DOCKETED	
Docket Number:	23-SB-100
Project Title:	SB 100 Joint Agency Report
TN #:	258363
Document Title:	Senate Bill 100 Demand Scenarios Demand Flexibility Resource Potential
Description:	**This document supersedes TN # 258330**
Filer:	J Padilla
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	8/7/2024 8:37:42 AM
Docketed Date:	8/7/2024

SB 100 Demand Scenarios: Demand Flexibility (DF) Resource Potential

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August 7, 2024

Agenda

- Purpose and Context
- Overview of Current Work
- Methodology and Sources
- Inputs for Production Cost Modeling
- Demand Flexibility Potential Results

Acronyms and Initialisms

AAEE – Additional Achievable Energy Efficiency

AAFS – Additional Achievable Fuel Substitution

BTM – Behind the meter

CAISO – California Independent System Operator

CARB – California Air Resources Board

CEC – California Energy Commission

CPUC – California Public Utilities Commission

DF – Demand Flexibility

DS – Demand Scenario

LSG - Load Shift Goal

LBNL - Lawrence Berkeley National Lab

MF = Multi-Family

PCM – Production Cost Model

SF = Single Family

TE – Transportation Electrification

Past CEC & Interagency efforts analyzing Demand Flexibility Potential

Keeping the lights on and emissions low!

- In 2020, the CEC engaged Guidehouse to develop a tool with which to ***estimate statewide potential for demand flexibility.***
- First iteration of the D-Flex Tool customized for **setting California's LSG** under Senate Bill 846 in 2023
- CEC facilitated an interagency working group to use the D-Flex tool for analysis of load shift potential and development of policy recommendations

New Use for D-Flex Tool for DS & SB 100

- Generate potentials for each hour of the year for use in the PCM
- Establish operation parameters (e.g., limited flex events in a day)
- Cost estimates for D-Flex options
- Not directly comparable to a load modifier

D-Flex Tool Basics

- Shed/Shift across multiple technologies
  - Four Sectors
  - 34 building types/segments
  - DERs such as EVs and BTM storage
- Draws on existing research from LBNL (supported by CPUC)

DF Potential Development

Note potential estimates are only for event-based, economically-dispatched programmatic interventions, not dynamic rates/CalFUSE

DF Tool Functionality Overview

1. Hourly Gross Load and Capacity Estimates

Estimate magnitude of resource that can be leveraged for DF:

- **Gross building load** by end use, including EV charging
- **Available capacity** from BTM battery and EV V2X resources

2. Apply DF Parameters and Assumptions

Calculate **hourly load reduction potential** for 38 DF options using:

- **Eligibility/Capability Per centage**
- **Participation Percentage**
- **Unit Impacts Load Dispatch**

3. Group and Simplify Results for use in PCM

Simplify DF tool outputs for use in the PCM:

- **Group 38 DF options into 7 resources**
- **Group resources into PAs**
- **Develop average 24-hour profiles by month**

Caveats on the D-Flex Tool

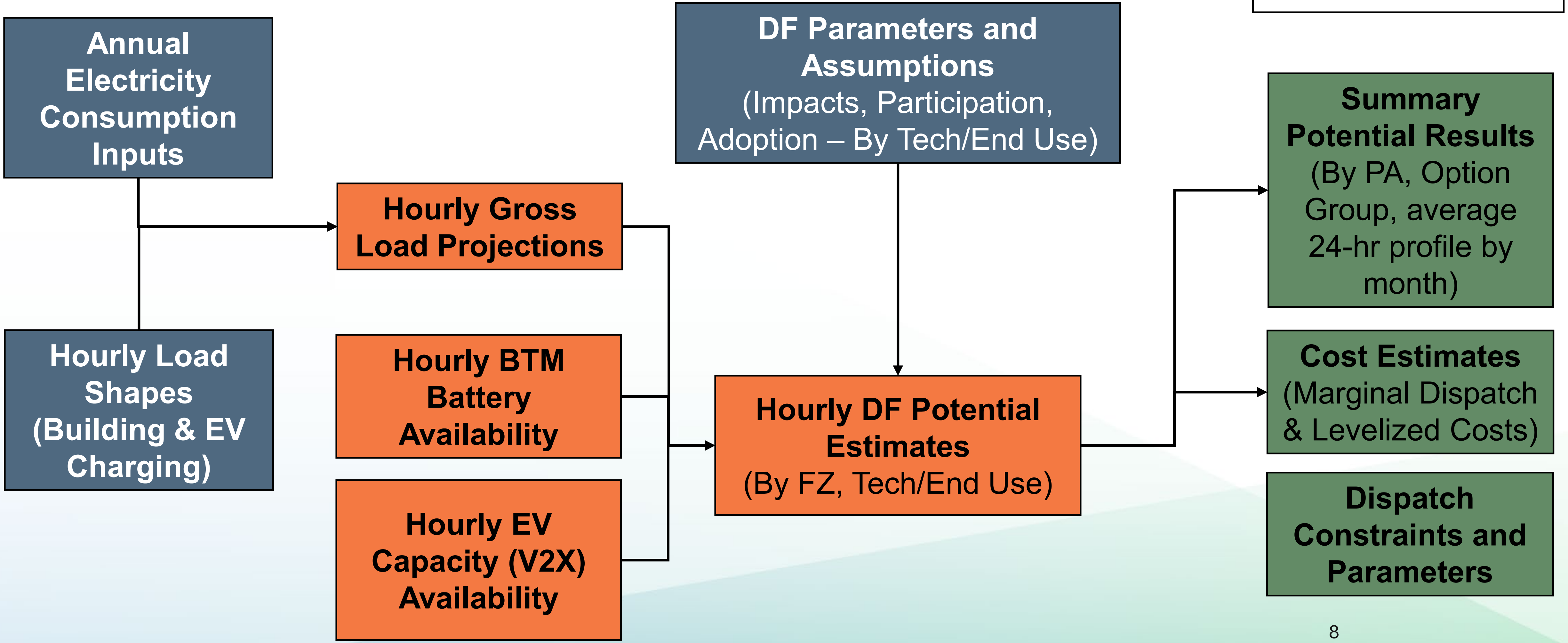
- DF potentials represent availability estimates of load reduction or load shifting that could be realized in future programmatic constructs.
  - By itself, it does not contain any predictions about when or to what extent DF resources are dispatched or utilized.
- DF resources are one component of the resource mix in the PCM for the SB 100 modeling.
- The final SB 100 analysis will likely contain only a portion of the potential load shed/shift resources as selected by the PCM.

