CROSSING OVER

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Roberto S. Verzola

With the research support of Prof. Miguel T. Escoto, Jr.

FRIEDRICH EBERT STIFTUNG

Crossing Over: The Energy Transition to Renewable Electricity

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To Antonio Nepomuceno, whose
vision of a solar-powered society
is a continuing inspiration

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Foreword

Energy is undeniably one of the most important requirements for development. It is in fact a development enabler upon which rely different industries and social services. Unfortunately, around 16 million Filipinos are energy poor.[1] The continuously increasing price of electricity is another issue that the Filipino people have to contend with. To date, the Philippines has the highest electricity rate in Asia. With the country largely dependent on imported oils, it is imperative that other energy sources be looked into.

Renewable energy is finding its way to the center of the debates on sustained, efficient and clean energy sources. The *Energiewende* framework of Germany which defines the country's transition to renewable energy demonstrates how the convergence of policies, technologies, resources and citizen participation can transform the course of how energy is harnessed and utilized.

The Philippines boasts of much renewable energy potentials. At present, 30% of Philippine energy comes from renewable sources as the country is the second largest generator of geothermal energy in the world and the first to invest in large-scale solar and wind technologies in Southeast Asia. Harnessing and development of this abundance may yet help break the chains from imported oil dependency and lead the country to a more sustained growth. This area of the energy industry still has much to be optimized.

For the past years, the Friedrich Ebert Stiftung has been working in the Philippines with local partners, providing platforms for coming up with comprehensive strategies to implement more viable and sustainable energy source alternatives. It is in this light that the Study on the Energy Transition to Renewable Electricity was drafted. The book hopes to provide policy makers and implementers, advocates and activists, academe, industry actors, and the consumers with honest assessments of the Philippines' energy issues and potentials and identify ways to move forward from the country's energy dilemmas.

FES would like to thank the author Roberto Verzola, for sharing his expertise as well as for the courage and enthusiasm to take the challenges of coming up with this comprehensive study. Our gratitude also goes to Professor Miguel Escoto Jr. and the University of the Philippines Solar Laboratory for sharing their time, experience and know-how. Special thanks to the participants of the public presentation and discussion of the study conducted in November 11, 2014 for the lively debates and noteworthy recommendations that helped enrich this publication.

We encourage the readers and all stakeholders to take into consideration the findings and recommendations in this study and join us in our pursuit for more sustainable and inclusive development.

Berthold Leimbach
Resident Representative
Friedrich-Ebert-Stiftung - Philippine Office

1 Adoracion M. Navarro, Maxensius Tri Sambodo and Jessie L. Todoc, "Energy Market Integration and Energy Poverty in ASEAN: Discussion Paper Series No. 2013-50," Philippine Institute of Development Studies, October 2013, http://dirp4.pids.gov.ph/webportal/CDN/PUBLICATIONS/pidsdps1350.pdf.

Preface

Many studies on renewable energy (RE) in the Philippines have already been done. This particular study on RE is focused on strategies that can lead to a full transition of electricity generation in the country from non-renewable to renewable energy.

This study paints in broad strokes a picture of the RE situation in the country's electricity sector. It includes enough highlights to give potential adopters and investors a sense of the terrain in terms of the physical, economic and institutional contexts within which they would be working.

This study also provides some criteria that can help local officials assess their locality's endowments in renewable electricity generation. If they find that they are well-endowed, and they are interested in hosting or setting up themselves an RE showcase in their area, then they should take immediate steps towards making a more thorough assessment of the technical and financial feasibility of such a showcase.

The specific goal of this study is to map out a process that will lead to at least one locality—or hopefully several—becoming a showcase for 100% renewable electricity in the Philippines.

Showcasing RE in some localities, it must be emphasized, is a strategy, not an end-goal. The goal is a nationwide shift to RE. Not overnight, of course, but as quickly as we can realistically make it.

The goal above is inspired by the experience of the village of Feldheim in Germany. In this village, 100% of the power for heating and electricity are sourced from renewable sources. The residents benefit from local electricity rates that are lower than the rates charged by the grid—and the village gets additional income from selling its excess electricity production to the grid!

The Feldheim model was of course made possible by a confluence of events and conditions specific to Germany, not all of which can be readily replicated in the Philippines.

Through this and follow-up studies, we want to identify events and conditions and to set into motion the processes that can lead to Feldheim-type showcases in the Philippines: 100% renewable, lower local rates and financially viable.

Lest someone claim that 100% renewable is a pipe dream, the table below lists studies that have been done in some developed economies to confirm the possibility of a fully renewable future in their own country.[2] The list shows that other countries are thinking of the same thing.

Title of Study	**Year pub.**	**Organization**	**Target Year**	**Energy Mix**
Solar Sweden: An Outline to a Renewable Energy System	1977	Secretariat for Future Studies	2015	61.8% biomass, 12.5% solar heat; 11.4% water power, 8.8% PV, 5.3% wind, 0.2% ocean energy
ALTER: A Study of a Long-Term Energy Future for France Based on 100% Renewable Energies	1978	Le Groupe de Bellevue (scientific group of leading research institutes	2050	49.5% solar, 27.2% biomass, 13.7% water power, 5.1% tide power, 4.6% wind power

2 Hermann Scheer, *Energy Autonomy: The Economic, Social and Technological Case for Renewable Energy*. (London: Earthscan, 2007), p. 50-51.

Energy Strategies: Towards a Solar Future (U.S.)	1980	Union of Concerned Scientists	2050	
Solar Energy Futures in a Western European Context	1982	International Institute for Applied Systems (IIASA)	2100	33.9% wind power, 28.3% on-site, 15.1% biomass, 9.4% PV, 8.5% water power, 3.4% solar-H_2, 1.4% wave power
Renewable Energy Supply under Conditions of Globalization and Liberalization	2002	Survey Commission of the German Bundestag	2050	84.6% local renewables; 15.4% imported renewables
Energy Rich Japan (ERJ)	2003	Institute for Sustainable Solutions and Innovations (ISUSI)		35.1% solar, 28.4% wind, 17.7% CHP, 13.5% geothermal, 5.2% water power

In fact, two countries have passed laws mandating 100% renewable electricity: by 2020 for Scotland,[3] and by 2035 for Denmark.[4]

And it has been a reality in at least one country since 2011. Iceland gets its electricity from hydroelectric (75%) and geothermal (25%) sources only.[5] No fossil fuels, no nuclear plants.

For these countries, 100% renewable electricity is not just a dream anymore.

3 http://www.go100percent.org/cms/index.php?id=70&tx_ttnews[tt_news]=39.
4 http://www.go100percent.org/cms/index.php?id=19&id=69&tx_ttnews[tt_news]=109&tx_locator_pi1[startLat]=45.93583305&tx_locator_pi1[startLon]=-4.86260045&cHash=215730a0771059056e307660236a46c9.
5 http://www.go100percent.org/cms/index.php?id=45&tx_ttnews[tt_news]=242&cHash=e34b862ab4318c0d956f7d0d3facad9a.

Acknowledgments

Renewable energy has been a long standing interest of mine, ever since I was a teen, ages ago. I would get drawn back to this interest again and again, despite diversions along the way.

In the 1980s, it was the Bataan Nuclear Power plant, with the Freedom from Debt Coalition and the Nuclear-Free Philippines Coalition that got me involved in energy issues. In the 1990s, it was solar energy, with the late Bishop Antonio Nepomuceno, who became a dear friend, and the non-profit group that he initiated, Soljuspax. It was Bishop Nep's dream—our group's dream—to build a manufacturing facility for photovoltaic panels in the Philippines. But he died in a tragic plane crash before he realized his dream. We did manage to make some solar cookers and give away some solar panels. I installed one of them at the Center for Ecozoic Living and Learning, a permaculture farm in Barangay Malaking Tatiaw, Silang, Cavite. The center was set up by another dear friend, Fr. John Leydon of the Columban Fathers. In the late 1990s and early 2000s, I experimented with water power, particularly in ram pumps, fashioning a working model using ordinary valves, pipes and tanks you could buy from a hardware store. I successfully tested the ram pump in my wife's remote village in Barangay Casispalan, Tagkawayan, Quezon. But I never got to the mass production and mass promotion stage. I still have the designs with me.

Other issues—equally important, I must say—intervened and drew me away from more active work on renewable energy. So I watched the developments from a distance, with deep interest but without the time needed to give it justice if I were to get involved deeply. Just the same, whenever I got an occasional invitation in fora to talk about nuclear power and renewable energy, I would talk about increasing nuclear power costs and decreasing solar/wind costs and the cross-over point between the two. I would never forget about the cross-over point.

Then the Active Citizenship Foundation involved me into a series of conferences on energy and climate change, culminating in a trip to Feldheim, a little village in Germany. This village draws all its electricity from the sun, the wind, biogas and occasional burning of woodchips—sources that are all renewable. It was not only an eye-opening trip for me. It was also a life-changing one. I decided then that renewable energy, once more, should become one of my priorities. This advocacy fits perfectly into my ecological and social justice advocacies. Like my other current advocacies on (organic rice farming methods and free software), it is also a positive advocacy, a departure from the "expose and oppose" advocacies that occupied me in the past. Furthermore, renewable energy advocacy fits right into my theoretical studies on the economics of abundance.

Still, I would not have gotten back so quickly into the thick of the renewable energy advocacy if Berthold Leimbach of the Friedrich Ebert Stiftung had not provided the perfect opportunity to do so, by asking me to do this study. Berthold must have seen the twinkle in my eyes, as I saw in his, when we talked about renewable energy. I said yes right away.

This study would not have been possible without my partnership with Prof. Miguel Escoto Jr. of the University of the Philippines (UP) College of Engineering and head of the UP Solar Photovoltaic Laboratory. My friendship with Mike goes a long way, ever since my student days at the College in the late 1970s. He let me play with the TRS-80 microcomputer in the EE Laboratory that nobody else seems to have found interesting enough. It was Mike's little kindness of lending me the key to the lab that set me off in the direction of computers and information technology. Mike should be listed as co-author of this study, but I didn't want to put him in the awkward position of defending the more strongly-worded formulations that I felt were needed to emphasize some of our findings. But this study would not have been possible without the data, analysis and advice that he had provided.

My thanks also to the two other members of our research team, Engr. Leo Tayo and Atty. Ma. Ronely Bisquera-Sheen. Dr. Eddie Dorotan of the Galing-Pook Awards was also very helpful in arranging meetings with some government officials, and agreed to be part of an advisory group that will continue to promote the idea of RE showcases throughout the country.

My thanks, furthermore, to all those who attended the forum sponsored by the Friedrich Ebert Stiftung and the UP Solar PV Laboratory, especially Rosario Venturina of the National Renewable Energy Board, Theresa Cruz-Capellan of the Philippine Solar Power Alliance, and Ma. Teresa Diokno of Center for Power Issues and Initiatives, who came as reactors, and the others who gave their comments during the forum or to me in private.

My thanks, finally, to Josua Mata of the Sentro ng Nagkakaisa at Progresibong Manggagawa and the Alliance of Progressive Labor for putting me in touch with union leaders in the electricity industry, who shared with me the labor sector's perspective of the industry. I wish him and his fellow labor leaders success in their heroic efforts at organizing the labor sector.

To all the others who helped and encouraged me along the way, my heartfelt thanks.

Roberto S. Verzola
January 29, 2015
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List of Abbreviations

AC	Alternating current
BOI	Board of Investments
BOS	Balance of system
CAPEX	Capital expenditure (or expense)
CEPALCO	Cagayan Electric Power and Light Company, Inc.
DC	Direct current
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
DOST	Department of Science and Technology
DU	Distribution Utility
EDU	Exploration, development and utilization
EPIRA	Electric Power Industry Reform Act
ERC	Energy Regulatory Commission
EPI	Emerging Power, Incorporated
FES	Friedrich Ebert Stiftung
FIT	Feed-in tariff
FIT-ALL	Feed-in-tariff allowance
FPIC	Free and prior informed consent
FTAA	Financial or Technical Assistance Agreement
GEF	Global Environment Facility
GENCO	Generation company
GFI	Government financial institution
GHG	Greenhouse gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GW	Gigawatts (one billion watts)
GWh	Gigawatt-hours
Ha	Hectare(s)
IPP	Independent power producer
kW	Kilowatt
kWh	Kilowatt-hour
kWp	Kilowatt-peak
LED	Light-emitting diode
LGU	Local government unit
m^2	Square meter
m/sec	Meter(s) per second

Meralco	Manila Electric Company
Mo	Month
MPPT	Maximum Power Point Tracking
MW	Megawatt (one million watts)
MWh	Megawatt-hour
NEM	Net energy metering
NCIP	National Commission on Indigenous Peoples
NGCP	National Grid Corporation of the Philippines
NGO	Non-government organization
NREB	National Renewable Energy Board
NREL	National Renewable Energy Laboratory, U.S.
NSO	National Statistics Office
O&M	Operating and maintenance
PDP	Power Development Program
PEMC	Philippine Electricity Market Corporation
PEP	Philippine Energy Plan
PEPOA	Philippine Electricity Power Operators Association
POP	Peak/Off-peak
PPA	Power purchase agreement
PSPA	Philippine Solar Power Alliance
PV	Photovoltaic
RE	Renewable energy
REMB	Renewable Energy Management Bureau
RESC	Renewable energy service contract
RPS	Renewable portfolio standards
SACASOL	San Carlos Solar Corporation
SEC	Securities and Exchange Commission
SHS	Solar home system
SIBAT	Sibol ng Agham at Teknolohiya
SME	Small- and medium-scale enterprise
TAREC	Trans-Asia Renewable Energy Corporation
TOU	Time of use
UP	University of the Philippines
V	Volts
WEDAP	Wind Energy Development Association of the Philippines
Wp	Watt-peak
WESM	Wholesale Electricity Spot Market

Chapter 1. Electricity: Solar is now cheaper than coal!

> **"As a simple example, the cost of electricity from a coal plant can run up to P5.50 per kilowatt hour, plus P6.50 for distribution and transmission, which amounts to P12.00. If you install solar panels on your rooftop, you will only spend P9.00 per kilowatt hour for generation and no cost for distribution or transmission. This already saves you up to P3 per kilowatt hour."**
>
> **—Secretary Carlos Jericho L. Petilla, Department of Energy, August 2014[6]**

The conventional wisdom that solar panels are the most expensive, among the various sources of electricity, was probably true a decade ago. The impression of many that, up to now, electricity from solar panels is more expensive than electricity from coal plants might have been true a few years ago.[7]

Today, things are different.

As Energy Secretary Petilla himself calculated in 2014, electricity generated from a coal plant and delivered through the national grid to households now costs around twelve pesos per kilowatt-hour, while the same amount of electricity generated from solar panels on one's rooftop costs only nine pesos, a cost advantage of three pesos per kilowatt-hour.

Today, rooftop solar is cheaper than grid-delivered coal in parts of the country where the retail price is more than nine pesos.

Energy Secretary Petilla's calculations show that electricity from rooftop solar panels will save you P3/KWh, compared to buying it from fossil-fueled electric utilities.

Decreasing solar prices too

Not only is solar electricity cheaper in many parts of the country, but solar panel prices keep decreasing as more and more people buy them. In the Philippines, for instance, the cost of solar panels in 2014 was around P55 per Wp. In 1995, it was around P129 per Wp.[8] Thus, over a 20-year

6 "DOE Sec. Petilla: Renewables Pave the Way to Energy Security in the Philippines," Department of Energy, (Accessed January 29, 2015), http://www.doe.gov.ph/news-events/events/announcements/2473-doe-sec-petilla-renewables-pave-the-way-to-energy-security-in-the-philippines.

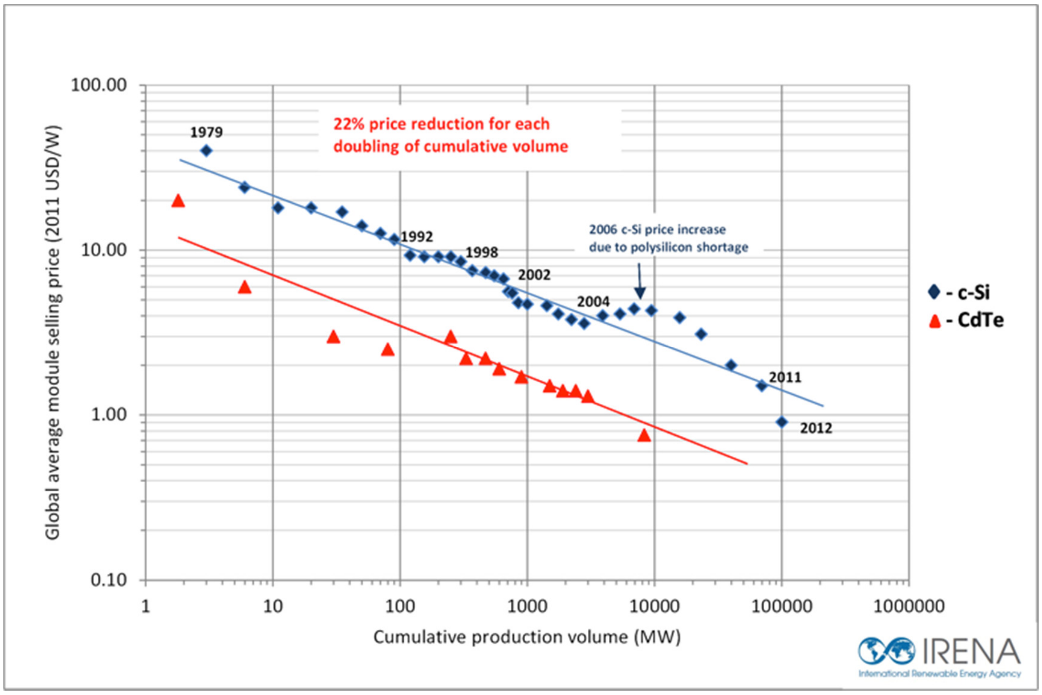
7 It was not true either, if the health, social and environmental costs of coal mining, transport and burning were fully taken into account.

8 This figure is taken from Ferdinand Larona in "Community-Based PV Electrification Project: The Gregorio del Pilar Experience" as reported in the proceedings of the Regional Workshop on Solar Power Generation Using Photovoltaic Technology held in Manila (March 1996, p. 220).

period, the price went down by an average of 4.17% per year.[9]

Just look at the following graph of global trends in the price of solar panels, which take up around half of the total cost of home PV systems.

Figure 1. Trend in Solar PV Panel Prices



Source: IRENA, "Renewable Energy Technologies: Cost Analysis Series Solar Photovoltaics," 2012, p.16

The upper trendline graphs the price of PV panels based on crystalline silicon while the lower trendline graphs the price of the cheaper but less efficient panels based on cadmium telluride (CdTe). The horizontal axis is the cumulative production volume of panels in megawatts, and the vertical axis is the price in dollars per Wp.[10]

Globally, the price of crystalline silicon was around US$9.00 in 1992, dropping to around US$1.50 in 2011, an average annual drop of 9.89% per year. Except for a slight increase in prices in 2006 due to a temporary shortage in silicon raw material, this steady downward has been observed consistently from 1979 to 2012. In 2014, crystalline silicon cost only around US$0.60 in the global market.

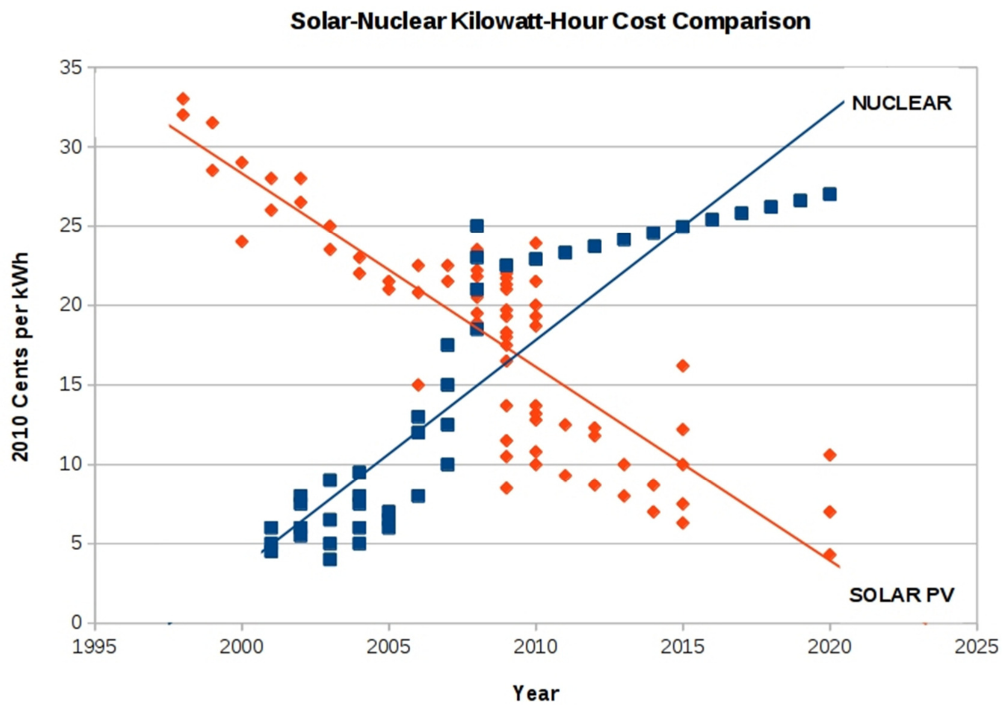
The next graph shows the trendline of solar electricity costs in the US, compared to the trendline of nuclear electricity costs, showing that the cross-over point between the two costs occurred sometime in 2010, when solar became cheaper than nuclear.[11]

9 $129 \times (1–0.0417)^{20} = 55$.

10 Note that the scales are logarithmic. Logarithmic scales exaggerate lengths/distances for very small numbers and compress lengths/distances for very large numbers.

11 The solar-nuclear cross-over point had occurred much earlier, if the health, social and environmental costs of nuclear power and nuclear wastes were fully taken into account.

Figure 2. Solar-Nuclear Kilowatt-hour Cost Comparison



Source: Blackburn and Cunningham, 2010 (graph redrawn by author to improve resolution)

Increasing prices of non-renewables

On the other hand, we can expect the prices of coal, oil and other fossil fuels to keep increasing in the long term, as the world gradually uses up these non-renewable fuels. In the short and medium terms, they will be subject to unpredictable ups and downs, as the following medium-term assessment by the International Energy Association shows:[12]

> "Global demand for coal over the next five years will continue marching higher, breaking the 9-billion-tonne level by 2019, according to Medium-Term Coal Market Report 2014. The report notes that despite China's efforts to moderate its coal consumption, it will still account for three-fifths of demand growth during the outlook period. Moreover, China will be joined by India, ASEAN countries and other countries in Asia as the main engines of growth in coal consumption, offsetting declines in Europe and the United States.
>
> "Global coal demand growth has been slowing in recent years, and the report sees that trend continuing. Coal demand will grow at an average rate of 2.1% per year through 2019, the report said. This compares to the 2013 report's forecast of 2.3% for the five years through 2018 and the actual growth rate of 3.3% per year between 2010 and 2013.
>
> "As has been the case for more than a decade, the fate of the global coal market will be

12 "Medium-Term Reports," International Energy Agency, (Accessed January 29, 2015), http://www.iea.org/publications/medium-termreports/#d.en.27705.

> determined by China. The world's biggest coal user, producer and importer has embarked on a campaign to diversify its energy supply and reduce its energy intensity, and the resulting increase in gas, nuclear and renewables will be staggering. However, the IEA report shows that despite these efforts, and under normal macroeconomic circumstances, Chinese coal consumption will not peak during the five-year outlook period.
>
> "Medium-Term Coal Market Report 2014's forecasts come with considerable uncertainties, especially regarding the prospect of new policies affecting coal. Authorities in China as well as in key markets like Indonesia, Korea, Germany and India, have announced policy changes that could sharply affect coal market fundamentals. The possibility of these policy changes becoming reality is compounding uncertainty resulting from the current economic climate."

Thus, in the future, solar will be cheaper than coal and other non-renewables by an increasingly larger margin. In fact, we can expect solar to become our cheapest source of electricity soon, *without government subsidy*.

Why solar costs will keep going down

It is important to understand and appreciate why decreasing costs is a feature of small systems like solar cells and panels (and silicon-based electronics, in general) but not of big systems like dams or coal plants.

Coal plants can be built 100 to 1,000 MW at a time. Dams can be built 10 to 100 MW at a time. Solar projects can be built with 100- to 250-watt panels at a time. Even a 1 MW solar power plant can consist of 4,000 250-watt panels.

To expand the country's generation capacity by 1,000 MW, we would need a 1–10 coal plants, or 10–100 dams, or 4–10 million solar panels. In fact, because of the lower capacity factor of solar panels, at least 20–50 million panels would be needed, to provide the same kWh output.

As the whole world makes the energy transition to renewables, particularly to solar electricity, several billion solar panels will eventually have to be manufactured *per year*.

Thus solar technologies can benefit from the logic of learning curves and economies-of-scale, in a way that is simply not possible when only ten or a hundred units need to be manufactured. Decreasing costs are *inherent* in the technology of solar PV.

This is why we can expect solar panel costs to continue their downward trend.

Note that Energy Secretary Petilla's calculations did not include the cuts in greenhouse gases that a shift from coal to solar will make. Consider also the benefits of reducing our dependence on imported fossil fuels as well as the savings by society because we avoid the social, health, and environmental costs of pollution from fossil fuels. If these external costs were taken into account, the cross-over point between solar and coal would have occurred many years earlier.

Through case studies and our own calculations, we will provide in this study further support for Secretary Petilla's conclusion.

Generating electricity from wind turbines and hydroelectric installations today is still cheaper than getting it from solar panels. But these two technologies do not enjoy the same economies-of-scale and learning curves in manufacturing that the latter does. Also, it is not practical to install wind and hydro power in every household. Thus, unlike solar, these two other forms of renewable power have to take into account the economics of transmission and distribution.

What about the hidden cost of non-renewables?

If coal- and oil-based generating plants had to reflect in their prices the health, environmental and social costs of using them—as they should—wind and hydro will also be cheaper sources of electricity than fossil fuels. Under current policy regimes where these externalities are ignored, representing huge hidden subsidies for fossil fuels, wind and hydro may need some external support themselves, to make them more competitive to coal while attracting more investors. The viability of wind projects will be further explored in subsequent chapters.

In general, given the same extent of support that fossil fuels are unfairly enjoying today, these three major sources of renewable energy can already be considered financially viable today. And if transmission and distribution costs were taken into account, rooftop solar is now cheaper than all other non-renewable technologies because it does not incur these additional costs.

We can therefore argue that *no* new fossil- or nuclear-fueled generating plants should anymore be initiated today, because this will lock us into technologies which are not only expensive today, but will be even more so in the future. On the other hand, renewables are already cheap today (cheaper than the rest, in case of rooftop solar) and will be even more so in the future.

Coal plants take around five years to build (nuclear plants take ten or more years). Once they start operations, their fuel prices will keep getting more expensive over the years, while renewables will keep getting cheaper and cheaper.

To allow ourselves to be locked-in today to highly pollutive, imported and soon-to-be expensive non-renewables will be sheer madness.

If this is the case, then why are we not yet sourcing all of our electricity from renewables? And what can we do to hasten the energy transition to 100% renewables?

These are the questions this study will try to answer.

But before we answer these questions, let us first convince ourselves that 100% renewable electricity is possible in the Philippines.

Fully renewable electricity in the future: Can we do it?

In 2013, the most recent year for which national data is available, the Philippines consumed a total of 61,566 GWh of electricity,[13] with an average annual increase over the 2000–2013 period of 4.09% per year. The historical trend can be seen in Table 1 (see next page).[14]

13 This figure excludes system losses and electricity produced by generating plants for their own use.
14 "Philippine Power Statistics 2013," Department of Energy, (Accessed January 29, 2015), https://www.doe.gov.ph/doe_files/pdf/02_Energy_Statistics/Power-Statistics-2013.pdf.

If we subtract from 61,566 GWh the amount of 2013 electricity production that is already coming from renewable sources (10,019 GWh from hydroelectric, 9,605 GWh from geothermal, and 279 GWh from other sources), we get 41,663 GWh.

Table 1. Philippine Power Statistics, 2002-2013

Year	Consumption (GWh)	Year	Consumption (GWh)	Year	Consumption (GWh)
2000	36,555	2005	45,159	2010	55,266
2001	39,140	2006	45,672	2011	56,098
2002	38,624	2007	48,009	2012	59,211
2003	42,720	2008	49,206	2013	61,566
2004	44,076	2009	50,868		

Source: DOE, 2015

This is the amount of electricity consumption from non-renewable sources that should have been replaced by renewables in 2013, if we wanted to attain a 100% energy transition to renewable electricity.

To estimate the share of non-renewables in subsequent years, we apply the annual growth rate of 4.09% to the amount of electricity consumption in 2013. This gives us:

Table 2. Projected Share of Non-renewables in the Energy Mix, 2013-2019

Year	2013	2014	**2015**	2016	2017	2018	2019
Non-RE (GWh)	41,663	43,368	**45,036**	46,768	48,567	50,435	52,376

Source: Author’s calculations.

The table above gives us the amount of renewable electricity we must generate, to attain 100% renewability in the electricity sector.

**To imagine 100% RE in the electricity sector in 2015,
we must generate around 45,000 GWh from renewables.**

Solar electricity

The earth's surface receives around 1,000 watts (1 kilowatt, or 1 kW) of solar irradiance per square-meter at sea level when the sun is directly overhead.[15]

In 2014, the most efficient photovoltaic panels could convert up to 24% of sunlight into electricity[16], and even better conversion efficiencies are expected in the future. The typical solar photovoltaic (PV) panels sold in the Philippines could convert sunlight at an efficiency of around 15%. From each square-meter of solar panel, therefore, we can get today around 0.15 kW of direct current electricity.

When the sun rises in the morning, the available sunshine becomes gradually more intense, reaching its peak around midday. Each hour which the sun spends when it is directly above, on cloudless days, is called a “peak sun hour.” We will use “peak sun hour” and “peak-hour” interchangeably. Past the sun's highest point, the available sunshine becomes gradually less intense until it flattens after sunset.

The output power (in watts) specified for a solar panel is measured under sunlight when the sun is at its peak, on cloudless days. That is why the capacity of a solar panel is specified in watts-peak (Wp).

In one peak sun hour, a one-kWp solar array produces one kWh of electricity.

If daylight lasts for twelve hours, even on cloudless days, a one-kWp solar array may produce not twelve but only six kWh of electricity, because of the variation in solar intensity from dawn to dusk. Thus, the three hours from 6 to 9 am might be the equivalent of only one peak-hour. The two hours from 9 to 11 am might be another peak-hour. Then, 11am to 12 noon would be a full peak-hour. Again, after midday, 12 to 1 pm might be a full peak-hour, 1 to 3 pm another peak-hour, and 3 to 6 pm a final peak-hour, for a total of only six peak-hours. Several hours of early morning hours, cloudy midday hours, late afternoon hours need to be accumulated to get the same output as one peak-hour. On cloudy days, the one-kWp solar array may produce in one whole day 3 kWh only. Such a day is said to consist of three peak-hours.

Thus, peak-hours is a measure of a location's average intensity of sunlight. The technical term is “incident solar radiation”, or insolation.

Solar PV output, costs

The Philippines gets 3.5 to 5.5 peak-hours of sunlight per day.[17] This means that a square meter of solar panel will produce from 0.525 to 0.825 kWh of household electricity per day. Let us use the average of 0.675 kWh per day or 20.25 kWh per month. If we assume a system efficiency of 85% in converting around 18 volts DC from the solar panel to the 220-volt AC that emulates the grid electricity from our home outlets, then the output of the same square-meter of panel goes further down to an average of 17.2 kWh per month per square meter.

In the Philippines, the price of a solar PV system in 2014 ranged from P90.00 to P130.00 per Wp. Henceforth, we will use the average of P110.00 per Wp, or P110,000.00 per kWp.

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15 Neville Williams, *Sun Power: How Energy from the Sun is Changing Lives Around the World, Empowering America, and Saving the Planet* (New York: Tom Doherty Associates, 2014), p. 345.

16 Bob Johnstone, et.al., *Switching to Solar: What We can Learn from Germany's Success in Harnessing Clean Energy* (New York: Prometheus Books, 2011), p. 314.

17 The DOE says “4.5 to 5.5” peak-hours (see DOE, “Large Solar Photovoltaic Project Development in the Philippines). A USAID document says “3.5 to 5.2” (see USAID, “Harnessing Solar Energy for Off-grid Rural Electrification”).

To recapitulate: one square meter of solar panel will produce 0.15 kWp of electricity and will cost P7,012.50. Passing this amount of power through a grid-compatible inverter will produce an average output of 17.2 kWh per month.

Let us turn the above figures into a table of solar conversion factors, to facilitate quick calculations:

Table 3. Solar PV System Conversion Factors

	= square-meters (m^2)	= kWp	= kWh/month	= thousand pesos
square-meters (m^2)		x 0.15	÷ 0.0581	x 16.5
kWp	÷ 0.15		x 114.75	x 110
kWh/mo	x 0.0581	÷ 114.75		x 0.9586
thousand pesos	÷ 16.5	÷ 110	÷ 0.9586	

Source: Author’s calculations.

The table above helps us convert from the units in left-most column to the units in the the top-most row. Their intersection is the conversion factor.

Let us say that our electricity consumption is 170 kWh per month and we want to know how much kWp of solar panels to buy to cover this level of consumption: the conversion factor from kWh/mo. to kWp is “÷ 114.75”. Thus, 170 ÷ 114.75 = 1.4815. We need around 1.5 kWp of solar panels. This means a solar array of fifteen 100-Wp panels, or ten 150-Wp panels, or six 250-Wp panels, or five 300-Wp panels. There are no 500-Wp panels yet in the Philippine market.

To determine how much a complete system of 1.5 kWp panels will cost, we can see from the table that the conversion factor from kWp to thousand pesos is 110. Thus 1.5 kWp x 110 = 165 thousand pesos or P165,000.00.

Another example: suppose you inherit P300,000.00 from a rich uncle and would like to know how much PV system this amount can buy. The conversion factor from thousand pesos to kWp is “÷ 110”. Since, 300 ÷ 110 = 2.727 kWp, this means you can afford to buy a 2.7 kWp PV system. The conversion factor from kWp to kWh/mo is x 114.75. Thus, 2.727 x 114.75 = 313 kWh/mo. This is the average monthly production you can get out of the PV system you can buy for P300,000.00.

Let us return to our target of 45,000 GWh per year, which is equivalent to 45 billion kWh per year or 3,750 million kWh per month. The conversion factor from Kwh/mo to m^2 is ÷ 17.2. Thus, we need 218 million m^2 (21,800 ha) of PV panels to generate all the electricity which we estimated above would let us attain 100% renewable electricity in 2015 (3,750 million ÷ 17.2 = 218 million).

Just 1% of the country's land area can generate nearly 14 times the 45,000 GWh we will generate from non-renewables in 2015.

The Philippines covers a land area of 30 million ha. Just 1% of this area means 300,000 ha, which is nearly 14 times the 21,800 ha required to become fully renewable in electricity in 2015. Even one-tenth of 1%, or 30,000 ha, is still 38% larger than the area needed to phase out all fossil-fuel-based electricity in 2015. We have assumed that the financial resources exist and enough storage facilities are available to store excess production, which could then be released when there is little or no sunlight.

These are obviously huge assumptions. But we are only trying to establish at this point whether we have the physical resources for a full energy transition to renewable electricity. So let us suspend our disbelief for a moment and continue what we might call a thought experiment.

The Philippines has 1,633 cities and municipalities (we will use the term “towns” for both). If we distribute among these the 21,800 ha required for an energy transition to 100% renewable electricity, then each town needs to put up 13.35 ha of solar panels. Around 4.5 ha per town will take us one-third of the way. Another 4.5 has will take us two-thirds of the way. Still another will be more than enough to make the full transition.

Temporarily setting aside at this point the little details that the devil can throw against us, we can easily imagine meeting our entire electricity consumption *from solar power alone*, if the money and the right storage facilities were available.

Wind electricity

We will use the following conversion table for wind turbines.

Table 4. Wind Turbine Conversion Factors

	= MW, rated	= MWh/yr	= million pesos
MW, rated		x 2,575	x 119.5
MWh/yr[18]	÷ 2,575		÷ 21.55
million pesos[19]	÷ 119.5	x 21.55	

Source: Author’s calculations.

According to a 2000 NREL study on wind energy resource development in the Philippines, based on a conservative estimate that excludes areas with average wind speeds lower than 6.4 m/sec:

> “The total wind electric potential from areas with good to excellent wind resource is conservatively estimated to be 76,000 megawatts of installed capacity or approximately 195 billion kilowatt hours per year.”

The study summarizes the country's wind resources in Table 5 (next page).

18 Based on an assumed wind turbine capacity factor of 30% and electrical system efficiency of 98%.
19 Based on the TAREC investment of P6.453 billion for 54 MW of wind turbines.

The NREL figure of 195 billion kWh wind electricity potential is equivalent to 195,000 GWh. This is more than four times the indicative target of 45,000 GWh we need to attain 100% RE in 2015. More than eight times our target, if we include the areas with moderate potential, which raises the total potential to 361,000 GWh. These figures already take into account the inherent variability of the resource.

Table 5. Potential Electricity Output from Wind Energy in the Philippines

Wind Resource Utility Scale	Wind Power W/m^2	Wind Speed m/s	Total Area km^2	Total Capacity Installed MW	Total Power GWh/yr
1. Moderate	200–300	5.6–6.4	14,002	97,000	165,800
2. Good	300–400	6.4–7.0	5,541	38,400	85,400
3. Excellent	400–600	7.0–8.0	4,304	29,800	82,400
4. Excellent	600–800	8.0–8.8	1,112	7,700	25,100
5. Excellent	800–1200	8.8–10.1	98	700	2,300
Total (#2-5)			11,055	76,600	195,200
Total (#1-5)			25,057	173,600	361,000

Source: Elliott, 2000.

Based on these conservative estimates, 25 provinces have at least 1,000 MW wind electric potential, and 22 more have 500–1,000 MW wind electric potential. The rest have a potential below 500 MW. If areas with average wind speeds of 5.6–6.4 m/sec were included (good for rural applications and non-commercial electric generation), 51 provinces will have at least 1,000 MW wind electric potential, and 13 more will have 500–1,000 MW wind electric potential.[20]

The study divided the country, for purposes of its regional wind resource mapping, into 13 regions: 1) Batanes and Babuyan Islands; 2) Northern Luzon; 3) Central Luzon; 4) Mindoro, Romblon, Marinduque, and Southern Luzon; 5) Southeastern Luzon, Masbate and Catanduanes (Bicol Region); 6) Samar and Leyte; 7) Panay, Negros, Cebu and Siquijor; 8) Bohol and Northern Mindanao; 9) Southern Mindanao; 10) Western Mindanao and Basilan; 11) Northern Palawan; 12) Southern Palawan; and 13) Basilan, Sulu and Tawi-Tawi. Each region is covered by a detailed wind resource map.

