Integrated Resource Planning

Roundtable 17-3

August 24, 2017

Meeting Logistics

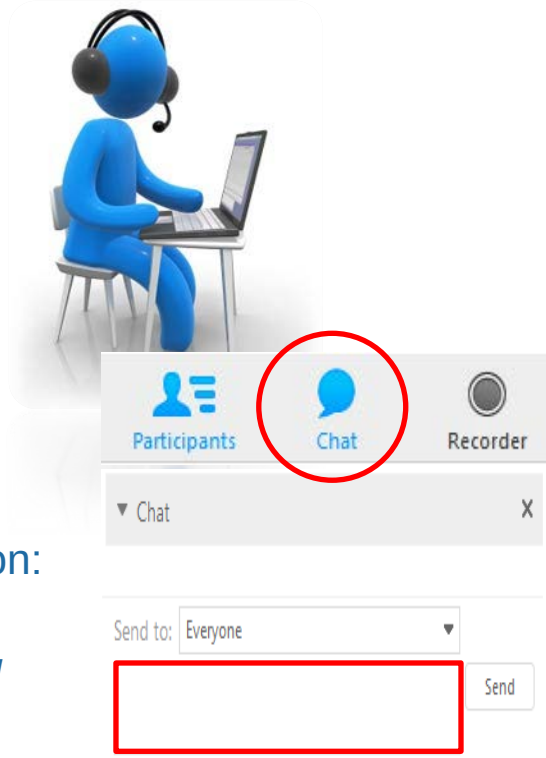
Local Participants:

- World Trade Center facility
- Wireless internet access
  - Network: 2WTC_Event
  - Password: 2WTC_Event$
- Sign-in sheets

Virtual Participants:

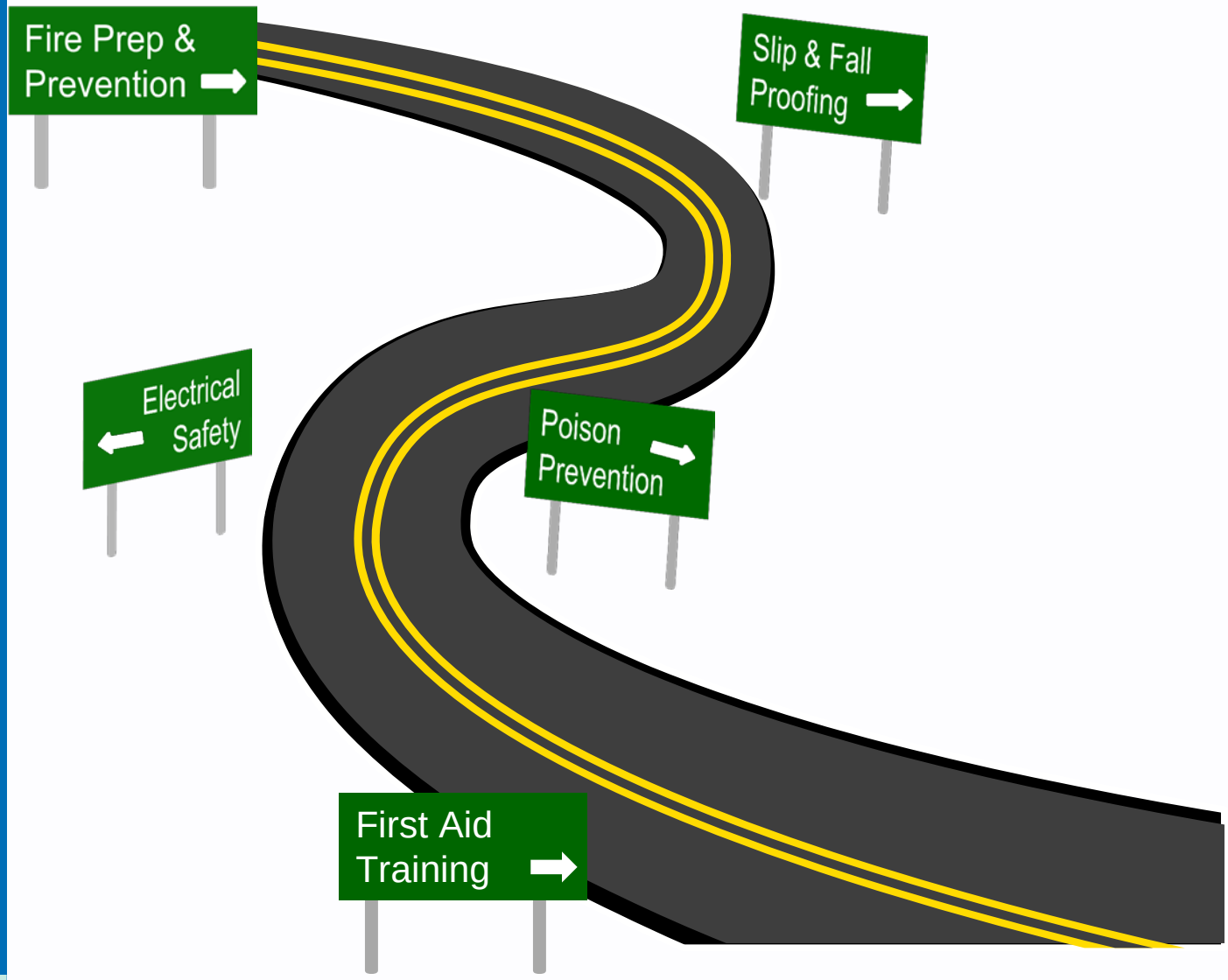
- Ask questions via 'chat' feature
- Meeting will stay open during breaks, but will be muted
- Electronic version of presentation: *portlandgeneral.com/irp*

>> Integrated Resource Planning



Road to Home Safety

- ❑ Install smoke alarms on every floor & replace batteries yearly
- ❑ Have a family escape plan
- ❑ Attach grab bars to showers & bathtubs
- ❑ Use bathmats
- ❑ Keep objects off the stairs
- ❑ Check plugs and cords regularly
- ❑ Read warning labels
- ❑ Pay attention to dosage directions & side-effect warnings on medicines
- ❑ Know the ABC's of first aid training



Today's Roundtable Topics

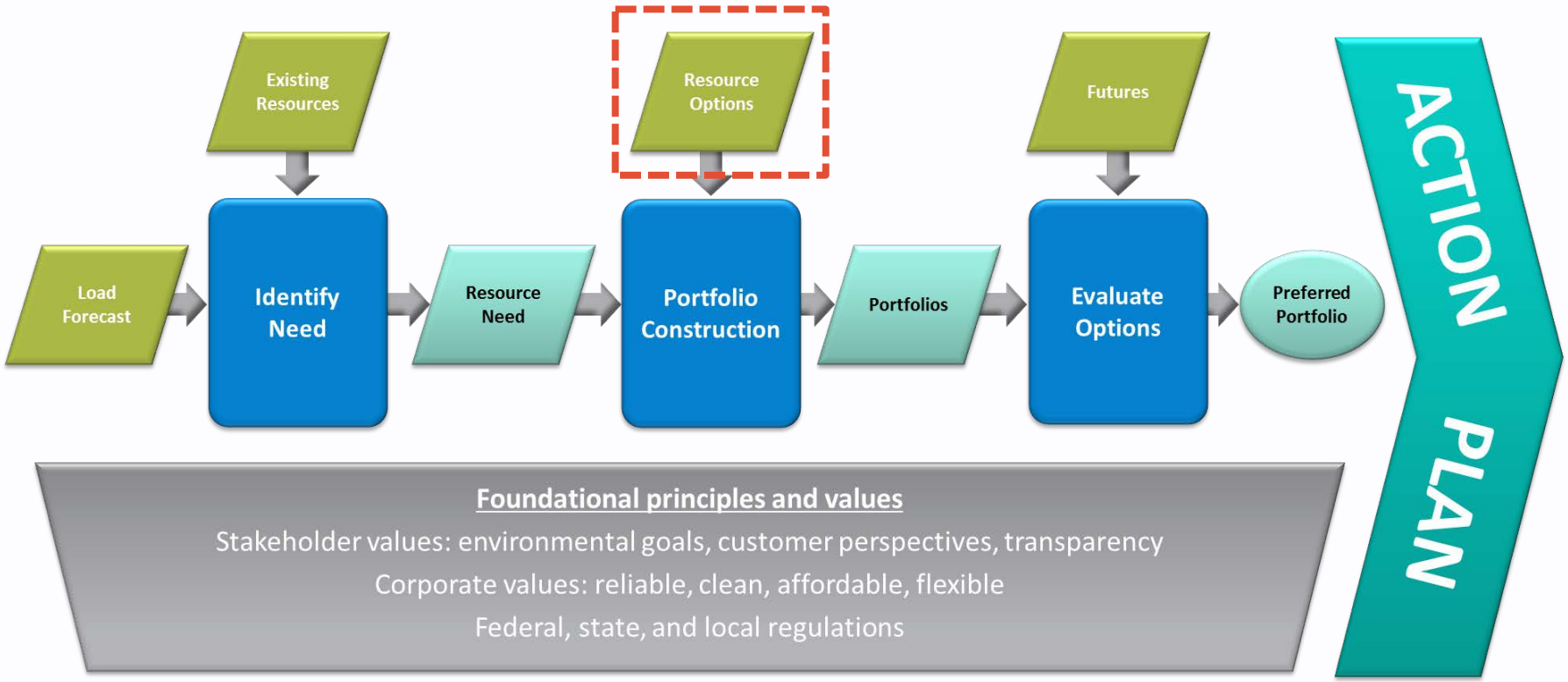
9:00a	**Start**
9:00a	Welcome / Safety Moment
9:15a	Resource Cost Studies Update
9:30a	Resource Cost & Levelization
10:15a	**Break (15 minutes)**
10:30a	Scoring Metrics Discussion
11:30a	Decarbonization Study
11:45a	IRP Scheduling/Planning
	Next Steps/Wrap-Up
12:00p	**Adjourn**

