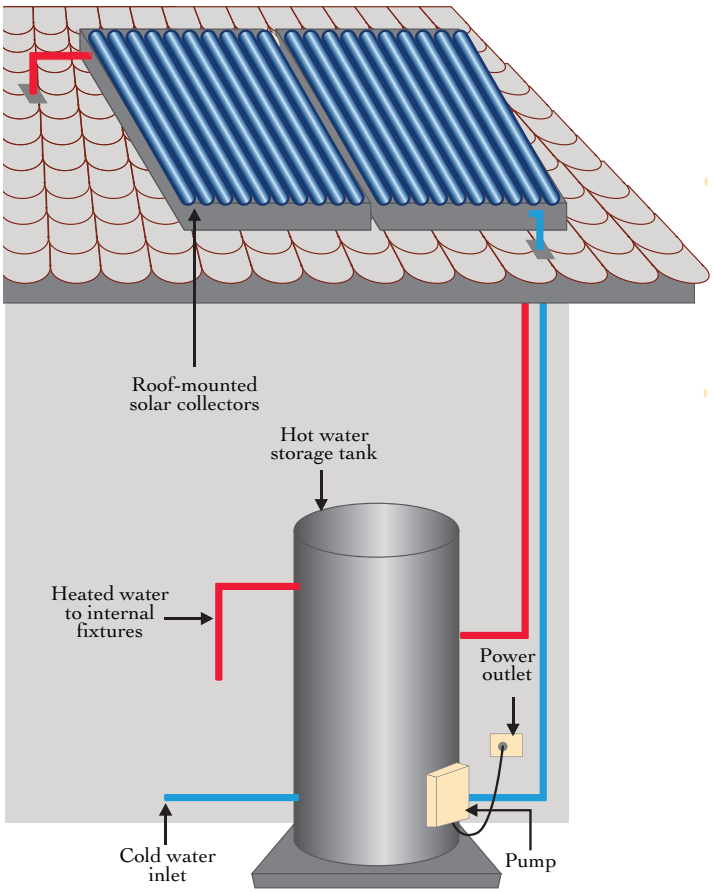


Table 3. SWH Demand assessment

Scenario	Typical Size (kWth)	Hot water Demand (gal/day)	Annual SHW Supply (kWh)	Solar Fraction of DHW	SHW Capacity Factor
Residential	1.4	44.2	1,225	94%	9.9%
Commercial	4.8	377	7,093	64%	16.9%

Source: Ministry of Energy, Science & Technology and Public Utilities, 2015

Even though the study "Belize's Sustainable Energy Strategy Final (Vol 2)" (Ministry of Energy, 2015), shows targets and potential of GHG reduction due to the implementation of SWH, this NAMA Concept will estimate a potential according to the field validation as a result of the first mission (please see Annex 1 for details regarding the mission).

Purpose and objectives of the SWH NAMA

The SWH NAMA aims to implement solar water heaters in the residential, commercial and industrial sectors in Belize; its main objective is to reduce the GHG emissions of the country, to generate a more sustainable scenario for the energy sector and a global access to clean and renewable energy.

A gradual implementation of the SWH systems is expected, considering a 13 years term in order to meet the "Belize Sustainable Development Strategy" goals related to climate change. The primary scope for the NAMA is to reach an 80% of the buildings, considering the ones that are, at the moment, capable of sustain the SWH system. Additionally, a pilot project is intended to be applied in the early years of the project, in order to identify further requirements and to test the proposed planning and implementation terms.

Analysis of institutional stakeholders

The stakeholder analysis is a key topic for the determination of the actual capacities of the country for the NAMA management and implementation. Also, it can be helpful for the planning and coordination needs through the lifetime of the project.

In this context, an institutional stakeholder is any organization related to the NAMA, who will be actually implementing the action or providing necessary conditions for the NAMA implementation. These institutional stakeholders could be public sector stakeholders (e.g. the related ministries or related units/offices), private sector stakeholders (e.g. providers and private banks) and supporting entities (e.g. development banks).

