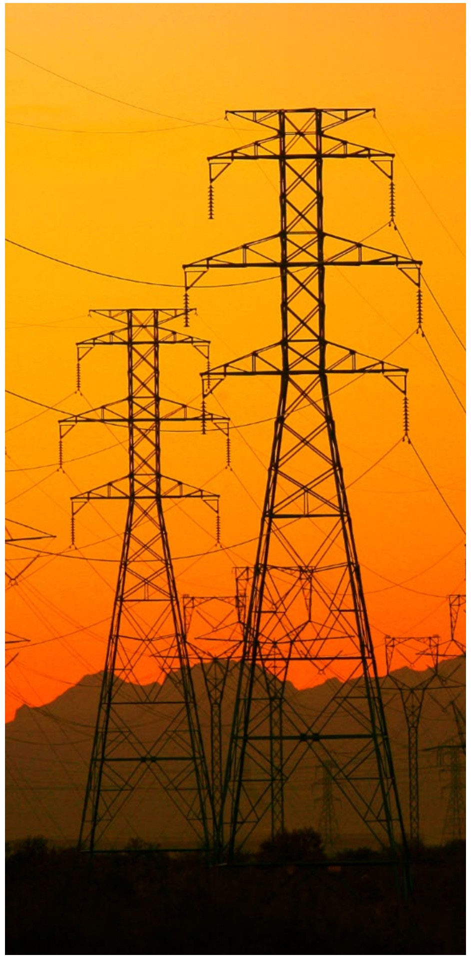
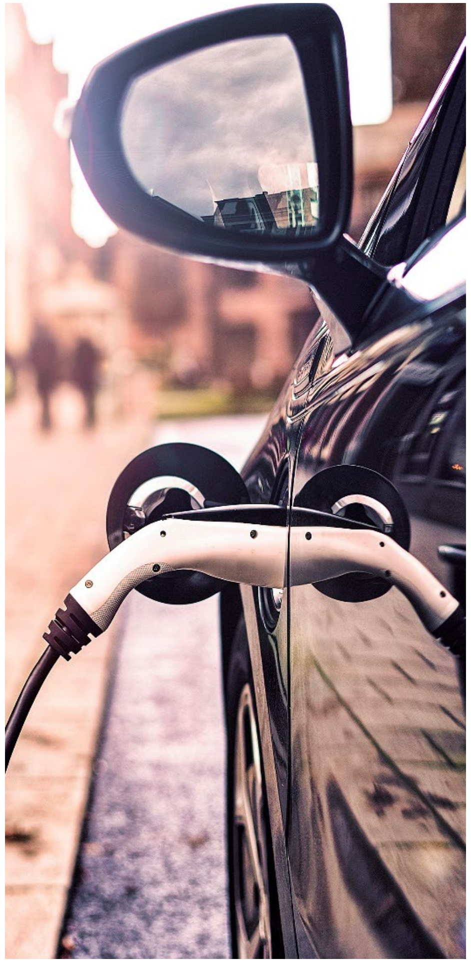


TEP
Tucson Electric Power

UniSourceEnergy
SERVICES

Resource Planning Advisory Council Meeting

March 2, 2023

Logistics & Introductions

Presenters will pause occasionally for clarifying questions.

Save in-depth comments and questions for the Q&A sessions.

During periodic pauses for clarifying questions:

- If joining remotely, raise your “hand” to provide comments or ask questions.
- Identify yourself and your organization.
- Please speak clearly.

The chat box will **only** be monitored for reports on **technical difficulties**.

Today's Agenda

- Update on SME Survey
- RMI presentation/discussion
- Portfolio modeling discussion and preparation
  - TEP portfolio modeling then and now
  - Objectives and outcomes of portfolio modeling in this IRP
  - Matching portfolio modeling capabilities with IRP needs/requirements and other issues of interest
  - Portfolio evaluation criteria
  - Portfolio dashboard demonstration
  - Discussion of first portfolios to be analyzed
- Next steps and topics for next meeting

Update on SME Survey

NONSO EMORDI, PH.D.

LEAD RESOURCE PLANNER

Subject Matters of Interest – Initial Survey Results

- **Regional markets and impacts on IRP**
- **Electric Vehicles**
  - EPRI presentation on EVs2Scale2030 effort
  - AZ status on National Electric Vehicle Infrastructure (NEVI) Program
- **Clean Energy Transition**
  - TEP perspective on Just and Equitable Transition
  - Balancing of costs in transition - clean energy vs affordable rates
  - Cost shift between customer classes – specifically residential customers.
  - Cost of Capital trends in clean energy transition *i.e.* trends in upfront investor costs in clean energy transition

