Puerto Rico Energy Efficiency Scenario Analysis Tool (PREESAT)

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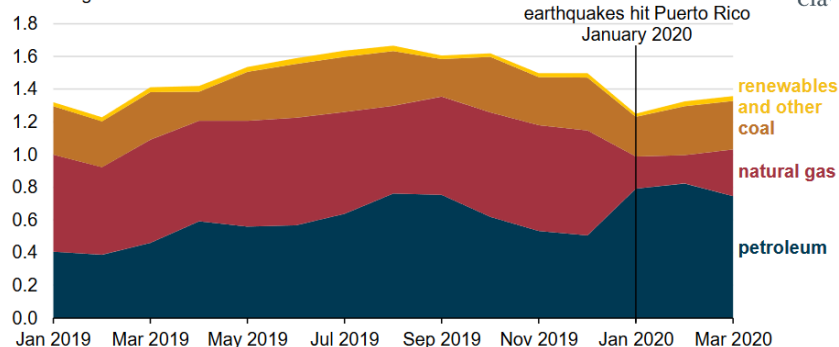
National Renewable Energy Laboratory

June 2021

Background

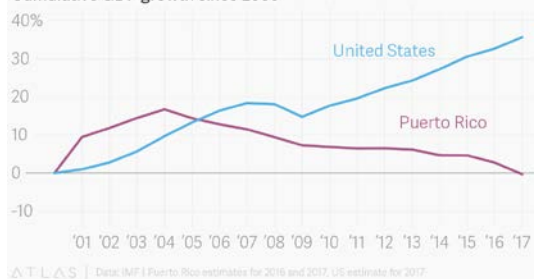# Ingredients for Energy Efficiency Action in Puerto Rico

High Fossil Fuel Imports

Puerto Rico monthly net electricity generation by fuel type (January 2019-March 2020)
million megawatthours

earthquakes hit Puerto Rico
January 2020

renewables and other
coal
natural gas
petroleum

eia

Jan 2019 Mar 2019 May 2019 Jul 2019 Sep 2019 Nov 2019 Jan 2020 Mar 2020

High Electricity Rates

Prices

Electricity	Puerto Rico	United States
Residential	22.22 cents/kWh	13.30 cents/kWh
Commercial	24.21 cents/kWh	11.00 cents/kWh
Industrial	21.16 cents/kWh	7.44 cents/kWh

Source: EIA 2019

Economic Recovery
(PR economy has been in a long recession.)

Cumulative GDP growth since 2000

United States

Puerto Rico

'01 '02 '03 '04 '05 '06 '07 '08 '09 '10 '11 '12 '13 '14 '15 '16 '17

ATLAS | Data: IMF | Puerto Rico estimates for 2016 and 2017, US estimate for 2017

Risk of Extreme Weather Impacts
(e.g., hurricanes and earthquakes)

Autoridad de
Energía Eléctrica
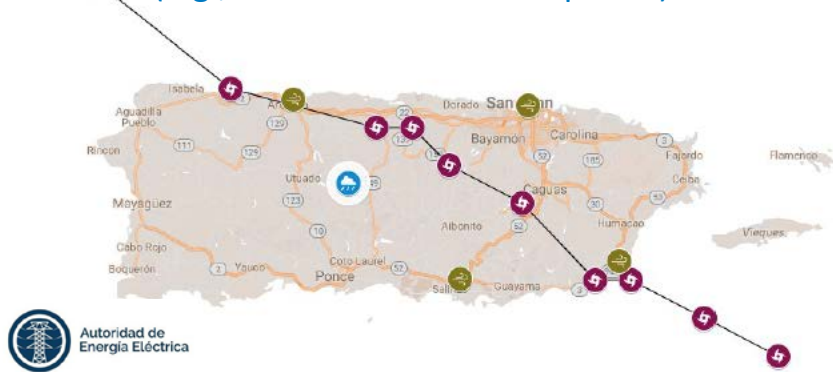
Multiple Benefits of Energy Efficiency

Job and Economic Benefits

IN PERSPECTIVE

No. 1 Energy efficiency is the fasting growing jobs sector in energy, accounting for half of the entire energy industry's job growth (133,000) in 2017

11% of energy efficiency jobs held by veterans, greater than the national average of veterans in the workforce (6%)

315,578 manufacturing jobs in energy efficiency, an increase of nearly 10% in 2017 alone

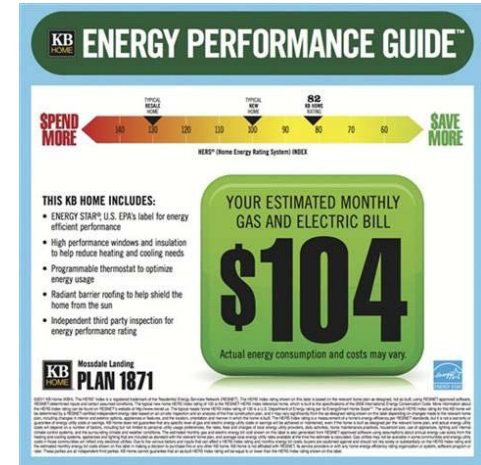**2X** Energy efficiency employs twice as many workers in the USA as all fossil fuel sectors combined

Source: Etterson 2018

Environmental Benefits
(e.g., reduced GHG emissions and pollution)

Customer Benefits
(energy bill savings)

KB ENERGY PERFORMANCE GUIDE

SPEND MORE — SAVE MORE

HERS® (Home Energy Rating System) INDEX

THIS KB HOME INCLUDES:
- ENERGY STAR®, U.S. EPA's label for energy efficient performance
- High performance windows and insulation to help reduce heating and cooling needs
- Programmable thermostat to optimize energy usage
- Radiant barrier roofing to help shield the home from the sun
- Independent third party inspection for energy performance rating

YOUR ESTIMATED MONTHLY GAS AND ELECTRIC BILL

$104

Actual energy consumption and costs may vary.

KB HOME — Mossdale Landing **PLAN 1871**

Resilience Benefits

Emergency response & recovery

Social & economic

Climate mitigation & adaptation

Policy Landscape

2014

- Act 57-2014 set energy efficiency targets for public sector buildings and municipalities.

2019

- **April:** Act 17-2019 established a comprehensive energy policy, including a mandate for 30% efficiency by 2040.
- **June:** Puerto Rico Electric Power Authority (PREPA) issued a proposed integrated resource plan with an appendix on demand resources.
- **September:** Puerto Rico Energy Bureau (PREB) passed a resolution and order for PREPA to implement an energy efficiency rider that will collect $13 million to support P.L. 17-2019 ($130 million over time). Implementation is currently halted.