The identified institutional stakeholders for the SWH NAMA are the following:

- Energy Unit of the Ministry of Public Service, Energy and Public Utilities
- National Climate Change Office
- Public Utilities Commission
- SWH systems providers
- Private financial institutions
- Development Finance Corporation

Policies

Main policies related to SWH are:

National Energy Policy Framework (Government of Belize, 2012): It includes SWH as an energy alternative to displace fossil fuels consumption, under the micro-generation technologies proposal. It also shows estimations on how SWH could be implemented according to Belize's conditions, as the following paragraph stands:

"*If we assume that all concrete houses are capable of supporting solar water heating systems, then almost all of the water heating needs of 50% of the households in Belize can be met by using solar water heaters, particularly during the warmer and sunnier days of the year. This conclusion is drawn from insights gotten from the IEA Buildings Technology Roadmap 2010 which reports that "solar water-heating systems for single-family dwellings are relatively small, with collector areas of 4 m2 to 6 m2, and meet 20% to 70% of average domestic hot water needs*".

Belize Sustainable Energy Strategy (Ministry of Energy, 2015): This document presents technical information for several technologies, which includes solar water heating as one of them.

Growth Sustainable Development Strategy (Ministry of Economic Development, Government of Belize, 2016): Besides this document does not state SWH specifically, it aims to guide the development of Belize for the period 2016-2019, considering sustainable development as one of its principles. This strategy is based on critical success factors, where renewable energy and low-carbon development are accounted.

The most relevant information included in this document is shown in the Solar Water Heating information section.

ESTIMATION OF THE IMPACTS OF THE SWH NAMA

The Solar Water Heating NAMA will be implemented in these 3 sectors:

Table 4. SWH NAMA accounted sectors

Residential	Household sector, composed of all the houses in Belize that fulfil the conditions for the installation of a SWH system.
Commercial	Buildings with commercial purposes, mainly the hotel sector and other related buildings with hot water demand.
Industrial	Industrial buildings that have several purposes, such as meat and fruit processing, which requires hot water for different uses.

Source: Own elaboration, 2017

Currently, the main barriers facing this technology in Belize are: the high cost of the devices - which is explained in part due to high import taxes -; the lack of incentives to install the devices; and the lack of knowledge about technology.

Baseline scenario

The Baseline scenario for the SWH NAMA in Belize is usually developed by calculating the GHG emissions generated by the fuel and electricity consumption from the water heating processes across the country; particularly in the aforementioned sectors. As the required information for the specific fuel and electricity consumption is not available, a baseline emissions scenario can't be directly calculated. Nevertheless, based on the emissions savings calculations of the SWH systems implementation and estimation of the baseline, GHG emissions can be determined.

In section 3.4 the method for this calculation is presented given that the complete baseline scenario cannot be calculated considering the available information. Instead, an estimation of the fuel and electricity consumption by building unit (household, commercial or industrial) has been made from the emission reduction calculation. This allowed for the different GHG emission projections and scenarios.

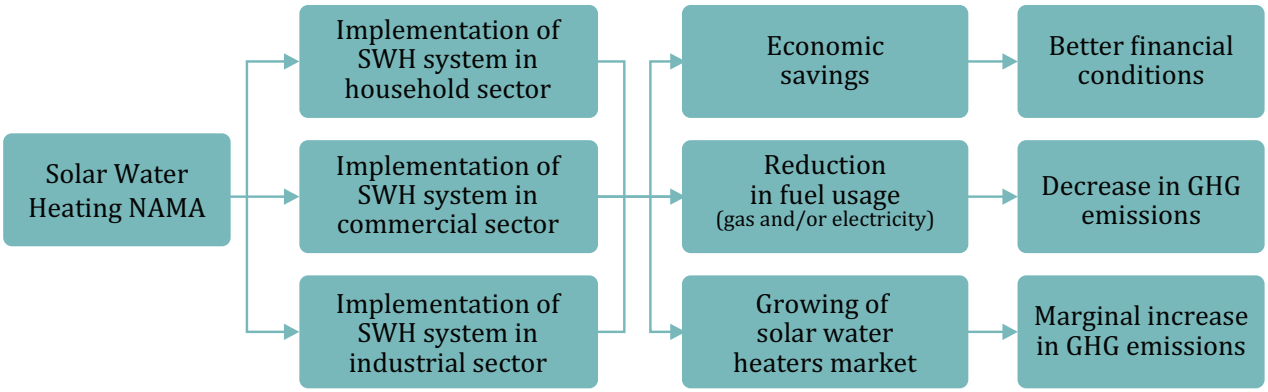
NAMA scenario

The NAMA scenario corresponds to the situation in which the SWH systems are already installed in the determined buildings and households, reducing the GHG emissions from the previous use of electricity and fossil fuels. The emission reduction produced in the NAMA scenario was calculated according to the hot water demand and the share that was covered by the SWH system, taking into consideration its size and performance.

