

UNIVERSITY OF THE PHILIPPINES
CENTER FOR
INTEGRATIVE AND
DEVELOPMENT
STUDIES

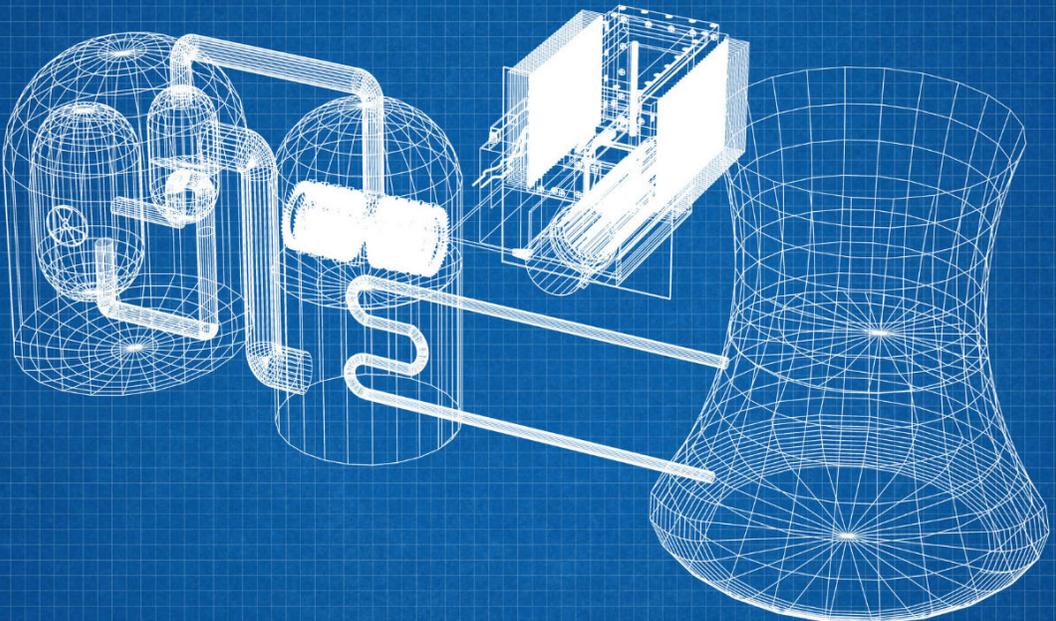
PROCEEDINGS 2023

DEBATING THE PROSPECTS OF NUCLEAR ENERGY IN THE PHILIPPINES

Why We Need Nuclear Energy: A Public Forum

25 January 2019, 1:00 PM – 3:00 PM

*Institute of Biology Auditorium,
University of the Philippines Diliman*





UNIVERSITY OF THE PHILIPPINES
CENTER FOR
INTEGRATIVE AND
DEVELOPMENT
STUDIES

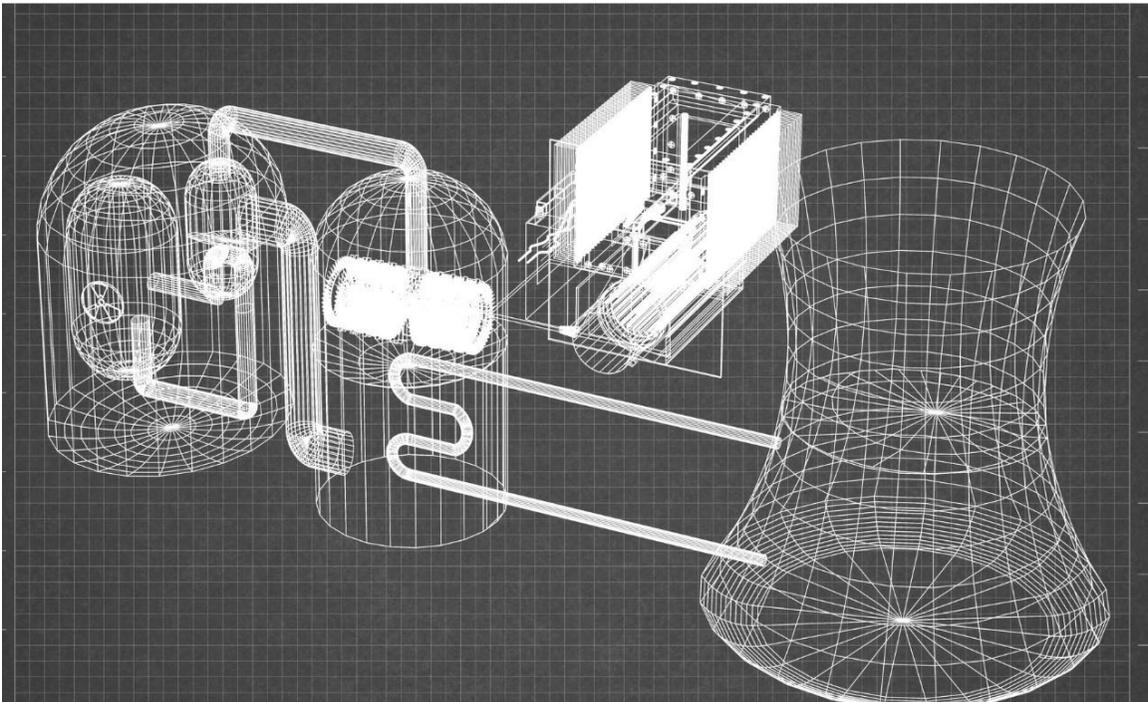
PROCEEDINGS 2023

DEBATING THE PROSPECTS OF NUCLEAR ENERGY IN THE PHILIPPINES

Why We Need Nuclear Energy: A Public Forum

25 January 2019, 1:00 PM – 3:00 PM

*Institute of Biology Auditorium,
University of the Philippines Diliman*



FORUM PROCEEDINGS

are published on occasion by the

UNIVERSITY OF THE PHILIPPINES

CENTER FOR INTEGRATIVE AND DEVELOPMENT STUDIES

Lower Ground Floor, Ang Bahay ng Alumni

Magsaysay Avenue, University of the Philippines

Diliman, Quezon City 1101

Telephone: (02) 8981-8500 loc. 4266 to 4268 / (02) 8426-0955

Email: cidspublications@up.edu.ph

Website: cids.up.edu.ph

Copyright 2023 by the

UP Center for Integrative and Development Studies

No copies can be made in part or in whole without
prior written permission from the publisher.

ISSN 2718-9295 (print)

ISSN 2718-9309 (online)

Cover design: Janus Isaac Nolasco

Cover graphics: Nuclear power plant by Jelena83 via Canva; "Radioactive
Symbol Illustration" by Ciker-Free-Vector-Images from pixabay via Canva

TABLE OF CONTENTS

ABOUT THE PROCEEDINGS	01
OPENING REMARKS	02
Maria Ela Atienza, PhD	
PRESENTATIONS	
Why The Philippines Needs Nuclear Energy	
Michael Shellenberger	06
Nuclear Energy and Sustainable Development for the Philippines	
Fabian M. Dayrit, PhD	12
Renewables will bring green investments, green jobs, and sunrise industries	
Roberto Verzola	15
OPEN FORUM	17
REFERENCES	23

ABOUT THE PROCEEDINGS

The present manuscript represents the proceedings of a public forum, “Why We Need Nuclear Energy,” that was held on 25 January 2019, at the Institute of Biology Auditorium, University of the Philippines Diliman. The forum was co-organized by the University of the Philippines Center for Integrative and Development Studies (UP CIDS) Program on Social and Political Change (PSPC), the UP CIDS Strategic Studies Program (SSP), and the Department of Political Science, University of the Philippines Diliman. For inquiries, please contact the UP CIDS PSPC at pspc.cids@up.edu.ph.

OPENING REMARKS

Maria Ela L. Atienza, PhD¹

Co-Convenor of the UP CIDS Program on Social and Political Change and Professor at the Department of Political Science, University of the Philippines Diliman.

