Chapter 5
Distributed Energy System in the Philippines

Introduction

For a developing country like the Philippines, energy demand will constantly increase through the years with rapid urbanisation and increased economic growth and industrialisation. The aspiration of the present Duterte administration towards industrialised Philippines would necessarily require ensured sufficient energy to support and drive the country towards this direction. And whilst the country is inducing more private investment in the generation sector and pursuing distribution and transmission reinforcements to support its power requirements, it still struggles to provide stable and reliable power supply.

The country's archipelagic state remains a major constraint in strengthening the transmission and distribution infrastructures to be able to deliver power supply to end users. This limitation clearly deprives the communities in remote islands from access to electricity. Furthermore, implementation of power projects in the projected period is not guaranteed due to lengthy government processes and requirements. These are just some challenges that have prompted the Philippines to start exploring distributed energy system (DES) as a viable option to satisfy immediate electricity demands.

DES applies to all distributed generation or decentralised power system where electric power is produced and consumed locally at or near the consumers; it can either be utility or consumer owned. Off grid can be a stand-alone generation having no connection to the national grid whilst on grid is termed embedded generation[1] or self-generating generator. Several technologies that form DES both in off-grid and on-grid areas include solar photovoltaic (PV), wind, solar, hydro, biomass, geothermal, diesel, coal, gas, and waste-to-heat recovery/cogeneration.

[1] Embedded generator refers to generating units that are indirectly connected to the grid through the distribution utilities system or industrial generation facilities that are synchronised with the grid.

The advent of DES applications in the Philippines is progressively transforming the landscape of the power sector and its associated challenges. Today, DES begins to become part of the country's power system primarily for services such as emergency power, uninterruptible supply, or ancillary service. Its dynamic features have responded to the complexity of the generation, transmission, and distribution systems incited by costly investment on conventional power plants, power losses, reliability issues, and environmental concerns, amongst others. It has become an effective energy solution for areas where electricity access seems to be unachievable. This energy system made it possible for consumers to be not just mere recipients of electricity supply, but also suppliers by allowing them to generate their own electricity and export excess to the grid.

As DES continuously becomes more desirable and economical because of its scale, flexibility, and proximity to the consumers, distributed generation may eventually be on par with centralised generation in the coming years. The continued technical advancement in the electric power system offers better opportunities for distributed generation to become as important as centralised generation. The widely growing interest of the implementation of DES applications simply suggests that it will become a significant element in restructuring and modernising the country's power industry.

Methodology

On-Grid/Embedded Generations

The 2008–2015 data on power generation submitted by generation companies and distribution utilities through their monthly operations report served as the working database to assess the demand projection of on-grid DES/embedded generations by 2025 and 2040. Since the country's system operator, the National Grid Corporation of the Philippines, does not capture and monitor embedded generations, the primary data needed for projections were sourced from the monthly operations report submitted to the Department of Energy (DOE). From this, all embedded generations were obtained and disaggregated per technology.

The base case demand projection was primarily derived using an econometric model of electricity generation based on technology, with economic growth and time trend as explanatory variables. Such estimation means that a unit change in electricity generation can be explained by the behaviour of economic growth and time trend over the planning period. This historical trend was used and applied to the actual 2015 electricity generation to come up with the baseline electricity generation forecasts.

From the forecasted electricity generations that have been established, the peak demand forecasts are then obtained using the load factor approach. In this method, the forecasted electricity generation is divided by a predefined load factor. For this purpose, a high load factor of 70% is assumed in consideration of increased diversities and management of loads in industrial zones and on-grid areas resulting in relatively constant power usage.

In this methodology, identification of the additional capacity is solely dependent on the projection of electricity demand unlike in other planning processes where reserve requirements and committed capacities are also considered. To determine the annual deficit per type of power plant, the peak demand forecast was subtracted from the existing dependable capacity as of December 2015. The resulting value is the required or necessary DES capacity to meet future demand. A negative result indicates that the existing capacity still has a surplus capacity for that specific period.

Off-Grid Generation

To illustrate a holistic picture of DES profile for off-grid generation, this study captured the respective off-grid areas under the coverage franchise areas of grid-connected electric cooperatives.

This study used the following information to determine the future capacity of DES in off-grid areas: (i) 2015 data of DES installed capacity and electricity generated, and (ii) off-grid electricity demand projections for planning horizon 2025 and 2040.

The main source of information is the 2016 individual distribution development plan (DDP) of off-grid electric cooperatives as submitted to and approved by the DOE. The DDP is a 10-year plan prepared annually by all distribution utilities for managing their distribution systems and ensuring continuous, reliable, and affordable electricity service to its customers through identification of infrastructure requirements and timely procurement of power supply agreements. The 2016 DDP has a baseline year of 2015 (actual) and projections from 2016 to 2025, utilising various forecasting models. For this study, the electricity demand projections were extended to 2040 to capture long-term demand and the corresponding additional capacity requirements in off-grid areas.

To identify the required DES capacities by 2025 and 2040, the current installed capacities were subtracted from the projected electricity demand on a per-technology basis. The resulting figure then provides for the required additional DES capacities, if the existing capacities fall short of the projected demand for the planning period. On the other hand, if the existing installed capacities are still sufficient to meet the 2025 and 2040 electricity demand, this indicates that no additional capacities are required for that outlook period.

On top of these, new DES technologies such as wind and geothermal energy sources were likewise accounted, with the understanding that these new technologies will essentially form part of the future DES energy mix. These new DES technologies are firm capacities that are electric cooperatives programmed in their power supply expansion plan.

Current Situation of Distributed Energy System

On-Grid/Embedded Generation

This section concentrates on the current situation of embedded generation in the country. Included in the discussions are the existing installed capacities per type of energy source and its substantial merits to the power sector, the present policies and opportunities to promote the use of distributed generation, and its share to the overall generation capacity to support enhancement of energy security.

Installed Capacity and Power Generation

As of 2015, the country's total installed capacity of embedded generation operating in industrial zones and on-grid areas was recorded at 609 megawatts (MW) with a total power generation of 1,292,700 megawatt-hours (MWh)[2] (Table 5.1). In this period, oil-based/diesel power plants with an equivalent installed capacity of 346.59 MW dominated embedded generation. This is attributed to the influx of embedded diesel power plants in Mindanao since 2012 as part of the government's proposed actions to augment the power crisis in the region. The renewable energy sources also had a significant contribution in the country's embedded generation with 159.77 MW, followed by combined heat and power (CHP) or industrial cogeneration, providing a considerable share of 103 MW. Meanwhile, there has been no record yet of coal-fired and geothermal power plants being utilised in the form of DES since they are widely used in centralised power as base load supply.

[2] Embedded generations included in the 2015 data of the Department of Energy (DOE) that are presently grid-connected, non-operational, and decommissioned have been excluded to isolate the effects of such occurrences.

Table 5.1. Total DES Installed Capacity and Gross Power Generation (On grid), 2015

Applications	Current/Existing Capacity	
	MW	MWh
Solar PV	16.60	21,732
Wind	54.00	53,947
Biomass/biogas	9.40	23,561
Micro hydro	79.77	367,944
Geothermal	0.00	0
Diesel generator	346.59	561,785
Thermal power (coal, slurry, fuel oil, others)	0.00	0
CHP incl. heat recovery facility	103.00	263,731
Other generators		
Total	**609.00**	**1,292,700**

CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.
Source: Philippine DOE (2015).