Potential impacts of the NAMA

The implementation of the NAMA will potentially result in reduction of the GHG emissions and it can also have other non-GHG impacts, which would include the potential sustainable development benefits of implementing SWHs in Belize. In order to identify all the effects, a causal chain will be mapped, following the Policy and Action Standard document of the Greenhouse Gas Protocol (World Resources Institute, 2014).

Figure 6. Causal chain



Source: Own elaboration, 2017

A causal chain represents a diagram that "trace the process by which NAMA brings different effects through a series of logical and sequential related stages". Due to complexity of possible cause effect relations of NAMA actions and the impossibility of mapping all possible effects, a causal chain will be always incomplete.

GHG impacts of the NAMA

In order to define the methodology that was used to calculate the GHG emission reduction of the SWH NAMA, a research of available applicable methodologies from climate change related mechanisms as CDM, VCS or CAR was carried out. Nevertheless, the only methodology that fits the requirements of the NAMA is the CDM Small Scale Methodology "AMS-I.J.: Solar water heating systems (SWH) --- Version 1.0".

This methodology is focused on residential and commercial SWH systems for hot water production, presenting guidelines for the determination of the Baseline scenario and the Emission Reductions calculation according to the energy savings from the project. This is then multiplied by an emission factor for the electricity and/or fossil fuel displaced, as shown on the following equation.

Where,

$$ER = (IFC - AFC) * EF$$

ER: Emission reduction (tCO2e)

IFC: Initial fuel consumption (kWh)

AFC: Actual fuel consumption (kWh)

EF: Fuel emission factor (tCO2e/kWh)

Projections

Considering the values for the emission reduction, a projection for each sector was made using the following data:

Table 5. Projection input values

Term	13 years (2018-2030)[2]
Scope	30%, 50% and 80%[3]

Source: Own elaboration, 2017

Available information, geographical data and general estimations were used as input for the emission reduction calculation using the RETScreen software.

Total emission reductions

The following table shows the total emission reductions considering the separate fuel types scenarios.

[2] Considering Belize's NDC
[3] Based on Belize's Sustainable Energy Strategy

Table 6. Total emission reductions

Sector	Fuel type/ Industry	Emission reduction (tCO2e) 30% Goal ER	50% Goal ER	80% Goal ER
Household	LPG	33,508	55,852	89,368
	Electricity	44,681	74,473	119,161
Commercial	LPG	2,130	3,558	5,700
	Electricity	3,018	5,042	8,077
Industrial	CPBL		988	
	Quality Poultry		806	
Total LPG		37,432	61,204	96,862
Total Electricity		49,493	81,309	129,032

Source: Own elaboration, 2017

Sustainable development benefits of the NAMA

Beside from GHG emission reductions from the SWH NAMA implementation in Belize, there are several benefits to other areas of the country's development; those can be classified as social, economic, environmental, technological and institutional, and may be contributions to achieving the Sustainable Development Goals.

As seen on the figure 12, there are 17 Sustainable Development Goals, from which the most relevant for the SWH NAMA are:

Figure 12. Belize Sustainable Development Goals

Source: United Nations Development Programme in Belize, 2017

1. No poverty: Even though the SWH NAMA is not directly related to economic issues, it certainly contributes to fighting poverty, allowing people to access to sustainable energy and long-term savings from the fuel and electricity consumption that was avoided.

7. Affordable and Clean Energy: The implementation of SWH systems across the country would increase and improve the access to hot water through sustainable technologies, making it affordable for the population, commercial establishments and industries.

9. Industry, innovation and infrastructure: The SWH NAMA aims to implement solar water heaters in several types of buildings, introducing and promoting this technology across the country.

11. Sustainable cities and communities: The implementation of SWH systems certainly contributes to more sustainable cities replacing the electricity and fossil fuel consumption with renewable energy for water heating.

13. Climate action: The SWH NAMA aims directly reduce the GHG emissions in Belize through the replacement of fossil fuels and electricity consumption, contributing to the country's NDC.

