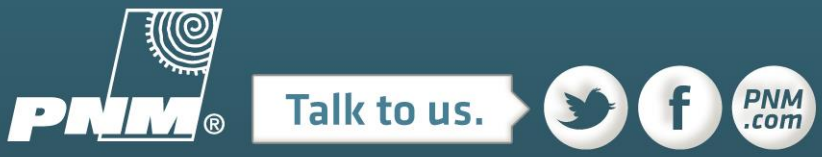
PNM 2020-2039 Integrated Resource Plan

JANUARY 14, 2020



AGENDA

2020-2039 IRP PUBLIC ADVISORY MEETING #7: TECHNOLOGY ADVISORY COUNCIL

- Welcome and Introductions
- Safety and Ground Rules
- Report on IRP Technology Advisory Council – Jon Hawkins
- Introduction of Scenario Modelling
- Future meeting topics and schedule

SAFETY AND LOGISTICS

- In case of an emergency, please follow any broadcast instructions and exit signs.
- We are required to participate in drills, just as in the case of a real emergency.
- Restrooms: Exit door to the north and down the hall.

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

- We ask that you complete the Questions/Comments sign-up sheet in advance of requesting the microphone to pose your written question or comment. All questions will be logged
- 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).

ENERGY STORAGE WORKSHOP AT THE NMPRC

For those interested, third in a series of workshops on energy storage being held at the PRC today, Tuesday January 14th, 2020 from 11:00 a.m. to 1:00 p.m. This workshop will take place in the 4th Floor Hearing Room (Open Meeting Room) of the Old PERA Building located at 1120 Paseo De Peralta, Santa Fe, NM 87504.

The topics of this workshop will be “Procurement, Commissioning, and Safety,” with Sandia’s ES projects manager Dan Borneo and “Procurement Mandates”, with Sandia’s policy lead Will McNamara.

PLEASE BE ADVISED, DUE TO UNFORESEEN NETWORK OUTAGES, THERE WILL NOT BE A LIVE-STREAM OPTION AVAILABLE FOR TOMORROW'S WORKSHOP!

PNM INTEGRATED RESOURCE PLAN TECHNOLOGY ADVISORY COMMITTEE RFI UPDATE

JON HAWKINS
PNM INNOVATION & COMMUNICATION

- What is it?
  - The utility industry in general is moving very quickly with new technologies being introduced very rapidly
  - To the extent that these technologies can help PNM meet its goal of 100% carbon free energy by 2040, we felt it was important to canvas the industry to see if there were technologies that were not currently included in our planning process.
  - To facilitate this, we put together an external team of industry experts to help us evaluate information provided back to us from vendors regarding new technology options

IRPTECHNICAL ADVISORY COMMITTEE

- Technical Advisory Team
  - Jon Hawkins – PNM, Associate Director Innovation and Communication (facilitator)
  - Murali Bagu – National Renewable Energy Laboratory
  - Charly Hanley- Sandia National Laboratory
  - Olga Lavrova – New Mexico State University
  - Jeremy Lewis – State Land Office, Director of Renewable Energy
  - Doug Howe – Western Grid Group

PROCESS USED

- A request for information (RFI) was developed by the Technical Advisory group.
  - The RFI stated that the information provided was for modeling purposes only
  - Any procurement of any technology would go through a separate and competitive future request for proposals (RFP) if there was interest in the particular technology and at such time as PNM needs the resource.
- The RFI was sent to various vendors of new types of technology that had contacted PNM in the recent past on November 11, 2019 with a response date of November 27th. An extension was allowed to December 4th for all vendors.
- The notification also went out via Power Advocate, which would then send notifications to any PNM vendor that has responded to past procurement efforts.
- Finally, a press release was sent out on November 12, providing a link to the RFI such that any company could submit a response to the RFI
- The Technical Advisory Team met last week to develop preliminary recommendations based on the RFIs received.

RFI CONTENTS – GENERAL INFORMATION

- General Information
  - Description
  - Physical space
  - Other customer benefits
  - Security Implications for technology and/or control system (cyber/physical)
  - Environmental management systems/policies
  - Raw materials – Environmental justice/black market concerns
  - Disposal/re-purpose at end of life
  - Waste Streams/Hazardous Materials
  - General regulatory requirements
  - Health, safety, emergency response requirements and studies
  - Animal and/or avian interactions

RFI CONTENTS – TECHNOLOGY READINESS

- Utilized a Technology Readiness Level (TRL) aligned with that used at Sandia National Laboratory
- Technology Readiness
  - TRL 1 (Basic Principles) to TRL 9 (Commercially available and operational)
  - Self rating with guided verification questions
  - Development timeline if less than operational
  - Potential barriers to continued development
  - Metrics
  - Integrations with other systems
  - References for various stages of readiness (articles, websites, media reports, grant applications and/or results)
  - Utility References

