On behalf of

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

of the Federal Republic of Germany

"Filipino 2040 – Energy: Power Security and Competitiveness EPDP Working Paper 2016 – 01R"

Comments (November 2016) and further reactions (July 2017) by
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Response by authors of EPDP study (March 2017)

Summary / General Comments

- While it is highly appreciated that EPDP is exploring the crucial topic of energy scenarios and future energy costs, GIZ strongly suggests that the Filipino 2040 paper on energy as published by UP-EPDP (EPDP Working Paper 2016 – 01R) **is not to be used as the basis for political decision making.** In many crucial parts, the paper **neglects scientific standards and presents assumptions, results and recommendations that are highly misleading and in certain cases clearly incorrect**. Furthermore, the paper does not take into account the most recent international developments in the energy sector and expected developments stemming from increasing shares of variable renewable energy.

  Author's response:
  These comments should be addressed to the Department of Energy and the National Economic and Development Authority (NEDA). DOE is the lead agency in charge of the policy making in the energy sector, with NEDA as the coordinating body. EPDP's paper is just one of the inputs that the agencies may consider. We believe that the DOE and NEDA have the technical expertise to evaluate studies. Other scholars who may have a different approach may write their own paper for the two agencies to consider.

  We understand that DOE makes policies in line with the Philippine Development Plan. Thus, our paper focuses on pursuing development and energy security, guided by the visioning exercise spearheaded by NEDA. The mandate of EPDP is to provide inputs that is conducive to sustained growth and poverty reduction.

  The authors of Filipino 2040 follow scientific standards and take into account the most recent international developments in the energy sector. We discussed not only developments stemming from increasing shares in variable renewables but also developments in other fuel sources. In the following, we explain the details.

  Reaction by GIZ:
  The comments have been shared with DOE and NEDA. As an official advisor to DOE under the "Support to the Philippines in Shaping and Implementing the International Climate Change Regime" (SupportCCC II) project, GIZ is providing its comments to support DOE in evaluating relevant scientific studies based on existing experience in Germany and around the globe.

One of the main points of criticism is that the authors have obviously not taken into account such "most recent international developments in the energy sector" and therefore offer energy development paths for the Philippines that do not consider the most important recent trends that are disruptive to current energy planning proposals, e.g.

- Changing energy sector framework conditions like the development of decentralized energy resources and connected changing requirements for the energy market structure.
- Impact of upcoming disruptive energy technologies such as PV, batteries, electric vehicles (EV), etc.
- Projected decrease of profitability and increasing financial risks of new coal power plant investments, manifested in the current worldwide slowdown of new coal power plant construction, in particular in China, US and Europe.
  - E.g. EU: Construction stop of any new coal power plant after 2020 in 26 of 28 EU member states[1]
  - E.g. China: Construction stop of 106 coal power plants partly even already under construction
- Projected impact of international climate change commitments following the ratification of the Paris Agreement

- While future global and national developments in the energy sector remain very difficult to predict and are characterized by a large number of uncertainties, the authors of the working paper make specific policy recommendations based on a **very limited number of future scenarios** which vary only in the fuel mix composition, but not other external factors. Rational decision making by policy makers would however require a much larger set of scenarios taking into account a whole range of possible future developments and risk factors, e.g. price developments of energy technologies, environmental charges, etc.

Authors' response:
As mentioned, this paper is just one of the inputs that can be used to assist decision-makers in formulating policies. The objective is to improve the well-being of Filipinos by lowering the price of electricity in an economically efficient manner. In the updated March 2017 paper, we have added two more cases regarding the evolution of fuel prices. One additional case reflects the simultaneous changes in the prices of fuel. All in all we have explored 20 possibilities. GIZ is also encouraged to provide other options and specific alternatives to provide the Government with an array of options for decision-making.

The external factors eventually get reflected in those prices. The results of the simulations with regard to blended generation charge illustrate that the fuel mix need not be constant over time but should exploit the opportunities opened up by less costly resources.

When this paper was conceived in 2015, DOE's mandate per circular 2015-07-0014 was to adopt at least 30% share of renewables in the country's total power generation capacity.

[1] https://insideclimatenews.org/news/06042017/coal-climate-change-european-union-paris-climate-agreement-donald-trump

Hence, the main focus of this paper is to illustrate how policies regarding fuel mix will affect the well-being of Filipinos as reflected by blended generation charges. The blended generation charges constitute about 47% of the bill paid by the consumers.

The current administration of DOE under the leadership of Sec. Cusi is reconsidering the said circular. The direction is to go for "technology agnostic" fuel mix.

Reaction by GIZ:
GIZ is in fact currently preparing a set of scenarios based on actual operating data of the power system using appropriate modelling software. The scenarios will be presented to DOE later this year.

The additional cases (4 and 5) considered in the latest version of the paper (March 2017) show that in case 4 (annual decrease of the price of solar by 8% and other RE by 3%) the generation price projection for 2040 is lowest for increased RE.

In addition, looking at total generation cost in 2040 (figure 19) one can see that the difference between the cases are minimal, except case 1 (Policy 1: 30 – 30 – 30) for which we agree that mandating a fixed fuel mix is not an advisable policy decision. As all other cases have very close total costs one must also consider other decisive factors to make a choice, such as the dependency of certain power sources on international fuel price developments. RE technologies do have the significant advantage, that their future generation costs are very well predictable as most costs are determined by the initial investments costs, while conventional power plants from coal and gas depend very much on international fuel price developments. Economic development of a country can be significantly hampered by such sudden fuel price changes, such as the oil price shocks in the eighties. Every kWh that is generated from RE reduces the risk of potential future price hikes. This significant economic benefit of RE technologies was neither mentioned nor considered in the paper.

