Ascend Analytics

PowerSIMM for Resource Planning

ETAC Technical Presentation
9/16/2024

About Ascend Analytics

- Founded in 2002 with ~150 employees in Boulder, Oakland, and Bozeman
- Six integrated service lines for asset operations, portfolio analytics, and planning
- Custom analytical solutions and consulting

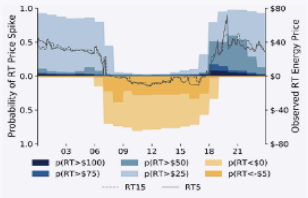
The Ascend Product Suite

DAILY OPS	HEDGING & PLANNING	VALUATION/SITING	MARKET FORECAST	MERCHANT FINANCE	TRANSACTIONS
5 minutes to 5 days	1 month up to 30+ years	1 month to 30 years	Next month to 30 years	5 to 10 years	Development Cycle

SmartBidder™

Bid Optimization & Scheduling Services

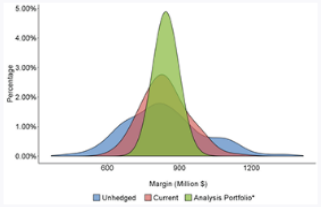
Forecasts Future Grid States



PowerSIMM™

Portfolio Risk Management & Resource Planning

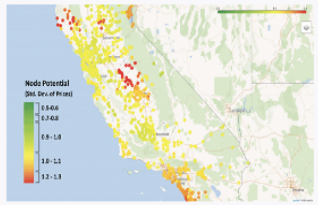
Evaluate Risk & Return



BatterySIMM™

Energy Storage & Renewables Valuation

Capture Nodal Volatility

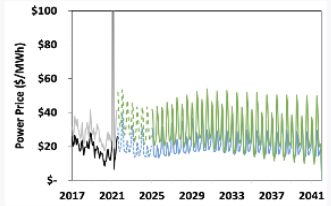


AscendMI™

Market Intelligence

Price & Market Forecasts for the Energy Transition

Market Forwards & Forecasts

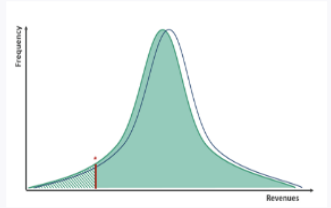


Ensurance™

Merchant Storage Financing

Finance Merchant Storage

Remove Downside Risk

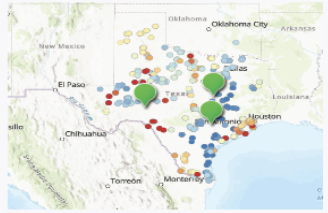


AEX

Ascend Energy Exchange

Clean Asset Marketplace

Project Sales



DUKE ENERGY · EDF renewables · NEXTera ENERGY · TERRA-GEN · aypa · New York Power Authority · ABLE GRID · STRATA SOLAR · LA Department of Water & Power · 8minutenergy · BWL · Glendale Water & Power · nrg · REU Redding Electric Utility · Shell · TID Water & Power · Silicon Valley Clean Energy · Ameren · Austin Energy

Agenda

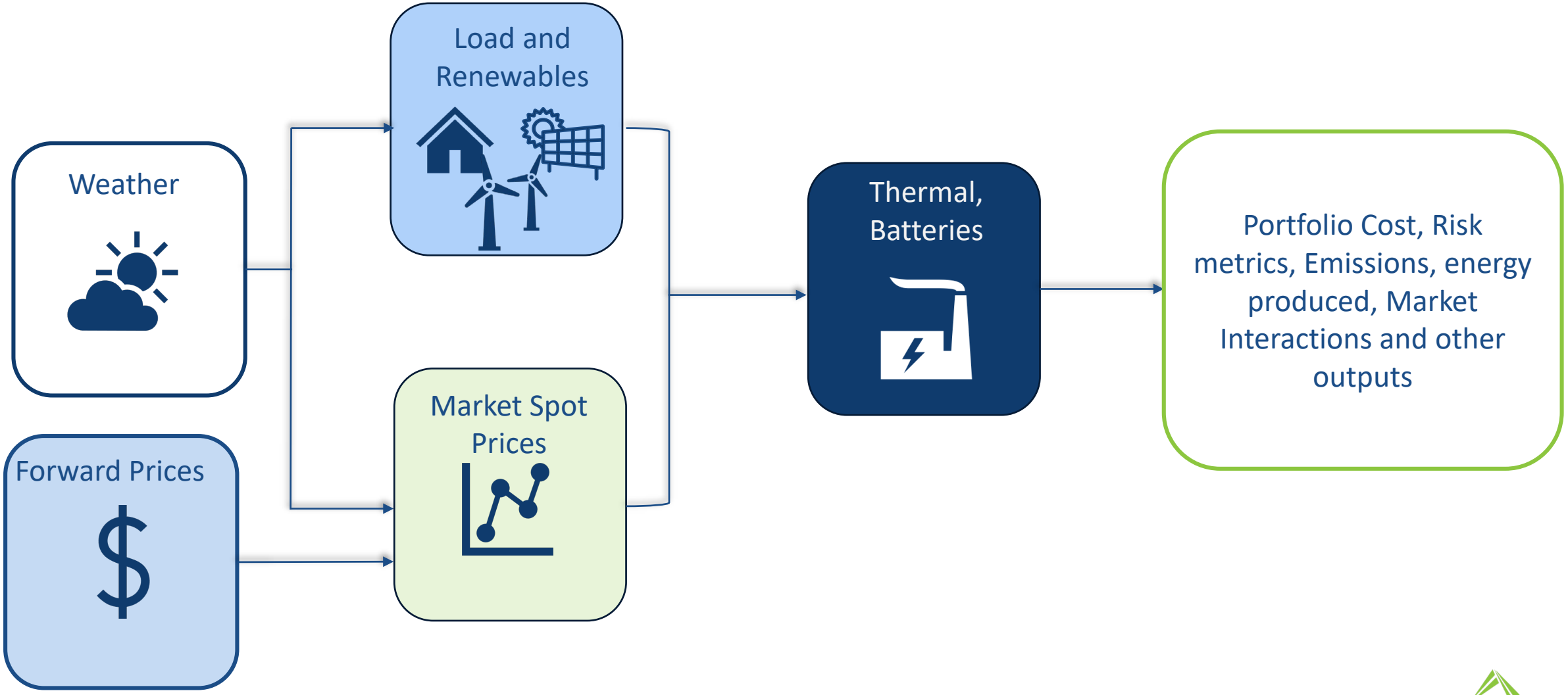
- Overview of PowerSIMM modeling
- Modeling uncertainty in PowerSIMM
- Resource Planning modeling in PowerSIMM
  - Capacity Expansion model
  - Production cost model
  - Resource Adequacy analysis
- Example Outputs from 2022 Montana IRP
- Modeling portfolios in PowerSIMM

Overview of PowerSIMM

Introduction to PowerSIMM

- Software program to model the performance of electric power system
- Helps in decision making in
  - Near-term on risk management or bidding strategies and
  - Long-term resource planning and investments
- Primary applications include:
  - Production cost modeling
    - Simulates power system operations on hourly (1 hour) or sub-hourly (5 min) timestep
    - Used in decision making for portfolio management and resource planning
  - Capacity expansion modeling
    - Provides roadmap for future resource procurements to satisfy policy and reliability needs economically
    - Used in decision making for long term resource planning
  - Resource Adequacy/Reliability analysis
    - Determines the probability that the available resources can serve the customer load in all hours of the year