Merits of Embedded Generation

Deployment and use of DESs in industrial zones and on-grid areas deliver substantial merits to both consumers and distribution utilities. Since most economic activities are centred in urbanised areas, ensured sufficient supply is very critical in all aspects for the continuous operation of cities, businesses, and homes. It is in this circumstance that majority of the embedded units installed today serve as backup especially during peak hours. Since application of renewable technologies is very site-specific, most units installed in these areas are diesel power plants.

In 2015, the DOE and Energy Regulatory Commission introduced the Interruptible Load Program (ILP) in Luzon in anticipation of the tight power supply during the summer period. In this mechanism, business customers of a distribution utility voluntarily disconnect themselves off the grid especially during peak demand period. Participating customers will be incentivised should they use their own embedded stand-by generation during power supply deficit. The ILP in some ways illustrated the practicality and helpfulness of embedded generations in today's power industry.

Embedded generation significantly contributes to reducing peak power requirements. This has benefited distribution utilities just like the power distributor giant Manila Electric Company (MERALCO), most of whose franchise areas are growing load centres. MERALCO provides financial incentives to customer owners of embedded units to make them available to electric system operators during peak demand periods. In Mindanao, electric cooperatives and distribution utilities have started integrating embedded generations in their networks to serve as ancillary service as the National Grid Corporation of the Philippines is not providing a contract for ancillary services. Consequently, these embedded units around the country shared their part in alleviating the line congestion being experienced and increasing the reliability of delivering power. Since the units are usually closer to the consumers, power loss is also reduced, resulting in higher efficiency and better performance of the system. Thus, the use of embedded generations is an effective solution in providing emergency power, particularly on those facilities that require highly reliable electricity.

Opportunities and Economy of DES in On-Grid Areas

In terms of economy, there are vast opportunities in the development of DES, particularly in industrial and commercial sectors situated in on-grid areas and economic zones. According to the Philippine Economic Zone Authority, 358 economic zones are operating nationwide, hosting some of the top global manufacturing and industrial companies[3] . These ecozones could be future sites for DES, particularly solar and wind farms that are expected to augment power requirements in the future.

The booming industrial and commercial field across the country denotes potential opportunities on the application of DES, especially that there is an ongoing trend of companies venturing on embedded generations to produce their own electricity for lower energy bills and increased reliability. From 2011 to 2015, the industrial and commercial sectors shares to total electricity consumption averaged 27% and 24%, respectively (Philippine DOE, 2016a). As these sectors are electricity intensive, meeting the electricity demands will require an unprecedented level of investment in fuel supply, generation, and networks. Thus, it is generally in these sectors that adoption of DES would be more beneficial in reducing electricity consumption and managing peak demands.

As the cost of DES becomes economical, it will be advantageous for some facilities and businesses requiring highly reliable electricity to install and generate their own power to

[3] http://www.peza.gov.ph/index.php/economic-zones/list-of-economic-zones

assure continuity of their operations. Since use of DES is limited to certain locations and conditions, many of the developers now are focusing on energising large commercial and industrial sectors through solar rooftops. Meanwhile, the application of cogeneration or waste heat recovery is also gaining popularity amongst the pulp and paper, refining, and manufacturing sectors.

Although application of DES is competitive with conventional generation, it is still difficult to attract investors as the government lacks concrete, transparent, and reliable policies regarding DES. Power investments are capital intensive; hence, these must be complemented with a market that is predictable and friendly to investors to enable and encourage higher penetration of embedded generations in the grid.

Energy Security Brought by Embedded Generation

Enhancing energy security has always been a major challenge the country has to deal with. Sudden power outages have dramatic implications for the country's economic activities resulting from interruption of business operations and loss of revenues. The introduction of generating power in the form of distributed generation can provide an enhanced energy security.

The Philippine DOE estimated that 3.18% of the country's overall power generation in 2015 came from embedded generation in on-grid areas and economic zones (Table 5.2). Out of this, the share of renewable sources and fossil-based power plants to the total capacity of power generation registered at 0.83% and 2.35%, respectively.

Table 5.2. Percentage Share of Installed Generating Capacity, 2015

	Installed Capacity, MW	Percentage Share
Off-grid generation	**404.50**	**2.1**
On-grid generation	**18,765.00**	**97.9**
Embedded generation	609.36	3.18
Renewable energy	159.77	0.83
Fossil based	449.59	2.35
Overall power generation	**19,169.50**	**100.00**

MW = megawatt.

Source: Philippine DOE (2016b).

CO_2 Emissions Reduction by Existing On-Grid/Embedded DES

The use of renewable energy and energy-efficient technologies such as cogeneration/CHP in producing energy has been proven to drive down carbon emissions since it reduces the need to produce electricity from carbon-intensive sources such as fossil fuels. Using the standard emission factor of 7.03 x 10-4 MT-CO2/kWh set by the US Environmental Protection Agency and the actual electricity generation for 2015, the carbon footprint offset from renewable energy and CHP was estimated at 513,833.25 MTCO2 for a total of 730,915 MWh of clean energy (Table 5.3).

Table 5.3. Total CO2 Emissions Reduction by Renewable Energy System and Combined Heat and Power (On-grid DES), 2015

Applications	Existing Dependable Capacity		CO2 Emission Reduction, MTCO2
	MW	MWh	
Solar PV	12.30	21,732	15,277.60
Wind	54.00	53,947	37,924.74
Biomass/biogas	7.88	23,561	16,563.38
Micro hydro	63.40	367,944	258,664.63
CHP incl. heat recovery facility	52.40	263,731	185,402.89
Total	**189.98**	**730,915**	**513,833.25**

CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, MTCO2 = metric ton of CO2, PV = photovoltaic.

Note: Emission factor = 7.03 × 10-4 MTCO2/kWh.

Source: Philippine DOE (2015a).

Case Studies of DES Application for Economic Zones

This study cites two manufacturing plants using on-site power generation to describe the state and performance of embedded generation in the country.

Case Study 1: San Carlos Ecozone Negros Occidental

San Carlos Bioenergy Inc. (SCBI) is a pioneer in ethanol manufacturing in the country. In 2008, it completed the first integrated sugar cane-based ethanol and power cogeneration power plant in Asia (Zabaleta, 2012). The integrated cogeneration facility located in San Carlos City, Negros Occidental has a capacity of 8.3 MW powered by indigenous biomass resources, particularly bagasse, by-products from ethanol production.

In 2010, the SCBI signed a power supply contract with VMC Rural Electric Services Cooperative Inc. (VRESCO) for 2.4 MW–4.8 MW in excess capacity for 30 years at P2.86 per kWh, subject to regular adjustments based on inflation (Gatdula, 2010). VRESCO distributes electricity to its franchise areas covering the cities of San Carlos, Victorias, Cadiz, Sagay, and Escalante and the municipalities of E.B. Magalona, Manapla, Toboso, and Calatrava in Negros Occidental.

In terms of power generation, the SCBI generated a total of 18,134 MWh in 2015 (Table 5.4). It is committed to providing sustainable power and maintaining the environmental integrity of its surrounding areas. The generating facility of the SCBI upheld this commitment in 2013 as it played a key role in the aftermath of Typhoon Yolanda (Haiyan). The whole province of Negros Occidental had no power due to damaged power lines of the local cooperative. But in just after 2 days, the facility was able to supply the city of San Carlos with 1.5–1.7 MW of electricity for 1 week.[4] This model case of the SCBI clearly demonstrated the defining attributes and qualities of distributed generation in terms of enhancing energy security and reliability.

Table 5.4. SCBI's Installed Capacity and Power Generation, 2015

Applications	Current/Existing Capacity	
	MW	MWh
Biomass/Biogas San Carlos Bioenergy Inc. (SCBI)	8.3	18,134

MW = megawatt. MWh = megawatt-hour.
Source: Philippine DOE (2015a).