2021

- PREB issued a proposed regulation on energy efficiency that clarifies the baseline for the Act 17-2019 "30% efficiency" mandate is Fiscal Year (FY)19 electric sales (seeking a 30% reduction in electricity consumption from FY19 sales by 2040 because of efficiency measures).

Achieving Energy Efficiency Goals

Develop a scenario analysis tool:

- To explore energy efficiency options and futures in Puerto Rico

- To meet a national goal of 30% reduction in energy use via energy efficiency by 2040

- For use by local policymakers (e.g., PREB and DDEC) and other stakeholders (e.g., UPR-M)

What is PREESAT and how should it be used?

What the Tool Does

- Allows a user to select specific energy efficiency measures for each sector and the level of adoption for each measure to then estimate the potential long-term energy savings for each sector
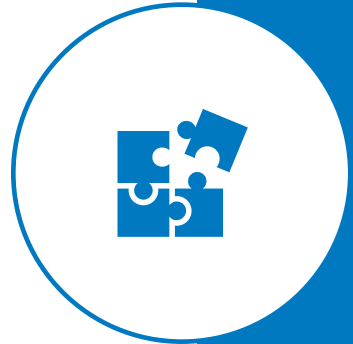- Provides an energy accounting framework
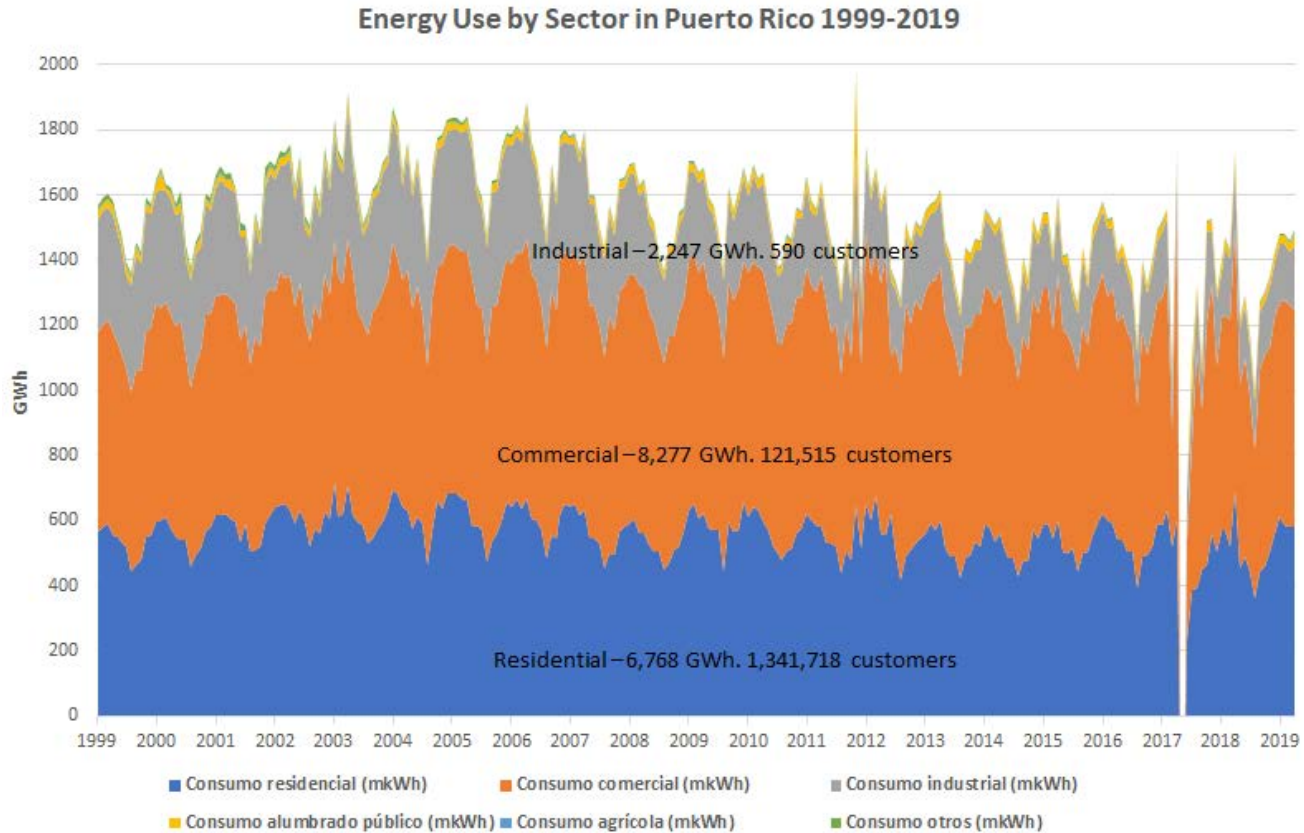
What the Tool *Does Not* Do

- Does *not* consider specific programs or policies—only technical measures
- Does *not* consider the cost of each energy efficiency measure; does *not* optimize for the most cost-effective measures
- Does *not* model thermal energy flows or physics within a building

PREESAT Approach

- Electricity-oriented analysis (does not address other fuels)
- Baseline data: PREPA IRP Demand Forecast (2019–2038)

- Two approaches
  - Top-down percentage reductions by sector
  - Measure-based approach for each sector
    - Assuming measures are adopted in existing and new buildings

- Three sectors: Residential, commercial, and industrial
- Identifies
  - Primary loads for each sector
  - Energy efficiency measures for each sector
  - Estimated savings for each measure
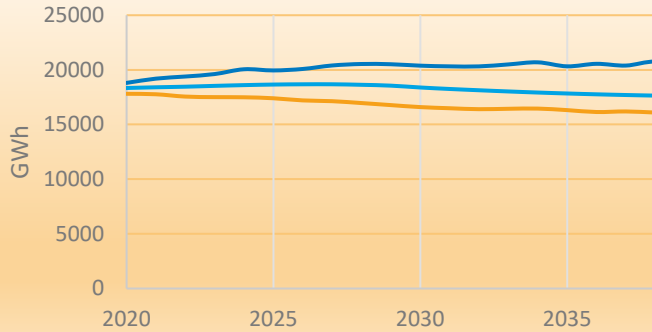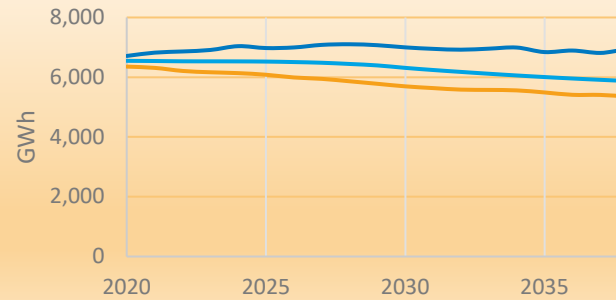 - Adoption levels for each measure