DF Potential Flowchart

Legend
Input
Calculation
Result for PCM

Goal: Forecast Hourly DF Potential Resource "Availability"

Granularity: Forecast Zone (FZ), Sector, Size, Building Type, End Use



DF Potential Data Sources [1]

Legend
- Input
- Calculation
- Result for PCM

Goal: Forecast Hourly DF Potential Resource "Availability"

Granularity: Forecast Zone (FZ), Sector, Size, Building Type, End Use

Annual Electricity Consumption Inputs

Demand Forecast Inputs (IEPR)
- Baseline consumption forecast
- AAEE and AAFS load modifiers
- TE forecasts
- BTM storage forecasts

Hourly Gross Load Projections

Hourly Load Shapes (Building & EV Charging)

LBNL DR Potential Study (Phase 4)
- Building load shapes, derived from IOU AMI data

CEC TE Forecast
- EV charging load shapes

Hourly EV Capacity (V2X) Availability

Summary Potential Results (By PA, Option Group, average 24-hr profile by month)

Cost Estimates (Marginal Dispatch & Levelized Costs)

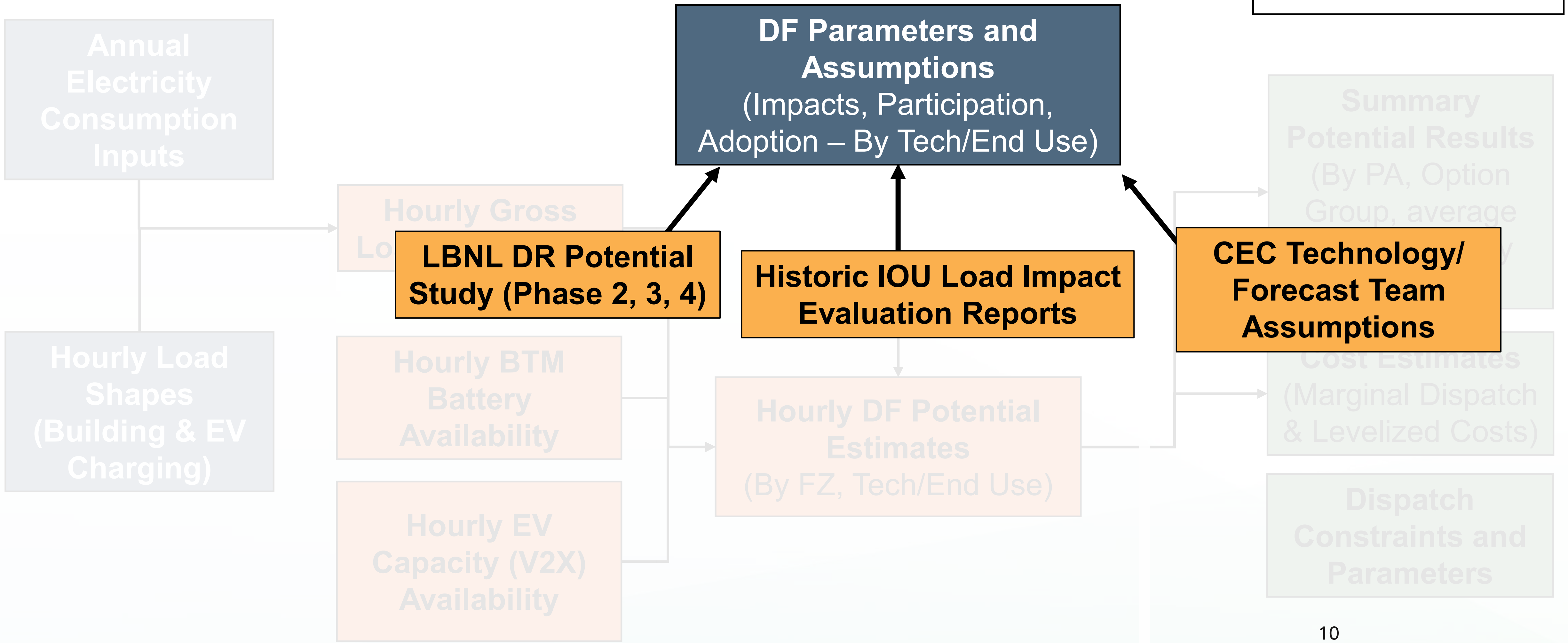
Dispatch Cost Constraints and Parameters

DF Potential Data Sources [2]

Legend
- Input
- Calculation
- Result for PCM

Goal: Forecast Hourly DF Potential Resource "Availability"

Granularity: Forecast Zone (FZ), Sector, Size, Building Type, End Use

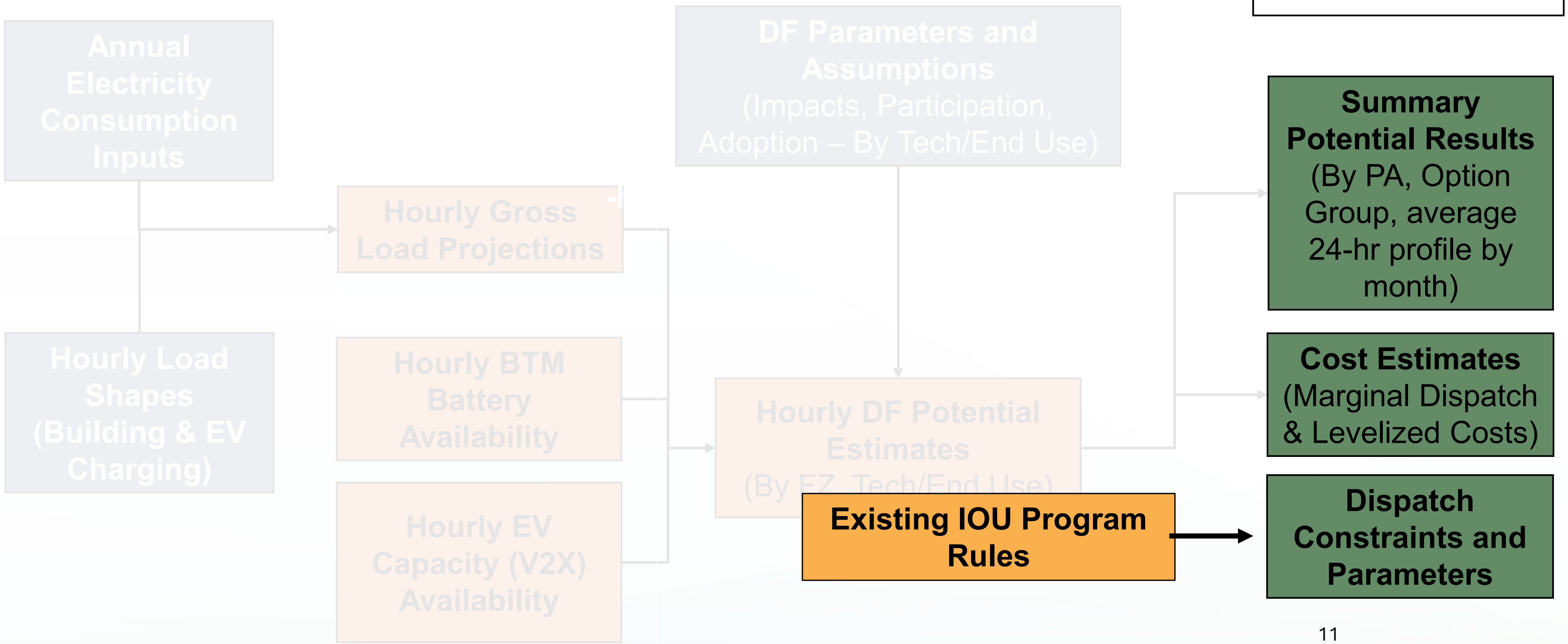


DF Potential Data Sources [3]

