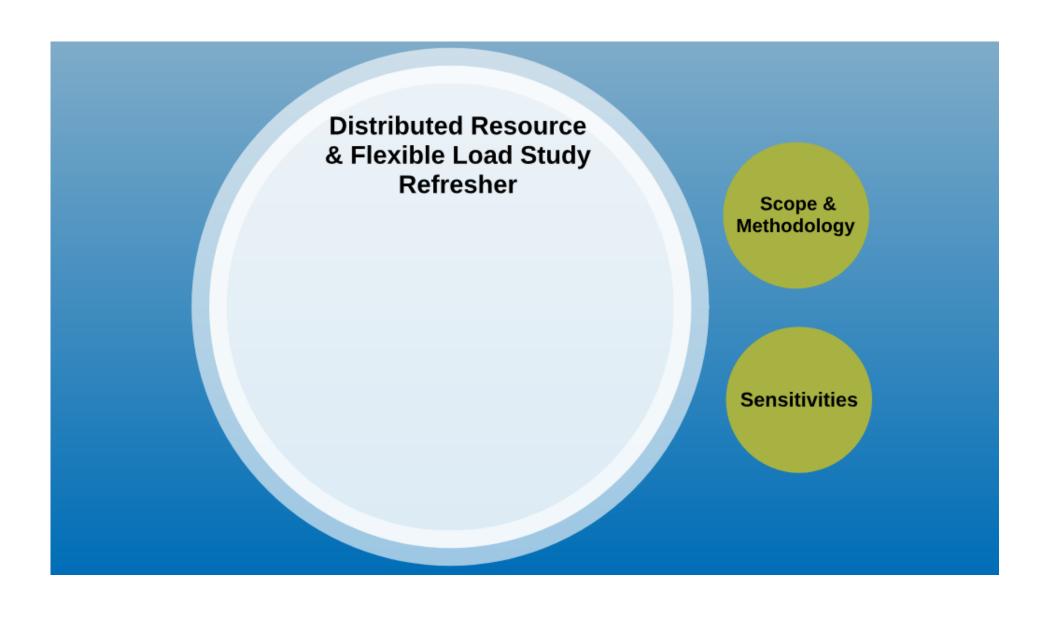
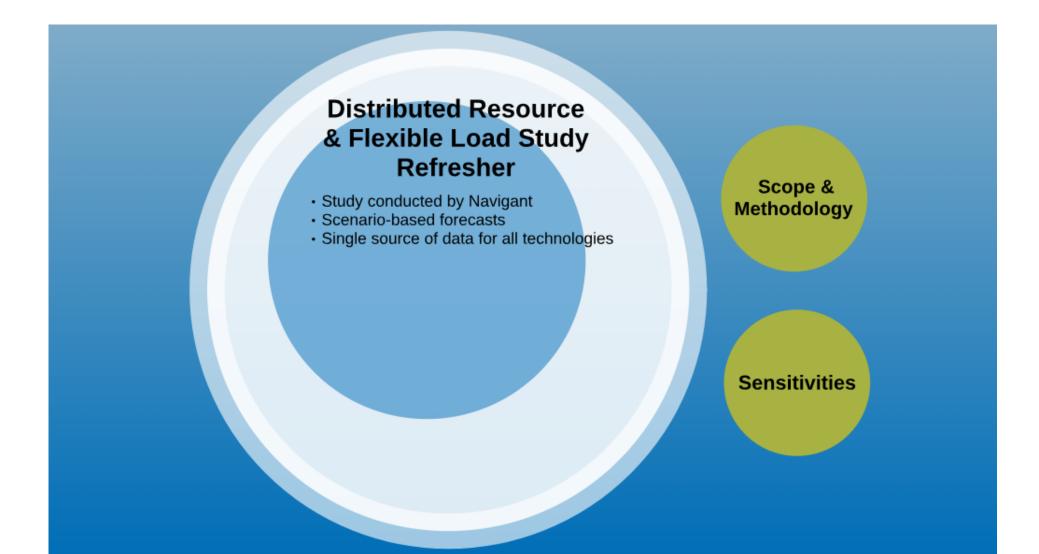
PGE July IRP Technical Meeting Distributed Resource & Flexible Load Study Update Incorporation into 2019 IRP Status





& Flexible Load Study Refresher

- · Study conducted by Navigant
- · Scenario-based forecasts
- Single source of data for all technologies
- Several DERs and flexible loads in conjunction
 - Interactive effects
 - · Coordinated development
 - Phased granularity
 - · Top-down and bottom-up

Scope & Methodology

Sensitivities

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- Inter-Departmental
 - Customer Programs, T&D, IRP, Load Forecasting

