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Can the Philippine electricity sector reduce its carbon emissions by 70%? p.1

CREST
FRIEDRICH EBERT STIFTUNG

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Erratum: In our Issue No. 7, Michael Templonuevo is the MENRO of Gen. Mariano Alvarez, Cavite, not Trece Martires.

CREST

FRIEDRICH EBERT STIFTUNG

Can the Philippine electricity sector reduce its carbon emissions by 70%?

Roberto Verzola

Part 1. We will need in the future more flexible plants, fewer baseloads

Over the past four decades, solar photovoltaic (PV) prices have been dropping by an average of 9% per year. As a result, rooftop solar is the cheapest daytime source of electricity today in many countries.

In the Philippines, the levelized cost of electricity (LCOE) from solar rooftops has gone below six pesos per kilowatt-hour, cheaper than any electric utility in the country. Some solar farms are already offering solar electricity below four pesos per kWh, cheaper than many fossil-based power plants.

While commercial systems have a solar conversion efficiency of around 20%, efficiencies in research labs already exceed 45%. As these research results are commercialized, we can expect solar prices to continue dropping in the coming years.

Wind power capital costs have been similarly coming down at a rate of around 14% per year over the past five years.

Thus, we face the happy prospect of even cheaper solar and wind electricity in the future.

The entry of solar and wind plants in the electricity mix results in three distinct types of power plants:

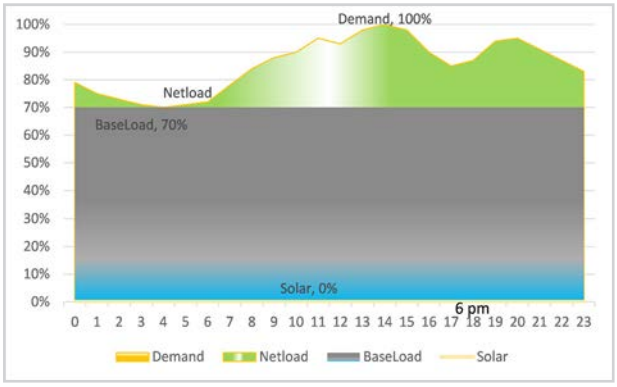
1. **Variable plants** (solar, wind) have no fuel costs. They produce additional kW-hours at no additional cost (zero marginal cost). For this reason, in mixed grids, their output is dispatched first. The country's Renewable Energy Act recognizes this, giving them priority in dispatch. However, these plants' output varies with the weather. Thus, zero-marginal-cost variables need the next type to take up the slack during cloudy or windless days.

> *We face the happy prospect of even cheaper solar and wind electricity in the future.*

2. **Flexible plants** (batteries, hydro, biomass, gas turbines, diesel) take up this slack. They can be started up or shut down each day, or as needed. Operators can ramp their output up or down. DOE calls them peaking or mid-range. Peaking plants operate only a few hours each day, during peak hours. Mid-range plants operate longer hours but still shut down daily, during periods of lowest demand. Except for hydro, flexibles tend to cost more to operate.

3. **Baseload plants** (geothermal, coal, nuclear) must run twenty-four hours a day, seven days a week. Shutting them down frequently makes them very inefficient and raises their costs unacceptably. Like the variables, baseloads also need flexible plants on standby, for a different reason: since baseloads must run 24/7, they are only good for loads that are also 24/7. This is called the base (i.e., minimum) load. As soon as demand exceeds the minimum, flexible plants have to come online to take up the slack. As long as they run 24/7, baseload plants have low average costs. For this reason, they got dispatched first—in the past. Today, zero-marginal cost plants get higher priority.

Cost determines dispatch priority: zero-marginal cost variables come first; low average cost baseloads come next. Flexibles take up the slack during cloudy or windless days, at night, when the demand exceeds the baseload, and when no cheaper solar, wind or baseload outputs can be dispatched.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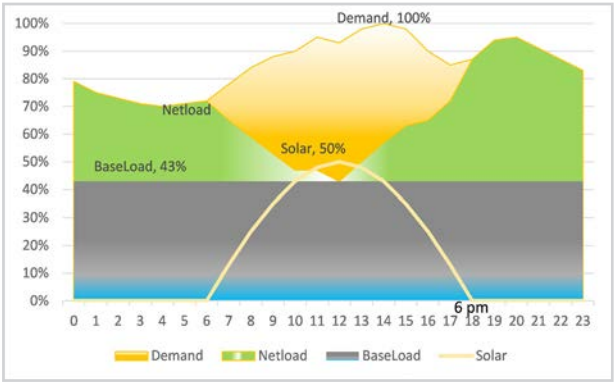
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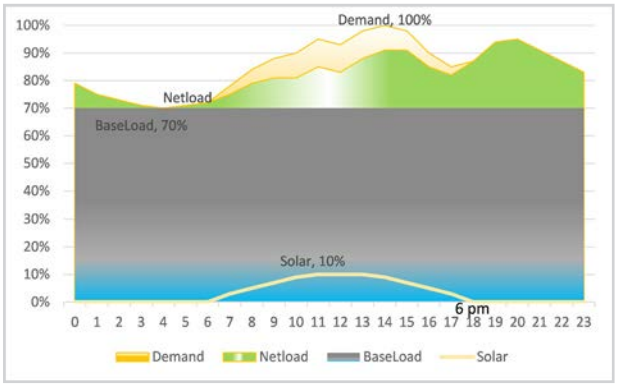
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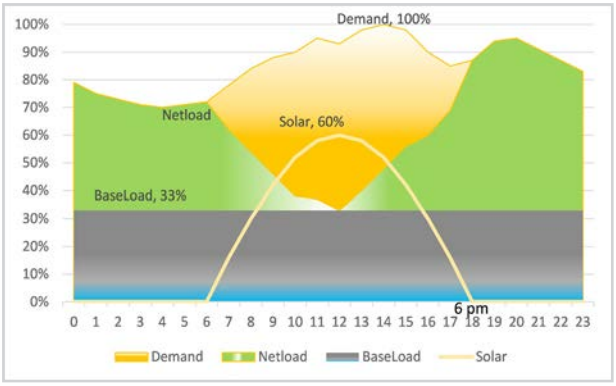
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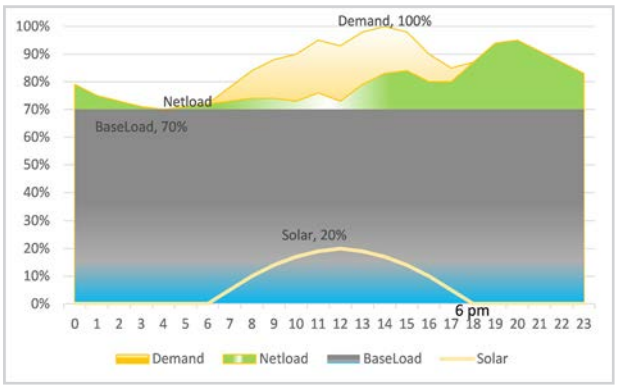
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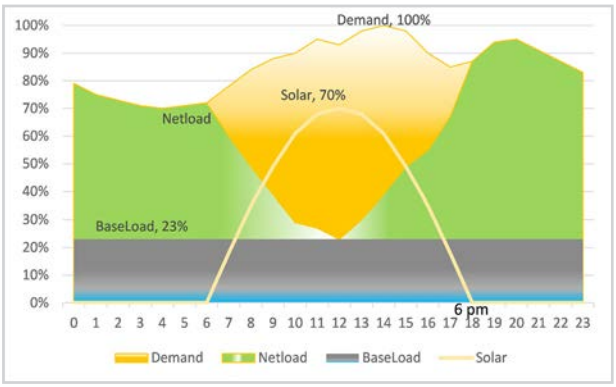
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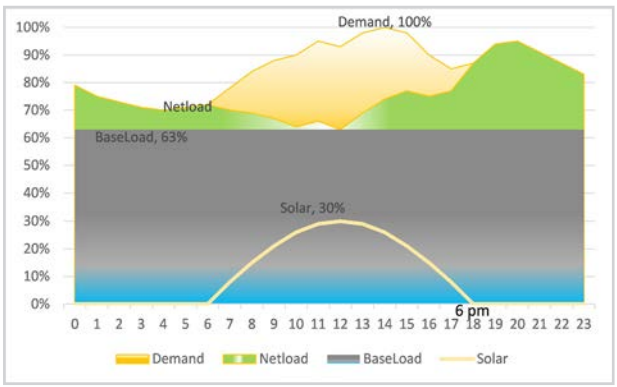
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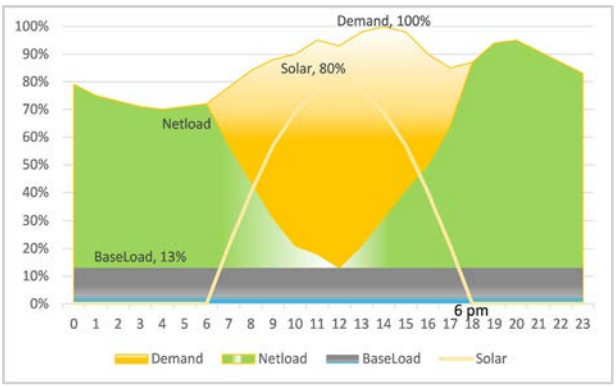
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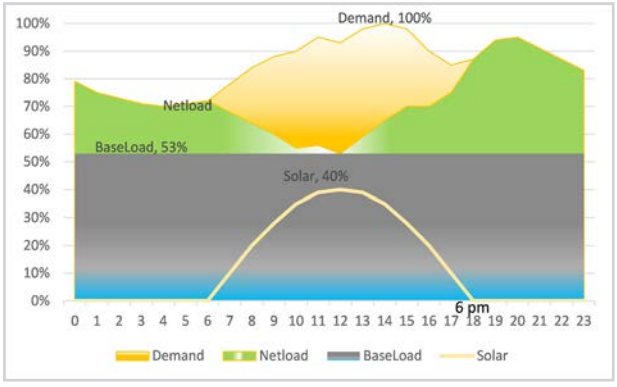
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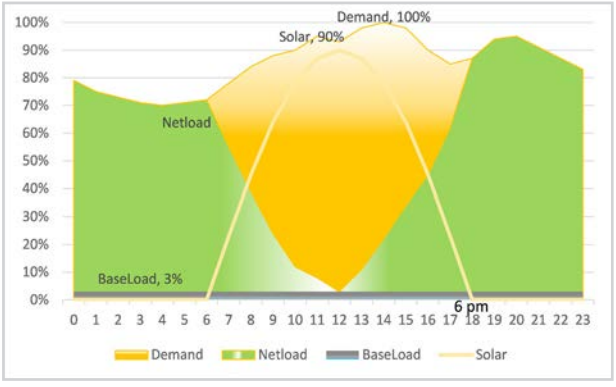
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How solar growth affects the electricity mix

Electricity consumption on the grid follows a general, predictable, 24-hour pattern with two peaks—a daytime peak around 1-3 pm, and a nighttime peak around 7-9 pm. In highly urbanized areas during weekdays, the daytime peak is higher than the nighttime peak. Otherwise, the nighttime peak is higher. Either way, the baseload usually occurs around 2-4 am. The top curve in Figures 1-10 shows this pattern. The highest solar output coincides roughly with the daytime peak.

