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**Solar Power's Rise and Promise**

by

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# SOLAR POWER'S RISE AND PROMISE

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## 1. Introduction

Renewable energy is not new though there is no consensus on the exact period of the genesis of any of its forms. Historical records suggest that most natural energy, as it's also known, such as hydro, wind and solar, began to be used by the earliest *Homo economicus* several centuries ago.

Modern hydropower's evolution is said to have begun only in the mid-1700s when a French hydraulic and military engineer Bernard Forest de Bélidor authored Architecture Hydraulique.[2] Wind energy became more popular in America later still, between 1870 and 1930, when farmers across the country used it to pump water. Subsequently, small electric wind turbines began to be used in rural areas in the 1920s, prior to larger machines built in the 1940s. Likewise, solar energy started to be given serious attention only in the 1860s when August Mouchout, a French mathematician invented the first solar-powered steam engine used to make ice when connected to a refrigeration machine.[3]

In the Philippines, apart from hydropower and geothermal energy, the adoption of natural energy from wind and sun is quite recent. The Northwind Bangui Bay Project – located in the municipality of Bangui, Ilocos Norte at the northwest tip of Luzon island – officially took off only on June 18, 2005.

Meanwhile, the first and biggest solar power plant, commercially financed and commissioned by San Carlos Solar Energy Inc. (Sacasol), officially started operations only in May 15, 2014 in Negros Occidental. The 22-megawatt solar power project is being developed by Bronzeoak Philippines and Swiss-German firm Thomas Lloyd. During the plant's inauguration, President Benigno S. Aquino lll encouraged the developers to put up more plants in other parts of the country. The adoption of individual or distributed solar photovoltaic (PV) panel systems, which are ideal especially for off-grid rural households and are already quite common in Africa and South Asia, appears to be still nascent.

Not too long ago, solar power was facilely dismissed as impractical, space-intensive, inefficient and expensive. In terms of social desirability, it was generally regarded a cellar-dweller among the various renewable sources. The costliness of solar energy is reflected in the range of government-approved feed-in-tariff (FIT) rates, namely, P9.68 per kilowatt hour (recently reduced to P8.69/kWh) for solar, P8.53/kWh for wind, P6.63/kWh for biomass, and P5.90/kWh for hydro. Economists generally appear to be not too sanguine about renewable energy (RE), solar in particular, owing to its perceived inefficiency.

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[2] http://energy.gov/eere/water/history-hydropower
[3] http://www1.eere.energy.gov/solar/solar_timeline.html

The Foundation for Economic Freedom (FEF) in a press release issued on June 16, 2014 opposed the Department of Energy's (DOE) plan to increase the installation target for solar energy from 50 megawatts (MW) to 500 MW, ostensibly due to the need to ramp up reserves for the 2015 and 2016 summer months. FEF pointed out the added burden imposed on consumers to the great advantage of solar energy developers, financiers, and foreign equipment suppliers. Qualifying their opposition, they added: "We … are not against renewable energy per se, but against the obscene prices that must be borne by the Filipino consumers due to the exorbitant Feed-in-Tariff rates and duration (20 years) given to renewable energy developers".

The World Wide Fund for Nature (WWF-Philippines) has taken the contrarian stance, concurring with DOE's move to scale up solar energy capacity and arguing that it will make power cheaper in the long run. They say that while FEF claims new solar projects will add P0.32 per kWh to consumers' electricity bills, their own energy experts reckon the added cost to be a maximum of P0.05/kWh for the additional 450 MW of solar plants. Which implies that a household with an average monthly bill of 300 kWh would pay only P15 more per month for clean and green energy.

It appears that skepticism or unease about solar power lingers in the Philippines. More empirical research and policy discussion seem called for. Meanwhile, there's much to learn from the international literature and field experience for raising the level of policy discourse.

The next section surveys the international literature and field experience regarding recent strides in solar energy, particularly in terms of innovations in technology, financing, and regulation. It also looks into the extent of adoption of solar energy in developed and developing countries, including the role of incentives, pricing, available financing, and private-sector investments. Section 3 then examines the Philippine situation as regards progress in adoption, promotion by the government, and private-sector participation. Section 4 discusses solar power's potential for energizing the poor. Section 5 takes up the general interest in solar energy vis-à-vis concerns about greenhouse gas emissions affecting climate change. The paper concludes with a summary of the main points and implications for policy and further research.

## 2. Strides in Solar Energy: International Perspective

Time was when solar energy was quite unappealing to consumers and producers of electricity as solar panels were deemed highly inefficient and costly. In recent years, however, with rapid technological advance, solar power has become increasingly attractive and a promising source of electricity.

The earlier skepticism about solar power has, indeed, made a turnaround, relate physicists and solar experts Pinner and Rogers (2015). While today solar power accounts for less than one percent of global energy supply, it is growing faster than any other source, averaging 50 percent yearly over the past six years. Annual installations of photovoltaic (PV) panels shot up from under 0.3 gigawatts (GW) in 2000 to 45 GW in 2014 – which can electrify upward of 7.4 million homes in a developed country like the United States, for example.

The surge in the viability of solar power, according to the solar expert authors, can be explained by innovations in regulation, industry, technology, and financing. It no longer needs public subsidies to be price-competitive vis-à-vis such traditional energy sources as coal, natural gas, and nuclear power. The International Energy Agency (IEA), which used to be lukewarm, if not altogether skeptical, about solar power, posits an upbeat forecast of solar energy becoming

the single largest source of power by 2050, accounting for as much as 27 percent of electricity worldwide. When that happens, the consequences will be profound and the benefits widespread. Electricity will reach far-flung off-grid villages in developing countries which have never tasted what it means to have light or heat on demand.

## 2.1 Technology, regulation, and financing

Commercial silicon modules in 2013 had an average efficiency rate of 16 percent, with a 0.3 percent improvement per year in the last 10 years (IEA 2014). More recent technological developments have included perovskite material that can potentially make solar cells more efficient still and at sharply lower costs, though issues have yet to be settled before commercialization (Renewable Energy Policy Network for the 21st Century [RNE21] 2014).

A group at Brown University in Providence, Rhode Island report that ultra-thin films with perovskite crystals can have a solar efficiency of over 15 percent (*The Economist Technology Quarterly*, May 30th 2015). On the other hand, Oxford Photovoltaics believes that perovskites can give an efficiency rate of over 20 percent. As well, Pinner and Rogers (2015) reckon that that a solar panel can now generate 2 watts (W) of electricity for every 10 W of sunlight hitting it, hence, an efficiency rate of at least 20 percent.

Apart from technological advances, the upsurge in the viability and use of solar power is attributable to innovations in regulation and financing (Pinner and Rogers, 2015). Various regulatory policies in the form of incentives such as feed-in tariffs (FITs), tax deductions, low-interest loans or grants, renewable portfolio standards, and net metering, as well as public competitive bidding have been implemented by various countries to spur renewable energy generation (RNE21, 2014). Developing countries now account for 95 of 138 countries having renewable energy (RE) support policies in place, thus leading in the adoption of RE policies in early 2014.