Legend
- Input
- Calculation
- Result for PCM

Goal: Forecast Hourly DF Potential Resource "Availability"

Granularity: Forecast Zone (FZ), Sector, Size, Building Type, End Use



LBNL Phase 4 Potential Study

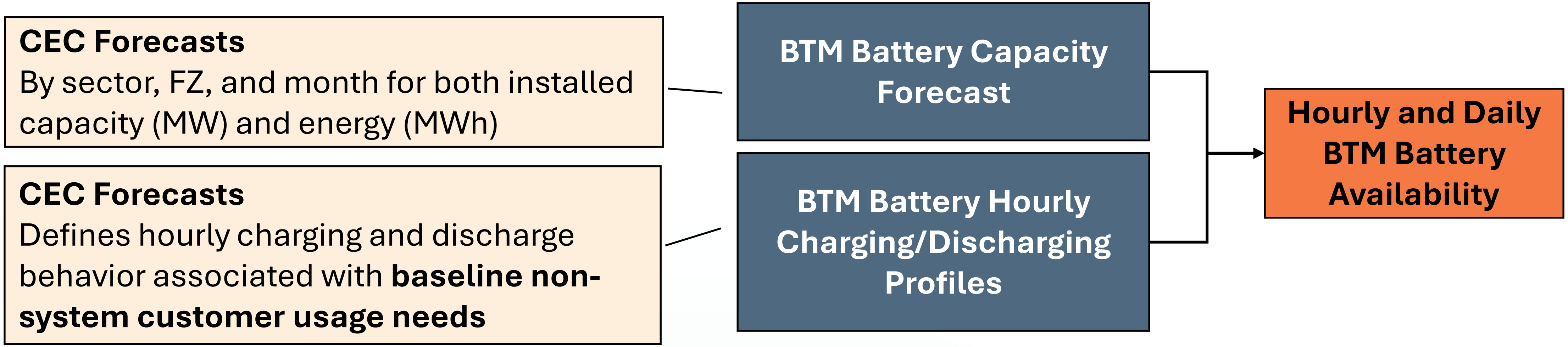
End Use	DR Measure
HVAC	Programmable communicating thermostat
HVAC	HVAC Direct Load Control Switch
HVAC	Manual thermostat adjustment
Dishwasher	Internal connection for remote control
Dishwasher	Manual delay cycle
Washer	Internet connection for remote control
Washer	Manual delay cycle
Dryer	Internet connection for remote control
Dryer	Manual delay cycle
Refrigeration	Internet connection for remote control
Refrigeration, Freezer	Smart power outlet

- List of end use and enabling technology DF options & eligibility assumptions
- Shed fractions (unit impacts)
- Participation rates
- Cost assumptions

**Gerke, B, et al. The California Demand Response Potential Study, Phase 4: Report on Shed and Shift Resources Through 2050. May 2024. Lawrence Berkeley National Laboratory. Report Number LBNL-2001596. https://eta-publications.lbl.gov/publications/california-demand-response-0.*

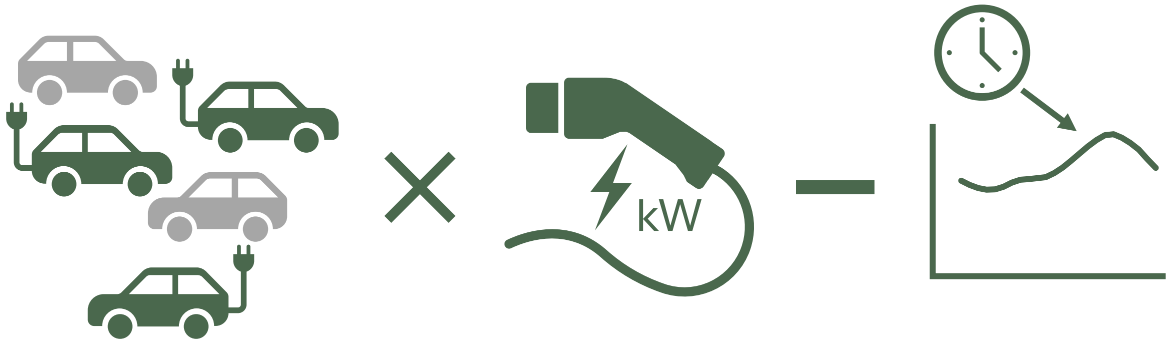
BTM Existing Battery Availability

- The DF potential analysis considers potential only from **existing** BTM battery resources that are expected to be installed for **customer needs**, such as **daily TOU arbitrage**, **back-up**, or **resiliency**.



- Battery **capacity** that is **not** used for pre-existing customer needs within a given **hour**, according to the baseline charging and discharging profiles, is considered available for grid dispatch.
- Battery **energy** that is **not** used for pre-existing customer needs within a given **day** is considered available for grid dispatch, subject to a **reserve margin** of 25%. The reserve margin assumes that customers will be unwilling to fully discharge the full extent of their battery nameplate energy capacity for operational, degradation, and backup purposes.