IDENTIFICATION AND ANALYSIS OF BARRIERS

The SWH implementation in Belize could face different type of barriers, such as economic and financial, regulatory and institutional, technical and market barriers at different levels: government, users, financial institutions and providers. The analysis of barriers provides useful information in order to define the potential interventions of the NAMA, aiming to reduce and overcome the barriers.

Typology of barriers

Based on a literature review of the potential barriers for the implementation of NAMAs, and for the implementation of SWH systems, a typology of barriers was defined with the purpose of representing the analytical framework for the barriers analysis.

The following table shows the identified barriers and its qualification is presented.

Table 7. Identified Barriers

Type of barrier	Barrier	Level
Regulatory and institutional	Lack of managing structure and related budget	High
Technical and capacity	Lack of awareness about SWH technologies	Medium
Technical and capacity Regulatory and institutional	Lack of specific information on energy consumption	High
Economic and financial	Lack of financing capacities	High
Economic and financial Technical and capacity	Different priorities for lower incomes families	Medium

Source: Own elaboration, 2017

ANALYSIS OF THE FINANCIAL AND TECHNICAL SUPPORT REQUIRED AND ESTIMATION OF THE FINANCIAL AND TECHNOLOGICAL RESOURCES NEEDED

The various NAMA implementation and operation stages require different technical and financial resources. The initial assessment of the required technical and financial resources is presented in this section.

Administration and financing

The National Climate Change Office (NCCO) is the entity that must be in charge of the SWH NAMA administration and financing management, assuming a coordination role for the development of the project. Additionally, other institutions should collaborate with the implementation of the NAMA. The Energy Unit of the Ministry of Public Service, Energy and Public Utilities can be responsible for the design and implementation of the project during its development; the Public Utilities Commission can also be part of the implementation process, through the certification and supervision of the equipment and technicians.

The organization in charge of the SWH NAMA management needs to administrate the financial resources for the several requirements of the NAMA: Investment for pilot projects, financing mechanisms for the industrial and commercial sector.

Direct investment on SWH

The development of the SWH NAMA will require a proper investment and budget management for the following:

- NAMA development and implementation: The development of the SWH NAMA will require appropriate management of its financial resources in order to achieve all the project administration needs.

- Technical capacities development: Improvement of the management capacities for the SWH NAMA administration and implementation; Suppliers registration in order to keep updated records of the available providers, installers and maintenance technicians for the project.

Divulgation and communication

In order to ensure the expected results of the SWH NAMA implementation, divulgation and communication of the NAMA features for all the interested parties and relevant stakeholders should occur, with special emphasis on the population of Belize, the commercial and industrial sector. Communication should include information on the responsible parties, objectives of the project, opportunities for participation, and general conditions and requirements for beneficiaries.

Local technical capacities

The institutions in charge of the management of the SWH NAMA should acquire and improve the technical capacities requirements for the effective development and implementation of the NAMA, the sustainment of its results and the maintenance of the equipment. For example, some minimum requirements to be strengthened are:

- Solar radiation and solar potential analysis and operative maximization of the resource, by districts.

- Sizing of the several types of solar water heaters, according to their operative differences and beneficiary requirements.

- Installation and maintenance of the several SWH systems.

- Identification of technical feasibility: Requirements for correct installation of SWH systems, as water quality, roof load capacity, installation point optimization for loss reductions, radiation gains, and costs reduction on intervention in structures.

Standards or regulation definitions

Standards, regulations or guidelines for technical requirements for imports, selection and installation of solar water heaters must be clearly defined, considering:

- Material resistance of solar water heaters should meet special climate conditions (hurricanes, for example).
- Water quality, considering calcium concentrations in some areas in the south-west region.
- Load capacity of the roof structure.

Pilot projects

A public outreach activity should be promoted in order to identify non-government associations that could access funds to develop demonstrative SWH projects. Those SWH systems must be installed by certified professionals and provide maintenance for two years at least, including training for at least two members of the community association.

Bidding rules and eligibility criteria must be developed according to technical documents (prefeasibility studies). Also, areas of socio-economic interest, disposition of the association to data collection for MRV and the ability to cooperate with other entities that want to replicate their experience, must be considered for the selection.

Technical information

The availability of public radiation records is a key requirement for the development of solar potential studies. Additionally, a list of suppliers containing at least the available equipment, sizes, reference prices, installation options, and technical services should be developed.

