Preliminary DPV Impact Analysis Results for the Philippines

High-level summary and policy implication

December 11, 2018

Agenda

- The DPV Impact Analysis
- Customer Economic Impacts
- Utility Revenue and Rate Impacts
- Technical Impacts

DPV Impact Analysis for the Philippines

- *The DPV Impact Analysis* provide data-driven analysis to evaluate the impacts of the existing net metering arrangement under implementation, inform the revision of net metering rules, and evaluate alternatives to net metering.
- In partnership with the Philippines Department of Energy, USAID, through Clean Power Asia program is leveraging expertise from two United States Department of Energy national laboratories (US DOE Labs): the National Renewable Energy Laboratory (NREL) and Lawrence Berkeley National Laboratory (LBNL) and Chulalongkorn University to conduct the DPV impact Analysis.

Activities	Timeline
Kickoff meetings	June 2018
1st workshop for scoping analysis	Jul 2018
2nd workshop for presenting preliminary results	Dec 2018
Delivery of final analysis	Feb 2019

Proposed Approach: Three Pillars of Analysis

"A well-design DPV policy can achieve a balance between ***incentivizing DPV adoption***, while ***minimizing negative impacts*** on other ***stakeholders*** and on ***the power grid***"

The Three analyses:

Customer economic impacts	Utility revenue and rate impacts	Technical impacts

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DPV Impact Analysis: Research Questions

1. Customer Economics Analysis

- How should the current compensation mechanism for DPV be adjusted to meet policy objectives?

End-users

2. Utility Revenue and Rate Impact Analysis

- How do current and alternative DPV forms influence: i) avoided costs and revenue costs for distribution utilities? ii) rate impacts for ratepayers?

Utilities and other ratepayers

3. Technical Impact Analysis

- What are the technical impacts of DPV deployment on the distribution grid and how can negative impacts be mitigated (through utility planning and operation practices and grid codes)?

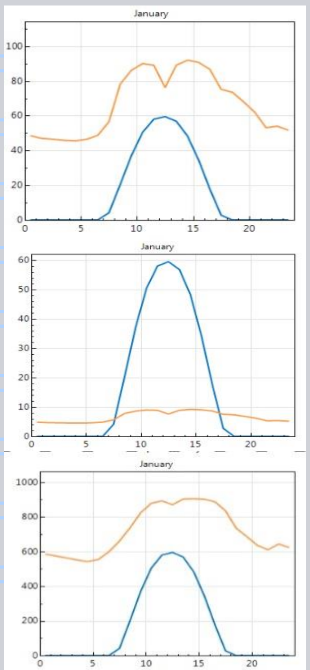
Distribution grid

Customer Economic Impacts

Analysis Framework

Customer economic impacts

Develop representative systems



Apply different elements of compensation mechanisms

- Sell rate for excess generation
- Netting frequency
- Billing period
- Banking period
- Expiration of credits
- Charges (e.g., net metering charge, backup fees)
- Other incentives

Results

- NPV
- IRR
- PB
- LCOE

Base Case

- Sensitivity Cases

Each representative system has a unique set of load profile/customer group, PV production profile, rate class, costs, financing method, business model, and discount rate.

Primary Analysis Results

Customer economic impacts

Features	S0: Net Energy Metering (NEM)	S1: Net Billing with rolling credits and no buyback	S2: Net Billing with rolling credits and yearly buyback
Compensation for exports?	Yes, in kWh	Yes, at rates set by regulator	Yes, at rates set by regulator
Incentivizes consumers?	+++	++	Depends on yearly excess and buyback rate
Incentivizes PV system oversizing – generating more than annual load? (if no capacity cap)	Yearly cutoff: No Infinite rollover: depends on load growth Yearly buyback: depends on buyback rate	No, due to low buyback rate	No, if buyback rate is lower than retail rate
Incentivize self-consumption	No	Yes	Yes, if buyback rate is lower than retail rate
Flexibility in changing compensation rate over time for new prosumers?	No	Yes. Export rate can change depending on market conditions	Yes. Export rate can change depending on market conditions
Utility needs to allocate funds to pay prosumers?	No	No	Yes
How do utilities' administrative costs change from current compensation scheme?	Similar	No change (current scheme)	Addition of yearly payment system