The country's wind potential is 16 times the 45,000 GWh of the electrical energy we need to generate to be 100% renewable.

The above study is based on a 30-meter turbine height, and has been updated by a more recent NREL study (March 2014). The 2014 study takes into account larger-sized and 80–100 meter-high turbines,

20 Dennis Elliott, et al., "Philippines Wind Energy Resource Atlas of the Philippines," p. 87.

enabling wind turbines to harvest more than four times the energy potential estimated in the earlier study. Our total wind potential then turns out to be more than 16 times what we need to go fully renewable.

This shows that the wind electric potential available to the country is far more than enough to attain a 100% RE goal *from wind power alone*, if we had the right storage facilities.

Micro-/Mini-hydro

The next table gives the conversion factors for mini- and micro-hydro installations.

The 32% capacity factor used in the table was calculated from the 2013 hydroelectric data of the DOE. It is somewhat low and therefore tends to understate the production potential of hydroelectric plants and overstate its levelized cost of electricity. The low capacity factor is probably due to the low rainfall that year, and is not inherent in the technology.

So, remember that the conversion factors given in the table are highly sensitive to variations in the capacity factor.

Table 6. Mini-and-Micro-hydro Conversion Factors

	= MW, rated	= MWh/yr	= million pesos
MW, rated		x 2,800	x 140
MWh/yr[21]	÷ 2,800		÷ 20
million pesos[22]	÷ 140	x 20	

Source: Author's calculations.

According to the DOE, the country's potential from its micro-hydro resources is 27 MW and 1,847 MW from mini-hydro. We are excluding for the moment large hydro as well as geothermal installations to skirt the debates on their social and environmental impacts.

Assuming a capacity factor of 32% for these micro- and mini-installations, we would be able to generate from these resources around 5.3 billion KWh or 5,300 GWh per year, good enough to replace about 12% of our national consumption of non-renewable electricity in 2015.

We have enough hydroelectric resources still untapped to replace 77% of the non-renewable electricity we will produce in 2015.

Of course, if we included the country's large untapped hydro potential of 10,500 MW (34,700 GWh per year at 38% capacity factor) into the equation, we would be able to replace 77% of our entire

21 0.32 x 24 x 365 = 2,800.
22 Based on 2.5 million euros/MW at P56.00/euro.

consumption of electricity from non-renewable resources in 2015, *from hydro alone*.

Assuming a geothermal plant capacity factor of 60%, our untapped geothermal potential of about 1,200 MW is good for around 6,300 GWh per year, or 14% of our non-renewable electricity consumption.[23]

Mixing the steady output from hydro and geothermal resources with the intrinsically variable output of solar and wind resources can provide more stability for the electricity grid.

It seems quite clear, from this brief introductory review, that we have enough physical renewable resources for a complete phase-out of fossil fuels like coal, oil, diesel and other non-renewables.

No more fossil-fueled generating plants?

Since rooftop solar is already cheaper than coal electricity from the grid, and we have seen that we have enough renewable resources to take care of all our needs, let us now see whether we can actually drop all new fossil-fueled—and nuclear-fueled—plants in future planning.

In the previous section, we answered the question: Do we have enough physical resources in the country to make the full transition to renewable electricity?

In this section, we will answer the question: Can we rely on renewables only for all future additions to our generating capacity?

According to the latest figures available, the Philippines consumed 61,566 GWh of electricity in 2013. Since 2000, electricity consumption has increased annually by an average of 4.09%. If we project this historical trend until 2020, we will get the following projections:

Table 7. Projected Consumption of Electricity in the Philippines, 2013-2020

Year	2013	2014	2015	2016	2017	2018	2019	2020
Consumption (GWh)	61,566	64,084	66,705	69,433	72,273	75,229	78,306	81,509

Source: Author's calculations.

The projected increases in consumption are 2,518 GWh in 2014, to 3,203 GWh in 2020. Thus, if we add each year enough capacity to produce some 3,200 GWh, we should be able to cover all but the most optimistic growth projections.

And if we use only renewable sources for these annual 3,200 GWh additions, we can drop all non-renewables completely in our future power sector planning.

For the sake of this exercise, let us say that the above additions will be split as follows: 1,800 GWh

23 The average capacity factors of 32% for hydro and 60% for geothermal were calculated by the author from 2013 MW capacity and GWh output statistics released by the DOE, using the formula CF = 1000 * Output (GWh) ÷ [capacity (MW) × 24 × 365].

for solar; 900 GWh for wind; and 500 GWh for hydro. This is how we might conceivably meet these targets:

Solar: If we allocate 1,800 GWh over the country's 1,633 towns, then each will have to produce an additional 1.1 GWh of solar electricity every year, on the average. This will require around 800 kWp of solar panels, involving an investment of around P88 million per town. Small towns can invest less, larger towns can invest more. It is best to install those panels in the rooftops of consumers, to obviate or minimize the need for large tracts of land as well as new transmission and distribution lines.

Wind: If we tap only the most wind-rich 170 towns (about 10% of the total) each year, then each of them will have to produce an additional 5.3 GWh of wind electricity every year on the average, equivalent to a capacity of 2.0 MW. In any subsequent year, the same 170, the next 170, or a combination of both, can provide the next round of 2 MW each. The TAREC wind turbines (see Chapter 3) have a capacity of 2 MW each and an investment cost of around P240 million per turbine.

Hydro: The 500 GWh hydro contribution will require annual capacity additions of around 180 MW per year, about 10% of our remaining untapped hydro potential. Again, the next 10% can be tapped in subsequent years.

If we figure in geothermal and biomass, the above mix can be further diversified, improving system reliability. If various energy efficiency and conservation measures (such as the shift to LED lighting) are also given priority, then the above requirements can be further reduced.

These are relatively demanding targets, but they are not impossible. Attaining them would take real political will, but consider the reward: a full stop to all future fossil and nuclear power plants in our electricity planning, preventing a technology lock-in that will even be more expensive than the ambitious renewable targets we outlined above.

Chapter 2. Unevenly distributed renewable potential

While we can generally conclude that solar, wind and hydro power are all financially viable today, these renewable resources are unevenly distributed throughout the country—in absolute amounts, in their relative intensities, and in the regularity of their availability. In short, they are unevenly distributed in terms of quantity as well as quality. Some areas are gifted with more of one RE source than another, others have better of one or two of these sources.

This makes it a real challenge to determine the best mix of renewable technologies for a particular site.

The potential, relative intensities and the regularity of availability of these renewables must therefore be further determined at the provincial, city, municipal and even village levels. Doing so will make it possible to design the mix of technologies and approaches that will optimize the reliability, efficiency and viability of the entire system.

This will ensure that our village and town showcases of 100% RE are also cheaper for the local consumers as well as viable for low-risk, long-term financing. Then, we can initiate our first Feldheim-type showcase.

Renewable resources are unevenly distributed throughout the country in absolute amounts, in their relative intensities and in the regularity of their availability.

Locating and assessing RE resources

A lot of physical data have already been collected and made available that can help provide an initial sense of what RE projects are possible in a particular locality. The following materials are only a sampling.

These materials suggest that the areas in the Philippines where one or another RE resource can be most financially viable. In a particular locality where several RE resources can be tapped in the right combination to create a highly attractive project that financial institutions can support, then the possibility of an RE project that meets our three conditions for a showcase can be considered.

Solar intensity distribution in the Philippines

Solar insolation and average daytime temperature maps for identifying potential sites for photovoltaic installations and other solar-powered equipment are available from NREL and also from NASA.

Here are some sample documents:

- Assessment of Solar Resources in the Philippines (NREL Internal Review Draft, October

2000), retrievable from: www.spug.ph/Solar.pdf.

- Interactive Solar Map, retrievable from: www.solargis.info/imaps.
- The Profile of Solar Insolation in the Philippines, retrievable from: solarelectricityhandbook.com/solar-irradiance.html.
- World Daily Solar Insolation Map, retrievable from: http://www.oksolar.com/abctech/solar-radiation.htm.
- Solar Dataset – UNEP, retrievable from www.unep.org.
- Solar Insolation (one month, NASA - NASA Earth Observations), retrievable from: neo.sci.gsfc.nasa.gov/view.php?datasetId=CERES_INSOL_M.
- DOE Solar Energy Potential Sites, retrievable from: www2.doe.gov.ph/ER/Maps%20-%20Solar.htm.

Maps such as the solar irradiation map in Figure 3 (see next page) show how solar peak-hours are distributed throughout the country.

CEPALCO's grid-tied 1-MWp PV power plant: a first in the developing world

The 1-MWp on-grid PV power plant of CEPALCO in Cagayan de Oro City went online more than ten years ago, on September 26, 2004. At the time of its inauguration, it was the developing world's first and largest power plant of its kind.

In its first three years of operation, the plant produced 4,169,100 kWh, an average of 1,389,700 kWh per year, and 10% higher than the expected output of 1,261,400 kWh per year.

In 2007, CEPALCO's plant supplied the needs of around 900 CEPALCO residential customers.

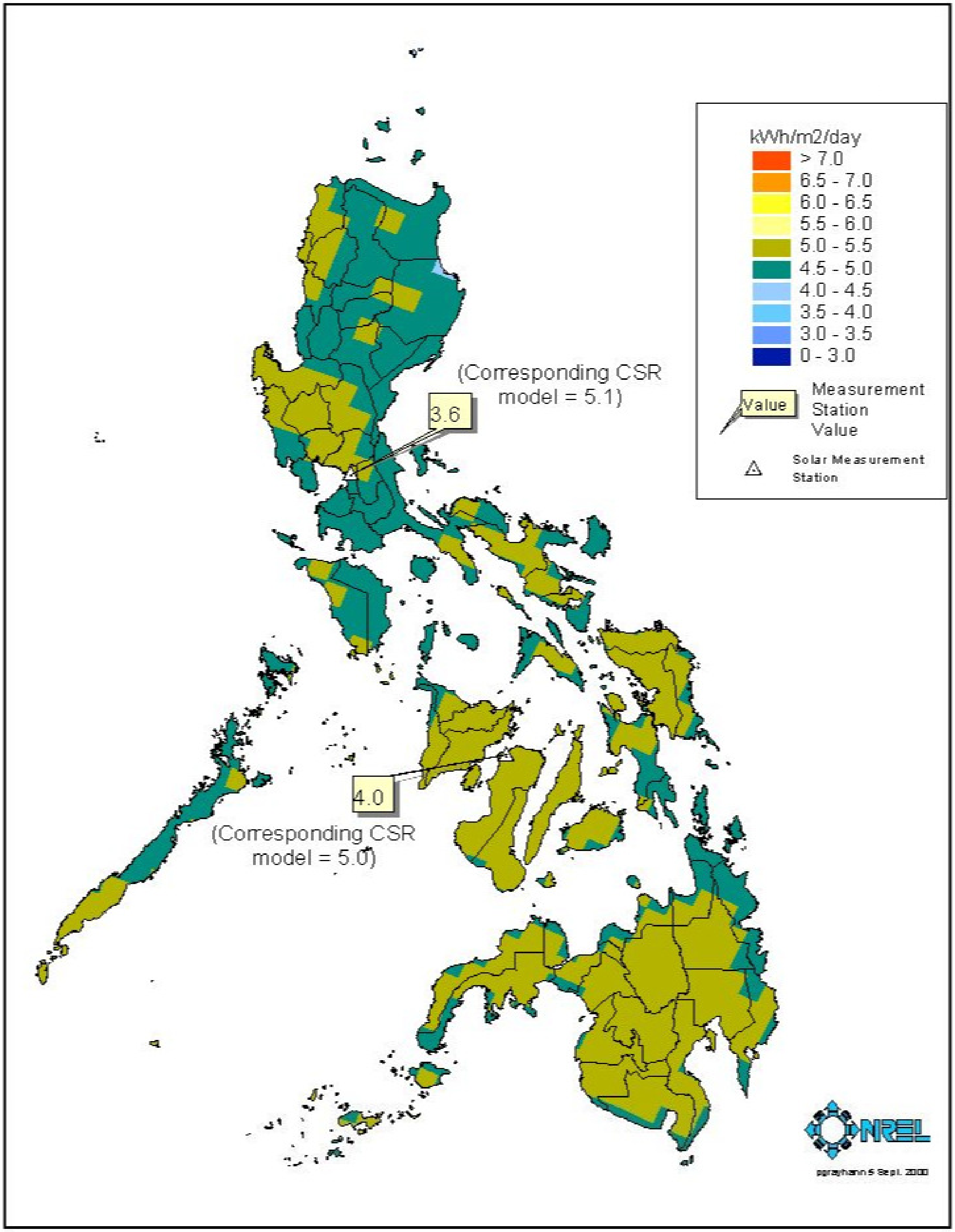
The 1-MWp plant cost CEPALCO around US$5.1 million to install. The plant consists of 6,500 167-Wp solar panels laid out on two hectares of land. The project was partially financed with a loan from GEF. The loan was facilitated by the World Bank through its International Finance Corporation. After five years of successful operation, the loan will be turned into a grant. Note the cost of $5.10 per Wp ten years ago, which made it necessary to provide the project with some financial support.

Sumitomo Corporation of Japan won the turnkey contract to build the plant. Another Japanese company, Sharp, made the PV modules while China's Sansha supplied the inverters. The balance of system components were procured locally.

The PV plant is designed to complement the 7 MW run-of-the-river hydroelectric plant owned by CEPALCO subsidiary Bubunawan Power Company.

The plant has attracted thousands of visitors, including 10,000 students and local as well as foreign renewable energy enthusiasts.

Figure 3. Incident Solar Radiation in the Philippines



Source: Renné, et al., 2000.

Due to its positive experience with PV technology, CEPALCO now plans to embark on a larger solar park within its service territory. The solar park will occupy 30 hectares inside the First Cagayan de Oro Business Park in Villanueva, Misamis Oriental, some 30 minutes away east of Cagayan de Oro City. A pre-feasibility study indicates that the plant can supply CEPALCO with around 14 million kWh per year of electricity, equivalent to some 30,000 barrels per year of fuel oil.

Figure 4. 1-MW Photovoltaic Power Plant, Barangay Indahag, Cagayan de Oro City, Philippines

Source: http://philnews.ph/wp-content/uploads/2013/10/Cepalco-Solar-Power-Plant-500x218.jpg

The proposed 10-MWp PV plant will be constructed over five years, to take advantage of the best available solar technology in the market. Phased-in construction will enable CEPALCO to take advantage of the increasing efficiency and decreasing costs of solar panels, which account for around 50% of the PV plant’s installed costs. Waiting for lower costs will cushion the plant's impact on CEPALCO’s rates.

In May 2011, seven years after it went online, around 25% of the panels had been damaged by micro-cracks and one of the nine inverters had failed. Although the plant was still in working condition, it was only producing 50-60% of its rated output. Fortunately for the project, Sharp honored its 20-year warranty and replaced the defective panels.

A 40-50% loss of output after seven years is a major concern. Without a long warranty, or if the supplier did not honor its warranty (these are common problems in the Philippines), such rapid deterioration of PV panels would drastically change the economics of solar power. On the other hand, a 33-Wp ARCO solar panel's output is said to have degraded by only 8% after thirty years.[24] This wide variation in the quality of PV panels should be a warning to buyers to take special care in choosing suppliers. A dependable warranty from a reliable supplier that will still be in business at least 10 years later is of utmost importance.

As of August 2014, the following developers have received Certificates of Commerciality from DOE, which authorizes them to proceed with the commercial development of their proposed project. Of the applications totaling 160 MW, only 13 MW (see the San Carlos Solar case study for details) have been fully installed and are ready to go online. Expected to go online next is the Majestics Cavite

24 Williams, p. 335.

project. The two will already fill up the initial FIT threshold of 50 MW, leading the rest to clamor for an increase in the threshold to 500 MW.

Table 8. Utility-Scale Solar PV Projects in the Philippines

Project Location (Province: Municipalities)	**Company**	**Capacity (MWp)**
Ilocos Norte: Currimao	Mirae Asia Energy Corporation	20
Pampanga: Mexico	RASLAG Corporation	8
Cavite: Rosario, Gen. Trias	Majestics Energy Corporation	40
Rizal: Rodriguez	ATN Philippines Solar Energy Group, Inc.	30
Negros Occ.: San Carlos City	San Carlos Solar Energy, Inc. (13 MW completed)	22
Leyte: Ormoc	Philippine Solar Farm-Leyte, Inc.	30
Davao del Sur: Digos	Enfinity Philippine Renewable Resources Inc.	10
	TOTAL	**160**

Source: DOE, 2014

Philippine wind maps

Wind studies result in wind maps that indicate averages and distributions of wind speeds in most parts of the country. The most comprehensive of these so far are those used for identifying potential sites for wind turbines. These maps and accompanying analysis of the distribution of wind power potential were prepared by the National Renewable Energy Laboratories (NREL) of the U.S. Here are some sample NREL documents:

- Philippine Wind Energy Resource Atlas Development (November 2000, NREL/CP-500-28903), retrievable from: www.nrel.gov/docs/fy01osti/28903.pdf.
- Wind Energy Resource Atlas of the Philippines (Feb. 2001, NREL/TP-500-26129), retrievable from: www.nrel.gov/wind/pdfs/26129.pdf, 206 pp.[25]
- Philippine Wind Farm Analysis and Site Selection Analysis (December 2001, NREL/SR-500-30934), retrievable from: pdf.usaid.gov/pdf_docs/PNADJ196.pdf.
- DOE Wind Energy Potential Sites, retrievable from: www2.doe.gov.ph/ER/Maps%20-%20Wind.htm.

The map in Figure 5 (see page 20), also taken from the NREL study, gives a good idea of the areas in the country which are good candidates for potential wind energy projects.

25 This atlas divides the Philippines into 13 regions and contains a detailed region-by-region analysis of the wind resource potential of the country.

The 2014 wind energy survey update[26]

The latest wind potential assessment was released in March 2014. The latest assessment reflects recent technological developments and takes into account larger-sized and taller turbines. The encouraging findings of this updated survey indicate that average wind speeds of greater than 6.5 m/sec can be found in 25% of the country at a tower height of 80 meters, and in 30% of the country at 100 meters. (Wind speeds higher than 6.0 m/sec are considered commercially relevant.)

Table 9. Average Wind Speeds and Specified Heights

	Area surveyed (km^2)		
Height	**< 6.0 m/sec**	**> 6.0 m/sec**	**Total**
80 m.	220,968 km^2	74,889 km^2	295,857 km^2
100 m.	207,164 km^2	88,693 km^2	295,857 km^2

Source: Jacobson, 2014.

And as turbine heights and rotor diameters have increased over the years, the economics of wind energy have improved significantly, with costs going down from $150/MWh in 1995, to around $50/MWh in 2012, an average decrease over the 17-year period of 6.7% per year[27].

Average wind speeds greater than 6.0 m/sec can be found in 25% of the country at 80-meter tower heights, and in 30% of the country at 100 meters.

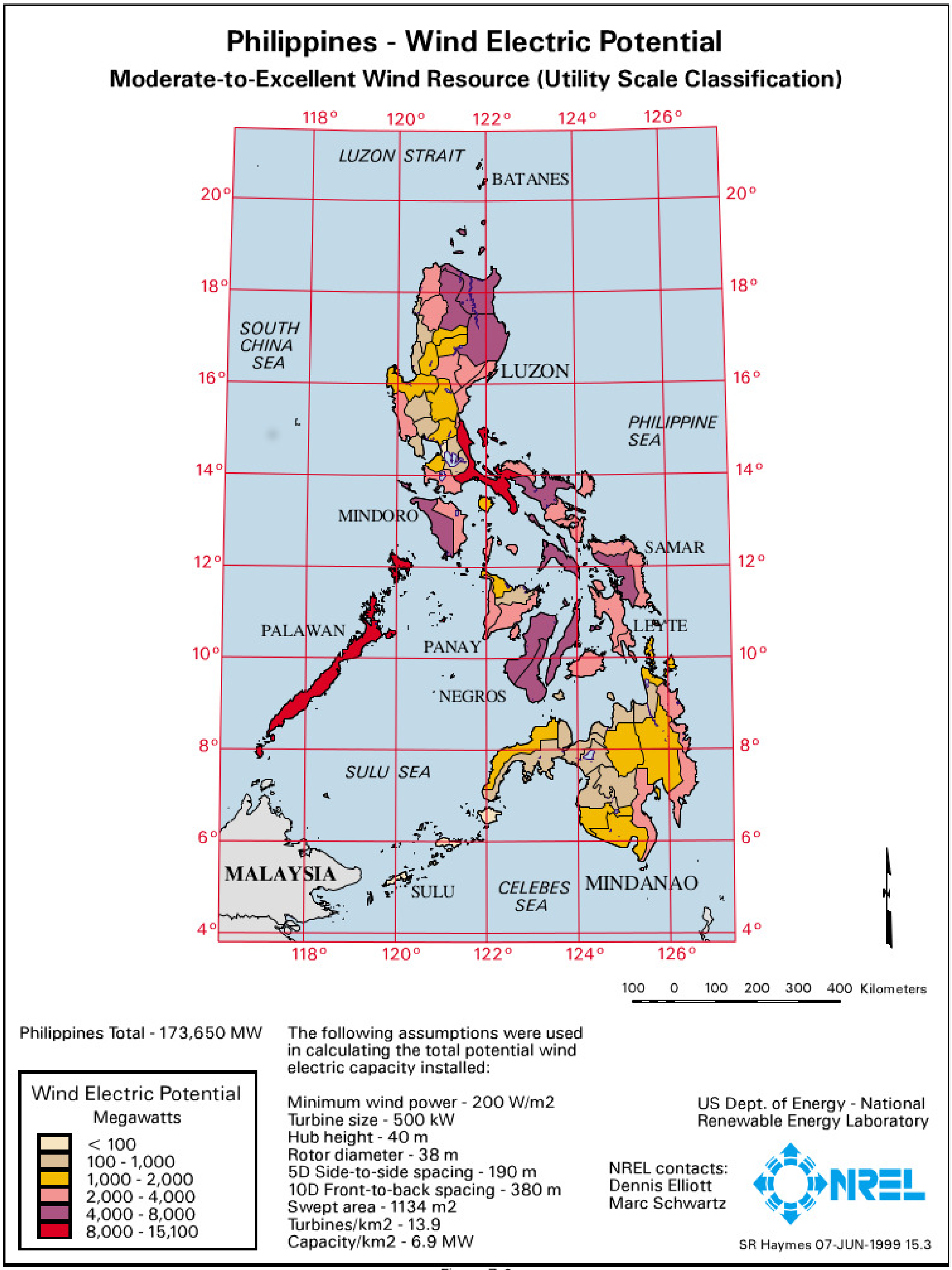
Table 10. Typical Energy Production from a 1.6 MW Turbine with 100m Rotor

Average wind speed (m/s)	**Net energy (MWh)**	**Net capacity factor (%)**
6.0	4,130	29%
7.0	5,321	38%
8.0	6,327	45%
9.0	7,134	51%

Source: Jacobson, 2014.

26 Mark D. Jacobson, "Philippine Wind Resource Assessment: Modern Approaches to Support the Development of a Nation's Wind Energy Potential," National Renewable Energy Laboratory (NREL), 2014, p. 30.
27 Jacobson, p.18.

Figure 5. Wind Electric Potential of the Philippines



Source: Elliott, p. 102.

The 2014 NREL wind energy survey is much more useful for wind developers in the Philippines for the following reasons:

- data for various heights are now available: 30, 50, 80, 100, 140 and 200 meters
- the models used are based on latest generation technology
- not only average speeds are available but also their frequency (Weibull) distribution
- shear, wind direction, temperature, air density, and temporal information are also available now.

A good indication of the wind energy potential of the country is the number of commercial RE developers, local as well as foreign, who have come knocking at DOE's door take advantage of the RE Act and its FIT provisions.

Of these, the following 57 firms below have been awarded service contracts by the DOE, and are at various stages of pre-development or development. They are targeting to exploit a total of 2,054.4 MW of wind energy potential, 1,861.4 MW in Luzon and 193 MW in the Visayas. This total is only 2.7% of the 76,600 MW estimated wind energy potential of the country, places where wind speeds of at least 6.5 m/s allow wind turbine capacity factors of 30% or higher, making commercial operation a real possibility. Indeed, there is a lot of room for growth.

The wind projects being built today cover only 2.7%
of the wind energy potential of the country.
There's a lot of room for growth.

As of September 30, 2014, only one of these projects was operational. This was the Phase 1 and 2 of Northwind Development Corporation's Bangui wind power project.

Table 11. Wind Projects in the Philippines

Project Location (Province: Municipalities)	**Company**	**Capacity (MW)**
1. Mt. Province: Sagada, Besao 2. Ilocos Norte: Pagudpud	Sagada-Besao Wind Power Corporation Bayog Wind Power Corporation	
3. Ilocos Norte: Pasuquin, Burgos	Energy Logics Philippines	48
4. Ilocos Norte: Burgos	EDC Burgos Wind Power Corp., Ph 1	87
5. Ilocos Norte: Burgos	EDC Burgos Wind Power Corp., Ph 2	63
6. Ilocos Norte: Burgos	First Gen Renewables, Inc.	
7. Ilocos Norte: Burgos	N Luzon Renewable Energy Corporation	90
8. Ilocos Norte: Burgos	N Luzon Renewable Energy Corporation	44
9. Ilocos Norte: Burgos	Energy Development Corp. (Burgos 1)	
10. Ilocos Norte: Burgos	Energy Development Corp. (Burgos 2)	
11. Ilocos Norte: Pagudpud	N Luzon Energy Development Corporation	81

12. Ilocos Norte: Pagudpud 13. Ilocos Norte: Pagudpud	N Luzon Energy Development Corporation EDC Pagudpud Wind Power Corporation	45 84
14. Ilocos Norte: Bangui	Northwind Power Development Corp, Ph 3	18.9
15. Ilocos Norte: Bangui (33 MW operational)	Northwind Power Devt. Corp, Ph 1-2	
16. Pangasinan: Infanta	Pangasinan UPC Asia Corporation	48
17. Pangasinan: Mabini	Pangasinan UPC Asia Corporation	48
18. Pangasinan: Labrador	Pangasinan UPC Asia Corporation	98
19. Cagayan: Claveria	FirstMaxPower International Corporation	15
20. Cagayan: Sanchez-Mira	FirstMaxPower International Corporation	50
21. Cagayan: Abulug, Ballesteros, Aparri	Trans-Asia Renewable Energy Corporation	45
22. Cagayan: Aparri, Buguey	Trans-Asia Renewable Energy Corporation	48
23. Cagayan: Aparri, Buguey	North Point Wind Power Devt Corporation	40
24. Zambales: Subic, San Antonio	Pan Energy Corporation	
25. Bataan: Morong, Hermosa	Jobin-Sqm, Inc.	50
26. Quezon: Calauag 27. Quezon: Infanta	Trans-Asia Renewable Energy Corporation Trans-Asia Renewable Energy Corporation	10 10
28. Rizal-Laguna: Tanay, Pililla, Mabitac	Alternergy Wind One Corporation	67
29. Rizal-Laguna: Pililla, Mabitac, Pakil	Alternergy Sembrano Wind Corporation	72
30. Oriental Mindoro: Bulalacao	PhilCarbon, Inc.	
31. Oriental Mindoro: Puerto Galera	Phil Hybrid Energy Systems, Inc.	16
32. Occidental Mindoro: Abra de Ilog	Alternergy Phil Holdings Corporation	40
33. Palawan: Puerto Princesa	Sunwest Water and Electric Company, Inc.	10
34. Romblon: Ferrol, Odiongan	Sunwest Water and Electric Company, Inc.	2
35. Camarines Norte: Vinzons	Trans-Asia Renewable Energy Corporation	26
36. Camarines Norte: Vinzons, Talisay, Daet	Coastal Power Development Corporation	100
37. Camarines Norte: Mercedes	First Gen Renewables, Inc.	
38. Sorsogon: Prieto Diaz, Gubat	Coastal Power Devt Corp	420
39. Sorsogon: Matnog, Magdalena	Energy Development Corporation	
40. Sorsogon: Matnog	Energy Development Corporation	
41. Sorsogon: Matnog	Energy Development Corporation	
42. Camarines Sur: Libmanan	Cornerstone Energy Development, Inc.	70
43. Albay: Legazpi	Sunwest Water and Electric Company, Inc.	10
44. Albay: Cagraray Island	Sunwest Water and Electric Company, Inc.	5
45. Aklan: Nabas, Malay	Tri-Conti Elements Corporation	
46. Guimaras: Nueva Valencia	Trans-Asia Renewable Energy Corporation	10
47. Guimaras: San Lorenzo	Trans-Asia Renewable Energy Corporation	54
48. Guimaras: Sibunag	Trans-Asia Renewable Energy Corporation	16
49. Iloilo: Dumangas	Trans-Asia Renewable Energy Corporation	12

50. Negros Occidental: Pulupandan 51. Negros Occidental: San Carlos City	FirstMaxPower International Corporation BronzeOak Phils, Inc.	50
52. Negros Occidental: Manapla, Cadiz	Energy Development Corporation	
53. Iloilo-Capiz: Batad, San Dionisio	Energy Development Corporation	
54. Iloilo: Concepcion	Energy Development Corporation	
55. Aklan: Malay	Green Earth Energy Ventures Inc	1
56. Negros Or: Bais, Bayawan, Tanjay, Pamplona	Constellation Energy Corporation	
57. Cebu: Balamban, Toledo, Minglanilla, Cebu Ct	Amihan Energy Corporation	
	TOTAL	**2,054.4**

Source: DOE, 2014

Potential mini-/micro-hydro sites

The old Department of Energy website contains a resource map of potential micro-hydro sites[28].

The Japanese government has been reported to be conducting a new comprehensive survey to update the country's assessment of its hydroelectric potential.

As of August 2014, the following hydroelectric projects have been awarded Certificates of Commerciality, and are now in various stages of completion:

Table 12. Hydroelectric Projects in the Philippines

Project Location (Province: Municipality)	**Company**	**Capacity (MW)**
Benguet: Kapangan, Kibungan	Cordillera Hydroelectric Power Corporation	60
Benguet: Sabangan	Hedcor Sabangan, Inc.	13.2
Benguet: Tuba	Hedcor, Inc.	3.8
Ifugao: Lagawe	Hydrocore, Inc.	4.5
Ifugao: Tinoc (1)	Quadriver Energy Corporation (Tinoc)	3
Ifugao: Tinoc (2)	Quadriver Energy Corporation	6.5
Ifugao: Tinoc (3)	Quadriver Energy Corporation	5
Ifugao: Tinoc (4)	PhilNew Hydro Power Corporation	6
Cagayan: Penablanca Nueva Vizcaya: Solano	Sunwest Water & Electric Company, Inc. Smith Bell Mini-Hydro Corporation	6 1.8
Nueva Ecija: Gabaldon	Constellation Energy Corporation	3
Aklan: Libacao	Sunwest Water & Electric Company, Inc.	15
Aklan: Madalag	Oriental Energy & Power Gen Corporation	18

28 http://www2.doe.gov.ph/ER/Maps%20-%20Micro%20Hydro.htm

Antique: San Remegio (Maninila Lower)	Century Peak Energy Corporation	4.5
Antique: San Remegio (Maninila Upper)	Century Peak Energy Corporation	3.1
Antique: San Remegio (Sibalom Lower)	Century Peak Energy Corporation	4
Antique: San Remegio (Sibalom Middle)	Century Peak Energy Corporation	4
Antique: San Remegio (Sibalom Upper)	Century Peak Energy Corporation	4.2
Iloilo: Igbaras	Century Peak Energy Corporation	5.1
Negros Occ.: Kabankalan (Lower)	Century Peak Energy Corporation	3
Negros Occ.: Kabankalan (Upper)	Century Peak Energy Corporation	4.8
Bohol: Loboc	Sta. Clara Power Corporation	1.2
Cebu: Basak	Meadowland Developers, Inc.	0.5
Negros Or.: Amlan	Natural Power Sources Integration, Inc.	1.5
Zamboanga del Sur: Zamboanga City	PhilCarbon, Inc.	0.05
Bukidnon: Baungon	First Gen Mindanao Hydro Power Corp.	9
Bukidnon: Baungon, Libona	First Gen Mindanao Hydro Power Corp.	23
Bukidnon: Impasugong, Sumilao	First Gen Mindanao Hydro Power Corp.	39
Bukidnon: Manolo	Oriental Energy & Power Gen Corporation	10
Misamis Or.: Claveria	PhilNew Hydro Power Corporation	4.85
Misamis Occ.: Clarin	PhilNew Hydro Power Corporation	6.2
Misamis Or.: Cagayan de Oro City	Turbines Resources & Devt Corporation	9
Davao del Sur: Sta. Cruz	Hedcor Tudaya, Inc.	7
Compostela Valley: New Bataan	Euro Hydro Power (Asia) Holdings, Inc.	1
Agusan del Norte: Cabadbaran	First Gen Mindanao Hydro Power Corp.	9.75
Agusan del Norte: Jabonga	First Gen Mindanao Hydro Power Corp.	30
	TOTAL	**330.55**

Source: DOE, 2014.

Other renewables

This study does not include much on biomass, biofuels, ocean and other renewable sources. These can be covered in subsequent studies or incorporated in subsequent editions of this study.

Some resource maps for these are also available on the old Department of Energy website:

- www2.doe.gov.ph/ER/Maps%20-%20Rice%20Residues.htm
- www2.doe.gov.ph/ER/Maps%20-%20Coconut%20Residues.htm
- www2.doe.gov.ph/ER/Maps%20-%20Bagasse.htm
- www2.doe.gov.ph/ER/Maps%20-%20Ocean%20Thermal.htm

A very good source of early information on biogas production and utilization is Maramba's account of the Maya Farms biogas project.[29]

29 Felix D. Maramba. *Biogas and Waste Recycling: The Philippine Experience*, (Metro Manila: Maya Farms, 1978).

It must be remembered that all data extracted from the databases above must be verified on the ground for a particular site under consideration, at least for a whole year, and preferably for two years or even more.

This is necessary to provide a reliable foundation for all the technical and financial calculations that will become the basis for evaluating the financial viability of a particular showcase.

We must also consider the ongoing electricity rates in a particular area. The higher the rates, the greater to reason to shift to renewables as soon as possible. Note that the latest Meralco rate (P10.39/kWh as of December 2014) is lower than what Sec. Petilla used when he concluded that rooftop solar was cheaper than the Meralco rate. But even under the lower Meralco rates, rooftop solar is *still cheaper*. Sec. Petilla's conclusion was robust and remained valid despite swings in the electricity rates.

In some parts of the country though, the retail price of electricity is still cheaper than electricity from solar rooftops. But not for long, given the continuing decrease in solar PV costs.

Remember the *new* conventional wisdom: in most parts of the country, solar electricity from your rooftop is now cheaper than grid electricity.

Appendix A (“Retail prices of electricity in the Philippines”) lists the current electricity rates in the service areas of various distribution utilities and electric coops in the Philippines.[30] These can be used by RE planners to determine whether a particular RE project is viable in comparison to the current rates in their area.

All data extracted from these databases must be verified on the ground for a prospective site, for at least a whole year.

30 http://www.kuryente.org.ph/electric-companies

Chapter 3. These RE projects are financially viable—*today*

The case studies that follow involve a wide range of renewable energy projects.

Most of these projects are business ventures, undertaken by entrepreneurs who looked at the financial viability of the project and, after due diligence, decided that the venture makes commercial sense.

Commercial financing for the project additionally meant that a second opinion—the bank's—agreed with the entrepreneurs that their renewable energy venture was commercially viable. In fact, it meant that the returns on the investment were high enough, that the entrepreneur, as well as the lending bank, were both going to make money from the venture.

What could be a better argument, in addition to the calculations of the DOE Secretary himself, to prove that renewable electricity is now a financially viable prospect?

A Pioneer Utility-Scale Solar Power Plant

Bronzeoak Philippines is a Negros-based Filipino corporation engaged in several renewable energy projects. The following details were gathered from a presentation by its President, Jose Maria Zabaleta Jr. on June 14, 2014 at the German Chamber of Commerce in Makati, supplemented by media stories about the project.

In partnership with a German company Thomas Lloyd, Bronzeoak formed the San Carlos Solar Energy (SACASOL), which set up in 2013 a 13-MW solar power generating plant. Other partners include Hua Goang and Conergy.

SACASOL's solar power plant is the first-of-its-kind plant to take advantage of the 2008 Renewable Energy Act. It is also the first to actually operate under the Philippine FIT system, with its FIT certificate of eligibility already signed by the DOE. They began feeding into the grid on May 15, 2014. The project took two years, from concept to completion. In answer to questions about bureaucratic delays, Zabaleta acknowledged that “around 120 signatures” were needed to get the project approved.

The cost of installing solar energy in the Philippines, Zabaleta says, is 3–4 times the cost of a similar facility in Europe. He cites as main reason the higher civil construction costs in the Philippines.

Zabaleta mentioned that another firm, the Majestics Energy Corporation, is implementing a solar generation project in Cavite. The firm has also completed construction and installation of its facilities, though it is not yet connected to the grid. The two companies alone, he says, will already fill up the 50 MW provided for under the FIT system. Because of this, the industry is expecting the DOE to raise the FIT-supported solar generation capacity from 50 MW to 500 MW.

The 13-MW SACASOL plant comprises the first phase of the project. Another 9-MW plant is scheduled for completion by “early 2015”—making up the project's second phase.

The first phase consists of 88,000 PV modules of fixed orientation. Each panel is rated at around 150 Wp. In addition, 22 inverters convert the solar farm's DC output to AC, to feed into the grid. The 13-MW plant occupies 35 ha. By generating electricity from the sun instead of fossil fuels, the plant displaces 17,000 tons of CO_2 per year.

The SACASOL solar power plant supplies electricity to the grid during the peak daytime hours, making it a "peaking plant." Thus, it is replacing not the lower-cost electricity from base-load bunker oil or coal-fueled plants but higher-cost electricity supplied by diesel-fueled peaking plants. In fact, the weighted average of peak prices at the Wholesale Electricity Spot Market (WESM), Zabaleta says, is "around 10 pesos". This is higher than the solar FIT rate of P9.68.

So, the solar power plant actually reduces the cost of electricity during peak hours, according to Zabaleta, by avoiding the use of diesel-fueled peaking plants. In a separate interview with media, Zabaleta asserted that typical diesel-fueled peaking plants produce electricity at a cost of P22 per kWh. This strongly suggests that even household-, building-, enterprise- and community-scale PV installations will be commercially viable for their owners, who can sell their output to the grid during peak hours, once the barriers to their entry are eliminated.

The output of solar farms at midday replaces the more expensive output of diesel-fueled peaking plants. Thus, solar farms actually reduce, not raise, the price of electricity. —Zabaleta

Zabaleta also claimed that electricity prices in Manila are actually higher than the solar FIT rate. The author confirmed this to be true. The author's June 2014 Meralco bill was P2,296.56, for consuming 208 kWh, or P11.04 per kWh.

This is also a confirmation of Energy Secretary Petilla's own calculations—that households generating their own electricity from solar panels can expect saving around P3.00 per kWh.

In response to questions about possible damage from typhoons, Zabaleta says the project is insured. No bank will finance such a project if it is not insured, he added.