Furthermore, the authors have completely neglected the impact of RE technology deployment on the local economy. It is a proven fact that RE deployment is more job-intensive per MWh than power generation from fossil fuels. Therefore, investments in RE technologies are more likely to generate local jobs e.g. for installation and maintenance of RE systems. This important economic relation between the type of power generation and impacts on local job markets and economic development was not considered in the paper.

- The authors of the working paper base their analysis on several **questionable assumptions**; the detailed comments below will focus mainly on three important key assumptions regarding a) cost developments of energy technologies, b) environmental charges, c) grid integration costs.

  Authors' response: (see responses to specific comments)

- The paper clearly **plays down the role of renewable energy** for future cost reduction and overemphasizes the role of coal: while the paper clearly provides evidence that considering even very conservative assumptions of RE cost reductions (3% a year), a scenario with high shares of variable RE would provide the cheapest overall costs, the paper keeps on emphasizing an initial "temporary utilization of less costly resources" (referring to coal) that "could potentially decrease the blended generation charge" (p.43). However, the paper never explains how coal power can be used in a "temporary" manner considering that coal power plants have a life time of 30-40 years. The paper does not discuss the real risk of a "coal lock-in" which would give the country little flexibility to integrate cheaper RE resources in the future without causing stranded coal investments in the mid to long term.

Authors' response:
The paper is focused on economic efficiency and is neither pro-coal nor pro-renewable. It aims to determine a fuel mix that respects the evolution of fuel prices over time. We highlight the role of competitiveness among various resources. If recent innovations make renewable energy more cost-competitive, then there is very little reason why the market will not adopt it, considering the least-cost principle. Thus, asserting that the paper downplays the role of renewable energy in favor of coal is inaccurate.

The "temporary utilization of less costly resources" does not refer only to coal. This refers to any fuel source of lesser cost.

The electricity market has been deregulated by EPIRA. Since the enactment of the EPIRA, the generation sector has already been privatized. The government can facilitate a more competitive environment not by restricting/prohibiting certain fuel mix but by letting the market work. Following market signals, the generation sector will rationally adhere to the utilization of least-cost resource.

We have revised the paper and used 5 cases regarding fuel price assumptions with 4 policy regimes for each case pertaining to our fuel mix assumptions.

"The evolution of power generation price for each type of fuel largely depends on how technology develops over time (see Viswanathan et al. 2006; ADB 2013; van Kooten 2013; and Knittel et al. 2015). One can think of many price trajectory possibilities. We use the following five cases on generation price to illustrate the effects of these price trajectories on the blended generation charge:

Case 1: Baseline
Policy 1 - 2015 prices constant for the next 24 years
Policies 2, 3, 4 - 2015 prices plus emissions charges constant for the next 24 years
Case 2: Prices of RE incorporate FIT degression rates in policies 1 to 4
Case 3: Annual decrease in average RE prices by 3% in policies 1 to 4
Case 4: Annual decrease by 8% and 3% in the price of solar and RE, respectively, in policies 1 to 4.
Case 5: All prices change simultaneously applying EIA projections on fuel prices in 2015 in policies 1 to 4

The paper recommends leaving the decision to the market after correcting fuel prices for externalities and fostering competition, concomitant to the full implementation of RCOA.

"To attain the goal of strong economic growth, electricity consumption is expected to grow at an annual average rate of 4.3%. With regard to the generation sector, we illustrated how policy reforms on fuel mix can potentially reduce blended generation charges that make up 47% of the total electric bill of households. The results of our simulations show that a policy that supports the increased utilization of less costly resources could potentially decrease the blended generation charge. On the one hand, with the base-case assumption that technology and, hence, fuel prices remain constant at 2016 prices from 2016-2040, this policy implies increased utilization of coal as fuel, since this is still by far the cheapest. With this assumption, blended generation charge could potentially decrease in 2040. On the other hand, if technology for variable renewable energy can evolve rapidly to bring fuel prices down by at least 3% from today's current average prices, then this implies increased utilization of variable RE resources."

"The objective is to improve the well-being of Filipinos by lowering the price of electricity in an economically efficient manner. The results of the five cases with regard to generation price illustrate that the fuel mix is not constant over time but should exploit the opportunities opened up by less costly resources."

Reaction by GIZ:
We appreciate the additional cases which already show that in case 3 and case 4 more investment in RE technologies lead to lower generation costs.
The authors still neglect that under the current market structure the different energy sources do not compete on a level playing field and therefore market outcomes do not necessarily reflect the expected outcome of least cost power provision to consumers in the long-run. Conventional power generation with coal or gas is mostly secured by PPAs with the possibility to pass through variable fuel costs to the end consumers. Therefore, the risks and impact of higher fuel costs are not borne by the investors and operators of these power plants, but solely by the consumers. Therefore, investment decisions are not taking into account fuel price risks in the long run. A level playing field between the current technology options could only be achieved if the following three conditions were fulfilled:

1. all conventional power producers (IPPs, etc.) get reimbursed via prices achieved at the trading floor (WESM),
2. fuel charges are not directly passed through to consumers,
3. power plants that are too expensive at any point in time are not dispatched nor reimbursed (merit order).

All three conditions would allow a much stronger market signal to supply power at the least cost.

