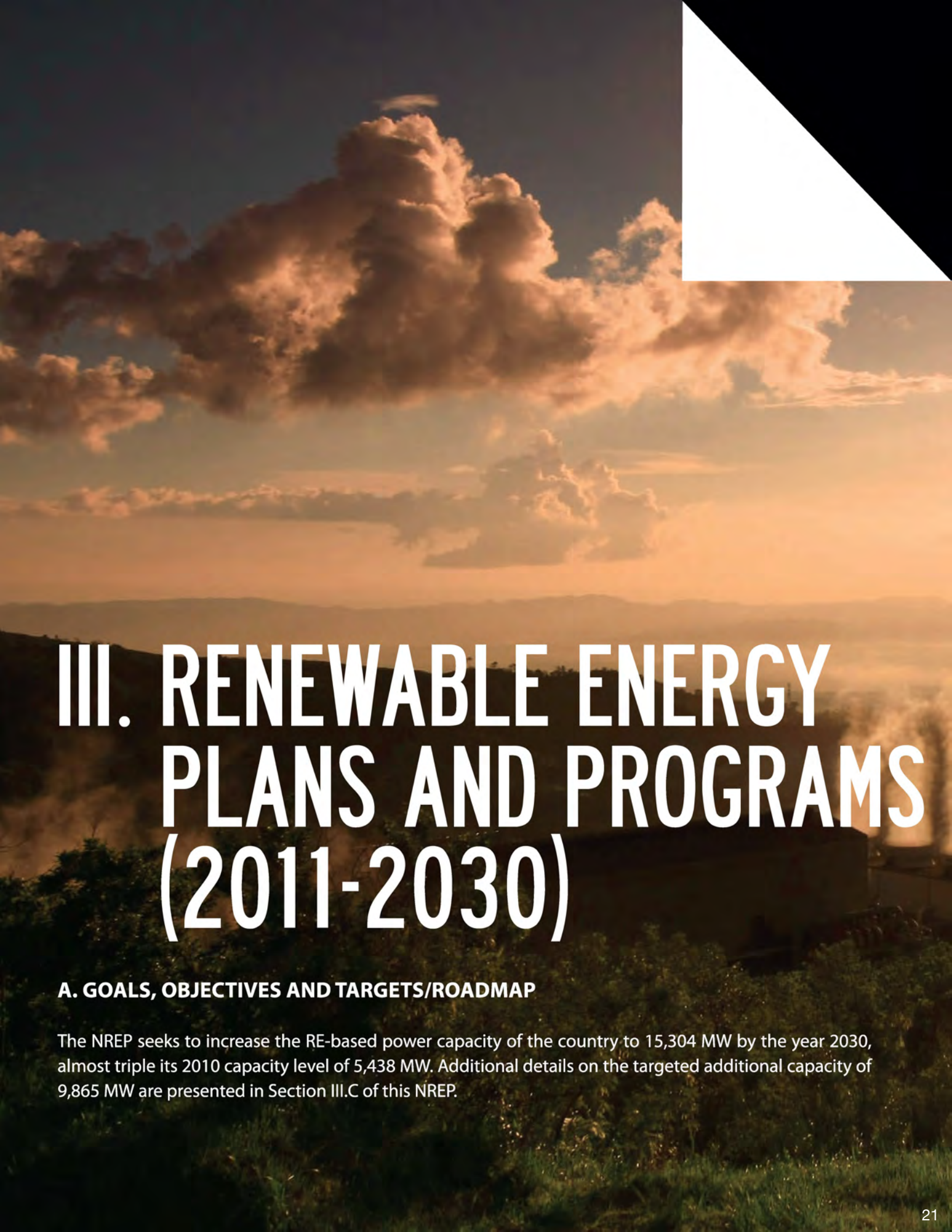


III. RENEWABLE ENERGY PLANS AND PROGRAMS (2011-2030)

A. GOALS, OBJECTIVES AND TARGETS/ROADMAP

The NREP seeks to increase the RE-based power capacity of the country to 15,304 MW by the year 2030, almost triple its 2010 capacity level of 5,438 MW. Additional details on the targeted additional capacity of 9,865 MW are presented in Section III.C of this NREP.

On a per technology basis, the NREP intends to:

1. Increase geothermal capacity by 75.0 percent;
2. Increase hydropower capacity by 160 percent;
3. Deliver additional 277MW biomass power capacities;
4. Attain wind power grid parity with the commissioning of 2,345 MW additional capacities;
5. Mainstream an additional 284 MW solar power capacities and pursue the achievement of the 1,528 MW aspirational target;
6. Develop the 1st ocean energy facility for the country.

To realize the goals of the NREP, the following shall be carried out:

1. Institutionalize a comprehensive approach to address the challenges and gaps that would prevent and/or delay wider application of RE technologies in a sustainable manner; and
2. Outline the action plans necessary to facilitate and encourage greater private sector investments in RE development.

The NREP is initially focused towards the addition of RE-based capacity for power generation. The program for non-power applications shall be incorporated later.

The estimates for the expected capacity additions are based on the RE Service/Operating Contracts which have been awarded and are being evaluated by the DOE. These are presented by RE sector in Table 3. Tables 4 to 6, on the other hand, present the capacity additions by location.

TABLE 3. RE-BASED CAPACITY INSTALLATION TARGETS, PHILIPPINES[10]

Sector	Installed Capacity, (MW) as of 2010	Target Capacity Addition by				Total Capacity Addition (MW) 2011-2030	Total Installed Capacity by 2030
		2015	2020	2025	2030		
Geothermal	1,966.0	220.0	1,100.0	95.0	80.0	1,495.0	3,461.0
Hydro	3,400.0	341.3	3,161.0	1,891.8	0.0	5,394.1	8,724.1
Biomass	39.0	276.7	0.0	0.0	0.0	276.7	315.7
Wind	33.0	1,048.0	855.0	442.0	0.0	2,345.0	2,378.0
Solar	1.0	269.0	5.0	5.0	5.0	284.0[11]	285.0
Ocean	0.0	0.0	35.5	35.0	0.0	70.5	70.5
TOTAL	5,438.0	2,155.0	5,156.5	2,468.8	85.0	9,865.3	15,304.3

[10] *For Tables 3-6, differences are due to rounding off of figures.*

[11] *Based on existing RE Service/Operating Contracts awarded and being evaluated by the DOE. The aspirational target of 1,528 MW solar power capacity will still be pursued.*

TABLE 4. RE-BASED CAPACITY INSTALLATION TARGETS, LUZON

Sector	Installed Capacity, (MW) as of 2010	Target Capacity Addition by				Total Capacity Addition (MW) 2011-2030	Total Installed Capacity by 2030
		2015	2020	2025	2030		
Geothermal	899.0	100.0	720.0	0.0	0.0	820.0	1,719.0
Hydro	2,346.0	182.0	2,169.5	1,510.0	0.0	3,861.5	6,207.5
Biomass	9.0	97.3	0.0	0.0	0.0	97.3	106.3
Wind	33.0	841.0	840.0	432.0	0.0	2,103.0	2,136.0
Solar	0.0	228.05	0.0	0.0	0.0	228.05	228.05
Ocean	0.0	0.0	35.5	0.0	0.0	35.5	35.5
TOTAL	3,287.0	1,438.4	3,765.0	1,942.0	0.0	7,145.4	10,432.4

TABLE 5. RE-BASED CAPACITY INSTALLATION TARGETS, VISAYAS

Sector	Installed Capacity, (MW) as of 2010	Target Capacity Addition by				Total Capacity Addition (MW) 2011-2030	Total Installed Capacity by 2030
		2015	2020	2025	2030		
Geothermal	964.0	70.0	140.0	65.0	60.0	335.0	1,299.0
Hydro	13.0	84.5	102.4	81.8	0.0	268.7	281.7
Biomass	29.0	142.6	0.0	0.0	0.0	142.6	171.6
Wind	0.0	217.0	0.0	10.0	0.0	227.0	227.0
Solar	0.0	34.0	0.0	0.0	0.0	34.0	34.0
Ocean	0.0	0.0	0.0	11.0	0.0	11.0	11.0
TOTAL	1,006.0	548.1	242.4	167.8	60.0	1,018.3	2,024.3

TABLE 6. RE-BASED CAPACITY INSTALLATION TARGETS, MINDANAO

Sector	Installed Capacity, (MW) as of 2010	Target Capacity Addition by				Total Capacity Addition (MW) 2011-2030	Total Installed Capacity by 2030
		2015	2020	2025	2030		
Geothermal	103.0	50.0	240.0	30.0	20.0	340.0	443.0
Hydro	1,040.0	74.8	889.1	300.0	0.0	1,263.9	2,303.9
Biomass	0.0	36.8	0.0	0.0	0.0	36.8	36.8
Wind	0.0	0.0	15.0	0.0	0.0	15.0	15.0
Solar	1.0	7.0	5.0	5.0	5.0	22.0	23.0
Ocean	0.0	0.0	0.0	24.0	0.0	24.0	24.0
TOTAL	1,144.0	168.6	1,149.1	359.0	25.0	1,701.7	2,845.7

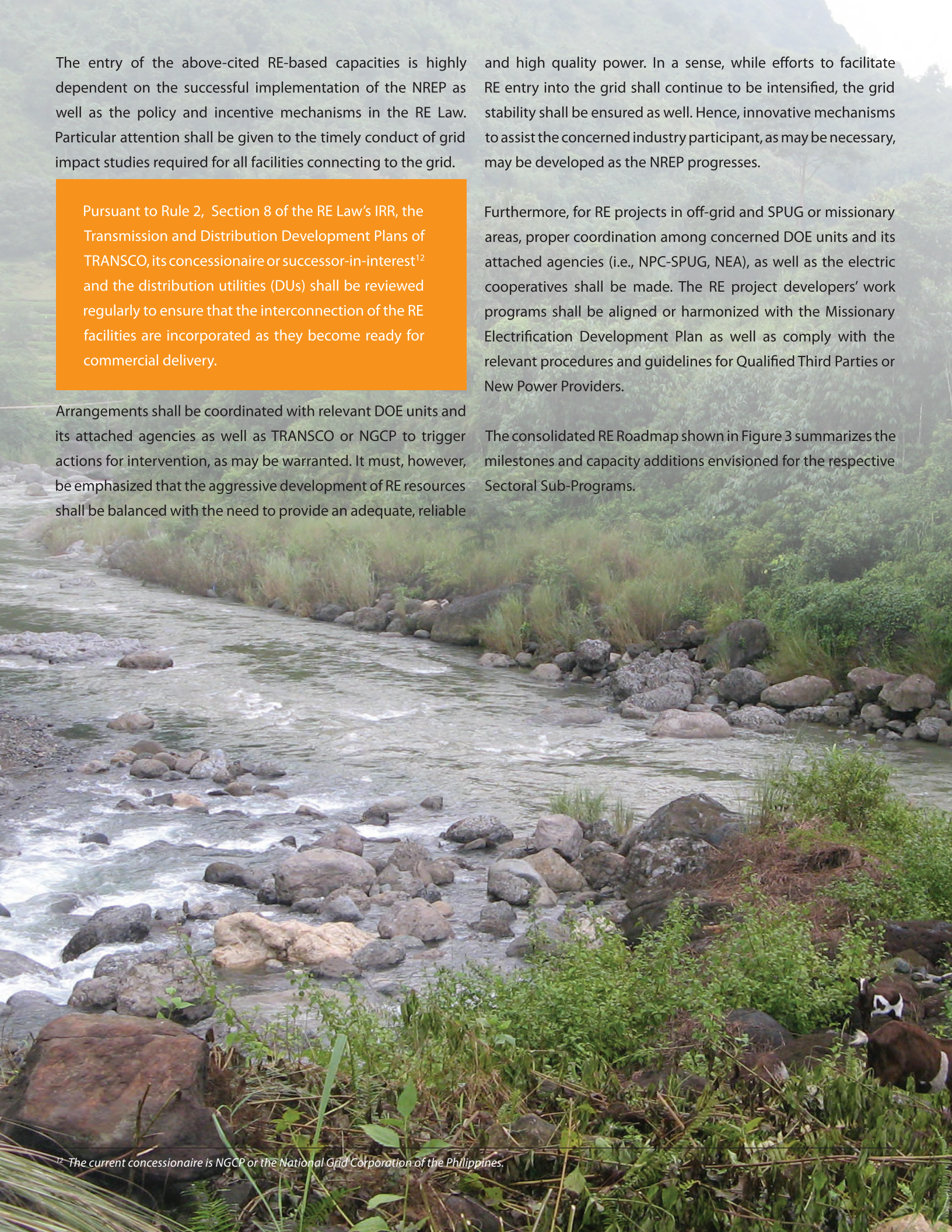
The entry of the above-cited RE-based capacities is highly dependent on the successful implementation of the NREP as well as the policy and incentive mechanisms in the RE Law. Particular attention shall be given to the timely conduct of grid impact studies required for all facilities connecting to the grid.

Pursuant to Rule 2, Section 8 of the RE Law's IRR, the Transmission and Distribution Development Plans of TRANSCO, its concessionaire or successor-in-interest[12] and the distribution utilities (DUs) shall be reviewed regularly to ensure that the interconnection of the RE facilities are incorporated as they become ready for commercial delivery.

Arrangements shall be coordinated with relevant DOE units and its attached agencies as well as TRANSCO or NGCP to trigger actions for intervention, as may be warranted. It must, however, be emphasized that the aggressive development of RE resources shall be balanced with the need to provide an adequate, reliable and high quality power. In a sense, while efforts to facilitate RE entry into the grid shall continue to be intensified, the grid stability shall be ensured as well. Hence, innovative mechanisms to assist the concerned industry participant, as may be necessary, may be developed as the NREP progresses.

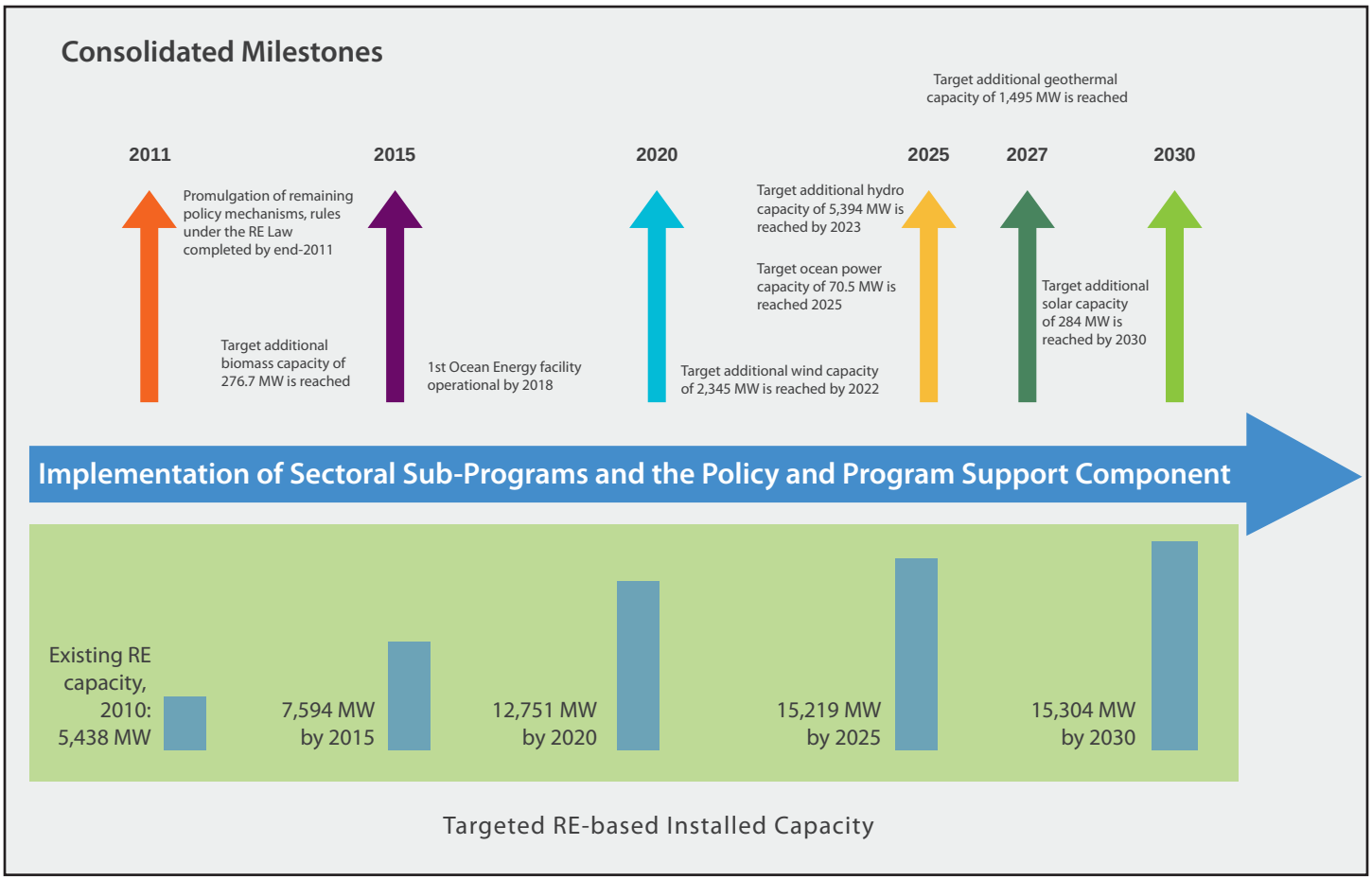
Furthermore, for RE projects in off-grid and SPUG or missionary areas, proper coordination among concerned DOE units and its attached agencies (i.e., NPC-SPUG, NEA), as well as the electric cooperatives shall be made. The RE project developers' work programs shall be aligned or harmonized with the Missionary Electrification Development Plan as well as comply with the relevant procedures and guidelines for Qualified Third Parties or New Power Providers.

The consolidated RE Roadmap shown in Figure 3 summarizes the milestones and capacity additions envisioned for the respective Sectoral Sub-Programs.



[12] *The current concessionaire is NGCP or the National Grid Corporation of the Philippines.*

FIGURE 3. CONSOLIDATED RE ROADMAP



The expected milestones over the period 2011 to 2030 are reflected in Table 7.

TABLE 7. NREP MILESTONES

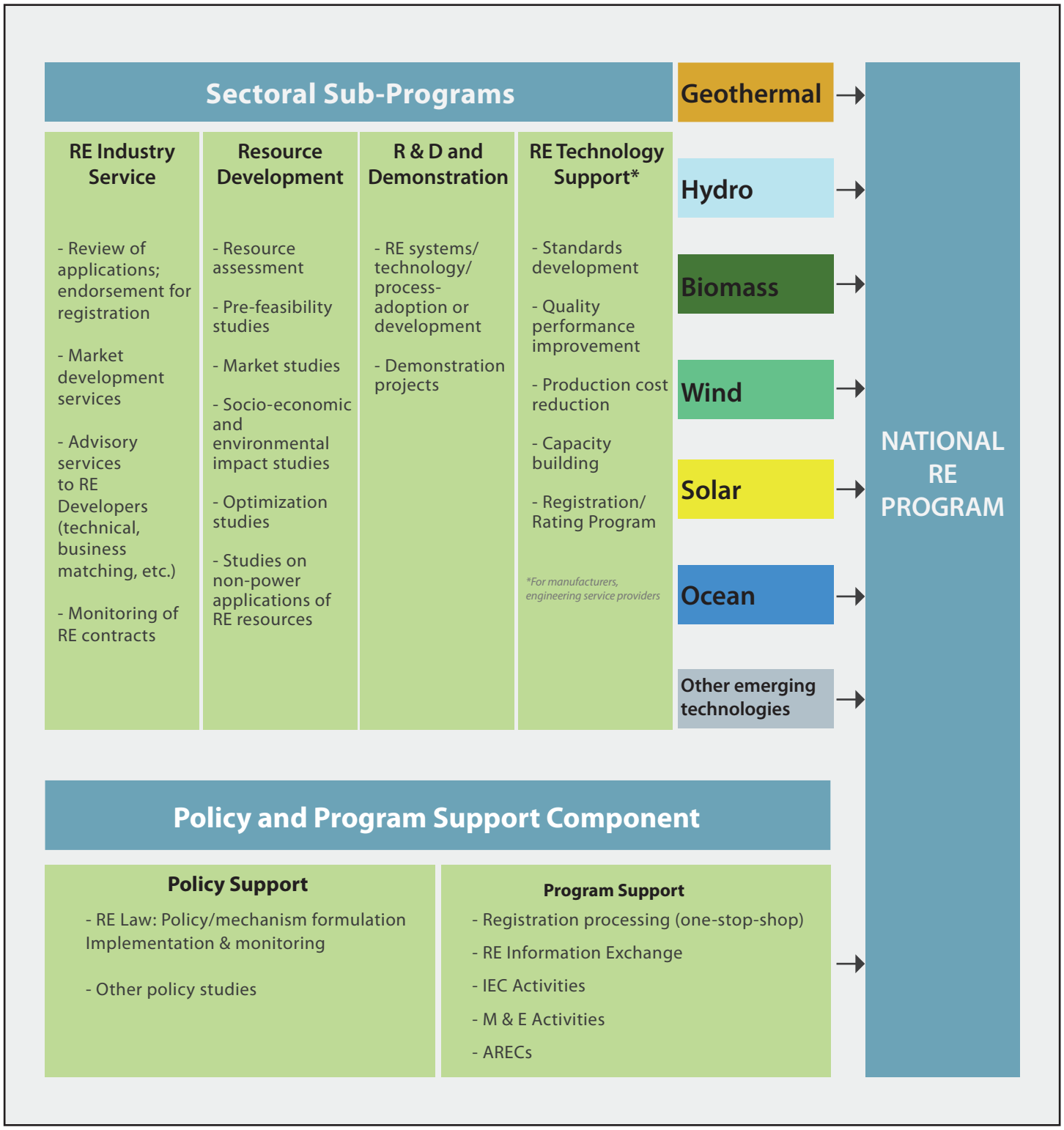
Sector	Target indicative capacity addition achieved by	Others
Geothermal	2027	Low-Enthalpy Geothermal Resource Assessment completed by 2015
Hydro	2023	Construction of Sea Water Pumped Storage Demo Facility by 2030
Biomass	2015	Mandatory E10 blend for all gasoline vehicles by 2012
Wind	2022	Grid parity by 2025
Solar	2030	Smart Grid and Concentrated Solar Thermal Power Demo completed by 2015; Grid parity by 2020
Ocean	2025	1st Ocean Energy Facility operational by 2018

B. NREP DEVELOPMENT FRAMEWORK

The NREP presents the overall approach to accelerate the development and utilization of the RE resources in the country. The framework for its development is shown in Figure 4.

The NREP begins from the individual work programs which are referred to as the sectoral sub-programs for each of the RE resource covered under the RE Law, namely: geothermal, hydro,

FIGURE 4. THE NATIONAL RENEWABLE ENERGY PROGRAM (NREP) DEVELOPMENT FRAMEWORK



biomass, wind, solar, and ocean[13].

Each sectoral sub-program follows a roadmap which serves as a guide for the achievement of the market penetration targets of a particular RE resource. It indicates the milestones over the 20-year planning period, the realization of which depends on the implementation of the following types of activities:

1. RE Industry Services

This is geared towards facilitating private sector investments in the energy sector. Assistance to the RE Developers shall start from the registration process[14] up to the implementation of the various stages of their respective RE Service/Operating Contracts. Close monitoring of the contracts shall be undertaken to ensure that appropriate interventions within DOE's control, and as authorized by law, are provided in a timely manner to avoid delays in the implementation of their respective work programs. Aside from technical assistance, DOE may also provide advisory services in the areas of market development, business matching, as well as on the various policy and incentive mechanisms under the RE Law to ensure that the RE projects come on stream as expected.

2. Resource Development

Efforts towards harnessing the huge RE resource potential of the country shall be improved. Among others, these may include: (a) resource assessment, either nationwide or in a particular area/location; (b) conduct of various studies such as those on the market, socio-economic and environmental impact or pre-feasibility of specific RE projects on its own or in partnership with interested groups/ organizations; and (c) optimization studies on the development and utilization of RE resources. To expand the market for RE, studies on its non-power applications, specifically for those of biomass and geothermal energy shall also be undertaken.

3. Research, Development and Demonstration (R, D & D)

Applied research and development (R & D) shall be undertaken to determine the viability of adapting certain RE systems, technologies or processes in the Philippine setting, in areas where there is no or limited local experience. As may be warranted, demonstration or pilot projects shall be implemented to showcase the feasibility of the technology or process. For instance, a demonstration project on sea water pumped storage shall be conceptualized under the Hydro Sector Sub-Program. A demonstration project on Concentrating Solar Thermal Power technology shall also be pursued. R, D & D activities may be undertaken in cooperation with R & D institutions and technical centers, both local and foreign, as well as interested multilateral organizations, NGOs or private sector partners.