RMI Presentation - Aaron Schwartz

REIMAGINING RESOURCE PLANNING

Resource Planning: Presentation to TEP's RPAC

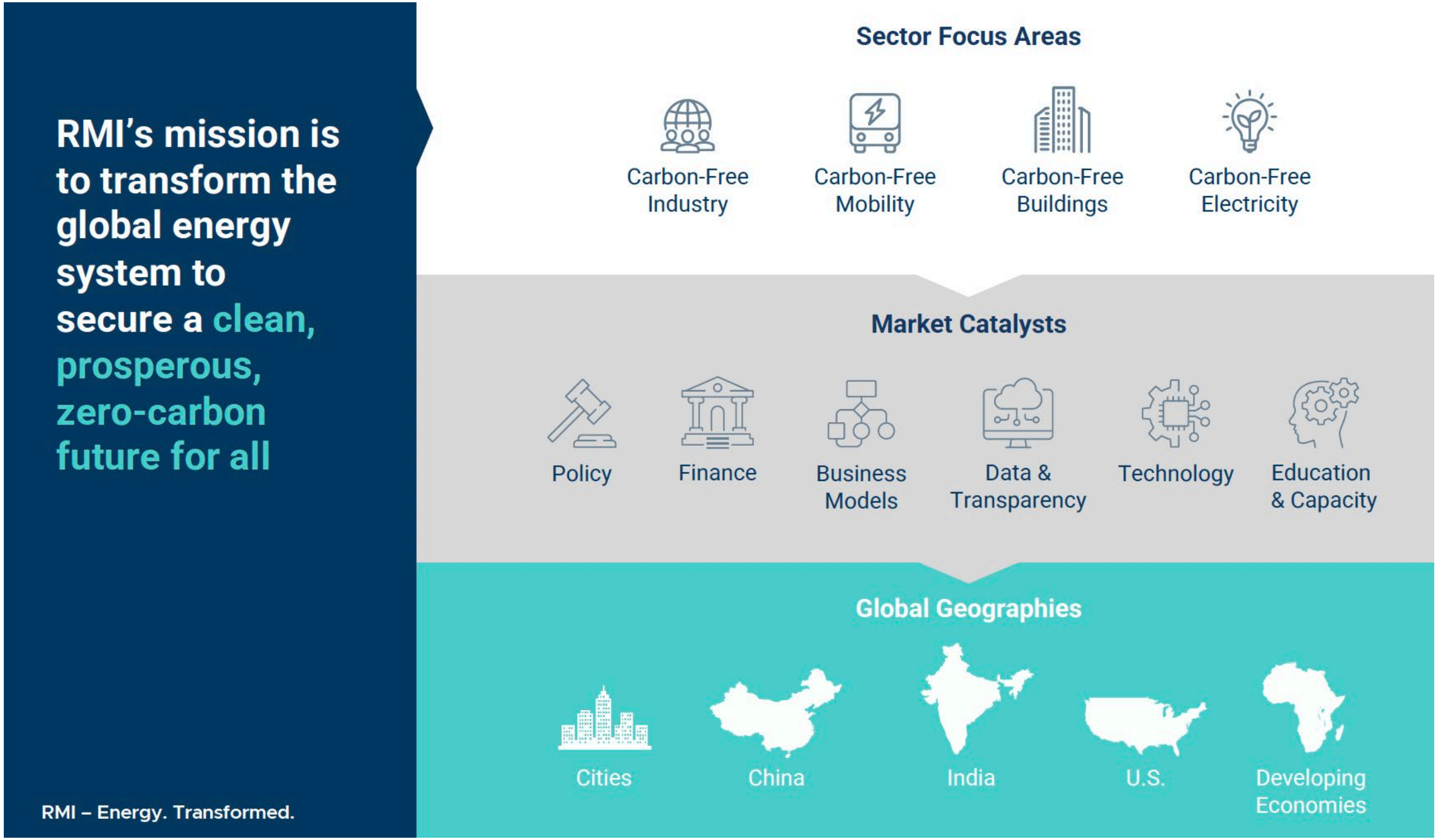
AARON SCHWARTZ

MARCH 2, 2023

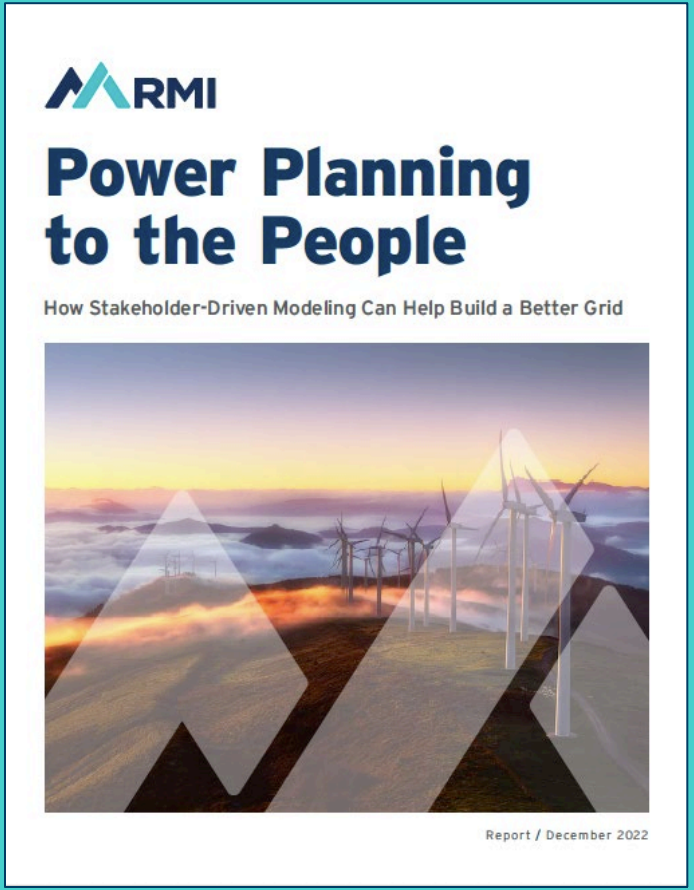
RMI

ENERGY. TRANSFORMED.

About RMI


RMI's mission is to transform the global energy system to secure a clean, prosperous, zero-carbon future for all
RMI – Energy. Transformed.
Sector Focus Areas
Carbon-Free Industry
Carbon-Free Mobility
Carbon-Free Buildings
Carbon-Free Electricity
Market Catalysts
Policy
Finance
Business Models
Data & Transparency
Technology
Education & Capacity
Global Geographies
Cities
China
India
U.S.
Developing Economies

