Integrated Resource Planning

ROUNDTABLE 21-6

AUGUST 2021

MEETING LOGISTICS

Electronic version of presentation:

https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning/irp-public-meetings

Teams Meeting

Please click the meeting link sent to your email or here:

Join Microsoft Teams Meeting

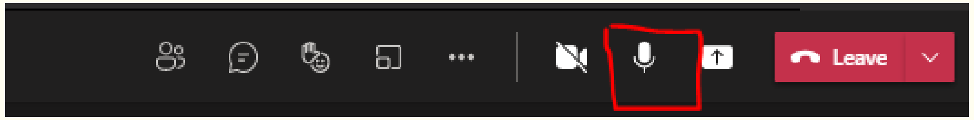
+1 971-277-2317 (dial this number into your phone for best results)

PW: 877 471 738#

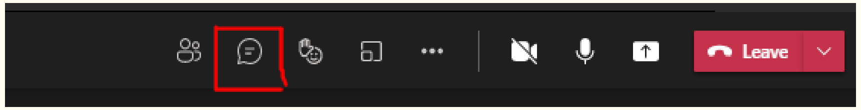
*Please use Microsoft Edge or Google Chrome with Teams as it will give you the best experience

PARTICIPATION

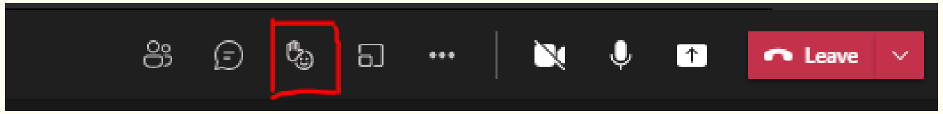
- Mute your mic while others are speaking; to unmute via phone press *6



- We will ask for comments and questions along the way
- Participate using the chat box or ask questions verbally



- Use the “raise hand” feature to signal you would like to ask your question verbally



- Wait to be called on
- Please be polite and respect all participants on the webinar
- Please stay on topic; we may interrupt or shorten questions to meet the time commitment of the meeting

AGENDA

Welcome and introductions	15 minutes
Safety moment	5 minutes
DER and flexible load phase 1 study	90 minutes
Portfolio requests from participants	5 minutes

SAFETY MOMENT

Heat Safety: heat causes stress, illness, and death. Take care of yourself, others in your life, and pets during high heat.

Job Sites

- Stay hydrated
- Take breaks in the shade often

Outdoors

- Limit strenuous activity
- Stay hydrated

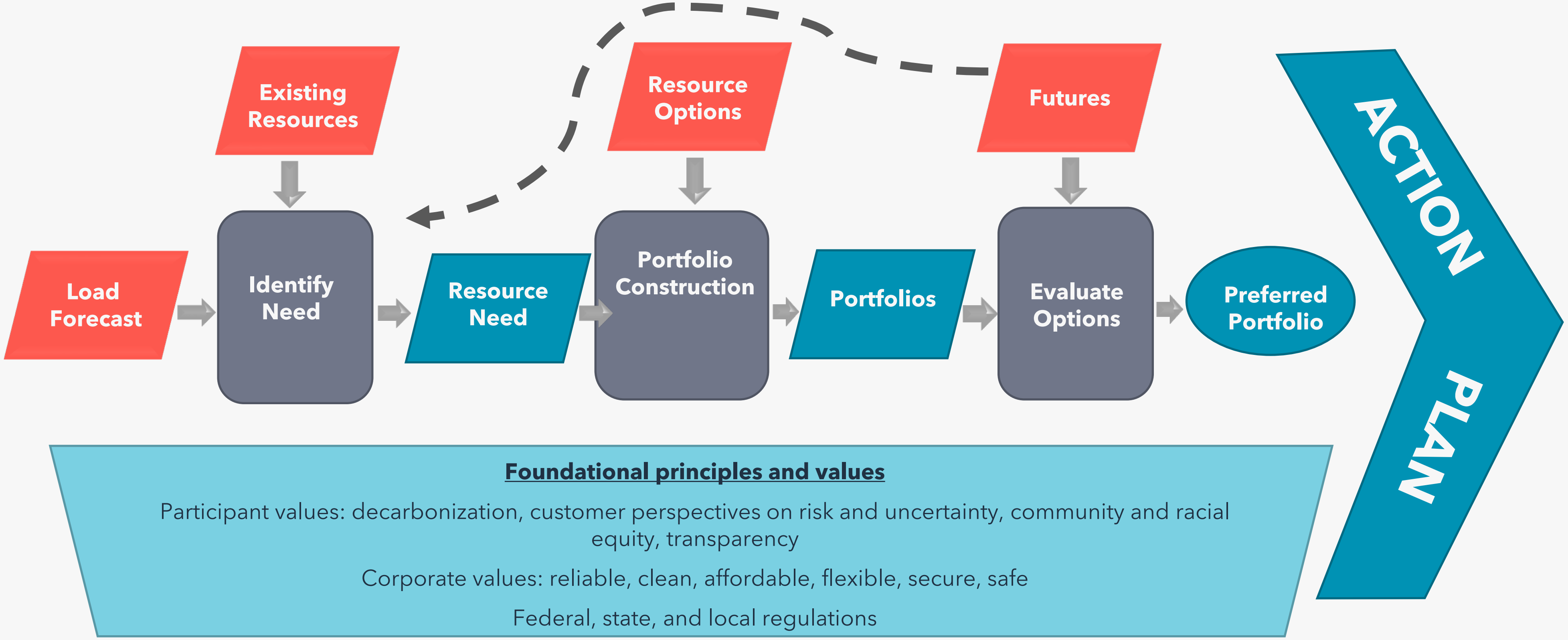
Vehicles

- Never leave kids or pets unattended
- Cool your car before entering
- Park in the shade

Find a cooling center in Multnomah County

https://www.multco.us/help-when-its-hot

IRP ANALYSIS PROCESS



DER AND FLEXIBLE LOAD PHASE 1 STUDY

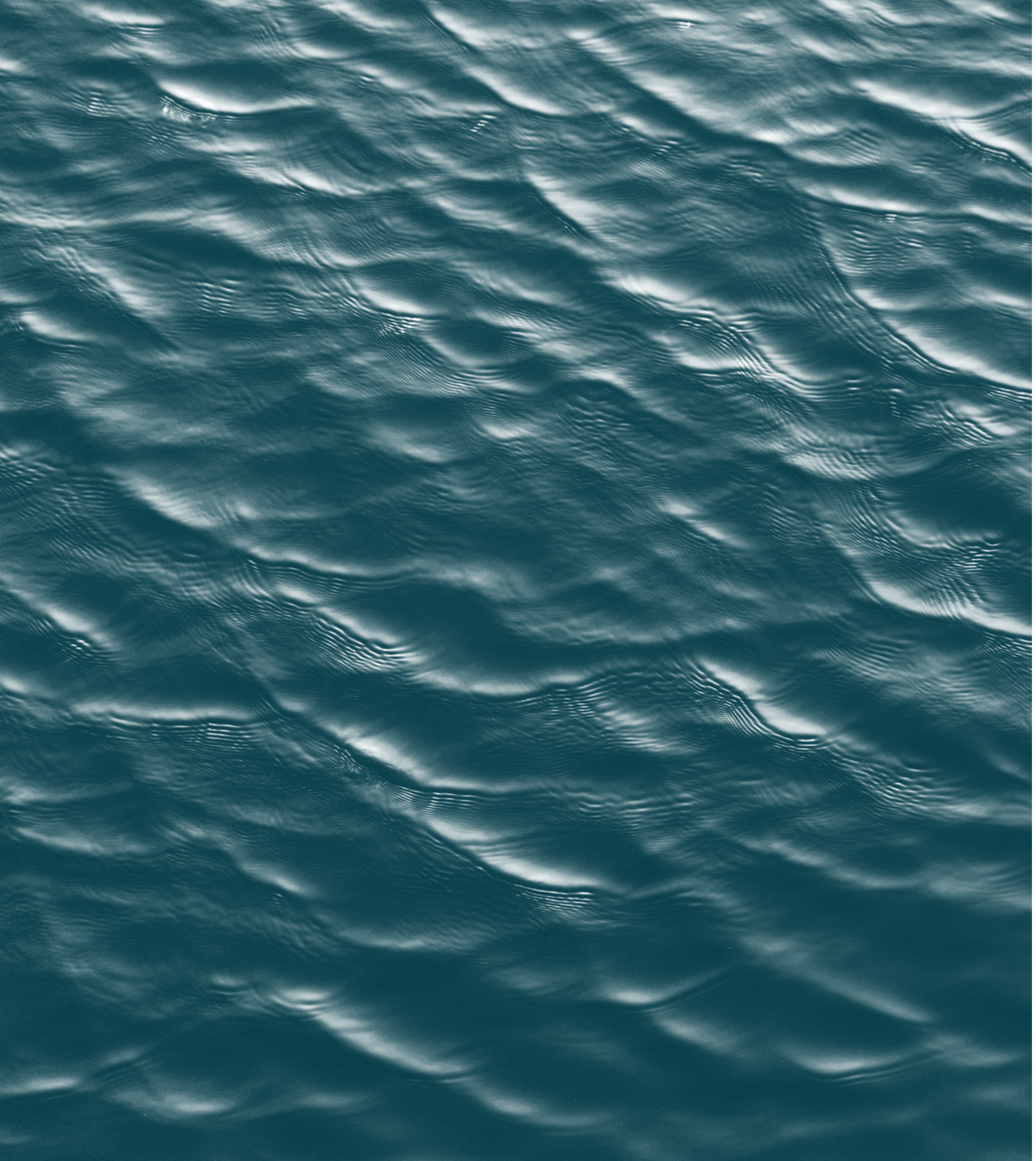
Andy Eiden

ROUNDTABLE 21-6

August 25, 2021

DER and Flexible Load Phase I Study Results

IRP Roundtable



Agenda

1. Study overview
2. Methodology
3. Market and technical potential
4. Reference case: achievable and economic potential
5. Cost-effectiveness
6. Scenario analysis
7. Conclusions and next steps

Study overview

- PGE contracted with Cadeo, Brattle, and Lighthouse to conduct a study and develop toolkit to support IRP, DSP, DER planning
- Purpose of the study:
  - Model the technical, market, economic, and achievable potential of all the DER, electrification, and flexible load measures likely in PGE's service territory over a range of scenarios
- Study completed in two phases:
  - Phase I provides system-level IRP inputs
  - Phase II provides locational, bottom-up inputs for DSP filing

Technical overview

The scope of the study includes the development of an open code base built upon open tools that can be iteratively refined

This reflects the reality of distribution resource planning: it's an evolutionary process that requires transparency and collaboration

Project requires that all third-party data comes from open sources that can be shared publicly and updated easily

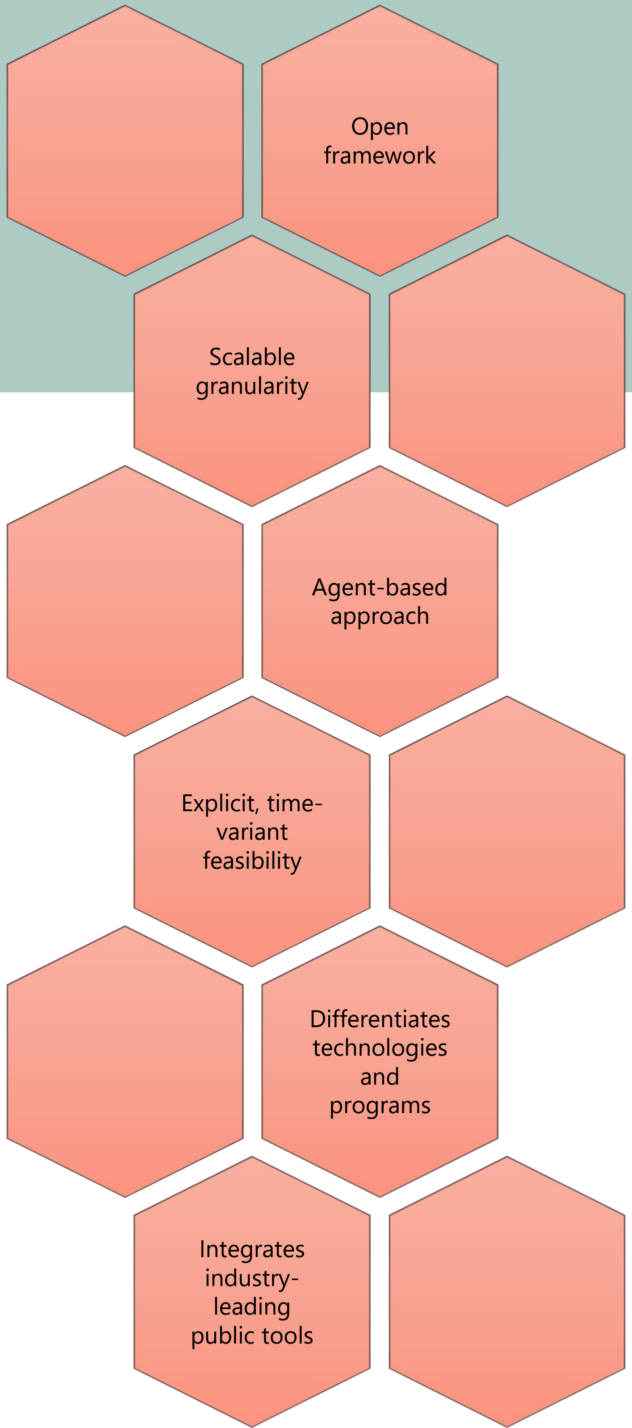
To the extent possible, analytic tools come from the public sphere:

- DGEN, REOpt Lite, EVI-Pro Lite, EnergyPlus, Electrification Futures Study, PVWatts, Project Sunroof

The AdopDER model

For this project, the team developed the AdopDER model:

- Comprehensive, open modeling framework
- Built in Python and integrated with NREL/USDOE toolkit
- Estimates adoption of distributed energy resources, electrification, and flexible loads dynamically and stochastically
- Models under different programmatic and market conditions
- Outputs hourly impacts at whatever desired geographic granularity, by year, scenario, resource, segment



Operational model narrative: technical potential

- Set scenario parameters
- Model initialization
  - Building stock
  - Load shapes
  - Measure characteristics
  - Macroeconomic variables
- Simulate stock turnover under base case
- Simulate new customers, their loads, and building characteristics
- Estimate technical potential adoption for each measure based on feasibility
- Simulate dispatch for dispatchable assets

Operational model narrative: economic, market, achievable

- Run each programmatic measure through CE screen
- Simulate adoption under each scenario based on customer economics and program parameters (including uncertainty in forecasts):
    - Market forecast
    - Achievable potential
- Report grid impacts and economics by desired segmentation (location, time, type, class)

Resource types

- A measure is an atomic unit (it’s a widget)
  - It could be adopted either through a **program** or in the **market** naturally
  - It could be **passive** or it could be **dispatchable**
- Measures in the market get adopted based on macroeconomic/policy/market dynamics
- Programmatic measures are clustered into programs and measure bundles that have their own eligibility, ramp rates, economics, etc.
  - Example: Direct install thermostat for heat pumps is a combination a smart thermostat, smart thermostat controls, eligibility criteria restricted to folks with heat pumps and not on PTR

Examples of resource types

PV	Water heater retrofit switch	Storage	Light Duty EV	Residential Smart L2 EVSE
Shape: Passive	Shape: Dispatchable	Shape: Passive	Shape: NA	Shape: Passive
Adoption: Market	Adoption: Program	Adoption: Market or Program	Adoption: Market	Adoption: Market or Program

DR and Pricing

- Residential high voltage smart thermostat
- Residential Low Voltage Smart Thermostat
- Residential Low Voltage Smart Thermostat Controls
- Cold thermal storage
- Irrigation DLC
- Large C&I ADR/curtailable tariff
- Electric Vehicle TOU
- Peak-time Rebates
- ERWH smart controls
- ERWH retrofit switch
- Residential DHP controls
- HPWH smart controls
- Smart HPWH
- Commercial low voltage smart thermostat
- Commercial low voltage smart thermostat controls
- TOU
- Residential High Voltage Smart Thermostat Controls

Transportation electrification

- Residential L1 EVSE
- Non-Residential L1 EVSE
- Residential L2 EVSE
- Smart Residential L2 EVSE
- Non-residential/Public L2 EVSE
- Smart non-residential/Public L2 EVSE
- Public/Non-residential DCFC EVSE
- Light-Duty Vehicle
  - Battery Electric Vehicle
  - Plug-in Hybrid Electric Vehicle
- Medium-Duty Vehicle
- Heavy Duty Vehicle
- Residential L2 DLC
- Non-residential L2 EVSE DLC
- Non-residential DCQC DLC

Solar and storage

- Solar PV
- Behind-the-meter energy storage
- BTM energy storage controls
- Single site microgrid (solar + storage + genset)
- Campus microgrid (solar + storage + genset)

Building Electrification

- Ductless heat pumps
- Ducted heat pumps
- Central VRF
- DOAS + High Efficiency Hp
- Smart Electric water heater
- Heat Pump water heaters
- Centralized hydronic (water and space)
- Residential/MF induction cooking

- Residential programs
  - Residential Opt-in PTR
    - Peak time rebates
  - Residential Storage
    - Res BYO-Battery Bundle
    - Res New Battery Bundle
  - SF Smart Charging
    - Residential Standalone L2 EVSE
    - Residential L2 EVSE + DR
  - Multifamily Demand Response
    - MF ERWH DLC retrofit
    - MF ERWH Smart ERWH
    - MF Full Retrofit (baseboard)
    - MF Full Retrofit (DHP)
  - Residential Smart Thermostats
    - BYOT-SF LV space heat only
    - BYOT-SF LV cooling only
    - BYOT-SF LV space heat and cooling
    - Direct install-SF LV space heat only
    - Direct install-SF LV cooling only
    - Direct Install-SF LV space heat and cooling
    - Direct Install-MF HV space heat only
  - Residential Smart Water Heating
    - Residential HPWH retrofit
    - Direct Install-HPWH
  - Residential Opt-in TOU
    - Standalone TOU
    - TOU-optimized thermostat
    - TOU-optimized storage
    - TOU-optimized WH
    - TOU-optimized EV charging
    - EV TOU without smart charging
- Nonresidential programs
  - Nonresidential Storage
    - Nonres BYO-Battery Bundle
    - Nonres New Battery Bundle
  - Energy Partner
    - Energy Partner-Thermostats
    - Energy Partner-ADR
    - Energy Partner-Agriculture
    - Energy Partner-Cold storage
  - Nonresidential Microgrids
    - Nonresidential Microgrid-Single site
    - Nonresidential Microgrid-Campus
  - Nonresidential Smart Charging
    - Workplace L2 - No DR
    - Workplace L2 - with DR
    - Public L2
    - Public DCFC
  - Nonresidential Fleet Program
    - Fleet L2
    - Fleet DCFC
  - Large C&I ADR

Potentials

- Market and achievable potential determined differently by resource type
  - S+S: DGEN, calibrated ramp rates for programmatic storage
  - TE: Brattle econometric model (LDV), Delphi (MDV/HDV), EVI-Pro (charging), PGE pilot data
  - BE: Electrification Futures Study
  - DR: Calibrated ramp rates based on historical participation, incentive, and benchmark data
- Program achievable potential is filtered by economic screens
  - Based on TRC developed using approach outlined in Flexible Load Plan
  - Also used to develop supply curves ($/kw-yr)
- Scenarios considered are consistent with IRP (hi/ref/low DER, hi/ref/low load)

Why are we doing this in such a complicated way?

