The ADB Solar Rooftop Project: Boosting Solar Energy Growth in the Philippines

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CASE STUDY

The Global Energy Problem
Energy demand projection and energy security issues worldwide

As of mid-2015, 7.3 billion people inhabit the earth. At 1.18 percent average annual growth rate or increasing by around 83 million people per year, 8.5 billion people are estimated to partake of the world's limited resources by the year 2030.[1] To maintain a decent quality of life, all of these people will require access to electricity, which has become as basic and essential as the need for food, water, clothing, and shelter.

Current power generation methods and issues surrounding them

In 2014, world energy consumption by power source was still dominated by oil, coal, and natural gas. Coal, considered the most polluting of all power stations both in terms of greenhouse gas emissions and local air pollution, increased its share of the global energy mix from 23 percent in 2000 to 29 percent in 2015.[2] But with global warming and climate change as undeniable realities of the 21st century, the need to shift to environment- friendly renewable energy (RE) sources has become more pressing.

The steep upfront costs of RE technologies and other barriers, however, have stalled the wide use of such technologies. A study on the cost competitiveness of renewable energies conducted by the GIZ (2013) acknowledged that "RE technologies require relatively high upfront investments compared to conventional fossil fuel technologies." But experts argued that the social and environmental impact should also be considered in order to have a more comprehensive cost-benefit analysis among the different sources of energy.[3] Annex 1 presents such social and environmental costs, or external costs, for different energy sources under Central European conditions cited in the GIZ study.

*This case study was developed by Ms. Anita M. Celdran, Asian Institute of Management, for the Asian Development Bank.

1 United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision, Key Findings and Advance Tables*. Working Paper No. ESA/P/WP.241. Retrieved 11 November 2015 from <http://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf>.

2 International Energy Agency (2015). *Key World Energy Statistics*.

3 Meller, H. and Marquardt, J. for Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2013). *Renewable energy in the Philippines: Costly or competitive?*

Why Solar Energy?

Solar energy is considered the most accessible, inexhaustible, and cleaner option among all the other available renewable energy (RE) sources, namely: geothermal, hydropower, wind, ocean, and biomass (see Annex 2 Solar Energy 101). Its relatively faster installation and commissioning time, (i.e. a few days for solar rooftop projects and 6-8 months for larger-scale solar farms versus 3 to 5 years for a hydroelectric or a geothermal power plant); the progressively decreasing cost of solar photovoltaic (PV) cells; and its relatively low maintenance cost and requirements makes solar energy the most favorable RE resource to develop. Solar energy is also best suited for remote, isolated, rural, and/or impoverished communities that do not have access to mainstream on-grid electricity supply.[4]

The dwindling cost of solar PV cells needed to harness solar radiation and convert it to electricity was one of the reasons for the increase in uptake of solar projects. The reduced cost has made it more attractive for residential and commercial users, as well as investors to patronize solar energy, thus spurring the growth of installed solar PV capacity worldwide. According to the 2014 edition of the International Energy Agency (IEA) Technology Roadmap for Solar Photovoltaic Energy, PV module prices were reduced by as much as 20 percent of its initial cost for the period 2008–2012 in mature markets such as Germany, Spain, and Italy. PV system prices likewise experienced a downward trend, reduced to a third of its initial rate during the same period. Prices eventually stabilized in 2013 and 2014, as manufacturers struggled to recover the cost of their investment in PV manufacturing.

This significant reduction in PV system prices was largely attributed to the shift in PV manufacturing capacity from Europe and the USA to Asia, mainly China and Taiwan. Germany, for instance, lost a quarter of its PV production capacity, which used to provide employment to around 88,000 people in 2012 (see Annex 3 PV Manufacturing by Country, 2003–2013).

[4] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in cooperation with Renewable Energy Developers Center and WWF Philippines (2013). *Policy Brief: It's More Sun in the Philippines*. Retrieved 07 October 2015 from <https://www.doe.gov.ph/netmeteringguide/net_metering_files/attachments/Policy-Brief-Its-more-sun- in-the-PhilippinesV3.pdf>.

The International Energy Agency (IEA) projected that solar PV would generate 16 percent of the world's electricity resources by 2050, and would comprise 17 percent of all clean electricity and 20 percent of all renewable energy. China was still expected to lead the global PV market, providing around 37 percent of global PV solar capacity by 2050.[5]

The Solar Solution: Solar Energy Projects in Asia and the Pacific

The use of solar power has gained a lot of ground globally and in the region over the past five years.[6] The global count for new solar PV installations in 2013 was recorded at around 37 GW in about 30 countries—equivalent to 100 MW per day—amounting to USD 96 billion in investments. China leads the growth of new PV installations globally, with more than 11 gigawatts (GW) of newly installed PV capacity in 2013, more than the collective total for Europe. Japan contributed almost seven GW of new solar PV installations in the same year, while the US activated over four GW of new capacity (see Annex 4 Global Cumulative Growth of PV Capacity, and Annex 5 Progress in Solar PV Markets and Installation since 2009).

In Asia and the Pacific, almost 700 million people still have no access to electricity. Thus, governments and development organizations were looking to solar power generation as a way to supply energy, particularly for countries with remote and far-flung islands, such as Indonesia, Maldives, and the Philippines, where localized solar plants could be the most viable solution. In addition, the region has the perfect conditions for utilizing solar power. For tropical countries such as those in South Asia and Southeast Asia with at least 1,400 kWh/sqm/year of solar irradiation, large areas of land could be ideal locations for solar PV installations.

However, the continued growth of solar energy generation and use faced important challenges. These include lack of access to technologies that could help further decrease the cost of solar

5 International Energy Agency (IEA) (2014). *Technology Roadmap: Solar Photovoltaic Energy, 2014 Edition*. Retrieved 28 October 2015 from <http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapSolarPhotovoltaicEnergy_2014edition.pdf>.

6 International Energy Agency (IEA) (2014). *Technology Roadmap: Solar Photovoltaic Energy, 2014 Edition*. Retrieved 28 October 2015 from <http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapSolarPhotovoltaicEnergy_2014edition.pdf>.

power generation and provide for more efficient energy storage systems, the uncertainty about long-term government policies and regulations, and the lack of appropriate financial incentives and subsidies that could attract investments in solar power generation.

Asian Development Bank's Asia Solar Energy Initiative and the Solar Rooftop Project

In May 2010, the Asian Development Bank (ADB) launched the Asia Solar Energy Initiative (ASEI) to address the barriers that hinder the development of solar energy generation in the region. The project was aiming to achieve 3,000 MW of new solar electricity generation and associated smart grid projects by providing up to USD2.25 billion in financing for solar projects. The Initiative also aimed to leverage an additional USD6.75 billion in solar power investments over the same period. To fast- track the growth of solar power towards grid parity,[7] the ASEI had a three- pronged approach:

1. ***Knowledge management*** through the Asia Solar Energy Forum, which brought together private sector companies, government representatives, and other stakeholders to share knowledge, develop partnerships, discuss new solar power proposals and incentive mechanisms, and organize major conferences on solar energy;
2. ***Project development*** assistance for installing 3,000 MW of solar power generation and smart grid projects from 2010 to 2013 in Asia and the Pacific region; and
3. ***Innovative finance*** solutions through the Asia Accelerated Solar Energy Development Fund (AASEDF), a multi-donor fund designed to mitigate associated risks and provide incentives, to subsequently reduce solar generation costs and encourage more private sector participation.[8]

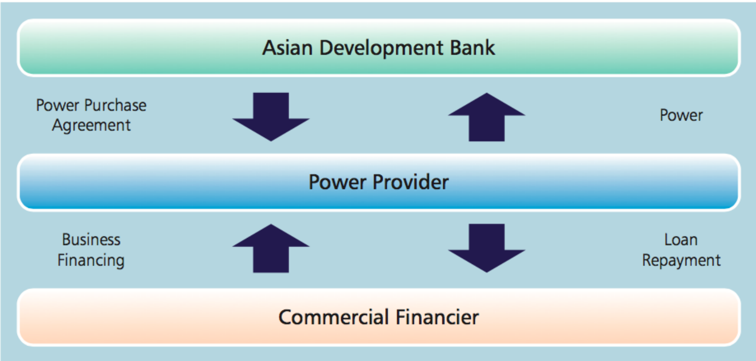
[7] **Grid parity** describes the point in time, at which a developing technology will generate electricity for the same cost to ratepayers as traditional technologies. That is, if the cost of unsubsidized new technology such as solar power is as low as the electricity generated by fossil fuels or by renewable alternatives to solar energy, it is said to have reached grid parity. The primary metrics used for comparing the cost of electricity produced by various generation options is the **Levelized Cost of Energy or LCOE**. It is calculated by accounting for all of a system's expected lifetime costs (including construction, financing, fuel, maintenance, taxes, insurance and incentives), which are then divided by the system's lifetime expected power output (kWh). All cost and benefit estimates are adjusted for inflation and discounted to account for the time-value of money.

[8] Asian Development Bank (2011). Asia Solar Energy Initiative: A primer.

In 2012, two years after the launch of the Asia Solar Energy Initiative, ADB installed 2,040 photovoltaic panels on the carpark rooftop of its Manila headquarters. This was ADB's way of showcasing a suitable model for the implementation of distributed generation potential of solar PV in an urban setting. It also aimed to encourage other organizations in the region to install similar facilities on their rooftops and other available spaces as the Bank believed that widespread use of solar energy and other cleaner energy technologies were key to combating climate change.[9] Hailed as "the first urban solar installation in the Philippines," ADB's solar rooftop installation had a capacity of 571 kilowatts and could generate 613 megawatt-hours of electricity per year, which was enough to supply four percent of the headquarter's electricity requirements.