Grid operators must dispatch power plant outputs so that supply equals demand at all times, while keeping costs as low as possible.

Figures 1-5 (first column) and 6-10 (second column). Simulating solar share in the capacity mix from 0-40% (first column) and 50-90% (second column), respectively.

Ten scenarios: solar capacity at 0%, 10%, 20%, 30%, ... to 90% of peak demand

Figures 1 to 5 in the first column and Figures 6-10 in the second column illustrate scenarios ranging from 0-40% and 50-90% solar share, respectively.

Consider the first two scenarios (Figure 1 and 2, 0-10% solar). As solar share (orange) rises from zero to 10%, it is displacing peaking plants (green). Since solar is cheaper, this is also pulling electricity prices down. The 70% capacity share of baseloads (gray, blue) is unaffected.

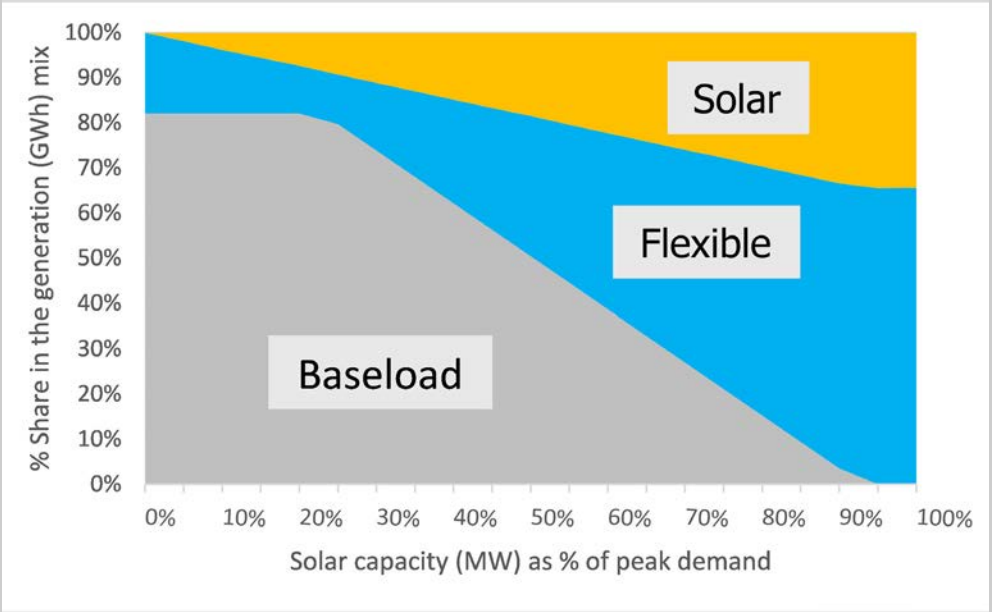
In the next two scenarios (Figure 3 and 4, 20-30% solar), something significant has happened. The midday solar output is so high that the residual demand (total demand minus solar output) is now lowest at midday. The baseload has shifted from early morning to midday. Also, the baseload is now slightly lower, from 70% to around 63%. Solar is now displacing baseload plants too.

In the next scenario (first figure on the second column, Figure 6), with solar at 50% of peak demand, baseload share shrinks further to 43%.

The future needs more flexibility, less baseload

As the solar share in the mix rises, flexible plants are affected first and their role diminishes. But as the solar share increases from 20% to 30% (Figures 3 and 4), baseload plants are affected next. At 50% solar (Figure 6), baseload share shrinks to 43%.
At 70% solar (Figure 8), baseload requirement will only be 23%. At 90% solar (Figure 10), we will need few baseloads.[1] With the baseload share shrinking, the nighttime demand that baseloads used to cover must then be met by flexibles. Beyond 20% solar, the role of flexible plants increases steadily. The trend is shown in Figure 11 (solar is orange, flexibles blue, and baseloads gray; wind is not yet included).

Figure 11. Changes in the generation mix (GWh) as solar increases its share in the capacity mix (MW)



Part 2. Flawed assumptions bloat the DOE baseload plans by 100%

Why is the trend shown in Part 1 so important?

First, because *it is inevitable*. As solar prices drop, solar growth will become increasingly market-driven. Households and businesses will simply decide to solarize their rooftops.

> *The DOE still assumes 70% baseload share until 2040. This assumption is patently wrong. The DOE also wants 70% of reserves to be baseload. This does not make sense. Baseloads must run 24/7 while reserves must be flexible plants that can start up or shut down quickly. Hence, baseloads cannot be used as reserves.*

Second, because the Department of Energy remains *inexplicably blind* to this trend. DOE's Power Development Plan 2016-2040 still assumes 70% baseload share *until 2040*. This assumption is patently wrong.

Assuming 50% solar by 2040, for instance, means a baseload share in the capacity mix of 43%—not 70%—by 2040. DOE's flawed assumption overestimates the country's baseload requirement by 63%,[2] creating a huge bloat in its baseload plans.

The DOE plan has three more flaws:[3]

Including reserves in baseload share calculations

Before Sec. Cusi took over the DOE, the baseload share was calculated as 70% of *peak demand*.

Under Cusi, the baseload share is now calculated as 70% of *total supply*. Since total supply equals peak demand plus reserves, the baseload share is now 70% of peak demand, *plus 70% of reserves*. This change does not make sense, because baseload plants must run 24/7 while reserves must be flexible plants that can start up or shut down quickly. Hence, baseload plants cannot used as reserves.

Before we can calculate how much bloat this flaw adds to the DOE's baseload plan, we need to know the reserve requirement first.

Raising the reserve requirement to 25%

Before Sec. Cusi took over the DOE, the reserve requirement was 4% of peak demand for frequency regulation, plus backup capacity for two of the largest generating units on the grid.

Under Cusi, the DOE has raised the reserve requirement to a flat 25% of peak demand.

Let us reinterpret this new DOE requirement based on the old one: setting aside 4% for frequency regulation leaves 21% of peak demand for backup. The projected 2040 peak demand in Luzon is 29,852 MW; thus, the required Luzon backup capacity by 2040 is 8,203 MW.[4]

The 24 largest generating units in Luzon (see Table 1 below) add up to 8,022 MW. Thus, DOE's new backup requirement means backing up by 2040 more than 20 of the largest generating units on the Luzon grid, from only two under previous DOE administrations.

Does the DOE really anticipate more than 20 of the largest generating units in Luzon to fail *unexpectedly at the same time*? Increasing the reserve requirement to three backups

may be reasonable; arguably, even four or five. But more than 20 is surely an overkill. If we take the national grid as a whole, the overkill will be even worse.

The 25% reserve requirement, plus the inclusion of 70% of reserves in the baseload share calculations, contributes another 17.5% to the baseload bloat.[5]

The 70% baseload share is actually somewhat high

If the baseload is expressed as a percentage of the peak load over 24 hours, the actual five-year average, based on 2012-2017 NGCP data, is: Luzon, 67.5%; Visayas, 63.8%; Mindanao, 64.1%.

If we assume that the actual average nationwide today is really 66%, then DOE's use of 70% adds another 6.1% to the baseload bloat.[7]

The DOE's new reserve requirement means backing up by 2040 more than 20 of the largest generating units on the Luzon grid, from only two under the previous DOE administrations.

We can now calculate the cumulative effect of these flaws on the DOE's baseload plan: **63%** by assuming that baseloads will retain their 70% share until 2040; **17.5%** more by adding 70% of the bloated reserve requirement (which is 25%) to the baseload share; and **6.1%** more because 70% is used instead of 66%.

Combining all these together, we get a total overestimate of 103%.[8] The DOE's baseload plan is twice what we need by 2040. In other words, half of the DOE's calculated baseload requirement is unnecessary.

The DOE plan will result in stranded assets of coal and possibly nuclear plants by 2040, which the Filipino people may end up paying for.

A similar disaster happened during the Ramos presidency, when it contracted independent power producers (IPPs) for huge generation capacities with guaranteed payments. We ended up paying for electricity we did not need, and which the IPPs did not even generate.

To be fair, Pres. Ramos could not have anticipated the financial meltdown in late 1990s that shrank economies and their energy demand.

In Cusi's case, however, ignoring renewable industry trends and changing calculation methods are clearly intentional. The resulting baseload bloat favors the coal industry.

Pres. Duterte should look into this matter ASAP, while there is still time to trim the DOE's long project pipeline of toxic coal and, possibly, nuclear power plants.

