SAMPLE REPORT: Electric Reliability Council of Texas Market Price Forecast E3 Core Case

2022 edition

Energy+Environmental Economics

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.

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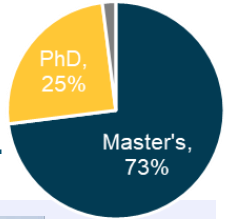- ERCOT Market and Bidding Rules

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Executive Summary

100+ full-time consultants | **30 years of deep expertise** | Engineering, Economics, Mathematics, Public Policy…

PhD, 25%
Master's, 73%

San Francisco

New York

Boston

Calgary

E3 Clients

Recent Examples of Relevant E3 Projects

300+ projects per year across our diverse client base

Investors, Developers & Asset Owners

Utilities & System Operators

Public and Non-Profit Sector

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)

Acquisition support for several portfolios and individual gas-fired and renewable generation assets (20+ GW | ~$4B)

Acquisition support of several electric vehicle infrastructure companies (~$500M)

Strategic advisory support for a SPAC offering of a distributed energy resource aggregation software company (~$1.3B)

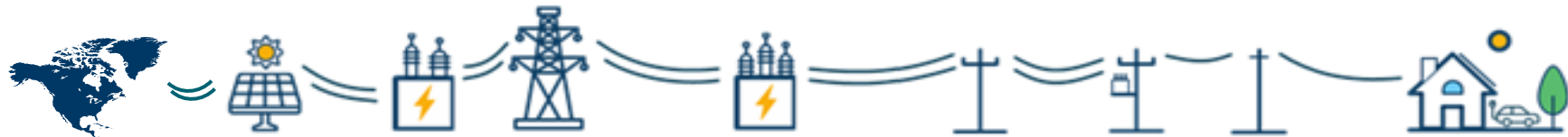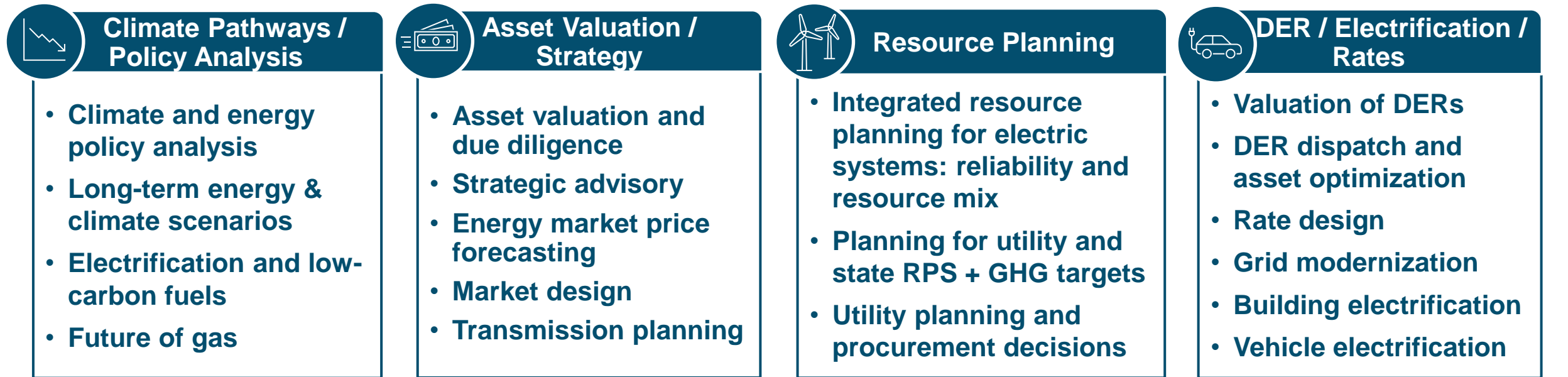**Supporting an investment into an electric vehicle V2G software company (~$750M)**

Buy-side diligence support to acquire several residential solar portfolios (~1+ GW |200,000+ customers)

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

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 the clean energy transition topics

+ E3 has **four major practice areas** covering energy systems from bulk grid to behind the meter

Climate Pathways / Policy Analysis

- Climate and energy policy analysis
- Long-term energy & climate scenarios
- Electrification and low-carbon fuels
- Future of gas

Asset Valuation / Strategy

- Asset valuation and due diligence
- Strategic advisory
- Energy market price forecasting
- Market design
- Transmission planning

Resource Planning

- Integrated resource planning for electric systems: reliability and resource mix
- Planning for utility and state RPS + GHG targets
- Utility planning and procurement decisions

DER / Electrification / Rates

- Valuation of DERs
- DER dispatch and asset optimization
- Rate design
- Grid modernization
- Building electrification
- Vehicle electrification

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?