Mr. Michael Shellenberger, Dr. Fabian Dayrit, Mr. Roberto Verzola, friends, scholars and students in the natural and social sciences, as well as friends from civil society, government, and the private sector, good afternoon to all of you and welcome to this lecture-forum entitled “Why We Need Nuclear Energy.” This particular forum is co-sponsored by the University of the Philippines’ Center for Integrative and Development Studies (UP CIDS) and the Department of Political Science of UP Diliman.

UP CIDS is the UP System’s policy research unit. It conducts activities like research, publications, lectures and roundtable discussions on important policy issues. The Center’s goal is to contribute not just to discussions of important policy areas but also to actually be the voice of the University of the Philippines in influencing our policy makers. The UP CIDS is organized into several programs, and the two programs that are co-organizing this event are the Program on Social and Political Change and the Strategic Studies Program.

The Program on Social and Political Change (PSPC) focuses on burning social and political issues in the Philippines and in the world. The goal is to bring together scholars, civil society organizations, government agencies, and the private sector to focus on providing discussions on policy alternatives to actually solve these social and political issues. The Strategic Studies Program (SSP) of UP CIDS, meanwhile, is concerned with issues related to foreign affairs and international relations, but the focus on security is not just on

1 At the time of the forum, Dr. Atienza was the Chair of the Department of Political Science.

traditional territorial notions of security but also on an expanded, more comprehensive concept of human security that covers energy security. Both programs of UP CIDS are very much interested in discussing issues and alternatives related to energy security.

The other organizer of this forum is the Department of Political Science of the University of the Philippines Diliman. It is the only political science department in the country accredited by the Commission on Higher Education as a Center for Excellence in the teaching, research, and extension activities in political science. We do have a number of colleagues, faculty, and students who are doing research in the area of energy, environment, and climate change.

We are, of course, grateful for the Institute of Biology of the College of Science of UP Diliman for hosting this important discussion. In fact, we see among the audience not just students and faculty of the natural sciences but also those of the social sciences; so, this is a very good multidisciplinary audience for such a very important topic.