Case Study 2: United Pulp and Paper Company, Inc.

United Pulp and Paper Company, Inc. (UPPC) is the Philippines' biggest industrial paper manufacturer located in Calumpit, Bulacan and a subsidiary of the Siam Cement Group of Thailand. This plant uses 100% waste paper as raw material and is powered by a 30 MW cogeneration power plant that runs on coal, paper rejects, waste paper sludge, and biomass like corn cob and straw dust.

Formerly a bunker-fired plant facility, the Siem Cement Group started to invest in 2004 to put up a circulating fluidised bed cogeneration plant to supply the power and steam requirements of its paper mills (Cahiles-Magkilat, 2005). This is part of the plant's strategy to generate fuel savings and reduce production cost as it cost consumes a high amount of energy.

[4] http://www.rappler.com/video/reports/46278-green-revolution-san-carlos-city

The UPPC generated a total of 143,359 MWh solely for its own consumption to run its machinery to produce paper (Table 5.5). The company's decision to venture in power generation is an important motivation for many businesses on how large power consumers can translate their demand into additional power generation through on-site generation.

Table 5.5. UPPC's Installed Capacity and Power Generation, 2015

Applications	Current/Existing Capacity	
	MW	MWh
CHP incl. Heat Recovery Facility United Pulp and Paper Company, Inc. (UPPC)	30	143,359

CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour.
Source: Philippine DOE (2015a).

Current Policies for Embedded Generation

Technically, the country does not have an existing policy with respect to embedded generation. In fact, even the minimum connection and operational requirements of embedded generators in the distribution system have yet to be established and integrated with the Philippine Distribution Code.

However, there are existing support mechanisms when it comes to embedded generations from renewable energy sources. The outstanding progress on applications of DES using renewable energy technologies is the result of the government's continuous promotion and encouragement of cleaner sources of energy. Currently, the government offers incentives under the Renewable Energy Act of 2008 such as income tax holidays, 10% corporate tax rates, duty-free importation of renewable energy machinery and equipment, and 0% value-added tax on renewable energy sales and purchases. Under this law is the adoption of a feed-in-tariff (FiT) system where an eligible producer of renewable energy is entitled to a guaranteed payment of a fixed rate for each kilowatt-hour of energy it supplies to the relevant grid (ERC, 2010). In addition to this is the implementation of the net-metering scheme, a non-fiscal incentive that allows consumers to produce its own power generation using eligible renewable energy facilities and to deliver excess supplies back to the electric grid to offset their electricity consumption at 100 kW maximum.

Off-Grid Generation

This section briefly discusses the profile of DESs in off-grid areas. As of this writing, about 20 electric cooperatives are serving the off-grid areas (Table 5.6).

Table 5.6. List of Off-Grid Electric Cooperatives

Island	Off-Grid Electric Cooperative
Luzon	Batanes Electric Cooperative (BATANELCO)
	Lubang Electric Cooperative (LUBELCO)
	Occidental Mindoro Electric Cooperative (OMECO)
	Oriental Mindoro Electric Cooperative (ORMECO)
	Marinduque Electric Cooperative (MARELCO)
	Tablas Island Electric Cooperative (TIELCO)
	Romblon Electric Cooperative (ROMELCO)
	Busuanga Island Electric Cooperative (BISELCO)
	Palawan Electric Cooperative (PALECO)
	First Catanduanes Electric Cooperative (FICELCO)
	Masbate Electric Cooperative (MASELCO)
	Ticao Island Electric Cooperative (TISELCO)
Visayas	Bantayan Island Electric Cooperative (BANELCO)
	Camotes Electric Cooperative (CELCO)
	Province of Siquijor Electric Cooperative (PROSIELCO)
Mindanao	Siasi Electric Cooperative (SIASELCO)
	Sulu Electric Cooperative (SULECO)
	Basilan Electric Cooperative (BASELCO)
	Tawi-tawi Electric Cooperative (TAWELCO)
	Dinagat Island Electric Cooperative (DIELCO)

Source: Philippine Department of Energy – 2016 Distribution Development Plan.

Table 5.7 lists the on-grid electric cooperatives with off-grid areas in their service franchises.

Table 5.7. List of On-grid Electric Cooperatives with Off-grid Areas

Island	Off-Grid Electric Cooperative	
Luzon	Quezon II Electric Cooperative (QUEZELCO II)	Polillo, Panukulan, Burdeos, Patnanungan, and Jomalig, Quezon
	Aurora Electric Cooperative (AURELCO)	Dinalungan, Casiguran and Dilasag, Aurora Dinapigue, Isabela
	Batangas II Electric Cooperative (BATELEC II)	Tingloy, Batangas
	Camarines Sur IV Electric Cooperative (CASURECO IV)	Caramoan and Garchitorena, Camarines Sur
	Isabela II Electric Cooperative (ISELCO II)	Divilacan, Palanan, and Maconnacon, Isabela
	Albay Power and Energy Corporation (APEC)[5]	Rapu-Rapu, Albay
Visayas	Antique Electric Cooperative (ANTECO)	Caluya Island, Antique
	Biliran Electric Cooperative (BILECO)	Higatangan Island, Biliran
	Bohol I Electric Cooperative (BOHECO I)	Inabanga, Calape, Baclayon, Tubigon and Panglao, Bohol
	Iloilo III Electric Cooperative (ILECO III)	Gigantes Island, Iloilo
	Mactan Electric Company (MECO)	Olango Island, Lapu-Lapu City
	Northern Samar Electric Cooperative (NORSAMELCO)	Municipalities of Biri, San Antonio, Capul, San Vicente and Batag Island
	Samar I Electric Cooperative (SAMELCO I)	Municipalities of Sto. Nio , Almagro, and Tagapul-an
	Samar II Electric Cooperative (SAMELCO II)	Municipality of Zumarraga
	Southern Leyte Electric Cooperative (SOLECO)	Limasawa Island
Mindanao	Davao del Sur Electric Cooperative (DASURECO)	Balut and Saranggani Islands
	Sultan Kudarat Electric Cooperative (SUKELCO)	Lebak, Kalamansig, Sen. Ninoy Aquino, and Palimbang, Sultan Kudarat
	Surigao del Norte Electric Cooperative (SURNECO)	Hikdop Island
	Zamboanga City Electric Cooperative (ZAMCELCO)	Sacol Island

Source: Philippine Department of Energy – 2016 Distribution Development Plan.

[5] APEC is the concessionaire of the defunct Albay Electric Cooperative, Inc. (ALECO).

Existing Power Plants (Off-Grid)

As of December 2015, there were about 322 existing power plants (314 were oil based whilst 8 were micro hydro) operating as stand-alone DES in off-grid areas. By type of ownership, about 291 power facilities, mostly oil-based diesel, were state owned through the National Power Corporation – Small Power Utilities Group (NPC–SPUG). About 24 power facilities were privately owned and operated by New Power Providers. About five micro-hydro power plants were owned by distribution utilities, and two oil-based power plants were under the qualified third party (QTP)[6] programme (Table 5.8).

Table 5.8. Existing Off-Grid Power Plants by Type of Ownership, 2015

Owner	No. of Power Plants		Total
	Oil based	Micro hydro	
NPC-SPUG	290	1	291
New power providers	22	2	24
Utility-owned	–	5	5
Qualified third parties	2	–	2
Total	**314**	**8**	**322**

– = zero, NPC-SPUG = National Power Corporation – Small Power Utilities Group.
Data Source: DOE, 2015.