Primary Analysis Results

Customer economic impacts

1) Under the current net metering program, the economics of distributed PV already favors the customers. However, improvements to the current net metering schemes can be made in several areas:

- **Compensation mechanism: incremental vs. structural changes**
- **Interconnection and Permitting process**
- **Financing**

2) When compared to the existing scheme, the introduction of a yearly buyback rate@ blended generation cost will cause various levels of additional benefits:

- **Residential, low load/low-income customers:** tangible benefits of cash payment
- **Residential, high-load/high-income customers:** negligible economic benefits
- **Industrial customers:** negligible economic benefits

3) A higher buyback rate can increase benefits across all customer groups and incentivizes oversizing the system or load reduction. Whether a higher buyback rate should be introduced depends on policy objectives:

- **DPV for self-consumption mainly OR**
- **DPV as new sources of generation**

Policy Implications

Customer economic impacts

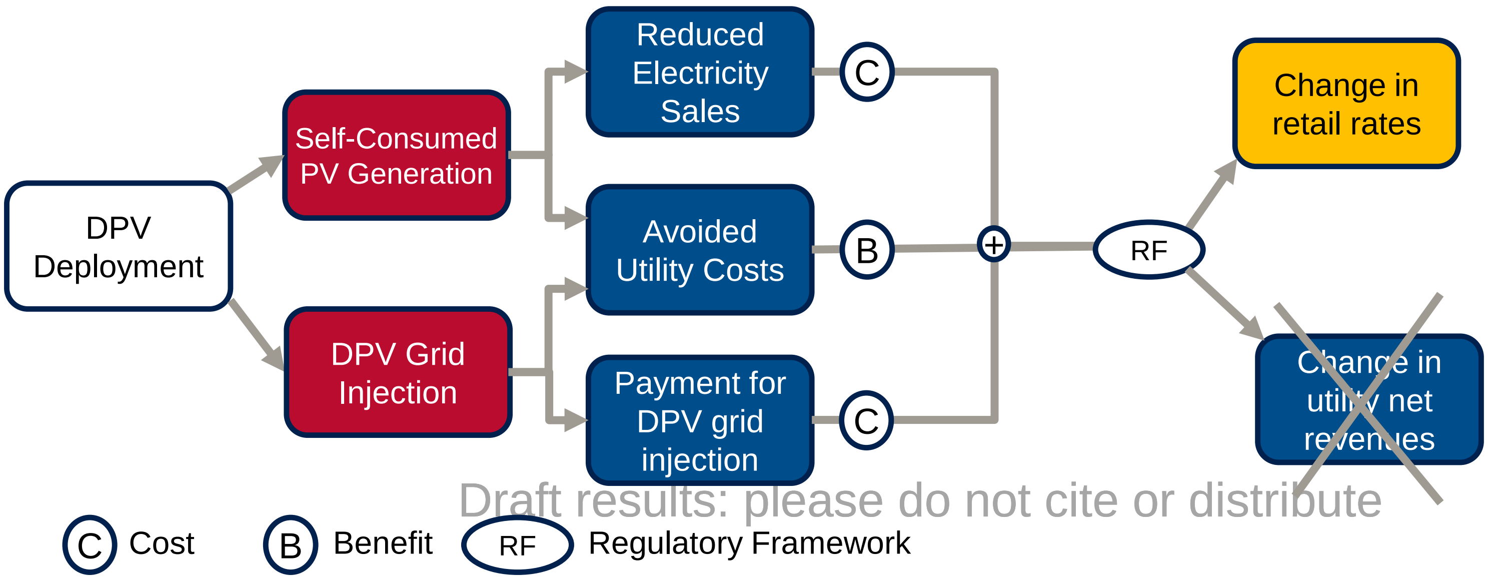
1. The selection of an improved compensation mechanism will depend on the policy objectives: whether DPV is to be used for self-consumption or new sources of generation.
2. If a yearly buyback feature is introduced @blended generation rate, it will automatically benefit low-income/low-use customers. However, whether it'll provide additional benefits to other groups depend on the nature of PV/Load relation.
3. Without individual capacity cap, certain groups of customers can gain additional benefits of a new scheme by oversizing the system.
4. A new compensation mechanism may involve new administrative procedures and costs to the utilities, but these costs should be surmountable and should be documented.
5. To ensure continuous DPV market expansion, other non-price barriers must be addressed to ease customers' adoption.
6. Increased access to customers' load profile data will not only benefit researchers and the customers who would like to invest in DPV, but will also encourage new business models.