The rooftop project also aimed to pioneer independent power producer-type development of solar energy for rooftop applications across the region as it used the power purchase agreement business model[10] (see Figure 1). In the power purchase agreement, the selected provider leased the ADB roof space, installed the equipment, and then would own and operate the solar facility for 15 years before transferring it to ADB at no cost. The agreement stated that the provider would sell all the generated power to ADB at a final bid price determined through a competitive bidding process. The agreement also stated that payments would be less when operating[11] efficiencies were lower or the design capacity was overstated.

Figure 1. ADB's Solar Power Business Model Diagram



9 Asian Development Bank (nd). *Asia Solar Energy Initiative: Affordable Solar Power for Asia and the Pacific*.

10 The Power Purchase Agreement was just one of the three financing models available for those interested in installing solar systems. In **direct investment**, a building owners fund their rooftop PV system using their own funding or by availing debt financing. **Solar leasing**, just like Power Purchase Agreement, is a third-party financing mechanism where the owner does not purchase the PV system, but instead enters into an arrangement with a company to make periodic lease payments or electricity payments for the PV system.

11 Asian Development Bank (2015). *Clean Energy Program: Accelerating Low-Carbon Development in Asia and the Pacific Region*. Retrieved 07 October 2015 from <http://www.adb.org/sites/default/files/publication/28995/clean-energy-programbrochure. pdf>.

Focus on the Philippines
The Philippine Power Demand

The Department of Energy (DOE) projected that the national peak demand for electricity[12] would grow at an average rate of 4.3 percent per annum from 2012 to 2030. This would translate to peak demand hitting 14,311 gigawatt hours (GWh) by 2018 and go up to 24,534 GWh by 2030, from peak demand of 9,226 GWh in 2008.

The country's energy consumption was seen to reach 86,809 GWh by 2018, and almost double to 149,067 GWh by 2030, from an actual demand of 55,417 GWh in 2008. This growth in energy consumption would be fueled by the country's good economic prospects, a young, technology-savvy demographic profile, and a growing population projected to reach 148 million by the year 2050.[13]

The country's future energy demand would require more than 30,000 MW of installed capacity by 2030, far more than the 17,025 MW capacity available on the network of the National Grid Corporation of the Philippines (NGCP) as of 2012. To meet the energy demand of the

population, around PhP2.80 trillion in investments would be required to finance the additional capacity installations.[14]

The Philippine Energy Supply Profile

The Philippines is still largely dependent on coal-fired and oil-based power plants, which generates 51.18 percent of the country's electricity supply.[15] Renewable energy, mainly

[12] It should be noted, however, that peak demand forecasts were derived from energy sales forecasts, which were in turn calculated based on actual energy sales data for the previous year multiplied bygrowth rate assumptions. Actual energy sales data are first adjusted to include non-utility sales and other factors that are not captured by the Power Delivery Services (PDS) of the transmission company, prior to factoring in the projected growth rate. Station use and transmission losses are then added to derive gross generation, which is then "converted to peak demand in MW using the assumed load factor for each grid based on historical performance." DOE. (2009). *Power Development Plan 2009-2030.*

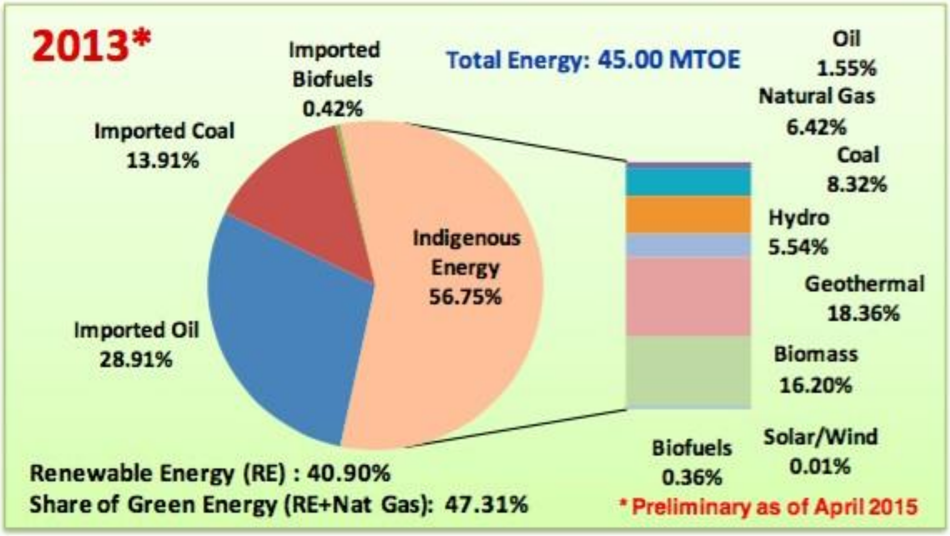
[13] United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision, Key Findings and Advance Tables*. Working Paper No. ESA/P/WP.241. Retrieved 11 November 2015 from <http://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf>.

[14] Department of Energy (2012). *Philippine Energy Plan (PEP) 2012-2030 Executive Summary.* Retrieved 04 November 2015 from <https://www.doe.gov.ph/doe_files/pdf/01_Energy_Situationer/2012-2030-PEP- Executive-Summary_revised.pdf>

[15] Department of Energy (2014). *2014 Power Situation*. Retrieved 04 November 2015 from <https://www.doe.gov.ph/doe_files/pdf/01_Energy_Situationer/2014_power_situationer.pdf.

geothermal, hydro, wind and solar, accounts for about 25 percent of total power generation. Solar energy's contribution in power generation has been minimal, with less than one percent contribution to the Philippines' total energy mix (see Table 1).

Table 1. Philippines' Total Energy Mix, 2013



Source: Annual Report – Energy Sector Accomplishment Report 2014

Coal-sourced electricity was expected to increase by more than 25 percent within the next three years, with the completion of projects that had already been approved prior to a cleaner fuel mix policy.[16] For the past several years, investments in coal-fired power plants were pushed forward over natural gas and renewables because these were considered to be "cheaper and quicker to build to meet growing electricity demand in the Philippines."[17] There were also arguments that coal-generated plants were most ideal as baseload power stations for large-scale electricity generation because they could generate electricity most of the time at full power.[18]

16 Tan, F. (2015*). Interview – Philippines sees bigger role for gas, renewables in new energy plan*. Reuters – Commodities. Retrieved 31 October 2015 from < http://in.reuters.com/article/2015/10/28/philippines- energy-idINL3N12R43O20151028>

17 Ibid

18 Baseload power plants are production facilities used to meet the given region's continuous energy demand, and produce energy at a constant rate, usually at a low cost relative to other production facilities available to the system. Examples of baseload power plants are nuclear and coal-fired plants which can continuously operate throughout the year barring repair or maintenance. While these large power plants provide the base load, peak power demand is sourced from smaller and intermittent power plants called peaking power plants that run during high demand. Renewable energy sources such as solar, wind, hydropower are tapped in such circumstances *(Source: Energy Dictionary – Baseload Plant. Vortex.com. Retrieved 2008-08-03).*

Renewable sources of energy, on the other hand, were considered to be 'intermittent' sources (one that switches on and off frequently), thus could not provide baseload power 24 hours a day, seven days a week.

Advocates of solar power in the United States, however, have challenged the notion of 'grid stability and reliability' with the breakthrough in energy storage systems. They believe that energy storage is the next frontier that could revolutionize the entire electricity generation system with homes no longer needing power supplied through electric wires connected to a central power plant. Instead, homeowners could opt to have solar power during daylight hours and use energy-storage batteries for electricity at night. The problem, however, is that cost for energy storage is still prohibitive.

Table 2. Comparative Gross Generation in the Philippines, 2014 and 2013

PHILIPPINES						
PLANT TYPE	2014		2013		Difference	
	GWh	% Share	GWh	% Share	MWh	%
Coal	33,054	42.78	32,081	42.62	973	3.03
Oil-based	5,708	7.39	4,491	5.97	1,217	27.10
Natural Gas	18,690	24.19	18,791	24.97	(101)	(0.54)
Geothermal	10,308	13.34	9,605	12.76	704	7.32
Hydro	9,137	11.83	10,019	13.31	(882)	(8.80)
Wind	152	0.20	66	0.09	86	131.59
Biomass	196	0.25	212	0.28	(16)	(7.68)
Solar	17	0.02	1	0.00	15	1068.03
Total Generation	77,261		75,266		1,995	2.65

Solar power generation was targeted to comprise only about 1.86 percent[19] of the country's total installed RE capacity by 2030 (see Table 3). This, despite the fact that the country is an ideal geographical location for high insolation levels and intended to position itself as "the solar manufacturing hub in Southeast Asia."[20]

19 Department of Energy (nd). *National Renewable Energy Program – Executive Summary v2*. Retrieved 11 November 2015 from XXX

20 Philippine Development Plan 2011-2016 cited in Rubio-Pardalis, M.C. (2014). *At A Glance on Renewable Energy*. Senate Economic Planning Office, AG-14-02. Retrieved 31 October 2015 from https://www.senate.gov.ph/publications/AAG%20on%20Renewable%20Energy_June%2030_FINAL.pdf

Table 3. National Renewable Energy Program (NREP) Installation Targets

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[1]	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

Source: NREP Executive Summary version

Filling in the Energy Supply-Demand Gap

As an archipelago with 7,107 islands, the Philippine government's main challenge was providing electricity to its more than 100 million inhabitants. As of December 2011, more than 6.1 million households or 30 percent of the country's more than 20.5 million households still had no access to electricity.[21] These households relied only on kerosene lamps and natural moonlight to illuminate their homes and streets at night.