Resource Cost Studies Update

Sima Beitinjaneh

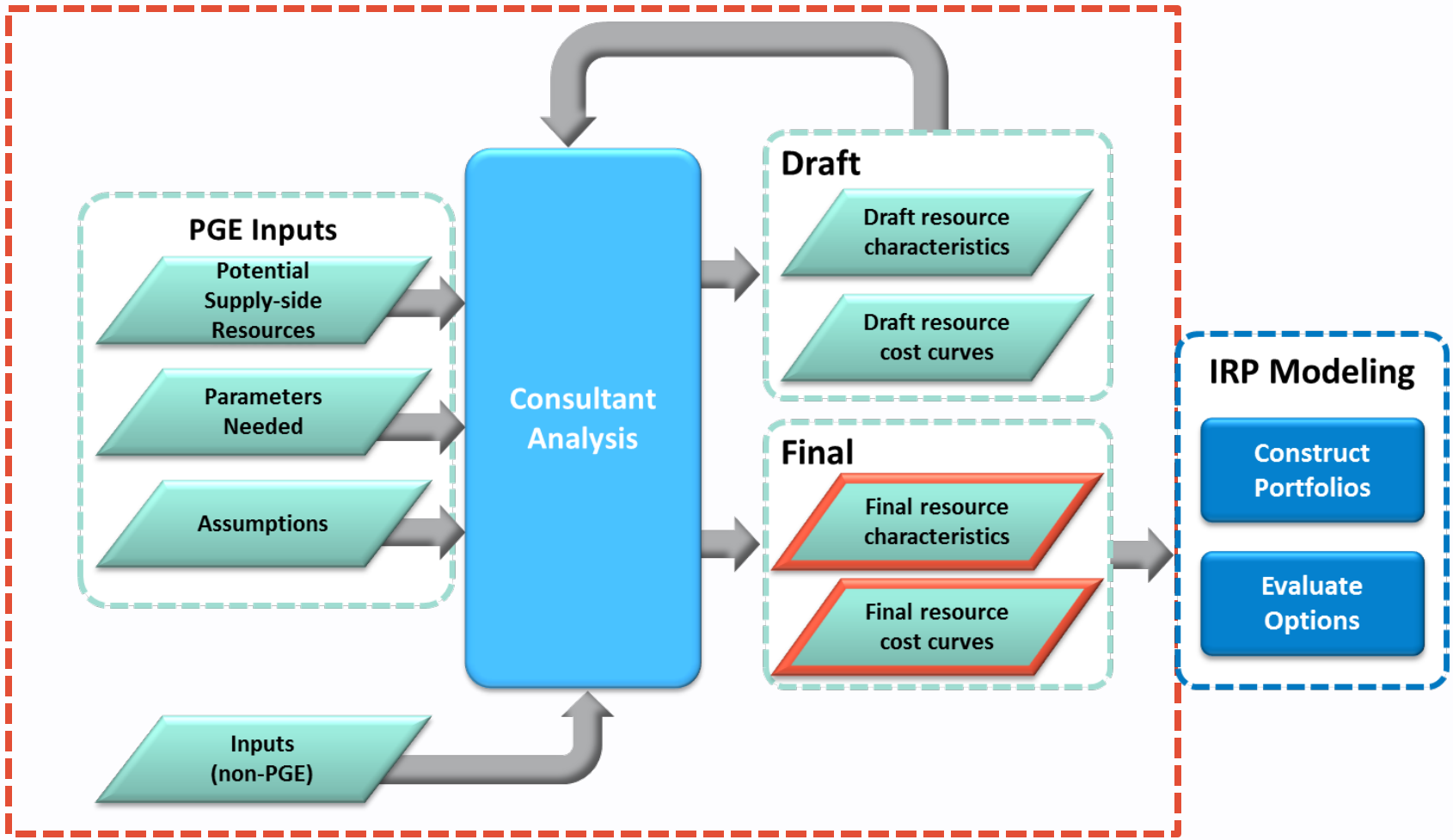
IRP Modeling Process

- Zoom in on “Resource Options” to focus on Supply-side Resource Options

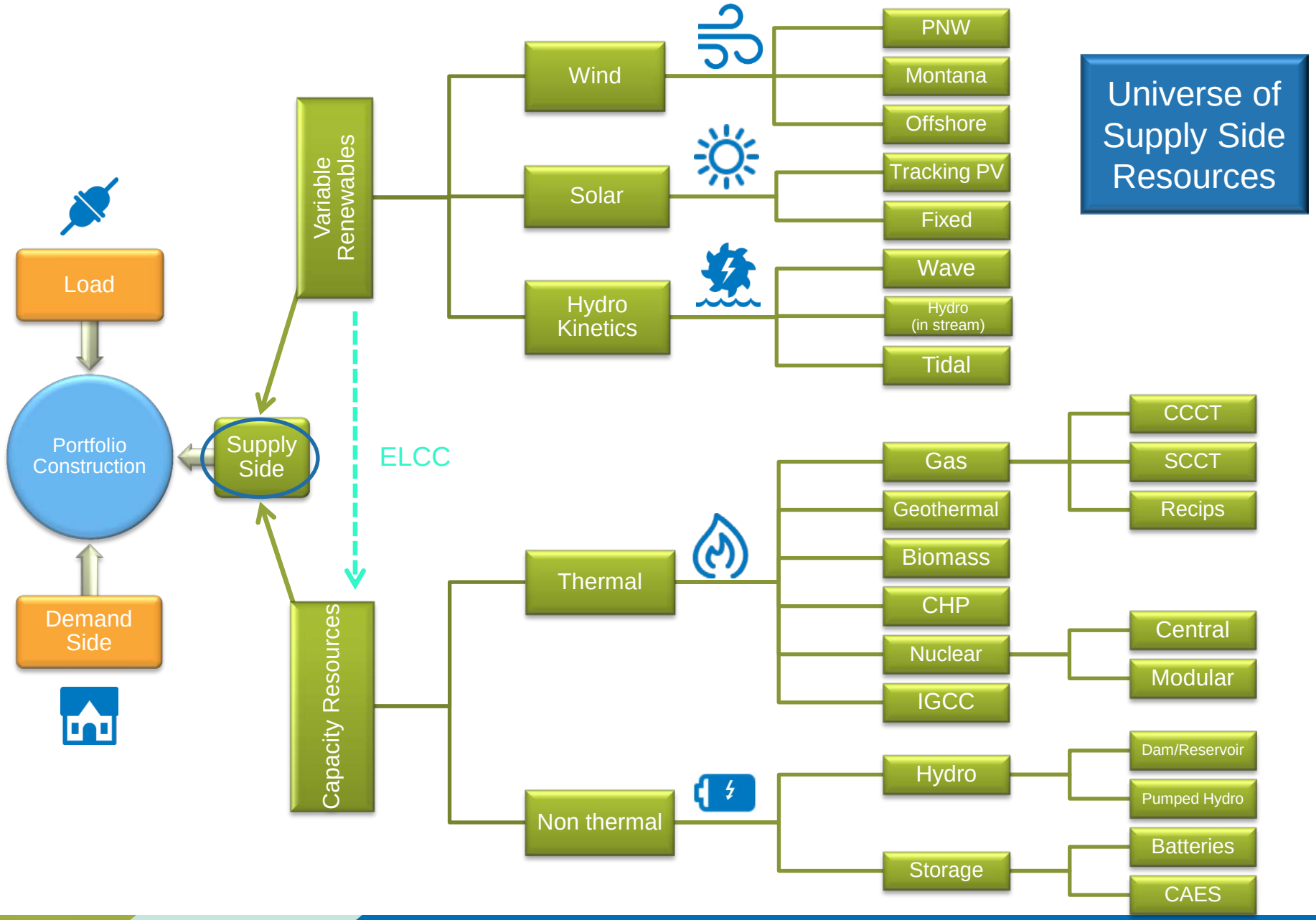


Supply-side Resources

- Performance and cost parameters for supply-side resources



Universe of Supply Side Resources



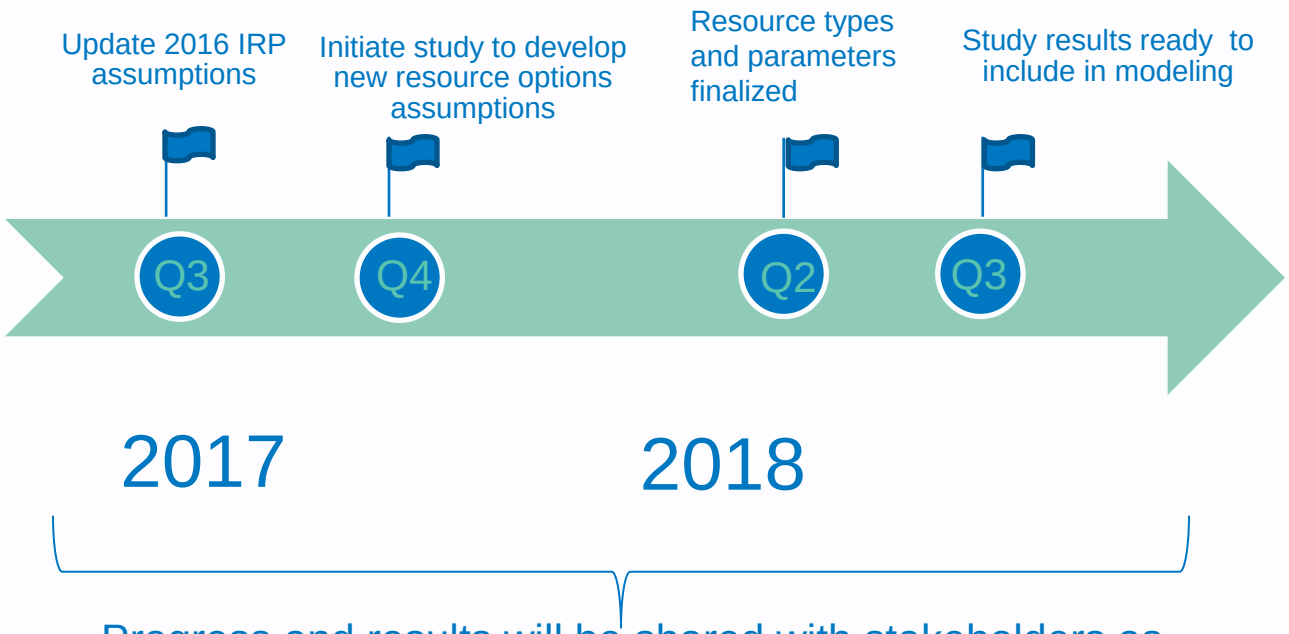
Resource Costs Assumptions

Third party studies update

- PGE is currently updating the supply side resource studies performed by Black & Veatch and DNVGL in 2015
- These studies concern the proxy resources used in the 2016 IRP modeling, and will inform the IRP Update of 2018
- For the next IRP PGE is planning to expand the studies to include more resource types and more detailed financial and technical assumptions