Scope & Methodology

Sensitivities

Merge Navigant propensity-to-adopt models with PGE baseline information to create technology forecasts:

- Solar
- Storage
- Electric Mobility
- Demand Response and Flexible Load
- Energy Efficiency

Solar

Navigant Inputs:

- Existing generators on PGE system
- · Gross historical load growth
- · Load profile data, segmented by rate and customer type
- Initializing technical potential from 2016 IRP
- T&D locational growth assumptions
- Navigant propensity-to-adopt profiles
- Applicable solar incentives
- Assume: smart inverter standard applies to all new installations

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Study Outputs:

- Projected adoption curves based on key indicators, accounting for sensitivities
- Solar+Storage technology combination forecast

Storage technology assumptions are consistent with EV battery projections Forecasts are created in Navigant's RESim model

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Navigant Inputs:

- Initialize with value streams established in UM 1856
 - Operational and generation capacity value: effective ancillaries
 - · Distribution of locational values across system
 - · Customer values: demand charge management (DCM), ToU
 - · Navigant accounts for DCM and/or capacity value to avoid double-counting uses
- Relative price streams for program design
 - · BYOS vs. low income and utility-owned, etc.
 - Storage pilot explores both models

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Customer storage adoption

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Study Outputs:

· Customer storage adoption

PGE to model utility-connected storage in AURORA, accounting for economic dispatch additional to customer adoption forecast

- · Defined by added utility value
- · Value assumptions are consistent between customer adoption and utility deployment models

Navigant Inputs:

- · Public sales and registration data for PGE service territory
- Navigant battery cost forecast
- · TROVE propensity-to-adopt model
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- · Charging infrastructure planning data

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Study Outputs:

- · Light Duty Vehicles (LDV):
 - · Navigant financial assumptions for base case, including reference battery costs
 - · Aggressive and conservative battery costs incorporated as part of the High and Low LDV scenarios
- · Medium Duty Vehicles (MDV):
 - · Bottom-up analysis of delivery fleets
- · Heavy Duty Vehicles (HDV):
 - · Bottom-up analysis of transit buses and school buses with high-level/general assumptions
 - · Top-down analysis of heavy duty trucks and buses
- Chargers:
 - · System-level counts by type (i.e., L2 vs. DCFC) over time
 - System-level load profiles by type (i.e., L2 vs. DCFC) over time (accounting for shifts in how charging stations are expected to scale and grow over time)

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Impacts on load forecast

• EV data from the study will be used to create a baseline, which can be subtracted from the forecast

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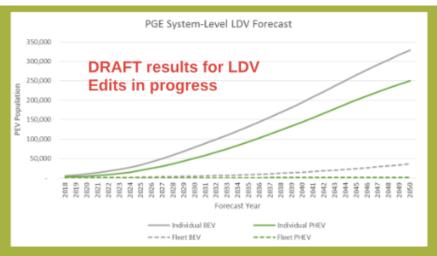
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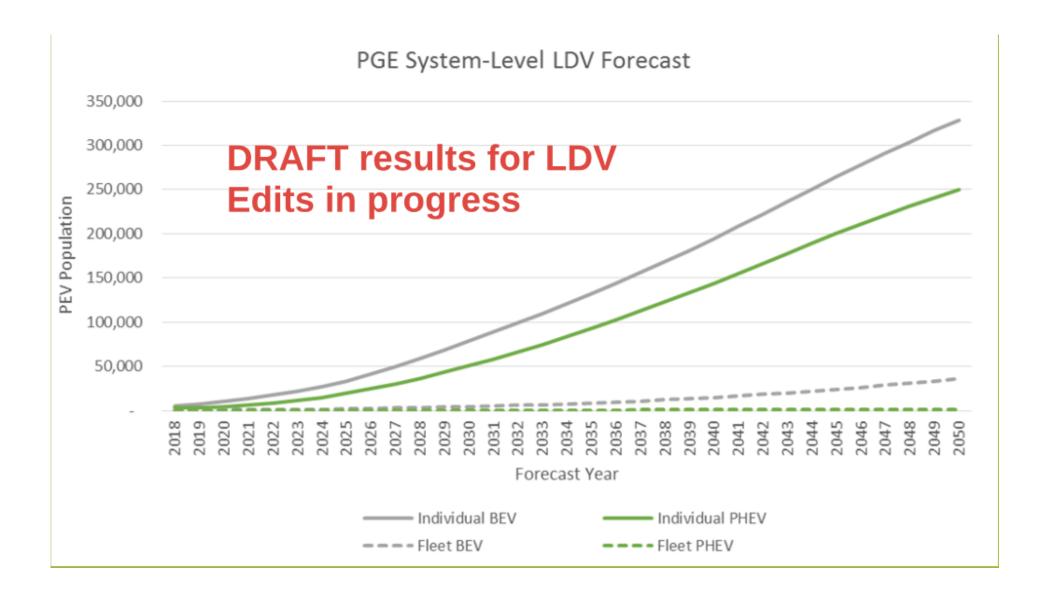
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Demand Response and Flexible Load