Installed Capacity and Gross Power Generation (Off-Grid)

As of 2015, the total installed capacity of DES operating in off-grid areas was 404.5 MW. About 392.4 MW or 97% of the installed DES capacity came from diesel generators, whilst roughly 12.2 MW or 3% were from micro-hydro power plants.

During the same period, power generation grossed 1,066,236 megawatt-hours (MWh). The bulk (96.9%) of the electricity generated came from fossil-based diesel power generators whilst a mere portion (3.1%) was sourced from renewable energy-based micro-hydro power plants (Table 5.9).

[6] QTP is created based on Section 59 of Republic Act No. 9136 or the Electric Power Industry Reform Act of 2001 or the EPIRA Law under Rule 14 of its Implementing Rules and Regulations. Said section stipulates that entities other than distribution utilities are authorised to provide electric service in remote and unviable areas that distribution utilities are unable to serve for any reason.

Table 5.9. Total DES Installed Capacity and Gross Power Generation (Off grid), 2015

Applications	Installed Capacity (MW)	Gross Generation (MWh)
Solar PV	-	-
Wind	-	-
Biomass/biogas	-	-
Micro hydro	12.15	33,335
Geothermal	-	-
Diesel generator	392.36	1,032,901
Thermal Power (coal, slurry, fuel oil, others)	-	-
CHP incl. heat recovery facility	-	-
Other generators	-	-
Total	**404.51**	**1,066,236**

- = zero, CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.
Source: Philippine Department of Energy (2015b).

Merits of DES in Off-Grid Areas

The deployment of DES applications has merits, especially in off-grid areas. For one, the concept of DES as stand-alone mini-grid is practically viable in island provinces, especially when public funds are limited to finance the extension of the main transmission lines to reach the off-grid areas.

Elaborating further, the mobility of fossil-based DES technologies such as diesel power generators enables sustainable supply of energy in far-flung areas. Compared to other technologies, diesel power generators can be easily installed through modular units, and their installed capacity can be conveniently augmented at any given time.

Potential renewable energy sources such as run-of-river hydro, geothermal, biomass, wind, and solar PVs are site-specific resources that are abundantly available in rural areas. The abundance of this cleaner set of renewable sources in the off-grid areas allow for the immediate application of DES to secure the electricity supply of remote communities.

Opportunities and Economy of DES in Off-Grid Areas

The Philippine energy sector is open for business. In fact, there is a huge potential for investment opportunities for both on-grid and off-grid infrastructure in the areas of power generation, transmission, and distribution. However, because off-grid areas have relatively smaller electricity demand compared to on grid, the private sector is reluctant to invest in DES power generation. Hence, the government implemented the Private Sector Participation (PSP) programme.

The PSP is a government programme promulgated through Department Circular No. 2004-01-001 to encourage the inflow of private capital investment to engage in missionary electrification.[7] This is pursuant to Section 3(b) of Rule 13 of the Implementing Rules and Regulations of Republic Act No. 9136 or the 'Electric Power Industry Reform Act (EPIRA) of 2001'. The section provides that NPC–SPUG shall periodically assess the requirements and prospects for bringing its functions to commercial viability on an area-by-area basis at the earliest possible time, including a programme to encourage private sector participation.

In the long run, the PSP is expected to improve the delivery of power-related services, such as efficiency and reliability of power generation, that would significantly benefit the end consumers. Consequently, the PSP aims to meet future demand growth.

Because of the lower peak demand level in off-grid areas, economies of scale in putting up DES technologies are likewise being applied. Depending on the economic activities taking place in the island grids, the size of DES varies. For instance, relatively large off-grid areas such as Palawan, Mindoro, Masbate, and Siquijor are amongst the progressive missionary areas whose installed DES capacities ideally range from above 10 MW. On the other hand, the rest of the developing islands and islets have DES capacities of less than 10 MW.

Energy Security brought by DES in Off-Grid Areas

DES applications primarily aim to attain energy security especially in off-grid areas. Table 5.10 presents the percentage share of the on-grid and off-grid installed generating capacities for 2015. As shown in the table, about 97.9% of the installed generating capacities are used for on-grid application, with merely 2.1% coming from off grid.

For on grid, 64.9% of the total installed generating capacities are fossil-based facilities comprised of oil-based, coal, and natural gas power plants, whilst renewable types of generating capacities sccpunt for a 33.0% share.

[7] Missionary electrification refers to providing basic electric services to remote or off-grid areas and ultimately bringing the operations in these areas to viable levels.

For off grid, the share of fossil-based generating capacities was only 2.1% of the total, mostly diesel. Roughly 0.1% of the off-grid capacities are sourced from renewable energy technologies.

Table 5.10. Percentage Share of Installed Generating Capacity, 2015

	Installed Generating Capacity (MW)	Percentage Share
On grid	**18,765.0**	**97.9**
Fossil based	12,435.0	64.9
Renewables	6,330.0	33.0
Off grid	**404.5**	**2.1**
Fossil based	392.4	2.0
Renewables	12.2	0.1
Total	**19,169.5**	**100.0**

MW = megawatt.

Source: Philippine DOE (2016b).

In general, off-grid capacities account for a very minimal share of the country's total installed generating capacities. Considering that small-island and isolated grids possess varied peculiarities, DES applications serve a significant purpose in ensuring energy security and sustainability in off-grid areas.

CO_2 Emissions Reduction by Existing Off-Grid DES

The increasing levels of greenhouse gas (GHG) emissions from the energy sector is widely viewed as a major contributor to global warming or climate change. Within the sector, these GHG emissions are largely attributed to the combustion of fossil fuels during the energy transformation processes. Whilst climate change has recently become an urgent and priority concern globally, the Philippines as a developing country remains a minor contributor to the world's GHG emission compared to the developed economies and other neighbouring countries.

For this study, the present and future domestic GHG emissions were duly accounted for to establish the potential advantage of reducing GHG emissions through DES, especially for off-grid areas. In estimating the GHG equivalencies, this study used the emission factor of 7.03 x 10-4 $MTCO_2$/kWh set by the United States Environmental Protection Agency (EPA).

Table 5.11 shows the 2015 electricity gross generation in off-grid areas and the potential CO_2 emissions reduction expressed in metric tons of carbon dioxide equivalent ($MTCO_2e$). For the reported period, off-grid areas recorded a total potential GHG emissions reduction of 749,563.91 MTCO2e based on the actual 1,066,236 MWh gross power generation. About 96.9% of this figure, or 726,129.40 $MTCO_2e$, can be reduced from fossil-based diesel generation. Avoided units of CO_2 emissions from renewable energy account for 23,434.51 $MTCO_2e$.

Table 5.11. CO_2 Emissions Reduction Equivalencies in DES Off-Grid Areas, 2015

Fuel Type	Gross Generation (MWh)	CO2 Emissions Reduction (MTCO2e)
Fossil-based (diesel)	1,032,901	726,129.40
Renewable Energy (micro hydro)	33,335	23,434.51
Total	**1,066,236**	**749,563.91**

$MTCO_2e$ = metric tons carbon dioxide equivalent, MWh = megawatt-hour.

Note: CO_2 emissions reduction was calculated using the US Environmental Protection Agency's emission factor of 7.03 x 10-4 $MTCO_2$/kWh.

Source: Department of Energy 2015 Gross Generation, 2015.

Cost–Benefit Analysis of On-Grid and Off-Grid Areas

Another envisioned advantage of utilising DES is to provide affordable energy. However, this vision is rather contrary in the case of the Philippines. To support this statement, the DOE conducted a cost–benefit analysis comparing the cost of providing electricity in the main grid against the off grid.