RFI CONTENTS – OPERATING CHARACTERISTICS

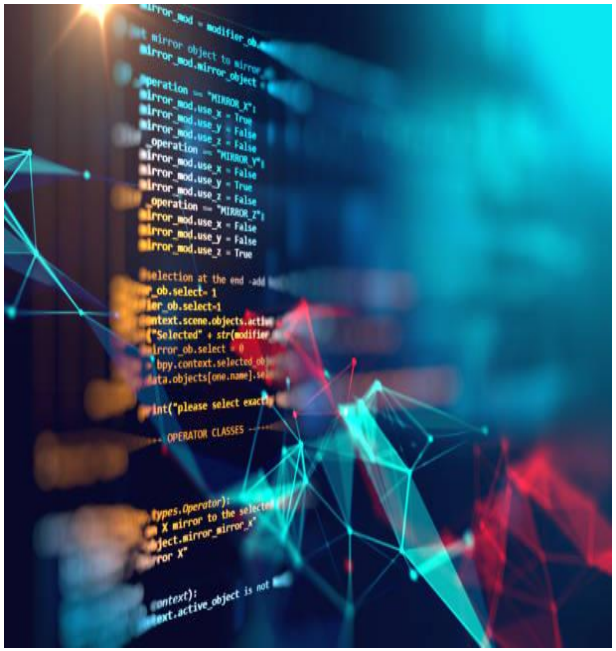
- The operating characteristics tended to look very “fossil fuel” like, however it was explained as part of the RFI to only provide information that was applicable to their technology
- Asked to discuss in terms of any applicable: capacity, energy, ancillary services
- Parameters were asked for to get data that could be used in support of modeling efforts in an mixed integer linear optimization program
- If it was not able to be modeled in optimization, it was asked if they could provide any model available currently available in other formats (Python, MATLAB, etc.)
- All operating characteristics were defined in Appendix
- Operating characteristics
  - Generation characteristics such as nameplate rating, ramp rates, start times, must run status, heat rates if applicable, emissions, water usage
  - Costs including capital costs, insurance, taxes, fuel, maintenance costs, and tax credits
  - Availability including time to construct, forced outage rates, mean time between failures, maintenance schedules, forced operating ranges, degradation, historical data if available

RFI CONTENTS – OPERATING CHARACTERISTICS (CONT.)

- Operating Characteristics
  - Flexibility
  - Inertia
  - Resiliency
  - Curtailment
  - Variability
  - Spinning reserve
  - Quick Start
  - Regulation up or down capability
  - Fuel parameters such as cost, primary fuel, start up fuel
  - Start/stop parameters such as hot start/cold start energy, cold start costs, shutdown costs, heat rate for fuel source
  - Generation curves if available
  - Hourly output characteristics
  - Transmission system support

RFI CONTENTS – SOFTWARE

- Software as a resource
  - Description and how it supports system operation
  - Integration needs with other systems
  - Software release schedules
  - Licensing costs
  - Cost model
  - Implementation timeline
  - On premise or cloud based
  - Cloud security if applicable (COBIT, NIST, ISO 27001/27002)
  - Regulatory standards required
    - PCI
    - HIPPA
    - NERC CIP
  - Adaptability for future requirements/avoidance of obsolescence



PRELIMINARY RESULTS

- In total there were 12 that ultimately submitted a response
  - Electriq – Customer side energy storage
  - Emera – Microgrid
  - Embala – Distributed Energy Resource Management System (DERMS)
  - Bright Energy – Concrete Thermal Energy Storage and Cryogenic Carbon Capture
  - ESS – Iron Flow battery
  - Energy Vault – Gravitational Potential Energy
  - Grid Flex – Pumped Hydro
  - Kinetic Power – Pumped Hydro
  - NuScale – Small Modular Nuclear Reactor
  - Microgrid Systems Laboratory (MSL) – no technology, but advocacy statement toward inclusion of microgrids as a resource
  - Packetized Energy – Demand Response
  - Shifted Energy – Demand Response
- Review was a preliminary review and recommended for further review and whether to consider as a new or existing technology
- We will be asking a few of the vendors for presentations
- Because this process does not consider vendor, we did group some like technologies

ELECTRIQ

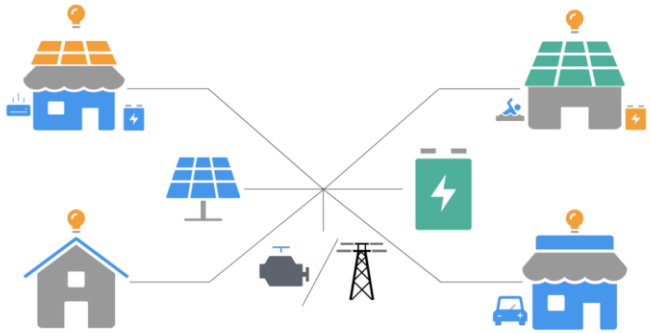
- Type of Technology – Residential side Energy Storage
- Considerations
  - Was provided without a control system solution although it could be paired with a submission from Enbala (next slide)
  - Commercially available
  - AC and DC coupled so it could provide both capacity as well as load