Key Resources: Reimagining Resource Planning & Power Planning to the People



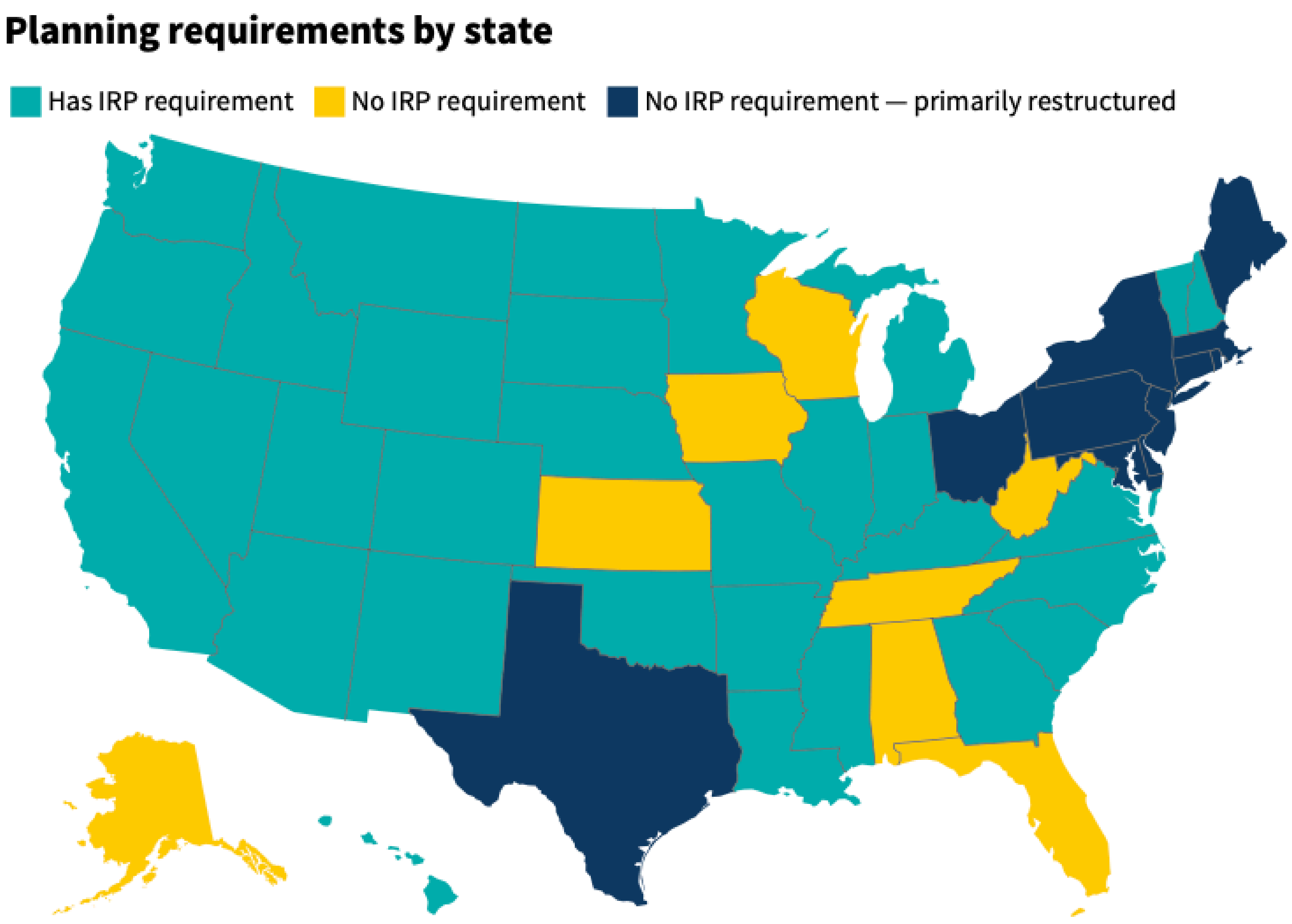
Resource planning is a crucial opportunity for utilities, regulators, and stakeholders to shape the future electricity system

Understand the energy needs of the households, communities, and businesses a utility serves, as well as how they will change over time, and translate them into system needs

Establish a common set of assumptions and evidence that can be used to assess which near- and long-term options can meet system needs and achieve desired utility performance across multiple objectives

Identify longer-term risks and opportunities and strategies to navigate them

Utilities in most states do resource planning



Source: US Environmental Protection Agency, *State Energy and Environment Guide to Action: Resource Planning and Procurement*, Figure 2; RMI analysis of EIA-860M to add distinction for primarily restructured states

IRPs must maintain three core qualities to be effective tools for utilities and regulators to evaluate resource decisions

IRP quality	*Definition*
Trusted	The IRP is **transparent and well vetted**, with stakeholder input.
Comprehensive	The IRP can **accurately represent the costs, capabilities, system impacts, and values of resources** that might be available within the planning time horizon; the IRP can **consider actions across the transmission and distribution systems** as portfolio options.
Aligned	It is clear how the plan evaluates options to meet traditional planning requirements such as **reliability, affordability, and safety,** as well as **state and federal policies and customer or company priorities**, such as reducing emissions and advancing environmental justice.

It is important for utilities to consider each of these qualities in their resources planning

IRP quality	*Why quality is important to utilities*
Trusted	When utilities seek input from their customers and engender trust in their assumptions, they can **develop an accurate plan that meets customer energy needs and leads to regulatory approval.**
Comprehensive	When plans are comprehensive, utilities can **adequately assess the value and risk of their potential future investments.**
Aligned	When utilities demonstrate that plans are aligned with policy and customer objectives, they can **avoid future disallowance of investments and under-or over-procurement of resources.**

Several key trends are challenging utilities and regulators to maintain these qualities in planning processes

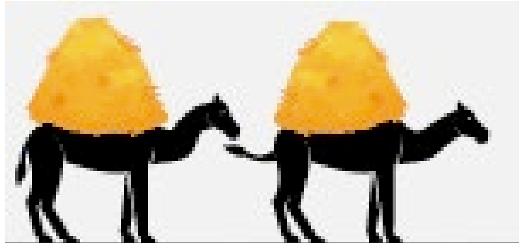
- **Rapid technology change and shifting resource costs**
- **A range of new state and federal policies that expand planning objectives beyond affordability, reliability, and safety to include:**
  - Emissions reductions
  - Advancement of environmental justice
  - Economic development
  - Support of electrification of transportation, buildings, and industry
- **Increasing recognition that decisions made on distribution and transmission systems affect generation resource planning (and vice versa)**
- **Increasing stakeholder awareness that resource planning can have an impact on local air quality, health, jobs, energy bills, and climate change**

Its time to reimagine resource planning to ensure these new expectations don’t “break the camel’s back”…