In 2008, Bronzeoaks also set up a bio-ethanol plant that produces 40 million liters of ethanol and 60 million kWh of electricity per year. In addition, a 20-MW biomass-fueled generating plant is in the works. Another 18-MWp solar farm in La Carlota, Negros Occidental is scheduled for grid connection in 2015. The plant cost P1.8 billion.

Is SACASOL's solar venture a profitable one?

Let us do the calculations:

> The venture required total investments of P1.9 billion (other reports say $41.7 million) for 22 MWp of solar generation capacity. Using a typical capacity factor of 18%, we can calculate the venture's expected energy production per year as follows:

22 MW × 0.18 × 1 GW/1,000 MW × 24 hrs/day × 365 days/year = 34.7 GWh = 34,700,000 kWh

This figure agrees closely with company press releases saying that the solar plant's expected energy output is 35 GWh per year.

With the solar FIT rate fixed at P9.68 per kWh, the venture's potential gross sales in electricity is therefore P336 million per year, or P28 million per month.

On the other hand, a P1.9 billion investment, assuming it was borrowed from banks at an interest rate of, say 9% (a typical bank lending rate in 2014), and payable over 20 years, would require a monthly amortization of P20.9 million per month.

It truly seems like a viable investment, with a potential monthly gross income of around P7.1 million per month. Of course, we can assume that SACASOL would have exercised due diligence and done a much more detailed feasibility study to convince their investors and lenders that their investment would generate the rate of return they are after.

Note by the way that $41.7 million for 22 MWp is around $1.90 per Wp, a 62.7% decrease compared to the $5.10 per Wp cost of CEPALCO's solar PV plant ten years ago. This means an average price drop over the past ten years of 9.4% per year[31] for utility-scale solar farms.

Note, finally, that solar electricity profit margins have become big enough that banks can now come in, take their share in the form of interest payments, and still leave enough for the investors and their suppliers. If the margins are now attractive for investors, they should even be more so for solar rooftop owners, who do not have to worry about transmission and distribution costs.

Over the past 10 years, the investment cost for solar PV farms has dropped by 9.4% per year.

A solar power plant at the Cavite Economic Zone[32]

This utility-scale solar PV project at the Cavite Economic Zone was developed by the G.A. Philkor Multi-Energy Corporation (GAPMEC), a local subsidiary of Majestics Energy Corporation in partnership with a Japanese investment firm, Mother Company, and is due for completion within 2014.

Once operational, the Cavite solar power plant will be the biggest solar power project in the country. Its initial phase consists of 10 MWp, which will be used by around 10,000 households in Naic, Cavite. It will occupy 22 of the 120 hectares of land being developed by GAPMEC in the province. The total target capacity of the project is 40 MWp of electricity.

31 $5.10 \times (1 - 0.094)^{10} = 1.90$

32 Madeleine B. Miraflor, "Bigger solar plant to be operational," *Manila Times*, June 11, 2014, http://www.manilatimes.net/bigger-solar-plant-to-be-operational-this-year/103458/.

Other firms have submitted to the DOE still bigger solar power projects, such as the Pasuquin East Solar Power Project, which will be located in Pasuquin, Ilocos Norte. The plant will have a capacity of 50 MWp.

A 10-MWp solar power plant in the Clark Freeport Zone in Pampanga is also in the pipeline.

A 5-kWp residential rooftop PV system owned by a Makati businessman

Mike de Guzman's family owns several businesses, including a hotel, an apartment building and a call center. His Makati home has three bedrooms and a second floor.

The de Guzmans used to pay an average of P24,000.00 per month in electric bills. Faced with even higher rates in the future, he decided to install a 5-kWp solar PV system in the roof of his house. The heart of the system consists of 20 solar panels, producing 250 Wp each. Every month, the system produces around 675 kWh of electricity, worth roughly P8,000.00 at current rates (P11.00–P13.00 per kWh).

Today, because he buys electricity from Meralco only when the sun goes down, his monthly electric bill hovers around P12,000.00. When the sun is up, the solar panels provide de Guzman with electricity for free. When the sun really shines, de Guzman's monthly bill goes as low as P9,000.00, and the panels produce as much as 34 kWh in one day, enough to power a one-horsepower air conditioning unit for 45 hours. In fact, when the PV system produces more electricity than he can use, he just keeps his three air conditioners on.

The whole 5-kWp solar PV system cost de Guzman P500,000.00, or P100.00 per Wp, which is the going rate today for PV systems without storage batteries. According to de Guzman, the system's payback period is five years. Three years earlier, such a system would have cost around twice as much, but China's entry into large-scale PV production has flooded the world market, including the Philippines, with cheaper solar panels, controllers and inverters. De Guzman gives as example a Chinese-made inverter which he recently bought for P47,500.00, and compares it to a US-made one that cost him P216,000 earlier. An inverter converts the solar panels' DC output, like a storage battery's, into AC, like the output from an electric outlet in the house.

The worst-case scenario is a payback period of 10.4 years;
a payback period of 4.2 years is the best case scenario.

Based on de Guzman's figures, the worst-case scenario occurs when you invest P100.00 per peak-watt and save only P9.60 per year per peak-watt of investment, resulting in a payback period of 10.4 years. The best-case scenario is when you invest P100.00 per peak-watt and manage to save P24.00 per year per peak-watt of investment, resulting in a payback period of 4.2 years.

De Guzman's experience is a direct confirmation of Secretary Petilla's statement that households which generate their own electricity from solar panels will save money.

De Guzman claims that 25 years after they are installed, the solar panels will still be producing 80% of their original output.

You can look at the solar savings in at least two ways:

- If the money that bought the solar PV system came from your own pocket, you will recover your investment within ten years, probably shorter.

- If the money that bought the system was borrowed from the bank, taking out a ten-year loan at 9% will result in a monthly installment that is more or less equal to the amount you will be saving monthly from your utility payments. A longer-term loan, on the other hand, means smaller monthly payments to the bank. Then, you will actually be earning some money, on top of the savings on your utility bill.

Most households, however, will not have the money to pay for the upfront costs of a solar PV system. Thus, the main obstacle that prevents an immediate conversion to solar by households is financing.

Given the right financing, Mike de Guzman's experience suggests that it now makes economic sense for every household to start converting to solar power *today*.

Seeing the economic viability of a solar PV system from his personal experience, de Guzman decided to go into the business himself and set up Solaric, a company that sells and installs PV systems. Solaric's services today include helping its customers apply for Meralco's net metering and POP programs.

Mike de Guzman's case is typical of a number of business-oriented individuals, who tried solar PV systems either out of curiosity, out of a sense of participation in ecological advocacies, or in search of new ventures, and found enough low-hanging fruits that can be harvested from the solar PV market to justify going into business themselves. They have struck gold.

Small-scale solar projects will be perfect not only for small- and medium-scale enterprises (SMEs) in the Philippines but also poor households. See, for instance, this story about a 10-watt installation from solarenergyph.com/tag/solar-power-cavite/.

The local solar PV industry is currently enjoying robust expansion, and the market will probably explode in the next few years, creating new jobs for designers, installers, maintainers, repair specialists, and technicians as well as niches for import-replacing local industries.

Germany found the job-creation aspect of the solar industry a major reason to justify institutional support. Today, Germany's solar industry employs more people than its coal industry.

Power purchase agreements (PPA): The right business model for solar?

Leandro Leviste is the president of Solar Philippines. His company's mission, he says, is “to offer solar energy cheaper than fossil fuel, paving the way for its adoption by every home and business in the country.”

Leviste's business model is different from the usual suppliers and installers who sell the solar PV equipment in cash or terms, or who provide service in installing and maintaining such equipment.

Instead, Leviste installs his own equipment, at his own expense, on his customers' premises. In exchange, customers sign a long-term contract committing to buy the electricity produced on their premises—rooftops, actually—by Leviste's solar PV equipment. Thus, instead of spending high upfront costs, the customer starts saving money on the very first day the system goes online.

Solar Philippines assumes the upfront costs of setting up the solar PV system. Its customers start saving on the first day of operation.

The power purchase agreement is similar in essence to the PPA's signed by the government in the past with independent power producers.

Leviste's first project under this model was the 700-kWp solar PV installation at the Central Mall Biñan, Laguna. The 2,514 panels used cover some 7,000 m^2 of rooftop. The set-up, Leviste claims, is "the largest self-consumption [solar] power plant in Southeast Asia". Under the purchase power agreement, the company operating Central Mall, Premiumlink, buys electricity from Leviste's company at a rate cheaper than the electric utility's rates, resulting in monthly savings of more than P100,000.00 for Premiumlink.

Leviste's model solves the biggest barrier today to consumers who want to go solar: the high upfront costs of solar electricity. They are being asked, in effect, to pay today their monthly consumption over the next five to seven years. Even if the long-term calculations indicate that they will save money that way, most consumers balk at the prospect. Leviste's model removes this barrier, because his company assumes the risks of financing the project upfront. In fact, this is logically the way it should be, because, given Leviste's familiarity with the technology. His company already knows that the risks are low, although most customers and the public do not know this yet.

Secretary Petilla himself recognizes the innovativeness of Leviste's approach, when he said at the inauguration of the Central Mall solar project, "The problem has been the business model and this is the first company to get it right... I commend Solar Philippines for bravely pioneering this zero up-front scheme, which is an obvious choice for customers."

At this time, Central Mall is not yet 100% solar, though. The 700-kWp system installed on their rooftops is big enough to replace only 30% of its electricity consumption. This conservative approach is understandable. Consumers, and possibly Leviste himself, since this is his first major solar project, are still testing the waters.

Leviste's next project is larger, a 1,400-kWp solar installation in SM North Edsa, which is operated by SM Prime Holdings, Inc.[33] The project is scheduled for commissioning by the first half of 2015. It will supposedly make SM North Edsa "the largest solar-powered mall in the world."

This is not the first solar project for SM Prime Holdings, either. They had earlier installed in 2013 a 1,100-kWp solar PV system in SM City Xiamen, their first shopping mall in China.[34] However, their

33 "Mall to construct biggest solar rooftop in the Philippines," *Yahoo Philippines*, October 20, 2014, https://ph.news.yahoo.com/mall-construct-biggest-solar-rooftop-philippines-193941066.html.

34 "SM Prime building largest comm'l solar rooftop," *The Philippine Star*, June 26, 2014,

Xiamen solar project followed the more traditional model of self-financed solar installations. SM Prime Holdings spent around $2 million for the project. Whether this is only the first of what could be a series of solar installations in SM malls, SM Prime Holdings' chief finance officer, Jeffrey Lim said, “We will consider installing in other locations subject to successful implementation of our first project in the Philippines.”[35] Like the others, they are also testing the waters.

The problem has been the business model.
This [Solar Philippines] is the first company to get it right.
—DOE Secretary Petilla

That a local bank, the Bank of the Philippine Islands (BPI), is financing Leviste's projects could be a signal that banks have taken notice of the significant savings realized when shifting to solar. The savings are obviously considerable since there are now enough to split between the electricity consumer, the project developer and the source of financing. JoAnn Eala, who heads the BPI's sustainable energy finance and specialized lending, has been quoted saying, “Funding is not a problem, as banks, like the BPI, have financing programs that also provide free technical advice.”[36]

If other banks get into act, especially if the government makes commercial lending to solar and other renewable project even more attractive, this can significantly speed up the energy transition to renewable electricity.

Leviste claims that his company is growing phenomenally. “Our company is now constructing more than 10 times the amount of solar rooftop installations that were installed in the entire Philippines in 2013,” he says. For 2014 alone, they are targeting the installation of solar PV systems in seven shopping malls in the country. Aside from Central Mall Biñan and SM North Edsa, these include Robinsons Palawan and CityMall Roxas City. The CityMall chain alone is planning to build some 100 community malls in the country, all of which will have solar PV systems, according to its owner Edgar Sia II.[37]

Some of Leviste's solar projects are in Table 13.

By first half of 2015, Leviste expects to have installed 50 MWp of solar PV systems[38]—as much as the DOE's initial target for the entire country for 6–7 years.

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http://www.philstar.com/business/2014/06/26/1338931/sm-prime-building-largest-comml-solar-rooftop.

35 Philippine Daily Inquirer, “Biz Buzz: SM going solar,” SM Investments Corporation, September 26, 2014, http://sminvestments.com/biz-buzz-sm-going-solar.

36 Doris Dumlao, “A power plant on every roof,” *Philippine Daily Inquirer*, September 22, 2014, http://business.inquirer.net/179216/a-power-plant-on-every-roof.

37 Ibid.

38 “Mall to construct biggest solar rooftop.” Yahoo Philippines

Table 13. Solar Philippines' PV Projects

Shopping Mall	kWp	kWh Saved
Central Mall Biñan	700	30%
SM North EDSA	1,400	<10%
Robinsons Palawan	1,200	
CityMall Roxas City	650	50%

Source: Author's compilation.

Since residential electricity rates are 50% higher than commercial rates, the potential savings are even greater for residential customers. All it needs is the willingness of banks to finance residential installations.

If these pioneering efforts are successful and Leviste's business model is adopted widely not only in the commercial but also in the residential sector, this can be a game-changer. It can open the floodgates to the installation of solar PV panels in every rooftop in the country, ushering the energy transition to renewable electricity.

By the first half of 2015, Solar Philippines will have installed 50 MWp of PV systems, as much as the DOE's target for the whole country.

Unfortunately, Leviste's company is afflicted with the typical business bias against small customers. Its PPA business model is available only to big customers like the SM Megamall, but not to households. Residential customers still have to pay for the upfront costs of a PV system. Solar Philippines' entry-level system (as of December 2014) is a 1.5-kWp grid-connected battery-less system which sells for P174,000.00 (P116.00 per kWp), which is also typical among solar PV suppliers in the country.

The Philippines today badly needs businesses that will cater to lower-income groups and bring to them the benefits of solar power which the rich are now enjoying.

Geothermal electricity: 40% cheaper than prevailing rates

A 40-MW geothermal plant being built for $185 million in the barangays of Montelago, Montemayor and Melgar-B in Naujan, Oriental Mindoro by the Filipino-owned Emerging Power Inc. (EPI) will go online in the second half of 2016. The EPI is getting technology support from Iceland and Indonesia for this project.

The geothermal project was granted by the government's Board of Investments tax incentives that include income tax holiday for seven years; duty-free importation of machinery, materials and equipment; cash incentives for missionary electrification; and tax credits on domestic capital equipment and services.

Martin Antonio Zamora, the EPI chair, committed to sell geothermal electricity in Mindoro for P6.58 per kWh, 40% lower than the utility's rates, which are based on bunker fuel.

Projects such as these can perfectly complement wind and solar projects to enable localities to enjoy 100% renewable electricity at rates cheaper than the grid rate, and where the renewable energy providers are at the same time commercially viable.

Another company, Basic Energy, Inc., is also developing geothermal projects in West Bulusan, Sorsogon; Iriga, Camarines Sur; Mariveles, Bataan; and East Mankayan, Benguet.

Mindoro will enjoy geothermal electricity that is 40% lower than utility rates.

Basic Energy is involved not only in geothermal, but also hydroelectric, projects. The town of Murcia plus the cities of Cadiz and Victoria, all in Negros Occidental, will be the main beneficiaries of its four mini-hydro projects, approved by the DOE in 2013. The mini-hydro projects are the following:

Table 14. Mini-hydro Projects in Negros Occidental

Hydro Power Project	Capacity (MW)
Puntian 1	2
Puntian 2	2
Malogo 2	3
Talabaan	2

Source: Author's compilation.

Basic Energy will implement the projects from beginning to end: exploration, development, production and utilization, including construction, installation, operation and maintenance of hydropower systems to convert hydropower to electrical power and the transmission of the electrical power.

The first commercial wind farm in the Philippines

The country's only commercial wind project at present, and Southeast Asia's largest, is the 33 MW wind farm in Bangui, Ilocos Norte. The plant, which started operation ten years ago, supplies power to the Ilocos Norte Electric Cooperative. The wind farm is operated by the NorthWind Power Development Corporation, which is now under the Ayala group.

The third phase of the Bangui project, which will add another 18 MW to the wind farm, is also vying for FIT support.

Utility-scale wind power: 54 megawatts in Guimaras

The Wind Energy Development Association of the Philippines (WEDA) sees the Philippines as having the potential of becoming a leader in wind energy production in Southeast Asia because of the abundance of wind sites. The group is composed of 14 companies, including Trans-Asia Oil and Energy (del Rosario group), Energy Development Corporation (Lopez group), PetroEnergy Resources and UPC Renewables.

As of October 2014, no wind power project among the 40 that have been awarded service contracts by the DOE has qualified for FIT support. The race was still on, so to speak.

More than 700 MW of Philippine wind projects are on the pipeline, most of which are targeted for completion by 2015 or earlier. However, the ERC put a cap of 200 MW on wind projects that will be supported through FIT. Thus, like the situation in solar projects, the wind project developers are engaged in a race to complete their wind plants and connect to the grid ahead of the others.

The leading contenders in the wind race include the Ayalas, Trans-Asia (54 MW in Barangay Sebaste, San Lorenzo, Guimaras), Nabas, and EDC of the Lopez group (87 MW in Burgos, Ilocos Norte).

Once the 200 MW are filled up, which NREB Chairman Pedro Maniego Jr. said may happen by the end of 2014, the late finishers are out of luck. They will not enjoy support through FIT, which includes priority dispatch and the guaranteed rate of P8.53. They will then have to look for buyers themselves, or try their luck at WESM. Maniego says that the wind cost per KWh is lower than WESM rates. However, the risk of not being able to sell their output will make the life of the late-finishers certainly complicated and possibly miserable.

One of the leading contenders for FIT support among wind projects is TAREC's 54-MW wind farm in San Lorenzo, Guimaras, which involves a total investment of P6.453 billion.

The 54-MW Trans-Asia wind farm in Guimaras involves a total investment of P6.453 billion.

The TAREC wind farm will take advantage of the seven-meter-per-second average wind speeds in the province. The project will erect 27 wind turbines, each capable of generating a maximum output of 2 MW. The total output will be sent via submarine cable to the Ingore, Iloilo substation, connecting it to the Visayas grid.

The TAREC wind farm is the first wind power project in the Visayas. It is expected to be fully online by the end of 2014. The wind project follows the heels of San Carlos Solar, whose 22-MWp solar power plant in Negros Oriental went online in May 2014 with an initial output of 13 MWp.

Sixty-five percent of the project is financed by a consortium of local banks. The rest is investor equity.

This is the first project of TAREC, a wholly owned subsidiary of Trans-Asia Oil and Energy Development Corporation, the energy arm of PHINMA, which is the holding company of the Del Rosario group. The project was also registered and approved by the Board of Investments, as well as by the DOE under the Renewable Energy Act of 2008. The Act entitles the project to income tax holiday, duty-free equipment importation, and other incentives.

PHINMA's other energy businesses include a small 3.2-MW electric power plant in Guimaras, a 21-MW power plant at the Carmelray Industrial Park II in Calamba, Laguna, a 116-MW power plant at the Subic Freeport, and a 52-MW power plant in Norzagaray, Bulacan.

Let us do the calculations for the TAREC project:

> We will assume a capacity factor for the 54-MW project of 25%, which is conservative for wind projects. Ideal sites, such as Bangui in Ilocos Norte, actually have capacity factors of 30% or more. Based on our conservative assumption, the project is expected to produce 9.7 million kWh of electricity per month. At the guaranteed FIT rate of P8.53 per kWh, it therefore expects a gross income of P83 million per month.
>
> The TAREC project involves an investment of P6.453 billion for 54 MW of wind power, or P120 million per MW. Assuming an interest rate of 7.5% per annum payable over 15 years, the cost of capital alone is around P60 million per month.
>
> This leaves it around P23 million per month for operating and maintenance costs, plus profits of course. This is a bit tight for the company, because the O&M costs for wind farms are definitely higher than solar farms. It will therefore have to watch its costs carefully, if it wants an acceptable profit margin. If TAREC manages to increase its turbines' capacity factor to 30%, its gross can go up to P99.6 million, giving it a more comfortable P39.6 million to split between the O&M costs and profits.
>
> That a difference of 5% in actual wind capacity factor may spell the difference between comfortable and tight profit margins is a sobering thought. Anti-wind advocate Ozzie Zehner, for example, claims that "when countries or regions start to install wind turbines, the average capacity factor goes up at first, then levels off or declines as additional turbines are sited in less-ideal conditions. For instance, between 1985 and 2001, the average capacity factor in California rose impressively from 13 percent to 24 percent, but has since retreated to around 22 percent. Over the years, Europe's maturing wind farms have stabilized below 21 percent. The US average is under 26 percent, according to field readings from the [US] DOE."[39]

While Zehner has his own agenda, his claims that wind capacity factors tend to be over-reported by the wind industry need to be double-checked especially by businesses that are setting up wind farms in the Philippines. It is of course logical to assume that before investing several billion pesos into their projects, these businesses would have done due diligence and did actual site measurements over long periods, to determine for themselves the wind potential in their chosen site, including such issues as transmission line capacity.

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39 Ozzie Zehner, *Green Illusions: The Dirty Secrets of Clean Energy and the Future of Environmentalism* (Lincoln/London: University of Nebraska Press, 2012), p. 52–53.

Off-grid communities are good candidates for RE showcases.

Lessons from the field: mainstreaming micro-hydro

In their book *Lessons from the Field: An Assessment of SIBAT Experiences on Community-Based Microhydro Power Systems*, the non-profit Sibol ng Agham at Teknolohiya (SIBAT) provides thorough documentation of their micro-hydro projects in 10 sites:[40]

Table 15. SIBAT Micro-hydro Projects

Site	Province	Date completed	Capital Cost, P	Capacity, kW	Capital Cost/kW	Util. rate, %	Household beneficiaries
Ngibat	Kalinga	1994	484,000	5	96,800	4.8	33
Tulgao-Dananao	Kalinga	1999	2,781,565	33	84,290	9.1	264
Balbalasang	Kalinga	2001	2,503,594	20	125,180	14.6	154
Lon-oy	La Union	2001	1,875,253	15	125,020	11.1	78
Tabuk	Kalinga	2001		2			11
Kapacnaan	Nueva Vizcaya	2001	389,271	5	77,850	2.9	Pastoral Center
Buneg	Apayao	2002	802,000	7	114,570	5.9	33
Katablangan	Apayao	2002	972,000	10	97,200	3.2	42
Adugao	Abra	2002	731,500	7.5	97,530	3.3	16
Caguyen	Abra	2002	749,476	7.5	99,930		26
Kimbutan	Nueva Vizcaya	2003	915,400	7	130,770		13

Source: SIBAT, 2005.

The outputs were used primarily for lighting. In the larger installations, the outputs were also used for agricultural equipment (e.g., sugar press and rice mill), rural industry (e.g., woodworking and blacksmithing), and for small appliances and school computers.

The SIBAT experience shows that off-grid communities are good candidates for RE showcases. Most of their sites were not grid-connected, and therefore enjoyed 100% renewable electricity from the micro-hydro project. The tariff rates were set by the communities themselves, and were set at levels that the beneficiaries could afford.

40 Sibol ng Agham at Teknolohiya (SIBAT), *Lessons from the Field: An Assessment of SIBAT Experiences on Community-Based Microhydro Power Systems* (Quezon City, Philippines: SIBAT, 2005), p.48.

Judging whether the projects were financially viable (in the Feldheim sense) is complicated by the fact that grant financing was the main source of funding, which eased the pressure on communities to maximize the utilization of the plants. This might partially explain the low utilization rates, which ranged from 2.9% to 14.6% only. (More recent SIBAT data indicate significant improvements.)

It is also worth noting that with these capacity factors and at today's prices, solar PV would probably be competitive with these plants in terms of capital costs per kW. Of course, other factors would still have to be taken into account, such as O&M costs, ease of installation, and capacity factor. Hydroelectric plants should have a capacity factor of 40% or more.

As the SIBAT experience shows, micro-hydroelectric plants continue to be a viable option for local generation of electricity.

The 240-MW pumped storage is a perfect complement to the FIT-supported solar (500 MW) and wind (200 MW) projects that are coming online soon.

Mini-hydro and larger hydroelectric plants in the pipeline

Some of the mini-hydro and larger hydro electric generating plants which are now in the project pipeline, after having been approved by the DOE's Renewable Energy Management Bureau in 2013, include the following:

Table 16. Ongoing Mini-hydro Projects

Location of Mini-Hydro Project	**Project Developer**	**Capacity**
Ibulao, Lagawe, Ifugao	Hydrocore, Inc.	4.5
Dupinga, Gabaldon, Nueva Ecija	Constellation Energy Corporation	3
Timbaban, Madalag	Oriental Energy and Power Gen	18
Culaman, Manolo	Oriental Energy and Power Gen	10
Tudaya, Sta. Cruz	Hedcor Tudaya	7
Ibgulo, Igbaras	Century Peak Energy	5.1
	TOTAL (MW)	**47.6**

Source: DOE, 2014.

Big hydro too

A large 350-MW hydroelectric complex approved by the DOE in August 2014 and consisting of three plants will be built in Ifugao by a joint venture of Norwegian SN Power and the local Aboitiz Power. The three components of the complex include a 100-MW hydroelectric plant, a 240-MW pumped-storage project and a 10-MW mini-hydro, all in Ifugao Province. The joint venture is called SNAP-Ifugao.[41]

The 240-MW pumped-storage component will complement perfectly the FIT-supported solar (500 MW) and wind (200 MW) that are coming online soon.

This is not the first hydroelectric project for the group, which also operates the 105-MW hydroelectric plant in Ambuklao, the 126-MW plant in Binga, and the 360-MW plant in Magat.

As wind and solar costs go further down, and the energy transition to a renewable future accelerates, more pumped-storage facilities will be needed by the grid. Eventually, as rooftop solar becomes as ubiquitous in the future as desktop computers are today, more and more storage facilities should be connected to the grid to complement the naturally variable output of solar and wind power.

It may now make sense, as solar panel costs go down even further, to study the feasibility of retro-fitting existing dams (especially stepped dams like those of the Agus River in Lanao, for instance) to turn them into pumped-storage that can handle the rapid expansion of solar electricity.

In the next section, we will see how policies have evolved to encourage renewable energy development.

**As the energy transition to renewables accelerates,
more pumped storage will be needed by the grid.**

41 "Philippines approves energy contract for 350-MW SNAP-Ifugao hydro complex," Hydro Review and HRW-Hydro Review Worldwide, August 12, 2014, http://www.hydroworld.com/.

Chapter 4. Helping renewables grow: Policy options

Globally, a whole range of policy options have been tried to encourage RE development, with varying success. Judging from dramatic and steady growth of its RE sector, the German model has been the most successful so far.

We will review below the range of policy options that have been explored in different countries, as policy advocates, lobbyists, and activists groped for ways to hasten the entry and growth of renewables within their country's energy mix.

1. Government subsidies

Subsidies are of course a common government approach towards industries and sectors they want to encourage. The subsidies have usually taken the form of tax exemptions or rebates for the purchase and installation of RE equipment.

This was, for instance, the approach taken by Japan: rebates to household PV installations.

From the energy crisis in 1974 to around 1993, over a 20-year period, the Japanese government spent $5 billion to subsidize solar PV systems. This led to applications like solar-powered watches and calculators, with little other results to show.

Undeterred, the Japanese government once more initiated what they called the "New Sunshine" project, which subsidized 50% of the installation cost of residential PV systems. The goal was to create a market for PV systems for the Japanese solar industry. They cut down the subsidy to 33.3% in 1997. By 2001, Japan boasted of more than 77,000 "solar roofs."[42] The program reached its apex in 2004, having subsidized a total of 400,000 homes. At this point, the subsidy was down to 3%. In 2005, the subsidy was finally phased out.

Japan's case was a clear lesson
in the limits of government subsidies.

Without government support, however, PV prices rose and fewer people were willing to buy. Within two years, the demand for PV systems in Japan was down by 50%.

If the Japanese, with their deep pockets, cannot afford to continue subsidizing RE development, then it would clearly be even harder for more cash-strapped countries to do so. Japan's case was a clear lesson in the limitations of government subsidies, at least in the case of renewables.

42 Daniel Yergin, *The Quest: Energy, Security, and the Remaking of the Modern World* (New York: Penguin Press, 2011), p. 576.

When South Korea launched its own FIT program, it tried to finance the whole thing with governments funding. Like Japan, they quickly found out that the approach was hard to sustain.[43]

2. Mandated targets

Under this approach, the government sets targets in terms of the absolute (MW or MWh) or relative (%) share in capacity or consumption of renewables in the overall mix. The government then requires its energy department or the industry to meet these targets. In the Philippines, the “Renewable Portfolio Standards” (RPS) incorporated in the Renewable Energy Act are a form of mandated targets.

To be effective, the targets must come with clear incentives for compliance (like subsidies) or punitive measures for non-compliance. If not, they will become no more than wish lists for policy makers.

3. Mandated grid sell-back

One of the early policy breakthroughs by RE advocates, now routinely accepted by policy-makers, was to allow RE developers to connect to the electric grid and to require utilities to pay for excess production by RE developers.

Before this, it was unthinkable for utilities to even consider their customers, especially households and other small players, as suppliers of electricity. Thus, payments to households for excess RE production was out of the question. In the past, early RE pioneers had to find creative ways of consuming excess energy, when they were not allowed to connect to the grid much less to get paid for sending their excess production into the grid.

This acted as a major brake on further RE development.

As RE advocates everywhere pushed for their governments to mandate grid connections and grid sell-back by RE pioneers, the principle was eventually accepted and firmly established. The renewable foot was in the door.

Even today, in many countries, selling excess RE production to the grid is a continuing struggle.

However, utilities continue to put barriers towards its implementation. They impose huge connection fees, demand very expensive “impact studies” whose costs are to be shouldered by RE producers, require bulky documentation, bind RE producers to iniquitous contracts, process connection applications at a glacial pace, and pay very low rates.

Thus, even today, in many countries, it is a continuing struggle for RE adopters to sell their excess

43 Johnstone, p. 192.

production back to the grid, and many simply abandon the idea. Once they produce enough for their own electricity needs, there is no more reason for them to expand their RE capacity further.

4. Financing innovations

Several major financing innovations have been tried in the US—all with good effect.

*Solar leasing. S*olar leasing was pioneered by a US start-up company called SolarCity. Customers leased the solar PV system from SolarCity, which retained ownership and maintained the system. Customers signed up for a 15-year lease, with no down payment. As soon as the system started operating, the customers started saving money, without the high upfront costs of solar electricity.

Three months after SolarCity introduced solar leasing, their business had grown by 300%. Within four years, the company grew from two employees in 2006 to 630 in 2010.

Power purchase agreements. Another approach solved the upfront cost problem not with a solar lease but with a PPA. This approach was pioneered by SunEdison (Baltimore) and MMA Renewable Ventures (San Francisco). Instead of leasing solar PV equipment, customers entered into a contract to buy power from PV suppliers, who installed their solar PV systems on the customers' premises. And the customers bought it for a fixed rate, which was cheaper than the utility rate. The PPA duration was typically eighteen years. The contracts then served as collateral for bank loans that would cover the upfront costs.

The pioneers of PPA focused on big customers, like supermarkets, who bought electricity produced from the PV equipment installed by the suppliers. Another company, SunRun, saw the benefit of the approach and focused on residential customers.

Financing innovations: solar leasing, power purchase agreements, and loan payments via property taxes

Under a solar lease, the customer still had to worry everyday whether it would be cloudy or not. Under the PPA approach, the customer would only pay for the electricity that the PV panels actually deliver. Without risk, they started saving money on the first day the panels start delivering electricity. The PPA approach was so effective that SolarCity, the solar leasing pioneer adopted it too, giving its customers two options: a long-term solar lease, or a long-term power purchase agreement.

Loan payments as property taxes. In 2007, Berkeley, California tried a third financing innovation: making financing payments part of property taxes. The approach went this way: homeowners would borrow money from the city to finance the installation of their solar PV system. This loan subjects the homeowner to a special tax, which goes towards repaying the loan over a 20-year period. The liability was not attached to the homeowner but to the property. Thus, if the property changed hands, the new owners would assume the tax liability.[44]

44 Johnstone, p. 236–237.

This arrangement involved a very low financing risk, because property taxes usually get priority, even when the property is foreclosed.

Berkeley initially budgeted $1.5 million to pilot the program, good for 40 installations. The whole amount was applied for within nine minutes!

Subsequently though, Berkeley changed tack and decided to require private financing for the program, delaying the expansion of its originally successful program.

5. Net metering

Net metering was a major advance in mandated sell-backs, because of two major advantages: a) it could be implemented easily; and b) consumers got a better deal for their RE surplus.

Net metering is very simple. The electric meter runs forward when the user is getting electricity from the grid. It runs backward when the user is supplying electricity to the grid. At the end of the billing period, the meter reading automatically reflects the net balance of the electricity consumption for that period. The price of electricity coming in and going out is considered to be the same ("parity pricing").

Utilities do not have to do anything, for net metering to happen. They do not even have to know that it is happening, just like they do not have to know that consumers have turned off their air conditioners or their heaters to save electricity.

All the consumer needs is a specific type of inverter that could synchronize its output with the grid's and use all the available self-generated electricity first before letting into the house wiring a single watt of electricity from the utility. When clouds obscure the sun, the inverter automatically lets more utility electricity in. When the sun comes out again, the inverter uses less electricity from the utility. When the solar panels generate more electricity than what the house needs, the surplus goes out to the grid, for use by the nearest neighbors, and the consumer's electric meter turn in reverse, transferring the liability for the exported electricity to the neighbors, whose meters will each register how much of the exported electricity they used.

Net metering is a major advance because it is so simple in concept and operation and because the consumer gets a better deal. Under the old sell-back mechanism, consumers paid the full retail price for electricity from the utility, but got credited only the smaller generation charge for selling back to the grid. Under net metering's parity pricing, the electricity cost the same, coming in or going out.

Net metering is such an important advance that we will devote the next chapter to this approach.

CSI: California dreaming

In 2006, under the California Solar Initiative (CSI) plan, the following combination of policy mechanisms was tried in California:[45]

- **Rebates**. Using funds collected from ratepayers, some $3.2 billion would be made available

45 Johnstone, pp. 230-232.

in rebates over an 11-year period, using funds already collected from utilities and some additional funds to be collected from ratepayers.

- **Mandated targets**. All new homes (a 100% target) coming in by 2011 were mandated to include solar power as standard.
- **Net metering.** Up to 2.5% of electricity sales were to be acquired under net metering.
- **Tax credits on investments**, up to 30%, were included. These would be degressed (i.e., reduced according to a fixed schedule) as the plan approached its targets.

The ambitious plan floundered on a similar combination of poisoned pill and bureaucratic red tape.

The poisoned pill was a provision in the plan which required those who applied for rebates to accept the utilities' “peak/off-peak” (also called “time-of-use”) pricing plan. The plan would charge them higher rates during peak periods. Unless one's PV system was large enough to take him off the grid, he would in fact end up with a higher bill under the provision.

In addition, the California Public Utility Commission left the implementation of the plan to the utilities themselves. This made it easy for the utilities to sabotage the plan. They delayed the payment of rebates from a few months to 7–10 months. They required a much more detailed application form, a one-page form bloating to 49 pages. The utilities also tacked on insurance requirements to the net metering agreement with customers, including deal-breakers such as indemnification in case of breakdowns.

The California experience shows how utilities can sabotage a well-crafted RE promotion program

The California experience shows various ways by which utilities can sabotage a well-crafted RE promotion program. In California and elsewhere, utilities close ranks, put up all kinds of barriers, and drag their feet whenever customers come forward to generate electricity on their own, especially when customers generate enough surpluses that they can actually sell back electricity to the utility.

Although California's population was only one-half that of Germany, it installed each year under the plan a tiny one-tenth of what Germany was putting online. Since by 2008 the money for subsidies was also running out, California's approach was leading to a dead end.

In the next chapter, we will look more closely at net metering.

Chapter 5. Kilowatt-hours in and out: Net metering

Net metering was a major advance from earlier arrangements where the utility set a much lower price for electricity sold to them by consumers, compared to the price of electricity they sold to consumers.

These earlier arrangements were a form of net billing, which account for the give-and-take of electricity not in energy terms (kWh) but in monetary terms (dollars or pesos). This usually required two sets of meters, one for the incoming electricity, and another for the outgoing electricity. The incoming and outgoing charges are calculated from the meter readings. If the balance is in favor of the RE producer, it is usually carried forward to the next month. If it is in favor of the utility, the RE producer is usually obliged to settle the balance every month, as usual.

Under net metering, the old electric meter was enough. The meter runs forward when the utility is supplying electricity to the consumer. It runs backward when the consumer is sending his surplus production to the grid. A net balance in favor of the user is usually carried forward to the next month, while a balance in favor of the utility must be settled at the end of the month as usual. In or out, the price of electricity is considered the same.

The greatest advantage of net metering was its simplicity, both in concept and in implementation. The solar panels were connected into the inverter's input. And the inverter simply plugged into a wall socket. No new metering equipment was needed. No change in accounting or billing procedures was needed. Electric meters *did* run backwards when power went the opposite direction.[46] The RE pioneers found that amazing. If their systems were large enough, they could actually end up with a zero balance, or even a balance in their favor, at the end of the year.

Or when you go on a summer vacation and you turn off all your appliances, practically all your solar PV output can go to the utility while you are away, earning you a huge credit that you can use for the next several months.

**The greatest advantage of net metering is
its simplicity both in concept and in implementation**

Utilities do not like net metering, for obvious reasons. They think consumers should be paying utilities, not the other way around. Luckily for consumers, the Renewable Energy Act of 2008 (RA 9513) requires utilities to implement net metering, as long as the size of a solar PV system is less than 100 kWp.

Philippine law explicitly prescribes net metering. True net metering bases electricity bills on the net meter reading, which is net kWh. Because incoming and outgoing electricity cancel each other out, they are presumed to have the same price, thus the term “parity pricing.”

46 For a video of a solar installation making a Meralco meter run backwards, see http:www.amaterasolar.com/demo-video.

This is the relevant provision in Section 4. Definition of Terms of R.A. 9513:

> "Net Metering" refers to a system, appropriate for distributed generation, in which a distribution grid user has a two-way connection to the grid and is only charged for his net electricity consumption and is credited for any overall contribution to the electricity grid."

The provision clearly says that only the "net electricity consumption", which is, of course, measured in kWh, will be charged.

ERC's guidelines and Meralco's implementation is not true net metering. It is a huge step backward for the country, and a violation of the spirit of the Renewable Energy Act.

The Philippines' version of net metering is elaborated in "Net Metering Reference Guide: How to avail solar roof tops and other renewables below 100 KW in the Philippines".[47]

The ERC guidelines on net metering, and Meralco's implementation of these guidelines, are not based on parity pricing. They allow distribution utilities to pay lower for consumer-produced electricity, but charge higher for utility-produced electricity. In other countries, this is called "net billing," not net metering.

Under ERC's guidelines and Meralco's implementation, the simplicity, the pro-RE impact and other benefits of true net metering have been lost.