Why is energy security very important in the case of the Philippines? The Philippines led all countries in “environmental sustainability” in the World Energy Council’s 2016 World Energy Trilemma Index. The World Energy Council is a United Nations (UN) “network of energy leaders promoting affordable, stable, and environmentally sensitive energy systems.”²

The Philippines “is the most environmentally sustainable country in the world due to its low carbon value that was below 2% growth rate in GHG emissions despite its population size...” Also, the country “has around 7,000 megawatts of renewable energy from 116 existing facilities and 224 more are projects in the pipeline.” Environmental sustainability is “part of the World Energy Council’s energy trilemma, along with energy security and energy equity.” All three are said to be very important in the concept of energy sustainability. However,

2 World Energy Council and Oliver Wyman, “World Energy Trilemma Index 2016,” London, United Kingdom, https://www.worldenergy.org/assets/downloads/Full-report_Energy-Trilemma-Index-2016.pdf. See section “About the World Energy Council.”

according to the same index, “the Philippines also lacks in the two other factors in the energy trilemma as it ranked 52nd in energy security and 92nd in energy equity,” the latter covering “power supply efficiency and cost of power.” Indeed, the Philippines “performs highly in environmental sustainability but needs to improve its energy equity and energy security to achieve better energy sustainability.”³ As the World Energy Council put it, “balancing these three goals constitutes a trilemma that is the basis for prosperity and competitiveness of individual countries.”⁴

The 2016 index explains that the Philippines’ “rank in energy security was driven by the 75% generation portfolio from thermal plants powered by fossil fuel imports, the slow development of renewable energy sources, and rotating power outages.” The report added that the Philippines also “underperformed in the accessibility and affordability of power, noting that 83% of the population has access to electricity and the power rates are the fourth highest in the Asia Pacific.” Therefore, “energy security requires the sufficiency and growth of power supply as well as diversity of generation portfolio and reduced dependence on imported fuel while energy equity assures affordability of electricity and fuel prices and access to electricity.”⁵

The forum today will certainly add to discussions on how we focus energy security and energy accessibility and sustainability. However, we understand that there are different discussions and different positions in this issue, and what we hope to discuss today is the viability of one alternative option for the Philippines, which is nuclear energy. This touches on a number of sensitive issues on the part of many Filipinos because nuclear energy for some has been associated with the Marcos dictatorship, and the symbol of this is the Bataan Nuclear Power Plant. But we hope that this afternoon, we can have a more comprehensive

³ Power Philippines, “World Energy Council: PH lacks in energy security, equity;” 5 January 2018, <https://powerphilippines.com/world-energy-council-ph-lacks-energy-security-equity/>. This write-up discusses the 2016 Energy Trilemma Index 2016.

⁴ World Energy Council, “World Energy Trilemma Index 2016,” see page 2 of the PDF.

⁵ Power Philippines, “World Energy Council: PH lacks in energy security, equity.”

discussion on nuclear energy and other options, and we hope that different perspectives can be discussed not only during the presentations of our renowned speakers and resource persons. Our audience are encouraged to participate in the discussion.

Thank you very much.

PRESENTATIONS

“Why The Philippines Needs Nuclear Energy”

Michael Shellenberger⁶

President of Environmental Progress

The first presentation focused on three main points on nuclear energy and the context of nuclear energy use in the Philippines.

First, Mr. Shellenberger situated the Philippines in terms of electricity generation. He also explained why nuclear energy is cheaper for producing electricity than other renewables, particularly solar and wind energy. Solar energy tends to be unreliable as it depends on the availability of sunlight, as well as on the generation of solar farms.

The second point tackled why the public fears the use of nuclear energy. He illustrated this point through Hollywood’s influence, the public’s being unused to it, and the safety record and concerns such as radiation release and the threat of thyroid cancer. He also tackled the negative impact of other renewable sources of energy, in particular solar and wind energy.

Mr. Shellenberger’s third point is that the cost of nuclear energy is low due to the material requirements, the waste, and the energy density it produces. Nuclear energy produces the least amount of waste material compared to solar and wind farms.

Lastly, in the context of the Philippines, Mr. Shellenberger points out that there is already one nuclear energy plant available, the Bataan Nuclear Power Plant. He mentions that the reluctance of the Corazon

⁶ Mr. Shellenberger is also the author of *Apocalypse Never*, a Green Book Award winner. Environmental Progress is an organization established to promote nature and prosperity through clean energy.

Aquino administration to use it comes from the fact that it was created by the Marcos administration. For concerns about its maintenance and upkeep, he suggests that the Philippines can communicate and contract workers from the Kori 2 plant in South Korea, which has virtually the same design. China and Russia were also pointed as potential sources of maintenance and upkeep training.

The Philippines currently has some of the most expensive electricity in the world, spending 18 cents (around 8.6 PhP) per kWh (kilowatt/hour). The country currently uses coal, natural gas, and geothermal electricity. However, natural gas in Malampaya is running out, with its stocks to be depleted in four to five years. While the country has been winning awards for sustainability, Mr. Shellenberger believes that sustainability is not the goal if one wants to lift people from poverty and reduce air pollution at the same time.