With reference to the 2015 data on electricity tariff (Table 5.12), the national average power rate in the main grid is ₱8.8029/kWh or US$0.1767.[8] This was computed by taking the average electricity tariff of the on-grid electric cooperatives (US$0.1890/kWh) and the public investor-owned utilities (US$0.1644/kWh). On the other hand, the national average electricity tariff in off-grid areas as of December 2015 is ₱10.7396/kWh or US$0.2156/kWh.[9]

For both main grid and off grid, the national average effective electricity rates are composed of the (i) generation charge; (ii) system loss charge; (iii) distribution, supply, and metering charges; (iv) subsidy charges;[10] (v) other charges;[11] and (vi) government charges (universal charge, and value added tax).

[8] Foreign exchange rate used: US$1 = ₱49.8126 (Reference: Bangko Sentral ng Pilipinas (BSP), accessed 30 May 2017).
[9] Including the cash incentive for renewable energy in off-grid areas; excluding the feed-in-tariff allowance.
[10] Includes lifeline and Senior Citizen's discount.
[11] Includes loan condonation, PEMC–SPA charges, over/under recovery and interclass cross subsidy.

Table 5.12. Comparative Effective Electricity Rates, 2015

Fuel Type	Average Electricity Rate	
	(₱/kWh)	(US$/kWh)
Main Grid Average Electricity Rate	**8.8029**	**0.1767**
On-grid electric cooperatives	9.4147	0.1890
Private investor–owned utilities	8.1912	0.1644
Off-grid Electric Cooperatives	**10.7396**	**0.2156**
Variance (Off grid – On grid)	**1.9367**	**0.0389**

kWh = kilowatt-hour.
Source: Philippine DOE (2015c).

As a result of the cost–benefit analysis, off-grid power rates are deemed higher by US$0.0389 compared to the power rates in the main grid.

Case Studies of DES Application for Off-Grid Areas

This section discusses two model cases where off-grid DES is being applied: the Romblon Electric Cooperative, Inc. (ROMELCO) and the Basilan Electric Cooperative, Inc. (BASELCO) that serve as distribution utilities in the provinces of Romblon and Basilan, respectively.

Case Study 1: Romblon Electric Cooperative, Inc.

The province of Romblon is in the MIMAROPA[12] region. It is composed of about 20 major and smaller islands scattered across the centre of the Philippine archipelago. The biggest is Tablas Island comprising nine municipalities (San Agustin, Calatrava, San Andres, Odiongan, Ferrol, Santa Fe, Looc, Alcantara, and Santa Maria); Sibuyan Island with three municipalities (Magdiwang, Cajidiocan, and San Fernando); and Romblon Island, the capital town, is an island municipality located in the middle of the islands. Four other major islands are the municipalities of Corcuera, Banton, Concepcion, and San Jose.

Romblon is primarily an agricultural province with most economic activities evolving in the basic sectors such as agriculture and livestock raising, marginal fishing, and small-scale mining activities with aggregates as the major product. Basically, major activities in the province are focused on the fishing and tourism industries, and crop production.

[12] MIMAROPA is an administrative region in the Philippines comprising the provinces of Mindoro, Marinduque, Romblon, and Palawan.

Two distribution utilities cater to the power requirements of the province: (i) Tablas Island Electric Cooperative, Inc. (TIELCO) serving the franchise area of Tablas Island, and (ii) ROMELCO, serving the rest of the island municipalities. This case study focuses only on the areas under the ROMELCO franchise.

As of end 2015, ROMELCO's power-generating facilities had an installed capacity of 8.38 MW. By type of power source, 7.48 MW come from diesel generators operated by NPC-SPUG and 0.9 MW are sourced from Cantingas micro-hydro power plant owned by the utility. The 2015 system peak demand of ROMELCO reached 3.07 MW whilst gross power generation was registered at 16,913 MWh (Table 5.13).

Table 5.13. ROMELCO's Installed Capacity and Gross Power Generation, 2015

Applications	Installed Capacity (MW)	Percentage Share (MWh)
Solar PV	-	-
Wind	-	-
Biomass/biogas	-	-
Micro hydro	0.9	4,879
Geothermal	-	-
Diesel generator	7.48	12,034
Thermal Power (coal, slurry, fuel oil, others)	-	-
CHP incl. heat recovery facility	-	-
Other generators	-	-
Total	**8.38**	**16,913**

- = zero, CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.
Source: ROMELCO (2016).

Case Study 2: Basilan Electric Cooperative, Inc.

In terms of gross provincial income, Basilan is a third-class island province located in the Autonomous Region in Muslim Mindanao. It is the largest island situated in the northernmost of the major islands of the Sulu archipelago.

The province is subdivided into 11 municipalities – Akbar, Al-Barka, Hadji Mohammad Ajul, Hadji Muhtamad, Lantawan, Maluso, Sumisip, Tabuan-Lasa, Tipo-Tipo, Tuburan, Ungkaya Pukan – and two cities – Isabela City, a component city, and Lamitan City, the capital.

Agriculture is the main source of livelihood with major products that include coconut (primarily copra), rubber, coffee, black pepper, and African palm oil. Other crops are palay, corn, cacao, and cassava.

Unlike Romblon, the power requirements of Basilan are being catered by its sole distribution utility, BASELCO. Basilan also belongs to the BASULTA area (Basilan, Sulu, and Tawi-Tawi), which is one of the large clusters of off-grid area in Mindanao.

In 2015, Basilan's installed generating capacity totalled 14.03 MW. The bulk of the power supply (95.2%) was sourced from diesel-based facilities owned and operated by NPC-SPUG, with the remaining power capacity (4.8%) from utility-owned Kumalarang micro-hydro power plant. During the same period, system peak demand was recorded at 8.3 MW whilst total electricity generated was at 39,370 MWh (Table 5.14).

Table 5.14. BASELCO's Installed Capacity and Gross Power Generation, 2015

Applications	Installed Capacity (MW)	Percentage Share (MWh)
Solar PV	-	-
Wind	-	-
Biomass/biogas	-	-
Micro hydro	0.67	579
Geothermal	-	-
Diesel generator	13.36	38,791
Thermal Power (coal, slurry, fuel oil, others)	-	-
CHP incl. heat recovery facility	-	-
Other generators	-	-
Total	**14.03**	**39,370**

= , CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.

(-) means zero.

Source: BASELCO Distribution Development Plan, 2016.

Current Policies for DES in Off-Grid Areas

a. *Universal Charge for Missionary Electrification (UCME)*

Since it is costlier to generate electricity in off-grid areas compared to the main grid, the government implemented a subsidy programme through the universal charge for missionary electrification. UCME is a policy mechanism created under

Rule 13 of the Implementing Rules and Regulations of Electric Power Industry Reform Act. Its sales revenue is a main funding source of NPC–SPUG to support the delivery of electricity services. More importantly, it cushions the impact of high generation costs in far-flung areas. The mechanism is expressed in peso per kilowatt-hour that is applied and charged to all electricity consumers of the country. The 2015 average UCME charge is US$0.0074/kWh.

b. Feed-in-Tariff

Republic Act No. 9513 or the 'Renewable Energy Act of 2008' articulated the government's thrust to promote the development, utilisation, and commercialisation of renewable energy resources to shift towards a low-carbon future. To realise this thrust, the renewable energy law provided for policy mechanisms to encourage and accelerate the development and utilisation of cleaner energy sources.