+ **The E3 Asset Valuation and Strategy team provides a variety of analytical support tailored to client needs.**

Asset Valuation / Strategy

- **Analyze asset value from multiple perspectives in vertical, bilateral, and wholesale markets**
- **Strategic support for project development, acquisition, and operation, including market entry**
- **Proprietary in-house models and in-depth knowledge of public policy, regulation and markets**

+ **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
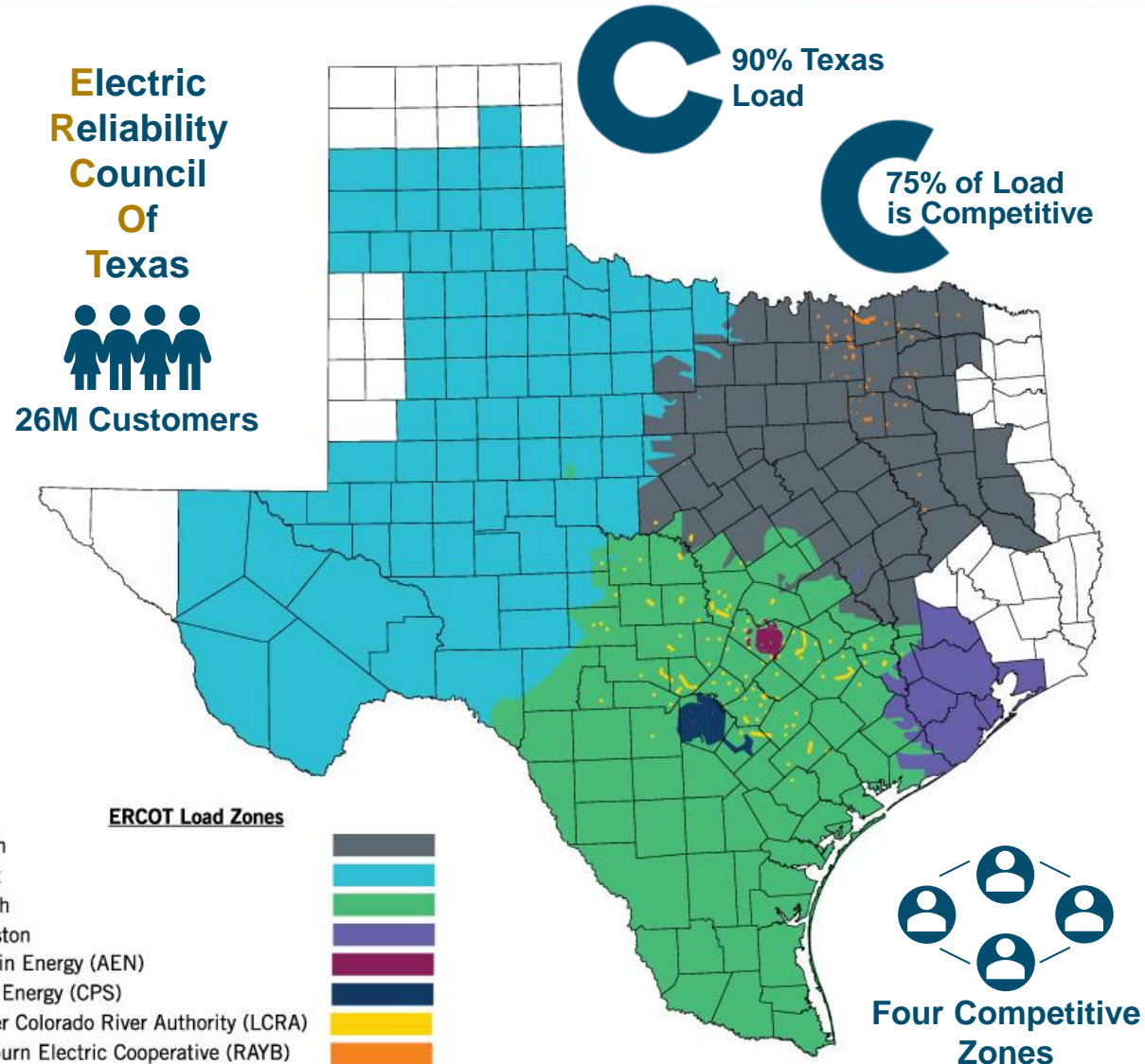- Wholesale market rules and bidding strategies