4. RE Technology Support

The improvement of the quality, performance and cost of local RE systems towards greater consumer protection and their competitiveness with conventional systems shall be further pursued. Among others, these may include: (a) the development of standards for locally manufactured/fabricated equipment or component such as wind towers, PV inverters, etc.; and (b) the establishment of a registration or rating program for engineering service providers. Capacity building activities shall also be conducted to enhance the skills and knowledge of RE stakeholders. DOE shall work closely with partners from the private sector (i.e., local RE manufacturers and engineering service providers), training institutions and the academe in the development and implementation of the appropriate projects/ activities.

The specific projects and activities in each sector shall vary depending on the challenges and gaps facing the sector as well as the expressed needs of the stakeholder groups being served.

The cross-cutting activities are grouped into the Policy and Program Support Component. This involves common activities

[13] *As may be decided later, other emerging RE technologies shall be included depending on their status of development and utilization.*

[14] *While the processing of the registration shall be centralized under a one-stop-shop, the relevant REMB Division shall take charge of coordinating with the RE Developer or Local Manufacturer/Fabricator/Supplier on the details of the application.*

which require a coordinated and integrated approach to implementation. Policy support mainly involves the continuation of efforts towards the formulation, implementation and monitoring of the mechanisms, rules and regulations prescribed by the RE Law. Program support, on the other hand, covers common activities which need to be undertaken to ensure the smooth implementation of the NREP. Each sectoral sub-program, however, shall also indicate specific areas where policy and program support may be required. Additional details on this component are found in Section III. D of this document.

C. SECTORAL SUB-PROGRAMS

Each sectoral sub-program includes an overview of the sector, the roadmap and the various action plans which address the specific needs of the said sector. As earlier mentioned, the DOE formulated the initial draft of each sectoral sub-program based on its knowledge and understanding of the challenges and gaps faced by the sector. These were then presented to the respective stakeholders for comments and suggestions. The work program presented is a result of such consultations. The classification of each project or activity may be adjusted depending on the progress of work (e.g., from Resource Development to R & D and Demonstration).

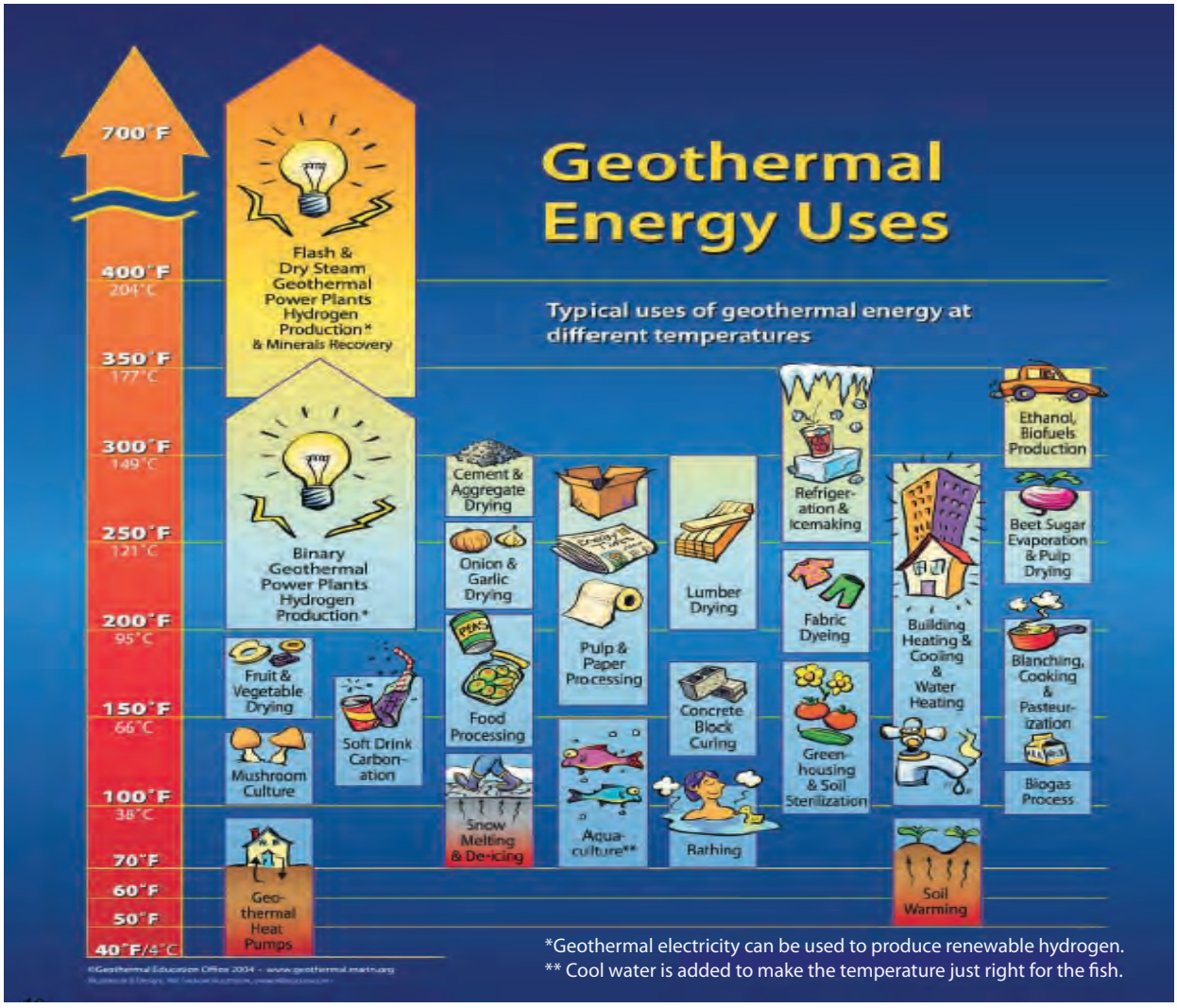
1. Geothermal Sector Sub-Program

Geothermal energy comes from the natural heat of the earth. This heat is stored in rock and water within the earth and can be extracted by drilling wells at depths shallow enough to be feasible.

a) Overview of the Geothermal Sector

Figure 5 is an illustration of the various geothermal energy uses at different temperatures. Low enthalpy resources (50°C - 150°C)

FIGURE 5. GEOTHERMAL ENERGY USES



Source: U.S. Geothermal Education Office (GEO), http://geothermal.marin.org

can be used for heating purposes: large base load demands such as district heating, crop drying and recreational uses such as spas; while medium and high enthalpy resources (>150°C) can be used for electricity production.

The country's geothermal resources are known to be of high quality since the Philippines lies in the Pacific Ring of Fire. Geothermal wells are scattered all over the country. Recent studies have indicated that the country has 2,027 MW proven reserves and 2,380 MW potential reserves which remain untapped.

As of 2010, there are seven (7) geothermal producing fields and power plants in the country. Most of the geothermal-based capacity is in the Visayas, accounting for 49% of the total capacity (Table 8). These plants are listed in Table 9.

TABLE 8. LOCATION OF GEOTHERMAL POWER PLANTS, 2010

Location	Capacity (MW)	% Share
Luzon	899	46
Visayas	964	49
Mindanao	103	5
Total	1,966	100

Source: DOE

TABLE 9. EXISTING INSTALLED GEOTHERMAL CAPACITY, 2010

Region	Power Plant Name	Installed Capacity	Power Plant Owner	Producing Field	Steam Field Developer	Location
	LUZON					
V	Bacon Manito Geothermal Power Plant	151.50	Bacman Geothermal Inc.	Bacman Geothermal Production Field	Energy Development Corporation	Sorsogon / Albay
V	Tiwi Geothermal Power Plant	289.00	AP Renewables Incorporated	Tiwi Geothermal Field	Chevron Geothermal Philippines Holding Inc.	Albay
IV-A	Mak-Ban Geothermal Power Plant	458.53	AP Renewables Incorporated	Mak-Ban Geothermal Field	Chevron Geothermal Philippines Holding Inc.	Batangas / Laguna
	SUB-TOTAL	899.03				
	VISAYAS					
VIII	Tongonan Geothermal Power Plant • Tongonan I • Unified Leyte	 112.50 610.18	Green Core Geothermal Inc. Energy Development Corporation	Leyte Geothermal Production Field	Energy Development Corporation	Leyte
VII	Palinpinon Geothermal Power Plant	192.50	Green Core Geothermal Inc.	Southern Negros Geothermal Production Field	Energy Development Corporation	Negros Oriental
VI	Northern Negros Geothermal Power Plant	49.38	Energy Development Corporation	Northern Negros Geothermal Production Field	Energy Development Corporation	Negros Occidental
	SUB-TOTAL	964.56				
	MINDANAO					
X	Mindanao Geothermal Power Plant	103.00	Energy Development Corporation	Mindanao Geothermal Production Field	Energy Development Corporation	North Cotabato / Davao del Sur
	SUB-TOTAL	103.00				
	TOTAL PHILIPPINES	1,966.00				

Source: DOE

All of the existing geothermal power plants are owned and operated by the private sector. The privatized Energy Development Corporation is responsible for the development of 1,219 MW production fields. Figure 6 presents the map of the installed geothermal capacities.

> The fuel oil displacement of power generated from the above-cited geothermal plants underscores the sector's crucial role in the country's energy security agenda.

The government has continuously sustained its efforts to increase the utilization of geothermal energy in the country. Despite this, more work is needed to harness the huge geothermal reserves that remain untapped. There is a need to take advantage of various opportunities and address the challenges and gaps facing the sector. Opportunities for the sector include: (i) the presence of foreign investments and growing interest in geothermal exploration and development especially with the fiscal and non-fiscal incentives under the RE Law; (ii) the availability of technological improvements for increasing power output and efficiency which may encourage the development of small-capacity power plants; and (iii) utilization of low temperature geothermal resources . The challenges that need to be addressed include: (i) environmental and socio-cultural concerns in protected areas and ancestral lands which affect investment decisions; (ii) technological constraints with respect to acidic reservoir; (iii) enhancement of public awareness on the non-power applications of geothermal energy.

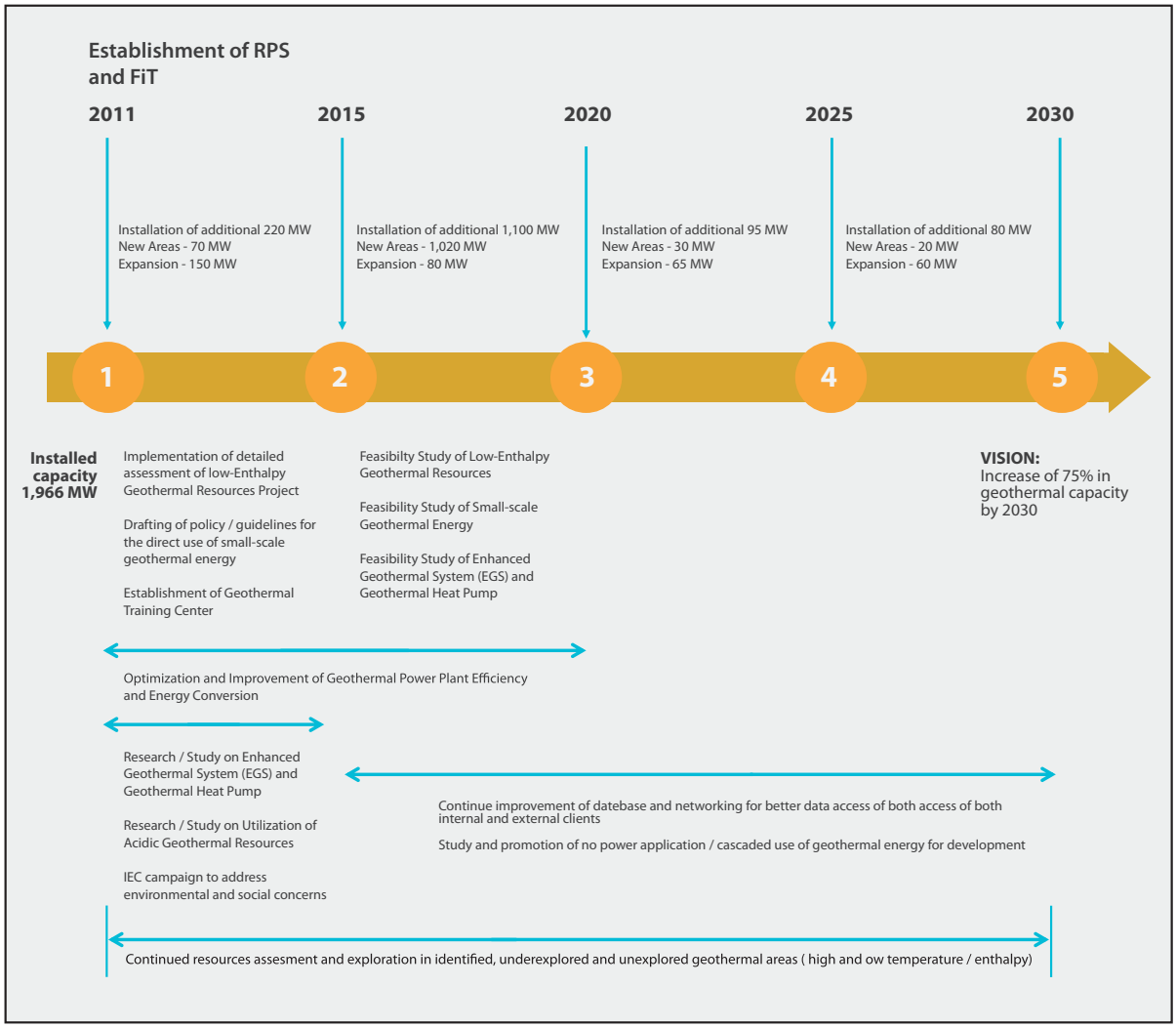
FIGURE 6. LOCATION MAP OF GEOTHERMAL POWER PLANTS

Source: DOE

b) Geothermal Sector Roadmap

Figure 7 shows the Geothermal Sector Roadmap which envisions an addition of 1,495 MW capacity to the grid over the planning period 2011-2030. This represents about 75% increase in the country's current installed capacity.

FIGURE 7. GEOTHERMAL SECTOR ROADMAP, 2011-2030



Of the total capacity addition, two projects with a total 70 MW capacity have already been committed for installation. Both are expansion projects which are intended to fully utilize or optimize already known fields in Palinpinon, Negros Oriental and Mt. Apo, North Cotabato (Table 10).

TABLE 10. LIST OF COMMITTED GEOTHERMAL PROJECTS

Name	Installed Capacity (MW)	Commissioning Year	Location
Nasulo Geothermal Power Project	20	2013	Palinpinon, Negros Or.
Mindanao III	50	2014	Mt. Apo, North Cotabato
Total	70		

The remaining 1,425 MW are divided into 32 projects. These are listed in Table 11.

TABLE 11. INDICATIVE GEOTHERMAL CAPACITY ADDITION (2011-2030)

REGION	PROJECT SECTOR	Potential Capacity (MW)	Commissioning Year
LUZON			
Cordillera Autonomous Region (CAR)	Acupan-Itogon	20	2017
	Daklan	60	2018
	Buguias-Tinoc	60	2018
	Kalinga	120	2016
	Mainit-Sadanga	80	2018
Region II	Cagua-Baua	45	2018
Region III	Natib	40	2017
Region IV-A	Mabini	20	2017
	San Juan	20	2018
	Maibarara	20	2014
Region IV-B	Montelago	40	2017
Region V	Tanawon	40	2015
	Rangas	40	2015
	Manito Kayabon	40	2017
	Del Gallego (Mt. Labo)	65	2018
	Isarog	70	2018
	Bulusan	40	2019
	Sub-Total	820	
VISAYAS			
Region VI	Mandalagan	20	2018
	Dauin	40	2017
	Lagunao	60	2027
Region VIII	Bato Lunas	65	2021
	Southern Leyte Geothermal Project	80	2019
	Biliran	50	2015
	Sub-Total	315	
MINDANAO			
Region IX	Lakewood	40	2019
Region X	Ampiro	30	2018
	Sapad-Salvador	30	2024
	Balingasag	20	2018
Region XI	Amacan	40	2020
Region XII	Mt. Matutum	20	2026
	Mt. Parker	60	2019
	Mt. Zion	20	2018
Region XIII	Mainit	30	2017
	Sub-Total	290	
	TOTAL	1,425.00[15]	

[15] *Committed projects (i.e., Nasulo and Mindanao III) are not included.*

The total installation target of 1,495 MW is expected to be met by 2027, with a large portion of it being commissioned during the period 2016-2020. The distribution of the targeted capacity addition, by grid, is presented in Table 12. As indicated in the table, the Luzon grid will host the majority, estimated at 55%, of the total capacity addition.

TABLE 12. TARGETED GEOTHERMAL CAPACITY ADDITION (MW), BY GRID

Location	Commissioning Year				Total Capacity Addition, MW	Share %
	2011-2015	2016-2020	2021-2025	2026-2030		
Luzon	100	720	0	0	820	54.8
Visayas	70	140	65	60	335	22.4
Mindanao	50	240	30	20	340	22.7
Total Philippines	220	1,100	95	80	1,495	100.0

Figure 8 shows the location map of these targeted capacity additions.

FIGURE 8. LOCATION MAP OF THE TARGETED GEOTHERMAL CAPACITY ADDITION

Source: DOE

c) Geothermal Sector Work Program

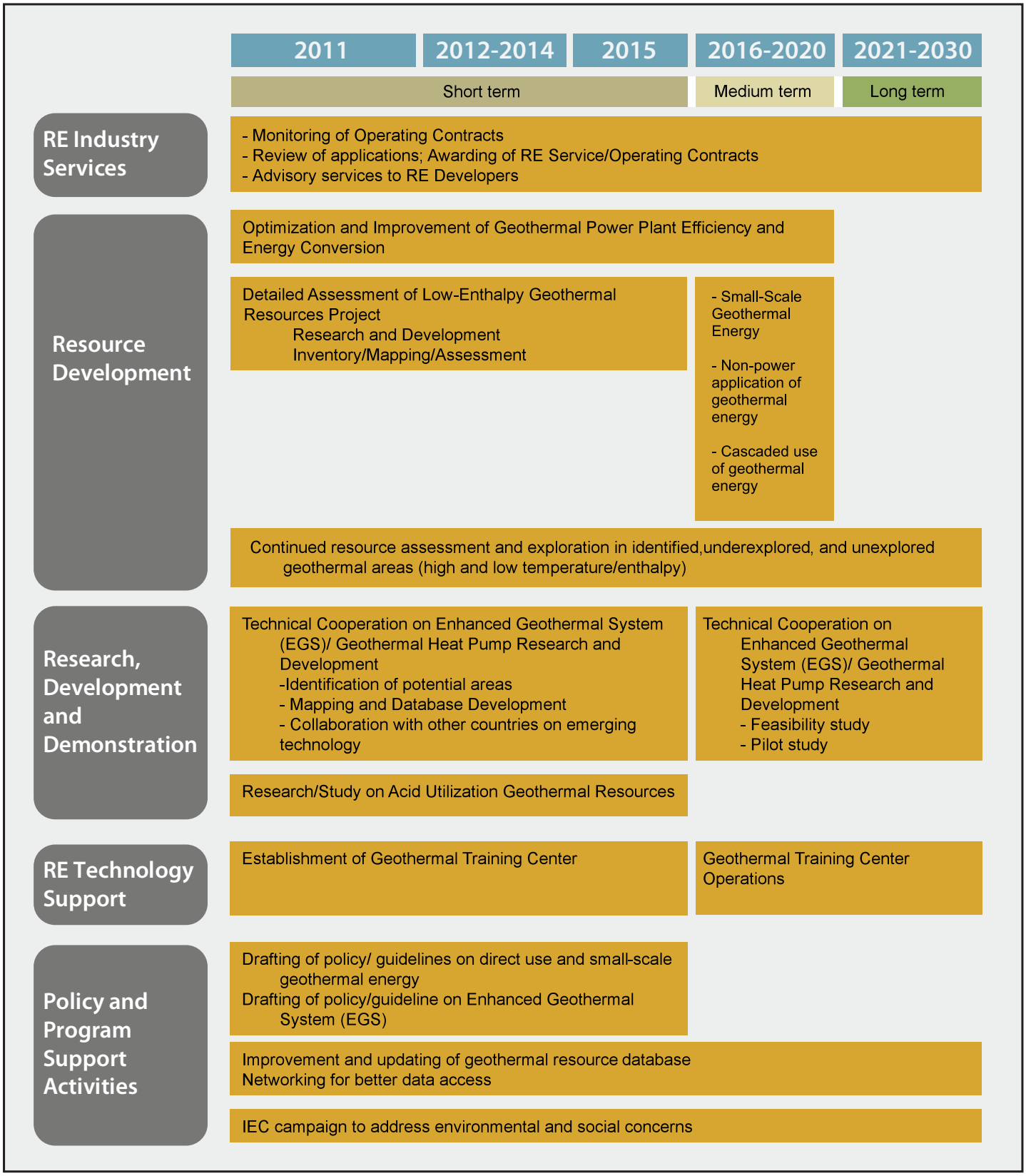
The DOE shall continue to actively promote the use of geothermal resources through the Open and Competitive Selection Process of awarding Geothermal RE Operating/Service Contract, an investment promotion campaign in which geothermal sites are offered and bid out to private investors for their development. Other activity thrusts of the Geothermal Sector Sub-program are the full utilization or optimization of already known fields and the expansion of geothermal uses, to include small-scale and non-power applications. Resource assessment and exploration in identified, underexplored, and unexplored geothermal areas (high and low temperature/enthalpy) shall likewise be continued.

The sector's work program is listed by type of activity in Table 13 while its phasing is shown in Figure 9.

TABLE 13. GEOTHERMAL SECTOR WORK PROGRAM

Type of Activity	Work Program
RE Industry Services	1. Review of applications; endorsement for registration of applications 2. Monitoring of RE contracts 3. Advisory services to RE developers on: • Implementation of policy/ guidelines on direct use and small-scale geothermal energy • Commercialization on Enhanced Geothermal System (EGS)/ Geothermal Heat Pump/Small –Scale Geothermal Energy • Promotion of non-power applications of geothermal energy • Promotion of cascaded use of geothermal energy for development
Resource Development	1. Detailed Assessment of Low-Enthalpy Geothermal Resources Project • Research and Development • Inventory/Mapping/Assessment • Feasibility Study of Low-Enthalpy Geothermal Resources 2. Optimization and Improvement of Geothermal Power Plant Efficiency and Energy Conversion 3. Feasibility Study of Small –Scale Geothermal Energy 4. Study on non-power application of geothermal energy 5. Study on cascaded use of geothermal energy for development 6. Continued resource assessment and exploration in identified, underexplored, and unexplored geothermal areas (high and low temperature/enthalpy)
Resource Development R, D & D	1. Technical Cooperation on Enhanced Geothermal System (EGS)/ Geothermal Heat Pump • Research and Development • Identification of potential areas • Mapping and Database Development • Collaboration with other countries on emerging technology • Feasibility Study • Pilot Study 2. Research/study on Acid Utilization Geothermal Resources
RE Technology Support	Establishment of Geothermal Training Center
Policy and Program Support-Related Activities	1. Drafting of policy/ guidelines on direct use and small-scale geothermal energy • Workshop/Consultation 2. Drafting of policy/guideline on Enhanced Geothermal System (EGS) • Workshop/Consultation 3. Improvement and updating of geothermal resource database 4. Networking for better data access 5. IEC campaign to address environmental and social concerns

FIGURE 9. GEOTHERMAL SECTOR SUB-PROGRAM PROJECTS/ACTIVITIES AND SCHEDULE OF IMPLEMENTATION



2. Hydropower Sector Sub-Program

Hydropower is the most dominant source of RE-based capacity in the country today.

As of 2010, hydropower accounted for 21% of the 16,359 MW total installed capacity in the country.