Utility Revenue and Rate Impacts

Analysis Framework

Utility revenue and rate impacts

- Distributed PV generation is either:
  - Self-consumed → reduced electricity sales
  - Injected in the grid → export payments from utility
- All PV generation leads to utility cost reductions
  - Quantify energy and capacity value of solar PV
- Net financial impact of DPV fully passed through to retail rates
  - Rate-making regulation ensures full cost recovery for distribution utilities

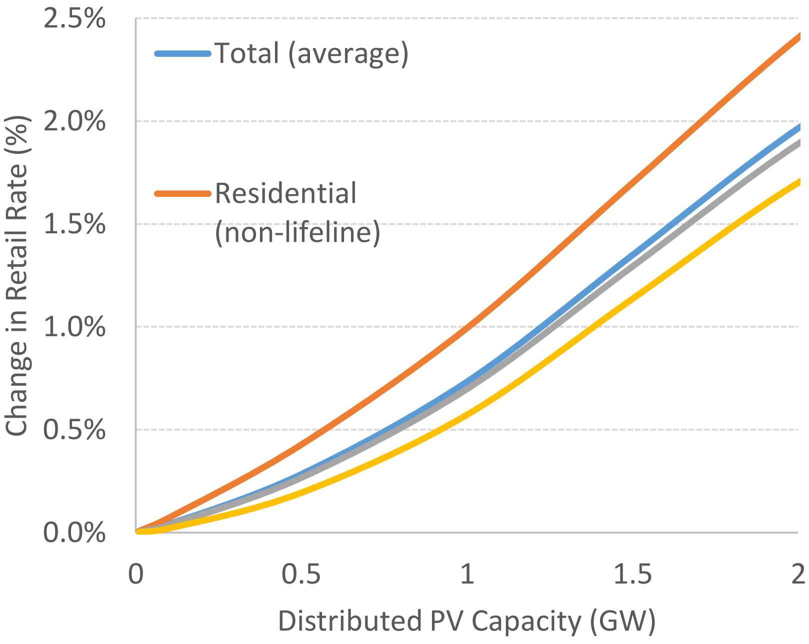


Full cost recovery ensured

Primary Analysis Result

Utility revenue and rate impacts

- Distribution utilities are fully protected from net revenue impacts from distributed PV deployment
  - Rates based on forecasted revenue requirement which include self-consumption and export payments for DPV
  - Under-recovery of revenue (resulting from under-estimation of DPV generation) is recovered by adjusting rates in the following year or regulatory period
- Meralco case study
  - Rates increase 0.2%-0.4% for first 500 MW depending on customer class
  - each additional 500 MW have higher impact due to decreased DPV energy and capacity value



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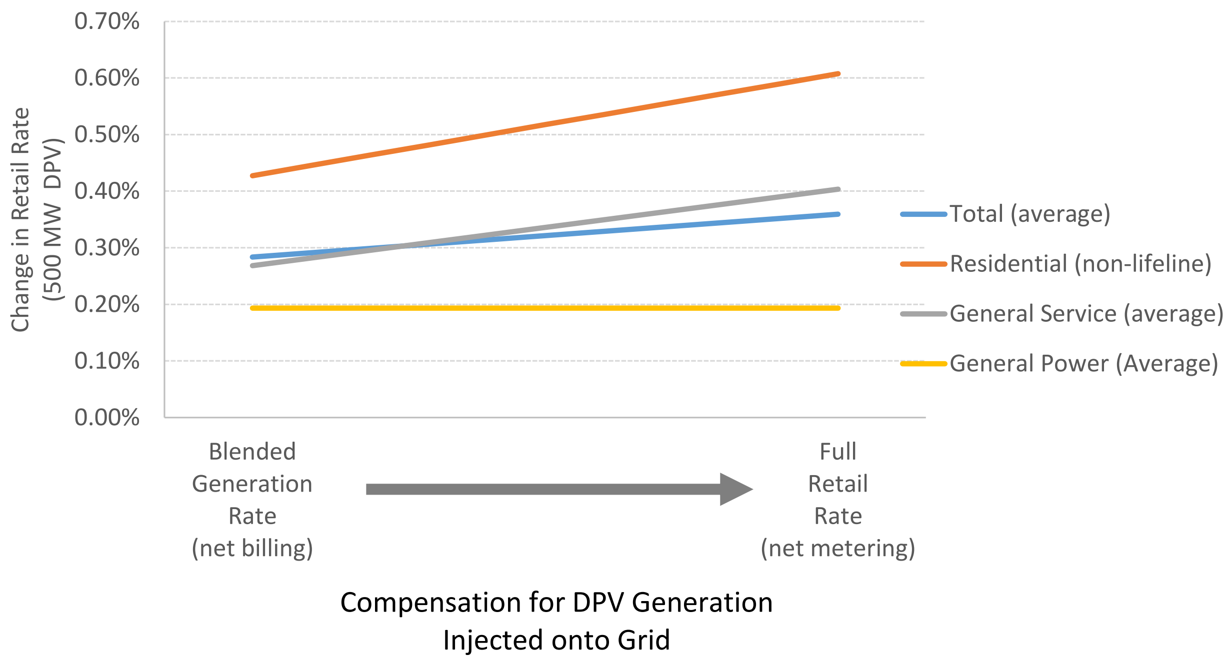
Primary Analysis Result