According to IEA (2014), different support policies are adopted as regards technology used to harvest solar energy. FIT rates or feed-in premiums and auctions are used for utility-scale PV plants in Europe, Australia, Canada and Japan. Many developing economies, from Brazil to South Africa, also commonly use auctions for utility-scale PV plants. Net metering is used for distributed PV panels in U.S., and FITs in Europe and Asia. All these policies are often introduced in combination with fiscal incentives like investment tax credits.

Various financing models are available to households. According to Speer (2012), in the U.S. there are four options for solar PV financing schemes. These are: (i) self-financing, such as cash purchase and home equity loan; (ii) third-party ownership, such as power purchase agreement and solar lease; (iii) utility financing, such as on-bill and meter-attached loans; and (iv) public financing, such as credit-enhanced and revolving fund loans. Third-party ownership is a new financing arrangement, whereby consumers pay a set monthly rate or a fixed price per unit of power while the companies install and maintain their solar panels (Pinner and Rogers 2015).

The surge in the use of solar PV panels in Bangladesh, which has the world's fastest solar home system (SHS) coverage rate, is attributed to microcredit financing, whereby households give a down payment and amortize the balance in tranches (Khandker et al. 2014). Likewise, the East Africa region is arguably a global leader in adopting new business models for off-grid SHS commercialization, reports World Bank energy consultant Terrado (2015a). Advances in LED bulbs and pico-solar technologies combined with creative pre-payment

arrangements and mobile-money facility have enabled private entrepreneurs and investors to cover increasingly wider markets.

## 2.2 Adoption of solar power

In the last 10 years, Germany added 35 GW of solar PV panels while in the U.S. the corresponding capacity increased from 18 MW in 2000 to more than 12,000 MW in 2013 (Pinner & Rogers, 2015). According to Barone (2015), there are now 644,000 existing solar panel systems in U.S. homes and businesses, a 32-fold increase from only 20,000 solar systems in 2005.

In China, as well, solar power is figuring palpably in its green-energy revolution (Mathews and Tan 2015). In 2014, electricity generated by renewable sources (water, wind and solar) increased 20 percent, with solar power generation alone rising a spectacular 175 percent. Solar power also beat nuclear energy in terms of new power created – an additional 17.43 terawatt-hours versus 14.70 terawatt-hours from nuclear sources.[4]

Africa is adopting concentrated solar power (CSP) technology that focuses the sun's radiation to heat a receiver and generate electricity. Africa is known to have six of the 10 biggest CSP plants in the world. A US$640 million CSP plant was inaugurated in March 2015 in South Africa (*The Economist*, June 6th 2015). A downside of CSP, however, is that it is suited for on-grid large plants and is relatively expensive. Solar PV module, in comparison, converts sunlight into direct current electricity and can be used for either on-grid or off-grid electricity generation (IEA 2011).

The off-grid application of solar PV panels is the most practical solution for rural electrification. Governments realize that building energy infrastructure such as large power plants and transmission lines takes decades. Extending power lines from the main grid to remote areas not only costs several thousand U.S. dollars per customer it also takes decades, whereas solar panels can electrify these areas much faster and more cheaply (*The Economist*, June 6th 2015).

Accordingly, the major source of electricity in rural Kenya, one of the world's leading markets for off-grid solar energy, is the SHS with an installed capacity of over 10 megawatt-peak (MWp) (Ondraczek 2014). Of the 320,000 solar SHSs installed in 2010, 4.4 percent are owned by rural households. More and more poor households can now afford SHS, which can be installed in a couple of days and are able to power a television set and light a few bulbs.

The SHS program in Bangladesh started in 2003 and in a few years time 50,000 units per month have been installed. While the country has had the world's fastest SHS coverage rate with three million rural households reached by early 2014, no more than 10 percent of off-grid households have been covered by the system (Khandker et al. 2014). Likewise, an Indian company (SELCO) has sold and maintained two million SHS in India facilitated by financing tailored to poor households (Bazilian 2014).

Falling PV panel prices have also encouraged new markets in Africa, Middle East, Asia and Latin America (RNE21, 2014). The top three countries with the highest solar PV capacities

[4] One terawatt-hour is equal to a sustained power of approximately 114 megawatts for a period of one year.

installed in 2013 were China with 11 GW, Japan almost 7 GW, and United States with over 4 GW (IEA 2014). Moreover, the solar boom in Japan resulted in a 47 percent overall increase in RE investments in the Asia-Oceania region in 2012 (RNE21, 2014).

All told, besides its off-grid facility, solar technology's progressive cost reductions and average learning rate of 19.3 percent over the period 1976-2010 have attracted more investors and households to solar PV systems (IEA 2011). New solar PV systems were installed in 2013 at a rate of 100 megawatts (MW) per day around the world such that total global capacity reached 150 GW) in early 2014 (IEA 2014).

## 2.3 Pricing and falling FITs

International PV module prices have dropped from about US$6 per Watt-peak (Wp) just five years ago to around US$1/Wp currently[5] (Terrado 2015b). Even in African countries, there are tens of MWs of grid-connected PV systems installed by private companies which seem to be profiting even without the FIT subsidy.

According to Barone (2015), the average price of a 6 kilowatt (kW) solar system, pre-tax credit in the U.S. is $20,867. In recent years, the price of solar panels dropped by more than half (*The Economist*, June 6th, 2015). The 20 percent decline in solar power investments in 2013 was mostly due to the reduction in the installed costs of solar PV systems (RNE21, 2014). The cost of residential PV systems in Japan had a 21 percent reduction, falling from US$5.9/W in 2012 to US$4.64/W in 2013 (IEA 2014). For a 50 Wp SHS in 2010, the cost in Kenya at US$6-12 per Wp is lower than that in Tanzania at US$9.5-16/Wp (Ondraczek, 2011). In Dubai, a power purchase agreement for a 200 MW solar farm was settled for 5cts/kWh while solar power cost was below 7 cts/kWh for Brazil, Uruguay, and other countries (Fraunhofer Institute for Solar Energy Systems 2015).

Solar PV systems and onshore wind installations have been built even without subsidies due to increasing efficiency and decreasing costs in some areas in the world, especially in the Latin America (RNE21, 2014). Likewise, PV panel is already competitive without subsidies in a number of developed countries such as Australia, Germany, Italy, Portugal, Spain, and Southwestern United States (LeVine 2015). In California, just under 40 percent of the solar PV installations availed themselves of state subsidies in 2013, compared to 2007 where almost all took subsidies (Pinner & Rogers, 2015). This happened while system costs in California continued to drop annually by 10-15 percent (IEA 2014).

RNE21 (2014) reports that many countries have scheduled reductions in the FIT rates to be in step with changing market conditions while some have reduced or altogether dropped FIT support because of capacity limits. There is a scheduled quarterly reduction in solar FIT rates in Germany while support in the Netherlands and Italy for new solar PV projects have been on hold as budgets have already been reached. Likewise, Portugal, China, and Japan reduced their FIT rates for solar PV systems in 2013-2014.