Referring to any fuel source in the context of "temporary utilization of less costly resources" is misleading, as many conventional fuels could simply not be used in a temporary way due to the required minimum lifetime of infrastructure investments necessary to make them economically viable. The paper should therefore clearly state what sources of energy it considers candidates for such "temporary utilization".

- The **depiction of data in figures is often misleading** and overemphasizing the cost difference of the compared policy regimes.

  Authors' response: The figures are not misleading and the vertical scales are clearly marked.

  Reaction by GIZ:
  While the vertical axis is marked properly in the most recent version of the paper, this does still not change the fact that it is misleading, e.g. figure 6 page 28. This is a classic example of a truncated graph. By choosing to include a break on the y-axis the differences between the individual values are clearly overemphasized. It is recommended to present the results in a table format as this would present the numbers in a more objective manner. Using the existing graphs is communicating the authors' subjective opinion that the respective values are significantly different.
  For further explanation of this common way of misrepresenting data, see
  https://en.wikipedia.org/wiki/Misleading_graph#Truncated_graph
  http://www.statisticshowto.com/misleading-graphs/

- **Important references used to back the paper's assumptions do not represent mainstream scientific/expert opinion**; this is in particular true for the topics environmental charges and grid integration issues.
  Authors' response:
  The authors would appreciate if Mr. Vemuri can provide, or at the very least identify, some of these alleged mainstream references so we can assess the validity of his claim. Furthermore, being mainstream does not necessarily mean correct. It is instructive to remind ourselves of when Aristotle proved that the Earth is round.

  We maintain that the references we used are both credible and widely-cited (e.g. Viscusi, Gayer, Van Kooten, Heal, and Tol). Mr. Vemuri and colleagues can always refer to metrics from Google Scholar, or use the H-index and the R-index, all standard academic measures. See table below for easy reference.

  Reaction by GIZ:
  It is noted that with the reference to Aristotle the authors seem to be openly positive about not following international mainstream scientific opinion.
  It is also noted that the authors after months of research are requesting GIZ to provide them with international references on environmental charges and grid integration issues. We would refer them to available online research tools such as Google as well as renowned international scientific institutions working on these topics, e.g. for grid integration: NREL or the Fraunhofer Institute for Sustainable Energy Systems as well as publications by IRENA, IEA, Agora Energiewende and others.

- There are **errors and miscalculations** that need to be addressed.

  Authors' response:
  Thank you. Noted. Please see updated March 2017 version.

<u>Specific Comments</u>

Assumptions Regarding Cost Developments of Energy Technologies

- **An "absence of data" is given as the explanation for keeping all generations costs constant at 2015 values until 2040 (p.21)**
  There are plenty of cost projections for RE technologies available, e.g. by IRENA, IEA, NREL. Long-term fossil fuel price projections beyond a 3-5 years framework are in fact close to impossible and associated with a very high level of uncertainty. Assuming constant fossil fuel prices at 2016 levels is completely negating fossil fuel price risks. Variables such as fossil fuel costs must be examined through separate high/low/medium price scenarios.
  Even considering an "absence of data" situation, choosing a conservative scenario would imply extrapolating and continuing past developments, not freezing generation costs (which is an extremely unlikely assumption).

  Authors' response:

  We have revised the paper and used 5 cases regarding fuel prices with 4 policy regimes for each case pertaining to fuel mix assumptions.

  Assuming a constant price for the next 24 years is a reasonable assumption as a baseline with which other assumptions on the evolution of prices can be compared. Projections for coal prices, for instance, show that values are only expected to change around 2022 (see World Bank study; link below). The comments even acknowledge that long-term price projections are "close to impossible." In the end, it is the relative price that matters.

  See WB Commodity Price Forecast as of October 2016 (pubdocs.worldbank.org/en/229461476804662086/CMO-October-2016-Forecasts.pdf)

  We added case 5 to illustrate what happens when all fuel prices are changing applying EIA's 2016 projection.
  "Case 5 illustrates what happens when all fuel prices change simultaneously. The evolution of generation charges for each type of fuel source largely depends on how technology develops over time. The heightened concerns over the environment and the energy crisis in the 1970s have since prompted research and development programs in finding ways towards increased efficiency of coal power plants (Viswanathan et al. 2006). Denmark, Germany, and Japan have been actively pursuing the development of an ultra-supercritical coal power plant that utilizes stronger high-temperature materials (World Coal Association 2015), enabling the power plant to utilize coal efficiently and thereby reducing carbon emissions. The shale gas boom and "fracking" technology would also affect the relative prices of fuel sources

(Stephenson 2015). The glut of shale gas in the US that brought down the price of natural gas by almost 70% in 2008-2012 has provided incentives for generators to switch from coal to gas (Knittel et al. 2015). Technology on renewable sources is likewise evolving, including the development of batteries that address the intermittent nature of these sources (van Kooten 2013; IRENA 2015).

To capture the changes in technology, we apply the growth projections of EIA (2016)1 on fuel prices in 2015 (from Table 6) to come up with a projection of fuel prices until 2040 for the Philippines."

See: EIA's (2016) projection of energy prices for the US https://www.eia.gov/outlooks/aeo/data/browser/#/?id=1-AEO2016&cases=ref2016~ref_no_cpp&sourcekey=0

Reaction by GIZ:
The addition of case 5 is appreciated, but in light of the price developments in the last decade the assumption that an average of RE technologies will only decrease by -0.64%/year is neither useful nor adequate for the case simulation. Future price assumptions for RE technologies need to be technology specific. The specific price development of -3%/year for wind or in case of PV solar of up to 8%/year seems to be more realistic. Price development for RE technologies must be technology specific to be realistic as each RE technology is in a very different stage of development e.g. hydropower already being a mature technology where further price deductions shall be less likely compared to PV technology.