Timeline for Updated Resource Costs

Timeline of Development of New Resource Options and Assumptions for the Next IRP



Resource Costs and Levelization

Brad Carpenter

Resource Costs and Levelization

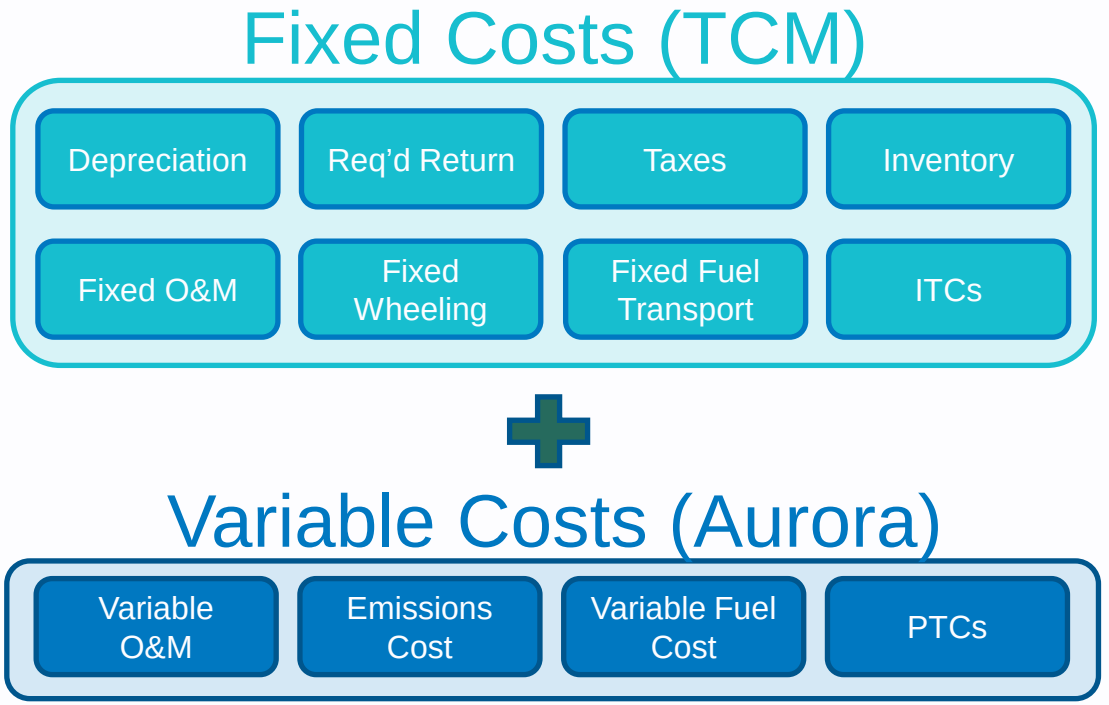
Goals for today:

- Describe how generic resource costs are utilized in the IRP modeling process at a high level
- Provide an overview of net present value
- Discuss how real levelized costs are calculated
- Identify key areas of interest for future technical meetings, learning more about methodology, or providing feedback

PGE's calculation of Revenue Requirement is based on fixed costs from the Transition Cost Model (TCM) and dispatch logic from Aurora to calculate variable costs