## 2.4 Government promotion and private-sector investments

The Asian Development Bank (ADB) reports that governments in some of its developing member countries (DMCs) have implemented programs that reduce installation costs, give

[5] Watt-peak (WP) – such as kilowatt-peak, megawatt-peak, etc. – refers to peak output of a photovoltaic (PV) system.

incentives to private firms, or establish goals for solar PV electrification (2011). For instance, Bangladesh has its Climate Change Strategy and Action Plan, China its Renewable Energy Law, India its Jawaharlal Nehru National Solar Mission, the Philippines its Renewable Energy Act of 2008, and Thailand has a policy of fixed added rate to tariff.

To more actively promote solar energy in its DMCs under the Asia Solar Energy Initiative, launched in 2010, ADB decided to lead by example by producing solar power at the ADB headquarters (2014). The initiatve was also intended to showcase how commercial buildings can reduce their carbon footprint and diversify energy supply with renewable energy.

In June 2012 ADB's solar energy system was completed and put to use -- which appears to have encouraged businesses in Manila and elsewhere in Asia to install similar facilities on their rooftops and other available spaces. "With energy demand projected to almost double in the region by 2030, ADB envisions that these pioneering projects will enable the power industry to meet new demand with reduced carbon impact. Reducing the region's reliance on fossil fuel is a necessary step toward enhancing future energy security and mitigating climate change" (2014, p. xiii).

ADB's rooftop solar PV system has a capacity of 571.2 kW, generating 50,000 kWh of electricity per month under average weather conditions -- enough to electrify 245 Metro Manila homes each consuming about 2,500 kWh per year. The system's capacity has been expanded to 681.9 kW with 110.7 kW more installed on ADB's newly finished Third Atrium Building in March 2015 – altogether accounting for some 4.2 percent of the institution's energy needs.

There are also projects launched by some countries that generate electricity from solar PV panels, namely, the Tenaga Suria Brunei project of Brunei Darussalam that started in 2010 with a capacity of 1.2 MW. Similarly, there is the world's first hybrid generation system of solar PV and small-scale hydro in the Lao People's Democratic Republic that started in 2005.

Two countries in Africa have different scenarios. Tanzania's solar market came on stream mainly because of the government's active role while Kenya's solar market developed mostly without active government involvement (Ondraczek, 2014). Private sector investment in solar PV installations can be seen in the support of organizations and development banks through funding or supply of SHS. Bangladesh's Climate Change Strategy and Action Plan was implemented by the Infrastructure Development Company, Ltd. and other partner organizations with funding coming from the World Bank and other development partners (Khandker et al. 2014).

Various for-profit social enterprises have succeeded in selling and installing SHS using the microcredit approach. Some of these are SELCO in India which sold and financed more than 115,000 SHS since 1995, Tecosol in Nicaragua, which installed more than 40,000 units in Central America, and Quetsol in Guatemala that put up SHS units in the country's rural areas (Khandker et al., 2014). Multilateral development banks such as the World Bank, European Investment Bank, and European Bank for Reconstruction and Development, as well as overseas aid agencies of the United States and other northern European countries, have also been sources of renewable energy investments (RNE21, 2014).

## 2.5 Power storage challenge

A key challenge is the inability of PV modules to harness energy from the sun at night or on cloudy days. The obvious solution is battery storage. Studies by the U.S. Western Electricity Coordinating Council suggest that better ways to store energy could reduce waste by about 18

percent and boost the efficiency of electricity use by up to 11 percent (Eikeland 2015). Better energy-storage methods would also make it easier to deliver electricity to remote and neglected rural areas.

Research and development in storage technology have of late resulted in significant price reductions. Battery costs have already fallen by about 70 percent over the last five years, prompting some companies, like SolarCity in the U.S., to pack solar panels with batteries (Pinner & Rogers 2015). In another 10 years or so, the price could fall further by 70 percent due to improvements in technology and manufacturing.

The company that created the battery for cars in the U.S., has already begun manufacturing batteries for homes, as announced by Tesla chairman, CEO and product architect Elon Musk on April 30, 2015. Tesla Powerwall is a rechargeable lithium-ion battery, a cost-effective device that stores electricity charged from solar panels or when utility rates are low. It is seen as a threat to distribution utilities in the U.S. (or locally, e.g., Meralco), as it has the potential for consumers to untether from the grid (Rappler.com, June 28, 2015). Experts regard this as a game changer, a major breakthrough in the formidable challenge of reliable RE storage.

Multiple Powerwalls can also be linked together for homes or institutions with larger energy requirements. Further, a recent initial breakthrough has been made by Professors Wang Changan of Tsinghua University in Beijing and MIT's Li Ju through their work on nanoparticles that can extend the lifetimes of lithium-ion batteries by up to four times (“Science and technology,” *The Economist*, August 15th, 2015).

Daniel Nocera, Harvard professor and inventor of artificial photosynthesis is nonchalant about Powerwall, however. He believes: “In the United States, the economics don’t make sense. If we could calculate all that you’ve invested in your energy infrastructure -- all the wires, all the power plants, we’re talking 70 hundred trillion dollars which you’ve already paid off," Nocera said, exaggerating for effect, "You’re not going to walk away from that,” Nocera told the Washington Post (Wishard, July 30, 2015).

## 3. Solar Power in the Philippines

### 3.1 Renewable energy projects

To foster the development, utililization, and commercialization of renewable energy, the Renewable Energy Act (Republic Act No. 9513) took effect in October 2008, with a view to lessening the country's dependence on fossil fuels. The Department of Energy has since awarded (as of 30 April 2015) a total of 664 projects, of which 629 are for grid-use and 35 for own-use (Table 1). Of the six RE sources, hydropower -- being relatively older -- has by far the most number of projects awarded, followed by solar, wind and geothermal, in that order, which is true also of "potential" capacity (defined by DOE as "in development stage"). Ocean energy is marginal.

**TABLE 1. AWARDED PROJECTS UNDER RENEWABLE ENERGY LAW (AS OF 30 APRIL 2015)**

| RENEWABLE ENERGY | AWARDED PROJECTS | | POTENTIAL CAPACITY* MW | | INSTALLED CAPACITY** MW | | INSTALLED RELATIVE TO POTENTIAL (%) |
|---|---|---|---|---|---|---|---|
| | GRID-USE | OWN-USE | GRID-USE | OWN-USE | GRID-USE | OWN-USE | |
| **Hydro Power** | 403.00 | 1.00 | 7,621.54 | 1.50 | 122.73 | 0.00 | 1.61 |
| **Ocean Energy** | 8.00 | - | 31.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Geothermal** | 42.00 | - | 750.00 | 0.00 | 1,896.19 | 0.00 | 252.83 |
| **Wind** | 50.00 | 1.00 | 1,272.00 | 0.01 | 336.90 | 0.00 | 26.49 |
| **Solar** | 82.00 | 11.00 | 1,749.53 | 3.58 | 108.90 | 0.00 | 6.21 |
| **Biomass** | 44.00 | 22.00 | 345.00 | 5.80 | 191.80 | 143.18 | 95.49 |
| **Sub-total** | 629.00 | 35 | 11,769.01 | 10.886 | 2,656.52 | 143.18 | 23.77 |
| **TOTAL** | **664** | | **11,779.96** | | **2,799.70** | | |

Source: Renewable Energy Management Board (REMB), Department of Energy, Republic of the Philippines (ROP), 2015.

