NARUC CPI Innovation Webinar

BEST PRACTICES IN INTEGRATED RESOURCE PLANNING: A GUIDE FOR PLANNERS DEVELOPING THE ELECTRICITY RESOURCE MIX OF THE FUTURE

INNOVATION WEBINAR

January 23, 2025

3:00 to 4:00 p.m. ET

Moderator: **Commissioner Sarah Freeman,**
Indiana Utility Regulatory Commission

Devi Glick,
Senior Principal,
Synapse Energy Economics

Shelley Kwok,
Senior Associate,
Synapse Energy Economics

Juan Pablo Carvallo,
Energy/Environmental Policy Research Scientist/Engineer,
Berkeley Lab

Phillip Popoff,
Director, Resource Planning Analytics,
Puget Sound Energy

About NARUC

- Founded in 1889, the National Association of Regulatory Utility Commissioners (NARUC) is a non-profit organization dedicated to representing the state public service commissions who regulate the utilities that provide essential services such as energy, telecommunications, power, water, and transportation.
- NARUC's members include all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands.
- Our mission is to serve the public interest by improving the quality and effectiveness of public utility regulation.

About CPI

- The NARUC Center for Partnerships & Innovation (CPI) builds relationships, develops resources, and delivers training to assist state commissions contending with complex current and emerging issues.
- CPI is funded by cooperative agreements with the U.S. Department of Energy (DOE) and the U.S. Department of Commerce's National Institute of Standards and Technology (NIST).
- NARUC CPI conducts work across five key energy areas and many topics within each: generation; transmission; distribution; customers; and critical infrastructure preparedness, response, and resilience.
- For more information, visit: https://www.naruc.org/cpi/cpi-home/

Upcoming Events

Virtual Events:

- **ERE Committee Meeting: EE for winter fuel consumption** – Jan. 27
- **NARUC-NASEO GEB Working Group: Scaling Demand Flexibility w/ Software** – Jan 30
- **NCEP N-Group Member Update Webinar -** Feb. 10
- **Bulk Power System Integrated Planning Training Series** – Feb. 13, Feb. 20, March 6
- **March Innovation Webinar** – March 20

Upcoming In-Person Events:

- **NARUC Winter Policy Summit**, Washington, DC, Feb. 23 - 26
- **Integrated Distribution System Planning/Electrification Training,** Detroit, March 11 - 12
- **Natural Gas Task Force Workshop,** Philadelphia, March 24 – 26
- **Advanced Nuclear State Collaborative Site Visit**, Charlotte, NC, April 14 - 16
- **Comprehensive Electricity Planning Workshop**, DC area, week of April 21
- **Integrated Distribution System Planning/Electrification Training,** Denver, April 30 - May 1

See our full list of events: https://www.naruc.org/cpi/cpi-events/

Today's Speakers

Best Practices in Integrated Resource Planning

Devi Glick and Shelley Kwok– Synapse Energy Economics
Juan Pablo "JP" Carvallo– Berkeley Lab
Phillip Popoff – Puget Sound Energy (contributor for today's webinar)

January 23, 2025

Synapse Energy Economics, Inc.

Energy Markets & Policy BERKELEY LAB

Recently released report

Today's webinar will discuss a recently released report by Synapse Energy Economics and Berkeley Lab, available here.

Principal Authors

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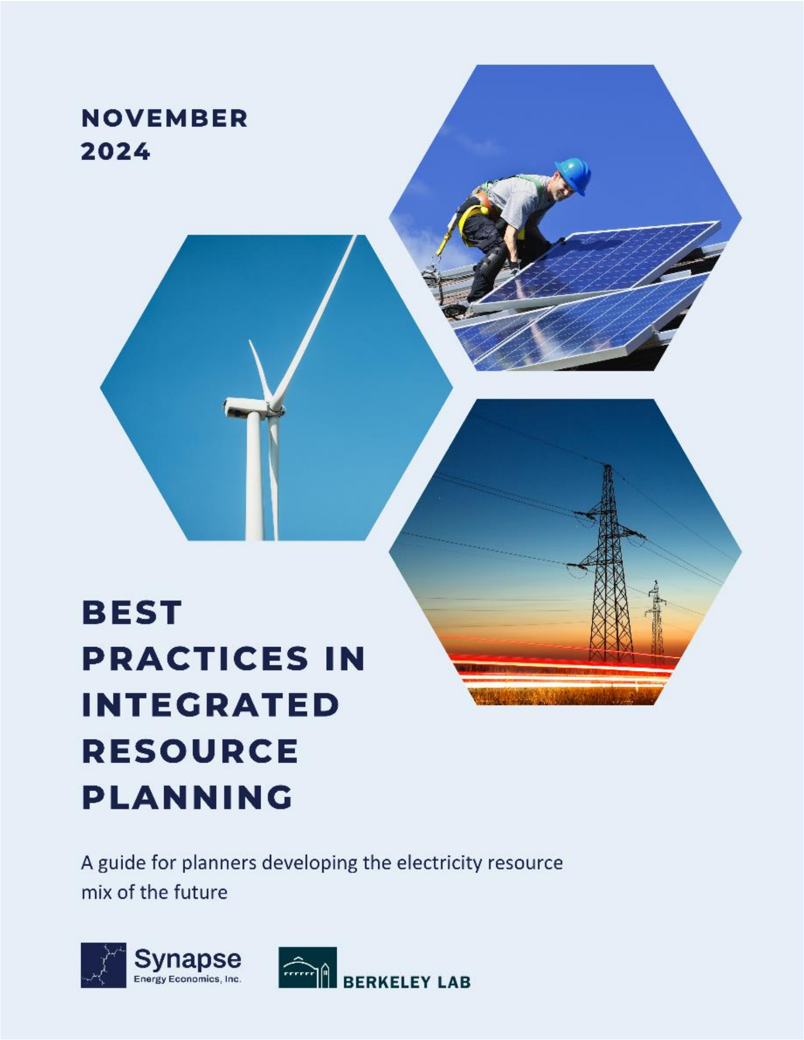

50 Best Practices Checklist

I. Stakeholder engagement

- **Best Practice 1:** Use an inclusive stakeholder process
- **Best Practice 2:** Engage technical stakeholders in IRP modeling

II. Resource adequacy

- **Best Practice 3:** Link resource adequacy assessments with resource planning
- **Best Practice 4:** Apply consistent accreditation frameworks to all resource types
- **Best Practice 5:** Use a regional perspective to plan for resource adequacy

III. Developing model inputs

- **Best Practice 6:** Use up-to-date inputs and assumptions
- **Best Practice 7:** Recognize historical data limitations

Load Inputs

- **Best Practice 8:** Develop a load forecast for the expected future
- **Best Practice 9:** Incorporate load flexibility into electrification forecasts
- **Best Practice 10:** Plan ahead for large growth
- **Best Practice 11:** Transparently represent distributed generation and storage

Supply-side resource inputs

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IV. Designing scenarios and sensitivities

- **Best Practice 28:** Model a base case that allows for easy comparison
- **Best Practice 29:** Design scenarios to evaluate uncertainty and risk
- **Best Practice 30:** Plan for and incorporate important regulatory factors

V. Running the models (and iterating)

- **Best Practice 31:** Thoughtfully select capacity expansion and production cost models
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VI. Evaluating portfolio results and communicating transparently to regulators and stakeholders

- **Best Practice 41:** Use appropriate metrics to evaluate IRP results
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VII. Integrating the IRP process with other utility proceedings

