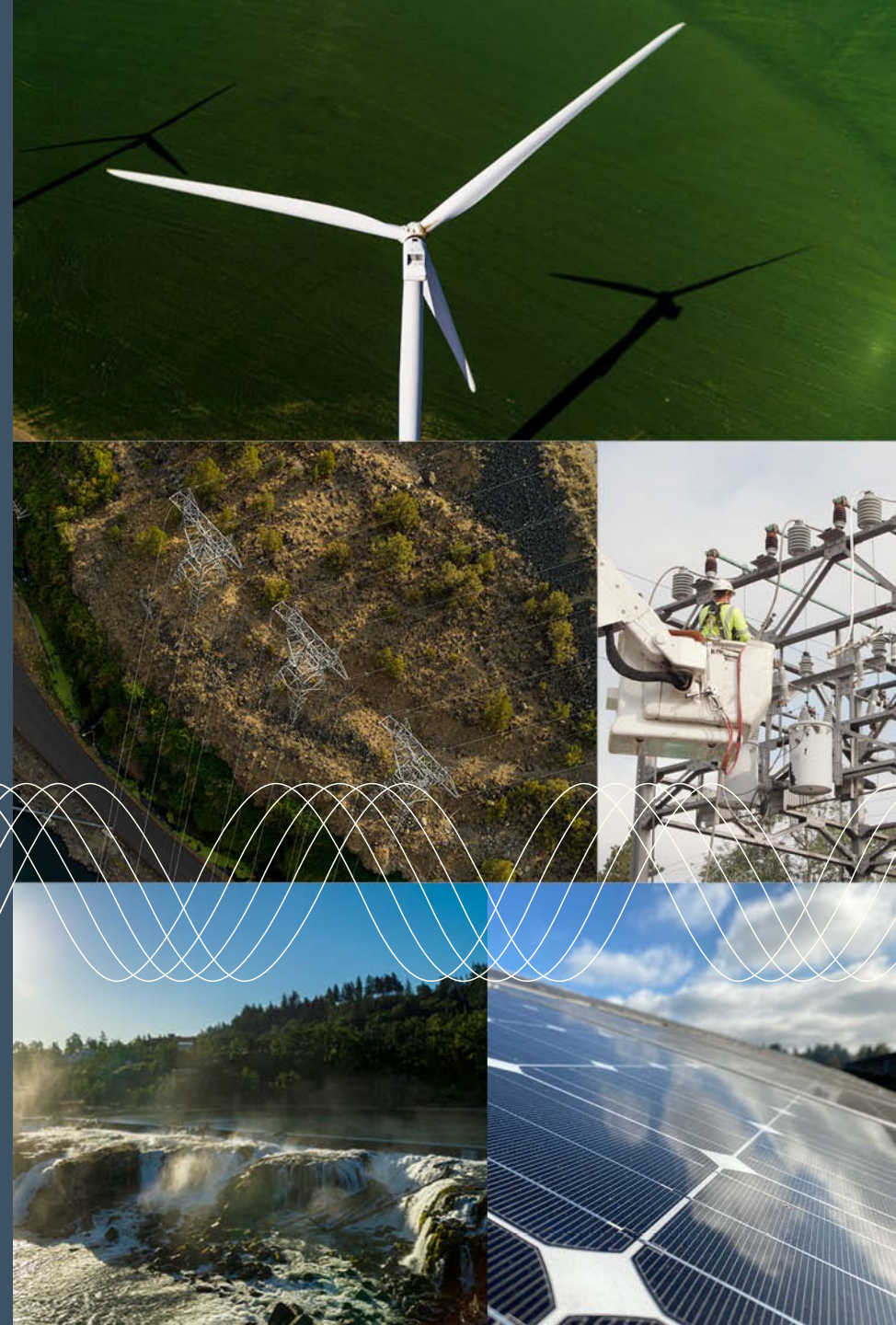


The Evolution of the Built Environment

Isaac Barrow, CRE Market Manager
January 2022



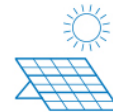
An Oregon kind of energy.SM

Portland General Electric



3,300+ MW of Generation

~ 10% Wind
~ 20% Hydro
~ 40% Conventional
~ 30% Purchased



1.99 million+ MWh
of energy sold through
our No. 1 voluntary
renewable program
Green FutureSM



1.2 million juvenile fish
migrated downstream
on the Deschutes
River through our
reintroduction efforts

1647268

1.6 million+ miles
powered at our Electric
Avenue charging stations
since October 2015, avoiding
~674 metric tons of CO₂

