PNM 2020-2039 Integrated Resource Plan

AUGUST 29, 2019

INTRO TO RESOURCE PLANNING

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AGENDA

2020-2039 IRP PUBLIC ADVISORY MEETING #2: INTRO TO RESOURCE PLANNING

- Welcome and Introductions
- Safety and Ground Rules
- Introduction to Resource Planning
- Outline of next meeting's topic

Nick Phillips
Director, Integrated Resource Planning

Mr. Phillips manages the PNM Resource Planning department and is responsible for developing PNM resource plans and the regulatory filings to support those resource plans.

Prior to joining PNM, Mr. Phillips was involved with numerous regulated and competitive electric service issues including resource planning, transmission planning, production cost analysis, electric price forecasting, load forecasting, class cost of service analysis, and rate design.

Mr. Phillips received the Degree of Master of Engineering in Electrical Engineering with a concentration in Electric Power and Energy Systems from Iowa State University of Science and Technology, and the Degree of Master of Science in Computational Finance and Risk Management from the University of Washington Seattle.

SAFETY AND LOGISTICS

- In case of an emergency please exit to the LEFT of the stage.
- Another exit is through the main entry of the Museum.
- Restrooms are located behind the Admission desk around the corner down the hall to the left.

MEETING GROUND RULES

01

- Questions and comments are welcome – One Person Speaks at a Time

02

- Reminder; today's presentation is not PNM's plan or a financial forecast, it is an illustration of the IRP process

03

- Please wait for the microphone to raise your question or make your comment so we can ensure you are clearly heard and recorded. ***Only Q&A are transcribed for our filing package***.
- Questions and comments should be respectful of all participants

04

- These meetings are about the 2020 IRP, questions and comments should relate to this IRP. Any questions or comments related to other regulator proceedings should be directed towards the specific filing

DISCLOSURE REGARDING FORWARD LOOKING STATEMENTS

The information provided in this presentation contains scenario planning assumptions to assist in the Integrated Resource Plan public process and should not be considered statements of the company's actual plans. Any assumptions and projections contained in the presentation are subject to a variety of risks, uncertainties and other factors, most of which are beyond the company's control, and many of which could have a significant impact on the company's ultimate conclusions and plans. For further discussion of these and other important factors, please refer to reports filed with the Securities and Exchange Commission. The reports are available online at www.pnmresources.com.

The information in this presentation is based on the best available information at the time of preparation. The company undertakes no obligation to update any forward-looking statement or statements to reflect events or circumstances that occur after the date on which such statement is made or to reflect the occurrence of unanticipated events, except to the extent the events or circumstances constitute material changes in the Integrated Resource Plan that are required to be reported to the New Mexico Public Regulation Commission (NMPRC) pursuant to Rule 17.7.4 New Mexico Administrative Code (NMAC).

INTRODUCTION TO RESOURCE PLANNING

INTRO TO INTEGRATED RESOURCE PLANNING

AGENDA

- Why Integrated Resource Planning (IRP)
- Flow of the IRP Process
- Analytical Tools
- Primary Inputs & Assumptions
- Analysis Flow, Scenario Development, Sensitivity & Risk Analysis

WHY INTEGRATED RESOURCE PLANNING

INTRO TO INTEGRATED RESOURCE PLANNING

WHY INTEGRATED RESOURCE PLANNING

Planning prior to the IRP process

- Planning was internal to the utility. Public and stakeholder involvement was limited, if available at all.
- Resources were limited, mainly to supply-side resources.
- Resources selected primarily to minimize cost and maintain system reliability.

INTRO TO INTEGRATED RESOURCE PLANNING

WHY INTEGRATED RESOURCE PLANNING

Key Characteristics of IRP paradigm

- IRP is comprehensive and gives explicit consideration of energy efficiency and load-management programs, T&D, Rates and supply side resources

- Consideration of environmental factors as well as direct economic costs

- Public participation and transparency

- Analysis of the uncertainties and risks posed by different resource portfolios and by external factors.

INTRO TO INTEGRATED RESOURCE PLANNING

WHY INTEGRATED RESOURCE PLANNING

IRP differs from traditional utility planning in several ways, including the types of resources acquired, the owners of the resources, the organizations involved in planning, and the criteria for resource selection

Diversity of resources, including utility-owned plants, purchases from other organizations, conservation and load-management programs, transmission and distribution improvements, and pricing

Planning spread among several departments within utility and often involves customers, public utility commission staff, and nonutility energy experts

INTRO TO INTEGRATED RESOURCE PLANNING

WHY INTEGRATED RESOURCE PLANNING

Some resources owned by other utilities, by small power producers, by independent power producers, and by customers

Diverse resource-selection criteria, including electricity prices, revenue requirements, energy service costs, utility financial condition, risk reduction, fuel and technology diversity, environmental quality, and economic development

PNM began using IRP process in 2005 with a fully open public advisory process beginning in 2011

INTEGRATED RESOURCE PLANNING PROCESS FLOW

INTRO TO INTEGRATED RESOURCE PLANNING

IRP RULE

The IRP Rule requires that New Mexico electric public utilities file an IRP that contains the following (17.7.3.9(B) NMAC):

- A description of existing electric supply-side and demand-side resources
- A current load forecast
- A load and resources table
- Identification of resource options
- A description of resource and fuel diversity
- Identification of critical facilities susceptible to supply source or other failures
- A determination of the most cost-effective resource portfolio and alternative portfolios
- A description of the public advisory process
- An action plan
- Other information that the utility finds may aid the NMPRC in reviewing the utility's planning processes

INTRO TO INTEGRATED RESOURCE PLANNING

IRP PROCESS FLOW

PLAN OBJECTIVES

Most Cost Effective Plan

- Balances cost and reliability
- Meets regulatory requirements
- Considers environmental impact

Comply with IRP Rules and Regional Haze Stipulation

COLLECT ASSUMPTIONS

Data

- Existing system
- Known technologies

Projections

- Demand
- Energy
- Prices
- Regulations

UNDERSTAND RISKS

Define scenarios

Identify sensitivities

ANALYZE

Model potential solutions

Identify best solutions over a range of scenarios

Test best solutions over a range of assumptions

Probabalistic assessment

EVALUATE

What works best under most conditions?

Which risks are easiest to mitigate?

Most cost-effective 20-year portfolio

Four-year action plan

REPORT

Results of analysis

Document the process

File with NMPRC every three years

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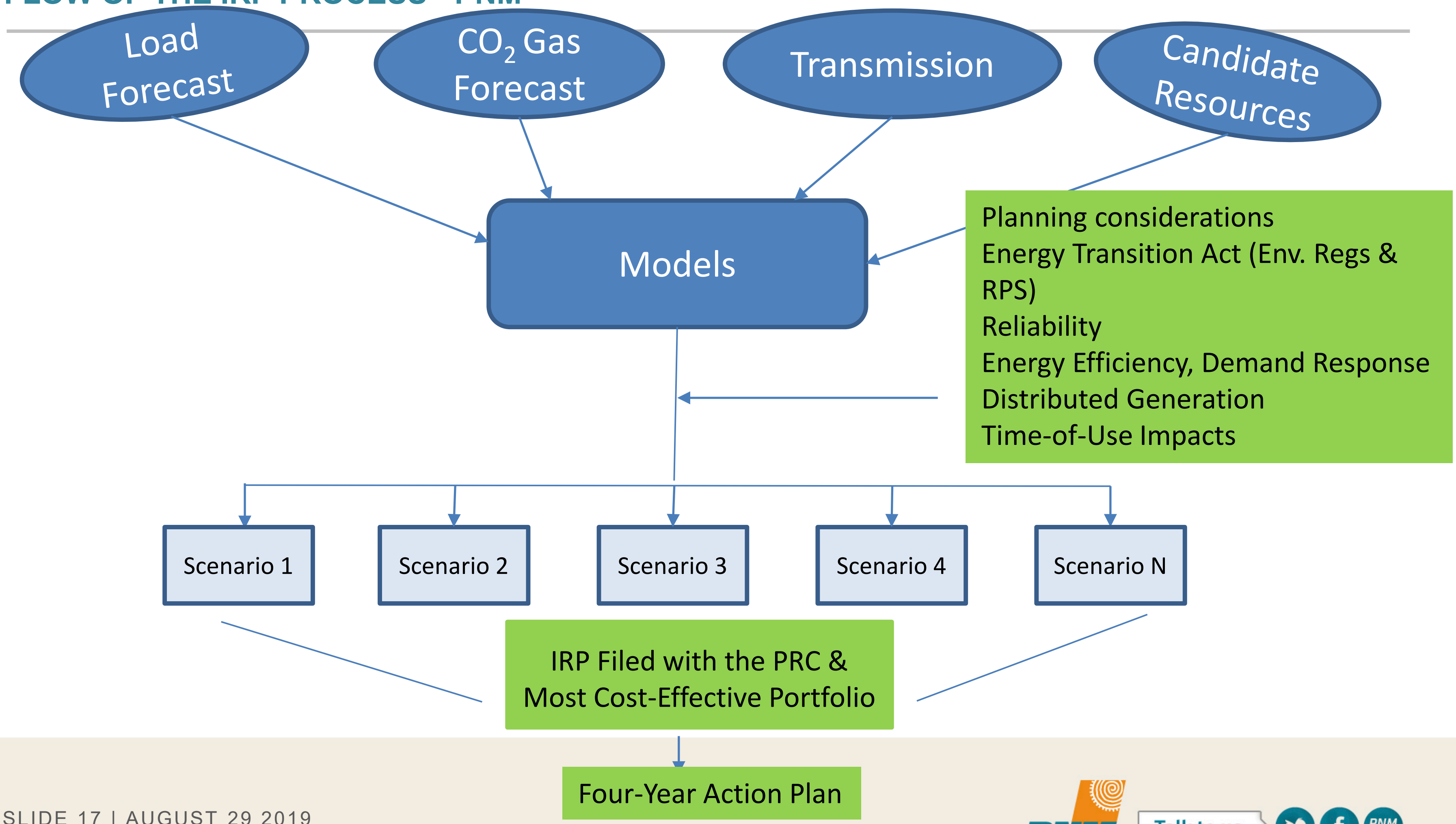
FLOW OF THE IRP PROCESS - PNM



INTEGRATED RESOURCE PLANNING ANALYTICAL TOOLS & SOFTWARE

INTRO TO INTEGRATED RESOURCE PLANNING

ANALYTICAL TOOLS

Three typical types of analysis are performed, each with a specific algorithm/ type of mathematical modeling software.

1. Capacity Expansion / Resource Optimization

   - Capital Investment Model

2. Production Cost Modeling

   - Detailed Chronological Variable Cost Model

3. Reliability Analysis

   - Deterministic or Probabilistic evaluation of investment plan to meet reliability criterion.

No one tool does it all!

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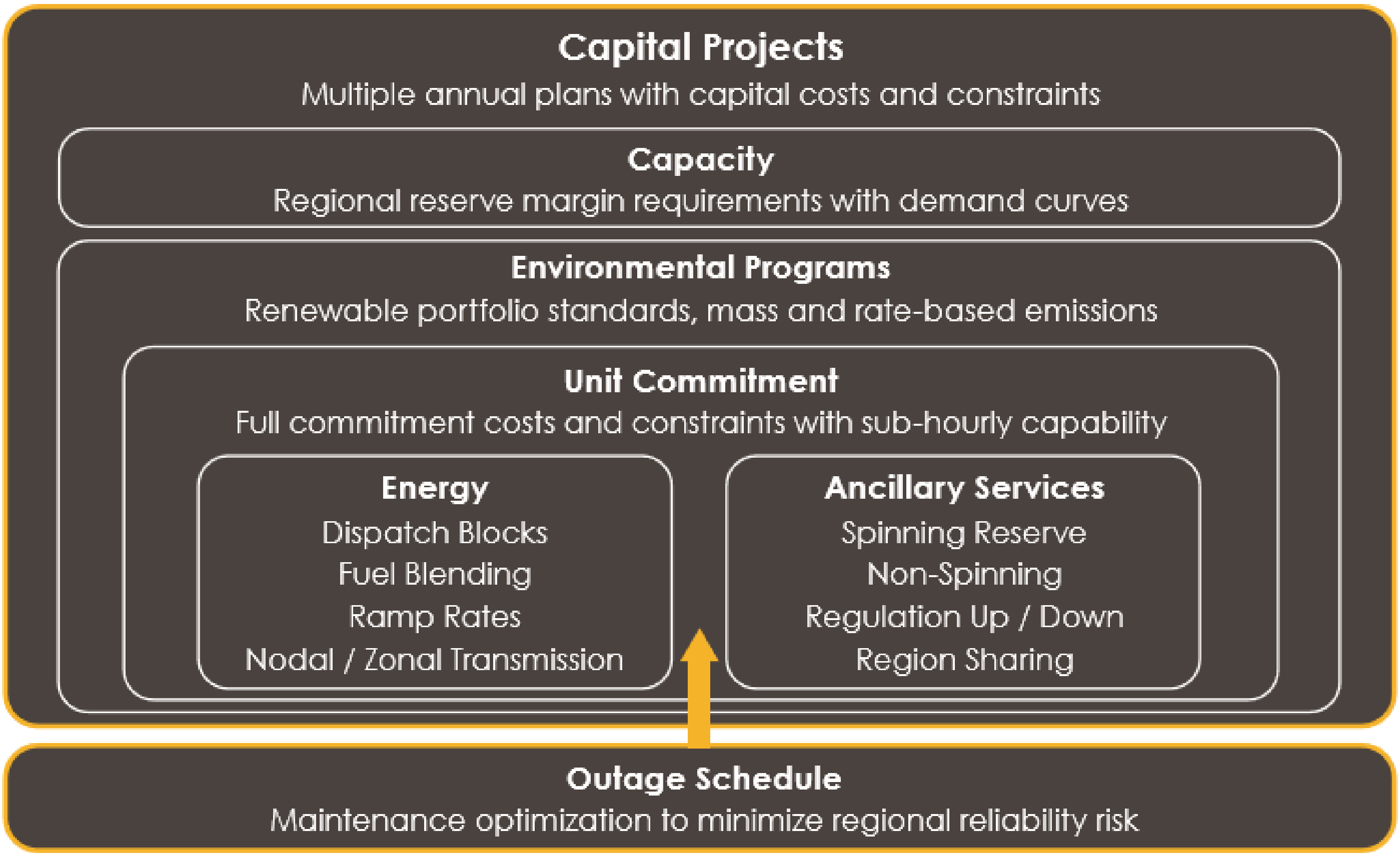
ANALYTICAL TOOLS - ENCOMPASS