- When you’re looking at everything, the interaction between measures matter a lot
- There are a lot of unintended consequences that can get missed when you treat each technology in isolation
- This isn’t simply about adoption; it affects a multitude of factors that can have cascading effects

Example of cascading effects: electric vehicles

- Customer is determined to be feasible for and adopts an electric vehicle
- In a traditional potentials approach, this is independent of non-TE resources
  - At best, a diffusion curve for something like solar might have TE adoption as an explanatory variable
- In our approach, the story is a bit more complicated…

Example of cascading effects: electric vehicles

- Customer adopts an electric vehicle
- They immediately assess eligibility, potential, and adoption decision for:
  - L1 EVSE, L2 EVSE, L2 smart EVSE, program L2 smart EVSE, program L2 smart EVSE + DLC, EV TOU
- If they adopt a charging measure of any sort, their load goes up
  - This increases their solar technical potential because that is a function of load
  - It also increase their PTR/TOU expected impacts because that is also a function of load
- If they adopt an L2 charging measure, they also lose a 220 breaker on their panel (we keep track of that stuff)
  - If that was the last potential 220 breaker they had, they are no longer eligible (people hate panel upgrades so we don't model them) for:
    - Solar
    - Storage
    - Any building electrification measure
    - Any more L2 EVSEs
- In phase II, we will also model the fact that the customer adopts that electric vehicle, it affects the likelihood that their neighbors adopt an electric vehicle

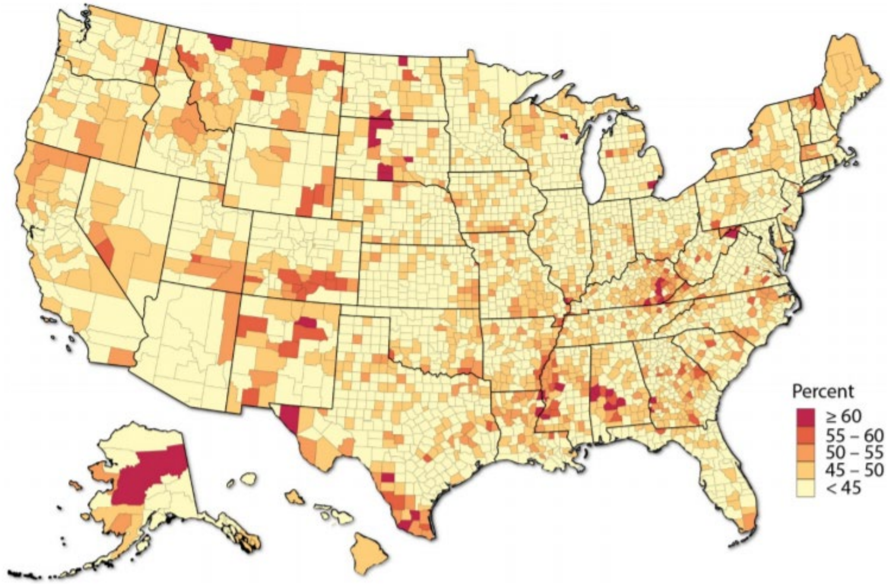
What we don’t have time to cover…

- … is how every class of resource, program, and technology was modeled in terms of adoption, feasibility, cost, load shape, dispatchability…
- Covering that detail could take multiple days
- But…here’s a little preview (and more details provided in forthcoming report)

A Little on Individual Measure Approaches

Solar approach

- Used DGEN to predict solar adoption as a function of technical potential based on Oregon specific inputs by sector
- Included adjustments for incentives under different scenarios
- These were then calibrated against technical potential modeled using site-level data, PVWatts, Project Sunroof



Microgrid / storage approach

- Used similar approach to solar for storage attached to existing solar installations
- Allocated to program/non-program based on participation rates seen in CA SGIP program
- For new solar installations, used a Bass diffusion model of storage attachments using a literature review of mature markets

Transportation electrification approach: vehicles

- LDV adoption based on Brattle econometric model
  - Purchase Incentives
  - EV Battery Price
  - Relative Fuel Price
  - Available Models
  - ZEV State
  - Vehicle Miles Traveled
  - Green Views
  - Charging Rate
- Fleet LDV/MDV/HDV adoption based on Delphi panel model
- Both scaled to DMV data and stock turnover

Transportation electrification approach: chargers

- Chargers generated at residential where feasible based on panel ampacity/parking availability
  - If L2 not feasible, but L1 was, then that was adopted
- Fleets adopt charging based on assumed 2:1 vehicle to charger ratio
- Public charging sites (public, workplace, MF/MUD) generated based on:
  - Assumed occasional public charging need for all sites (from EVI Pro)
  - Additional public charging needed for sites that can't have personal charging (calculated based on EV consumption need)

Building electrification approach

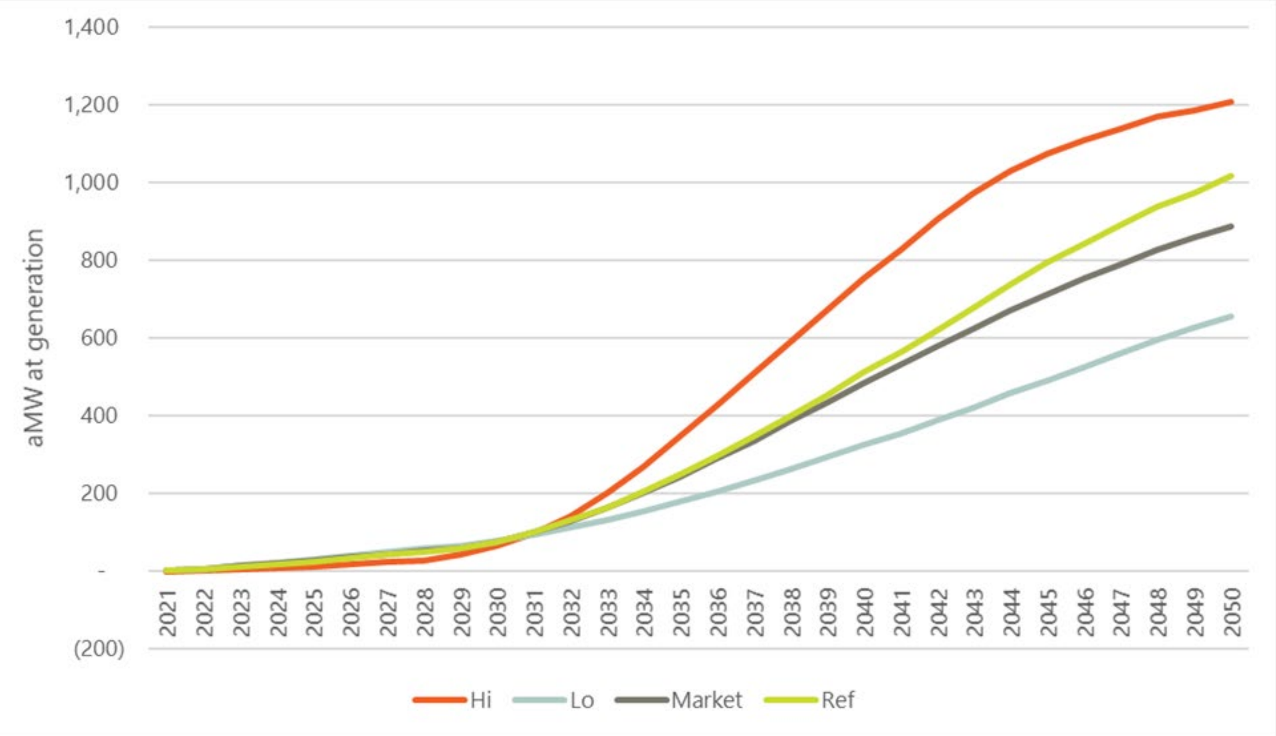
- Modeled turnover of HVAC, WH, and cooking equipment for all sites
- Developed adoption curves for fuel switching based on LBNL Electrification Futures Study results for Oregon
  - Factors in trends in codes & standards, policy changes, carbon pricing, etc.
- Assumed no new code changes or any programmatic intervention
- Used Energy Trust assumptions as baseline probabilities for different equipment types
- Applied fuel switching probabilities incrementally

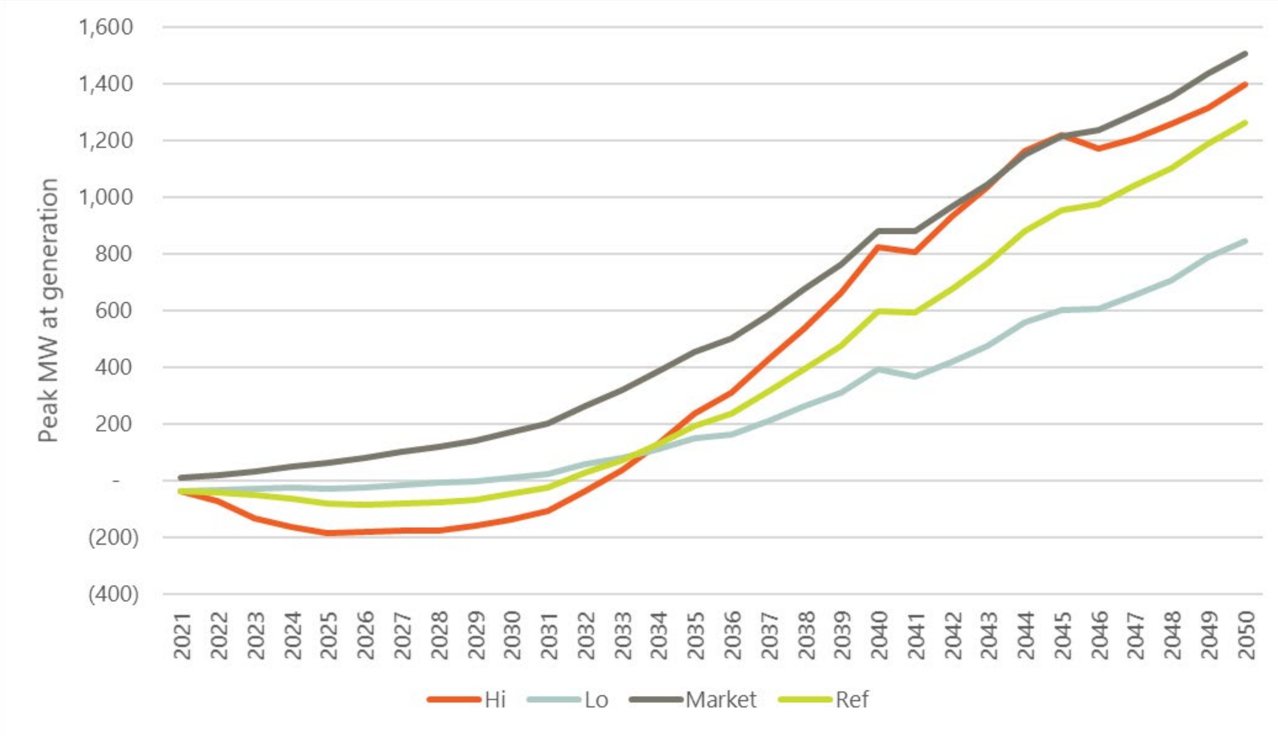
Flexible loads approach

- Developed Bass diffusion curves using both historical participation in PGE programs and comparable programs in other studies
- Fit S-curves to historical participation to estimate “steady state” participation
- Took the average of PGE experience and data found in the literature review to arrive at final curves by measure
- These are then applied to sites that are feasible, based on existing tech, building characteristics, and/or competing programs

Scenario Results

System level aggregate impacts

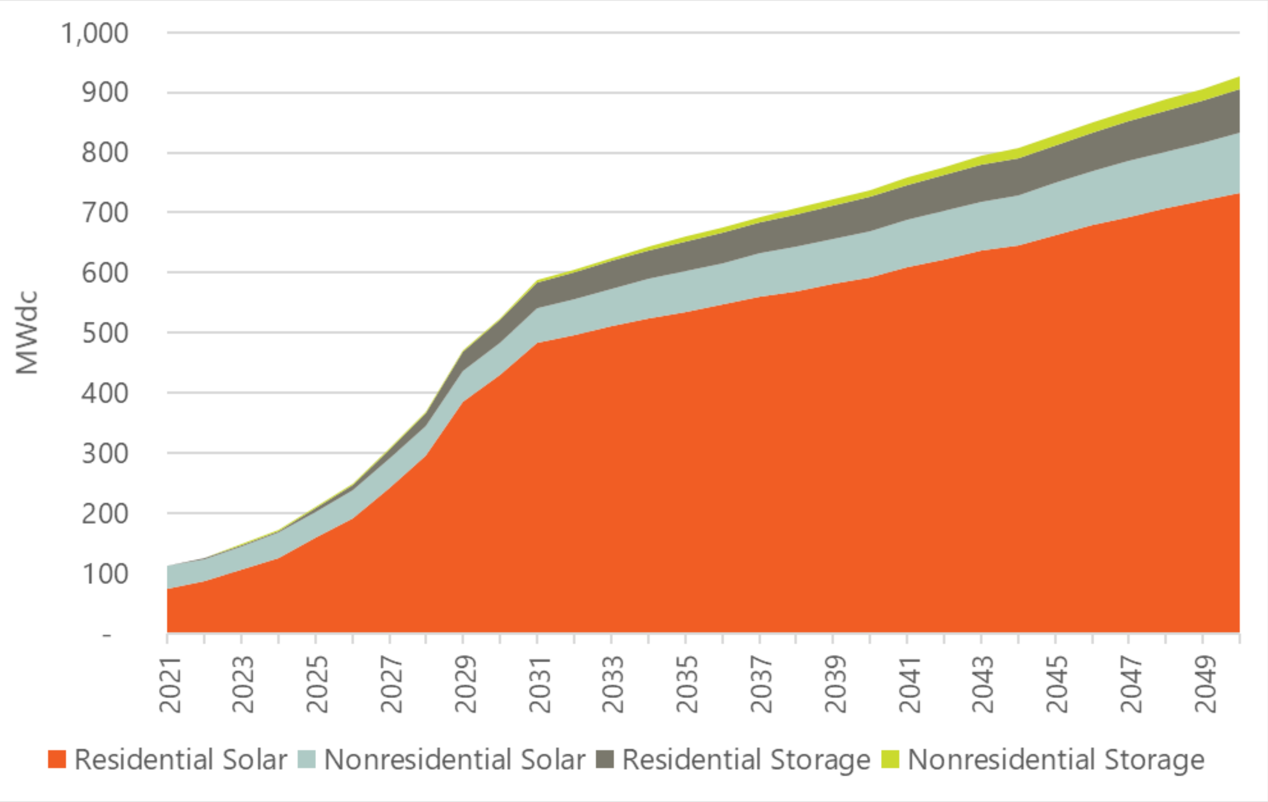




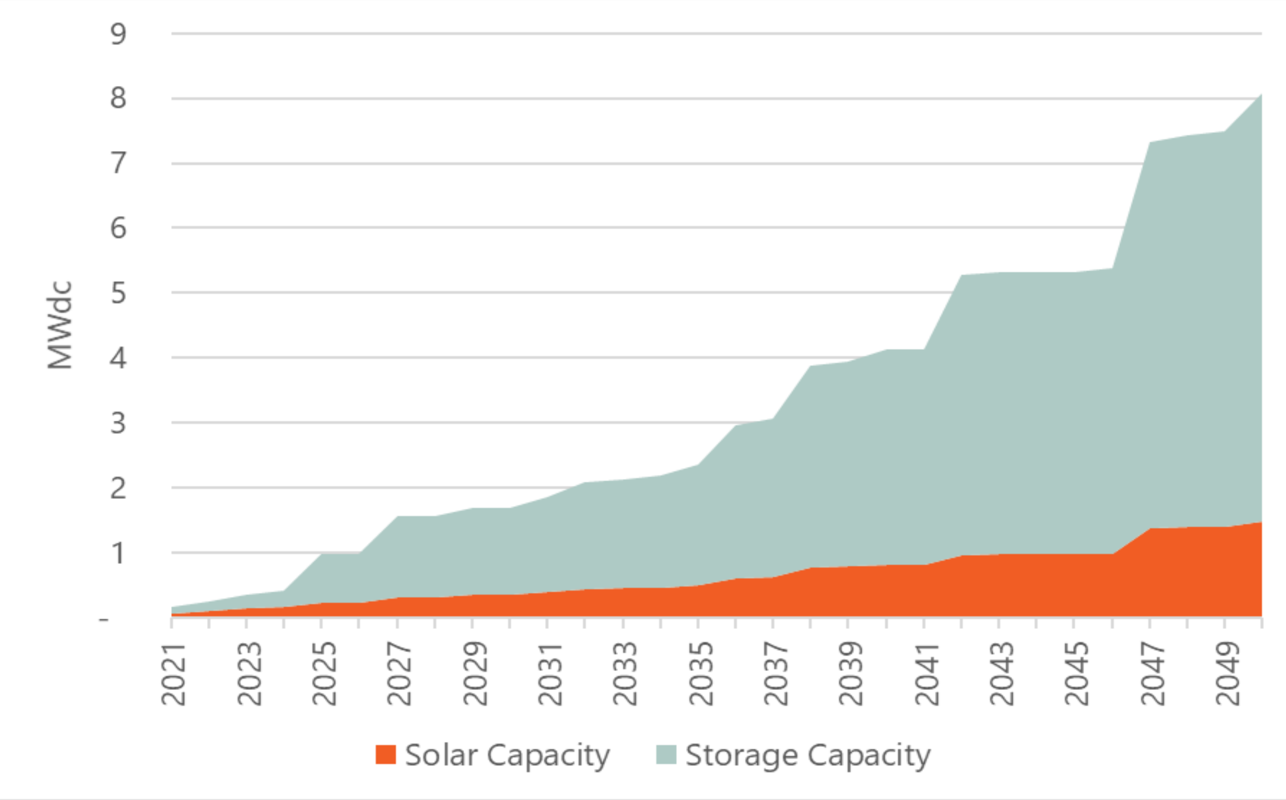
Solar + Storage

Nameplate forecasts (reference)