- **Best Practice 46:** Use IRP results to inform an Action Plan and utility procurement processes
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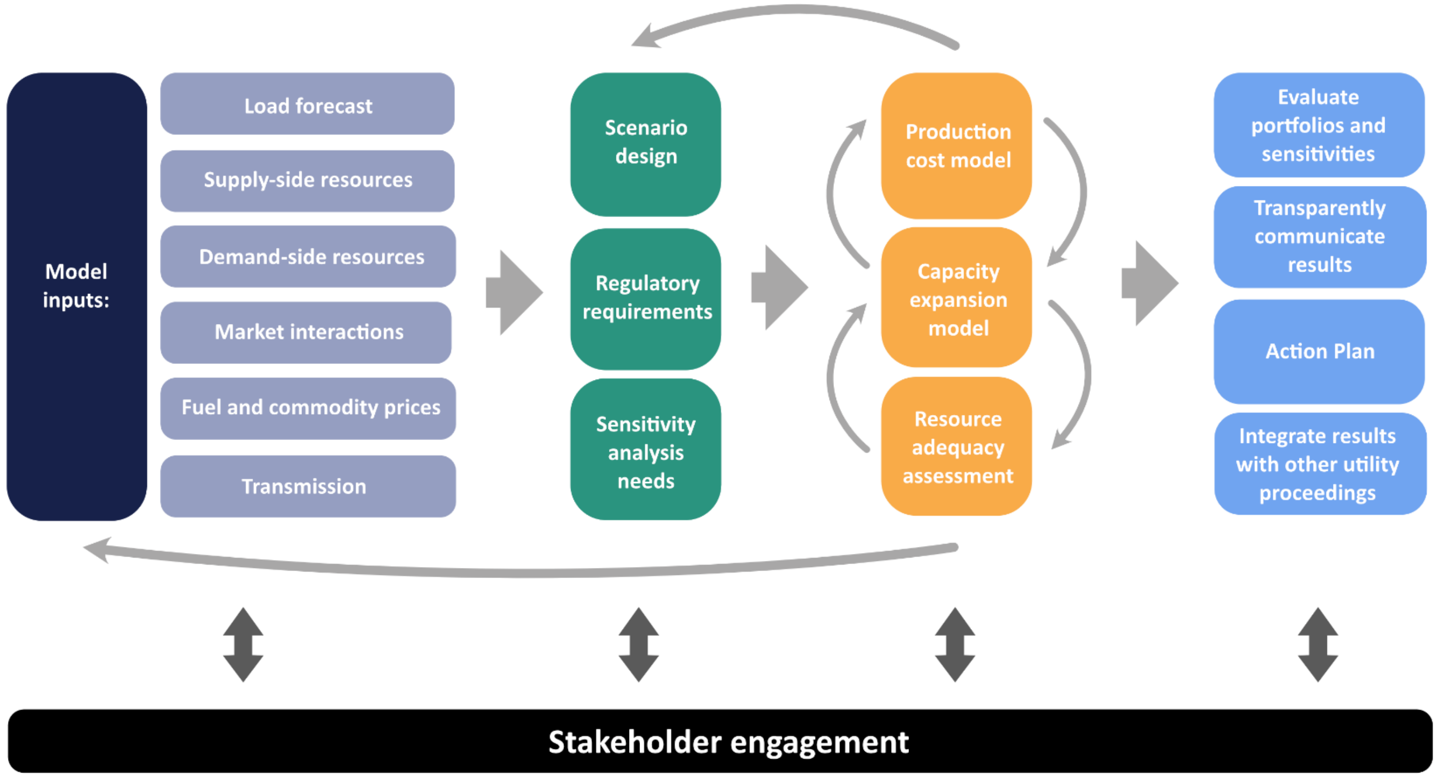
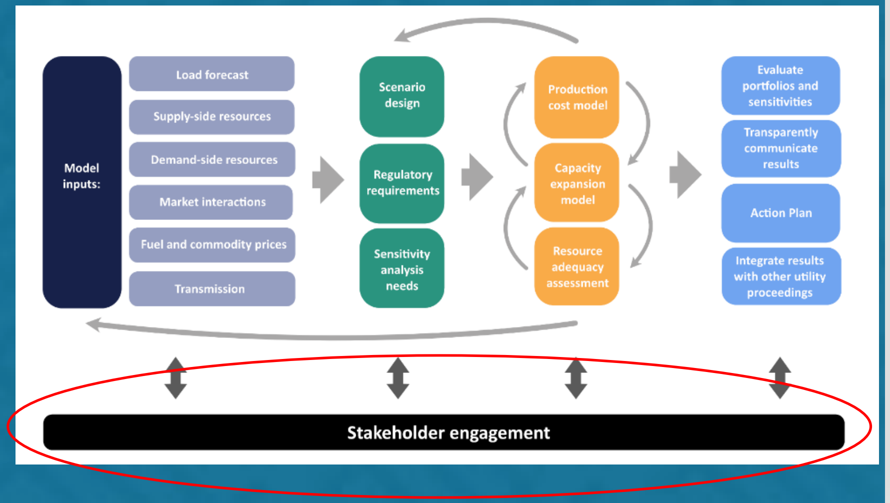
- **Best Practice 48:** Evaluate bill impacts
- **Best Practice 49:** Consider energy justice comprehensively
- **Best Practice 50:** Consider the evolving natural gas distribution industry

Agenda

- What is IRP and where are IRPs used?
- Review of best practices
  - Stakeholder engagement
  - Model inputs
  - Scenario design
  - Modeling tools
  - Evaluating portfolios and presenting results
  - Action plan and other proceedings



Stakeholder engagement

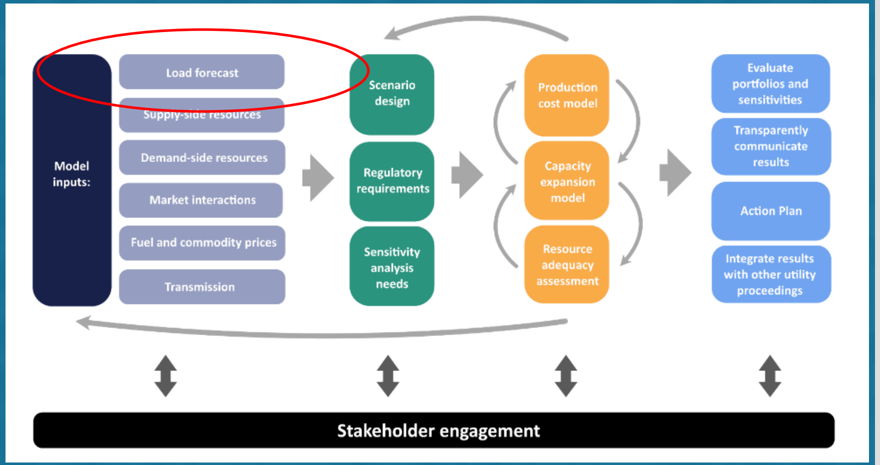


Engaging stakeholders

Best Practice 1. Use an inclusive stakeholder process
Best Practice 2. Engage technical stakeholders in IRP modeling

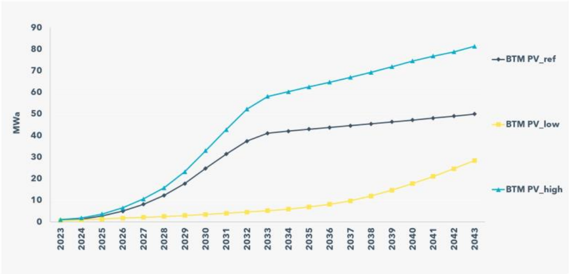
- Design an inclusive process that balances access and transparency with reasonable time commitments
  - Intentionally establish process norms to collect and respond to feedback
  - Remove barriers to participation
  - Prioritize transparency
- Provide modeling files and other information to allow technical stakeholders to replicate modeling outcomes and develop alternative portfolios
  - Input data
  - Explanations of how the utility used input data and values
  - Spreadsheets used for pre-processing and post-processing of inputs and results
  - Software licenses paid for by the utility