DOE's definition of net metering was written by Atty. Ranulfo Ocampo, president of the Private Electricity Power Operators Association (PEPOA) and chairman of the NREB Sub-Committee on Net-Metering. So, it was a distribution utility (DU) representative who defined net metering for DOE. Under "How Net Metering Works: Understanding the Basics of Policy, Regulation and Standards," in answer to the question "What is Net-Metering," Atty. Ocampo writes:[48]

> "Net-metering allows customers of Distribution Utilities (DUs) to install an on-site Renewable Energy (RE) facility not exceeding 100 kilowatts (kW) in capacity so they can generate electricity for their own use. Any electricity generated that is not consumed by the customer is automatically exported to the DU's distribution system. The DU then gives a peso credit for the excess electricity received equivalent to the DU's blended generation cost, excluding other generation adjustments, and deducts the credits earned to the customer's electric bill."

This new definition states that a DU "gives a peso credit for excess electricity received equivalent to the DU's blended generation cost..." The definition clearly prices the exported electricity (which is presumably renewable, because net metering is being discussed here in the context of the Renewable Energy Act) at the utility's "blended generation cost". This would be the generation charge that appears in a Meralco bill, for instance. This generation charge is much lower than the retail price of

47 http://www.doe.gov.ph/netmeteringguide/

48 http://www.doe.gov.ph/netmeteringguide/index.php/1-how-net-metering-works-understanding-the-basics-of-policy-regulation-and-standards.

electricity, which the utility charges the consumer. In Metro Manila today, the general charge hovers around P5.50 while the retail price of electricity is around P11.50.

Where did the DOE get its definition of "net-metering?" The DOE guide's author quotes the Wikipedia:

> "Net metering is an electricity policy for consumers who own renewable energy facilities (such as . . . solar power) which allows them to use electricity whenever needed while contributing their production to the grid."

Here is the Wikipedia definition, quoted in full:

> "**Net metering** is a service to an electric consumer under which electric energy generated by that electric consumer from an eligible on-site generating facility and delivered to the local distribution facilities may be used to offset electric energy provided by the electric utility to the electric consumer during the applicable billing period.
>
> "Net metering policies can vary significantly by country and by state or province: if net metering is available, if and how long you can keep your banked credits, and how much the credits are worth (retail/wholesale). Most net metering laws involve monthly rollover of kWh credits, a small monthly connection fee, require monthly payment of deficits (i.e. normal electric bill), and annual settlement of any residual credit. Unlike a feed-in tariff (FIT) or time of use metering (TOU), net metering can be implemented solely as an accounting procedure, and requires no special metering, or even any prior arrangement or notification.
>
> "Net metering is a policy designed to foster private investment in renewable energy. In the United States, as part of the Energy Policy Act of 2005, all public electric utilities are required to make available upon request net metering to their customers."

Wikipedia very clearly defines net metering in terms of offsetting "electric energy" and "kWh credits", not terms of currency or monetary amounts. The offsets or credits are in kWh, because that is what the electric meter records, and when the flow of energy goes in either direction, the meter records only the net flow. Hence, *net metering*. By its very definition, net metering is based on parity pricing, incoming and outgoing kWh have the same price, that is why only the net flow is billed.

In fact, while Wikipedia is a good starting point for gathering research leads, it is a poor source of authoritative information. No respectable scholar would cite it as an authoritative source because anyone can change Wikipedia entries anytime, and resolving Wikipedia disputes about such changes can take months or even more, if they are ever resolved at all.

Let us cite instead a net metering expert who studied this approach for the US Department of Energy's NREL. Here is what Yih-huei Wan says:[49]

> "The concept of net metering programs is to allow the electric meters of customers with generating facilities to turn backwards when their generators are producing more energy than the customers' demand. Net metering allows customers to use their generation to offset their consumption over the entire billing period, not just instantaneously. This offset would enable customers with generating facilities to receive retail prices for more of the electricity they generate. Without a net metering program, utilities usually install a second meter to measure

49 Yih-huei Wan, *Topical Issues Brief: Net Metering Programs,* 1996. p. v.

> any electricity that flows back to the utility grid and purchase it at a rate that is much lower than the retail prices."

The ERC "net-metering" guidelines specify a second meter and a blended generation charge, which is lower than the retail price. Thus, the Philippine guidelines specify what precisely is *not* a net metering program.

Yih-huei Wan further describes the advantages of net metering:

> "The strength of net metering lies in its simplicity: the use of a single meter. It does not need constant regulatory interaction or supervision after the program is in place. No requirements are made of utilities. It allows customers to make renewable energy technology choices and only impacts the customer's meter. As a policy option, net metering provides economic incentives to encourage renewable energy technologies without public funding. Because more of the customer-generated electricity can receive a utility's retail price, it can lower the economic threshold of small renewable energy facilities."

In short, net metering is a good way to open participation by small players in the government's RE program, with minimum of regulation, supervision and public funding.

Lowering the economic threshold: batteries not needed

Solar panels have no output at night. The standard solution is to store their daytime output in batteries, for use at night.

One way that net metering can lower the economic threshold for small players is that it obviates the need for batteries, which are expensive, short-lived, difficult to maintain and also a common source of failure of solar PV systems.

Net metering customers do not need batteries for night time use because they can accumulate credits with the utility during the daytime by exporting their surplus. They can then draw these credits from the utility at night.

Thus, net metering customers do not need batteries at all (unless they want electricity when the grid is down). Their PV set up becomes cheaper, simpler to set up, and easier to maintain, lowering further the barriers to entry into the government's RE program.

The "net-metering" scheme currently implemented by utilities such as Meralco goes against the spirit, if not actually the letter, of the law. The 2008 Renewable Energy Act provides for charging only the net electricity consumption by consumers who feed their renewable energy surplus back to the utility.

The current "net-metering" scheme is double-charging

We will now explain why the current implementation of "net-metering" in the Philippines (which is in fact net billing,), is actually *double-charging*.

Let us start with an analogy.

Let us say that you ordered from an LPG supplier three filled tanks worth P550.00 each. But since the nearest supplier is several hundred kilometers away, the delivery and other charges per tank (like VAT, provision for losses, etc. is P600.00 (These hypothetical numbers mirror Meralco's generation charge of around P5.50 per kWh and the P6.00 per kWh charge for “delivering” the electricity.)

In the meantime, however, you have built a small household-scale biogas system that enables you to save 1/3 of your LPG consumption.

When the LPG tanks are delivered at your door step, you inform the delivery boy that you will return one tank and will only pay for two. However, you also tell him that you have made arrangements with your neighbor, who is willing to pay at the usual rate of P550.00 plus P600.00 for the LPG tank you are returning. You explain to the delivery boy that he still delivers the same three tanks, and he will still take home the same expected payment per tank of P1,150.00 (P550.00 + P600.00).

Unsure, the delivery boy calls his bosses. They agree to let your neighbor pay for the third tank, but instruct him to charge you P600.00 for the delivery charges. They argue that they have already incurred various expenses in delivering the third tank to you, and therefore they can only cancel P550.00, the value of the tank's contents. They insist that you should pay them the delivery and other charges, worth P600.00 in all.

You refuse, of course. You argue that the third tank will be fully paid for by your neighbor, contents plus the delivery and other charges. Thus, if the LPG supplier also insists on charging you for the delivery of the third tank, they will be double-charging. The best proof of this, you argue, is that the delivery boy now expects to bring back for the third tank, your neighbor's P1,150.00 payment, plus your P600.00, a clear case of double-charging of delivery charges.

You bring your dispute to the government. Will the government decide in your favor or in favor of the LPG supplier?

The current Philippine definition of “net-metering” enables utilities to double-charge their customers

This is exactly the situation under the “net-metering” scheme implemented by distribution utilities today. When you generate surplus electricity from your solar panels and export them to the grid, this exported surplus is used by your neighbors and will register in their meters. Thus, when your neighbors pay the utility their electric bills, their payment covers the part of your surplus, which they used. As usual, both the generation charge and the “delivery” and other charges will appear on their electric bills. In short, the kWh you returned to the grid is fully paid for by your neighbors, who paid for both generation and “delivery” charges.

A distribution utility that charges its “net-metering” clients “delivery” charges for electricity that these clients returned to the grid is double-charging these clients, because these delivery charge were already paid for by neighbors who used the clients' surplus.

Some DUs can do worse than this, if they replace existing meters with uni-directional electric meters.[50] This kind of meter will move forward, whether the customer is getting electricity from the grid, or exporting his surplus from the grid. This means that solar rooftop owners exporting their surplus to the grid not only do not get paid, but they will even be charged for it, both the surplus returned, as well as the delivery charge. Instead of getting paid the full amount, they will be charged the full amount! This effect was actually documented in a study of a water-refilling station with a 3-kWp PV system connected to the grid via a uni-directional meter.[51] And since the neighbors' use of the exported surplus will also register in their electric meters, the neighbors will also be charged for the same surplus, a bizarre case of triple-charging.

The government should not allow these multiple-charging schemes to persist, especially through uni-directional meters. With uni-directional meters, net metering will lose its inherent simplicity and will now require complicated and costly arrangements.

Parity pricing corrects the double-charging

To correct this double-charging scheme, the government should order the distribution utilities to give those who export their surplus electricity full credit for their exported surplus. Full credit means the same price for kWh in and kWh out. It means parity pricing.

Once the authorities acknowledge that parity pricing will rectify the double-charging scheme, they will also realize that parity pricing is very simple to implement—just retain the analog meters that turn back when a client exports electricity to the grid and make sure that any electric meter replacement, including digital ones, will likewise reverse properly when the flow of energy through the meter also reverses. This is true net metering—one that prevents utilities from double-charging its RE clients.

We badly need in the country today *true net metering,* where, with no modification to existing utility service, connections or electric meters, consumers can simply plug in a solar-driven inverter that meets government and international standards and their outgoing surplus will turn their electric meter backwards.

Net metering requires no technical or administrative action from the distribution utility. Neither the government nor the utilities have to do anything, for consumers to enjoy net metering. Most analog meters, will automatically run backward if electricity flowed out instead of in. All the consumers need is the right inverter, an MPPT inverter that meets the standards of the electricity industry. Net metering took off in many countries because of its simplicity, in concept and in operation.

As long as utilities stick to electric meters that reverse when the consumer exports his surplus and

50 The author confirmed from a technician working with one distribution utility that they install uni-directional meters.

51 Erees Queen B. Macabebe, et al., “Performance of a 3-kWp grid-tied photovoltaic system in a water refilling station” (Paper presented at the 5th International Conference on Sustainable Energy and Environment: Science, Technology and Innovation for ASEAN Green Growth, 19-21 November 2014, Bangkok, Thailand).

consumers use only certified grid-tie inverters, net metering will happen as a matter of course. Even the old accounting and billing methods will work as usual. Joining the government's RE program using solar panels and an inverter will then become as easy and as simple as plugging in any other appliance, like a refrigerator—plug and forget.

It is probably better for the consumer to inform the DU, as they do in Germany, to spare the DU of conducting unnecessary investigations should they mistakenly accuse their legitimate net metering customers of tampering with electric meters to reduce electricity bills.

By the way, this is how net metering is implemented in Germany. “German homeowners simply informed their utility that they would be connecting a PV system. The utility was obliged, by law, to accept the connection.”[52]

Exporting one's RE surplus to the grid is definitely legal. There is nothing illegal in returning a product like LPG tanks or electricity and asking your willing neighbor to pay for it instead. In fact, our RE law makes this explicit by requiring DUs to accept the exported surplus, and to charge the RE exporter only his net electricity consumption.

It is the simple, time-tested, approach of net metering which will enable the ordinary low-income consumer to enjoy the benefits of clean energy and cheaper electricity without any red-tape, without any hassle. With the price-barrier gradually receding, and as various financing schemes become available to small players, true net metering will open the floodgates for “solar selfies,” the soon-to-be-common phenomenon of self-generation of electricity by solar-enabled households and small enterprises.

True net metering is the biggest missing piece, after innovative financing schemes, to enable every grid-connected residential and commercial structures in the Philippines to go solar.

Net metering is pro-poor

True net metering will enable even the poorer strata of utility customers to save the P3.00 per kWh that Secretary Petilla has referred to, when they shift from utility electricity to rooftop solar electricity.

Imagine an ordinary worker who can only afford a 100-Wp grid-tied solar home system costing around P11,000.00, perhaps paid through a special SSS, GSIS or Pag-IBIG loan or an RE window of the Land Bank. Since most wage-earners are at work during the day, they will not be able to use the electricity generated by their PV system. Adding a battery is out of the question, because it would make the system more expensive and less viable, not to mention more complicated to maintain.

With net metering, wage-earners can export all or most of their daytime output to the grid and accumulate kWh credits, recorded as a reverse movement on their electric meters. Then, when they go home in the evening, they can use these credits, their meter turning in the forward direction as usual. They will save from their electric bills more than enough to pay for the monthly amortizations for the PV system. And when it is fully paid, they will be saving even more, month after month, year after year, through the lifetime of the PV system.

52 Johnstone, p. 251.

The larger the PV capacity they can afford, the bigger their savings.

The only risks they have to guard against are catastrophic events like typhoon damage or equipment theft. If some government agency sold insurance for these kinds of risks, then workers can be protected against them too.

In short, net metering—and FIT too, if the Philippines followed the German model of encouraging the entry of small players into the FIT system—will immediately benefit even poor electricity consumers, especially if they received help in acquiring PV systems through low-interest loans.

Net metering is what we need today

In the context of the decade of the 2000s, in the specific conditions of Germany, FIT was the right mechanism to jumpstart the renewable energy industry.

But this is now the decade of 2010s. Solar panels today cost, on the average, 50% less than they did a decade ago. Electricity from solar rooftops is cheaper today than electricity from the grid. Because our electricity rates are one of the highest in the world, reducing one's electricity bill is a very important motivator among consumers. Thus, in this country, the mechanism that we most badly need at this time is true net metering, where, with no modification to existing utility service, connections or electric meters, consumers can simply plug in a solar-driven inverter that meets international industry standards and their surplus electricity makes the meter turn backwards.

Limitations of net metering

In countries at the forefront of RE advocacy, net metering and parity pricing do not go far enough, because they assign the same price to fossil-based grid electricity and to clean, renewable electricity. In these countries, typified by Germany, RE advocates have won so much ground that they can now demand and governments have agreed, that renewables should be paid *premium* prices. Renewables deserve a higher price, their argument goes, because they supply the grid with clean, renewable energy and have much lower externalized health, social and environmental costs than fossil- and nuclear-derived energy.

The justification for a premium price is especially strong for solar projects, whose outputs are highest during hours of peak demand. A solar PV system that peaks at noon will be supplying electricity to the grid at peak hours, when the utility would otherwise need to buy from expensive peaking plants that also sell at premium prices. Net metering fails to take this into account.

The desire to go beyond the limitations of net metering and other approaches eventually led advocates to what turned out to be the most successful policy instrument yet for promoting renewable energy—feed-in-tariffs.

Chapter 6. Feed-in-Tariffs: Germany and Spain

The most successful mechanism in encouraging RE development so far is an approach called the feed-in-tariff (FIT), where tariff means payments to the providers of electricity and feed-in-tariffs are the payments to owners of renewable system that "feed in" to the grid.

The core idea that made FIT so successful is the idea that the income from investing in RE must be high and stable enough over at least the payback period of the project, so that lending to FIT-supported RE projects becomes a low-risk affair. If this is so, then the financing will come.

And this is what happened in Germany.

Best example of FIT: Germany

The policy innovation that has succeeded best in encouraging RE development is FIT, in particular, the version that has been implemented by the German Federal government. The German FIT system contains the following features:[53]

1) Higher tariffs (fixed rates over a 20-year period) were mandated for cleaner, renewable energy sources to encourage their further development.
2) The utilities and the grid were obligated by law to accept and dispatch on priority basis electricity generated from clean renewable sources.
3) As the share of clean renewables in the energy mix increased, the higher tariffs were reduced accordingly for later participants (the industry term is "degressed"), to reduce the impact of the FIT system on electricity prices.
4) The higher tariffs are paid from a universal charge that is collected from all electricity consumers, and not from government subsidies.
5) These measures were meant to ensure the financial viability of RE installations, making them attractive borrowers for commercial lending institutions.
6) The paperwork required to join the system was drastically reduced.
7) Small players were particularly encouraged to join in the program.

With this system (the law was adopted in 2000, and amended in 2004), the German renewable energy sector took off.

Germany now leads the world in terms of the share of renewables in the energy mix (23.4% in 2013, from 6.2% in 2000). Germany plans to close all its nuclear power plants in 2022. By this time, they plan to source 40–45% of their electricity supply from renewables. By 2035, the figure will be 55–65%, and by 2050, 80%.

Germany did not leave the ordinary households behind. By 2014, some 1.2 million households have installed solar PV systems, not only because they wanted a clean, renewable source, or because they preferred greater independence from the grid, but also because they got extra income by doing so.

They obtained loans from banks, set up the system, joined the FIT system, paid their loan amortizations regularly, and had money to spare.

53 Johnstone, p. 191.

These 1.2 million households have also become a major political force that no political party could afford to ignore. More Germans are employed in the solar and wind sector today than in the coal sector. When suggestions to phase down the FIT system are raised, threatening to slow down the energy transition to full renewability, they mobilize and intensify their lobbying, providing a counter-balance to the powerful nuclear and fossil-fuel lobbies.

Germany's spectacular success has become a model for the rest of the world.

By 2014, some 1.2 million German households have installed solar PV systems.

Spain: FIT systems can fail too

An illustrative case study of FIT failure is Spain, where a modified FIT was launched in 2007 and ended disastrously. The Spanish case has since served as a negative example of how not to do FIT.

Although it modeled its FIT after Germany's, Spain made a few modifications of its own. The changes turned out to be ill-conceived.

The Spanish government decided to pay for the premiums itself, rather than pass on the cost of the program to consumers. The high FIT rates were also locked in, and the degression provisions omitted.

The high, locked-in FIT rates, plus incident solar radiation that was twice Germany's, offered investors extremely high rates of return. The attractive margins drew a rush of opportunistic investments. A speculator-driven boom ensued, involving mega-scale installations.

In the meantime, households found it hard to participate because of the bureaucratic requirements built into the system.

As the flood of speculative investments fueled itself, the boom turned into a bubble. The government found itself unable to pay the potential $26 billion bill.

The bubble eventually burst and many projects collapsed, as the government backed out of its initial commitments.

Spain needs to learn from its hard-earned lessons, so that it can resume its march towards it own energy transition.

It is not as bad as the anti-renewables put it, though. Today, Spain is trying to pick up the pieces, and its renewable energy sector may yet rise from the ashes. The speculators were properly punished by the market, but many solid projects survived. Spain just needs to learn from its hard-earned lessons, so that it can resume its march towards its own energy transition.

Around the time Spain's FIT was heading towards a bubble, other countries were also looking at adopting the FIT system. One of these countries was the Philippines.

In the next section, we will see how the FIT concept was implemented in the Philippines.

Chapter 7. It's more FIT in the Philippines?

Following the success of feed-in-tariffs (FIT) in Germany, many countries followed suit, hoping to replicate the German success in encouraging the rapid growth of their renewable energy industry.

The Philippines is one of the countries that also incorporated a FIT system in its renewable energy law. Understandably, the Philippines made modifications on the German model, to suit the system to its own requirements and particularities.

The Philippine FIT system

Like Germany, the Philippine FIT also guarantees a market at fixed rates (called the FIT rates). Four types of renewables are covered in the Philippine FIT—solar, wind, run-of-the-river hydro, and biomass—each getting its own FIT rate. The rates are fixed and guaranteed for at least twelve years. Developers who are eligible for FIT enjoy priority connections to the grid and priority in purchase, transmission and payment by the grid system operators.

The Department of Energy (DOE) emphasizes that the FIT system is only one among an RE developer's market options. A developer's market options include: sell the output to a local electric cooperative or distribution utility; sell to a large consumer; sell to the wholesale electricity spot market (WESM); and non-fiscal incentives like the FIT.

FIT rules have been promulgated by Energy Regulatory Commission (ERC). A DOE order was also issued, Department Circular 2013-05-0009 entitled “Guidelines for the Selection Process of Renewable Energy Projects Under Feed-In-Tariff System and the Award of Certificate for Feed-In-Tariff Eligibility.”[54] The circular specified the criteria and rules for selecting FIT-eligible proponents.

There are two rates under the FIT system: the FIT rate, which is the rate paid to RE producers, and the FIT allowance (“FIT-All” in industry lingo), which is the universal charge collected from all consumers. The FIT allowance will go towards paying the FIT rates. The fund administrator for the collected fund is the National Transmission Corporation, which pays the RE producers based on the FIT rate. As approved by ERC, the FIT rates (in pesos per kWh, valid for 20 years) and thresholds are:

Table 17. FIT Rates and Thresholds

RE Technology	FIT rate (P/kWh)	Degression rate	Installation threshold (MW)
Solar	9.68	6% after 1 year from effectivity of FIT	50
Wind	8.53	0.5% after 2 years from effectivity of FIT	200
Biomass	6.63	0.5% after 2 years from effectivity of FIT	250
Run-of-river hydropower	5.90	0.5% after 2 years from effectivity of FIT	250

Source: DOE, 2013.

54 “Department Circular No. DC-2009-005-009,” Department of Energy, May 28, 2013, http://www.doe.gov.ph/doe_files/pdf/Issuances/DC/DC2013-05-0009.pdf.

The above rates are fixed, regardless of changes in the grid rates.

When the thresholds are exceeded for each category, the FIT rates for the next batch of developer-applicants will be "degressed" (i.e., reduced according to a fixed schedule). The lower rates will apply to the subsequent batch of FIT applicants. Those who made the threshold will enjoy the higher, non-degressed rates for 20 years.[55] The degression rates are also specified in the third column of the preceding table. "Effectivity of FIT" refers to the date the FIT allowance is approved.

The Philippine FIT system is a race to finish one's project ahead of the others. The developers who get their Certificates of Completion before the threshold is completely filled up get to enjoy the FIT rate before it is degressed. Those that get their Certificates after the threshold is filled up will have to live with the degressed FIT rates. After the first degression, it is not clear what will be the new thresholds.

According to DOE's Renewable Energy Management Bureau (REMB) Director Mario Marasigan, the high degression rate for solar is based on the rapid decrease in the cost of solar panels.

RE Service Contract first, then Certificate of Registration

Before one can avail of FIT and other incentives, 2008 RE Act requires RE developers to first register with DOE through REMB.[56] However, before RE developers get a DOE Certificate of Registration, they must hold a valid RE Service/Operating Contract.[57]

To implement the two provisions above, the DOE spelled out in its Circular No. 2013-05-0009 the guidelines for the selection of projects that would qualify under the FIT. The guidelines provide that "only those RE Developers with valid and subsisting Renewable Energy Service Contracts may apply for the eligibility and inclusion of their project under the FIT system."

RESC, first step

To get a service contract though, one has to undergo an application process first. The applicant must meet several requirements: 1) payment of the application and processing fees;[58] 2) Filipino ownership (60% Filipino for corporations, except for geothermal projects, which can be foreign-owned); 3) SEC registration;[59] as well as 4) legal, technical and financial requirements.

Legal requirements

For single proprietorships, the legal requirements include: 1) National Statistics Office (NSO)-certified true copy of birth certificate; 2) business permit; and 3) other applicable documents.

55 The 2008 Renewable Energy Act says "at least 12 years;" ERC set it at 20 years.
56 Republic Act 9513, Section 25.
57 Ibid.
58 Ibid, Section 6 (a.iii).
59 Section 6(a) of Department Circular No. DC 2009-07-0011, "Guidelines Governing a Transparent and Competitive System of Awarding Renewable Energy Service/Operating Contracts and Providing for the Registration Process of Renewable Energy Developers."

For corporations, the requirements include: 1) original copy of certification from its Board of Directors or officers authorizing its representative to negotiate and enter into an RE Contract with the DOE; 2) duly certified Articles of Incorporation or equivalent legal documents; 3) latest General Information Sheet or equivalent, with the names of its officials, ownership, control and affiliates.

Foreign corporations engaged in geothermal projects must get their documents duly authenticated by the Philippine Consulate having consular jurisdiction over them.[60]

Technical requirements

The applicant must also possess the necessary technical capability to undertake the obligations under the RE Service Contract in terms of track record or experience, work program, key personnel experience, and existing company-owned equipment for RE operations and any leased RE equipment.[61]

Financial requirements

The following financial documents must be submitted: 1) audited financial statements for the last two years and unaudited financial statement if the filing date is three months beyond the date of the submitted audited Financial Statement; 2) Bank certification to substantiate the cash balance in the audited Financial Statement or updated Financial Statement; 3) Projected cash flow statement for two years; and 4) List of company-owned equipment/facilities available for the proposed RE projects.

If the RE applicant is a relatively new company, and cannot produce the documents above, it can submit instead 1) an audited Financial Statement and duly certified and/or notarized guarantee or Letter of Undertaking/Support from its parent company or partners to fund the proposed Work Program; and 2.) Proof of the ability of the RE Applicant to provide the required minimum amount of Working Capital which shall be equivalent to 100% of the cost of its work commitment for the first year of the proposed Work Program.[62] In the case of foreign parent-company, the audited Financial Statement and the guarantee or Letter of Undertaking/Support shall be duly authenticated by the Philippine Consulate Office that has consular jurisdiction over the said parent company.

RESC, second step

The second step in securing the RE Service Contract is by participating in the award process of the DOE. There are two ways: 1) through an open and competitive selection process or 2) through direct negotiation.

Open and competitive selection process involves 1) invitation for submission of RE project proposals; 2) submission of project proposal; 3) creation of a review committee to evaluate the proposal; 4) evaluation by the review committee based on the rules that it will set (Note that the evaluation of the technical and financial criteria shall proceed only after a finding that all the legal

60 Ibid, Section 6(b).
61 Ibid, Section 6(c).
62 Ibid, Section 6(d).

requirements have been complied with); and 5) notification as to the result of the evaluation.[63]

The other mode of awarding RE contracts is through direct negotiation of the terms and conditions of the contract between the DOE and the RE applicant negotiates, within a minimum period of 120 days.[64] Direct negotiation is allowed only under the following circumstances: 1) in "frontier" areas, where the DOE can find no sufficient technical data available; and 2) if the open and competitive selection process fails because a) no RE proposal was received by the REMB; b) the Review Committee determined that no applicant met the legal requirements; or c) some applicants met the legal requirements, but the Review Committee determined that no applicant complied with the technical and financial requirements.[65]

RESC, third step

If the applicant qualifies, then the Review Committee recommends approval of the RE Service Contract by the DOE Secretary, who then signs it. If the application involves an FTAA, it is the President of the Philippines who must sign the contract. The qualified applicant is then duly notified.[66]

Posting a bond

Within 60 days after the RE Service Contract takes effect, and at the start of every contract year thereafter, the RE developer is required to post a bond or any other guarantee of sufficient amount. The bond should not be less than the minimum expenditures commitment for the corresponding year.[67]

Finally, the Certificate of Registration

Once the RE Service Contract takes effect, the RE developer shall be registered in the DOE and issued a Certificate of Registration.[68]

Can I FIT now?

Given an RE Service Contract and a Certificate of Registration, can RE developers now join the FIT? Apparently, not yet. They can only do the feasibility studies and other activities associated with the pre-development stage of the project, to determine if the project is in fact commercially viable. For the actual project development stage, the RE developers again have to undergo another process of application, and have to comply *once more* with documentary and technical requirements, as provided in DOE Circular No. 2013-05-0009.

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63 Ibid, Section 9.
64 Ibid, Section 10 (a).
65 Ibid, Section 10.
66 Ibid, Section 11.
67 Ibid, Section 13.
68 Ibid, Section 15.

Application to convert, first step

The developer has to apply again, to convert its RESC, which is still at the pre-development stage, to the development stage. It needs to submit a Declaration of Commerciality, informing the DOE that the project is in fact commercially viable on the approved FIT rate.

Application to convert, second step

The DOE evaluates the application.

Application to convert, third step

The DOE issues a Certificate of Confirmation of Commerciality, which is in effect the notice to proceed to the construction phase under the Development Stage. The DOE may likewise issue an endorsement to the National Grid Corporation of the Philippines (NGCP) for the conduct of requirements for interconnection such as Grid Impact Study and Interconnection Agreement, if applicable.

Application to convert, fourth step

Finally, the DOE issues a Certificate of Endorsement for FIT Eligibility (CEFE).

Can I FIT now?

Not yet, because the CEFE involves, in turn, several more technical processes . . . (After all, it is just an “endorsement” that the applicant is “eligible.”)

Towards the end, the FIT “eligibility” turns out to be eligibility to join a race to build the RE facility. The earliest finishers—the winners—are entitled them to enjoy the FIT rates announced earlier. Once the threshold for a particular technology (solar, 50 MW; wind, 200 MW; hydro, 250 MW; and biomass, 250 MW) is exceeded, the late finishers slide down to the lower “degressed” rates, presumably to continue the race. However, the rules are not clear what the next thresholds are, and what new certificates are required, if any.

Clearly, the process described above reflects our 300 years of Spanish tutelage, more than any appreciation of German efficiency.

Despite the convoluted process of joining the FIT race, the potential gains were large and attractive enough that hundreds of RE developers applied just the same.

There are currently more than 500 RE service contracts, mostly in the pre-development stage. The thresholds for wind and solar have already been exceeded, and there have been demands from industry to raise the thresholds.

Director Marasigan says all of the service contracts are listed on the DOE website (see www.doe.gov.ph/awarded-projects/awarded-wind, www.doe.gov.ph/awarded-projects/awarded-solar, www.doe.gov.ph/awarded-projects/awarded-hydropower, and so on). There is also another monitoring board online for the FIT system (see www.doe.gov.ph/feed-in-tarriff-monitoring-board/for-conversion-from-pre-development-to-development-commercial-stage and www.doe.gov.ph/feed-in-tarriff-monitoring-board/with-certificate-of-confirmation-of-commerciality).

Under the current policies of DOE on FITs, it is quite clear that the cumbersome process to join is a huge barrier to small players, making it available only to big players. While there is no express prohibition against households and building establishments joining the FIT system, the number, nature and cost of the requirements are so daunting that only the big players with deep pockets would be able to comply.

Can small players FIT?

There *are* provisions in the guidelines in securing RESC for micro-scale projects: sections 26, 27 and 28 of DOE Circular No. DC 2009-07-0011.

Section 28, in particular, provides for a set of “simplified” procedures and requirements for the grant of RESCs for own-use and micro-scale RE projects. But the rules have not been released yet.

As far as the bureaucratic requirements of its FIT system are concerned, the Philippine FIT is closer to the Spanish rather than the German model. The system is obviously designed for big players, including foreign companies who may not have the local track record yet, but can bring in capital and technology. The FIT system simply has no place for ordinary workers or employees who may want to install solar panels on their rooftops and enjoy the incentives and benefits offered to the big players.

This would have been alright, if small players could enjoy the simplicity and savings of true net metering, giving them even better rates of return than Philippine-style FIT.

However, it turns out that when the big players were negotiating the FIT with the government, and complained about the approval of the FIT allowance taking too long, the government side decided to appease the big players by quickly redesigning net metering and offering it to the latter as an interim measure. DUs apparently took advantage of this rare opportunity to redefine net metering to their advantage. Thus, the small players lost what would have been the simplest way for them to participate in the government's RE program. (See Chapter 5 for details.)

Conclusion

The essence of the FIT is to assure RE investors a stable, low-risk, and high-enough return on investment to encourage more investments in the RE sector. In the successful German FIT approach, households and other small players were also seen as investors, and their participation in the system was highly encouraged.

The Philippine system has several features of the successful German FIT system, but it does not have the friendliness of the latter to small players. Instead, the bureaucratic FIT requirements are closer to the unsuccessful Spanish model, which also kept the small players out of the FIT system.

Whether the Philippine government can recognize this flaw, among several others, and move quickly enough to correct it, will probably determine how much of a success the Philippine FIT will turn out to be.

Chapter 8: Modeling the right FIT

DOE and ERC are considering proposals to raise the maximum capacity level for solar energy projects under the Philippine feed-in-tariff (FIT) system from 50 MW to 500 MW.

That the FIT-supported solar capacity has to be adjusted by an entire order of magnitude suggests some significant mismatch between the model and its assumptions and the reality of relationships between the FIT rate, the renewable energy capacities that should fall under the FIT system, and the final impact of these decisions on electricity prices.

Since the model used by the ERC is not available to the public, a simple model is presented here that will give stakeholders a transparent look at the relationships between FIT rates, FIT capacities and electricity price impact, given certain assumptions. The model will need further refinement and fine-tuning. But even in its present form, it is already insightful enough to give us a sense of the terrain over which the rapidly changing dynamics of the renewable energy industry is playing itself out.

The model's equation (please see Appendix C for its detailed derivation) is given below:

$$\left(P_{ren} - P_{grid}\right) \cdot \left(\frac{8.76 \cdot R_{cap} \cdot M_{wpeak}}{E_{total}}\right) = P_{inc}$$

where

E_{total}: Total consumption of electricity in the Philippines (60,000 GWh)
P_{grid}: Average grid price/kWh, which appears in our electric bills as the generation charge (P5.31)
R_{cap}: Capacity factor (the ratio of actual production over, say, a year to the theoretical maximum over the same period, assuming peak production 24/7).

The variables of interest are P_{ren} (the FIT rate), M_{wpeak} (the MW capacity allowed under the FIT rate), and P_{inc} (the peso/kWh contribution of the technology to the retail price of electricity).

To take into account the various RE sources, a policy decision is needed regarding the importance to be given to each technology (say, solar, wind, micro-hydro, and biomass). Their relative importance should be reflected in their share in the universal charge. The simplest approach is to assign each technology equal importance, and therefore, equal shares in the FIT allowance (the increase in the end-user price of electricity), subject to adjustments later.

DOE and ERC have adopted a FIT allowance/RE universal charge of four centavos. If the four are assigned different levels of importance, this can be reflected in their share of the FIT allowance. Otherwise, each technology can be allowed to expand its capacity contribution until it contributes at most one centavo to the generation charge and the final consumer electric bill. To fill in the model, we are making the following assumptions about the values of some variables:

E_{total}: 60,000 GWh (the Philippine electricity consumption in 2009 was 57,600 GWh)
P_{grid}: P5.31 (average grid price/kWh, based on the generation charge in the author's

June 2014 electric bill)

R_{cap}: 0.18 for solar (the estimated capacity factor of San Carlos Solar, the first solar generation project to qualify under the Philippine FIT system, based on the expected output of 35,000 GWh from a capacity 22 MWp); 0.35 for wind; 0.45 for hydro; and 0.70 for biomass.

Under these assumptions, the following four tables show how the model relates the three variables: FIT rate, total capacity under FIT rate, and the contribution of each of the FIT-supported technology to the increase in the consumer electric bill (in pesos). Use the tables as follows:

1. The left-most column indicates which technology the table was calculated for (solar, wind, biomass and hydro). Choose the appropriate table.
2. The next column indicates the ERC-approved FIT rate for that technology. The first entry is the currently approved FIT rate. The subsequent entries are the degressed rates (6% per year for solar and 0.5% every two years for the three other technologies). Thus each entry is 6%/0.5% lower than the entry above it. Choose the FIT rate you are interested in. The 0.5% degression occurs every *two* years.
3. The top row in each table indicates the MW capacity supported under the given FIT rate, 50–800 MW for solar, and 200–800 MW for the three other technologies.
4. To use the table, determine the FIT rate and MW capacity you are interested in, and look up the corresponding contribution (in pesos) of the technology to the generation charge. Add up the contributions of the four technologies, to estimate the RE universal charge. Their contributions under prevailing DOE and ERC rulings are highlighted in the table.
5. The total you will get does not include yet the administrative costs of implementing the program. Depending on your administrative cost assumptions, adjust accordingly.

The equation model presented above (see the next page for the tabular equivalent) answers the following type of questions:

1. Under the current solar FIT rate of P9.68 set by the government, if the public will only accept a maximum increase of P0.04 in the electric bill, and assuming further that assuming that only 1/4 (i.e., P0.01) of the RE universal charge will go to solar, how much solar generation capacity in MWp should be authorized by the government under this FIT rate? **Answer**: 87 MWp.
2. If the government authorizes 500 MWp of solar generation under the current FIT rate of P9.68, what will be solar's contribution to the RE universal charge? **Answer**: P0.0574. (This amount alone exceeds the four-centavo universal charge approved by ERC in December 2014.)
3. If the government authorizes 500 MWp of solar generation capacity under the FIT system to meet a specified target share of solar energy in the total electricity output of the country, but the public is only willing to accept at most a one-centavo solar contribution to the RE universal charge, what should the solar FIT rate be? **Answer**: P6.071 (This is 37% lower than the approved FIT rate of Php 9.68 per kWh).