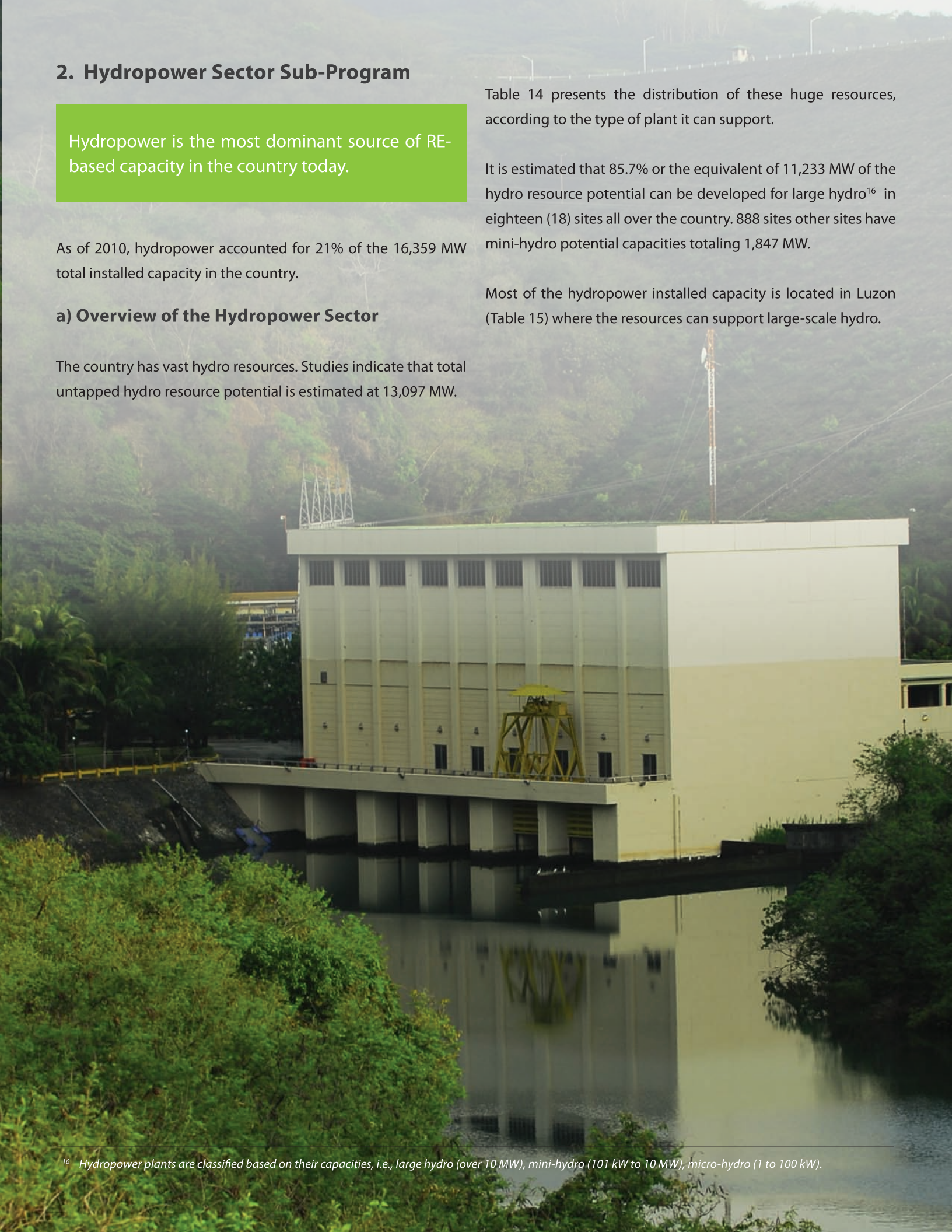
a) Overview of the Hydropower Sector

The country has vast hydro resources. Studies indicate that total untapped hydro resource potential is estimated at 13,097 MW.

Table 14 presents the distribution of these huge resources, according to the type of plant it can support.

It is estimated that 85.7% or the equivalent of 11,233 MW of the hydro resource potential can be developed for large hydro[16] in eighteen (18) sites all over the country. 888 sites other sites have mini-hydro potential capacities totaling 1,847 MW.

Most of the hydropower installed capacity is located in Luzon (Table 15) where the resources can support large-scale hydro.



[16] *Hydropower plants are classified based on their capacities, i.e., large hydro (over 10 MW), mini-hydro (101 kW to 10 MW), micro-hydro (1 to 100 kW).*

TABLE 14. DISTRIBUTION OF HYDRO RESOURCE POTENTIAL, BY PLANT TYPE

Location	Hydropower Resource Potential (MW)	% Share
Large hydro	11,223	85.7
Mini-hydro	1,847	14.1
Micro-hydro	27	0.2
Total	13,097	100.0

Source: DOE

TABLE 15. LOCATION OF HYDROPOWER PLANTS, 2010

Location	Capacity (MW)*	% Share
Luzon	2,346	69.0
Visayas	13	0.4
Mindanao	1,040	30.6
Total	3,400	100.0

Source: DOE
* Differences due to rounding off of figures for individual power plant.

Hydropower is considered a commercially mature and viable technology. With sufficient resources, hydropower has a large generation capability and can compete with conventional fossil-fired plants. Large hydropower plants however, require large capital costs, and have a longer gestation period, most often requiring the building of roads to facilitate construction work. Development is also influenced by the climatological and hydro-geological conditions of the site. Since hydro plants need suitable rainfall catchment areas or mass of water, most are situated in remote mountainous areas where accessibility is limited, resulting to higher transmission costs. Moreover, socio-cultural concerns in protected areas and ancestral lands have affected construction schedules and investment costs for hydropower development projects.

Micro and mini-hydropower plants, on the other hand, have simple power generation systems which can be easily operated by local communities.

Hydro resource is abundant even in remote mountainous areas that cannot be reached by on-grid power. Opportunities for hydro development abound in many potential sites that remain untapped. An added incentive for the utilization of hydro resources is the opportunity for creating local employment in these rural communities.

Hydro resources also have non-power applications, predominantly for mechanical uses, such as grain milling. These have been found suitable for off-grid communities, at micro-hydro capacities. Additional ancillary uses to the community like flood control, and household and irrigation water supply from the dam may likewise be provided. However, since water is location-specific, the application may be limited only to certain areas. Hydro is also season-dependent. Hence, care must be taken in the design to avoid a situation where, during dry season, water supply may decrease to a level insufficient to run the plant.

The above-cited challenges and gaps facing the sector are addressed by this sub-program.

b) Hydropower Sector Roadmap

The Hydropower Sector Roadmap for the period 2011-2030 is shown in Figure 10. The roadmap envisions an addition of 5,394.1 MW hydropower capacity. This installation target is expected to be met by 2023.

Of the total capacity addition, nine (9) projects with a total capacity of 27.8 MW have already been committed for installation. Six (6) of these projects are located in Luzon while there are two in the Visayas and one in Mindanao (Table 16).

The distribution of the total targeted capacity addition, by location, is presented in Table 17. Luzon will host a majority or an estimated 71.5 %, of the total capacity addition. The list of the hydropower projects is presented in Annex 2 while Figure 11 shows their location in the map.

c) Hydro Sector Work Program

The overall thrust of the Hydro Sector Sub-program is the intensification of efforts to develop the huge untapped hydro resource potential of the country. The provision of services to the hydro sector participants shall be sustained over the long-term (i.e., 2011-2030) to ensure that the targeted hydro capacity addition is met.

During the short-term planning period, (2011-2015), initiatives

TABLE 16. LOCATION OF COMMITTED HYDROPOWER PROJECTS

Location	Number of Committed Projects	Total Capacity (MW)	% Share
Luzon	6	9.8	35.2
Visayas	2	10.0	36.0
Mindanao	1	8.0	28.8
Total Philippines	9	27.8	100

to optimize the mini-hydro-potential in validated sites shall be undertaken. Efforts shall progress towards the development and eventual commissioning of higher capacity projects over the medium term (2016-2020). Technology support to the sector, in terms of upgrading of local manufacturing capability, establishment of standards and best practices and technology mentoring, shall likewise be sustained. Moreover, research capabilities shall be improved with the establishment of a hydro research center during the period 2011-2015 and its operation throughout the remainder of the planning period (2016-2030)

In the medium-term (2016-2020), new hydropower designs or technologies, such as the sea water pumped storage technology, shall be studied and demonstrated. This shall, hopefully, progress towards the construction of such a facility in the long-term (2021-2030).

For off-grid areas, a comprehensive micro-hydro program for rural electrification shall be formulated during the period 2011-2015. An inventory of micro-hydro projects shall be conducted to determine the possibility of optimizing the use of the hydro resources and/or interconnection via mini-grid systems. Advisory services to interested investors shall be provided throughout the implementation period (i.e., 2016-2020).

The sector's work program, by type of activity, is listed in Table 18 while the schedule of implementation is shown in Figure 12.

FIGURE 10. HYDROPOWER SECTOR ROADMAP (2011-2030)

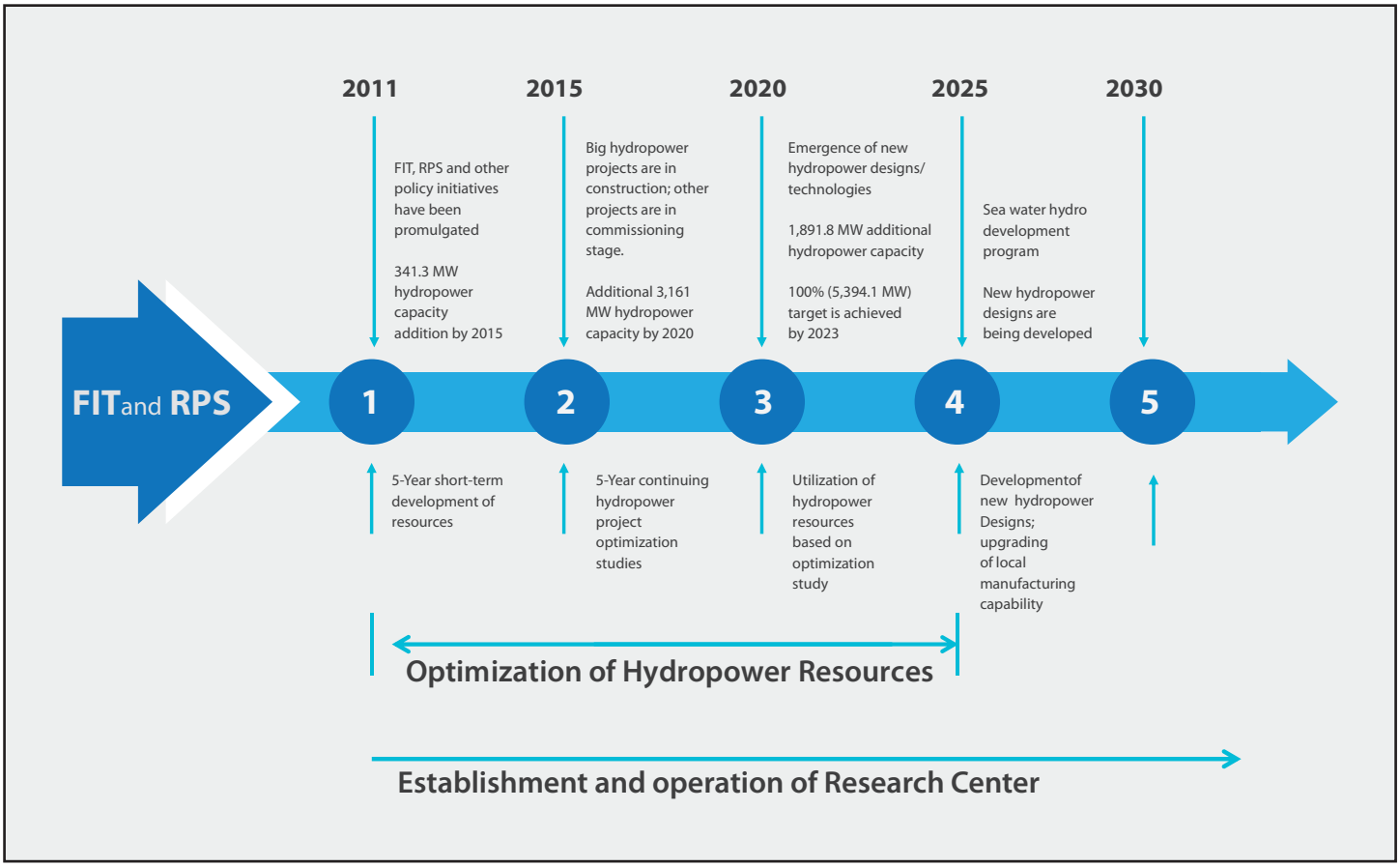


TABLE 17. TARGETED HYDROPOWER CAPACITY ADDITION (MW) BY LOCATION

Location	Commissioning Year			Total Capacity Addition (MW)	% Share
	2011 - 2015	2016 - 2020	2021- 2025		
Luzon	182.0	2,169.5	1,510.0	3,861.5	71.6
Visayas	84.5	102.4	81.8	268.7	5.0
Mindanao	74.8	889.1	300.0	1,263.9	23.4
Total Philippines	341.3	3,161.0	1,891.8	5,394.1	100.0

FIGURE 11. LOCATION MAP OF TARGETED HYDROPOWER CAPACITY ADDITION

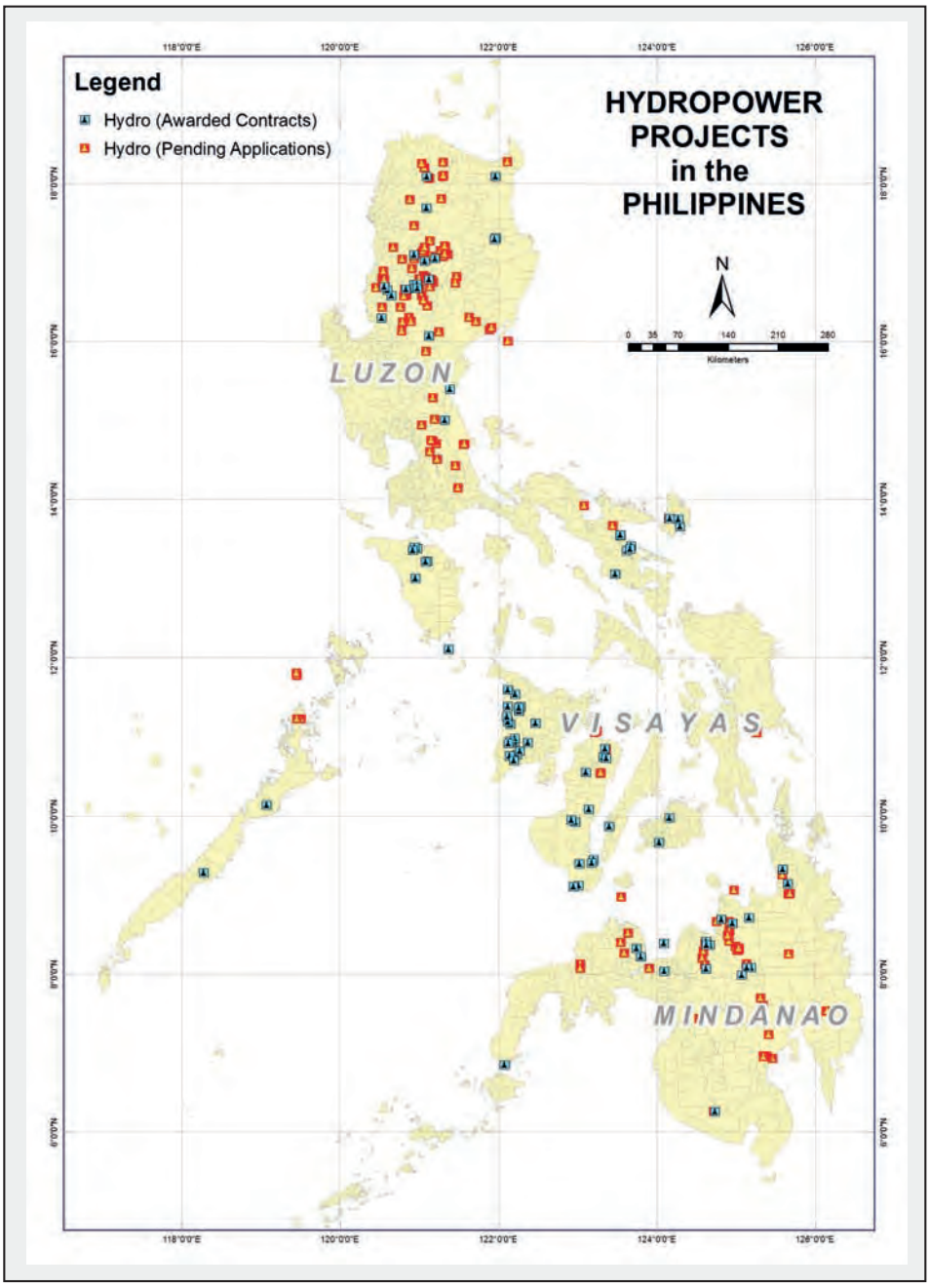
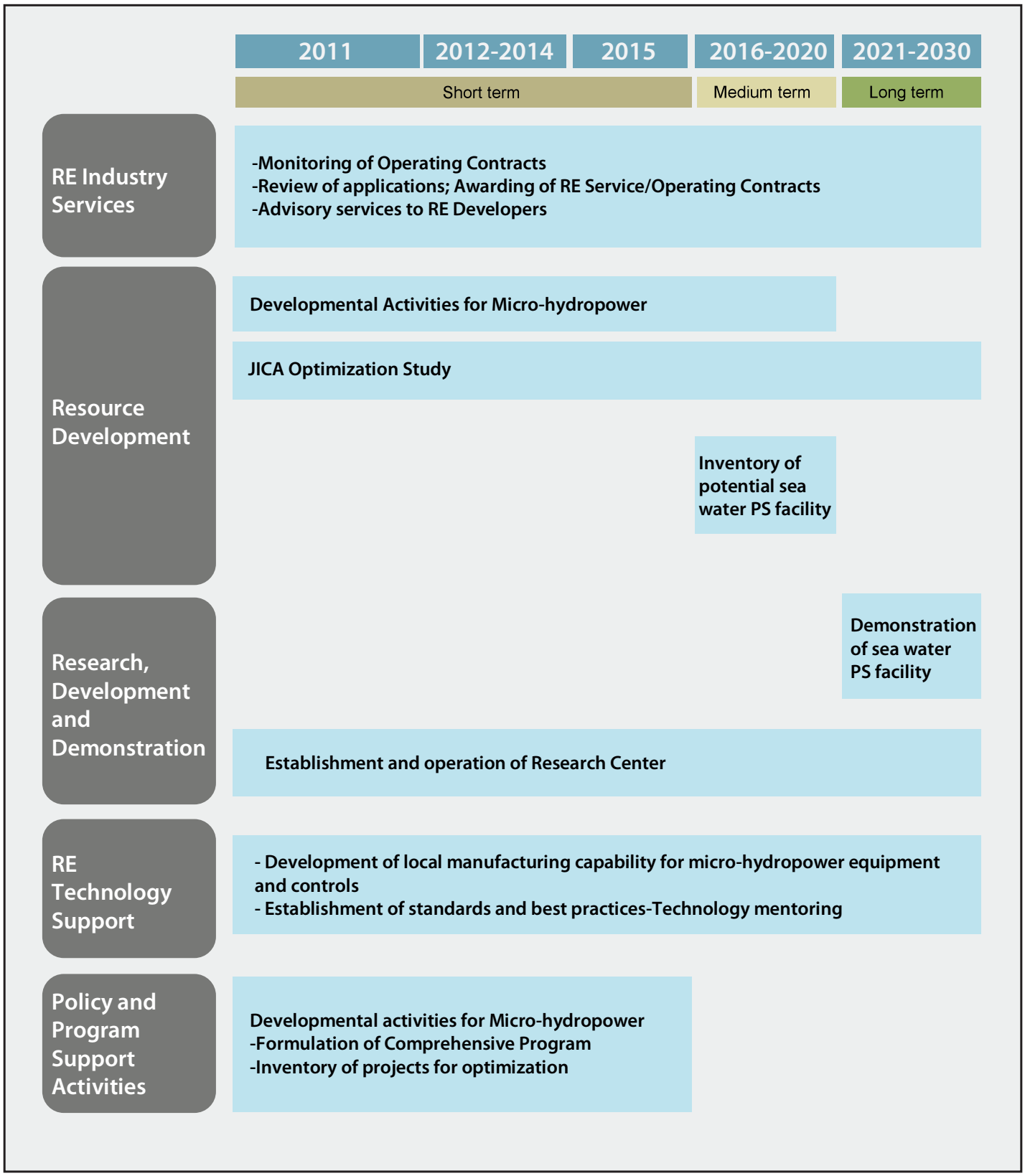


TABLE 18. HYDROPOWER SECTOR WORK PROGRAM, 2011-2030

Type of Activity	Work Program
RE Industry Services	1. Review of applications; endorsement for registration of applications 2. Monitoring of RE contracts 3. Advisory Services to RE Developers on: • RE policy mechanisms/guidelines • Sea water Pump Storage (PS) Hydropower Plant • Rural electrification using micro-hydropower
Resource Development	1. Developmental Activities for Micro-hydropower • Commercialization thru Mini-Grid System • Rural electrification using micro-hydropower 2. JICA Optimization Study a. Identification of at least 50 potential sites b. Project packaging of JICA 's optimization studies for hydropower; o Tendering/Bidding and Awarding of contracts o Construction and development activities o Commissioning and Operation 3. Sea water Pump Storage Hydropower Plant • Inventory of potential sea water PS facility
R, D & D	1. Sea water Pump Storage Hydropower Plant • Development of Sea water Pump Storage Plant o Project Packaging o Tendering/Bidding and Awarding of contracts o Construction and development 2. Establishment of Research Center • New technology and designs for hydropower • Redesign and Retrofitting Program
RE Technology Support	1. Development of local manufacturing capability for micro-hydropower equipment and controls 2. Establishment of standards and best practices 3. Technology mentoring
Policy and Program Support-Related Activities	Developmental activities for Micro-hydropower • Formulation of Comprehensive Program • Inventory of projects for optimization

FIGURE 12. HYDROPOWER SECTOR SUB-PROGRAM: PROJECTS/ACTIVITIES AND SCHEDULE OF IMPLEMENTATION



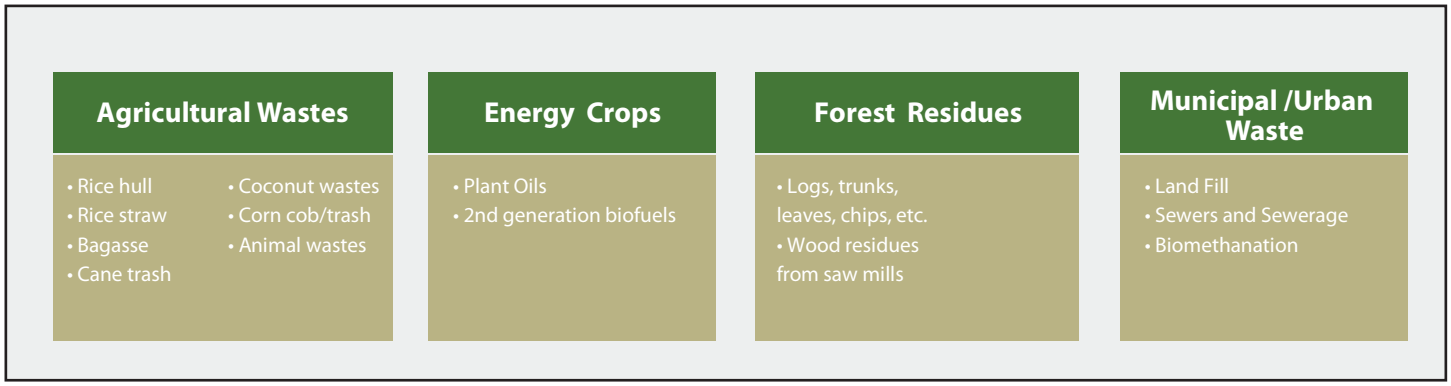
3. Biomass Sector Sub-Program[17]

a) Overview of the Biomass Sector

Biomass resources refer to natural or processed plants and plant materials, trees, crop residues, wood and bark residues, and animal manure or any organic or biodegradable matter that can be used in bioconversion process. Figure 13 shows a diagram on the types of biomass resources which abound in the country.