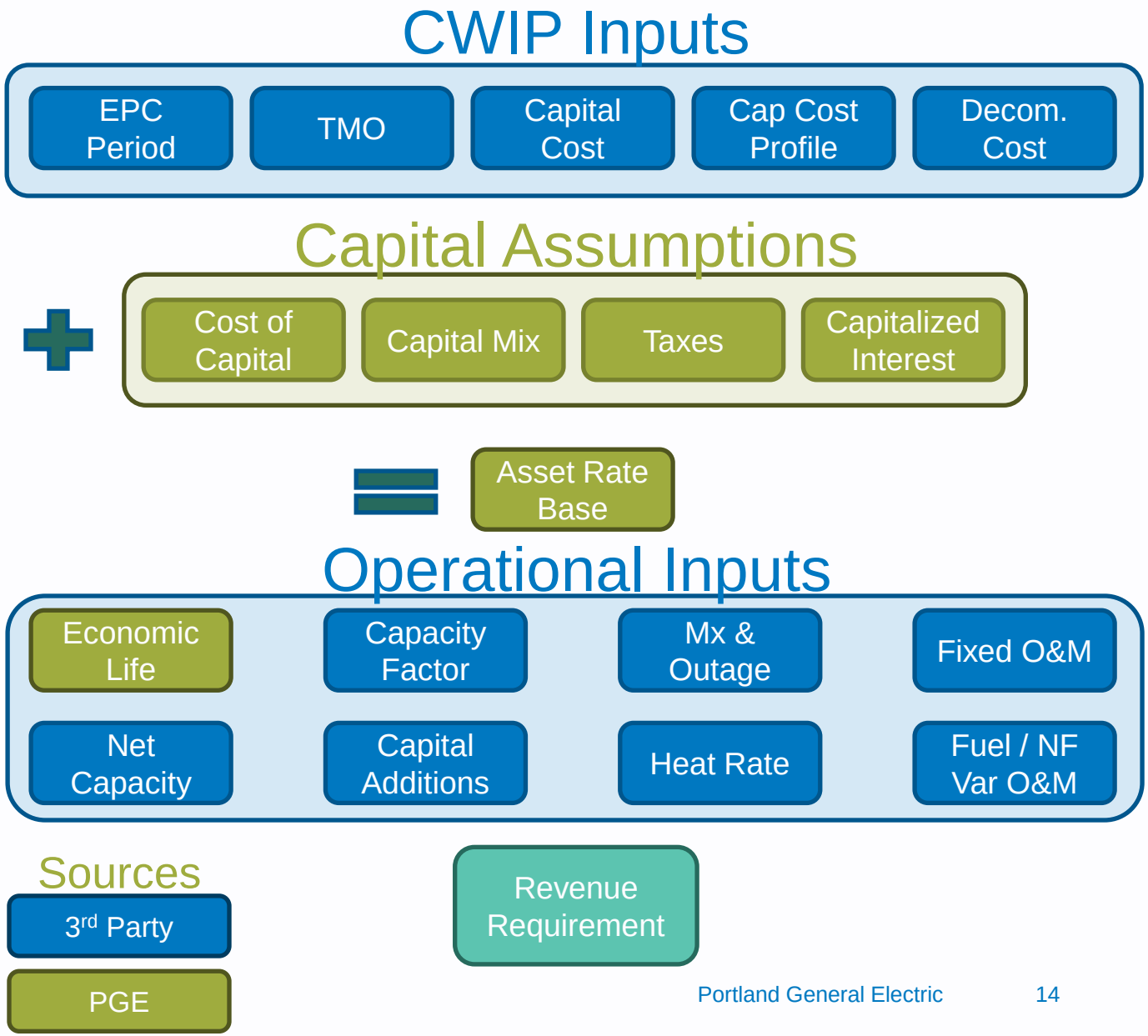
What is "Revenue Requirement"?

A levelized revenue amount that allows a utility to recover expected reasonable expenses and the opportunity to earn a reasonable rate of return (as allowed by regulators).



Rev-Req Overview

PGE's Revenue Requirement calculation uses cost and operational assumptions from consultants in addition to PGE-specific capital assumptions



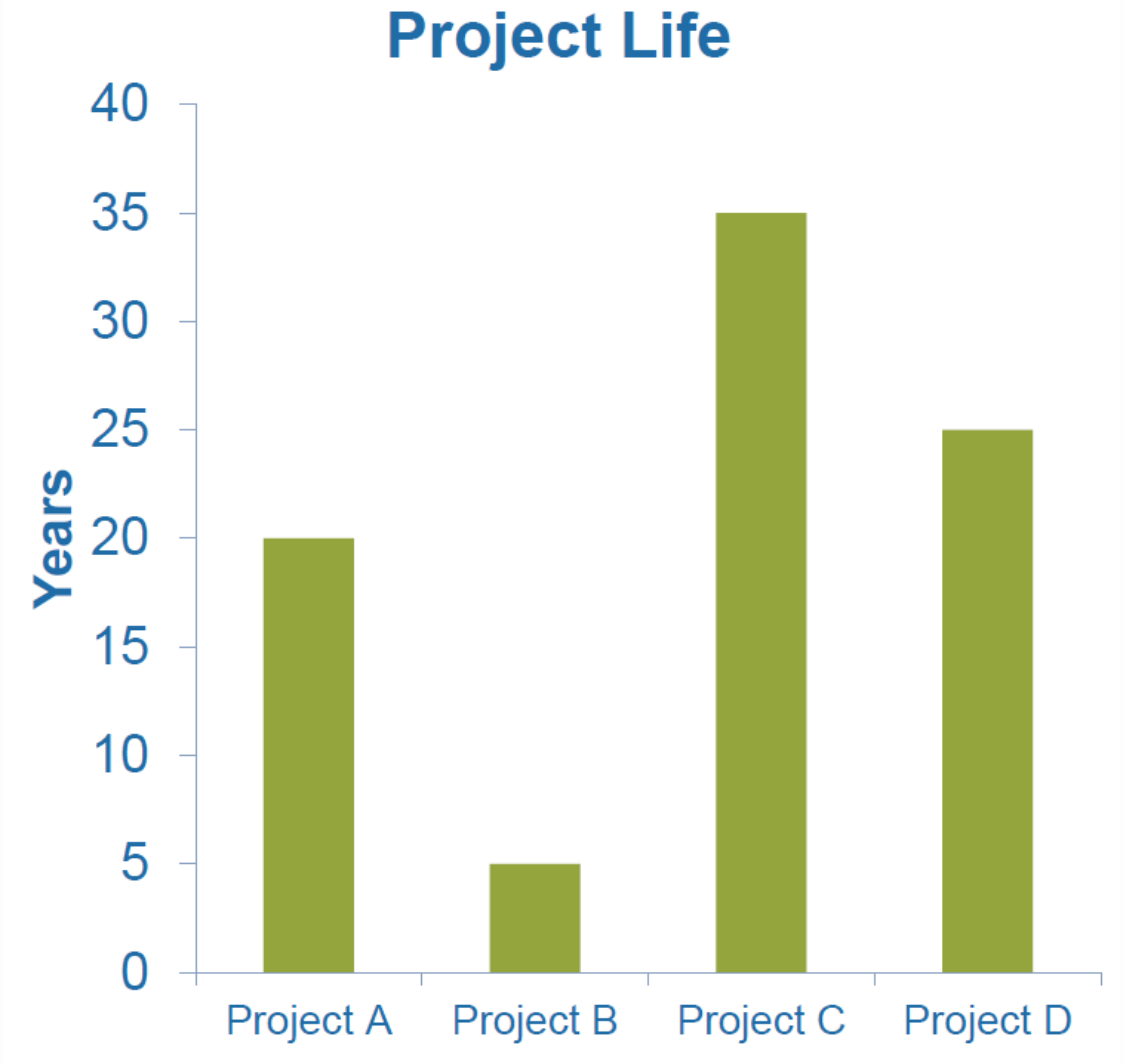
Time Value

- How do we compare different projects with different time horizons?
- When evaluating electric generating resource alternatives within the IRP, PGE accounts for differences in expected resource lives
- PGE uses standard practices to comparably evaluate resources

Net Present Value Formula:

$$NPV = \frac{c_1}{(1+r)} + \frac{c_2}{(1+r)^2} + \cdots + \frac{c_n}{(1+r)^n}$$

Where c = cash flow; r = discount rate; n = year



Weighted-Average Cost of Capital (WACC)

Example:

r_D = 5.5%

r_E = 10.0%

T_C = 40%

% Debt = 50%

% Equity = 50%

AT WACC = 6.65%

…if we include inflation (assumed at 2%) = 4.56%

"All resources must be evaluated on a consistent and comparable basis: The after-tax marginal weighted-average cost of capital (WACC) should be used to discount all future resource costs." - OR PUC IRP Standard & Guidelines 1.a.4

$$\left[5.5\% \times (1 - 40\%) \times \frac{1}{2}\right] + \left[10\% \times \frac{1}{2}\right]$$

