

MISO

Market Price Forecast

E3 Core Case

2023 edition



Energy+Environmental Economics

marketprices@ethree.com

Disclaimer

E3 created the following forecasts and analyses using the best available public information and our expertise and knowledge of the relevant markets, along with commercially available 3rd party software models and proprietary in-house energy market price forecasting tools. However, the future is uncertain, and these forecasts (along with underlying market expectations) may change due to many factors, including unforeseen events, new technology adoption or inventions, new market structures, regulatory actions, and changes in both state and federal government policies. E3 makes no guarantees related to these forecasts or the information presented herein and should not be held liable for any economic damages associated with independent investment decisions.

Contents

- 1) Introduction to E3
- 2) E3 Forecasting Approach
- 3) E3 Modeling Assumptions
- 4) Forecast Results

Introduction to E3

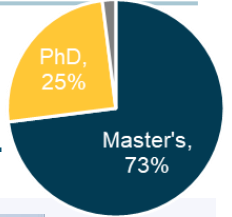


Energy+Environmental Economics

Who is E3?

Thought Leadership, Fact Based, Trusted.

110+ full-time consultants | 30 years of deep expertise | Engineering, Economics, Mathematics, Public Policy...



San Francisco



New York



Boston



Calgary

E3 Clients

300+ projects per year across our diverse client base



Recent Examples of Relevant E3 Projects

Assessment of **offshore wind opportunities** in New York and other jurisdictions for other market players

Developed **hydrogen roadmap** for the State of Colorado; H₂ market study: **Mitsubishi Americas**

Buy-side diligence support on several successful investments in **electric utilities** (~\$15B in total)

Supporting investment in several **stand-alone energy storage** platforms and individual assets across North America (**15+ GW | ~\$5B**)

Evaluation of **electric vehicle and V2G markets** in North America for several large automakers

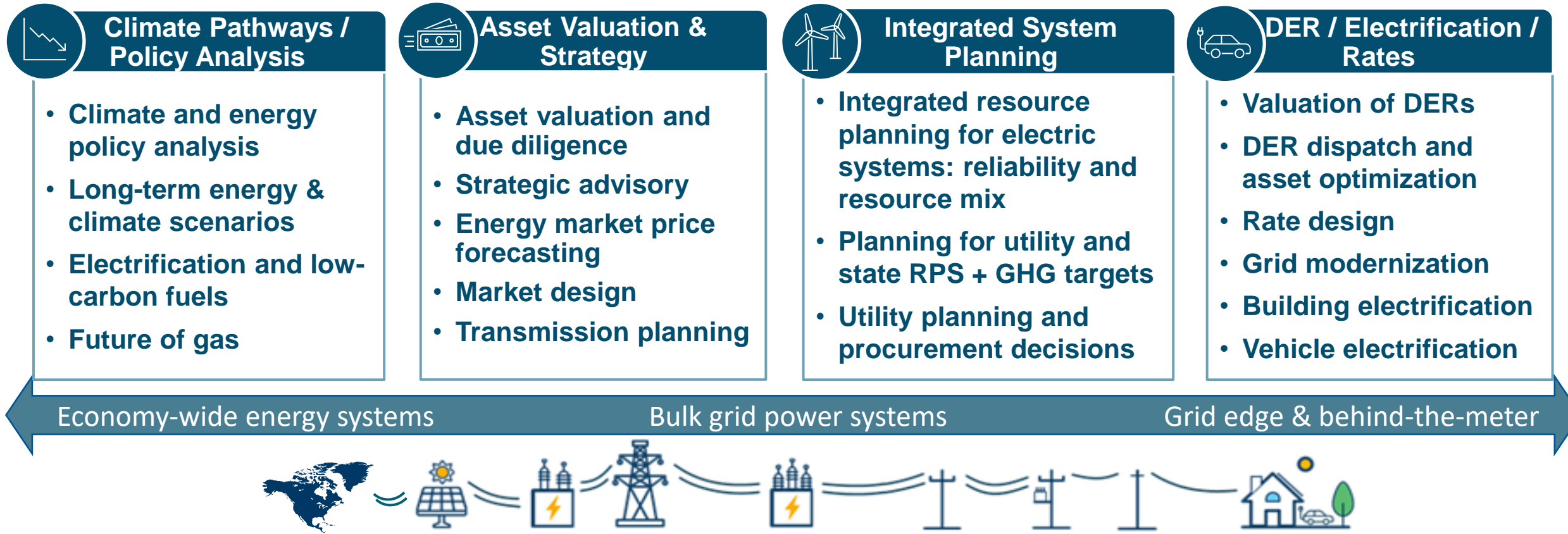
Supporting **NYSERDA** across multiple facets of the **Climate Leadership and Community Protection Act**