Overview of Sectors

Energy Use by Sector in Puerto Rico 1999-2019

Industrial—2,247 GWh. 590 customers

Commercial—8,277 GWh. 121,515 customers

Residential—6,768 GWh. 1,341,718 customers

- Consumo residencial (mkWh)
- Consumo comercial (mkWh)
- Consumo industrial (mkWh)
- Consumo alumbrado público (mkWh)
- Consumo agrícola (mkWh)
- Consumo otros (mkWh)
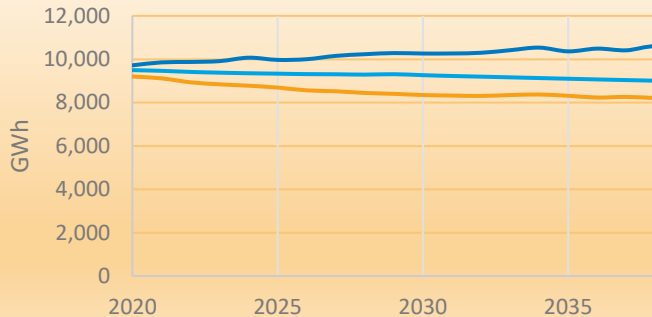
PREPA Forecasts
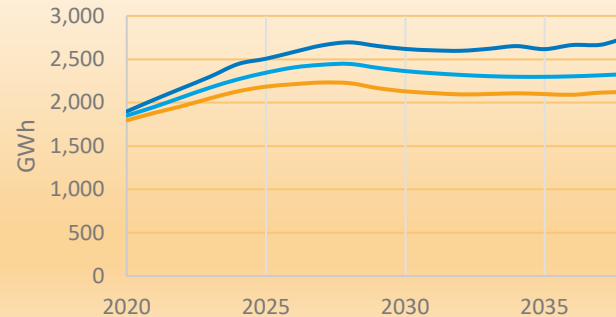
PREPA IRP EE Wedges (June 2019)
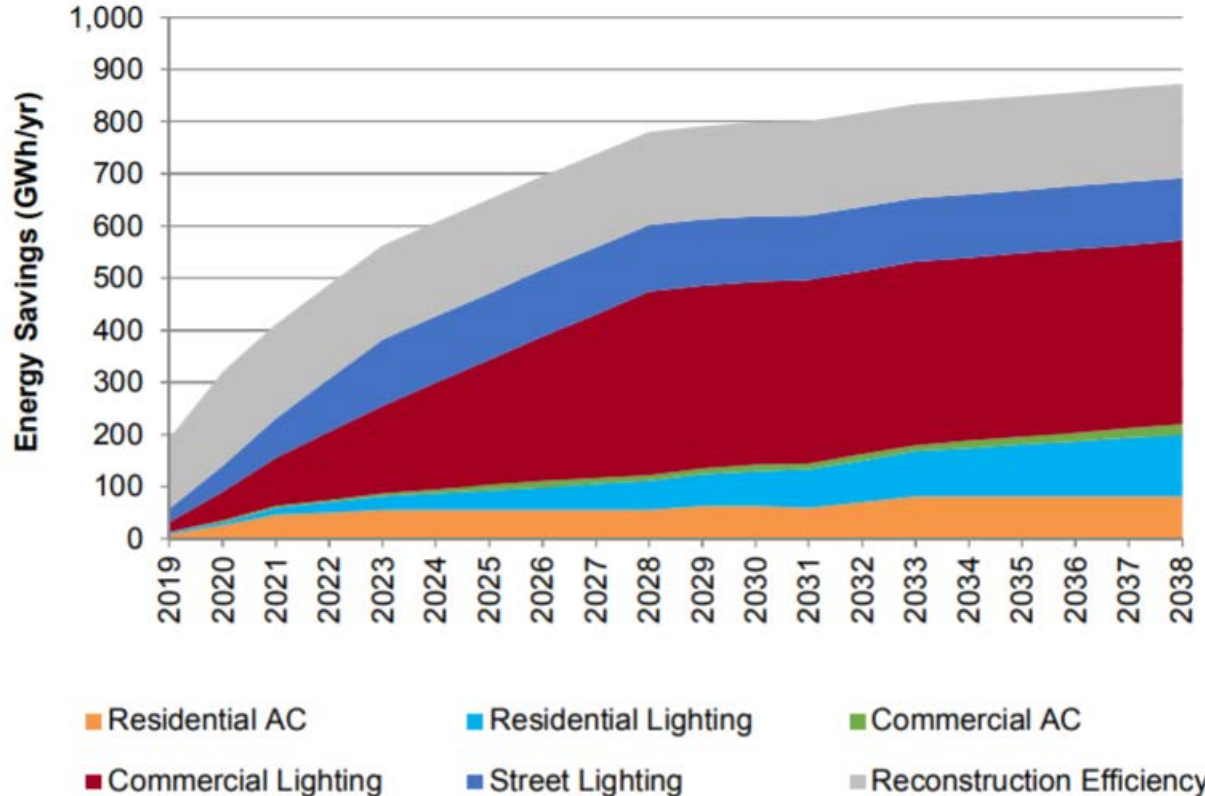
In the IRP, energy efficiency was modeled as 2% of annual sales from 2020 through 2038.

Note: Reconstruction Efficiency refers to efficiency gains from reconstruction in the aftermath of Hurricane Maria that were due to more efficient infrastructure/technology.

Residential Sector

Residential Sector Background

- 2019: 38% of total electricity consumption
- 2019: 6,768 GWh/yr.
- 2019: 1,341,718 customers
- Large number of low income and multifamily housing units

Residential Data Sources and Methodology

- U.S. Virgin Islands Energy Efficiency Tool
  - Some differences between Puerto Rico and U.S. Virgin Islands residential
- WAP PREAT (D.O.E.'s Weatherization Assistance Program's Puerto Rico Energy Audit Tool) draft report
  - Low-income only
  - 2009
- ResStock data for Florida
- IRP savings estimates (AC and lighting)
- Puerto Rico Building Association (contracted with the Puerto Rico Energy Center at the University of Turabo)
- Puerto Rico Stakeholder Workshop (Feb. 2020)

Residential Workflow

Photos: Dave Christensen, NREL; modernmec.com

EXAMPLE

Annual Electricity Savings per Customer		Portfolio Percentage		Level of Adoption		Number of Residential Customers		Annual Electricity Savings
1,106 kWh/yr. savings per customer for upgrading one AC window unit from SEER 8.5 to SEER 12	✖	40% of AC upgrades take this measure.	✖	10% of residential customers upgrade AC.	✖	1.3 million residential customers in Puerto Rico	=	57,501,894 kWh/yr. of electricity savings

PREESAT has different ranges for energy savings, and the user can select the level of adoption for the various energy efficiency measures.