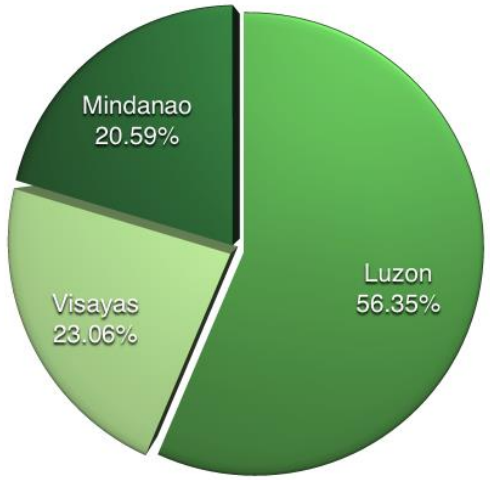
These projects have an aggregate "potential" capacity of 11,780 MW – of which 11,769.01 MW are for grid-use and the balance is for own-use. "Installed" (DOE-defined as "operational") capacity is 2,800 MW (23.8 percent relative to potential), mostly for grid-use and 5.1 percent for own-use. Of the installed capacity, slightly more than two-thirds are accounted for by geothermal energy, followed by wind, hydro, and biomass (for own use only). Solar power has 1,753 MW potential capacity but a measly 109 MW installed (for grid-use) accounting for a mere 3.9 percent of all RE projects' installed capacity. Zero solar MW has been installed for own-use, under which off-grid SHS is classified.

It seems clear our country has been lagging behind even the poorer countries in East Africa and South Asia in tapping solar power. This may be attributable to the country's accustomed over-reliance on geothermal energy and hydropower, besides the traditional energy sources, of course. This implies that a more vigorous pursuit of solar energy's potential, besides that of wind power, could greatly help toward the goal of minimizing the country's energy shortfall.

## 3.2 Solar energy projects

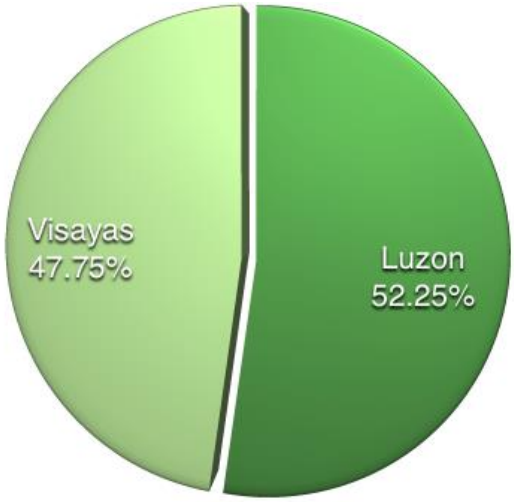
The distribution of awarded on-grid solar projects across the country's three main island regions and respective provinces is displayed in Figures 1A for potential capacity and 1B for installed capacity.

**FIGURE 1A. POTENTIAL CAPACITY OF AWARDED ON-GRID SOLAR PROJECTS***




* **Total potential capacity = 1,749.5 MW**
Source: REMB, Department of Energy, ROP, 2015.

**FIGURE 1B. INSTALLED CAPACITY OF AWARDED ON-GRID SOLAR PROJECTS***




* **Total installed capacity = 108.90 MW**
Source: REMB, Department of Energy, ROP, 2015.

Of the total potential capacity of 1,749.5 MW, more than half are in Luzon where Bataan has the highest with 275 MW but zero installed, and Metro Manila has among the lowest at only 3.2 MW and 1.5 MW installed (Table 2A). Luzon's total solar potential capacity is 986 MW but only 57 MW are installed, accounting for more than half of the total installed in the country.

**TABLE 2A. AWARDED ON-GRID SOLAR PROJECTS, LUZON (AS OF 30 APRIL 2015)**

| | POTENTIAL CAPACITY (MW) | INSTALLED CAPACITY (MW) | INSTALLED RELATIVE TO POTENTIAL (%) |
|---|---|---|---|
| **Ilocos Norte** | **230.00** | **4.10** | **1.78** |
| Currimao | 20.00 | | |
| Pasuquin-Burgos | 50.00 | | |
| Burgos | | 4.10 | |
| Paoay | 160.00 | | |
| **Pangasinan** | **2.00** | **-** | **-** |
| Manaoag | 2.00 | | |
| **Cagayan** | **105.00** | **-** | **-** |
| Aparri | 105.00 | | |
| **Pampanga** | **12.00** | **10.00** | **83.33** |
| Mexico | | 10.00 | |
| Mabalacat | 12.00 | | |
| **Bataan** | **275.00** | **-** | **-** |
| Morong | 5.00 | | |
| Mariveles | 20.00 | | |
| Orani | 150.00 | | |
| Morong-Hermosa | 100.00 | | |
| **Bulacan** | **5.00** | **-** | **-** |
| San Rafael | 5.00 | | |
| **Zambales** | **5.00** | **-** | **-** |
| Palauig | 5.00 | | |
| **Nueva Ecija** | **10.00** | **-** | **-** |
| Cabanatuan City | 10.00 | | |
| **Tarlac** | **100.00** | **-** | **-** |
| Concepcion | 50.00 | | |
| Tarlac City | 50.00 | | |
| **Cavite** | **53.80** | **41.30** | **76.77** |

| | POTENTIAL CAPACITY (MW) | INSTALLED CAPACITY (MW) | INSTALLED RELATIVE TO POTENTIAL (%) |
|---|---|---|---|
| Rosario-Gen. Trias | | 41.30 | |
| Naic | 50.00 | | |
| Noveleta-Rosario-Gen. Trias-Tanza | 3.00 | | |
| Dasmariñas | 0.80 | | |
| **Rizal** | **30.00** | **-** | **-** |
| Rodriguez | 30.00 | | |
| **Laguna** | **46.91** | **-** | **-** |
| Calamba | 0.21 | | |
| Binan | 0.70 | | |
| Cabuyao | 16.00 | | |
| Luisiana | 30.00 | | |
| **Batangas** | **32.00** | **-** | **-** |
| Calatagan | 30.00 | | |
| Lian | 2.00 | | |
| **Quezon** | **50.00** | **-** | **-** |
| Candelaria | 50.00 | | |
| **Palawan** | **13.00** | **-** | **-** |
| Puerto Princesa | 10.00 | | |
| El Nido Island | 3.00 | | |
| **Metro Manila** | **3.20** | **1.50** | **46.88** |
| Quezon City | | 1.50 | |
| Pasay City | 3.20 | | |
| **Camarines Sur** | **12.00** | | |
| Pili | 12.00 | | |
| **Catanduanes** | **1.00** | | |
| Caramoran | 1.00 | | |
| **LUZON** | **985.91** | **56.90** | **5.77** |

Source: REMB, Department of Energy, ROP, 2015.