Supporting investment in over **5+ GW** of **community solar and distributed energy resource** projects

Currently supporting several **electric vehicle infrastructure and automakers with strategy**

Who is E3? (cont'd)

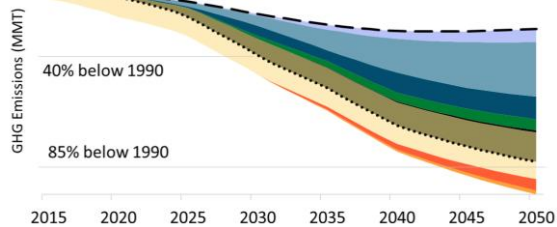
- + E3 is the **largest consulting group** focused on the clean energy transition in North America
- + E3 is a recognized **thought leader** on decarbonization and clean energy transition topics
- + E3 has **four major practice areas** covering energy systems from bulk grid to behind the meter



E3's Comprehensive and Best-in-Class Modeling Toolkit

PATHWAYS

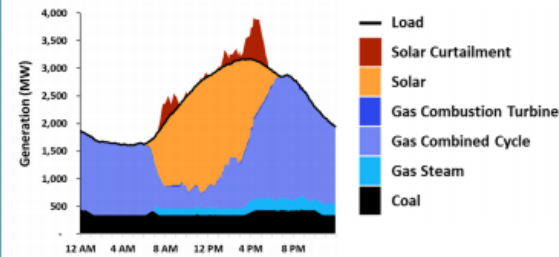
Economy-wide accounting of energy supplies and demands under deep decarbonization scenarios



Production Simulation

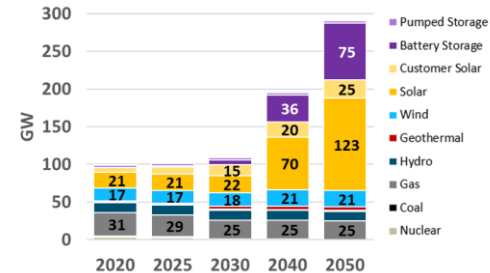
(AuroraXMP and PLEXOS)