Residential Measures

NOTE: Reduction percentages are the savings achieved out of the load for that measure only (Column 8).

Total Percent Reduction in Residential Electricity Consumption in 2040 Compared to Baseline:
44%

Return to Dashboard

Total Number of Residential Customers in 2020:	1,300,000
Total Residential Electricity Use 2020 (kWh):	6,548,870,475
Baseline Residential Electricity Use 2040 (kWh):	5,806,944,851

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
	Measures by End-Use	% of Total Residential Consumption by End-Use	Annual Electricity Savings Per Residential Customer (kWh)	End-Use Measures Portfolio (% by Measure)	% of Residential Customers Adopting End-Use Efficiency Measures by 2040*	End-Use Electricity Consumption Reduction in 2040 Compared to Baseline (kWh)	% Reduction in End-Use Electricity Consumption in 2040 Compared to Baseline	% Reduction in Residential Electricity Consumption in 2040 Compared to Baseline
AC		7%		100%	20%	281,337,409	69%	5%
	Upgrade Window Unit from SEER 8.5 to SEER 12		1,106	40%	20%	115,003,788	28%	2%
	Upgrade Window Unit from SEER 8.5 to Split Unit SEER 18.0		1,165	50%	20%	151,484,238	37%	3%
	Upgrade Split Unit from SEER 12.5 to SEER 18.0		571	10%	20%	14,849,383	4%	0%
	Upgrade window units to EER 12 units		1,228	0%	20%	0	0%	0%
Lighting		13%	-	100%	30%	352,329,821	47%	6%
	Entire Building Incandescent to CFL		1,602	0%	30%	0	0%	0%
	Entire Building Incandescent to LED		1,607	50%	30%	313,366,384	42%	5%
	Entire Building CFL to LED		200	50%	30%	38,963,438	5%	1%
	5 free LED bulbs		172		30%	0	0%	0%
Hot Water Heating		33%	-	100%	25%	649,030,086	34%	11%
	Standard Electric to New Standard Electric		654	0%	25%	0	0%	0%
	Standard Electric to Solar HWH		1,997	100%	25%	649,030,086	34%	11%
	Standard Electric to Tankless		203	0%	25%	0	0%	0%
	Standard Electric to Heat Pump		1,777	0%	25%	0	0%	0%
	Standard Electric to High Efficiency		310	0%	25%	0	0%	0%
	Upgrade to New Tankless		855	0%	25%	0	0%	0%
	Tankless to SHW		2,951	0%	25%	0	0%	0%
	Tankless to Heat Pump		3,892	0%	25%	0	0%	0%
	Tankless to High Efficiency Electric Resistance		2,828	0%	25%	0	0%	0%
	SHW to new SHW		528	0%	25%	0	0%	0%
	SHW to Heat Pump		(319)	0%	25%	0	0%	0%
	SHW to HEEHW		2,462	0%	25%	0	0%	0%

Cooling: AC and Fans

- AC is not prevalent and usually exists as window units.
  - AC: 7% of residential electricity consumption
    Fans: 19% of residential electricity consumption
- AC incentive programs *could* increase the overall energy use.

COOLING		US Virgin Islands EE Tool	WAP PREAT	RESSTOCK Florida	IRP
AC		Savings per unit	Savings per unit	Savings per household	Savings per unit
	Upgrade Window Unit from SEER 8.5 to SEER 10.7	**986 kWh/year**	**2262 kWh/year**	-	
	Upgrade Window Unit from SEER 8.5 to Split Unit SEER 18.0	**1165 kWh/year**	**2375 kWh/year**	-	
	Upgrade Split Unit from SEER 12.5 to SEER 18.0	**571 kWh/year**	-	-	
	Upgrade window units to EER 12 units	**1228 kWh/year**	-	**1955 kWh/year**	**500 kWh/year**
Ceiling Fans					
	High Savings	**956 kWh/year**			
	Med Savings	**597 kWh/year**		Not Included	
	Low Savings	**359 kWh/year**			
	Avg. # of fans	4-5 fans			
Standing Fans					
	High Savings	**799 kWh/year**			
	Med Savings	**799 kWh/year**		Not Included	
	Low Savings	**640 kWh/year**			
	Avg. # of fans	3-8 fans			

Lighting

- 13% of total residential electricity consumption (USVIEET)
- Low cost, quick payback, and low overall energy savings
- Measure considers mostly upgrading to LEDs
- Available for renters

LIGHTING	US Virgin Islands EE Tool	WAP PREAT	RESSTOCK Florida	IRP
	Household savings			*10% participation/year*
Entire Building Incandescent to CFL	1443 kWh/year		-	-
Entire Building Incandescent to LED	1663 kWh/year	Not Included	1218 kWh/year	-
Entire Building CFL to LED	220 kWh/year		-	-
5 free LED bulbs	-		-	172 kWh/year

Hot Water

- 25% of total residential electric consumption (USVIEET)
- Mostly electric tank water heaters

HOT WATER		US Virgin Islands EE Tool	WAP PREAT	RESSTOCK Florida	IRP
Baseline Tech		*85% elec, 10% solar, 5% tankless-->*	*Electric Tank-->*	*Electric Tank-->*	Not included
Efficient Tech		*60% elec, 15% solar, 5% tankless, 20% HP*	*Efficient Electric Tank*	*Heat Pump*	
Energy Savings High (per household)		**1187 kWh/year**	**132 kWh/year**	**669 kWh/year**	
Notes:		*High Income - 44% WH savings*	*9% WH savings*		
Baseline Tech		*80% elec, 20% solar-->*	*Electric Tank-->*		
Efficient Tech		*60% elec, 20% solar, 20% HP*	*Electric Tankless*		
Energy Savings (per household)		**1086 kWh/year**	**203 kWh/year**		
Notes:		*Med Income - 45% WH savings*	*13% WH savings*	**PR Building Association**	
Baseline Tech		*100% elec-->*	*Electric Tank-->*	*Electric Tank-->*	
Efficient Tech		*60% elec, 20% solar, 20% HP*	*Solar with Pump*	*Solar with Pump*	
Energy Savings (per household)		**1425 kWh/year**	**1367 kWh/year**	**2126 kWh/year**	
Notes:		*Low Income - 51% WH savings*	*88% WH savings*		
Baseline Tech		*100% elec-->*	*Electric Tankless*	*Upgrading water heaters can have as much as a 41% reduction on household electric bills!*	
Efficient Tech		*45% elec, 5% solar, 50% HP*	*Solar with Pump*		
Energy Savings (per building)		**2989 kWh/year**	**1164 kWh/year**		
Notes:		*Multifamily low income*	*87% WH savings*		