EV Capacity (V2X) Availability



Theoretical Discharge Power at Hour

EVs *[times]* **Charger Power** *[minus]* **EV Charging Load at Hour**

Functional V2X Dispatch Potential at Hour =

% EV Drivers Participating in V2G Program

% EVs/Sites with Technical Capabilities

% EVs Plugged In

% EVs at Suitable V2G Site at Hour

Results of Potentials Are Summarized and Grouped for PCM Use

Option Groups

DF Tool Output

Ag-Auto-DR-Pumping Control	Ind-HVAC Control
Ag-DLC Switch-Pumping Control	Res-DLC-HVAC-Switch
Water Supply/WW pumping control	Res-HVAC-Thermostat
Ag-Battery Dispatch	Com-Lighting control
Com-Battery Dispatch	Com-Other End Uses Control
Ind-Battery Dispatch	Com-Refrigeration control
Res-Battery Dispatch	Com-Refrigeration TES
EV-Electric Buses-Charging Control	Ind-Lighting control
EV-HDV-Charging Control	Ind-Process Control
EV-LDV-Charging Control	Ind-Refrigeration control
EV-MDV-Charging Control	Res-Appliances Control
EV-Electric Buses-V2X	Res-Lighting Control
EV-HDV-V2X	Res-Other end uses control
EV-LDV-V2X	Com-DLC-Water Heating-Switch
EV-MDV-V2X	Com-Water Heating-Add-on CTA 2045 control
Com-DLC-HVAC-Switch	Com-Water Heating-Smart Water Heater
Com-HVAC-EMS	Res-DLC-Water Heating-Switch
Com-HVAC-TES	Res-Water Heating-Add-on CTA 2045 control
Com-HVAC-Thermostat	Res-Water Heating-Smart Water Heater

38 Individual DF Options

7 Option Groupings

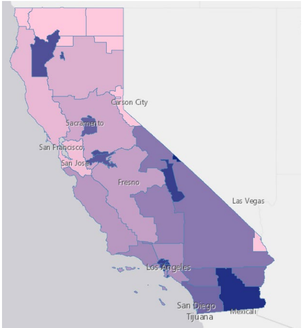
- Ag Pumping
- Battery – Non-Res
- EV Charging
- HVAC
- Battery – Res
- EV V2X
- Other

Grouped based on similarities in end use, magnitude of potential, and common programmatic constructs

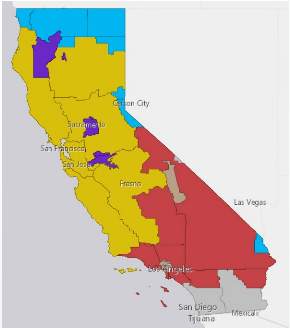
PCM Input

Geographic Granularity

DF Tool Output



20 FZs



7 PAs

PCM Input

Hourly Averaging

DF Tool Output

Full 8760 hourly results per year

- Option Group (7)
- Planning Area (7)
- Year (2023-2050)

Average 24-hour potential by month (288 values per year)

- Option Group (7)
- Planning Area (7)
- Year (2023-2050)

PCM Input

Cost Estimates for PCM

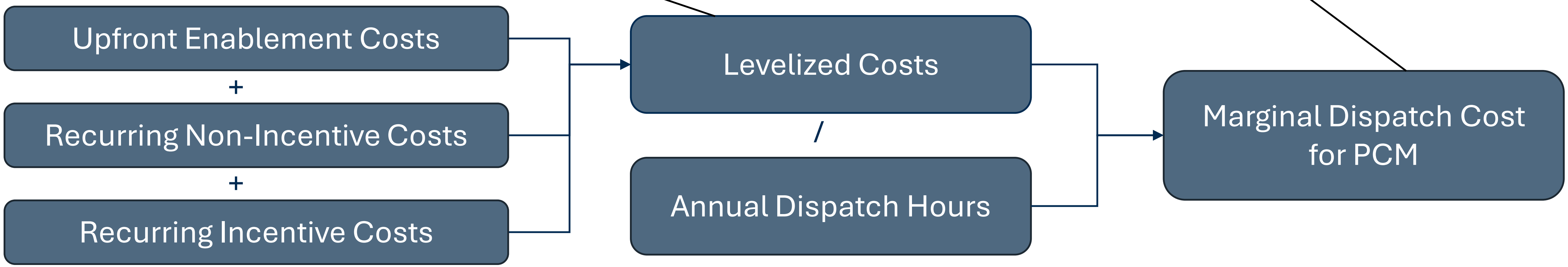
First, the DF Tool calculates **levelized costs ($/kW)** to represent all costs for DF resource availability.

Includes **upfront enablement**, **recurring non-incentive** costs, and **recurring incentive** cost components.

Sourced from the LBNL Phase 4 Study.

The Tool calculates **marginal dispatch costs ($/MWh)** to represent the "bid" cost for a resource. Calculated by spreading the levelized cost over an **assumed number of dispatch hours** in each year.

Marginal dispatch costs ($/MWh) are utilized by the PCM.



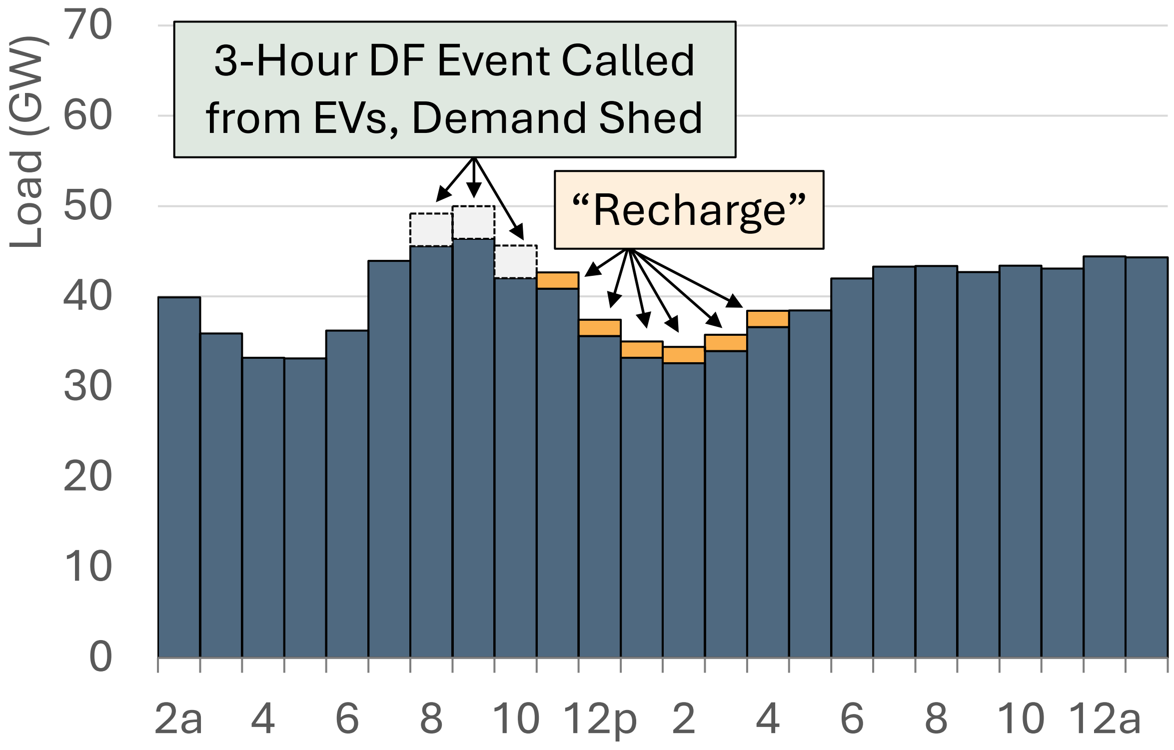
Dispatch and Load Shift Parameters

- Limited customer willingness to curtail/shift
- Dispatch constraints based on physical characteristics of technologies