Amongst the major incentives provided under the Renewable Energy Act is the feed-in-tariff (FiT). FiT refers to a renewable energy policy that offers guaranteed payments on a fixed rate per kilowatt-hour for emerging renewable energy sources, excluding any generation for own use. The implementation of the FiT system aims to:

- allow renewable energy developers to recover their investments and provide them with internationally acceptable return on investment during the FiT period;
- accelerate the development of emerging/competitive renewable energy technologies; and
- not unduly burden the consumers with heavy pass-on charges.

To further safeguard consumer interest, the FiT system was accompanied by a corresponding installation target per type of renewable energy resource. Installation targets are the renewable energy-rated capacities per technology projected based on the awarded renewable energy service contracts for a given period as certified by the government through DOE. The installation targets aim to pre-determine the impact of the FiT rates at a given period and the maximum penetration of renewable energy capacities to the grid. Table 5.15 summarises the current FiT rates and installation targets per renewable energy technology.

Table 5.15. Approved Feed-in Tariff Rates and Installation Target (as of June 2017)

RE Technology	Approved Rates (US$/kWh)	Percentage Share (MWh)
Run-of-river hydro	0.1184	250
Biomass	0.1331	250
Wind	0.1486	400
Solar	0.1943	500

kWh = kilowatt-hour, MW = megawatt.

Source: ERC Resolution No. 10, series of 2012; ERC Resolution No. 1, series of 2017.

At present, the FiT system is only applicable and can be availed of by prospective developers of renewable energy in the main grid. To guarantee that the FiT system would be practicable to all electricity consumers, the National Renewable Energy Board, the Department of Energy, and the Energy Regulatory Commission, in consultation with energy stakeholders, periodically conducts a review.

c. *Cash Incentive for Renewable Energy Developers in Off-Grid Areas*

As the government finds it very challenging to entice private investment for the development of renewable energy in off-grid areas, it likewise put in place a cash incentive mechanism.

As provided under Chapter VII General Incentives and Section 15(h) of the renewable energy law or Republic Act 9513, a renewable energy developer 'shall be entitled to a cash generation-based incentive per kilowatt-hour rate generated, equivalent to fifty percent (50%) of the universal charge for power needed to service missionary areas where it operates the same, to be chargeable against the universal charge for missionary electrification'. In 2015, the cash incentive for renewable energy developers was US$0.000034/kWh.

d. *Competitive Selection Process in Securing Power Supply Agreements*

In June 2015, DOE issued Department Circular No. 2015-06-0008, mandating all distribution utilities to undergo a competitive selection process in securing power supply agreements with generation companies. The foremost objective of the policy is to reinforce good governance and instil a transparent process amongst distribution utilities in managing, negotiating, and procuring long-term power supply contracts. Correspondingly, the policy issuance enables a level-playing field and facilitates fair competition amongst generation companies that redound benefits to electricity consumers through reliable, adequate, and least-cost supply of electricity.

Development of Distributed Energy System

There is a great possibility that the future of power system is DES. This is becoming increasingly clear as demonstrated by the growing presence of stand-alone and on-site generations, advances in applications and new technologies, and the changing preference of consumers. In this section, the additional required capacities of DES per type of energy source for 2025 and 2040 will be identified. Determining the future power requirements is crucial as it will entail additional investments in meeting future demand.

On-Grid/Embedded Generation

2025 Outlook

Table 5.16 shows that the aggregated existing dependable capacity of 508.28 MW for embedded generation is theoretically sufficient to meet the projected demand of 457.71 MW by 2025 as denoted by an excess capacity of 50.57 MW. This is attributed to the huge presence of embedded diesel generators as it still has the surplus capacity of 93 MW in 2025.

However, considering that most of these units are stand-alone generations and that transfer of power is not readily possible, the excess capacity of diesel generators is not guaranteed to offset any deficiency of supply of other DES technologies to include the 1.52 MW for solar, 2.97 MW for biomass, 13.66 MW for hydro, and 24.28 MW for CHP. With this analysis, these technologies will have a shortfall of 42.43 MW in total by 2025.

Similarly, energy demand for embedded generations is estimated to double from its total generation of 1,292,700 MWh in 2015 to 2,529,921 MWh by 2040. This can be translated to an additional required energy of 1,237,221 MWh for the same period.

Table 5.16. Projected DES Required Capacity and Energy Demand by 2025 (On grid)

Fuel Type	Existing Dependable Capacity, 2015		2025			
	MW	MWh	Peak Demand, MW	Required Capacity, MW	Energy Demand, MWh	Required Energy, MWh
Solar PV	12.30	21,732	13.82	1.52	84,732	63,000
Wind	54.00	53,947	54.00	-	53,947	-
Biomass/biogas	7.88	23,561	10.85	2.97	66,560	42,999
Micro hydro	63.40	367,944	77.06	13.66	472,544	104,600
Geothermal	-	-	-	-	-	-
Diesel generator	318.30	561,785	225.30	(93.0)	1,381,917	820,132
Thermal power (coal, slurry, fuel oil, others)	-	-	-	-	-	-
CHP incl. heat recovery facility	52.40	263,731	76.68	24.28	470,221	206,490
Total	**508.28**	**1,292,700**	**457.71**	**(50.57)**	**2,529,921**	**1,237,221**

CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.

Note: Required Capacity and Energy Demand by 2025 is based on author's calculation.

Source: Philippine DOE (2015a).

2040 Outlook

Demand is forecasted to significantly increase from 2015 to 2040. Total peak demand is projected to reach 908.11 MW by 2040, requiring an additional capacity of 298.75 MW (Table 5.17). The need for additional capacities to support the expected demand comprises 17.36 MW for solar, 11.2 MW for biomass, 46 MW for hydro, 140.77 MW for diesel, and 83.42 MW for CHP.

Likewise, energy demand will continue to grow to about 4,671,609 MWh by 2040 from power generation of 1,292,700 MWh in 2015. This denotes an additional energy requirement of 3,378,909 MWh within the 25-year period. The future demand of the case models that practice the DES applications using on-site generation was likewise determined.

Projected CO2 Emissions Reduction by Future On-Grid/Embedded DES

Table 5.18 shows the cumulative CO2 emission reduction by the renewable energy system and CHP for on-grid DES from 2015 to 2040. In this approach, the computed

Table 5.17. Projected DES Required Capacity and Energy Demand by 2040 (On grid)

Fuel Type	Existing Dependable Capacity, 2015		2040			
	MW	MWh	Peak Demand, MW	Required Capacity, MW	Energy Demand, MWh	Required Energy, MWh
Solar PV	12.30	21,732	29.66	17.36	181,893	160,161
Wind	54.00	53,947	54.00	-	53,947	-
Biomass/biogas	7.88	23,561	19.08	11.20	117,017	93,456
Micro hydro	63.40	367,944	109.40	46.00	670,871	302,927
Geothermal	-	-	-	-	-	-
Diesel generator	318.30	561,785	459.07	140.77	2,815,035	2,253,250
Thermal power (coal, slurry, fuel oil, others)	-	-	-	-	-	-
CHP incl. heat recovery facility	52.40	263,731	135.82	83.42	832,846	569,115
Total	**508.28**	**1,292,700**	**807.03**	**298.75**	**4,671,609**	**3,378,909**

CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic. (-) means zero

Note: Required Capacity and Energy Demand by 2040 is based on author's calculation.