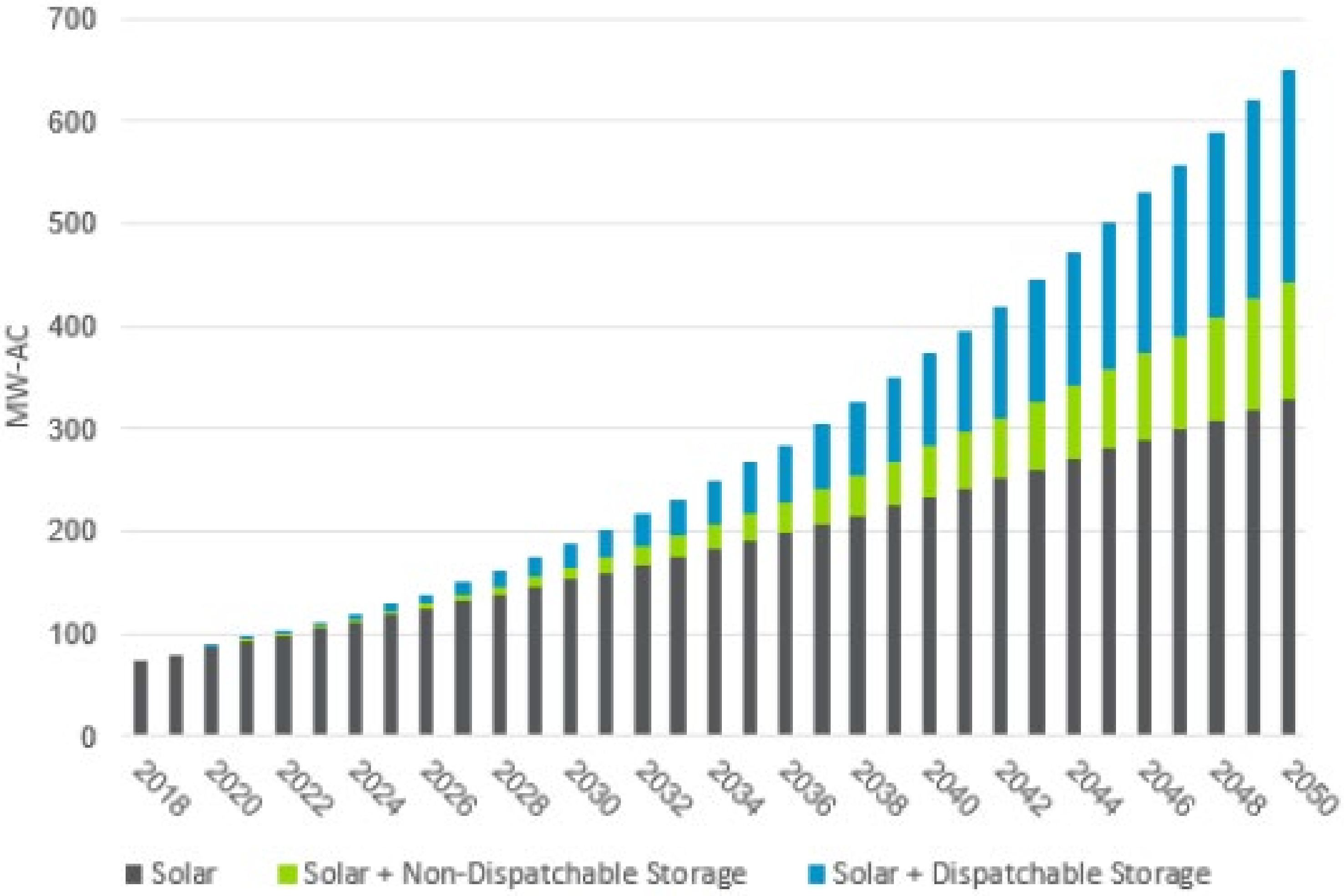
Solar and Storage



Critical Microgrids

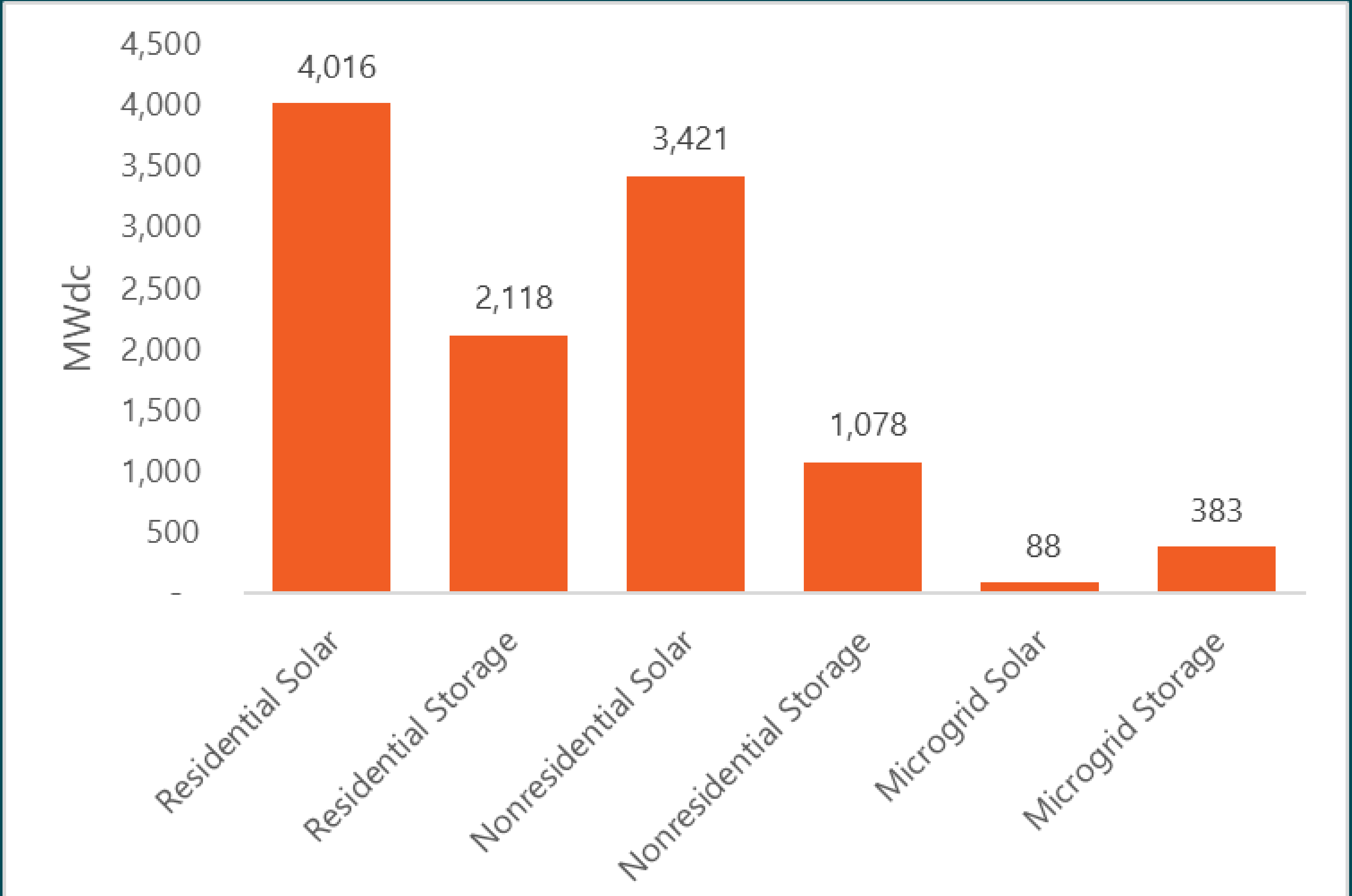


Benchmark



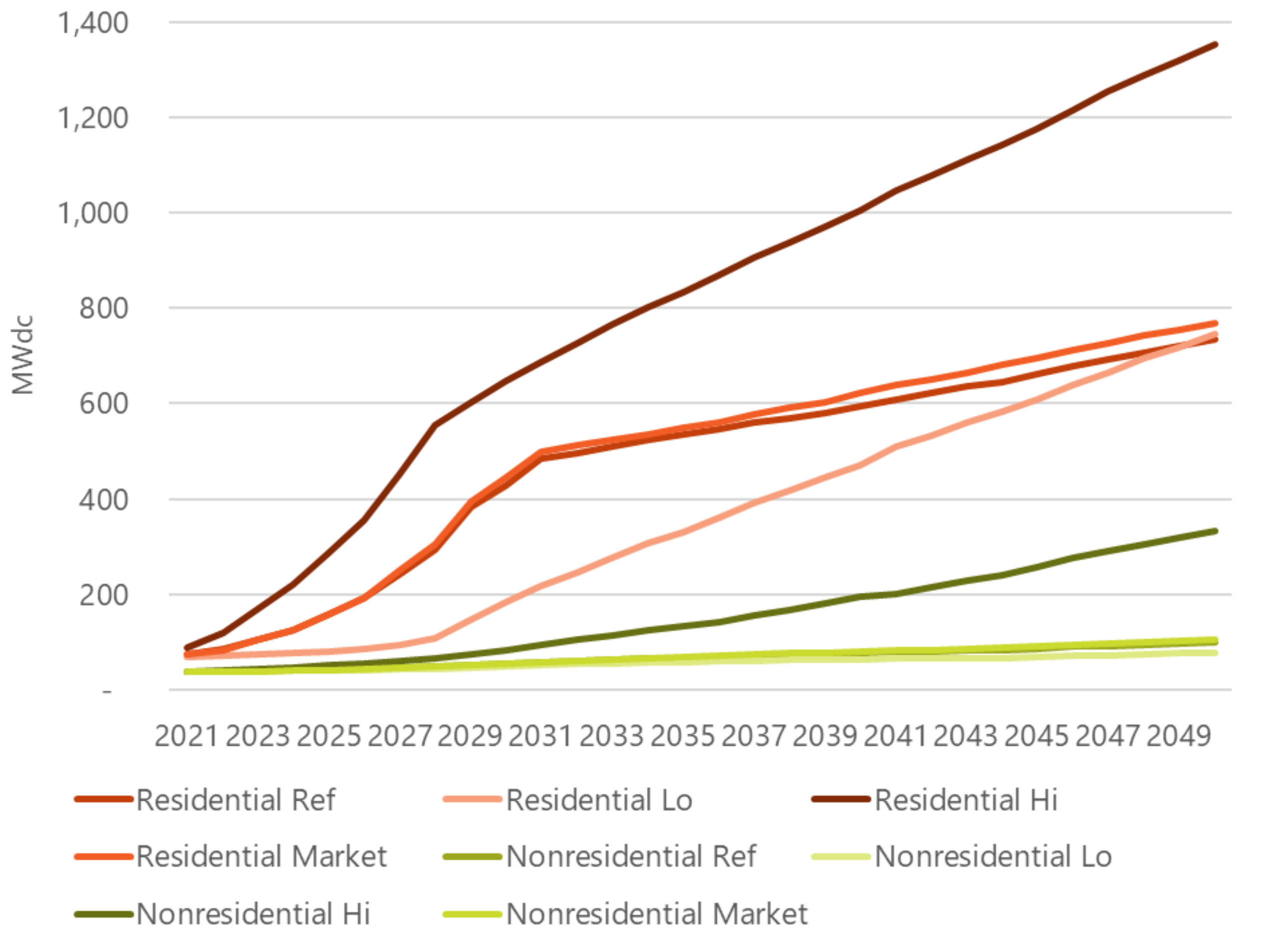
Source: Navigant

Nameplate technical potential

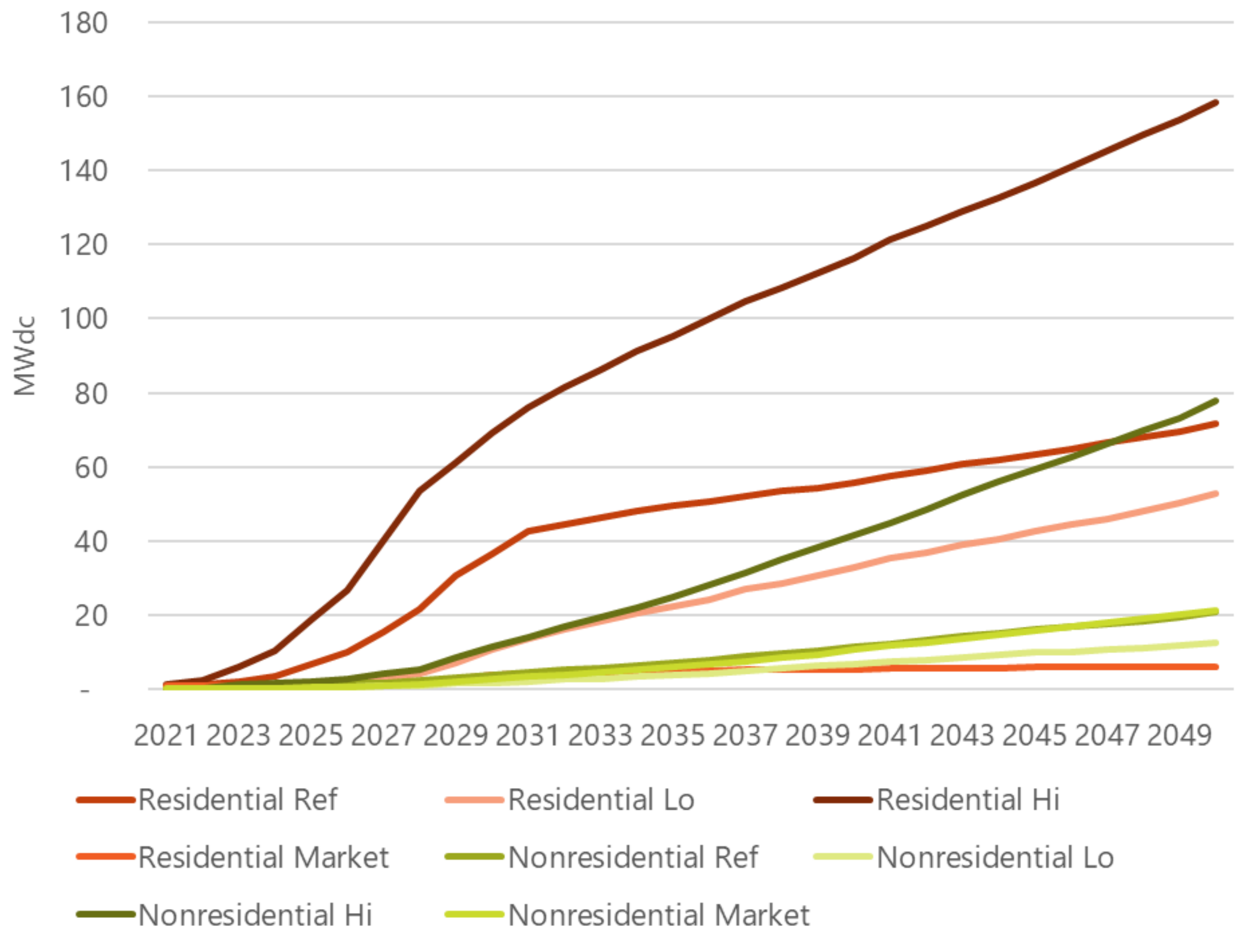


Nameplate potential by scenario

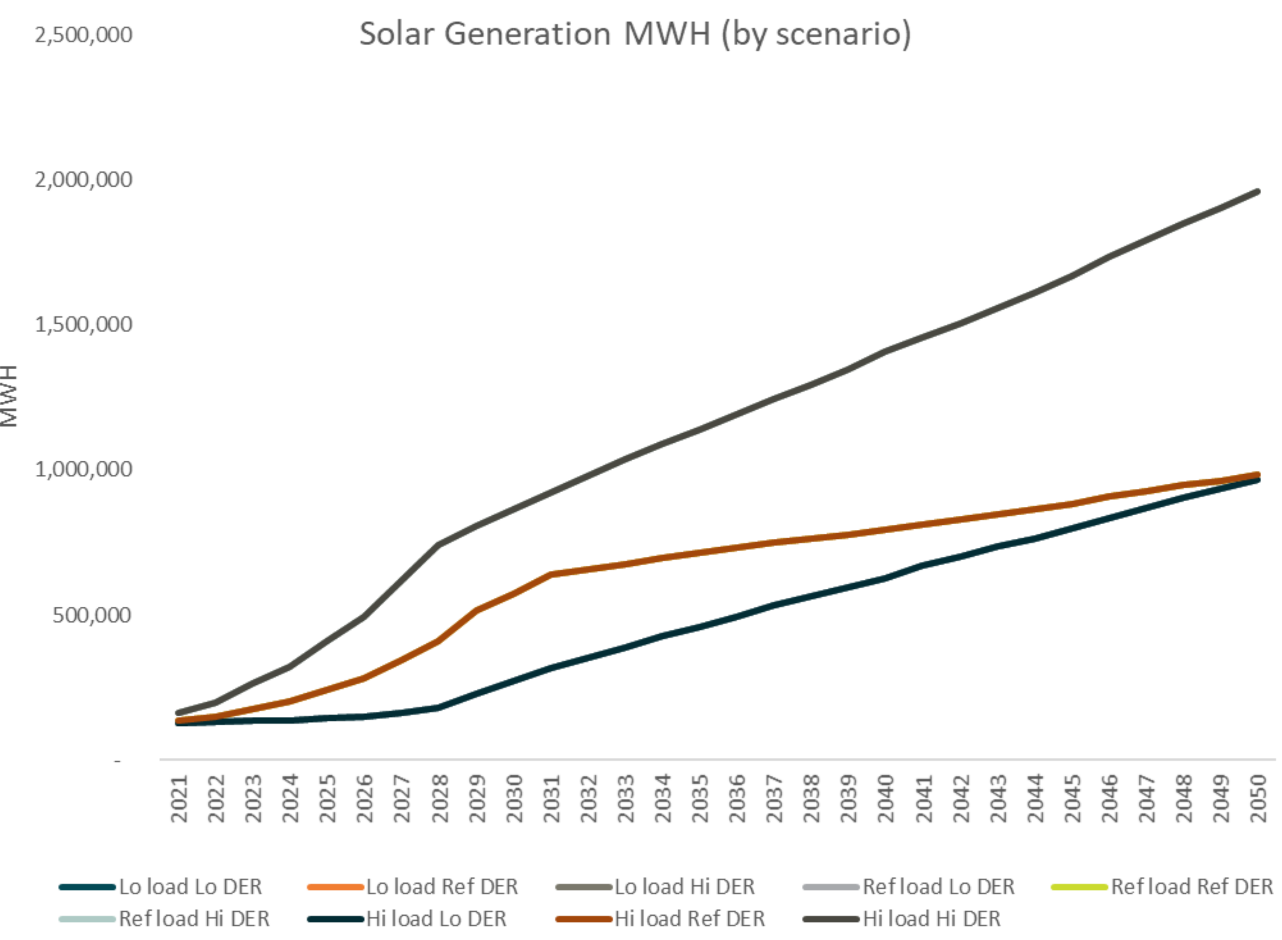