The authors cited documents wherein recent technology developments in coal power plants are cited. It is correct, that in Europe and the US super critical coal power plants have been constructed and that their efficiency is slightly above 40%. However, the authors neglect that the future development of coal power plant technology will come to an end in Europe as no more new coal power plant will be constructed after 2020. In addition, super critical coal power plants need a very high standard to technology and are therefore much more costly in the investment phase. Therefore, in case the authors assume super critical coal power plants in the Philippines, they need to change their price assumptions.

We agree that the current shale gas boom especially in the US will be a game changer in the near future for the fuel costs of gas even in Asia. It is not clear how long "cheaper" LNG will be available in ASEAN, but it currently looks as if this fuel will have an impact on fuel cost price relations even in the Philippines once LNG port facilities are available in sufficient number and size. How long that will last is not clear.

- **The sensitivity analysis for RE cost reductions uses a) average FIT degression rates and b) a 3% annual decrease (p. 29)**
  The paper states that as per ERC case No. 2015-216 RC "degression rates for solar and wind no longer applies [apply]". It therefore remains unclear and is not explained why then average FIT degression is used for the sensitivity analysis.

Authors' response:

Taking into account ERC Case No. 2015-216 RC, the degression rates were applied only for biomass and run-of-the-river hydro. Prices presented are already averages for the four RE sources.

"Case 2 takes into account the degression rates in the feed-in-tariff (FIT), which is already in place as per ERC Case No. 2011-006 and ERC Resolution 10, Series of 2012. Incorporation of FIT will alter the price of must-dispatch renewables in policy regimes 1 to 4. The FIT and degression rate is based on the adjusted 2016 rates as per ERC Case No. 2015-216 RC, where biomass, hydro, solar, and wind have FIT rates of PhP 7.0508, PhP 6.4601, PhP 8.69, and PhP 7.40, respectively. The same circular notes that degression rates for solar and wind no longer apply. The degression rate for biomass and hydro is 0.5% after year 2 from effectivity of FIT."

- Generation costs in the Philippines have already decreased well under the FIT rates; future FIT rates are expected to be significantly lower, a development which will also be further boosted by the implementation of an auctioning scheme for FIT as currently under development by DOE. A future projection cannot focus on FIT rates, but has to focus on expected actual levelized costs of energy.

Authors' response (1st part):

There is no specific provision explaining when the FIT program will actually end. Per DOE Circular No. 2013-05-0009, the DOE shall issue the certificate of endorsement for FIT 1 EIA's (2016) projection of energy prices for the US

https://www.eia.gov/outlooks/aeo/data/browser/#/?id=1-AEO2016&cases=ref2016~ref_no_cpp&sourcekey=0

Eligibility until the maximum installation target per technology is fully subscribed. The aim of using FIT is to illustrate the reduction in RE costs given this incentive. The use of FIT rates for biomass and run-of-the-river hydro remains valid considering that no new policy instrument has been issued to replace it.

Reaction by GIZ:
The above mentioned EIA projection for the US is related to oil, coal and gas and does not give any specific price development for the specific RE technologies like PV, Wind etc. Therefore, if the EIA price development is taken as one case the future price development of PV and Wind technology will have to be taken from different sources, as EIA does not give any projections on these new technologies! The assumptions of 3%/year or 8%/year in case of PV solar are quite reasonable based on historic price developments.

Authors' response (2nd part):

Moreover, the suggested method of using levelized costs of electricity (LCOE) is questionable. The US EIA (2013) notes that "the direct comparison of LCOE across technologies to determine the economic competitiveness of various generation alternatives is problematic *and potentially misleading. Joskow (2011) calls levelized cost a "flawed metric for comparing the economic attractiveness of technologies such as wind and solar with conventional dispatchable generating technologies such as nuclear, coal, and gas combined-cycle because it effectively treats all electricity generated as a homogeneous product governed by the law of one price."3 Finally, Leifman (2013) notes that LCOE has too many pitfalls including masking many site-specific issues, ignoring system interaction issues and the fact that it is barely used in actual decisions about technology choice.*

Nonetheless, our simulation in case 5 already incorporates LCOE. The 3% annual decline in the prices of renewables is actually more liberal than the LCOE and LACE values found in the EIA Outlook.

Reaction by GIZ:
We agree that taking LCOE is not enough to compare different power generation technologies; however, IEA and all other major institutions are taking LCOE as one major base to compare full true costs of different power technologies. It is correct that other aspects, like impact on foreign exchange, economic impact of sudden fluctuating fuel prices, grid integration costs, flexibility, local and regional economic impact, environmental impact etc., must be taken into account as well when comparing different technologies. However, at this moment LCOE seems to be the best base to compare different power generation technologies based on kWh, if this method is accompanied with the other above criteria.

- While the paper states that the second sensitivity analysis aims at "asking to what extent the price of renewable[s] must go down for policy regimes 1 and 4 to be superior to the other policy regimes", this question is never answered. The actual sensitivity analysis is only performed using an annual generation cost decrease of 3% per year. The reason for selecting the 3% value remains unclear, as this still remains very conservative considering past developments and future projections, e.g. since 1998, reported PV system prices have fallen by 6-8% per year on average[2].