Detailed operational simulations of system dispatch and flexibility needs



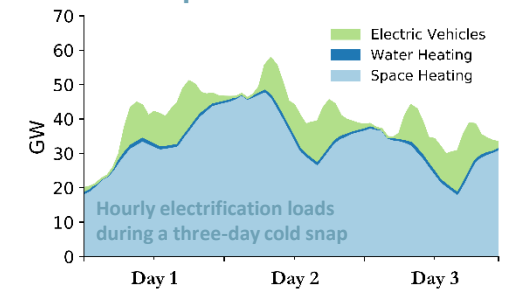
RESOLVE

Optimal capacity expansion model for electric systems



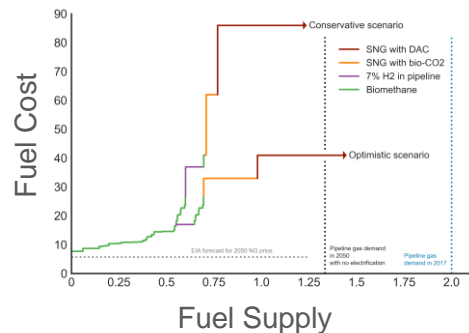
RESHAPE & EVGrid

Hourly simulations of electric loads for specific end uses



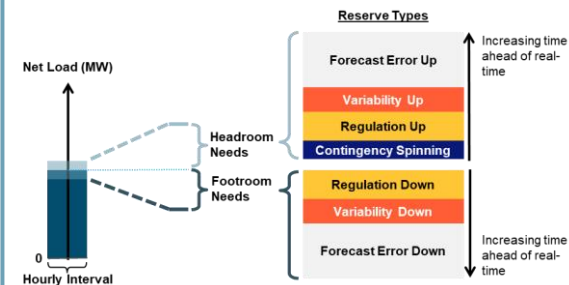
Low-Carbon Fuels and Future of Gas

Role of fuels in deep decarbonization



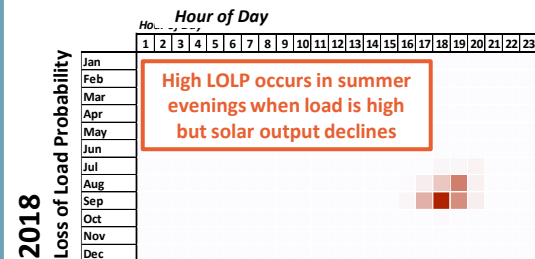
RESERVE

Dynamic operating reserves for renewable integration



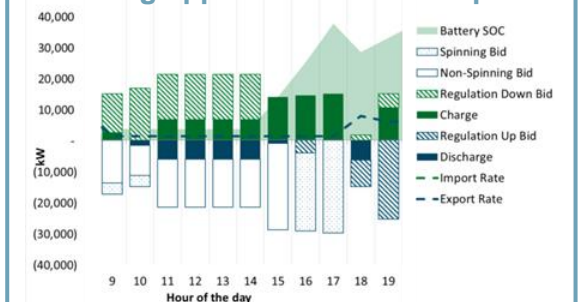
RECAP

Loss of load probability simulation to measure resource adequacy



RESTORE & IDSM

DER Toolkit for optimizing DER value stacking opportunities and adoption



Economy-wide energy systems

Bulk grid power systems

Grid edge & behind-the-meter

Asset Valuation and Strategy Practice Area

- + The Asset Valuation and Strategy practice area works primarily with project developers, asset owners, and investors
- + Insights informed by work being done across the firm that provides a unique 360-degree perspective of rapidly evolving markets
 - Clean Energy Policy → how will policy change the playing field for different resources?
 - Planning → what resources will power the grid in 2020? 2030? 2050?
 - Market Analysis → how will market prices evolve in the grid of the future?



Asset Valuation / Strategy

Determines asset values and strategies from multiple perspectives

Uses proprietary in-house models and in-depth knowledge of public policy, regulation and market institution

- + The E3 Asset Valuation and Strategy team provides a variety of analytical support tailored to client needs; Typical services include:

- Transaction support and due diligence on both the buy side and sell side
- Strategy formulation and market entry
- Board-level reports on market outlook and asset performance
- Customized forward-market price projections incorporating impacts of policy and technology changes
- Revenue stream/benefits analysis, either on an individual asset or portfolio basis
- Production simulation cost modeling using in-house proprietary tools or customized commercial software
- Project site evaluation
- Off-taker assessments
- Basis spread assessment
- Wholesale market rules and bidding strategies

E3 Forecasting Approach



Energy+Environmental Economics

E3 Model Ecosystem for Market Price Forecasts: Built on Decades of Experience and 360° Analysis

E3 Model Toolkit

Input Models

E3 PATHWAYS

Least-cost decarbonization pathways across sectors to meet GHG targets

E3 RESHAPE

Load simulation for building electrification & EVs

E3 Pro Forma Model

Levelized costs of new resources including financing and tax incentives

E3 RECAP

Stochastic reliability modeling for ELCCs of renewables and storage

Output Models

E3 RESTORE

Optimized battery operations and revenues

E3 Scarcity + RT Price Model

Forecasts scarcity and real-time energy prices with regression analysis

E3 Nodal Price Model

Node-zone basis forecast for nodal prices

E3 Ancillary Services Model

Forecasts AS prices with regression analysis and market saturation

E3 Capacity Market Models

Capacity price formation by market, aligned with unique market dynamics

E3 REC Market Models

Renewable Energy Credit prices aligned with unique market dynamics

Market Price Forecasting Approach

Key Scenario Variables

1 Load Forecasts
Regional load growth, energy efficiency, building electrification, and EVs

2 Policies
RPS, CES, GHG, other mandates

3 Regional Coordination
Transmission, Trading, and policy alignment

4 Costs:

- New resource costs
- Gas prices
- Carbon prices

AURORA Model Outputs

5 Long-Term Capacity Expansion (Annual)

New Resource Additions

- Economics
- Policies and mandates (RPS, CES, GHGs)
- System reliability needs
- Retirements

6 Production Cost Simulation (Hourly)

Energy Market Forecasts

- Hourly day-ahead energy prices by zone
- Dispatch, renewable curtailment, and transmission flows

E3 Forecasts

Market Product	Geographic Granularity	Temporal Granularity
Energy (Day-Ahead and Real-Time)	Zonal	Hourly
Capacity (low, medium, high forecasts)	System / Local	Annual
Ancillary Services (Reg, Spin, Non-Spin)	ISO	Hourly
ELCC Curves	Regional	Annual
RECs	State / ISO	Annual
System Operations	System / Local	Hourly / Monthly