Solar

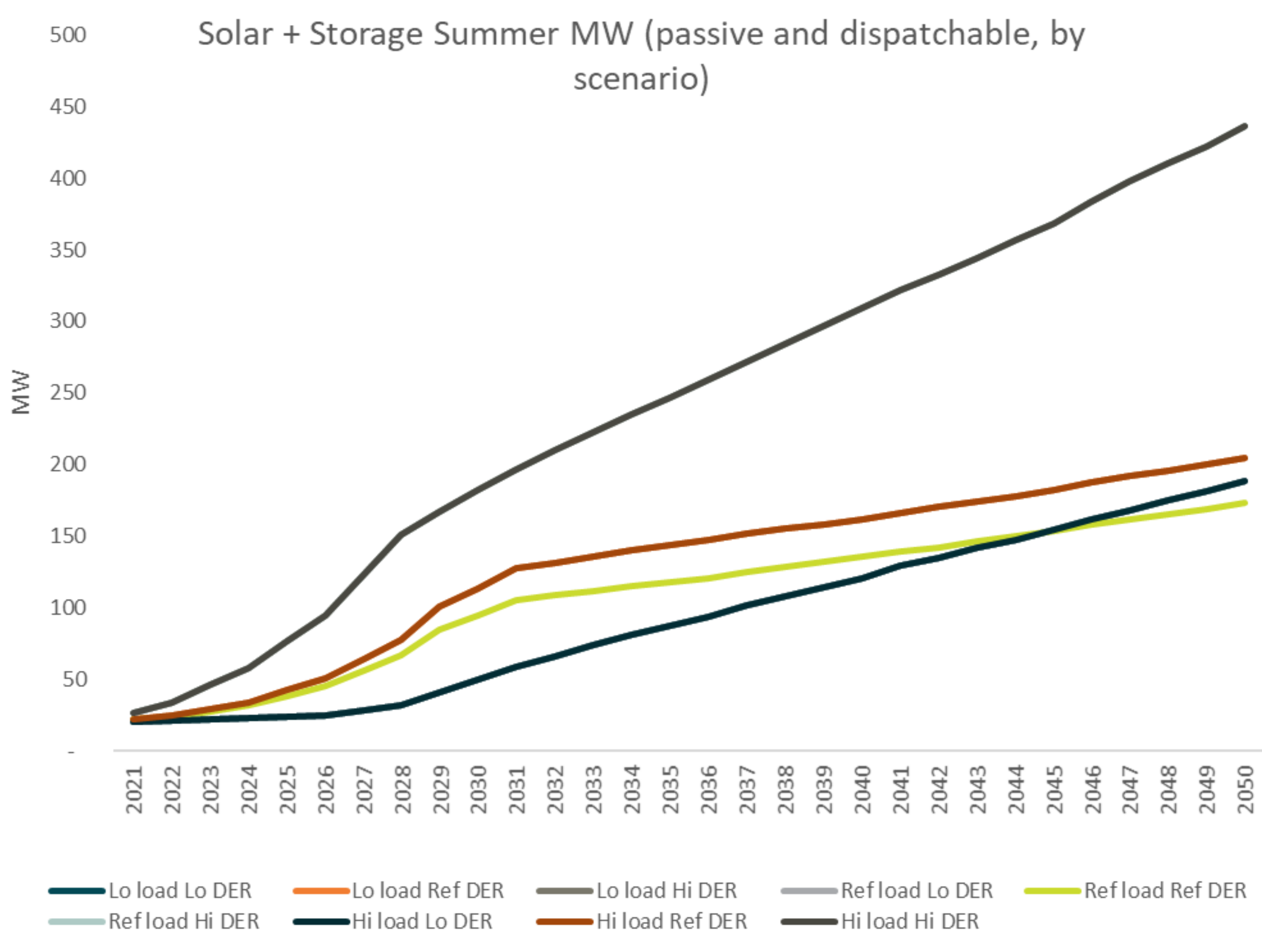


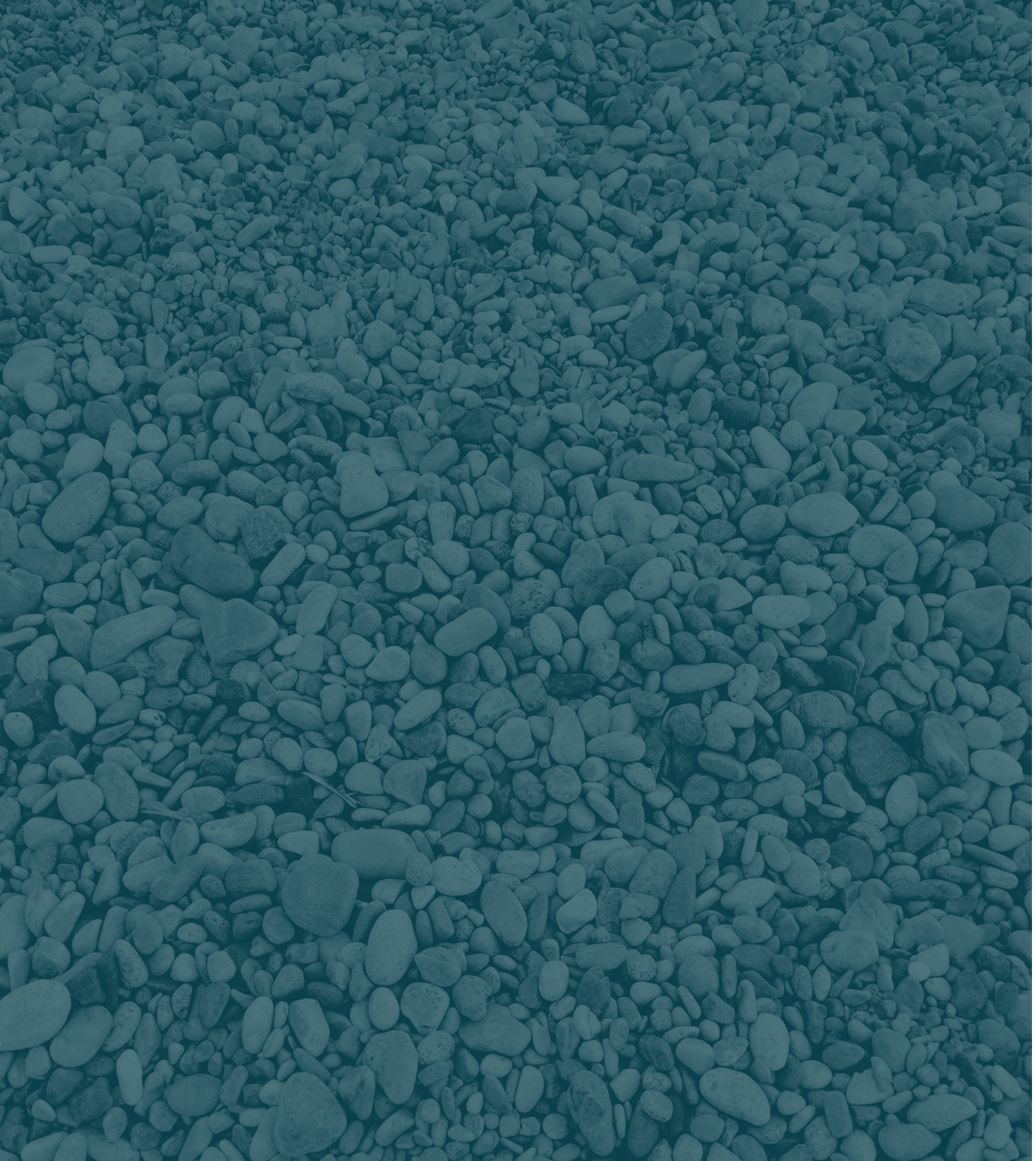
Storage



Consumption and peak impacts

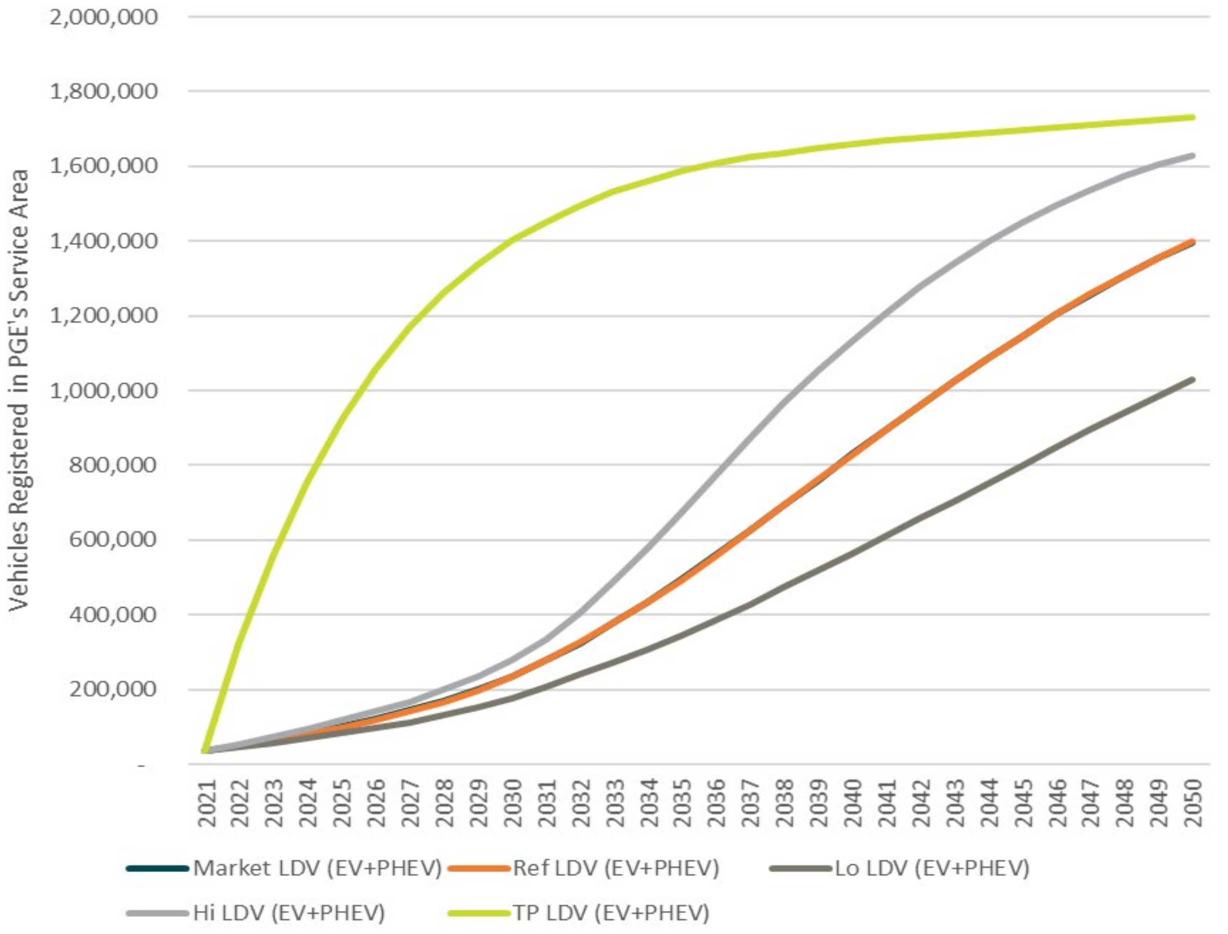


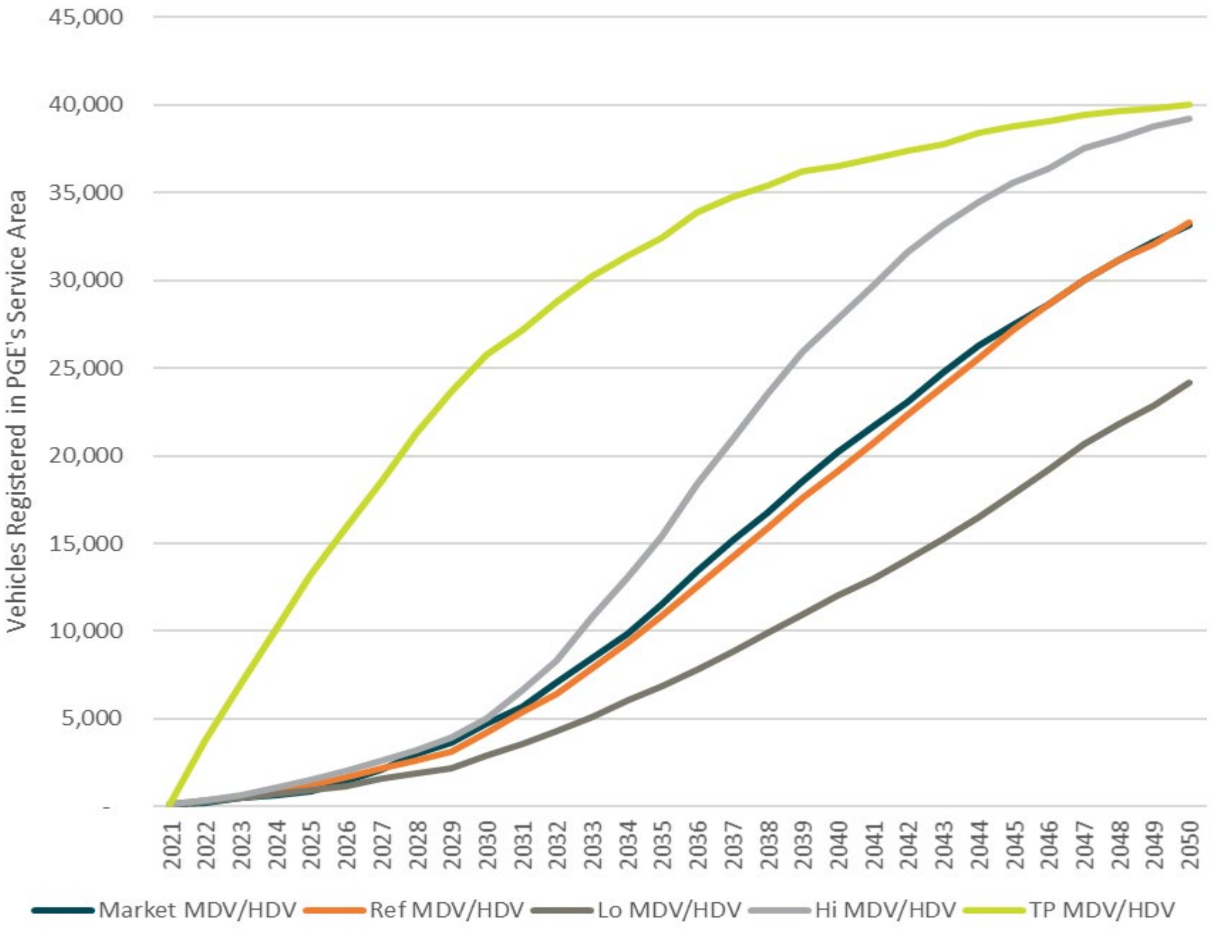




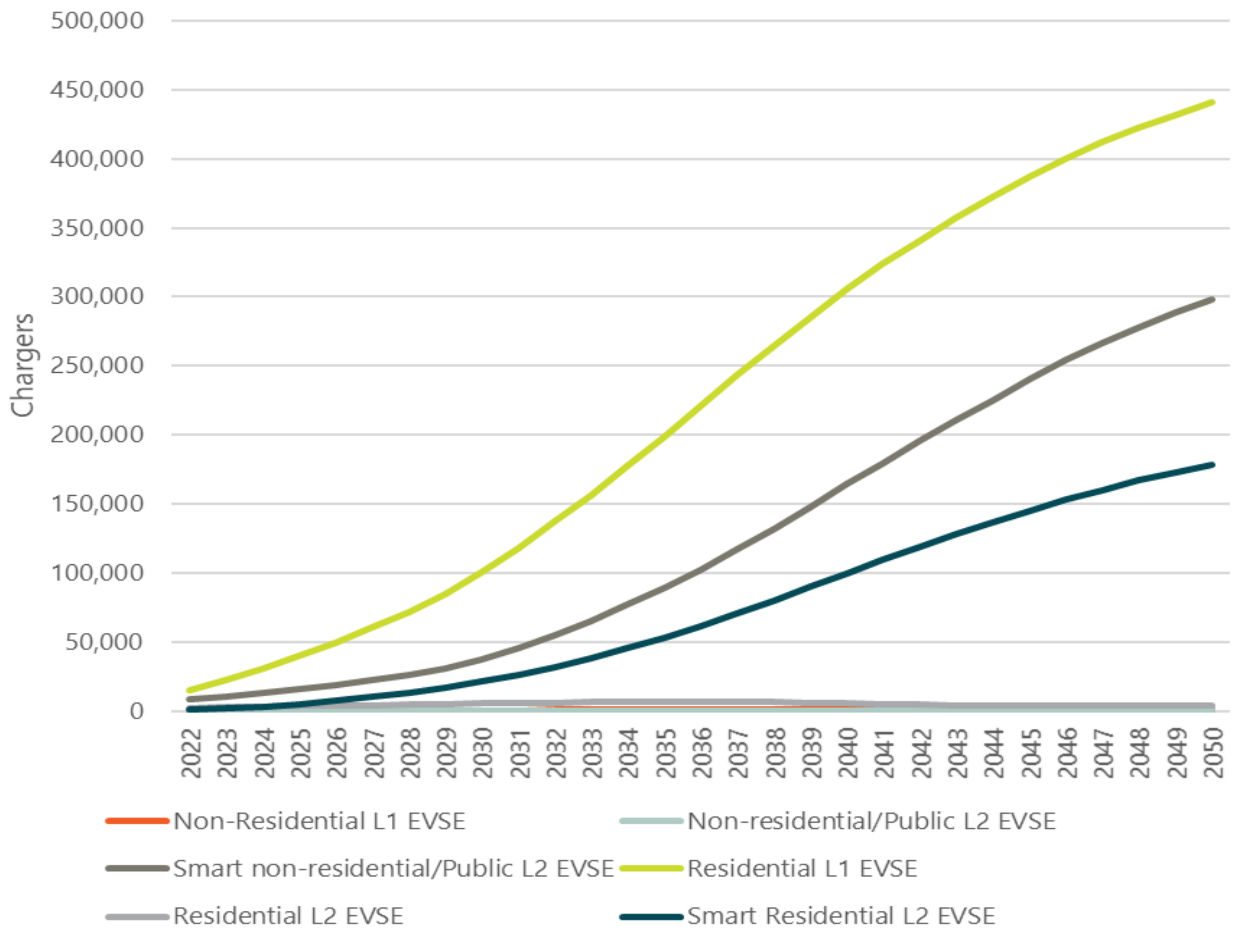
Transportation

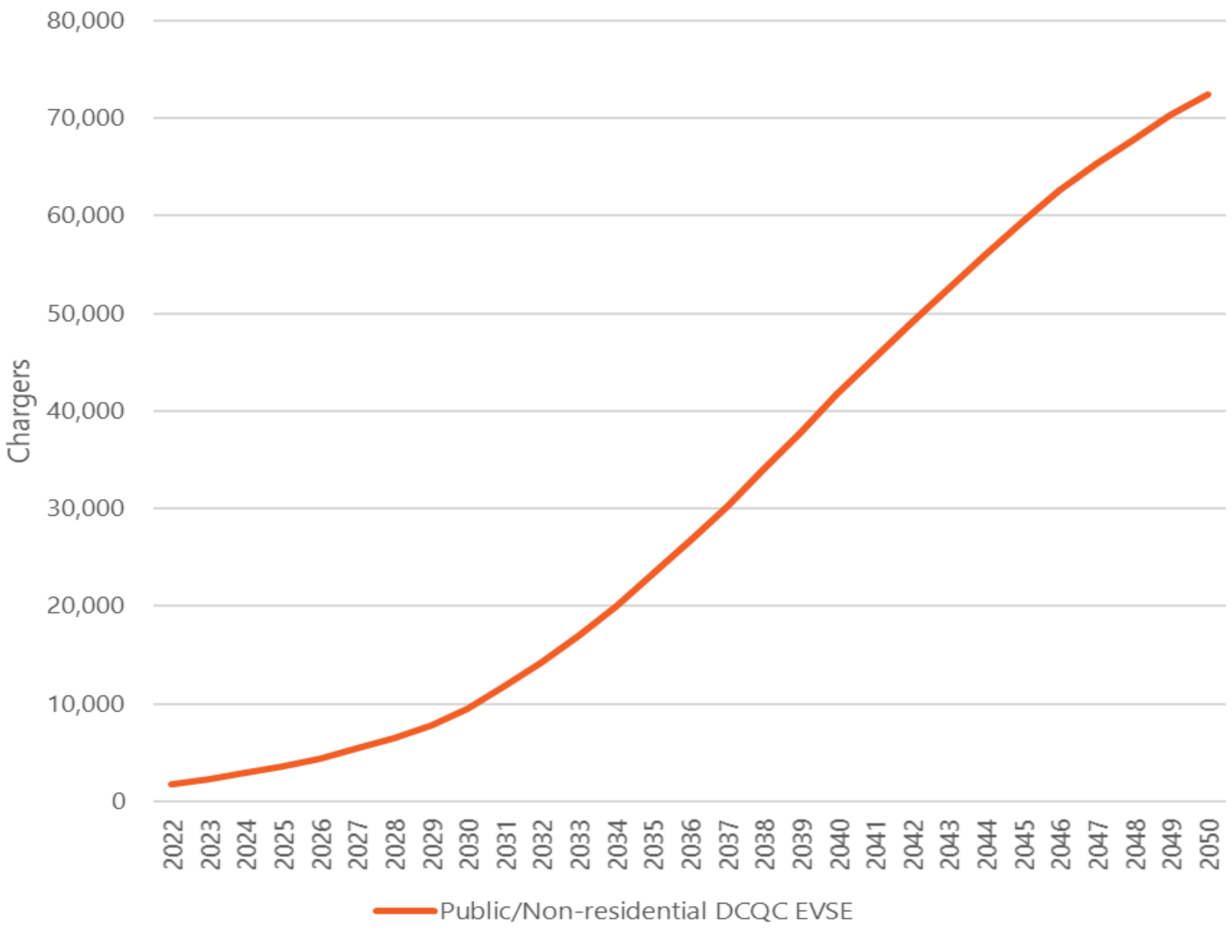