Visayas has 403.4 MW potential capacity and only 52 MW installed (Table 2B). Negros Occidental has the highest at 262 MW and merely 22 MW installed, followed by Leyte at 80 MW potential and 30 MW installed. Lastly, Mindanao has 360.3 MW potential capacity and none installed (Table 2C). Hence, Visayas has the rest (48 percent) of the total installed country-wide.

**TABLE 2B. AWARDED ON-GRID SOLAR PROJECTS, VISAYAS (AS OF 30 APRIL 2015)**

| | POTENTIAL CAPACITY (MW) | INSTALLED CAPACITY (MW) | INSTALLED RELATIVE TO POTENTIAL (%) |
|---|---|---|---|
| **Negros Occidental** | **262.00** | **22.00** | **8.40** |
| Cadiz City | 100.00 | | |
| San Carlos City | 23.00 | 22.00 | |
| La Carlota City | 18.00 | | |
| Manapla-Cadiz | 22.00 | | |
| Bais City | 25.00 | | |
| Victorias City | 60.00 | | |
| La Carlota City | 14.00 | | |
| **Iloilo** | **35.67** | | |
| Miag-ao | 5.67 | | |
| Tigbauan | 30.00 | | |
| **Capiz** | **0.70** | | |
| Roxas City | 0.70 | | |
| **Cebu** | **25.00** | | |
| Daan Bantayan | 25.00 | | |
| **Leyte** | **80.00** | **30.00** | **37.50** |
| Ormoc | 30.00 | 30.00 | |
| Tacloban-Santa Fe-Palo | 50.00 | | |
| **VISAYAS** | **403.37** | **52.00** | **12.89** |

Source: REMB, Department of Energy, ROP, 2015.

**TABLE 2C. AWARDED ON-GRID SOLAR PROJECTS, MINDANAO**
**(AS OF 30 APRIL 2015)**

| | POTENTIAL CAPACITY (MW) | INSTALLED CAPACITY (MW) | INSTALLED RELATIVE TO POTENTIAL (%) |
|---|---|---|---|
| **Misamis Oriental** | **100.00** | **0.00** | **0.00** |
| Villanueva | 20.00 | | |
| Laguindingan | 20.00 | | |
| Claveria | 60.00 | | |
| **Bukidnon** | **14.00** | | |
| Kibawe | 12.00 | | |
| Sumilao | 2.00 | | |
| **Davao del Sur** | **60.00** | | |
| Sta. Cruz | 35.00 | | |
| Digos City | 25.00 | | |
| **Davao Oriental** | **10.00** | | |
| Mati | 10.00 | | |
| **South Cotabato** | **106.25** | | |
| Surallah | 6.25 | | |
| General Santos City | 90.00 | | |
| Polomolok | 10.00 | | |
| **Sarangani** | **15.00** | | |
| Alabel | 15.00 | | |
| **Agusan del Norte** | **20.00** | | |
| Butuan City | 20.00 | | |
| **Lanao del Sur** | **35.00** | | |
| Tagoloan II-Saguiaran-Marawi City | 35.00 | | |
| **MINDANAO** | **360.25** | | |

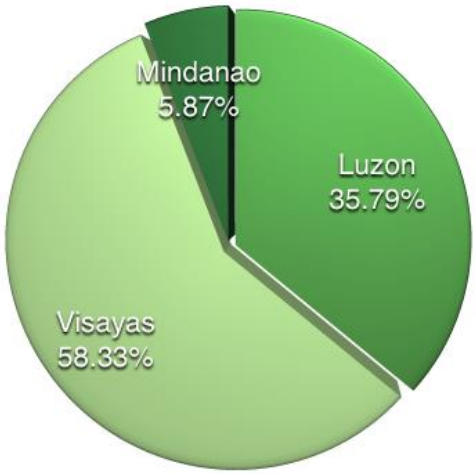
Source: REMB, Department of Energy, ROP, 2015.

Meanwhile, DOE raised in May 2014 the installation goal for solar energy generation under the FIT system to 500 MW when the original 50 MW target had been reached. For the additional 450 MW, the Energy Regulatory Commission (ERC) reduced the FIT rate from P9.68/kWh to P8.69, though the DOE secretary stated that the first 70 MW had qualified for the higher rate.

On-grid electricity consumers are being charged a FIT-Allowance (FIT-All) by distribution utilities, such as Meralco, starting February 2015, with a fixed rate of P0.04 per kWh (Olchondra, February 2, 2015). The FIT-All, managed by the National Transmission Corporation (Transco), comprises funds used to pay RE developers.

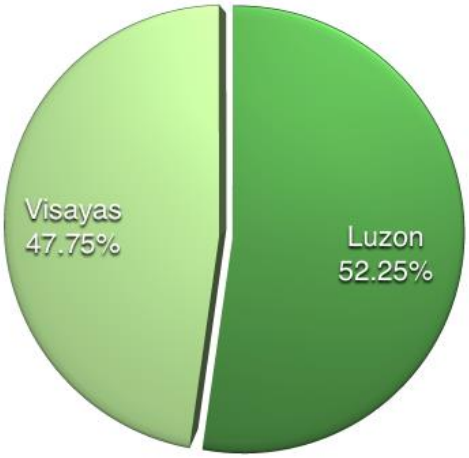
The distributions of "declared" and "approved" solar projects under the FIT system across the three main island regions are presented in Figures 2A and 2B. Luzon has a "declared" FIT capacity of 121.9 MW-peak (MWp) and 56.9 MW are "approved". Cavite has the highest declared capacity at 44.3 MWp and 41.3 MW approved. Metro Manila has 1.5 MWp capacity both declared and approved, all in Quezon City (Table 3A).

**FIGURE 2A. DECLARED FIT CAPACITY OF SOLAR PROJECTS***




* **Total declared FIT capacity = 340.57 MWp**
Source: REMB, Department of Energy, ROP, 2015.

**FIGURE 2B. APPROVED FIT CAPACITY OF SOLAR PROJECTS***




* **Total approved FIT capacity = 108.90 MWp**
Source: REMB, Department of Energy, ROP, 2015.