Overview of PowerSIMM

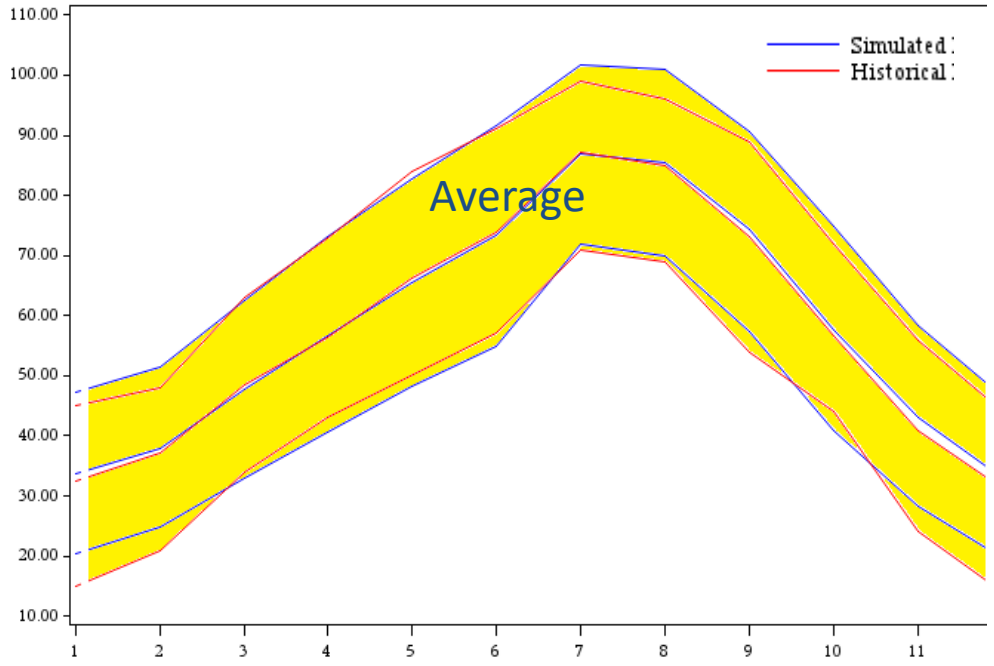


Modeling uncertainty

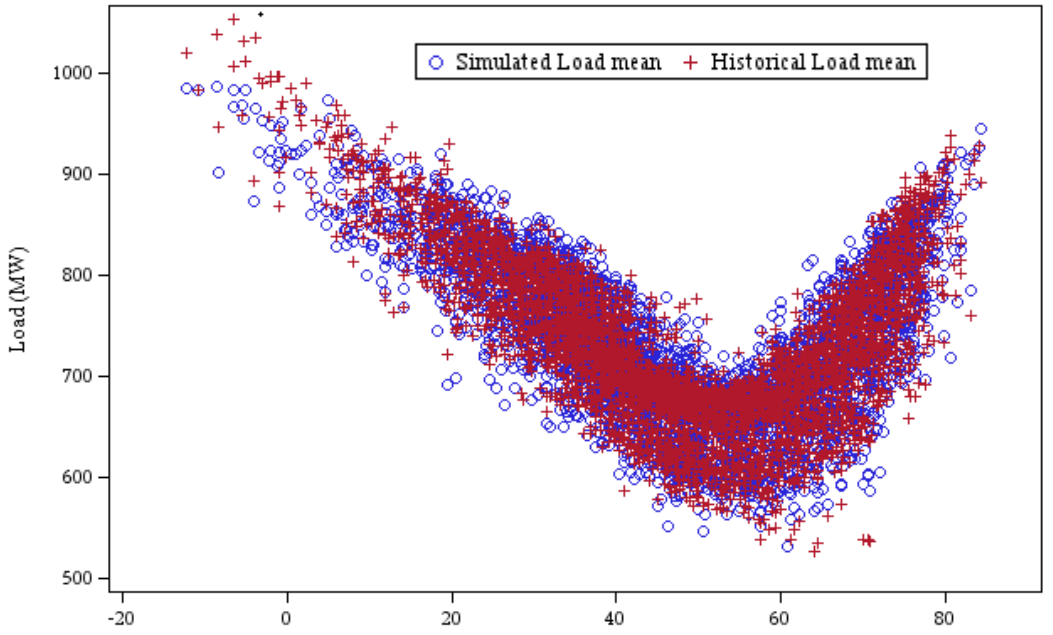
- Powersimm uses stochastic optimization to incorporate uncertainty in future
  - Simulates over a range of historical weather years => captures variation in Load and renewable generation
  - Captures the variation market prices, thermal generation and outages