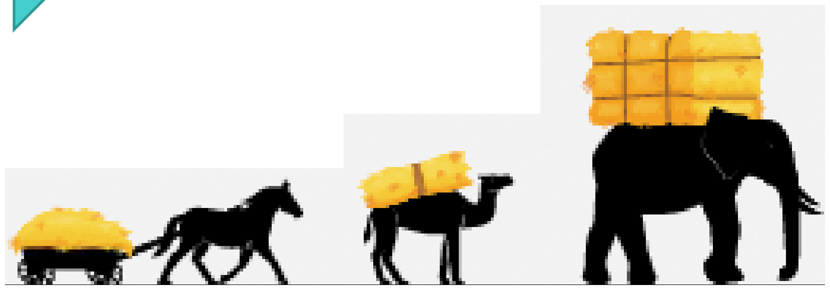
New IRP expectations risk being like the straw that breaks the camel’s back

…by ensuring utilities and regulators are proactively and repeatedly refining IRP purpose, scope, roles, and tools

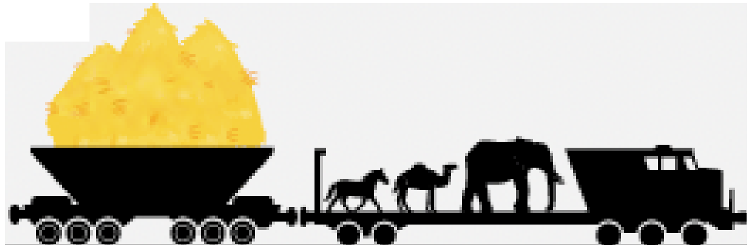
Purpose



Scope



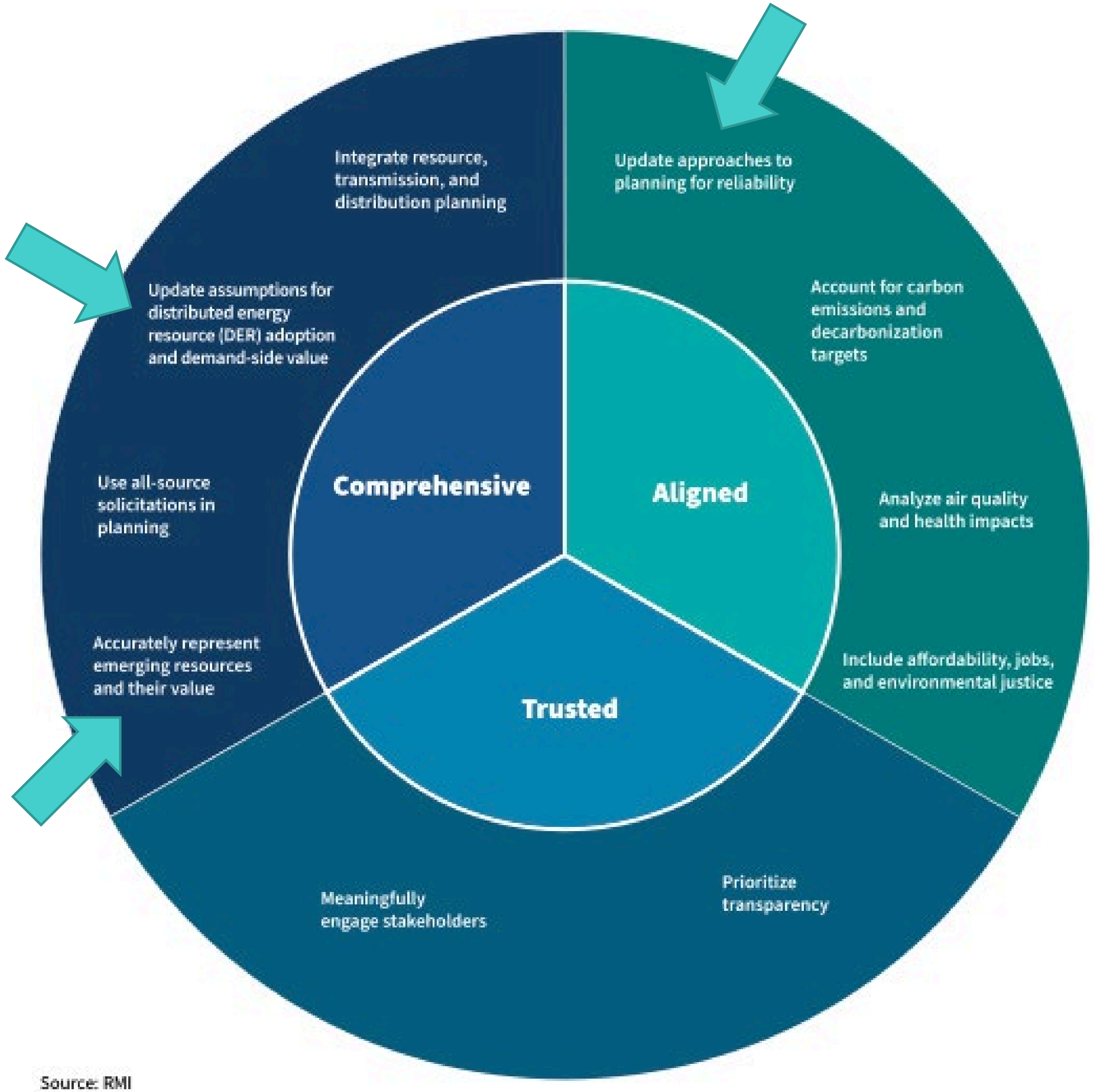
Roles



Tools

RMI has identified several options to enhance resource planning practices to make them more comprehensive, trusted, and aligned

- **We will discuss three of these today:**
  - Accurately representing emerging resources and their value
  - Updating assumptions for distributed energy resource (DER) adoption and demand-side value
  - Updating approaches to planning for reliability



Source: RMI

Each of these options affect one or more "building blocks" of integrated resource planning

- Establish assumptions
- Develop forecasts
- Set objectives and scenarios
- Determine system needs
- Identify solutions
- Evaluate solutions
- Finalize plan
- Implement

Source: "Standard Building Blocks" from the National Association of Regulatory Utility Commissioners-National Association of State Energy Officials (NARUC-NASEO) Task Force on Comprehensive Electricity Planning, 2019

Options for accurately representing emerging resources and their value

Select models and use features that enable more spatial and temporal granularity*