Monitoring, report and verification

For the MRV framework, the following considerations should be fulfilled:

- The emissions and energy consumption baseline should be improved with more reliable data, informed by industries, hotels and a significant sample of households.
- Installation of SWH systems must be recorded, including size, replaced energy consumption and solar fraction data.
- Monitoring and reporting horizon should be clearly stated.
- Communication channels for monitoring should be determined, along with data recording, measuring and gathering requirements.

Financial and technical resources needs estimation

The estimation of the financial and technical requirements estimation is based on referential values for the proposed activities of the SWH NAMA development and implementation.

First, for the direct implementation of SWH devices, considering the referential values of the different SWH systems, provided by Chromagen (GREENSUN Ltd., 2016), the implementation costs for the several sectors are shown in the table below.

Table 7. Unit costs of SWH system

Sector	Number of collectors	Total cost (BZD)
Hotel	5	16,307
Household	1	4,112
CPBL	150	457,313
Quality Poultry	600	1,829,250

Source: Own elaboration

With the values presented in the table above, and considering the amount of buildings to be covered by the NAMA, as detailed in the previous report, the total values for the full implementation are shown in table 8. These costs are expected to be covered by the users (private sector).

On the other hand, the costs of the planning and the technical requirements of the SWH NAMA are shown in the following table.

Table 8. Total costs by sector

Sector	Total buildings	Total cost (BZD)
Hotel	680	11,088,675
Household	42,560	175,001,400
CPBL	150	457,313
Quality Poultry	600	1,829,250
Total		**188,376,638**

Source: Own elaboration

Table 9. Technical requirement costs

Item	Includes	Annual Cost (BZD)	Comments
Administration	- One employee	$50,000	One person exclusively dedicated to the NAMA management
Dissemination and communication	- Campaign - Capacity building for households, and private sector	$60,000	- Dissemination strategy and materials - Capacity building: 4 sessions per year
Capacity Building	- Capacity building for institutional stakeholders	$30,000	4 sessions per year
Standard definitions	- Part-time employee	$60,000	- Referential value
Pilot projects	- Installation of SWH Systems in 1% of Households and Hotels	$2,326.000	Competitive funds
MRV	- Design and building of technology system	$400,000	Complete MRV system implementation
MRV	- QA/QC - Audits - Verification	$30,000	Annual operational costs
Total			**$2,956,000**

Source: Own elaboration, 2017

ELABORATION OF AN MRV FRAMEWORK DESIGN FOR THE SWH NAMA

The main objective of the elaboration of an MRV framework is to generate an appropriate evaluation system for the SWH NAMA impacts, considering the measurement, reporting and verification specific requirements of this project. This MRV system must accurately account for the expected GHG emission reductions from the use of solar water heating systems, replacing fossil fuel-based heaters. The system is intended to have a gradual approach, according to the implementation of the NAMA. Thus, the MRV system can be equally applied to earlier phases of the project and also fully operational ones.

The MRV system will be based on several indicators that aim to consistently measure the impacts of the NAMA, considering the values of transpa-rency, consistency, comparability completeness, and accuracy according to the IPCC 2006 guidelines. All the data from the project activity must be collected and stored by the NAMA coordinating entity, while using an integrated system to allow access to all the information.

Measurement

Monitoring activities from the MRV framework have two main purposes, according to the Greenhouse Gas Protocol's document "Policy and Action Standard":

- To monitor and measure relevant indicators to assess the implementation progress of the SWH NAMA.
- To estimate GHG impacts through data collection for the ex-post GHG emission reduction calculation.

Monitoring procedures

The monitoring process will cover several data collection activities, considering the relevant indicators required for the assessment of the SWH NAMA development.

The main data collection method will be the development of specific surveys to be applied to a representative sample of the household and commercial sectors. This sample will be determined for each district, in order to assess the results of the SWH NAMA in each one, considering the different conditions and situations across the country. Furthermore, for the industrial sector, surveys may be applied to all the available industries.

The collected data for the monitoring process should be stored in a specifically designed system for the SWH NAMA, which allows the data input from several locations and access to the updated data.

A key factor for the success of the NAMA will be the implementation of pilot projects, which will serve as demonstration projects to obtain the acceptance and interest of the local population in order to increase the awareness of the SWH technology. They will also be considered as the first stage of a gradual implementation of the NAMA.