Weather simulation captures extreme days

Daily Maximum Temperatures by Month in Billings, MT

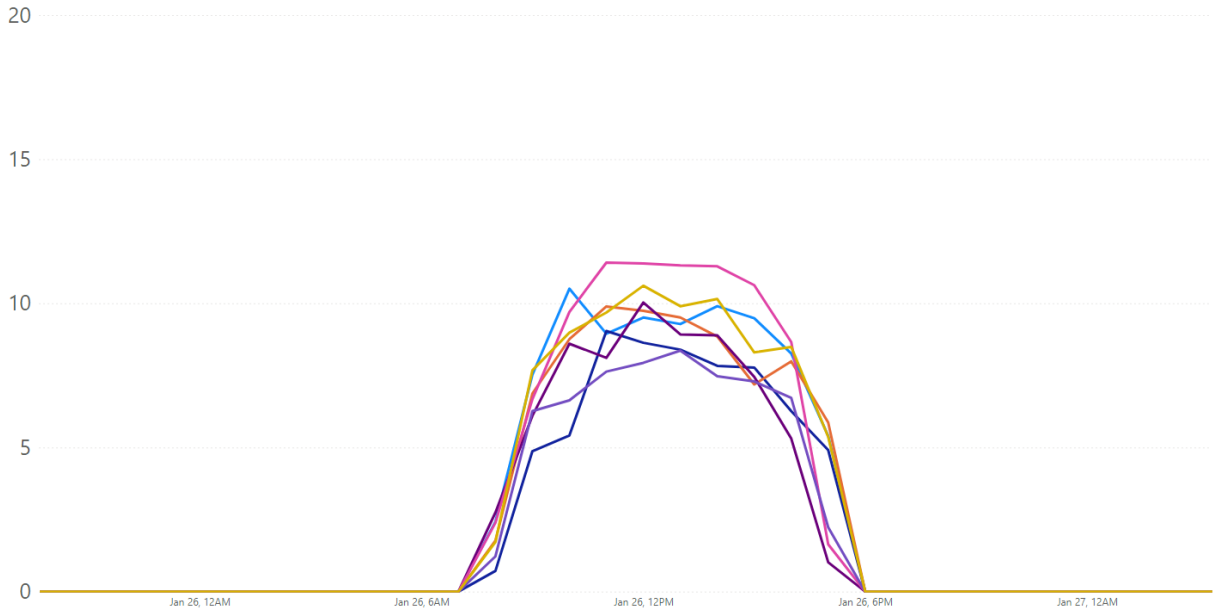


Actual and Simulated Load –Weather relationship

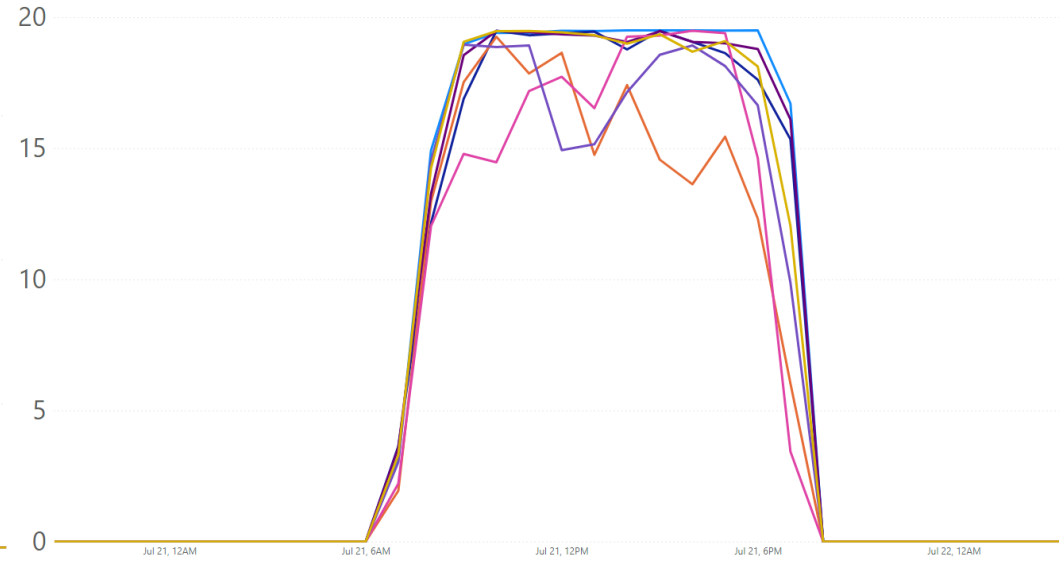


Uncertainty in Renewable generation

Variation in solar generation



One typical day in Jan



One typical day in July

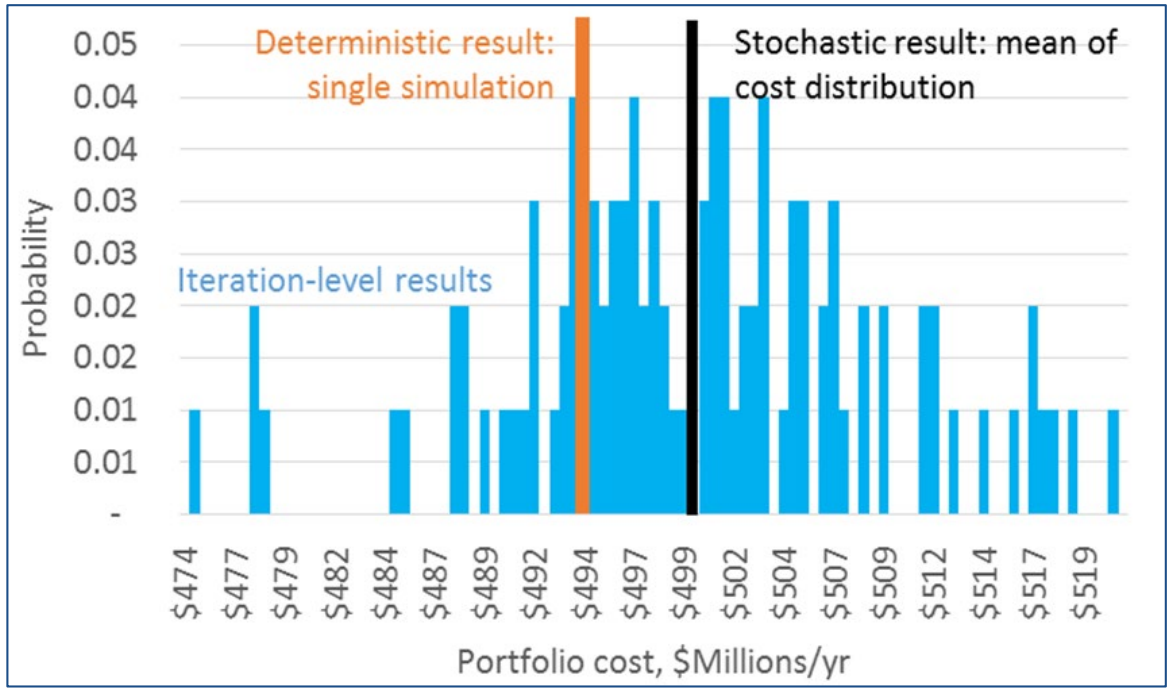
Stochastic vs Deterministic

Limitations of Deterministic models

- Limited view of possible future
- Can oversimplify complex systems leading to results that may not reflect actual outcome
- The simulated outcome is uncertain

Advantages of Stochastic models

- Captures variability
- Provides robust results by exploring multiple possibilities
- Helps to assess risks by considering the probability of different outcomes
- Enables better decision-making in uncertain situations.



Integrated Resource Planning (IRP) using PowerSIMM

Process for Resource Planning Modeling

1. Identify goals and needs
   - New Resources
   - Renewable requirements
   - Define priorities for planning

2. Forecast items affecting future resource needs
   - Predictions for market and fuel prices
   - Technology costs
   - Energy demand

3. Develop scenarios to model future conditions
   - Policy drivers
   - Technology availability

4. Analyze the future electric system over each scenario
   - Capacity Expansion
   - Production Cost analysis
   - Resource Adequacy

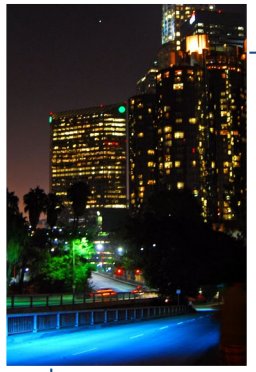
5. Test the robustness of the resource selection with uncertainty of assumptions in sensitivity analysis
   - Peak demand growth
   - High power and high gas prices
   - Carbon costs

6. Report outputs

Resource Planning Modeling Attempts to Answer These Questions

What resources should NWE acquire?

Capacity expansion models select resources to meet planning targets



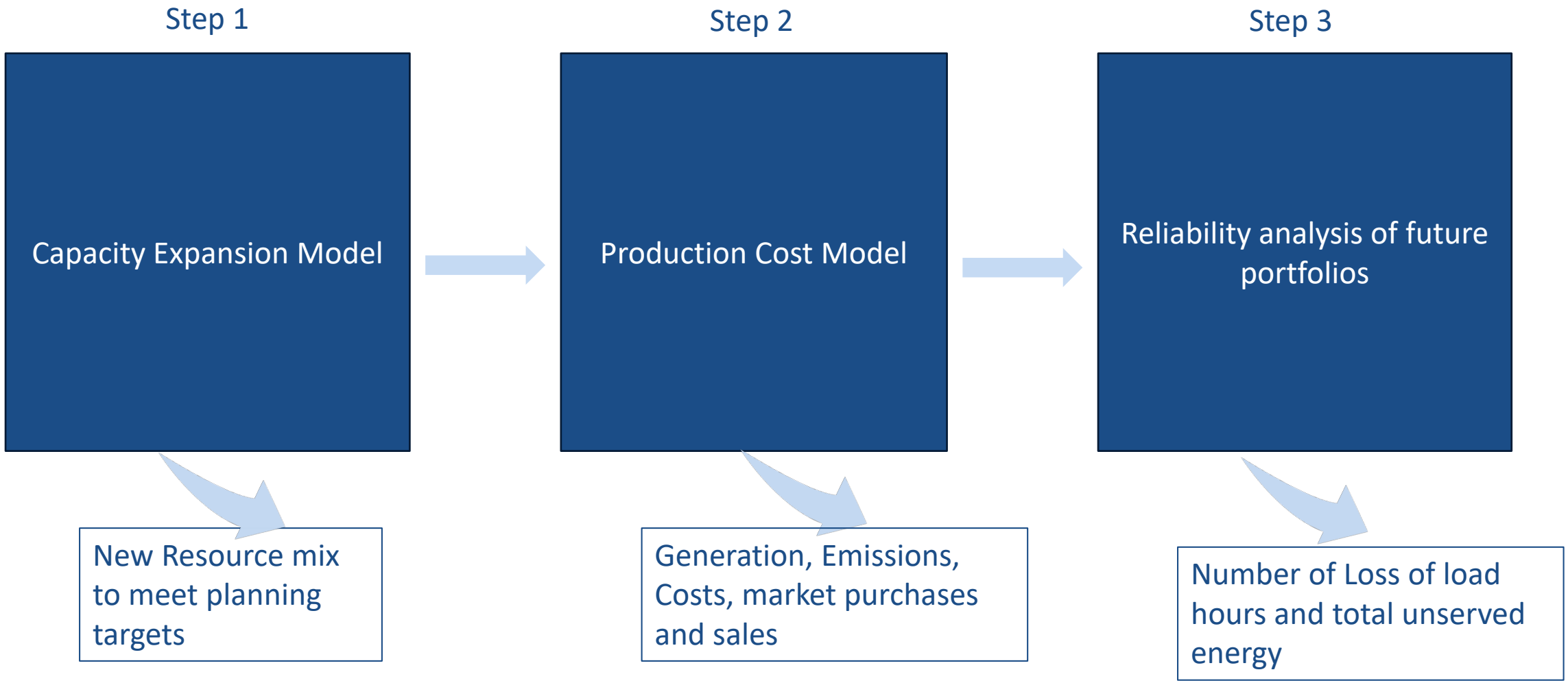
Will those resources provide reliable service?