Vehicle forecasts



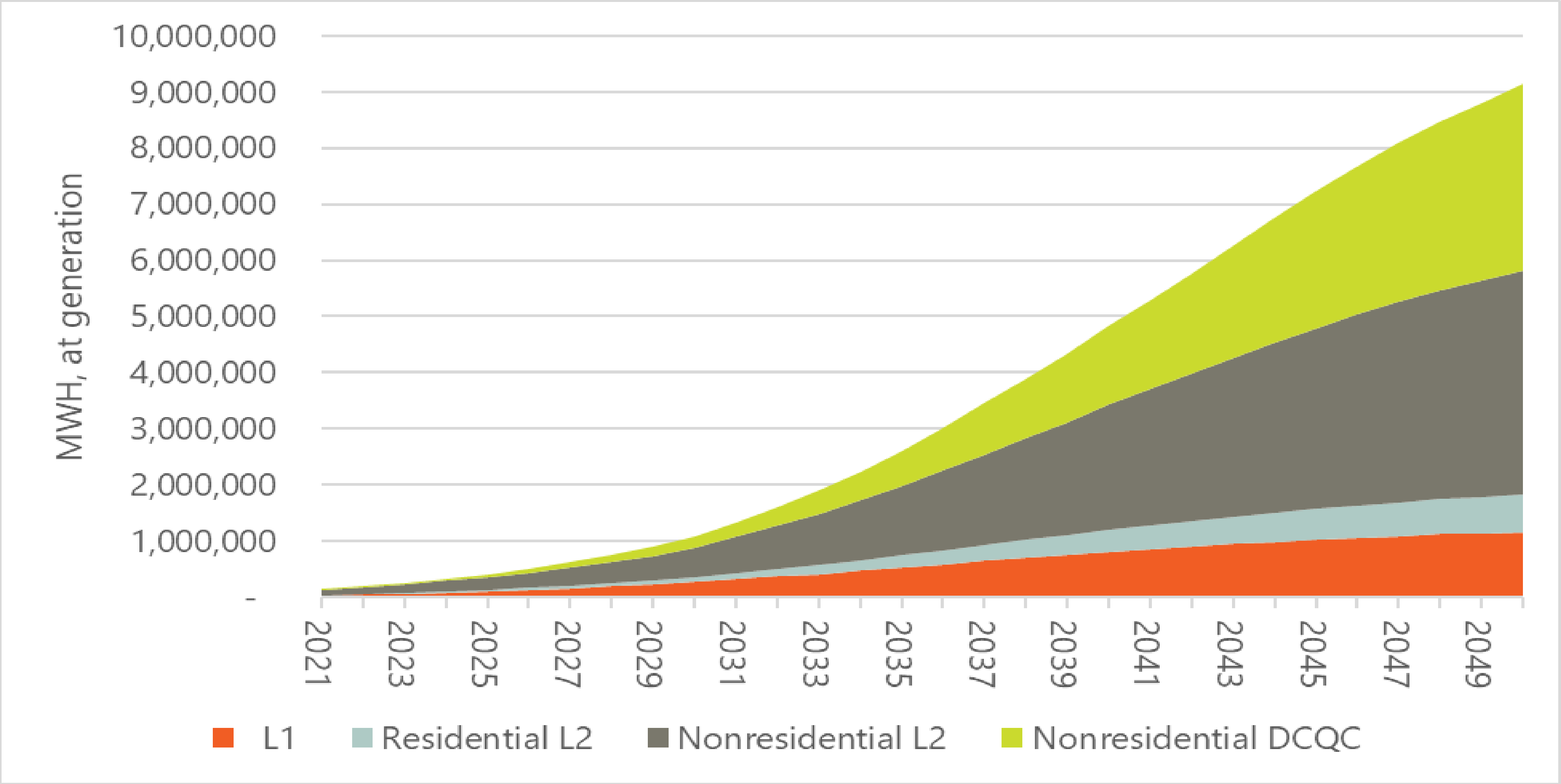


Charger forecasts



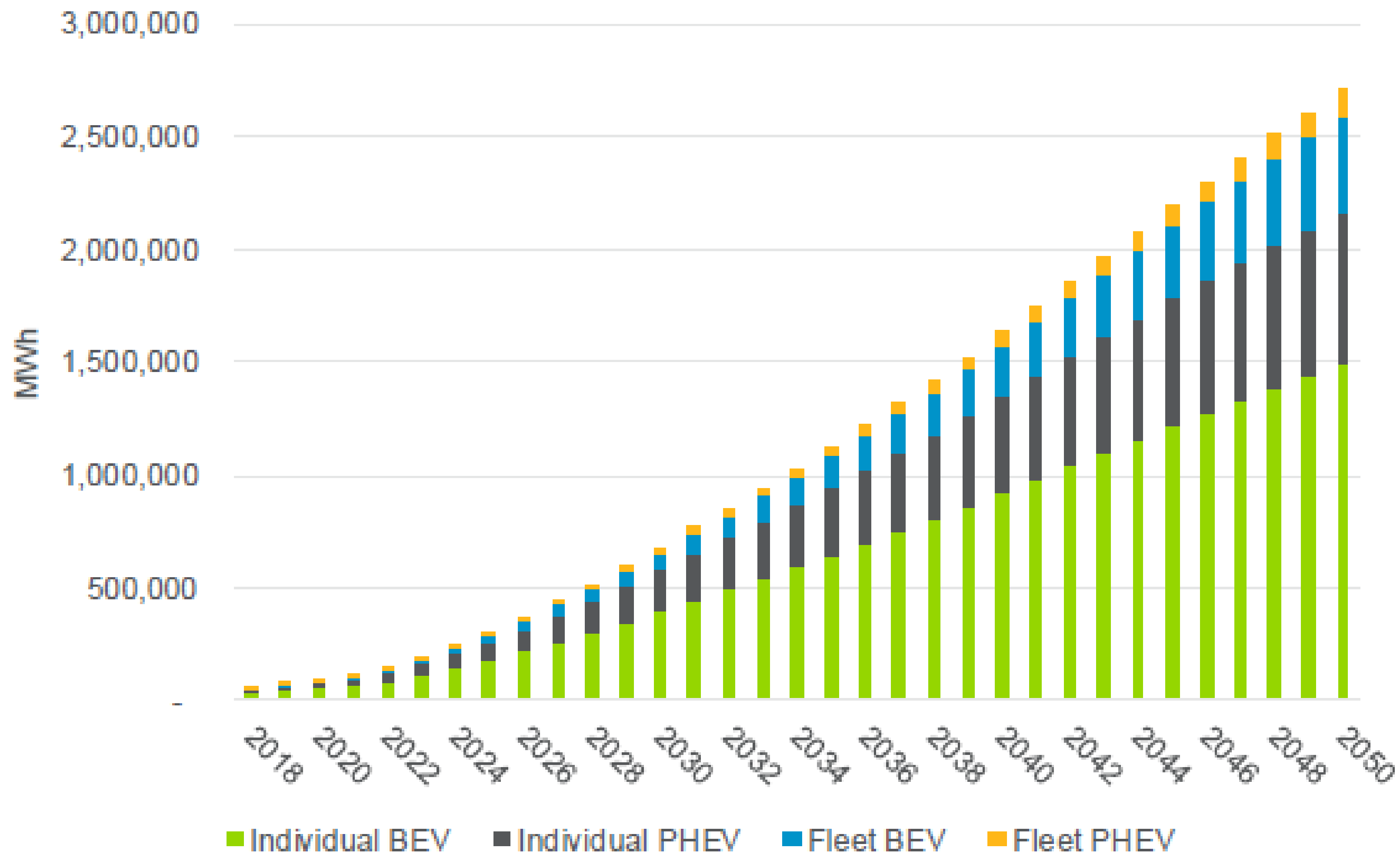


Transportation electrification energy impacts



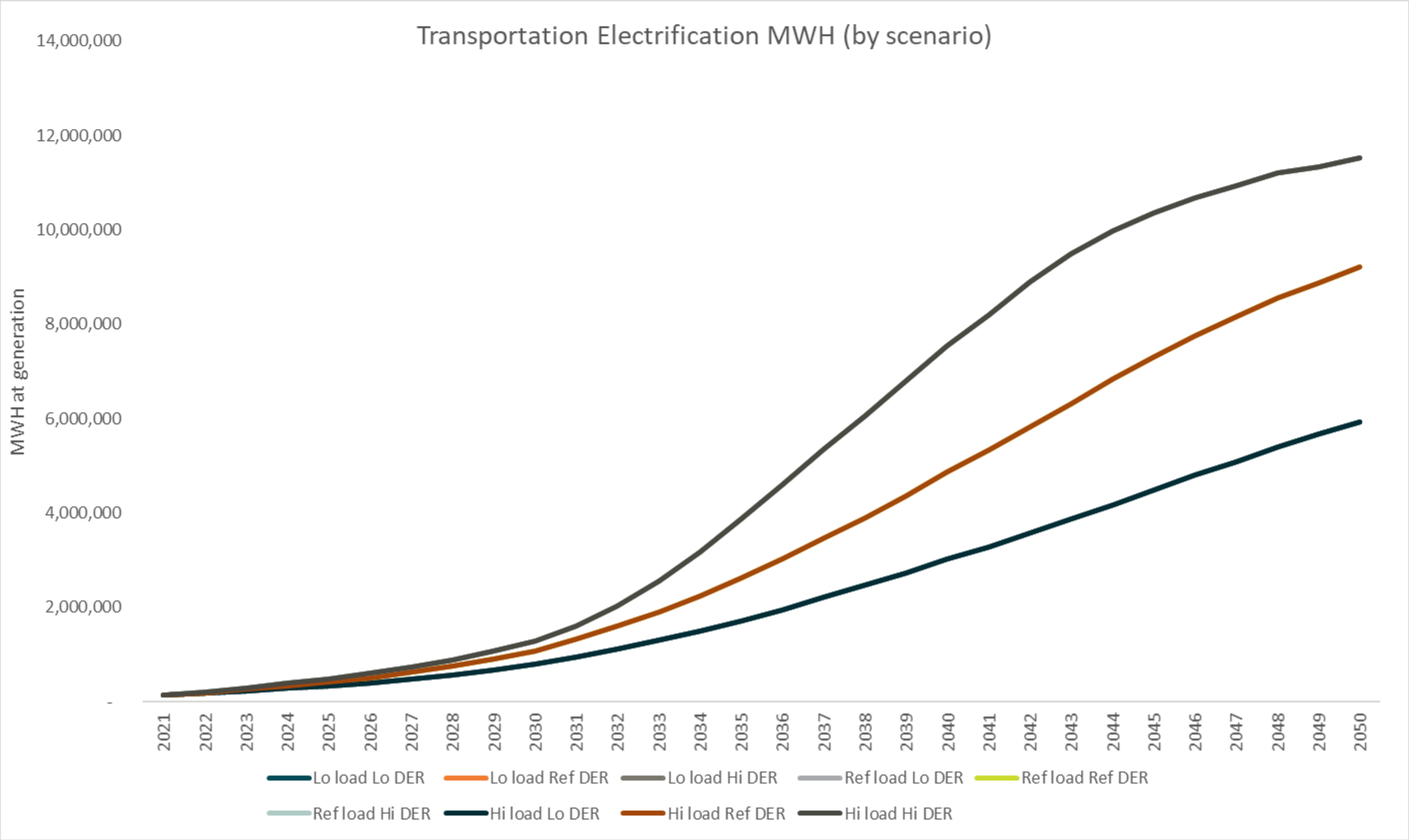
Benchmark

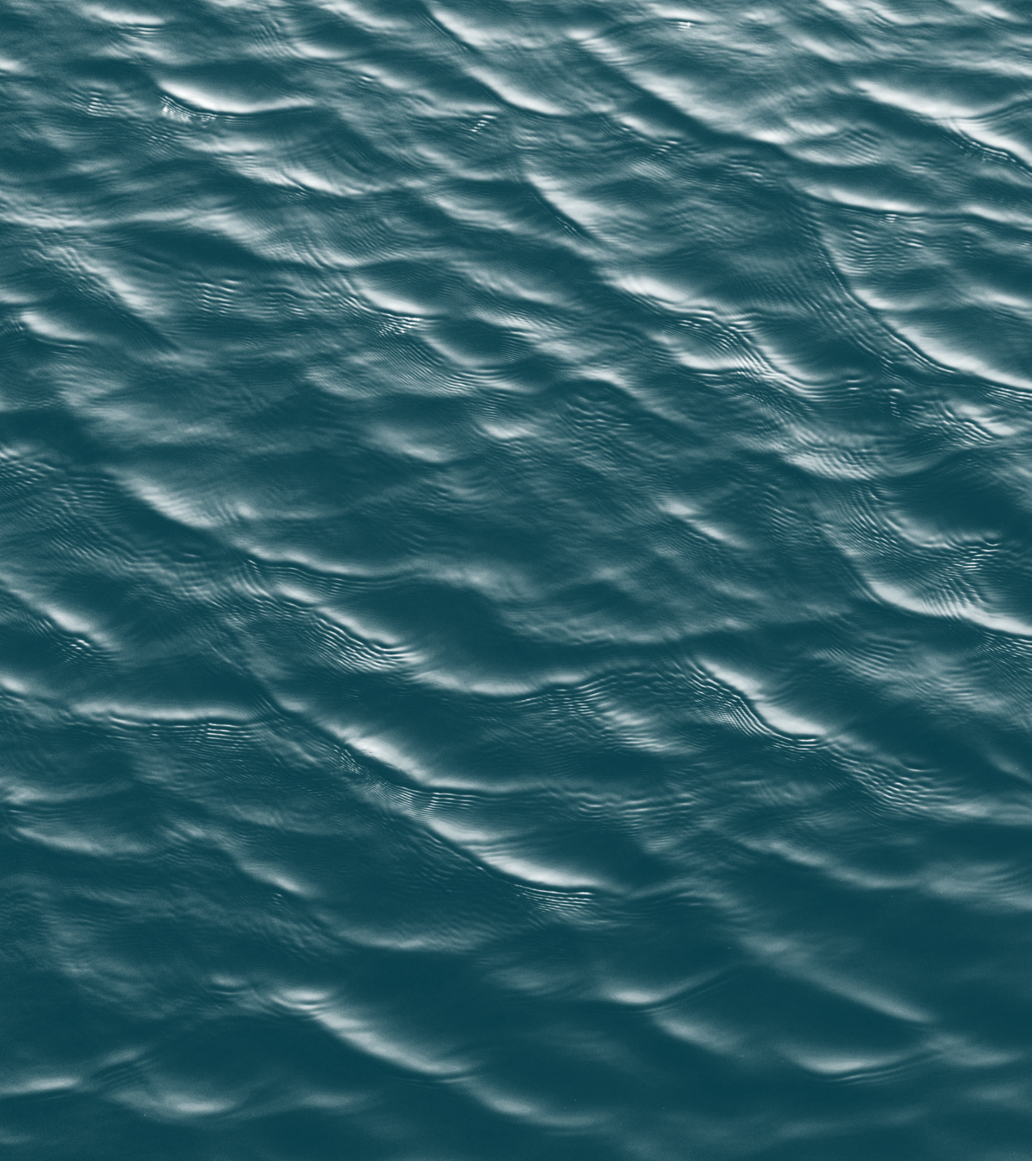
Figure 4. PGE System-Level Base Case LDV Energy Forecast (MWh)