[21] Tamang, J. (2013). *Philippine Energy Sector Plans and Programs 2013-2030*. Presentation during the National Government-Local Government Joint Energy Forum, The Heritage Hotel, Pasay City, 06 September 2013. Retrieved 31 October 2015 from <http://ppei.dilg.gov.ph/sites/default/files/1.%20Phil%20Energy%20Sector%20Plans%20and%20Programs_1.pdf>.

To address this gap, the Small Power Utilities Group of the National Power Corporation (NPC-SPUG)[22] was mandated by Republic Act 9136, or the Electric Power Industry Reform Act (EPIRA) of 2001[23] to pursue electrification in missionary areas or those places that were too distant and remote, or the terrain not readily passable that laying down transmission lines was too difficult and costly to accomplish. Missionary areas were typically low-income communities with minimal economic activity, thus revenues from electricity provided by SPUG power plants were usually not enough to cover its installation and maintenance costs. As such, NPC-SPUG's operations were largely subsidized by all other electricity consumers, through the Universal Charge for Missionary Electrification (UCME) that became part of everybody else's monthly electricity bill.

As of December 2012, NPC-SPUG generated a total capacity of 283.06 MW using 291 land-based diesel-fed power plants, one hydroelectric plant, one hybrid wind turbine farm and 11 power barges in 233 island communities all over the country. Its customer base included 41 electric cooperatives (EC) and 10 local government units (LGU).[24] The bulk of its energy source was diesel and bunker fuel, which was subject to price volatility since a huge portion of the country's oil supply was imported and based on world market rates.

The high cost of diesel and bunker fuels increased the true cost of power generation in missionary areas to more than the usual selling price for electricity. This price difference, or shortfall, was also subsidized through the UCME. Annex 6 presents a sample of true power generation costs from diesel-fed plants and effective electricity selling rates in some NPC-SPUG areas in 2012 and projections for 2020.[25]

[22] NPC-SPUG was a consolidation of the Small Islands and Isolated Grids (SIIG) group and the Integrated Barge Management Group (IBMG), created by the NPC in 1996. SIIG had been tasked to manage the power generation facilities of various electric cooperatives (EC) in 1988, while the IBMG was in charge of the small capacity power barges operating in SIIG areas. The power barges had been commissioned to address the power crisis in the Philippines during the late 1980s to early 1990s.

[23] Republic Act 9136, or the Electric Power Industry Reform Act (EPIRA) of 2001 embodied two major reforms: (1) the restructuring of the electricity supply industry, which called for the separation of the different components of the power sector namely, generation, transmission, distribution and supply, and (2) the privatization of the National Power Corporation (NPC), which involved the sale of the state-owned power firm's generation and transmission assets (e.g., power plants and transmission facilities) to private investors.

[24] Small Power Utilities Group (SPUG) (2009). Retrieved 22 October 2015 from www.spug.ph.

[25] Meller, H. and Marquardt, J. for Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2013). *Renewable Energy in the Philippines: Costly or competitive?*

Further, to address the power requirements of off-grid communities, the Department of Energy (DOE) through its Household Electrification Program (HEP) and the Philippine Energy Sector Plans and Programs 2013– 2030, was aiming to "achieve 90 percent household electrification by 2017, preferably using [a] combination of renewable energy sources"[26] and "mature renewable energy technologies such as photovoltaic (PV) solar home systems, photovoltaic streetlights, and micro-hydro systems."[27] The HEP targeted households that were still off-grid, or not connected to the "high voltage backbone system of interconnected transmission lines, substations, and related facilities."[28] Through the HEP, DOE'S Visayas Field Office began installing Solar Home Systems (SHSs) in 375 households in the province of Eastern Samar covering four municipalities in 2014. The installed SHS was enough to power three units of 3-watt LED lights, and one unit of 1-watt LED lights with a built-in AM/FM radio and cell phone charger.

Complementing DOE's HEP was the Sitio Electrification Program (SEP) of the National Electrification Administration (NEA), which commenced in 2011. The program aimed to achieve 100 percent *sitio*[29] electrification by providing electricity to 32,441 *sitios* by means of grid connection or RE technologies. As of 30 January 2015, over 21,500 *sitios* had already been energized,[30] bringing electricity to about 646,290 households benefitting some 3.23 million Filipinos.[31] The project included the installation of 46 and 75 communal photovoltaic systems in various *sitios* in 2011 and 2012, respectively.[32]

26 Tamang, J. (2013). *Philippine Energy Sector Plans and Programs 2013-2030*. Presentation during the National Government-Local Government Joint Energy Forum, The Heritage Hotel, Pasay City, 06 September 2013. Retrieved 31 October 2015 from <http://ppei.dilg.gov.ph/sites/default/files/1.%20Phil%20Energy%20Sector%20Plans%20and%20Programs_1.pdf>.

27 DOE cited in Navarro, A. (2013). *Cost Efficiency and Effectiveness of the Sitio and Household Electrification Program*. Final Report for the Department of Budget and Management (DBM). Philippine Institute for Development Studies. Retrieved 04 November 2015 from <http://www.dbm.gov.ph/wp-content/uploads/DBM%20Publications/FPB/ZBB-2012/d.pdf>.

28 Congress of the Philippines. (2008). *RA 9513 Renewable Energy Act of 2008*.

29 A *sitio* is a hamlet or subdivision of a village (barangay).

30 It should be noted that the NEA considers a *sitio* energized or on-grid "if there are at least 20 potential households to be served." It was therefore possible that an energized *sitio* may still have some households with no access to electricity.

31 National Electrification Administration (2015). *Sitio Electrification Target on Track.* Retrieved 25 August 2016 from <http://www.nea.gov.ph/news/290-sitio-electrification-target-on-track>.

32 DOE cited in Navarro, A. (2013). *Cost Efficiency and Effectiveness of the Sitio and Household Electrification Program*. Final Report for the Department of Budget and Management (DBM). Philippine Institute for Development Studies. Retrieved 04 November 2015 from <http://www.dbm.gov.ph/wp-content/uploads/DBM%20Publications/FPB/ZBB-2012/d.pdf>.

Both government programs —the HEP and SEP— provided a PhP2,500 subsidy per household beneficiary to cover the cost of the electricity meter, electrical wiring, and light bulbs. Despite this incentive, however, not all households in both programs' target communities opted to subscribe to the program.[33]

Supplying Energy to Remote and Poor Communities: Can Solar Energy Do It?

Industries, commercial establishments and residential users were beginning to look to solar energy as a means to save on their electricity bills and to promote the use of clean energy. One example was Mike de Guzman, a homeowner in Makati City, who installed 20 solar panels on the rooftop of his house. His panels generated an average of 675 kilowatt hours (kwh) per month and supplied 80 percent of the electricity requirements of his two- story, three-bedroom home. Since harnessing the sun's natural radiant energy to power up his home, and also making use of the net metering program (see **page 17** for a discussion on net metering), the de Guzman's electric bill decreased to less than half their pre-solar levels, from around PhP24,000 per month to PhP9,000–PhP12,000 per month.[34]

SM Prime Holdings Inc. has invested to build the largest commercial solar rooftop system in the country and the largest solar-powered mall in the world. The project aimed to build a 1.5-megawatt (1,500 kilowatt) solar rooftop at the SM City North EDSA that would supply a significant portion of the mall's energy requirements.

There were also non-government organizations that utilized solar energy to provide electricity or a simple lighting system to poor communities. One example was the MyShelter Foundation, a non-government organization that aimed to provide energy to impoverished homes. Its program, the Liter of Light or *Isang Litrong Liwanag* movement, has installed 55-watt solar bulbs using only discarded one-liter plastic soda bottles, water, and chlorine bleach in over 30,000 homes in

[33] Navarro, A. (2013). *Cost Efficiency and Effectiveness of the Sitio and Household Electrification Program*. Final Report for the Department of Budget and Management (DBM). Philippine Institute for Development Studies. Retrieved 04 November 2015 from <http://www.dbm.gov.ph/wp-content/uploads/DBM%20Publications/FPB/ZBB-2012/d.pdf>.

[34] Ranada, P. (2014). How practical is solar power for PH home owners? Retrieved 07 October 2015 from <http://www.rappler.com/business/industries/173-power-and-energy/64165-solar-power-ph-households- net metering>

the Philippines.[35] This program adopted the technology developed in 2002 by Brazilian mechanic Alfredo Moser who used a small solar panel, a battery, four LED lights and other inexpensive[36] materials to develop improvised solar lights. The foundation is targeting to install one million bottle lights in poor communities across the archipelago.

In the Visayas, the San Carlos Solar Energy Inc. (SACASOL), a joint venture between Bronzeoak Philippines Inc., and the Thomas Lloyd Group, launched two solar energy projects. Their first solar-power plant was built in Negros Occidental with a capacity of 22 MW and expected to supply 35- million kilowatt hours of energy to the Visayas grid. Its second project is the 18-MW solar power plant in La Carlota, also in Negros Occidental, with a total investment of PhP1.8 billion. For this project, the company would install 72,000 solar panels, making it one of the largest solar farms in the country once completed.

Breaking Down Barriers to Solar Energy Development

One of the main criticisms on solar energy generation was the high upfront cost for installation. This high price still marginalized households with low-income levels, which only required a small amount of electricity for their homes.

In 2014, the cost of installing a 1.5 kWp solar PV rooftop system (that could yield 1,400 kwh per year) was typically around PhP190,000.[37] This amount usually covered only the components of the solar PV system (i.e., solar panels, panel mounts, and inverter) and installation-related labor costs.