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ANALYTICAL TOOLS – SERVM

Strategic Energy Risk Valuation Model (SERVM)

- Probabilistic hourly and intra-hour chronological production cost model designed specifically for resource adequacy and system flexibility studies

- SERVM calculates both resource adequacy metrics and costs

  Loss of Load Expectation ($LOLE_{CAP}$): Expected number of firm load shed events in a given year due to capacity shortfalls

  Loss of Load Expectation ($LOLE_{FLEX}$): Expected number of firm load shed events in a given year due to not having enough ramping capability

INTEGRATED RESOURCE PLANNING
IDENTIFY GOALS & OBJECTIVES

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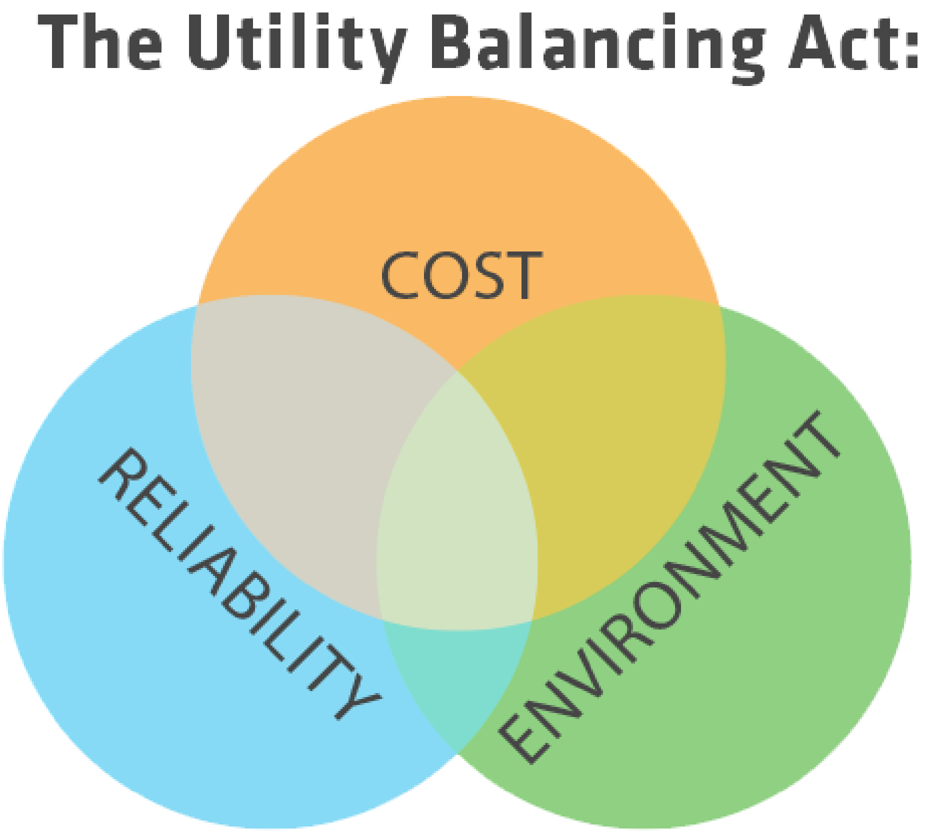
IDENTIFY GOALS



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IDENTIFY GOALS

COST	• Net Present Value of Revenue Requirements
RELIABILITY	• Peak Day Reserves • Hourly Operating Reserves • LOLH and LOLE
ENVIRONMENTAL IMPACTS	• CO2 Emissions • Water Usage • Other Emissions
REGULATORY REQUIREMENTS	• Energy Efficiency Spending • Renewable Portfolio Standards • Energy Transition Act Requirements • Regional Haze Stipulation Requirements

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IDENTIFY GOALS

- Reliable Electric Service
- Electrification
- Minimize Environmental Impact
- Energy Security
- Use of Local Resources
- Diversify Supply
- Increase Efficiency
- Minimize Costs
- Provide Social Benefits
- Provide Local Employment
- Acquire Technology and Expertise
- Retain Flexibility

*Possible objectives for IRP, not all will apply

INTEGRATED RESOURCE PLANNING INITIAL CONDITIONS

INTRO TO INTEGRATED RE

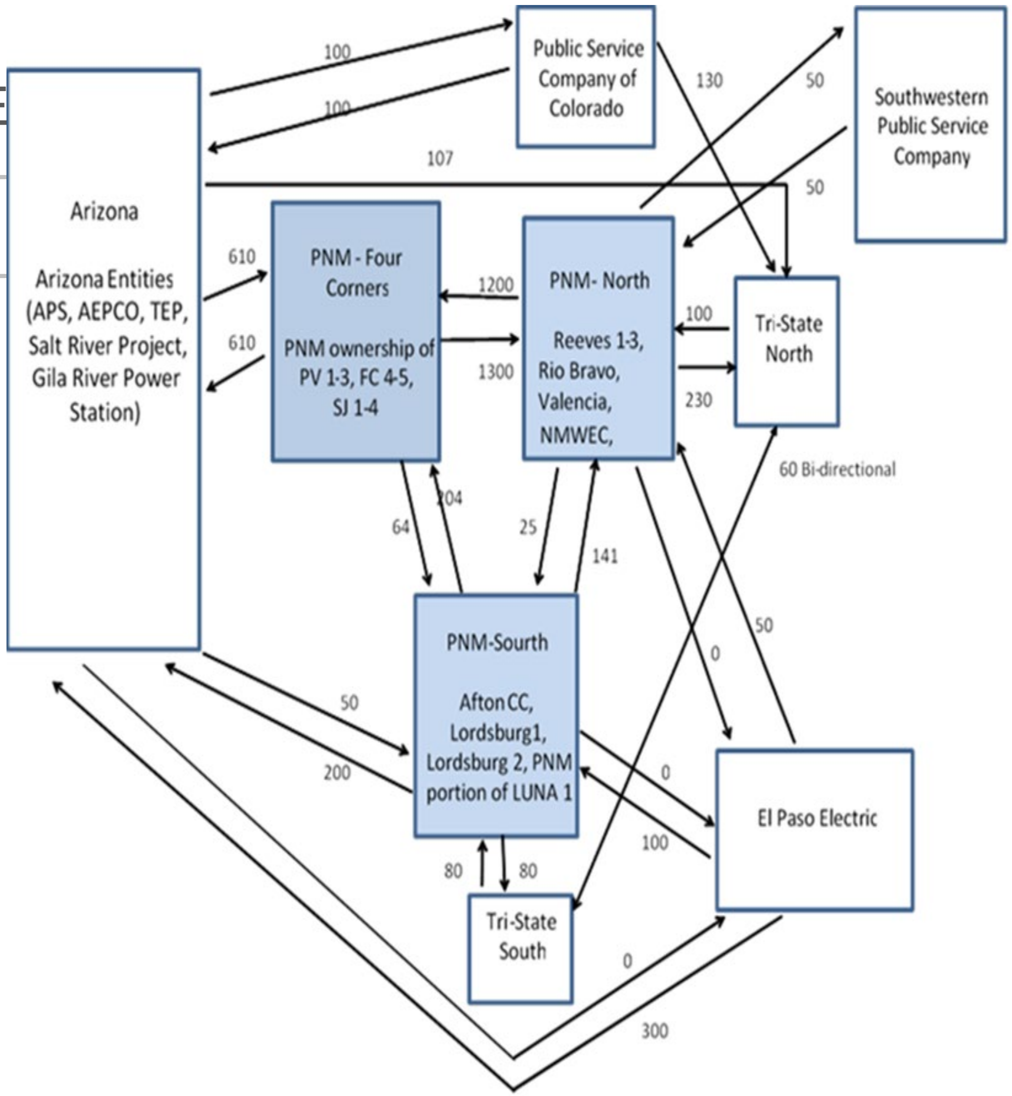
INPUTS AND ASSUMPTIONS

Initial Conditions &
The Existing System

Gather Historic Data:

- Load by Zone
- Legacy Gen. Unit Characteristics
- Transmission Topology
- Weather & Renewable Generation
- Neighboring Systems & Markets

Known, Approved, or Anticipated Changes to the Existing System



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INTEGRATED RESOURCE PLANNING INPUTS AND ASSUMPTIONS

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INPUTS AND ASSUMPTIONS

Data Types	Specifics
Load Forecast	Existing customer counts and load by rate class, historical and projected population growth, assumptions around growth in use per customer or customer class, large customer changes, wholesale contracts
Existing Generation	Additional capital improvement costs, operation and maintenance (O&M) costs, min/max capacity, heat rate, forced outage rate, maintenance schedules, production curves, fuel type, fuel price and contract prices
Historical and Future Energy Efficiency Savings	Energy and demand savings
Demand Response	Available capacity, limits on use, contract costs and terms.
New Generation	Capital costs, O&M costs, min/max capacity, heat rate, forced outage rate, daily availability, maintenance schedules, production curves, fuel type, fuel price, interconnection costs, siting considerations, water needs, transmission costs, and revenue requirements
Fuel Price Forecasts	Price forecasts for natural gas, fuel oil, coal, and nuclear fuel ranges
Regulations	Existing regulations and constraints, potential future regulations

DEMAND AND ENERGY FORECAST

INTRO TO INTEGRATED RESOURCE PLANNING

INPUTS AND ASSUMPTIONS – LOAD FORECAST

- The utility must have adequate resources to meet the power demands of its customers
  - Adequate defined by regulators based on probabilistic loads and probabilistic supply
  - In times of stress, we can call on support from the regional grid, but we must also be prepared to support our neighbors
- We must meet the peak load and have a plan to meet future peak with resource additions
- “Load” is sometimes used interchangeably with demand, which is a customer’s electric requirements both instantaneously and over time

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INPUTS AND ASSUMPTIONS – LOAD FORECAST

The Importance of Demand and energy forecasts for IRP

- Load forecasts are important planning tools
- Future resource mix in the most cost-effective portfolios is affected by
    a) Peak demand
    b) Energy sales
- Typically we present three forecast scenarios for use in the Integrated Resource Planning Process
    a) Future is unpredictable
    b) Scenario analysis provides insight into four-year action plan items

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INPUTS AND ASSUMPTIONS – LOAD FORECAST

Many factors influence electricity consumption:

a) Weather
b) Income/Employment
c) Population/household size
d) Regional economic growth
e) Changes in electricity-using products; efficiency gains vs. new toys
f) Prices
g) Commercial and Industrial output
h) In New Mexico, swamp coolers vs. refrigerated air
i) Electrification of the Economy – electric vehicles