Table 18. Contribution to the RE Universal Charge, per Technology

Table: Contribution to the RE Universal Charge, per Technology

		Capacity factor= 0.18			Pgrid(peso)= 5.31			Etotal(GWh)= 60000			
	MW	**50**	**75**	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**
FIT RATE, SOLAR	**9.68**	0.0057	0.0086	0.0115	0.0230	0.0345	0.0459	0.0574	0.0689	0.0804	0.0919
	9.10	0.0050	0.0075	0.0100	0.0199	0.0299	0.0398	0.0498	0.0597	0.0697	0.0797
	8.55	0.0043	0.0064	0.0085	0.0170	0.0256	0.0341	0.0426	0.0511	0.0597	0.0682
	8.04	0.0036	0.0054	0.0072	0.0143	0.0215	0.0287	0.0359	0.0430	0.0502	0.0574
	7.56	0.0030	0.0044	0.0059	0.0118	0.0177	0.0236	0.0295	0.0354	0.0413	0.0473
	7.10	0.0024	0.0035	0.0047	0.0094	0.0141	0.0189	0.0236	0.0283	0.0330	0.0377
	6.68	0.0018	0.0027	0.0036	0.0072	0.0108	0.0144	0.0180	0.0216	0.0252	0.0288
	6.28	0.0013	0.0019	0.0025	0.0051	0.0076	0.0102	0.0127	0.0153	0.0178	0.0203
	5.90	0.0008	0.0012	0.0016	0.0031	0.0047	0.0062	0.0078	0.0093	0.0109	0.0124
	5.55	0.0003	0.0005	0.0006	0.0012	0.0019	0.0025	0.0031	0.0037	0.0044	0.0050
		Capacity factor= 0.3			Pgrid(peso)= 5.31			Etotal(GWh)= 60000			
	MW	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**700**	**800**
FIT RATE, WIND	**8.53**	0.0071	0.0106	0.0141	0.0282	0.0423	0.0564	0.0705	0.0846	0.0987	0.1128
	8.49	0.0070	0.0104	0.0139	0.0278	0.0418	0.0557	0.0696	0.0835	0.0974	0.1113
	8.44	0.0069	0.0103	0.0137	0.0275	0.0412	0.0549	0.0687	0.0824	0.0961	0.1098
	8.40	0.0068	0.0102	0.0135	0.0271	0.0406	0.0542	0.0677	0.0813	0.0948	0.1084
	8.36	0.0067	0.0100	0.0134	0.0267	0.0401	0.0534	0.0668	0.0802	0.0935	0.1069
	8.32	0.0066	0.0099	0.0132	0.0264	0.0395	0.0527	0.0659	0.0791	0.0923	0.1054
	8.28	0.0065	0.0097	0.0130	0.0260	0.0390	0.0520	0.0650	0.0780	0.0910	0.1040
	8.24	0.0064	0.0096	0.0128	0.0256	0.0384	0.0513	0.0641	0.0769	0.0897	0.1025
	8.19	0.0063	0.0095	0.0126	0.0253	0.0379	0.0505	0.0632	0.0758	0.0884	0.1011
		Capacity factor= 0.7			Pgrid(peso)= 5.31			Etotal(GWh)= 60000			
	MW	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**700**	**800**
FIT RATE, BIOMASS	**6.63**	0.0067	0.0101	0.0135	0.0270	0.0405	0.0540	0.0675	0.0809	0.0944	0.1079
	6.60	0.0066	0.0099	0.0132	0.0263	0.0395	0.0526	0.0658	0.0789	0.0921	0.1052
	6.56	0.0064	0.0096	0.0128	0.0256	0.0384	0.0513	0.0641	0.0769	0.0897	0.1025
	6.53	0.0062	0.0094	0.0125	0.0250	0.0374	0.0499	0.0624	0.0749	0.0874	0.0998
	6.50	0.0061	0.0091	0.0121	0.0243	0.0364	0.0486	0.0607	0.0729	0.0850	0.0972
	6.47	0.0059	0.0089	0.0118	0.0236	0.0354	0.0473	0.0591	0.0709	0.0827	0.0945
	6.43	0.0057	0.0086	0.0115	0.0230	0.0344	0.0459	0.0574	0.0689	0.0804	0.0919
	6.40	0.0056	0.0084	0.0112	0.0223	0.0335	0.0446	0.0558	0.0669	0.0781	0.0892
	6.37	0.0054	0.0081	0.0108	0.0217	0.0325	0.0433	0.0541	0.0650	0.0758	0.0866
	6.34	0.0053	0.0079	0.0105	0.0210	0.0315	0.0420	0.0525	0.0630	0.0735	0.0840
		Capacity factor= 0.35			Pgrid(peso)= 5.31			Etotal(GWh)= 60000			
	MW	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**700**	**800**
FIT RATE, HYDRO	**5.90**	0.0015	0.0023	0.0030	0.0060	0.0090	0.0121	0.0151	0.0181	0.0211	0.0241
	5.87	0.0014	0.0021	0.0029	0.0057	0.0086	0.0115	0.0143	0.0172	0.0200	0.0229
	5.84	0.0014	0.0020	0.0027	0.0054	0.0081	0.0109	0.0136	0.0163	0.0190	0.0217
	5.81	0.0013	0.0019	0.0026	0.0051	0.0077	0.0103	0.0128	0.0154	0.0180	0.0205
	5.78	0.0012	0.0018	0.0024	0.0048	0.0072	0.0097	0.0121	0.0145	0.0169	0.0193
	5.75	0.0011	0.0017	0.0023	0.0045	0.0068	0.0091	0.0113	0.0136	0.0159	0.0181
	5.73	0.0011	0.0016	0.0021	0.0042	0.0064	0.0085	0.0106	0.0127	0.0149	0.0170
	5.70	0.0010	0.0015	0.0020	0.0040	0.0059	0.0079	0.0099	0.0119	0.0138	0.0158
	5.67	0.0009	0.0014	0.0018	0.0037	0.0055	0.0073	0.0091	0.0110	0.0128	0.0146
	5.64	0.0008	0.0013	0.0017	0.0034	0.0051	0.0067	0.0084	0.0101	0.0118	0.0135

Source: Author’s calculations.

4. If the government authorizes 500 MWp of wind power under the current FIT rate of P8.53, what will be wind's contribution to the RE universal charge? **Answer:** P0.0705. (This amount alone is 75% more than the four-centavo universal charge approved by ERC.)
5. How much will the currently approved FIT rates (solar – P9.68/500MW; wind – P8.53/200MW; hydro – P5.90/250MW; biomass – P6.63/250MW) actually add to the generation charge? **Answer:** P0.07690 (This is nearly double the four-centavo RE universal charge approved by ERC.)
6. In the original ERC plan (solar – P9.68/50MW; the rest are the same), how much would the plan have added to the generation charge? **Answer:** P0.0252 (This is less than 2/3 of the proposed universal charge. More than a third—a bit too much—would presumably have gone to administrative costs.)

When the ERC raised from 50MW to 500MW the solar capacity to be supported under the P9.68 FIT rate, presumably basing their decision not on the model they were using but on the clamor of solar RE developers, the consequence was they nearly tripled the contribution of the FIT-supported RE technologies to the generation charge, from 2.52 to 7.69 centavos per kWh. Yet, they have not modified their four-centavo RE universal charge proposal, presumably fearful of the public reaction to a doubling of the universal charge. Where will the system get the other 5.17 centavos per kWh to pay the RE developers their FIT rates?

The answers above were derived from the model, based on assumptions about the other variables in the model which are specified below. The model can also be subsequently used to see how sensitive the answers will be to changes in some of the assumptions.

Future refinements to the FIT model to extend its usefulness

- Compare this model with the NREB model, which was used to arrive at their FIT recommendations to ERC. Their methodology was accepted by the ERC, but the latter further adjusted the FIT rates to take into account the rapidly decreasing costs of solar PV panels and the fuel risk for biomass plants. ERC also raised the capacity factors to allow only the more efficient plants within the FIT system.

- For the FIT rate comparison, use not the grid price but the average price of electricity from peaking plants, as traded in the wholesale electricity spot market. This possible refinement is based on the observation made by SACASOL President Jose Ma. Zabaleta Jr. that the current solar FIT rate is actually *lower* than the average of peak prices of electricity in the WESM, which are today based on expensive diesel fuel (at P22.00 per kWh, according to an interview with Zabaleta). Since solar energy peaks in the daytime, when the peaking plants also come into operation, it may make more sense to compare the FIT rate to the average peak prices instead of the average grid price. This matter needs to be studied further. If the point raised is valid, it is going to be a game-changer, because the average grid price is P5.31, but the average of peak prices is around P10.00, and is already higher than the FIT rate for solar. The use of peak prices instead of the grid price as the base price for the premiums will have to be reconsidered on a case-to-case basis for the various renewable sources. The best approach would be to do so in real-time, so that the actual charge that would have gone to the non-renewable source being replaced is properly credited to the FIT-supported capacities that are online at that point in time. This real-time approach can easily be tested through simulation studies.

- Base the various assumptions on more solid data. For instance, the willingness of the electricity end-user to tolerate a slight increase in their electric bill in support of RE development needs to be more accurately determined through a professional survey, which is beyond the capacity of this paper. The average grid price also needs to be determined based on a wider set of data points.

- Determine the appropriate degression rate (i.e., schedule of decrease) of the FIT rates from the behavior of the variables as they change over time.

- Take the cost trends within the various renewable technologies into account.

At what point should the consumer start benefitting from RE by enjoying a lower price for electricity?

- Follow the different variables as they change over time, given changes in RE costs (PV panels, for instance, are getting cheaper all the time), fossil-based electricity costs (which are becoming more and more expensive), and the end-user price of electricity (the end-users deserve a share in the savings accruing from lower RE costs, which should be reflected not only in higher profitability for solar developers, but also lower prices for consumers). A more comprehensive model will show the time line for the important variables: the FIT premium, the average price of fossil-based electricity, the average grid price, the cost of generation, the grid price, and the end-user price. Such a model can eventually be used to determine degression rates and how the share of each technology in the total energy mix should be expanded. It is important to answer the following policy question: at what point should the consumer also start benefitting from RE by enjoying a *lower* price for electricity?
- Given the continuing decrease in solar and wind costs, this study raises the possibility of what can be called a "price-neutral" FIT approach.

To implement this approach, data will need to be collected about the quantities and prices of the non-renewable sources actually replaced by the FIT participants, in a particular billing period. The average price of these avoided non-renewables will then become the baseline FIT for all technologies. If this average price is used for paying the FIT participants, there will be zero impact on the retail price, making it price-neutral. However, because their cost structures are different, the baseline FIT rate cannot be applied as-is to all FIT participants. The final FIT rate for each technology must then be adjusted, in a transparent, rule-based way, to equalize better their profitabilities, while retaining the price-neutral feature of the approach. In effect, the FIT support for the less profitable renewables will come from the more profitable ones.

This approach would have been impossible ten years ago, because of the higher costs of solar and wind then. Today, it is doable. In the future, as the cost of renewables like wind and solar continue to drop, consumers can even enjoy a "universal refund" instead of a universal charge.

Aside from net metering and the FIT, other options are available to RE developers in the Philippines. These will be covered in the next chapter.

Chapter 9. Other RE policy options in the Philippines

The Renewable Energy Act of 2008 specifies five other approaches for encouraging RE development, aside from net metering and FIT, which have been covered in previous chapters. The other five approaches are:

1. Renewable portfolio standards (RPS)

RPS are what this study called mandated targets in Chapter 4. Electricity suppliers or DUs are required under RPS to produce from RE sources a specified minimum percentage of their electricity, as set by the NREB. RPS involves RE certificates earned by certified RE generators whenever they produce a specified amount of electricity. RE generators can then sell these certificates to distribution utilities, separately from the electricity itself. To prove compliance with RPS standards, DUs must submit to a regulatory body RE certificates, which can be bought from certified RE generators.

A lot of details still have to be worked out, for the RPS to work properly. These details are supposed to be incorporated into implementing rules and regulations (IRR). The details include the types of RE resources, the process of identification and certification of RE generators, the annual process of setting the minimum RE requirements (not less than 1% of demand over the next 10 years), the rules for trading certificates in an RE market, and so on.

One can only hope that the Spanish style of bureaucracy will not manifest itself once more in the RPS, as it did in the FIT. Hoping for the best, it would be nice to see a place for households and other small players on the RPS table, so that their solar rooftops can be entitled to RE certificates too, and that they too will be allowed to sell these certificates to the highest bidders.

So far (as of December 2014), the RPS IRR have not been issued yet, so there might still be an opportunity to make sure the flaws in the government's FIT and net metering approaches are not repeated under the RPS.

2. Green Energy option (GEO)

This approach gives consumers a choice: electricity end-users may choose an RE source as their source of electricity to ensure that their payments go to operators of RE facilities rather than to fossil-fueled plants. If enough environmentally conscious end-users are willing to pay a premium price for renewable electricity—just as health-conscious families are willing to pay premium for organic foods—this might even preclude the need for a universal charge for RE.

As in the RPS option, lots of details have to be worked out, and the devil lies in ambush.

But the details have been worked out in other countries like the US and Germany, which made this option available much sooner.

Originally, the option was part of the regulatory process within the electricity industry, which enabled DUs to choose which electricity suppliers they could buy electricity from, although they all used the same grid. GEO extends the freedom of choice to consumers themselves.

If the GEO IRR is promulgated with the small players in mind, one can imagine setting up solar panels and marketing one's surplus to relatives and friends, until they decide to install solar panels themselves. Used imaginatively, GEO will make a great marketing vehicle for RE.

3. A minimum percentage of RE for off-grid areas

This provision of the 2008 Renewable Energy Act seems specifically addressed to the Small Power Utilities Group (SPUG) of the National Power Corporation. It requires those who provide “missionary” electrification to source a minimum percentage of their annual output from available RE resources in the area. The minimum percentage would be recommended by the NREB.

The operators of the local RE resources would be entitled to RE certificates. If the local electricity providers are unable to identify and use local RE resources, they can instead buy RE certificates elsewhere, as provided under RPS.

4. Micro-scale projects

Since the government claims to own solar and wind resources, it insists that as owner, it is entitled to a share in an RE developer's profit. And the government in fact gets a share in the profits of the big players.

However, it has decided to be generous to small players. For what it calls “micro-scale” projects, which it defines as projects not greater than 100 KW in capacity, Section 13 of the Renewable Energy Act waives the government's share of the proceeds of micro-scale projects for communal purposes and non-commercial operations.

Perhaps such government generosity will encourage more communal and non-commercial efforts to tap renewable sources.

5. Other government incentives

Other incentives include the usual income tax holiday, duty-free importation, special tax rates, net operating loss carry-over, lower taxes rates on corporate net income, accelerated depreciation, zero percent VAT, cash incentives for RE developers for missionary electrification, tax exemption of carbon credits, tax credits on domestic capital equipment and services, and other goodies.

Of course, to avail of these goodies, one has to be registered with the DOE. And before one can register with the DOE, one has to have an RE Service Contract. And before can get an RE Service Contract, one has to . . . (Read about the bureaucratic maze once more in Chapter 7!)

Chapter 10. Where do solar rooftops FIT?

They are called “solar home systems” (SHS) in some countries. Terms like “residential solar” and “rooftop solar” have also been used. In today's lingo, they will probably be called “solar selfies.”

It is important for policy makers and the public to understand why household-scale and other small-scale solar power generation should get as much support, if not more, as utility-scale solar PV plants and other renewables.

The building block of photovoltaic (PV) systems, whether at the sub-kilowatt household level or at the multi-megawatt utility level, is the PV cell, a 70 cm^2 silicon wafer that produces roughly around two Wp.

All PV systems big and small use this same building block. First, the cells are connected in series (the positive end of one to the negative end of the next) to build up the output to a particular voltage standard. This is similar to the way 1.5-volt (V) batteries are connected in series to reach the 6 V needed to run a transistor radio. For solar panels, the typical standard voltage for this next-level building block is around 18 V, suitable for charging 12-V batteries. Other panels have higher voltage outputs, for charging 24-V batteries. In the future, panels that can charge 48-V batteries for electric vehicles) may become common, but they will, in all probability, use the same building block.

There is no fundamental difference between household-scale and utility-scale solar plants. They use the same building block.

The blocks are further connected in parallel (all positive ends form one connection, all negative ends form another connection) to increase their peak wattage, resulting in the standard commercially-available PV panels. In the Philippine market today, one can find 5- or 10-Wp PV panels (usually for cellphone charging), up to 100- or 150-Wp panels for roof-mounted household PV systems. Recently, 250-Wp panels have become more common and 300-Wp panels are just coming into the market.

These commercially available panels are simply combined in larger solar arrays (in series to increase the voltage, and in parallel to further increase the wattage) to reach whatever levels are required by the household or the utility. The San Carlos Solar Energy (SACASOL) utility-scale PV plant, for instance, will be using 88,000 150-Wp panels to get its peak output of 22 MW.[69]

Thus, there is no fundamental difference between the household-scale and the utility-scale solar plant. The latter simply uses more of the same building blocks.

A second important point to consider is that PV systems (and other electrical generation facilities) are most efficiently operated at the point of use. The farther away the source is from the point of use, the more losses will be incurred in supplying electricity from the source to the user. By minimizing system losses associated with transmission and distribution, practically the full PV output becomes

69 “Solar Energy,” Bronzeoak Philippines, (Accessed January 29, 2015), http://www.bronzeoakph.com/solar.html.

available to the end-user. This results in very high efficiencies, instead of electricity being dissipated as waste heat in the transmission and distribution system.

There are additional reasons why electrical generation is most efficiently operated at the point of use:

1. *Less investment in transmission and distribution.* The need for investment in transmission and distribution lines, and their associated control facilities is minimized. The need for these lines cannot be entirely eliminated, because PV users need to take electricity from the grid when there is not enough sunshine. They can also sell electricity to the grid in times of excess production. The grid is also needed for the transmission and distribution of wind, hydro and other utility-scale renewables.
2. *Less investment in spinning reserves.* The need is also minimized for investments in huge spinning reserves, which are plants generating electricity on standby, ready to take-over in case the largest plant on the electric grid fails.
3. *Less land needed.* Because household-scale systems can be roof-mounted, the need is also minimized for huge tracts of land exclusively for solar power generation.
4. *PV panels as roofs will reduce roofing costs.* In the future, even greater savings can be incurred when PV panels themselves are used as roofing material, reducing the need for galvanized iron and other roofing materials.

Consumption at source minimizes system losses as well as investments in transmission and distribution

5. *Expansion in smaller steps in less risky.* The incremental investments for new solar installations can occur at the kilowatt and sub-kilowatt levels instead of megawatt and gigawatt levels. Thus, expansion can occur in small steps, made by many, instead of the riskier big leaps, made by a few.
6. *Technology lock-in is avoided.* The smaller incremental investments reduce the risk of technology lock-in. Technology lock-in is a major problem in long-gestation, multi-million dollar projects such as coal and nuclear plants, which can commit a society to a specific technology for decades to come. Thus, if a superior technology for electricity generation were to become viable next year, a country with a coal or nuclear plant project that is, for instance, nearly complete would be faced with a huge dilemma what to do with a white elephant. The small incremental investments needed for household-scale solar power avoids this kind of long-term technology lock-in.
7. *In general, distributed approach is usually better*. A further advantage of including small-scale production reflects the advantages in general of a distributed over a centralized approach. The advantages of a distributed approach can be seen in the rapid growth and huge success of the information Internet.

Given these additional efficiencies and other advantages realized by household-scale solar power generation, it is essential therefore to include and actively incorporate households and similar small-scale entities into the various government incentive systems for solar power and other clean renewables, including the FIT system.

Yet, such is not the case today. Two case studies cited earlier provide a stark contrast.

SACASOL took 12 days to get its 22-MWp solar power plant project approved by the DOE, a clear expression of political will by the government to hasten the energy transition to renewables. As the first FIT beneficiary, SACASOL will get paid P9.68 per kWh for its electricity output.

The 5-kWp home PV system of Mike de Guzman took Meralco ten months to approve for a "net-metering" scheme (which is not true net metering, as explained in Chapter 5), under which Meralco will only pay de Guzman P5.50 per kWh for the latter's excess electricity output. But when de Guzman has to buy electricity from Meralco, he has to pay P10.00 per kWh during off-peak hours and P14.00 per kWh during peak hours.

In the Philippines today, the big players in renewables enjoy the kind helping hand of the government. But the small-players are left to the mercy of utilities who feel threatened as more of their customers get cheaper electricity directly from the sun or the wind.

A big 22-MWp utility project took the DOE 12 days to approve and will get paid P9.68/kWh.

A small 5-KWp home project took Meralco 10 months to approve and will get paid P5.50/kWh, but Meralco will charge it P10/kWh off-peak and P14/kWh on peak hours.

Chapter 11. Can utilities work with rooftop solar?

In many countries, utilities have been historically leery of, if not actually hostile to, renewable options with inherently variable output, like wind and solar. They generally prefer the consistent availability and steady output of conventionally-fueled power plants.

Thus, the renewables that usually made it to the energy mix in the past were hydroelectric dams, geothermal plants and biomass-fueled power plants whose steady outputs were very similar to fossil-fueled plants.

While many utilities today retain this attitude, an increasing number have embraced wind and solar, particularly once they are convinced that the economics do work out to their advantage. Thus, utility-scale solar and wind farms are becoming increasingly common in Europe—where Denmark and subsequently Germany took the lead—as well as the US where states like California have adopted aggressive renewable targets. The hundreds of RE developers who applied to join the Philippine FIT system attest to the increasing acceptability of wind and solar farms for utility-scale generating plants.

Distribution utilities (DUs) have also preferred big projects to small ones. DUs are not afraid of big generation companies such as utility-scale wind and solar farms, because their generated output will be sold through the DUs anyway. Thus, the interests of these two big players more or less coincide, with the DU simply tacking on its charges over the generation charge of the RE project developer.

Small players are a different matter. Once their rooftop systems are installed, their consumption of DU-delivered electricity will start going down, reducing the sales of the DU. Thus, it is understandable that DUs would try to discourage self-generation by small players.

However, just like the central computing facilities of old who had no choice but to live with desktop computing, or the landline monopolies who had no choice but to live with mobile telephony, DUs will have to learn to accept and to live with rooftop solar. With PV systems getting cheaper every year, small players will increasingly occupy a larger role in the generation of electricity.

Where utility-scale solar farms are becoming financially viable, self-generation from solar power—solar selfies, so to speak—will even be more viable. Consumption at-source will always be ahead of utility-scale generation because the former practically eliminates the costs of transmission and distribution.

In short, self-generation of electricity, mostly through solar panels and possibly through wind turbines in farms, is here to stay, regardless of the DUs' own wishes.

When small players exceed their own requirements and start exporting their surplus to the grid, this surplus will not decrease DU sales, because it will register as consumption in other electric meters nearby. The DUs will therefore get paid their usual retail price of electricity including all the add-ons tacked on the electricity bill.

Under true net metering, the DU's administrative costs will not increase either, because the electric meter's forward and reverse movements automatically take care of crediting the exporters of surplus electricity and shifting the charges to their neighbors.

Can the DUs benefit from rooftop solar?

In fact, DUs can benefit from rooftop solar (and wind turbines, too).

They will, for instance, earn RE certificates to meet their legal obligations under the renewable portfolio standard (RPS) provisions of our RE law. If they exceed their RPS obligations, the DUs can also sell these certificates on the RPS certificate market, to be bought by other DUs that are unable to meet their RPS obligations.

DUs themselves can also set up solar PV systems in residential homes and commercial buildings as part of their "outside plant" capital expansion. They can use exactly the same leasing and PPA business models that solar start-ups like Solar Philippines have used to attract new customers.

Utilities can expand their capacity in smaller kilowatt increments, rather than larger megawatt increments.

These customer-sited PV systems can bring DUs several attractive benefits:

- Utilities can expand their generation capacity in kilowatt- instead of megawatt-increments, a wise move that reduces technological, financial and project risks significantly and avoids long-term technology lock-in.
- Because the generated electricity is consumed at source, this helps reduce system losses, including transmission, distribution, transformer and other heat losses. It also reduces capital expenditures, as consumption-at-source does not require additional investments in transmission and distribution lines.
- Expansion in small increments does not require additional static and spinning reserves (generating plants that can supply electricity at moment's notice, if a big generating plant unexpectedly goes down.)

  (These and other benefits of incremental expansion are discussed more thoroughly in Chapter 10.)

Self-generation through cheaper and cleaner renewables is a trend that DUs cannot stop. Logically, therefore, once small players install their own generating facilities on their rooftops, DUs would prefer that small players become large enough as quickly as possible, so that these small players can generate more electricity not just for their own use, but also for export to the grid. This way, "solar selfies" with surpluses will be benefitting DUs too.

Unfortunately, many DUs do not as yet see it this way. They still respond to small players with a knee-jerk response and put up all kinds of barriers to the latter's participation in the energy transition to renewable electricity.

Already, by generating and selling power right at the customers' premises, companies like Solar Philippines are taking market away from DUs like Meralco.

It simply needs a change of mindset among utility planners and engineers to realize that they can do the same, and possibly keep their customers. If utilities like Meralco generate electricity in their customers' premises, they would save on various costs, and they can share their savings with their customers. Only by sharing, and offering better deals than upstarts like Solar Philippines, can utilities hope to keep their markets.

By generating and selling power at the customers' premises, companies like Solar Philippines are already taking market away from utilities like Meralco.

Chapter 12. Energy transition: Why is it taking too long?

If we have more than enough physical resources to tap, if renewable projects are now within the range of financial viability, and if business models now exist that solve the problem of high upfront costs, then why are coal and oil power plants still in the planning stages and in the project pipeline? Why are not more solar, wind, hydro and other renewable projects in the pipeline? What is keeping us from making the energy transition to full renewability?

We will try to answer these questions in this chapter.

The barriers to full renewability can be roughly categorized into the following:

1. *Lack of physical resources.*

While we have shown in Chapter 1 that we have enough renewable resources nationwide to meet our electricity needs many times over, we have also seen in Chapter 2 how these resources are unevenly distributed in the country.

Thus, some locations may not be as well endowed as other locations. Geographic features such as mountains may cause obscuring clouds to appear more often and block out more sunlight. Others may disrupt wind flows and cause turbulence, making it harder to harvest electricity from the wind. In flat areas, it will be harder to find water systems that can be exploited for hydroelectric generation. Biomass generation will depend on the steady availability of biomass for fuel, and some areas may simply not have enough biomass to support a biomass-fueled generating plant. In addition, using biomass for fuel competes with its use for compost in food production.

The solution in such cases will be to import electricity from nearby areas better endowed with renewable sources. Given that we can be self-sufficient in renewable electricity nationwide, possibly even region-wide, the less endowed areas should not have to look too far to import electricity. This is no different from what we do today, when we construct plants at the hundred-megawatt and gigawatt levels. These plants are so widely spaced apart that they have to export their output to distant, less endowed locations too.

Transporting electricity to localities in need requires transmission and distribution lines. Thus, even where renewables make it possible for more households and communities to consume electricity at the point it is generated, we would still need a transmission infrastructure to support the electricity requirements of less endowed localities.

The need for transmission lines is even greater as we become more dependent on wind and solar. Given their inherent variability in output, even well endowed areas will occasionally need to import electricity from neighbors when their sources are producing less than the current demand.

2. *Renewable electricity is too variable and cannot be used for baseload plants.*

It is possible to cope with the variable output of solar panels and wind turbines, in the same way that banks cope with the inherent unpredictability of deposits and withdrawals. There are technical, structural and social solutions, which are discussed more thoroughly in the next chapter.

3. *Renewable electricity is still too expensive to compete with fossil-fuels.*

This might have been true until a few years ago. But it is not so true anymore today, as Energy Secretary Petilla himself has realized and as we have shown in various case studies as well as calculations in this study. And it will become more glaringly false in the future. We have already shown how rooftop solar is viable today. But if consumers still mistakenly think otherwise, then the market for renewables, especially for PV systems, will remain sluggish.

What is needed at this point is for the public to be better informed about the state of prices in PV systems. This is something that can be done by suppliers who market their systems, by independent studies like this one, and by the government. Quality and reliability of PV products are also becoming a major concern. The government needs to protect consumers whose enthusiasm for solar power can make them vulnerable to unscrupulous suppliers. We must remember that to realize the promise of solar power, PV panels should last for more than 15 years, preferably 20–25.

4. *The upfront costs are still too high.*

This was probably true until recently, when innovative financing approaches like solar power purchase agreements (PPAs) finally made their way to the Philippines. It is still partially true today, because only one company so far is engaged in solar PPAs, that company may not be fast or big enough to service the pent up demand for cheaper electricity, and its innovative approach excludes households and small businesses.

But it won't be long. The success of Solar Philippines can be expected to attract businesses to use its business model. Then, some can hopefully focus not only on malls but also small players. The market is big enough to support several more PPA-type operations.

5. Artificial barriers to the adoption of net metering.

The absence of true net metering is one of the worst barriers to the wider adoption of RE in the Philippines, especially among small players. It is the biggest flaw in the government's RE strategy. This problem is fully explained in Chapter 5.

6. *Ignoring small players.*

The government should realize that small players, who directly consume most if not all of their production, are the most efficient among RE producers, for reasons explained in Chapter 10. Unfortunately, small players have been left to fend for themselves in the market, while big players have gotten most of the attention and focus. Small players are out of the FIT system entirely. The small players' best option, net metering, has been mangled in favor of utilities instead. The provisions in the 2008 Renewable Energy Act which small players can take advantage of remain lacking in implementing rules and regulations.

7. Slow government response to urgent issues.

A good illustration of the slow response is the grid interconnection problem. The first solar utility company to qualify for the FIT is SACASOL. During a workshop on renewable energy sponsored by GIZ in October 2014, the SACASOL representative complained that they had been ready to connect to the grid since May 2014. However, the NGCP would not allow them to do so, because there was no risk analysis yet done on the impact of a 13-MWp solar facility on the stability of the grid.

One can just imagine the dismay of the SACASOL project developers. They had gone through the hoops, applying to the DOE, getting the necessary 120 signatures, gathered the investors, the financiers, and worked out the thousands of little details involved in such a huge undertaking. They had already invested nearly P2 billion into the project. They had been ready since May 2014 to supply clean, renewable solar electricity to the grid. Yet, no cash was flowing after four months of waiting, because the NGCP had done no risk analysis of SACASOL's entry into the grid. Had not the DOE announced its 50-MWp solar target more than a year earlier?

**SACASOL had been ready to connect 13 MW of clean, renewable solar electricity since May 2014.
As of October 2014,
the grid operator has not connected them to the grid yet.**

The credibility of the government is at stake here. This highly troubling development puts the renewable energy program of the country on the line. President Aquino himself should step in, if that is what it should take, to make things right for those who have risked their necks and joined in good faith the country's renewable energy program. After all, the President was at the ceremonies that inaugurated the SACASOL project on May 15, 2014.

Is this what also awaits the other finishers in the FIT race? Majestic's solar project will be going online by the end of 2014 or the beginning of 2015. The leading wind contenders are expected to follow suit. Will the NGCP have done the risk analysis by then?

Even if SACASOL eventually gets connected, future investors will surely take notice and take this kind of treatment into account in their decision whether to invest in RE or not.

The government's perspective

The government's perspective is very different. Because it is focused on the FIT as a means to encourage RE development, the government attributes the slowness of the energy transition to such things as uncertain approval by the National Commission on Indigenous Peoples (NCIP) and problems with local government permits and licenses. In short, local and social acceptability.

This was the opinion of DOE-REMB Director Mario Marasigan who cited as example the issuance of local licenses and permits. He has received complaints, he says, that up to 165 signatures were needed to get local approval.

In a June 2014 interview, the REMB director admitted that “more than 50%” of the 500-plus RE project applications were bogged down in problems involving local permits and licenses, including approval from NCIP.

The positive side, he says, is that 40-50% have hurdled these problems.

But this is not even the biggest hurdle of all, Marasigan says. Marasigan cites as the biggest hurdle the non-cooperation of NCIP, their concept of "ancestral domain" and conflicts over land that this has generated. The contested area can be much larger than the 30% of the country that is already covered by ancestral domain claims, the REMB director says. He quotes NCIP's argument that indigenous peoples usually move from place to place as part of their culture and life style. Thus, if an IP is sighted near an RE development site, "the project is in trouble," because that locality could turn out to be part of their ancestral domain. "It could take years" before NCIP can give its approval, he says.

More than 50% of the RE project applicants were bogged down in local permits and licensing problems

As an indication—perhaps also a cause—of the problem, the NCIP is not a member of NREB. It is only invited to attend meetings as an observer.

From Director Marasigan's perspective, the most important role that NGOs can play is in facilitating social acceptability. NGOs, he says, can help explain RE projects to local communities, LGUs and NCIP.

Truly, social acceptability is important. It would even be better if social participation became more widespread, by opening the doors wider for small players to join the energy transition to renewable electricity—not just as consumers but as producers themselves.

Without the participation of small players, the energy transition will indeed take too long.

Chapter 13. Variable output: Dealing with highs and lows

The variable nature of solar and wind resources is often used as argument against renewable energy. Their unpredictability, the argument goes, means they cannot be relied on to provide the electricity when it is needed. Thus, the argument says, we need fossil-fueled (or nuclear) plants as back-ups, to ensure that we have electricity when we need it.

It is possible to deal with variable output.

Rain, wind and sunshine in a particular place can be compared to bank depositors, who also behave individually in variable and unpredictable ways. But, like wind and sunshine, their behavior over longer periods of time can be characterized. And this can be known with sufficient statistical certainty, that banks can—and actually do—bet their money on this knowledge.

Wind, sunshine and rain in a place are like bank depositors. Individually, they behave in variable and unpredictable ways. But their behavior over longer periods can be characterized with enough statistical certainty to bet our money on.

When banks face heavier withdrawals than usual, they can borrow cash from other banks, to enable them to meet the unexpected demand. Thus, heavy activity in some areas and sluggish activity in other areas tend to even out over a larger area, as long as enough secure transport is available to move cash back and forth. This is also true among renewable producers, whose variable outputs will tend to even out over a larger area, as long as enough transmission lines are available to move electricity back and forth.

Another approach in coping with variability is to diversify sources to even up the peaks and troughs of their individual outputs. In many places, wind speeds approach their highest around sun up and sun down, nicely complementing solar power, which peaks around noon. Micro-hydro installations can provide the steadier output, and biomass output can be on-call.

And in those not-so-common instances when depositor behavior departs radically from their expected statistical behavior, a central bank steps in to soften the impact of such outliers, and in the worst of cases, insurance companies—truly the last resort—pick up the pieces.

Solar and wind energy also need banks of storage devices to hold excess production, when demand falls below their output, and to release the stored energy, when demand shoots up. Energy storage is a technological requirement and technologies have been, and continue to be developed, to keep pace with the storage requirements of variable energy sources. These include pumped storage of water, compressed air storage, battery banks and the production of hydrogen and synthetic methane. As solar and wind energy take the center stage, more storage options are expected to emerge.

Pumped water storage

In the US grid, for instance, pumped water storage composes 95% of the grid's total storage capacity. Pumped water storage is a mature technology. In the Philippines, a 240-MW pumped storage facility is now underway in Ifugao, to be supported under FIT once it goes online.

During off-peak hours, when the output of all operating plants may exceed the demand, the surplus electricity can be used to activate pumps to force water up for storage in an elevated water reservoir. During peak hours, the reservoir can channel more water into its turbines, and increase its output within minutes.

The other 5% of energy storage facilities in the US grid consist of flywheels, compressed air, thermal storage, electrochemical capacitors and various battery-based storage.

Flywheels

In the case of flywheels, electricity is converted to and stored as rotational energy. Giant flywheels, large enough for utility-scale applications, are now being used to even up the highs and lows of power flow. As high as 3 MW of these flywheels have been used for "frequency regulation," and 20-MW sizes are in the pipeline.[70]

An example of a commercially available flywheel storage is the one-ton Beacon Power's "Smart Energy." Its 25-inch diameter flywheel can exceed a rim speed of 2,400 kph and store 25 kWh of electricity, more than enough for household use. An array of 200 such flywheels was recently installed in Stephentown, New York, for storing up to 5 MWh of electricity.[71]

Compressed-air energy storage

Compressed-air energy storage (CAES) involves using surplus electricity to pump compressed air into a sealed geological formation like an abandoned mine or a salt dome. The compressed air can later be used to drive turbines to generate electricity. Compressed-air storage facilities are already operating in the US and in Germany.[72] A CAES facility planned in Norton, Ohio consists of a huge cavity in an abandoned limestone mine, that will be able to store 2.7 GW.[73]

Supercapacitors

Supercapacitors do not depend on chemical reactions, as batteries do, and can therefore store and release electricity much more quickly than batteries. And they last longer too. They are still more expensive than batteries at this time, though.[74]

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70 Philip Warburg, *Harvest the Wind: America's Journey to Jobs, Energy Independence, and Climate Stability*, (Boston: Beacon Press, 2012), p. 177.
71 Richard A. Muller, *Energy for Future Presidents: The Science Behind the Headlines, (*New York*:* W.W.Norton and Company, 2012), p. 175.
72 Warburg, p. 178.
73 Muller, p. 172.
74 Muller, p. 176.

Storage batteries

Storage batteries are now the center of intense research and development as three major industry clusters rely on batteries for power storage: the mobile computing and telecommunications industries, the electric vehicle industries ranging from golf carts to sports cars, and the solar and wind energy industries. The result of the synergisms in battery developments among these industry clusters is extremely rapid growth. Thus, the storage battery market is expected to grow from $200 million to $19 billion within five years, a phenomenal growth rate of almost 150% per year (a doubling of the market every nine months).

The requirements for storage systems of mobile devices and vehicles are very demanding. They need to store huge amounts while staying small and light, and they will be subject to extremes of environmental conditions. Such storage systems are one of the areas of interest of intensive research today. Renewables will be getting a free-ride on these research efforts, because storage systems which fail to meet the stringent requirements of mobile and transport applications may still serve perfectly well for home storage applications.

The lithium-ion battery commonly found in low-power applications such as mobile phones and laptop computers has also been used in electric vehicles and power utility storage systems. A Massachusetts-based company called 24M says they will soon be able to deliver "1 megawatt of power over a four-hour period from a battery the size of a small walk-in closet."[75] In what is probably the largest lithium-ion battery bank planned so far, Edison of Southern California has embarked on a seven-year project to build a huge bank of lithium-ion batteries with a total capacity of 400 MWh of electricity.

Newer battery technologies include flow batteries, whose capacity are only limited by the size of the tanks that contain the electrolytes used; molten metal batteries which operate under temperatures high enough to melt metals; and zinc-air batteries.

A promising battery technology based on molten metal is the sodium-sulfur battery. A 4-MW version has been installed in Presidio, Texas, which can supply its rated capacity for eight hours. A larger 36-MW version is being planned for the Notrees Windpower Project, also in Texas. Current designs can last for 4,500 charge/discharge cycles, while lithium-ion and lead-acid batteries are usually only good for more than 500 cycles.[76] Molten sodium, however, has a temperature of around 350° C, requiring special handling.

In the future, a parallel shift from fossil-fueled to electric vehicles will perfectly complement the growth of solar and wind electricity. Since most private cars are idle much of the time, they can in their idle periods be connected to the grid, not only to recharge their batteries from the grid but also to *feed in electricity from their batteries to the grid*. They can actually *sell back* electricity to the grid, if the electricity from their battery banks will be less expensive than electricity generated from fossil-fueled peaking plants. Obviously, the economics of these will have to work themselves out, but when electric cars reach millions, their combined storage capacity will in fact be equivalent to several utility-scale power plants. It will therefore make economic sense to tap this idling storage capacity.

75 Warburg, p. 178.
76 Muller, p. 168.

An e-jeepney for Metro Manila

One example of a local e-vehicle project is the zero-emission Comet (City Optimized Managed Electric Transport).

Comet is an electric-powered jeepney substitute developed by the company Global Electric Transportation (GET) Ltd, a joint venture (50% Filipino, 50% American) headed by former Taguig representative Sigfrido Tinga.

GET foresees deploying a thousand units by the end of 2014, and 15,000 units over the next three years. If their plans materialize, GET CEO Ken Montler says this will be “the largest deployment of e-vehicles anywhere in the world.”

Powered by lithium batteries, Comets will be able to cover 80 km for each full charge. They will cost more than one million pesos each.

If the Comet developers design their charging stations properly, these stations can serve not only to charge batteries but also to sell stored electricity back to the grid at peak hours, at times when the vehicle is not on the road. Thus, the vehicle operators could be earning money not only when they are transporting passengers, but also when they are plugged into the grid in between trips.

Vehicle operators could be earning money not only when they are moving passengers but also when they are plugged into the grid.

Currently, the few utilities that currently have a net metering scheme will not let consumers participate in the program if the consumer's renewable setup includes a battery. This institutional barrier to entry is apparently meant to prevent a situation where the consumer buys cheap electricity from the utility during off-peak hours, stores the electricity in batteries, then sells it back to the utility during peak hours at a higher price—for a profit. They apparently do not want their customers to make money on them, a knee-jerk reaction that has been commonly observed in many utilities in other countries.

In fact, when utilities act this way, they are going against the interests of their own stockholders. If they are willing to buy peak-hour electricity from diesel- or gas-fueled peaking plants at more than P20.00 per kWh, why should they refuse to buy from their own customers at say P12.00 per kWh and save P8.00 per kWh? It makes economic sense to do so, even if the electricity they are buying originally came from the utilities themselves.