Mr. Shellenberger went on to explain why solar and wind energy are actually dirtier than nuclear energy by showing examples from Sweden, France, Germany, and Switzerland. Sweden, France, and Switzerland have the cleanest energy, which stems from the use of a lot of nuclear and hydro energy. However, in the Philippine context, the country has already maxed out its capability to build hydroelectric dams. He compared France with Germany in terms of clean energy production. Germany is producing only half as much clean energy as France and is paying twice as much for it. This is due to Germany's reliance on solar and wind in comparison to France's reliance on nuclear energy, which generates 75 percent of its electricity.

Solar energy is unreliable because of its very nature.⁷ It may also produce too much electricity when it is not needed, and too little when it is needed. This fluctuation increases its economic cost in comparison to power plants that are always ready to serve and produce electricity. Natural gas or oil plants are needed to make up the difference when solar energy is at its lowest.

7 Michael Shellenberger, "Renewables can't save the planet. Only nuclear can." *Environmental Progress*, 16 August 2017, <https://environmentalprogress.org/big-news/2017/8/16/renewables-cant-save-the-planet-only-nuclear-can>.

Mr. Shellenberger also highlighted that nuclear power propaganda is one of the main reasons why it is feared by the community. He illustrated that Hollywood is one of the culprits, citing movies such as *The China Syndrome* (Germany also created its own version), and *Pandora*, a South Korean production. He also stated that the reluctance is due to the infrequent use, and little-understood nature, of nuclear energy. He used historical references to fire vis-à-vis human evolution; humans had used it to advance evolutionary change, such the emergence of smaller intestines and larger forebrains because of cooked meat. Humans followed a later path during the industrial revolution, creating furnaces and building up factories. Mr. Shellenberger noted that while humans know that fire is deadly, they are no longer afraid of it because of the long history of its use. Nuclear energy, on the other hand, is relatively new, which is the reason people are reluctant to use it.

On safety concerns, Mr. Shellenberger tackled the research and medical issues. Research has been ongoing about the relative safety of different energy sources for about 40 to 50 years. According to the most recent study from *The Lancet*, a British medical journal, coal burning causes millions more deaths due to air pollution than nuclear energy. Mr. Shellenberger quoted a study done by James Hansen, a climate scientist and co-founder of Environmental Progress. It found that it was possible to save up to 1.8 million lives by stopping the burning of fossil fuels, which increases the toxicity of the air.⁸

Renewable energy sources such as solar and wind energy also have their own health hazards. Solar panels produce 300 times more solar waste than nuclear waste. The components of solar panels—lead, cadmium, and chromium—do not biodegrade, and their toxicity does not decline over time. Recycling solar panels is also difficult due to the expense of doing so. It is cheaper to create new panels than to recycle them. There is also a substantial impact on land use since solar farms require large fields of land to generate electricity. Land is a big concern

8 Pushker A. Kharecha and James Hansen, "Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power," *Environmental Science and Technology* 47, no. 9: 4889-4995, <https://pubs.acs.org/doi/full/10.1021/es3051197?source=cen>

in the Philippines since it could be used for other endeavors such as farming, urbanization, and tourism. Mr. Shellenberger points out that the land used for solar panels would eventually be filled with electronic waste because they are difficult to recycle.

Wind energy, meanwhile, requires more land than solar farms. On matters of safety, wind turbines have killed over 180 people in the UK alone due to accidents, and are an ecological catastrophe since birds get caught in the turbines.⁹ Also, a study found that migratory bat species may become extinct due to wind turbine accidents.

Mr. Shellenberger also addressed the possible health risks that nuclear power plants may pose. He said that according to the United Nations' International Atomic Energy Agency, even after the Fukushima Nuclear Power Plant accident, no one died of cancer from the radiation. The deaths that occurred were mainly from the ensuing panic and from fear; there was none from, say, thyroid cancer. In Chernobyl, one of the most studied accidents in history, the reactor was built without a containment dome. The reactor caught fire, and radiation leaked out. Dr. Gerry Thomas, an expert from the Chernobyl Tissue Bank, has collected and maintained samples of thyroids that were affected by the accident. According to their research (as cited by Dr. Shellenberger), 160 to 200 people would die over a 50- to 80-year period due to thyroid cancer.

Despite this, she is still an advocate for nuclear power since thyroid cancer is relatively one of the most easily treatable cancers. Surgery can remove the gland and thyroxine, and an inexpensive synthetic thyroid hormone replacement can be done. Mr. Shellenberger suggested that those who passed away from thyroid cancer could have lived if they managed to receive medical attention. Another concern is mutations and birth defects. The birth defects were found to have occurred before and after the accident, with no increase after Chernobyl. A popular image of mutated dandelions from Fukushima was also circulated, but after

9 For related/current statistics, see Scotland Against Spin, "Turbine Accident Statistics," n.d., <https://scotlandagainstspin.org/turbine-accident-statistics>

research, the photo was revealed to have been taken at a site several hundred miles away from Fukushima. Mutant dandelions were also found to occur in nature, albeit they are uncommon.