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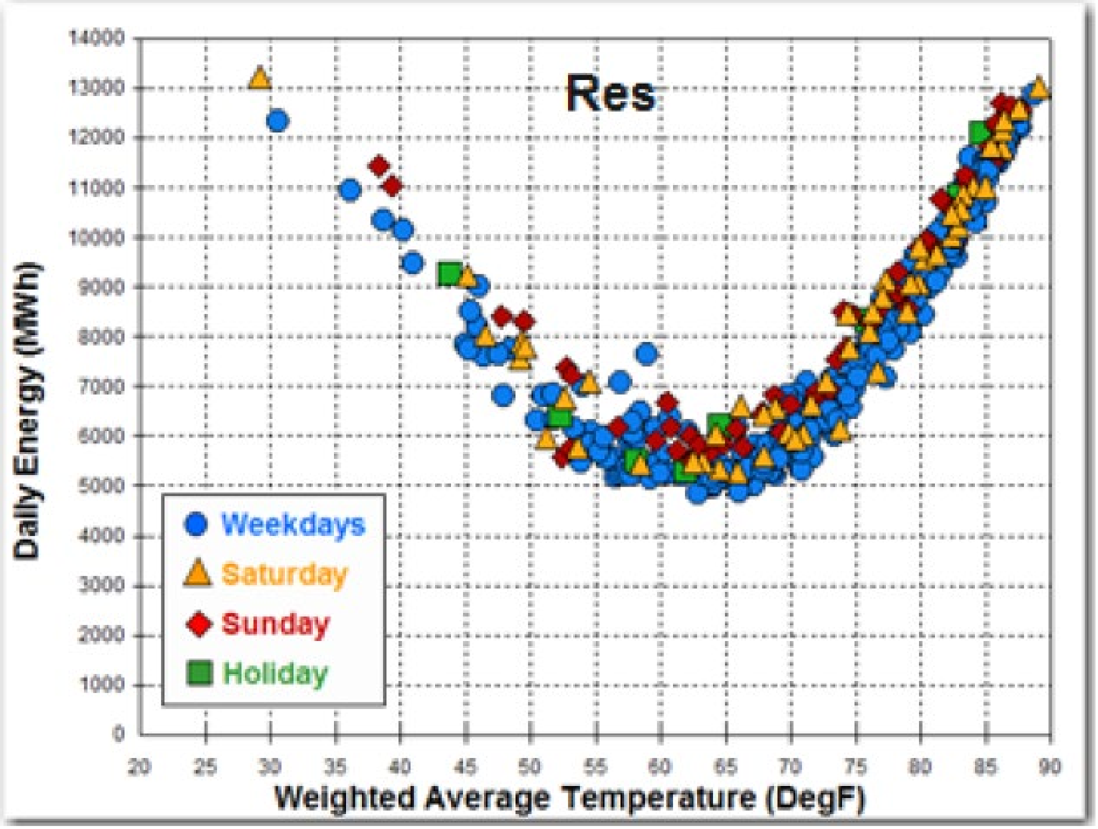
INPUTS AND ASSUMPTIONS – LOAD FORECAST



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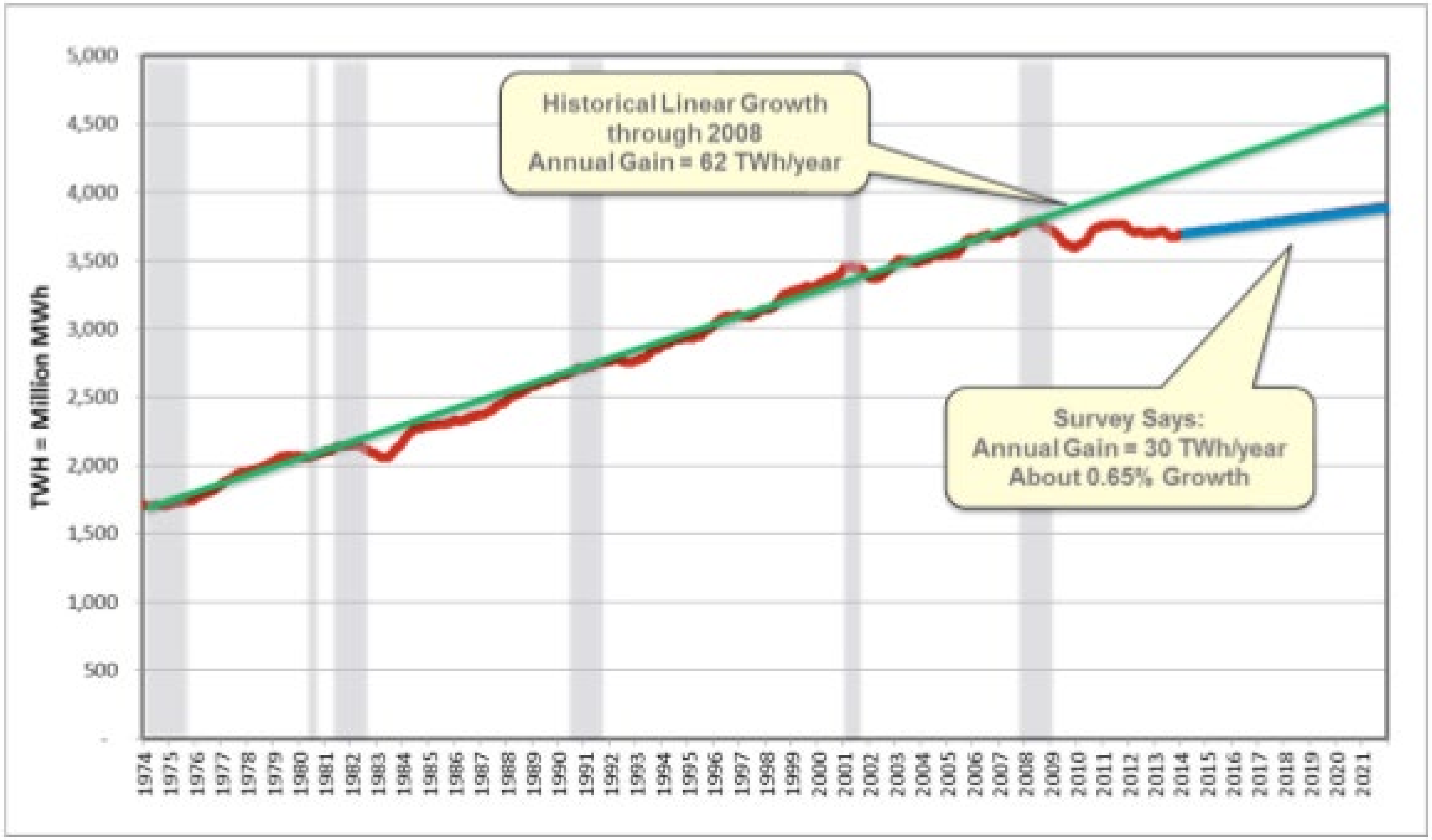
INPUTS AND ASSUMPTIONS – LOAD FORECAST



INPUTS AND ASSUMPTIONS – LOAD FORECAST

Load Forecasting Models – Typically Econometric/Statistical Models:

- Typically regression or neural network models or a combination thereof depending on the duration of the forecast
- Multiple Steps & Models for a single forecast
- Forecast based on “Normal” weather

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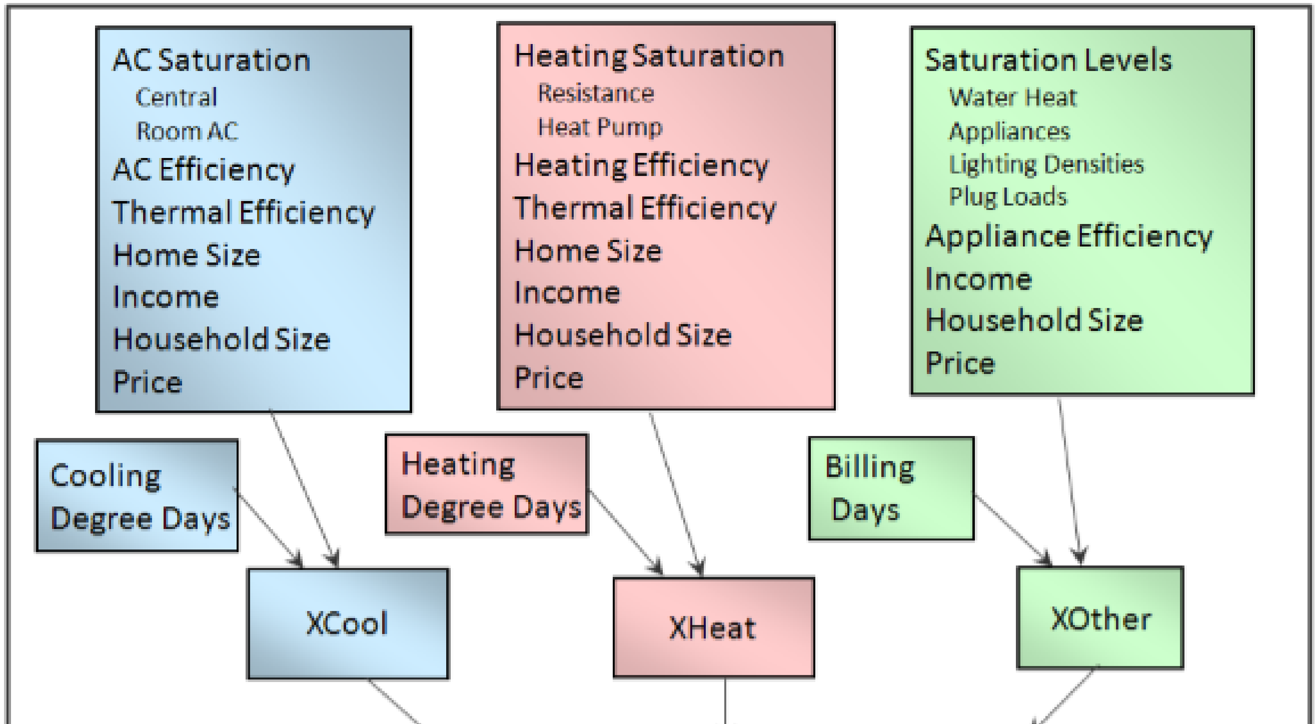
INPUTS AND ASSUMPTIONS – LOAD FORECAST



$$\text{Load}_t = a + b_c \times \text{XCool}_t + b_h \times \text{XHeat}_t + b_o \times \text{XOther}_t + e_t$$

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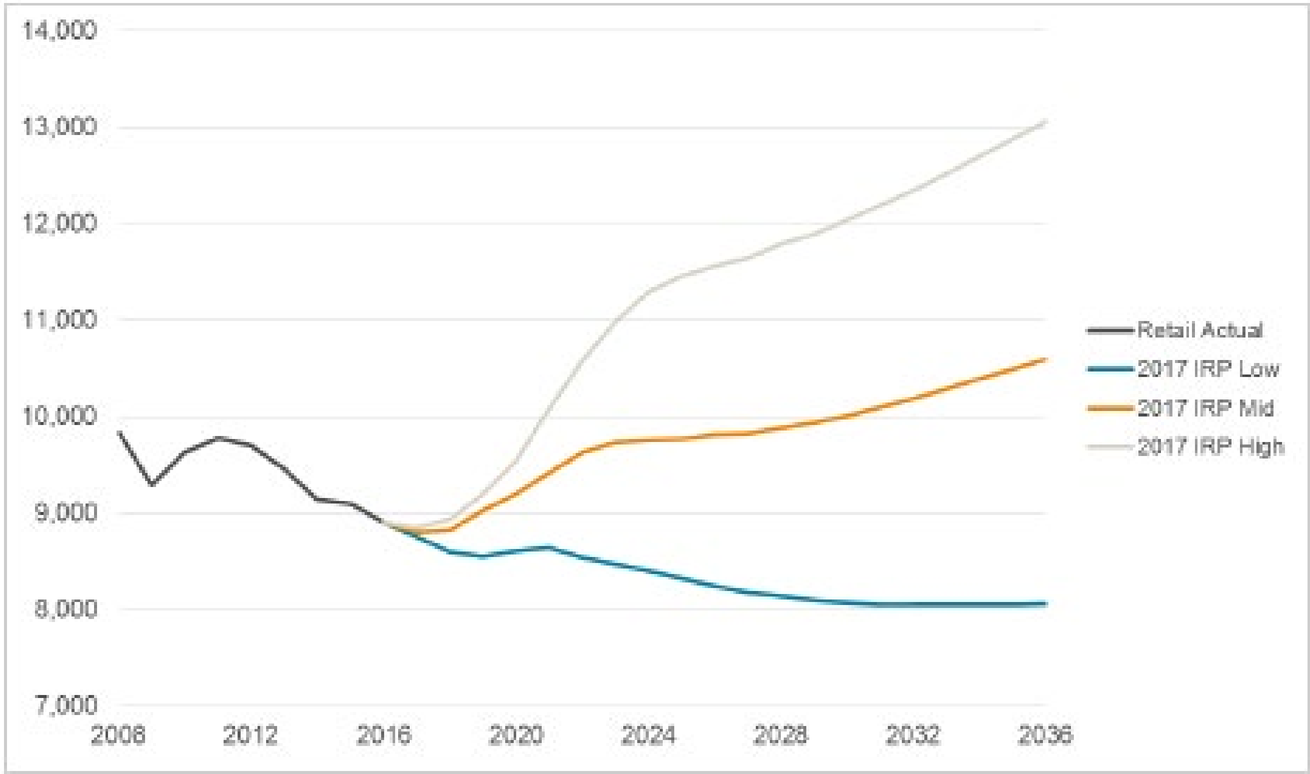
ENERGY FORECAST 2017 IRP