Cost of Debt | Corp Tax Rate | % Debt Funded | Cost of Equity | % Equity Funded

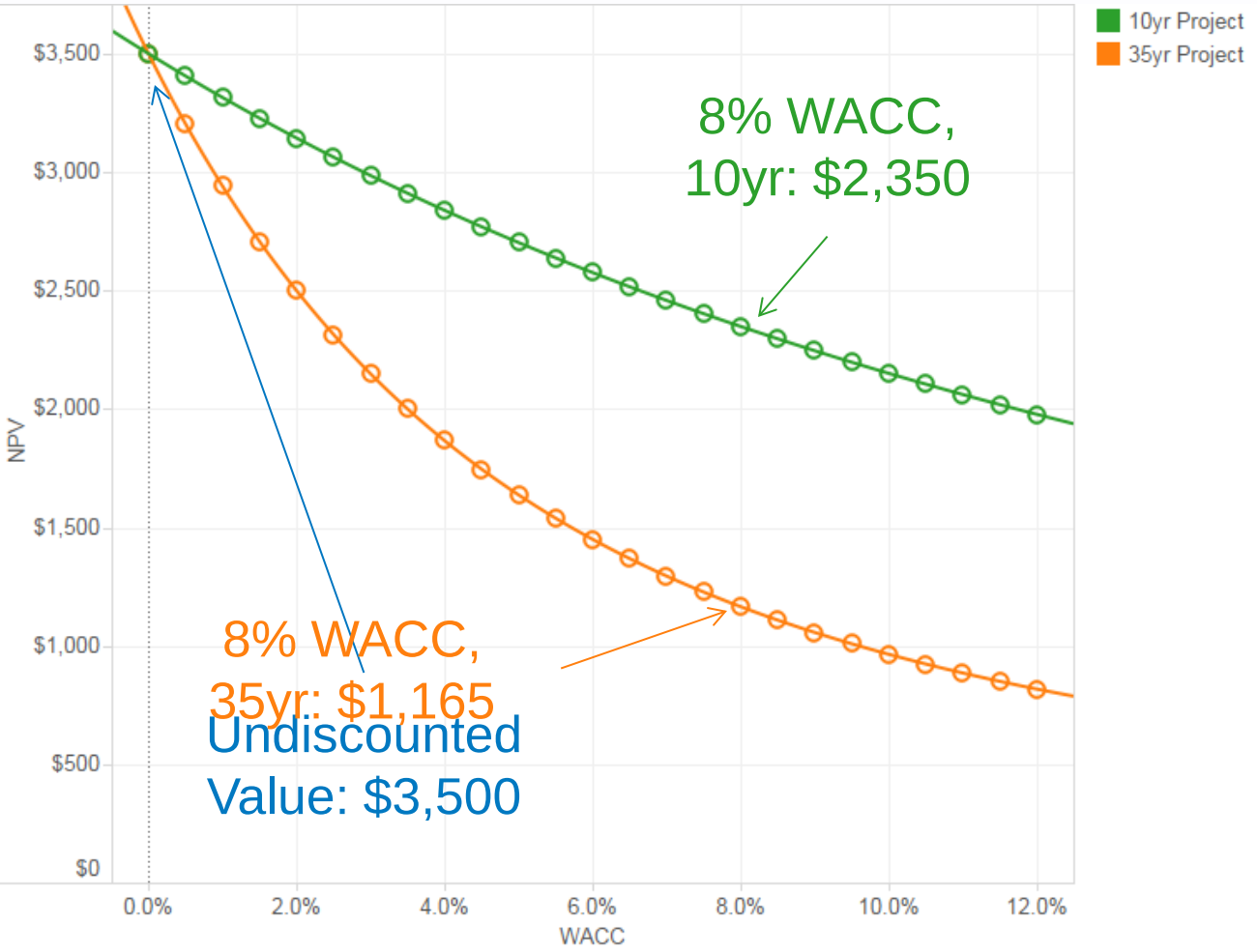
After Tax WA Cost of Debt + WA Cost of Equity

6.65%

Illustrative Example
How WACC Affects NPV

As the discount rate increases (in this case, WACC), the NPV of a project decreases.

Spreading cash flows out across more time increases sensitivity to WACC.



Discounting

- Discounting accounts for timing of resource costs / revenues
- The value of dollars decreases over time – i.e., a dollar today has greater value than a dollar tomorrow
- PGE uses its weighted average cost of capital as the discount rate
- Net Present Value (NPV) is a formula used to calculate the present value of all expected cash flows

Net Present Value Formula:

$$NPV = \frac{c_1}{(1+r)} + \frac{c_2}{(1+r)^2} + \cdots + \frac{c_n}{(1+r)^n}$$

Where c = cash flow; r = discount rate: n = year

Years	Project A	Project B	Project C	Project D
1 - 5	$55	$60	$148	$182
6 - 10	$55		$30	$20
11 - 15	$55		$20	$10
16 - 20	$55		$20	$10
21 - 25			$20	$10
26 - 30			$20	
31 - 35			$20	

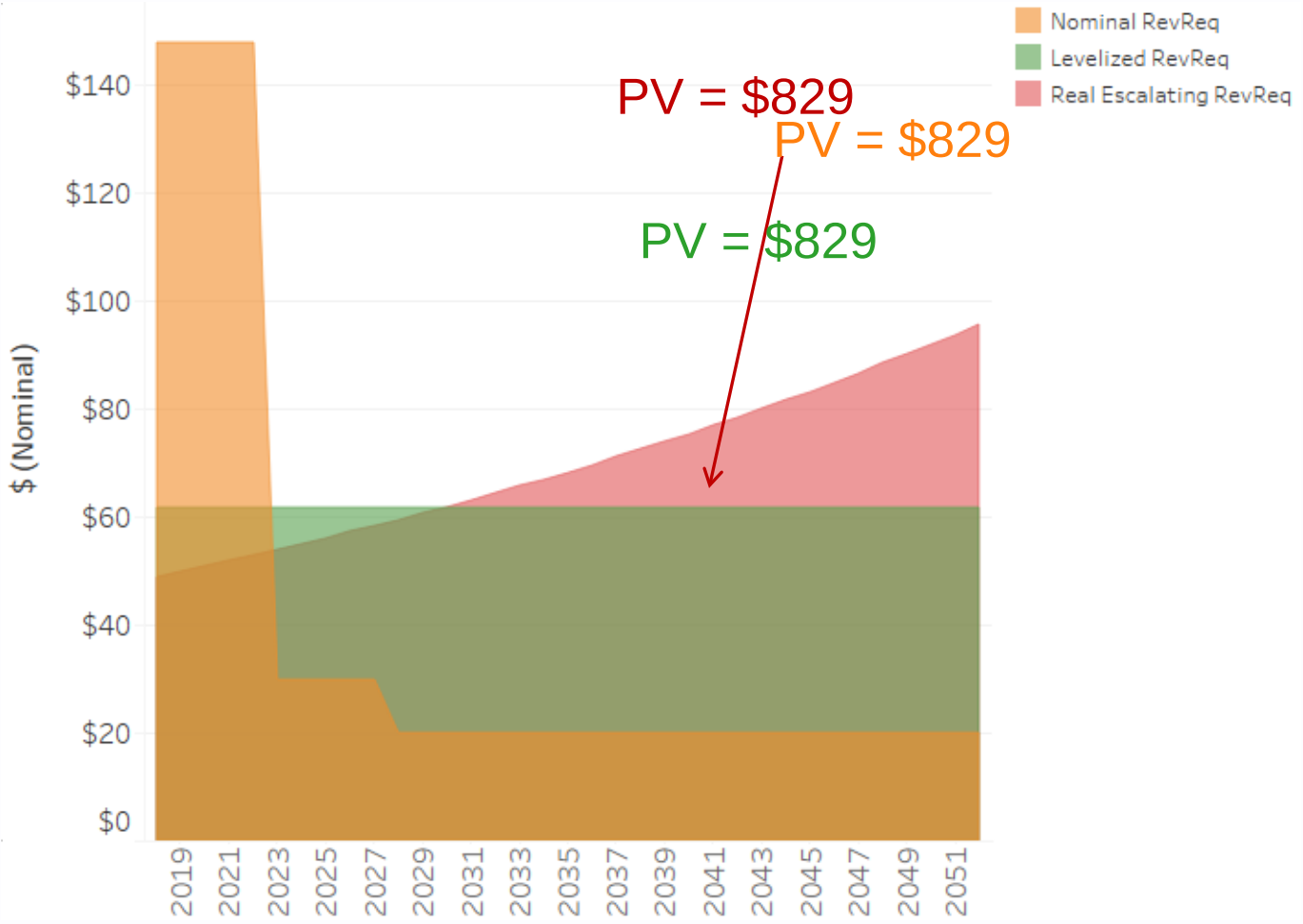
Levelization

- Levelization accounts for differences in resource term
- A resource's PV is converted into an annual cost applied across the levelization period
- Levelization identifies the fundamental price for large, lumpy investments and / or variable cash inflow / outflows