The utilities must abandon this knee-jerk reaction and adopt the perspective that they are outsourcing peak-electricity, which can come from peaking-plants that generate the electricity at peak-hours, or from service providers that sell storage facilities for utilities. In the latter case, the utilities are actually outsourcing storage services. As more and more renewables based on solar and wind come online, given their inherently variable output, a new market for the storage of electricity will emerge.

This is where electric vehicles come in. Once e-vehicles are deployed in millions, their batteries can doubly serve as storage facilities for the variable output of renewables.

In fact, the frantic research for electric storage facilities suitable for mobile applications (from cellphones to electric vehicles) can produce batteries which may not be light enough for portable use, but will make perfect storage for stationary applications in solar PV and wind systems.

The introduction of the electric car Tesla Roadster in 2008 was a landmark not only for electric vehicles, but also for the use of batteries in high-powered applications.[77]

Already, a new business model is now being tried, in which gasoline stations will be replaced by "battery stations" where e-vehicle owners can take newly-charged batteries in place of their discharged batteries.[78] All these batteries are potentially useful too for smaller scale solar and wind facilities.

Every new development in batteries for e-vehicles will benefit the renewable energy industry. In fact, even before batteries become practical for e-vehicles, they will already be useful for solar and wind applications.

In this regard, renewables and e-vehicles have a common future.

Once e-vehicles are deployed in millions, their batteries can doubly serve as storage facilities for renewables.

Structural approach: A very different energy system and energy market

In 2013, a German think-tank, Agora Energiewende, published a highly influential discussion paper.[79] The paper explored the key challenges for Germany's power sector, which was slowly but surely shifting to renewables, mainly solar and wind. Their conclusion: among the various potential sources of renewable electricity, wind power and photovoltaics were "the most cost-effective technologies with the greatest potential in the foreseeable future." The study noted that the costs for wind systems have fallen by 50% since 1990 (3.1% per year), while photovoltaic systems costs have fallen by 80 to 90% over the same time period (~8.3% per year), "with no end in sight." Other technologies (water, biomass/biogas and geothermal) were either "significantly more expensive" or had "limited potential for further expansion."

This section is a summary of the twelve insights in the Agora study:

> **1. "It's all about wind and solar!"** The study concluded that wind and PV power were "the two essential pillars" of Germany's transition to renewable energy. The paper noted that as energy sources, wind and photovoltaics were "fundamentally different" from fossil fuels because of their inherently variable output and their high capital costs but extremely low

77 Yergin, pp. 697-698.
78 Yergin, p. 698.
79 Agora Energiewende, "12 Insights on Germany's Energiewende: A Discussion Paper Exploring Key Challenges for the Power Sector," Berlin, February 2013.

operating costs. For solar, it was 1–1.5% of capital costs per year, while for wind, it was 2–4% of capital costs per year. Thus, the paper concluded that these fundamental differences will “profoundly alter the energy system and energy market.”

Agora suggested that “wind and PV power should be expanded in tandem since they have mutually complementary features; generally speaking, the wind blows when the sun is not shining and vice-versa.” Even if Germany's north is better endowed with wind, and its south is better endowed with sun, “wind power should not be generated exclusively in Northern Germany, and solar power should not be generated only in Southern Germany.” Spreading out the different generation facilities is better for optimizing the system as a whole, the study said.

2. “'Base-load' power plants disappear altogether, and natural gas and coal operate only part-time.” Germany's future energy system, the paper asserted, will be based mainly on wind and PV, and the rest of the system will be optimized around the two. “Most fossil-fueled power plants will be needed only at those times when there is little sun and wind, they will run less hours, and thus their total production will fall. Other technologies like combined heat-and-power as well as biomass plants will also be operated similarly—at those times when there is little sun and wind. The inherent variability of wind and PV will therefore “create new requirements for both short- and long-term flexibility.”

3. “There's plenty of flexibility—but so far it has no value.” Technical solutions already exist for various technologies to meet these new requirements for flexibility. By flexibility, the paper means *quicker* in handling start-up times, minimum loads and load fluctuations. But since flexibility has little market value so far, the paper says that “the challenge is not about technology and control, but rather about incentives.”

4. “Grids are cheaper than storage facilities.” This is the paper's conclusion, after comparing the two possible approaches to flexibility. And this is true both at the transmission and distribution levels—at least with current prices and costs. The paper makes clear, however, that part of this conclusion is based on Germany's access to the European grid. In the Philippine case, we will need to review carefully the necessary balance between grid and storage.

5. “Securing supply in times of peak load does not cost much.” Agora also acknowledges that this insight is based on Germany's access to the whole European grid. In our case, peaking plants usually charge a huge premium for their services.

6. “Integration of the heat sector makes sense.” Because heat is easier to store than electricity, bringing in the heat sector eases the overall problem of energy storage for the whole system. This is especially relevant in countries like Germany, where winds blow hardest during the winter months and where there is significant demand for both process and space heating.

7. “Today's electricity market is about trading kilowatt hours—it does not guarantee system reliability.” Today's markets ensure that the output from the lowest-cost power plants are dispatched first, followed by the next lowest-cost, and so on, according to their increasing cost, until the entire demand is met. The market price is set by the marginal supplier (the latest to be dispatched, which is also the most expensive one). Under this mechanism, the plants with the highest cost will be dispatched last and will earn the least, even if they are essential for covering peak demand. As they will probably operate for only a few hours per year, their profitability will be at risk. The problem will become worse as the share of cheaper renewables in the energy mix increases, causing the average price to go down further.

This is one of the biggest challenges of the new energy market based on wind and sun: how to ensure profitability for these marginal plants that will operate for only a few hours per year.

8. "Wind and PV cannot be principally refinanced via marginal-cost based markets." While economic theory prescribes marginal cost pricing, "wind and PV produce electricity when the wind blows and the sun shines, regardless of electricity price." The two do not heed the price signals required by this approach and economic theory, that production should go down as prices go down. And because wind and sun do not heed price signals, "in times when wind and/or sun is plentiful, wind and PV facilities produce so much electricity that prices decrease on the spot market, thus destroying their own market price." That is why they cannot be refinanced with marginal-cost pricing.

Agora states the fundamental market problem as follows: "Wind and PV cannot earn enough revenues to cover the average cost of their initial investment in the market, because the price will always be lower than the market price average whenever the wind is blowing or the sun shining, which is precisely when electricity can be produced from these weather-dependent technologies."

Agora's solution is in the next insight.

9. "A new Energiewende market is required." [80] This market will be designed differently—aside from its old function of balancing electricity supply and demand through price signals and marginal-cost pricing, it must also perform the new function of attracting the required investments for new plants, demand-side flexibility and storage technologies. Aside from its old revenue source of selling energy output (megawatt-hours), it must develop a new revenue source of selling energy capacity (megawatts).

The new investment market for megawatts must reward reliable, flexible supply- and demand-side resources to guarantee system reliability. Flexibility means quick ramp-up and ramp-down times for both power stations and loads. The participation of energy storage systems in the market must also be enabled.

The details of the new market's configuration must be further worked out. Agora listed several options, including premiums/bonuses, tenders/auctions, and certificates/quotas. The study made clear that the new market is a move beyond feed-in-tariffs, which have been the main drivers in the past of the renewable energy program of Germany.

Agora emphasized that the participation of citizens as well as SMEs was essential in the past. It would again be essential for the new market.

10. "The Energiewende market must actively engage the demand-side." By improving demand-side flexibility, more wind and PV sources can be integrated into the grid without relying on expensive storage. For instance, how can users be shifted en masse from period of little wind and sun to periods of high wind or sun? Because of inelastic demand, prices signals such as time-of-use pricing have not been very effective.

80 Energiewende means "energy transition" in German.

Where technological and behavioral approaches have worked, demand-side measures have invariably proven cheaper than supply-side or storage solutions. In many cases, some industry loads can be temporarily shifted without additional investment. Efficiency improvements in buildings can also reduce air conditioning requirements. Shifting to equally bright but cooler LED lighting can further reduce the air conditioning load, at the same time reduce electricity consumption, without sacrificing the lighting needs of building occupants. Demand-side participants should be able to participate more actively in bidding negative loads by eliminating onerous requirements. The next chapter covers this topic in more detail.

11. "The Energiewende market must be considered in the European context." Its connection to the larger European grid gives Germany unique advantages that are not available to smaller grids like ours. Nonetheless, it is still useful to know that enlarging our national grid by interconnecting the Luzon, Visayas and Mindanao grids will also be good for renewables, among its other benefits.

12. "Efficiency: A saved kilowatt-hour is the most cost-effective kilowatt-hour." This lesson has been proven again and again in various countries. Energy efficiency and conservation are the cheapest ways to make available more kilowatt-hours to meet the increasing demand for various energy services. This is explained further in the next chapter.

All the measures described in this chapter will help the grid cope with the variable output of wind turbines and solar panels.

Chapter 14. Improving energy productivity

Consumers pay for electricity because they want a particular service, like lighting (so that they can read at night), heating (to cook meals), mechanical power (to run a water pump or an electric fan), or electronic applications (to watch TV or use a computer). The latter are called energy services. Consumers are actually after these energy services, not electricity per se.

One can, for instance, imagine using a gas lamp to light up the evening's dinner, an LPG stove to cook one's meals, or the sun to dry one's clothes. It just so happens that consumers may prefer to use electricity to provide these energy services, because electricity is more convenient.

It is not always necessary to generate more electricity to make more energy services available to the consumer.

It is not always necessary to generate more electricity to provide more energy services to the consumer.

Consumers can also save on electricity that has already been generated, so that these savings may be used to provide additional energy services. In other words, they can improve the productivity of energy, so that the same amount of electricity can provide more energy services.

Energy productivity can be improved in two ways:

1. *Energy conservation.* A consumer can cut down on energy services which are wasteful, and then use the electricity saved for other energy services. By turning off a 50-W incandescent lamp in an empty room, for instance, the consumer saves on an energy service that was unnecessary anyway, and makes available 50 W that can now be used to provide another energy service. A watt saved, to be used elsewhere, is often called a "negawatt" because the watt became available not by being created in a generating plant, but by reducing the consumer's electricity consumption. Note that energy conservation costs very little, if at all, to implement. It is the cheapest way to provide more energy services.

2. *Energy efficiency.* A consumer can provide the same energy service, but use less electricity to provide the service. Replacing the 50-W incandescent bulb with a 12-W LED lamp that provides the same amount of light, for instance, saves 38 W but provides the same service. Now, every time the light is turned on in the room, 38 W are being saved, compared to the old lighting set up. These 38 "negawatts" can then be used to provide other energy services. Energy efficiency usually involves the replacement of a less efficient technology (like the incandescent lamp) with a more efficient one (like the LED lamp), thus it incurs some costs. Nonetheless, the costs are often considerably lower, compared to the investment needed to increase the generation capacity of a grid by 38 W.

Energy productivity is the term often used, to describe these two ways of providing more energy services without adding new generating capacity.

Measures that improve energy productivity are often cheaper than constructing new generating plants to provide the same amount of electricity. Muller, for instance, showed that in a typical American home, reducing energy consumption by investing in improved home insulation in the attic is equivalent to a tax-free, no-risk invesment with a 17.8% annual rate of return, while replacing a 75-W incandescent bulb with a 22-W CFL is a tax-free, no risk return on investment of 209% per year.[81] Today, LED lamps would make a much better replacement, due to concerns about mercury pollution from CFL lamps.

Muller estimates that, in general, the average return on investment of energy efficiency programs "is about 2.5 times greater than the return on a new power plant".[82]

The original and still the best advocate for energy efficiency has been physicist Amory Lovins, whose piece "Energy Strategy: The Road Not Taken"[83] carefully worked out the concept of energy efficiency, turning it into a workable, actionable program.

Improving energy productivity through demand-side measures such as these will perfectly complement parallel supply-side measures to speed up the shift from fossil-fuels to renewables.

The average return on investment of energy efficiency programs is about 2.5 times greater than the return on a new power plant.

In his book *Green Illusions*[84], Ozzie Zehner lumps all renewables with fossil-fuel and nuclear technologies and criticizes them as two sides of what he calls the "productivist" mindset, which responds to energy problems by producing more energy. Zehner argues that we should respond to our energy problems not by producing more energy, but by reducing our energy dependence.

Promoting renewables but retaining the "productivist" mindset, he says, will not solve but may even worsen our energy problems. The problems created by the never-ending vicious cycle of production and consumption, driven by the twin mindsets of productivism and consumerism, will dwarf and negate whatever energy we can get from renewables. Sooner or later, there will simply be not enough.

The problem is social and not technological, Zehner says and the solutions should be predominantly social in orientation too.

Unfortunately, Zehner presents his one-sided arguments too stridently, to the extent of over-exaggerating the costs and disadvantages of renewables, while underestimating their benefits.

81 Muller, pp. 114-119.

82 Muller, p. 120.

83 Amory Lovins, "Energy Strategies: The Road Not Taken," *Foreign Affairs*, October 1976.

84 Ozzie Zehner, *Green Illusions: The Dirty Secrets of Clean Energy and the Future of Environmentalism* (Lincoln/London: University of Nebraska Press, 2012).

“Someday,” Zehner says, “renewable energy will supply most of humanity's energy needs.”[85] But, he adds, “there likely won't be enough of the precious renewable energy to go around.”[86] This is where his energy reduction message comes in: reduction must come first, for the renewable approach to work.

Zehner argues that major social changes, rather than “technological fixes,” are the key towards the long-term resolution of the world's energy problems. Zehner asks, “Why do we seem to have a predisposition for preferring production over energy reduction?”[87] He blames this to the “productivist” mindset, which extends not only to energy production but also to human procreation, work ethic and other pursuits.

Zehner tends to lump together the fossil fuel and nuclear industry on one hand, and the solar and wind industry on the other, as two sides of the same “productivist” coin. He says, for instance: “As it stands now, even if alternative energy schemes were free, they might still be too expensive given their extreme social costs and striking inability to displace fossil fuel use. But as it turns out, they aren't free at all—they're enormously expensive.”[88] Zehner then proceeds to explain how renewables and energy efficiency can also lead to the “boomerang effect,” where energy savings lead to greater consumption elsewhere.

Despite the strident rhetoric, over-exaggerations, and highly questionable anti-solar and anti-wind data, the energy solutions that Zehner suggests nonetheless turn out to be surprisingly simple and down-to-earth.

Because they are socially- rather than technologically-oriented, the suggestions might be more challenging to implement, but they deserve serious consideration. In fact, these suggestions would complement nicely our efforts to make the energy transition to renewables. This is why we took the effort to wade through the strident arguments to dig out the interesting socially oriented suggestions:

Zehner's suggestions offer opportunities “to consume less energy and enjoy the benefits of doing so”. These include[89]:

Focus on women's rights: This has “greater potential for reducing greenhouse gases, preventing resource conflicts, shrinking energy consumption and improving human wellbeing than all of the solar cells, wind turbines and hybrid cars that we could possibly churn out of our manufacturing plants.” Zehner first presents long and detailed arguments about the need to scale down human population towards some lower level optimum. This can be done, he says, by focusing on the individual reproductive rights of women, and as an end in itself, which will result in positive changes that will propagate throughout society. After going through his long chain of arguments (basically: women's rights, lower birth rates, decreasing population, decreasing consumption and production and easier solutions to energy problems), Zehner concludes: “There can be little argument, then, that advancing the rights of women and girls is an important ethical goal in its own right that could also dramatically lower the incidence of abortion, save billions of dollars in health-care costs, increase wellbeing, strengthen communities and handily offset more fossil fuel consumption than all of the nation's existing and planned solar cells, wind turbines and biofuels *combined*.” Maybe so, but

85 Ibid., p.176.
86 Ibid.
87 Ibid., p. 140.
88 Ibid., p. 173.
89 Ibid., Part III.

Zehner's either/or approach is seriously flawed. Is it not better to promote *both* women's rights and clean renewables?

Improving consumption: Zehner reserves his most virulent tirades against consumerism, especially when it carries the labels “natural”, “sustainable”, “green”, “organic”, “fair trade”, or “local.” He concludes that “the *best* material consumption is *less* material consumption.” Zehner says that the consumerist mindset is drilled by media into children early in life, and the bombardment never stops; using such strategies as infiltration, “bro-ing” (commodification of radical youth culture), spying and exploitation of children, and neuromarketing. The result: extreme over-consumption and “affluenza.” Improving consumption, he says, involves “enticing people” to 'prefer lower-energy but higher-quality lifestyles. To do so, he variously suggests downshifting, volunteering, eliminating ads that target children, setting up social enterprises for youth, taxing consumption not income, smart packaging, discouraging junkmail, abandoning GDP for better measures of wellbeing, shifting budget from military to energy security, and vegetarianism—good suggestions, actually.

Architecture of community: According to Zehner, paying attention to the architecture of communities will enable major energy savings at little or no cost. He starts by launching another long tirade against suburbanization. His alternative is the village model, a number of which can comprise “bikeable” cities that provide options for walking, bikes, public transit and taxis. These options should provide better facilities for walking, show sensitivity to the needs of non-motorists, and implement traffic calming of residential neighborhoods. The use of motor vehicles should be restricted more, both motorists and non-motorists should be rigorously educated about traffic, and traffic regulations should be strictly enforced to protect pedestrians and bicyclists. He praises the following trends: from cars to cafes, from parking to parks, car sharing, congestion pricing, prioritizing bicycle roadways, bicycle insurance, reform zoning and retrofitting suburbia. In short, a radical redesign of human habitats and built environments.

Efficiency culture: This is basically the same energy efficiency concept that Zehner earlier lambasted for its “boomerang effect” (savings leading to greater consumption elsewhere), but now in the context of an energy reduction mindset. It is possible to enjoy comfort from simple materials, functional furniture, and small footprints, he says, citing 17th century Dutch homes which “still stand as seamless mixture of culture, community and economy rendered in brick and mortar”. Zehner goes deeper into the cultural roots of their design, then proceeds to see how these can be applied to modern American homes. Zehner describes some of these Dutch designs which still exist today: “The most efficient homes populate older, mixed-use downtown neighborhoods and occupy small lots, close to shops, restaurants, neighbors and public transit. They aren't too large, which minimizes construction materials, decreases heating and cooling requirements, and prevents them from doubling as storage units for runaway material accumulation. They have windows with adjustable shades, plenty of roof and wall insulation, adequate weather stripping, energy-efficient appliances and kitchens with linoleum floors. These homes are unremarkable indeed—hardly the fodder of green-eyed journalists—but they are also unremarkably green. And it may be worth noting that there is a correlation between living in these walkable neighborhoods of unremarkable homes and personal satisfaction. Unremarkably green homes make people happy— high-tech homes make them poor.”

It is unfortunate that Zehner's toxic style, one-sided argumentation and careless use of questionable data to disparage renewables—only to admit eventually that he also sees them as our future—can lead his readers to ignore what are actually good complementary measures to facilitate the energy transition to renewables. Many advocates of renewables promote his various advocacies, possibly before he even started thinking about these issues. And yet they will probably be alienated by, or even find themselves at the receiving end of his shotgun approach and sweeping attacks.

This is also a good time to clarify the relationship between social and technological approaches. Zehner draws a sharp line between the two—to the extent of ignoring their dynamics. We prefer to think of social and technological approaches as complementary strategies that work best when they mutually support each other. We agree with Zehner that social approaches should take precedence much of the time. But we do not share his absolutist stance that technological approaches—like renewables—will make things worse, unless the required social changes are already in place. Sometimes—perhaps often—technological changes can themselves initiate social changes too. It was E.F. Schumacher who said that many technologies in fact contain built-in value-systems, and when a particular technology is adopted, its users will find it hard to avoid absorbing the value-system—ideology, if you will—that is embedded into that technology. Others have expressed it differently: that we create tools and technologies for ourselves, but once we use them, they will change us too, and sometimes in ways that we did not anticipate. In short, technologies can also be drivers of social change themselves, for better or for worse.

Let us take the example of solar power on one hand, and wind/hydro power on the hand. Because solar power can be installed on a roof, every household has the potential to use the technology to attain energy independence. Because wind and hydro—and for that matter most big generating plants—attain better efficiencies as they are scaled up, the most efficient will be those operated by big, capital-rich organizations like corporations and governments. It is easy to see that the spread of solar panels on rooftops will lead to very different social consequences compared to the spread of wind and hydro power, even if the latter are both renewable. For instance, those who rely on solar power for most of their electricity will probably start to reorganize their household activities so that the electricity-intensive ones happen during the daytime.

A similar observation can be made between household-scale storage technologies like batteries and fuel cells on one hand and grid-scale storage technologies like pumped hydro, liquid metals or compressed air on the other hand. Household-scale technologies will encourage highly-independent thinking in households, while large-scale technologies will give rise to high-centralized social, economic and political institutions to manage these technologies.

The role of technologies in changing our energy base is again illustrated by authors McDonough and Braungart who wrote that "[technological] design is a signal of intention." They look at the entire history of industrial revolution and development as a parade of (mostly bad) designs.

The two authors think in the same broad strokes as Zehner, but they approach the same problems in a much more positive way—that is, without Zehner's toxic carping that makes enemies out of friends and potential allies.

McDonough and Braungart's book *Cradle to Cradle: Remaking the Way We Make Things* includes stories about their (and others') efforts to redesign technologies based on a different perspective.[90] It describes how the authors embedded a different value-system or ideology, so to speak, in their designs, with spectacularly positive consequences in various areas, including energy consumption.

Like Zehner, McDonough and Braungart were not content with the "less bad". "What about a different model?" they ask. "What would it mean to be 100% good?"

It meant the redesign of existing technologies or creation of new ones by embedding a different set of

90 William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things,* (New York: North Point Press, 2002).

design intentions within their products, particularly the intention not just to be "less bad," but to be "100% good." The McDonough-Braungart approach is decidedly a combination of social intentions and technological implementation.

Consider for instance how the two, who were also business partners, designed in the early 1990s a compostable upholstery fabric for mass production. The design was not focused on energy, but is nevertheless a perfect illustration of their approach. Their first try used natural cotton and recycled PET bottles. Since upholstery gets abraded during normal use, they had to make sure that minute particles from the material, if swallowed or inhaled, will not be harmful. PET did not fit the bill. Combining the two materials into a hybrid also meant that the worn fabric could neither be composted nor easily recycled. Instead of settling with this "less bad" material, they worked on something else that was "100% good," they "decided to design a fabric that would be safe enough to eat: it would not harm people who breathed it in, and it would not harm natural systems after its disposal. In fact, as a biological nutrient, it would nourish nature."

We will now let McDonough and Braungart continue to tell their story:

> "The team decided on a mixture of safe, pesticide-free plant and animal fibers for the fabric: wool, provides insulation in winter and summer, and ramie, which wicks moisture away. Together these fibers would make for a strong and comfortable fabric. Then we began working on the most difficult aspect of the design: the finishes, dyes, and other process chemicals. Instead of filtering out mutagens, carcinogens, endocrine disrupters, persistent toxins, and bioaccumulative substances at the end of the process, we would filter them out at the beginning. In fact, we would go beyond designing a fabric that would do no harm: we would design one that was nutritious.
>
> ". . . We ended up selecting only thirty-eight [chemicals], from which we created the entire fabric line. What might seem like an expensive and laborious research process turned out to solve multiple problems and to contribute to a higher-quality product that was ultimately more economical.
>
> "The fabric went into production. The factory director later told us that when regulators came on their rounds and tested the effluent (the water coming out of the factory), they thought their instruments were broken. They could not identify any pollutants, not even elements they knew were in the water when it came into the factory. . . . The equipment was fine; it was simply that by most parameters the water coming out of the factory was as clean as—or even cleaner than—the water going in. When the factory's effluent is cleaner than its influent, it might well prefer to use its effluent as influent. Being designed into the manufacturing process, this dividend is free and requires no enforcement to continue or to exploit. Not only did our new design process bypass the traditional responses to environmental problems (reduce, reuse, recycle), it also eliminated the need for regulation, something that any businessperson will appreciate as extremely valuable.
>
> "The process had additional positive side effects. Employees began to use, for recreation and additional work space, rooms that were previously reserved for hazardous-chemical storage. Regulatory paperwork was eliminated. Workers stopped wearing the gloves and masks that had given them a thin veil of protection against workplace toxins. The mill's products became so successful that it faced a new problem: financial success, just the kind of problem businesses want to have.

> "As a biological nutrient, the fabric embodied the kind of fecundity we find in nature's work. After customers finished using it, they could simply tear the fabric off the chair frame and throw it onto the soil or compost heap without feeling bad—even, perhaps, with a kind of relish. Throwing something away can be fun, let's admit it; and giving a guilt-free gift to the natural world is an incomparable pleasure."[91]

In energy systems, McDonough and Braungart promote the energy-efficiency concepts originated by Lovins in the design of homes and buildings. But they eschew the term "efficiency" and prefer to call their approach "eco-effectiveness." They cite various examples of traditional architecture that had solved the problem of keeping homes comfortable despite extremes in outside temperature. To them, "connecting to natural energy flows is a matter of reestablishing our fundamental connection to the source of all good growth on the planet: the sun, that tremendous nuclear power plant 93 million miles away." From this perspective, they say, "the greatest innovations in energy supply are being made by small-scale plants at the local level. For example, in our work with one utility in Indiana, it appears that producing power at the scale of one small plant for every three city blocks is dramatically more effective than more centralized production. The shorter distances reduce the power lost in high-voltage transmission to insignificant levels."

They tell another story about how they designed a building:

> "Working with a team assembled by Professor David Orr of Oberlin College, we conceived the idea for a building and its site modeled on the way a tree works. We imagined ways that it could purify the air, create shade and habitat, enrich soil, and change with the seasons, eventually accruing more energy than it needs to operate. Features include solar panels on the roof; a grove of trees on the building's north side for wind protection and diversity; an interior designed to change and adapt to people's aesthetic and functional preferences with raised floors and leased carpeting' a pond that stores water for irrigation; a living machine inside and beside the building that uses a pond full of specially selected organisms and plants to clean the effluent; classrooms and large public rooms that face west and south to take advantage of solar gain; special windowpanes that control the amount of UV light entering the building; a restored forest on the east side of the building; and an approach to landscaping and grounds maintenance that obviates the need for pesticides or irrigation. These features are in the process of being optimized—in its first summer, the building began to generate more energy capital than it used—a small but hopeful start. Imagine a building like a tree, a city like a forest."[92]

Theirs is renewable design, not just of energy sources but the total context in which energy is used. As they said, not just "less bad" but "100% good."

In summary, this chapter emphasizes that we should not only look at the *production* of electricity, but also at *reducing* our over-reliance on this form of energy. We can imagine the act of saving as an act of production too, because any kilowatt-hour saved is now available for other uses.

And very effective ways of saving can be found if we go beyond the sector of electricity—or even the field of technology—into our social practices and lifestyles, and into the way we structure our communities, our relationships and our lives.

If we manage to do this, we will find that renewables are more than enough to cover all our

91 Ibid., pp. 107-109.
92 Ibid., 138-139.

electricity needs. But if we remain stuck in our current social structures, there will never be enough electricity—renewable and non-renewable—to meet our insatiable wants.

Chapter 15. Recommendations

This study will focus its recommendations on four major areas: removing barriers to the entry of small players, setting RE standards, fine-tuning FIT and more innovative financing.

Prioritizing small players

Recommendation 1: *The government should mandate true net metering at once.* Distribution utilities should be strictly monitored to prevent any discrimination and artificial barriers against customers who are exporting their surplus renewable electricity to the grid. The misdefinition of net metering in favor of DUs and the various barriers against net metering is the single biggest flaw in the government's renewable energy program. True net metering is based on parity pricing.

The government should mandate *true net metering* at once.

Recommendation 2: *Because of their higher efficiency, RE consumption-at-source should get government priority.* The lack of proactive measures in favor of small RE players who consume much of what they produce is the second biggest flaw in the government's RE program. This is especially urgent for rooftop solar facilities.

Recommendation 3: *All buildings of the national and local governments should start installing solar panels with grid-tied inverters on their rooftops.* This is imperative, not for any missionary reason, but to save on their electricity bills. Under true net metering, they will save even more as they expand their capacity.

Government institutions that occupy sufficiently big tracts of land and where the wind conditions are favorable, including state colleges and universities and other land grants, should install wind turbines upon determination of feasibility, to further save on their electricity bills.

Cash-strapped agencies and LGUs can tap government institutional financing or other innovative financing schemes to cover the high upfront costs of RE.

Priority should be given to those who use renewable electricity most efficiently, i.e., those who consume what they produce.

Setting RE standards

Recommendation 4: *The government should immediately adopt and enforce RE-friendly standards for electric meters, grid-tied inverters and other RE equipment.* The standards should allow only electric meters for utility customers that accurately measure energy flow in either direction, as the older analog meters do, to ensure the implementation of true net metering. The government should adopt internationally accepted standards for grid-tied inverters that maximize the use of power from internal sources such as PV panels, before bringing in electricity from the utility. Utility customers should be able to install standards-compliant RE equipment such us inverters, controllers, batteries, etc. without the need for additional permission, impact studies, acceptance testing or installation charges from distribution utilities.

Recommendation 5: *The government should impose strict labeling requirements on RE equipment.* Labels should include sufficient and accurate information about the guaranteed specifications and performance of the equipment, and suppliers should be closely monitored for compliance with their claims and guarantees.

Recommendation 6: *Government or academic institutions should set up independent testing facilities to counter-check product specifications and claims*. All kinds of claims are being made today about RE products. Without third-party testing, unscrupulous suppliers can take advantage of the naïveté and lack of information of consumers who are enthusiastic to jump into the RE bandwagon.

To preserve its credibility, the government should resolve at once the grid connection problems of FIT-qualified RE developers.

Fine-tuning the FIT

Recommendation 7: *The grid connection problems of FIT-qualified RE developers should be solved forthwith by the government.* Decisive government action is essential in this matter to preserve the credibility of the government.

Recommendation 8: *The government should immediately commission a risk analysis of the impact of variable-output renewable resources such as solar and wind, including the impact of large numbers of small players, on the stability of the grid.* It should also commission a feasibility study to explore the concept, originating from Germany, of creating a market for the reduction of risk associated with variable-output sources of electricity.

Recommendation 9: *Pumped-hydro projects should be fast-tracked, and more sites for these should be explored and developed.* This should happen along with the expansion of solar and wind projects, to provide sufficient energy storage.

Research, development and commercialization should also be fast-tracked on the use of electric vehicles for grid storage and on various smart grid applications that allow utilities to "suggest" shorter duty-cycles to intermittent loads such as air conditioners as well as non-essential loads.

Recommendation 10: *The determination of degression rates and period coverage should be transparent, with the target year for ending the universal charge clearly indicated.* The government should take into account the actual savings contributed by RE facilities that come on line during peak hours. The government should likewise study the feasibility of "price-neutral" FIT rates, as explained in Chapter 8.

Recommendation 11: *The government should ensure that the savings from lower renewable electricity prices are shared with ratepayers.*

The savings from lower renewable electricity prices should be shared with ratepayers.

Recommendation 12: *The government should adopt none of the following toxic incentives*:

- *No sovereign guarantees.* Under a sovereign guarantee, the Philippine government—and in the final analysis, the Filipino taxpayer—would take responsibility for loans incurred by project developers, if the latter are unable to pay for these themselves. Such guarantees have been granted to energy projects in the past, both nuclear and coal. This study recommends excluding sovereign guarantees to any energy project, renewable or not.

- *No opportunity sales.* Opportunity sales are contract provisions that require the government or any other contracting party to continue paying for the outputs specified in the contracts, even if the developer does not generate this output, as may happen in unforeseen situations when demand for electricity unexpectedly collapses (as in the 2008 financial crisis). We call them opportunity sales since the government is contractually obligated to pay for electricity which was not generated—based on the power producer's claim that it has lost, through no fault of its own, the opportunity to sell the electricity it would have generated.

- *No sacrificial consumers.* Consumers become sacrificial lambs when they end up bearing all the sacrifices in terms of higher electric bills, while developers enjoy not only premium rates in sales, but also shrinking costs, as the trend in the wind and solar PV industry indicates. Early enough in the process, the decreasing costs of renewable electricity production should also be reflected as a decrease in the end-user price of electricity. The fair approach is to split the benefits of RE cost savings between the consumer and the RE developer.

Like any other business firms, RE developers can be expected to ask for terms as favorable to them as possible, for as long as possible. As a matter of public policy, it should be recognized that RE developers certainly do deserve favorable terms for a while. However, these should be balanced by the interests of the electricity end-users, who also deserve as much, if not more, in terms of fair treatment.

Innovative financing and others

Recommendation 13: *The government should encourage business models—such as solar leasing, PPAs and loan payments through property taxes—that solve the problem of high upfront costs of renewables.* The government should also encourage more financial institutions to provide greater access to credit for these business models. These can be done through enabling policies as well as incentives. The new Pag-IBIG window for loans of up to P130,000.00 for solar PV installations in new housing is a very good step in the right direction. Similar loans should be made available for existing housing. GSIS, SSS, Landbank and other government lending institutions should get into the act too.

Recommendation 14: *Cash rich local governments like Quezon City or Makati should support RE development.* They can, for instance, lend money to homeowners for the purchase and installation of solar PV systems at very reasonable interest rates and collect the annual payments as part of the homeowners' property tax. Even cash-strapped LGUs can get into the act by refinancing their solar PV loans through commercial banks. The payments can still collected as part of property taxes to ensure high payment rates, so that they can fall under the low-risk loan category that banks prefer.

Recommendation 15: *Put all RE data online for easy access.* The government should put all data on renewable energy resources in the country online, in an easily accessible and downloadable form. This enables any locality to search the database and determine the RE potential that is available in their area.

The next chapter will focus on our recommendations specific to the "power crisis" being anticipated in 2015.

The government should encourage more financial institutions to provide greater access to credit for innovative business models.

Chapter 16. Dealing with the 2015 shortfall

There are currently [in 2014] lots of talk about an electricity supply shortfall that will hit the Philippines in 2015, as demand continues to grow and supply provision lags behind. A 500-MW shortfall in supply has been predicted.

The proposed solutions to this anticipated crisis range from fielding barge-mounted, oil-fueled power plants that can be put online quickly, to building more coal plants over the medium-term, and even returning to the nuclear option over the long-term.

In fact, the actual expected shortage is only 31 MW, over two weeks in April, according to a testimony of DOE Assistant Director Irma Exconde in October 2014 before Congress. Exconde clarified that they had announced a much larger shortage because the DOE also wanted to maintain the ideal reserve of 647 MW, as backup for the largest power generating unit in Luzon. The DOE's proposed solution was "negotiated contracts for rental or for purchase of generator sets for additional power supply for the summer months, which would cost the government an estimated amount of P6 billion to P10 billion."[93]

Using Table 3 in Chapter 1, we can calculate how much solar PV capacity can P10 billion buy: 90.9 MWp, available when the sun is up in the summer sky, precisely during the hours when power for air conditioning is needed most. Furthermore, the P10 billion will not only cover the expected two-week shortage in April 2015, but will also be supplying afterwards 10 million kWh per month of electricity for the next 20 years!

**To deal with the 2015 shortfall, adopt an ambitious goal:
all new demand should be met through renewable energy.**

To minimize the financial burden on the government, the P10 billion can be released in the form of low-interest emergency loans. If the loans are payable in ten years or more, the monthly savings generated by the PV systems will be more than enough for paying back the loans.

Given these and the points raised in the rest of this study, it is clear that the 2015 shortfall can be met by renewables alone. This is the approach that we recommend to the government.

We strongly recommend that the government adopt decisive measures in 2015 to jumpstart its renewable energy program through a specific and ambitious goal: *henceforth, all new demand should be met through renewable energy.* Let all existing fossil-fueled plants operate in the meantime, but *all future expansion should be based on renewable sources.*

After all, the critical period is expected to materialize only at the onset of summer, when the need for

93 Lira Dalangin-Fernandez, "DOE: 2015 power crisis an issue of reserves, not supply; negotiated deals for gensets junked," October 20, 2014, http://www.interaksyon.com/article/97611/doe-2015-power-crisis-an-issue-of-reserves-not-supply-negotiated-deals-for-gensets-junked.

daytime air conditioning will stress the ability of existing plants to meet the demand. But the highest insolation also occurs during summer days, in right synchrony with the higher demand. Solar power is clearly the most appropriate solution for the increased summer demand. If the government has to subsidize anything, let it be a renewable solution, not a fossil fuel-based solution.

Secretary Petilla has already acknowledged that it is cheaper for consumers to generate their own electricity with solar panels, than to buy coal-based electricity from the grid. In this regard, wind-based electricity is not far behind. This is further confirmed by the rush of solar and wind projects that applied for FIT support, forcing the DOE to adjust their solar thresholds ten-fold.

And solar was, in the past, considered the most expensive of the renewables, while coal was considered the cheapest. The cost/pricing situation has changed dramatically in the past few years.

Clearly, the issue of cost is already settled. More so in the future, as solar and wind electricity continue to get cheaper, while non-renewables continue to get more expensive. It will be foolhardy to lock-in ourselves today to technology options which are dirty or unsafe—or both—and which will cost us even more in the future, not only in monetary terms but also in their health, environmental and social impacts.

In the past, the solar option was saddled by a financing problem. Since most of solar costs were incurred at the investment, pre-operational stage, early adopters were forced to pay five to seven years' worth of future consumption, in effect, in order to realize savings after the upfront costs have been paid back. No bank was willing to underwrite these upfront costs for households and small businesses, which were generally considered poor risks. Also, consumers were not inclined either to go into debt for those many number of years to save on their electricity bill.

Opening the floodgates to solar rooftops will not raise electricity prices but will bring it down, because solar panels work best at noon, replacing expensive electricity from "peaking" plants.

But the entry of Solar Philippines and its business model has changed all this. Under this model, the solar PV system supplier, who knows the technology best, assumes the risks. Consumers then realize savings, starting on the first day of operation, and banks are more willing to lend to a business with PPAs.

In short, the financing barrier is now being solved too. The only problem is that Solar Philippines may not be able to grow fast enough to meet the demand unleashed by its business model. Leviste's company is also biased against residential customers, who are still asked to pay for the full upfront costs of PV systems. Thus, more companies have to get into the act, including ones that focus on low-income residential customers. More banks too.

The government simply needs to do everything it can to encourage more business models of this kind, perhaps by assuming part of the risks itself. The entry of a government agency into solar lending, such as extending loans of up to P130,000 for the purchase of a solar PV system when a Pag-IBIG member constructs a new house, is a big step. It will even be better if similar loans were extended to members who also want to retrofit their existing house with solar panels. Other government agencies like SSS, GSIS and the Landbank should also get into the act.

The government should definitely not use the 2015 crisis to justify new construction of coal plants. By the time these plants are ready to go online, the price of their output would have escalated, while the cost of renewables would have gone down even further. And we will be caught in the worst situation of all: locked into a non-renewable and highly-pollutive technology whose fuel we must import and whose output gets more expensive year after year.

If we succeed in 2015 in meeting new demand with renewables—and only renewables—subsequent years will be easier because renewables get cheaper year after year.

Opening the floodgates to solar rooftops will not raise the price of electricity but will bring it down. This is because the solar panels work best at noon, when the demand is also high and the supply must be supplemented with peaking plants which charge a premium for their services. Since the cost of solar electricity is lower than peak prices, switching to solar will bring down the average cost of generating electricity. This should result in lower electricity rates, as long as the savings are passed on to consumers.