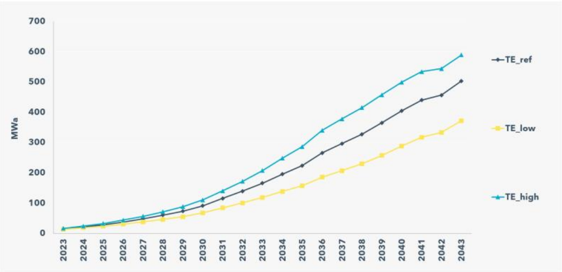
Model Inputs - Load and DER forecasting



Load and DER forecasting

- Best practices in this section of the report several topics
  - Examine historical data limitations
  - Develop a load forecast for the expected future
  - Incorporate load flexibility into electrification forecasts
  - Plan ahead for large load growth
  - Transparently represent distributed generation and storage





PV (left) and EV (right) forecasts from PGE's 2023 IRP

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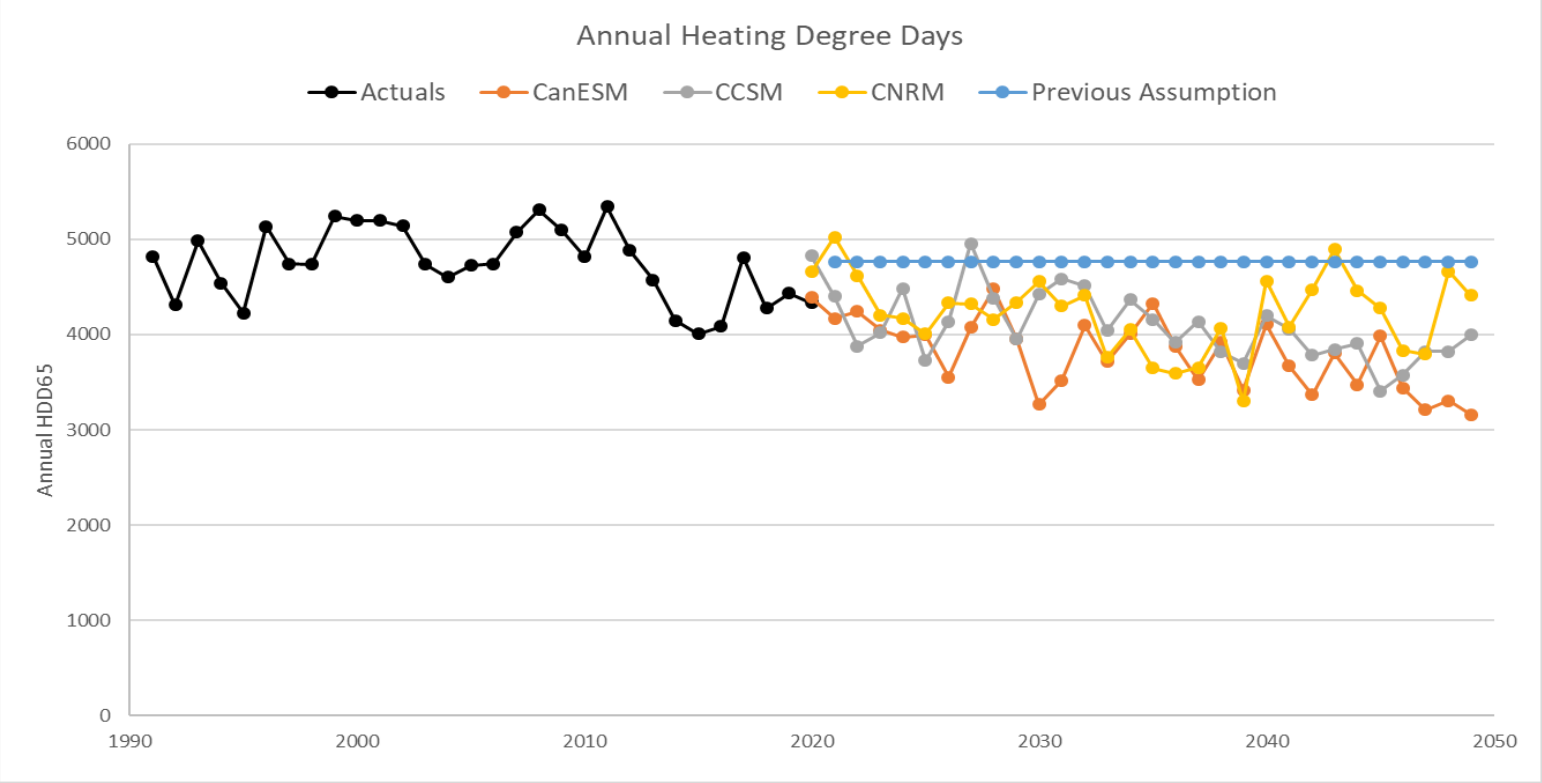
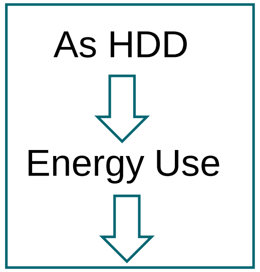
Historical data limitations – PSE Case





Load forecast

Best Practice 8. Develop a load forecast for the expected future
Best Practice 10. Plan ahead for large load growth

- End use-based bottom-up forecasts – with a particular focus on modeling emerging large data center and industrial loads – are the basis of best practices to forecast load
- Best practices
  - Granularity and resolution: (i) hourly temporal resolution and (ii) locational spatial resolution, matching bulk power system models
  - Individual end use forecasts for (i) adoption, (ii) operation, and (iii) flexibility. Limited role for time series or econometric approaches
  - Internalize impacts of state-level electrification goals or indirect decarbonization goals
  - Large load best practices
    - Collaborate with customers to develop construction milestones to track load materialization; PUCs can connect these to cost recovery for the utility
    - Work with customers on managing timing to achieve win-win for system reliability and affordability
    - Integrate large loads into IRP scenarios and modeling