Simple Annuity Formula:

$$\$48 = \$829 \times \frac{4.56\% \times (1+4.56\%)^{35}}{(1+4.56\%)^{35}-1}$$

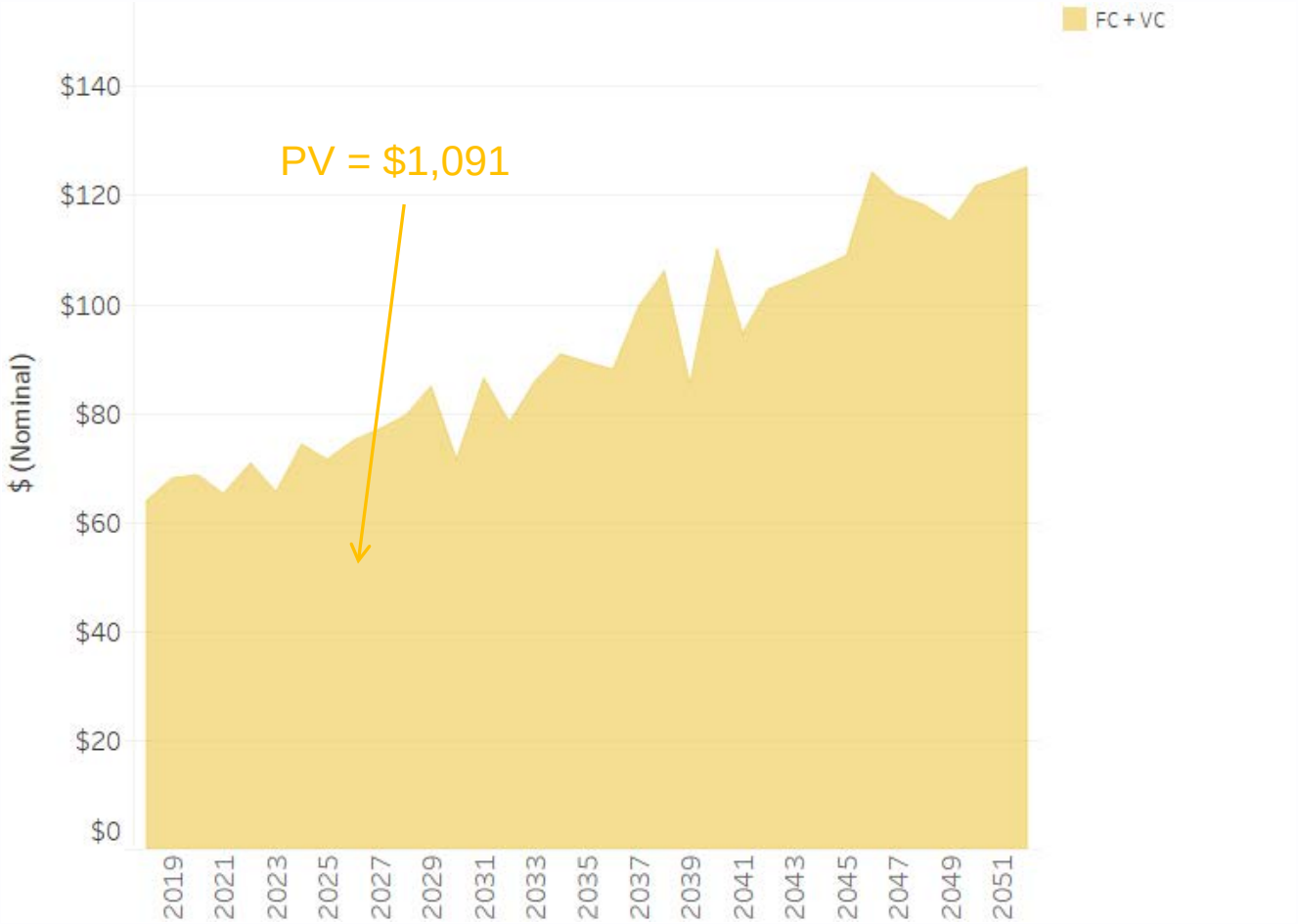
Where A = levelized cost; P = present value ; r = discount rate; n = year



Cost Analysis: IRP

- For IRP purposes, PGE inputs real levelized fixed costs into Aurora
- The resource is dispatched, providing variable costs
- The PV of the total costs is then utilized in portfolio analysis

Illustrative Example

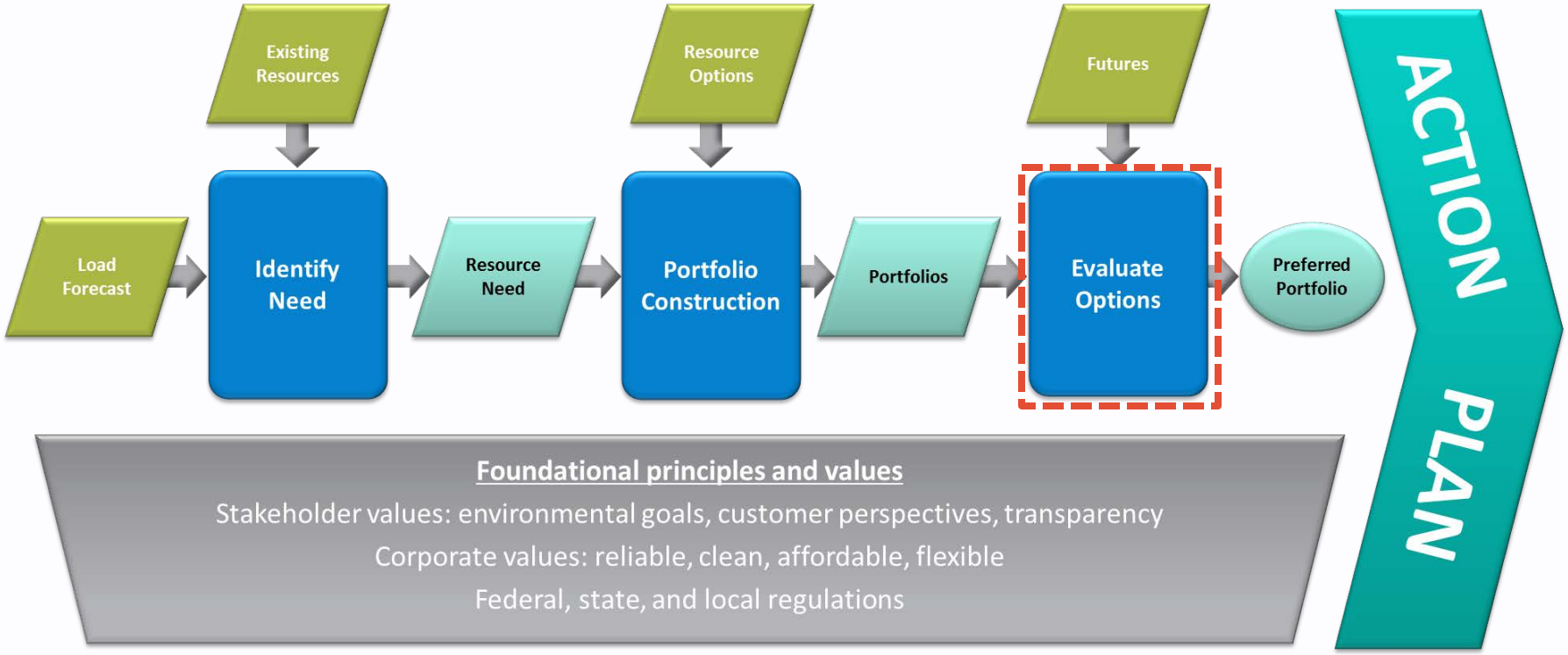


Scoring Metrics

Franco Albi

IRP Modeling Process

- The primary steps utilize input data developed in a number of sub-processes, summarized by four areas below



Scoring Metrics Dialogue

- Role of Metrics
  - Why?
- IRP Guidelines
  - What's required?
- 2016 IRP metrics
  - Review
- Metrics research
  - What do others do?
- Values discussion
  - What's important?