Source: Philippine DOE (2015a).

annual emission reduction of 513,833 MTCO2 for 2015 (Table 3) was used as the baseline for the annual CO2 emission reduction. In reference to this, renewable energy and CHP are expected to avoid total carbon emissions of at least 5,652,165.70 MTCO2 for 10 years, starting in 2015. Likewise, for a crediting period of 25 years (2015–2040), the total CO2 emission reduction is estimated to be at least 13,359,664 MTCO2. The computed CO2 emission reductions for 2025 and 2040 are minimum since the annual electricity production from renewable energy and CHP re assumed to be the same in 2015–2040 and that annual emission reduction for the entire crediting period is constant.

Case Study 1: San Carlos Ecozone Negros Occidental

The existing capacity of SCBI is forecasted to be insufficient to meet future demand. Based on projected demand, there will be a need of 1.31 MW by 2025 as its peak demand will reach 8.31 MW from its dependable capacity of 7 MW in 2015. Similarly, for 2040, it will need an additional capacity of 6.74 MW as peak demand is expected to be 13.74 MW. These additional capacities are necessary to support the SCBI's own-use

Table 5.18. Projected CO_2 Emission Reduction by Renewable Energy System and Combined Heat and Power (On-Grid DES)

RE Technology	Projected CO_2 Emission Reduction, $MTCO_2$
2015	513,833.25
2016	1,027,666.49
2017	1,541,499.74
2018	2,055,332.98
2019	2,569,166.23
2020	3,082,999.47
:	:
2025	**5,652,165.70**
:	**:**
2040	**13,359,664.37**

Note: CO_2 emissions reduction was calculated using US Environmental Protection Agency's emission factor of 7.03 x 10-4 $MTCO_2$/kWh

consumption for running its facilities and to comply with its power supply contract to VRESCO.

In terms of energy demand, the additional required energy by 2025 and 2040 is about 32,816 MWh and 66,103 MWh, respectively (Table 5.19).

Case Study 2: United Pulp and Paper Company, Inc.

UPPC's future demand is estimated at 0.25 MW additional capacity by 2025 whilst in 2040, its required capacity is projected at 0.58 MW (Table 5.20). Noticeably, there is a slight increase on the projected power requirements of the company. This may be attributed to the constant number of units of their machinery being used for the past years especially since the forecasted demand was primarily derived from their actual power generation with time trend as independent variable. Also, large plant facilities like the UPPC strictly practice load management to have constant power usage for more efficient use of electricity. Thus, the company's decision to expand and increase its machinery will result in a surge in its future demand.

Table 5.19. SCBI's Projected Energy and Capacity Requirements, 2025 and 2040

Applications	2015		2025				2040			
	Dependable Capacity (MW)	Energy Production (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)
	(a)	(b)	(c)	(d)	(c – a)	(d – b)	(e)	(f)	(e – a)	(f – b)
Biomass/ biogas San Carlos Bioenergy Inc. (SCBI)	7.0	18,134	8.31	50,950	1.31	32,816	13.74	84,237	6.74	66,103

CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.

Note: Required Capacity and Energy Demand by 2025 is based on author's calculation.

Source: Philippine DOE (2015a).

Table 5.20. UPPC's Projected Energy and Capacity Requirements, 2025 and 2040

Applications	2015		2025				2040			
	Dependable Capacity (MW)	Energy Production (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)
	(a)	(b)	(c)	(d)	(c – a)	(d – b)	(e)	(f)	(e – a)	(f – b)
CHP incl. Heat Recovery Facility United Pulp and Paper Company, Inc. (UPPC)	24.0	143,359	24.15	148,096	0.15	4,737	24.58	150,741	0.58	7,382

MW = megawatt, MWh = megawatt-hour.

Note: Required Capacity and Energy Demand by 2025 and 2040 is based on author's calculation.

Source: Philippine DOE (2015a).

Envisaged Policy for Embedded Generation

As mentioned above, the country does not have a holistic policy that captures embedded generation. A well-defined treatment of embedded generation in the power market system is needed. DOE should consider self-generation as an effective energy solution that will be substantial and easy to implement in the future. Some of the self-generating industries in the country are ready to deliver power to the grid; however, the mechanism to do so is still not in place. Stating these specific concerns, it is essential to formulate and implement policy on embedded generation to provide the direction for embedded generators. Opening opportunities for embedded generations will enable DES to penetrate the power sector and compete in the market.

Off Grid

This section briefly discusses the future development of DESs in small-island and isolated grids. Specifically, the discussion highlights the projected energy (in MWh) and capacities (in MW) of DES for 2025 and 2040, respectively, capturing the additional requirements for the medium and long term. It also considers new power generation technologies that are projected to form part of the future DES capacity mix, and briefly discusses avoidance of GHG emissions.

On a per technology basis, Table 5.21 presents the total peak and energy demand as well as the corresponding additional capacity requirements of the off-grid areas by 2025 and 2040.

2025 Outlook

For the 2025 outlook, the off-grid system peak demand is projected at 813.2 MW. Considering the existing 2015 installed capacity of 404.5 MW, an additional 408.7 MW (excluding reserve capacities) is seen as necessary to meet the overall power requirement for the period.

Per type of technology, diesel-based capacities need to be augmented by 371.5 MW whilst micro hydro, by 11.14 MW. On the other hand, aside from new capacities from micro hydro, additional firm capacities for new renewable energy sources, such as wind and geothermal, are foreseen at 6.0 MW and 20.0 MW, respectively. The entry of these new renewable energy capacities were accounted for from the power supply expansion plan of the Oriental Mindoro Electric Cooperative, Inc. Said capacities are programmed to commercially operate by 2017.

Table 5.21. Projected DES Required Capacity and Energy (Off Grid)

Fuel Type	2015			2040		
	Peak Demand, MW	Required Capacity, MW	Required Energy, MWh	Peak Demand, MW	Required Capacity, MW	Required Energy, MWh
Solar PV	–	–	–	–	–	–
Wind	6.00	6.00	66,000	6.00	6.00	66,000
Biomass/biogas	–	–	–	–	–	–
Micro hydro	23.29	11.14	103,162	23.29	11.14	103,162
Geothermal	20.00	20.00	161,184	20.00	20.00	161,184
Diesel generator	763.90	371.54	525,372	1,276.31	883.95	2,076,962
Thermal power (coal, slurry, fuel oil, others)	–	–	–	–	–	–
CHP incl. heat recovery facility	–	–	–	–	–	–
Other generators	–	–	–	–	–	–
Total	**813.19**	**408.68**	**855,718**	**1,325.60**	**921.09**	**2,407,308**

CHP = combined heat and power, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.

(-) means zero

Note: Required Capacity and Energy Demand by 2025 and 2040 is based on author's calculation.

Source: Individual Distribution Development Plan of Electric Cooperatives (2016).

Total energy demand by 2025 is estimated at 1,921,954 MWh. Since the 2015 existing power plants have a net energy production of 1,066,236 MWh, the required energy for 2025 is 855,718 MWh.

Oil-based power generation will continue to dominate the energy demand at 61.4%, whilst renewable energy generation's share is expected to be 38.6%.

2040 Outlook

In 2040, off-grid system peak demand is forecasted to reach 1,325.6 MW. Subtracting the 2015 existing capacity of 404.5 MW, the required additional capacity for the period is around 921.1 MW.

Per plant type, 883.95 MW of additional capacity is required for diesel-based generators to meet demand. Except for micro-hydro power plants, renewable energy–based capacities, particularly wind and geothermal, have fixed energy and peak demand considering that these renewable sources have been commissioned at their maximum potential capacities.

On the other hand, total energy demand by 2040 was projected at 3,473,544 MWh. To meet this energy requirement, an additional 2,407,308 MWh should be generated on top of the net energy production of 1,066,236 MWh in 2015. The bulk of the required energy is seen to come from diesel-based technology.

