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PV Self-Consumption Pilot Project Evaluation

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Presented at *Scoping a DPV Impact Analysis for the Philippines*

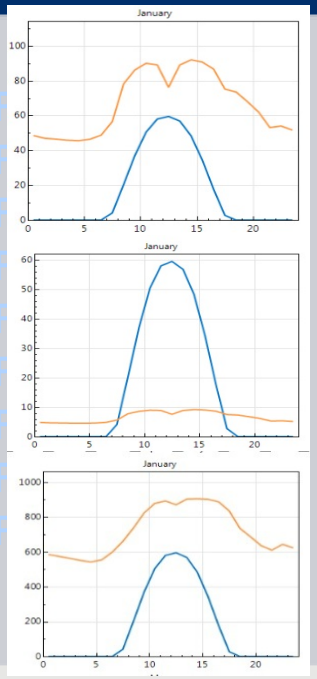
Primary analysis question

- **How can the current compensation mechanism for DPV (i.e., existing net metering arrangement) be adjusted to align with policy objectives?**

- Potential implications:
  - Detailed DPV compensation mechanism design, including appropriate compensation levels for DPV exports
  - Other policy and regulatory revisions to incentivize greater DPV adoption and achieve other policy objectives.

Analysis framework

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.

Design elements of DPV compensation schemes

Design elements	Explanation
Compensation	DPV electricity can be divided into two parts: the self-consumed part and the exported part. While the self-consumed part of electricity is typically valued at the retail rate, the exported part may be valued differently depending on the policy and regulation.
Sell rate (or buyback rate)	If excess generation is valued in monetary term, a sell rate will be applied to exported electricity. If excess generation if valued in energy term (kWh), there will be no sell rate, except at the end of the banking period in some cases (see "banking period" below).
Netting frequency	The time period under which DPV production and customer electricity consumption are summed and measured for billing purposes. Netting frequency can be hourly, daily, or monthly. In the case that the sell rate for excess generation is lower than retail rate, the longer the netting frequency, the more benefits can the prosumer obtain from PV electricity.
Billing period	In most cases, the billing period is set to repeat on a monthly basis. Therefore, after one month, excess electricity will be compensated or credited. The crediting can be in energy term (kWh) or monetary term (peso).
Banking period	A 'banking period' is a finite number of billing periods. At the end of the banking period, the prosumer's remaining credits from excess generation can either expire or get compensated.

Other design elements of interest to stakeholders in the Philippines?

Analysis scope

- Customer groups
  - Residential, commercial, industrial customers
- Service areas
  - One selected DU (e.g., MERALCO, co-op)
- Customer adoption rate
  - Beyond the scope of this study
- Factors that affect decision making
  - Economic return, peer effect, environmental concerns, interests in innovation

Outputs

- Payback period
- Internal rate of return (IRR)
- Levelized cost of electricity (LCOE)

Sensitivity analyses

- PV-to-load ratio
- Additional incentives (if interested)

Literature review on customer economics analysis

	Input Variables					Outputs
	PV Sizes	**PV Locations**	**Load Profiles**	**Retail Tariff Rates**	**Support Schemes**	
Poullikkas (2013)	1-7 kW	1 location (Cyprus)	1 residential load profile	16-24 €c/kWh	3 FIT cases 2 Net Metering cases	NPV IRR
Dufo-López (2015)	1.5 kW 2.0 kW	1 location	1 residential load profile	1 Type of retail tariff (the rate is not specified)	2 self-consumption cases 5 net metering cases 5 net billing cases 1 case with no PV	Net Present Cost (NPC) And LCOE
(Gobind G. Pillai, 2014)	3.0 kW	20 locations in UK and 22 in India	2 profiles in winter and summer for each country	2 cases of electricity rate for India	FIT NM	Prosumer electricity unit cost
David Watts et al. (2015)	1 kW 3 kW 10 kW	10 locations in Chile	29 daily load profiles to represent 365 days in a year	2 types of retail tariff	NM NB	LCOE
Ghiani and Pilo (2013)	60-160 kW for commercial business 60-140 kW for industrial plant	1 location in Italy	2 typical average load profiles of industrial plant and commercial business	2 types of retail tariff	With FIT Without FIT	NPC (Net Present Cost) LCOE
Ghosh et al. (2015)	5 specific systems: - 5 kW - 250 kW - 30 kW - 350W with storage	1 locations in Bangalore, Karnataka, India	Depending on specific cases	Depending on specific cases	NM REC (Renewable Energy Credit) FIT	LCOE