Authors' response:

Case 3 is a scenario for reducing the price of renewables for policy regimes 1 and 4 to have a blended generation charge lower than those of the other policy regimes in 2040.

This is a bottom-up exercise because we ask the question by how much, at the minimum, will prices of renewables have to go down for Policy 1 and 4 to perform better. Note that the 3% reduction is average for the four RE technologies (Solar, Wind, Run-of-the-river hydro, and biomass).

In the March 2017 version, we have included Case 4 to consider the trend in the decrease in the price of solar. Feldman et. al (2014) reported that the prices of PV systems for the US have fallen by 6-8% per year on average since 1998. We use an 8% reduction in solar prices coupled with a 3% reduction in other renewables as in Case 3 to further illustrate when policy regime 4 becomes superior relative to other policy regimes.

[2] http://www.nrel.gov/docs/fy14osti/62558.pdf

"Case 4 is a variant of Case 3. Solar price is projected to decrease by 8% annually and average prices of must-dispatch renewables decreased by 3%. As expected, the result shows that Policy regime 4 gives the lowest blended generation charge by 2040 at PhP 4.10 per Kwh. Similarly, if technology of solar changes rapidly, then policy regime 2 transforms into policy regime 4, increased utilization of the lower -cost solar resource."

Reaction by GIZ:
We agree that this case considerations 3 and especially 4 with a differentiated price development for the various new RE technologies gives a more accurate and specific base for the simulation.

Assumptions Regarding Environmental Charges

- **The base social cost of carbon of 25 US$/tC is based on the paper by Tol, 2013, "Targets for Global Climate Policy: An Overview" (p.22).**
  The opinion of Tol to assume such a low social cost of carbon is highly controversial[3]. In his own paper, he mentions other studies with a total of 588 estimates for social cost of carbon values with a mean estimate of 196 US$/tC and a median of 135 US$. Again, as the future developments remain very uncertain also regarding potential future carbon fees, scenarios including higher and lower assumed social costs of carbon would have to be taken into account by the study. It is never explained why the paper chose the extremely conservative 25 US$ as provided by Tol.

  Authors' response:

  The calculations have been revisited, see Box 4. As explained, we use a global social cost of carbon (SCC) ($25/MT of CO2), which is obtained as a midpoint of the SCC reported in Nordhaus (2011) and the United States Environmental Protection Agency (2013, revised August 2016). Nordhaus reports an SCC of $12 per MT of CO2 while the EPA reports an SCC of $37 per MT of CO2. Absent a strong and binding global agreement and assuming that carbon-induced damages in the Philippines are 5% of worldwide damages, the Philippine carbon tax should be $1.25 per MT of CO2, given a global social cost of carbon of $25 per MT of CO2.

  Note: NTRC even suggests a lower tax; health and environmental costs

  Reaction by GIZ:
  See comment on downscaling the social cost of carbon below.

- **The calculation of the CO2 equivalent of 25 US$/tC is incorrect (p.22)**
  Considering 3.67 tCO2 equals 1 tC, 25 US$/tC would equal 6.8 US$/tCO2 (25/3.67), as a ton of CO2 contains less carbon than a ton of pure carbon. The used value of 91 US$ is wrong.

  Authors' response: Thank you. See Box 2 (Notes on Carbon Emissions) of the revised March 2017 version.

[3] E.g. http://frankackerman.com/Tol/Tol_on_climate_policy.pdf

- **The damages / social cost of carbon are downscaled to match the relative GDP of the Philippines compared to the rest of the world, based on Gayer, Viscusi, 2014, "Determining the Proper Scope of Climate Change Benefits" so that in the end only 0.44% of actual social costs are taken into account (p. 22)**

  The suggestion of a 0.44% share in global Social Cost of Carbon (SCC) does not properly reflect the discussion about global SCC vs. domestic SCC. The individual paper cited as reference for this approach was a critical suggestion in the US context suggesting that benefits of CO2 mitigation measures should only be accounted to US taxpayers to an extent that climate change impacts occur in the US. However, this view is not universally accepted and the US EPA is not following this approach when it comes to benefits of mitigation projects. This approach would imply that emitters in the Philippines would not have to show any financial responsibility for emission-related damages that would occur in other parts of the world (carrying the burden of the remaining 99.56% of social costs). However, this would then also imply that other countries applying the same concept would not take any responsibilities for their emission-related damages occurring in the Philippines. This would actually have catastrophic impacts on the Philippines as one of the most vulnerable countries to the negative impacts of climate change.

  As becomes clear, such an important debate about how a potential future carbon fee could be implemented must take place in the Philippines and the decision cannot be taken by the authors of the EPDP Working Paper, but must finally be left to the Government of the Philippines.

  Unfortunately, the paper never explains the rational for following the approach promoted by Gayer, Viscusi nor does it provide different scenarios with differing assumption about the carbon price methodology even though this simple decision has an immense impact on the outcome of the overall study.

  Authors' response:

  Gayer and Viscusi's point is that in using the global cost of carbon, the EPA is violating well established U.S. govt. procedures of project evaluation.

  The argument about the retaliation by other countries leading to more emissions has no foundation in economics. If the Philippines enters into a strong and binding global agreement, then a higher SCC would be warranted. However, the Paris agreement is neither strong nor binding. As a matter of sensitivity analysis, one could evaluate the hypothetical case wherein the Philippine commitment is viewed as binding (which it's not). This still would not result in a huge increase in SCC because the commitment is quite modest.