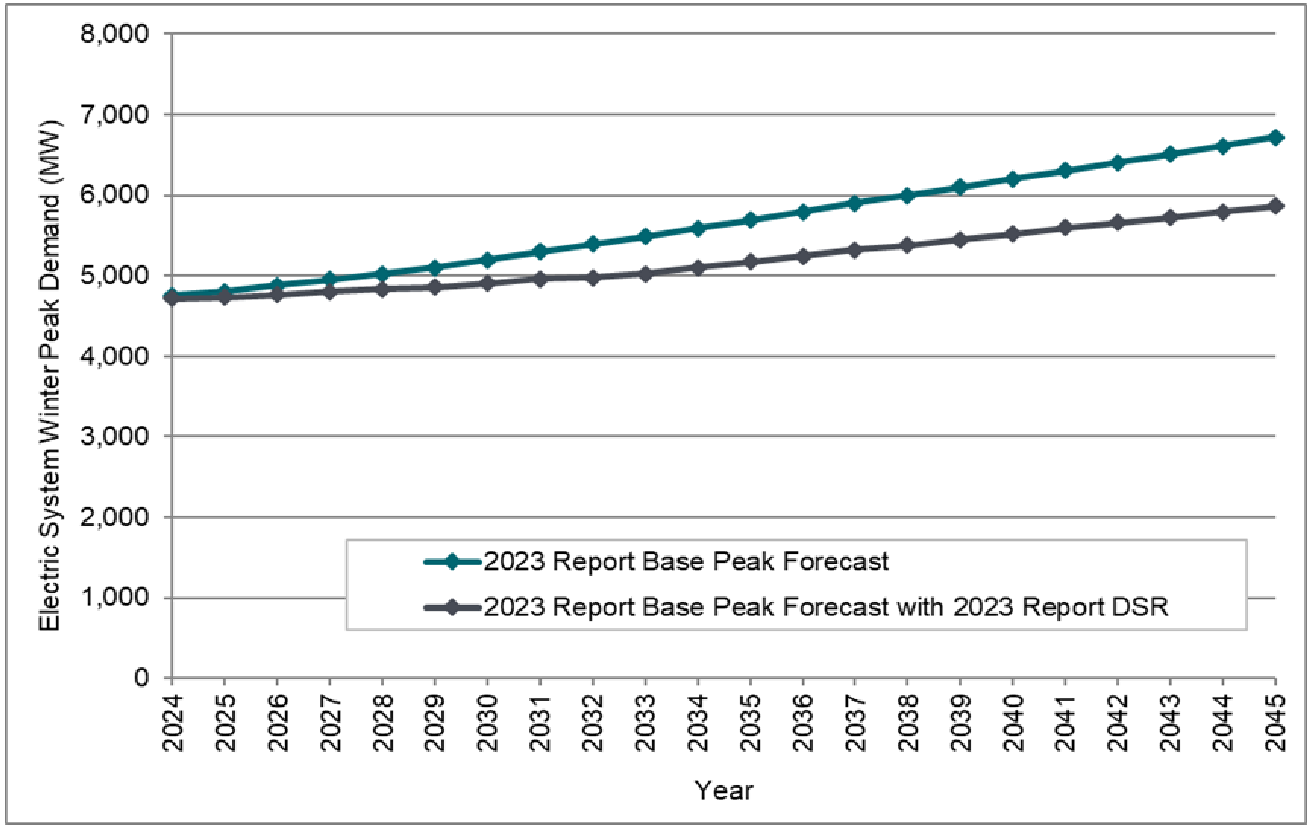
Flexibility and DER forecast

Best Practice 9. Incorporate load flexibility into electrification forecasts
Best Practice 11. Transparently represent distributed generation and storage

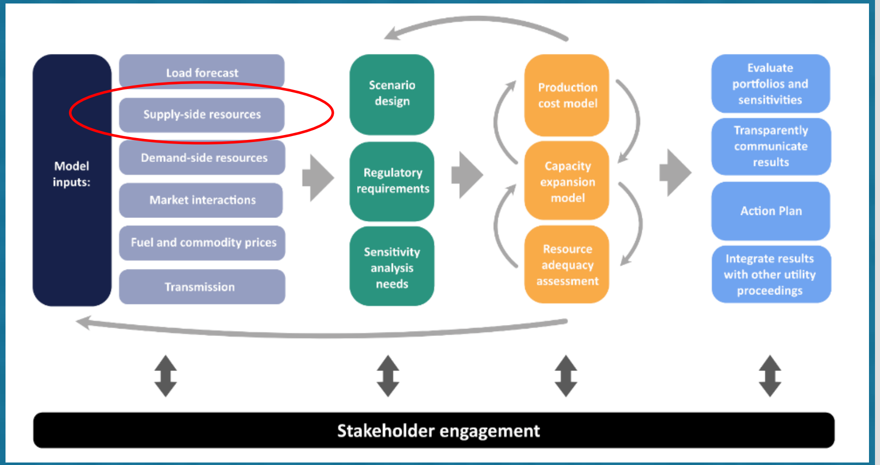
- Integration of demand-side resources into forecasts with transparent characterization and modeling of flexibility, distributed generation, and storage
- Best practices
  - Traditional **demand response remains in the market potential study**; EV and heat pump flexibility modeling based on realistic assumptions for control and behavior
  - Separately forecast **adoption of DER over time and space**, as well as modeling DER **operation.** Adoption and operation follow **economic logic**, but are strongly **influenced by policy, regulatory, and retail rate incentives**
  - **Adoption**: Propensity of adoption method; **operation** does not have a best practice → scenarios
  - **Do not "hide" the DER forecast** with the load forecast
  - If a distribution system plan is available, **ensure the IRP uses the same assumptions** and outcomes

Flexibility and DER forecast – PSE Case

Electric Winter Peak Demand Forecast (MW), before Additional DSR and after Additional DSR



Model Inputs - Supply-side resources



Supply Side Resources

- Best practices in this section of the report cover topics such as:
  - New resource cost assumptions
  - Advanced and emerging technologies
  - Resource availability timing
  - Renewable integration cost adders
  - Forward-going resource costs
  - Battery energy storage resources

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Resource costs

Best Practice 13. Represent the full cost and risk of advanced technologies
Best Practice 18. Be consistent in treatment of emerging technologies

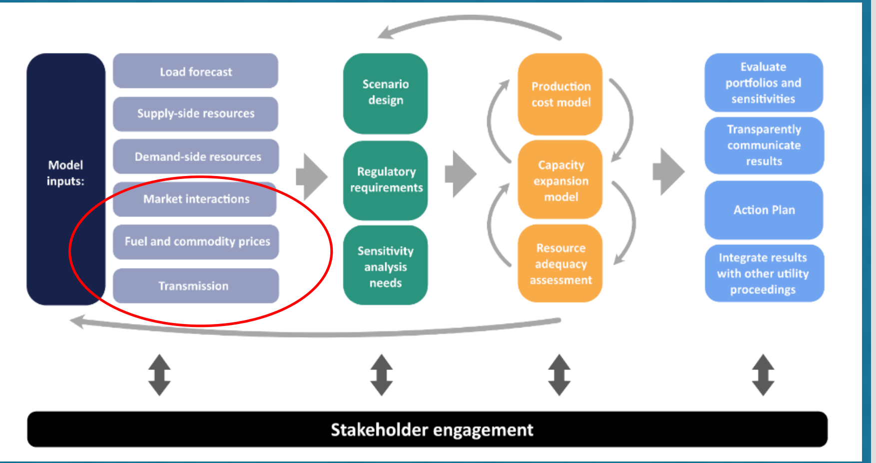
- There can be substantial costs and risks, and limited market data, on advanced technologies that are not commercially available.
- Challenges for utilities include deciding which technologies to include and how to incorporate costs and risks.
- Capacity expansion models cannot make optimized retirement decisions if they don't see avoidable capital costs (planned capex and environmental capex).
- Best practices
  - Model worst cases to account for uncertainty and risk of large cost over-runs for large, complex projects (+20%, 50%, 100%)
  - Employ consistent and unbiased evaluation of cost and performance of technologies in deciding which to include in an IRP
  - Conduct studies outside the IRP where necessary to inform inputs
  - Rely on reasonable timelines for deployment (i.e., model emerging technologies 5+ years out)
  - Program avoidable costs into the model rather than addressing them outside the model.

Best Practice 15. Limit renewable integration cost adders
Best Practice 17. Model battery energy storage options

- Deployment of renewables can require grid services incremental to those that are already captured in capacity expansion and production cost modeling.
- Energy storage is a highly flexible resource, and the value to a system changes as system portfolio and needs change.
- Best practices
  - Conduct external renewable integration studies and sync up studies with resource planning models to track / manage double-counting of services.
  - Model integration costs across a range of resource portfolios and points in time and understand how flexibility of existing resources impacts results.
  - Model the costs and capabilities of a range of short- and long- duration storage options to determine the best fit for the utility's system.