Source: Navigant

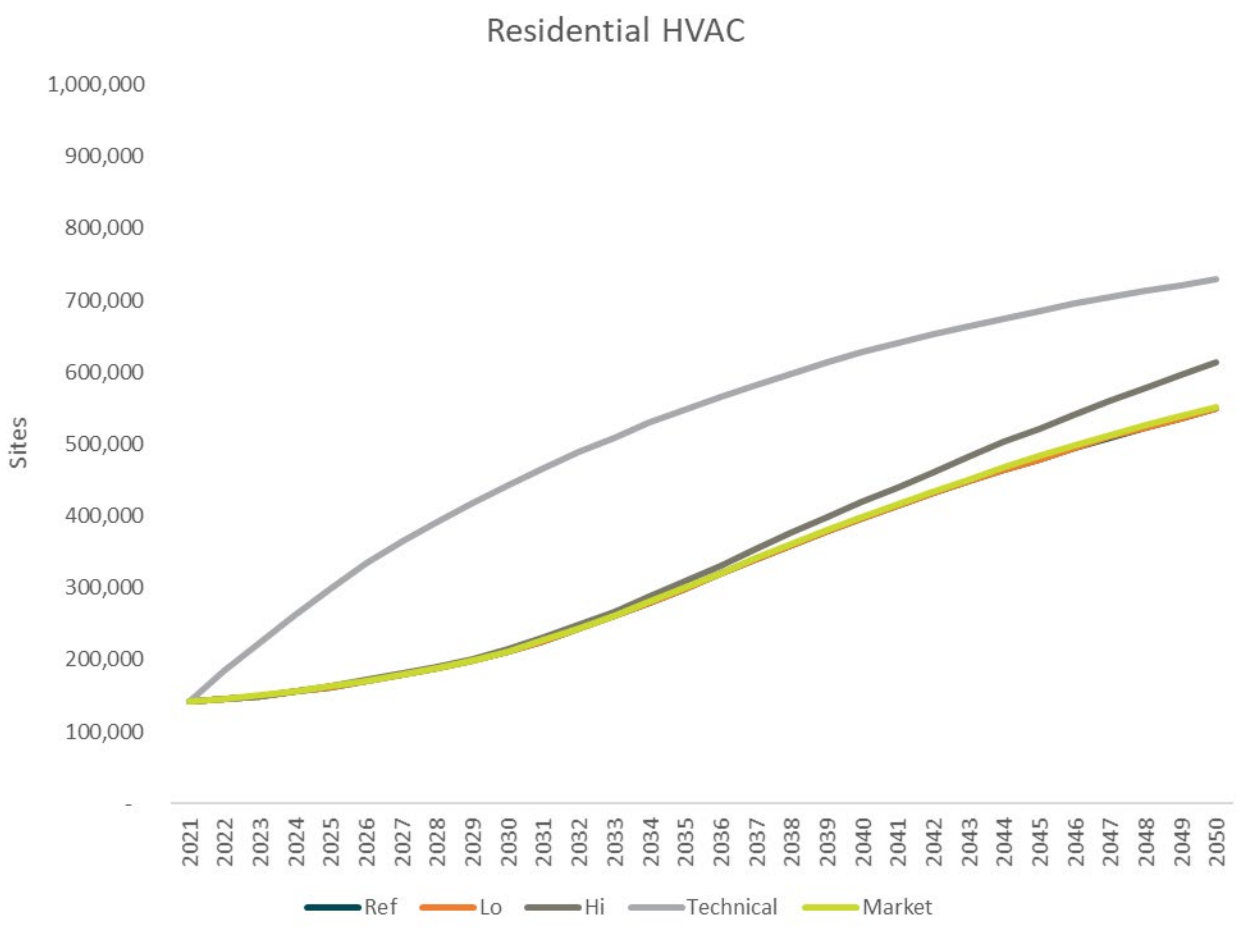
Transportation consumption by scenario



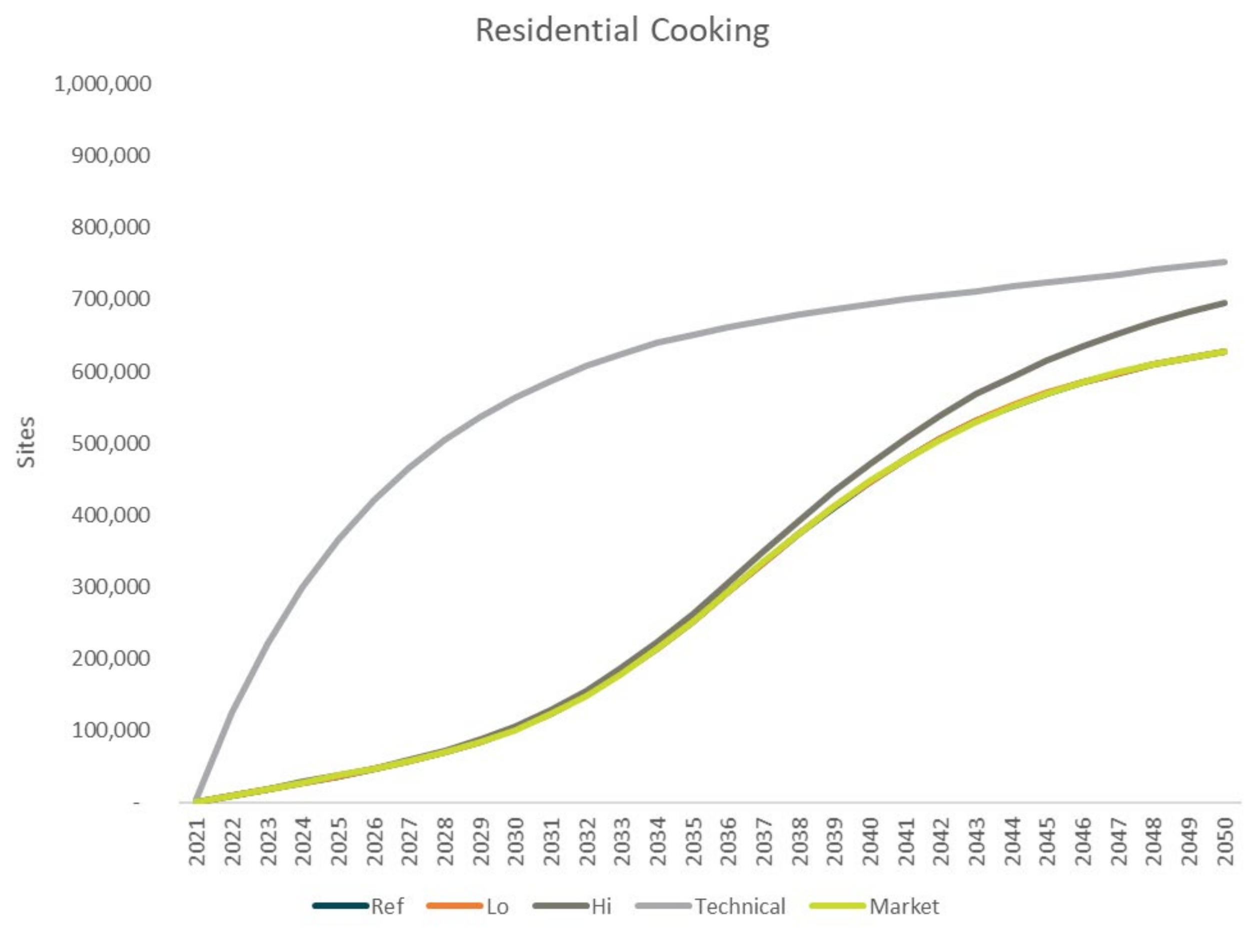


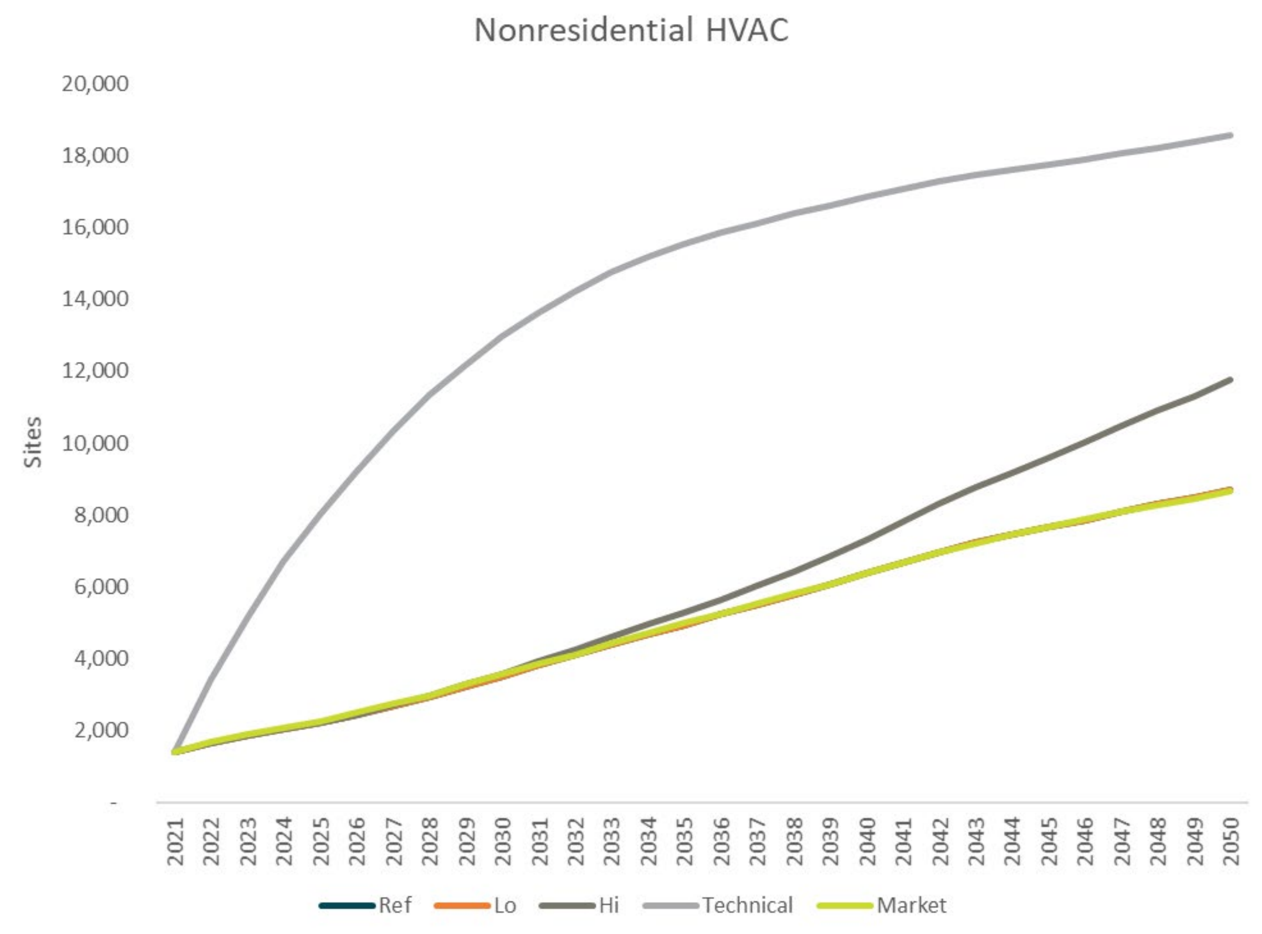
Buildings

Building electrification by measure

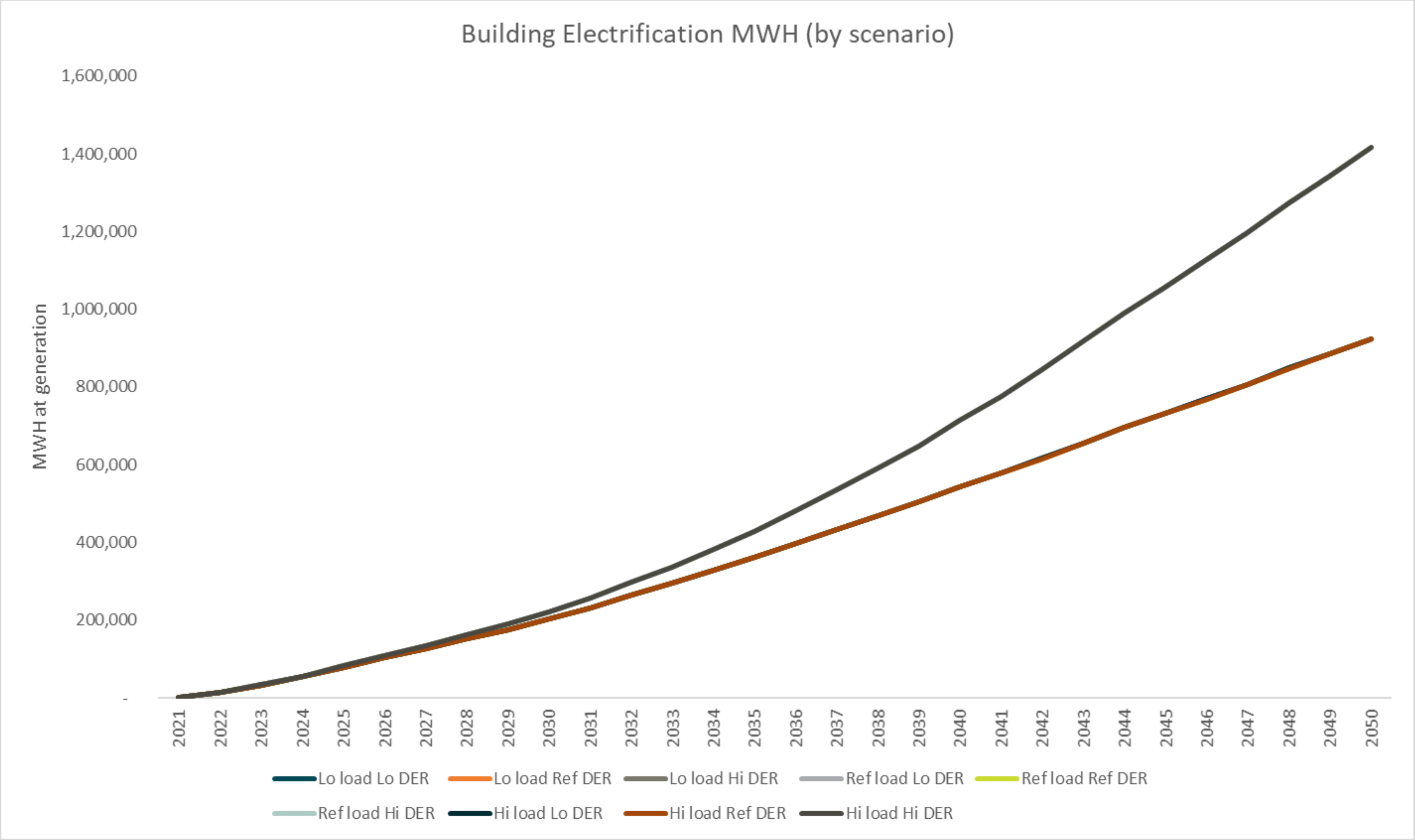


Building electrification by measure





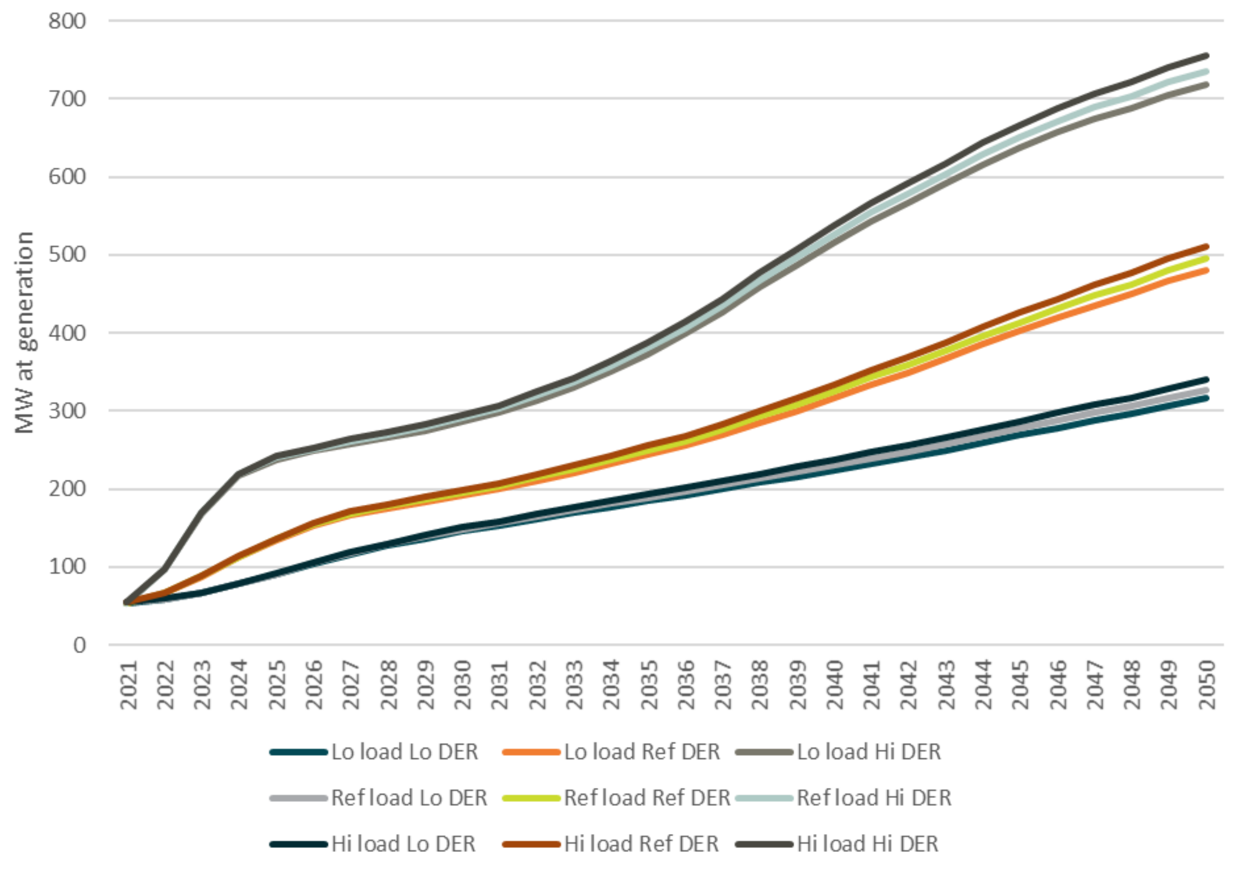
Building Electrification by scenario



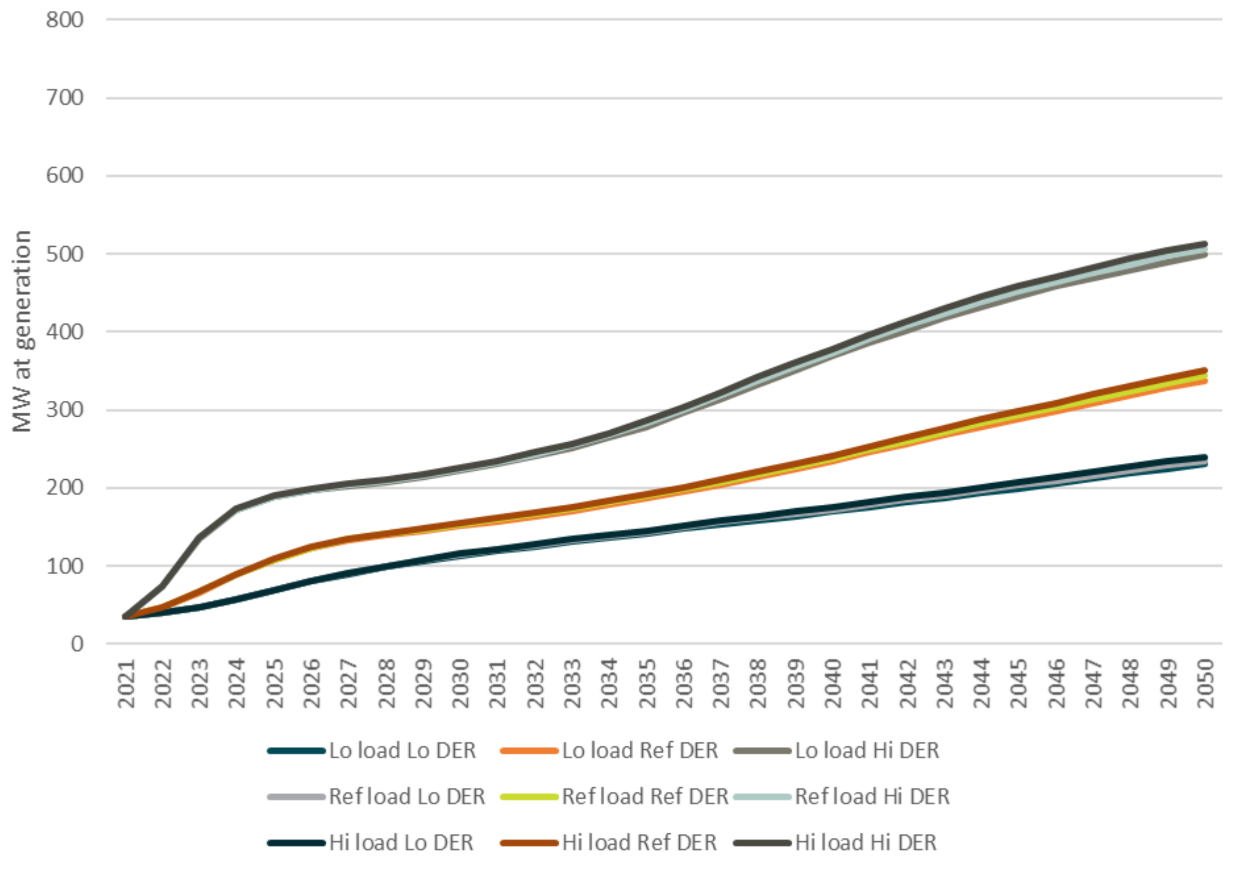
Flexible Loads

Flexible load resources by scenario

Summer

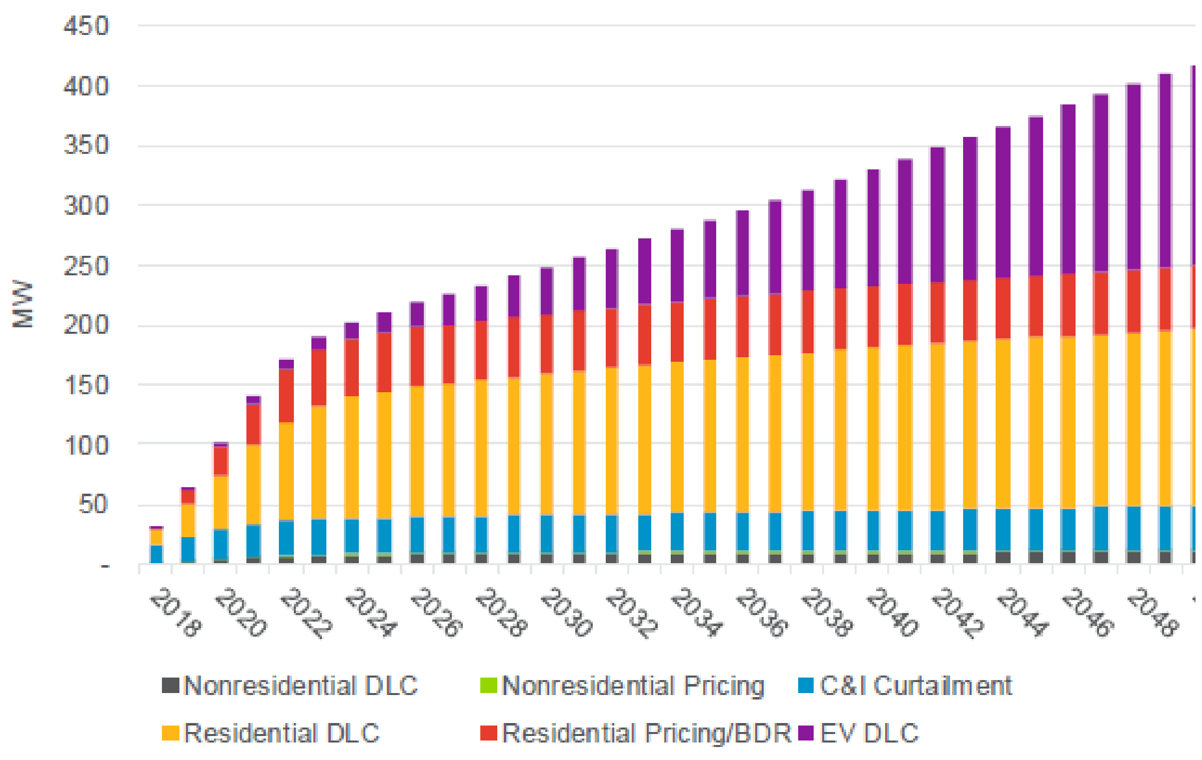


Winter



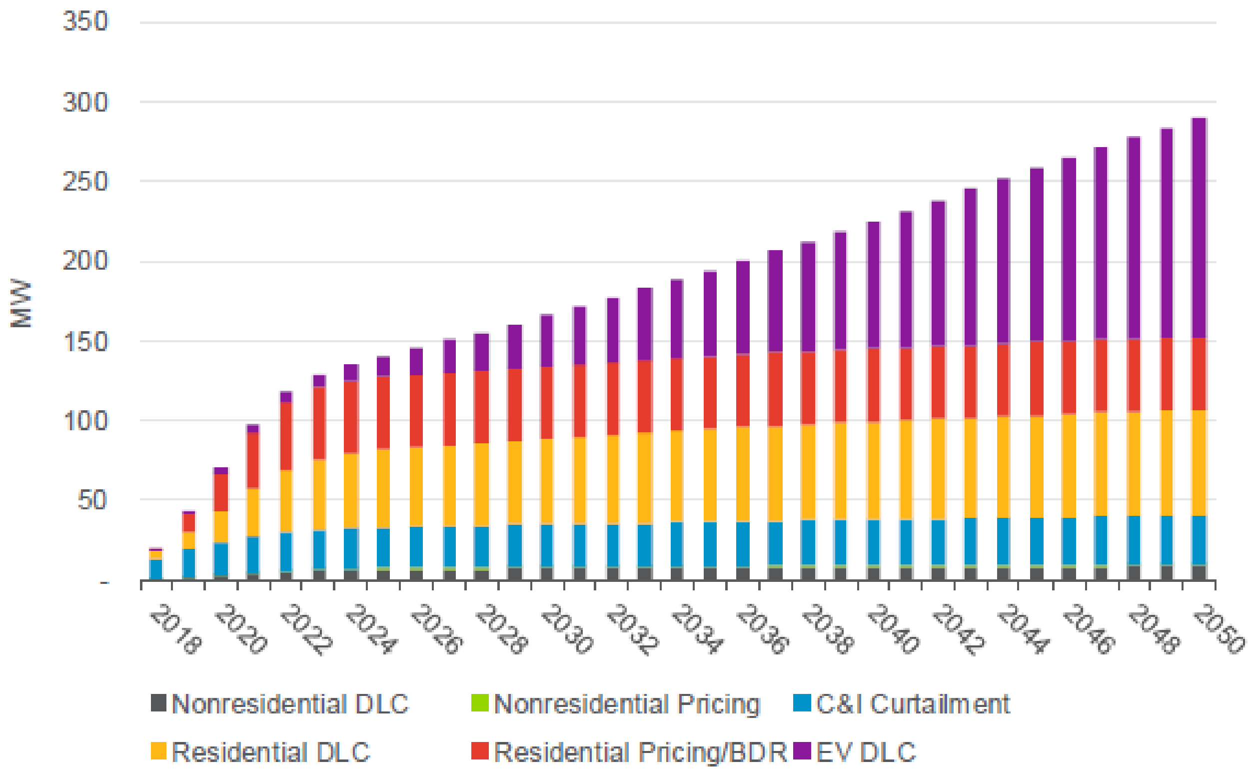
Benchmark

Figure 9. PGE System-Level Summer Peak Demand Reduction Forecast (MW)