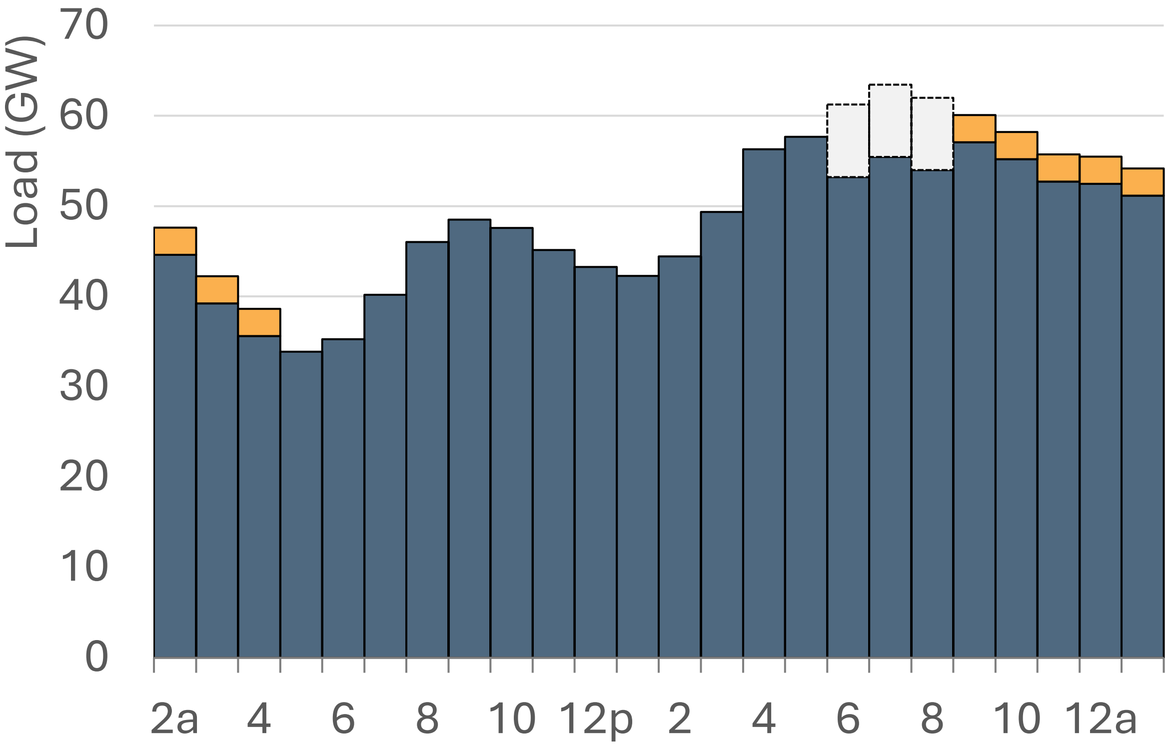
Option	Max Hours per Dispatch	Max Dispatches per Day	Max Dispatches per Month or Year	Load Shift Timing
Ag Pumping	6	1	10/month, 30/year	Up to 8 hours before dispatch
BTM Battery (Res)	4	2	50/season, 100/year	Up to 6 hours after dispatch
BTM Battery (Nonres)	4	2	50/season, 100/year	Up to 6 hours after dispatch
EV Charging	4	2	50/season, 100/year	Up to 6 hours after dispatch
EV V2X	4	1	50/season, 100/year	Up to 6 hours after dispatch
HVAC	4	1 (Summer) 2 (Winter)	25/season, 50/year	2-hour pre-cool, 6-hour snapback
Other	6	1	72/year	Up to 4 hours before and after dispatch