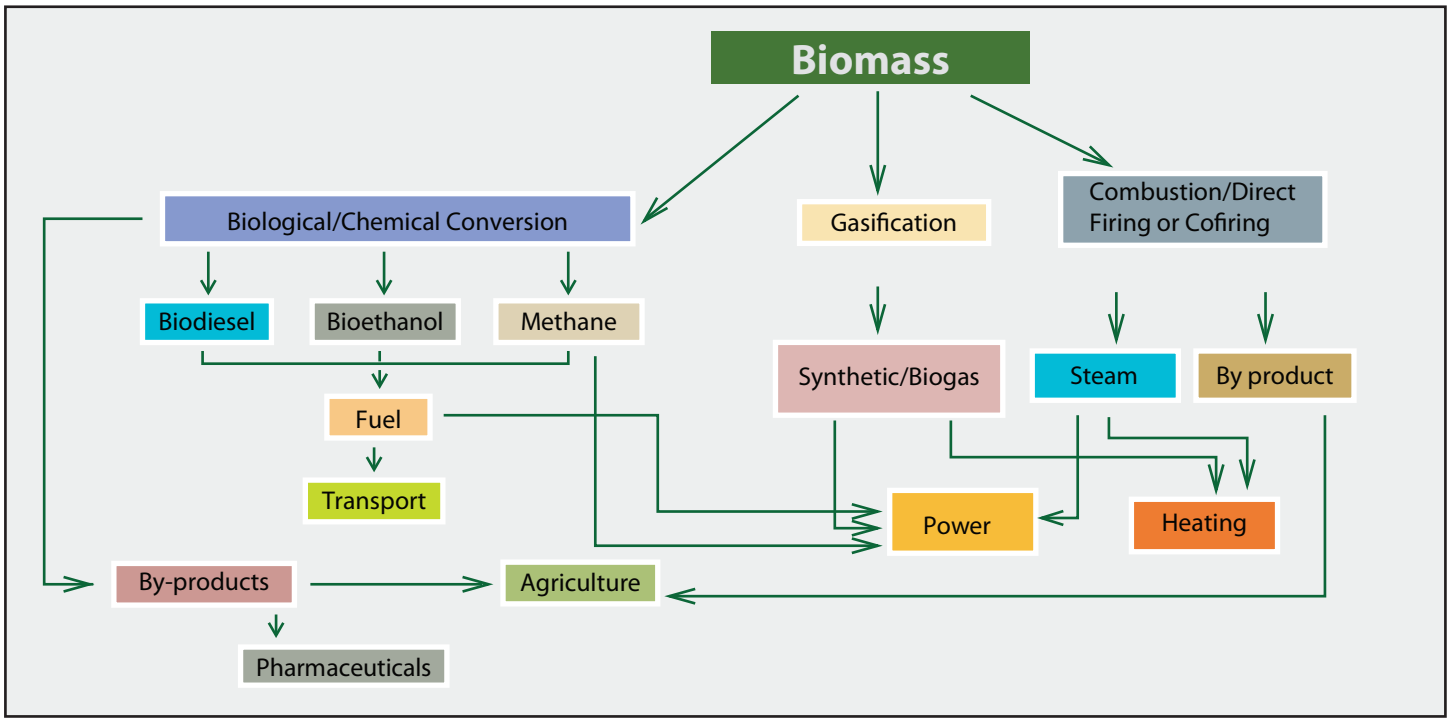
Figure 14 illustrates the variety of ways biomass resources are utilized in various sectors. Biomass energy is produced either through direct combustion (usually solids in furnaces or boilers), through anaerobic digestion (accelerating the natural conversion of biomass into methane-rich biogas for use as a gaseous fuel), gasification (the physical or chemical conversion of biomass into secondary gaseous compounds used as a fuel), or chemical or biochemical conversion (using yeast to decompose carbohydrates such as starches in grains, sugar cane juice or molasses to produce bioethanol or reaction of plant oils with methanol "transesterification" to produce biodiesel). Depending on the conversion technology used, several by-products are also generated. Some of these by-products have high value in other industrial sectors, such as the pharmaceuticals sector.

FIGURE 13. CLASSIFICATION OF BIOMASS RESOURCES



Source: DOE

FIGURE 14. BIOMASS UTILIZATION



Source: DOE

[17] *This sub-program does not cover aspects already covered by the National Biofuels Program which has been drawn up for the period 2007-2012, in compliance with the 2006 Biofuels Law. Excerpts from the said program are presented in Annex 3.*

The country generates substantial volumes of waste residues which could be utilized as fuel.

The figures cited below are results of previous studies undertaken on the assessment of the biomass resource potential in the country[18]. These shall be validated as part of the NREP, and will consider the outputs of the Biomass Resource Inventory being conducted under the CBRED Project[19].

- There is an abundant supply of bagasse in Regions III, IV, VI, and VII. Sugar cane field thrash, on the other hand, are produced at a rate of about 11 to 21 tons per hectare of sugarcane depending on the quality of growth, thereby providing a considerable energy resource.
- Rice hull production in the country is estimated at 45.2 million tons per annum. These are mostly generated in the major rice-producing regions of the country, namely, Regions II, III, IV, and VI.
- Coconut residues are abundant in Regions IV, VIII, IX, and XI.
- Fuelwood is still widely used for domestic cooking and heating applications in the rural areas and, on a small-scale, for commercial activities in both rural and urban areas.
- For animal and municipal wastes, the national average waste generation rate per capita is estimated to be 0.3 kg/capita/day, or about 22,500 tons/day (equivalent to 8.2 million tons/year). In urban areas, the range is from 0.50 to 0.70 kg/capita/day.

Biomass resources also include biofuels. The Biofuels Law of 2006 mandates the use of two types of biofuels, namely, biodiesel as blend with diesel fuel and bioethanol with gasoline. These two key liquid fuels are produced from agricultural crops and other renewable feed stocks.

Despite this substantial potential, biomass utilization in the country is mostly for non-power applications, such as biofuels in the transport sector, fuelwood in the household and commercial sectors and waste residues in agro-industries. Biomass power capacity is only 30 MW, as of the first semester of 2010[20].

The biomass sector sub-program shall address, among others, the following challenges and gaps: (i) high feedstock cost, particularly sugarcane and coconut oil for bioethanol and biodiesel production, that translate to higher biofuel cost. High biofuel cost affects the pump price of biofuel-blended diesel or gasoline; (ii) need for continuing R & D on non-food based feedstock for biofuel production; (iii) concerns on supply availability, price, quality and logistical infrastructure if higher biofuel blend mandate is pursued; (iv) increased utilization of marginal land for energy crops; (v) competing land uses; (vi) additional permitting requirements for use of private lands as biomass plantation sites; (vii) need to align DOE position with policies related to forestry and forestry-based activities as there are already existing policy issuances on agro-forestry, e.g., CBFM (community-based forestry management), IFMA (integrated forestry management agreement) programs on forest products as possible biomass feedstock source; (viii) lack of transmission line infrastructure; (ix) need for standards and best practices for sustainable biomass supply; and (x) need to improve separation technologies at the Municipal Recovery Facilities (MRF) and environmental compliance challenges for waste-to-energy (WTE).

Efforts shall be intensified to increase the utilization of biomass resources.

b) Biomass Sector Roadmap

Figure 15 shows the Biomass Sector Roadmap which envisions an addition of 276.7 MW biomass power capacity to the grid by the year 2015, based on RE Operating Contracts which have been awarded and pending applications being evaluated by the DOE. Additional projects are expected to be identified once the inventory and assessment of the biomass utilization studies have been completed within the year.

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[18] *References: DOE Website; RE Policy Framework; RE Market Study under the CBRED Project.*

[19] *CBRED is a capacity building project to remove barriers to renewable energy development, implemented by UNDP and DOE with funding from the Global Environment Facility (GEF).*

[20] *Source: Power Situationer, 1st Semester 2010, DOE.*

The projected commissioning dates of the targeted projects are indicated in Table 19 while the full list is presented in Table 20. Majority or 68% of the capacity addition shall be commissioned by 2014.

Table 21 presents the targeted biomass power capacity distribution, by grid. An estimated 142.6 MW or 51.5% of the targeted biomass power capacity shall be located in the Visayas. This is followed by Luzon, which is expected to host 97.3 MW or 35.2% of the targeted biomass power capacity addition.

Figure 16 shows the location map of these indicative biomass power projects.

FIGURE 15. BIOMASS SECTOR ROADMAP (2011-2030)[21].

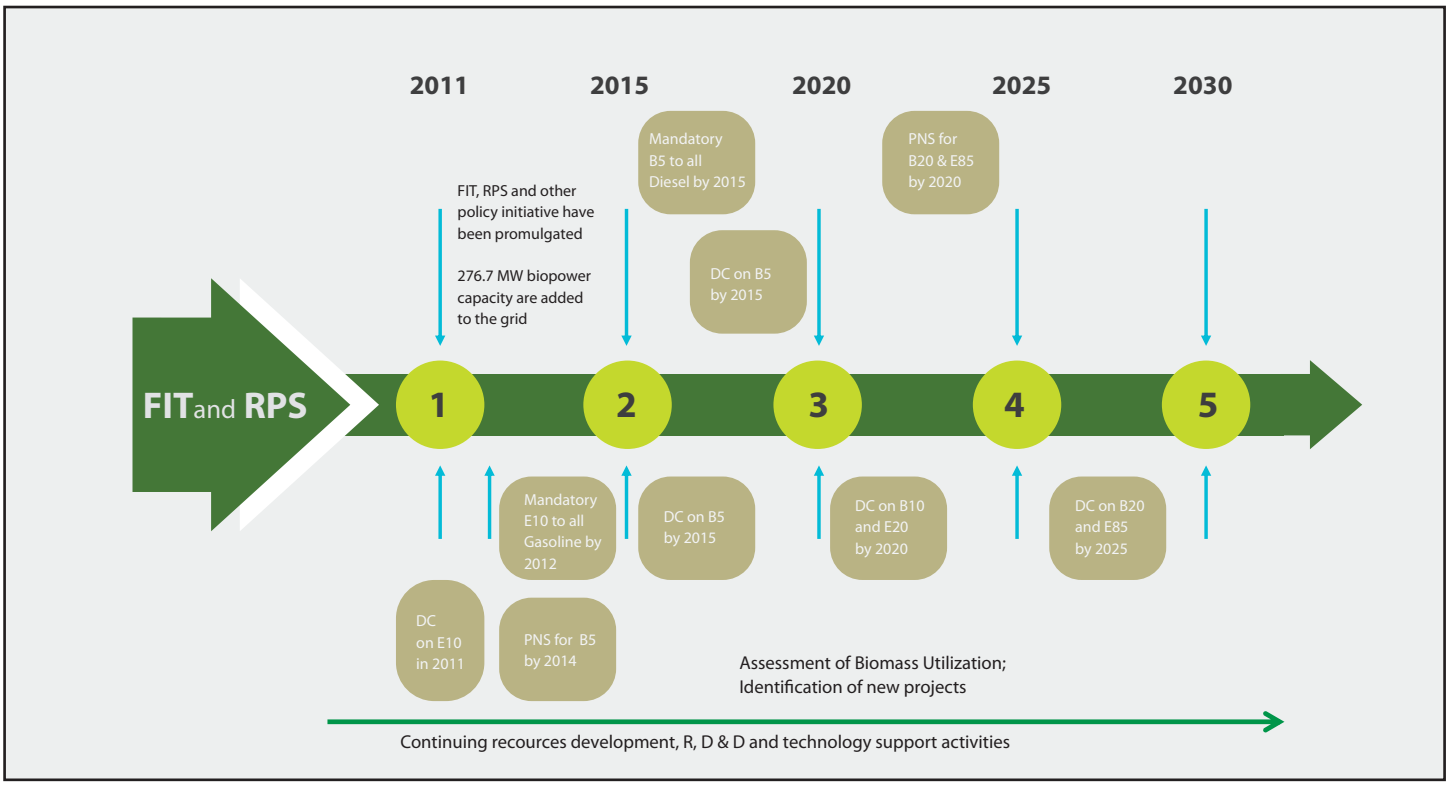


TABLE 19. EXPECTED COMMISSIONING DATES, ADDITIONAL BIOMASS POWER CAPACITY

Expected Commissioning Date	Aggregate Biomass Power Capacity (MW)
2011	26.8
2012	1.0
2013	57.9
2014	187.0
2015	4.0
TOTAL	276.7

[21] *Legend: DC- DOE Circular; PNS – Philippine National Standard; E10, E20, E85 – Ethanol blends; B5, B10, B20- Biodiesel blends.*

TABLE 20. LIST OF BIOMASS POWER PROJECTS

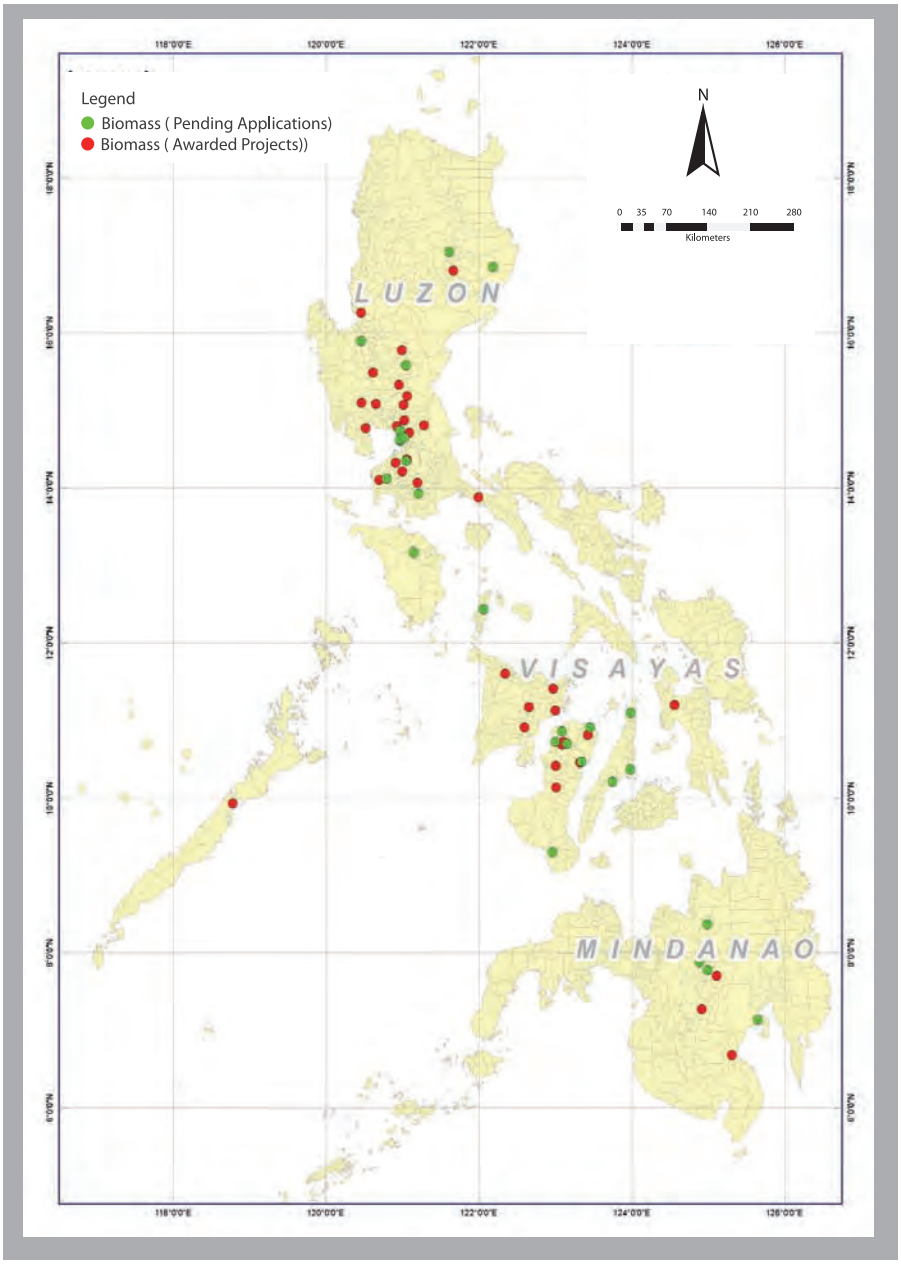
No.	Name of Project	Capacity (MW)*	Target Commissioning Year
Luzon			
1	Isabela Rice Hull Gasification (Alicia)	6.5	2.9 MW - 2011; 3.6 MW - 2013
2	Biomass Power Plant using Coconut Wastes (Quezon)	10	2013
3	Bulacan Biogas Power Generation System	0.4	2011
4	San Pedro Landfill Methane Recovery and vElectricity Generation	4	2011
5	Bataan Rice Hull-fired Cogen Plant	7.5	2011
6	Nueva Ecija Rice Husk-Fired Biomass Power Plant Project (San Jose City)	9.9	2014
7	Nueva Ecija Multi-Fuel Biomass Power Generation Facility (San Leonardo)	15.5	2014
8	Waste to Energy (WTE) Conversion-Payatas Disposal Facility	1	2012
9	Pangasinan Multi-Fuel Biomass Power Generation Facility	15.5	2014
10	Isabela Rice Hull-Fired Gasification Power Facility (San Manuel)	3	2014
11	Mindoro Rice Hull-Fired Biomass Power Plant	6	2014
12	Cavite Bagasse Cogeneration System	5	2013
13	Isabela Biomass/Biogas Power Generation Plant (San Mariano)	13	2013
	Sub-Total	97.3	
Visayas			
14	Aklan Multi-Fuel Biomass Power Plant	10.8	2013
15	Iloilo Multi-Fuel Biomass Power Generation Facility (Mina)	32	15.5 MW - 2013; 16.5 MW - 2014
16	Iloilo Multi-Fuel Biomass Power Generation Project (Ajuy)	30	2014
17	San Carlos Multi-Fuel Biomass-Fired Power Generation Project	15	2014
18	Consolacion Landfill Methane Recovery and Electricity Generation	4	2015
19	Silay Bagasse-Fired Power Generation Facility	8	2014
20	Negros Multi-Fuel Biomass Power Generation Plant	32	2014
21	Cebu Waste to Energy Project using Catalytic Hydrothermal Gasification	1.8	2014
22	Victorias Bagasse-Fired Power Generation Facility (VMC)	2	2011
23	San Antonio Bagasse-Fired Power Generation Facility (CASA)	7	2011
	Sub-total	142.6	
Mindanao			
24	Bukidnon Multi-Fuel Biomass Power Generation Facility	32	2014
25	Bukidnon Bagasse-Fired Power Generation Facility (Crystal Sugar)	3	2011
26	Davao Waste to Energy Project using Catalytic Hydrothermal Gasification	1.8	2014
	Sub-total	36.8	
Total Philippines		276.7	

** Does not include capacity for own use.*

TABLE 21. TARGETED BIOMASS POWER CAPACITY ADDITION (MW), BY GRID

Location	Commissioning Year					Total Capacity Addition (MW)	% Share
	2011	2012	2013	2014	2015		
Luzon	14.8	1.0	31.6	49.9	0.0	97.3	35.2
Visayas	9.0	0.0	26.3	103.3	4.0	142.6	51.5
Mindanao	3.0	0.0	0.0	33.8	0.0	36.8	13.3
Total Philippines	26.8	1.0	57.9	187.0	4.0	276.7	100.0

FIGURE 16. LOCATION MAP OF THE TARGETED BIOMASS POWER CAPACITY ADDITION



[22] *Includes location of projects for own use.*

c) Biomass Sector Work Program

The Biomass Sector Sub-program's activity thrusts are as follows:

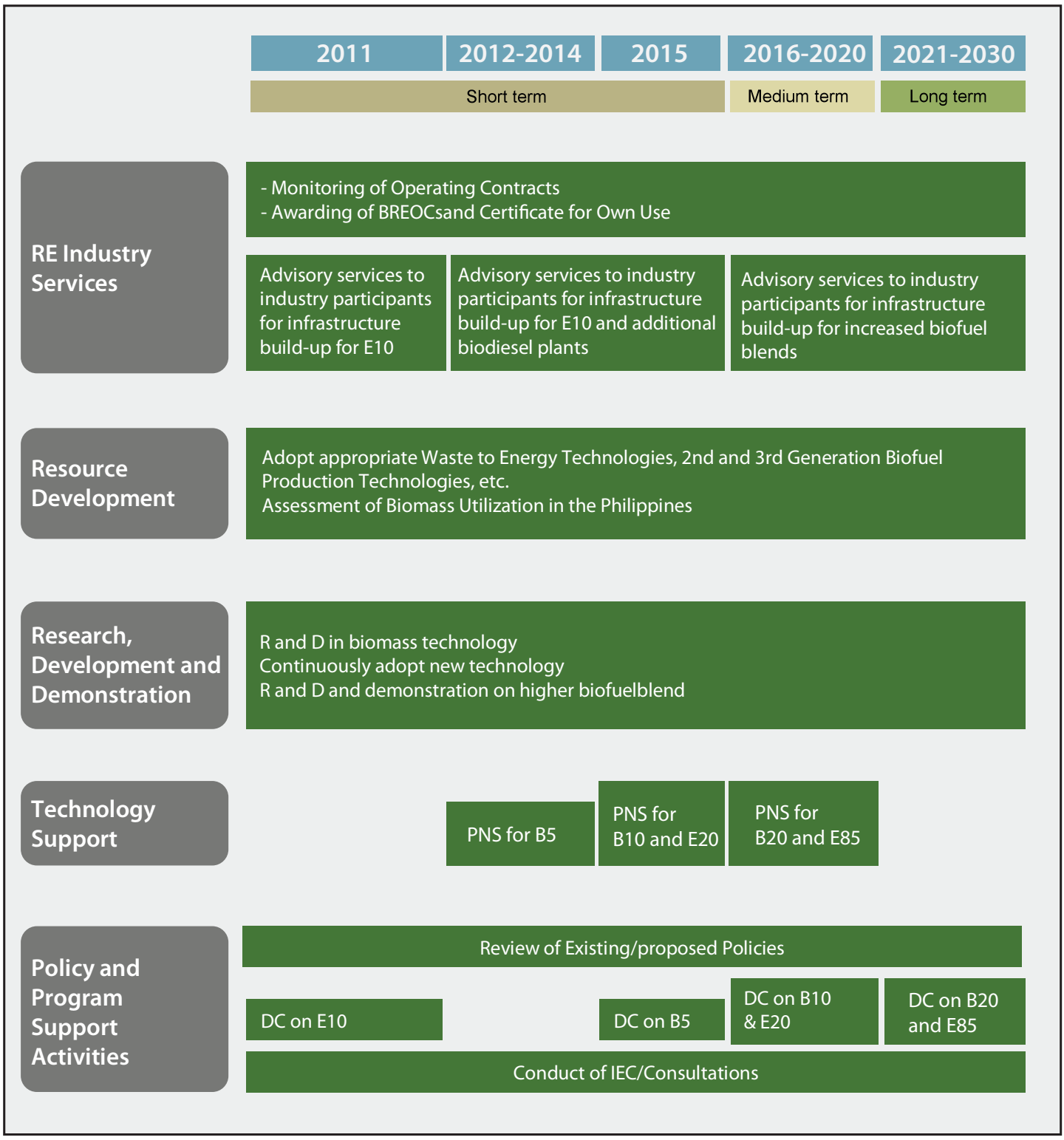
1. intensive promotional campaign to encourage investments in the biomass sector;
2. effective and efficient delivery of assistance/advisory services to the biomass sector participants;
3. assessment of biomass utilization in the country to identify additional projects; and
4. resource development on new and emerging biomass technologies; and (5) R, D & D of higher biofuel blends (i.e., flexible fuel vehicle technologies).

The sector's work program, by type of activity, is listed in Table 22 while its phasing is shown in Figure 17.

TABLE 22. BIOMASS SECTOR WORK PROGRAM

Type of Activity	Work Program
RE Industry Services	1. Review of applications; endorsement for awarding of Operating Contracts and Certificate for Own Use 2. Monitoring of RE contracts 3. Advisory services to RE Developers • RE policy mechanisms/guidelines • Growing of non-food bioenergy crops for biofuels • Growing of high yielding biomass crops • Land availability to support biomass plantations • Infrastructure build-up for E10 • Infrastructure build-up for additional biodiesel plants • Infrastructure build-up for increased biofuel blends
Resource Development	1. Adopt appropriate Waste to Energy Technologies 2. 2nd and 3rd Generation Biofuel Production Technologies 3. Assessment of Biomass Utilization in the Philippines
R, D & D	1. R & D on biomass technology 2. Continuously adopt new technology 3. R, D & D on higher biofuel blend
RE Technology Support	Philippine National Standards for: 1. B5 and B20 2. E20 and E85
Policy and Program Support-Related Activities	1. Review of Existing/Proposed Policies 2. Drafting of DOE Circular on • B5 and B20 • E20 and E85 3. Conduct of IEC/Consultations

FIGURE 17. BIOMASS SECTOR SUB-PROGRAM: PROJECTS/ACTIVITIES AND SCHEDULE OF IMPLEMENTATION



The study identified around 10,000 sites in the country with good to excellent resource levels equivalent to an annual average wind power of 300 W/m2 or greater and can support at least

76,600 MW

of installed capacity generating about 195,200 GWh/year.

4. Wind Energy Sector Sub-Program

Until 2005, utilization of wind energy in the country was done on a limited scale, with technology narrowly applied to windpumps for pumping water for agricultural, households and livestock uses, and a few demonstration wind-PV or diesel hybrid power plants for electricity generation at KW levels.

a) Overview of the Wind Energy Sector

The country is said to have a very good wind resource potential based on the wind resource analysis and mapping study conducted by the National Renewable Energy Laboratory (NREL).