Fundamentals-based market modeling built on day-ahead energy prices

E3 Modeling Assumptions



Energy+Environmental Economics

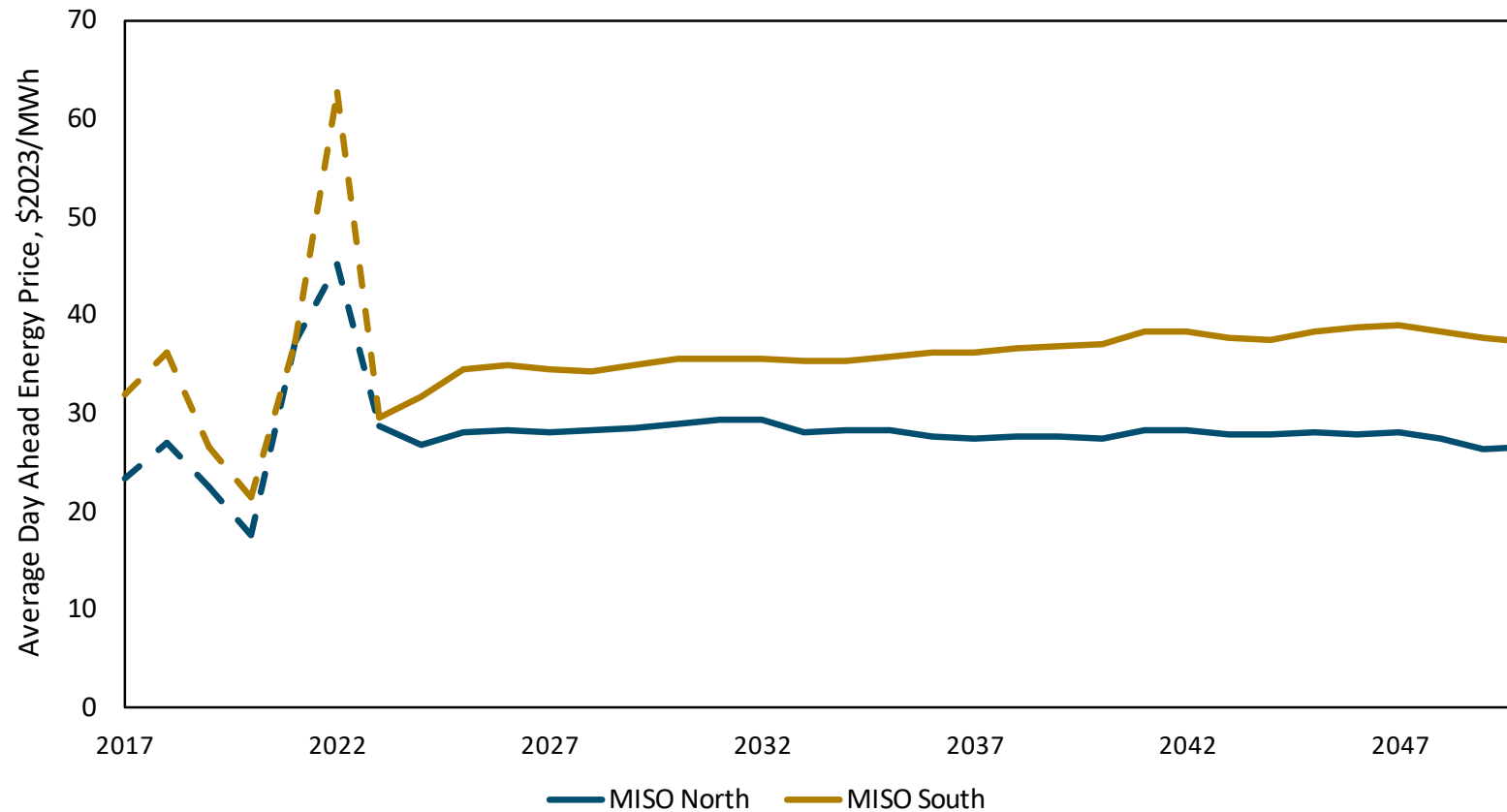
E3 Forecast Results



Energy+Environmental Economics

MISO North and MISO South Annual Average Prices

- + Annual average prices expected to stabilize after recent volatility led by changes in natural gas prices
- + Longer term, prices remain stable as wind builds primarily meet load growth and coal generation is replaced by renewables and gas generation, while total installed gas capacity remains stable over the long term



* Average annual prices for the historical years are pulled from ABB's Velocity Suite through November 2023, and are shown in nominal unadjusted numbers