Example Demand Flex and “Recharge” Event

Reference Scenario December Day, 2040



Reference Scenario September Day, 2040

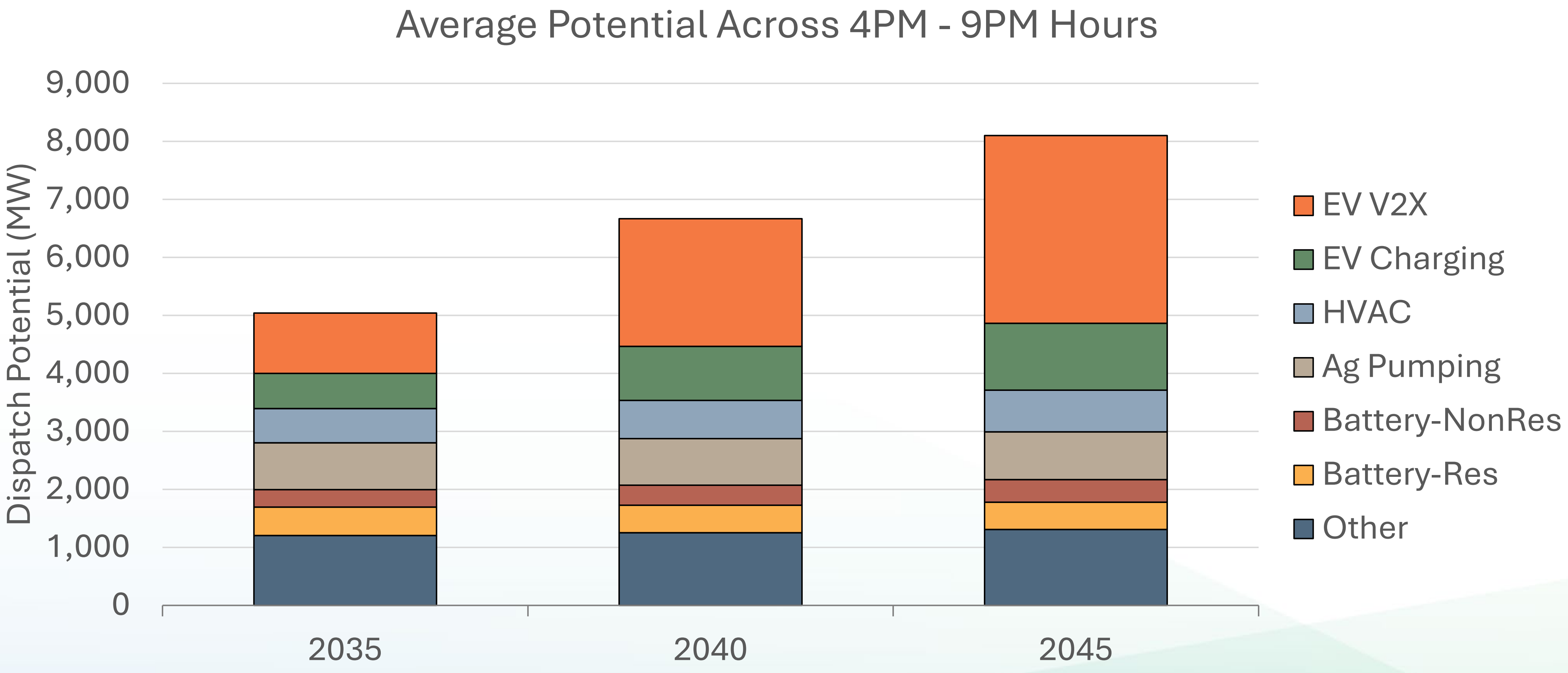


In earlier hours of the day, there is less EV potential, leading to less EV flexibility during winter peaks

DF Scenarios

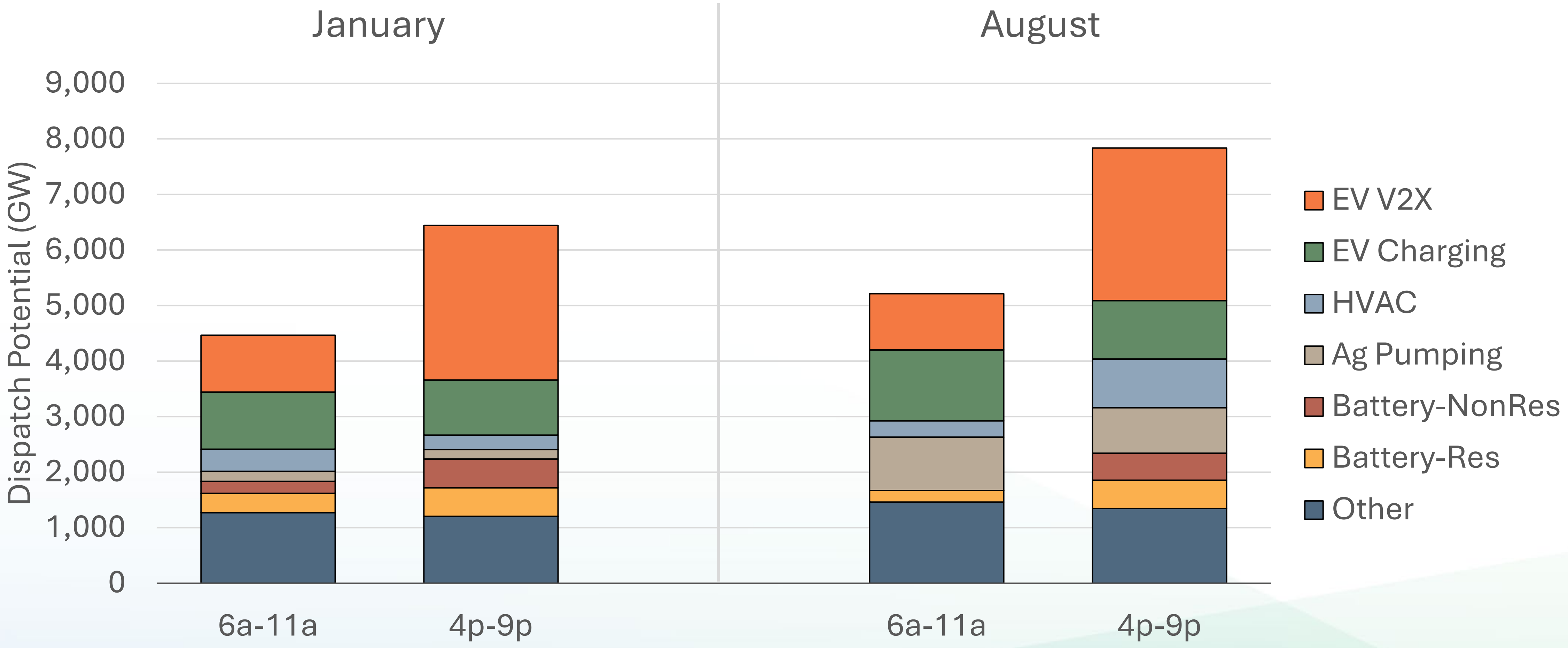
	Input	Policy Scenario (Moderate DF)	Policy Scenario (High DER & High DF)	Policy Scenario (High Hydrogen Use & Moderate DF)
Demand Scenario Inputs	AAEE 3 Adjustment	AAEE 3	AAEE 4 (res/com) AAEE 3 (all other)	AAEE 3
	AAFS Adjustment	AAFS 4	AAFS 4	AAFS 4
	TE Adjustment	Policy Scenario TE	Policy Scenario TE	Policy Scenario with HFS
	BTM Battery Forecast	2023 IEPR	Augmented Forecast	2023 IEPR
Demand Flexibility Inputs	EV V2X LD Applicability	SF Only	SF + MF + Commercial Fleet	SF Only
	EV V2X Plugged-In Factor	50%	65%	50%

DF Potential Results (Policy Scenario with Moderate DF)