Resource adequacy determines likelihood that resources can serve load

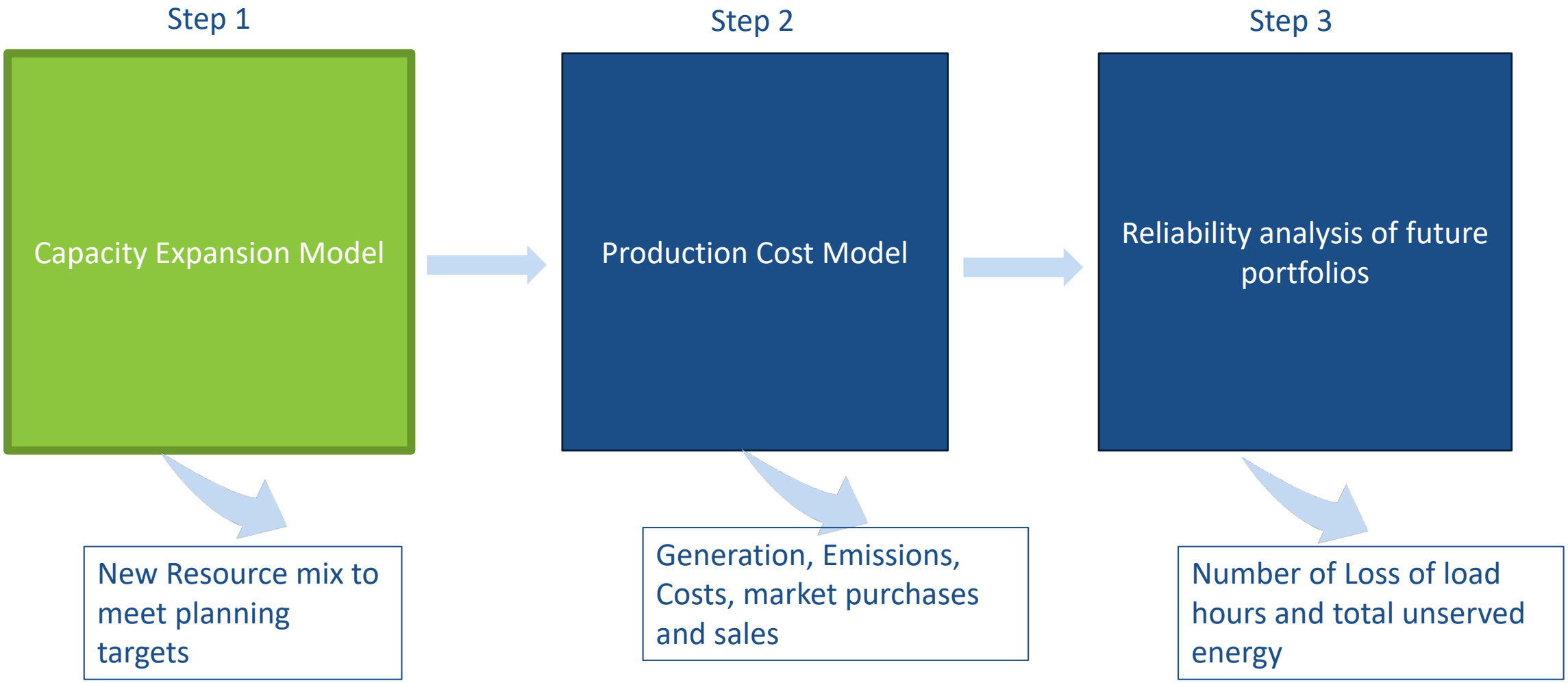
How will the system operate with the new resources?

Production cost model simulates system operations for costs, renewable generation, market interactions etc.

Resource Planning Modeling Steps

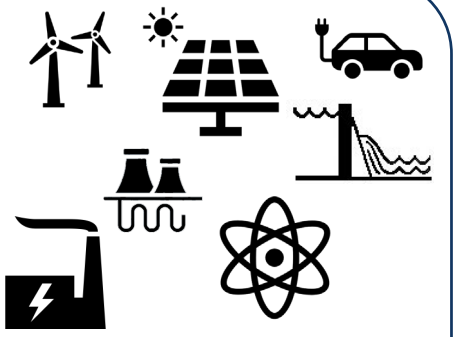


Resource Planning Modeling: Step 1

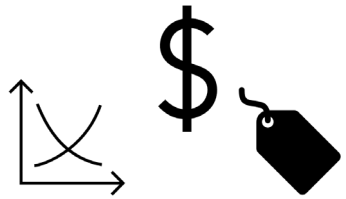


Capacity Expansion Modeling

Inputs to the Capacity Expansion Model



New and Existing Resources



Market Prices, new technology and resources costs, WACC, inflation rate

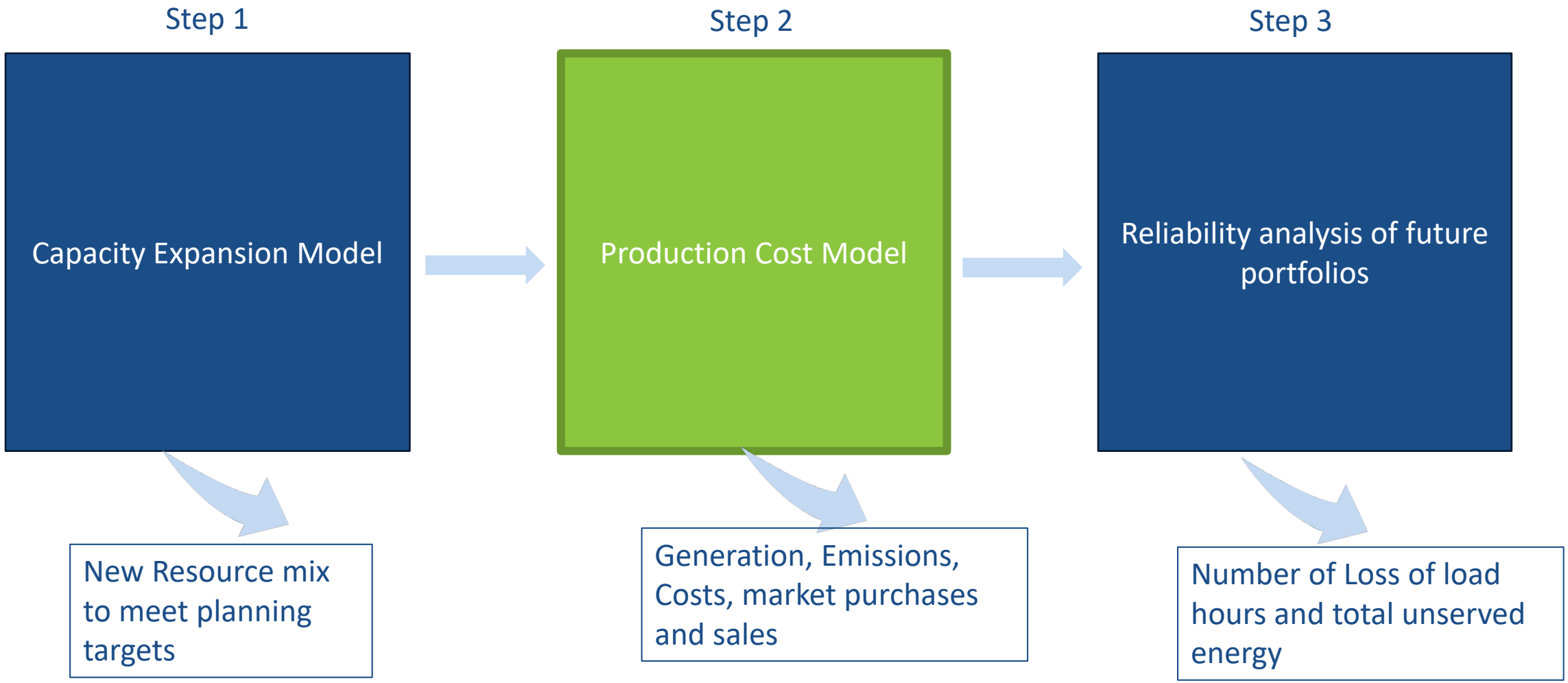
Portfolio

Combination of existing, new firm generation and renewable candidates

Reliability	Energy	Sustainability
✓	✓	✓

- ✓ New portfolios can be created by changing the inputs.
- ✓ The model runs an algorithm and selects resources that meet all the planning targets at lowest possible cost