Table 1. The largest installed and committed generating units on the Luzon grid[6]

Power Plant	MW/unit	Total MW	No. of units
Sual 1&2	647	1,294	2
Quezon Power	511	1,805	3
San Gabriel	430	2,235	4
Pagb ilao 1&2	382	2,999	6
Mariveles 1&2	326	3,651	8
Malaya 1&2 OPP	325	4,301	10
Masinloc 1&2	315	4,931	12
Calaca 1&2	300	5,531	14
San Lorenzo 1&2	275	6,080	16
Sta. Rita 1-4	274	7,175	20
Ilijan 1-4	212	8,022	24
Ilijan 5	212	8,234	25
Ilijan 6	212	8,446	26

Part 3. Cutting power plant carbon emissions by 70% is doable

It was suggested in Part 1 that future DOE plans should focus on more flexible plants that can be shut down once a day and whose output can be easily ramped up or down, rather than baseload plants which must run 24/7 to stay ef-

ficient. The DOE baseload overestimate means that the country can in fact afford to gradually decrease its fleet of fossil-based baseload plants, as the electricity sector's contribution to the international effort to deal with climate change.

Having suffered through typhoon Yolanda ang other recent extreme weather events, Filipinos feel in their gut what global warming and climate change mean. Thus, the Philippine government made an international commitment to do its share in greenhouse gas (GHG) reduction. This commitment in the Paris climate treaty reads as follows:

"The Philippines intends to undertake GHG (CO_2e) emissions reduction of about 70% by 2030 relative to its business-as-usual (BAU) scenario of 2000-2030. Reduction of CO_2e emissions will come from energy, transport, waste, forestry and industry sectors. The mitigation contribution is conditioned on the extent of financial resources, including technology development & transfer, and capacity building, that will be made available to the Philippines."

The treaty was signed by Pres. Duterte and ratified by the Philippine Senate in March 2017. This makes the treaty part of the laws of the land, providing the legal basis for the suggestions below.

This part quantifies what a 70% reduction of the BAU scenario means for the electricity sector, in terms of gigawatt-hours (GWh) of generation from fossil-based power plants, which are the sector's main source of GHG emissions.

"Business-as-usual" scenario: 182,007 GWh

The Philippines generated 25,865 GWh of electricity from fossil-fueled power plants in the year 2000. By 2007, this had increased to 40,774 GWh, an average annual growth rate (AAGR) of 6.72%[9]. The Renewable Energy Act was passed in 2008, so we will use the 2000-2007 AAGR as the BAU growth rate. Assuming that fossil-based generation continued at this same BAU rate until 2030, we get a projected BAU scenario by 2030 of 182,007 GWh.[10] This is what we committed to reduce by 70%, to attain a climate-friendly, low-carbon scenario.

> *Our Paris commitment means reducing our fossil-based generation, which was 71,181 GWh in 2017, by 2% per year. If the Duterte administration, by the end of its term, brings down our fossil-based generation to the same level as when it assumed office, we can meet our Paris commitment.*

Climate-friendly scenario: 64,280 GWh by 2022, 54,602 GWh by 2030

Reducing by 70% means retaining 30%. In effect, we committed to generate by 2030 no more than 30% of 182,007 GWh, or 54,602 GWh, of fossil-based electricity. We will call this ceiling the climate-friendly "low-carbon scenario".

Our fossil-based generation at the end of 2017 was 71,181 GWh. Bringing this down to 54,602 GWh by 2030 means an *actual* reduction over 13 years of 23.3% from the 2017 level, [11] or an average reduction of 2.02% per year.[12]

The useful life of coal plants is 25 years, before they need to be rehabilitated. This means that if we let coal plants operate until the end of their useful life, without rehabilitating or replacing them, 1/25 or 4% of them will be retired each year. Our Paris commitment requires us to retire fossil-fueled power plants at the rate of 2% a year. This is half their natural attrition rate, leaving enough room for flexibility.

To get a sense of what our Paris commitment means specifically for the Duterte administration, let us apply a steady decrease of 2.02% per year, starting from the historical figure of 71,181 GWh in 2017. The resulting year-by-year fossil-based generation targets in GWh are as follows: 2018, 69,744; 2019, 68,336;

2020, 66,956; 2021, 65,604; **2022, 64,280**, 2023, 62,982; 2024, 61,710; 2025, 60,464; 2026, 59,244; 2027, 58,047; 2028, 56,875; 2029, 55,727; **2030, 54,602**.

The 2018-2022 targets above are the climate-friendly, low-carbon scenario for the Duterte administration.

The 64,280 GWh target for 2022 was our level of fossil-based generation in mid-2016, when Pres. Duterte started his six-year term.[13]

Thus, if the Duterte administration, by the end of its term, brings down our fossil-based generation to the same level as when it assumed office, we can meet our Paris commitment.

Insiders say that the DOE has been campaigning within the Cabinet to bring down our 70% BAU reduction commitment to 40%. This means retaining 60% of BAU instead of 30%, or a fossil-based generation ceiling by 2030 of 109,204 GWh instead of 54,602 GWh.[14] The DOE proposal means our carbon emissions will increase by 3.35% per year instead of decreasing by 2.02%.[15] With DOE's bad idea, we will remain part of the problem instead of becoming part of the solution.

Over the next 13 years, DOE's idea will result in some 370,000 GWh being sourced from fossil-based plants instead of renewables.[16] At four pesos per kWh, that is 1.48 trillion pesos at stake in this DOE proposal. Do we really want this money to go to the coal industry instead of the renewables industry?

What about our growing electricity requirements?

National development requires power. If we took the low-carbon path and reduced our fossil-based generation by 2% per year, can non-fossil-based sources cover the balance?

The next piece will show that indeed renewable energy projects already approved by the DOE can cover the balance, with a few years to spare.

> *As long as all approved RE projects as of 2017 are implemented on time, we can generate more than enough electricity for our national development goals and exceed our Paris commitment at the same time.*

Part 4. Power sector can meet our Paris commitment and power needs too

Part 3 showed that our greenhouse gas reduction commitment to the Paris climate treaty meant a gradual 2.02% annual reduction in fossil-based electricity generation, for a total reduction of 23.3% by 2030 compared to 2017 levels. The annual reduction required by this low-carbon path is only half the 4% natural attrition rate of coal plants, if they are retired at the end of their 25-year useful life. This provides the country with some flexibility.

Our commitment gives the Duterte administration a fossil-based generation ceiling of around 64,280 GWh by 2022, which was our level of fossil-based generation in mid-2016. Thus, if the Duterte administration, by the end of its term, brings down our fossil-based generation to the same level as the level when it assumed office, we can meet our Paris commitment.

Meeting our growing electricity requirements

We definitely do not want to sacrifice national development and our power needs for the sake of meeting our Paris commitment. This is the real question: if we took the climate-friendly path and reduced our fossil-based

▼ Table 2. RE projects approved by the DOE as of 2017[19]

RE Technology	Awarded, MW	Capacity Factor	GWh/year
Hydro	13,468	35%	41,291
Ocean	26	35%	80
Geothermal	575	63%	3,173
Wind	2,462	23%	4,959
Solar	6,883	14%	8,441
Biomass	347	27%	820
	23,760		**58,765**

generation by 2% per year, can renewable energy (RE) and energy efficiency (EE) cover the balance?

This part will show that as of 2017, enough RE projects have already been approved by the DOE to cover the balance.

Let us first determine what this balance is.

Using the DOE's load factor method in the DOE's Power Development Plan 2016-2040, we estimate the DOE generation target to be around 118,000 GWh by 2022 and 182,000 GWh by 2030.[17] Since a low-carbon scenario limits the Duterte administration to at most 64,280 GWh (54%) of fossil-based generation by 2022, this means that the balance of 53,720 GWh (46%) must be covered by RE.[18]

Can the Duterte administration produce 53,720 GWh from RE by 2022?

As of end-2017, some 1,075 private sector RE projects had been submitted to the DOE. Of these, 869 projects had been approved (Table 2), while 206 were still pending.

The approved projects totaled 23,760 MW, good for an annual generation of more than 58,000 GWh based on very conservative capacity factor assumptions (35% hydro, 35% OTEC, 63% geothermal, 23% wind, 14% solar, and 27% biomass[20]). As long as all approved RE projects as of 2017 are implemented on time, we can generate more than enough electricity for our national development goals and exceed our Paris commitment at the same time, with several years to spare.

Including the 206 RE projects still awaiting approval raises the potential annual generation to 68,000 GWh, far exceeding our low-carbon target of 53,720 GWh RE by 2022. Remember that these are just RE projects approved *as of 2017*. The Duterte administration has four more years to exceed its low-carbon targets.

With a further 10% reduction in electricity demand through energy efficiency, subsequent administrations can go for even more ambitious carbon cuts or GDP growth rates in the future.

Other benefits of a low-carbon path

This low-carbon path will also 1) help the Philippines access climate-related international grants and financing; 2) reduce local pollution; 3) pull down the price of electricity as solar, wind and battery prices decline steadily; 4) open the country's industrialization program to sunrise industries offering green investments and green jobs; 5) democratize the electricity sector as more rooftops are solarized; 6) improve the resilience as well as efficiency of our energy infrastructure through distributed generation; and 7) reduce financial and project risk through expansion in smaller increments.

RE project delays due to energy speculation and red tape

Sadly, some RE developers have dilly-dallied in finishing their projects. They are apparently more interested in reselling their service contracts to latecomers.

Worse, some of these speculators are also building coal plants, whose outputs are contracted out to electric utilities through long-term power supply agreements. And these plants are completed with little delay, especially today, with DOE's EO 30 fast-tracking "projects of national significance". Thus, RE projects are locked out of potential markets, while we are locked in for the next decade or more to coal plants which cause global warming, local pollution, fuel price volatility risks and other problems.

To foil these energy speculators, the DOE must insist on clear milestones, iron-clad contracts, performance bonds, and hefty penalties for delays in or abandonment of RE projects.

The red-tape problem, a common complaint, can be solved: the DOE should do the pre-feasibility studies and project specifications, collect all the necessary government signatures, and package the projects itself. It can then auction off the packaged projects to the most qualified bidders, i.e., those who bid to finish them on time at the lowest cost.