  This approach is also consistent with the Lindahl solution to the public good problem. Harvard University's Chen and Zeckhasuer (2016) consider climate change mitigation as a global public good and show that gross national income (GNI) "is a robust and valid measure of nation size in the climate change mitigation context. Thus, big nations in terms of GNI have to contribute more to the public good than little nations.

  The top ten emitters of CO2 into the atmosphere accounts for 68 percent of the world's total emission for the period (Enerdata 2015). This group includes USA, China, Russia, Japan, India, *Germany, United Kingdom, Canada, South Korea, and Italy. The next ten countries contributing to the world's emission constitute 13 percent. The remaining 166 countries, including the Philippines, constitutes 19 percent (see Figure below). The Philippines' share average for the period is only 0.26 percent.*

We do not wish to join the vigorous debate surrounding these estimates. Our point here is just that, assuming that the estimates are correct, the mitigation posture of the Philippines, even if attained, will contribute only to a small reduction on the world carbon emissions and its global warming outcome. The Philippines alone will have a small impact on the international target to limit global warming to 2 degrees Celsius; this outcome is totally out of the country's control. In decision theory, the Philippines is far from being a "critical decision maker". It is in the red zone of the figure above that effective CO2 reduction should be found. This is not to say that the Philippines and the other smaller countries should renege on their contribution to carbon emissions reduction effort. Rather, the Philippines should be more prudent in binding themselves to the Paris Agreement. A stronger and more binding agreement can be best achieved where the big emitters commit to be the first movers.

Finally, we agree with GIZ that the decision ultimately lies with the Government.

Reaction by GIZ:
We agree that it should not be the scope of the paper to discuss which method for calculating the social cost of carbon should be used. This is ultimately a decision to be taken by the government. However, we want to reiterate that in the absence of a final decision and a high degree of uncertainty, several scenarios of different levels of social costs of carbon must be taken into account. In particular, as this factor seems to have tremendous impacts of the overall results of the study. At least one scenario should account for the full damage caused by the country's CO2 emissions on a global scale. Avoiding such a scenario implies that such political decisions had already been taken or alternative scenarios were extremely unlikely. We do not see why this should be the case.

- **The computation of the carbon tax of 1 US$/tCO2 remains unclear and is not further explained (p. 22)**

  Authors' response: Thank you. See Box 4 (Notes on Carbon Emissions) of the updated March 2017 version.

- **Emissions of particulates and sulfur dioxide are described as "small" even though they make up 2/3 of the final environmental charge of 3 US$. Calculation of these values is not further explained.**

  Authors' response:

  Policy regimes 2, 3, and 4 incorporate emission charges.

  "The incorporation of emissions charges is an attempt to reflect the true social cost, albeit incomplete. The full social cost would have to incorporate local pollution, including cost of

particulates and sulfur dioxide. This may be larger than the emissions charges (see Roumasset et al., 2016) but an estimate for the Philippines is wanting."

The tax on emissions of particulates and sulfur dioxide should have a larger share in the computation of environmental tax since it takes into account local health costs. These particulates are considered as a local public bad that has a more direct impact to Filipinos; hence, it is appropriate to apply a larger weight on these emissions. However, there are relatively fewer studies on this area compared to carbon tax.

A recent study on "Air pollution emissions and damages from energy production in the US" (Jaramillo & Muller, 2016) estimates total damages across four industries (power generation, oil & gas extraction, coal mines, oil refineries) to be around $131 billion in constant 2000 prices as of 2011. This has already decreased from $175 billion in 2002, but the cost is still substantial. The analysis also shows SO2 emissions from power generation is the largest contributor to total damages though it was highlighted as well that marginal damages vary considerably within each sector across different years.

Assumptions Regarding Grid Integration Costs

- **P. 29, second paragraph is depicting the challenges around integration of variable renewable energy as very costly and difficult.**
  A 34% share of RE in the UK, of which a large share is variable solar and wind power, is a very steep increase, but in particular for variable RE not foreseen for the Philippines any time soon (current level of variable RE <1%). Such an increase obviously requires grid updates, but the quoted seemingly high absolute costs must be put into relation to total energy system costs. International experience shows that grid integration costs for variable RE generally range around 0.5 EURcents/kWh; most conservative estimates reach 2 EURcents/kWh (0.25-1.00 PHP/kWh)[4]. It must not be forgotten that other energy technologies such as coal or nuclear also have integration costs, an issue that is often forgotten in the debate.

Authors' response:

The point is coal is already a well-established resource, so it is easily integrated into the grid and does not face as high a cost as in the case of variable RE. In fact, the NGCP acknowledges the challenges and the high integration cost for variable RE (Remoroza, 2015). The comparison with other countries can be misleading, since the cheaper integration costs may be a result of the fact that their grids have already been upgraded, unlike in the case of the Philippine. Thus, we cannot categorically deny the existence of integration costs for RE.

Reaction by GIZ:
While for any power technology grid integration costs exist, like the N-1 rule for any power plant, it is true that for variable renewable energies different kind of integration costs exist. However, the international practise has shown that with investments in forecasting of demand of customers groups and forecasting of the supply side from variable renewables,

[4] https://www.agora-energiewende.de/en/topics/-agothem-/Produkt/produkt/248/The+Integration+Cost+of+Wind+and+Solar+Power/

like Wind and PV together with improved energy market signals the integration costs can be minimised. As shown in Germany, the costs of variable renewables integration into the grid, varies between 0.5 - 2 Eurocents/kWh. It has been proven that through a steady learning process by the TSO/DSO and the market participants in the energy market the costs are greatly reduced.
As the proportion of RE in the Philippines is growing slowly, the energy market participants, the regulator and the TSO have enough time to learn from other countries which steps shall be taken to minimise the cost of grid integration. However, they should start to learn now and not wait until grid congestion becomes an issue.