Integration grid services:
- Balancing
- Transmission upgrades
- Regulation and reserves
- Voltage support
- Real-time variability

Model Inputs - Other



Market, Commodity, and Transmission Inputs

Best practices in these sections of the report cover topics such as:

- Modeling market interaction
- Modeling fuel supply limitations, impacts of gas price volatility, and coal supply constraints
- Modeling transmission alternatives

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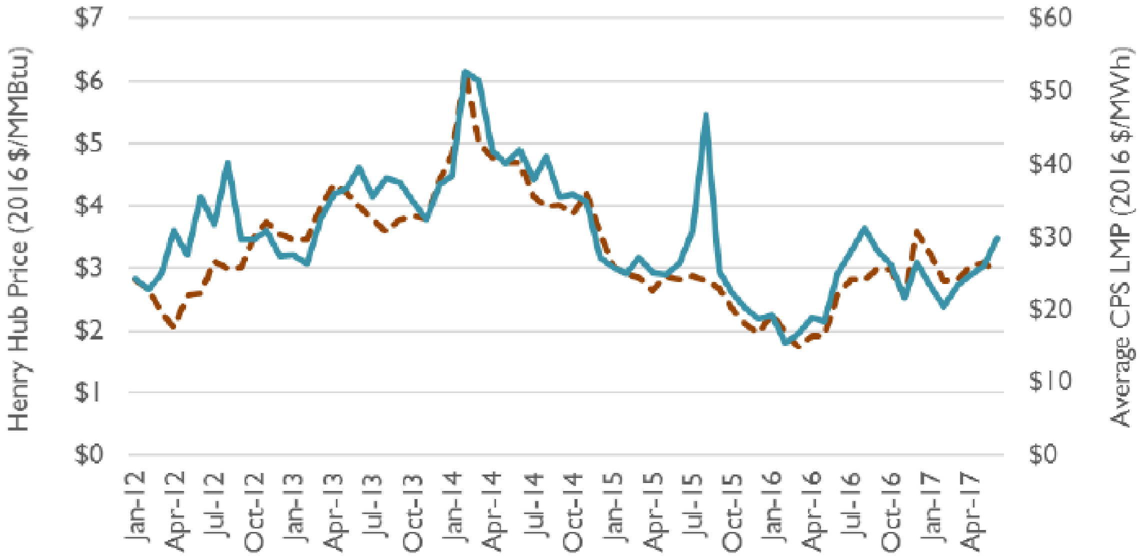
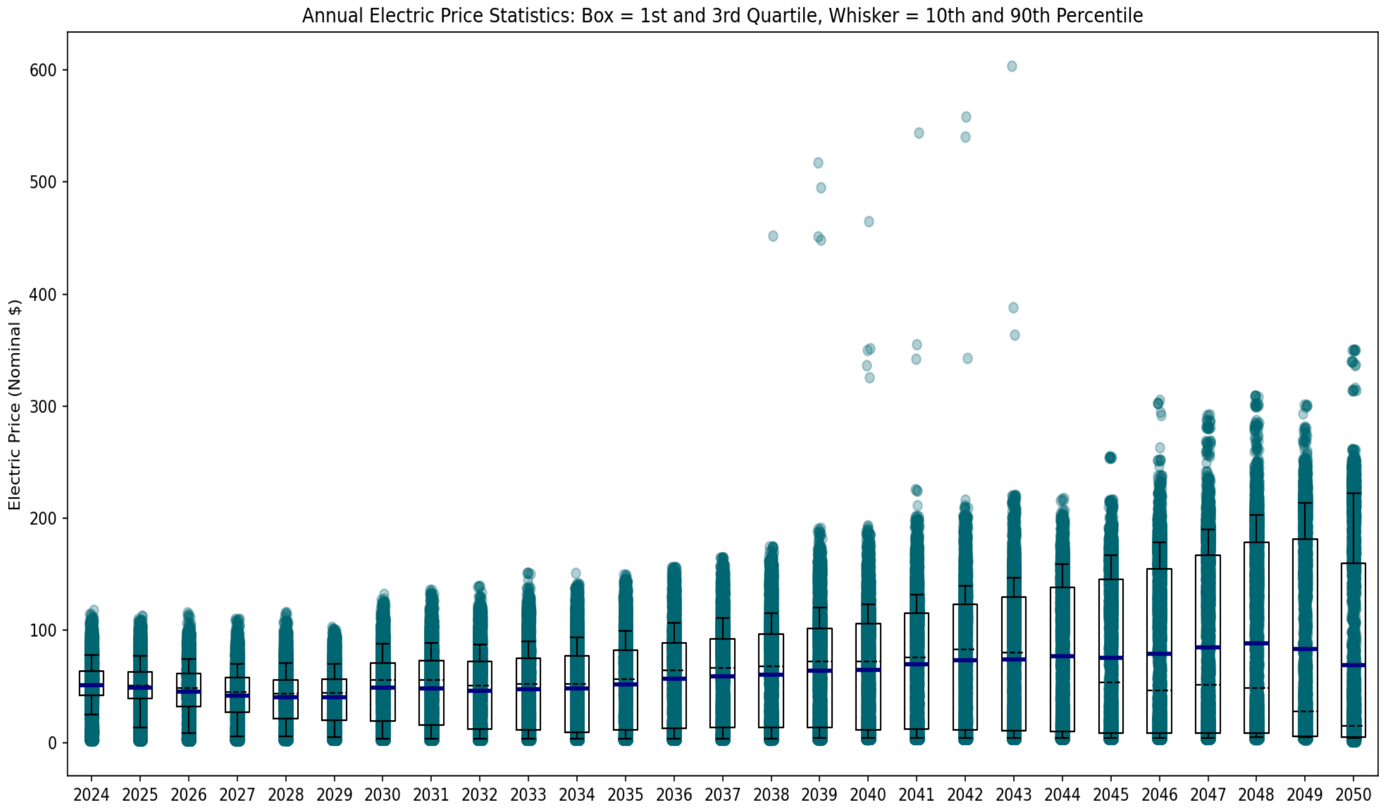
Best Practice 23. Use reasonable market interaction assumptions

- Market interaction assumptions need to balance the benefits from reasonable levels of market purchases with risks of high levels of market exposure
- Best practices
  - Conduct regional studies and align utility resource adequacy modeling and capacity expansion modeling assumptions with regional assessment results
  - Synchronize market price forecasts with fuel price forecasts



Market price forecast – PSE Case

- The deterministic electric price forecast is based on normal weather conditions with average hydro, wind, and solar generation every year.
- The variability in the latter years comes from an increase in renewable resources to meet clean energy requirements across the WECC. As the renewable resources suddenly stop generating, other more expensive resources will need to pick up to meet demand causing large swings in hourly prices.
- The stochastic prices varies weather, demand, renewable generation (hydro, wind and solar), fuel prices, and CO2 prices. There are 90 draws total of hourly prices