Dismal results from the RE Act

The Renewable Energy Act of 2008 is ten years old this year. Its implementation has been dismal.

The feed-in-tariff (FIT) system for big players was hobbled from the beginning by an ill-conceived high-risk "race-to-finish" approach which required developers to finish their RE project first before they can learn if they qualify for FIT or not. FIT participants regularly complain of delayed payments.

The net metering provision for small players was recast by electric utilities into an unattractive net billing system and saddled with barriers like permitting requirements, impact studies and unnecessary charges.

Other provisions like the renewable portfolio standards, renewable energy certificates and green energy options have languished, unimplemented after ten years.

Pres. Duterte should step in to ensure that Filipinos are not denied the full benefits from renewable technologies that are increasingly enjoyed by people in countries with better pro-RE policies.

If the administration shows the same political will as it did in the Boracay cleanup, the power sector should be able to meet our international climate commitment as well as the power needs of national development.

Roberto Verzola studied electrical engineering and economics at the University of the Philippines. The German foundation Friedrich Ebert Stiftung published in 2017 his book "Crossing Over: The Energy Transition to Renewable Electricity" (second edition, PDF is online). He is currently president of the non-profit Center for Renewable Energy and Sustainable Technology (CREST).

Endnotes:

1 Email rverzola@gn.apc.org for the full 0-100% simulation in 5% steps.

2 70÷43 - 1 = 0.63

3 All four flaws can be seen in the Demand-Supply Outlook (p.44) of the DOE's PDP 2016-2040, which is on the DOE website.

4 21% of 29,852 = 8,203

5 0.70 x 0.25 = 0.175

6 The third and fourth columns are cumulative totals.

7 70 ÷ 66 – 1 = 0.061

8 1.63 x 1.175 x 1.061 – 1 = 1.03

9 $25865 \times 1.067182^{7} = 40774$. The growth rate is rounded off to 6.72% and this is the number used for all subsequent calculations. See next footnote, for instance.

10 $25865 \times 1.0672^{30} = 182007$

11 54602 ÷ 71181 – 1 = –0.233

12 $(54602 \div 71181)^{(1/13)} - 1 = -0.0202$

13 Historical fossil-based generation was 61,450 GWh end of 2015 (or start of 2016) and 68,818 GWh end of 2016.

14 100% – 40% = 60%. 60% of 182,002 = 109,204.

15 $(109204 \div 71181)^{(1/13)} - 1 = 0.03347$

16 The year-by-year breakdown is as follows (see Table 3):

17 The 2022 generation target (GWh) was calculated from PDP 2016-2040 peak demand projections and load factor estimates for Luzon (12,579 MW, 74.6%), Visayas (2,812 MW, 71.6%) and Mindanao (2,782 MW, 72.6%). Using the formula GWh = LF x MW x 24 x 365 / 1000 results in generation targets for Luzon, Visayas, and Mindanao of 82,203 GWh, 17,637 GWh, and 17,692 GWh, respectively, for a total of 117,532 GWh. This was rounded off to 118,000. Following the same procedure, 182,000 GWh is obtained for 2030.

Table 3. Difference (in GWh) between Paris commitment (70%) and DOE proposal (40%)

Year	Paris	DOE	Difference
2017	71181	71181	
2018	69744	73563	3820
2019	68336	76026	7690
2020	66956	78570	11614
2021	65604	81200	15596
2022	64280	83918	19638
2023	62982	86727	23745
2024	61710	89629	27919
2025	60464	92629	32165
2026	59244	95730	36486
2027	58047	98934	40886
2028	56875	102245	45370
2029	55727	105667	49940
2030	54602	109204	54602
TOTAL			369471

18 118000 – 64280 = 53720.

19 If second column is MW, third column is CF and fourth column GWH, GWH = CF x MW x 24 x 365 / 1000.

20 Based on historical capacity factors of each technology for the past five years. Because we have no historical data on ocean power, we assumed that ocean CF is the same as the hydro CF.

Renewable energy syllabus now ready for piloting

CREST has just released as an open-source document the final version of its renewable energy (RE) syllabus project. The project involved drafting a syllabus for a 3- to 5-unit one-semester introductory course on renewable energy, which can be part of a four-year engineering program.

The program is meant to help meet the human resource requirements of the fast-growing renewable energy industry.

The drafting of the syllabus was supervised by a Technical Working Group (TWG) which comprised of representatives from academic institutions like the MAPUA University, Polytechnic University of the Philippines (PUP), University of the East (UE), Development Academy of the Philippines (DAP), and the University of the Philippines (UP).

The final syllabus version was edited by Engr. Gisela Siapno, chairperson of the electrical engineering department of University of Pangasinan.

A number of academic institutions have already expressed interest in piloting the syllabus, after it is further adapted to their specific institutional requirements. The pilots will probably start in 2019.

The syllabus outline is in Table 1. The complete syllabus includes desired learning outcomes, de-

Table 1. List of modules covered by the RE syllabus

	Module Title	Number of hours
1	Basic Energy Concepts	2
2	Why Renewable Energy	3
3	Estimating Demand	2
4	Energy Efficiency and Demand-Side Management	2
5	Storage batteries: Storing DC	2
6	Inverters: Converting DC to AC	2
7	Solar Energy	3
8	Solar PV Experiments	2
9	Turbines	2
10	Generators	2

11	Generator and Turbine Experiments	2
12	Wind Energy	2
13	Hydroelectric Energy	2
14	Energy Storage	2
15	Biogas Digesters	2
16	Heat Transfer and Heat Pumps	2
17	Gasifiers	2
18	Geothermal Energy	2
19	Ocean Energy	2
20	Emerging RE Technologies	2
21	Instrumentation, Metering and Control	2
22	Transmission and Distribution	2
23	Energy Mix and Grid Interconnection	2
24	Grid Interconnection Experiments	2
25	Occupational Safety and Health	2
26	Renewable Energy Economics	3
27	Renewable Energy Financing	2
28	Management and Social Entrepreneurship	2
29	Public Administration and Governance	2
30	Ecological and Social Framework for Impact Evaluation	2
31	Written Exams	3
32	Site Visits	4
33	Attendance in Industry Conferences/Exhibits	3
34	Presentation of Report on Capstone Project	2
	Total number of hours	75

tailed topics per module, references, and possible lecturers.

The total number of hours comprising the syllabus can be cut or raised, depending on a particular institution's requirements.

As a follow-up project, a training workshop for RE lecturers and resource persons is now being developed.

Plans are now underway to expand the syllabus further into an 18-unit certificate course on renewable energy.

To implement this proposal, an RE Education Consortium is being considered that can draw equipment and other donations for an RE laboratory and other resources required to improve RE education in the Philippines.

A link-up with the Renewable Energy Academy (RENAC) of Germany is also being pursued.

Academic institutions interested in piloting the RE syllabus or an RE certificate course should contact CREST at crestphilippines@gmail.com.

Solar PV energizes Dumagat Heritage Village in Bulacan

Riedo Panaligan

More than 30 Dumagat families in the Punduhan ng mga Dumagat, a heritage village in the Angat Watershed, are now enjoying clean electricity through solar energy.

The 1,200-watt solar PV system is a project of the Sagip Sierra Madre Environmental Society (SSMESI). Donations from concerned individuals funded the project. CREST helped install the system. CREST also trained Dumagat leaders and volunteers in solar PV basics and in operating and maintaining the system.

The solar PV system provides light and electricity to the tribal hall, main kitchen, and the training/lecture area. It also powers the street lights around the village.

"The solar project provides a lot of benefits to the community. Before, the village was so dark at night. Now pathwalks are lighted and the Dumagats can conduct social activities at the tribal hall even at night," said Bro. Martin Francisco of SSMESI.

Punduhan ng mga Dumagat is located in Norzagaray, Bulacan. It is around 25 kilometers from the Quezon City Memorial Circle.

Aurora folks learn micro-RE installation

Riedo Panaligan

CREST held a series of training workshops on design and installation of small-scale ("micro-") renewable energy technologies on the second quarter of 2018. The series was held in partnership with the Friedrich Ebert Stiftung (FES) and the municipal government of San Luis headed by Mayor Mariano Tangson.

The in-depth workshops focused on solar photovoltaic (PV) rooftops (April 17-18, 2018), microhydro (June 5-6, 2018) and anaerobic biodigesters (June 28, 2018).

Workshop participants included technical units of the LGUs of San Luis and Baler, barangay officials and youth councils in San Luis and faculty members of the Aurora State College of Technology (ASCOT).

"We are glad to hold this training to promote renewable energy here in Aurora," said Mayor Tangson during the solar PV training.

Solar training participants learned the basic equipment, the functions of each, and safety protocols in solar PV rooftop installation. They also learned to design simple off-grid solar PV setups such as solar streetlights.

Participants of the microhydro training learned the principles of generating power from river runoffs.

The biodigester training participants learned the biological interactions behind anaerobic digestion and methane production. Participants went through a hands-on fabrication of small-scale biogas systems using plastic drums and containers.

My internship at CREST

Hazel Formes

Choosing a company for on-the-job training (OJT) is a hard decision for a student. Most choose a company because it is accessible and convenient, or because it is a famous name in the field.

Electrical engineering offers vast opportunities. It is important to choose wisely. One should ask oneself, "What career do I want in the future?"

Born where electricity was a given, I saw it as a common privilege. But I also saw places where light was a luxury. I was furthermore concerned about global warming, a survival issue which was forcing us to change our ways. Coal plants, a major cause of global warming, dominate the electricity supply in the Philippines. As a solution to global warming, renewable energy was a rising industry. It offered unlimited opportunities for the future.

For me, OJT is important not only for the experience but also to kick-start my career choice.

I met CREST in a conference at the Polytechnic University of the Philippines (PUP), where I studied electrical engineering. I was an usher, assigned to assist sponsors and speakers. I had very little idea about CREST, except that they promoted microrenewables.

CREST offered great experience to meet new people and go places, and the organization advocated microrenewables, so I chose them. I was their first intern.