Source: Navigant

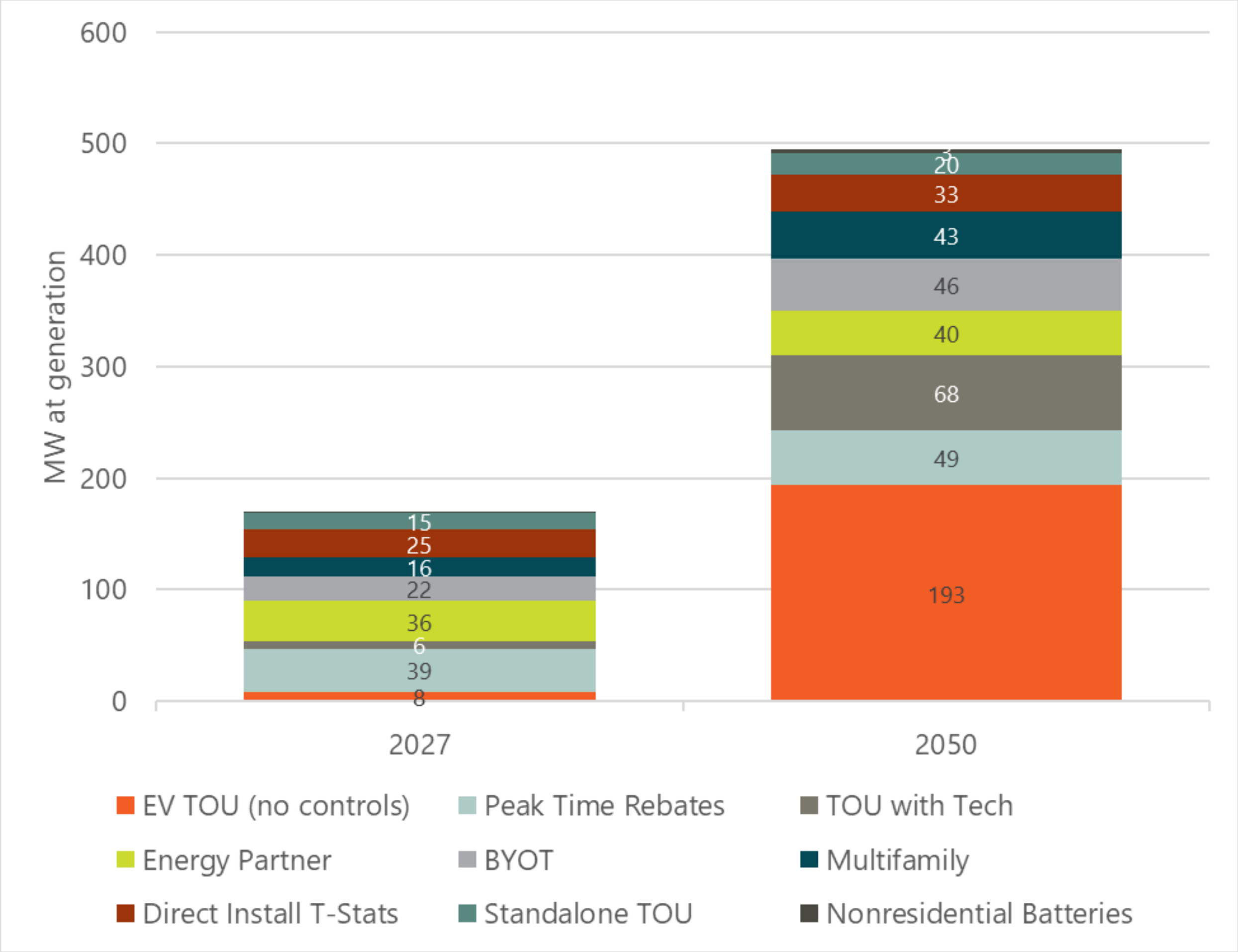
Figure 10. PGE System-Level Winter Peak Demand Reduction Forecast (MW)



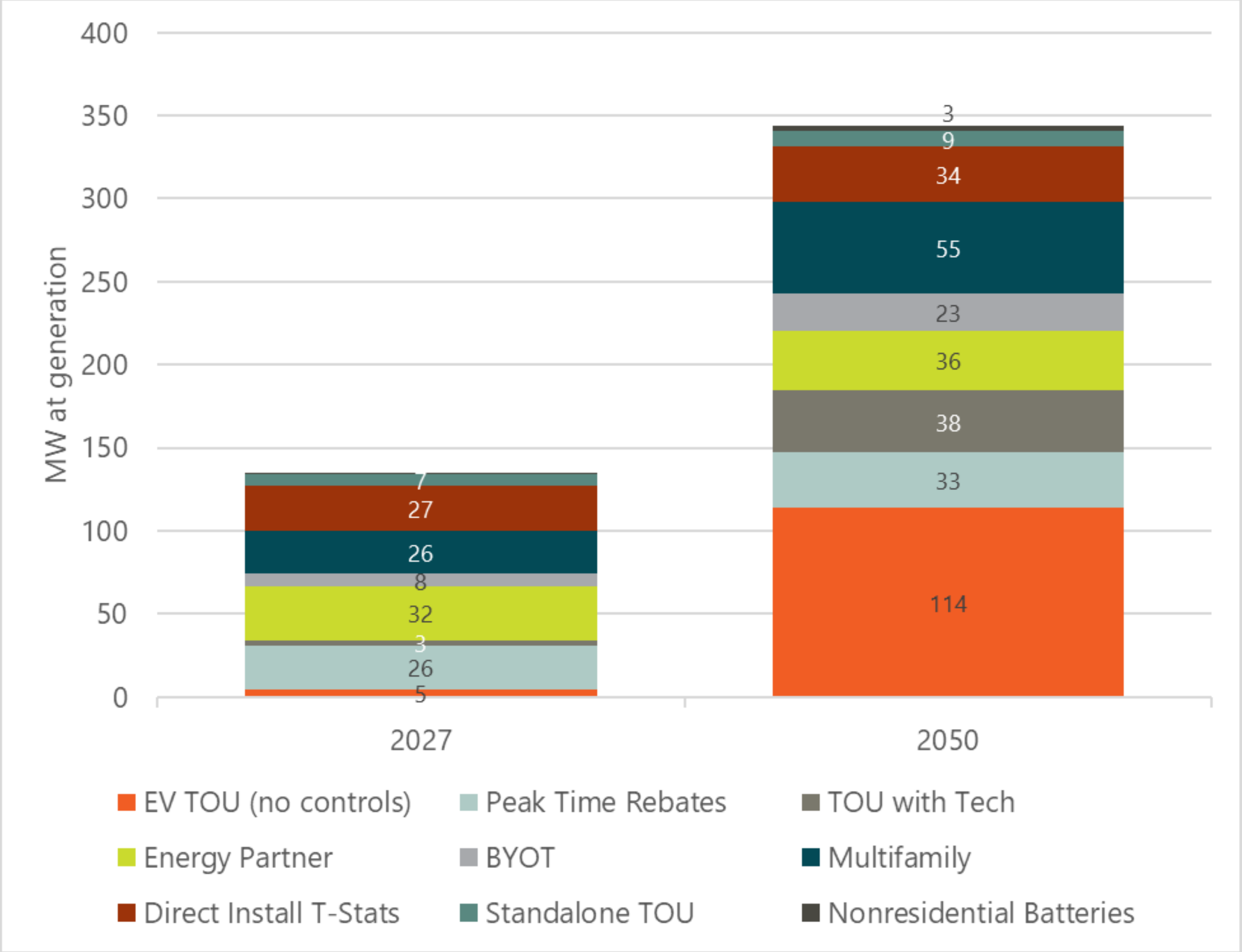
Source: Navigant

Economic achievable demand response

Summer



Winter

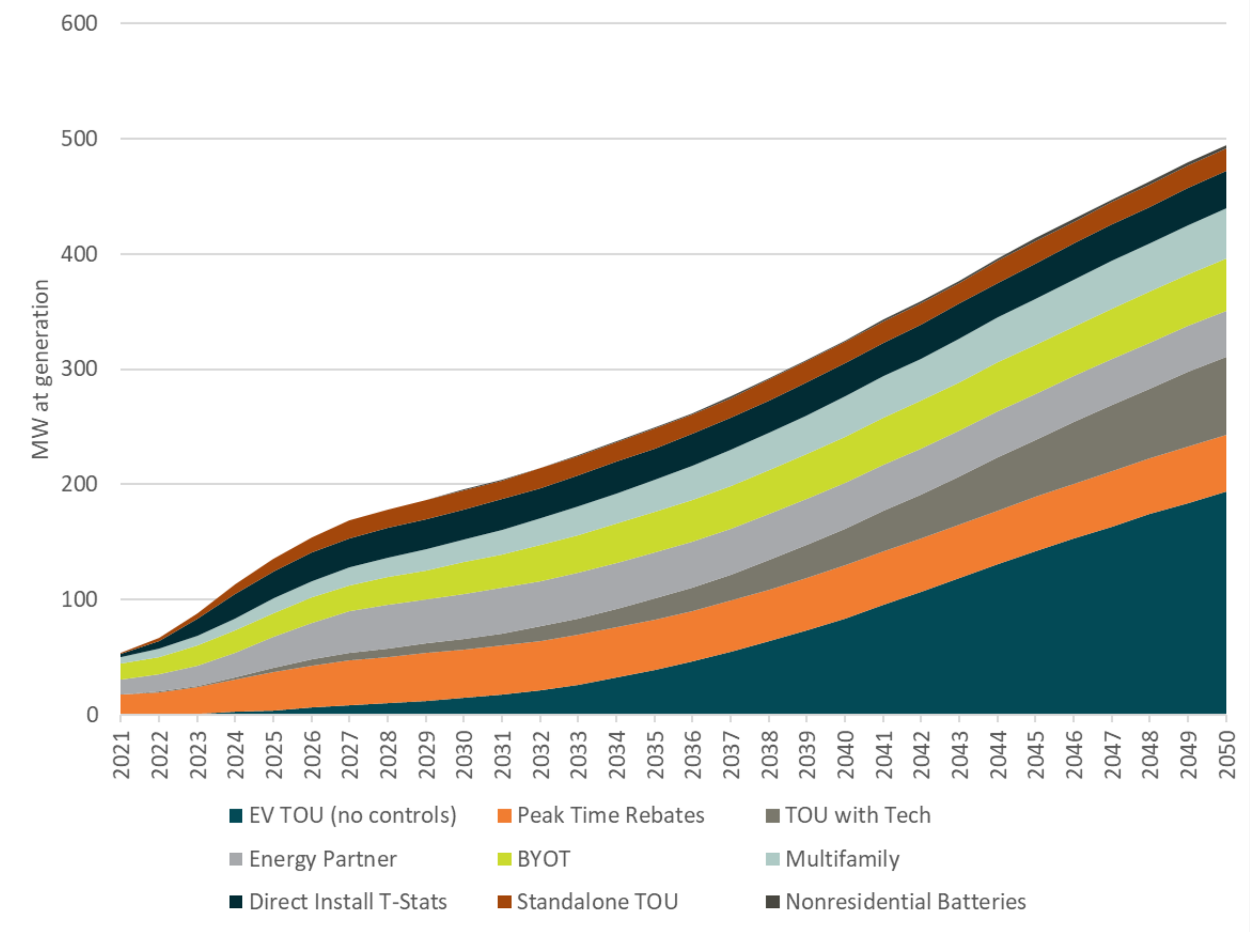


Results by scenario

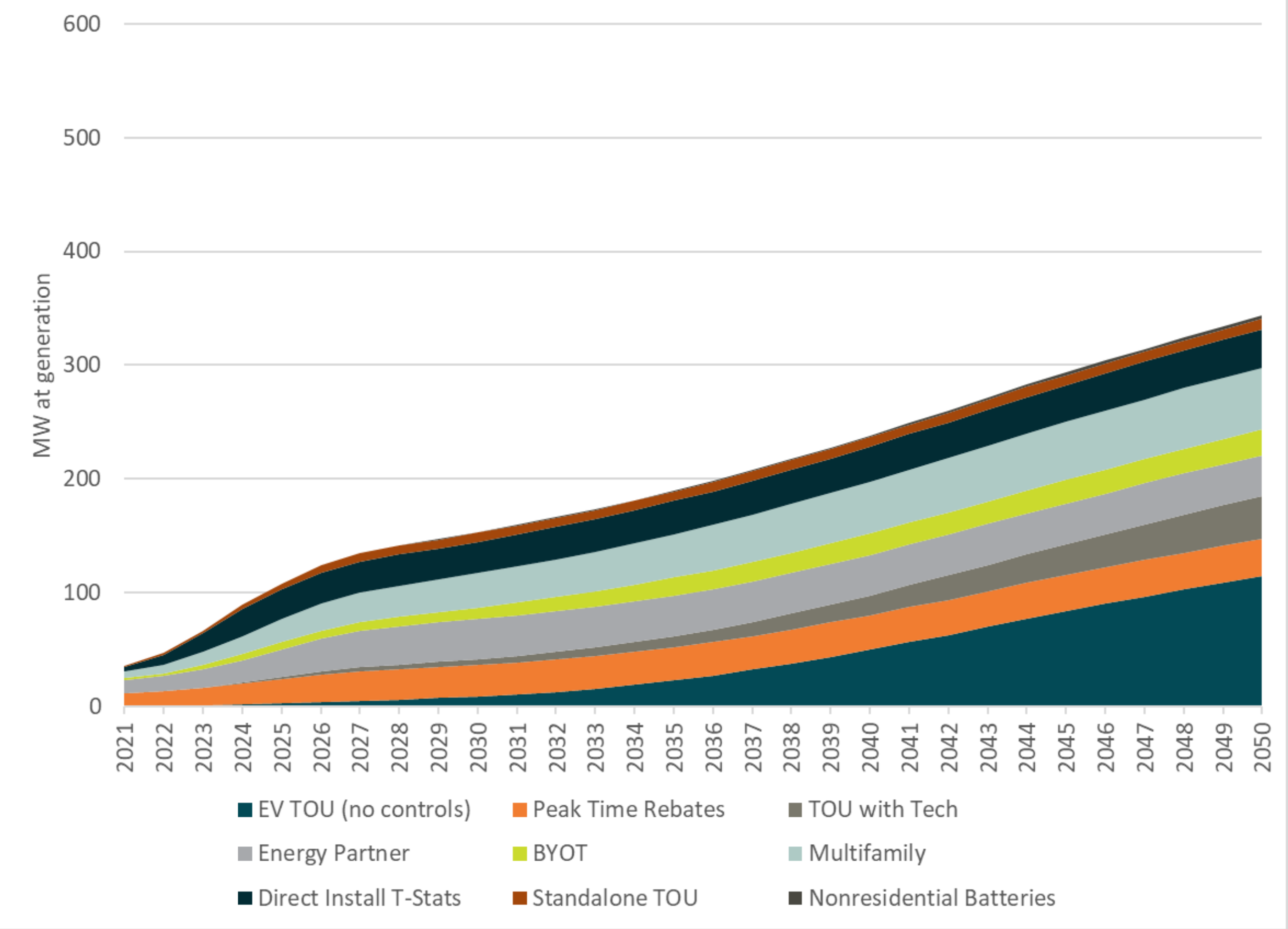
Scenario	Season	2027		2050	
		All Achievable	Economic Achievable	All Achievable	Economic Achievable
Reference	**Summer**	**207**	**169**	**598**	**495**
	Winter	**162**	**134**	**452**	**344**
Low	Summer	133	117	399	327
	Winter	100	91	310	235
High	Summer	298	261	912	735
	Winter	240	204	703	506