Resource Planning Modeling : Step 2



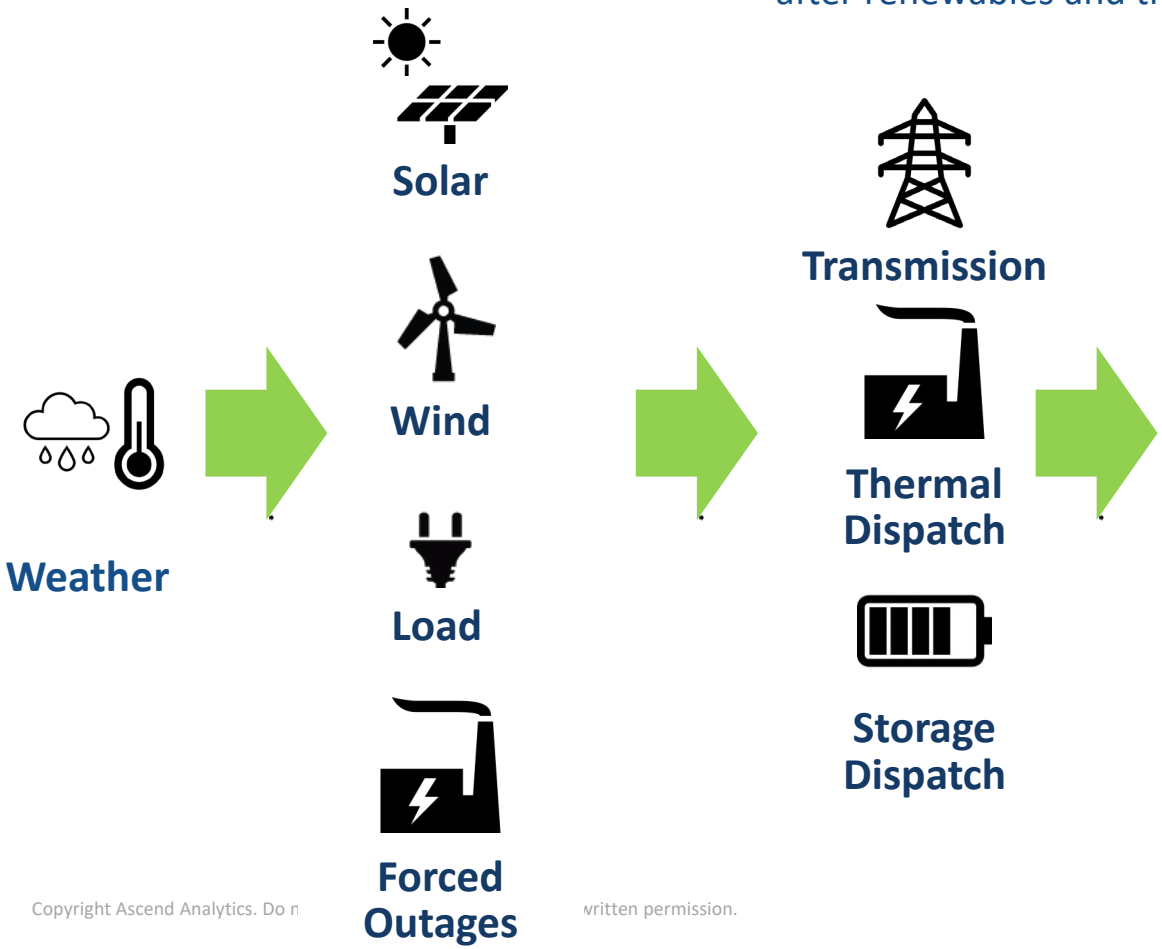
Production Cost Modeling

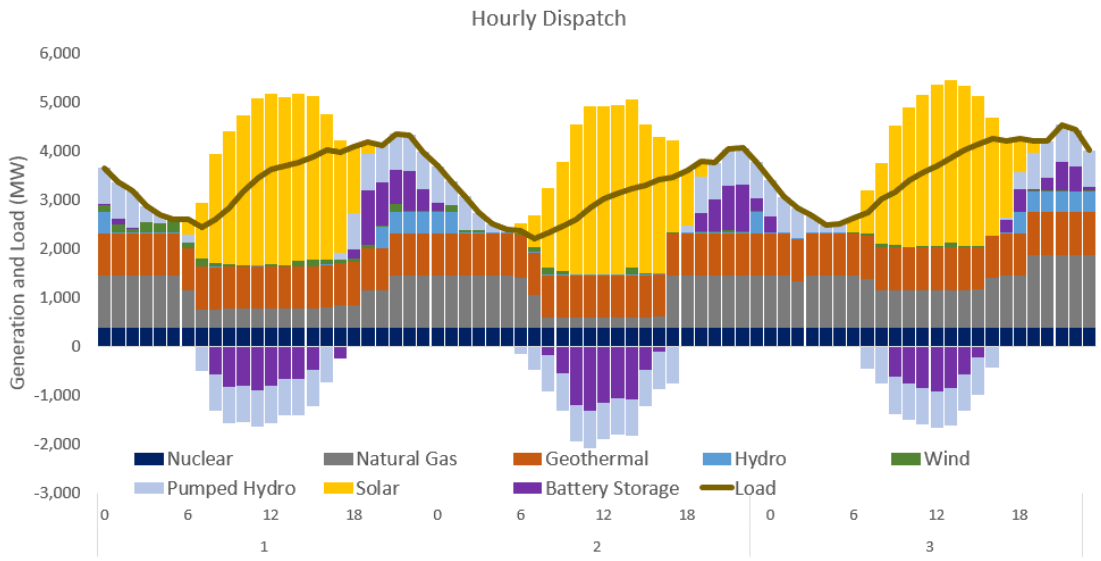
- ❑ New resources selections from the Capacity Expansion model are added to the “current” portfolio
- ❑ Simulate and Dispatch the power system on an hourly basis to understand how the portfolio meets customer load

Simulated renewables, load and generator outages

Energy storage and transmission resources used optimally serve load after renewables and thermals

Hourly renewable generation, dispatch for thermal assets and batteries, emissions, etc. are outputs from the production cost model





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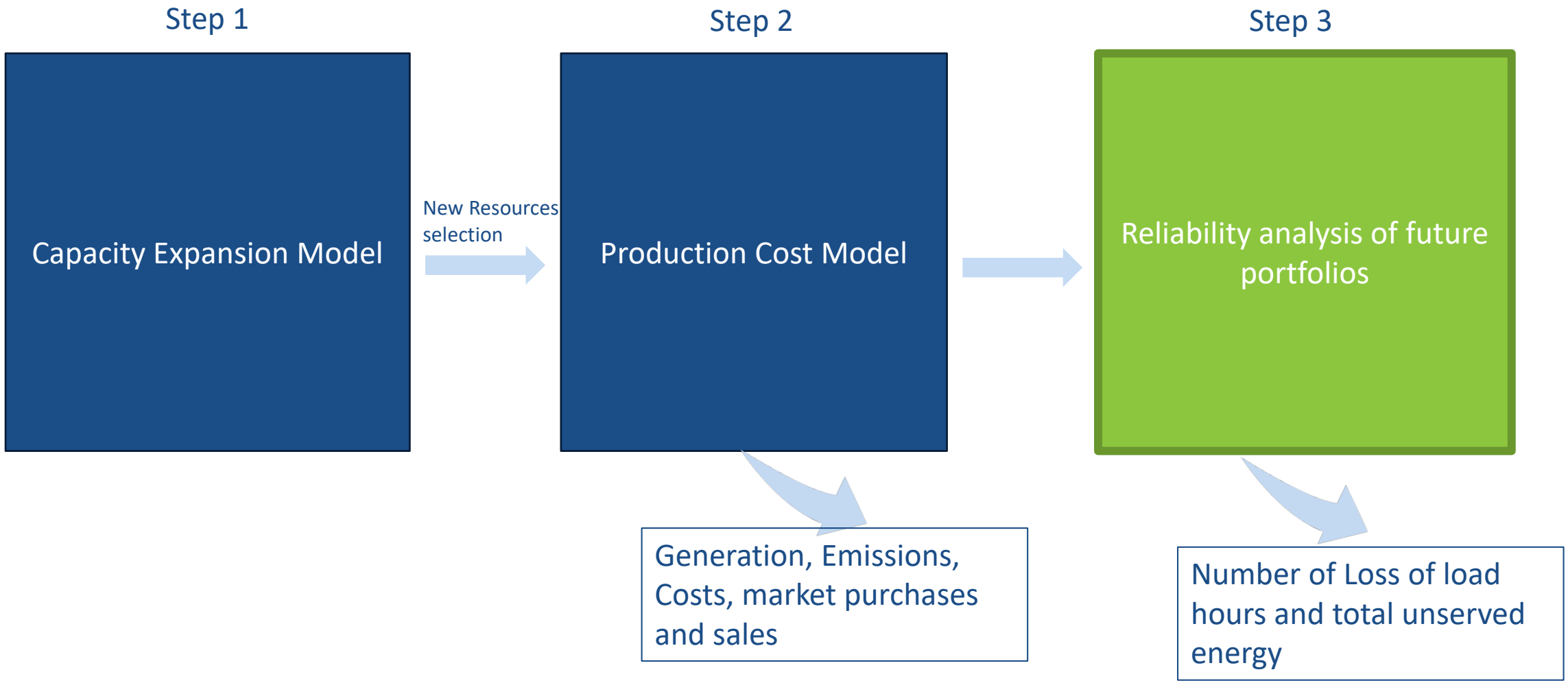
17