Overview

+ **ERCOT has a summer peaking system**
  - 79.6 GW all-time summer peak (July 2022)
  - 92 GW of peak summer capacity

+ **52,700 miles of Tx**

+ **35.7 GW of wind (March 2022), the most of any state**
  - Encompasses 29% of generating capacity and 24% of energy use

+ **11.5 GW of utility solar and 1.7 GW of battery storage (April 2022)**

+ **Natural gas makes up 44%+ generating capacity and 42% of energy use**

+ **An RPS target of 10 GW by 2025 was implemented in 1999 and already surpassed in 2009**

Source: ERCOT_Fact_Sheet.pdf

Electric
Reliability
Council
Of
Texas

26M Customers

90% Texas Load

75% of Load is Competitive

Four Competitive Zones

ERCOT Load Zones

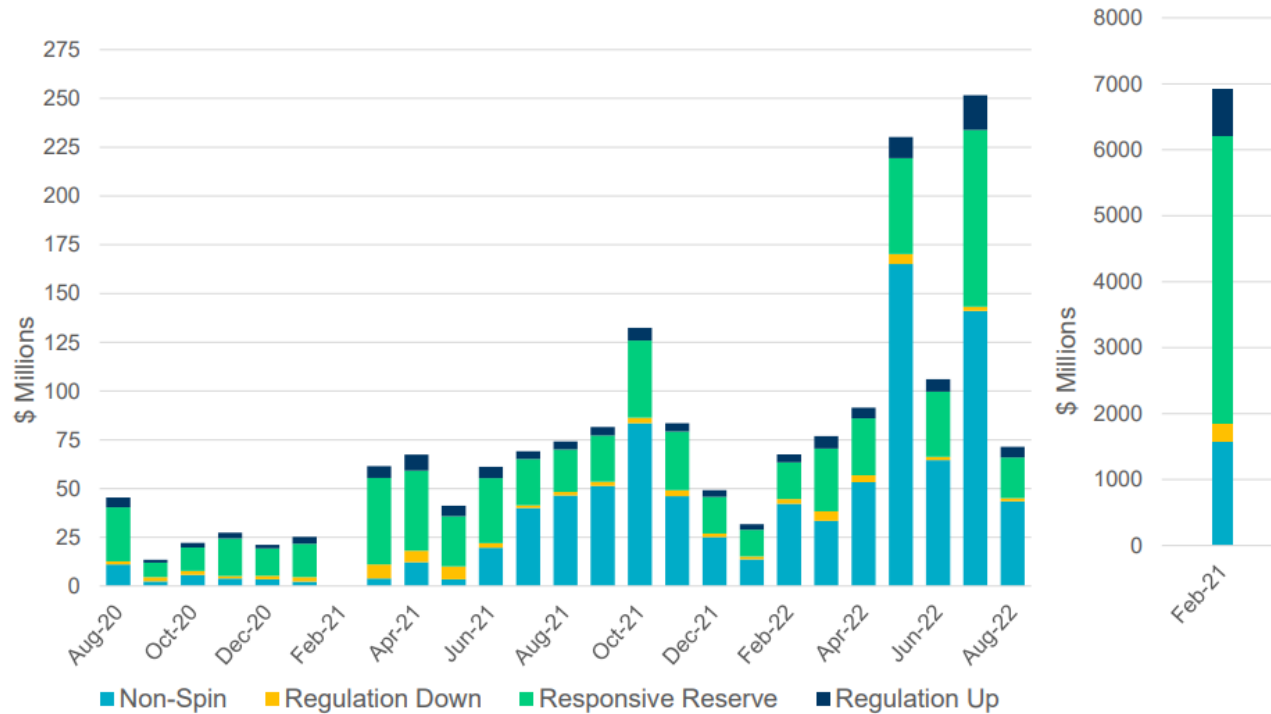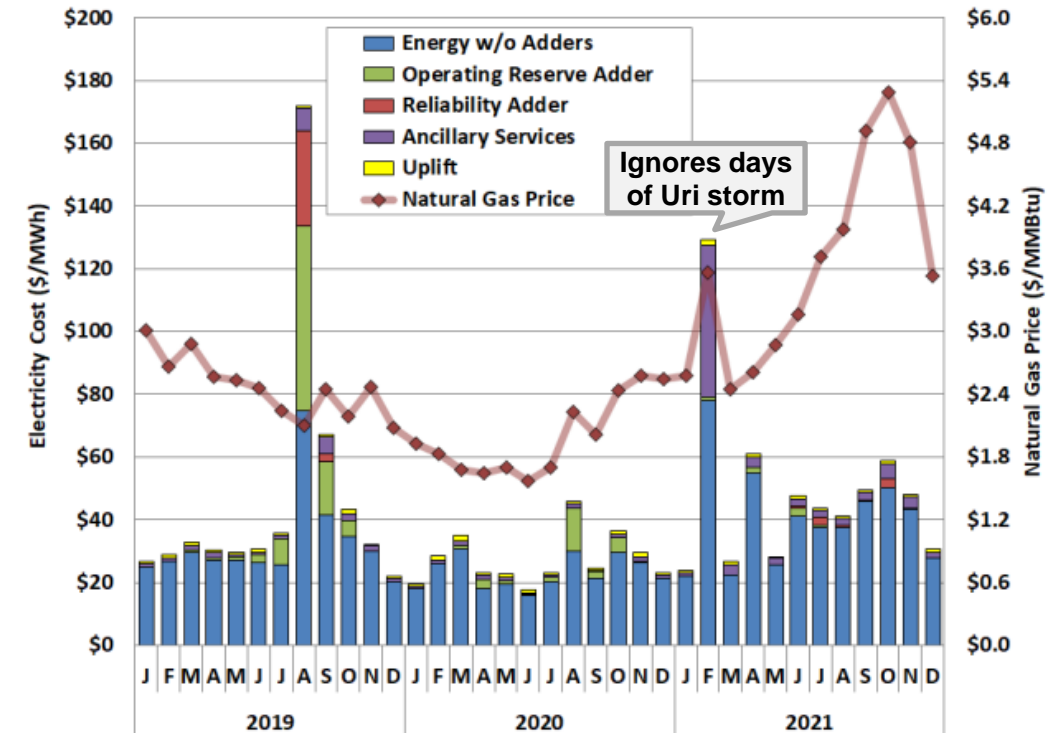| Zone	
North	
West	
South	
Houston	
Austin Energy (AEN)	
CPS Energy (CPS)	
Lower Colorado River Authority (LCRA)	
Rayburn Electric Cooperative (RAYB)	