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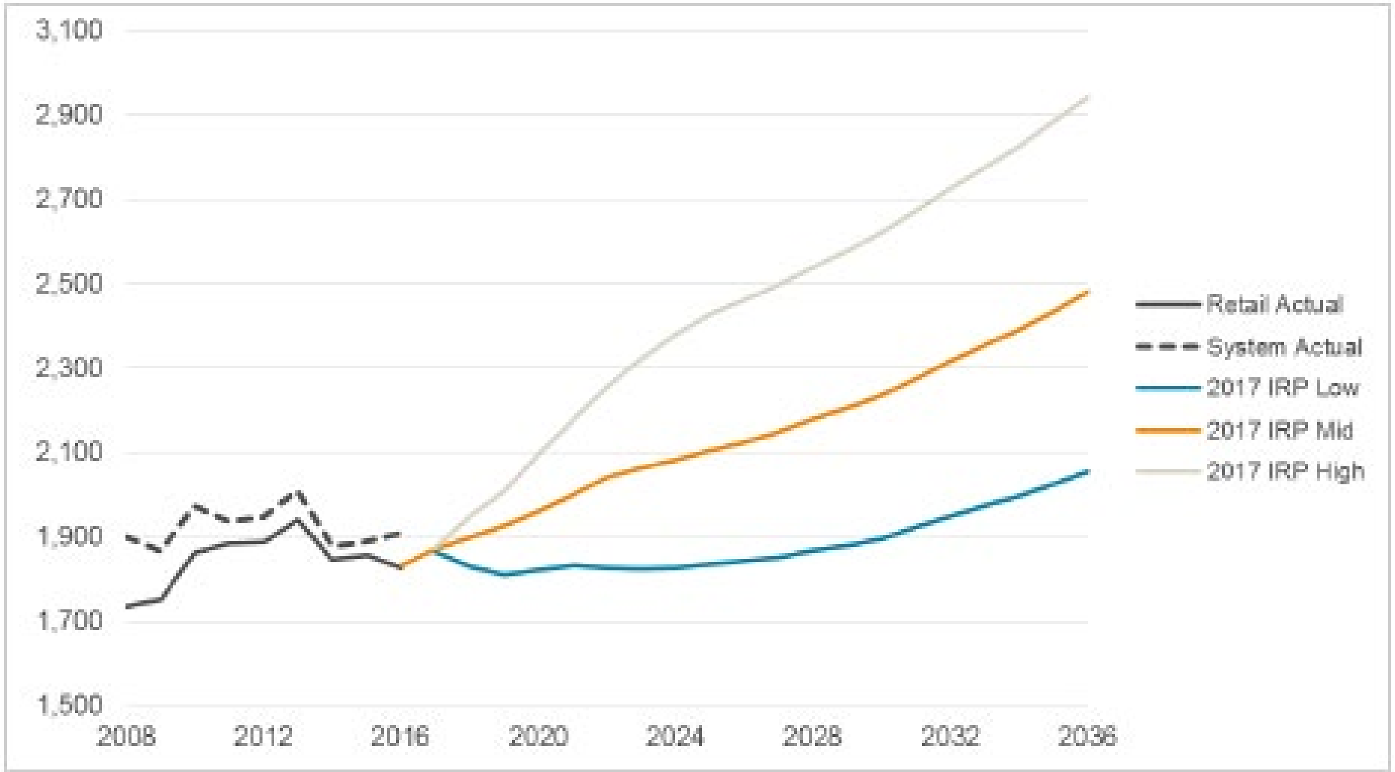
DEMAND FORECAST 2017 IRP



COMMODITY FORECASTS

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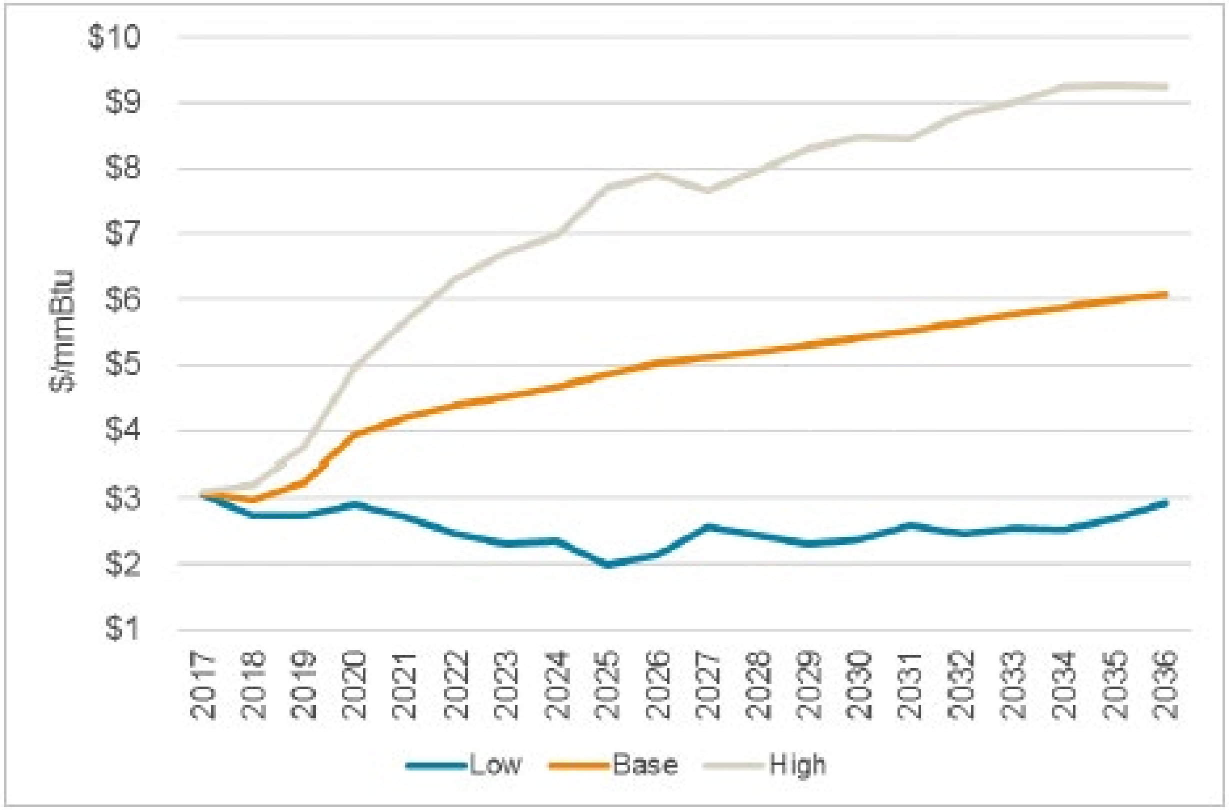
GAS PRICES 2017 IRP



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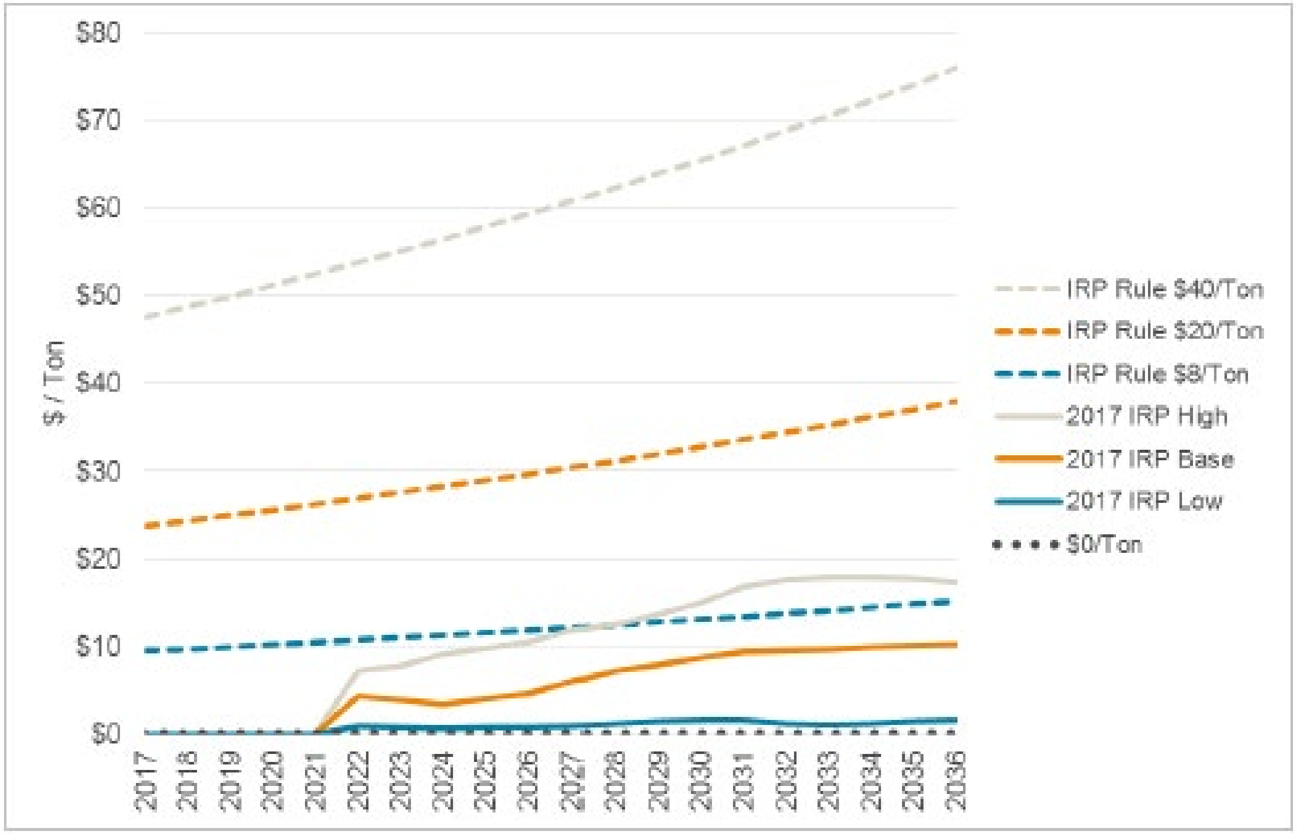
CO2 PRICES 2017 IRP



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CANDIDATE RESOURCES

INPUTS AND ASSUMPTIONS – THERMAL RESOURCE MODELS

Unit characteristics

- Capacity
- Must Run
- Minimum Stable Generation
- Variable O&M Cost
- Startup Cost (hot, warm, cold)
- Ramp Up Rate (hot, warm, cold)
- Ramp Down Rate
- Minimum Up Time
- Minimum Down Time
- Heat Rate
- Emission Rates

Fuel Data

- Fuel cost adders
- Fuel cost multipliers

Outages

- Planned
- Forced

Financial Assumptions

- Fixed & Capital Costs
- Tax Rates
- Project Life
- T&D Costs

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INPUTS AND ASSUMPTIONS – RENEWABLE RESOURCE MODELS

Unit characteristics

- Capacity
- ELCC
- Technology Type
- Variable O&M Cost
- Curtailable

Financial

- Fixed & Capital Costs
- Tax Rates
- Project Life
- T&D Costs

Output Profiles

- Historic
- Physics based
- Degradation

Outages

- Planned
- Forced

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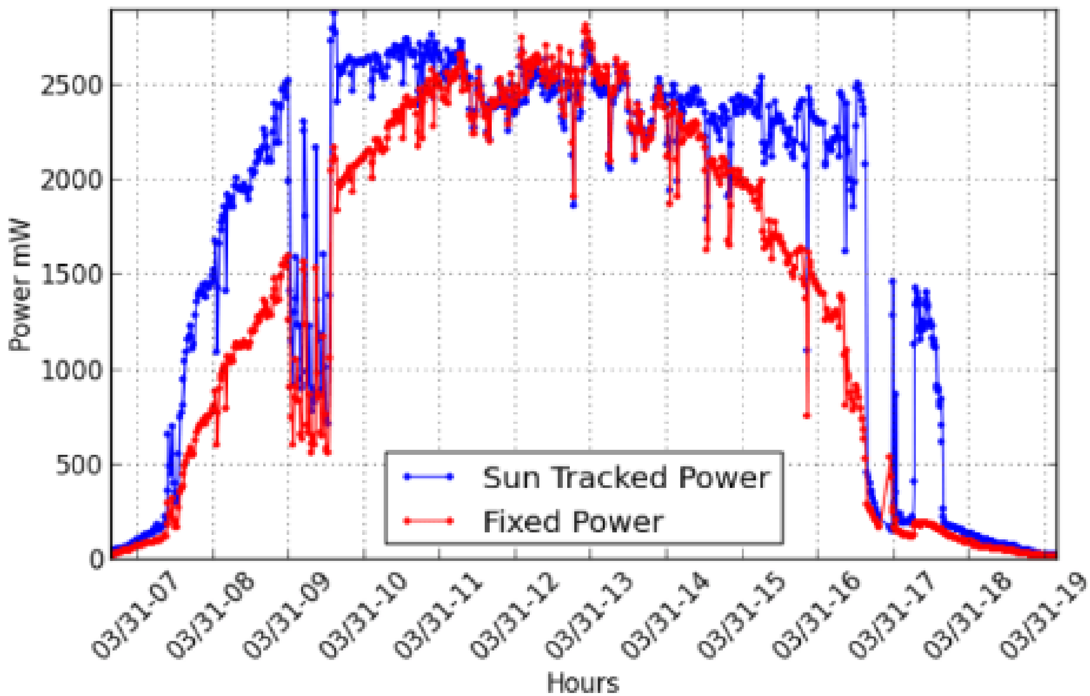
INPUTS AND ASSUMPTIONS – SOLAR CURVES



SunTracker Mar 31 (TP= 21.88Wh, UP= 17.52Wh +24.9%)