Industrial Sector

Industrial Sector Data Sources and Methodology

- Industrial sector
    - 13% of total electricity consumption
    - Most energy-intensive sector (GWh/customer)

- Data sources
    - Industrial assessment centers, University of Miami (https://iac.university/)
    - Puerto Rico Industrial Company (http://www.pridco.com/industries/Pages/default.aspx)
    - IRP and PREPA total sector energy consumption

Industrial Assessment Center Data

(1 of 3)

#|Description	Savings / Cost	Status	Electricity Usage $	Electricity Usage kWh	Electricity Demand $	Electricity Demand kW/month	Administrative Changes $	$
01: 2.4236 ELIMINATE LEAKS IN INERT GAS AND COMPRESSED AIR LINES/VALVES	**$97,830** / $1,660	✔	$64,505	457,480	$33,325	3,517	-	-
02: 2.2628 UTILIZE A LESS EXPENSIVE COOLING METHOD	**$33,524** / $10,000	✘	$28,309	200,770	$2,615	276	$2,600	-
03: 2.7425 CLEAN OR COLOR ROOF TO REDUCE SOLAR LOAD	**$28,589** / $4,520	✔	$24,582	174,343	$4,007	419	-	-
04: 2.3212 OPTIMIZE PLANT POWER FACTOR	**$27,970** / $22,300	✘	-	-	$27,970	2,952	-	-
05: 2.7142 UTILIZE HIGHER EFFICIENCY LAMPS AND/OR BALLASTS	**$21,644** / $21,418	✔	$18,627	132,106	$3,017	318	-	-
06: 2.7221 LOWER TEMPERATURE DURING THE WINTER SEASON AND VICE-VERSA	**$19,177** / $1,440	✔	$16,441	116,603	$2,736	280	-	-
07: 2.7142 UTILIZE HIGHER EFFICIENCY LAMPS AND/OR BALLASTS	**$3,449** / $10,720	✔	$3,449	24,461	-	-	-	-
08: 2.7134 USE PHOTOCELL CONTROLS	**$938** / $342	✔	$938	6,656	-	-	-	-
09: 2.7135 INSTALL OCCUPANCY SENSORS	**$889** / $1,320	✔	$889	6,306	-	-	-	-
TOTAL RECOMMENDED	**$234,010** / $73,720		$157,740	1,118,725	$73,670	7,762	$2,600	-
TOTAL IMPLEMENTED	**$172,516** / $41,420		$129,431	917,955	$43,085	4,534	-	-
	Savings / Cost		$	kWh	$	kW/month	$	$
			Electricity Usage		Electricity Demand		Administrative Changes	

Took data from the top 20 (highest energy bill) industrial customers from the IAC sample

- Audits all performed from 2007 to 2020
- Represented ~12% of total industrial sector energy use
- Calculated the total savings (kWh) from this sample
- Extrapolated this to the entire sector
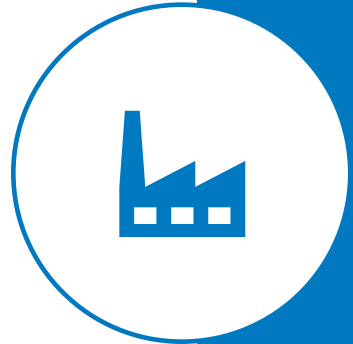
Industrial Measures

46 energy efficiency measures

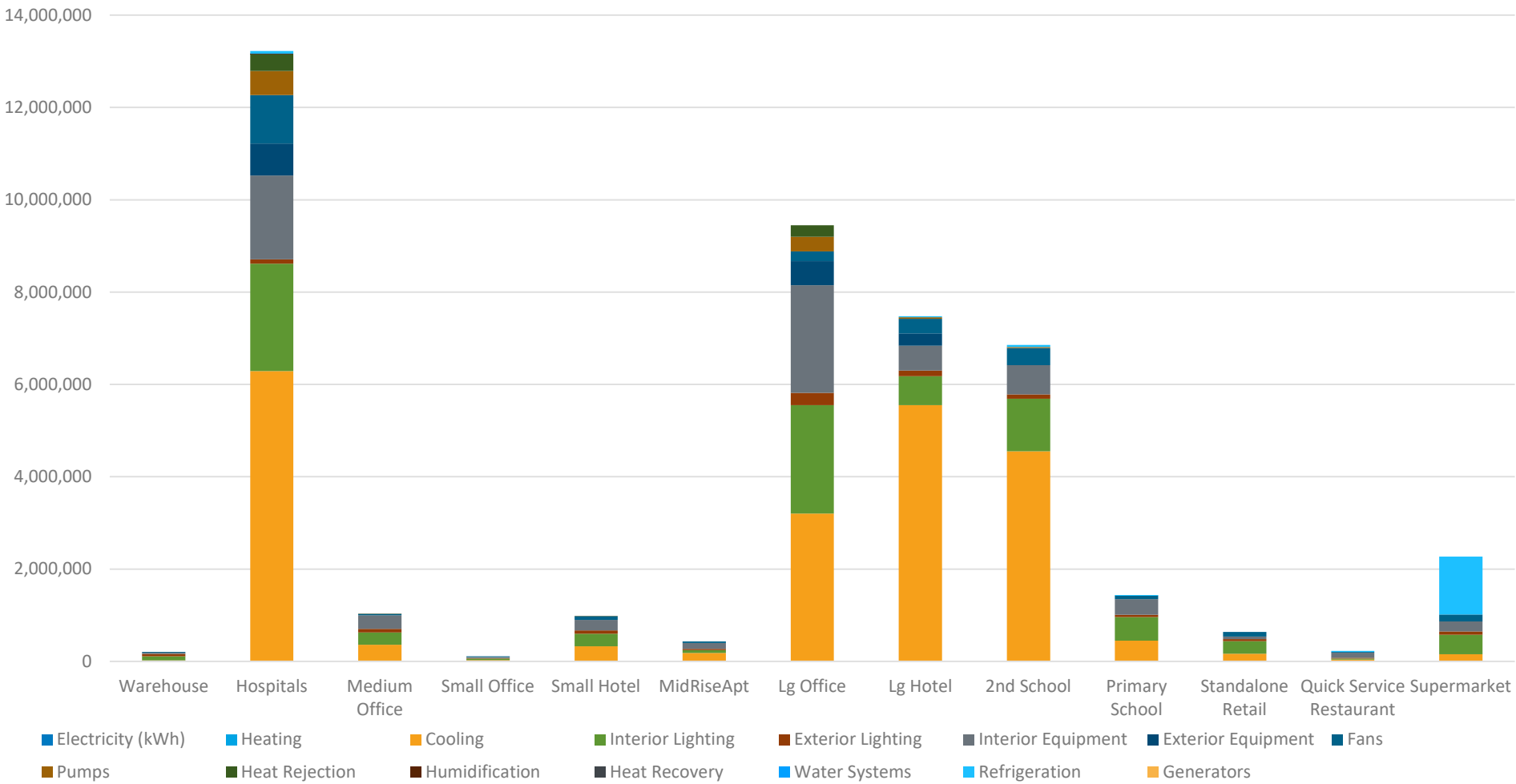| Total Percent Reduction in Industrial Electricity Consumption in 2040 Compared to Baseline:		Set Overall Adoption Percentage for Efficiency Measures:
16%	Return to Dashboard	50%