Resource Planning Modeling : Step 3

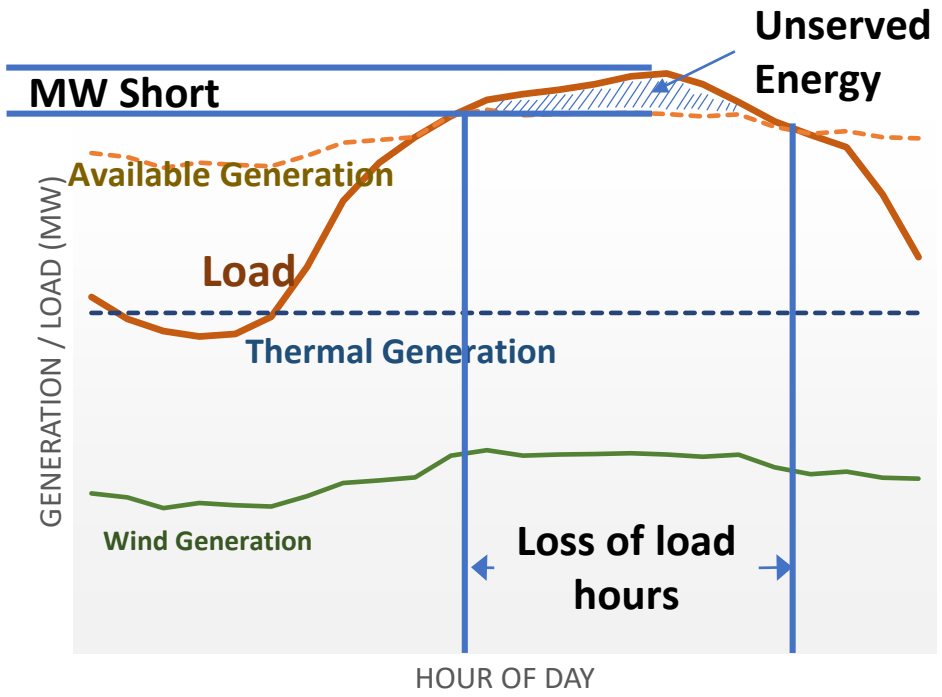


Reliability Analysis

Risk assessment to determine if the available resources can supply customer load in all hours of the year

- Large sources of uncertainty: renewable generation, forced outages and load

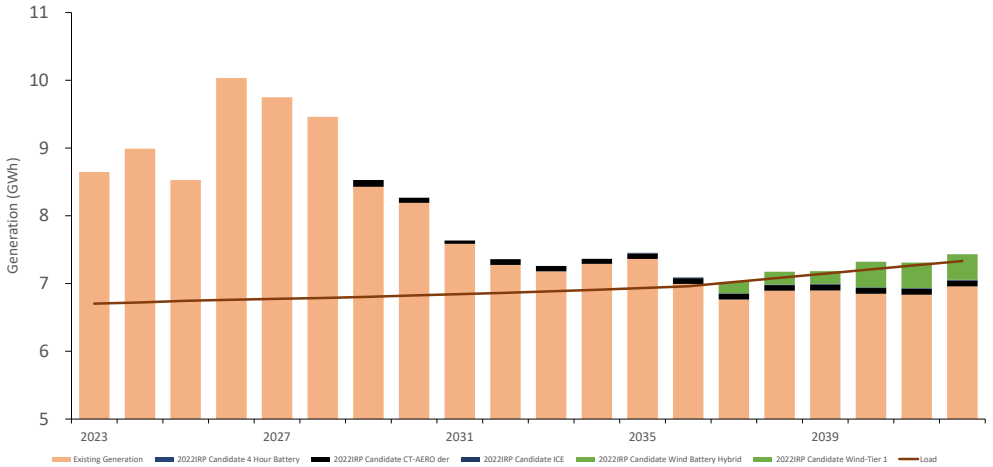
- ✓ Uses the same set of resources as used in Production cost analysis.
- ✓ Thermal resources are considered as firm capacity and provide energy to serve load every hour unless in an outage event.
- ✓ Runs an algorithm that determines the number of hours load can not be served with available generation.
  - Model can also determine additional capacity required to meet resource adequacy requirements