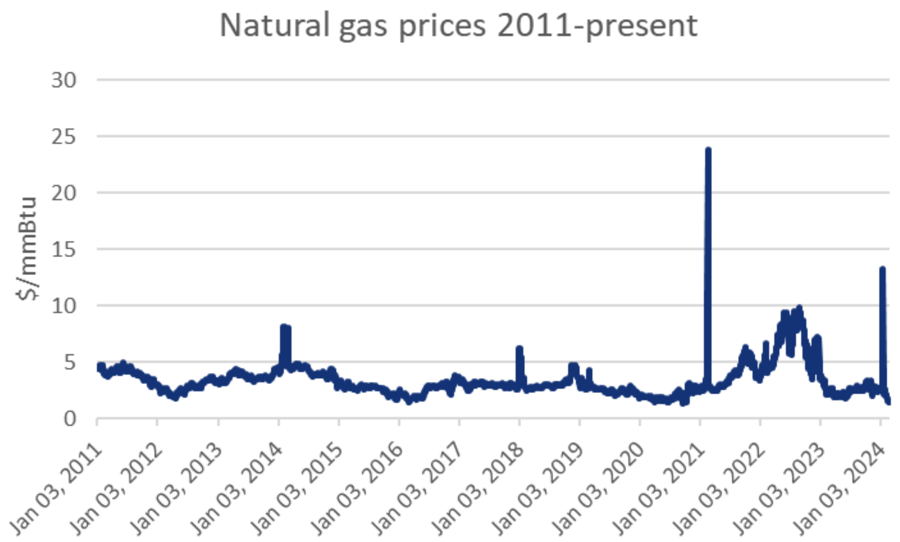


Fuel inputs

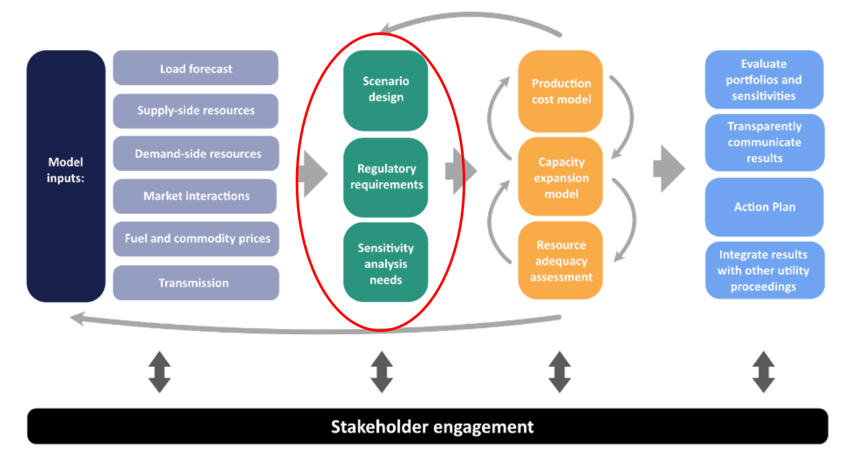
Best Practice 24. Model fuel supply limitations
Best Practice 25. Evaluate the impacts of gas price volatility and coal supply constraints

- Fuel supply constraints and price volatility impact both the cost of relying on fossil-fuel resources and how the resources are operationally modeled

- Best Practices
  - Model weatherization costs and correlated outages
  - Conduct stochastic risk analysis to evaluate volatility in fuel prices
  - Reduce reliance on fossil-fuel resources through resource planning



Designing Scenarios and Sensitivities



Scenario and sensitivity design

- Best practices in this section of the report cover:
  - Setting up a good base case
  - Designing scenarios to evaluate uncertainty, risk, and regulatory factors

Definitions

- A **scenario** represents a change to major assumptions and tends to portray a world or future that looks markedly different from base assumptions.
- A **sensitivity** changes a single key input to understand how that input affects or drives results, often across multiple scenarios. The goal of a sensitivity is to understand how sensitive the results are to a single variable.

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Considerations when designing scenarios and sensitivities

Planners often face challenges during the scenario design process, including:

- Modeling a full, comprehensive range of uncertainties vs. producing clear, informative results
- Balancing stakeholder requests with utility priorities and commission requirements
- Minimizing shareholder risks vs. minimizing ratepayer costs

Best practices for designing scenarios and sensitivities

Best Practice 28. Model a base case that allows for easy comparison

- Thoughtfully develop a base scenario and ensure that all subsequent scenarios and sensitivities are internally consistent so that results can be readily compared across them.
- This does not preclude resource planners from intentionally designing scenarios that deviate from the base scenario in a clear manner to evaluate the impact of different load forecasts or cost assumptions.

Best Practice 29. Design scenarios to evaluate uncertainty and risk

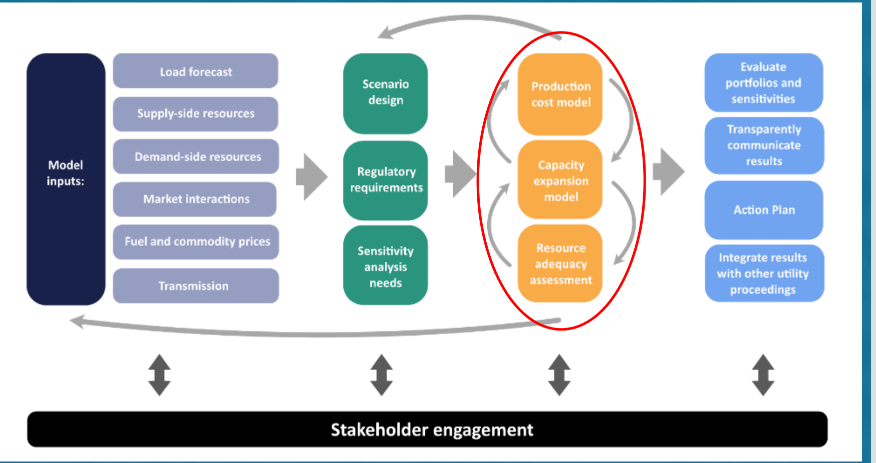
- Focus on developing a range of scenarios that evaluate real and likely futures.
- Scenarios that evaluate extreme themes or views may be interesting, but are ultimately not likely to provide useful information for IRP purposes.

Regulatory compliance

Best Practice 30. Plan for and incorporate important regulatory factors

- IRP is about selecting a least-cost, least-risk plan ***subject to compliance with reliability and regulatory constraints***.
- Best practice is to model all final, proposed, and likely regulations to allow time for proactive planning and identification of no-regrets actions.
- Modeling compliance as a single alternative scenario and not in the base case limits the utility's ability to plan for a future with the regulations in place.
- While there may be uncertainty, planners can analyze alternative futures with varying levels of regulations in other scenarios or sensitivities.
- Assuming that proposed environmental regulations will not exist in the future or ignoring results from scenarios with regulations included can lead to costly decisions and delays.

Models


Model inputs:
Load forecast
Supply-side resources
Demand-side resources
Market interactions
Fuel and commodity prices
Transmission
Scenario design
Regulatory requirements
Sensitivity analysis needs
Production cost model
Capacity expansion model
Resource adequacy assessment
Evaluate portfolios and sensitivities
Transparently communicate results
Action Plan
Integrate results with other utility proceedings
Stakeholder engagement

Running the models

Best Practices 31–40

- Best practices in this section of the report cover:
  - Choosing and calibrating capacity expansion and production cost models and using them iteratively
  - Selecting geographic and temporal scales for both models
  - Letting models optimize, including retirement decisions
  - Capturing the value of energy storage
  - Using stochastic approaches for robust portfolio creation