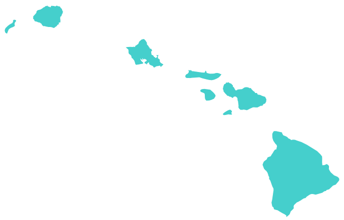
- Establish assumptions
- Develop forecasts
- Set objectives and scenarios
- Determine system needs
- Identify solutions
- Evaluate solutions
- Finalize plan
- Implement

Entergy Louisiana's pre-IRP filing included a comprehensive assessment of the technological maturity levels of all options it might consider in its IRP, and included several "demonstration" options in its modeling

Include resource options that are expected to be available in the market within the planning horizon

*Applied before and throughout the process

Options for improving DER adoption and value in the IRP process



Hawaiian Electric uses “bookend” scenarios by combining DER adoption trajectories

Model DER adoption and electrification forecasts more granularly

- Establish assumptions
- Develop forecasts
- Set objectives and scenarios
- Determine system needs
- Identify solutions
- Evaluate solutions
- Finalize plan
- Implement

Model interactions among DERs and integrate those into planning scenarios

Treat DERs, including energy efficiency, as a resource in planning

Value the reliability contribution of DERs in planning

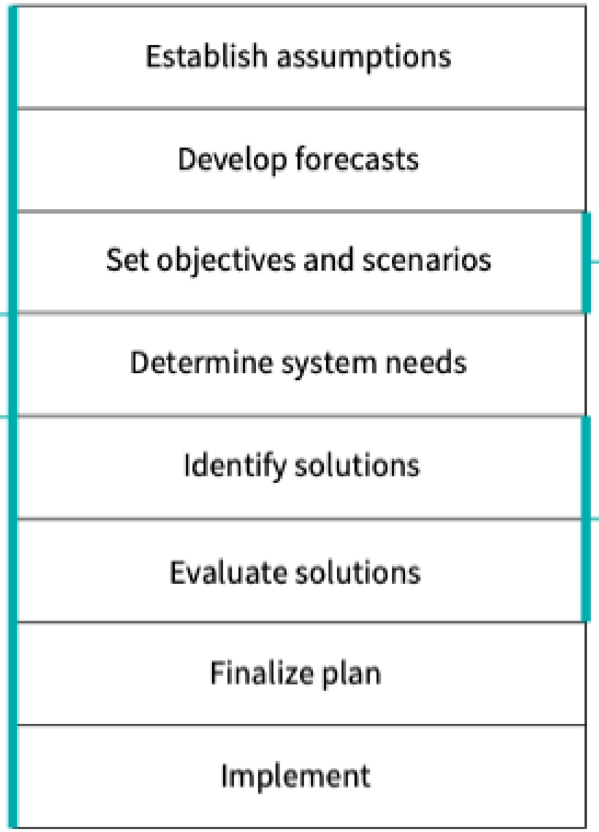
AES Indiana has created demand-side management supply curves that are selectable resources

Options for updating reliability modeling throughout the IRP process

Redefine the goals and metrics for assessing reliability in an IRP*

Integrate resilience into planning*

Oregon planning guidelines require utilities to assess expected and worst-case unserved energy in addition to loss of load probability and planning reserve margins



Analyze the impacts of reliability-threatening scenarios, including those exacerbated by climate change

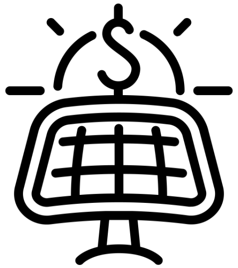
Understand regional reliability needs

Improve alignment between portfolio optimization models and reliability analysis

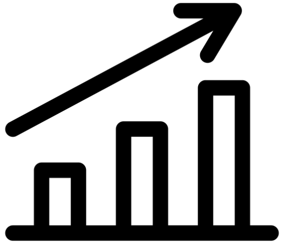
PacifiCorp in Washington assesses climate impacts on load and resource availability

*Applied before and throughout the process

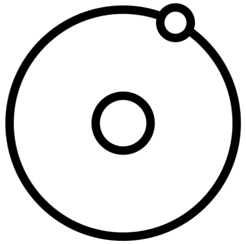
The IRA can impact resource planning by lowering clean energy costs, driving electrification and EE, lowering costs associated with fossil retirements, and more



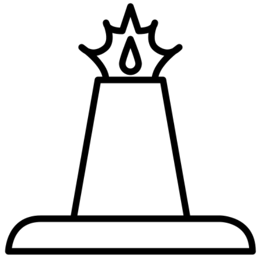
Updated resource costs include new ITC and PTC assumptions



Load projections reflect accelerated customer electrification and additional energy efficiency



Emerging resources are included as options



Fossil retirement costs and timelines consider the opportunity to leverage Energy Infrastructure Reinvestment (EIR) program funding

By incorporating assumptions related to IRA tax credits, DTE executives projected that they will be able to save customers ~$500 million over the course of the 20-year IRP.

Thank You

Reimagining Resource Planning:
https://rmi.org/insight/reimagining-resource-planning/

Power Planning to the People:
https://rmi.org/insight/power-planning-to-the-people/

Contacts:

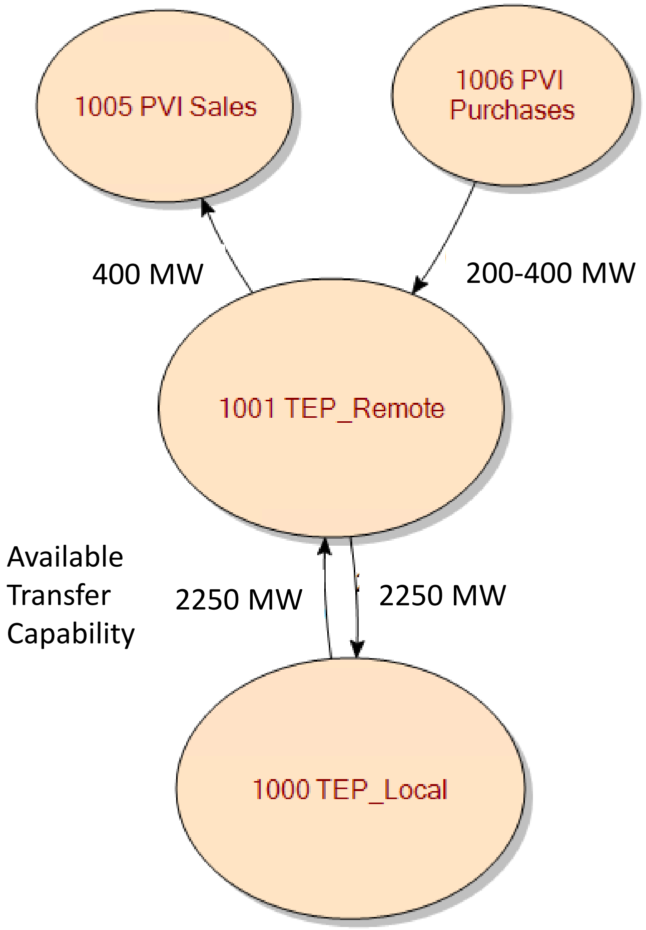
- *Lauren Shwisberg* – lshwisberg@rmi.org
- *Aaron Schwartz* – aschwartz@rmi.org