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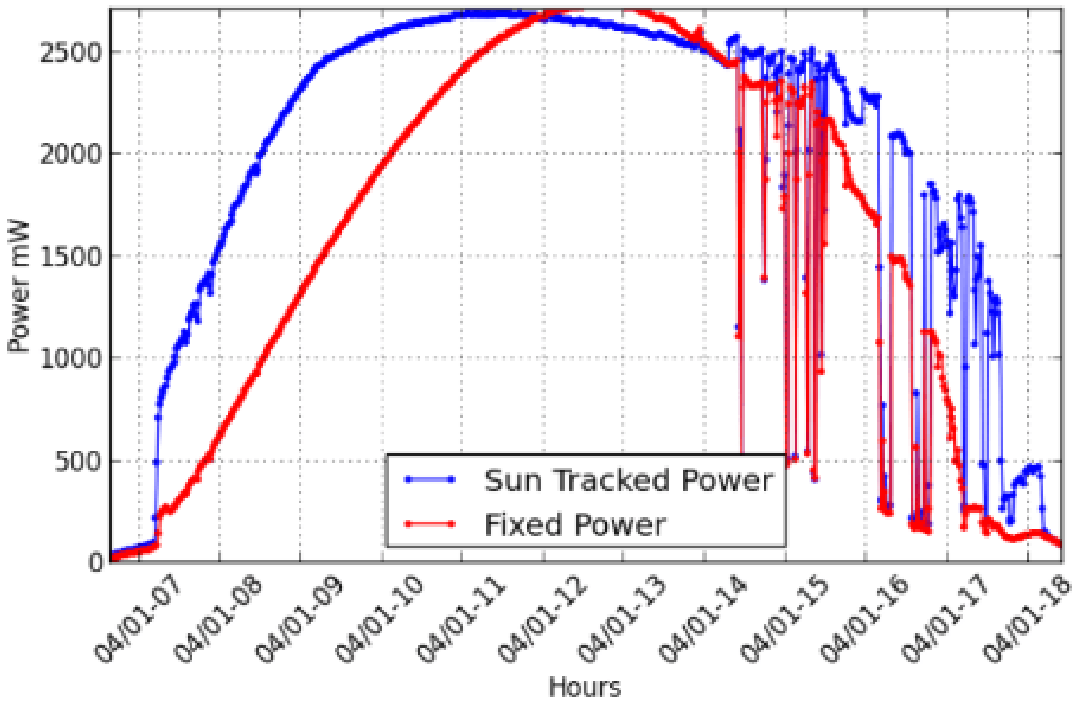
INPUTS AND ASSUMPTIONS – SOLAR CURVES



SunTracker Apr 1 (TP= 22.65Wh, UP= 18.30Wh +23.8%)

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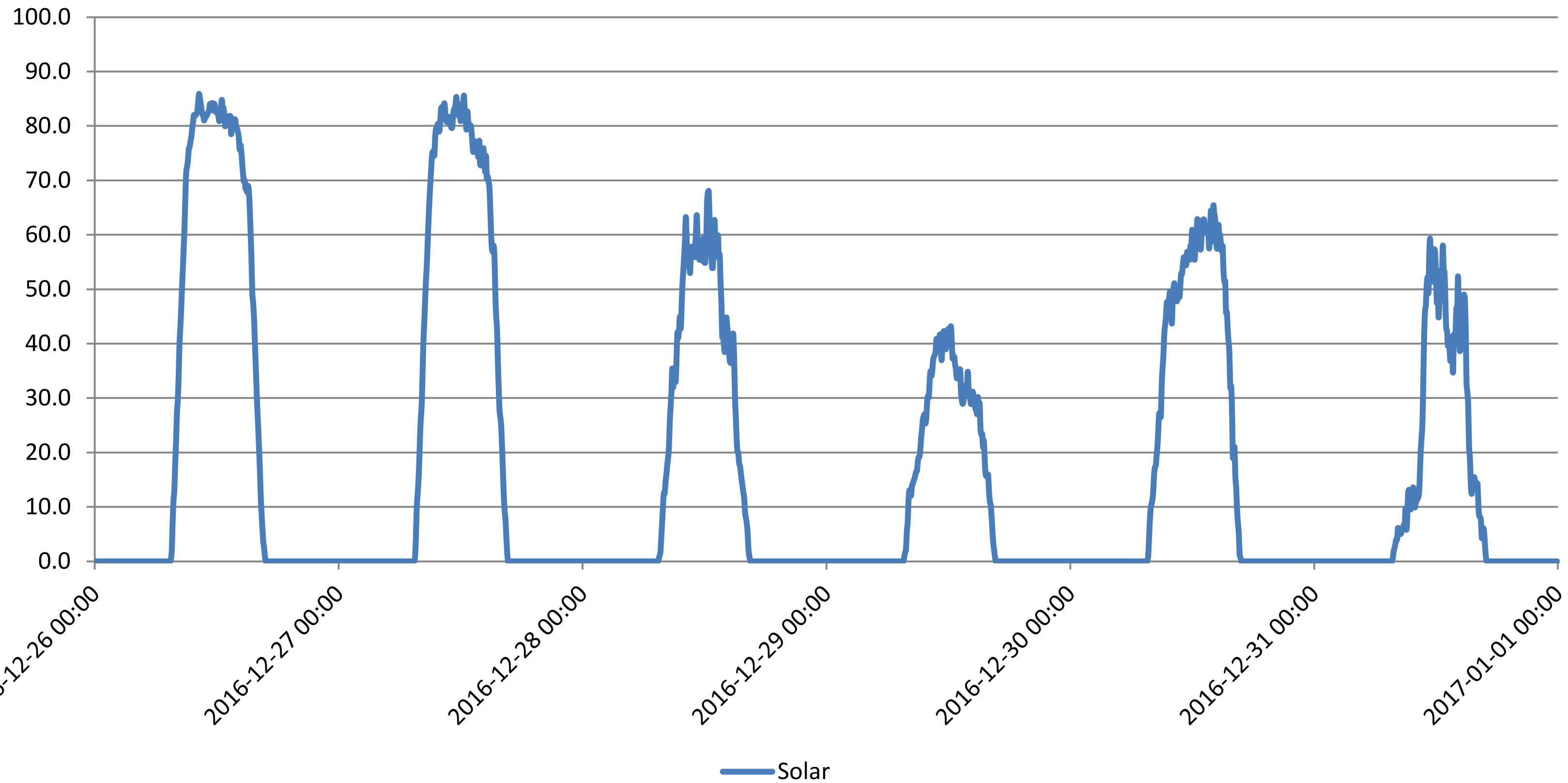
INPUTS AND ASSUMPTIONS – SOLAR CURVES



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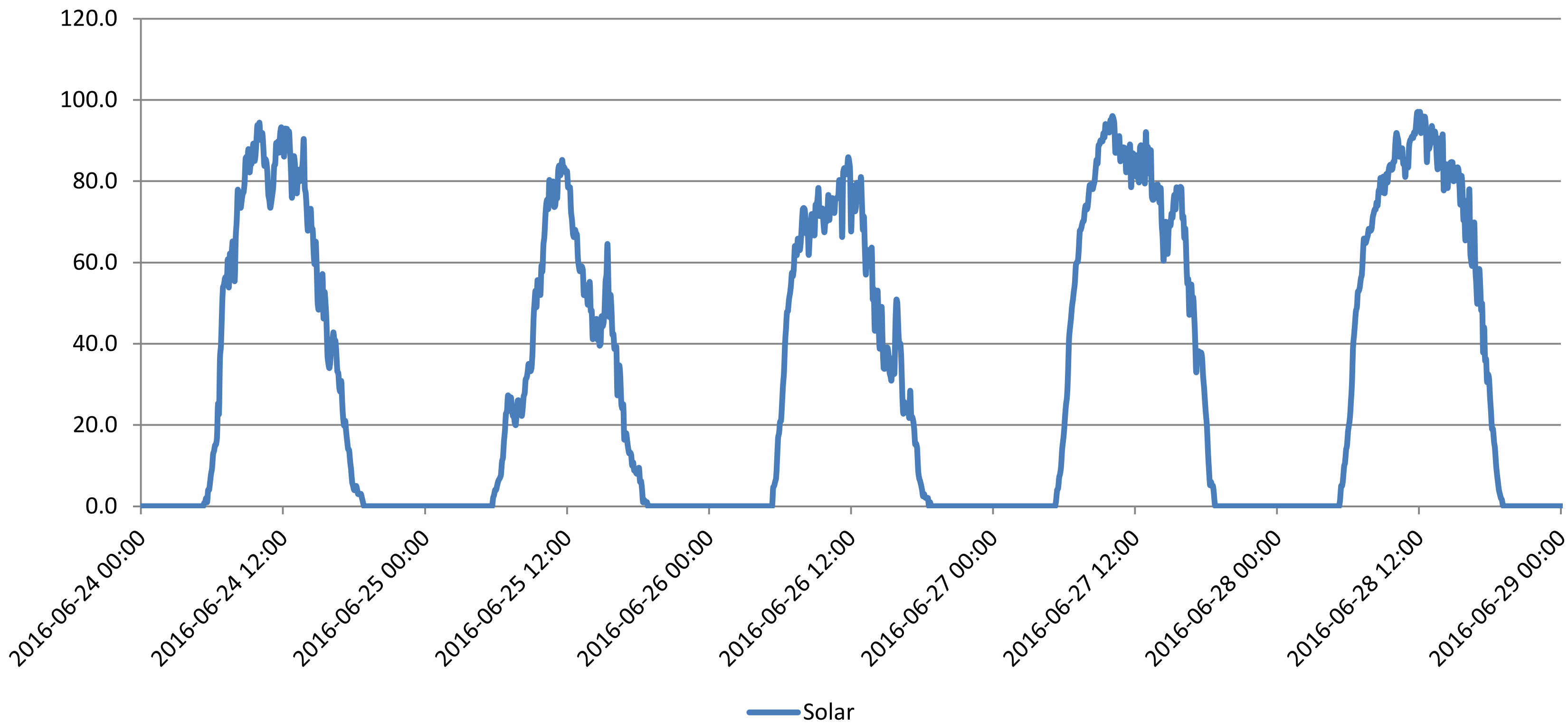
INPUTS AND ASSUMPTIONS – SOLAR CURVES



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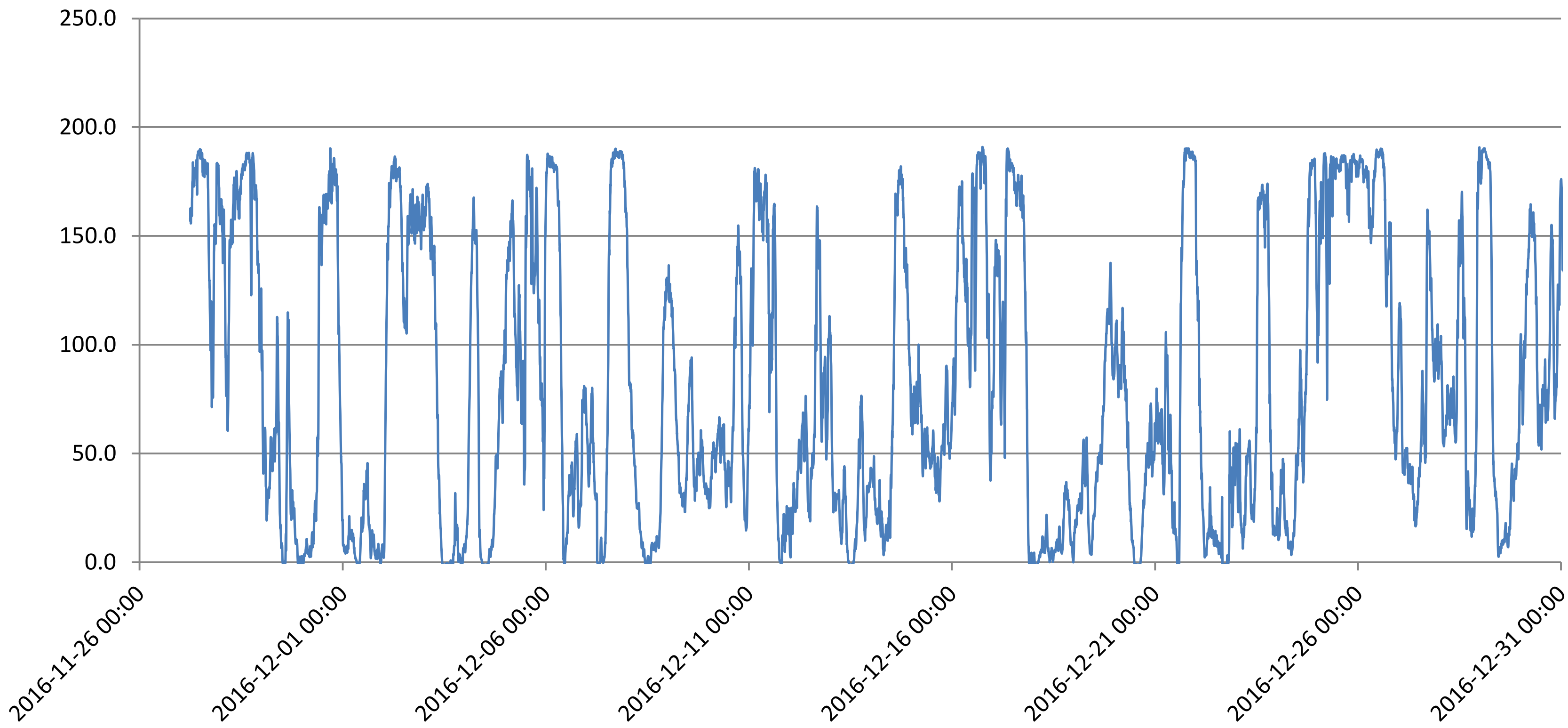
INPUTS AND ASSUMPTIONS – WIND OUTPUT NMWEC