**TABLE 3A. SOLAR PROJECTS UNDER FIT SYSTEM, LUZON**
**(AS OF 30 APRIL 2015)**

| | DECLARED FIT CAPACITY (MWP) | APPROVED FIT CAPACITY (MWP) | APPROVED RELATIVE TO DECLARED (%) |
|---|---|---|---|
| **Ilocos Norte** | **24.10** | **4.10** | **17.01** |
| Currimao | 20.00 | | |
| Burgos | 4.10 | | |
| **Pampanga** | **22.00** | **10.00** | **45.45** |
| Mexico | 10.00 | | |
| Mabalacat | 12.00 | | |
| **Cavite** | **44.30** | **41.30** | **93.23** |
| Noveleta-Rosario-Gen. Trias-Tanza | 3.00 | | |
| Rosario-Gen. Trias | 41.30 | | |
| **Rizal** | **30.00** | **-** | **-** |
| Rodriguez | 30 | | |
| **Metro Manila** | **1.5** | **1.50** | **100.00** |
| Quezon City | 1.5 | | |
| **LUZON** | **121.90** | **56.90** | **46.68** |

Source: REMB, Department of Energy, ROP, 2015.

Visayas has 198.7 MWp declared FIT capacity and 52.1 are approved. Most of the declared capacity (163 MWp) are in Negros Occidental but only 22 MW are approved (Table 3B). Mindanao has 20 MWp declared capacity and zero approved (Table 3B).

**TABLE 3B. SOLAR PROJECTS UNDER FIT SYSTEM, VISAYAS AND MINDANAO (AS OF 30 APRIL 2015)**

| | DECLARED FIT CAPACITY (MWP) | APPROVED FIT CAPACITY (MWP) | APPROVED RELATIVE TO DECLARED (%) |
|---|---|---|---|
| **Negros Occidental** | **163.00** | **22.00** | **13.50** |
| San Carlos City | 45.00 | 22.00 | |
| Cadiz City | 100.00 | | |
| La Carlota City | 18.00 | | |
| **Iloilo** | **5.67** | **-** | **-** |
| Miag-ao | 5.67 | | |
| **Leyte** | **30.00** | **30.00** | **100.00** |
| Ormoc | 30.00 | | |
| **VISAYAS** | **198.67** | **52.00** | **26.17** |
| **Davao del Sur** | **20.00** | **-** | **-** |
| Digos City | 20.00 | | |
| **MINDANAO** | **20.00** | **-** | **-** |

Source: REMB, Department of Energy, ROP, 2015.

In sum, awarded solar projects' aggregate "potential" capacity of 1,753 MW is the second highest after that of hydro projects, but its "installed" capacity is 109 MW (a mere 6.2 percent relative to potential), accounting for a paltry 3.9 percent of all RE projects' installed capacity; none is installed for own-use that includes off-grid SHS. As to the awarded on-grid solar projects, the total potential capacity is 1,749.5 MW, but there are also only 109 MW installed. In terms of solar projects under the FIT system, 340 MWp are "declared" capacity and 109 MW are "approved".

## 3.3 Solar power developers, providers, and users

San Carlos Solar Energy (SaCaSol) is said to be the first ever RE developer to get the FIT subsidy (Olchondra, June 6, 2015). SaCaSol developed the 13 MW Phase 1A and 9 MW Phase 1B solar projects in Negros Occidental that started commercial operations in May and August 2014, respectively. The P9.68 FIT rate issued to SaCaSol by the Energy Regulatory Commission (ERC) is scheduled to extend from May 15, 2014 to May 14, 2034.

Solar Philippines is also now in business, offering companies a "pay-what-you-save" program that allows zero down payment and freedom to choose from terms of 3, 5, 7, 10, and 15 years (Olchondra, June 20, 2015). Through this program, Solar Philippines enables business owners to put up solar plants specific to customer conditions such as applicable utility rates, electricity demand profile, and operating hours. Ownership of the solar power plant is transferred to the the business partner after the chosen payment term. Toyota San Pablo car dealership, Tri-Pack Philippines plastic manufacturer, and Davao Diamond industrial supply and retailer in Mindanao are among businesses in the country reportedly enjoying up to 50-percent savings in their utility bills.

The Sy-led SM Prime Holdings Inc. in November 2014 inaugurated its 1.5-MW rooftop-mounted solar power farm and power station at the multilevel car-park building of SM City North Edsa (Olchondra, July, 8, 2015). This project was put up in partnership with Solar Philippines. The SM group expects to build more solar rooftops on its malls. To illustrate, a 1.5-MW capacity is reckoned to electrify up to 2,000 Filipino homes.

Taking advantage of the FIT system, Absolute Distillers Inc. (ADI) of the Lucio Tan (LT) Group set up a 2-megawatt solar power plant in Batangas in March 2015. This was the LT Group's first venture into renewable energy. "This is just the tip of the iceberg. We will build more, but we want to see first how the government manages the FIT and what direction it is taking," remarked the Group's vice president (Olchondra, July 8, 2015).

Schools, too, appear to be jumping into the solar bandwagon. Manuel L. Quezon University (MLQU) has joined three other schools -- namely, Mapua Institute of Technology, St. Scholastica's College, and La Consolacion College -- in generating electricity from solar panels (Tayco-Juego, November 19, 2014). MLQU has 320 solar panels with a 96 kW capacity provided by Propmech Corp. which charges P9.50 per kWh. MLQU expects to save 20 percent of its monthly electricity bill of P120,000.

Three solar power plants are reportedly being built in Zambales that would potentially augment Luzon's power supply by 135 MW (PDI, August 16, 2015). These are roughly distributed among Barangays Bulawen and Bato of Palauig town and in Barangay San Juan in Botolan town.

Ayala Corp. Energy recently signed an agreement with Bronzeoak Clean Energy Inc. of Bronzeoak Philippines Inc., for the development, construction, and operation of a solar power farm in Bais, Negros Oriental (PDI, September 10, 2015). The project is to be owned and operated by Monte Solar Energy Inc., a special purpose vehicle. The project has a capacity of 18 MW to cost P1.3 billion, targeted for completion by March 2016, and may be expanded later on to 40 MW.

ATN Philippines Solar Energy Group Inc. (ATN Solar) plans to tap as much as US$69 million in financing for a 60 MW solar power project and related assets in Rizal province (Olchondra, July 7, 2015). It may avail itself of engineering, procurement, and construction financing from China Machinery Corp. and Guangdong Electric Power Group. The solar project is designed to have initial gross generation capacity of 30 MW through the Manila Electric Co. franchise distribution area via a 34.5-kV distribution line connected to the Diliman, Novaliches, and Parang circuits.

THE SUBIC Bay Metropolitan Authority also plans to install a $200 million solar power plant besides a wind farm within the freeport (Remo, September 23, 2015). The solar plant

producing 150 MW will be the biggest solar installation in the whole Southeast Asia, according to SBMA chair Roberto Garcia. It will be undertaken by Emerging Power, Inc. which put up a 40 MW geothermal power plant in Mindoro last year.

### 3.4 Net-Metering with electricity distributors

Apart from the FIT, net-metering is another policy measure mandated by the RE law to promote solar energy in the country. It is in fact the first non-fiscal incentive mechanism already fully implemented under the law. This allows customers of distribution utilities (DUs) to install RE facility not exceeding 100-kW capacity to generate electricity for their own use. As of June 2015, there are 112 customers registered under PV net-metering with a total capacity of 741.01 kWp, excluding the three private schools mentioned above with a total capacity of 325 kWp.