PGE: Your Clean Energy Partner



Green Future Choice

Go 100% renewable with one easy step



Green Future Block

Add "blocks" of wind energy to your mix



Green Future Solar

Add "blocks" of solar energy to your mix



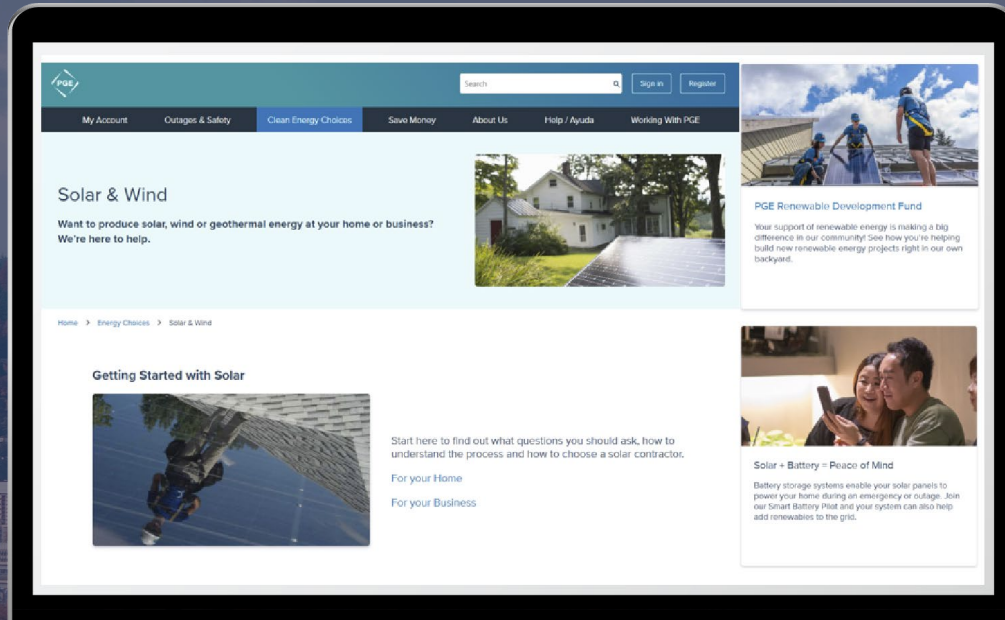
Green Future Enterprise


Clean Wind power for large commercial



Green Future Impact

Source up to 100% of your business' energy



The background image is a wide-angle photograph of a city skyline at sunset or sunrise. The sky is a gradient of deep blue at the top, transitioning through orange and yellow to a bright white glow where the sun is positioned. Large, dark, textured clouds are scattered across the sky, some catching the low light. The city skyline is visible as a dark silhouette along the horizon, with various building shapes and structures. The overall mood is dramatic and atmospheric.

The Evolution of Grids

What is a modern, integrated grid?

More Critical Components:

- Two-way flow
- Automated
- Flexible
- Customer participation
- Communication and data