Major Changes to TEP/UNSE Portfolio Modeling

Modeling Aspect	2020 IRP	2023 IRP
Load Shapes	"Typical" load shape for a year	Four years of actual net load (2017-2020) and DG
Renewable Generation Shapes	Two years of actual data (2016-2017)	Four years of actual data (2017-2020) Load and renewable output are therefore synchronized
Capacity Credit for Renewables	Based on average output on the hottest summer afternoons	Based on loss of load probability modeling (ELCCs)
Transmission	Very simple representation	Incorporates transmission constraints to help predict renewable curtailment, possible loss of load, and best locations for siting future resources
Consolidation	Separate databases and Aurora/Excel files for each utility Multiple spreadsheets for post-processing and integration of results	Same database and Aurora/Excel files used for each utility Only 1-3 spreadsheets depending on type of analysis
Miscellaneous	Traditional unit commitment and no thermal minimums Gila 3 modeled as two separate units (TEP and UNSE) Negative pricing not permitted in Aurora No fuel constraints	Commitment optimization and thermal mins respected Gila 3 "units" operate more in tandem as one unit Negative pricing enabled Constraints now ensure min burn of must-take coal and no exceedance of max gas allocations

TEP System Topology in Aurora: 2020 IRP

- Bubbles represent pricing zones in which there are no transmission constraints. Thus, there is no cost or limits on energy transferred between loads & resources within each zone.
- The price of power within such zones equals the marginal cost of supply within the zones.
- If cheaper power is available from a linked zone or if there are insufficient resources to serve native load, power is imported to serve load and the price is set by the supplying zone + any transmission fees.
- If supply- and demand-side resources within the zone and in connecting zones are insufficient to serve load, then "loss of load" occurs (e.g., rolling blackouts).



Loads and Resources per Zone

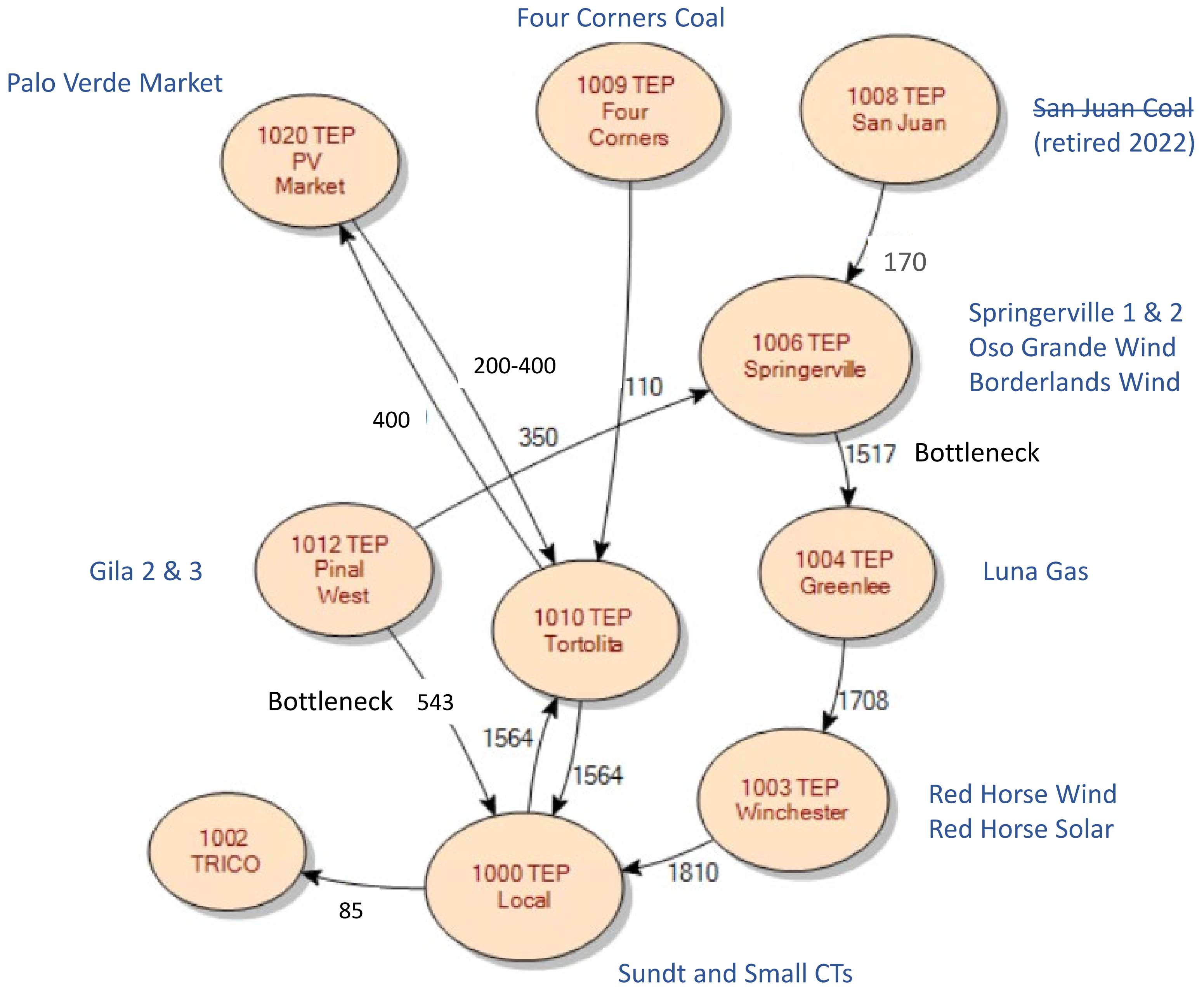
Palo Verde Market Trading Hub
- Wholesale market purchases and sales based on hourly regional prices determined through extensive modeling of the Western grid
- Could discuss further at next meeting