Other costs such as additional civil works and application cost for net metering were not included in this cost estimate.[38]

35 MyShelter Foundation (nd). *About Liter of Light*. Retrieved 24 October 2015 from <http://literoflight.org/about-us/>.

36 Williams, L. (2015). *Liter of Light's solar-powered DIY lamp made from a plastic bottle is transforming lives.* The Independent. Retrieved 24 October 2015 from <http://www.independent.co.uk/life- style/gadgets-and-tech/features/…m-aplastic- bottle-is-transforming-lives-9993728.html#commentsDiv>.

37 Solar Philippines Power Project Holdings (2014). *Solar Panel Installation*. Retrieved 07 October 2015 from <http://www.solarphilippines.ph/solar-panel-home/>.

38 Solarpinoy (2009). *FAQ – Solar panel Manila Philippines*. Retrieved 07 October 2015 from <http://www.solarpinoy.ph/index.ph/faq>.

A study published by the GIZ on the Rules and Processes for Off-Grid PV Project Development in the Philippines (2013) revealed that the cost of retro-fitting a 3-kW PV system onto an existing house could amount to PhP510,000. Administrative processes were estimated to cost PhP56,840, which was roughly 11.15 percent of the total budget.[39] For a PV rooftop system that could produce an average of 567 to 729 kWh of electricity per month, the cost of installing solar panels could reach PhP475,000 and return on investment can be realized after 2.9 to 3.4 years (see **Annexes 7, 8 and 9** for the Administrative Costs and Efforts in Installing PV systems in the Philippines).

An estimated 28 workdays was the supposed timeline for the administrative processes, which included obtaining the necessary government permits and connection with the distribution utility company. However, this 28-day period would actually only refer to the physical installation of the solar PV rooftop system. It did not include the time needed to apply for the necessary building permits, and coordination with other relevant agencies, and application and processing for net metering with the respective distribution utility. For Meralco clients, it could take three months before an end user's solar panels could be connected to the net metering program (see **page 17** for a discussion on net metering).

The high upfront cost, administrative hurdles, and long payback period made solar energy still inaccessible to many households. Furthermore, the limited subsidies and uncertain policies have served to discourage many private sector investments.

In the past couple of years, however, some government regulations have been put in place, with incentives and financing schemes made available to encourage industries, commercial establishments, and households to start solar projects. Two policy mechanisms, the Feed-in Tariff system (FiT) and Net metering, are discussed, and these are differentiated in terms of scale and applicability.

[39] Brückmann, R. (2013). *Administrative Procedures: Rules and Processes for Off-Grid PV Project Development in the Philippines*. Retrieved 07 October 2015 from <https://www.doe.gov.ph/netmeteringguide/net_metering_files/attachments/giz2013-en- administrative-procedures-philippinesoff-grid.pdf>.

Feed-in Tariff System - The feed-in-tariff (FiT) was one of the provisions in the Renewable Energy Act of 2009 (RA 9513) to provide renewable energy generators with a guaranteed market and a guaranteed price for their power.[40] The FiT was the fixed price for the electricity generated from RE, and was applicable to the capacity approved by the DOE based on its installation targets for each RE resource type. The Energy Regulatory Commission (ERC) approved feed-in tariff rates in July 2012, almost three years beyond the timeline prescribed in RA 9513 (see Table 4 below). [41]

Table 4. Initially ERC-approved FiT rates vs. NREB-recommended rates

RE Type	**ERC Approved Rates (July 2012)** (P/kWh)	**NREB Recommended Rates** (P/kWh)	**Difference**	
			(P/kWh)	(%)
Run-of-river hydro	5.90	6.15	0.25	4.1%
Biomass	6.63	7.00	0.37	5.3%
Wind	8.53	10.37	1.84	17.7%
Solar	9.68	17.95	8.27	46.1%

The FiT for solar energy (PhP9.68) was initially applicable to the first 50 MW of installed solar capacity, which was quickly filled up by various proponents. This led the ERC to increase the solar capacity to 500 MW, ten times more than the original 50 MW solar installation target. Since it was not possible to break up the excess capacity of the last project, the actual installed solar capacity under the first wave of solar projects under the FiT system was 70 MW. The second round of solar FiT rates was PhP8.69 per kWh and was applied to the next 71 to 500 MW of solar generation projects, or until March 15, 2016, whichever came first.[42] The new FiT rates for the expanded solar capacity was approved by the ERC on March 27, 2015.

[40] The Renewable Energy Act of 2008 calls for a renewable portfolio standard, which would require power suppliers to include a percentage of energy from renewable sources. In addition to the feed-in-tariff, the act also includes provisions on tax credits for developers, value added tax and duty-free importation of renewable technologies, and support for micro-generation and for the communities that host generation facilities.

[41] Morales, N.J. (2012, July 28). *ERC approves feed-in tariff rates*. Philippine Star.

[42] Olchondra, R. (2015). *FIT rates for new solar projects trimmed*. Philippine Daily Inquirer, 04 May 2015. Retrieved 07 October 2015 from < http://business.inquirer.net/191242/fit-rates-for-new-solar-projects- trimmed>.

As of September 30, 2015, 27 solar projects had been awarded a Certificate of Confirmation of Commerciality, yielding a total of 131.90 MW of solar capacity under the FiT system (see Tables 4 and 5 below).[43] Further reduction of solar FiT rates was attributed by the National Renewable Energy Board (NREB) to "lower overall project cost, expected increase in plant efficiencies due to advances in technology and increased materials supply, lower prevailing interest rates, and a slightly stronger dollar".[44]

Table 4. Awarded Solar Projects as of November 30, 2015

Island/ Grid	Number of projects	Potential Capacity (MW)	Installed Capacity (MW)
Luzon	33	1,593.15	56.90
Visayas	23	807.07	75.00
Mindanao	48	443.80	
TOTAL	104	2844.02	131.9

Table 5. Awarded Solar Projects as of November 30, 2015 (Own-use)

Island/ Grid	Number of projects	Potential Capacity (MW)	Installed Capacity (MW)
Luzon	11	2.1872	1.799
Visayas	1	0	0.096
Mindanao	0	0	0
TOTAL	12	2.1872	1.895

Net metering – In 2013, the ERC approved net metering rules, which allowed electricity end users to "sell back" their excess renewable energy capacity like solar, wind, and biomass to the grid. This scheme was prescribed in the Renewable Energy Act of 2008 or RA 9513.

In the Net Metering Rules and Interconnection Standards, end users with RE installations of up to 100 kilowatts could get peso credits for excess RE electricity that was plowed back into the grid.[45] These peso credits were then used to offset or pay for the end user's electric bill. Figure 2 illustrates a simple diagram of how electricity flows under a net metering scheme, while Annex

43 Department of Energy (2015). *Solar Projects under FIT System with Certificate of Confirmation of Commerciality as of September 30, 2015*. Retrieved 06 November 2015 from <https://www.doe.gov.ph/feed-in-tariff-monitoring-board/withcertificate-of confirmation-of- commerciality/doc-download/1601-solar-projects-under-fit-system-as-of-september-30-2015>.

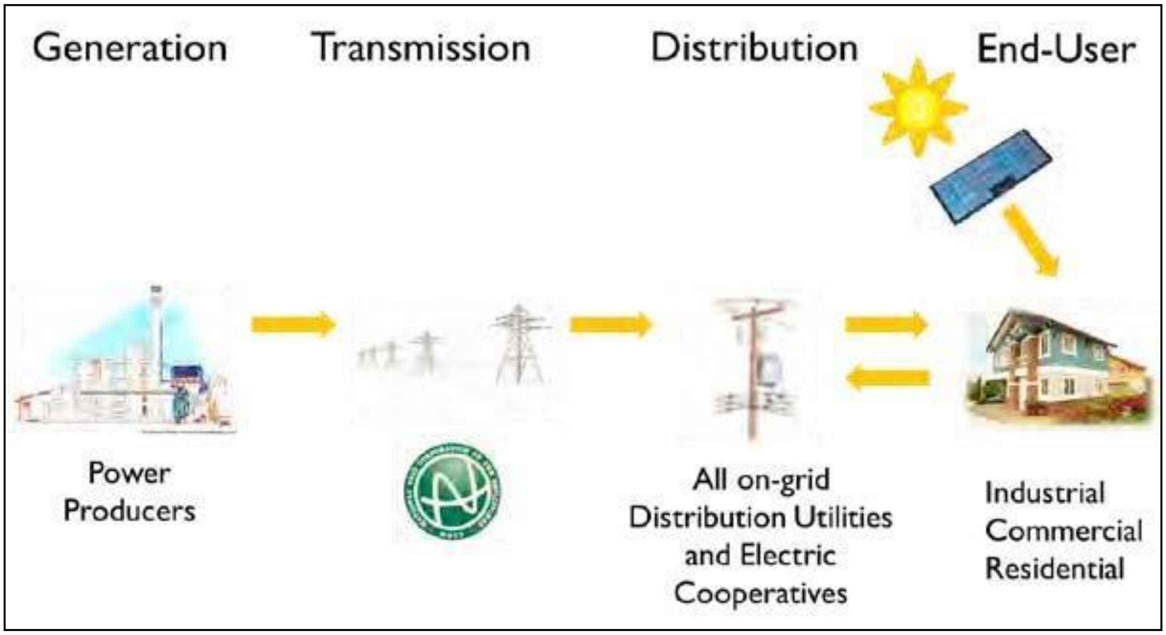
44 Olchondra, R. (2015). FIT rates for new solar projects trimmed. Philippine Daily Inquirer, 04 May 2015. Retrieved 07 October 2015 from http://business.inquirer.net/191242/fit-rates-for-new-solar-projcets- trimmed.