Net metering (NM) allows households to sell excess electricity generated by institutions' or households' RE systems that can be used as credits to reduce electricity bills the following month. Meralco conservatively reckons cost savings to be 5-15 percent depending on a number of factors including, inter alia, quality and efficiency of PV panels, equipment maintenance, and the customer's specific kWh rate.

Meralco launched its NM program in September 2013. Mike De Guzman is among the first to avail himself of the program (Ranada 2014). His household now obtains around 80 percent of its electricity needs from the sun. His roof is strapped with 20 solar panels that produce an average of 675 kWh (worth about P8,000) of electricity a month.

The De Guzmans use their solar PV system for their daytime electricity requirements, while at night they switch to their subdivision's Meralco grid. Since solar panels usually generate more electricity than they need, the excess capacity goes to the grid for use by other customers. Meralco then pays for this extra energy by subtracting its price from De Guzman's bill the following month.

Households can save even more by combining net metering with Meralco's Peak/Off-Peak (POP) program. Meralco charges a higher rate (P7.50/kWh) for daytime use and a lower rate (P3.50/kWh) for night-time consumption. Meralco typically buys excess electricity for P5.50/kWh.

De Guzman claims to have cut his monthly Meralco bill by a whopping half from what used to be about P24,000 (Ranada 2014). He spent around P500,000 for his solar panel system. Financial payback is estimated to be five years while the solar panels are expected to last for 25 years.

### 3.5 Individual distributed SHS

The DOE is also involved in Household Electrification Program in off-grid areas using PV systems which is a component of the government's Rural Electrification Program. Over the period 2010-2014, DOE reports to have facilitated the installation of PV solar home systems (PV-SHS) in 16,004 households and installed 151 units of PV communal lighting facilities (PV streetlights) in off-grid areas. In 2015, installation of PV-SHS in 6,919 more households has been done. Hence, a total of 22,923 household installations were reportedly accomplished from 2010 to 2015 with an estimated capacity of 670 kW.

Seen against the above-cited DOE data, however, these reported PV-SHS "installations" seem inconsistent with solar's "installed capacity" in Table 1 defined as "operational" which is still zero. Thus, they probably pertain to "potential capacity" which is defined as "in development stage".

The National Electrification Administration's (NEA) Energy Reform Agenda under the Medium-Term Philippine Development Plan (MTPDP) has refocused its Rural Electrification Program to Sitio Electrification Program (SEP) and Barangay Line Enhancement Program (BLEP). A sitio "is a territorial enclave that forms part of a barangay, the location of which may be distant from the center of the barangay itself". The SEP aims to energize 33,370 sitios out of the potential 100,231 (as of year-end 2009) through on-grid electrification by 2020. Similarly, the BLEP intends to construct electric distribution systems to 2,195 barangays for on-grid connection.

It appears that the NEA is going against the grain of the more sensible and efficient approach gaining currency worldwide, namely, off-grid individual or distributed SHS to electrify remote underserved villages. For, as governments in other developing countries have already realized, energy infrastructure such as power plants and transmission lines is not only very costly, it also takes years if not decades to build. NEA's plans for SEP and BLEP appear to explain the general slowness in the implementation of the off-grid SHS approach. A serious rethinking of the SEP and BLEP plans seems called for.

## 4. Energizing the Poor

Infrastructure -- both physical and human -- is, by definition, a *sine qua non* for development. Transportation, electric power, and water, in addition to human capital, undergird human activity -- indeed, life itself -- for it to prosper (Pernia and Quibria 1999).

Roughly two billion people worldwide lack electricity, and nearly three billion rely on such dirty fuels as firewood and animal dung for cooking and heating, writes World Bank energy specialist Bazilian (2015). Almost 90 percent of those suffering from energy poverty are in South Asia and sub-Saharan Africa.

The Philippines is by no means free from energy poverty especially in rural areas and its remote countryside which are home to the majority of the country's poor. Given the country's thin power reserves, any shortfall events, caused by plant shutdowns due to accidents, planned maintenance, or weather-related disturbances, always adversely affect the poor first in both rural and urban areas. Mindanao usually has negative reserves throughout most of the year, and Visayas' power situation remains highly precarious, while Luzon's is neither a source of comfort.

Renewable energy projects in a number of developing countries have demonstrated that solar power, among other REs, can directly contribute to poverty uplift by supplying the electricity needed for starting businesses and generating jobs (Pueyo et al. 2013). As well, electricity facilitates many household chores, mobile-phone charging, use of radio, etc. Moreover, it enables children to study at night, thereby motivating them to continue schooling. Adds Bezner (2014): "Providing access to electricity will allow hospitals to keep life-saving refrigerated vaccines on hand, allow students and entrepreneurs to continue their work after dark, and ensure that families do not need to rely on dangerous and costly kerosene powered lamps".

According to Herrin (1979), rural electrification in Misamis Oriental province in the southern Philippines has engendered social and economic investments resulting in marked pick-ups in agricultural, business, and industrial productivity; employment opportunities; health and medical services; and educational facilities. Higher household incomes and increased opportunities for saving and investment have likely reduced children's value to parents as productive and old-age-security assets, thereby motivating family planning to limit the number and spacing of children.

Research points to evidence on the link of electricity to the welfare of the poor. But the costs involved in connecting to the power grid and regularly paying for utilization often deter poor households, thereby keeping them without electricity (Ali and Pernia 2003). Now, with individual and distributed off-grid small SHS, including affordable financing modalities for installation and eventual ownership, as discussed in preceding sections, energizing the poor is well within reach. This is demonstrated by the experience in Bangladesh reputed to have the world's fastest SHS coverage rate, which has significantly lifted living standards and reduced poverty especially in previously lagging regions (Khandker et al. 2014). Poverty reduction can be hastened if rural electrification is complemented by, inter alia, roads and schools made in pivotal locations to maximize distributive and multiplier effects (Ali and Pernia, 2003).

An interesting case study concerns a small community effort that's likely replicable. The Diwata-Women in Resource Development (Diwata) recently sent four Aeta grandmothers to Barefoot College in India to undergo a six-month training course in "solar engineering", specifically fabricating, installing, repairing, and maintaining solar lighting equipment (Almacen, June 29, 2015). These women were Evelyn Clemente and Sharon Flores from Gala, Zambales, and Cita Diaz and Magda Salvador from Bamban, Tarlac. Upon return home after their training, the goal of these so-called "Solar Lolas" was to help 100 households in their communities to have electricity. They needed P2.6 million funding for the project which they managed to raise from donors. Most residents in Bamban town use kerosene lamps for lighting while not all families in Gala town can pay for electricity. Each household would get a 40-watt solar panel, wall-mounted charge controller, battery in waterproof battery box, three LED high-intensity wall lights, one mobile charger, one large solar portable lantern, workshop tools, supplies and spare parts. Diwata plans to send more indigenous women to Barefoot College after it completes the project, resulting in the electrification of the two selected communities.