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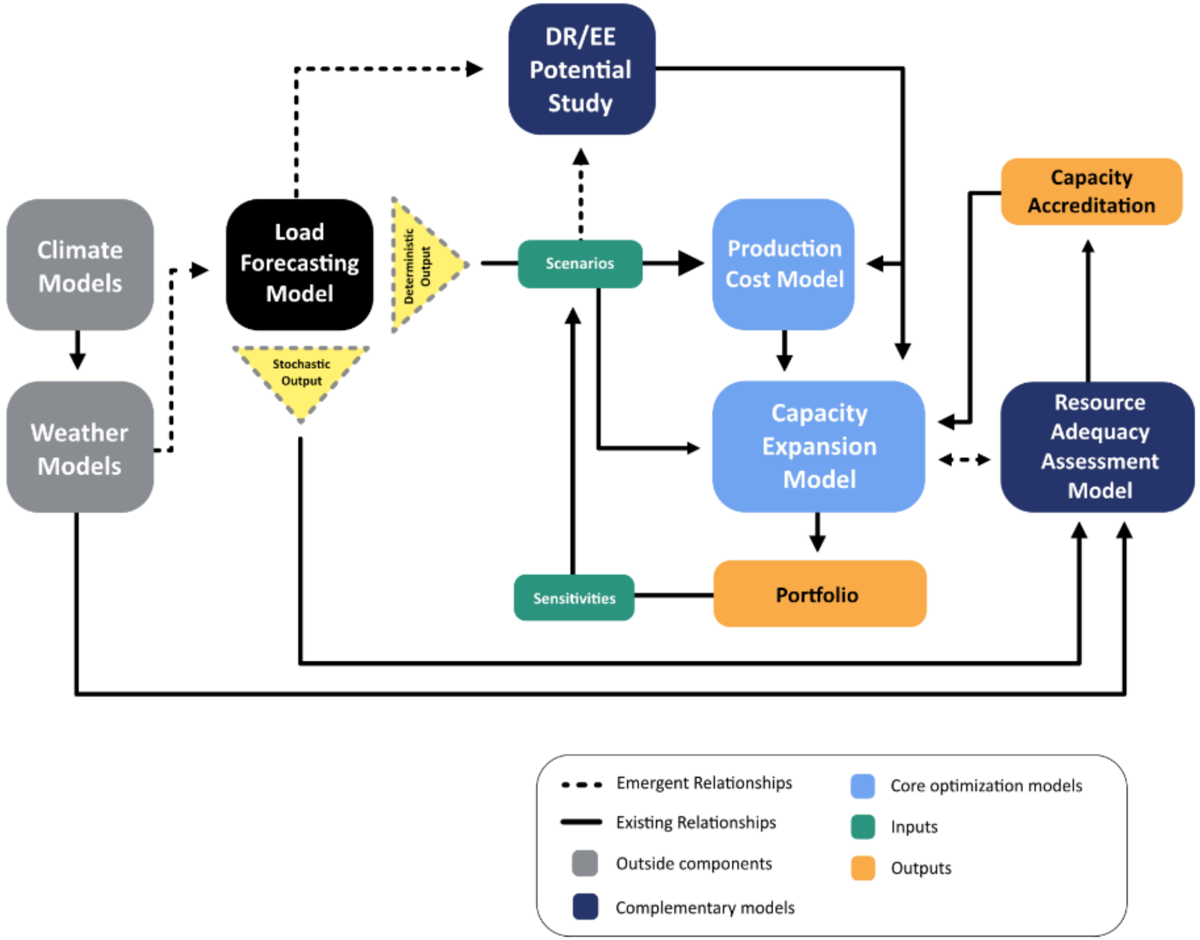
- **Best Practice 45:** Model state goals and priorities in preferred portfolio

VII. Integrating the IRP process with other utility proceedings

- **Best Practice 46:** Use IRP results to inform an Action Plan and utility procurement processes
- **Best Practice 47:** Use IRP results to inform other types of planning
- **Best Practice 48:** Evaluate bill impacts
- **Best Practice 49:** Consider energy justice comprehensively
- **Best Practice 50:** Consider the evolving natural gas distribution industry

Best practices for modeling

- **Ensure** capacity expansion and production cost models are **state-of-the-art**
- Select **spatial and temporal scales thoughtfully**, including (i) temporal granularity and (ii) planning horizon
- **Calibrate** both models!
- Let optimization **models optimize**
  - Don't force **build decisions** unless resources are under construction
  - Don't force **resource retirement decisions** unless testing specific scenarios
- Use **stochastic approaches** for robust portfolio creation
- Use **models iteratively**



Resource adequacy (RA) analysis

Best Practice 3: Link RA assessments with resource planning
Best Practice 4: Apply consistent accreditation frameworks
Best Practice 5: Use a regional perspective to plan for RA

- RA is a **core component of IRP** to ensure that least cost portfolios meet prescribed BPS reliability standards
- Best practices in this section of the report cover:
  - Integrating resource adequacy analysis, resource planning analysis, and development of robust reserve margins
  - Aligning resource accreditation with resource availability
  - Taking a regional perspective on resource adequacy

I. Stakeholder engagement

- **Best Practice 1:** Use an inclusive stakeholder process
- **Best Practice 2:** Engage technical stakeholders in IRP modeling

II. Resource adequacy

- **Best Practice 3:** Link resource adequacy assessments with resource planning
- **Best Practice 4:** Apply consistent accreditation frameworks to all resource types
- **Best Practice 5:** Use a regional perspective to plan for resource adequacy

III. Developing model inputs

- **Best Practice 6:** Use up-to-date inputs and assumptions
- **Best Practice 7:** Recognize historical data limitations

Load Inputs

- **Best Practice 8:** Develop a load forecast for the expected future
- **Best Practice 9:** Incorporate load flexibility into electrification forecasts
- **Best Practice 10:** Plan ahead for large growth
- **Best Practice 11:** Transparently represent distributed generation and storage

Supply-side resource inputs

- **Best Practice 12:** Use accurate assumptions for the costs of new resources
- **Best Practice 13:** Represent the full cost and risk of advanced technologies
- **Best Practice 14:** Include realistic assumptions about resource availability timing, without unnecessary constraints
- **Best Practice 15:** Limit renewable integration cost adders
- **Best Practice 16:** Model all avoidable forward-going resource costs
- **Best Practice 17:** Model battery energy storage options
- **Best Practice 18:** Be consistent in treatment of emerging technologies

Demand-side resource inputs

- **Best Practice 19:** Ensure thoughtful and consistent assumptions for demand-side resources
- **Best Practice 20:** Model and bundle demand-side resources carefully
- **Best Practice 21:** Ensure consistency with IRP scenarios
- **Best Practice 22:** Incorporate all relevant benefits for demand-side resources

Market inputs

- **Best Practice 23:** Use reasonable market interaction assumptions

Fuel and commodity inputs

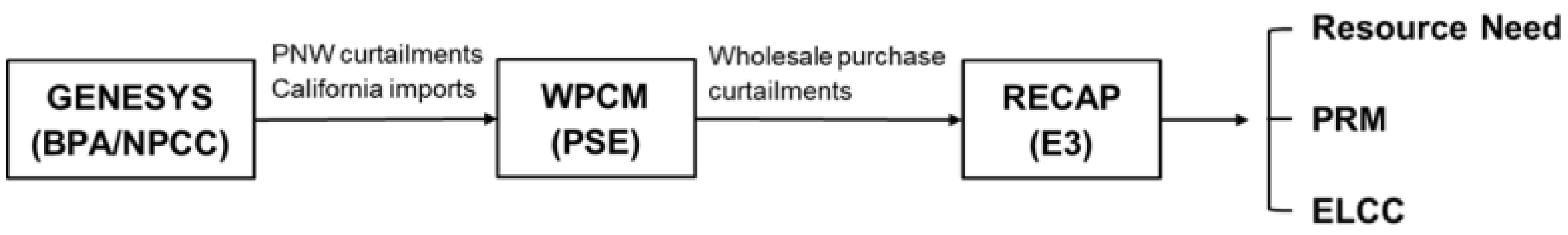
- **Best Practice 24:** Model fuel supply limitations
- **Best Practice 25:** Evaluate the impacts of gas price volatility and coal supply constraints