Indicators

The following table shows the proposed indicators to be measured for the assessment of the SWH NAMA results.

Table 10. MRV indicators

Indicator	Unit	Frequency	Collection type
Implementation progress			
Number of installed SWH systems	Number	Annual	Measured
Investments on SWH technology	BZ$	Annual	Measured
Maintenance procedures	Number	Annual	Measured
GHG effects			
GHG emission reduction	tCO2e	Annual	Calculated
Fossil fuel consumption	m3	Annual	Measured
Electricity consumption	kWh	Annual	Measured
Hot water Consumption	L	Annual	Measured
Hot water temperature	ºC	Annual	Measured

Source: Own elaboration, 2017

Reporting

Reports under the MRV framework of the SWH NAMA will meet international requirements, providing detailed and consistent information for decision making at the national level on programmes and policies. International standards on GHG emission reductions will be considered for reports, in order to make a proper comparison between NAMA and baseline scenario. Also, considering the measurement methodologies described above, emission reduction results will be available in both disaggregated and complete data.

The MRV system will provide relevant information for the national reports of Belize to the UNFCCC, considering the scope, actions and results of GHG mitigation from the SWH NAMA implementation. Nevertheless, the information provided by the NAMA reports won't match the level of detail required by the national reports, serving only as an input. In the long term, it is expected that the data collected and calculated by the NAMA could be improved and be useful for GHG Inventories and National Communications. Also, annual reports will be delivered and will be available for relevant stakeholders, both private and public institutions.

Verification

Data and calculations for GHG emissions reduction of the SWH NAMA will be subject to a series of verification processes to ensure the values of transparency, consistency, comparability completeness, and accuracy according to the IPCC 2006 guidelines. Initially, collected data will pass through a basic verification, analyzing its internal and temporal consistency, and correcting or excluding atypical values if necessary.

Emission reduction calculation and data entered will be subjected to an independent audit, by a government agency or organization, analyzing the data collection, transcription and emission reduction calculation process. The MRV framework for the SWH NAMA will consider the recommendations made on the IPCC 2006 guidelines. Additionally, emission reduction calculations will be verified by a third-party independent institution which will reproduce the calculations with the collected data, including comparisons between the calculations and relevant information as National Greenhouse Inventories. The MRV framework stated above is matched with the IPCC 2006 guidelines. The scheduling of audits by external institutions can guarantee those requirements.

NEXT STEPS FOR THE SWH NAMA

A series of activities have been identified in order to continue with the NAMA preparation and implementation. The most relevant next steps for the SWH NAMA preparation and implementation are the completion of the NAMA proposal, designing the specific MRV system and the financial mechanism for the implementation of the NAMA. The following table summarizes the proposed next steps and their related outcomes, responsible and timeframe.

Table 11. Next steps for the SWH NAMA

Outcome/ Activity	Description of outcome/activity	Main responsible	Timeframe
Outcome 1	**NAMA implementing entity and institutional arrangements in place**		
Activity 1.1	Definition and implementation of a managing structure for the NAMA (NAMA implementing entity)	Energy Unit	NAMA preparation
Activity 1.2	Development of institutional arrangements between the NAMA implementing entity and related institutional stakeholders	Energy Unit	NAMA preparation
Activity 1.3	Capacity building for institutional stakeholders	Energy Unit	NAMA preparation
Outcome 2	**Technical capacities and baseline information are available**		
Activity 2.1	Data collection (water heating needs, service temperature, water flow, actual energy source for water heating) for main industries	Energy Unit/ SIB	NAMA preparation
Activity 2.2	Update of emission reduction calculation for the industry sector	NCCO/ Energy Unit	NAMA preparation
Activity 2.3	Development of standards and codes (SWH devices, water quality, buildings)	BBS, CBA/ LBA	NAMA preparation
Activity 2.4	Certification of technicians and equipment	PUC	NAMA implementation
Outcome 3	**MRV system established**		
Activity 3.1	Design of a MRV system	Energy Unit/ NCCO	NAMA preparation
Activity 3.2	Implement information gathering system	Energy Unit/ SIB	NAMA implementation
Outcome 4	**Funds for the adoption of the SWH are delivered to eligible activities**		
Activity 4.1	Design of the financial mechanism for the NAMA	Energy Unit/ NCCO	NAMA preparation
Activity 4.2	Establishment of policies (incentives)	Energy Unit/ Ministry of Finance	NAMA preparation
Activity 4.3	Establishment of a MRV for financial mechanism	Energy Unit/ NCCO	NAMA preparation
Activity 4.4	Dissemination of the financial mechanism	Energy Unit	NAMA implementation
Activity 4.5	Execution of the financial mechanism	Energy Unit	NAMA implementation