45 End users could sell back excess RE electricity at a rate equivalent to the blended generation cost of the distribution utility (DU) they were connected to, excluding other generation adjustments.

10 presents a sample calculation of how net metering could impact the electric bill of an end user with a 2 kW solar-powered rooftop system.[46] Net metering was considered to be more beneficial for end users whose peak electricity demand was during the day, and whose installed solar capacity did not exceed their peak daytime demand.

However, there were criticisms that distribution utilities such as Meralco were making it difficult for end users to avail of the net metering scheme. In 2013, the Philippine Solar Power Alliance called on the ERC to look into the high cost of applying for net metering as Meralco charged PHP20,000 payment for handling the Distribution Impact Study (DIS) prior to interconnection to Meralco lines. The Alliance argued that this hefty fee was hindering the growth of solar power installations as it became a disincentive for consumers to adopt renewable energy solutions.[47] In addition, the waiting time from net metering application to technical feasibility study to connection or energization took three months (the DIS process alone usually took 60 days to complete).

Figure 2. Electricity flow under a net metering scheme



Source: GIZ Net Metering Reference Guide (2014)

[46] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2014). *Net Metering Reference Guide: How to avail solar roof tops and other renewables below 100 KW in the Philippines*.

[47] Anonuevo, E.P. (2013). Gov't probe sought on Meralco fee for home-based solar energy facilities. Interaksyon.com, 10 December 2013. Retrieved 28 August 2016 from http://interaksyon.com/business/76600/govt-probe-sought-on-meralco-fee-for-home-based-solar-energy- facilities

There were also issues of double charging that occurred under the net metering scheme. Under RA 9513, net metering users should only be charged for their net electricity consumption (total consumption minus their credits in kilowatt hours), and that a common reference price for a net-metered exchange should be applied. However, distribution utilities were allegedly applying a different price for the energy they delivered and for the energy they took from their net metering customers. As Roberto Verzola, Executive Director of the Center for Renewable Energy Strategies, explained in his paper *Philippine Pseudo-Net-Metering Scheme Results In The Double- Charging of Consumers*:

> "In the Philippines, contrary to the RE Act, its IRR, and the ERC enabling rules, solar-enabled net metering customers are charged not their net but their total electricity consumption, based on the full retail price of electricity. They are not allowed to use the energy they contribute to the grid to offset their consumption. Instead, their energy contribution is first converted into pesos using the much lower generation price, and this is used to offset not their kWh consumption but their peso-denominated electric bill, which is calculated based on the much higher retail price. It is a "net billing" scheme, not net metering."[48]

There was also an apparent loophole in net metering rules that could make private owners who 'export' excess electricity to the grid be eligible for subsidies intended for poor consumers. The ERC is seeking to address all these issues.

Aside from the FiT system and net metering scheme, RA 9513 also prescribed other incentives to strengthen the development and commercialization of RE resources. Among these were income tax holidays, duty-free importation of RE machinery, equipment and materials, value-added tax (VAT) exemptions, and other similar mechanisms for RE players. Host communities were likewise given royalty shares (80%) to subsidize end users with monthly electrical consumption of less than 100kWh.[49]

[48] Verzola, R. (nd). *Philippine Pseudo-Net-Metering Scheme Results In The Double-Charging Of Consumers*.
[49] Congress of the Philippines. (2008). *RA 9513 Renewable Energy Act of 2008*.

In the DOE's 2012–2016 Missionary Electrification Development Plan (2012 MEDP), the government sought to enlist private sector participation in the electrification of off-grid areas. The department intended to use a business franchising model, where the NPC-SPUG was the business owner and potential New Power Providers (NPP) were the franchisees. In compliance with the provisions of RA 9513, the Renewable Energy Act of 2008, RE developers in missionary areas would be given a cash incentive equivalent to 50 percent of the universal charge for missionary electrification (UCME). However, apart from the cash incentive for RE development in missionary areas in the 2012 MEDP, there was no explicit directive to install solar power plants to either generate additional capacity or replace the power barges, or convert existing diesel-fed power plants into hybrid RE models.

Global and regional financial institutions, such as the World Bank and the Asian Development Bank, were stepping in by offering grants and financial assistance for RE development. Local banks such as the Bank of the Philippine Islands (BPI) and Banco de Oro (BDO) also began to offer financing options for those who wished to install solar generation systems and other forms of RE power generation facilities. The Development Bank of the Philippines (DBP) also offered term loans for end users who wished to employ the net metering scheme.[50] Some solar energy equipment distributors and service providers also provided installment options. Equipment leasing options were likewise available.

Non-government organizations (NGOs), both local and international, were also taking steps to bring solar power and other forms of RE-generated electricity to households that did not have access to the main power grid. Among these was the Alliance for Mindanao Off-grid Renewable Energy (AMORE) funded by the United States Agency for International Development (USAID). An eleven-year project that began in 2002, AMORE has provided solar-powered electricity to over 13,000 households in 474 remote, conflict- ridden rural communities in the Autonomous Region of Muslim Mindanao (ARMM).[51]

50 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2014). Net Metering Reference Guide: How to avail solar roof tops and other renewables below 100 KW in the Philippines. Retrieved 07 October 2015 from <https://www.giz.de/fachexpertise/downloads/giz2013-en-net metering-reference- guide-philippines.pdf>

51 Climate Change Asia-Pacific (nd). Alliance for Mindanao Off-Grid Renewable Energy (AMORE) Project. Retrieved 09 November 2015 from <http://climatechange-asiapac.com/projects/alliance-mindanao-grid-renewable- energy-amore-project>

A Way Forward for Solar Energy in the Philippines

The prospects for solar power in the Philippines are promising. A number of projects in the Philippines and the rest of the region has already shown how solar energy can be tapped using different technologies, applied in various locations, and scaled to fit the needs and circumstances of a variety of end users. Accessibility of technology to harness solar power is no longer the issue, although there is still room for improvement in terms of technology. More efficient energy storage systems and the high concentrated PV systems, which are twice more efficient in capturing the energy of the sun than current c-Si technology utilized in the Philippines, are on the cusp of a breakthrough and commercialization in technologically advanced countries.

In terms of financing and incentives, the DOE has already approved 2.5 GW of solar projects as of November 2015 and investors are just waiting for the announcement of the new FIT scheme at a reduced rate.

As Project Manager of the ADB Solar Rooftop Project, Mr. Navarro considered how non-technological factors such as financial and policy constraints hinder the deployment of solar energy. Had the ADB Solar Rooftop Project achieved its goals and sparked a momentum to harness the power of the sun? He also thought about his next challenge: to determine how off-grid solar applications can take off on a larger scale and reach remote, impoverished areas in the country.

Annex 1.

External costs for energy sources under Central European conditions

External costs (US cents/ kwh)	PV (2000)	PV (2003)	Hydro 300 kw	wind 1.5 Mw on	wind 2.5 Mw off	Geo-thermal	Solar thermal	Lignite η = 40%	Coal η = 43%	Nat. gas η = 58%
Climate	0.86	0.48	0.11	0.09	0.08	0.33	0.11	9.3	7.4	3.4
Health	0.43	0.25	0.075	0.09	0.04	0.15	0.11	0.63	0.46	0.21
Material	0.011	0.008	0.001	0.001	0.001	0.00	0.00	0.019	0.016	0.006
Agricultural losses	0.006	0.004	0.002	0.002	0.0005	0.002	0.001	0.013	0.011	0.005
Ecosystems[2]										
Sum	**1.3**	**0.74**	**0.19**	**0.18**	**0.12**	**0.49**	**0.22**	**>9.9**	**>7.9**	**>3.6**

1 Valuation of climate change is based on 90 uSD/tCO social costs of carbon.
2 Green: no significant impacts/costs worth mentioning; red: impacts/costs will arise that cannot be neglected. Data from Krewitt & Schlomann (2006).

Source: Meller and Marquardt, GIZ, 2013

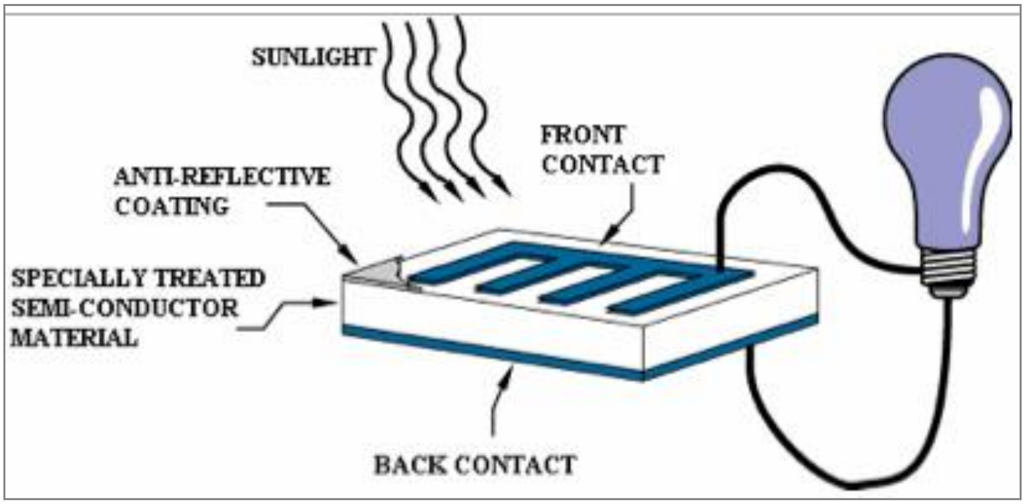
Annex 2

Solar Energy 101

There are three (3) main types of technologies to actively harvest energy from the sun: *photovoltaics (PV)*; *solar heating and cooling (SHC)*; and *concentrating solar power (CSP)*.[52]