Programs:

- Pricing
 - ToU, PTR (Opt-in, Opt-out)
- Water Heaters
 - Single-Family, Multi-Family
- · Commercial & Industrial
 - · Thermostats, Auto-Control, Manual-Control
- Residential Thermostats
 - · BYOT, Direct Installation, Direct Ship

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Forecast Methodology:

- Pilot program near-term goals extrapolated into theoretical 5-year targets
- · Initialize Navigant model with 2016 IRP trajectory
- Scale to 5-year targets
- Adjust trajectory based on technology models
- · Model interactive effects with comparable benefit providing programs

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Study Outputs:

- High, Reference, and Low interactive forecasts
- · Technologies grouped in functional dispatch categories: emergency, flexible, fixed shape

Energy Efficiency

- Energy Trust forecast fed into Navigant interactive DER model
 - Account for EE targets and incentives
 - November 2017 Energy Trust Long-term forecast
 - Technical potential
 - · Cost effective
 - Achievable

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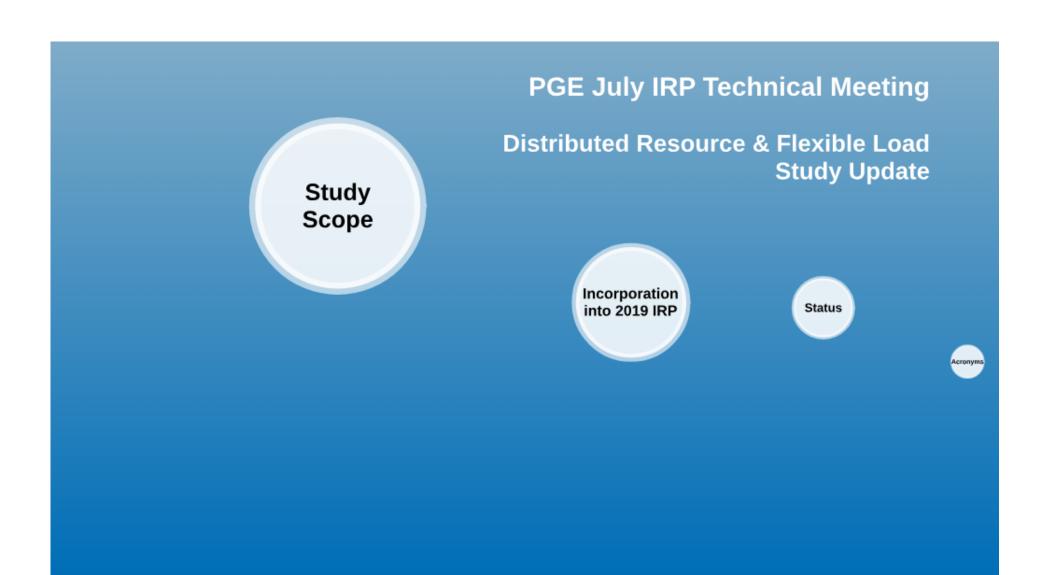
Study Output:

Cumulative DER forecasts accounting for contributions from EE



Sensitivities

- Technology
 - Navigant proprietary models
- Incentives
 - · Navigant research, informed by PGE
- Policy
 - Navigant research
 - Cumulative sensitivity to create "favorable policy" and "unfavorable policy" futures
- Market variance
 - Percent sensitivity based on AURORA high and low wholesale energy prices
 - Fuel
 - Carbon









AURORA Dispatch

Inputs to PGE Zone Model

- Low, reference, and high DER forecasts
- Resource Stack
 - Solar
 - Storage
 - Curtailable and flexible DR
- Load Modifier
 - EE
 - EV
 - Fixed shape dispatch DR