Utility revenue and rate impacts

- Full net metering (s0) leads to slightly higher retail rate impacts than net billing (s1 and s2)
  - Difference is that DPV generation injected into the grid is compensated at the full retail rate instead of the blended generation rate (which is 12%-47% lower than the retail rate)
  - Mostly affects smaller load consumers classes (residential and small general service) since larger load consumer classes (large general service and general power) do not inject much DPV generation into the grid.



Summary

Utility revenue and rate impacts

Features	S0: Full Retail Rate Net Energy Metering (NEM)	S1: Net Billing with rolling credits and no buyback	S2: Net Billing with rolling credits and yearly buyback
Impact on distribution utility revenues	No change (utilities recover all costs)	No change (utilities recover all costs)	No change (utilities recover all costs)
Retail rate impact	+++	+	++

- Utility financial health protected by regulatory structures and rate-making rules
  - Rates designed using forecasted sales and revenue – accounting for DPV generation ensuring full cost recovery
- Tariff impacts from DPV
  - Analysis shows that DPV impacts <1% on average for 1 GW of DPV in Meralco service territory
  - Full retail rate net metering leads to higher rate impacts for residential and small commercial customers; no change for larger customers as they are unlikely to export PV generation significantly

Policy Implications

Utility revenue and rate impacts

- There are policy mechanisms that could be adopted to ensure acceptable future retail rate impacts from DPV
  - Protecting target customer groups (e.g. lifeline residential customers)
  - Potentially implementing program caps to trigger automatic rate impact evaluations and policy reviews
- Future rate impact analyses are conditional on quality of DPV data collection and forecasts
  - DPV generation profiles
  - Metered DPV export data
  - PV system characteristics (location, size, orientation, etc.)
  - DPV deployment modeling for forecasted DPV capacity

Technical Impacts

Analysis Framework

Technical impacts

Analysis of DPV Impacts on Distribution System

Voltage

- DPV integration can result in voltage rise at the connection point and vicinity.
- Because voltage impacts happen locally, the analysis can focus only at the connection points of DPV.

Loss

- DPV integration may cause reverse power flow and increase the magnitude of distribution line current and line loss (depending on generation capacity and load profile).
- Usually losses are considered as a whole including LV/MV/HV systems and are related to economics.

Line Capacity

- DPV, which generally decreases the magnitude of feeder current, can result in deferral of system investments (depending on load profile).
- Enhancement of line capacity is related to utility financial planning.

Analysis Framework

Technical impacts

Approach for Grid Code Modification

Grid code contexts related to DPV impact

1. **DPV Capacity**
2. **Voltage**
3. Frequency
4. Power Factor
5. Active power Control
6. Reactive power Control
7. Protection

Detailed analysis in aspects of voltage, loss, and line capacity

Review and Comparison between international and Philippines

Improving the Grid code to accommodate more DPV penetration without negative impact.