Column 1	Column 2	Column 3	Column 4	Column 5
IAC Industrial EE Measure	% Electricity Savings Compared to Baseline	% of Industrial Customers Adopting End-Use Efficiency Measures by 2040*	% of Industrial Customers for Whom Measure is Viable**	% Reduction in Industrial Electricity Consumption in 2040 Compared to Baseline
ANALYZE FLUE GAS FOR PROPER AIR/FUEL RATIO	0.00%	50%	0%	0.00%
USE HEAT FROM BOILER BLOWDOWN TO PREHEAT BOILER FEED WATER	0.00%	50%	0%	0.00%
USE WASTE HEAT FROM HOT FLUE GASES TO PREHEAT	0.00%	50%	0%	0.00%
PAY UTILITY BILLS ON TIME	0.00%	50%	0%	0.00%
CLOSELY MONITOR CHEMICAL ADDITIONS TO INCREASE BATH LIFE	0.00%	50%	0%	0.00%
REPAIR OR REPLACE STEAM TRAPS	0.00%	50%	0%	0.00%
OPTIMIZE PLANT POWER FACTOR	0.00%	50%	0%	0.00%
ISOLATE HOT OR COLD EQUIPMENT	0.00%	50%	0%	0.00%
USE OPTIMUM THICKNESS INSULATION	0.00%	50%	0%	0.00%
REPLACE TREATED WATER WITH WELL / SURFACE WATER	0.00%	50%	0%	0.00%
REDUCE EXCESSIVE BOILER BLOWDOWN	0.00%	50%	0%	0.00%
CHANGE RATE SCHEDULES OR OTHER CHANGES IN UTILITY SERVICE	1.45%	0%	0%	0.00%
USE A FOSSIL FUEL ENGINE TO COGENERATE ELECTRICITY OR MOTIVE POWER; AND UTILIZE HE	49.94%	50%	15%	3.75%
USE PHOTOCELL CONTROLS	0.08%	50%	10%	0.00%
AVOID INTRODUCING HOT, HUMID, OR DIRTY AIR INTO HVAC SYSTEM	0.23%	50%	5%	0.01%
UTILIZE ENERGY-EFFICIENT BELTS AND OTHER IMPROVED MECHANISMS	0.10%	50%	15%	0.01%
UTILIZE ENERGY-EFFICIENT BELTS AND OTHER IMPROVED MECHANISMS	0.10%	50%	15%	0.01%
UTILIZE DAYLIGHT WHENEVER POSSIBLE IN LIEU OF ARTIFICIAL LIGHT	0.16%	50%	10%	0.01%
RECOVER WASTE HEAT FROM EQUIPMENT	0.39%	50%	5%	0.01%
REPLACE EXISTING HVAC UNIT WITH HIGH EFFICIENCY MODEL	0.71%	50%	5%	0.02%
UPGRADE OBSOLETE EQUIPMENT	0.90%	50%	5%	0.02%
USE SOLAR HEAT TO HEAT WATER	0.92%	50%	5%	0.02%
MAINTAIN AIR FILTERS BY CLEANING OR REPLACEMENT	0.31%	50%	15%	0.02%
USE MOST EFFICIENT TYPE OF ELECTRIC MOTORS	1.44%	50%	5%	0.04%
RE-USE OR RECYCLE HOT OR COLD PROCESS EXHAUST AIR	1.66%	50%	5%	0.04%
INSTALL OCCUPANCY SENSORS	0.21%	50%	40%	0.04%
INSTALL PARTITIONS TO REDUCE SIZE OF CONDITIONED SPACE	0.83%	50%	15%	0.06%
USE OPTIMUM SIZE AND CAPACITY EQUIPMENT	0.42%	50%	35%	0.07%
INSTALL VINYL STRIP / HIGH SPEED / AIR CURTAIN DOORS	0.73%	50%	25%	0.09%
UTILIZE A LESS EXPENSIVE COOLING METHOD	2.45%	50%	10%	0.12%
INSULATE GLAZING, WALLS, CEILINGS, AND ROOFS***	5.15%	50%	5%	0.13%

Commercial Sector

Commercial Sector Data Sources and Methodology

- **Scout**
  (U.S. Department of Energy's Building Technologies Office)
  - Estimates for specific energy conservation measures (ECM) for AIA Climate Zone 5

- **Commercial Buildings Energy Consumption Survey**
  (U.S. Energy Information Administration)
  - Commercial building survey data for ASHRAE Climate Zone 1

- **Commercial Reference Buildings**, Miami
  (U.S. Department of Energy's Energy Efficiency & Renewable Energy)
  - Focus on 13 building types: hospitals, large hotel, large office, medium office, mid-rise apartment, primary school, quick service restaurant, secondary school, small hotel, small office, standalone retail, supermarket, warehouse

Post-1980 Energy Consumption by End Use (kWh) for Commercial Reference Buildings in Miami

Legend:
- Electricity (kWh)
- Heating
- Cooling
- Interior Lighting
- Exterior Lighting
- Interior Equipment
- Exterior Equipment
- Fans
- Pumps
- Heat Rejection
- Humidification
- Heat Recovery
- Water Systems
- Refrigeration
- Generators

Categories (x-axis): Warehouse, Hospitals, Medium Office, Small Office, Small Hotel, MidRiseApt, Lg Office, Lg Hotel, 2nd School, Primary School, Standalone Retail, Quick Service Restaurant, Supermarket

Public Sector Data Sources and Methodology

Public Sector Buildings: Act 57-2014

- Reduce electrical energy consumption by at least 40% by 2022
- Benchmark energy use and monitor energy efficiency measures

Annual reporting by public sector agencies of EE measures and impact on electricity consumption