The resulting wind resource map from that study is shown in Figure 18. Areas identified to have high potential for wind energy utilization are Ilocos, Mountain Province, Cuyo Island, Basco, Batanes, Catanduanes, Tagaytay City, Lubang, Cabra Islands off the Northwestern cost of Mindoro, western portions of Batangas, Guimaras, Masbate, the northeastern coast of Negros Occidental, and Palawan.

A 2003 World Wildlife Fund (WWF) study likewise identified potential sites with power density of at least 500 W/m2 and transmission line cost of not over 25% of levelized cost of combined generation and transmission costs. The results of the study show that the Philippines total potential is about 7,412 MW covering 1,038 wind sites (Table 23).

TABLE 23. LIST OF POTENTIAL WIND SITES IN THE PHILIPPINES

Province	No.	Estimated Aggregate Capacity (MW)	Estimated Aggregate Annual Generation (GWh)
LUZON			
REGION CAR			
Abra	26	183	567
Benguet	20	137	421
Ifugao	15	98	299
Kalinga	21	158	484
Mountain Province	5	33	100
REGION I			
Ilocos Norte	31	265	832
Ilocos Sur	8	52	161
Pangasinan	17	125	382
REGION II			
Isabela	90	620	1,922
Nueva Vizcaya	43	315	971
Quirino	21	165	509
REGION III			
Aurora	46	320	1,011
Bataan	26	169	530
Bulacan	2	41	126
Cagayan	8	80	246
Nueva Ecija	20	151	478
Pampanga	7	46	143
Tarlac	4	40	123
Zambales	117	796	2,486
REGION IV-A			
Batangas	16	104	328
Cavite	8	87	267
Laguna	5	40	125
Quezon	11	86	263
Rizal	15	98	307
REGION V			
Albay	26	183	576
Camarines Norte	18	117	372
Camarines Sur	36	234	742
Sorsogon	24	163	509
Sub-total	686	4906	15,280
VISAYAS			
REGION VI			
Aklan	24	163	517
Antique	41	309	965
Capiz	1	7	20
Iloilo	12	85	266
Negros Occidental	26	169	519
REGION VII			
Bohol	6	39	120
Cebu	30	202	620
Leyte	52	357	1,113
Negros Oriental	48	347	1,065
REGION VIII			
Eastern Samar	2	14	43
Biliran	20	144	466
Samar	10	75	229
Southern Leyte	33	259	795
Sub-total	305	2,170	6,738
MINDANAO			
REGION X			
Camiguin	4	28	86
REGION XIII			
Agusan del Norte	19	133	408
Agusan del Sur	6	42	129
Surigao del Norte	14	105	322
Surigao del Sur	4	28	86
Sub-total	47	336	1,031
Grand Total	1,038	7,412	23,049

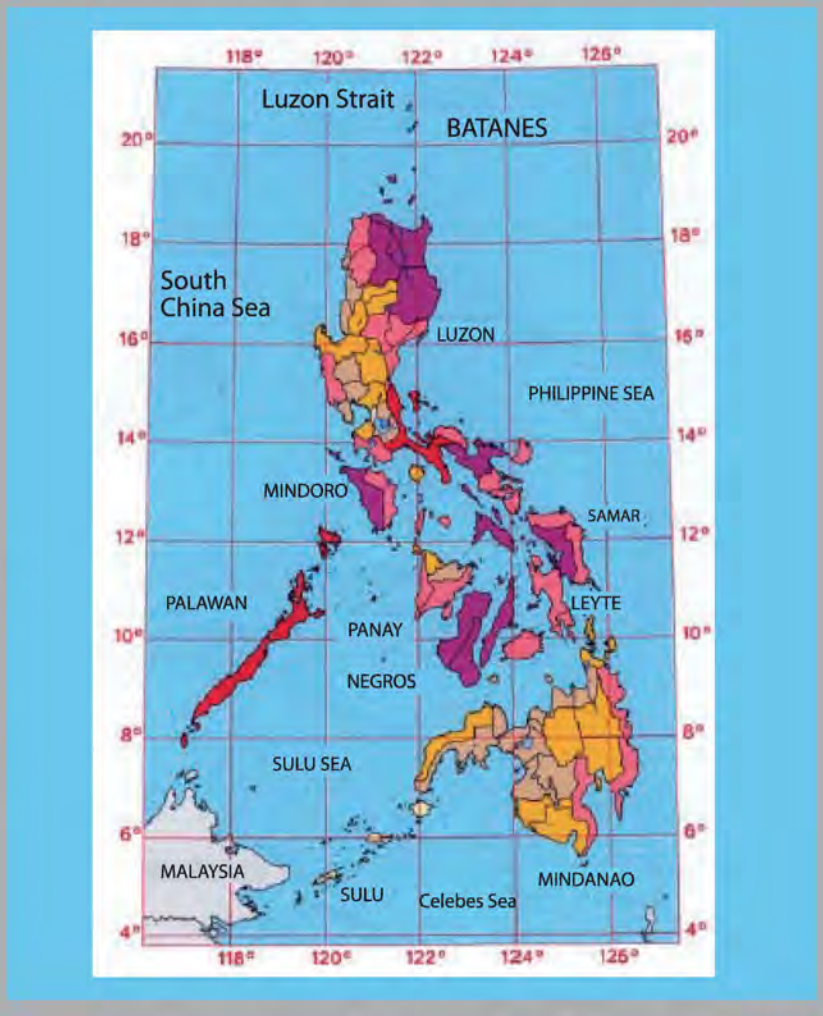
A remarkable development in the wind energy sector was the completion and successful operation of the NorthWind Power Project, the country's first wind farm, located in Bangui Bay, Ilocos Norte, in 2005. A private sector-led endeavor, the 25 MW wind farm consists of 15 units of on-shore and single row-arranged wind turbines. In September 2008, its capacity was increased by 8 MW for a total capacity of 33 MW.

Wind energy is converted into useful electrical and mechanical energy through wind turbines and wind pumps, respectively. Wind turbines can be used either as a stand-alone system or connected to a utility distribution or grid transmission system. It can work in hybrid with other renewable energy systems and/or conventional power generation facilities such as diesel-fueled systems. Wind turbines can co-exist with agricultural crops. Wind pumps are typically used for pumping water for agricultural, household and livestock uses.

FIGURE 18. WIND RESOURCE MAP, PHILIPPINES

Philippines - Wind Electric Potential

Moderate-to-Excellent Wind Resource (Utility Scale Classification)



Philippines Total - 173,650 MW

Wind Electricity Potential Megawatts

- <100
- 100 - 1,000
- 1,000 - 2,000
- 2,000 - 4,000
- 4,000 - 8,000
- 8,000 - 15,100

The following assumptions were used in calculating the total potential wind electric capacity installed

Minimun wind power - 200 W/m2
Turbine size - 500 kW
Hub height - 40 m
Rotor diameter - 38 m
5D Side-to-side spacing - 190 m
10D Front-to-back spacing - 380 m
Swept area - 1134 m2
Turbines/km2 - 13.9
Capacity/km2 - 6.9 MW

US Dept. of Energy - National Renewable Energy Laboratory

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The commercial and technological developments in wind turbines are most apparent in the size of the turbines themselves. From ten meters in diameter (typically with 22 kW to 35 kW of installed power) in the mid-1970s, wind turbines have grown to diameters of 80 meters and more (with multi-MW installed power). Technology development has also resulted in variable pitch (as opposed to fixed blades), direct drives (as opposed to classical drive trains), variable-speed conversion systems, power electronics, better materials, and better ratio of weight of materials to capacity installed. Other trends are towards increasing rotor diameter for use in offshore applications and towards serving the growing demand for small-sized wind farms in developing countries.

To address concerns on power quality and system reliability, modern wind turbines are soft starting, i.e., they connect and disconnect gradually to the grid using thyristors, a type of semiconductor continuous switches which may be controlled electronically. Thyristors waste about 1 to 2 % of the energy running through them. Modern wind turbines are, therefore, normally equipped with a so-called bypass switch, i.e., a mechanical switch which is activated after the turbine has been soft started. This minimizes the amount of energy wasted.

Modern wind turbines also have electronic controllers to constantly monitor the voltage and frequency of the alternating current in the grid. In case the voltage or frequency of the local grid drifts outside certain limits within a fraction of a second, the turbine will automatically disconnect from the grid and stop itself immediately, to prevent islanding.

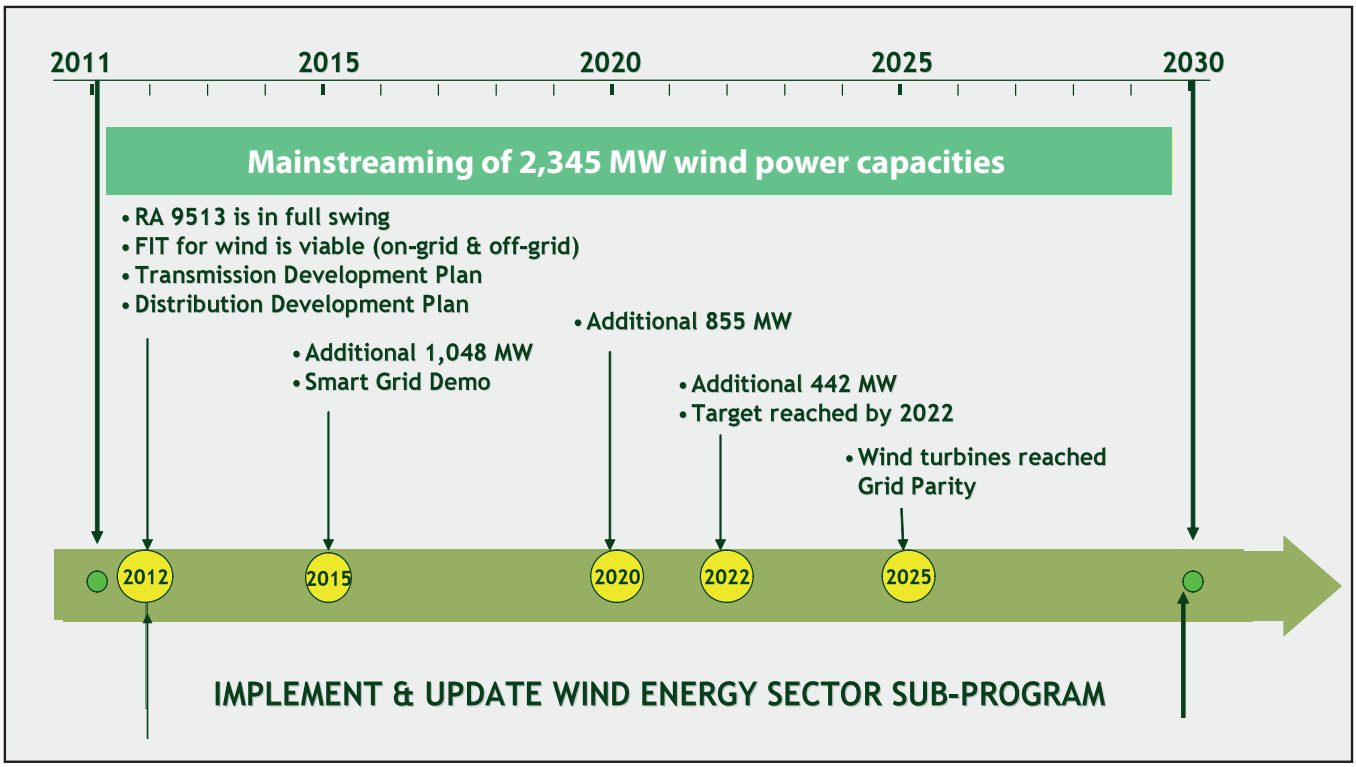
Through a combination of good location and improved technology, many large wind farms are able to meet the strict technical requirements for on-grid connection.

b) Wind Energy Sector Roadmap

Figure 19 shows the Wind Energy Sector Roadmap for the period 2011-2030. The roadmap envisions an addition of 2,345 MW wind power capacity, based on the RE Service/Operating Contracts which have been awarded and those that are being evaluated by the DOE[23] . This installation target is expected to be met by 2022.

The additional capacity is accounted for by 57 projects. These are listed in Table 24. The distribution of the targeted capacity addition, by location, is presented in Table 25. Most of the additional capacity is located in Luzon, with a large portion of it being targeted to be commissioned during the period 2011-2015.

FIGURE 19. WIND ENERGY SECTOR ROADMAP



[23] *Pending applications as of April 27, 2011 without proposed capacity were not included in the tabulation.*

TABLE 24. LIST OF INDICATIVE WIND PROJECTS

No.	Name of Project	Capacity (MW)	Target Commissioning Year
Luzon			
1	Balaoi Wind Power Project (1)	30	2013
2	Caparispisan Wind Power Project	50	2013
3	Burgos Wind Power Project	86	2013
4	Pasuquin Wind Power Project	120	2013
5	Balaoi Wind Power Project (2)	40	2013
6	Sual Wind Power Project	30	2014
7	Aparri Wind Power Project (1)	30	2015
8	Aparri Wind Power Project (2)	48	2015
9	Aparri Wind Power Project (3)	30	2014
10	Sta. Ana Wind Power Project (1)	30	2015
11	Gonzaga Wind Power Project	15	2015
12	Sanchez Mira Wind Power Project	15	2015
13	Claveria Wind Power Project	15	2015
14	Abulog-Ballesteros-Aparri Wind Power Project	45	2014
15	Sta. Ana Wind Power Project (2)	12	2014
16	Caliraya Wind Power Project	30	2015
17	Tanay Wind Power Project	30	2015
18	Infanta Wind Power Project	10	2015
19	Calauag Wind Power Project	10	2015
20	Abra de Ilog Wind Power Project (Off-Grid)	30	2015
21	Mercedes Wind Power Project (1)	10	2015
22	Paracale-Vinzons Wind Power Project	26	2015
23	Bangui Wind Power Project (Expansion)	17	2013
24	Bangui Wind Power Project (Phase III)	30	2013
25	Bayog Wind Power Project	12	2015
26	Pagali-Saoit Wind Power Project	15	2015
27	Carranglan Wind Power Project (1)	30	2016
28	Carranglan Wind Power Project (2)	50	2017
29	Mercedes Wind Power Project (2)	100	2020
30	Prieto Diaz Wind Project (2)	420	2222
31	Sta. Rita Wind Power Project	90	2016
32	North Pasuquin Wind Power Project	100	2017
33	Mt. Redondo Wind Power Project	112	2018

TABLE 24. LIST OF INDICATIVE WIND PROJECTS CONTINUATION

No.	Name of Project	Capacity (MW)	Target Commissioning Year
34	Puerto Galera Wind Power Project	15	2015
35	Misibis Wind Power Project	5	2020
36	Dapdap Wind Power Project	10	2020
37	Donsol Wind Power Project	5	2020
38	Prieto Diaz Wind Power Project (1)	10	2020
39	Napsan Wind Power Project	10	2222
40	Bayog Wind Power Project	90	2017
41	Buduan Wind Power Project	44	2016
42	Mabini Wind Project	48	2018
43	Infanta Wind Project	48	2019
44	Labrador Wind Project	98	2020
45	Odiongan Wind Power Project	2	2021
Sub-Total		2,103	
Visayas			
46	San Lorenzo Wind Power Project	54	2013
47	Ilog Wind Power Project	30	2015
48	Nabas Wind Power Project	30	2015
49	Ibajay Wind Power Project	10	2015
50	Barotac Nuevo Wind Power Project	12	2015
51	Sibunag Wind Power Project	16	2014
52	Nueva Valencia Wind Power Project	10	2014
53	Pulupandan Wind Power Project	15	2015
54	Bayawan-Tanjay-Bais-Pamplona Wind Power Project	30	2015
55	Anda-Guindulman Wind Power Project	10	2015
56	Pandan Wind Power Project	10	2222
Sub-Total		227	
Mindanao			
57	Nubenta Wind Power Project	15	2018
Sub-Total		15	
TOTAL		2,345	

TABLE 25. TARGETED WIND CAPACITY ADDITION (MW), BY LOCATION

Location	Commissioning Year				Total Capacity Addition (MW)	% Share
	2011 - 2015	2016 - 2020	2021- 2025	2026- 2030		
Luzon	831	840	432	0	2,103	89.7
Visayas	217	0	10	0	227	9.7
Mindanao	0	15	0	0	15	0.6
Total Philippines	**1,048**	**855**	**442**	**0**	**2,345**	**100.0**

c) Wind Energy Sector Sub-Program

The Wind Energy Sector Sub-Program (WESP) is envisioned to support the following policy thrusts of the Philippine Energy Plan: (i) ensuring energy security; (ii) pursuing effective implementation of energy sector reforms; and (iii) implementing social mobilization and cross-sector monitoring mechanisms.

The goal of mainstreaming the grid system (on-grid and off-grid) with 2,345 MW wind power capacity shall be pursued by accelerating the development and utilization of the country's wind energy potential within the planning horizon 2011 to 2030. This scenario is based on the following assumptions:

- The different mechanisms of the RA 9513 are fully in place by 2012;
- Approved Feed-in-Tariff rates for wind energy systems are favorable;
- Innovative financial programs for wind energy projects are available from both government and private financial institutions; and
- Infrastructure supports are in place.

The strategies to be adopted to attain the abovementioned goals include:

- Intensify research, development, demonstration and deployment of wind energy technologies;
- Conduct detailed wind energy resource assessments;
- Aggressively pursue the development of wind energy projects;
- Implement extensive IEC campaigns on the benefits of wind energy; and
- Institutionalize area-based energy planning and management for wind energy systems.

The WESP shall be implemented in close coordination with other energy-related agencies. These include the National Power Corporation-Small Power Utilities Group (NPC-SPUG), Philippine National Oil Company (PNOC), and the National Electrification Administration (NEA).

While the WESP shall basically have the same types of activities similar to the other renewable energy sectors, it has five (5) strategic components each addressing a range of concerns facing the sector, namely:

i) Technology Component

This aims to develop economically viable wind energy systems to levels of technical maturity wherein they can be commercially competitive with conventional energy systems. The types of activities under this component include: Resource Development, Technology Support, RD&D and Program Support-related Activities.

The Technology Component consists of the following activities:

a. Technology Roadmap

The Wind Turbine Technology Roadmap is intended to guide the DOE in the local adoption of wind energy technologies thru intensive research, development, demonstration and deployment in complementation with the academe and concerned government agencies. It will be regularly updated to incorporate new policies and technological advances, among others.

A Windpump Technology Roadmap shall also be developed, implemented and regularly updated.

b. Resource Assessment

As a proactive support to the private sector, detailed resource assessments will be conducted by the government for wind energy resource. Identified potential areas will be offered for development by the private sector through the procurement process under R. A. 9513.

c. National Wind Energy Database

A national database containing wind resource data in forms that are useful, readily accessible and known to target clients such as potential private investors and policy makers shall be established and uploaded in the Internet. It will also include information on best practices and approaches in the local wind energy development and utilization and other related information.

d. Demonstration of Smart Grid

This activity will aim to demonstrate the effectiveness and efficiency of the technology in addressing the technical challenges of integrating intermittent power generating facilities, such as wind, into the grid.

ii) Commercialization Component

This envisions the creation of a favorable market to encourage private sector investment and participation in the development and utilization of wind energy projects and activities. The types of activities under this classification include: RE Industry Services, Technology Support and Policy and Program Support-related activities.

Activities under this component are:

a. Full Implementation Of R. A. 9513 For The Wind Energy Sector

Inputs shall be provided to the development of policy mechanisms related to the wind sector in consonance with the RE Law and to attain the goal of the WESP.

b. Registration, Accreditation, And Monitoring Of Developers Per R.A. 9513

Under the Act, the DOE administers the registration of wind developers and accreditation of wind energy systems fabricators, manufacturers and suppliers. Likewise, the performance of wind energy players will be regularly monitored and evaluated as part of regulatory compliance monitoring.

c. Household Electrification Program

The program aims to energize off-grid households in support of efforts to achieve 90% household-level electrification by 2017 using commercially-viable and technically-feasible wind energy systems. This is intended to create demand in off-grid areas that would eventually support future grid extension.

d. Market Study On The Local Manufacturing Of Balance-Of-Systems (Bos) Of Wind Turbine Systems

The study seeks to improve the financial viability of wind turbine systems through local manufacturing of component parts such as turbine towers.

iii) Promotions Component

This intends to heighten public awareness on the advantages and benefits of the use of wind energy systems. In intensifying promotional efforts and information campaign on wind energy, the following activities shall be undertaken:

a. Public Awareness

The Information, Education, and Communication (IEC) Program established under the DOE-UNDP-GEF CBRED Project will be updated and implemented to promote public awareness on the benefits and advantages of wind energy sources and technologies. This will involve the conduct of various promotional and information dissemination activities that will enhance the appreciation of various RE stakeholders (both government and civil society) on the use of said technologies.

IEC activities will likewise aim to stimulate private sector and investor interest in wind energy projects. LGUs, NGOs and other local organizations shall be encouraged to develop and formulate local and community-based projects using wind energy systems. Consumers shall also be encouraged to use and utilize wind energy sources and technologies.

b. Capacity Building

Linkages with the academe for the institutionalization of wind energy subjects in technical and engineering courses will be established. Training activities on the use of computer softwares for analyzing technical feasibility of wind power sites shall be pursued.

iv) Policy Component

This activity component will involve the formulation, advocacy, implementation, and evaluation of policies on the development and utilization of wind energy resources and technologies.

Activities under this component include:

a. Policy Study On The Internalization Of External Cost

This activity will be directed at leveling the playing field between conventional and renewable energy systems such as wind.

b. Policy Study On Mainstreaming Smart Grid

Efforts will aim to address technical challenges of optimizing the integration of intermittent power generating facilities, such as wind, in the grid.

c. Advocacy On The Passage Of The Land-Use Bill

This will involve an advocacy for the declaration of qualified areas prioritized for wind power generation.

d. Assessment Of The Wind Energy Sector Sub-Program

Regular monitoring and evaluation of the efficiency and effectiveness of the sub-program will be conducted.

e. Evaluation of the Effectiveness and Efficiency of R. A. 9513 (Particularly On Wind)

This will involve the regular monitoring and evaluation of the outcome of the Act relative to the wind energy sector.

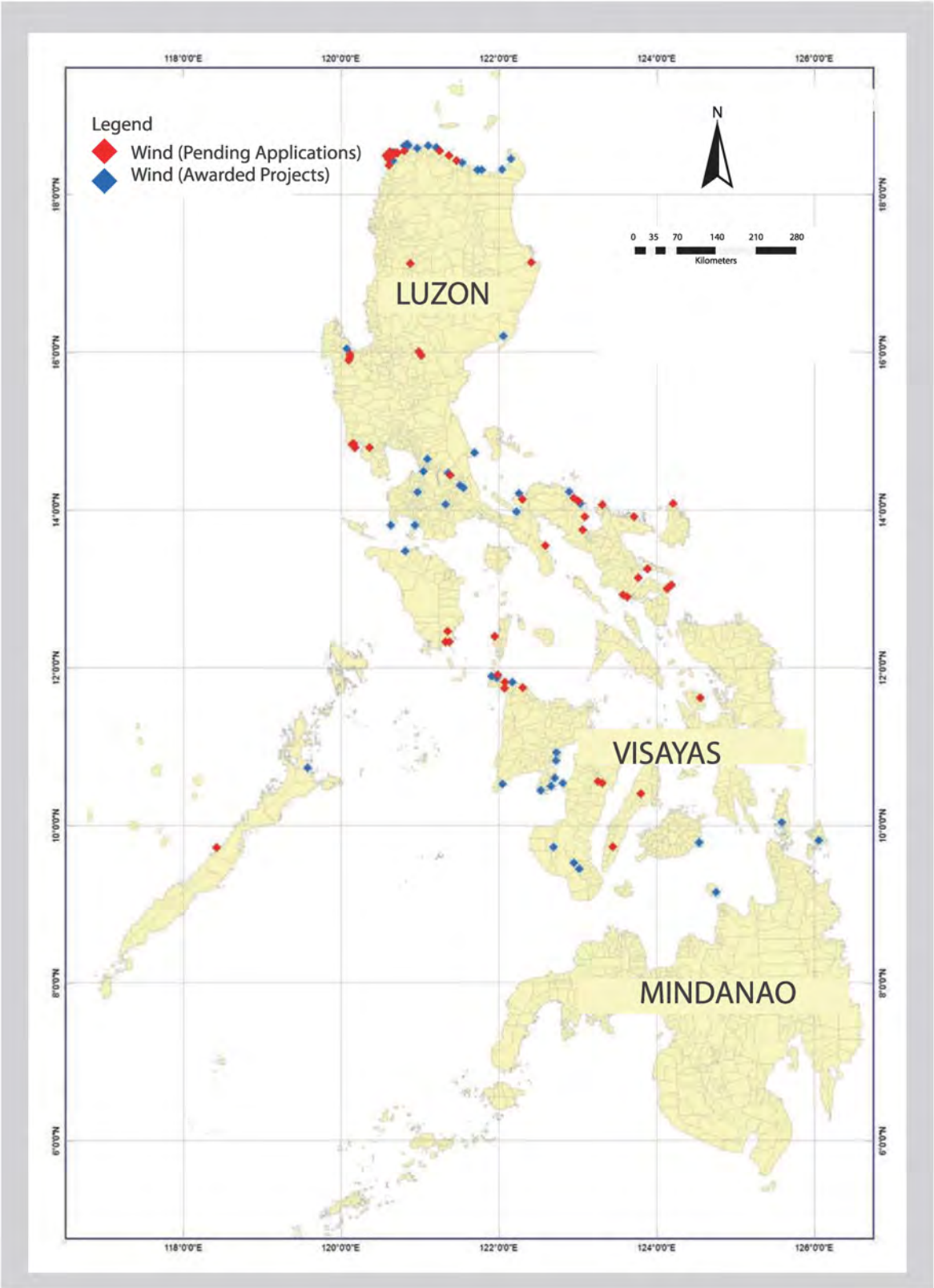
v) Area-Based Energy Component

This serves as a mechanism to accelerate the promotion, commercialization and use of renewable energy (RE) technologies such as wind at the regional and sub-regional levels through a decentralized, area-based approach.