Mr. Shellenberger also noted that the United Nations Scientific Committee found that most of the effects of radiation come from radon. Other parts of the world have had higher radiation levels than the Fukushima site. Radiation also comes from the food we eat, most commonly from bananas. Radiation is also commonly used in x-rays and various medical scans. It is detectable at very low levels and is easy to trace. The mortality rate of those living in cities is higher (2.8 percent) than those cleaning up Chernobyl (1 percent).

Mr. Shellenberger also pointed out that the cost of nuclear power would be lower than those for other renewables. He used solar panels to illustrate this point, mentioning that solar energy requires the most materials in production, energy density, and waste. Nuclear energy would entail the least. Solar energy requires steel, glass, concrete, and cement while providing a lower energy density, which increases its cost. He also discusses the nonrecyclable waste that it produces.

On the other hand, nuclear energy has a lower energy density, making it cheaper and more sustainable. The nuclear waste would be stored in metallic covered cans. According to Shellenberger, all the nuclear waste that the United States produces can be put in a single football field if it is stacked 50 feet high. Plastic waste and landfills, as well as toxic air, can kill up to 67 million people a year; it can also kill wildlife, which he believes is far worse. Nuclear waste is radioactive and will remain so for a long time due to its components' half-life, but Mr. Shellenberger pointed out that the chemicals found in solar waste will not decrease their toxicity over time, making it worse for the environment.

Finally, Mr. Shellenberger touched on the Philippine context and the nuclear power plant in Bataan. He believes that the Filipino people do not use it simply due to its being a Marcos era project. He pointed out that technology does not have any ideology and that Filipinos should use it to maximize their energy output. To maintain and keep up

the Bataan plant, Filipinos would need expertise from those with similar plants. South Korea currently has a plant called the Kori 2, which is identical to the Bataan plant in the Philippines. It is possible to build up to three more reactors on the same site to increase energy production. Other options would be working with Russian and Chinese experts.

Mr. Shellenberger closed his presentation by stating that students led the nuclear movement in South Korea and activists in Taiwan. He hopes that the younger generation would lead the same movement in the Philippines.

Nuclear Energy and Sustainable Development for the Philippines

Fabian M. Dayrit, PhD

President of the Integrated Chemists of the Philippines; Academician of the National Academy of Sciences and Technology - Philippines; Professor of the Department of Chemistry, Ateneo de Manila University.

Dr. Dayrit divided his presentation between discussing his ten-point criteria to determine whether nuclear energy is the best fit for the Philippines, whether Ocean Tidal Energy is more suitable.

The ten-point criteria revolved around nuclear energy's:

1. Potential in providing universal energy;
2. Potential in decreasing carbon dioxide emissions;
3. Safety;
4. Infrastructure requirements;
5. Human resource requirements;
6. Waste;
7. Economic issues;
8. Social and political issues;
9. Energy independence; and
10. Renewable energy.

Dr. Dayrit found that nuclear energy is not universal, since it cannot help off-grid islands and is therefore not equitable. The Philippines also

only accounts for 0.33 percent of greenhouse gas emissions, and going nuclear would not make a significant contribution to an overall decrease of carbon dioxide emissions around the world.

Nuclear energy is a high-risk technology; while it can provide a large amount of energy, it also involves a high risk. As such, infrastructure requirements must be kept high for the plant, waste storage, support infrastructure, nuclear emergency protocols, health facilities, and insurance. This would require creating a new set of policies that must be debated and passed before a plant can become operational. The human resource requirements, such as engineers, scientists, waste management, safety, security, health, and public safety officers, are huge. All will have to be trained and insured, which adds to the cost.

Nuclear waste has no current viable long-term solution in the world, and the Philippines is also not currently equipped to store nuclear waste. There is no social and political acceptability for the economic and environmental costs of a nuclear plant. Nuclear energy will require government subsidy since the private sector may be unwilling to build and maintain plants. The cost of nuclear accidents is also high; there are decommissioning costs and the compensation of victims to factor in, which are not included in the estimation of building costs.

While using nuclear energy will help decrease dependence on petroleum, there will, however, be a rise in dependence on uranium in other countries. The Philippines has no uranium sources. There is a proposal from the International Atomic Energy Agency (IAEA) to extract uranium from seawater at three parts per billion, but there is a question on how feasible it will be to purify the uranium and if the amount will be acceptable for the needs of power plants.

Because of his ten-point criteria, Dr. Dayrit does not see nuclear energy as favorable in the Philippine context. The second part of Dr. Dayrit's presentation focuses on his proposed alternative, i.e. ocean tidal energy or OTE. The Department of Energy (DOE) has found eight probable sites for this type of renewable energy. It is similar to geothermal energy, of which the Philippines is the second-highest producer. Dr. Dayrit proposed that various technologies be developed for

OTE; large and small plants can be distributed and designed especially for smaller off-grid islands, ensuring universal access, in accordance with the UN's sustainable development goals.

The largest current-driver power plant is in Scotland, generating up to almost 200 megawatts. There are also several proposals to build similar ones in the Philippines such as the Ocean Tidal Plant in the San Bernardino Strait in Northern Samar. However, the infrastructure requirements may be expensive and economic research into this type of technology has not yet been done.