Projected CO2 Emissions Reduction by Future Off-Grid DES

Table 5.22 illustrates the projected GHG emissions reduction equivalencies for the 2025 and 2040 planning horizons.

As projected, by year 2025 there will be a total of 1,351,134 MTCO2e GHG emissions reduction equivalencies given a forecasted energy demand of 1,921,954 MWh. Out of this figure, about 1,095,466 MTCO2e is foreseen to be avoided from fossil-based diesel generation. On the other hand, for the incoming set of cleaner technologies, such as hydro, wind, and geothermal energies, the potential GHG emissions reduction is expected to be 255,668 MTCO2e.

Come 2040, the almost-doubling energy demand projected at 3,473,544 MWh is expected to yield GHG emissions reduction equivalencies of up to 2,441,901 MTCO2e. Fossil-based diesel generation is projected to contribute 2,186,234 MTCO2e or a roughly 89.5% share of GHG emissions potential avoidance. Potential GHG emissions reduction from renewable energy are estimated to be a mere 10.5%.

Table 5.22. Projected CO_2 Emissions Reduction Equivalencies in DES Off-grid Areas, 2025 and 2040

Fuel Type	2015		2040	
	Energy Demand, (MWh)	CO_2 Emissions Reductions ($MTCO_2e$)	Energy Demand, (MWh)	CO_2 Emissions Reductions ($MTCO_2e$)
Fossil-based (diesel)	1,558,273	1,095,466	3,109,863	2,186,234
Renewable Energy (micro hydro)	363,681	255,668	363,681	255,668
Total	**1,921,954**	**1,351,134**	**3,473,544**	**2,441,901**

MTCO2e = metric tons carbon dioxide equivalent, MWh = megawatt-hour.

Note: CO2 emissions reduction was calculated using the US Environmental Protection Agency emission factor of 7.03 x 10-4 MTCO2/kWh.

Source: Author's calculation.

Case Study 1: Romblon Electric Cooperative, Inc.

Table 5.23 shows the 2025 and 2040 energy and peak demand projections of ROMELCO based on its 2016 Distribution Development Plan. It also highlights the baseline data for the installed capacity and the net electricity production in 2015. Furthermore, the table presents the corresponding additional energy and capacity requirements for 2025 and 2040.

Total peak demand was projected to reach 4.66 MW by 2025. It was nearly shared equally by micro-hydro and diesel power applications, posted at 2.35 MW and 2.31 MW, respectively. Per fuel type, micro-hydro capacities will require an additional 1.45 MW from its existing 0.9 MW installed capacity in 2015. The current installed capacity of diesel power plants at 8.38 MW is sufficient to cover the 2.31 MW demand for diesel.

ROMELCO's energy demand for 2025 was forecasted at 26,004 MWh. Considering the 2015 net energy production of 16,913 MWh, the additional energy requirement for the period is 9,091 MWh.

For the 2040 outlook period, ROMELCO's expected peak demand of 7.02 MW will almost catch up with the existing supply of 8.38 MW, leaving an excess capacity of 1.36 MW. Although capacity requirements for micro hydro is still pegged at 1.45 MW, the required energy has significantly increased to 13,179 MWh compared to the 2025 energy requirement of 5,826 MWh. Existing diesel-based capacities should still be adequate by 2040, whilst energy requirements are expected to increase to 14,446 MWh, four times the 2025 demand level.

Case Study 2: Basilan Electric Cooperative, Inc.

Based on the demand and supply projections of BASELCO, the existing installed capacity of 14.03 MW and net energy production of 39,370 MWh in 2015 already falls short by 1.80 MW and 12,618 MWh, respectively, in 2025. Although there is a minimal excess in micro-hydro capacity at 0.03 MW, most of the capacity and energy requirement is expected to come from diesel-based technology.

By 2040, the almost doubling of peak demand is notable at 26.70 MW from its 2025 demand level of 15.83 MW, considering the economic growth of the area. To fill this gap, an additional 13.31 MW of diesel-based capacity is necessary.

Towards the long-term period, peak and energy demand for micro-hydro technology was similarly fixed at 0.64 MW and 600 MWh, respectively, having no capacity augmentation plan programmed by BASELCO for its Kumalarang micro-hydro power plant (Table 5.24).

Table 5.23. ROMELCO's Projected Energy and Capacity Requirements, 2025 and 2040

Applications	2015		2025				2040			
	Installed Capacity (MW)	Net Energy Production (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)
	(a)	(b)	(c)	(d)	(c – a)	(d – b)	(e)	(f)	(e – a)	(f – b)
Micro hydro	0.9	4,879	2.35	10,705	1.45	5,826	2.35	18,058	1.45	13,179
Diesel	7.48	12,034	2.31	15,299	(5.17)	3,265	4.67	26,480	(2.81)	14,446
Total	**8.38**	**16,913**	**4.66**	**26,004**	**(3.72)**	**9,091**	**7.02**	**44,538**	**(1.36)**	**27,625**

MW = megawatt, MWh = megawatt-hour.

Note: Required Capacity and Energy Demand by 2025 and 2040 is based on author's calculation.

Source: ROMELCO (2016).

Table 5.24. BASELCO's Projected Energy and Capacity Requirements, 2025 and 2040

Applications	2015		2025				2040			
	Installed Capacity (MW)	Net Energy Production (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)	Peak Demand, MW	Energy Demand (MWh)	Required Capacity (MW)	Required Energy (MWh)
	(a)	(b)	(c)	(d)	(c – a)	(d – b)	(e)	(f)	(e – a)	(f – b)
Micro hydro	0.67	579	0.64	600	(0.03)	21	0.64	600	(0.03)	21
Diesel	13.36	38,791	15.19	51,388	1.83	12,597	26.70	91,685	13.34	52,894
Total	**14.03**	**39,370**	**15.83**	**51,988**	**1.80**	**12,618**	**27.34**	**92,285**	**13.31**	**52,915**

MW = megawatt, MWh = megawatt-hour.

Note: Required Capacity and Energy Demand by 2025 and 2040 is based on author's calculation.

Source: BASELCO (2016).

Envisaged Policies for Off-Grid DES

This section enumerates envisaged policies and support mechanisms to further promote the development of DES in off-grid areas.

Additional Incentives

Whilst the FiT system is applicable to on-grid renewable energy developers, the government is looking at relinquishing the FiT system because the mechanism is becoming a burden to electricity consumers as an added cost to the electricity bill. As a policy recommendation, now that the investment costs for putting up renewable energy systems have significantly gone down and are at par with other conventional technologies, the FiT system applied in the off-grid is one considerable policy measure envisioned to encourage private sector interest in developing renewable energy resources.

Power Capacity Portfolio

As a priority thrust in the main grid, the government embarked on a national policy towards institutionalising a 70–20–10 percentage sharing of the baseload, mid-merit, and peaking load categories as well as reserve capacity requirement equivalent to 25% of the total peak demand. Whilst the existing profile of DES in off-grid areas is notably dominated by diesel-based technologies, diversification of the capacity mix – coupled with an appropriate power capacity portfolio such as the one being instituted in the main grid – will unquestionably strengthen the adequacy, reliability, and affordability of electricity supply.

Energy Resiliency Policy

The Philippines, most especially its remote communities, have become more vulnerable to various forms of natural and man-induced disasters and calamities in the advent of climate change. For this reason, the government has drafted a policy measure that will extensively strengthen the resiliency of the energy infrastructure, be it on grid or off grid. This initiative is visualised to reinforce the energy infrastructure to withstand the impacts of uncontrollable disruptive events.