(1) ***Photovoltaic (PV)*** cells, or solar cells, are made of certain materials, such as silicon, whose atoms release electrons when exposed to sunlight. Capturing these electrons using electrical conductors to form an electrical circuit generates an electric current, or electricity (see **Fig. 1**).[53]

Figure 1. Basic Photovoltaic (PV) Cell



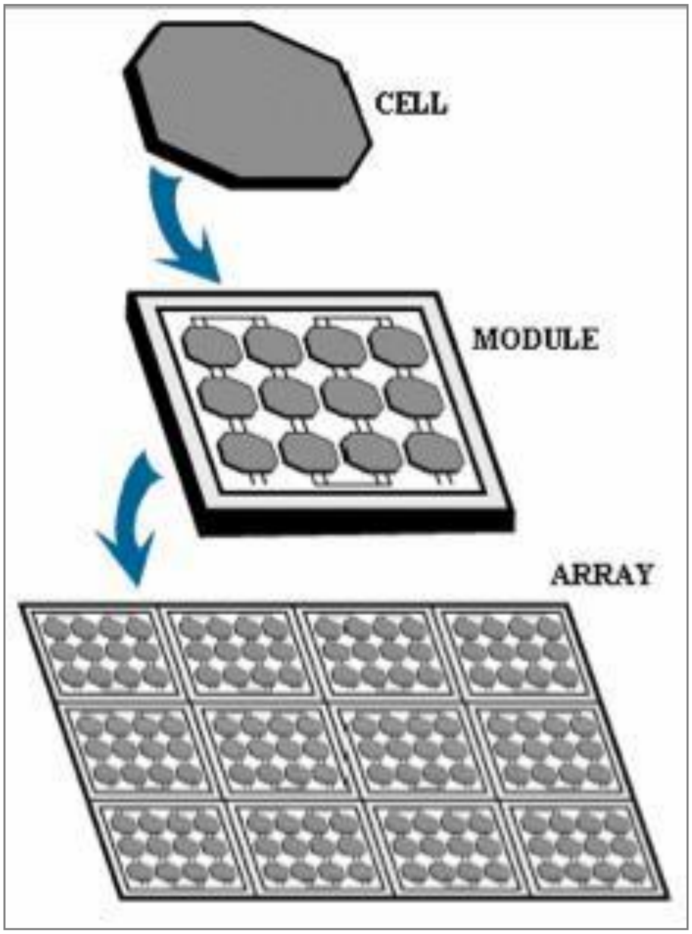
Source: http://science.nasa.gov/science-news/science-at-nasa/2002/solarcells/

[52] Solar Energy Industries Association (nd). *How does solar work?* Retrieved 28 October 2015 from <http://www.seia.org/about/solar-energy/solar-faq/how-does-solar-work>.

[53] Knier, G. (2002). *How do Photovoltaics Work?* NASA Science. Retrieved 28 October 2015 from <http://science.nasa.gov/science-news/science-at-nasa/2002/solarcells/>.

Individual PV cells measure around 4 inches on average, and typically generate less than 2 watts of electricity.[54] Several PV cells are then grouped together to form a PV module, generating 50 to 200 watts of direct current (DC) electricity.[55] PV modules can subsequently be linked together to create arrays (see **Fig. 2**).

Figure 2. Solar Cells to Arrays



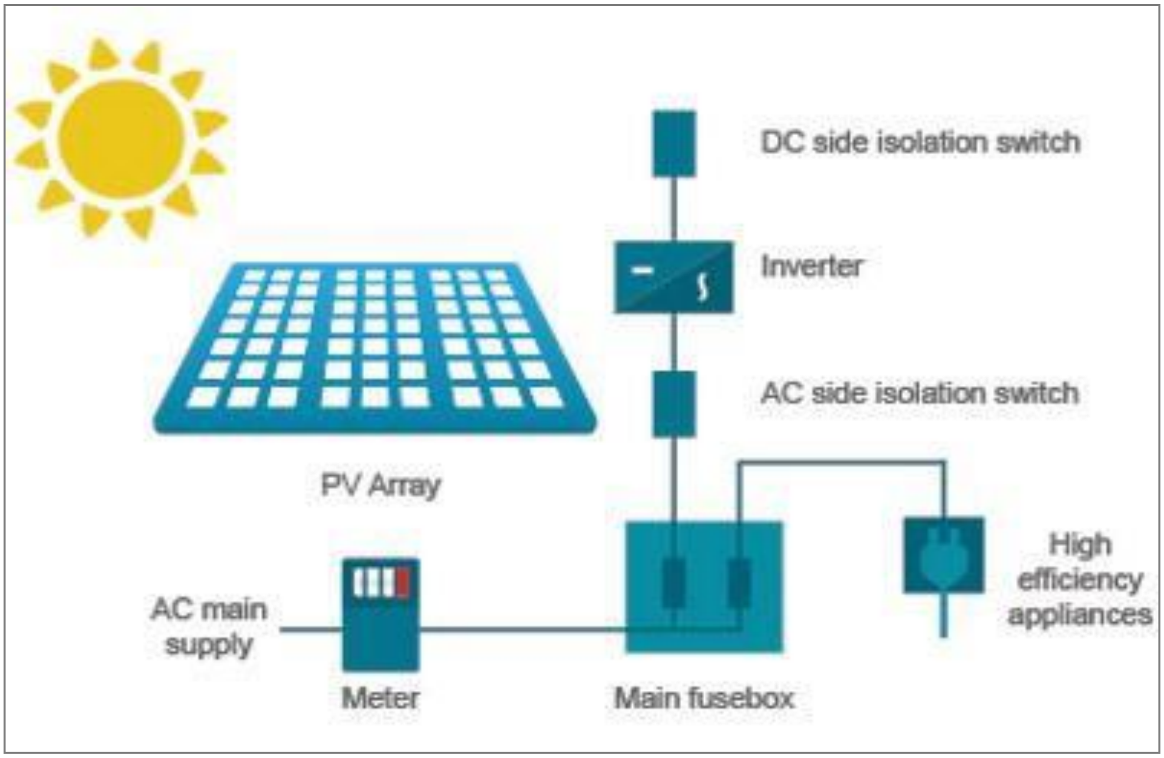
Source: http://science.nasa.gov/science-news/science-at-nasa/2002/solarcells/

[54] Union of Concerned Scientists (nd). *How Solar Energy Works*. Retrieved 28 October 2015 from <http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-solar- energy-works.html#.VjDCwhwxoko>.

[55] International Energy Agency (nd). *About solar photovoltaics*. IEA-Solar. Retrieved 28 October 2015 from <http://www.iea.org/topics/renewables/subtopics/solar/>.

Connecting these PV modules and/or arrays to inverters converts DC to alternating current (AC) electricity. Add batteries, other electrical components, and mounting systems, and a PV system is created (see Fig.3). [56] [57] [58]

Figure 3. Sample PV System



Source: http://www.sasonbisolar.com/about/how-solar-energy-works/

[56] Ibid

[57] Knier, G. (2002). *How do Photovoltaics Work?* NASA Science. Retrieved 28 October 2015 from <http://science.nasa.gov/science-news/science-at-nasa/2002/solarcells/>.

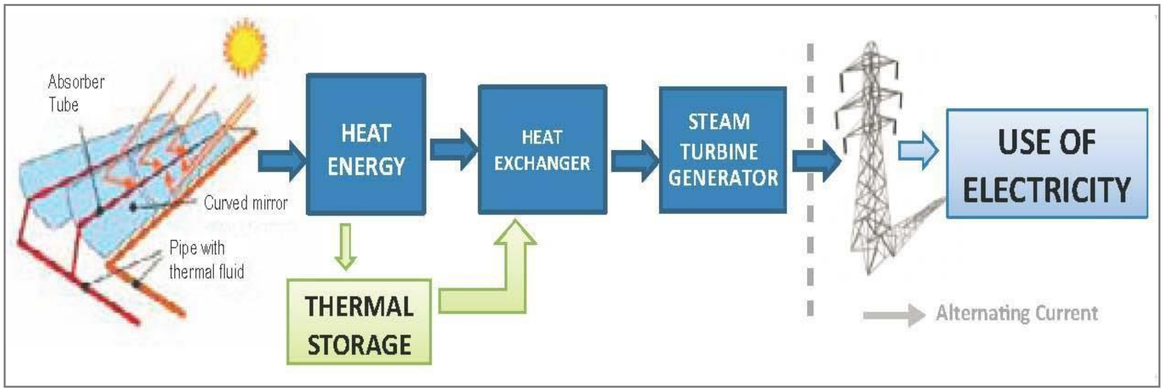
[58] Sasonbi Solar (2013). *How does solar energy work?* Retrieved 28 October from < http://www.sasonbisolar.com/about/howsolar-energy-works/>.

[58] Sasonbi Solar (2013). *How does solar energy work?* Retrieved 28 October from < http://www.sasonbisolar.com/about/howsolar-energy-works/>.