Scoring metrics will be discussed and developed through a series of three round table meetings

Aug 2017

Review Metrics

- Review 2016 scoring metrics
- Align customer and stakeholder values

Nov 2017

Draft Metrics

- Identify preliminary metrics
- Value mapping of metrics
- Define metrics and potential use
- Categorize metrics

Feb 2018

Final Metrics

- Final metrics, categories and definitions
- Metric scorecard design

Role of Scoring Metrics

Metrics help facilitate the selection of a portfolio and development of action plan that are consistent with values and goals

- Assess the performance and flexibility of portfolios
- Help focus the evaluation of portfolios
- Reflect the utility's and the stakeholder's values and goals
- Enhance insight when clearly defined, described and presented

"The primary goal must be the selection of a portfolio of resources with the best combination of expected costs and associated risks and uncertainties for the utility and its customers."

IRP Guidelines

Guideline 1(c)

- Cost
  - "Utilities should use present value of revenue requirement (PVRR) as the key cost metric."
  - Current & estimated future costs for long- and short-lived resources
- Risk
  - "Two measures of PVRR risk: one that measures the variability of costs and one that measures the severity of bad outcomes."
  - "Discussion of the proposed use and impact on costs and risks of physical and financial hedging."

2016 IRP Scoring Metrics

For the 2016 IRP, PGE identified least cost, least risk portfolios by measuring the cost and risk associated with each portfolio

Cost – 50 %

- **NPVRR –** **N**et Present Value of Revenue Requirement for Reference Case portfolio costs

Risk – 50%

- **Severity** – magnitude of most expensive outcomes
- **Variability** – variance of most expensive outcomes
- **Durability** – likelihood of low vs. high portfolio cost outcomes across the different futures
- **Curtailment*** – the potential for renewable curtailment

* Curtailment metric was removed following discussions with stakeholders

Scoring Metrics Research

6 utilities reviewed

- Arizona Public Service
- Dominion (Virginia Electric & Power)
- Duke Energy
- Indianapolis Power & Light
- PacifiCorp
- Tennessee Valley Authority

- Recently completed IRP
- Traditional least cost resource planning
- Provide sufficient details on scoring
- Current generation mix (similarities to PGE)
- Promoting renewables
- Promoting Energy Efficiency and Demand Response

Selection Characteristics

Metrics Identified

Financial

- Risk-adjusted PVRR
- NPVRR
- Avg. $/MWh
- Risk-benefit ratio
- Risk Exposure
- Cumulative CapEx
- Capital investment concentration
- Expected value
- Shareholder Value

Risk

- Fuel mix diversity
- Fuel Price Volatility
- Reliability
- Flexibility
- Distinct baseload option
- Reliance on market for annual energy & capacity

Environmental

- CO_2 Emissions
- CO_2 Intensity
- Annual Avg. CO_2
- Avg. NO_x and SO_x
- Annual avg. waste
- Water use

Customer Impact

- Avg. monthly increase in customer bills
- Cost-shifting
- Local/Regional economic impact
- Rate impact over 30 yrs.

Observations:

- Most utilities focus on 3 to 5 metrics when evaluating portfolios and do not weight metrics
- All utilities use some measure of cost in the evaluation (at least PVRR)
- Many utilities have some reliability metrics and environmental metrics
- Final recommendations frequently relied on qualitative comparison of metrics

PGE's Values

PGE's long-term planning values stem from our role as a provider of essential services to our customers and the community

- Reliability
  - Ensure that all customers have reliable essential services
- Affordability
  - Ensure that customers have access to that service at affordable, equitably-allocated costs into the future
- Sustainability
  - Ensure that resource actions support local, regional, and national decarbonization goals
- Flexibility
  - Ensure operational and procurement flexibility to provide essential services efficiently in changing markets

Stakeholder Input

What are your values?

Potential Metrics

Financial

- Risk-adjusted PVRR
- NPVRR
- Avg. $/MWh
- Risk-benefit ratio
- Risk Exposure
- Cumulative CapEx
- Capital investment concentration
- Expected value
- Shareholder Value

Risk

- Fuel mix diversity
- Fuel Price Volatility
- Reliability
- Flexibility
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Others

-
-
-
-
-

Environmental

- CO_2 Emissions
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Customer Impact

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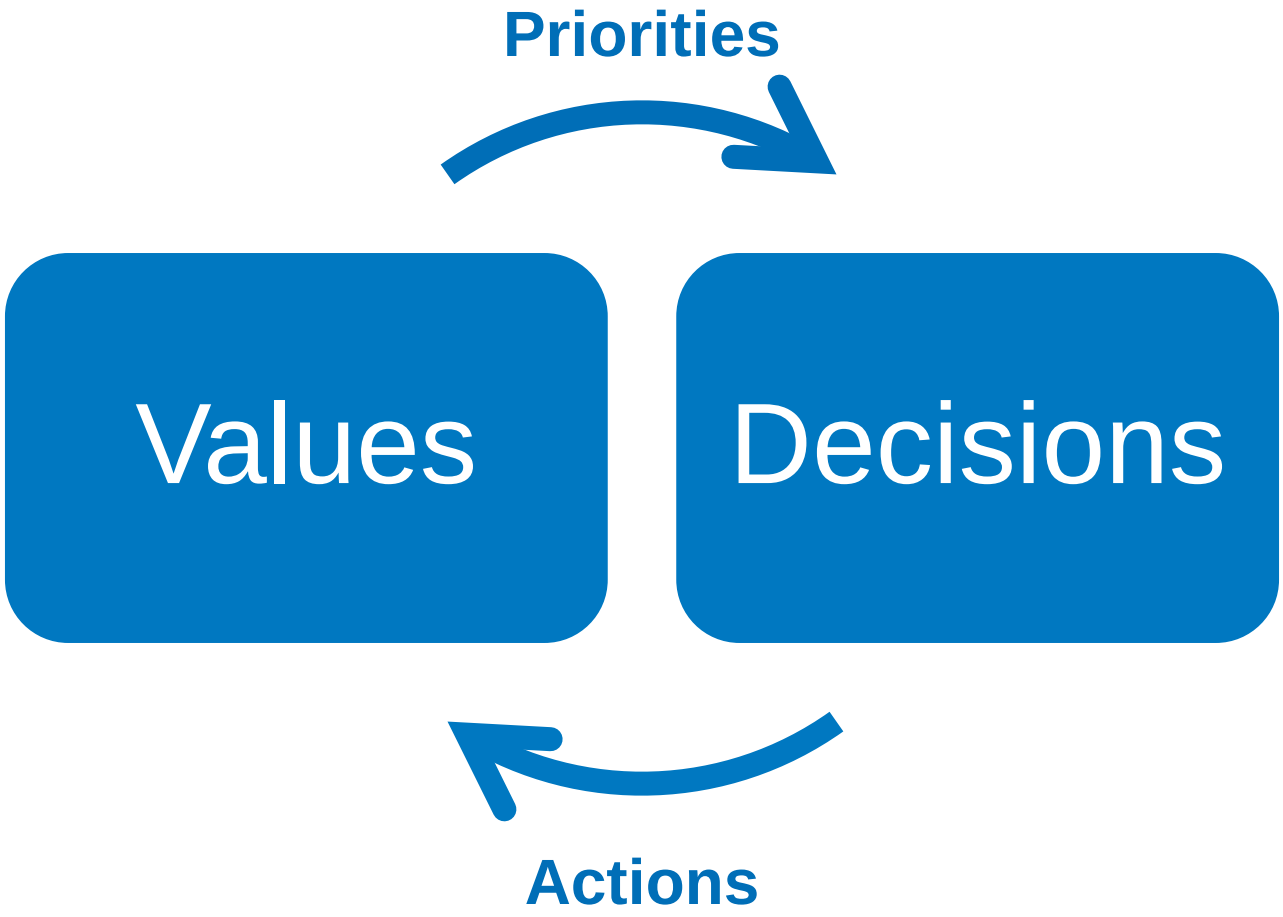
Aligning Values with Decisions