The followings are the approach for the grid code modification:

1. Study of DPV Impacts on Distribution System
2. Study of the Philippine Distribution Code 2017
3. Review of international Grid Codes
4. Comprehensiveness Study of the PDC 2017 and the International Grid Codes on DPV Impacts
5. Suggestion on Grid Code Modification

Primary Analysis Results

Technical impacts

Technical Impacts Analysis – In aspects of voltage, loss and line capacity

Voltage and Loss analysis

- The location of DPV installation on MV and LV feeders influences the allowable penetration level; the further from the transformer DPV is installed, the less penetration level becomes.
- In both MV and LV systems, the penetration level of DPV is limited by loss increase rather than voltage violation. The limit is approximately 40–50% of transformer rating, while reverse power flow can occur at these limits.
- If reverse power flow is considered to be one of the constraints, the penetration level tends to be lower.

Line Capacity Analysis

- DPV installation cannot defer the LV system investment since the system peak demand is at the night time.
- During the 10 year period, although DPV installation can reduce the MV system peak demand, DPV cannot significantly postpone system investment due to the low level of peak demand, low level of load growth, and non-significant DPV growth compared to load growth.

Primary Analysis Results

Technical impacts

Technical Impacts Analysis – Grid code review

DPV Capacity

- The Philippines : Limited by minimum load value of transformers and rated capacity of feeders
- Recommended countries : Limited by voltage, loss, reverse power flow and simulation results

Voltage

- The Philippines : Requiring voltage variation within ±5%
- Recommended countries : Requiring voltage variation within ±10%, voltage rise by feed-in 2-3%, and exception for small DPV (> 2 kVA (1 Phase), > 15 kVA (3 Phase))

Power control

- The Philippines : Classical active power control depending on frequency
- Recommended countries : Classical active power control depending on frequency, remote control, active power curtailment, and reactive power control depending on voltage

Policy implications

Technical impacts

Technical Impacts Analysis - In aspects of voltage, loss and line capacity

Voltage and Loss analysis

- The penetration level of DPVs in feeders should be considered based on the installation locations of DPVs. Feeders with DPV installation at the beginning (closet to the transformer) shall have higher penetration level, while feeders with DPV installation at the ending shall have lower penetration level.
- The limit of DPV penetration level should be considered from technical impacts, not rated capacity of transformers and feeders. In addition, the utilities may allow loss increase due to DPV installation. However, there should be a measure to compensate the loss increase for the utilities, such as subsidy from the government, penalty to DPV owners.
- Since the analysis results is based on the typical system, to confirm the limitation of DPV for any other systems, a specific system study should be carried out before the installation of DPV, especially ones large in size.

Technical impacts

Policy implications

Technical Impacts Analysis - In aspects of voltage, loss and line capacity

Line Capacity Analysis

- Based on the current situation of the Philippines, the increase of DPV should not be considered as part of system investment deferral. This is because the peak load of the system is at the night time.
- The deferral of system investment can be achieved locally, if the government can promote the installation of DPV at the areas with high system peak demand at the noon time.
- The policy to shift the system peak demand to the noon time may be necessary, as this policy has been implemented in Kyushu, Japan, where the peak demand at the noon time is increased around 30% with pumped hydro storage. Another option may be the use of battery storage in the future.

Policy implications

Technical impacts

Technical Impacts Analysis - Grid code review

- There should be a separate grid code for DPV, because in the Philippines Distribution Grid Code (PDC), there are some specifications that are not suitable for DPV such as black start and ancillary service requirement.
- Suggestions for short-term planning : Grid code should not be very strict to promote DPV installation in distribution systems.
  - Capacity limit may not be required, but may be determined by considering the actual negative impacts on system (System Study).
  - Currently there is some voltage requirements for small DPV, and the grid code should introduce some exception for these small DPVs.
  - The power factor configuration should also consider the cost effectiveness of the installer.

Policy implications

Technical impacts

Technical Impacts Analysis - Grid code review

- Suggestions for Long-term planning : Grid code should be designed to address the impacts of the DPV high penetration.
  - Ramp rate or forecasted generation data of DPV should be submitted to utilities or a new-established RE forecasting center.
  - The inverter should have functions that can mitigate the negative impacts such as constant reactive power, fault ride through and curtailment.
  - In the worst area, the inverter can be controlled remotely. (remote control)