AS Market Size

+ **Value of ORDC adder and AS is concentrated in a handful of hours when the system is constrained (typically in Summer, but can also occur in winter storms, or shoulder periods when many units down for maintenance)**

Ancillary Services for August 2022 totaled $71.42M

Legend: Non-Spin, Regulation Down, Responsive Reserve, Regulation Up

Figure 4: Average All-in Cost for Electricity in ERCOT (without Uri)

Legend: Energy w/o Adders, Operating Reserve Adder, Reliability Adder, Ancillary Services, Uplift, Natural Gas Price

Ignores days of Uri storm

*ORDC adder is for energy prices

E3 Forecasting Approach
Selected Slides

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
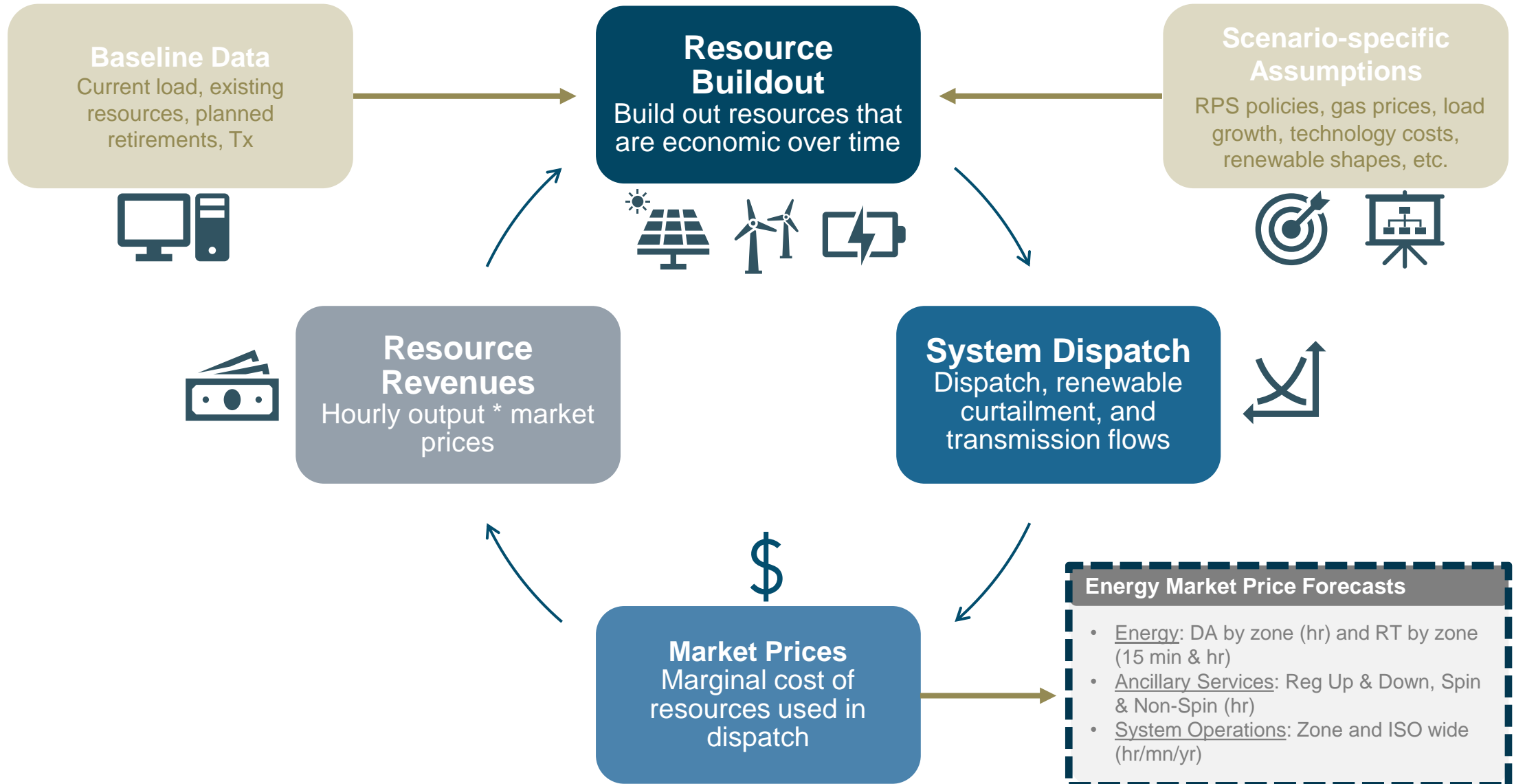- Dispatch, renewable curtailment, and transmission flows

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

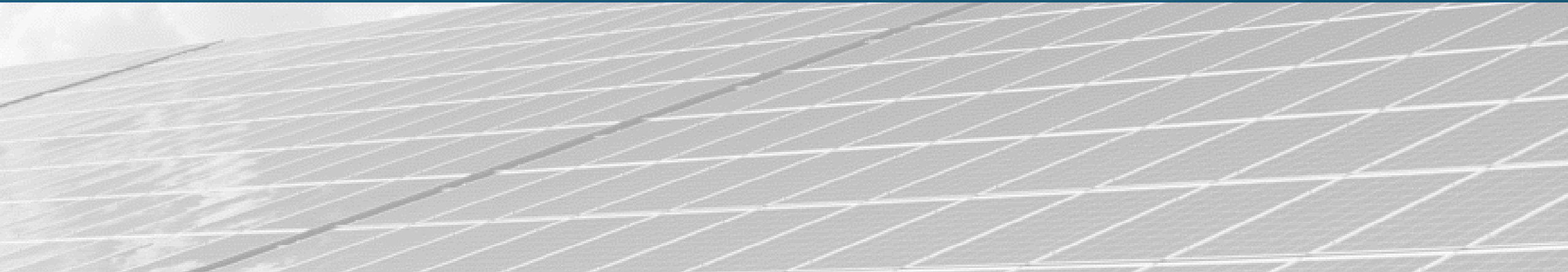# Modeling Approach for Long-Run Resource Builds

Baseline Data
Current load, existing resources, planned retirements, Tx

Resource Buildout
Build out resources that are economic over time

Scenario-specific Assumptions
RPS policies, gas prices, load growth, technology costs, renewable shapes, etc.