Scoring Metrics Next Steps

- Role of Metrics
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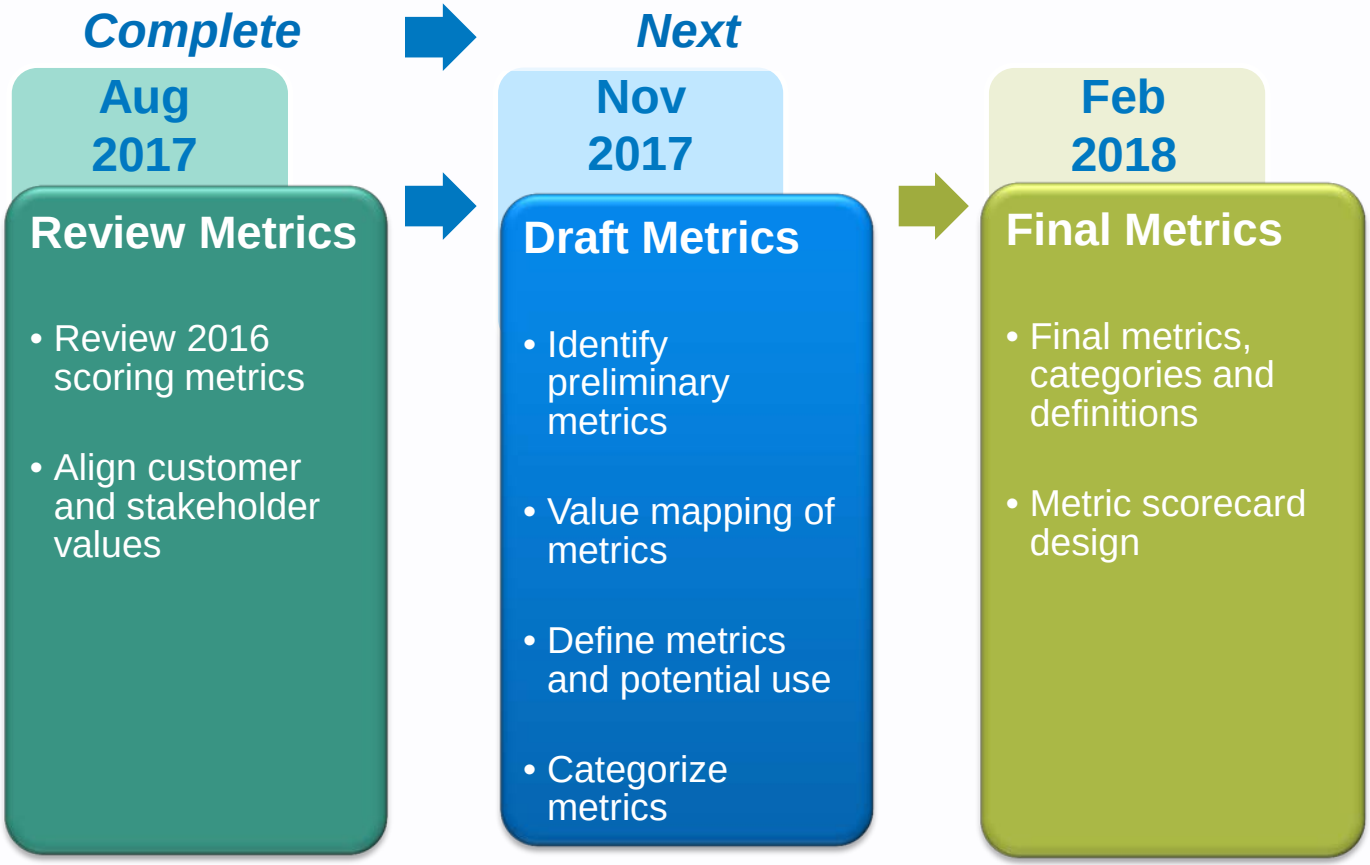

Decarbonization Study

Elaine Hart

Decarbonization Study

PGE is conducting a decarbon-ization study to inform the next IRP

- In the 2016 IRP, stakeholders expressed interest in seeing portfolios that meet more aggressive long term GHG targets
  - State of Oregon economy-wide goal: 75% below 1990 levels by 2050
- In June 2017, the City of Portland and Multnomah County announced resolutions to achieve deep reductions in carbon emissions
  - 100% clean & renewable electricity by 2035
  - 100% economy-wide clean & renewable energy by 2050

Study Scope

PGE is interested in understanding multiple pathways to a lower carbon future

Study seeks to help PGE understand how decarbonization may affect utility long-term planning

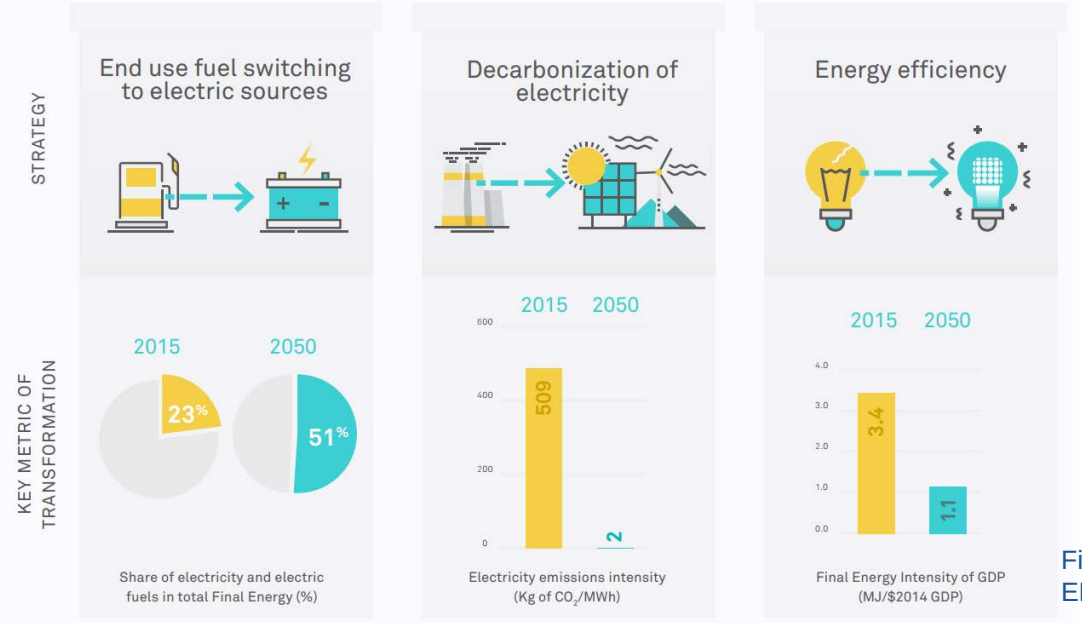

Figure source: EER

PGE has engaged a consultant (Evolved Energy Research) to develop three scenarios that meet aggressive carbon emissions targets in PGE's service area by 2050:

- High Electrification
- Low Electrification
- High Distributed Energy

Modeling Approach

Decarb Study will provide high level insight for long-term planning exercises

Will not choose a future or replace existing cost effectiveness analysis

EnergyPATHWAYS model characterizes rollover of energy infrastructure stock over time (light bulbs, furnaces, power plants, etc.) given scenario assumptions.

Key inputs include:

- Infrastructure cost, performance, and existing stock data
- Fuel emissions intensities and price forecasts
- Carbon reducing measures (e.g., electric vehicle adoption rate or increased renewable procurement)

For each scenario, study outputs will include:

- Economy-wide carbon emissions over time
- High level characterization of energy demands, fuel mixes and carbon intensities by end use, and fuel and energy infrastructure costs over time
- Study will not identify the best way forward or replace existing cost/benefit analysis for energy efficiency, resource procurement, etc.

Next IRP

?

Decarb Study

Stakeholder Engagement

Consultant to present the analysis to stakeholders at a future IRP Roundtable Meeting

PGE will seek input from stakeholders regarding how the study findings could be incorporated into the next IRP

2016 IRP Update

Franco Albi