Springerville 1 and 2 Coal
Four Corners Coal
~~San Juan Coal~~ (retired 2022)
Gila River Gas
Luna Gas
Wind Power and Some Solar

Retail Load, DG, and EE
Irvintgon/Sundt Gas
Small Gas Combustion Turbines (CTs)
Most of Utility-Scale Solar

TEP System Topology in Aurora: 2023 IRP

- ***Do not quote or cite.***
- Total Transmission Capability is currently being investigated and is subject to change.
- ATC can also change over time.



New York Times, 2/23/2023

The U.S. Has Billions for Wind and Solar Projects. Good Luck Plugging Them In.

“Plans to install 3,000 acres of solar panels in Kentucky and Virginia are delayed for years. Wind farms in Minnesota and North Dakota have been abruptly canceled. And programs to encourage Massachusetts and Maine residents to adopt solar power are faltering.”

“The energy transition poised for takeoff in the United States amid record investment in wind, solar and other low-carbon technologies is facing a serious obstacle: The volume of projects has overwhelmed the nation’s antiquated systems to connect new sources of electricity to homes and businesses.”

“So many projects are trying to squeeze through the approval process that delays can drag on for years, leaving some developers to throw up their hands and walk away.”

“More than 8,100 energy projects — the vast majority of them wind, solar and batteries — were waiting for permission to connect to electric grids at the end of 2021, up from 5,600 the year before, jamming the system known as interconnection.”

Portfolio Modeling Objectives

- Focus more on implementation of energy transition and identifying major hurdles and opportunities for reducing costs and environmental and community impacts
- Improve TEP/UNSE's awareness of the system impacts and demands of alternative portfolios, thereby improving the ability to capitalize on the best that each type of resource has to offer
- Adjust, as appropriate, the major clean energy transition plan first committed to in the 2020 IRP
- Provide guidance to the resource procurement process
  - Include resource procurement plan in the IRP?
    - Coordinate procurement cycles with resource replacements and expected load changes over the 15-year planning horizon
    - Identify good and poor regions for interconnecting new resources, including those with social and tax-incentive benefits in addition to transmission access
    - Identify any types of resources in the portfolio modeling, such as DSM and long-lead time projects, that have significant potential but may require special consideration, targets, or amendments to be considered fairly in the procurement process

Portfolio Planning Periods

2024 - 2028

- Comprises 5-year action plan required of the IRP
- Replace Springerville 1 with a set of new resources providing an equivalent or greater amount of capacity and reliability
- Assume all new resources are solar, wind, 4h battery storage, and DSM resulting from the current and subsequent All-Source RFP
- Additional actions possible to prepare for integrating more clean energy in future periods

2029 - 2033

- Major focus of IRP
- Replace Springerville 2 with a set of new resources providing an equivalent or greater amount of capacity and reliability
- Transition to a system where a majority of energy is zero-carbon
- Resources become available that require long lead times, such as pumped hydro, compressed air, and natural gas

2034 - 2038

- Possibly achieve 90-100% clean energy
- Resources become available that require very long lead times, such as new transmission lines and emerging technologies
- Load pattern and load control opportunities may be very different from today

Portfolio Categories

Reference Case: Updated Analysis of 2020 Resource Plan

Natural Gas Reliability Resource

- 1 portfolio
- Due to factors beyond our control, the clean energy transition is slower than expected and natural gas resources are required to meet growing demand and to replace some of the retired coal capacity.
- UNSE in particular may need this to hedge against significant exposure to large and volatile power prices.
- Cumulative emission reductions over the planning period are maintained.

Various Portfolios Achieving the 2020 Clean Energy Goals That Could Result from the ASRFP Process But Which Do Not Rely on New Natural Gas Resources

2. A greater proportion of solar than reference
3. A greater proportion of wind than reference
4. A greater proportion of DSM than reference
5. 8-12 hour storage is available, competitive, and displaces other resources
6. Fully dispatchable clean energy is available, competitive, and displaces other resources
7. More transmission becomes available and reduces the need for new generation

90-100% Clean Energy

- 1-2 portfolios
- Achieved in the latter third of the planning period
- Relies to some extent on fully dispatchable clean energy

Evaluation

Revised Resource Plan and Procurement Recommendations

Portfolio Design

Loss of Load Modeling

- Determines a planning reserve margin and capacity credits for renewables and storage
- Based on stochastic analysis and assumptions about resource variability, outages, and a given mix of resource types
- Very simplified representation of grid

Capacity Expansion Modeling

- Determines least cost, optimal resource plan (additions and retirements) given input assumptions, user-specified constraints, and a simplified representation of the grid
- Resource intensive (days to run)
- Unique expertise

Either or Both

Hand-Crafted Designs

- Crafted through professional judgment, consultation, and iterations of Aurora modeling

Aurora Modeling

- Security-constrained economic dispatch
- Not a full reliability model but can analyze for loss of load under a variety of conditions

Risk Assessment

- Probability analysis on inputs
- Sensitivity analyses that challenge the vulnerabilities of the portfolio or system
- Qualitative assessments

Matching Modeling Capabilities with IRP Needs and Other Issues of Interest

Aurora Model Inputs and “Levers”	Sample of IRP Requirements and Planning Issues
Load magnitude and shape	40% cumulative energy savings EV adoption and charging DG and DSM programs Climate impacts Rate design Regional market enhancements Early coal plant retirement Optimization of resources across T&D Just and equitable transition Technology-agnostic / least-cost portfolio
Transmission costs and characteristics	
Resource costs and characteristics	
Fuel and power market prices	
How all the above relate to each other	