Selection of compensation mechanisms for simulation

- Consultation with stakeholders (DOE, utilities, PV associations, consumers)
- Today's survey results
- Literature review

Net Metering

Net Billing

Self-consumption only

Data *(SEE DETAILED DATA SHEET)*

TECHNICAL

PV system data
PV production data
Weather data
Load profiles

FINANCIAL/ MARKET

PV system pricing
Discount rates
Inflation rate

TARIFFS

Retail tariffs
Wholesale tariffs (Historical & projection)

Discussion questions for the proposed study

1) What would be the appropriate compensation mechanisms to study?
2) Which design elements should be improved the most?

   For example…

   – Eligibility of customer groups
   – Assigned value for excess generation
   – Indefinite banking period?

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APPENDIX: Data Requirements for Distributed PV Economic and Technical Analysis

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Data requirements: Department of Energy

Data Type	Explanation
Power development plan	- Power development plan, including both conventional and renewable power generation - Yearly load forecast

Data requirements: Distribution utilities

Data type	Explanation
Load profile	Load profile of retail electricity customers in one year, disaggregated by: -time interval (15 minutes) -customer type (residential, commercial, industrial, agricultural, etc.) -tariff type
Tariff types, structures, and rate	Types and structures of electricity tariffs: -Retail tariffs (current and historical for 10 years; projected retail rate growth (if available)) -Wholesale tariffs (current and historical for 10 years; projected wholesale rate growth (if available))
Number of customers and load distribution by tariff types	-Number of customers by type of retail tariff -Load distribution (kWh) by type of retail tariff -Under each customer type (residential, commercial, etc.), number of customers and load distribution by tariff types.
Distributed PV production data	-The real generation data (every 15 minutes) from rooftop PV systems that have already been installed in the Philippines. - Weather data at 15 minute resolution for the studied area

Data requirements: Distribution utilities

Data type	Explanation
Typical data of distribution systems	**Transformer :** - Voltage levels both primary and secondary sides (Volt) - Capacity (MVA) - Number of distribution lines connected to the transformer (Number) - Tap setting or voltage setting (Volt) - Resistance (ohm or p.u.) and reactance (ohm or p.u.) - Utilization Factor (%) - Average load supplied (MW) **Distribution line :** - Voltage level (Volt) - Capacity (A) - Average line length (km) - Resistance (ohm/km or p.u./km), reactance (ohm/km or p.u. /km), Line Charging (uS/km) - Utilization Factor (%) - Average load supplied (MW) **Other equipment frequently used in distribution system, Ex. Capacitor bank, etc.** - Voltage level (Volt) - Rated Power Capacity (MVA) - Impedance (Ohm) - installation position, e.g. distance from transformer (km) - equipment setting - other relevant parameters
Distribution system expansion	- Conditions of distribution system expansion; for example, the system will be expanded when its utilization factor reaches 80% - How distribution utilities expand their systems; for example, constructing a new feeder, increasing/changing feeder size, etc.

Data requirements: Energy Regulatory Commission

Data type	Explanation
Grid code or any requirements related to DPV or other types of distributed generation (DG)	- Grid code - Condition for DPV connection; for example, capacity limit of DPV for each distribution line, voltage level, inverter setting, power quality, additional equipment of DPV for connecting to the system, etc.

Data requirements: Private companies/EPC contractors

Data type	Explanation
Distributed PV market data	Data on existing grid-connected rooftop PV systems in the Philippines: -System size (kW), number of customers by system size -Panel size and brands; Inverter size and brands -Location (e.g., which city, town) -System pricing (and if available, component pricing, such as BOS cost, installation cost) -financing model (e.g., whether the systems are bought with cash or loan) -financial parameters (inflation rate, discount rate)

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