- These measures and the associated savings will be calculated on an energy intensity basis and could be extrapolated for other public sector buildings.
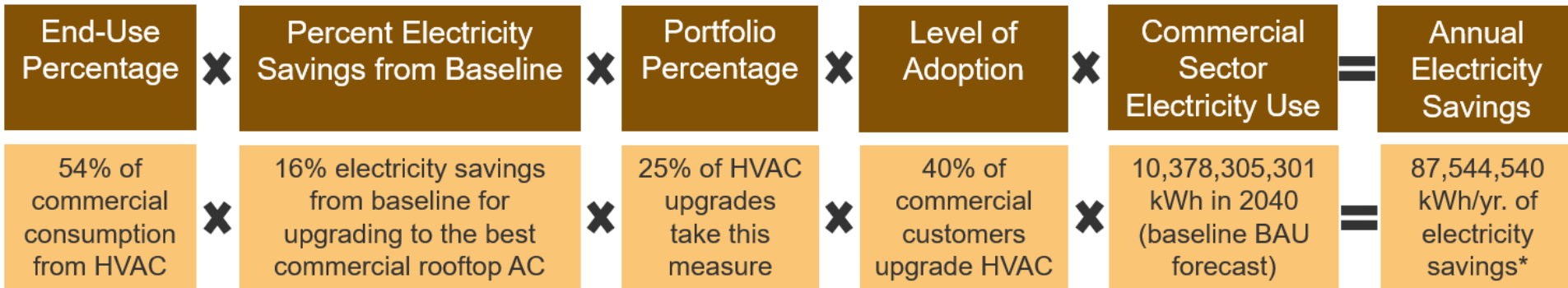
Commercial Workflow

Photo from Werner Slocum, NREL

EXAMPLE

End-Use Percentage		Percent Electricity Savings from Baseline		Portfolio Percentage		Level of Adoption		Commercial Sector Electricity Use		Annual Electricity Savings
54% of commercial consumption from HVAC	✕	16% electricity savings from baseline for upgrading to the best commercial rooftop AC	✕	25% of HVAC upgrades take this measure	✕	40% of commercial customers upgrade HVAC	✕	10,378,305,301 kWh in 2040 (baseline BAU forecast)	=	87,544,540 kWh/yr. of electricity savings*

PREESAT has different energy savings for each measure, and the user can select the level of adoption for the various energy efficiency measures.

Commercial Sector Measures

Total Percent Reduction in Commercial Electricity Consumption in 2040 Compared to Baseline:
37%

Return to Dashboard

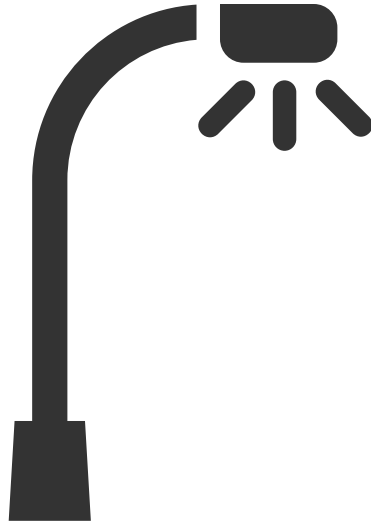|	
Total Number of Commercial Customers in 2020:	121,515
Total Commercial Electricity Use 2020 (kWh):	9,497,174,272
Baseline Commerical Electricity Use 2040 (kWh):	8,960,310,127

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
	Measures by End-Use	% of Total Commercial Consumption by End-Use	% Electricity Savings Compared to Baseline	End-Use Measures Portfolio (% by Measure)	% of Commercial Customers Adopting End-Use Efficiency Measures by 2040*	End-Use Electricity Consumption Reduction in 2040 Compared to Baseline (kWh)	% Reduction in End-Use Electricity Consumption in 2040 Compared to Baseline	% Reduction in Commercial Electricity Consumption in 2040 Compared to Baseline
HVAC		54%		100%	50%	352,632,318	7%	4%
	Best Commercial Rooftop AC		16%	25%	50%	94,479,084	2%	1%
	Commercial Chillers, 90.1 c. 2016		13%	25%	50%	81,654,059	2%	1%
	ENERGY STAR RTU v. 2.2		11%	25%	50%	66,238,506	1%	1%
	Best Rooftop Heat Pump		16%	10%	50%	37,875,544	1%	0%
	ENERGY STAR Rooftop HP v. 2.2		5%	10%	50%	13,256,819	0%	0%
	Prospective Commercial AVCT HVAC		45%	3%	50%	27,534,321	1%	0%
	Prospective Commercial NVC HVAC		52%	3%	50%	31,593,984	1%	0%
	Add enthalpy wheels				50%	0	0%	0%
Lighting		21%		100%	60%	424,424,700	23%	5%
	Best Commercial LED Lighting		32%	50%	60%	178,109,595	9%	2%
	ENERGY STAR Commercial LED Lighting		44%	50%	60%	246,315,104	13%	3%
	Prospective Commercial SSL		62%	0%	60%	0	0%	0%
	Exterior Lighting - full cut off lamp posts				60%	0	0%	0%
Hot Water Heating		0%		100%	75%	0	0%	0%
	ENERGY STAR Electric HPWH (Com.)		54%	25%	75%	0	0%	0%
	Prospective Commercial CO2 HPWH		70%	25%	75%	0	0%	0%
	Prospective Commercial Non-CO2 HPWH		65%	25%	75%	0	0%	0%
	Prospective Commercial NVC HPWH		46%	25%	75%	0	0%	0%

Street Lighting

Street Lighting Data Sources and Methodology

PREESAT street lighting uses estimations from the PREPA 2019 IRP, Appendix 4

- Street lighting historically accounts for ~ 2% of PREPA's annual electricity consumption.

- Conversion from high-pressure sodium lamps to more efficient LED technology would offer estimated savings of up to 65% (Arnold and Buckley 2015).

- The IRP assumes all public lighting will be replaced over a 5-year time-frame.