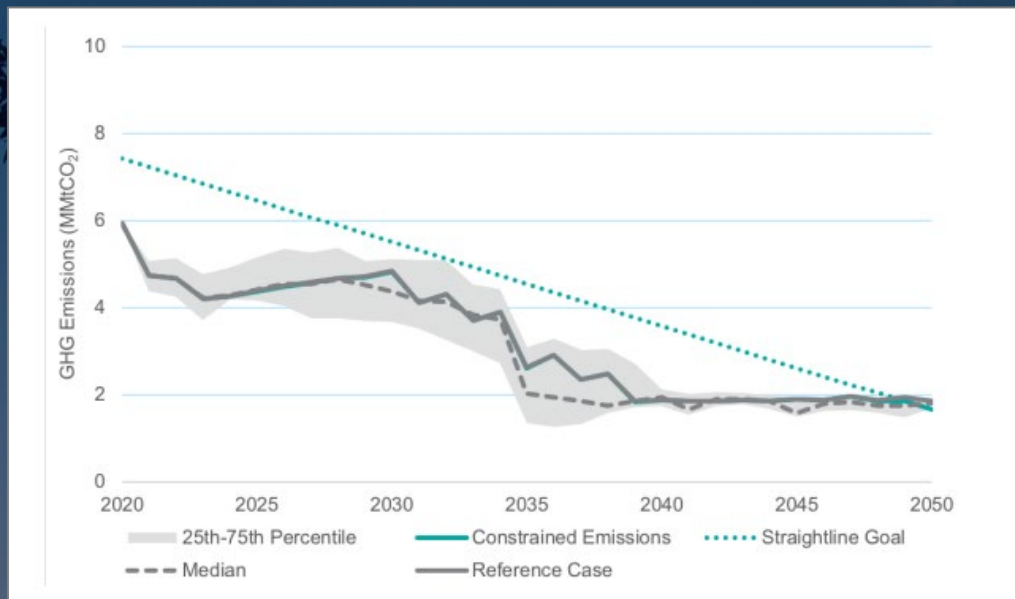
PGE's Path to Decarb

EF and Time chart
Sustainability Report + 2019 IRP

Current commitments

2019 Integrated Resource Plan

Greenhouse Gas Emissions Forecast



2020 Climate Goals

- 80% Reduction in emissions by 2030, 20 years faster than planned
- Zero emissions associated with power we serve by 2040
- Reducing emissions in our operations
 - 60% fleet electrification by 2030
 - 100% of class 1 vehicles by 2025
- Reducing emissions in energy choices

Flexible Load Portfolio



Active Programs

COMMERCIAL + INDUSTRIAL

Energy Partner

Multi-family
Water Heater

RESIDENTIAL

Smart Thermostat

Peak Time Rebate
(behavioral DR)



Under Development

COMMERCIAL + INDUSTRIAL

Battery Storage

EVSE

Heat Pump
Water Heater

RESIDENTIAL

Battery Storage

EVSE

Mass Transit Charging

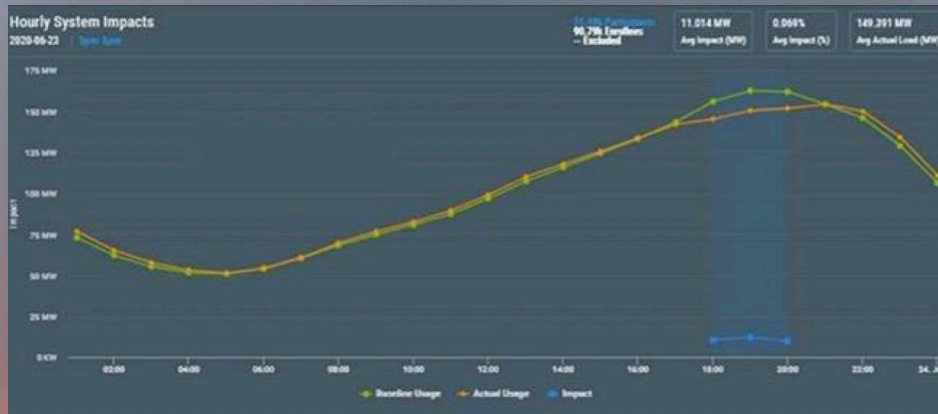
Smart Grid Testbed

Understanding and Realizing DR Value



- Exploring the potential and value of DR/DER adoption
- Unique partnership with customers, stakeholders, and regulator
- Aggressive deployment of distributed flexibility across all segments
- 22K customers, three substations
- Goal: 66 % customer participation

Peak Time Rebates



June 23 - 5pm to 8pm

90,430 customers participated
52,153 earned rebates (\$97,358)

Average Reduction:
0.12 kW

Overall Load Reduction:
11MW per event hour



Get Notified



Shift Use



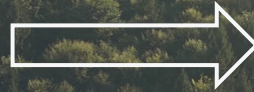
Earn Rebates

What is a Virtual Power Plant?

**Traditional
Generation**



Electricity Generation



Transmission Power



Power Distribution

**Virtual
Power Plant +
Smart Grid**



Price Forecast



Production Forecast



Demand Forecast



Smart Grid



Flexible Demands



Energy Storage



Solar PV

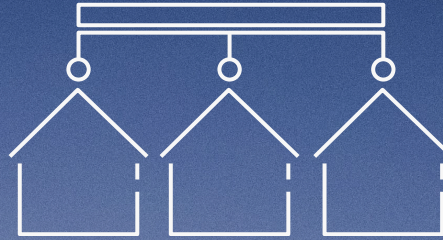


Wind Generation



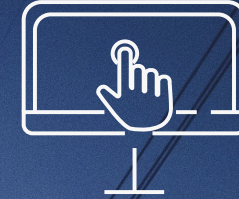
Direct Load Control

One-way communication
High cost
Load shed only
Zero touch with customer



Basic DR

Two-way communication
Manage events in aggregate
Limited device flexibility
Low-touch with customer



Real-Time Control

Device optimized
Manage events at household level
Infinite device types
High-touch with customer
AI and Machine Learning

PGE Smart Battery Pilot

Target of 525 interconnected batteries.

On bill credits for participation plus rebates for customers within the Test Bed.

Objective is to better understand the potential for distributed energy storage on the grid, learn how to structure and operate a future program with high penetration.



