



SAM International Case Studies: DPV Analysis in Mexico

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February 26, 2017

- SAM Mexico Case Studies
 - Customer impacts from changes to net metering and billing agreements
 - Potential benefits of PV for a) customers b) the Mexican Treasury and c) the environment
- Overview of International Utility Rate Database (I-URDB)
- International SAM next steps

Mexico Background

- In 2015, Mexico passed the Energy Transition Law (LTE) that required the energy regulator, CRE, to develop a fair compensation mechanism for distributed generation (DG)
- The LTE also required SENER, the Ministry of Energy, to examine the customer benefits of DG
- CRE reached out to NREL to look at impact of different compensation mechanisms on DPV customers
- In Mexico, there are different electricity tariff classes (1-1F) with tiered rates for electricity use
- There is a limit to electricity usage and if a customer goes over that usage in a 12 month rolling average, the customer is bumped into a high rate tariff class (DAC)
- The Mexican Treasury (Hacienda) subsidizes tariffs 1-1F to keep electricity rates low

Compensation Mechanism Analysis

- Based on three compensation schemes, determine the payback period for PV systems in 5 different locations
- Locations: Tijuana, Monterrey, Guadalajara, Merida, and Mexico City
- Mexico currently has Net Energy Metering (CM #1)

	M&B	Sell Rate	Retail Rate
CM #1	Net Energy Metering (NEM)	No compensation for net excess generation	<i>Low Consumption Customers: Tariff 1 or 1C</i> <i>High Consumption Customers: Tariff DAC</i>
CM #2	Net Billing (NB)	Real-time location marginal pricing (LMP) for all grid injections	
CM #3	Buy-all, Sell-all (BASA)	Real-time LMP for all production	

Source: NREL, forthcoming

SAM Modelling

- SAM Inputs
 - Mexico electricity tariffs
 - PV system costs
 - Customer consumption data
 - System size (sized to displace 100% of customer's load)

Results – Payback Period (years)

Compensation Mechanisms in SAM – ‘Electricity Rates’

Monthly Accounting of Excess Generation

- Monthly total excess rolled over to next month bill in kWh
- Monthly total excess credited to next month bill in \$ at sell rate(s)
- Cumulative hourly (subhourly) excess credited to current month bill in \$ at sell rate(s)
- Cumulative hourly (subhourly) excess credited to next month bill in \$ at sell rate(s)
- All generation sold at sell rate(s) and all load purchased at buy rate(s)

	Tariff 1/1C			DAC		
	#1 NEM	#2 NB	#3 BASA	#1 NEM	#2 NB	#3 BASA
TIJ	14	19	27	10	13	27
MON	16	20	24	14	16	24
GUAD	13	15	17	9	10	17
MER	16	17	18	14	15	18
MEX	13	16	19	11	12	19

Source: NREL, forthcoming

Multi-Perspective DPV Benefits Analysis

- SENER reached out to NREL to examine DG benefit's to:
 - Solar customers – annual customer bill savings and payback period
 - Mexican Government (Treasury) – avoided subsidy payments and decreased tax collection per kW DG
 - Environment – avoided CO₂, NO_x, and SO₂ emissions per kW and avoided water withdrawal
- Analysis looked at 8 tariff classes (1 -1F and DAC) for each of the 16 tariff divisions in Mexico

- SAM Inputs
 - Entered electricity tariffs (1-1F) and all 16 DAC regional tariffs into I-URDB
 - Confidential Treasury subsidization rates
 - Customer load data, by tariff class
 - PV system costs (\$35 MXN/W)
 - Average Mexican generation fleet (for environmental)
 - Assumed a 1:1 ratio for DG offset average generation
 - System size (sized to displace 100% of customer's load)
- Calculated generation in each tariff division's three largest cities and averaged for yearly PV generation

Benefits Analysis Results

Distributed photovoltaic deployment equal to 1% of total installed generation capacity

Benefits to Government of Mexico

Benefits to DPV Customers

Benefits to Environment

Avoided:
1.5 Billion MXN
(~2.5% of the current electricity subsidy expenditures)

Avoided:
Up to 75% of the electricity consumed in 680,000 homes (for 1 kW systems)

Avoided:
1.3M tons of CO₂
680M liters of water

Payback period (years) per tariff class

	1	1a	1b	1c	1d	1e	1f	DAC
Min	21	17	18	16	16	16	15	4.5
Avg.	22	22	21	19	20	18	16	5.1
Max	26	27	26	22	27	21	17	6.0

- Analysis found that subsidized customers were unlikely to install PV (~20 year payback period)
- However, these customers would have the highest benefit to Treasury
- Policy intervention is likely needed to address these benefit differences

Source: <https://www.gob.mx/sener/documentos/beneficios-de-la-generacion-limpia-distribuida-y-la-eficiencia-energetica-en-mexico>

International Utility Rate Database (I-URDB)

- Developed by NREL for compiling different utility rates
- SAM can pull in rates automatically from website
- All relevant rate information (fixed charge, demand charge, electricity prices, tiers, etc.) is uploaded to the database and organized by utility
- Currently, rates for Mexico, Belize and a few Canadian utilities are available
- Rates can be added as needed and can occur for countries where NREL performs analyses
- Found at <https://openei.org/apps/IURDB/>

I-URDB: Tariff 1C

Period	Tier	Max Usage ?	Max Usage Units ?	Rate \$/kWh ?	Adjustments \$/kWh ?	\$
1	1	75	kWh	0.793		
	2	175	kWh	0.956		
	3		kWh	2.802		
2	1	150	kWh	0.697		
	2	300	kWh	0.822		
	3	450	kWh	1.05		
	4		kWh	2.802		

Allows for tiered electricity rates

Fuel Adjustments Monthly (\$/kWh)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

No fuel adjustments used in Mexico analysis

Weekday Schedule

	12 am	1 am	2 am	3 am	4 am	5 am	6 am	7 am	8 am	9 am	10 am	11 am	12 pm	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
Jan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Feb	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mar	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Apr	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
May	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Jun	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Jul	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Aug	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sep	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Oct	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nov	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dec	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Seasonality and weekend/weekday rate entry available

Next Steps – International SAM

- Creation of a SAM International website to provide information on past analyses
- Creation of SAM Mexico Example file with standard data values in SAM
- DPV Analysis in Peru
 - Customer benefit analysis
 - Displaced diesel generation analysis

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www.nrel.gov



- <https://sam.nrel.gov/>
- <https://openei.org/apps/IURDB/>
- http://www.dof.gob.mx/nota_detalle.php?codigo=5463923&fecha=02/12/2016
- <https://www.gob.mx/tramites/ficha/interconexion-de-centrales-electricas-con-capacidad-menor-a-0-5-mw/CFE3143>
- <https://www.gob.mx/sener/documentos/beneficios-de-la-generacion-limpia-distribuida-y-la-eficiencia-energetica-en-mexico>