Economic potential by program

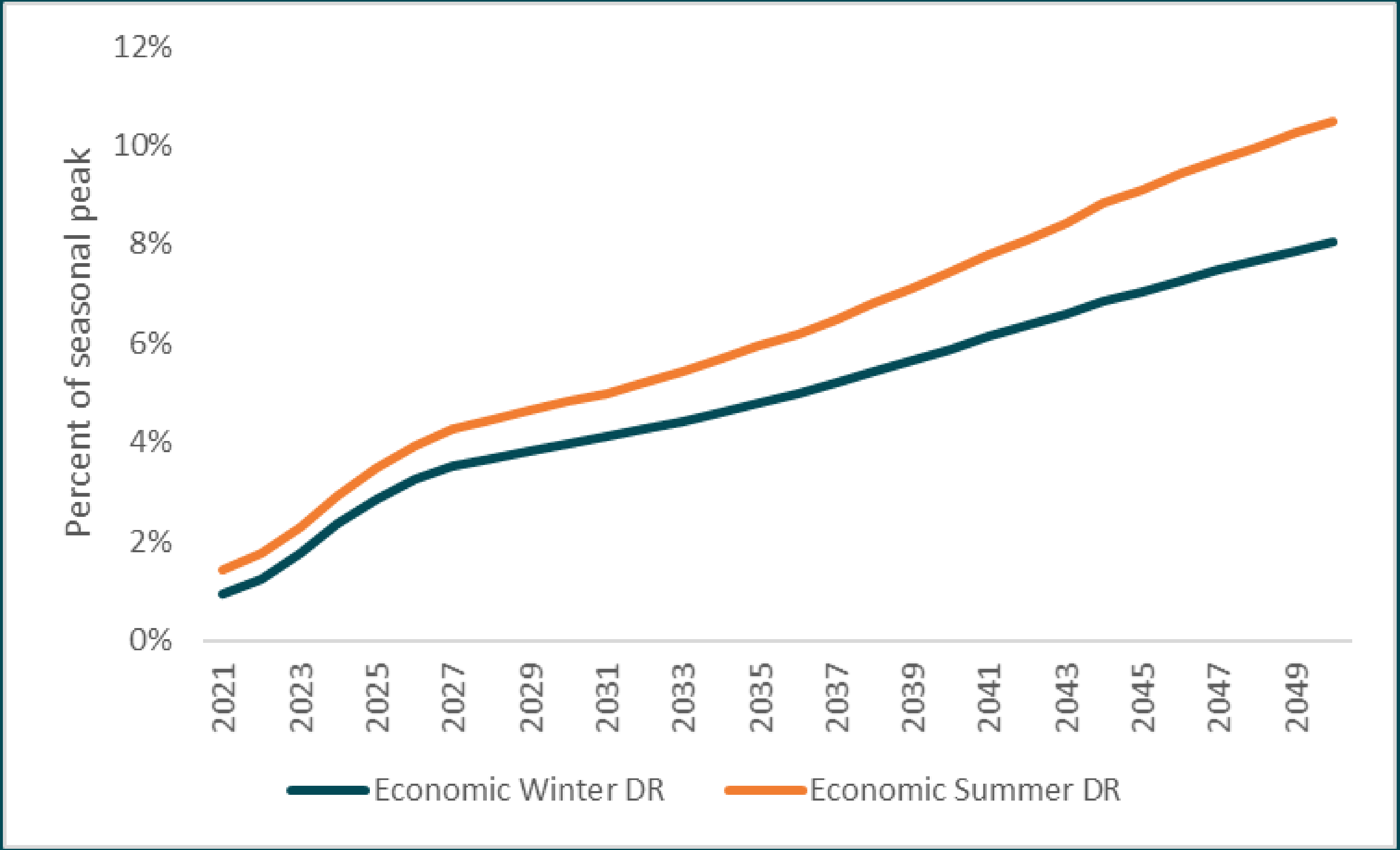
Summer



Winter

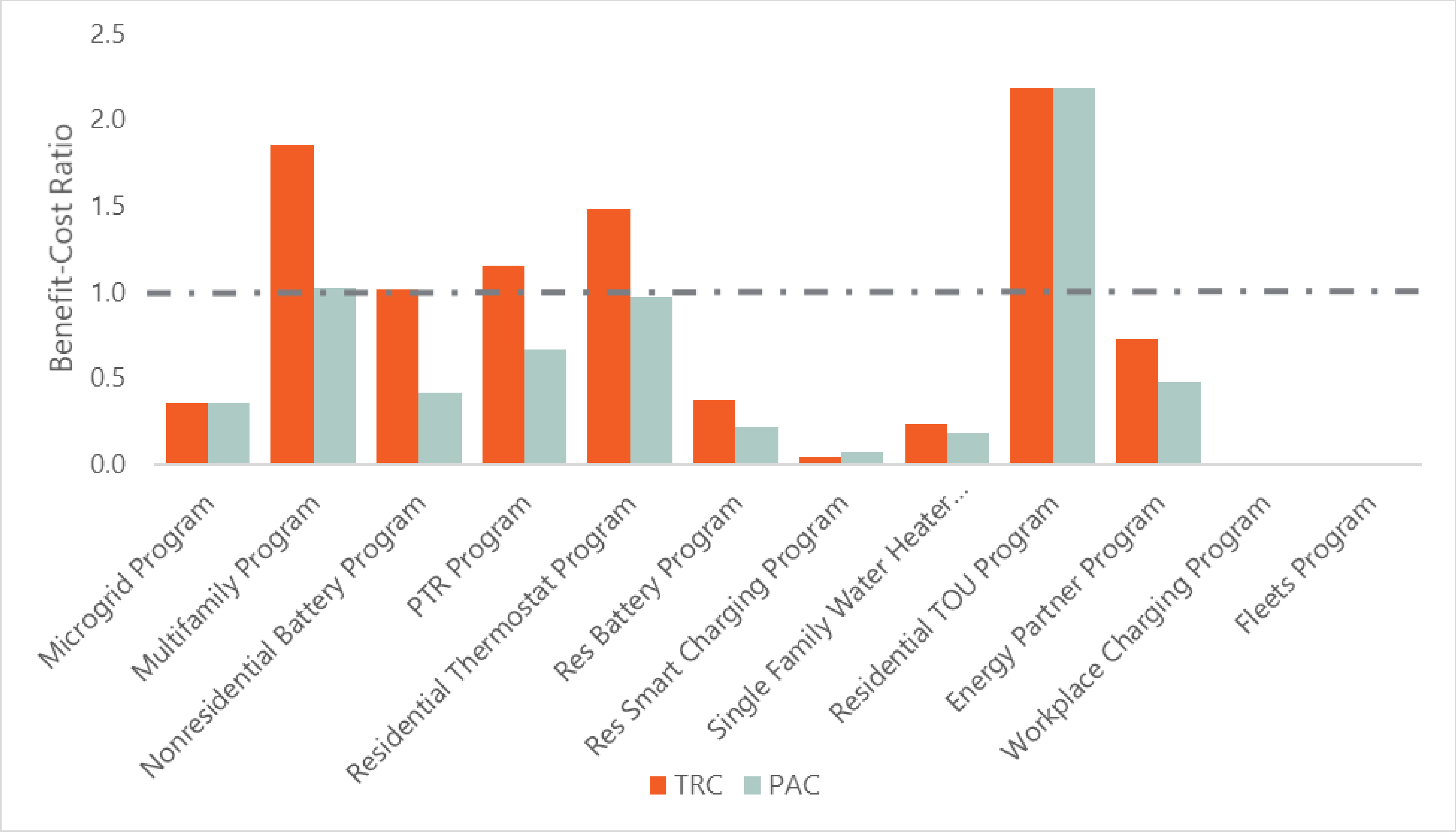


Demand response as a percent of seasonal peak

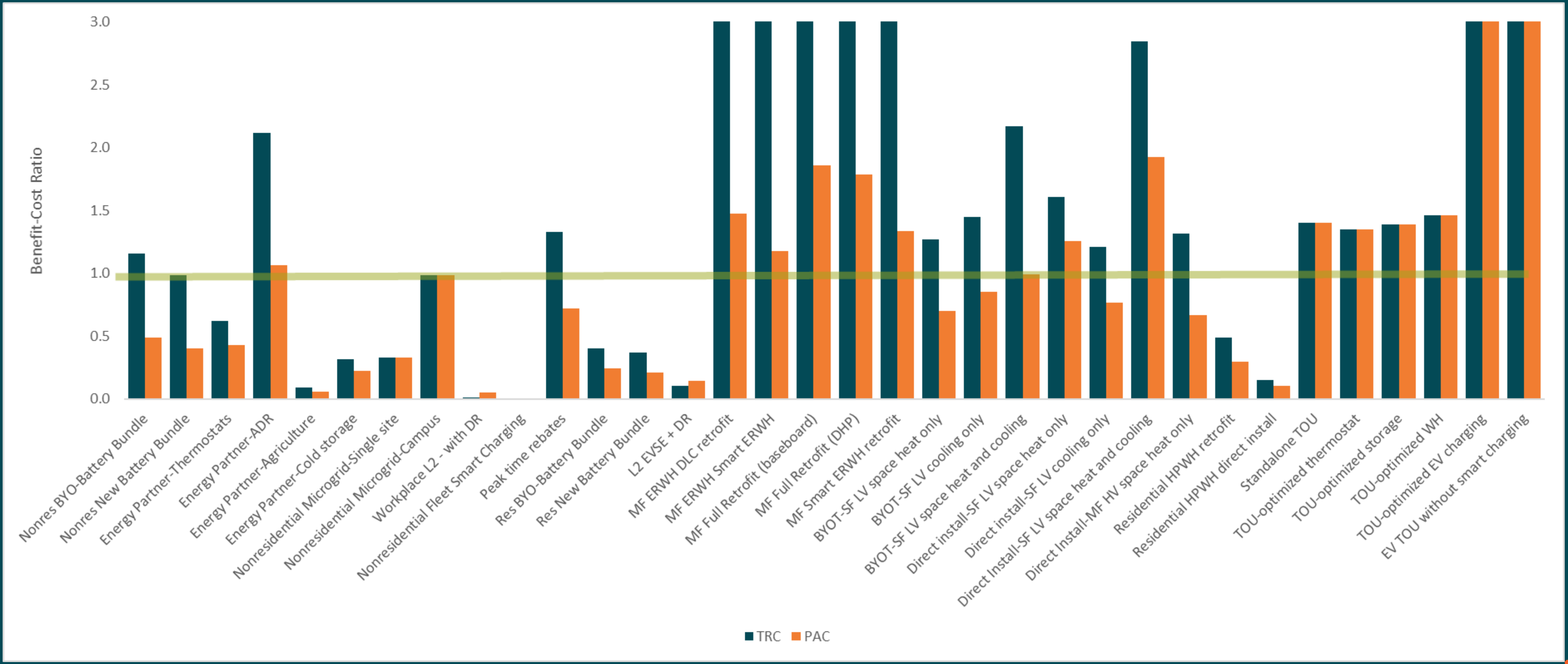


Cost-effectiveness

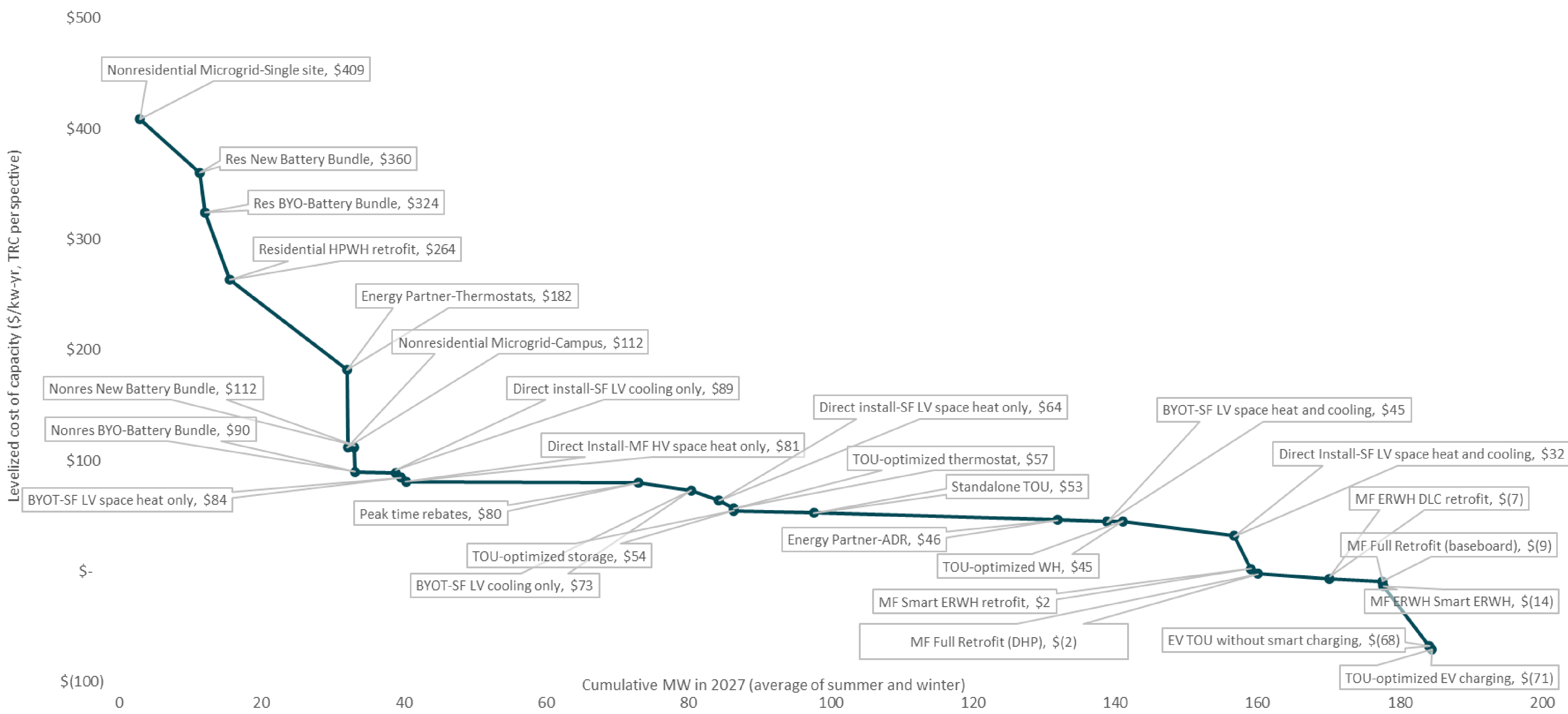
Program Benefit-cost ratios (reference)



Ratios by measure bundle (reference)



Supply curve (TRC basis, reference)



Conclusions and Next Steps

- So… what’s next?

Emerging trends

- Dramatically increasing adoption of residential solar expected to increase needs on distribution and encourage storage
- EVs will create unprecedented impacts and present growing opportunities for flexible loads
- Looking at historical trends in charging could dramatically underestimate need for shared/public charging
- Flexible loads are increasingly cost-effective and there are opportunities to integrate them with new DERs

Actionable insights

Achieving DR Targets

169 summer/134 winter MW of economic achievable DR by 2027, made largely of programs already in pilots

Continued focus on streamlining and scaling these programs will be critical

Continue exploring new channels/program designs to accelerate adoption

Rates + Tech

Time of use rates, particularly when paired with enabling tech, show promise to manage system peaks, particularly with EVs

Further work to deploy dynamic rates more rapidly could help PGE manage costs for all ratepayers

Storage within Reach

Storage and campus microgrids are nearly cost-effective

PGE should explore new opportunities to find cost savings and/or capture new value streams

Leveraging funds may present an opportunity to target underserved populations

Market Transformation

Our analysis of smart WH shows a growing opportunity for market transformation

We expect a program utilizing CTA-2045 more broadly would be very cost-effective

This approach could have value with other technologies as well

Next steps

- Integrating outputs into IRP analysis
- Developing locational forecasts with PGE team for DSP
- These forecasts will be integrated into DSP efforts, as well as complementary work:
  - Flex load program planning
  - Resilience products
  - TE planning and deployment
  - Product development

Questions?

Josh Keeling, Cadeo
jkeeling@cadeogroup.com

Appendix: Phase II Overview

Locational adoption

- Locational adoption a function of two factors:
  - Differences in measure feasibility/technical potential
  - Differences in adoption probability by location
- Modeled feasibility/technical potential at site level in phase I
  - Will conduct a review of all data inputs at onset to determine if refinements can be made for Phase II
  - Only other potential overlay would be locational codes
    - Will defer to PGE on recommendations there
- Feasibility will be the primary driver for locational adoption of DR and BE

Locational adoption: solar + storage

- Locational adoption probability will be used for solar + storage, transportation electrification
- Solar
  - Adoption modeled as a function of demographics, neighbor adoption, historical outages
  - Will fit propensity model based on historical adoption
- Storage
  - Will develop heuristic propensity model for storage based on secondary data (insufficient PGE data)
- Microgrid
  - Will develop heuristic propensity model for storage based on secondary data and discussion with PGE staff

Locational adoption: transportation

- Fleet (vehicles and charging)
  - Adoption mapped based on existing customer projections, heuristic propensity developed with PGE
- LDVs (and any accompanying private chargers)
  - Adoption modeled as a function of charger feasibility, public charging proximity, demographics, neighbor adoption, historical outages
  - Will fit propensity model based on historical adoption
- Public chargers
  - Scaled up based on bass curve applied to on-site unmet charging demand
  - L2 allocation between workplace and public based on EVI-Pro
  - Workplace sites allocated based on employee count and green score
  - Public sites allocated based on predictive model using proximity of LDVs w/o home charging, density, VMT, presence of retail, major roadways

Load research and forecasting

- Will develop individual CalTRACK models at the customer level for:
  - All customers at Schedule 83 or above
  - 10% sample of all other customers, stratified by feeder
- Individual profiles will be mapped to non-sampled customers and new customers
- Weighting factors will be developed using SCADA data at the feeder level for each customer
- Baseline gross forecasts at the feeder level weight calculated against system forecast

Load research and forecasting

- Locational adoption provides DER shapes to be added to gross load
- Net load shapes will be aggregated to the feeder level using statistically derived weights
- Reporting then done at the feeder level

QUESTIONS/ DISCUSSION?

PORTFOLIO REQUESTS FROM PARTICIPANTS

SETH WIGGINS

ROUNDTABLE 21-3

PORTFOLIO REQUESTS

- Our portfolio optimization model ROSE-E has flexibility to evaluate any specific resource/size/year combination
  - ⑩ For example, we could estimate the portfolio effects of adding 235 MW of SE Washington wind in 2036 and/or 150 MW of 6-hr batteries in 2026
  - ⑩ In the 2019 IRP, we used this capability to evaluate the size and timing of 16 different renewable additions MW/year combinations

- We are open to any suggestions for portfolio questions to be evaluated
  - Please contact us (email: IRP@PGN.com)

QUESTIONS/DISCUSSION?

NEXT STEPS

A recording from today's webinar will be available in one week





THANK YOU

CONTACT US AT:
IRP@PGN.COM

ATTACHMENT A: ACRONYMS

ADR = Auto Demand Response

BE = Building Electrification

BTM = Behind-the-meter

BYO = Bring your own

BYOT = Bring your own thermostat

CE = Cost effectiveness

C&I = Commercial & Industrial

DCFC = Direct Current Fast Charge

DER = Distributed Energy Resource

DHP = Ductless Heat Pump

DLC = Direct Load Control

DR = Demand Response

DSP = Distribution System Plan

ERWH = Electric Resistance Water Heater

EV = Electric Vehicle

EVSE = Electric Vehicle Supply Equipment

HDV = Heavy Duty Vehicle

HVAC = Heating, Ventilation, & Air Conditioning

IRP = Integrated Resource Plan

kW = kiloWatt

L1/L2 = Level 1 / Level 2 EV charging

LDV = Light Duty Vehicle

LV = low-voltage

MDV = Medium Duty Vehicle

MF = Multifamily

MUD = Multi-user dweilling

NREL = National Renewable Energy Lab

PAC = Program Administrator Cost test

PTR = Peak Time Rebate

PV = Photovoltaic

SCADA = Supervisory Control and Data Acquisition

SF = Single Family

SGIP = Self-generation Incentive Program

TE = Transportation Electrification

TOU = Time of Use

TRC = Total Resource Cost test

USDOE = United States Department of Energy

WH = Water Heater

VMT = Vehicle Miles Traveled

VRF = Variable Refrigerant Flow

ZEV = Zero Emission Vehicle