In developing area-based RE projects, oversight on the performance of the Affiliated Renewable Energy Centers (ARECs) with regards to the wind energy sector shall be provided. These Centers serve as the extension arm of the DOE at the regional and provincial levels. As the link between the national and local structures, the ARECs are envisioned to improve the local energy situation through an area-based planning approach. The ARECs' activities, include among others, the formulation of rural energy plans and programs including their implementation; installation of wind energy demonstration systems; maintenance and rehabilitation of non-operational demonstration units; conduct of trainings/seminars for end-users, manufacturers and other key players; and assistance to local/rural clientele.

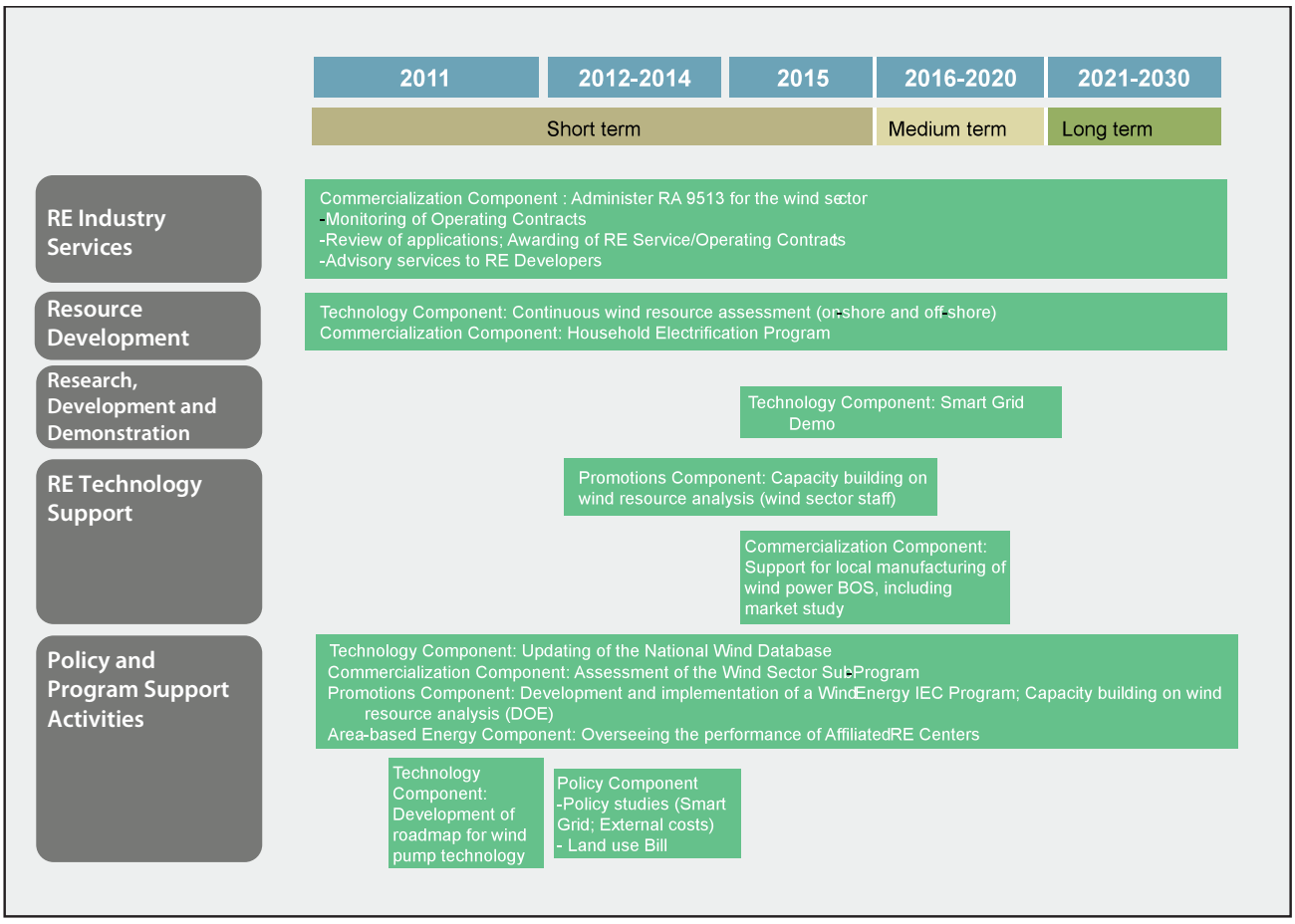
The schedule of implementation of the above-cited activities is shown in Figure 21.

FIGURE 20. LOCATION MAP OF TARGETED WIND CAPACITY ADDITION[24]



[24] *Includes pending applications without proposed capacity as of April 20, 2011.*

FIGURE 21. WIND SECTOR SUB-PROGRAM PROJECTS/ACTIVITIES AND SCHEDULE OF IMPLEMENTATION



5. Solar Energy Sector Sub-Program

Solar energy is used for power or non-power applications. Various technologies capture the energy derived from solar radiation, concentrate it, store it, and convert it into other useful forms of energy, such as electric energy or useful thermal energy.

a) Overview of the Solar Energy Sector

Most of the solar energy applications in the country are found in the rural areas, due in part to the rural electrification initiative of the national and local government units (LGUs).

Solar energy applications in the rural areas are mostly photovoltaic (PV) stand-alone systems which range from 20-75 watt-peak (Wp) individual solar home systems to community-based lighting applications (e.g., streetlights, village centers, and schools). Technological developments have allowed telecommunication companies to use PV as back-up power supply in their remote cell sites. In urban areas, solar energy is most commonly used to supply thermal energy for water heaters.

The only grid-connected solar power plant in the country was built by the Cagayan de Oro Electric Power and Light Company (CEPALCO), a private distribution utility based in Northern Mindanao. The 1-MW PV power plant, the largest grid-connected plant in the developing world, maximizes the efficiency of the utility's 7-MW Bubunawan hydroelectric facility.

The country also hosts the Sunpower Solar Wafer Fabrication Plants located in Laguna and Batangas.

Based on a study undertaken by the US-National Renewable Energy Laboratory (NREL) using the Climatological Solar Radiation (CSR) Model, the Philippines has an average daily insolation of 5 kilowatt hour per square meter (kwh/m2). The CSR model is illustrated in Figure 22.

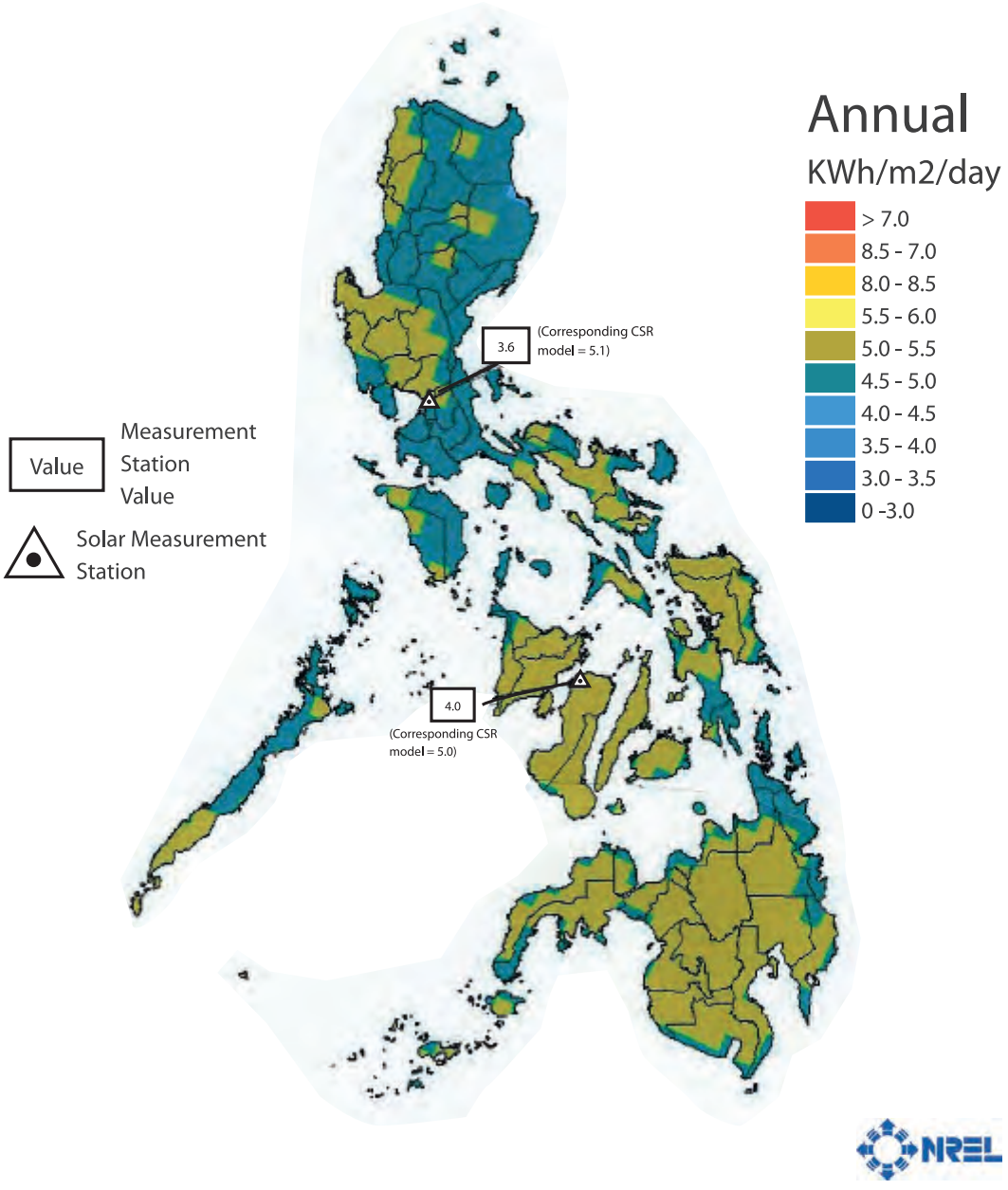
Solar energy can be used almost anywhere in the country. A factor affecting its use in large-scale solar power plants,

however, is the land requirement. Estimates put the land area requirement at approximately one square kilometer for every 20-60 megawatts (MW) of electricity produced through solar energy.

Since the land requirement is a concern for large central solar power plants, PV in unused space of rooftops in homes and buildings and in urban and industrial lots have become prevalent in other countries. In solar building designs, the structure itself acts as the solar collector, thereby, decreasing the need for additional space.

The solar sector is composed mainly of solar PV suppliers and integrators which source most of their system components abroad. The solar sector's outlook is expected to remain positive and improve due to the continued governmental policy of pursuing rural electrification and the incentive mechanisms in the RE Law such as Net Metering and FiT. There is still a need, however, to address challenges and gaps to fully harness this abundant resource, which include, among others, (i) intermittency of the resource; (ii) high initial cost; (iii) land area requirement; and (iv) need for additional R, D and D as well as capacity building on other technologies, such as the Concentrating Solar Thermal Power (CSP) technology and solar thermal cooling/heating technology.

FIGURE 22. CLIMATOLOGICAL SOLAR RADIATION MODEL



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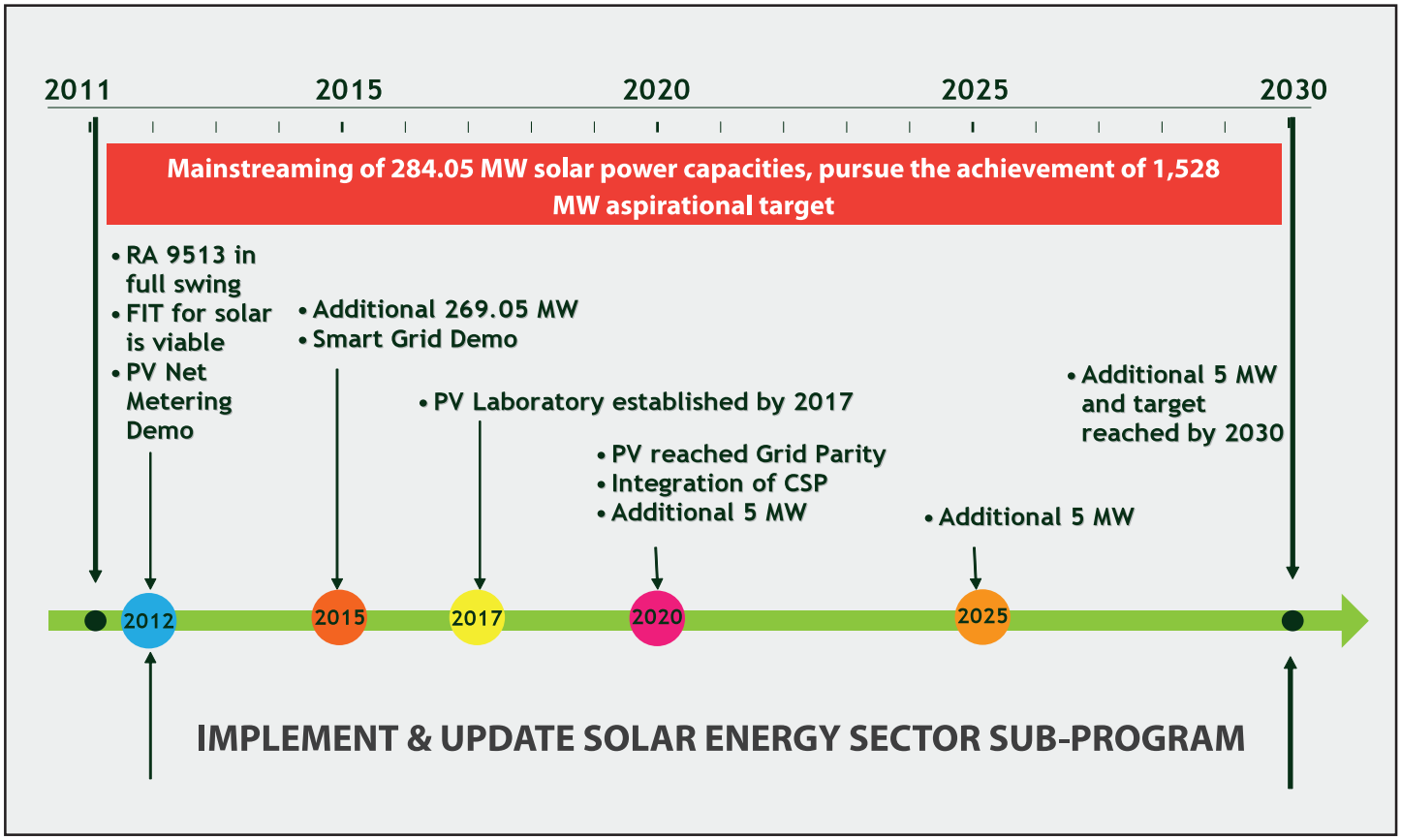
b) Solar Energy Sector Roadmap

Figure 23 shows the Solar Energy Sector Roadmap for the period 2011-2030[25]. The roadmap sets an aspirational target of additional 1,528 MW of solar power capacity, representing 3 % of the country's 2010 total RE installed capacity of 5,438 MW. In setting this aspirational target, it has been noted that there are projections that solar energy will provide 5% of the global electricity consumption by 2030[25] .

This aspirational target is leveraged on the assumption that massive private sector interest will be generated by the fiscal and non-fiscal incentives provided under the RE Law, particularly the feed-in-tariff (FiT) and net metering, as well as the fast technological advances of PV which is predicted to reach its grid parity by 2020 or even earlier. the feed-in-tariff (FiT) and net metering, as well as the fast technological advances of PV which is predicted to reach its grid parity by 2020 or even earlier. Of the above-cited aspirational target, an aggregate capacity of 284 MW has already been programmed over the planning period, based on RE Service/Operating Contracts awarded and are being evaluated by the DOE. Comprising of twenty (20) projects, this installation target is expected to be met by 2030 (Table 26). Luzon shall host majority (80%) of the additional solar capacity, with a large portion expected to be ready for commissioning by 2013. Table 27 presents the distribution of the projects by location.

FIGURE 23. SOLAR SECTOR ROADMAP



[25] *Reference: Solar PV Technology Roadmap by the International Energy Agency.*

TABLE 26. LIST OF INDICATIVE SOLAR PROJECTS[26]

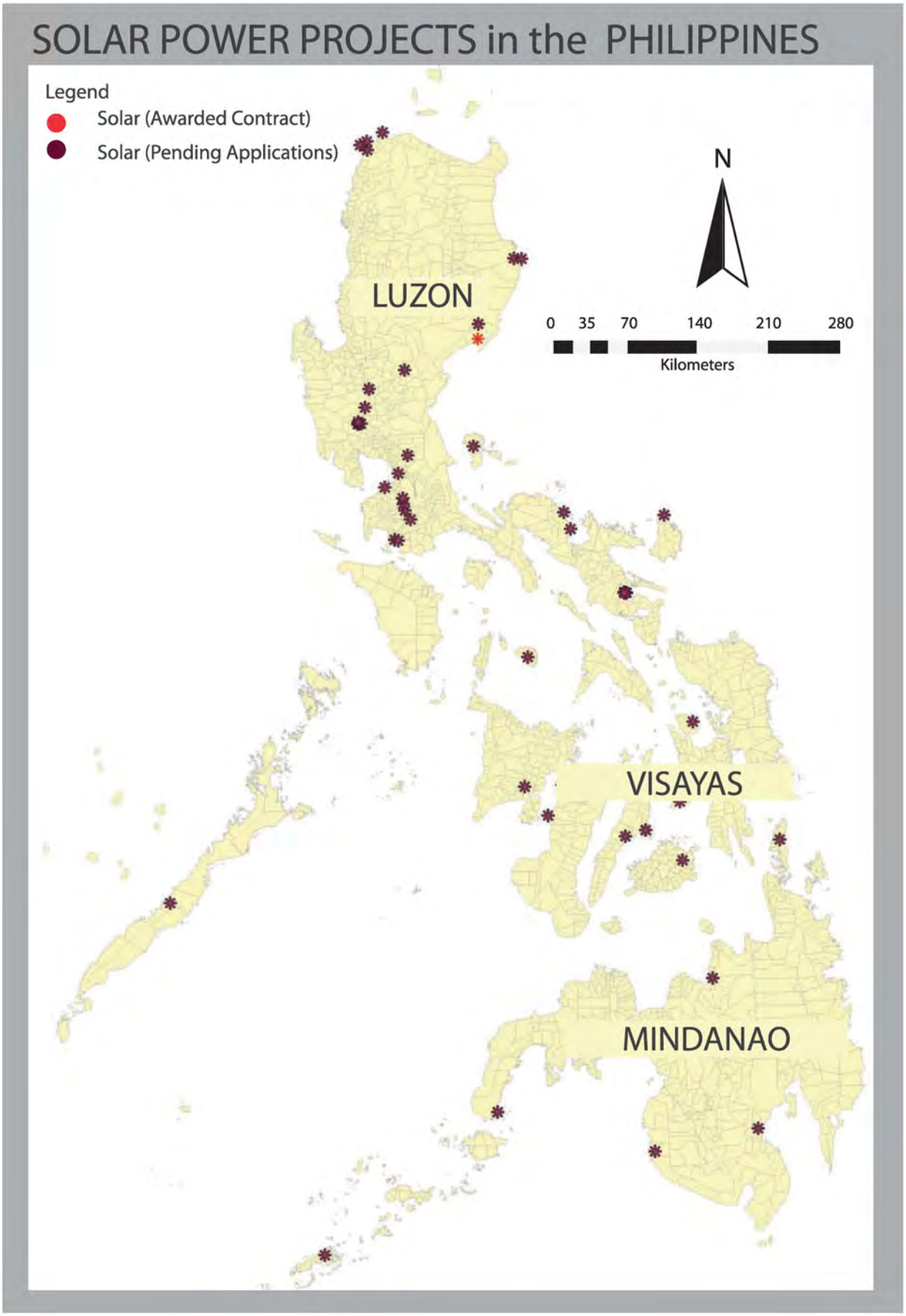
No.	Name of Project	Capacity (MW)	Target Commissioning Year
Luzon			
1	Casiguran Solar Project	1.000	2012
2	Pasuquin - Burgos Solar Power Project	50.000	2013
3	Clark Freeport Zone Solar Power Project	50.000	2013
4	Cavite Export Zone Solar Power Project	50.000	2013
5	Ulano, Tanauan City Solar Power Project	0.180	2011
6	Metro Manila Solar Power Project	20.000	2013
7	Laguna Solar Power Project	12.500	2013
8	Clark Economic and Freeport Zone	7.500	2013
9	Macabud, Rodriguez, Rizal Solar Power Project	30.000	2013
10	Casiguran Solar Power Project	2.000	2013
11	Polilio Solar Power Project	2.000	2013
12	Canlubang Solar Power Project	0.215	2011
13	Pantabangan Dam Solar Power Project	2.000	2013
14	Malvar, Batangas Solar Power Project	0.150	2012
15	Sta. Rita Solar Power Project	0.500	2013
	Sub-Total	228.045	
Visayas			
16	Camotes Solar Power Project	2	2013
17	Sibuyan Solar Power Project	2	2013
18	E. Magalona Solar Power Project	30	2013
	Sub-Total	34	
Mindanao			
19	Kirahon Solar Power Project	20	2013-2 MW; 2015-3 MW; 2020-5 MW; 2025-5 MW; 2030-5 MW;
20	Dinagat Solar Power Project	2	2013
	Sub-Total	22	
	TOTAL	284.05	

[26] *Pending applications without proposed capacity were excluded in the tabulation.*

TABLE 27. TARGETED SOLAR CAPACITY ADDITION (MW), BY LOCATION

Location	Commissioning Year				Total Capacity Addition (MW)	% Share
	2011-2015	2016-2020	2021-2025	2026-2030		
Luzon	228.05	0	0	0	228.05	80.03
Visayas	34	0	0	0	34	12.0
Mindanao	7	5	5	5	22	7.7
Total Philippines	269.05	5	5	5	284.05	100.0

FIGURE 24. LOCATION MAP FOR TARGETED SOLAR CAPACITY ADDITION[27]



[27] *Includes applications without proposed capacity.*

c) Solar Energy Sector Sub-Program

The Solar Energy Sector Sub-Program (SESP) is envisioned to support the following policy thrusts of the Philippine Energy Plan: (i) ensuring energy security; (ii) pursuing effective implementation of energy sector reforms; and (iii) implementing social mobilization and cross-sector monitoring mechanisms.

The goal of mainstreaming the grid system (on-grid and off-grid) with 1,528 MW solar power capacity shall be pursued by accelerating the development and utilization of the country's solar energy potential within the planning horizon 2011 to 2030. This scenario is based on the following assumptions:

- The different mechanisms of the R. A. 9513 are fully in place by 2012;
- Approved Feed-in-Tariff rates for solar energy systems are favorable;
- Innovative financial programs for solar energy projects are available from both government and private financial institutions; and
- Infrastructure supports are in place.

The strategies to be adopted to attain the abovementioned goals include:

- Intensify research, development, demonstration and deployment of solar energy technologies;
- Conduct detailed solar energy resource assessments;
- Aggressively pursue the development of solar energy projects;
- Implement extensive IEC campaigns on the benefits of solar energy; and
- Institutionalize area-based energy planning and management for solar energy systems.

The SESP shall be implemented in close coordination with other energy-related agencies. These include the National Power Corporation-Small Power Utilities Group (NPC-SPUG), Philippine National Oil Company (PNOC), and the National Electrification Administration (NEA).