- **"The intermittent nature of renewable generation such as in wind and solar, requires additional investment in new capacity from reliable conventional sources (or even in nuclear energy) to serve as back-up sources" (p. 29)**
While a slight increase of reserve requirements can be expected in scenarios with higher variable RE, additional capacities will be required only in very rare circumstances as variable RE often frees existing conventional generator capacities that can use those capacities as reserves. The last sentence in this paragraph ("In the United Kingdom, the pursuit of a 15% renewables target requires roughly doubling the requirement for new capacity") remains unclear as it is not specified what new capacities the source refers to. Nuclear energy cannot act as a balancing plant for variable renewable energy as its immediate ramping capabilities are very limited and reduced power generation output would make the plant uneconomic.

Authors' response:

Heal (2016) discussed that there is a need 'to make specific provisions for coping with the stochasticity of renewable power output" through the development of back-up sources such as investment in energy storage or conventional renewable energy technologies in order to avoid comprising the integrity of the grid.

Reaction by GIZ:
Storage as a flexibility option for larger grids with high shared of variable renewables is not expected to be required until their share reaches 40%. Improved forecasting of variable renewables' availability can accommodate for their stochastic nature. Additional conventional capacities will be required only in very rare circumstances as variable RE often frees existing conventional generator capacities that can use those capacities as reserves. Once the forecasting is improved, handling variable renewables becomes similar to handling demand changes during the day, something energy markets can cope with, as has been proven in Germany even under extreme conditions, e.g. during the solar eclipses in March 2015 where only through energy market signals and differential market prices up to 10 GW of decrease of PV solar power in 15 minutes could be handled.

Miscellaneous Comments

- Some of the figures comparing the generation costs of the different policy regimes depict the results in a very misleading way by not setting the y-axis at zero. This overemphasizes the actual very small differences, e.g. figure 6, page 28

  Authors' response: The y-axis is clearly marked.

  Reaction by GIZ:
  Please refer to the comment on misleading graphs above.

- The paper does not account for the impact of high shares of variable RE on baseload requirements. Scenarios with higher shares of solar and wind need to incorporate a reduced requirement for baseload power plants and a higher need for mid merit and peaking plants to provide for balancing needs. Experiences from countries like Germany have proven this effect over the recent years.

  Authors' response:

  For the Philippines, the major concern of the power sector is the security of supply and electricity access for all. With the current situation of the country, the DOE has identified that the development of baseload resources is their priority in order to address the issues of the sector. Moreover, unlike variable RE, baseload generation plants cannot be easily turned on and off; hence, it would be difficult to impose a reduction in the use of baseload generation plants which would actually lead to a more inefficient use of resources.

  Reaction by GIZ:
  While the authors are partly right that most coal generators in the Philippines are currently not able to ramp flexibly, the situation looks very different for the future as there is a long list of new coal plants in the pipeline. The need of any future power plant technology to be more flexible is a given fact in light of the changing composition of future power generators. What is needed in the future are flexible power plants and not base load plants that cannot cycle. These can be gas or be coal plants designed for mid-merit and peaking operation.[5] Through the introduction of more variable renewables, the demand for base load will be reduced, while demand for mid-merit and peaking power plants would increase. Therefore, it is very risky and would lead to "stranded assets" to invest into too many power plants that can only operate in baseload mode.

- Abstract: "This paper looks at one major commodity that bears heavily on every Filipino consumer's expenses: electricity"
  Could you present concrete data to back this up? Data on the percentage of electricity costs on the consumers' monthly or annual expenditures?

  Authors' response:

  Based on the latest Family Income and Expenditure Survey by the Philippine Statistics Authority, electricity expenses rank 3rd among non-food household expenditures. Only rental

[5] cp. Agora Energiewende: Flexibility in thermal power plants: https://www.agora-energiewende.de/fileadmin/Projekte/2017/Flexibility_in_thermal_plants/115_flexibility-report-WEB.pdf

value (1), and transportation costs (2) rank higher. In fact, electricity is even ranked higher than spending on health (4) and education (5). It is therefore readily apparent just how important electricity is in terms of expenditures.

- P. 7: high power costs are depicted as the main barrier for industrial development in the Philippines. This point should be backed up with concrete data for Philippine industries, as even though companies often complain about high power costs, those costs actually often represent a minor share of overall manufacturing costs and vary between industrial sectors. It is therefore not clearly obvious that power prices represent the main barrier for industrial development, as there might be other more significant issues.

  Authors' response:

  While it is true that electricity prices do not constitute the largest share in the cost of production, investors have consistently cited the comparatively higher cost of power in the Philippines as the biggest impediment in investing in the country. Enerdata (2014) acknowledges that both the high cost of power and the sketchy reliability of electricity supply remain the main deterrents to investment, with firms considering the problem as "a persuasive reason to invest elsewhere."