Transmission inputs

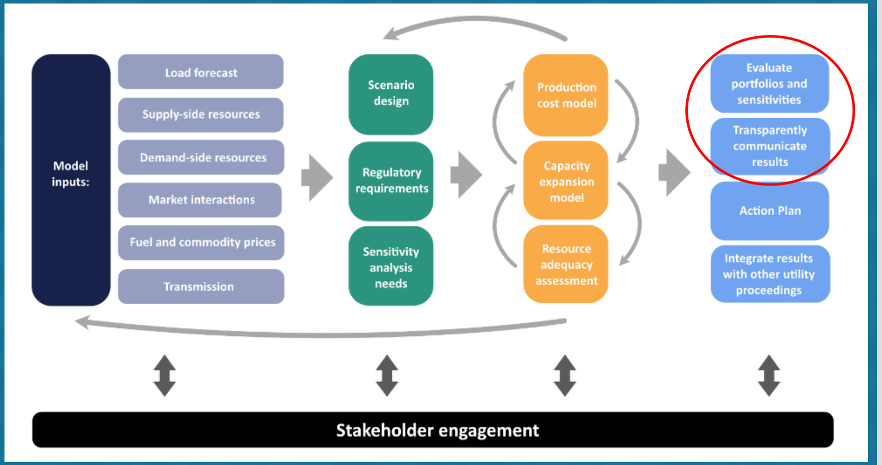
- **Best Practice 26:** Consider transmission alternatives and infrastructure expansion
- **Best Practice 27:** Properly justify bulk power system interconnection costs and constraints

RA Modeling – PSE Case

Figure L.3: Models in the Resource Adequacy Analysis



Results Evaluation



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Energy Markets & Policy BERKELEY LAB

Evaluating and communicating results

- Best practices 41–45 in this section of the report cover:
  - How to use appropriate metrics to evaluate results
  - Reporting results clearly
  - Benchmarking inputs and results
  - Selecting and modeling a preferred portfolio

IV. Designing scenarios and sensitivities

- **Best Practice 28:** Model a base case that allows for easy comparison
- **Best Practice 29:** Design scenarios to evaluate uncertainty and risk
- **Best Practice 30:** Plan for and incorporate important regulatory factors

V. Running the models (and iterating)

- **Best Practice 31:** Thoughtfully select capacity expansion and production cost models
- **Best Practice 32:** Thoughtfully select a geographic model scale
- **Best Practice 33:** Thoughtfully define the appropriate study period
- **Best Practice 34:** Thoughtfully select the appropriate time granularity for production cost modeling
- **Best Practice 35:** Calibrate the production cost and capacity expansion models
- **Best Practice 36:** Let optimization models optimize
- **Best Practice 37:** Base power plant retirement decisions on forward-looking costs
- **Best Practice 38:** Use modeling parameters that capture the value of battery energy storage
- **Best Practice 39:** Use stochastic approaches for robust portfolio creation
- **Best Practice 40:** Use the models iteratively

VI. Evaluating portfolio results and communicating transparently to regulators and stakeholders

- **Best Practice 41:** Use appropriate metrics to evaluate IRP results
- **Best Practice 42:** Report results clearly
- **Best Practice 43:** Benchmark inputs and results to other utilities
- **Best Practice 44:** Select a preferred portfolio
- **Best Practice 45:** Model state goals and priorities in preferred portfolio

VII. Integrating the IRP process with other utility proceedings

- **Best Practice 46:** Use IRP results to inform an Action Plan and utility procurement processes
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Valuing and comparing plans

Best Practice 41. Use appropriate metrics to evaluate IRP results

- At the outset of the IRP process, define core metrics that are aligned with region-specific needs and goals to avoid skewing results towards a predetermined outcome
- Collaborate with stakeholders and regulators when defining metrics

Example:

- AES Indiana developed the evaluation categories for its IRP scorecard based on a set of pillars for electric utility service defined by a task force created by the Indiana General Assembly

	Affordability	Environmental Sustainability						Reliability, Stability & Resiliency	Risk & Opportunity							Economic Impact	
	20-yr PVRR	*CO_2 Emissions*	*SO_2 Emissions*	*NO_x Emissions*	*Water Use*	*Coal Combustion Products (CCP)*	*Clean Energy Progress*	*Reliability Score*	*Environmental Policy Opportunity*	*Environmental Policy Risk*	*General Cost Opportunity **Stochastic Analysis***	*General Cost Risk **Stochastic Analysis***	*Market Exposure*	*Renewable Capital Cost Opportunity (Low Cost)*	*Renewable Capital Cost Risk (High Cost)*	*Generation Employees (+/-)*	*Property Taxes*
	Present Value of Revenue Requirements ($000,000)	Total portfolio CO2 Emissions (mmtons)	Total portfolio SO2 Emissions (tons)	Total portfolio NOx Emissions (tons)	Water Use (mmgal)	CCP (tons)	% Renewable Energy in 2032	Composite score from Reliability Analysis	Lowest PVRR across policy scenarios ($000,000)	Highest PVRR across policy scenarios ($000,000)	P5 [Mean - P5]	P95 [P95 – Mean]	20-year avg sales + purchases (GWh)	Portfolio PVRR w/ low renewable cost ($000,000)	Portfolio PVRR w/ high renewable cost ($000,000)	Total change in FTEs associated with generation 2023 - 2042	Total amount of property tax paid from AES IN assets ($000,000)
1	$ 9,572	101.9	64,991	45,605	36.7	6,611	45%	7.95	$ 8,860	$ 11,259	$ 9,271	$ 9,840	5,291	$ 9,080	$ 10,157	222	$ 154
2	$ 9,330	72.5	13,513	22,146	7.9	1,417	55%	7.95	$ 8,564	$ 11,329	$ 9,030	$ 9,746	5,222	$ 8,763	$ 9,999	99	$ 193
3	$ 9,773	88.1	45,544	42,042	26.7	4,813	52%	7.86	$ 9,288	$ 11,462	$ 9,608	$ 10,237	5,737	$ 9,244	$ 10,406	195	$ 204
4	$ 9,618	79.5	25,649	24,932	15.0	2,700	48%	7.90	$ 9,135	$ 11,392	$ 9,295	$ 9,903	5,512	$ 9,104	$ 10,249	74	$ 242
5	$ 9,711	69.8	25,383	24,881	14.8	2,676	64%	7.57	$ 9,590	$ 11,275	$ 9,447	$ 10,039	6,088	$ 9,017	$ 10,442	55	$ 256
6	$ 9,262	76.1	18,622	25,645	10.9	1,970	54%	7.95	$ 8,517	$ 11,226	$ 8,952	$ 9,629	5,136	$ 8,730	$ 9,909	88	$ 185

Preferred portfolio selection

Best Practice 43. Select a Preferred Portfolio

It is important to select a preferred portfolio to guide near-term actions such as procurement.

Without a preferred portfolio, it is challenging for stakeholders and regulators to focus their feedback and oversight

The utility's selection of a preferred portfolio does not necessarily tie the utility to that portfolio, especially if conditions change

Best practices for selecting a preferred portfolio

- Justify any substantial deviations from the optimized portfolio when selecting a preferred portfolio
- Avoid developing preferred portfolios outside of the model that are not subject to the same level of sensitivity and risk analysis as the other scenarios
- Align the preferred portfolio with articulated state goals and priorities

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About Puget Sound Energy

- Washington's largest and oldest utility, **serving 1.2 million electric customers** in 10 counties and **900,000 gas customers** in 6 counties covering over 6,000 square miles
- **12,955 miles** of natural gas pipeline and **13,351 miles** of gas service lines
- **23,700 miles** electric distribution system and **2,900 miles** of electric transmission system (enough to wrap around the Earth!)
- Our **3,100+ employees** live and work in the communities we serve

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