Travelling to different places, I learned the importance of electricity to a community.

In Norzagaray, Bulacan, we helped a tribe of Dumagats tribe set up solar electricity to light up common areas. As time passed, I noticed a change: starting from a few houses, more and more Dumagats chose to reside in the area. This was unexpected, because Dumagats were nomadic.

In rural places off the grid, I realized the importance of street lights for a community. Without moonlight, people stayed inside their houses at night. Imagine walking towards an abyss of darkness, where you felt like the dark will consume you.

In urban communities, night light on streets protect people against robbery, car accidents, and other untoward incidents.

Off-the-shelf solar street lights are expensive. Some fail because of poor design, or poor siting. I helped design a better one, which was more efficient and cheaper.

I was also involved in creating a renewable energy syllabus. We met with professors and renewable energy specialists. With their help, we drafted various modules for the syllabus, from basic concepts to economics.

Such an RE syllabus is a big step in preparing engineers with renewable energy as their specialty.

In the end, I realized that access to electricity was actually a right. Everyone had the right to electricity because a simple lamp could change their life.

Hazel H. Formes is a 19-year old 4th year electrical engineering student at the Polytechnic University of the Philippines (PUP) in Manila. She was a national officer of the Council of Student Chapters of the Institute of Integrated Electrical Engineers of the Philippines (IIEE-CSC). She is currently the vice president for organizational relations of the EE Network, an academic student organization in PUP Manila. Hazel likes reading novels and building circuits.

DIY lithium battery storage

Gregory Divino

Following the success of lithium batteries for TESLA electric vehicles, TESLA Motors released in 2015 the Powerwall, a stationary energy storage device for residences and commercial establishments.

Powerwall was based on the same battery storage as the Tesla S, but with a smaller 2-kWh capacity. Powerwall 2, an improved version with liquid cooling and double the capacity at the same price, was released subsequently.

The building blocks inside Tesla's batteries are 18650 battery cells. The good thing is that we can now get these 18650 cells from the Internet. We can get it from Alibaba and other Chinese suppliers, from eBay, or from focused distributors such as batterybro.com (Hongkong) and batteryspace.com (U.S.). In the Philippines, 18650 cells are also available from Lazada, online shops, VAPE shops, and many Chinese suppliers. If you assemble them yourself, battery packs can be built for as low as □50 per cell. You can Facebook groups for hobbyists and DIYers that share how this is done. You can, in fact, build your own powerwall (note the small 'p').

Lithium batteries lend themselves well to do-it-yourselfers (DIYers) for two reasons:

1) Cell assembly is scalable and configurable. You can use as few as 4 cells or expand to as many as 1,000 cells, depending on your budget.

2) There is a big secondary market for used batteries from electric vehicles such as Tesla, Chevy Bolt or Nissan Leaf. Many of them are sold online. The best of these batteries still have 80% of their original storage capacity.

Used properly, lithium batteries are good for 3,000 to 5,000 charge/discharge cycles. You can make sure that these numbers are attained through the following:

1) They should not be charged beyond 4.2V.

Standard lithium batteries are now available in the Philippines. If you assemble them yourself, battery packs can be built for as low as P50 per cell.

▲ Figure 1. Typical 18659 lithium battery cells

2) They should not be discharged below 2.5V.

3) They should not be allowed to overheat.

Case study: room lighting

For our case study, let us try to light up two rooms at night. It takes 10-20 watts to light up a conventionally-sized room of 10-20 m². For two rooms, we need 40 watts maximum. To light up the rooms 4-8 hours each night, we would need 160-320 Wh.

To power the 12V DC bulbs, we will use a 4s configuration (four cells in series). The nominal voltage will thus be 3.7*4=14.8V. To get 320Wh, we need: 320Wh/14.8V = 21.6Ah

Since we can only use 75% capacity, we will need a minimum rated capacity of: 21.6Ah / 0.75 = 28.8Ah or 29Ah

The number of 4s battery banks needed is: 29Ah/3.5Ah = 8.28 or 8 banks

So all in all, we will need 4s8p or 32 cells (4 cells in series, 8 of these in parallel).

For long battery life, charging currents (in amperes) should be around 10% of the battery's Ah capacity. I.e., a 40-Ah battery should be charged with a 4A current (10% of 40). This is called 0.1C charging. A 20A charging current is called 0.5C charging, and a 40A charging current is called 1C charging. Based on a recommended 0.1C charging current, a 50W solar panel can charge the battery bank in around 6 hours. This is just about right for a typical sunny day in the Philippines. Charging at 0.5C will shorten the charging time to 2 hours, but at the cost of higher charging temperature and shorter battery life.

If charged too fast (1C and above), lithium batteries may overheat and even blow up. A battery management system (BMS) keeps the battery temperature within safe operating limits, removing this risk. Many Chinese suppliers offer their own BMS. These BMS disconnect the charger from the batteries when their sensors detect any abnormal condition that could cause the batteries to malfunction or explode. If you don't have a system to prevent thermal runaway, in which the battery can explode, it is best to keep charging currents at 0.1C.

To charge a 14.8-V 28-Ah battery, an average 0.1C charging current of 2.8A (10% of 28) would be needed.

A 100-watt panel can do this but there will be days when it cannot sustain 2.8A of current. Better to use a 60-cell panel with a rating of at least 250W. This would give a charging current close to 2.8A on the average and in the 4-5A range at midday. This will also charge the battery even on rainy days, when only 10% of the solar panel's rated capacity may be available.

If lithium batteries are only charged to a maximum of 4.15V, 4.10V, or 4.0V per cell, we can extend the life of lithium batteries by 1.4x, 2x, and 4x, respectively. The life of a lithium battery doubles for each tenth of a volt (0.1V) reduction in the maximum charging voltage.

The final battery bank configuration uses 32 cells (4s8p) rated at 3500mAh each. The bank will have a total rated capacity of between 300-500 Wh, enough to power small DC lamps in the kitchen and dining area. There are 3 sets of lamps, each set consisting of 4 lamps each. The lamps vary from 3W to 5W and each set of lamps can be turned on at the same time. All these lamps can run as the same time as a DC stand fan.

The life of a lithium battery doubles for each tenth of a volt (0.1V) reduction in the maximum charging voltage.

Gregory Raymund "Gerry" C. Divino is the founder/CEO of Amatera Solar Technology Inc. (AST). In 2006, with solar panels as a hobby, Gerry connected a 20-W panel to a home-made charger to light up a bahay kubo in their garden. Encouraged by friends who wanted help in reducing their electricity bill, Gerry formalized AST into a corporation in 2014. As of July 2018, AST has installed over 1,558 solar panels in 64 locations all over Luzon. On a sunny day, those "power plants" deliver 413.8 kW of peak power, helping their owners save ₱6M every year in electricity bills. Gerry can be reached at gerry.divino@amaterasolar.com.

SRI beats 10 hybrid varieties in 2017 Samar rice derby

During the rainy season of 2017, the Department of Agriculture sponsored a "rice derby", pitting 18 hybrid rice varieties against each other to determine the best variety. At the last moment, the SRI method, using an inbred variety rather than a hybrid, was allowed to compete.

The contest was held in Basey, Samar. The DA brought farmers from all over the country to observe the competition.

The SRI field was prepared, planted and maintained by farmer-cooperator Maritess F. Durana. She was a first-time SRI farmer. Maritess was supervised by DA-Region 8 staff, Farm Supervisor Debbie J. Ortega and Science Research Specialist Purisima C. dela Cruz, who were also trying SRI for the first time. It was the only all-woman team in the contest. Technical advice was provided by the Eastern Visayas coordinator of SRI Pilipinas, Juanito Poliquit of the Visayas State University (VSU).

The yield results are in Table 1.

Bayer's Bigante Plus placed first (8.5 tons/ha). The non-hybrid SRI entry placed ninth (6.76 tons/ha). Eight hybrid entries attained higher yields than SRI, while the SRI entry got a higher yield than ten hybrid entries.

SL Agritech entered four varieties in the competition. SRI beat three of the four. The fourth placed eighth, slightly ahead of SRI (6.83 tons/ha vs 6.76 tons/ha).

Why would the DA withhold the cost data in the Basey derby, and then exclude SRI from subsequent derbies? Why would the DA prefer the hybrid approach, which is more expensive and riskier for the farmer? It is a real mystery.

The PhilRice entry, Mestiso 20, placed a poor 17th (third to the last), with a yield of 5.95 tons/ha

It was clear from the beginning that good results meant high yields at low cost. It does not make sense for farmers to adopt a high-yielding variety if the costs are also high. These high costs negate the potentially high hybrid yields. They also force farmers to borrow money, risking bankruptcy if their crops are hit by typhoons, floods, pests or diseases.

The curious thing, however, is that the DA did not release any cost data, despite repeated requests.

SRI Pilipinas is certain that its entry had the lowest cost because inbred seeds cost less. Also, SRI uses fewer seeds, less water, and inexpensive farmer-mixed organic inputs.

Is it possible that SRI actually won the competition if both yields and costs were taken into consideration?

The Basey results are just the most recent of a string of

SRI successes in trials done by government agencies and local governments. The benefits are well-established: higher yields, lower cost, and no poisonous agrochemicals.

What is even more curious is that the DA did not invite SRI Pilipinas anymore to participate in subsequent rice derbies.

A hybrid program will cost billions, because hybrid seeds are very expensive. Farmers who use them must buy the seeds every planting season. Hybrid seeds cannot be planted over and over again. The inbred variety that SRI used can be replanted. Also, hybrid protocols specify high external inputs to realize the promised high yields.

SRI on the other hand simply involves training farmers on the new method, which does not cost as much. What little money is involved goes mostly to paying for training materials, honoraria to trainers, and snacks for the farmers. The biggest additional costs for farmers are the one-time cost of a mechanical rotary weeder, which can be made in most welding shops, and the compost and organic concoctions, which they can also make themselves. Most poor farmers rely on family labor, in which case the wage expense goes right back to them.