In the Philippines, the greatest motivator today for the adoption of RE is the high cost of electricity. If the government removes all barriers to the entry of households, small businesses and other small players in the RE industry, we can expect consumers to adopt the cheaper RE alternatives in droves.

Congress seems amenable to grant emergency powers to President Aquino, to enable him to react quickly to the power crisis. Should the President get such powers, the best thing he can do is to use these powers to implement our recommendations immediately, starting with the removal of barriers to the participation of ordinary citizens in the country's renewable energy program.

The biggest missing piece, after financing, is net metering.

If a single company like Solar Philippines can install 50 MW within a year, there is no reason why a crash RE program initiated under the President's emergency powers cannot do 10 times that, if it goes all out to prevent a 2015 power crisis.

Indeed, the 2015 shortfall is a timely opportunity to fast-track the government's renewable energy development program.

Chapter 17. Should you try solar now?

This study has focused on solar energy because PV systems can be bought off-the-shelf and are simpler to install and maintain compared to wind or small hydro. The continuing drop in the prices of solar panels and associated equipment has convinced us that it is now time for everyone to seriously consider trying this technology—at the level they can afford.

Of course, just like cellphones, computers and similar silicon-based products, dropping prices mean that the longer you wait, the cheaper these things will be. However, waiting also means that you are in the meantime foregoing the benefits of using the technology and learning more about it. So, you will simply have to decide at a certain point that you have done enough waiting, and that it is now time to try.

But before you do, make sure you have kept a detailed record of your electricity consumption, so that you can compare your bill before and after installing your solar panels. It is best if you have data of your consumption and electric bill for at least the previous 12 months.

We suggest that your first try be an exploratory one. Do not try to become grid-independent overnight by producing yourself your entire consumption right away. Also, avoid at the start the additional complication and cost of a battery. Add this option later, after you have mastered the basics of replacing watts from the electric utility with watts from the sun and are confident about the various costs.

We suggest that you start small, say 50 to 500 Wp.

Assuming that yours is within the range of a typical household, we suggest that you start small, say 50 to 500 Wp, depending on your budget. Try to size your system so that it will register enough savings for you to see a noticeable drop in your electric bill, say a 25–35% drop.

Let us say that your current consumption is 200 kWh per month. If you target 30% savings, this means you want to produce around 60 kWh per month. Using Table 3 in Chapter 1 to convert kWh per month to kWp, you will arrive at $60 \div 114.75 = 0.523$. This means you need a PV capacity of 0.523 kWp or 523 Wp. You can use two 250-Wp panels, which will produce around 57.4 kWh per month (0.5×114.75).

Once you have determined from your own experience the true costs and benefits of solar electricity, you can then expand your set-up as you see fit and as your pocketbook will allow. Getting your feet wet and testing the water first also postpones your full commitment, giving the prices more time to drop further.

For your decision-making process, you can use the formula for the payback period of a solar PV system given in Appendix B.

Note that the payback period is *not* sensitive to either the capacity of the PV system or its life time—

as long as the system lasts longer than the payback period. This means that a 50-Wp system will have the same payback period as a 500-Wp or a 5-kWp system. This also means that systems whose panels last for only 15 years will have the same payback period as systems with 20-year or 30-year panels. Of course, your return on investment is much better, the longer the panels last.

Five variables determine payback period

The payback period depends on five variables.

Variables with a direct effect on the payback period:

- the price per kWp of the solar PV system (the higher the price, the longer the payback period)
- the bank lending rate (the higher the rate, the longer the payback period)
- the percentage of savings spent for maintenance, repair, and other expenses (the bigger the percentage that go to miscellaneous expenses, the longer the payback period)

Variables with an inverse effect the payback period:

- the peak-hours per day (the more the hours, the shorter the payback period)
- the retail price of electricity and its rate of escalation (the higher the price as well as its escalation rate, the shorter the payback period)

Below are some assumptions you can use. We will give figures for three system capacities: 50 Wp, 500 Wp, and 5,000 Wp (5 kWp). The table below is for a 50-Wp system:

Table 19. Solar Calculations for a 50-Wp PV System

		Assumed	Calculated	Units
1	System capacity, watts-peak	50		watts-peak
2	Current cost of PV systems, with installation, P/Wp	110		pesos/Wp
3	Total cost of system, pesos (#1 x #2)		5,500	pesos
4	Peak-hours, hours per day	4.5		peak-hrs/day
5	Gross output, kWh/month (#1 x #4 x 30 days/month)		6.75	kWh/month
6	Electrical efficiency, %	85%		%
7	Net output, kWh/month (#5 x #6)		5.7375	kWh/month
8	Retail price of electricity, pesos per kWh	11.50		pesos/kWh
9	Bank interest rate, % per year	9.00%		%/year
10	Average escalation in the retail price, % per year	5.00%		%/year
11	Adjusted interest rate/month ((1+#9)/(1+#10) – 1)/12		0.32%	%/month
12	Electric bill savings per month (#7 x #8)		65.98	pesos/month
13	Maintenance, repair and misc. expenses, % of savings	15%		%
14	Amortization expense, pesos/month (#12 x (1-#13))		56.08	pesos/month
15	Payback period, months (r = #11, A = #14, L = #3)		117.7	months
16	Payback period, years (#15/12)		9.8	years

Source: Author’s calculations.

The next table is for a 500-Wp system:

Table 20. Solar Calculations for a 500-Wp PV System

		Assumed	Calculated	Units
1	System capacity, watts-peak	500		watts-peak
2	Current cost of PV systems, with installation, P/Wp	110		pesos/Wp
3	Total cost of system, pesos (#1 x #2)		55,000	pesos
4	Peak-hours, hours per day	4.5		peak-hrs/day
5	Gross output, kWh/month (#1 x #4 x 30 days/month)		67.5	kWh/month
6	Electrical efficiency, %	85%		%
7	Net output, kWh/month (#5 x #6)		57.375	kWh/month
8	Retail price of electricity, pesos per kWh	11.50		pesos/kWh
9	Bank interest rate, % per year	9.00%		%/year
10	Average escalation in the retail price, % per year	5.00%		%/year
11	Adjusted interest rate/month ((1+#9)/(1+#10) – 1)/12		0.32%	%/month
12	Electric bill savings per month (#7 x #8)		659.81	pesos/month
13	Maintenance, repair and misc. expenses, % of savings	15%		%
14	Amortization expense, pesos/month (#12 x (1-#13))		560.84	pesos/month
15	Payback period, months (r = #11, A = #14, L = #3)		117.7	months
16	Payback period, years (#15/12)		9.8	years

Source: Author's calculations.

Solar panels currently (2014) sell for P45 to P65 per watt-peak.

And the following table is for a 5 kWp system. The figures are somewhat different from Mike de Guzman's (Chapter 3) due to slightly different assumptions.

Table 21. Solar Calculations for a 5K-Wp PV System

		Assumed	Calculated	Units
1	System capacity, watts-peak	5,000		watts-peak
2	Current cost of PV systems, with installation, P/Wp	110		pesos/Wp
3	Total cost of system, pesos (#1 x #2)		550,000	pesos
4	Peak-hours, hours per day	4.5		peak-hrs/day
5	Gross output, kWh/month (#1 x #4 x 30 days/month)		675	kWh/month
6	Electrical efficiency, %	85%		%
7	Net output, kWh/month (#5 x #6)		573.75	kWh/month
8	Retail price of electricity, pesos per kWh	11.50		pesos/kWh
9	Bank interest rate, % per year	9.00%		%/year
10	Average escalation in the retail price, % per year	5.00%		%/year
11	Adjusted interest rate/month ((1+#9)/(1+#10) – 1)/12		0.32%	%/month
12	Electric bill savings per month (#7 x #8)		6598.13	pesos/month
13	Maintenance, repair and misc. expenses, % of savings	15%		%
14	Amortization expense, pesos/month (#12 x (1-#13))		5608.41	pesos/month
15	Payback period, months (r = #11, A = #14, L = #3)		117.7	months
16	Payback period, years (#15/12)		9.8	years

Source: Author’s calculations.

Let us go through the variables that influence the payback period.

PV system cost

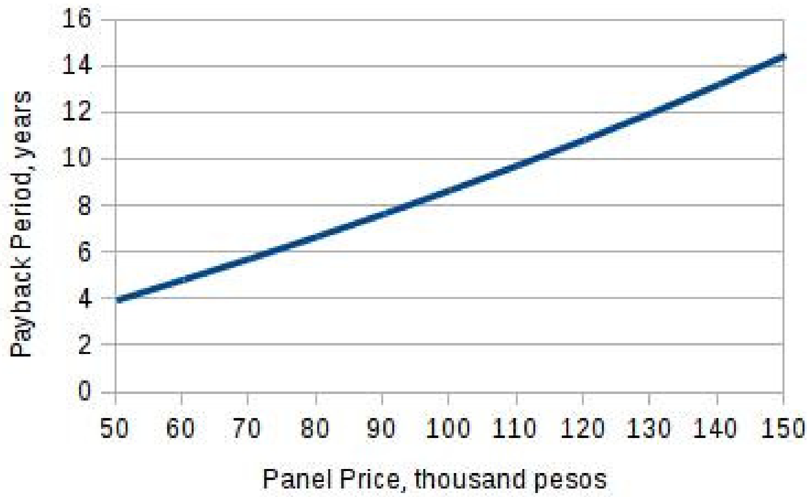
Solar panels, the component that actually converts sunlight to direct current electricity, currently (2014) cost from P45.00 to P65.00 per Wp. Suppliers charge higher for what they claim are better quality panels (for example, if they are made in Germany or Japan instead of China, or if they are “class A” Chinese-made panels). However, it is hard at this time to evaluate the various quality claims. An independent body that can conduct such an impartial evaluation would be extremely helpful to consumers today.

Complete solar PV systems cost from P90 to P130 per watt-peak.

A solar PV system includes, in addition to the solar panels, an inverter, and an optional battery accompanied by a charge controller. The general rule today is that a complete system (minus the battery) costs around twice the cost of the solar panels. Applying this rule to the range above gives a system cost range of P90.00–P130.00 per Wp. A properly-sized battery and charge controller costs about as much as the panels themselves. So if you want this option, figure on a system cost that is at least three times the cost of the solar panels alone. Considering that batteries have a much shorter life than solar panels, we would suggest, for your first trial, to avoid the additional costs and complications of a battery and a charge controller.

As the solar PV market expands rapidly, consumers would need to be protected from deceptive advertising and false claims concerning the specifications and capabilities of solar panels, controllers, unscrupulous suppliers can spoil the benefits of switching to solar energy. The government should ensure the protection of consumers through standards setting, rigorous testing and regular market monitoring.

Figure 6. Sensitivity of Payback Period to Panel Price



Source: Author’s calculations.

Mike de Guzman of Makati (see Chapter 3) spent P500,000.00 for a 5 kWp system or P100.00 per Wp.[94] According to de Guzman's calculations, a 250-Wp solar panel saves P200.00–P500 per month. Thus, each watt-peak saves P0.80 to P2.00 worth of electricity consumption per month. Our estimate is P1.32 per month per Wp, which is within the range given by de Guzman. Since the solar PV system cost him P100.00 per Wp, his P100.00 per Wp investment is earning P1.32 (1.32%) per month or 15.8% per year.

The analysis of the sensitivity of the payback period to changes in PV system prices shows a direct linear relationship. With PV prices continuing to go down, this factor is the major driver for reduced prices of solar electricity in the future.

Escalation rates of electricity prices

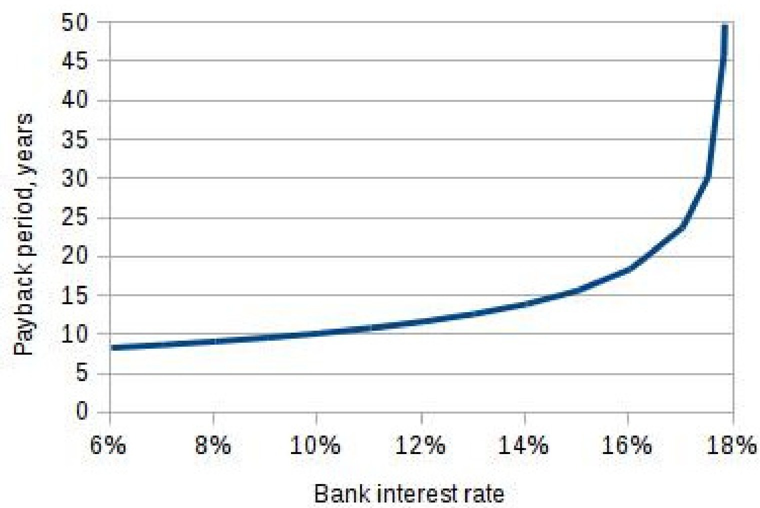
The payback period is quite sensitive to lending rates, which are often the basis of the discount rates used in evaluating the feasibility of investments. The growth in the solar PV market today is benefiting immensely from the lower interest rates currently prevailing in the country.

The payback period is sensitive to a big increase in bank interest rates. If the current 9% per annum rate doubles, for instance, then the viability of solar PV projects will be threatened. However, for

94 http://www.rappler.com/business/industries/173-power-and-energy/64165-solar-power-ph-households-net-metering.

small changes in the interest rate, the change in the payback period is relatively linear.

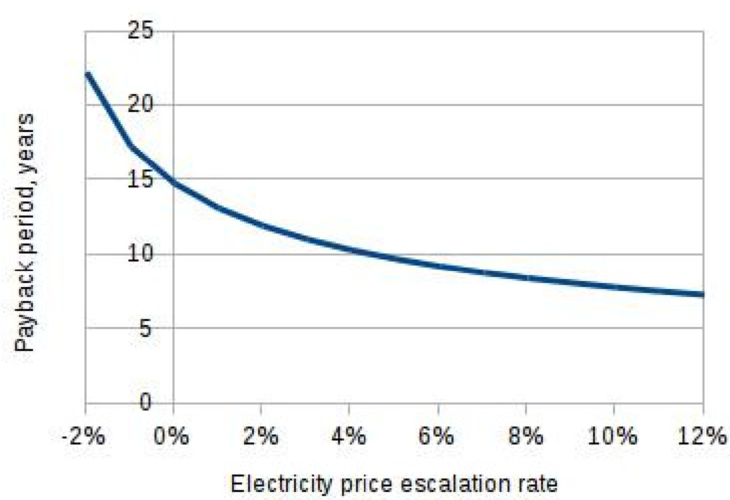
Figure 7. Sensitivity of Payback Period to Interest Rates



Source: Author's calculations.

The current (2014) lending rate among banks today hovers around 9% per annum. It is hard to determine how long the rate will stay at this level. Unless you have a strong reason to expect otherwise, you can just assume the same rate for the duration of the payback period.

Figure 8. Sensitivity of Payback Period to Electricity Price Escalation Rate



Source: Author's calculations.

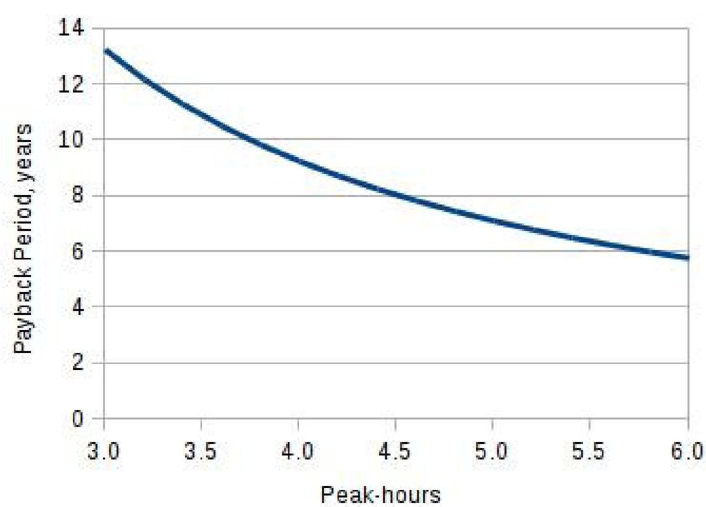
Historically, Meralco rates have been increasing at around 5% per year. This escalation of electricity retail prices works in favor of solar power users, because their peso savings—and consequently the amount they can spend on loan amortizations—increase in proportion to the price escalation. The effect is equivalent to a reduction in the bank interest rate, as explained in detail in Appendix B.

Peak-hours per day

In the Philippines, a day may consist of between 3.5 to 5.5 peak-hours, depending on the location. In most of our calculations, we use 4.5 peak-hours per day. If you want to be conservative, you can assume 4.0 peak-hours per day. However, it is best to check the insolation maps for your particular location. It is best to make some measurements at least during the most cloudy as well as the least cloudy months of the year.

Under the 4.5 peak-hours assumption, a one-kWp solar array will produce, on the average, 4.5 kWh of electricity per day, 135 kWh per month and 1,620 kWh per year. The insolation rates in Visayas and Mindanao tend to be generally higher. But in solar, as in wind, everything is location-specific. Site measurements must be taken over at least a year, preferably more. The theoretical models of NREL, applied specifically to Philippine conditions, suggest an insolation range of 4.5–5.5 peak-hours per day. However, these NREL models do not take local pollution into account. Also, these figures refer to the PV panel output. The usable output will be somewhat less, depending on the efficiency of the inverter and the rest of the system. Our calculations assume 85%, which is quite conservative. You can use the solar conversion table in Chapter 1.

Figure 9. Sensitivity of Payback Period to Daily Isolation



Source: Author’s calculations

The payback period is quite sensitive to this assumption. It is longer when one assumes low peak-hours, and shorter when one assumes high peak-hours. When a supplier promises short payback periods, check his assumed peak-hours per day.

If you are thinking of investing in a solar PV system yourself, the uncertainty might be a little unnerving. Assuming an average of 3 peak-hours, with 15% of the savings going to miscellaneous expenses and only 85% going to paying the investment back, this means a payback period of 13 years. An average of 6.0 peak-hours means a payback period of seven years. Based on the assumptions we used above, it is 9.8 years. So is it seven years or 9.8 years?

The uncertainty lies in the peak-hours assumption that figures prominently in the calculations, which is inherently uncertain. Daily, weekly and monthly variations in cloud cover make it hard to fix the figure. Of course, highs and lows even themselves out eventually and past experience allows us to bracket the average peak-hours per day, over a month or a year. Multiply the average daily peak-hours by 30 days and by the system efficiency of the PV system (we assumed 85%) to get the estimated average usable production of electricity in kWh per month.

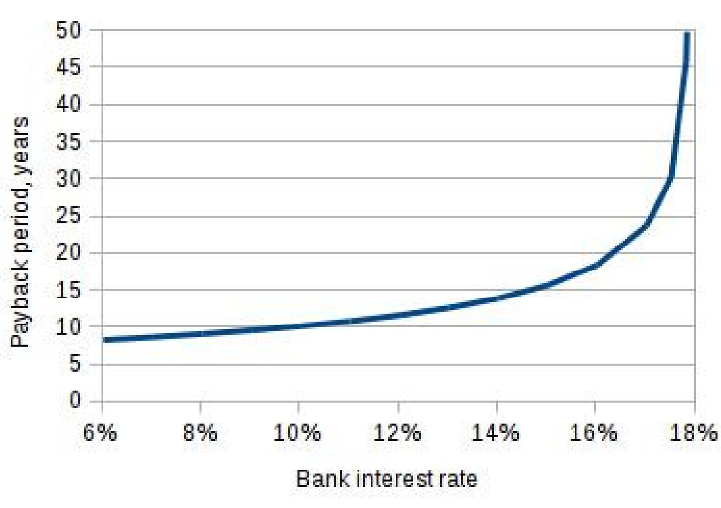
The retail price of electricity

Under the Meralco franchise, today's (2014) retail price hovers around P11.50. Meralco's historical records show an average steady increase in their retail prices of 5% per year, which is about 0.41% per month.

In areas served by other electric utilities or electric cooperatives, retail electricity prices may be higher, or lower.

The higher the retail price of electricity, the more viable renewable sources become.

Figure 10. Sensitivity of Payback Period to the Retail Price of Electricity

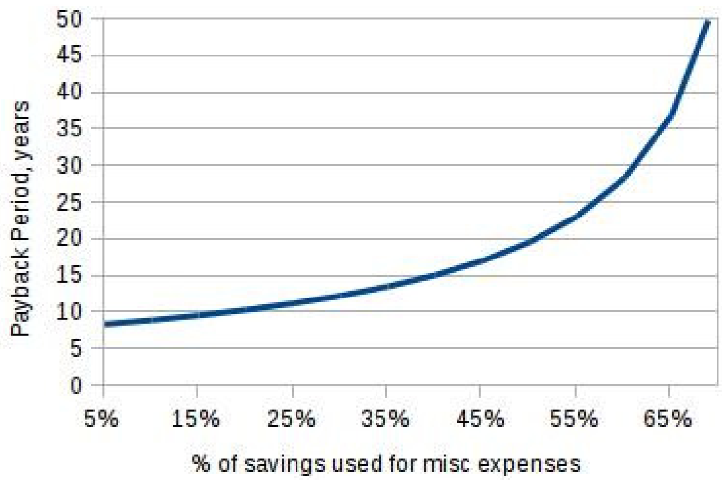


Source: Author’s calculations.

And if renewables are already within the range of viability today, then they will become more so as electricity prices from non-renewables continue to rise. Thus as the rate of escalation of electricity prices get higher, the shorter will the payback period become.

With these two unmistakable trends, the rising retail price of electricity distributed by utilities and the dropping costs of solar panels, the decision to shift is really a no-brainer. The only question left is whether you should do it today, next year or the year after next.

Figure 11. Sensitivity of Payback Period to the % of Savings Set Aside for Expenses



Source: Author's calculations.

The decision to shift to solar is a no-brainer. The only question left is whether you should do it today, next year or the year after next.

And if the banks wake up, and see the savings becoming large enough, they will want a share in the pie. With commercial bank financing opening up, especially if the government takes even more effective steps to minimize the financial risks, we can make the 100% transition to renewables faster than anyone thought possible.

Maintenance, repair and miscellaneous expenses

Among the renewables, solar PV requires the least in terms of maintenance and operating expenses. Still, you must set aside a portion of your savings for this purpose. The rest can go to the amortization payments for the system.

As the sensitivity analysis below shows, setting aside 40% of your savings for miscellaneous expenses and using only 60% for the amortization payments roughly doubles the payback period.

Remember: when suppliers claim a particular payback period, always ask about their assumptions.

For the ordinary consumer, the most interesting finding of this study is that the payback period for such a project is the same, regardless of the capacity, and that the payback periods are now within attractive range. The estimated payback periods of 5–10 years are already acceptable to many people.

Thus consumers can start with whatever capacity they can afford, and expand their system as solar costs drop further. Everyone can recover their investment. Given the proper financing, individual consumers today can make a dent, in the aggregate, on the country's energy mix in favor of renewables.

Levelized cost of electricity (LCOE)

Although we have focused on the payback period, it is also possible to calculate the actual cost of solar electricity per kilowatt-hour. The most common method is called the levelized cost of electricity (LCOE). This method adds up the present values of all investment and maintenance/operating costs, and divides this by the total lifetime production of the system. This makes LCOE inversely proportional to the expected lifetime of the PV panels and associated equipment.

Let us go through the exercise, using the 5-kWp panel as example. Let us assume 4.5 peak-hours average daily insolation, P55.00 per Wp for solar panels with miscellaneous hardware, with a 20-year life, and the same P55.00 per Wp for the grid-tie inverter with miscellaneous wires and connectors, but with a 6.7-year life (i.e., you need to buy three inverters over the lifetime of the solar panels). Assume further maintenance and operating costs of 25% of the solar panel costs. The total lifetime costs will then be P1,169,576.00[95] The total output over the lifetime of the system is 139,612.5 kWh[96]

Dividing total cost by total output, we get an LCOE of P8.38 (see Figure 12 next page, under 4.5 peak-hours per day, panel cost of P55,000 and panel life of 20 years).

If we try other assumptions in daily insolation, panel cost and panel lifetime, we can look up the LCOE in Figure 12.

By comparing the costs in the above tables with the retail price of electricity in your area (see Appendix A), you can determine whether or not it is time for you to start generating solar electricity on your rooftop.

Note that as of 2014, 76 of the 126 distribution utilities (60%) in the list in Appendix A were charging consumers at a retail price higher than the cost of rooftop solar electricity (estimated at around nine pesos per kWh), which makes rooftop solar cheaper than grid electricity within their service areas.

By using Figure 12 and Appendix A, you can get a good picture of the financial viability of rooftop solar in your service area.

95 (5,000 × 55 × 1.25) + (5,000 × 55 × 3) = 1,169,576.
96 0.85 × 5 × 4.5 × 365 × 20 = 139,612.5 kWh.

Figure 12. Levelized Cost of Solar Rooftop Electricity (Pesos per kWh)

4.0 peak-hrs/day	Panel cost, P/kWp								
Panel life, years	60,000	55,000	50,000	45,000	40,000	35,000	30,000	25,000	20,000
6	34.27	31.41	28.56	25.70	22.85	19.99	17.14	14.28	11.42
8	25.70	23.56	21.42	19.28	17.14	14.99	12.85	10.71	8.57
10	20.56	18.85	17.14	15.42	13.71	11.99	10.28	8.57	6.85
12	17.14	15.71	14.28	12.85	11.42	10.00	8.57	7.14	5.71
14	14.69	13.46	12.24	11.02	9.79	8.57	7.34	6.12	4.90
16	12.85	11.78	10.71	9.64	8.57	7.50	6.43	5.35	4.28
18	11.42	10.47	9.52	8.57	7.62	6.66	5.71	4.76	3.81
20	10.28	9.42	8.57	7.71	6.85	6.00	5.14	4.28	3.43
22	9.35	8.57	7.79	7.01	6.23	5.45	4.67	3.89	3.12
24	8.57	7.85	7.14	6.43	5.71	5.00	4.28	3.57	2.86
	LCOE: P/kWh								

4.5 peak-hrs/day	Panel cost, P/kWp								
Panel life, years	60,000	55,000	50,000	45,000	40,000	35,000	30,000	25,000	20,000
6	30.46	27.92	25.39	22.85	20.31	17.77	15.23	12.69	10.15
8	22.85	20.94	19.04	17.14	15.23	13.33	11.42	9.52	7.62
10	18.28	16.75	15.23	13.71	12.19	10.66	9.14	7.62	6.09
12	15.23	13.96	12.69	11.42	10.15	8.89	7.62	6.35	5.08
14	13.06	11.97	10.88	9.79	8.70	7.62	6.53	5.44	4.35
16	11.42	10.47	9.52	8.57	7.62	6.66	5.71	4.76	3.81
18	10.15	9.31	8.46	7.62	6.77	5.92	5.08	4.23	3.38
20	9.14	8.38	7.62	6.85	6.09	5.33	4.57	3.81	3.05
22	8.31	7.62	6.92	6.23	5.54	4.85	4.15	3.46	2.77
24	7.62	6.98	6.35	5.71	5.08	4.44	3.81	3.17	2.54
	LCOE: P/kWh								

5.0 peak-hrs/day	Panel cost, P/kWp								
Panel life, years	60,000	55,000	50,000	45,000	40,000	35,000	30,000	25,000	20,000
6	27.42	25.13	22.85	20.56	18.28	15.99	13.71	11.42	9.14
8	20.56	18.85	17.14	15.42	13.71	11.99	10.28	8.57	6.85
10	16.45	15.08	13.71	12.34	10.97	9.60	8.22	6.85	5.48
12	13.71	12.57	11.42	10.28	9.14	8.00	6.85	5.71	4.57
14	11.75	10.77	9.79	8.81	7.83	6.85	5.87	4.90	3.92
16	10.28	9.42	8.57	7.71	6.85	6.00	5.14	4.28	3.43
18	9.14	8.38	7.62	6.85	6.09	5.33	4.57	3.81	3.05
20	8.22	7.54	6.85	6.17	5.48	4.80	4.11	3.43	2.74
22	7.48	6.85	6.23	5.61	4.98	4.36	3.74	3.12	2.49
24	6.85	6.28	5.71	5.14	4.57	4.00	3.43	2.86	2.28
	LCOE: P/kWh								

Source: Author's calculations.

Chapter 18. Who wants to be a showcase?

The specific focus of this study is identify and subsequently help villages and towns make the full transition to a renewable future without using fossil-fuels, nuclear plants, and other dirty, dangerous and non-renewable sources.

While this study is fully supportive of individual solar, wind, small hydro, biomass and other renewables, we need to go beyond these individual projects. We need to show that *we can make the energy transition now*, *village by village*.

The local executives of the towns listed below have expressed interest in becoming a showcase for renewable energy or have actually initiated a renewable energy project in their locality. By focusing on sites where the local government is willing to take—or has actually taken—the lead in setting up a renewable energy project, the problem of social acceptability is much easier to surmount.

1. **Claveria, Cagayan**. This town is located in the northern tip of Luzon, a few towns east of Bangui in Ilocos Norte, where utility-scale wind plants have been operating for a number of years. A one-year study of the wind patterns in Claveria's coast has already been done, indicating favorable wind speeds that can power turbines with potential capacity factors of up to 40%. Capacity factors this high are indeed promising for wind developers. The town is now looking for potential investors.

2. **Aringay, La Union.** This town is located on the northwestern coast of Luzon. The local government is aggressively pursuing an organic agriculture program and has expressed interest in renewable energy projects to complement its sustainable agriculture program for farmers.

3. **San Luis, Aurora and Jaro, Iloilo.** These towns are currently tapping some of their hydroelectric potential. Thus a possible showcase can be planned around this renewable resource.

4. **Puerto Princesa, Palawan.** This city is also setting up some RE projects.

5. **The islands of Romblon, Siquijor, and Basilan.** These island provinces have considerable hydroelectric potential that have remained largely untapped. These can provide the base load plants that can then be supplemented by wind and solar power.

6. **Molave, Zamboanga del Sur**. This town is located in mainland western Mindanao, roughly midway between the region's major cities of Dipolog and Pagadian. The mayor is already an organic agriculture advocate and has expressed interest in renewable energy projects.

7. **Cepalco, Cagayan de Oro.** This company in Northern Mindanao was a solar pioneer, setting up a 1-MW solar PV plant early on. (See the story on CEPALCO in Chapter 3.) Because its 1-MW solar PV plant is complemented by a mini-hydro plant, it is ahead in the showcase game. What it needs is to do is to focus on a specific geographic entity that can be serviced fully by the renewable sources which are already at its disposal.

8. **Agusan del Norte (RTR), and Agusan del Sur (Sibagat).** These provinces in Mindanao's Caraga Region also have hydroelectric resources they can tap to open up the possibility of an RE showcase.

9. **Sultan Kudarat, Maguindanao.** The 10-MW biogas plant that is being set up in the town of Sultan Kudarat in Maguindanao can form the core of a mix of renewables that can make possible an RE showcase in this part of ARMM.

10. **Marawi City, Lanao del Sur.** An 80-ha solar farm is being planned in this ARMM province. But this needs to be supplemented by other renewable resources, to make an RE showcase possible.

    DOE has already determined in a study that Mindanao can source up to 70% of its requirements from renewables. Given the uneven distribution of renewable resources, this figure might be lower in some areas and higher in other areas. Specially-endowed areas might have enough renewable resources to make 100% RE possible.

11. **SPUG areas.** The small islands and isolated grids served by NAPOCOR's SPUG unit are another good candidate for an RE showcase. Today, they rely mostly on expensive diesel and bunker fuels. The smallest are in the 10–100 KW range, and will make ideal pilot projects before tackling the larger mini-grids.

A renewable energy roadmap for local governments

We propose the following RE roadmap for LGUs who want a showcase set up in their locality:

1. On the first year: they should display political will regarding an RE showcase, by allotting a sufficient amount in their budget for a one-year study on the feasibility of an RE showcase in their locality, and simultaneously installing a properly-sized solar PV system in their municipal hall.

   The study would include a year-round monitoring and recording and verification of wind, solar and hydroelectric resources as predicted in various wind/solar mapping projects for the Philippines. It would also include a financial feasibility study, and if determined to be viable, a project design that can be submitted to potential investors and lenders.

   The municipal hall's solar PV system will feed into the feasibility study and immediately validate or modify some of the assumptions and findings of the study. Municipal officials should also negotiate with the local utility for the implementation of true net metering, which will significantly increase the savings.

The 13-MW Sacasol project took two years to progress from project conceptualization to project operation.

2. Bid out the conduct of the feasibility study to RE contractors, universities and other qualified organizations. Bid out or negotiate the purchase of the solar PV system.

3. On the second year: once financial feasibility is determined, LGUs should invite investors and, if it deems appropriate, invest its own equity in the project.
4. Apply for a service contract for the RE projects. (Note that DOE took only 12 days to process the application of SACASOL, the first RE project to go online.)
5. Facilitate the issuance of local business permits and licences.
6. Open for bidding, choose the winning bidder, construct and install.
7. On the third year: Start operations! (Note that it took SACASOL two years to progress from project conceptualization to project operation.)

We already have many localities that host at least one renewable technology, such as a solar farm, wind turbines, and small hydro, or a biomass-fueled generating plant. They are one step ahead of the rest in making the transition. Their executives and local councils need to expand their horizon and think farther into the future. They need to dream about a future that they want for their grandchildren. And they need to make that dream come true.

The dream of clean, renewable and cheap energy is within our reach. That dream is not only ours. It is the dream of many. We only need to exert the final effort and reach out, and that dream will become reality.

There is no doubt, that the first localities in the Philippines that will make the energy transition to 100% renewable electricity will become true showcases in sustainable living for the country. People will want to visit the area (eco-tourism); other local government officials will want to replicate the experience (model municipality); and the national polity will take notice.

We call on every local as well as national official to make this dream of a full energy transition your dream too. You have the means to turn it into reality.

Chapter 19. The electric grid of the future

In the future, the electric grid will appear more like the Internet—an internetwork of networks of electricity stakeholders that include big and small consumers, and big and small producers, including big and small stakeholders who may buy electricity from the grid some of the time and sell electricity to the grid at other times.

As built-in intelligence, processing power, memory and other technological improvements developed for the Internet are also deployed for the electric grid, the various sources and sinks of electricity will be able to negotiate among themselves. They will be able to keep account of how much they are getting from the grid, at what price, and how much they are feeding into the grid, at what price.

In parallel with the electronic Internet (the Internet of information), we will have an electric Internet (the Internet of energy).

The energy Internet, like the information Internet before it, will see two conflicting trends: the client/server model, and the peer-to-peer model.

The Internet of information was designed as a peer-to-peer network—and began as such—with universities and governments connecting to each other as network peers (though they may not have been peers as far as resources were concerned). Once one had an IP address (xx.xx.xx.xx), one had a host on the Internet that could send or receive files and mails to any other host.

The grid will be more like the Internet—networks of big and small electricity stakeholders who may buy from the grid some of the time, and sell to the grid at other times.

Gradually, however, a different kind of model was superimposed on this peer-to-peer model (which remains at the foundation of the Internet). This superimposed model was the client/server model, in which a few servers provided services for many clients. Instead of peer-to-peer exchange of files and mails (which can still be done today, if users would learn how to do it), users were drawn by convenience to surrender their peer status. They then became clients relying on large servers for file and mail services and all their derivatives. (It is not so simple at the technical level, as client/server approaches may be employed in the context of the peer-to-peer model, where one side acts as server in one aspect of a connection, and as a client on another aspect of the connection.)

With the US National Security Agency working hand-in-glove with the largest file and mail servers on the Internet to monitor the private lives of individuals all over the globe, peer-to-peer networking is currently enjoying a healthy and well-deserved revival, turning the choice of models into a socio-political debate about centralized and decentralized approaches.

In the earliest days of electricity, like the early days of computing, the client-server approach held sway. The electric Internet was based on the client/server model from the beginning of its growth, with large utilities providing electricity as a service to consumers as their clients.

The growth of solar energy generated with PV panels is now making it possible for households to generate electricity *at a lower cost* than large-scale utilities that have to tack on to their generation charge various other charges such as distribution charges, systems losses, universal charges and other mysterious expenses that the hapless consumer can hardly figure out. In Germany, there are already 1.2 million households who have invested in PV technologies, having obtained bank financing to take care of the high up-front costs of solar investments. They went solar because they realized they can sell electricity to the grid and make money. In fact, during peak hours, it makes more economic sense for them to sell all their PV production to the grid—at premium FIT rates.

When millions of electric vehicles go online and connect themselves to the electric grid, not only to buy electricity but also to sell it during peak hours, they will further significantly expand the social base for the peer-to-peer model in the emerging electric Internet. Technical developments in storage batteries which may not be good enough for mobile applications such as phones, laptops and electric vehicles, may serve perfectly well for distributed storage of electricity. This creates a much larger market for such batteries and providing battery makers better economies of scale.

The peer-to-peer versus client/server trends will continue to battle it out in the Internet of information and the Internet of electricity.

Thus, the peer-to-peer versus client/server trends will continue to battle it out, both in the Internet of information and the Internet of electricity.

Many of us have participated in three major intertwined technological revolutions in our lifetime.

The first was desktop computing which literally put a computer in almost every desktop, in almost every urban home.

The next was the Internet, which connected our desktop computer to millions of others, enabling us to expand our educational, cultural, economic and political horizons and reach in ways that we could not even imagine a decade ago.

The third was the mobile revolution, which turned the telephone into a personal communicator now morphing into something that does not even have a proper name yet.

We are now at the threshold of the fourth revolution, that will soon empower every household to generate its own electricity cheaply from the sun.

If you can't see it happening yet, visit the sidewalks of Raon in Quiapo, Manila, for a glimpse of the future. In the Philippines, Raon contains the highest concentration of vendors for electronic parts and supplies. Today, you will find in Raon solar panels being sold on the sidewalks. The sale of solar panels (up to 300-Wp panels) and deep cycle batteries on sidewalks by street vendors suggests that solar PV profit margins have become large enough to support more than one layer of the supply chain. Just as the proliferation of retail outlets ushered the computer desktop and later the mobile phone mass market, this is another indication of the emerging mass market for solar PV.

Figure 13: Solar Panels Sold in Sidewalks of Raon, Quiapo, Manila

Source: Photo by Author.

The fifth revolution will come when reliable energy storage—probably not the lead-acid battery—likewise becomes cheap enough to sell not only in Raon but also in mom-and-pop stores throughout the country.

Indeed, we live in challenging times.

Unfortunately, there are dark clouds on the horizon too.

Chapter 20. Coping with oil insecurity, global warming

Two defining global problems confront our era: oil insecurity and global warming. Both are the culmination of more than a century of burning fossil fuels without regard for conserving resources for the needs of future generations nor for the Earth's capacity to absorb industrial emissions.

Oil insecurity[97]

Oil insecurity is best described by those concerned about peak oil, the term referring to the highest level of production in the oil industry. Many experts have conceded that peak oil will probably happen in the next decade or two, if not in this one. Beyond peak oil, production will plateau, then gradually decline.

When oil supply tightens, we can expect a bidding war—perhaps even a shooting war—for control over the world's oilfields.