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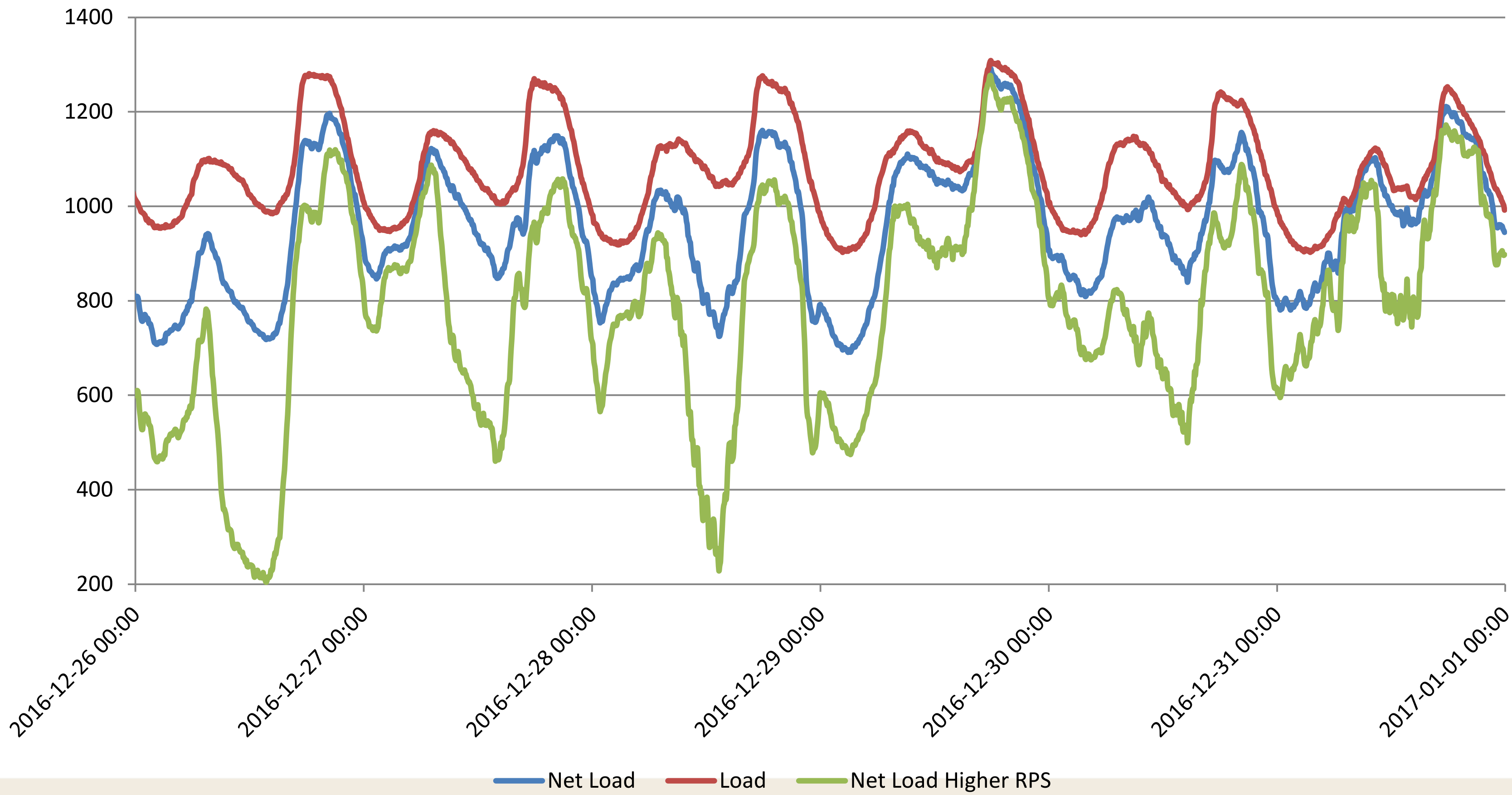
INPUTS AND ASSUMPTIONS – NET LOAD



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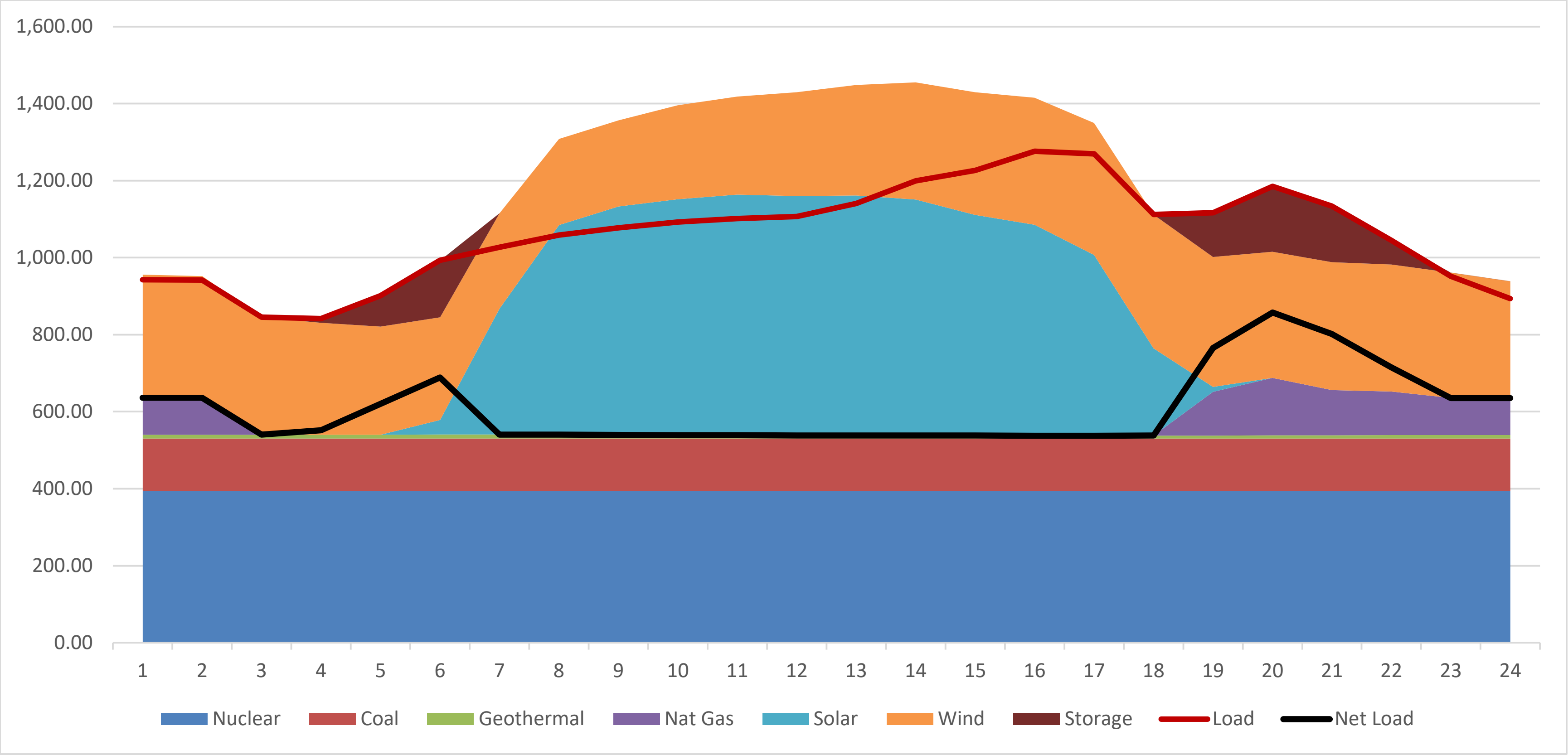
INPUTS AND ASSUMPTIONS – NET LOAD



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STORAGE

Storage Technology	Expected Life	Description	Comments
Compressed Air	15-20 Years	Uses off-peak energy to compress air for storage; suitable geologic space required for large scale	Requires geology with good containment (salt caverns, underground mines, etc.); mature technology
Flywheel	20+ Years	Mechanical devices that spin, storing rotational energy that is released when needed	High power density, relatively low energy capacity (short powerful discharge)
Pumped Hydro	20+ Years	Water lifted off-peak to a reservoir above a conventional hydro power plant	Limited available sites; proven technology
Other	Varies	Includes ice and other thermal storage	

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STORAGE

Battery Lead-Acid	5-15 Years	The most common battery; a mature technology, available since the 19th century	Proven workhorse, but in utility application has low depth of discharge, poor operation in partial charge and short lifespan;
Battery Lithium Ion	5-15 Years	Most common battery type for current utility scale storage installations. Used extensively in electronics.	Electric vehicle and utility applications
Battery Sodium	5-15 Years	Classified as high temperature; generally maintained at temperature of 300°C or more	High cost with support system requirements (high temperature)
Battery Zinc	5-15 Years	Zinc batteries have a number of potential advantages, but are not in widespread commercial deployment	Currently unproven at commercial cost level requirements
Flow Battery	15-20 Years	Rechargeable and akin to fuel cells; two chemical solutions allow current to pass thru a separating membrane	Scalable, some concerns with balance of system costs; high potential for future advances

TRANSMISSION

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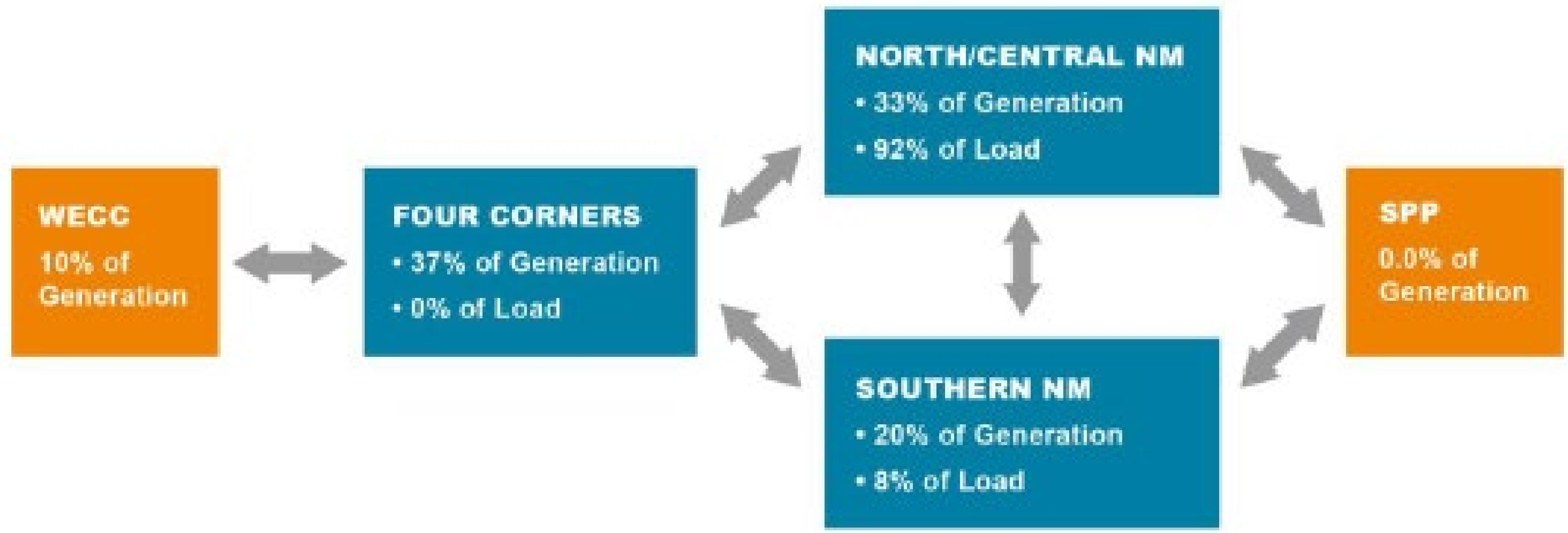
TRANSMISSION