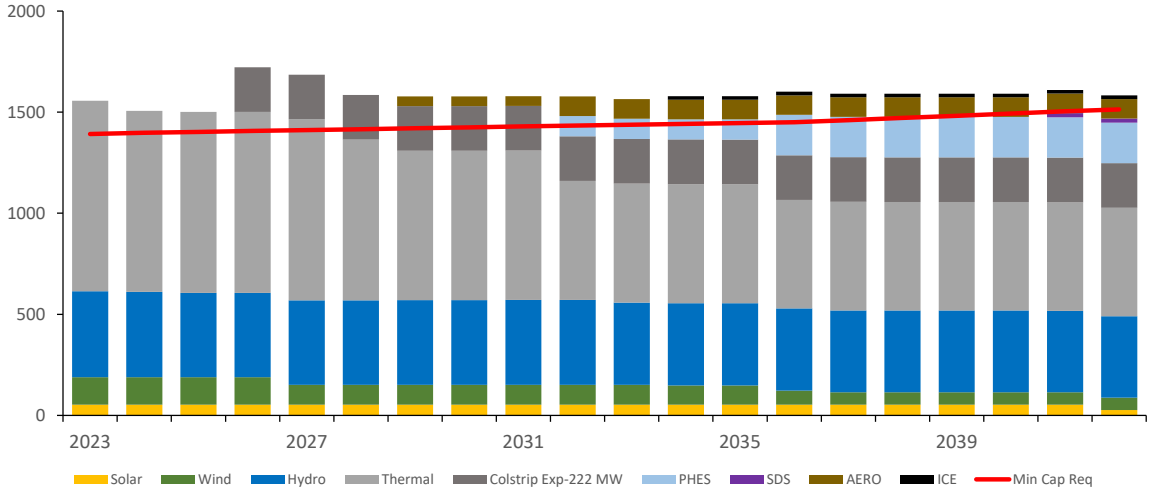
Example Outputs from the 2022 MT IRP

Total Costs Comparison

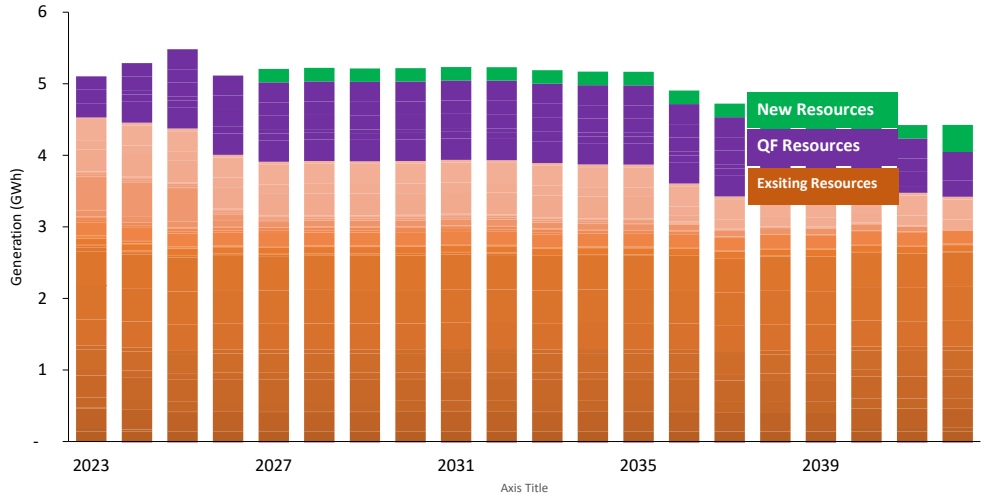
Energy Generation and Load



Capacity Position



Clean Energy Generation



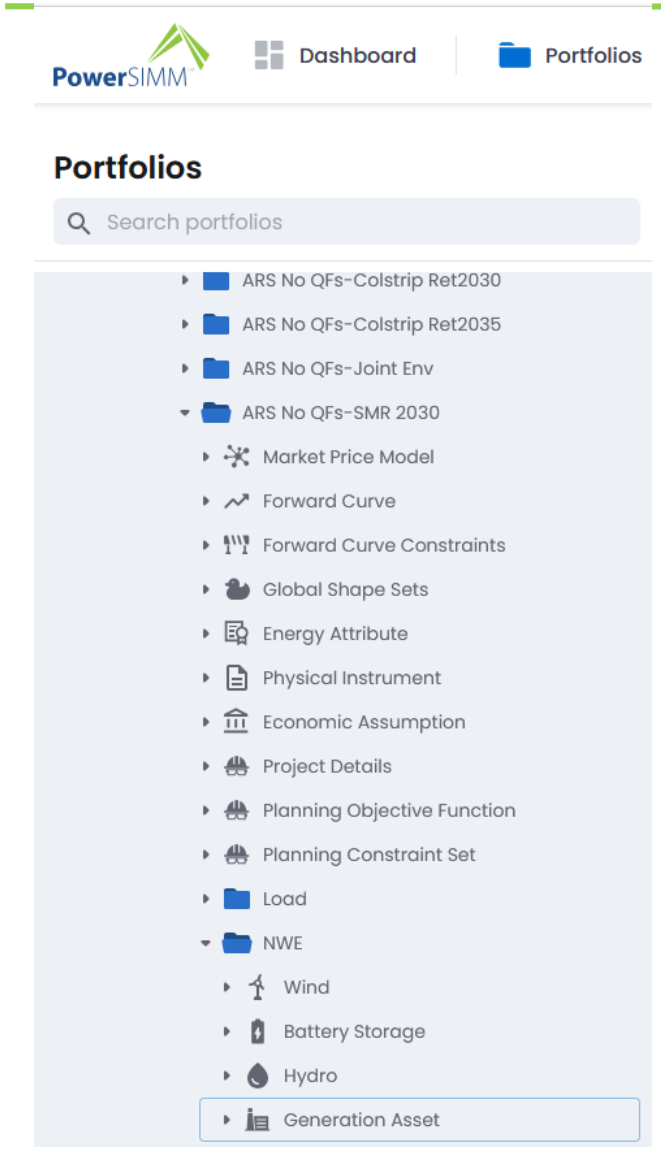
Summary

- Capacity Expansion model provides optimal resource selection to meet planning needs
- Production cost model provides in-depth insights for several outputs
- Reliability analysis determines the probability of the resources serving the load

All the three models helps in decision making to procure resources and satisfy planning needs.

Extra Slides

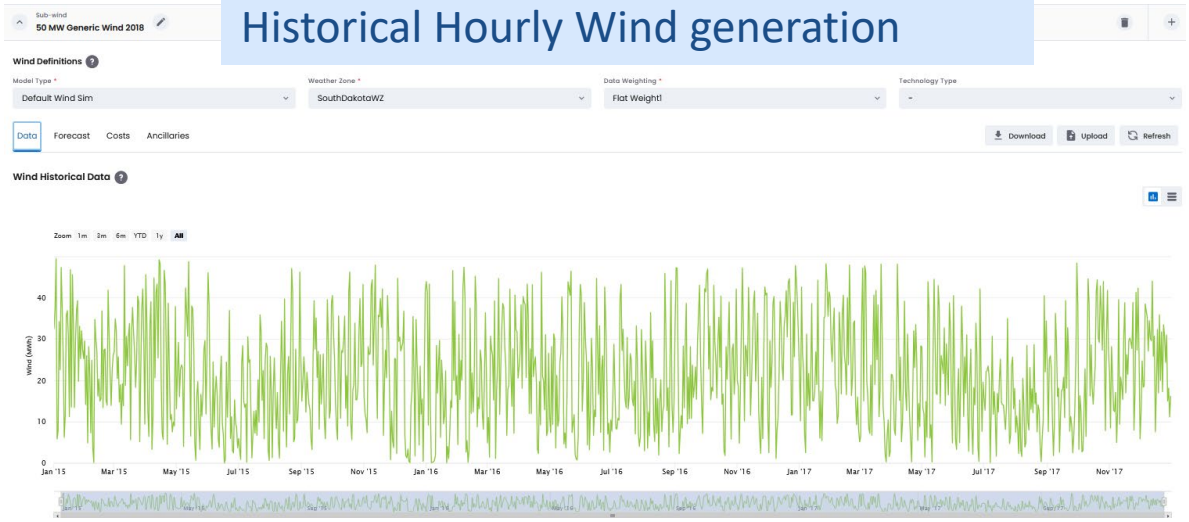
Modeling Portfolios in PowerSIMM



- Market Prices
  - Power (MIDC) and Gas (AECO, CIG) prices
  - Energy Imbalance Market (EIM) prices
  - Power and Gas price volatility and correlation
  - Expected price shapes
- Load
- Renewable resources like Solar, wind and hydro
- Thermal assets like Colstrip, Dave Gates etc.
- Battery Storage
- New candidate resources being considered for the IRP
- Economic Assumptions
  - WACC
  - Inflation Rate
- Resource planning targets
  - Reserve margin requirements
  - Energy requirements
  - RPS requirements