Yet, the DA insists on pursuing an expensive hybrid rice program, while ignoring the lower-cost SRI approach, which SRI Pilipinas has been trying since 2001 to convince the DA to adopt.

The Philippines is suffering from recurring rice shortfalls so serious that we often need to make emergency rice imports to forestall rice shortages. SRI will clearly help solve this problem.

Why would the DA withhold the cost data in the Basey derby, and then exclude SRI from subsequent derbies? Why would the DA prefer the hybrid approach, which is more expensive and riskier for the farmer?

Ranking	Company	Variety	Yield
1	Bayer	Bigante Plus	8.5
2	Bayer	INH15133	8.03
3	Bayer	Bigante Plus	7.58
4	Syngenta	SG003	7.29
5	SeedWorks	US88	7.18
6	Syngenta	RH9000	7.09
7	LongPing	LP 205	6.86
8	SL Agritech	SL8	6.83
9	SRI	NSIC RC 360	6.76
10	SL Agritech	SL12	6.74
11	Syngenta	NK5017	6.66
12	Pioneer	PHB77	6.64
13	SeedWorks	TH82	6.22
14	Pioneer	PHB73	6.21
15	SL Agritech	SL19	5.98
16	SL Agritech	SL18	5.94
17	PhilRice	Mestiso 20	5.95
18	Syngenta	RH9000	5.78
19	PhilSCAT	P6F1/P9F1	5.61

▲ Table 1. Yield results of the 2017 DA-sponsored rice derby in Basey, Samar

It is a real mystery.

President Duterte should ask DA Secretary Piñol about the Basey derby results, insist on getting the cost data, and see for himself whether SRI can indeed do better than hybrids in helping solve our rice shortfalls by raising farmers' yield and reducing their costs.

SRI: the seven basic practices

Roberto Verzola

In SRI, the "secret" of increasing rice yields is to learn how you can coax the rice plant to produce more tillers. Once you are able to make your rice plants produce an average of 25 or more productive tillers per plant, instead of the usual 3-10 tillers per plant, then you will surely improve your yields.

Farmers today are doing several things wrong, which is why their plants produce a few tillers only. SRI practices correct these mistakes, enabling the rice plant to express its natural capacity to produce many tillers.

To understand what farmers are doing wrong, and why SRI practices release the rice plant's natural capacity for profuse tillering, farmers must have a good idea when the tillering stage starts.

This is the most important piece of information farmers must learn, if they want to understand SRI: *when does tillering start?*

The rice plant is not a machine, and therefore, we can give no exact numbers. Farmers must observe closely, as one leaf after another emerges from their rice seedlings.

In general, tillering starts at the same time as the emergence of the fourth leaf. In typical lowland varieties, this means 16-20 days after sowing. But farmers must observe their seedlings closely, to know for sure, as this information varies based on various factors, including the variety used. It may even vary from seedling to seedling. But the emergence of the fourth leaf generally marks the emergence of the first tiller too. Observe!

When do farmers transplant? Usually between 15 to 25 days. This means that when the seedlings are uprooted for transplanting, *tillering is about to start or has already started*. This is the first mistake. Uprooting the seedling around this time disturbs the tillering process and delays it or, worse, stops it altogether.

How are the uprooted seedlings treated? This is the second mistake. They are thoroughly shaken, or struck against a board, to remove all soil, exposing the sensitive roots. They are tied together tightly. Sometimes the leaves are cut. Less often, the roots are also cut. The tightly bound seedlings are thrown into the field, exposed to the sun, sometimes for a whole day, until they are transplanted. What a terrible ordeal for a seedling that is ready to switch to the tillering stage!

At this very early stage, *the farmer has already lost* the rice plant's maximum capacity to produce tillers. After taking many days to recover, assuming they can recover completely at all, the rice plants resume the tillering process, but many days have been

Tillering starts at the same time as the emergence of the fourth leaf. In typical lowland varieties, this means 16-20 days after sowing.

lost. Soon tillering stops as the rice plants switch to the reproductive stage.

These two mistakes are corrected by the first two SRI practices:

One, transplant early; and two, transplant with tender loving care.

"Early" means seedlings with only two leaves, or around 8-12 day-old seedlings. Do not wait for the third leaf, because the faster growing seedlings might be starting their fourth leaf already.

"Tender loving care" means transporting seedbed soil to the field, the seedlings still quietly growing on the soil, and then transplanting the seedlings, their roots still covered with soil, less than an hour after they have been taken from the seedbed. Remember, you dig into the seedbed with your palm, taking with you soil which carries the seedlings. You go to the field and straightaway transplant the seedlings on your palm into the field. Treat the seedlings like a baby you are moving from its cradle to its bed, without disturbing, hurting, or injuring the baby. That's tender loving care.

When transplanting, farmers usually take a clump of 3 to 5 seedlings to stick into the soil. Third mistake. When two or more rice plants grow in touch with each other, the taller plant will get more sun and grow faster; the shorter plant will grow more slowly, eventually losing the competition. The losers, all around the field, will be less resistant to pest and disease. In fact, *they will attract pests and diseases*. Once the weak plants succumb, the plants beside them will get hit too.

Not only do farmers tend to stick several seedlings into a single hill, the hills are also too close to each other. Fourth mistake.The space between hills is not enough for many tillers to grow into.

These mistakes are corrected by the next two SRI practices:

Three, transplant one seedling per hill. Not three, not two, but one seedling per hill.

What does the rice plant do when it experiences a dry period? It will send out more roots! And what do the roots do? They go after the water! As the soil dries and the wet part gets deeper, the roots go deeper too.

Four, use wider distances between hills. SRI recommends as a starting distance 25x25 cm. In inches, that is 10x10. When the farmer has mastered the method, even wider distances can be tried later. The SRI starting distance is wider than the hybrid rice recommendation of 20x20 cm.

Distances between individual plants must be wider for another reason: for it to grow healthy, each plant must have a lot of space for sunlight, air and soil nutrients. As tillers emerge, they will fill up the space around the rice plant, spreading out more horizontally to catch more of the sun.

Farmer who follow these recommendations will need less than 10 kg of seeds per hectare, a major cost reduction.

The four SRI practices above will all result in many more tillers than usual. But they are not enough.

Farmers usually grow their rice plants under a few inches of water throughout the growing season. Fifth mistake.

A rice plant whose base is continually submerged in water has no reason to grow many deep roots. Why should it, when water

is already all around it? In fact, its roots will start to die, due to continuous immersion in water. They will turn dark as they die. Healthy roots are white, or nearly so. Dig a few rice plants and see for yourself.

Rice plants with a few weak and shallow roots will "lodge" (i.e., topple over) in strong winds or flood currents. Also, they will be unable to support many productive tillers. You may get many tillers doing the first four SRI practices, but many of their grains will be unfilled. There are simply not enough roots to supply nutrients to all the tillers and their grains.

The "secret" of growing many strong and deep roots is this: *the rice plant must experience occasional dry periods*. Say 2-3 days each week when it is just starting to tiller and 3-4 days each week when the tillering process is well on its way. This is called alternate wetting and drying (AWD), SRI's fifth practice.

During a dry period, sun and wind dry the top surface of the soil first. But it is still wet underneath. As the soil continues to dry, the upper layers begin to lose moisture too, but the lower layers stay wet. Imagine a gradient of dryness: very dry on the surface, gradually getting more and more wet as you go deeper.

What does the rice plant do when it experiences a dry period? It will send out more roots! And what do the roots do? They go after the water! As the wetness goes deeper in the soil, the roots go deeper too.

This is the secret of growing many strong and deep roots. With such roots, the rice plant will be able to support many tillers, fill up the grains, and resist strong winds and flood currents as well as extended droughts.

Two more SRI practices remain, which will be discussed here briefly.

Six, control weeds as soon as they emerge (usually during the drying period). The most common SRI method for doing this is the mechanical rotary weeder, which is pushed along the rows and columns of rice plants. Some SRI farmers are also trying ducks. The weeds do not have to be killed. If their growth is delayed, the rice plants will grow ahead and once the rice canopy closes, the weeds will lose the competition. The rotary weeder also aerates the soil, which is good for the roots. Rotary weeding is supplemented by many other practices during the land preparation stage to ensure that weeds do not become a major problem.

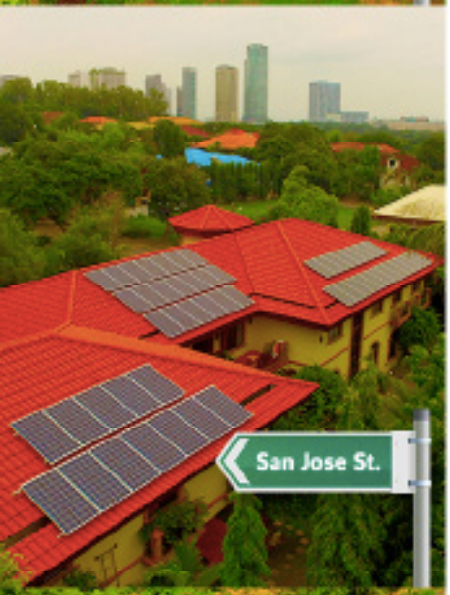
Seven, stop using chemical fertilizers, use lots of compost instead. How much? SRI Pilipinas recommends as many bags of compost as the bags of palay you want to harvest from a particular area. For example, if you want to harvest 20 bags of palay in one rice field, put 20 bags of compost there during the land preparation stage. It is much cheaper to make your own compost than to buy them. You can be surer about the quality too. If you do not have enough compost, do your SRI trial is a smaller area. Roughly, we recommend one bag (50 kg) per 100 sqm of rice field.

SRI Pilipinas has many detailed suggestions for weed and snail control, as well as compost-making, which even poor farmers can easily afford. Get in touch with CREST for details.

Finally, farmers who want to try SRI are strongly advised to start small—100-500 sqm only. Definitely do not start with half or one hectare! Also, try to get several of your neighbors or friends to try SRI too, also on small trial plots. Make it a friendly contest. The chances of seeing dramatic results will be much better, as more independent trials are done.