Multisector Dashboard

Dashboard

PUERTO RICO ENERGY EFFICIENCY SCENARIO ANALYSIS TOOL (PREESAT)

Legend:	Calculated in Spreadsheet	User Input	Links to Other Spreadsheet Data	Hard Entries	Data Under Investigation

USER INPUTS

Input (1)
Select Baseline BAU:
Medium Demand

Input (2)
Select Residential Efficiency Measures:
CLICK HERE

Input (3)
Select Commercial Efficiency Measures:
CLICK HERE

Input (4)
Select Industrial Efficiency Measures:
CLICK HERE

Input (5)
Select EE Scenario:
PREESAT Analysis (NREL)

Input (6)
Select Adoption Curve:
S-curve

Input #7
Select Year:
2040

Fig 1. Baseline BAU Electricity Consumption by Sector (GWh)

Residential ■ Commercial ■ Industrial ■ Street Lighting

Table 1. Baseline - Consumption Change from 2020 to 2040

	Average Annual Change	Change from 2020-2040
Residential	-0.60%	-11.33%
Commercial	-0.29%	-5.65%
Industrial	1.30%	28.71%
Street Lighting	-0.21%	-4.18%
Other	-0.21%	-4.19%
Total	-0.21%	-4.17%

Fig 2. Electricity Consumption Forecasts (GWh)

— All Sectors BAU
- - All Sectors EE
— Commercial BAU
- - Commercial EE
— Residential BAU
- - Residential EE
— Industrial BAU
- - Industrial EE
— Street Lighting BAU
- - Street Lighting EE

Table 2. Energy Efficiency Reductions from Baseline*

	2021 (GWh)	2021 (%)	2040 (GWh)	2040 (%)
Residential	93	1.4%	2,563	44%
Commercial	82	0.9%	3,274	37%
Industrial	97	4.9%	388	16%
Street Lighting	9	2.5%	250	69%
Other	0	0.5%	0	0%
Total	281	1.5%	6,475	37%

*Reductions are compared to baseline forecast GWh consumption in 2021 & 2040

Scenarios
PREESAT Analysis (NREL)
IRP EE High
IRP EE Medium
IRP EE Low
IRP EE+DR+DG - Medium Consumption
2% fixed annual reduction
5% fixed annual reduction
1% fixed annual reduction

RESULTS

Result (1)
Percent Reduction in Electricity Consumption from PREB-Specified Baseline in 2040*
30%
*P.L. 17-2019 Target: 30% below PREPA FY19 sales
FY19 Sales (GWh): 15,813

Result (2)
Percent Reduction in Electricity Consumption from Selected PREESAT Baseline BAU in 2040
37%

Result (3)
Cumulative Electricity Savings from 2021 to 2040 (GWh)
84,029

Result (4)
Average Per Capita Annual Electricity Savings (kWh/yr)
1,788

Result (5)
Estimated Per Capita Annual Cost Savings ($/yr)*
393
*Does not include upfront cost of efficiency measures

Fig 3. Business As Usual Electricity Consumption (GWh)
362; 2%   71; 0%

Fig 4. EE Scenario Electricity Consumption (GWh)
112; 1%
71; 1%

An Invitation to Help!

- We are interested in collaborating with local experts in Puerto Rico.

- We need help with:
  - Information on local building construction practices
  - Typical equipment and building envelope characteristics
  - Energy conservation measures appropriate to Puerto Rico
  - Data on energy consumption, building characteristics, and impact of energy efficiency measures.

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AIA	American Institute of Architects
BAU	business as usual
CFL	compact fluorescent lighting
DDEC	Department of Economic Development and Commerce
ECM	energy conservation measure
EE	energy efficiency
GWh	gigawatt-hour
IAC	industrial assessment center
IRP	integrated resource plan
kWh	kilowatt-hour
PR	Puerto Rico
PREAT	Puerto Rico. Energy Audit Tool
PREB	Puerto Rico Energy Bureau
PREESAT	Puerto Rico Energy Efficiency Scenario Analysis Tool
PREPA	Puerto Rico Electric Power Authority
SEER	Seasonal Energy Efficiency Ratio
UPR-M	University of Puerto Rico, Mayagüez
USVIEET	U.S. Virgin Islands Energy Efficiency Tool
WAP	Weatherization Assistance Program

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Thanks

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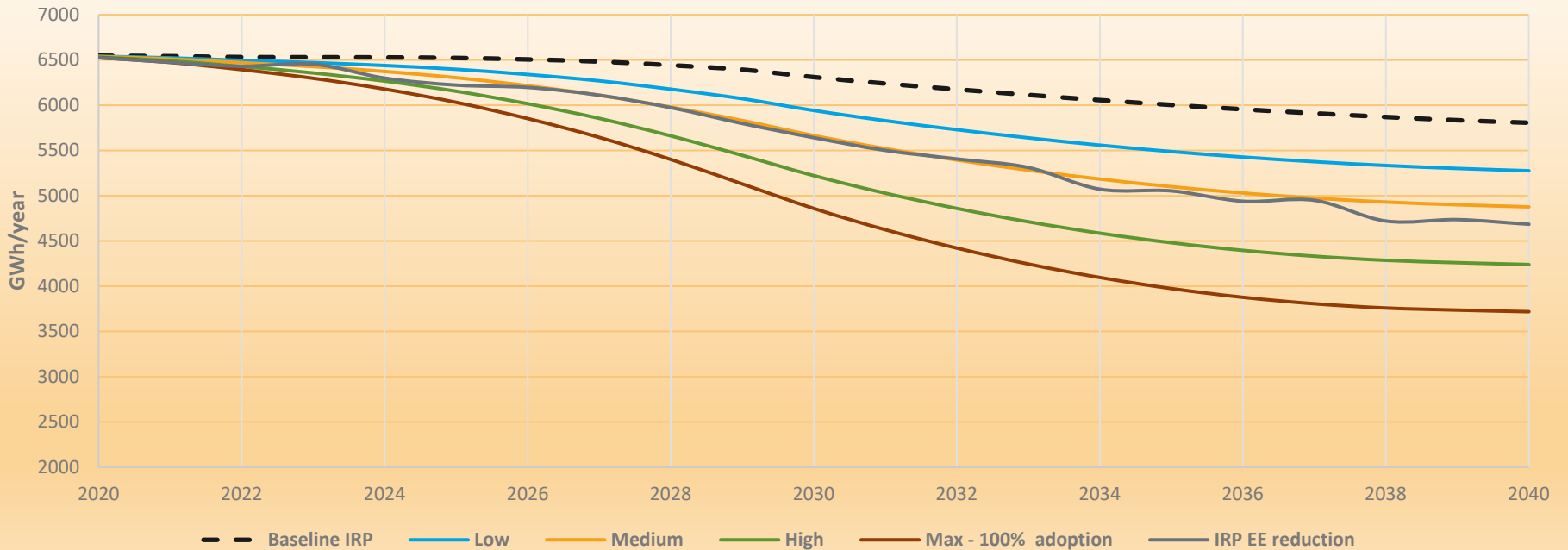
www.nrel.gov

NREL/PR-6A20-79983

Extra Slides

Illustrative Residential Scenario Results

TOTAL ESTIMATED RESIDENTIAL SAVINGS:
Low – 8% (10% adoption)
Mid – 14% (20% adopt.)
High – 27% (50% adopt)
Max – 36% (100% adopt.)

Residential Energy Efficiency Scenarios

Legend: Baseline IRP, Low, Medium, High, Max - 100% adoption, IRP EE reduction

Illustrative Industrial Scenario Results