While the SESP shall basically have the same types of activities similar to the other RE sectors, it has five (5) strategic components each addressing a range of concerns facing the sector, namely:

i) Technology Component

This aims to develop economically viable solar energy systems and/or components to levels of technical maturity wherein they can be commercially competitive with conventional energy systems. The types of activities under this classification include: Resource Development, Technology Support, R, D & D and Program Support-related Activities.

This component consists of the following activities:

a. Technology Roadmaps

The Technology Roadmaps are intended to guide the DOE in the local adoption of solar energy technologies through intensive research, development, demonstration and deployment in cooperation with the academe and concerned government agencies. The PV Technology Roadmap and the CSP Technology Roadmap have already been developed and incorporated in this work program. The solar cooling/ heating technology roadmap shall also be developed and implemented over the planning period. The said roadmaps shall be regularly updated to incorporate new policies and technological advances.

b. Resource Assessment

As a proactive support to the private sector, detailed resource assessments shall be conducted by the government for solar energy resource. For PV, the resource assessment shall focus on the identification of commercial areas feasible for centralized systems. On the other hand, assessment of the solar energy resource for CSP system will be undertaken. Identified potential areas will be offered for development by the private sector through the procurement process under R. A. 9513.

c. National Solar Energy Database

A national database containing solar resource data in forms that are useful, readily accessible and known to target clients such as potential private investors and policy makers shall be established and uploaded in the Internet. It would also include information on best practices and approaches in the

local solar energy development and utilization and other related information.

d. RP-Japan Project For Introduction Of Clean Energy By Solar Electricity Generation System

The project aims to demonstrate the financial viability and technical feasibility of solar photovoltaic power generation facility under the net metering mechanism of the R. A. 9513.

e. Other Activities In The Pipeline Include:

- Establishment of a Solar PV Laboratory – this will serve as the center for solar energy RD&D activities;
- Establishment of a Solar PV Institute – this will serve as the manpower resource training and research center for solar RD&D activities;
- Demonstration of CSP Technology – this aims to demonstrate the technical feasibility and financial viability of CSP in the country;
- Demonstration of Smart Grid – this will demonstrate the effectiveness and efficiency of the technology in addressing the technical challenges of integrating intermittent power generating facilities, such as solar, in the grid;
- Establishment of Solar PV Codes and Standards – this would support the standardization of solar energy system components, specifically the balance-of-systems (BOS), and ensure that locally-manufactured components are competitive with imported components.

ii) Commercialization Component

This envisions the creation of a favorable market to encourage private sector investment and participation in the development and utilization of solar energy projects and activities. The types of activities under this classification include: RE Industry Services, Technology Support and Policy and Program Support-related activities.

a. Full implementation of R.A. 9513 for the solar energy sector

Inputs shall be provided to the development of policy mechanisms related to the solar sector in consonance with the RE Law.

b. Registration, Accreditation, And Monitoring Of Developers Per R.A. 9513

Under the Act, the DOE administers the registration of solar developers and accreditation of solar energy systems fabricators, manufacturers and suppliers. Likewise, the performance of solar energy players will be regularly monitored and evaluated as part of regulatory compliance monitoring.

c. Household Electrification Program

The program aims to energize off-grid households in support of efforts to achieve 90% household-level electrification by 2017 using commercially-viable and technically-feasible solar energy systems. This is intended to create demand in off-grid areas that would eventually support future grid extension.

d. Market Study On The Local Manufacturing Of PV Balance-Of-Systems (Bos)

The study attempts to improve the financial viability of PV systems through local manufacturing of component parts such as inverters and controllers.

e. Market Study On Processing Of Local Materials For PV Manufacturing

The study attempts to determine the viability of using locally-available materials for PV module manufacturing.

iii) Promotions Component

This intends to heighten public awareness on the advantages and benefit of the use of solar energy systems. In intensifying promotions and information campaigns on solar energy, the following activities shall be undertaken:

a. Public Awareness

The Information, Education, and Communication (IEC) Program established under the DOE-UNDP-GEF CBRED Project will be updated and implemented for the creation of public awareness on solar energy. It shall develop strong consciousness of the government and the people on the benefits and advantages of solar energy sources and technologies. This will involve the conduct of various promotional and information dissemination activities that will enhance the appreciation of various RE stakeholders (both government and civil society) on the use of said technologies.

IEC activities will likewise aim to stimulate private sector and investor interest in solar energy projects. LGUs, NGOs and other local organizations shall be encouraged to develop and formulate local and community-based projects using wind energy systems. Consumers shall also be encouraged to use and utilize wind energy sources and technologies.

b. Strengthening of Linkages

Linkages with the academe for the institutionalization of solar energy subjects in technical and engineering courses will be established.

iv) Policy Component

This activity component will involve the formulation, advocacy, implementation, and evaluation of policies on the development and utilization of solar energy resources and technologies. Activities are mainly Policy and Program Support-related.

a. Policy Study On The Internalization Of External Cost

This aims to level the playing field between conventional and renewable energy systems such as solar.

b. Policy Study On Mainstreaming Smart Grid

This aims to address the technical challenges of optimizing the integration of intermittent power generating facilities such as solar.

c. Advocacy on the Passage of the Land-Use Bill

This aims to support the declaration of qualified areas prioritized for solar power generation.

d. Assessment Of The Solar Energy Sector Sub-Program

Regular monitoring and evaluation of the efficiency and effectiveness of the sub-program.

e. Evaluation Of The Effectiveness And Efficiency Of R. A. 9513 (Particularly On Solar)

Regular monitoring and evaluation of the outcome of the Act as it pertains to the solar sector.

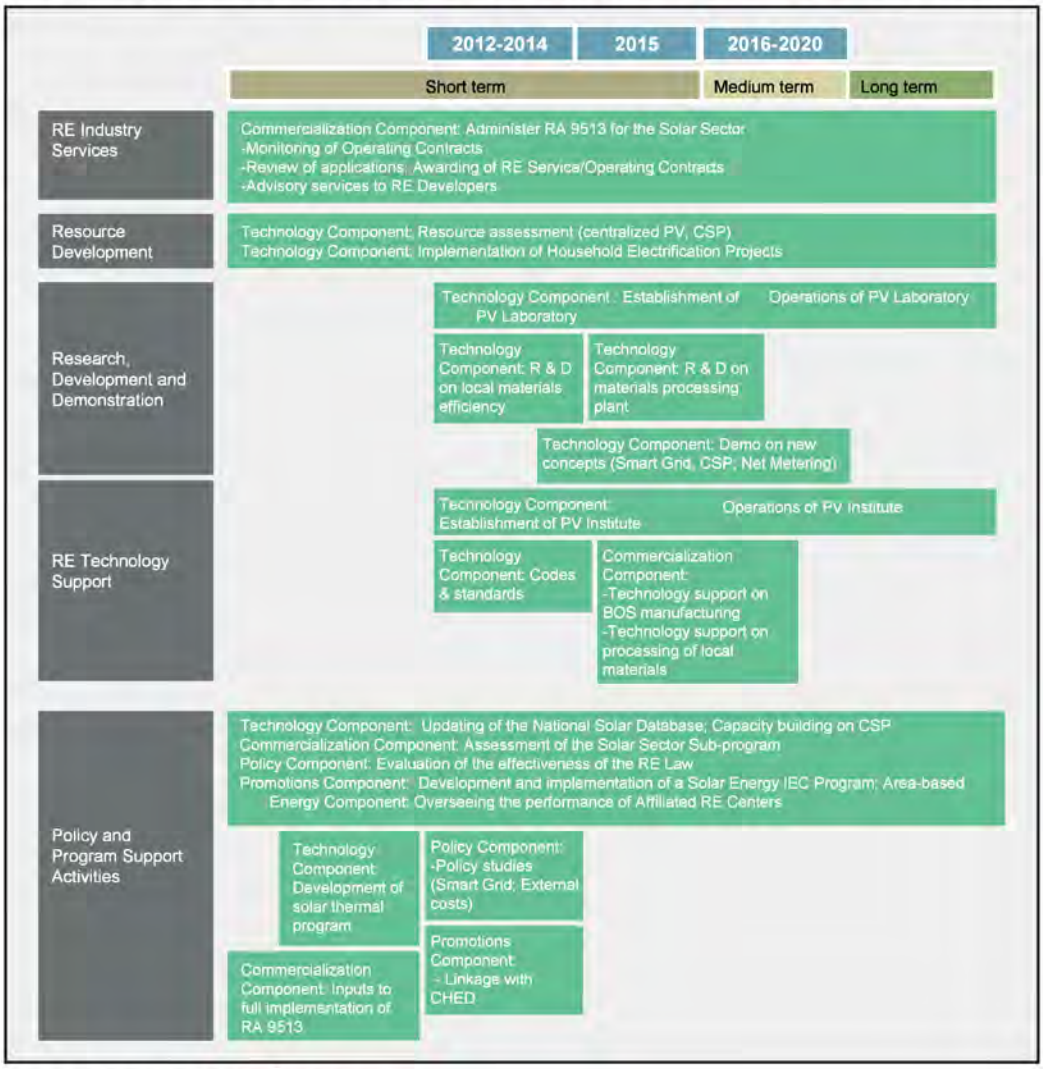
v) Area-Based Energy Component

This serves as a mechanism to accelerate the promotion, commercialization and use of renewable energy (RE) technologies at the regional and sub-regional levels through a decentralized, area-based approach.

In developing area-based RE projects, oversight on the performance of the Affiliated Renewable Energy Centers (ARECs) with regards to the solar energy sector shall be provided. These Centers serve as the extension arm of the DOE at the regional and provincial levels. As the link between the national and local structures, the ARECs are envisioned to improve the local energy situation through an area-based planning approach. The ARECs' activities, include among others, the formulation of rural energy plans and programs including their implementation; installation of solar energy demonstration systems; maintenance and rehabilitation of non-operational demonstration units; conduct of trainings/seminars for end-users, manufacturers and other key players; and assistance to local/rural clientele.

The schedule of implementation of the above-cited activities is shown in Figure 25.

FIGURE 25. SOLAR SECTOR SUB-PROGRAM PROJECTS/ACTIVITIES AND SCHEDULE OF IMPLEMENTATION



6. Ocean Energy Sector Sub-Program

While the country is endowed with vast ocean resource potential, there have been very limited activities in this sector. This is primarily because of the high investment cost for its exploitation. Considering its limited resources, the government maintains a watchful eye on developments in other countries which may be applicable in the Philippines but at the same time it has kept itself open to opportunities for involvement and the development of the ocean energy sector.

a) Overview of the Ocean Energy Sector

A study conducted by the Mindanao State University indicated that the country, being an archipelago, has a theoretical capacity of 170,000 MW over a 1,000 sq. km ocean resource area. Table 28 lists the 16 areas where ocean thermal energy conversion (OTEC) has a good potential. Table 29 on the other hand, presents the 18 potential sites for wave power.

Previous initiatives on ocean energy dealt mostly on resource assessment. With the passage of the RE Law; however, renewed interest on the technology has surfaced. There are currently a total of 73,710 hectares, divided into 910 blocks, open for ocean energy development. At present, the DOE has signed three (3) Pre-Development Service Contracts with two companies covering a total of 5,508 hectares. Figure 26 presents the location map of the above-cited potential areas for OTEC and wave power, including those with Pre-Development Contracts.

There are two types of energy that can be produced from the ocean, namely: (1) thermal energy from the sun's heat, and (2) mechanical energy from tides and wave. The few ocean energy facilities that have been built worldwide are utilized for power

production. In previous years, however, tidal energy has been used by building small dams along ocean estuaries and small streams. The tidal water behind these dams was used to turn water wheels to mill grains.

There are three ways of harnessing ocean energy: the first two using mechanical energy and the third using thermal energy. Wave power or energy can be tapped by capturing the kinetic energy or the back-and-forth or up-and-down movement of the waves, and use this to spin a turbine or drive a piston. Most wave systems in operation power small lighthouses and warning buoys.

Tidal power or energy, on the other hand, involves the trapping of water at high tide in reservoirs behind dams. The energy is captured as it rushes out and drops in its change to low tide. This works in a similar way as a hydroelectric power plant. The main concern in making tidal power plants more cost-effective is the availability of the energy - the plant can only generate when the tide is flowing in and out, which is normally only about 10 hours a day. The resulting capacity factor is, therefore, low, usually in the range of 20-35%. This is, however, compensated by its predictability and reliability as tides are generally predictable. Advance planning is, therefore, possible for occasions when the tidal station is out of action. While the potential for tidal power has long been recognized, its full commercialization is hampered by its high capital investment. Massive structures need to be built in a difficult saltwater environment. A very wide area for the structures is also required. Familiar and reliable low-head hydroelectric generating equipment, conventional marine construction techniques, and standard power transmission methods are used. Placing the impoundment offshore, rather than using the conventional "barrage" approach, eliminates environmental and economic problems that have prevented the deployment of commercial-scale tidal power plants.

In an Ocean Thermal Energy Conversion (OTEC) system, energy is extracted through the flow of heat with the difference in the temperatures of the deep and surface waters. A difference of at least 38°F between the warmer surface water and the colder deep ocean water is required. An OTEC power plant requires an expensive, large diameter intake pipe, which is submerged a kilometer or more into the depths of the ocean. This brings the very cold water to the surface.

The challenges and gaps facing the sector include: (i) the need to conduct detailed resource assessment to validate and identify potential sites; (ii) high investment cost; (iii) long construction period; (iv) huge area requirement; (v) environmental concerns on marine life; (vi) need for capacity building.

b) Ocean Sector Roadmap

Figure 27 shows the Ocean Sector Roadmap for the period 2011-2030. Since the ocean power projects are still in the exploration stage, only a minimal 70.5 MW capacity addition is expected. The roadmap envisions the operation of the country's 1st ocean energy facility by 2018.

Table 30 shows the list of the indicative projects for ocean energy. Table 31, on the other hand, summarizes their distribution by location. Majority of the ocean power projects shall be located in Luzon.

TABLE 28. POTENTIAL OTEC SITES

Potential Site	
1.	Luzon Strait – Batan Island • Y'ami Island East Coast • North Island East Coast • Mabudis Island East Coast • Silayan Island West Coast • Itbayat Island West Coast • Batan Island North Coast • Balintang Island West coast • Babuyan Island East Coast
2.	Luzon Island • Caramoan Peninsula on Lagonoy Gulf – East Coast • Cape Bolinao West Coast • Cape San Ildefonso East coast • Palauig Point West Coast • Bondoc Point South Coast
3.	Mindoro Island • Cape Calauite – North Coast • Dongon Point – West Coast
4.	Tablas Strait – East Coast
5.	Burias Strait – Aguja Point
6.	Ticao Island – West Coast
8.	Samar Island • Cape Espiritu Santo to Bunga Point – East Coast • Tugnug Point
9.	Leyte Island • Sogud Bay – South Coast
10.	Panon Island
11.	Bohol Island – Nauco Point
12.	Southern Part - Mindanao • North Coast • Gingoog Bay • Macajalar Bay • Iligan Bay
13.	West Coast of Zamboanga Peninsula • Batutindog Point • Illana Bay • Tapian Point
14.	Maguling Point
15.	East Coast • Tambunan Point • Cape San Agustin
16.	Tugubuan Point Mayo Bayat

TABLE 29. POTENTIAL WAVE POWER SITES

Potential Site			
1.	Batan Island, Batanes	10.	Northeastern Coast, Catanduanes
2.	Northeastern Coast, Ilocos Norte	11.	Southeastern Coast, Sorsogon
3.	Babuyan Island	12.	Northern Samar
4.	Aurora Province, East Coast	13.	Southeastern, Tacloban City
5.	Northeastern Cagayan	14.	East Coast, Dinagat Island
6.	West Coast of Bolinao, Pangasinan	15.	East Coast, Siargao Island
7.	East Coast, Polilio Island, Quezon	16.	Northeastern Coast, Surigao del Sur
8.	East Coast, Camarines Sur	17.	East Coast Davao Oriental
9.	East Coast, Camarines Norte	18.	West Coast, Palawan

Source: DOE

FIGURE 26. LOCATION MAP OF POTENTIAL AREAS FOR OCEAN POWER DEVELOPMENT

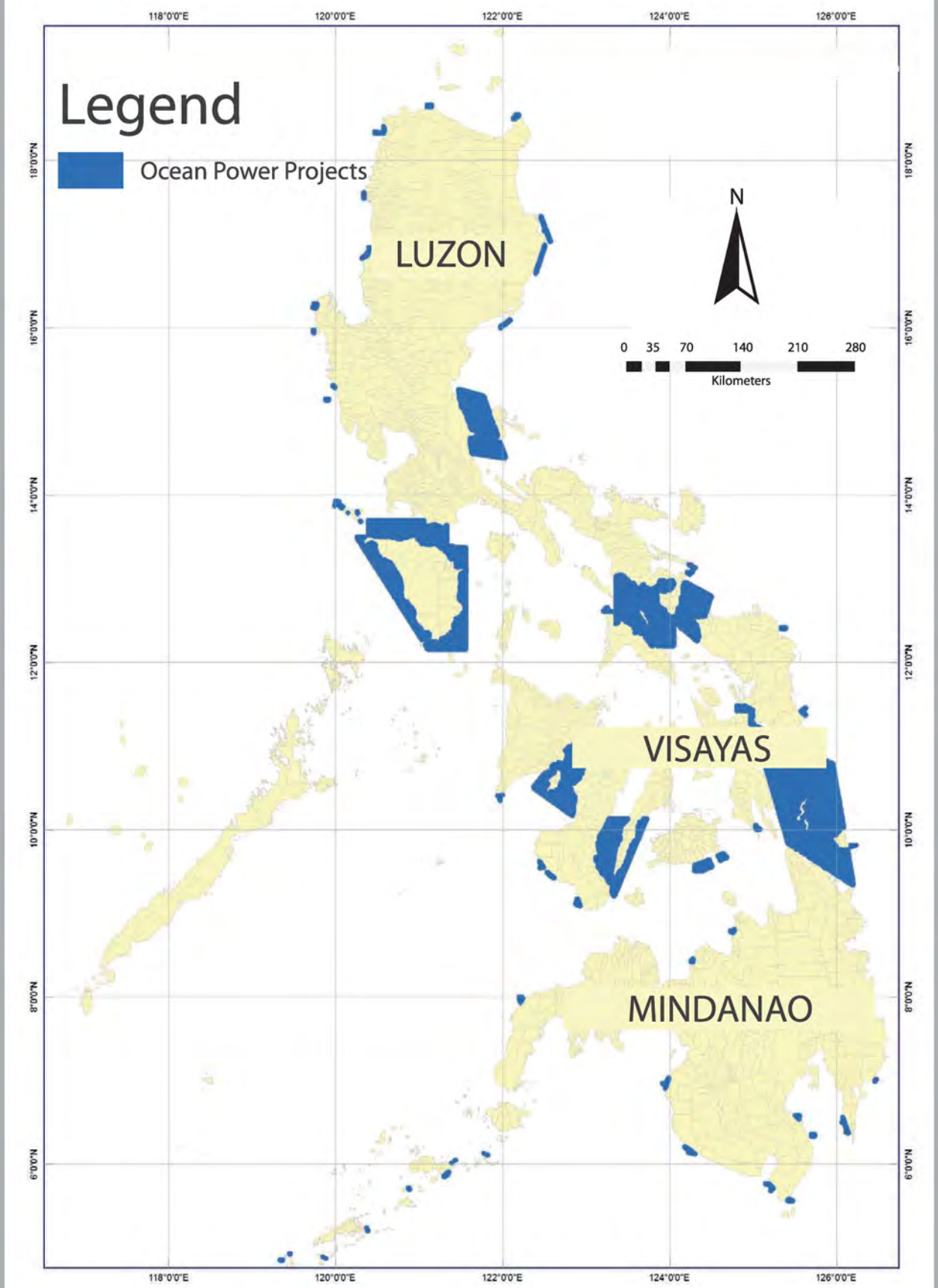


FIGURE 27 OCEAN SECTOR ROADMAP (2011-2030)

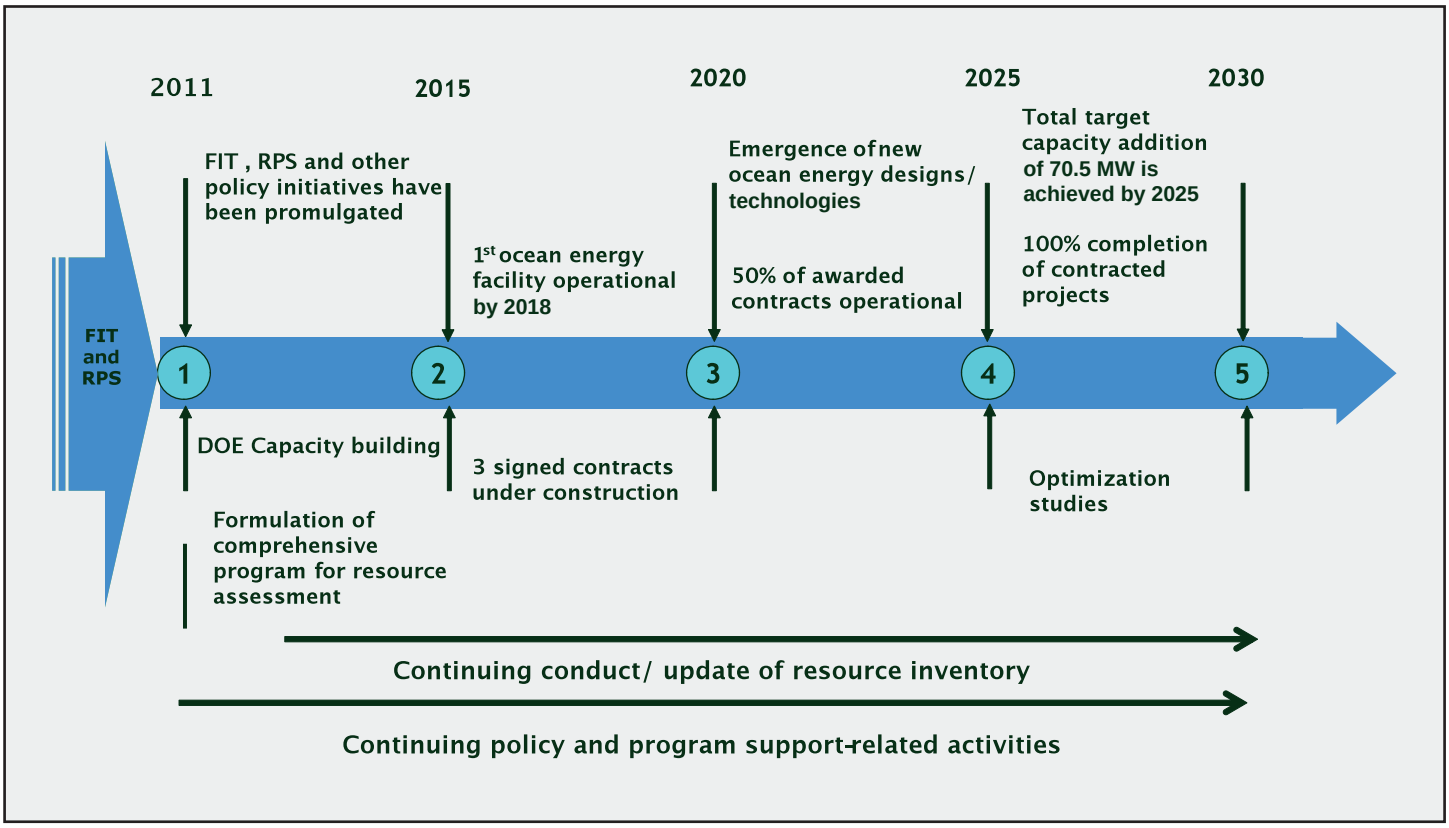


TABLE 30. LIST OF INDICATIVE OCEAN ENERGY PROJECTS[28]

No.	Name of Project	Capacity (MW)	Target Commissioning Year
Luzon			
1	Palaui Island Tidal Power	5.0	2020
2	Cabangan OTEC	10.0	2018
3	Matoco and Arenas Point Tidal Power	1.0	2020
4	Rosario-Malabrigo Point Tidal Power	1.0	2020
5	Cabra Island Tidal Power	2.5	2020
6	Looc Tidal Power	1.0	2020
7	San Bernardino Strait Tidal Power	10.0	2020
8	Sta. Magdalena Tidal Power	5	2020
	Sub-Total	35.5	
Visayas			
9	Iloilo City-Buenavista Tidal Power	1.0	2023
10	Nueva Valencia Tidal Power	2.50	2023
11	Balcuatro Point-San Bernardino Bank Tidal Power	5.0	2023
12	Sta. Rita Tidal Power	2.50	2023
	Sub-Total	11.0	
Mindanao			
13	Bongo Island Tidal Power	1.0	2025
14	Dapa Tidal Power	5.0	2025
15	Hinatuan Passage Tidal Power	10.0	2025
16	Buculus-Bulaan Island Tidal Power	1.0	2025
17	Lugus-Tapul Island Tidal Power	2.5	2025
18	Northern Sibulu Tidal Power	2.5	2025
19	Sibulu Island Tidal Power	1.0	2025
20	Simunul Tidal Power	1.0	2025
	Sub-Total	24.0	
	TOTAL	70.5	

TABLE 31. TARGETED OCEAN POWER CAPACITY ADDITION (MW), BY LOCATION

Location	Commissioning Year				Total Capacity Addition (MW)	% Share
	2011-2015	2016-2010	2011-2015	2016-2010		
Luzon	0	35.5	0	0	35.3	50.4
Visayas	0	0	11	0	11	15.6
Mindanao	0	0	24	0	24	34
Total Philippines	**0**	**35.5**	**35**	**0**	**70.5**	**100**

[28] *Pending applications without proposed capacity were excluded in the tabulation.*

c) Ocean Sector Work Program

Throughout the planning period, the DOE shall intensify efforts to assist and advise interested investors in exploration and development of the untapped ocean energy resource potential.