The commercial exploitation of new oil sources, such as the Canadian tar sands, Brazilian presalt, North American tight oil (also called shale oil), kerogen-rich oil (also called oil shale) and other unconventional sources of oil[98] has led to a recent downward trend in oil prices. These new sources may delay the onset of peak oil, but will not stop it. They will also result in more local pollution and greenhouse gas emissions. Worse, they can lull economies and governments into a "business-as-usual" attitude and postpone the implementation of badly-needed measures to wean the world away from fossil fuels and arrest global warming.

There are many who do not believe that peak oil is a major problem for our generation, but who nevertheless acknowledge a "liquid fuel" problem, or an "oil shortage". Take UC Berkeley physicist Richard Muller, for instance. Muller believes in nuclear power, hydraulic fracturing (fracking), and the widespread extraction of shale gas and oil. He also believes that the the BP Gulf oil mega-spill as well as the nuclear explosions in Chernobyl and Fukushima were bad but not catastrophic.

As for peak oil, Muller writes: "The true energy crisis in the United States, and much of the rest of the world, derives predominantly from two issues: energy security and global warming. The security problem comes not from an energy shortage (we have plenty), but from an oil shortage—more precisely, from the growing gap between domestic petroleum production rate and the demand for gasoline, diesel, and jet fuel."[99] Muller emphasizes: "We don't have an energy crisis; we have a *transportation fuel* crisis. We don't have an energy shortage; we have an *oil* shortage. We not running low on fossil fuels; we're running low on *liquid fuels*."[100] [Emphasis in the original]

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97 Many books have been written on this topic. See for instance Paul Roberts, *The End of Oil: The Decline of the Petroleum Economy and the Rise of a New Energy Order.* (London: Bloomsbury, 2004). See also Daniel Yergin, *The Quest: Energy, Security, and the Remaking of the Modern World.* (New York: The Penguin Press, 2011).

98 Yergin, pp. 252-262.

99 Muller, p. 291.

100 Muller, p. 102.

Call it "oil shortage," "liquid fuel shortage," or "peak oil." We call it oil insecurity. When the oil supply tightens and eventually plateaus (worse, when it declines), while demand continues to rise to satisfy the fuel-thirsty economies not only of US, Europe, Japan and Russia, but also of China, India, Brazil and South Africa—not to mention the rest of the world—then a bidding war for the limited supply will drive oil prices up.

To ensure supply, some countries may resort to military action. Then a shooting war may erupt. Countries will go to war for oil—we can already see that today. What will happen then to those countries like the Philippines who neither have the wealth to bid for oil, nor the military power to fight for it?

By shifting to renewable resources, which are all locally available, we are also ensuring a peaceful future for our children and grandchildren.

Global warming

Global warming is a direct result of the world's unquenchable thirst for oil and other fossil fuels. It will keep getting worse, if shale oil and similar alternatives are exploited on a large scale. In turn, global warming is resulting in climate change, coastal flooding and more extreme climate events.

Given its long coastline and its location in the typhoon belt, the Philippines is one of the countries that will have to bear the worst impacts of this problem. Typhoon Yolanda (international name: Haiyan) in 2013 is just a preview of the kind of disasters that global warming will bring.

Our grandchildren will have a hard time surviving in this very different world of encroaching sea levels, extreme weather events, and threatened ecosystems.

The point of no return for global warming will probably happen in this decade, if it is not already happening. Beyond that point, we will be swept in global warming's vicious cycles. Melting snow will reduce the reflectivity of the poles and this will speed up the warming. Further warming will reactivate the decomposition process in erstwhile frozen soils as they warm up. This will then release more greenhouse gases that cause more warming. Long buried over eons, methane in the oceans may be released, triggering new vicious cycles. Our grandchildren will have a hard time surviving in this very different warming world of encroaching sea levels, extreme weather events and threatened ecosystems.[101]

Fortunately, there is a way out—but only if we take it soon. An immediate shift to renewables will keep peak oil at bay for a while, perhaps for good. Then we do not have to worry about going to war to get our share of oil fields. Phasing out fossil fuels will gradually—ever so gradually—slow down

101 The clearest description of the impacts of global warming for every degree rise in average global temperatures is still Mark Lynas, *Six Degrees: Our Future on a Hotter Planet.* (Washington, DC: National Geographic, 2008). The most authoritative book on global warming and climate change is of course the IPCC Assessment Reports, the latest of which were issued in 2013 and can be downloaded for free at https://www.ipcc.ch/report/ar5/.

the rising CO_2 levels in the atmosphere. Hopefully, decades after, perhaps centuries after the levels of greenhouse gases in the atmosphere stabilize, the climatic and ecological balance that used to envelop our world will return.

If you were asked to make a single practical act to help make our world more peaceful and more livable, there is one thing you can do, easily and quickly: shift to LED lights and put solar panels on your rooftop today. Encourage your neighbor to do it too. Do not stop telling others, until every single fossil-fueled plant in the country has ground to a stop.

You can easily and quickly do today one single practical act to help make our world more peaceful and more livable: shift to LED lights and put solar panels on your rooftop.

Postscript. Thinking it out, doing it: Think tanks for RE

It is clear that we have enough wind, solar and hydro resources—not to mention other options like biomass, geothermal and ocean waves. The technologies for tapping these resources have now become financially viable in most areas, for many people. Only the financing is missing today. With the right policies for minimizing the financial risks and drawing commercial banks to get their feet wet on renewable projects, the floodgates can be opened that will help us make the energy transition to renewable electricity quickly.

As a result of this study, the author and several friends have decided to set up a renewable energy think tank and to register with the government as an organization of individuals who are passionate about renewables. As a think tank, our organization will provide advice not only to individuals and groups but more importantly to local governments, with a specific goal in mind:

To reach the energy transition to 100% renewables household by household, village by village, town by town, until we have crossed over to a fossil- and nuclear-fuel free future.

Goal: to reach the energy transition to 100% renewables household by household, village by village, town by town, until we have crossed over to a fossil- and nuclear-fuel free future.

We do not intend to compete with RE developers, suppliers, installers and other pioneers of this rapidly growing industry. We will leave to them with task of bidding for and implementing the RE projects we are providing advice for.

We now have within our group an engineer/writer (the author); a UP professor of electrical engineering; another UP engineering professor whose expertise is geographical information systems; an energy policy expert and renewable energy implementor from the private sector; an environmental lawyer; a former mayor and compiler of best practices by local governments; and a banker. Together, we believe we can provide the right advice for village and town executives and other leaders who want to bet their locality's future on renewable energy.

Among the things that think tanks such as the group we are forming can do are the following:

> **To do:** Educate policy-makers about the benefits of true net metering and urge the government to review its definition of "net-metering," to end the ongoing double-charging of net metering clients, and to implement true net metering in the Philippines as part of its measures to remove existing barriers to the widespread adoption of solar PV technology by the public. Educate the public about the savings they can realize once true net metering is in place.

> **To do:** Tap the treasure-trove of experiences of the 500+ RE developers who have applied to join the FIT system for information, knowledge and lessons, to help ensure that their mistakes

are not repeated in developing an RE showcase. The individual experiences of these developers can be studied for positive and negative lessons. The successful developers can be seen as a pool of potential bidders for a Feldheim-type RE showcase, when the conditions are right to build it. They can be included in a directory of RE developers that should also include SMEs, who can later be tapped to bid in RE projects initiated by LGUs.

To do: Develop the necessary technical skills to determine the suitability and viability of a specific location for renewable energy development, using various data sources such as NREL, NASA, the Philippine government, NAPOCOR and other government/private corporations and others, for the specific purpose of conceptualizing, siting, designing, financing and implementing at least one Feldheim-type RE showcase (100% RE, local rates lower than grid rates and commercial viability for the RE operators) in the Philippines. The companies emerging that offer services similar to these are oriented more towards specific technologies, rather than combining a mix of technologies to attain RE self-sufficiency.

To do: In conceptualizing a Feldheim-type Philippine showcase, we must give special attention to social acceptability—as Feldheim did—to ensure that the local government and the affected social sectors buy into the project. Instead of searching the country for the best wind/solar sites, we propose an approach of identifying localities first, where the local government is enthusiastic about an RE showcase and there are no foreseeable social acceptability issues. Working with the local stakeholders as partners, we can then proceed with data gathering to determine feasibility and commercial viability, prior to the identification of investors and banks willing to finance the showcase. Out of more than 1,600 towns/cities in the country and more than 42,000 barangays (villages), we are confident of finding at least a few good candidates for an RE showcase.

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Appendices

Appendix A. Retail prices of electricity in the Philippines[102]

Distribution Utility	Region	Elec. Price (Php/kWh)	Data As Of 2014
Aurora Electric Coop	Region 3	16.2642	March
Guimaras Electric Coop	Region 6	15.4811	September
Capiz Electric Coop	Region 6	13.2241	February
Northern Negros Electric Coop	Region 6	12.9232	October
Kalinga Apayao Electric Coop	CAR	12.6595	March
Camarines Sur IV Electric Coop	Region 5	12.2664	March
Camarines Sur III Electric Coop	Region 5	11.9053	March
Isabela I Electric Coop	Region 2	11.8912	August
Leyte III Electric Coop	Region 8	11.8759	May
Antique Electric Coop	Region 6	11.6007	March
Samar I Electric Coop	Region 8	11.5958	March
Quezon II Electric Coop	Region 4-A	11.5879	July
Iloilo III Electric Coop	Region 6	11.5439	June
Quezon II Electric Coop	Region 4-A	11.4683	July
Iloilo I Electric Coop	Region 6	11.3442	March
Camarines Sur I Electric Coop	Region 5	11.3296	October
Camiguin Electric Coop	Region 10	11.3269	December
Negros Oriental I Electric Coop	Region 7	11.2127	October
Visayan Electric Company	Region 7	11.1116	July
Cagayan I Electric Coop	Region 2	11.1012	August
Ifugao Electric Coop	CAR	11.0829	July
Pangasinan III Electric Coop	Region 1	10.9763	August
Southern Leyte Electric Coop	Region 8	10.9597	February
Davao del Norte	Region 11	10.911	March
Cagayan II Electric Coop	Region 2	10.902	September
Sorsogon II Electric Coop	Region 5	10.8842	October
Negros Oriental II Electric Coop	Region 7	10.7749	March
Albay Electric Coop	Region 5	10.7715	July
Panay Electric Company	Region 6	10.7627	February
Ibaan Electric & Engineering Corp.	Region 4-A	10.7553	January
Aklan Electric Coop	Region 6	10.6849	July
Northern Samar Electric Coop	Region 8	10.6834	February
Abra Electric Coop	CAR	10.5673	July
Quirino Electric Coop	Region 2	10.5559	July
Cebu I Electric Coop	Region 7	10.3888	March
Manila Electric Corporation	NCR	10.3859	January
Quezon I Electric Coop	Region 4-A	10.3698	September
Iloilo II Electric Coop	Region 6	10.3287	July
Albay Electric Coop	Region 5	10.3281	July
Nueva Vizcaya Electric Coop	Region 2	10.3056	June
Negros Occidental Electric Coop	Region 6	10.2913	July
Samar I Electric Coop	Region 8	10.2646	March
Quezon II Electric Coop	Region 4-A	10.2583	July
Tarlac Electric	Region 3	10.2229	March
Moutain Province Electric Coop, Inc	CAR	10.1613	January
First Laguna Electric Coop	Region 4-A	10.1229	October
Pampanga III Electric Coop	Region 3	10.0954	December
Eastern Samar Electric Coop	Region 8	10.0289	July
Central Pangasinan Electric Coop	Region 1	10.0012	June

102 http://www.kuryente.org.ph/electric-companies.

Batangas I Electric Coop	Region 4-A	9.9353	April
Quezon II Electric Coop	Region 4-A	9.8666	July
Leyte IV Electric Coop	Region 8	9.8332	July
Samar II Electric Coop	Region 8	9.8039	August
Don Orestes Romualdez Electric Coop	Region 8	9.7626	July
Cabanatuan Electric Corporation	Region 1	9.735	August
San Fernando Electric Light & Power Co.	Region 3	9.6919	January
Sorsogon I Electric Coop	Region 5	9.6901	March
Batangas II Electric Coop	Region 4-A	9.6047	August
Angeles Electric Corporation	Region 3	9.59	June
Pampanga Rural Electric Service Coop.	Region 3	9.4929	July
Tarlac II Electric Coop	Region 3	9.4814	October
Isabela 2 Electric Coop	Region 2	9.4222	December
Misamis Oriental II Electric Service Coop	Region 10	9.388	December
Cebu II Electric Coop	Region 7	9.2882	August
Nueva Ecija I Electric Coop	Region 3	9.2633	August
Central Negros Electric Coop	Region 6	9.25	July
La Union Electric Coop	Region 1	9.2427	October
Biliran Electric Coop	Region 8	9.2272	May
Southern Leyte Electric Coop	Region 8	9.2123	February
Camarines Norte Electric Coop	Region 5	9.1924	October
Nueva Ecija II- Area I Electric Coop	Region 3	9.1854	July
Camarines Sur II Electric Coop	Region 5	9.1449	October
Leyte V Electric Coop	Region 8	9.1003	May
Zambales II Electric Coop	Region 3	9.0477	June
Ilocos Norte Electric Coop	Region 1	9.0452	October
Mactan Electric Company	Region 7	9.0239	June
San Jose City Electric Coop	Region 3	8.9667	June
Peninsula Electric Coop	Region 3	8.9658	May
Bohol I Electric Coop	Region 7	8.9581	July
Ilocos Sur Electric Coop	Region 1	8.907	October
Bohol II Electric Coop	Region 7	8.9012	April
South Cotabato II Electric Coop	Region 12	8.8986	June
Agusan del Sur Electric Coop	CARAGA	8.7551	December
Davao Oriental Electric Coop	Region 11	8.7512	July
Olongapo City - Public Utilities Dept.	Region 3	8.6774	October
Nueva Ecija II- Area II Electric Coop.	Region 3	8.6742	December
Misamis Occidental I Electric Coop	Region 10	8.6688	February
Surigao del Sur I Electric Coop	CARAGA	8.6593	December
Bohol I Electric Coop	Region 7	8.6554	July
Pampanga II Electric Coop	Region 3	8.6091	December
Davao del Sur Electric Coop	Region 11	8.6038	July
Surigao del Sur II Electric Coop	CARAGA	8.5263	February
Tarlac I Electric Coop	Region 3	8.52	December
Zambales I Electric Coop	Region 3	8.4726	June
Bohol Light Company	Region 7	8.4722	July
Sultan Kudarat Electric Coop	Region 12	8.4687	August
Sultan Kudarat Electric Coop	Region 12	8.4414	August
Cagayan Electric Power & Light Co.	Region 9	8.3833	August
Cotabato Electric Coop	Region 12	8.3344	December
Benguet Electric Coop	CAR	8.2734	November
Pangasinan I Electric Coop	Region 1	8.251	November
Zamboanga del Sur II Electric Coop	Region 9	8.1261	January
Dagupan Electric Corporation	Region 1	8.0806	March
Leyte II Electric Coop	Region 8	8.0622	April
Sultan Kudarat Electric Coop	Region 12	8.0337	August

Misamis Oriental I Rural Electric Coop	Region 10	7.9431	April
South Cotabato I Electric Coop	Region 12	7.8431	July
Maguindanao Electric Coop	ARMM	7.8239	March
Davao del Sur Electric Coop	Region 11	7.7078	July
Zamboanga del Norte Electric Coop	Region 9	7.622	July
Agusan del Norte Electric Coop	CARAGA	7.6173	August
Pampanga I Electric Coop	Region 3	7.6001	September
Lanao del Norte Electric Coop	Region 10	7.5953	July
Misamis Occidental II Electric Coop	Region 10	7.5908	April
Siargao Electric Coop	CARAGA	7.5677	August
Zamboanga del Sur I Electric Coop	Region 9	7.4929	February
Zamboanga City Electric Coop	Region 9	7.4712	February
Bukidnon II Electric Coop	Region 10	7.4188	April
Davao Light & Power Company	Region 11	7.4148	August
Sultan Kudarat Electric Coop	Region 12	7.3747	August
Surigao del Norte Electric Coop	CARAGA	7.2571	October
First Bukidnon Electric Coop	Region 10	7.2052	November
Cebu III Electric Coop	Region 7	6.9403	June
Iligan Light & Power	Region 10	6.747	October
Cotabato Light & Power Company	Region 10	6.6297	August
Lanao del Sur Electric Coop	ARMM	6.1825	June

Appendix B. Payback period: Deriving the formula

The standard formula that relates a sequence of adjacent amortization payments to a lump sum, interest rate and number of periods is called the Amortization Formula.

In spreadsheets, these variables are often represented by the variables PMT (payment), PV (present value of a lump sum), RATE (interest rate) and NPER (number of periods). This is the same formula used in financial calculators to relate the four variables, which are often called the "monthly installment," "loan amount," "interest rate" and "loan period."

The amortization formula comes from the following open-ended equation:

$$A+\frac{A}{(1+r)}+\frac{A}{(1+r)^2}+\frac{A}{(1+r)^3}+\ldots+\frac{A}{(1+r)^{(T-1)}}+\frac{A}{(1+r)^T}=L$$

If we multiply the above equation by (1+r), and then, from this product, subtract the equation above, we will get the closed form of the amortization formula : $A=\frac{Lr}{\left(1-(1+r)^{-T}\right)}$.

Paying it back: how long will it take?

The amortization formula can be written as a proportion: $\frac{L}{A}=\frac{1-(1+r)^{-T}}{r}$ where

L	is the present value of the lump sum
A	is the amortization amount
r	is the interest rate
T	is the number of amortizations (or time periods)

We will now solve for the amortization period T (remember, operations are always done on both sides of the equation):

Multiply with Ar: $Lr = A-\frac{A}{(1+r)^T}$

Take the negative, then add A: $A-Lr=\frac{A}{(1+r)^T}$

Take the reciprocal, then multiply by A: $\frac{A}{A-Lr}=(1+r)^T$

Take the logarithm (base 10): $\log\left(\frac{A}{A-Lr}\right)=T\cdot\log(1+r)$

Divide by log(1+r): $T = \dfrac{\log\left(\dfrac{A}{A - Lr}\right)}{\log(1 + r)}$

T is the number of periods it will take to pay back a loan L borrowed at interest rate r, if the amortization payment is A. One can imagine the loan being invested into a project, whose earnings go into paying back the loan, until the loan is fully paid after T periods. Thus, applied to a project, T is also the payback period of the project, L is the project cost, and A is the project income per period, assuming that it can be represented by a constant cash flow.

Thus, the formula above can also be used to estimate the payback period of a solar PV project, after some slight modification to take into account the particularities of such a project.

The formula also suggests a way to test viability quickly: the savings generated (A) per month should be greater than the monthly interest expense L × r (plus any monthly expenses that the project must incur). The larger the savings compared to the monthly expenses, the shorter the payback period.

Appendix C. Payback period of a solar PV project

The starting point for the payback period is the formula in Appendix B:

$$T = \frac{\log\left(\frac{A}{A - Lr}\right)}{\log(1 + r)}$$

The formula above needs to take into account of the particularities of a solar PV project. These particularities include:

Variables in a solar PV project

For a solar PV project, we need to express L and A in terms of the project variables, as follows:

L is now the solar PV system cost: $L = P_{kwp} \cdot C$, where

P_{kwp}	is the price of solar PV systems, in pesos per kWp
C	is the total capacity of the system, in kWp

A is now the peso savings per month. It is obtained by multiplying the kWh savings per month by the retail price of electricity and then subtracting miscellaneous (maintenance, repair, etc.) expenses:

$A = 30 \cdot (1 - m) \cdot H \cdot C \cdot P_{util}$, where

H	is the peak-hours of sunshine, in hours per day
C	is the total capacity of the system, in kWp
P_{util}	is the retail price of electricity, in pesos per kWh
m	is the percentage of savings that is set aside for maintenance and repair

The variable m takes into account the monthly cost of maintaining the PV system. This cost may be small but it should not be ignored, to avoid any surprises. In case no cost is incurred for maintenance and repair, this provision can simply be treated as a sinking fund, from which money can be drawn for unexpected expenses, whenever the need occurs.

Substituting the values of L and A into the formula for the payback period, we get the following formula: (r is the interest rate *per month* and the payback period T is also in months)

$$T = \frac{\log\left(\frac{30 \cdot (1-m) \cdot H \cdot P_{util}}{30 \cdot (1-m) \cdot H \cdot P_{util} - P_{kwp} \cdot r}\right)}{\log(1+r)}$$, which can also be written as:

$$T = \frac{-\log\left(1 - \frac{P_{kwp} \cdot r}{30 \cdot (1-m) \cdot H \cdot P_{util}}\right)}{\log(1+r)}$$. (Note that the system capacity C has been cancelled out.)

Recall that $P_{kwp} \cdot r$ represents the monthly interest expense, and $30 \cdot H \cdot P_{util} \cdot (1 - m)$ represents the monthly savings. The larger the savings relative to expenses, the shorter the payback period, and the more viable the project.

The formula above still assumes that the retail price of electricity is constant over the duration of the payback period. It will have to be adjusted to take into account an escalating retail price of electricity.

Adjusting for the escalation of electricity prices

Assuming an escalation rate of e, and a bank interest rate r, then the adjusted interest rate R becomes:

$$R = \frac{1+r}{1+e} - 1$$

To show that this is so, let us look at the original amortization formula:

$$A + \frac{A}{(1+r)} + \frac{A}{(1+r)^2} + \frac{A}{(1+r)^3} + \ldots + \frac{A}{(1+r)^{(T-1)}} + \frac{A}{(1+r)^T} = L$$

where A is the monthly savings discounted over T periods.

If A is itself escalating at a fixed rate e, then the equation above should now include the escalation rate as follows:

$$A + \frac{A \cdot (1+e)}{(1+r)} + \frac{A \cdot (1+e)^2}{(1+r)^2} + \frac{A \cdot (1+e)^3}{(1+r)^3} + \ldots + \frac{A \cdot (1+e)^{(T-1)}}{(1+r)^{(T-1)}} + \frac{A \cdot (1+e)^T}{(1+r)^T} = L$$

But the equation above can also be written as follows:

$$A + \frac{A}{\left(1 + r/_{1+e}\right)} + \frac{A}{\left(1 + r/_{1+e}\right)^2} + \frac{A}{\left(1 + r/_{1+e}\right)^3} + \ldots + \frac{A}{\left(1 + r/_{1+e}\right)^{(T-1)}} + \frac{A}{\left(1 + r/_{1+e}\right)^T} = L$$

Comparing the equation above with the original, we can see that by taking into account the escalation rate, (1+r) has simply been replaced by $\left(\frac{1+r}{1+e}\right)$. Since (1+e) is greater than 1, this tends to decrease the numerator. This means the discount factor becomes smaller too.

If we call the new discount factor R, then $1 + R = \frac{1+r}{1+e}$ or $R = \frac{1+r}{1+e} - 1$.

For instance, if the interest rate is 0.09 (9% per annum) and the electricity escalation rate is 0.04 (4% per annum), then the adjusted interest rate, that incorporates the retail price escalation, is $\frac{1+r}{1+e} - 1$ or 0.0481 (4.81% per annum). The original 9% has gone down to 4.8%.

When we use the payback formula therefore, we will presume that the interest rate being used has been adjusted for the escalating retail price of electricity

A significant result of this derivation is the fact that the capacity of the system in kWp cancels out. This means that the size of the system has no effect on the payback period and on project viability.

A small loan pays for a small system which generates small savings for paying back the small loan. A large loan pays for a large system which generates large savings for paying back the large loan.

In both cases, as long as the other system variables do not change, the payback period is *the same*.

This means that consumers who want to install a solar PV system can start with whatever size they can afford, without affecting the payback period.

An energy project may also be evaluated using the levelized cost of electricity (LCOE) approach. This method involves summing up the present values of the various costs of the project and dividing this by the energy production (in kWh) over the lifetime of the project. This approach introduces an additional uncertainty in the results, because one needs a reliable estimate of the lifetime of a solar PV system. But it is necessary to take this approach if we want to validly compare solar PV costs with the costs of other technologies which have also been evaluated using LCOE. Please see Chapter 17 for LCOE calculations.

By using the payback period, we only need to be concerned that the system's lifetime should exceed the payback period. Once the project has paid itself back, all earnings beyond that period are returns on investment.

To recap, the formula that we will henceforth use to estimate the payback period of a solar PV project is:

$$T = \frac{-\log\left(1 - \dfrac{P_{kwp} \cdot r}{30 \cdot (1-m) \cdot H \cdot P_{util}}\right)}{\log(1+r)}$$

This is the formula used in Chapter 17.

Appendix D. An equation model of the Philippine FIT

To get a better grasp of the dynamics of the Philippine FIT program, the author has developed a simple equation-based model that determines the contribution of a technology to the generation charge, given the FIT rate in pesos for that technology, and the capacity in MW allowed under that FIT rate.

The model can be implemented by generating tables using a spreadsheet program, or by directly solving the model's equation.

This appendix explains the details of the model.

First, let us break up the retail price of electricity into its two components: the generation charge, and the non-generation charges.

Retail price of electricity (pesos per kWh) is $P_{grid}+P_{notg}$.

Let us assume that all of the total electricity output for the year, E_{total} (in GWh), comes from non-renewable sources. And we intend to replace E_{ren} (also in GWh) of non-renewable electricity by an equal amount of renewable electricity. After the replacement, the total output E_{total} will now have two components: the renewable component E_{ren}, and the non-renewable component $E_{total} - E_{ren}$. The renewable component E_{ren} will have a new (presumably higher) price P_{ren}, while the old price P_{grid} will now apply only to the non-renewable component $E_{total} - E_{ren}$.

To combine the two prices, we cannot just take their average, because the renewable component is smaller than the non-renewable component. It is only a small part of the energy mix.

The right way to calculate the impact of the FIT rate P_{ren} is to take the weighted average of P_{ren} and P_{grid}, P_{ren} being weighted by E_{ren} and P_{grid} being weighted by $E_{total} - E_{ren}$. If P_{inc} is the increase in the generation charge P_{grid}, then the new grid price will be $P_{grid} + P_{inc}$, and:

$$P_{grid} + P_{inc} = \frac{P_{ren} \cdot E_{ren} + P_{grid} \cdot (E_{total} - E_{ren})}{E_{ren} + (E_{total} - E_{ren})}$$

or

$$P_{grid} + P_{inc} = \frac{P_{ren} \cdot E_{ren} + P_{grid} \cdot (E_{total} - E_{ren})}{E_{total}} ..$$

In this weighted averaging process, a small amount of non-renewable GWh consumption is replaced by the same GWh consumption of a more expensive renewable technology, thus raising the average generation charge slightly.

The difference between this new weighted average, and the old average generation charge, is P_{inc}, the increase in the retail price of electricity per kWh.

The following model implements the concept described above.

We introduce and define below the following variables used in the model. Note that some of these variables refer to a single technology only. The different technologies are accounted for by applying the model to each of the technologies.

Energy Output (GWh/year)

E_{total} : the total energy production output of the country's electricity grid

E_{ren}: the output that will be replaced by the FIT-supported renewable source, reducing the non-RE output by the same amount. This non-RE output will then become $E_{total} – E_{ren}$

Peak power (MWp)

M_{wpeak}: the maximum renewable capacity supported under the FIT system

Electricity price (pesos per kWh)

P_{ren}: the price paid by the grid under the FIT system for electricity from a PV plant. P_{ren} is also called the FIT rate

P_{grid}: the average grid price of electricity, reflected in our electric bills as the generation charge

P_{notg}: the non-generation component of the final consumer price of electricity. These non-generation components include transmission, system loss, distribution, subsidies, government taxes, universal charges and other charges

P_{user}: the price as it appears in a typical consumer's electric bill. Note that $P_{user} = P_{grid} + P_{notg}$

P_{inc}: the increase in the average grid price P_{grid}, which will be passed on to the consumer, so it is also the increase in P_{user}. Note that $P_{grid} + P_{inc} = P_{ren}$

Percentage increase (in decimal, dimensionless)

I_{fp}: The FIT premium, which is the FIT rate percentage increase over the average grid price P_{grid}. Thus the actual FIT rate is $P_{ren} = P_{grid} \cdot (1 + I_{fp})$. For instance, if the FIT rate is 82% higher than the grid rate, then $I_{fp} = 0.82$ and $P_{ren} = 1.82 \cdot P_{grid}$

I_{grid}: The percentage increase in the average grid price P_{grid}, as a result of mixing in FIT-supported renewable plants. The new grid price is therefore $(1 + I_{grid}) \cdot P_{grid}$. For instance, if the FIT system raises the average grid prices by 0.75%, then the new grid price is $1.0075 \cdot P_{grid}$.

I_{user}: The percentage increase in the electric bill and in the final price of electricity for the end-user (P_{user}), as a result of the FIT program. Under the FIT system this is also called the FIT allowance. If the final price of electricity goes up by 0.75%, then $I_{user} = 0.0075$.

Ratios to total (in decimal, dimensionless)

R_{grid}: The ratio of the grid price P_{grid} to P_{user}, the final billing price of electricity as it appears to the end-user. It is the percentage share of the generation charge in the end-user price. If the generation charge is 48% of the total bill, then $R_{grid} = 0.48$. The percentage share of the non-generation component of the end-user's electric bill is $1 – R_{grid}$, which is 0.52 in the above example.

R_{cap}: The ratio of the actual output over a specified period (say, one year) to its theoretically ideal output for the same period, if it operated at its peak capacity 24/7. It is also called the plant's capacity factor. If a PV plant is actually generating electricity 18% of its theoretical ideal, then its capacity factor k is 0.18.

R_{ren}: The ratio of the FIT-supported output to the total output. In other words, it is the percentage share of technology's output production in the electricity mix.

The new average grid price will be the weighted average of the FIT rate P_{ren}, and the old grid price P_{grid}. The FIT rate is weighted by the renewable output E_{ren}, and the old grid price is weighted by the non-renewable output $E_{total} - E_{ren}$. This leads to the following initial equation of the model:

$$P_{grid} + P_{inc} = \frac{\lfloor P_{ren} \cdot E_{ren} + P_{grid} \cdot (E_{total} - E_{ren}) \rfloor}{E_{total}} \text{ or } P_{inc} = \frac{\lfloor P_{ren} \cdot E_{ren} + P_{grid} \cdot (E_{total} - E_{ren}) \rfloor}{E_{total}} - P_{grid}$$

Noting that

$$\frac{E_{ren}}{E_{total}} = R_{ren} \text{ ,}$$

this equation can be simplified, providing us an expression for the increase in the electricity rate in pesos per kWh, given the FIT rate P_{ren}, the current generation charge P_{grid} and the percentage share R_{ren} of the FIT-supported renewable technology in the total energy mix:

$$\mathbf{P_{inc} = (P_{ren} - P_{grid}) \cdot R_{ren}}$$

The equation above is the model's core equation in peso form. The equation tells us that the impact of the FIT premium ($P_{ren} - P_{grid}$) in pesos per kWh is moderated by percentage share of the FIT-supported renewable source in the total energy mix. Thus, if the FIT premium is five pesos, but the renewable source's share in the total mix is currently 0.1% (0.001 in decimal), then the increase in the user's electric bill will be 5 × .001 or one-half centavo per kWh. For a user consuming 200 kWh per month, this means the FIT premium adds one peso to his monthly electric bill. Once the share of the source improves to 1%, this would add P10.00 to his monthly electric bill. At 10% share in the energy mix, P100.00 will be added to his monthly electric bill. Finally, at 100% share, the impact of the five-peso premium will be fully reflected as a P1,000.00-increase in the electric bill. By this time, however, the many of the renewables will probably have attained or exceeded grid parity, in which case no premium is necessary to help them become viable.

In its most general form, the model's core equation above can be written as:

$$\mathbf{P_{inc}(t) = [P_{ren}(t) - P_{grid}(t)] \cdot R_{ren}(t)}$$

That is, each of the variables will be changing their values over time, but these values will continue to be governed by the equation.

To make it easier to relate the model's core equation above to the FIT numbers approved by ERC, we must be able to express the share of the FIT-supported energy source to the total energy mix (R_{ren}) to actual M_{wpeak}.

It must be remembered that PV plants do not generate electricity 24/7. Generating plants that do would have a capacity factor of 100% , which is a theoretical ideal. According to the company that obtained the first Certificate of Compliance under the FIT system, San Carlos Solar Energy, their PV plant has a capacity factor of around 18%. (This should not be mistaken for the conversion efficiency of solar panels, which can also reach 18% or even higher.)

Using this number and various other conversion factors, we get the following equation:

$$E_{ren} = M_{wpeak} \cdot R_{cap} \cdot \frac{1GW}{1000MW} \cdot \frac{24hrs}{day} \cdot \frac{365days}{year}$$

Simplifying and then dividing by E_{total}, we get an expression for R_{ren} in terms of M_{wpeak}:

$$R_{ren} = \frac{8.76 \cdot R_{cap} \cdot M_{wpeak}}{E_{total}}$$

By putting in the values of R_{ren} (above) into the first equation, we get:

$$P_{inc} = \left(P_{ren} - P_{grid}\right) \cdot \left(\frac{8.76 \cdot R_{cap} \cdot M_{wpeak}}{E_{total}}\right)$$

Since E_{total} and R_{cap} are relatively constant, the equation relates the peso/kWh increase in the consumer's electric bill P_{inc} to the renewable source's FIT rate and the FIT-supported generation capacity M_{wpeak}.

In conclusion, the model equation we will be using is:

$$P_{inc} = \left(P_{ren} - P_{grid}\right) \cdot \left(\frac{8.76 \cdot R_{cap} \cdot M_{wpeak}}{E_{total}}\right)$$

where

E_{total}:	60,000 GWh (the Philippine electricity consumption in 2009 was 57,600 GWh)
P_{grid}:	P5.31 (average grid price per kWh, based on the generation charge in the author's June 2014 electric bill)
R_{cap}:	0.18 for solar (the estimated capacity factor of San Carlos Solar, the first solar generation project to qualify under the Philippine FIT system, based on the expected output of 35,000 GWh from a capacity of 22 MWp; 0.35 for wind; 0.45 for hydro; and 0.70 for biomass

and the variables of interest are P_{ren} (the FIT rate), M_{wpeak} (the MW capacity allowed under the FIT rate), and P_{inc} (the contribution of the technology to the retail price of electricity).

This is the model discussed in Chapter 8.

For those who want to explore this simple model further, they might also want to express the core equation in percentage rather than peso form. If they have the patience to do so, they should get the following percentage form of the core equation:

$$\mathbf{I_{fp} \cdot R_{ren} \cdot R_{grid} = I_{user}}$$

where I_{fp} is the percentage increase of FIT rate over the generation charge, R_{ren} is the percentage share of the renewable in the energy mix, R_{grid} is the percentage share of the generation charge in the total electricity price per kWh, and I_{user} is the percentage increase in the public's electricity bill.

The equation above can be explained simply, in terms that can be easily grasped by policy makers and the public, as follows:

The impact of a higher price (the FIT percentage premium I_{fp}) paid to solar electricity is moderated (i.e., reduced) by the share of the renewable energy production output to the total energy mix. It is further moderated by the share of the generation charge to the total price of electricity as seen by the end-user. Suppose that renewable technologies are able to supply 1% of our total electricity requirements, and that the grid price is 50% of the final end-user price. Then, giving solar technologies a FIT premium of 100% of the grid price (i.e., double the grid price), will result in a price increase to the end-user of 100% × 1% × 50% or 0.5%.

Appendix E. Wind, Solar and Microhydro Suppliers

This section is reserved for a directory of big and small players in the renewable energy industry. In particular, we would like to include here the various business that home and building owners, farm managers, community leaders and local government officials can contact if they want to pursue as a goal turning their site or their community into a renewable energy showcase. In particular, we expect local governments to refer to this list for companies that can be invited to submit bids on their renewable energy projects. Companies that want to be listed on the next edition of this book should contact the author (0917-811-7747; 0939-117-8999) for details.

The inclusion of a company in the list below is *not* an endorsement by the author. The quality of a company's product or service is something that readers and consumers should determine by themselves.

1. Ace Elec-Tech Center (Sta. Cruz, Manila) sells solar and wind power equipment.

2. Amatera Solar Technology (Quezon City) sells and installs solar PV equipment.

3. Brightlux LED Company (Mandaluyong City), founded by Alan Lee, distributes LED lighting of all kinds for improving lighting efficiency and reducing consumption.

4. Dazzling Lite Enterprises (Quezon City) markets LED lights, building management systems (BMS) for energy consumption and solar PV systems.

5. Elektra Power Control Trade (Dumaguete City, Negros Oriental) is a dealer and reseller of solar equipment and wind turbines ranging in capacity from 750W to 10 KW.

6. First Gen Renewables, Inc. (Pasig) is a designer, seller and installer of solar PV systems.

7. Freidrich Enterprise (Caloocan City) installs small-scale solar PV systems including solar water heaters.

8. Green Heat Corp. (Intramuros, Manila) installed the solar panels at the Asian Development Bank, an early and significantly large (0.57 MWp) roof-mounted solar installations in the Philippines.

9. Green Power Philippines (Los Banos, Laguna) supplies RE equipment made in Germany and other European countries.

10. Hydrotec Renewables, Inc. handles hydroelectric design and construction projects in the range of 100 kW to 20 MW using German technology.

11. Maschinen & Technik, Inc. (Alabang, Muntinlupa City) markets various equipment for solar, wind and hydroelectric applications.

12. Meister Solar Philippines (Angeles, Pampanga) designs and installs various solar PV equipment.

13. Paris Manila Technology Corporation (Makati City) focuses on off-grid rural electrification and commercial/industrial installations.

14. Philippine Rural Reconstruction Movement (PRRM) is an NGO with experience in installing micro-hydro power systems.

15. Philippine Solar Power Alliance (PSPA), headed by Tetchie Capellan, is an industry association of solar PV equipment suppliers, installers and various promoters of solar energy.

16. School of Engineering and Architecture, Ateneo de Davao University in Davao City designs and installs solar panels and micro-hydro power systems.

17. Sibol ng Agham at Teknolohiya (SIBAT) is an NGO that has set-up more than 30 micro-hydro systems in the country. It also installs solar and wind energy systems.

18. Solar Energy Philippines (Cavite) installs household-scale as well as enterprise-level solar PV systems, and conducts trainings that demystify the technology for the layperson.

19. Solar Pacific, a company founded by former Energy Secretary Vince Perez, develops solar farms in the range 1–10 MWp.

20. Solar Philippines, a company founded by Leandro Leviste, pioneered the innovative solar financing scheme based on power purchase agreements, but it caters to big customers only.

21. Solar Systems Philippines (Cebu City), sells and installs various solar components and equipment. It has an outlet in Tacloban City.

22. Solaric (Makati City) is a company founded by Mike de Guzman, whose rooftop PV system is described in one of the case studies in this book.

23. Sustainable Energy and Enterprise Development for Communities is a Cebu City-based NGO that provides RE systems to indigenous peoples and disaster-hit areas.

24. Toyani Marketing (Cubao, Quezon City) is an outfit that markets LED lighting and solar and wind equipment.

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