SOLARIC
LOCAL SOLAR GUYS

1120 JP Rizal Ave., Makati City ☎ (02) 504-0092 +63 917 860-3141 www.facebook.com/solaricPH
www.solaric.com.ph info@solaric.com.ph



STEPS TO SIGN UP FOR SOLAR

STEP 1:
Setup a site survey:
Email info@solaric.com.ph or
Text 0917-860-3141 I Call 504-0092
and mention this flyer. We will send an engineer at a time of your convenience

STEP 2:
Have your most recent electric bill on hand during the site survey, as well as information such as what appliances are typically used everyday, during the hours of 8AM to 4PM? (How many refrigerators and freezers? Got any pool pumps or pond pumps? Aircons running in the daytime? Etc)

STEP 3:
Within 1-2 business days from your site survey, you will receive a quote with a roof layout and several options, and of course your Alabang discount reflected.

STEP 4:
Choose your system and you can TURN ON THE SUN within a few days! Installation usually takes 1-3 days.

FAQ:
Will this work during brownouts? – No – the grid tied solar setups do not work during power outages. However, if you go with a hybrid or lithium battery setup, it can function as a small generator during power outages, as well as something you can use daily (at night).

What type of system should I get for quickest Return on Investment? A grid tied system. With an unobstructed south-facing GI Sheet roof at 15 degree angle, you can easily obtain a 4 year ROI on a system that easily lasts 25 years with very minimal maintenance cost. That's a 25% Yield!

What is the maintenance like? – Basic cleaning and visual inspection once or twice a year. There are no moving parts

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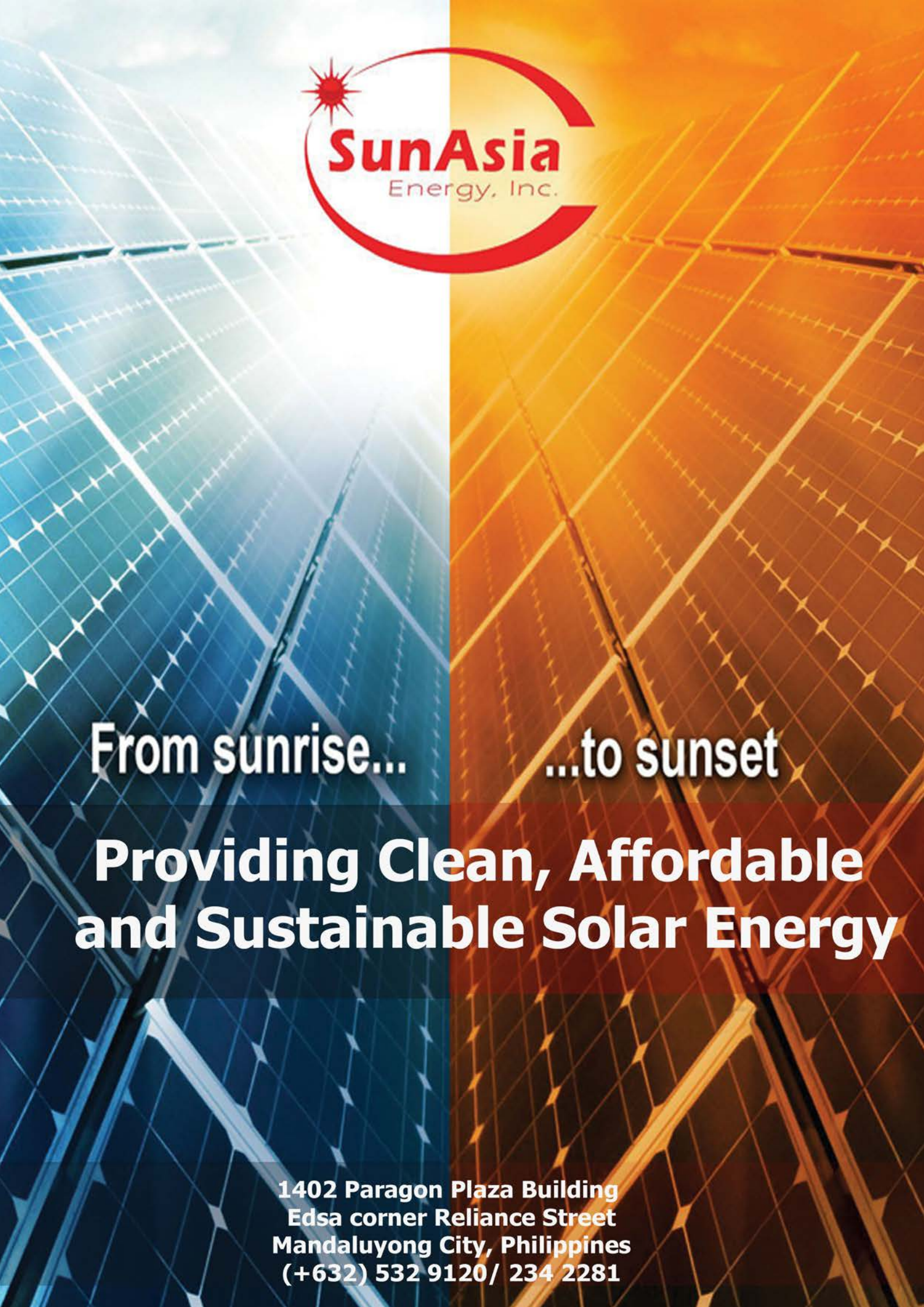
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Are you paying too much for your electricity bills? We can help you reduce your power consumption while managing and controlling how you use your energy through our solar power systems. With our grid-tied systems you can reduce your electricity bill by 15-30% while running all your daytime loads through solar. With our hybrid systems, you can enjoy zero energy consumption up to 70%-100% of the day.

We are a full service solar energy integrator with over 4 years experience in mounting over 1300 solar panels in 50+ locations from Pangasinan to Batangas.

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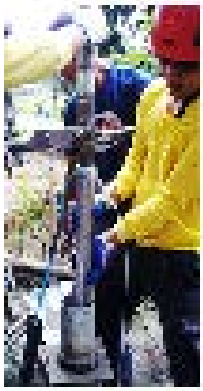
SolarSolutions

COMMUNITY • ENERGY • INNOVATION

We go the extra mile to provide sustainable, innovative, and reliable energy solutions for Filipino communities

www.solarsolutions.ph



Ito na ang inyong pangmatagalang solusyon!

Ang One Renewable ay isang solar integrator na nagbibigay serbisyo para sa inyong panyagdangan sa kuryente at tubig. Kami ay gumagawa ng mga solusyong solar para sa inyong mga tahanan at sakahan.

Sa Solar, Tuloy Ang Masaganang Ani!

Tumawag o Magtext sa (0x) 584 0990/ 0916 484 7168
Magpadala ng email sa info@onerenewable.com.ph

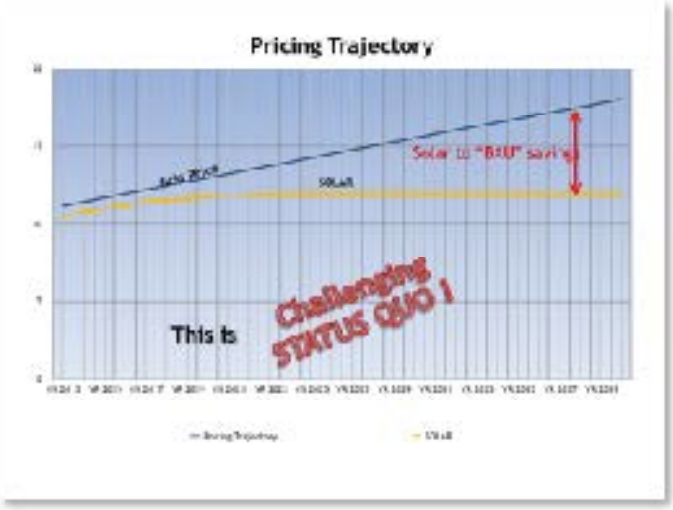
ONE RENEWABLE ENERGY ENTERPRISE, INC.

EASI SOLAR
Enerpower Access Solutions Inc.

The Green Energy
EASI

We are an Innovative Technology Solution Provider within the Energy, Efficiency and Sustainability marketplace for Solar in the Philippines.

We build solar solutions for residential, commercial, institutional and industrial entities that go beyond boundaries of "business as usual". We provide innovative programs that meet the requirements of these market entities to lower their electric bill, help build a robust economy and improve environmental strategies to meet the challenges of climate change. These are our clients. They can change the world by starting change in their own backyard.



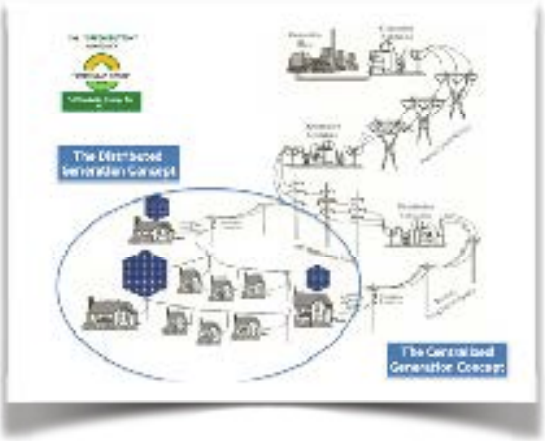
Our clients leverage on the power of "communities" working in a cooperative element of shared resources and its optimal use. These are our evolving solar-sharing communities, now formed as "solar share" cooperatives.

They explore our solutions that go beyond the evolution of conservation and sustainability realm. Our goal is to revolutionize these communities as producers and consumers (PROSUMERS) of electricity right in their own backyard or their own rooftops.

These are communities who don't give a blind eye on issues that impact them. Issues like, expensive electricity, sagging economy and degradation of the ecology (the environment). We create smart communities with a purpose : self-development anchored on renewable resources, shared resiliency and local community determination to succeed.