Resource Revenues
Hourly output * market prices

System Dispatch
Dispatch, renewable curtailment, and transmission flows

Market Prices
Marginal cost of resources used in dispatch

Energy Market Price Forecasts
- <u>Energy</u>: DA by zone (hr) and RT by zone (15 min & hr)
- <u>Ancillary Services</u>: Reg Up & Down, Spin & Non-Spin (hr)
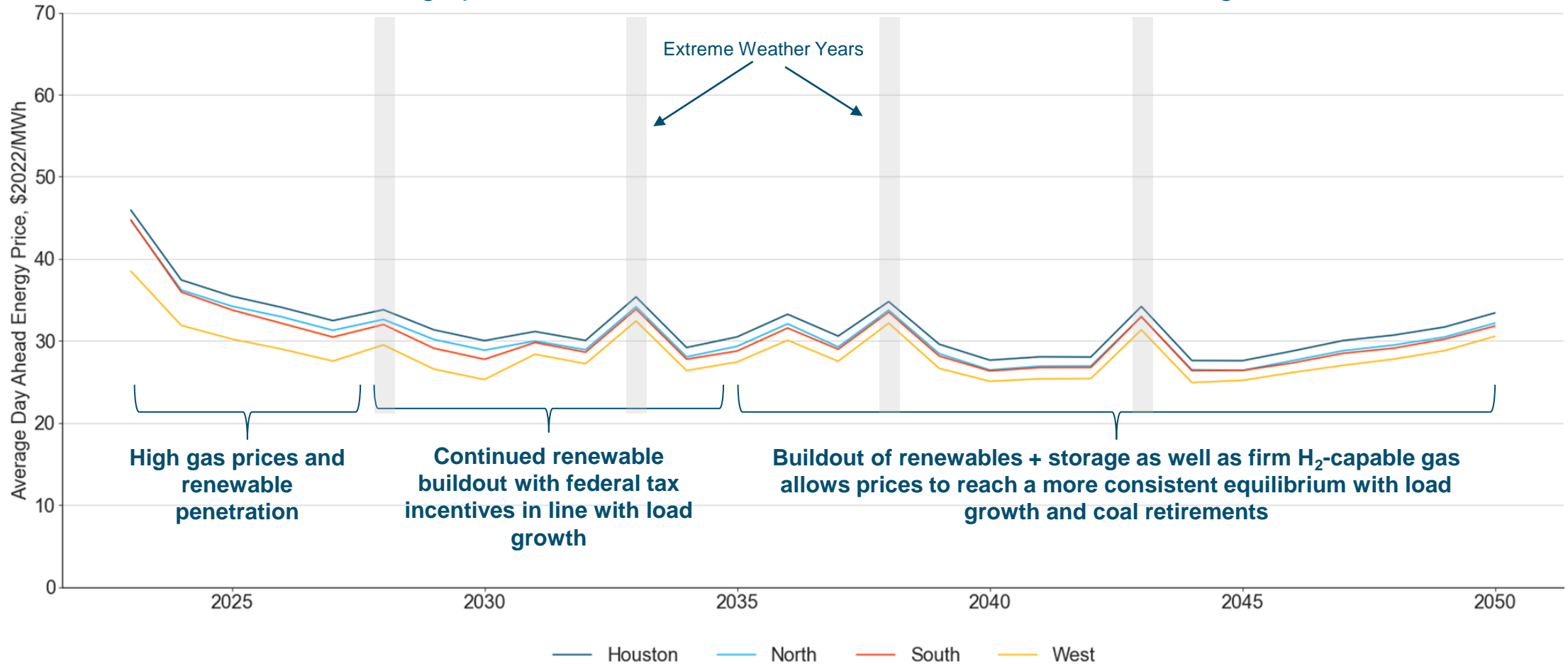- <u>System Operations</u>: Zone and ISO wide (hr/mn/yr)

Average Annual Energy Price

+ **The North price is viewed as indicative of the average ERCOT system**

  • Houston – due to its high load center and limited resource access – is ~$1/MWh more than average, whereas the West – with lower load and high penetration of renewables – is ~$1/MWh less than average

Appendix

ERCOT Market and Bidding Rules