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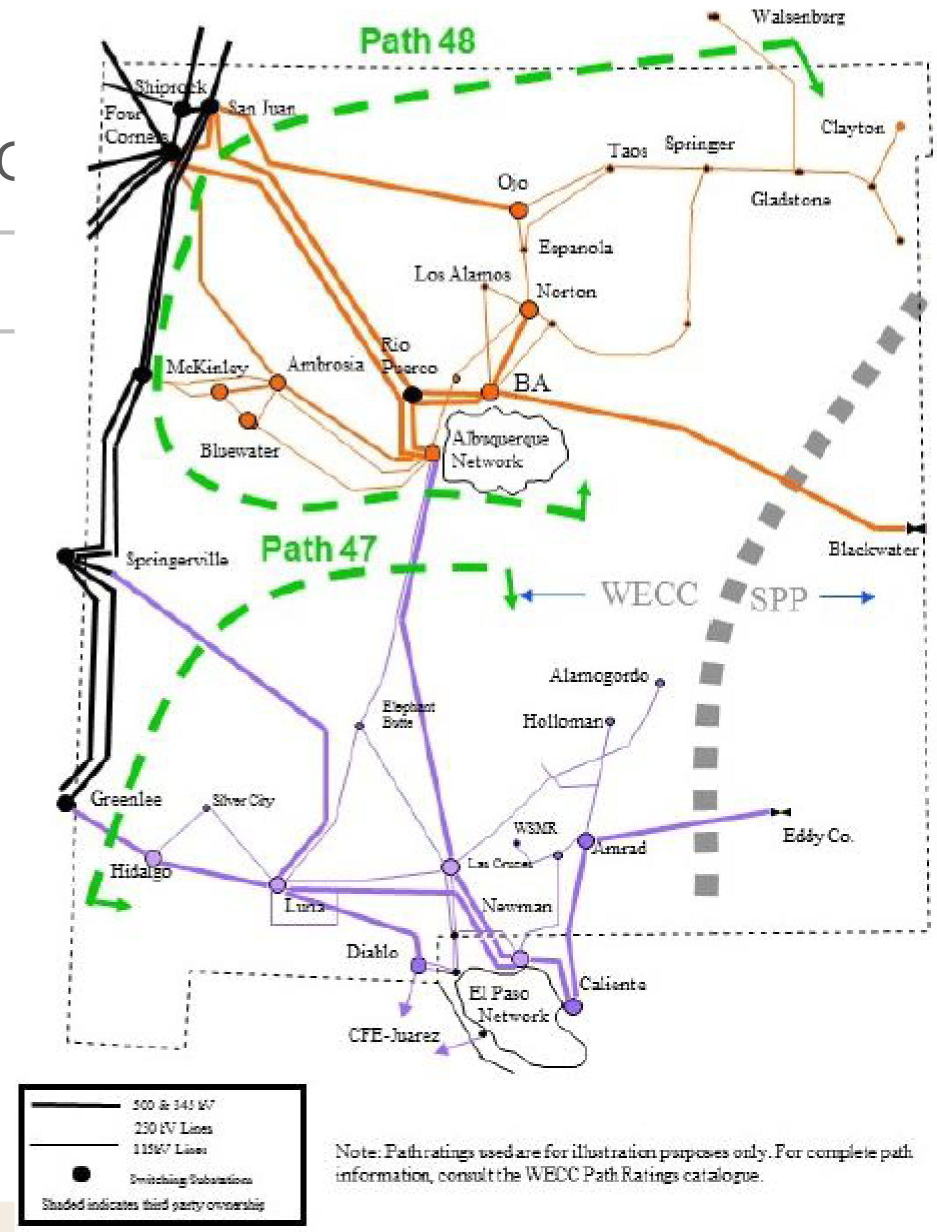
TRANSMISSION

PNM's capacity in Path 47 and Path 48 is fully committed. Transferring existing firm resources and any new resources sited that require transmission along these paths will need to include a transmission system expansion.

Siting, permitting, cost, and construction timelines for new transmission line projects will continue to be a challenge.



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DEMAND SIDE RESOURCES

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DEMAND SIDE RESOURCES – ENERGY EFFICIENCY

Selected End-Use Electric Energy Efficiency Measures

Residential Sector

- Higher-efficiency appliances (air conditioners, refrigerators, stoves, water heaters, electronic devices)
- Devices that save hot water (efficient washing machines, plumbing fixtures)
- Compact fluorescent lamps
- Automatic lighting controls
- Building envelope improvements (insulation, window improvements) to reduce cooling, heating, and sometimes lighting needs.

Commercial/Institutional Sectors

- Higher-efficiency air conditioning, refrigeration equipment
- High-efficiency fluorescent bulbs, lamp ballasts, and lighting fixtures
- Lighting, cooling, space heating, and water heating controls
- High-efficiency office equipment
- Building envelope improvements
- High-efficiency electric motors, drives, and controls

Industrial Sector

- Process improvements
- High-efficiency electric motors, drives, and controls
- Applicable commercial/institutional sector measures

Other Sectors

- High-efficiency cooling and refrigeration equipment for the agricultural sector
- High-efficiency electric motors, drives, and controls for mining and transport applications
- High-efficiency lighting products for street lighting

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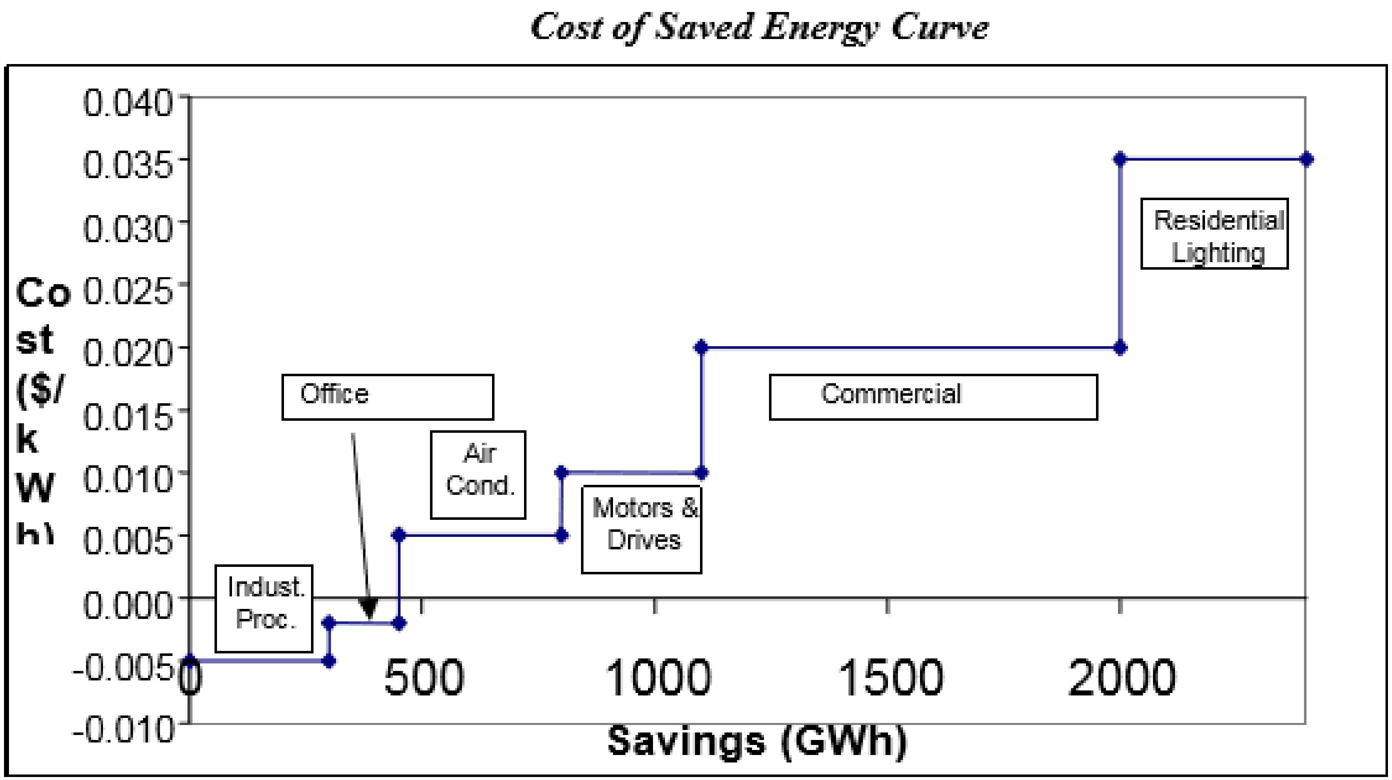
DEMAND SIDE RESOURCES – ENERGY EFFICIENCY



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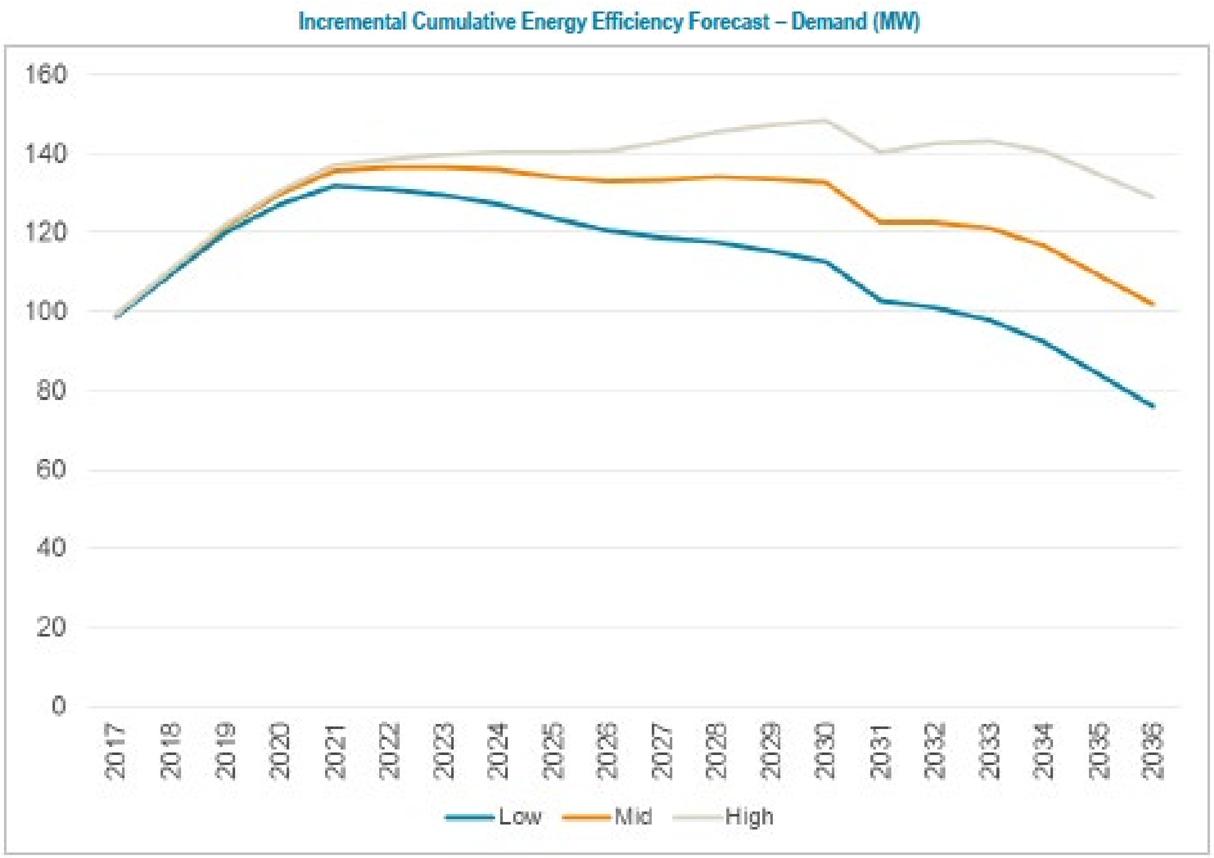
INPUTS AND ASSUMPTIONS – DEMAND SIDE MEASURES