Long-Term potential growth dominated by EVs

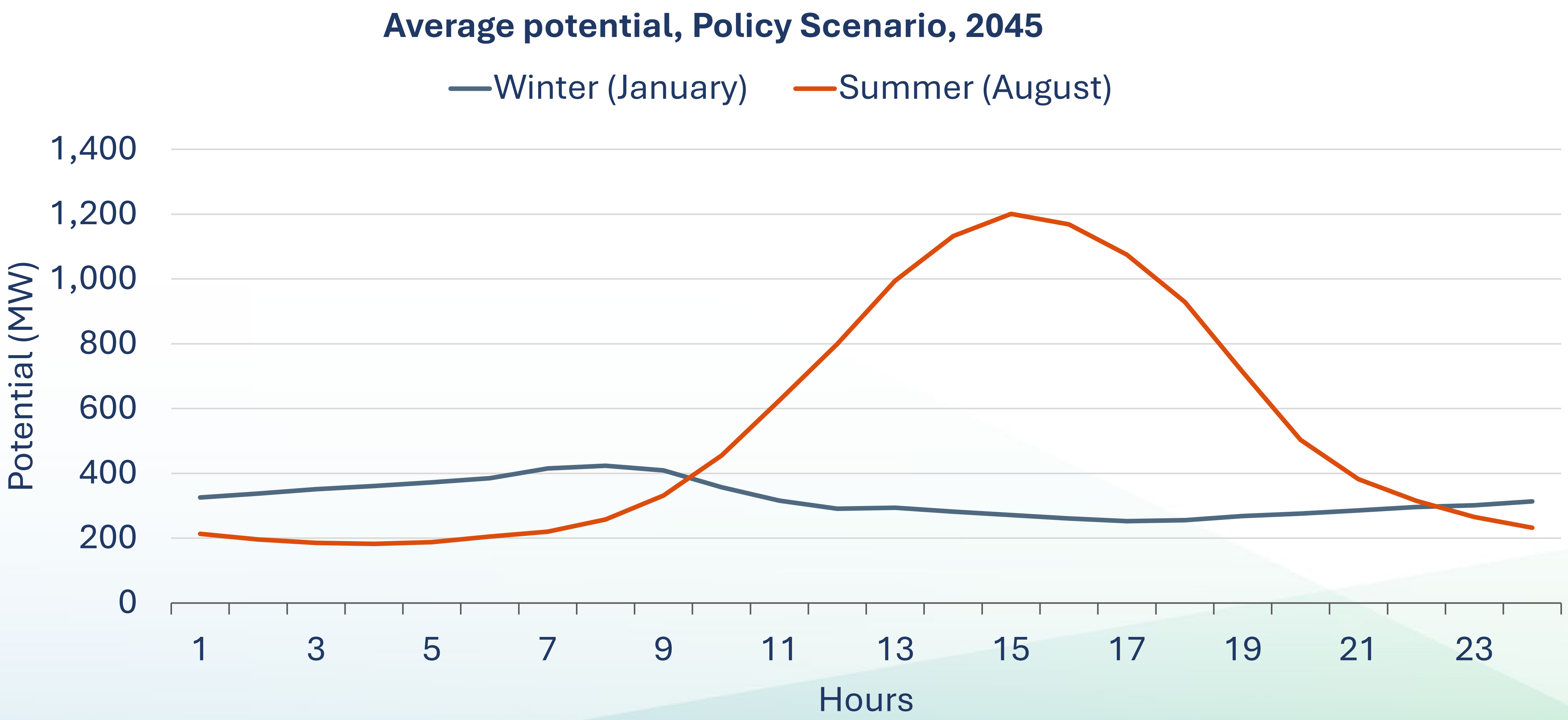
Seasonal Variation at Key Times During the Day (2045)