Dr. Dayrit closed his presentation by stating that the current OTE feasibility in the Philippines is at 25 percent, but it still is more accessible than nuclear energy.

Renewables will bring green investments, green jobs, and sunrise industries

Roberto Verzola

President of the Center for Renewable Energy and Sustainable Technology (CREST).

Mr. Verzola's presentation focused on the impact of solar-generated power on electricity cost, and stressed the importance of a flexible and mixed energy solution for the Philippines. He calculated that for the solar-levelized cost of electricity, the cost can be around 5 PhP per KWH.

The Philippines' 24-hour demand curve for electricity peaks at midday and again at the evenings, with the lowest demand between 3:00-4:00 AM. To meet the variable demand, base load plants and flexible plants are used to regulate electricity. Base load plants do not turn off and run continuously since the demand will never go below the minimum load. Base load plants are generally coal or nuclear; they cannot be turned off to operate efficiently. Flexible plants may be turned off at least once a day, as the demand for energy wanes. To handle the peak load, peaking plants may also be utilized and run in a similar vein to flexible plants.

If Filipinos introduced solar energy by putting panels on their rooftops, Mr. Verzola calculated that the cost of electricity would be around 6 PhP per kilowatt/hour. It is much cheaper than the 10 PhP/KWH that Meralco, a major electricity provider, charges. He added that using LED lamps and replacing fluorescent lighting with LED lighting will generate more savings.

The entry of solar energy, according to Mr. Verzola, will be a market-driven process. with the government unable to control the shift. To illustrate his point, he compared the entry of solar energy to the entry of cellphones into the market. Consumers found cell phones to be more convenient and bought more of it, despite the call for more landline use.

The introduction of solar energy to the grid for electricity generation would be able to shave off peak demand, and help reduce the price of electricity. Mr. Verzola explained that the introduction of solar energy would replace peak loading plants, which are more costly to run. At 30 percent solar energy penetration, the minimum demand or load is lessened, thus decreasing the demand from base load plants. As more solar energy is introduced, the role of base load plants drops considerably. On the other hand, the demand for flexible plants will increase to supplement solar energy.

The Philippine government's current policies, however, assume that the base load role will remain at 70 percent. This makes the current Philippine Energy Plan incompatible with the introduction of solar power and with Mr. Verzola's market-driven solar energy model. According to Mr. Verzola, this will bloat the base load even if the country will use nuclear energy (instead of coal) since it is also a base load-type plant.

Mr. Verzola also contextualized the issue of the Bataan Nuclear Power Plant by examining corruption in the government. He illustrated this with the Statement of Assets, Liabilities, and Net Worth (SALN) of the 2019 Department of Energy (DOE) secretary who submitted his original SALN of 165 million PhP in 2016, which increased eight times in 2017 to reach 1.35 billion PhP. While Mr. Verzola stated that this is not absolute proof of corruption, but the unexplained wealth must be investigated.

Like Dr. Dayrit, Mr. Verzola closed his presentation by emphasizing the hidden costs (such as those for insurance) of building and maintaining a nuclear power plant. The insurance companies are the 'best measures of risk,' and they put a ceiling on insuring nuclear power plants because of the high risks they entail. These costs would trickle down to the citizens, instead of leading to higher taxes in case of emergencies, which would negate the possible savings from operating such a plant.

OPEN FORUM

Moderator: Herman S. Kraft

Professor and former Chair of the Department of Political Science of the University of the Philippines, Diliman; Co-convenor of UP CIDS Strategic Studies Program.

Solar Power Concerns

One member of the audience, who was a former member of the Philippine House of Representatives, raised two concerns that were echoed by others in the audience: universal access to solar energy and the need for batteries. He stated that only rich would be able to afford solar panels. However, the claim on the accessibility of solar panels was disputed by another member of the audience, who was from Miriam College. According to that participant, there are already more affordable solar panels for financially challenged areas and for rural areas that are not covered by the grid. As a response, the earlier participant who raised the comments on solar energy discussed how the cost of batteries for solar panels would be unsustainable due to the need to replace them. That audience member also questioned the calculation of the base load change model that Mr. Verzola presented.

Mr. Verzola first addressed the issue of the disparity between the rich and poor in terms of affording solar energy. He mentioned that government subsidy and financing would bridge the gap, likening it to the programs the government put in place to finance housing or house ownership. Second, he addressed the cost of solar energy and the calculations for the model he presented. He reiterated that as the net demand decreases as solar energy increases, the need for base load plants will decrease due to their inflexibility (i.e., they cannot be turned off). Third, he explained that although solar energy has a steep upfront cost, the energy produced afterward is “free” because of the marginal cost of electricity. According to Mr. Verzola, the marginal cost from solar energy (essentially zero) is much lower than that for coal.