Always on, even in stormy weather



More renewables on the grid



Monthly bill credits



Hypothetical Case Study by PAE and SERA: Energy Concepts in Practice

BUILDING STATS

170,000 sf total floor area

100' x 200' site

10 floors

ENERGY USE + MANAGEMENT

27 kBtu/sf/yr

All electric

Energy load shifting strategies

Grid-interactive controls

ORIENTATION

E-W axis

South exposure

Peak Emissions Reduction: Case Study Results

Annual Building Impact

CO₂e was reduced by 19 MT

Energy use was reduced by 33 MWh

THIS EQUATES TO:

2.5% reduction in total energy use

4% reduction in CO₂e

Operating Impact

DR events only occurred 5% of total operating only

DR EVENT

Expanded temperature range

Reduced Lighting (33% reduction)

Reduced plug loads (25% reduction either through behavior or battery discharge)

Flexible Load – Grid Impact

	2014	2015	2016	2017	2018	2019	2020
Participating Sites	24	39	57	N/A	50	55	59
Max Summer Capacity MW	2.7	9.7	11.1	10.6	15.2	19.4	19.7
Max Winter Capacity MW	6.3	6.3	13.1	30	12.5	12.7	13.8

A high emissions natural gas peak engine can be avoided with minor operating changes.

**Little changes can
create big impacts.**

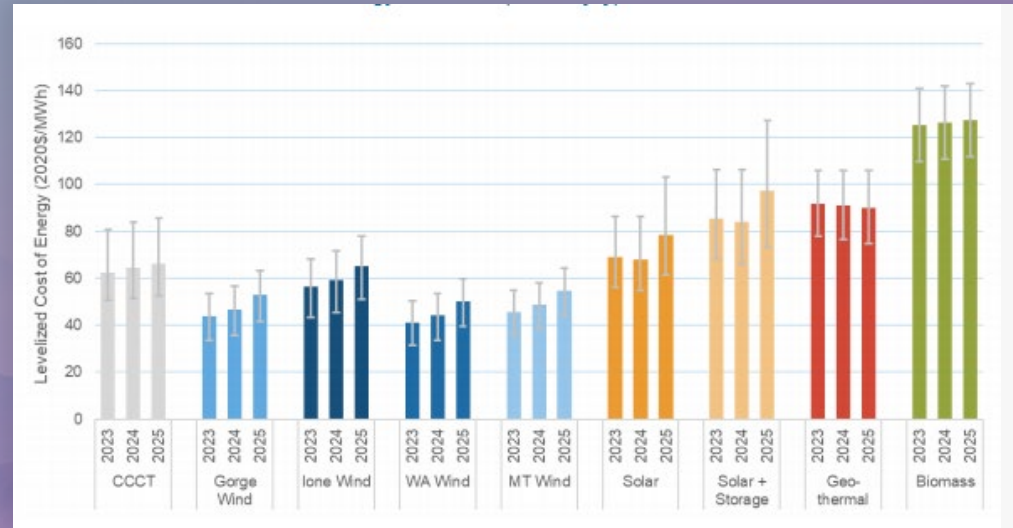
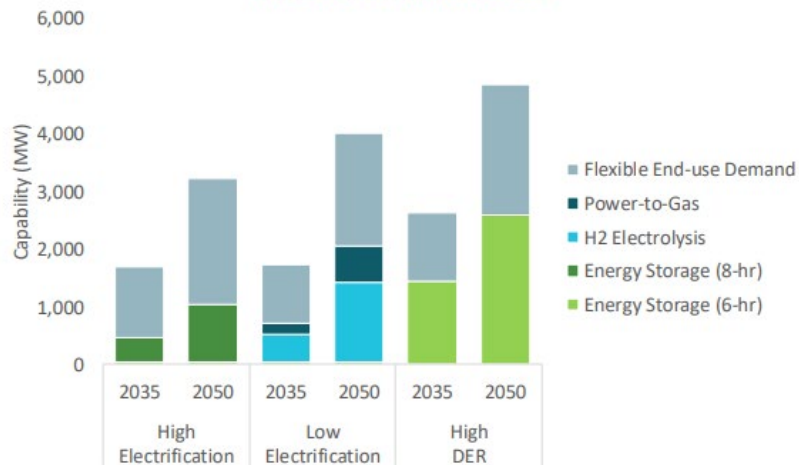
Aggregated flexible loads can be used like a grid-scale battery.



The Future is Grid Interactivity

2019 Deep Decarbonization Study

Figure 32 Balancing Resources



PGE's Action Plan

1) Customer Resources

A) Energy Efficiency

B) Distributed Flexibility

- 141 MW of Winter DR
- 211 MW of Summer DR
- 141 MW of Dispatchable Generation and utility controlled storage

Thank You