In the short-term (2011-2015), a comprehensive program for resource assessment and development shall be formulated. Thereafter, the inventory of the country's ocean resources shall be updated continuously. To enable the provision of appropriate assistance and advisory services to sector participants, DOE personnel shall be capacitated through attendance to local and foreign training as well as participation in study tours to operational ocean energy technologies.

Activities during the medium-term (2016-2020), shall progress towards the conduct of an active promotional campaign to encourage private sector partners to invest in ocean energy technologies. The ocean resource studies in previous years shall be packaged into development projects. Hopefully, the aggressive campaign shall culminate in the completion of the 1st ocean energy facility by the year 2018.

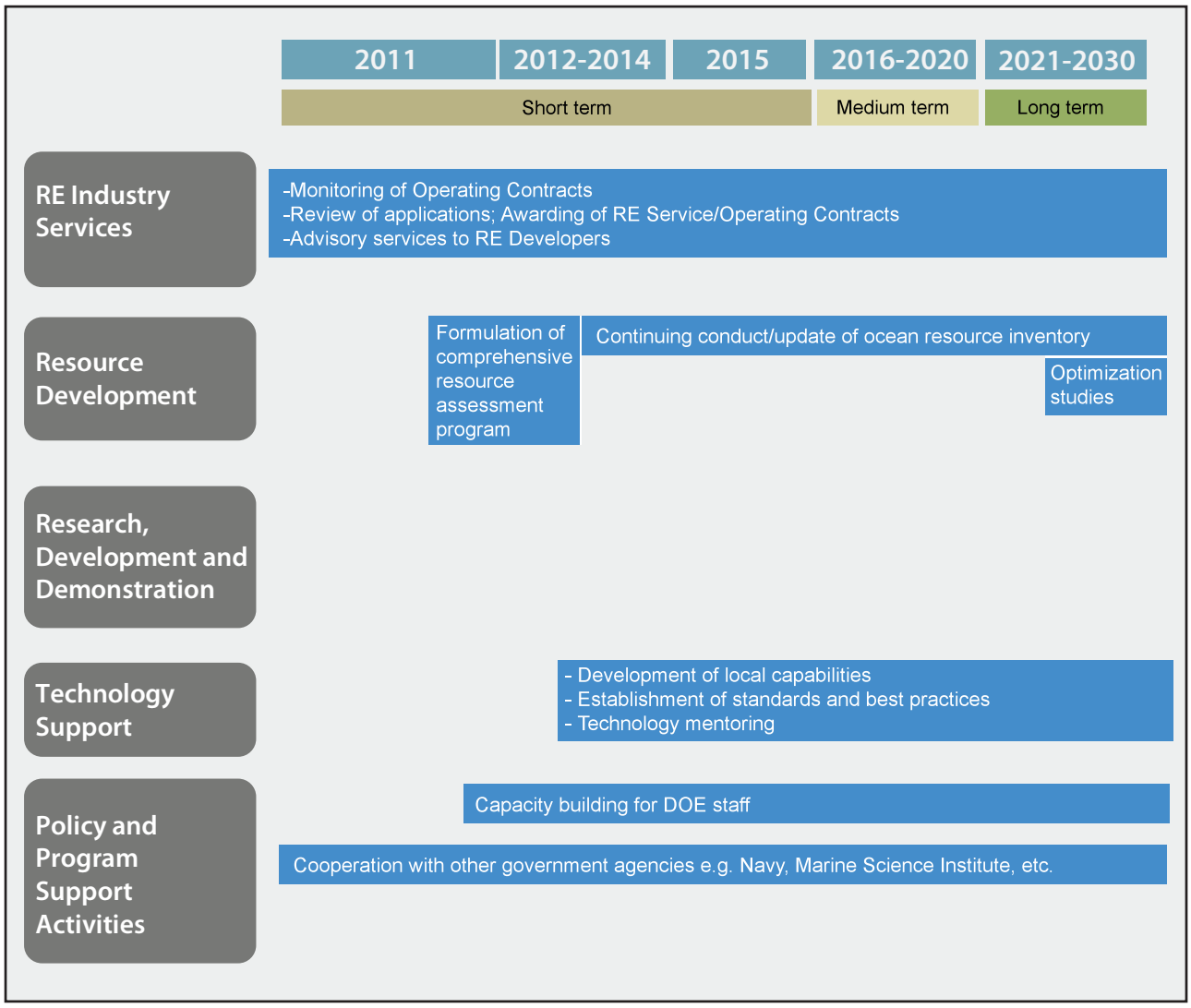
The DOE shall keep a close watch on developments abroad to identify opportunities for technology transfer. Technology support activities, through capacity building and mentoring of sector participants' personnel as well as the establishment of standards and best practices, shall be sustained throughout the planning period (2011-2030). Program support activities, such as technical cooperation with relevant agencies, e.g., Philippine Navy, Marine Science Institute, shall likewise be continued.

The sector's work program is listed in Table 32 while the schedule of implementation is shown in Figure 28.

TABLE 32. OCEAN SECTOR WORK PROGRAM, 2011-2030

Type of Activity	Work Program
RE Industry Services	1. Review of applications; endorsement for registration of applications 2. Monitoring of RE contracts 3. Advisory Services to RE Developers on: • RE policy mechanisms/guidelines • Ocean energy project packaging
Resource Development	1. Conduct of Ocean Energy Resources Inventory 2. Feasibility studies 3. Project packaging 4. Optimization of resource inventory
R, D & D	None
RE Technology Support	1. Development of local capabilities 2. Establishment of standards and best practices 3. Technology mentoring activities
Policy and Program Support-Related Activities	1. Cooperation with other government agencies e.g. Navy, Marine Science Institute, etc. 2. Capacity Building Program for DOE staff • Foreign Training • Study Tour to Ocean Energy Facilities

FIGURE 28. OCEAN SECTOR SUB-PROGRAM: PROJECTS/ACTIVITIES AND SCHEDULE OF IMPLEMENTATION



D. POLICY AND PROGRAM SUPPORT COMPONENT

To ensure the smooth and successful implementation of the NREP, it was deemed necessary to incorporate a Policy and Program Support Component.

1. Situationer

The policy and incentive mechanisms provided under the RE Law are comprehensive. Their formulation and implementation involve the participation of various DOE units, attached agencies, and industry stakeholders.

The successful implementation of the NREP hinges on the assumption that the RE policy and incentive mechanisms prescribed by the RE Law are in place.

It is imperative that the various policy mechanisms provided by the RE Law are promulgated and implemented in a timely manner. This will help sustain private sector interest as evidenced by the massive applications for registration of RE projects upon effectivity of the RE Act.

Common support activities that cut across all the RE sectors are included in the program component.

a. Policy Support

Policy support covers the remaining activities that need to be undertaken for the formulation of the required mechanisms, rules and guidelines mandated by the RE Law. This entails close coordination with all concerned entities, particularly, the NREB.

Additionally, there are other policies which could further

encourage or guide private sector participation. Policy mechanisms that need not require legislative action shall be considered initially. These will be studied and deliberated on for the issuance of the necessary rules and guidelines, as may be warranted. Those that require legislative actions shall be considered only after an assessment of the effectiveness of the RE Law in supporting the growth of the RE industry.

b. Program Support

Common support activities shall be undertaken to ensure the smooth implementation of the NREP. At the outset, this is anticipated to include the following:

i. RE One-Stop Shop

The RE One-Stop-Shop is envisioned to serve as the contact point within the DOE for the processing of applications for RE Service/Operating Contracts. It shall facilitate and expedite the review and approval process. It shall also be the focal point for the provision of information services needed by the industry participants for project design, as described in Item (b) below.

When fully operational, the RE One-Stop-Shop is expected to provide the following:

- Integrated RE services with participation of concerned government agencies;
- Integration of Web-based RE Systems Infrastructure, and Database; and
- Automated RE applications.

ii. RE Information Exchange

The RE Information Exchange shall be implemented to provide accurate and specialized RE resource and market information that are useful and readily accessible to target clients such as investors and policy-makers. This aims to address the information barriers encountered in the past. Information that will be made available will include technical data that may be required in the conceptualization or design phase, such as wind speeds and other meteorological data, the volume and maps showing location of RE resources, and market information needed for the evaluation of the economic/ financial viability of a certain RE project (e.g., electricity prices, fuel prices, power demand, among others).

This activity shall take off from the RE Information Exchange system set up under the CBRED Project. As resources may allow, the NREP shall work towards a Web-based service.

iii. Integrated Information, Education And Communication Plan (IEC Plan)

An Integrated IEC Plan shall be developed and implemented to enhance public awareness on the benefits and advantages of RE, the RE Law and the NREP.

It aims to encourage private sector participation in the RE industry as well as to manage public perception on the impact of certain rules and regulations such as the FiT All.

The IEC Plan shall include the conduct of workshops, conferences and promotional events as well as the use of tri-media channels to disseminate information that will develop a strong consciousness on the advantages of RE resources and technologies.

iv. Integrated RE Monitoring and Evaluation System (RE M & E System)

An Integrated RE M & E System shall be developed and implemented to assess the effectiveness of the NREP and the impact of the RE Law. The RE M & E System shall consider lessons learned from past implementation of RE projects and the RE Law, with the view to recommending appropriate action from concerned groups. The RE M & E System shall include, among others, the following:

- the implementation framework;
- timetable of activities;
- performance indicators and data collection methods;
- responsibilities of each party/group/unit;
- reporting requirements (e.g., format, frequency) for the different participants;
- other mechanisms to trigger appropriate action.

The participating groups or units shall be consulted before the system is finalized to ensure their full involvement. This will likewise encourage advocacy, ownership and political will to ensure that the vision of the NREP and the RE Law are met.

v. Affiliated Renewable Energy Centers (ARECs)

The DOE shall continue to oversee the performance of the Affiliated Renewable Energy Centers (ARECs). The ARECs serve as the extension arm of the DOE at the regional and provincial levels. The activities of the ARECs include, among others, the following: (i) monitor the operations of existing RE installations; (ii) provide technical and extension services to RE users/clienteles; (iii) assist in the conduct of the RE resource inventory; (iv) develop regional/provincial RE energy database; (v) assist in the conduct of policy advocacies on RE; (vi) assist in the conduct of IEC campaigns on RE; and (vii) undertake R & D activities on RE. At present, there are 21 ARECs in the various state universities and colleges in the country (Figure 29). These ARECs are expected to play an important role in the M & E System cited above.

vi. Collaboration With Relevant Organizations

The DOE shall ensure that the NREP is consistent with its commitments in various regional groupings such as the Association of South East Asian Nations (ASEAN) and the Asia-Pacific Economic Cooperation as well with its bilateral and multilateral agreements on RE. It shall continue its collaboration work with local, regional and multi-lateral organizations. In particular, committed activities in the following international cooperation and agreements shall be undertaken: the ASEAN Plan of Action for Energy Cooperation 2010-2015, the ASEAN Renewable Energy Sub-Sector Network (RE SSN), the ASEAN+3 New and Renewable Energy and Energy Efficiency and Conservation Forum (NRE EECF), and the APEC Expert Group on New and Renewable Energy Technologies (EGNRET).

2. Work Program

The work program for this component is listed in Table 33 while the schedule of implementation is shown in Figure 30.

FIGURE 29

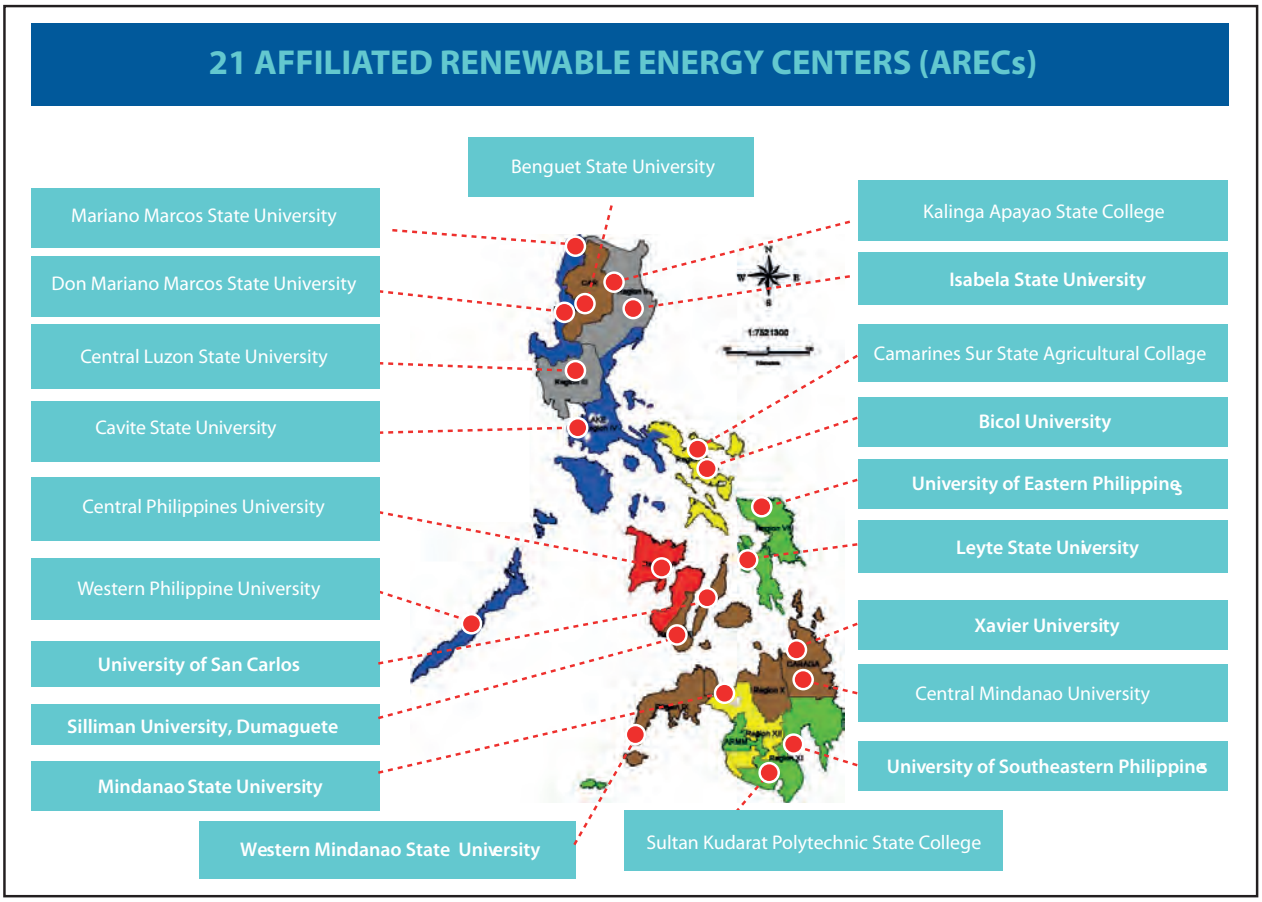
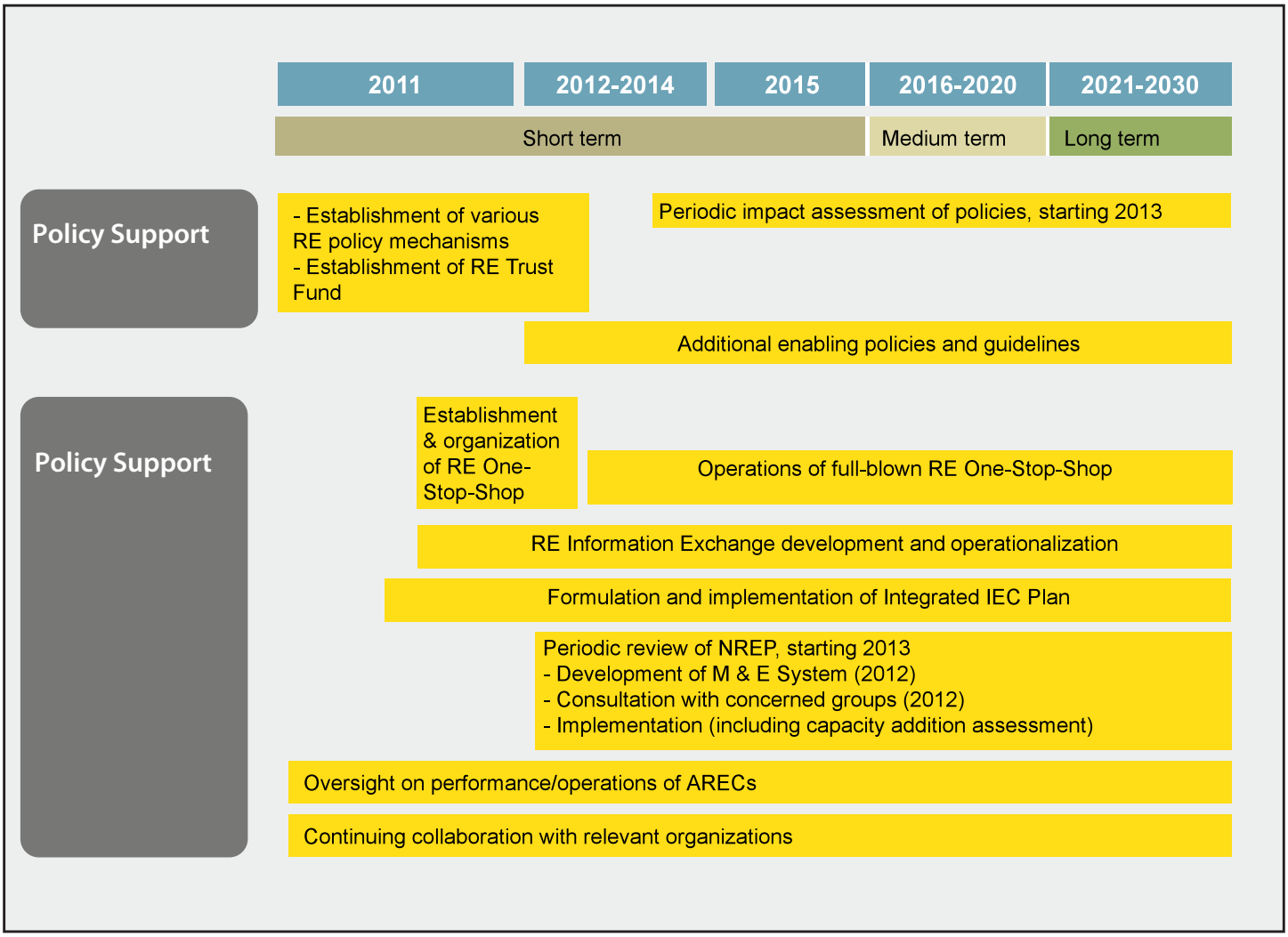


TABLE 33. POLICY AND PROGRAM SUPPORT COMPONENT WORK PROGRAM

Type of Activity	Work Program
Policy and Support	1. Establishment and implementation of Renewable Energy Policy Mechanisms • Renewable Portfolio Standard (RPS) o Rules promulgation o Implementation • Feed-in-Tariff o FiT rates; FiT All o Implementation • RE Market o Framework establishment o Rules for the operation of REM under WESM o Implementation • RE Registrar o PEMC to operationalize RE Registrar o Implementation • Green Energy Option Program (GEOP) o IRR for the Program o Implementation • Net Metering o Formulation of Rules o Public consultations o Rules promulgation o Implementation • Fiscal Incentives (e.g., tax credit, tax rebates, cash incentives of RE developers for missionary electrification, etc.) o Formulation of guidelines o Implementation • Transmission and Distribution System Development • Incentives for Renewable Energy Host Communities/LGU's o Formulation of Rules o Implementation • Formulation of Rules on Off-grid RE Development 2. Administration of Renewable Energy Trust Fund (RETF) • Formulation of mechanism for fund transmittal to DOE • Guidelines in utilization • Promulgation 3. Continuous monitoring and review of implemented RE Policies • Recommendations for possible amendments, if any, to RE Policy Mechanisms implemented 4. Impact Assessment of RE Policies and mechanisms implemented
Program Support	1. Operationalization of RE One-Stop-Shop • Integrated RE services from concerned government agencies • Integration of Web based RE Systems Infrastructure, and Database • Automated RE applications 2. RE Information Exchange • Web based RE applications • RE data base modification and updating 3. Development and implementation of an integrated RE IEC Plan 4. Periodic review of National Renewable Energy Program (NREP) • Development of M & E mechanism • Consultation with concerned groups • Implementation • Capacity addition assessment (off-grid/on-grid) 5. Oversight on performance/operations of ARECs 6. Collaboration with relevant organizations 7. Market assessment for new or emerging RE; support to sub-program development, as may be necessary

FIGURE 30. POLICY AND PROGRAM SUPPORT: PROJECTS/ACTIVITIES AND SCHEDULE OF IMPLEMENTATION



D. INVESTMENT REQUIREMENTS

The targeted RE-based capacity addition of 9,865.3 MW will mainly be financed and undertaken by the private sector and will entail a total investment of PhP1.2 Trillion (equivalent to around USD 26 billion). Table 34 presents the breakdown of this requirement by resource.

Of the said amount, an estimated PhP 17.2 billion have already been committed by the private sector for the development of 124.6 MW projects in the geothermal, hydropower and biomass energy sectors. Another PhP 1.15 trillion shall be needed for the development of the indicative projects with an aggregate capacity of 9,740.7 MW.

Annexes 4 and 5 provide additional details on the cost breakdown for committed and indicative projects, respectively.

Bulk of the investments for indicative projects needs to be infused in the hydro sector with PhP 680 billion required in the development and generation of 5,366.3 MW in 310 proposed sites all over the country. The wind sector comes next with PhP 211 billion needed to produce 2,345 MW from 57 sites which are mainly concentrated in Luzon. The geothermal sector will provide an indicative capacity of 1,425 MW from 32 sites at a cost of PhP 192 billion. Further, an indicative 284 MW is expected to be generated from solar energy in 20 sites and would require PhP32 billion. The biomass sector will require PhP 28 billion to generate an indicative 250 MW from 20 sites nationwide while the ocean sector will require PhP 11 billion for the development of twenty (20) indicative projects.

As necessary, funding proposals shall be prepared for submission to relevant partners. Funding sources may include multilateral organizations through their Clean Technology / Clean Energy financing windows, the RE Trust Fund, bilateral partners and the private sector.

Aside from direct investments for the RE projects, the government shall require both internal and external funding for its projects/ activities. At the outset, external funding may be required in the areas of: (a) resource development; (b) research, development and demonstration; (c) RE technology support, particularly in capacity building; and the program support which may include the development of Web-based RE Information Exchange System and the IEC campaign.

Assumption: 1USD=PhP45.00

TABLE 34. INVESTMENT REQUIREMENTS FOR RE PROJECTS BY RESOURCE

RE Resource	Indicative Capacity (MW)	Estimated Investment Requirement (MIllion USD)	Estimated Investment Requirement (MIllion PhP)
Committed Projects			
1. Geothermal	70.0	210.0	9,450.00
2. Hydropower	27.8	69.5	3,127.50
3. Biomass	26.8	102.1	4,592.90
Sub-total	**124.6**	**381.6**	**17, 170.40**
Indicative Projects			
1. Geothermal	1,425.0	4,275.0	192,375.00
2. Hydropower	5,366.3	15,112.8	680,073.75
3. Biomass	249.9	622.4	28,010.01
4. Wind	2,345.0	4,690.0	211,050.00
5. Solar	284.0	710.1	31,955.06
6. Ocean	70.5	246.8	11,103.75
Sub-total	**9,740.7**	**25,622.1**	**1,154,792.57**
Grand Total	**9,865.3**	**26,038.7**	**1,171,737.97**