Outcome 5	SWH technology adopted by the users (residential, commercial and industrial sector)		
Activity 5.1	Definition of eligibility criteria and bidding rules	Energy Unit/ NCCO	NAMA preparation
Activity 5.2	Design and development of an ongoing dissemination program of the SWH technology and the SWH NAMA	Energy Unit	NAMA preparation and implementation
Activity 5.3	Implementation of pilot projects in the residential and tourism sector in the different districts of Belize	Energy Unit	NAMA implementation
Activity 5.4	Capacity building for the users (pilot projects)	Energy Unit	NAMA implementation
Activity 5.5	Maintenance program for the pilot projects (2 years)	Energy Unit	NAMA implementation

Source: Own elaboration, 2017

CONCLUSIONS

The relevant institutional stakeholders are identified and assessed in this NAMA concept. The identified NAMA implementing entity is the Energy Unit of the Ministry of Public Service, Energy and Public Utilities, working with the collaboration from the NCCO.

Currently, the main barriers that this technology faces in Belize are the high cost of the devices, which is partially explained due to high import taxes; the lack of incentives to install the devices; and the lack of knowledge about the technology. In addition, in the residential sector the hot water demand is not constant over the year (hot water is mainly demanded in winter), and some of the existing households need to be retrofitted to incorporate the additional plumbing for installation of SWHs. The lack of human resources and technical capacities, and also the unavailability of national public funds to support the implementation of the NAMA are important limitations that should be addressed for implementation of the NAMA.

The GHG emission reduction for the residential and tourism (commercial) sector was calculated. The overall GHG emission reduction calculated in this NAMA concept represents an initial estimation of the GHG emission reduction potential of the SWH NAMA, and could be improved if new data is collected in the future. Thus, additional efforts are required in order to collect enough data to improve the GHG emission reductions estimation. An MRV framework is proposed, consistent with the principles of transparency, consistency, comparability, completeness, and accuracy according to the IPCC 2006 guidelines. The proposed MRV framework will require the participation of the different stakeholders from Belize, such as the Energy Unit, NCCO, SIB and BBS, in order to achieve a robust system to follow up the progress and results of the SWH NAMA.

The identified financial and technical needs for the SWH NAMA implementation involve administration and financing of the NAMA, direct investment on SWH (expected to be covered directly by the SWH users, who should be given the proper incentives and technical support), divulgation and communication, local technical capacities, definition of standards or regulation, implementation of pilot projects, availability of technical information and implementation and operation of a MRV system. In this context, a key factor of success will be the implementation of pilot projects, which will serve as demonstrative projects to get the acceptance and interest among the local population in order to increase the awareness of the SWH technology among the population of the country. In addition, these pilot projects will be considered as the first stage of a phased implementation of the NAMA. Thus, the

functioning of the MRV system for the pilot projects will provide critical information to domestic stakeholders that should inform any changes to elements of the proposed system as part of the final design of a national system. In this way the pilot projects can be seen as part of an incremental step-wise approach to the final development of a national system. The dissemination and divulgation, as well as the capacity building among the institutional stakeholders and the private sector is also relevant for the success of the SWH implementation and operation, to ensure that the stakeholders as able to acquire the necessary skills.

The next steps towards the SWH NAMA implementation involve the completion of the NAMA proposal, designing the specific MRV system and the financial mechanism for the implementation of the NAMA, among other activities. The development of the financial mechanism for the implementation of the NAMA shall assess and include the appropriate financial instruments to provide the right incentives to consumers as well as to reduce the upfront costs. The establishment of policies, such as reducing the import taxes and to provide additional support to afford the initial cost of the technology, is important to help to overcome the identified barriers.

The current NAMA concept proposal has the acceptance of the relevant institutional stakeholders, who have validated this proposal through a National workshop, where the NAMA concept was presented and discussed.

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