Meanwhile, another member of the audience, formerly associated with San Miguel Global Power, echoed the concerns on solar energy. He discussed that the batteries needed for a massive solar energy plan would require lithium-ion batteries. The sources for lithium-ion are already limited, and are being used to manufacture other products. The cost for a single lithium-ion battery for a small house would cost up to 200,000 PhP, and would need to be replaced every two years. Apart from the cost of panels, the former member of the Philippine House of Representatives also mentioned the need for a huge amount of land. He compares the need for land of a coal fire plant, which is about 26 hectares, to the amount needed for a solar plant that will produce the same amount of energy: 620 hectares. This also would have to be cleared of environmental hazards, plants, and animals. The size of land that solar energy requires would take away land that could be used for other ventures. However, he agreed with Mr. Verzola's idea of an energy mix: complementing solar energy with ocean tidal energy that Dr. Dayrit proposed, and with Mr. Shellenberg's proposal of more nuclear plants. Together, this will increase the overall energy output of the Philippines.

Mr. Verzola emphasized that the Philippines should not rely solely on solar energy but on a mix of different energy sources. He stressed the importance of flexible plants to alleviate the stress on the solar energy system. Flexible plants could be turned off at least once a day. He likened them to batteries to balance out the energy requirements that solar plants could not meet; he proposed that the Philippines use geothermal and ocean tidal technology as the source of base load plants.

Lastly, another audience member asked about the mining and environmental risks that are associated with the production of solar panels. As previously mentioned by Mr. Shellenberg, chromium and lead are required to produce the panels, posing the risk of leaking toxic elements to the environment since they do not degrade in the same way and are not biodegradable. There is also an issue of mining that will be required to harvest the materials, which would lead to the destruction of natural habitats and unbalance the ecosystem in affected areas.

Nuclear Power Concerns

An audience member asked Mr. Shellenberg about the potential price of nuclear fuel for the next 20 to 30 years. Many in the audience expressed worries that the Philippines and other non-uranium source countries may fall into subservience (because of the price) to other countries that can mine and produce nuclear fuel. The former member of the Philippine House of Representatives, who initially discussed the issues attributed to solar power, answered that it is possible to state that uranium is a renewable resource; ocean uranium is replenished by the seabed; however, as the cost of uranium increases, so will the price of nuclear assemblies. Meanwhile, another audience member (from Miriam College) also expressed that the price of power is also political. While the energy it produces may be cheaper for consumers, it will take its toll on the government, which would have to subsidize the cost. In turn, this may lead to an increase in taxes, as well as the other expenses such as fines and fees that must be shouldered by the nuclear plant companies.

Mr. Shellenberg replied that the price of uranium was at an all-time low and that it is possible to recycle nuclear fuel, which still contains over 95 percent of the energy that is still in power plants. There are specific facilities that can recycle nuclear waste in the United States, Russia, South Korea, Japan, and China. He stated that in 50 to 100 years, it would be possible to replace the current plants and use the nuclear waste as fuel. Mr. Shellenberg also discussed two issues that were brought up by other audience members: imports, and public versus private interests. He stated that the South Korean electrical grid and the French nuclear program are both publicly owned. Mr. Shellenberg emphasized that the Philippines cannot keep importing energy or having high electricity prices in the name of public interest; whether by socialism or capitalism, the issue does not matter.

Dr. Dayrit discussed that he has doubts on whether nuclear energy is the right fit for the Philippines. Although there are filters available to purify uranium from seawater, it would only produce three parts per billion. He emphasized alternative methods of energy production such as the ocean tidal energy, which would be less difficult to develop, since the Philippines has several sources it can draw from.

Mr. Verzola explained that nuclear plants are still base load plants, although their energy output is variable. He also mentioned that the cost of nuclear power in other countries is heavily subsidized by their respective governments, primarily through their militaries. He also discussed low-level nuclear waste, which will also be produced in higher volumes than high-level waste, which can be used for recycling.

Ocean Tidal Energy Concerns

An audience member, who worked before with San Miguel Global Power, raised concerns about Dr. Dayrit's OTE proposal; his former company had previously conducted studies on the feasibility of OTE in the Philippines. He mentioned that there are currently no working models for OTE in the world. The tidal height disparity needed for the current technology was at least 17 feet. There are very few places in the Philippines that meet that requirement; thus it cannot be done on a massive scale. Their studies found that there were only five sites of sustainable tidal power in the Philippines, which limits the amount of energy output from this system.

Dr. Dayrit replied that he agreed that currently, more OTE technology research is needed to develop better equipment that can improve efficiency and optimize Philippine tidal power. However, he pointed out that the Department of Energy has found eight straits that have the potential to produce OTE. However, tidal height disparity is not the only way to generate OTE. There are other methods such as north- or south-oriented straits.

Final Remarks

To conclude the lecture, Mr. Shellenberger thanked the members of the audience, as well as the organizing team for the opportunity to share his views. He then followed it up by discussing some of his observations. He mentioned the idea that solar [energy] is indigenously created in the Philippines, whereas nuclear is not. There are two issues with this, he said: the issue of imports and of public versus private ownership, and the two countries that was mentioned earlier that are

heavy nuclear energy users and have socialized energy production. If you want socialism, there's no obstacle between that and using nuclear power. The French nuclear program is publicly owned, as is the South Korean electrical grid. However, he also claimed that the data can be statistically manipulated; he kept the sources cited at the bottom of his slides. He also asked the public to look for these cited sources themselves.