By engaging technologies, our "solar-share" solution will help residences, communities, property owners reduce the 'cost-of-electricity'. The program benefits both the consumers, the cooperatives and the utility.

At EASI, we believe in building solutions that make a difference in communities. Let us create smart grids in LGU's and reduce your electric bills thru solar without upfront cost. Call us at Globe 0915-793-8239, 02-646-4470; or email us at melromano@easisolar.com, URL: www.easisolar.com



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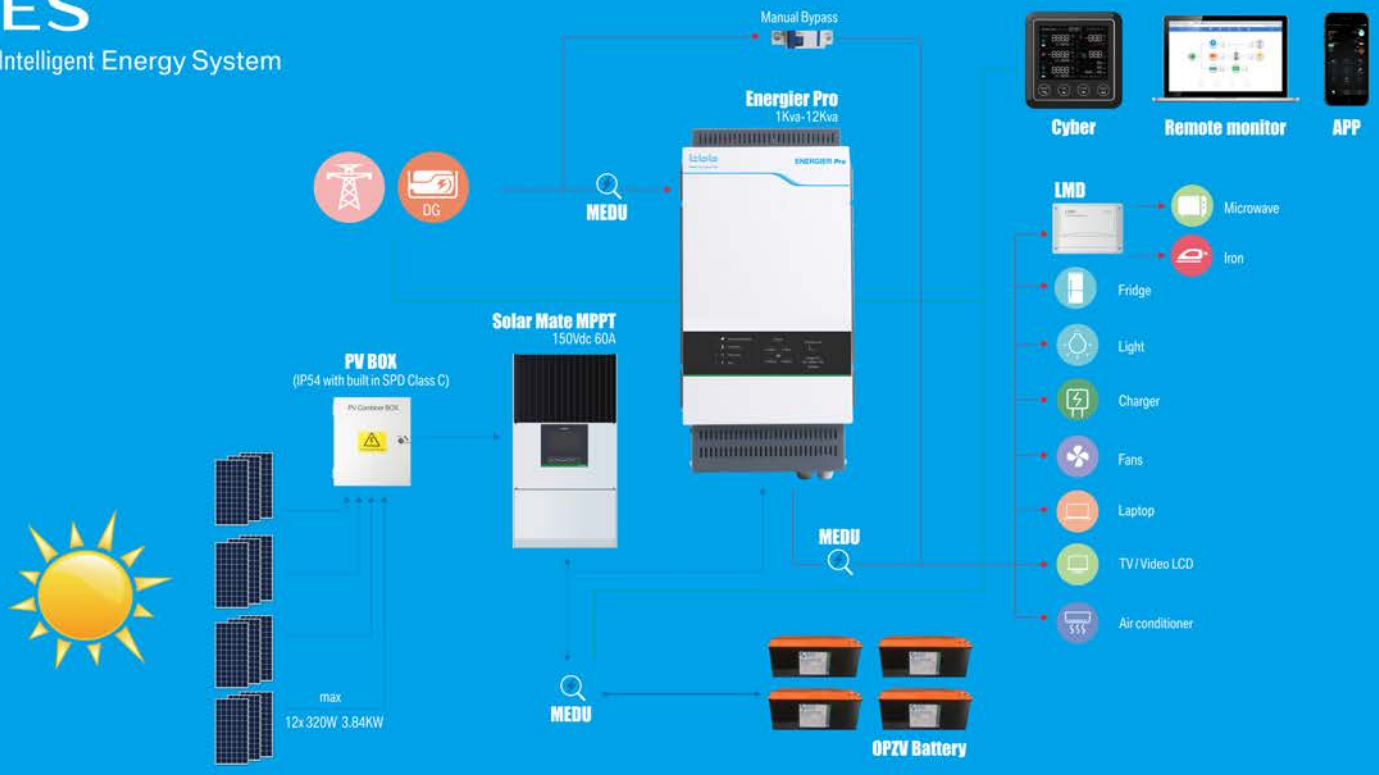

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PV power from **1kw – 8kw**

MPPT from **35A – 120A**

Inverter power from **2kva – 8kva**

Company Introdution

TBB Power aimed to supply multiple independent power solutions for area without grid or suffers unstable grid. Solution offered included power backup, solar offgrid, hybrid power solution and self consumption storage system. It can be applied for urban private, small commercial, remote resort and rural electrification.

SOLASTRA RENEWABLE ENERGY

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Email : solastrare@gmail.com

Tel : 255 - 6799 / + 639175937469

Website : www.solastraenergy.com

TBB Power CO.,LTD.

Addresse : No.15th, ShiShan North Road, HaiCang District, Xiamen China 361027

Email : sales@tbbpower.com

Tel : +86 - 5925796068 / 5796287

Website : www.tbbpower.com

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VISION

PNOC RC is the government arm for the development and implementation of Renewable Energy and Energy Efficiency Projects, known for operational excellence, superior stakeholder satisfaction and outstanding financial performance in the Philippines by 2030.

MISSION

To provide renewable energy and promote energy efficiency to enhance the quality of life of the Filipino people.

To advance customer and stakeholder interests, employee welfare, environmental stewardship, and community well-being.

QUALITY POLICY

"PNOC Renewables Corporation is committed to be the government arm in the development and implementation of Renewable Energy and Energy Efficiency Programs through the preparation of quality Feasibility Studies, satisfying applicable requirements, and continuously improving the QMS."

PNOC RC PROJECTS

Solar PV Rooftop Systems for Government Buildings

Hydro Power Project

Geothermal Project

PNOC
The Energy Company
Renewables Corporation

Contact us:
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Rizal Drive Bonifacio Global City, Taguig City, Philippines 1634
Contact No. (+632) 840-3079 to 82 or 812-0991
Email Address: www.pnoc-rc.com.ph / info@pnoc-rc.com.ph

A regular publication for the renewables industry

The renewables industry is taking off. The main driver for this take-off is the solar PV industry. But climate change considerations are bound to create new opportunities for other renewables, like wind, hydro, biomass, geothermal, ocean, and others, including storage batteries.

CREST sees the industry today in a similar stage as the computer industry when microcomputers were starting to be used by techies and increasingly by businesses. When these products reached a certain market volume, economies of scale began to take effect, resulting in a virtuous cycle of steady price reductions and continuing market growth.

The spread of microcomputers was greatly aided by the rise of industry publications, where new developments were covered in detail and which enthusiasts read avidly. Many of these enthusiasts eventually became the business tycoons of the industry.

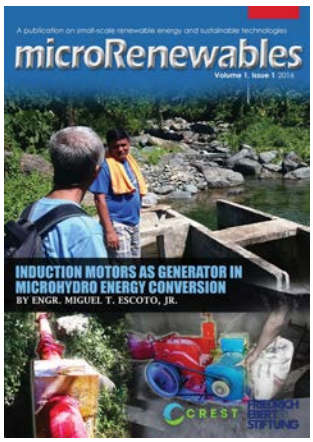
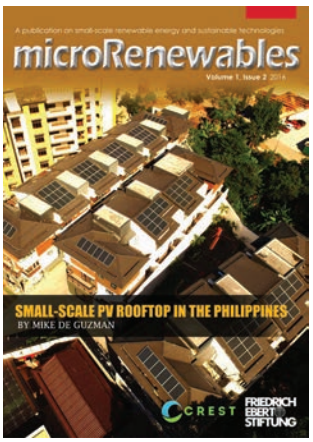
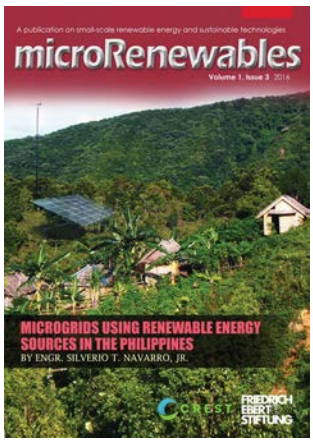
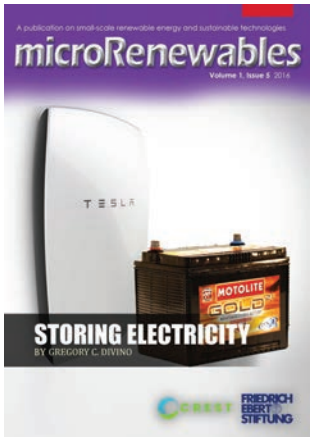
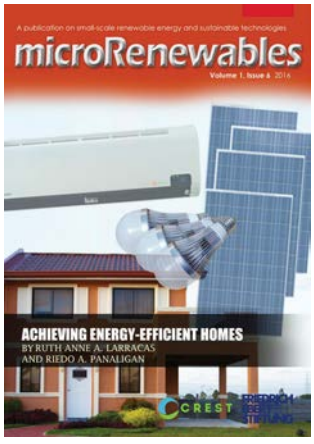
The renewables industry today needs such publications. This publication, whose focus is microrenewables, will be one of them. Of course, it will also be available online.

CREST has been holding a series of round-table discussions since 2015, producing papers about the industry. These papers will feed into this publication. We have been compiling a catalog of new products, product descriptions, a directory of suppliers. They will be featured here too. For the past two issues, we have offered free full-page ads to the industry. Congratulations to those who took the free offer seriously.

The first six issues of *microRenewables* were not yet magazine issues. They were research reports. The seventh and eighth issues are proto-magazines. They look more like the industry magazine we will become in the future.

CREST wants to grow this publication with the microrenewables industry ecosystem: suppliers, contractors, retailers, installers, maintenance people and—most important of all—the users.

We invite you to further submit stories about actual installations, new product descriptions, and other things that you expect a regular publication to contain. At the very least, submit your entries to the product catalog and supplier directory or send in feedback as a reader. We will keep offering free ads, as long as we can.

In the future, our issues will be supported by advertisements rather than grants. Obviously, this cannot happen without industry support. Remember, CREST is non-profit. All its ad income will go towards making the publication better and reaching more people.

Together, we will build the microrenewables industry and help turn this industry, like the microcomputer industry before it, into a deep economic and social game-changer.