(2) ***Solar heating and cooling (SHC)*** systems capture thermal energy or heat from the sun for space heating, water heating, and space cooling purposes. This is usually done by means of heating up a water-alcohol mixture inside insulated pipes, and using the heated liquid to warm up water in a tank or radiators. On the other hand, desiccant evaporators or absorption chillers use solar collectors to cool down air by drying out its moisture content or heating up a pressurized refrigerant until it releases pressure to cool the air around it.[59]

(3) ***Concentrating solar power (CSP)*** plants use mirrors and lenses to intensify the heat gathered from the sun, generating temperatures "as high as 3,000 degrees Celsius". This intense heat is then used to power traditional steam turbines or engines to produce electricity.[60] (see **Fig. 4**) Aside from these active solar energy systems, buildings can also be designed to harness solar power to heat, light, or cool down homes, offices, schools, commercial establishments, and other built-up structures. Skylights, awnings, or simple orientation of the house may be employed to capture heat or daylight from the sun in a passive manner.

Figure 4. Concentrating Solar Power (CSP)

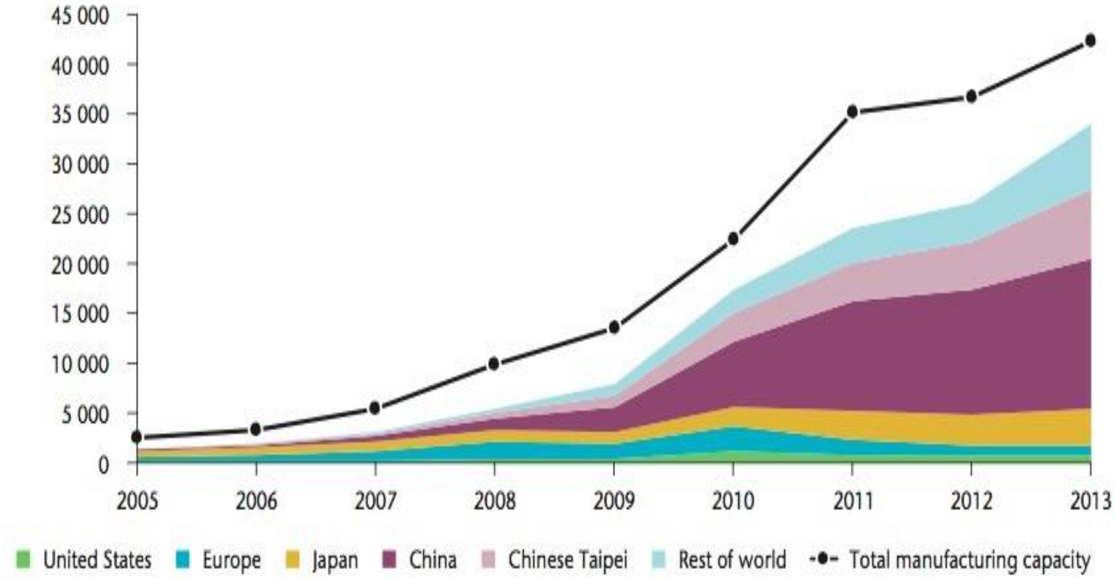


Source: Asian Development Bank, Asia Solar Energy Initiative: Affordable Solar Power for Asia and the Pacific, nd.

59 Union of Concerned Scientists (nd). *How Solar Energy Works*. Retrieved 28 October 2015 from <http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-solar- energy-works.html#.VjDCwhwxoko>.

Annex 3

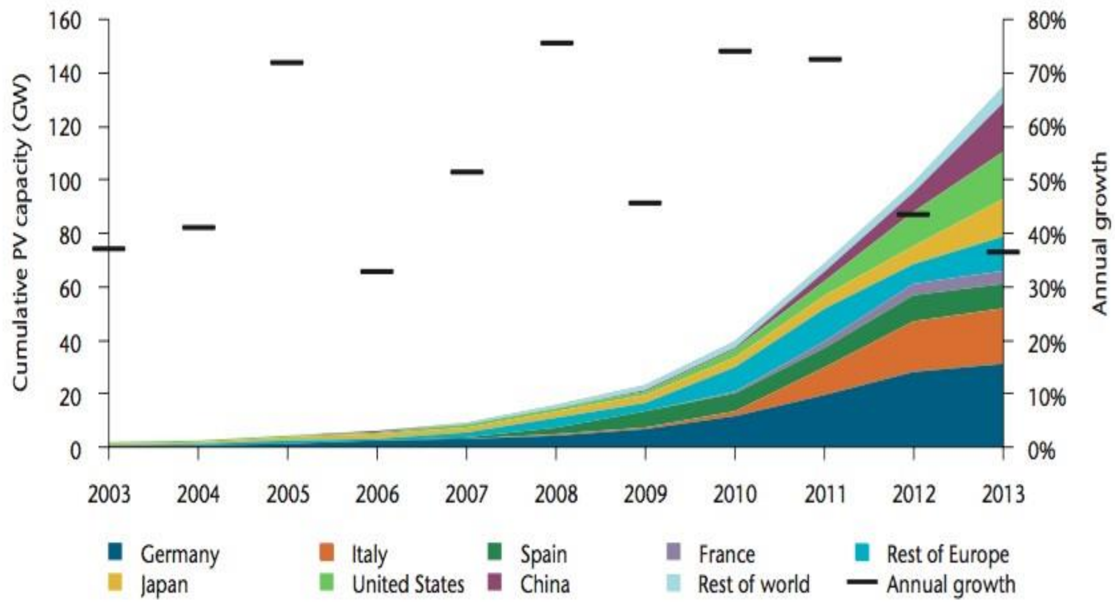
PV Manufacturing by Country, 2003-2013



Source: SPV Market Research (2014), *Photovoltaic manufacturer Shipments: Capacity, Price & Revenues 2013/2013*, Report SPV-Supply 2, April.

Annex 4

Global Cumulative Growth of PV Capacity



Source: Unless otherwise indicated, all tables and figures derive from IEA data and analysis.

Annex 5

Progress in Solar PV Markets and Installation, 2009 and 2013

	End of 2009	*End of 2013*
Total installed capacity	23 GW	135 GW
Annual installed capacity	7 GW	37 GW
Annual investment	USD 48 billion	USD 96 billion
Number of countries with >1 GW installed	5	17
Number of countries with >100 MW yearly market	9	23
PV electricity generated during the year	20 TWh	139 TWh
PV penetration levels	% of yearly electricity consumption	
Europe • Germany • Italy		2.6% 5.3% 7%

Source: IEA Technology Roadmap: Solar Photovoltaic Energy, 2014 Edition

Annex 6

Sample Diesel Generation Costs and Selling Rates in NPC-SPUG areas

*Rounded to MWh; **rounded to '000s PhP; ***rounded to two decimal figures

Area	Genera. 2012 MWB*	Costs 2012 Th PHB**	True Costs 2012	Selling Rate 2012 HB/KWB***	redict 2020
1 Basco BATANES	5,378	75,555	14,04	6,59	34,27
2 Lubuagan KALINGA	722	11,942	16,52	5,76	40,10
3 Polillio QUEZON	5,511	76,720	13,92	6,59	33,50
4 Palumbanes CATANDUANES	20	439	21,56	6,59	48,92
5 Cabra MINDORO	47	937	19,80	5,75	42,11
6 Alad ROMBLON	106	2,976	28,03	6,59	67,90
7 Caluya LEYTE	1,433	27,066	18,89	6,84	41,94
8 Camotes CEBU	9,277	142,436	15,35	6,07	37,25
9 El Nido PALAWAN	5,397	80,599	14,93	6,59	37,79
10 Siquijor SIQUIJOR	18,206	281,932	15,49	6,07	n.a.
11 Talicud DAVAO D. NOR.	662	11,175	16,87	6,27	40,32
12 Basilan BASILAN	33,817	463,126	13,70	6,58	32,21
13 Manuk Mankaw TAWI TAWI	168	2,950	17,60	6,27	40,23

Source: http://www.spug.ph/MEP2012-2021.asp (May 9, 2013) cited in GIZ Study on Renewable energy in the Philippines: Costly or competitive? (Meller and Marquardt, 2013)

Annex 7

Administrative Costs and Efforts for Installing a 3-kW PV System in the Philippines

System Cost Roof Top < 100KW	**Retro-Fit**			
Price per KW		PhP170.000,00		
3KW	3	PhP510.000,00		
			calendar days	
	%		time worked	time waiting
Barangay Clearance	3,00%	PhP15.300,00	6	2
Fire Safety	2,00%	PhP10.200,00	8	14
Electric Permit	0,30%	PhP1.530,00	8	14
Building Permit	3,00%	PhP15.300,00	5	1
Inspection	0,10%	PhP510,00	1	1
DU Application and connection				
			28	32
Total Permitting cost		PhP42.840,00		
Overhead		PhP1.000,00		
Time worked Cost	500	PhP14.000,00		
Time waiting cost		PhP0,00		
Total Administration Cost		**PhP56.840,00**		
% of System Cost		**11,15%**		
Optional Zoning Clearance	0,80%	PhP4.080,00		
Environmental clearance	0,75%	PhP3.825,00		
Tax declaration			2	

Source: Eclareon as cited in Brückmann, R., Administrative Procedures: Rules and Processes for Off-Grid PV Project Development in the Philippines, 2013

Annex 8

Sample ROI Calculation for a Six-KWp Solar PV Rooftop System

No	Assumptions		
1	Life time of PV	Years	20
2	Rated Capacity of PV System (RC)	KWp	6
	Module Efficiency (ME)	%	16%
	Hours/Year	Hours	8,760
3	Yield (RC * ME * hours/year)	kwh/year	8,410
4	Degradation Factor	%	0.5%
5	% Own Consumption	%	70%
6	DU Total Customer Charge	PhP/kWh	12.5718
7	Annual Increase in DU/Generation Charge	%	3%
8	% Net Export	%	30%
9	DU Generation Charge	PhP/kWh	5.4951
10	Operations and Maintenance/Year/KWp	PhP	900
	Cost of installed PV System	PhP/kWp	120,000
11	Cost of installed PV System total	PhP	720,000