Portfolio Evaluation Example: Fortis BC

Table 11-2: Attributes of Portfolios Considered for Preferred Portfolios

Portfolios	Resource Mix	Portfolio Attributes: Cost			Environment			Resiliency		Economic
		LRMC ($/MWh)	Average Cost ($/MWh)	Rate Impacts (CAGR)	% Clean Resources	GHG Emissions	Footprint (Hectares)	Operational Flexibility	Geographic Diversity	BC Employment (Job Persons)
Clean [C3]	PPA Market DistBattery6 [2030] RNG_SCGT2 [2031] RNG_SCGT1 [2035] Solar2 [2038] Solar3 [2039] DistSolar3 [2039] Solar1 [2040] Wind1 [2040]	$81	$76	1.58%	99%	6.5 CO2e tonne/GWh Scope 1: 122 Scope 3: 355,480	292	High	High	1346
Energy Self Sufficiency 2030 [B2]	PPA Market (up to 2030) RNG_SCGT1 [2030] Wind5 [2031] DistBattery6 [2033] DistSolar3 [2034] Solar7 [2035] Solar3 [2038] Solar2 [2039] Wind1 [2039] RoR3 [2040]	$82	$79	2.01%	99%	7.4 CO2e tonne/GWh Scope 1: 19 Scope 3: 404,297	597	Medium	High	1915
Clean No RNG SCGT [C4]	PPA Market Battery4 [2030] Solar7 [2031] Solar1 [2033] DistSolar2 [2033] RoR3 [2034] Wind5 [2035] Solar2 [2037] Solar3 [2038] Wind3 [2039] Biomass1 [2040] DistSolar1 [2040] DistSolar3 [2040] RoR2 [2040]	$97	$78	2.10%	99%	6.4 CO2e tonne/GWh Scope 1: 0 Scope 3: 353,609	723	Low	High	2504

Portfolio Evaluation Example: Tennessee Valley Authority

IRP Scorecard Metrics		Low-Cost Reliable Power	TVA Mission Economic Development	Environmental Stewardship
Cost	PVRR ($Bn)	✓	✓	
	System Average Cost ($/MWh)	✓	✓	
	Total Resource Cost ($Bn)	✓		
Risk	Risk/Benefit Ratio	✓		
	Risk Exposure ($Bn)	✓		
Environmental Stewardship	CO_2 (MMTons)		✓	✓
	CO_2 Intensity (lbs/MWh)		✓	✓
	Water Consumption (MMGallons)			✓
	Waste (MMTons)			✓
	Land Use (Acres)			✓
Operational Flexibility	Flexible Resource Coverage Ratio	✓		
	Flexibility Turn Down Factor	✓		
Valley Economics	Percent Difference in Real Per Capita Income	✓	✓	
	Percent Difference in Employment		✓	

Portfolio Evaluation Example: Tennessee Valley Authority

SENSITIVITY CASE Base Case comparison is the Current Outlook unless otherwise noted	CAPACITY EXPANSION IMPACTS BY 2038 GREEN indicates increase and RED indicated decrease in resource						
	NUCLEAR	COAL	GAS	HYDRO	SOLAR	WIND	EEDR
Higher Natural Gas Prices				+55 MW	+2,050 MW		
Lower Natural Gas Prices			2,000 MW CT replaced by CC		-5,900 MW		
Lower Wind Costs			-1,100 MW		-3,100 MW	+4,200 MW	
Greater EE & DR Market Depth			-2,000 MW		-2,200 MW		+2,100 MW
Integration Cost & Flexibility Benefit			Minor timing differences		Minor timing differences		
Pace & Magnitude of Solar Additions					+1,100 MW		
Magnitude of Solar Additions (Valley Load Growth)			1,000 MW CC replaced by CT		+6,000 MW		
Higher Operating Costs for Coal Plants		-2,200 MW	+1,500 MW				
More Stringent Carbon Constraints (Decarbonization)		-2,000 MW accelerated	CC expansion accelerated	+175 MW			
Variation in Climate	Summer derates	Summer derates	CT expansion accelerated		+2,100 MW		

Portfolio Evaluation Example: Tennessee Valley Authority

	COST	RISK	ENVIRONMENTAL STEWARDSHIP		OPERATIONAL FLEXIBILITY	VALLEY ECONOMICS
			CO_2, Water, Waste	Land Use		
STRATEGY A: BASE CASE						All strategies have similar impacts on the Valley economy as measured by per capita income and employment
STRATEGY B: PROMOTE DER						
STRATEGY C: PROMOTE RESILIENCY						
STRATEGY D: PROMOTE EFFICIENT LOAD SHAPE						
STRATEGY E: PROMOTE RENEWABLES						

Good Better Best

Portfolio Evaluation Example: Salt River Project

Affordability

Total Costs

Average System Rate Impact

Average Residential Bill Impact (absolute and relative to inflation)

Sustainability

CO2 Reductions Over Time

Water Use

Carbon-Free Generation

Capacity Factor for Gas Fleet

Direct Air Emissions (NOx, SO2, PM10, PM2.5, VOC)

Reliability

Resource Contribution to Reliability

Reliance on Emerging Technologies

Qualitative Risk Ratings (Development Risk and Operational Risk)

Planning Reserve Margin

Customer Focus

Customer Preference Rating

CO2 Reductions from EE, DR, DG and Electrification

Portfolio Dashboard Demonstration

- Ideally use a “business intelligence” software such as Tableau or Power BI to make inputs and results available to RPAC via website
  - See WECC site as an example
- TEP not likely to implement Power BI Pro in time so we’re developing an Excel workbook that imports Aurora and other cost data
  - Includes dashboard summaries as well as detailed monthly results on costs, resource performance, and system performance and reliability
  - Hope to make the full version or something similar

Next Steps in Portfolio Modeling

- Start with the least complicated analyses (about 4)
  - Reference case, heavy solar, heavy wind, and ____?
  - Apply to both TEP and UNSE
- At next meeting:
  - Review results, draft scorecards, and draft dashboards
  - Discuss next portfolios to evaluate and how

Conclusion and Topics for Next Meeting

THANK YOU!