Winter and Early Hours Have Less Potential than Summer Later Hours

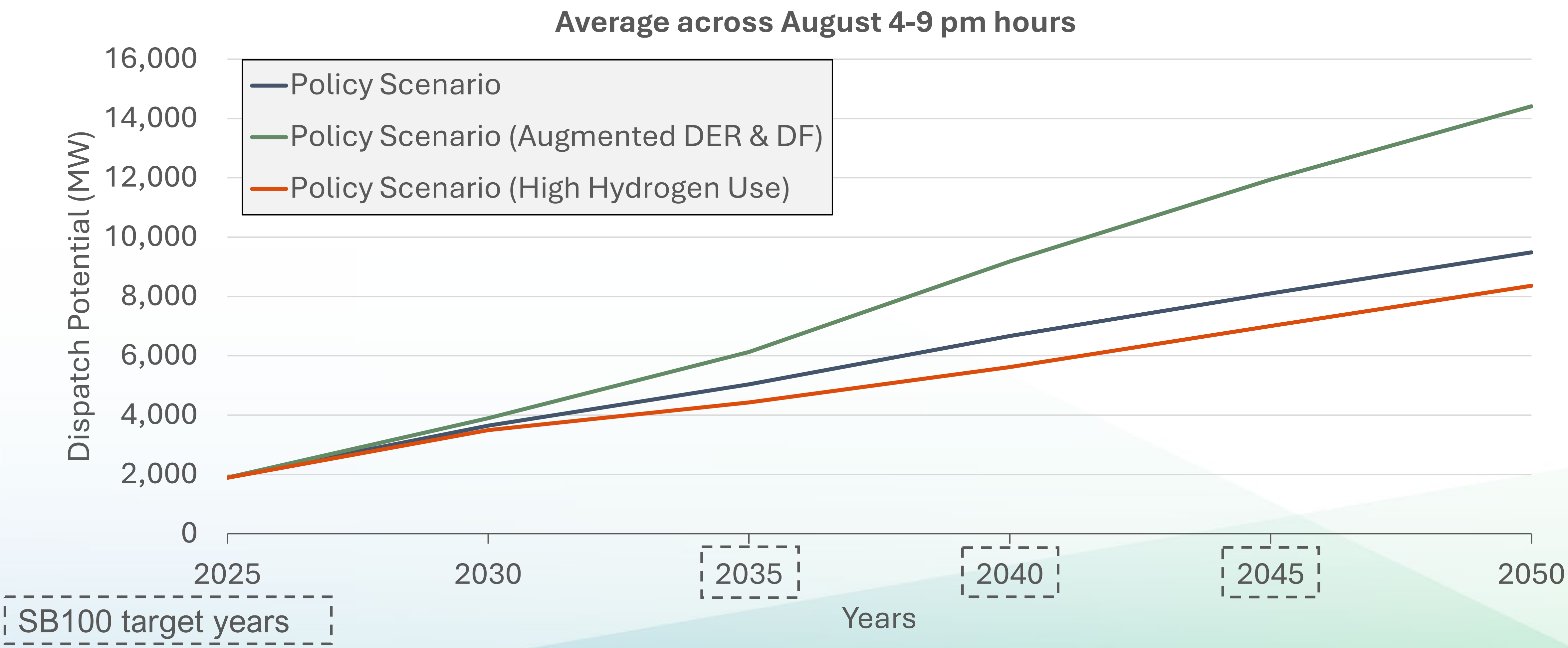
HVAC Seasonal and Hourly Variation

Large hourly dispatch shape change between summer and winter for HVAC



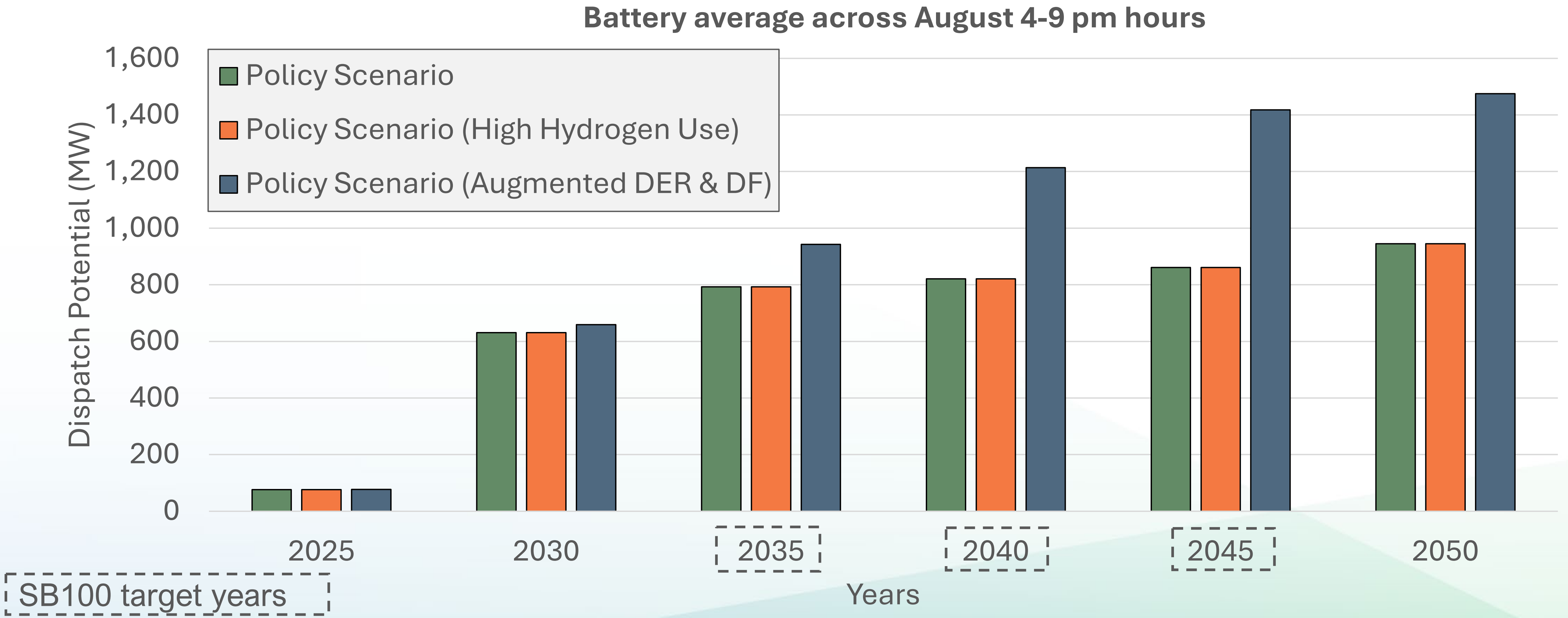
Potential by Scenario

The primary driver of differences between scenarios are in the **BTM Battery** and **Electric Vehicle (Managed Charging and V2X)** Options

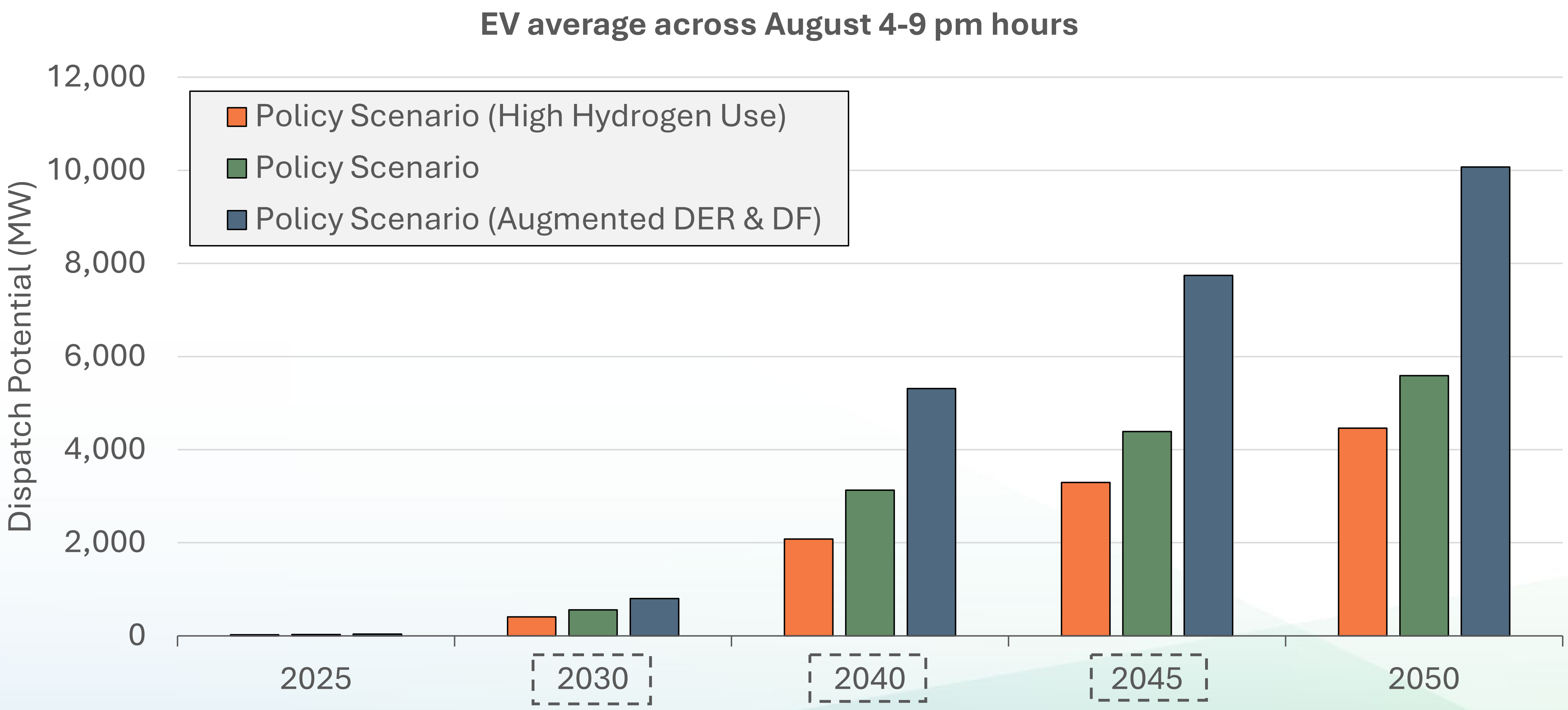


BTM Battery Scenario Comparison

Scenarios with **DER Augmentation** include a higher forecast of installed BTM batteries, primarily from the residential sector.



EV Scenario Comparison



SB100 target years

Key Takeaways

- The expanded D-Flex tool allows for full 8760 load flex potentials for a given demand scenario
- D-Flex tool outputs are potentials, not actual load or load modifiers
- The "realization" of potentials depends on PCM selections and resource mixes.
- The largest contributor to potential is the EV category
- Seasonal factors play a role
  - Summer hours 12-19 have high HVAC potential
  - Winter hours 6-10 have lower total potential, critical hours of expected heating loads in the demand scenarios

Thank You!

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