Renewable Assets

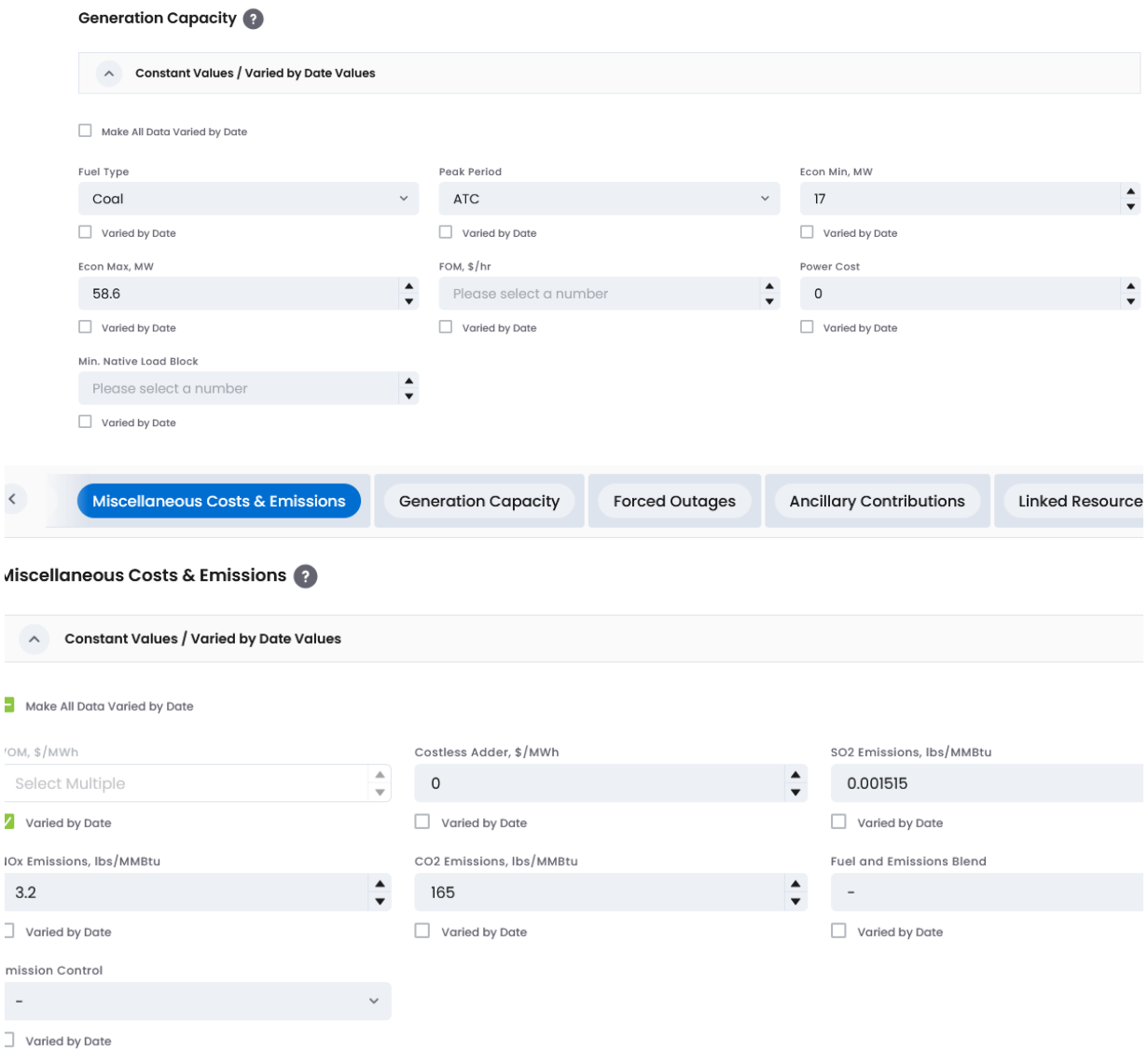
Historical Hourly Wind generation

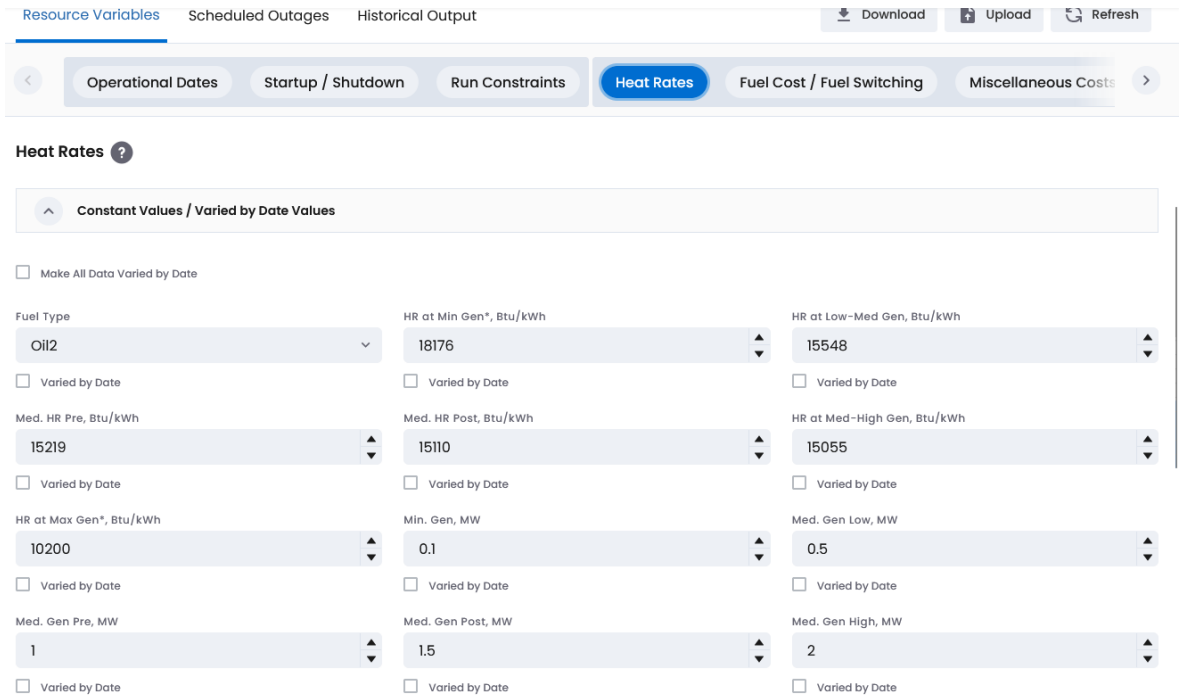


Monthly Energy Production Forecast

FORECAST TYPE	START DATE	END DATE	EXPECTED ENERG
Energy	04/01/2030 12:00:00 AM	05/01/2030 12:00:00 AM	16058
Energy	05/01/2030 12:00:00 AM	06/01/2030 12:00:00 AM	15351
Energy	06/01/2030 12:00:00 AM	07/01/2030 12:00:00 AM	12420
Energy	07/01/2030 12:00:00 AM	08/01/2030 12:00:00 AM	12546
Energy	08/01/2030 12:00:00 AM	09/01/2030 12:00:00 AM	11584
Energy	09/01/2030 12:00:00 AM	10/01/2030 12:00:00 AM	15322
Energy	10/01/2030 12:00:00 AM	11/01/2030 12:00:00 AM	18646
Energy	11/01/2030 12:00:00 AM	12/01/2030 12:00:00 AM	18596
Energy	12/01/2030 12:00:00 AM	01/01/2031 12:00:00 AM	17682

Thermal Assets





Planning Constraints

Energy Constraint

START DATE	END DATE	LHS VARIABLE	PEAK P...	LOGIC...	RHS V...	RHS M...	RHS A...	VIOLAT
06/01/2044 01:00:00 AM	07/01/2044 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=	ANNUALLO...	0.8	0	1000
07/01/2044 01:00:00 AM	08/01/2044 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=	ANNUALLO...	0.8	0	1000
08/01/2044 01:00:00 AM	09/01/2044 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=	ANNUALLO...	0.8	0	1000
09/01/2044 01:00:00 AM	10/01/2044 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=	ANNUALLO...	0.8	0	1000
10/01/2044 01:00:00 AM	11/01/2044 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=	ANNUALLO...	0.8	0	1000
11/01/2044 01:00:00 AM	12/01/2044 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=				
12/01/2044 01:00:00 AM	01/01/2045 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=				
01/01/2045 01:00:00 AM	02/01/2045 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=				
02/01/2045 01:00:00 AM	03/01/2045 12:00:00 AM	ENERGYCONSTRAINT	ATC	>=				

Planning Reserve Margin Requirements

START DATE	END DATE	LHS VARIABLE	PEAK P...	LOGIC...	RHS V...	RHS M...	RHS A...
11/01/2025 01:00:00 AM	12/01/2025 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	429.54225...
12/01/2025 01:00:00 AM	01/01/2026 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	429.54225...
01/01/2026 01:00:00 AM	02/01/2026 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	437.89661...
02/01/2026 01:00:00 AM	03/01/2026 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	437.89661...
03/01/2026 01:00:00 AM	04/01/2026 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	437.89661...
04/01/2026 01:00:00 AM	05/01/2026 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	437.89661...
05/01/2026 01:00:00 AM	06/01/2026 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	437.89661...
06/01/2026 01:00:00 AM	07/01/2026 12:00:00 AM	RESMARGINCONSTRAINT	ATC	>=	MAXLOAD	0	437.89661...

Economic Assumptions

Economic Assumptions

Base case asummptions 6.24 WACC

conomic Assumption Details

Download | Upload | Filters | Delete All | Add Table Rows

DETAIL	START DATE	END DATE	VALUE
Inflation Rate	01/01/2000	01/01/2999	0.025
Income Tax Rate Composite	01/01/2000	01/01/2999	0.11
WACC	01/01/2000	01/01/2999	0.0624