  A comparison between Indonesia and the Philippines, for instance, show the possibility of self-selection among firms, where early energy intensive firms locate in countries with lower electricity cost like Indonesia. Thus, power-intensive industries (electronic components, paper) do not figure considerably in Philippine manufacturing while in the case of electrical machinery/components, the share has been declining since the early 2000s.In contrast, power-intensive industries (paper, textile, chemicals, machinery) drove the Indonesian manufacturing sector and FDIs, especially in the late 1980s and early 1990s. More importantly, high power rates have also been shown to have significantly contributed to the premature deindustrialization in the Philippines.

  Reaction by GIZ:
  The reason for high electricity costs in the Philippines is connected to the effects of the power crises in the late eighties, which lead to unfortunate "terms of trade" for any investment in the power sector. The privatisation of the power industry has not lead to the expected reduction in costs as competition among power sector investors could not be established as anticipated. The existing rate on return on investments in the power sector in the Philippines is well above comparable rates in other countries.

- P. 7: the Philippines electricity rates are compared to the rates of other ASEAN countries. These rates cannot be easily compared as they don't reflect actual power generation costs. All mentioned countries except Singapore highly subsidize electricity from their state budgets.

  Authors' response:

  This misses the point. Investors do not simply look at generation costs. They decide based on the final cost of power that they have to pay, which of course, is reflected in the actual market rate.

As for the subsidies, several studies comparing the electricity rates across ASEAN countries have revealed that when subsidies are added back to retail tariffs, the Philippines' rates remained higher compared to the other countries in ASEAN.

Reaction by GIZ:
Reason see comment above

- P. 16: assumptions for capacities vs. generated power show several inconsistencies, e.g.
    - The capacity mix for policy regimes 3 and 4 are exactly the same, but the energy consumption mix is different. What is the basis for this assumption?
    - Conventional RE in Luzon has a 21% capacity share in 2040, but only generates 8% of power
    - In 2040 High vRE scenario, the installed vRE capacity is 16%, while the generated power share is also 16%. What assumptions are taken about capacity factors?

  Authors' response:
  Based on the historical values of the installed capacity and generation of the country, there is a difference in the mix due to the capacity factors of the different technologies. The generated power is derived from the installed capacity mix while accounting for the historical relationship of electricity generation and installed capacity of each technology.

  Reaction by GIZ:
  This does not explain the mentioned inconsistencies.

- P. 21, box 3: The paper does not give any supporting arguments how the distribution of base load, mid merit, peaking is established. It is common engineering and scientific standard to look at the demand load curve and the in 2040 existing composition of the different must-run power technologies (PV, Wind, biomass as CHP, Hydropower from run-off and Geothermal) and then define the residual load curve. Based on the then established residual load curve the base load requirement for conventional power technologies, like coal, gas etc. which need to be able to provide the required flexibility through ramping, is defined.
  The given composition does not reflect the development of variable RE and need of flexibility. More than 60% base load in 2040 will hinder any substantial development of variable RE in the country. That kind of composition between base load, mid merit and peak will lead to stranded investments in the time of 2030 and after.

  Authors' response: The distribution is based on DOE's Power Development Plan. See Table 8 of the paper for further details.

  Reaction by GIZ:
  DOEs recent Power Development Plan does not yet consider the expected future changes in the requirements for power plants' flexibility, meaning the changing share between base load, mid-merit and peaking power. Determining fixed shares between base load, mid-merit and peak power plants is no longer adequate in modern power planning, as variable renewable power technologies with their operating costs close to zero will be the cheapest power source in any power market, and therefore require any conventional power source with higher operating costs to operate as a more flexible power plant. If conventional power plants in a fair and open energy market cannot cycle and operate flexibly, they will become

stranded assets and either the private sector or society will have to cover these costs. It is therefore strongly recommended to change the approach of giving "fixed" proportions to power plants between base, mid-merit and peak power.

- P.29: the last paragraph ends abruptly; some information seems to be missing.

  Authors' response: Noted.

- P.29: a 16 GW wind turbine does not exist. Neither in Scotland, nor anywhere else in the world.

  Authors' response: Thank you. Noted.

  GIZ Reply to Author's response:
  In the new version the size of the wind turbine is replaced with a 16 MW wind turbine. That kind of wind turbine does not exist yet either. The biggest available turbines are still below 10 MW.

- p. 39: it is suggested to expand the grid to cope with future RE capacities; while this is correct, it should also be mentioned that the government can actively steer the placement of RE resources to ensure that RE locations are in areas with best grid "absorption" capacity for RE. A future auctioning system could provide such spatial guidance.

  Authors' response: Noted.

- P. 43: "… nuclear energy, considered the cheapest source of power…"
  For many years now, nuclear is definitely not considered univocally as the "cheapest source of power". As a scientific paper, making such statements should be avoided. A more balanced and reflected approach would be appreciated. Recent experience from the UK shows, that nuclear can be significantly more expensive than most other energy sources, including RE; not considering costs for future waste disposal which still remain an unsolved challenge and long-term cost factor. The fact that the paper asks to "soften resistance to nuclear power" (p. 43) instead of suggesting a proper economic and environmental assessment for the Philippines is communicating the author's personal opinion without basing it on sound evidence.

  Authors' response: Thank you. Noted.

- P.44, box: "The government can facilitate a more competitive environment by not mandating a fuel mix but rather by letting the market work. Following market signals, the generation sector will rationally adhere to utilization of least cost-resource"
  The market as is will not be able to account for cost-relevant factors such as carbon emissions or other externalities. Government regulation will have to be in place to steer the sector accordingly.

  Authors' response:

  We recognize the need to correct for externalities. As per EPIRA, the generation sector has already been privatized hence the recommendation, after correcting for externalities.