## 5. Climate Change

In recent years, international organizations and governments have been raising awareness about global warming, pointing out its serious threats to mankind’s living environment and overall well-being. Thus, warned the ambassadors to the Philippines of the EU Delegation, United Kingdom, France, Germany, and Denmark: "Climate change is the most formidable challenge of our century. Global temperatures are gradually increasing. Each of the past three decades has been warmer than any preceding decade since records began in 1850. The frequency of extreme weather events increases as a result. Typhoon “Yolanda” was probably the consequence of a world where temperatures have increased by less than 1 degree Celsius. Science tells us this is just a glimpse of what is to come. We are effectively on track to a 4-degree-C increase by the end of the century if we fail to take action—a scenario for which no amount of preparation can prepare us" (Ledoux, Ahmad, Garachon, Ossowski, and Christensen 2015).

Relatedly, the IEA (2014) has declared: “There is a pressing need to accelerate the development of advanced energy technologies in order to address the global challenges of clean energy, climate change and sustainable development” (p. 7). It projected that CO2

emissions from the energy sector would increase by 61 percent over 2011 levels by 2050 if new policies supporting low-carbon solutions are not implemented. The persistent use of traditional sources of energy concretizes this projection while solar energy, among other REs, can attenuate it (Barone 2015). To illustrate, coal produces 2.1 lbs of CO2 per kWh, and natural gas 1.2 lbs of CO2 per kWh. By contrast, solar energy produces none of it.

In December 2015, 196 countries will convene in Paris for the 21st Conference of the Parties under the United Nations Framework Convention on Climate Change (COP21) to formulate a global agreement that will curb greenhouse gas emissions responsible for climate change. The aim is to keep emissions in check so that global temperatures remain within +2 degrees C above preindustrial levels by the end of the century.

According to the European Union's ambassadors to the Philippines, the target of the EU's 28 member states is to reduce greenhouse gas emissions 40 percent by 2030 (relative to 1990). Another legally binding commitment is an increase in the use of renewable energy and ambitious energy efficiency targets leading to at least 27-percent energy savings by 2030. EU's long-term goal is to decarbonize its economies by making economic growth free from the use of fossil fuels.

Studies show that about half of accumulated greenhouse gas emissions since the Industrial Revolution have originated in developing countries. The EU in toto, the world's largest economy, emits only about 10 percent of global emissions. China by itself is known as the world's largest emitter, accounting for 30 percent of the total.

The same EU ambassadors (2015) feel that "the Philippines can play a significant role at the conference and can influence the final outcome. The onset of Yolanda shortly before the UN Conference on Climate Change in Warsaw exposed to the world not only the vulnerability of the Philippines but also its resilience, its ability to stand back up, and have its voice heard in international forums. The Philippines chairs the Climate Vulnerable Forum and is actively engaged in UN climate bodies such as the Green Climate Fund. It has the capacity to inspire other nations."

The "Manila Call to Action on Climate Change" was launched jointly by President Hollande and President Aquino as an appeal for the international community to conclude an ambitious, universal, and legally binding agreement on climate at the COP21 in December. The Philippines has a rare opportunity to lead by example and to make a difference in Paris.

The EU ambassadors recognize that the Philippines has at present a comparatively low level of carbon emission (0.3 percent of global total) as it is a world leader in geothermal energy coupled with its many hydroelectric plants. Further, its scaling-up of the installation target for solar energy is noteworthy. On the other hand, there are several moves to build more coal-fired power plants that would spike greenhouse gas emissions. Greater utilization of renewable energy is called for to combat climate change besides bringing about cleaner and cheaper electric power in the longer run to benefit the lower-income groups as well.

## 6. Conclusion and Policy Implications

An appreciation of the international literature and field experience reveals that the erstwhile skepticism about solar energy has made a sharp turnaround. Solar power is fast becoming a leader among renewable energy (RE) sources owing to innovations in technology, regulation, financing and industry, resulting in steeply falling prices. It is warmly welcomed by

developed countries particularly concerned about climate change, on the one hand, and by developing countries still having to deal with mass poverty, on the other.

Adoption of large on-grid solar photovoltaic (PV) systems is perceptibly becoming commonplace especially in the developed world, and so is that of small and distributed off-grid solar home systems (SHS) particularly suited for remote often neglected villages in developing countries. Mini-grids, as well, either connected to or unconnected from the main grid are becoming widely used. The dramatic rise in the viability and acceptance of solar power has led the International Energy Agency (IEA), which used to be lukewarm about it, to make an upbeat forecast of solar energy becoming the single largest source of power by 2050, accounting for as much as 27 percent of electricity worldwide.

An examination of data from the Department of Energy suggests that, despite its Renewable Energy Act of 2008, the Philippines lags behind even the poorer countries in East Africa and South Asia in availing itself of solar power's advantages. For instance, of 664 awarded RE projects (as of 30 April 2015) only 93 (14 percent) are solar. Its corresponding "potential" (in development stage) capacity is 1,753 MW but only 109 MW are "installed" (operational) -- all for grid-use, zero for own-use that covers off-grid SHS. Solar's installed capacity accounts for a measly 3.9 percent of all RE projects' installed capacity. In terms of solar projects under the FIT system, 340 MWpeak are "declared" capacity but only 109 MW are "approved".

To illustrate the comparative slowness of our country's SHS uptake: the Philippines had 22,923 households (HHs) "installed" (more likely still under development) with SHS over the period 2010-2015; Kenya had 320,000 HHs as early as 2010; India two million in 2014; and Bangladesh since 2003 has recorded 50,000 units per month cumulating to three million HHs with SHS by early 2014. Bangladesh is reputed to have the world's fastest SHS coverage rate.

As regards the incentive system for developers/investors, the formulation of the feed-in tariff (FIT) rates and the 20-year lock-in period now appear to be premature or probably done without taking into account solar's technological strides. Which have made solar power price-competitive even against traditional energy sources, such that FITs are being downscaled or altogether dropped in a number of countries.

The rise and promise of solar power seem indisputable. There are a few policy implications that may be worth considering. One, to hasten the development/installation and adoption of solar technology, particularly distributed off-grid SHS for the thousands of marginalized households in various parts of the country. As well, there's ample room for larger on-grid systems — in lieu of the heavily-polluting coal-fired plants, justifiably much loathed by local communities — toward addressing the country's energy deficits.

Two, to critically review and rationalize the operative FIT system toward greater equity and fairness between power producers/distributors and consumers. Three, to establish a good data collection system for solar power development/production and use, including data to enable assessments of impacts on, inter alia, economic growth, employment, poverty reduction, and greenhouse gas emissions.

Fourth, an initial research project could probably already be carried out to gauge, for instance, how satisfied are households and institutions using solar PV technology in terms of its efficacy, cost savings, and general impact on households' living standards or institutions' operations. Further, a comparative benefit-cost analysis of the various renewable energy sources would be in order.

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