Key Performance Indicators		
Total Solar Energy Produced	kwh	160,438
Total Cost	PhP	828,000
Total Savings	PhP	2,133,227
Break Even	Year	8
Internal Rate of Return	%	12%

Source: Markus Dietrich, GIZ Consultant (cited in GIZ Net Metering Reference Guide, 2014)

Annex 9. (continuation)

Year	Total Solar Energy Produced	Solar Energy Own Consumption	DU Total Customer Charge	Avoided Cost	Solar Energy Export	Generation Charge	Credit from Export	Savings	O&M	Total Savings	Investment and Cumulative Savings
	kWh	kWh	PhP/KWH	PhP	kWh	PhP/KWH	PhP	PhP	PhP	PhP	PhP
1	**3 – 4 (per year)**	**B*5**	**6 + 7 (per year)**	**C*D**	**B*8**	**9 + 7 (per year)**	**F * G**	**E + H**	**2 * 10**	**I-J**	**11 - K**
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
											(720,000)
1	8,410	5,887	12.5718	74,007	2,523	5.4951	13,863	87,870	5,400	82,470	(637,530)
2	8,368	5,857	12.9490	75,846	2,510	5.6600	14,208	90,054	5,400	84,654	(552,876)
3	8,326	5,828	13.3374	77,730	2,498	5.8298	14,561	92,292	5,400	86,892	(465,985)
4	8,284	5,799	13.7375	79,662	2,485	6.0046	14,923	94,585	5,400	89,185	(376,800)
5	8,243	5,770	14.1497	81,642	2,473	6.1848	15,294	96,935	5,400	91,535	(285,264)
6	8,201	5,741	14.5742	83,671	2,460	6.3703	15,674	99,344	5,400	93,944	(191,320)
7	8,160	5,712	15.0114	85,750	2,448	6.5614	16,063	101,813	5,400	96,413	(94,907)
8	**8,120**	**5,684**	15.4617	**87,881**	**2,436**	6.7583	**16,462**	**104,343**	**5,400**	**98,943**	**4,036**
9	8,079	5,655	15.9256	90,064	2,424	6.9610	16,872	106,936	5,400	101,536	105,572
10	8,039	5,627	16.4033	92,303	2,412	7.1699	17,291	109,593	5,400	104,193	209,765
11	7,998	5,599	16.8954	94,596	2,400	7.3850	17,720	112,317	5,400	106,917	316,682
12	7,958	5,571	17.4023	96,947	2,388	7.6065	18,161	115,108	5,400	109,708	426,390
13	7,919	5,543	17.9244	99,356	2,376	7.8347	18,612	117,968	5,400	112,568	538,958
14	7,879	5,515	18.4621	101,825	2,364	8.0697	19,075	120,900	5,400	115,500	654,458
15	7,840	5,488	19.0160	104,355	2,352	8.3118	19,549	123,904	5,400	118,504	772,962
16	7,800	5,460	19.5865	106,949	2,340	8.5612	20,034	126,983	5,400	121,583	894,545
17	7,761	5,433	20.1740	109,606	2,328	8.8180	20,532	130,139	5,400	124,739	1,019,284
18	7,723	5,406	20.7793	112,330	2,317	9.0826	21,043	133,373	5,400	127,973	1,147,256
19	7,684	5,379	21.4026	115,121	2,305	9.3550	21,565	136,687	5,400	131,287	1,278,543
20	7,646	5,352	22.0447	117,982	2,294	9.6357	22,101	140,084	5,400	134,684	1,413,227
Total	**160,438**	**112,306**		**1,887,623**	**48,131**		**353,604**	**2,241,227**	**108,000**	**2,133,227**	

Source: Markus Dietrich, GIZ Consultant (cited in GIZ Net Metering Reference Guide, 2014)

Annex 10
Sample Return of Investment (ROI) Calculation

GIVEN :

CURRENT RATE :	Php10.22				MONTHLY AVERAGE CONSUMPTION :	2,400
COST OF SOLAR :	5		475,000		% SAVINGS PER MONTH (MINIMUM)	24%
ANNUAL YIELD :	1,360	Average	(4 hours X 340 days)		% SAVINGS PER MONTH (MAXIMUM)	30%
MONTHLY KWH :	567	Minimum	729	Maximum		
ANNUAL ESCALATION :	3.50%	Meralco Annual Increase				
DOWN PAYMENT :	30%	Minimum			142,500.00	

YEAR	SAME RATE		3.5% MINIMUM		BANK LOAN 5% INTEREST		ADDITIONAL EARNINGS	
	RATE	SAVINGS	RATE	SAVINGS	RATE	ANNUAL	MINIMUM	MAXIMUM
1st year	10.22	138,992	10.22	138,992	7.33	99,750	39,242	39,242
2nd year	10.22	138,992	10.58	143,857	7.33	99,750	39,242	44,107
3rd year	10.22	138,992	10.95	148,892	7.33	99,750	39,242	49,142
4th year	10.22	138,992	11.33	154,103	7.33	99,750	39,242	54,353
5th year	10.22	138,992	11.73	159,497	7.33	99,750	39,242	59,747
6th year	10.22	138,992	12.14	165,079	7.33	99,750	39,242	65,329
7th year	10.22	138,992	12.56	170,857	7.33	99,750	39,242	71,107
8th year	10.22	138,992	13.00	176,837	7.33	99,750	39,242	77,087
9th year	10.22	138,992	13.46	183,026	7.33	99,750	39,242	83,276
10th year	10.22	138,992	13.93	189,432	7.33	99,750	39,242	89,682
		1,389,920		1,630,570		997,500	392,420	633,070

					TOTAL	INTEREST	BANK SAVINGS VS SOLAR	
AVERAGE		138,992		163,057	1,140,000	665,000	120%	570,000.00
ROI YEARS		3.4		2.9			343%	1,630,569.80

Annex 11
Sample Electric Bill with Net Metering

Assumptions:
Rated Capacity of Solar Rooftop
2.00 kW Yield @ 100%
Capacity Factor (2kWx720hrs)
1,440 kWh Yield @ 16%
Capacity Factor 1,440x16%
230 kWh
Own Use @ 60% 138 kWh
Net Export @ 40% 92 kWh

Table A. DU Charges to Customer

Billing Concept	Base	Price	Amount
Generation Charge	460	5.6673	2,606.96
Prev Mos Adj on Gen Cost	460	0.0314	14.44
Prev Yrs Adjustment	460	0.0000	0.00
SUBTOTAL			**2,621.40**
TRANSMISSION CHARGE (P/kWh)	460	0.9333	**429.32**
Transmission Charge (NONVAT)	429.32	99.4725	427.06
Transmission Charge (VATABLE)	429.32	0.5264%	2.26
System Loss Charge	460	0.6062	**278.85**
Distribution Charge	460	2.5043	1,151.98
Fixed Metering Chrg	1	5.00	5.00
Metering Chrg per kWh	460	0.4066	187.04
Fixed Supply Charge	1	19.88	19.88
Supply Charge per kWh	460	0.6043	277.98
SUBTOTAL	**1,641.88**		
Net metering Charge:			
Fixed Metering Chrg	1	5.00	5.00
Metering Chrg per kWh	92	0.4066	37.47
Fixed Supply Charge	1	19.88	19.88
SUBTOTAL			**62.35**
SUBSIDIES			
Lifeline Rate Subsidy	460	0.1173	53.96
Sr Citizen Subsidy (P/kWh)	460	0.0001	0.05

SUBTOTAL			**54.01**
Government Taxes			
Local Franchise Tax	5,087.81	0.750%	38.16
TRAC	460	0.0160	7.36
VALUE ADDED TAX			
Generation Charge	2,606.96	10.9700%	285.98
Prev Mos Adj on Gen Cost	14.44	9.8800%	1.43
Transmission Charge (VATABLE)	2.26	12%	0.27
System Loss Charge	278.85	9.43%	26.30
Distribution Rev & Subs	1,758.24	12%	210.99
SUBTOTAL			**570.48**
Universal Charges:			
Missionary	460	0.1163	53.50
Environmental	460	0.0025	1.15
NPC Stranded Debt			
NPC Stranded Contract Cost	460	0.1938	89.15
Equl'n of Taxes & Royalties			
DU Stranded Contract Cost			
SUBTOTAL			**143.80**
Other Charges			
Annual Bill Deposit Interest			(19.05)
SUBTOTAL			**(19.05)**
TOTAL CURRENT AMOUNT DU TO CUSTOMER			**5,783.05**

Table B. Customer Charges to DU

Billing Concept	Bas	Price	Amount
Generation Charge (net export)	92	**5.4951**	506.43
Residual Credit Earned in Prior Mos.	0	**5.4951**	0.00
TOTAL CURRENT AMOUNT CUSTOMER TO DU			**506.43**

Table C. Net Metering Customer's Bill

TOTAL CURRENT AMOUNT DU TO CUSTOMER	**5,783.05**
LESS: TOTAL CURRENT AMOUNT CUSTOMER TO DU	**(506.43)**
LESS: Credit Amount from Previous Month	
Net Bill Amount	**PhP5,276.6**

Avoided Cost (Own Use)	138	PhP 12.5718	PhP 1,737.93
Credit earned	92	5.4951	506.43
TOTAL AVOIDED COST			**PhP 2,244.36**
Avg. Savings Rate/kWh		230	PhP 9.76

Source: GIZ Net Metering Reference Guide, 2014