As regards his views on nuclear energy, Mr. Shellenberger mentioned that it took him five years to change his mind about nuclear power. He cannot imagine that anybody will simply change their minds in five (5) minutes.

In terms of countries that produce a lot of solar energy, Mr. Shellenberger mentioned that they are actually private electrical grids which the Philippines has. Germany has a private electrical grid, and is a heavy user of solar energy. California has a private electrical grid. There are people who have grown very rich from selling solar panels and from gaining subsidies for solar panels. He cannot cite an example of a publicly owned solar program in the world.

In terms of imports, Mr. Shellenberger discussed that the Philippines makes geothermal energy and has a small amount of natural gas, which is gradually running out. He also noted that the Philippines imports coal to generate energy. He also said that the cost of uranium fuel is 20 percent of the total cost attributed in harnessing nuclear energy.¹⁰ The rest are/can be produced indigenously. As a reflection point, Mr. Shellenberger asked the public to reflect on how South Korea became a rich country after being exploited by capitalist and socialist interests in terms of its electricity grid; the issue does not really make much sense. South Korea created their wealth by doing it indigenously with nuclear power.

When Mr. Shellenberger met with South Koreans, they mentioned that before they had nuclear energy, they were slaves. He asked what

10 This is still true today. See World Nuclear Association, "Economics of Nuclear Power," August 2022, <https://world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx>.

they meant by that statement. To which the South Koreans retorted, “We were slaves to the outside world.”

The Philippines remains poor because the country has chosen to remain dependent on the outside world. It’s fine for Americans for the Philippines to buy its supply of coal or natural gas from the US. The same dependence goes for Indonesians and Australians.

If the Philippines wants to grow and be prosperous and lift people out of poverty, it needs to generate its own electricity on its own, and it needs to reduce the price of energy. It can be done either through capitalism or socialism; however, it cannot be done by simply importing the country’s energy requirement as it keeps the Philippines’ electricity prices so high.

Lastly, he thanked again everyone for the invitation to speak in the forum.

REFERENCES

- Kharecha, Pushker A. and James Hansen. 2013. "Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power." *Environmental Science and Technology* 47(9): 4889–95. <https://pubs.acs.org/doi/full/10.1021/es3051197?source=cen>
- Shellenberger, Michael. 2017. "Renewables can't save the planet. Only nuclear can." *Environmental Progress*, 16 August 2017. <https://environmentalprogress.org/big-news/2017/8/16/renewables-cant-save-the-planet-only-nuclear-can>
- Scotland Against Spin. 2022. "Turbine Accident Statistics." <https://scotlandagainstspin.org/turbine-accident-statistics/>
- World Energy Council. 2016. "World Energy Trilemma Index 2016." London, United Kingdom: World Energy Council and Oliver Wyman.

EDITORIAL RESPONSIBILITIES

The Editor-in-Chief, the Deputy Editor-in-Chief, and the Program Editors ensure that proceedings contain findings on issues that are aligned with the core agenda of the research programs under the University of the Philippines Center for Integrative and Development Studies (UP CIDS).

The Editor-in-Chief, the Deputy Editor-in-Chief, and the Program Editors are responsible for maintaining high standards of scholarship, and for generating and disseminating new knowledge that can be utilized for the public good.

EDITORIAL BOARD

Teresa S. Encarnacion Tadem
EDITOR-IN-CHIEF

Janus Isaac V. Nolasco
DEPUTY EDITOR-IN-CHIEF

PROGRAM EDITORS

EDUCATION AND CAPACITY BUILDING CLUSTER

Dina S. Ocampo
Lorina Y. Calingasan
Education Research Program

Fernando DLC. Paragas
Program on Higher Education
Research and Policy Reform

Marie Therese Angeline P. Bustos
Kevin Carl P. Santos
Assessment, Curriculum, and
Technology Research Program

Jalton G. Taguibao
Program on Data Science for
Public Policy

DEVELOPMENT CLUSTER

Annette O. Pelkmans-Balaoing
Program on Escaping the
Middle-Income Trap: Chains for
Change

Antoinette R. Raquiza
Political Economy Program

Eduardo C. Tadem
Benjamin B. Velasco
Program on Alternative Development

Antonio Miguel L. Dans
Jose Rafael A. Marfori
Program on Health Systems
Development

SOCIAL, POLITICAL, AND CULTURAL STUDIES CLUSTER

Maria Ela L. Atienza
Jorge V. Tigno
Program on Social and Political
Change

Darwin J. Absari
Islamic Studies Program

Herman Joseph S. Kraft
Maria Thaemar C. Tana
Strategic Studies Program

Marie Aubrey J. Villaceran
Frances Antoinette C. Cruz
Decolonial Studies Program

EDITORIAL STAFF

Mika Andrea O. Ramirez
EDITORIAL ASSOCIATE

Virna Liza O. Guaño
Angeli P. Lacson
SENIOR EDITORIAL
ASSOCIATES

Zylyka Mae F. Gendraule
LAYOUT ARTIST