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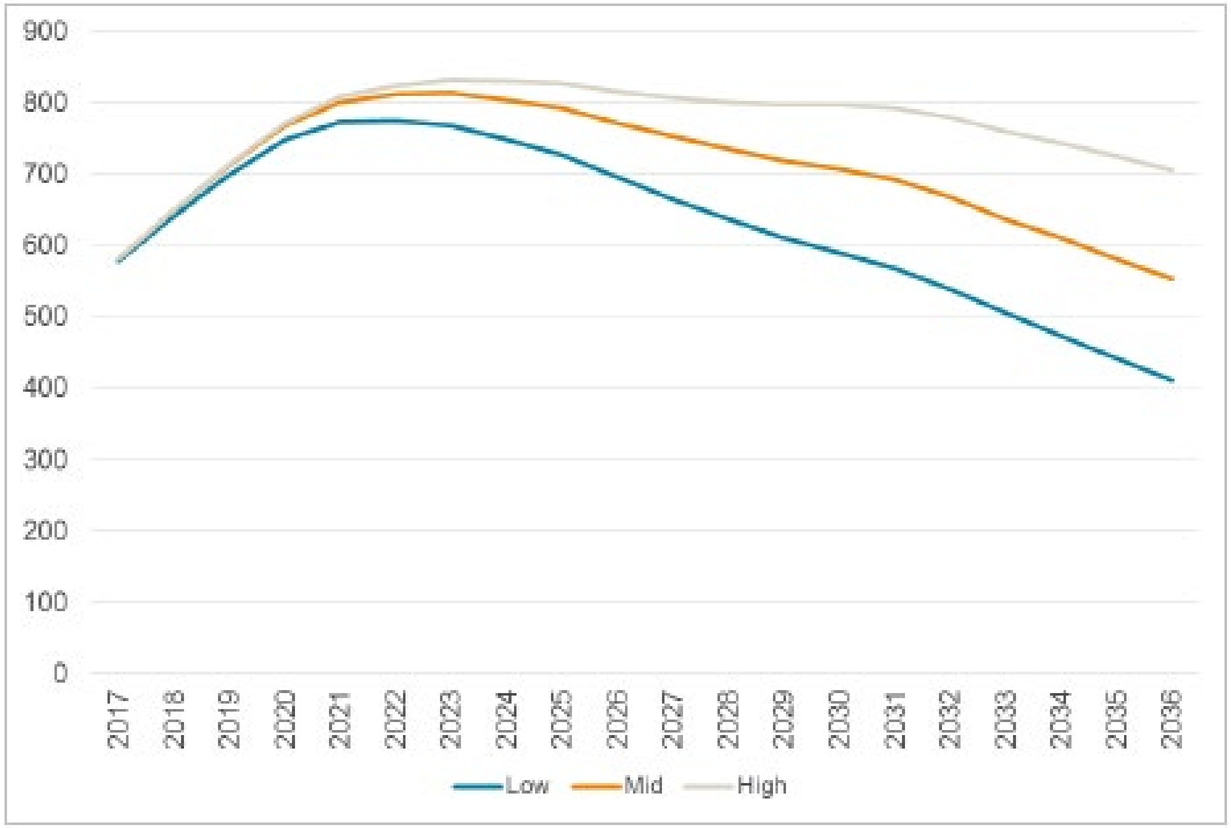
INPUTS AND ASSUMPTIONS – DEMAND SIDE MEASURES

Incremental Cumulative Energy Efficiency Forecast – Energy (GWh)



INPUTS AND ASSUMPTIONS – DEMAND SIDE MEASURES

In addition to energy efficiency, there are also other demand side resources

- Demand Response
  - Peak Saver
  - Power Saver

- Interruptible Loads
  - Flexibility and response time is key
  - Can offer buy through

SYSTEM REQUIREMENTS

INPUTS AND ASSUMPTIONS – A/S AND RESERVE REQUIREMENTS

PNM is its own Balancing Area Authority

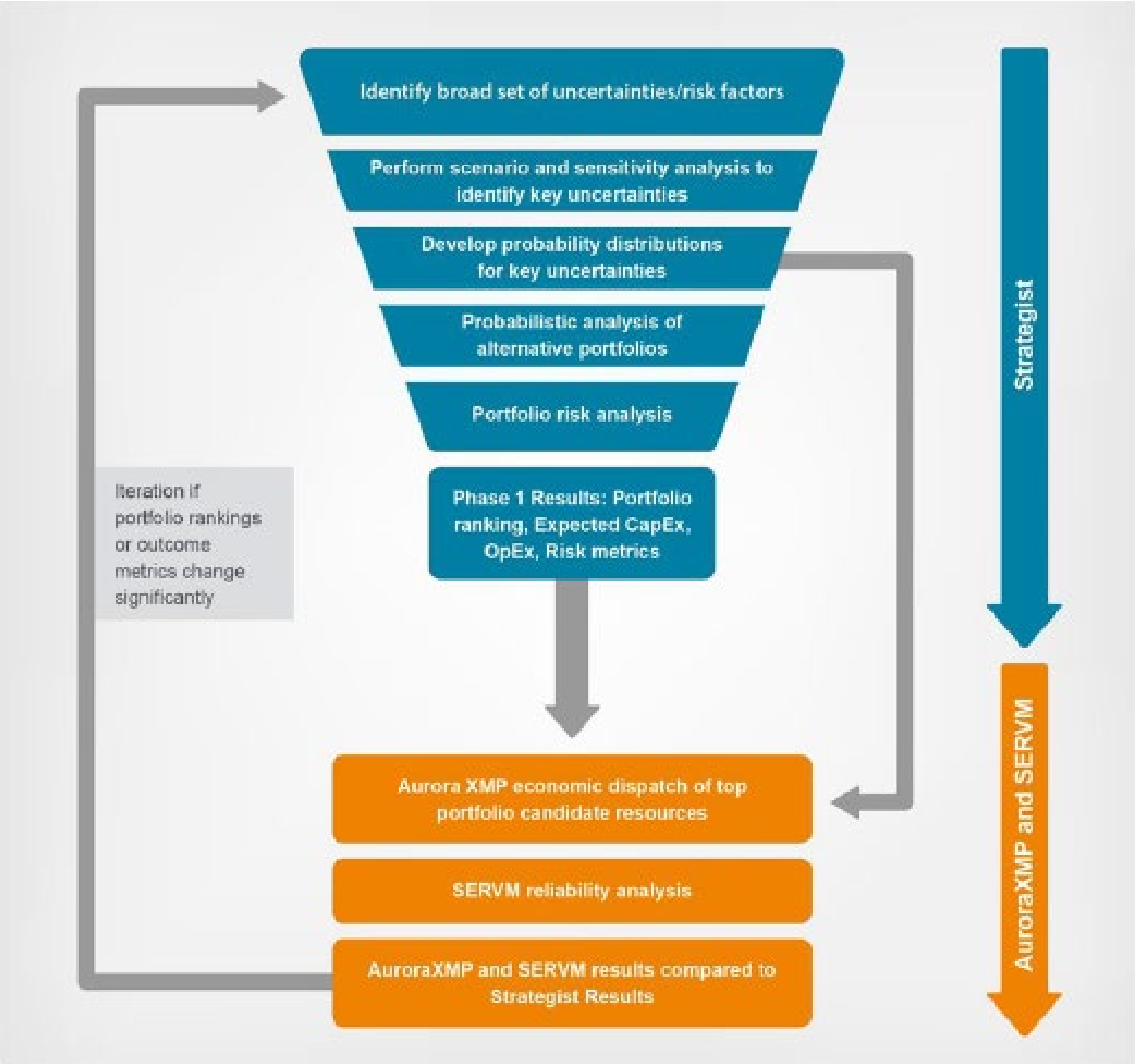
- Models take as inputs reserve requirements and A/S
  - Planning Reserve Margin
  - Spin
  - Non-Spin
  - Regulation Up
  - Regulation Down
- Production Cost Models Co-optimize the Unit Commitment and Dispatch with Ancillary Services

ANALYSIS FLOW, SCENARIO DEVELOPMENT, SENSITIVITY & RISK ANALYSIS

INTRO TO INTEGR

ANALYSIS

Note that we are now using EnCompass instead of Strategist and AuroaXMP

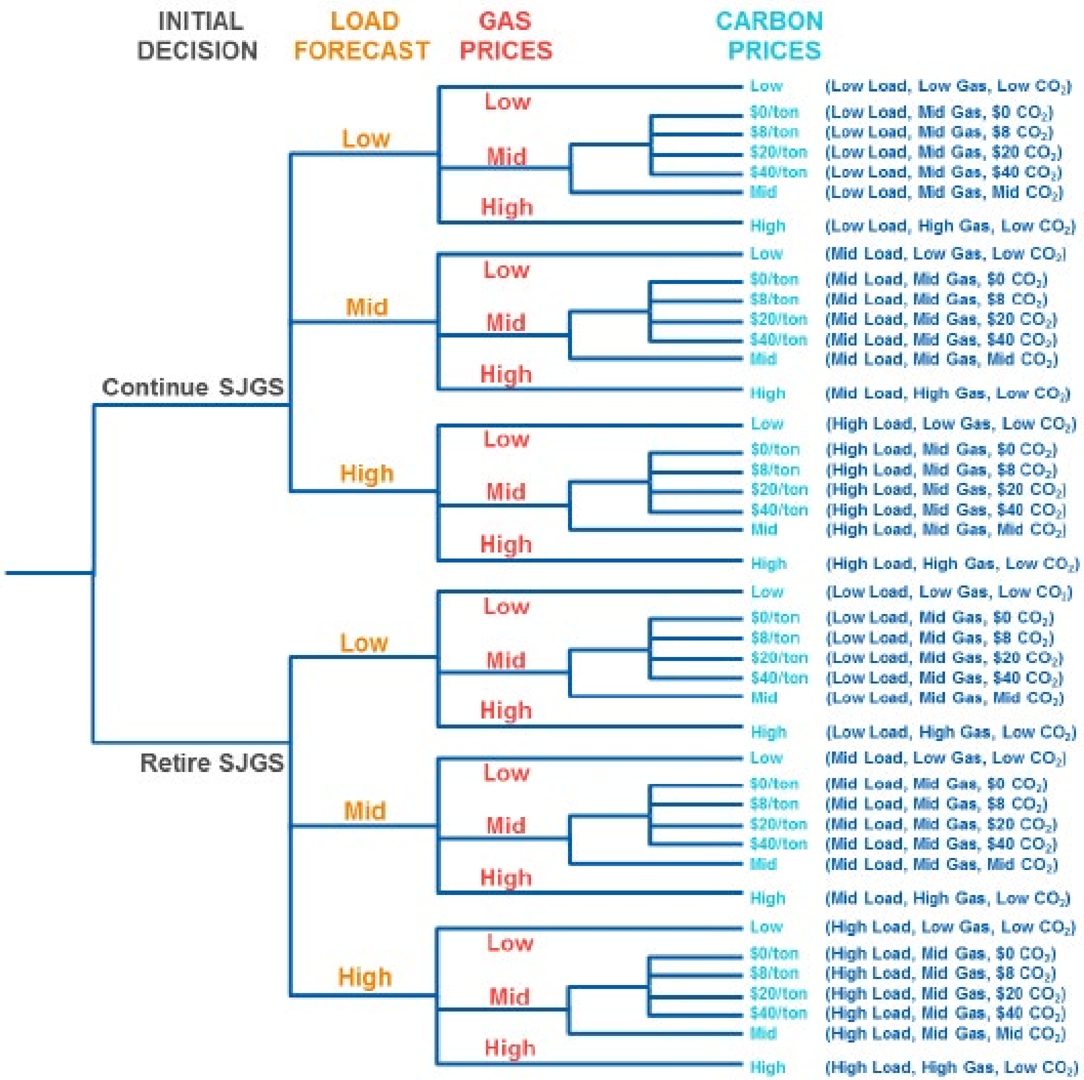


INTRO TO INTEGRATED

SCENARIO ANALYSIS

Scenario Tree from 2017 IRP

For the 2020 IRP PNM has already committed via the 2016 Rate Case stipulation to examine early exit of its share of Four Corners in 2024 and 2028 along with PNM's current plan to exit in 2031.



RISK ANALYSIS

Many Ways to Examine Risk

- Scenario Analysis / Extreme Scenarios

- Monte Carlo / Stochastic Analysis
  - Price – Commodities (Fuel, C02, Renewable Output, etc.)
  - Conditions – Load, Weather, Renewable Output, Outages, etc.

- Reliability Analysis
  - Planning Reserve Margin
  - LOLE
  - Sub-hourly analysis

FINAL PRODUCT

INTRO TO INTEGRATED RESOURCE PLANNING

THE IRP FILING

- Throughout the IRP process, public participation is important to provide input for the assumptions used in the scenario analysis.
- The IRP process requires identifying one resource portfolio, defined as the "most cost-effective portfolio," and the development of a four-year action plan to begin implementing the portfolio. After filing the IRP, PNM will issue an RFP to solicit proposals for new resources to test the resource assumptions and MCEP analysis provided in this report
- The IRP will present a four-year action plan that captures and describes the actions PNM must take to create the MCEP and to take advantage of potential future opportunities identified in the MCEP creation process
- PNM will file its 2020 IRP July 1, 2020 for NMPRC Acceptance

FUTURE MEETINGS

INTEGRATED RESOURCE PLAN SCHEDULE

THREE PUBLIC ADVISORY PHASES, ONE DEADLINE

- July – October: Build assumptions and discuss scenarios and sensitivities
- November – February: Discuss analysis plan and discussion of findings
- March – June: Discuss draft report
- July 1, 2020 – File report documenting the Plan and process with New Mexico Public Regulation Commission

NEAR TERM SCHEDULE

TENTATIVE MEETING SCHEDULE THROUGH JANUARY

July 31:	Kickoff, Overview and Timeline
August 20:	The Energy Transition Act & Utilities 101
August 29:	Resource Planning Overview: Models, Inputs & Assumptions
September 6:	Transmission & Reliability (Real World Operations)
September 24:	Resource Planning "2.0"
October 22:	Demand Side/EE/Time of Use
November 5:	Load & CO2 Forecast
December 10:	Technology Review/ Finalize scenarios based on technical adv
January 14:	Deadline for Scenario Requests

MAKE SURE WE HAVE UP TO DATE CONTACT INFORMATION FOR YOU

www.pnm.com/irp for documents

irp@pnm.com for e-mails

Register your email on sign-in sheets for alerts of upcoming meetings and notices that we have posted new information to the website.

Meetings Scheduled:

Friday, Sept. 6, 2019, 1:30 p.m. to 4:30 p.m.

Tuesday, September 24, 2019, 1:30 p.m. to 4:30 p.m.

Thank you

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Talk to us.

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