DER in RECAP Model

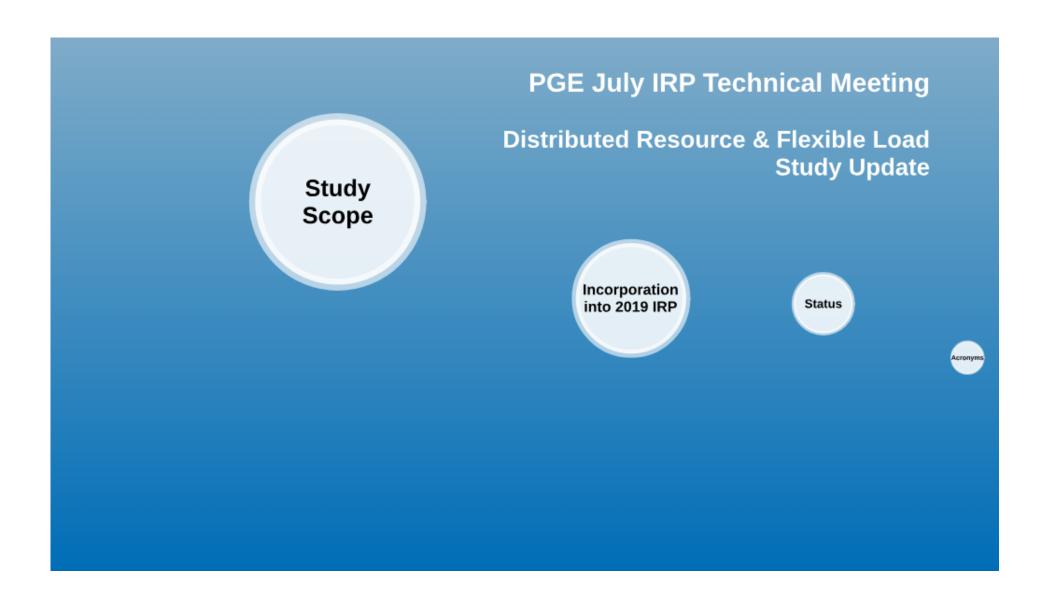
Input Low, reference, and high DER forecasts

- Projected annual resource capacity
- Generation and load shapes

Simulate resource contribution

Output remaining capacity need by year

Feed output to ROSE-E for portfolio construction

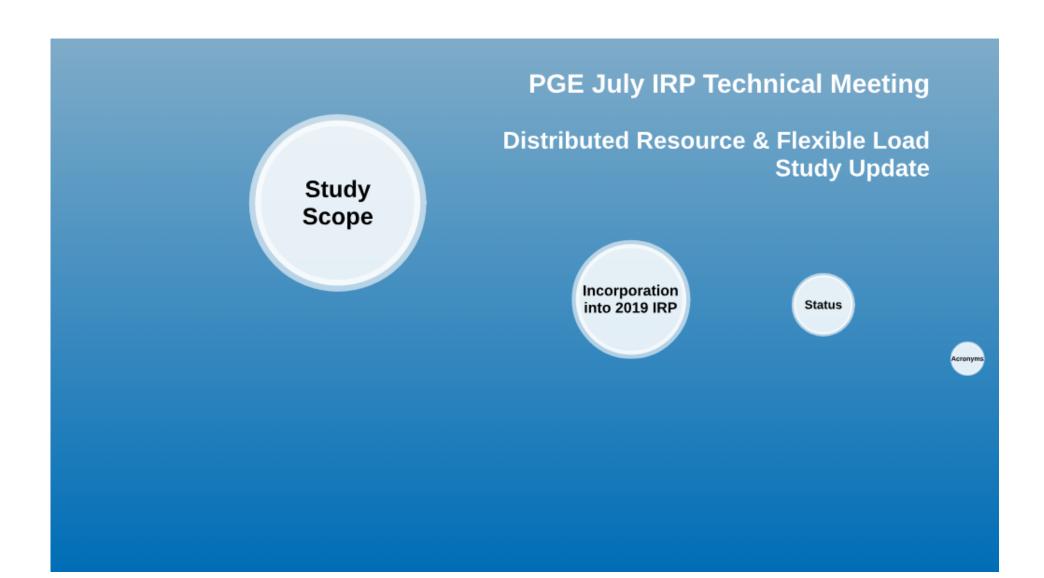


Status

Results will be presented by Navigant in August Round Table
• IRP interactive forecast

- · Electric Mobility

Future Round Table meeting: discuss how information from the DER and Flexible Load Study feeds into futures



Distributed Resource and Flexible Load Study Update

Acronym Definitions

BYOS - Bring Your Own Storage

BYOT - Bring Your Own Thermostat

DCFC - Direct Current Fast Electric Vehicle Charger

DCM - Demand Charge Management

DER - Distributed Energy Resources

DR - Demand Response

EE – Energy Efficiency

EV - Electric Vehicle

HDV - Heavy Duty Vehicle

IRP - Integrated Resource Planning

L2 - Level 2 Electric Vehicle Charger

LDV - Light Duty Vehicle

MDV - Medium Duty Vehicle

PTR - Peak Time Rebate

T&D - Transmission & Distribution Planning

ToU - Time of Use