- Preliminary recommendation
  - Taken as submitted (no control system)
  - Without control system the team viewed it as providing individual home owner benefits and not a system resource
  - Viewed as an existing demand side resource as part of energy efficiency program and should be analyzed in the demand side resource filings
  - Preliminary Recommendation – do not forward on for modeling

EMERA

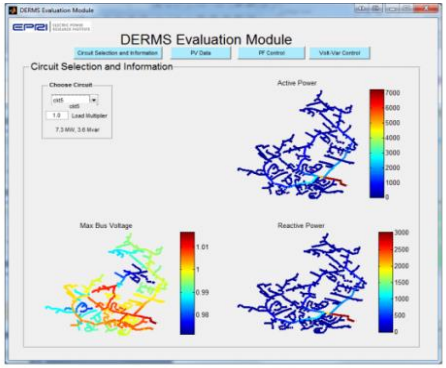
- Type of Technology – Microgrid
- Considerations
  - Can be deployed in small blocks to aggregate over time to larger resource
  - No commercial systems to date
  - Pre-Commercial

- Preliminary Recommendation
  - As submitted the technology included on site natural gas generator
  - While distribution level the proposal was able to describe how it could be considered as a system resource
  - Preliminary recommendation – Recommended for further in-person presentation to the technical advisory group and possible modeling for the IRP



ENBALA

- Type of Technology – Software system, Distributed Energy Resource Management System (DERMS)/Virtual Power Plant (VPP)



- Considerations
  - Software only system assuming control of existing resources
  - Can control distributed energy resources and provide utility visibility to those resources
  - Communications systems to end devices may need to be developed
  - The company has defined multiple use cases for this technology
  - Depending on use case the technology is varies from commercially available to pre-commercial activities

- Preliminary Recommendation
  - Team knew of other utilities utilizing this as a system resource
  - The ability to model and control demand side resources is going to be a larger need as we move to a zero carbon goal
  - Preliminary recommendation – Should model as part of the IRP

BRIGHT ENERGY

- Type of Technology – Concrete Thermal Energy Storage (hot concrete), compressed air storage, and cryogenic carbon capture

- Considerations
  - Primary response was for Concrete Thermal Energy Storage
  - Cryogenic carbon capture and compressed air were only mentioned as a type of technology but no response for the rest of the RFI
  - Does work with existing power plants (coal and/or natural gas)
  - Pre-commercial

- Preliminary Recommendation
  - Ask for more information for each of the other technologies in particular use cases that include non fossil fuel applications
  - Lots of components to consider in this response
  - Defer to a future meeting to get more clarity on the various technologies

ESS

- Type of Technology – Energy Storage, Iron Flow Battery

- Considerations
  - Stated long duration (4 to 10 hours of energy storage)
  - 20,000+ cycles
  - Non hazardous/non-toxic chemicals
  - 20+ years of operating life
  - Commercially available

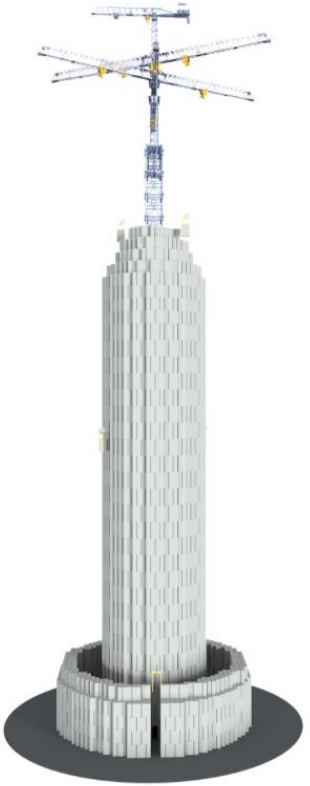
- Preliminary Recommendation
  - Would like to see price projection
  - Preliminary recommendation – Move on for further IRP analysis to model against Lithium Ion for cost, operation, and maintenance

ENERGY VAULT

- Type of Technology – Energy Storage, Potential Energy

- Attributes
  - Utilizes towers powered by electrical energy to lift large bricks to “charge” the tower then unloading the tower to drive an electrical generator
  - Capacity of 25, 35, or 80 MWh of storage
  - Continuous power of 4 to 8 MW
  - Discharge 8 to 16 hours to provide capability similar to deep discharge of a chemical battery
  - Pre-commercial

- Considerations
  - Would like Energy Vault to present to the larger Technical Advisory Group
  - Preliminary recommendation is to move along for analysis by IRP group

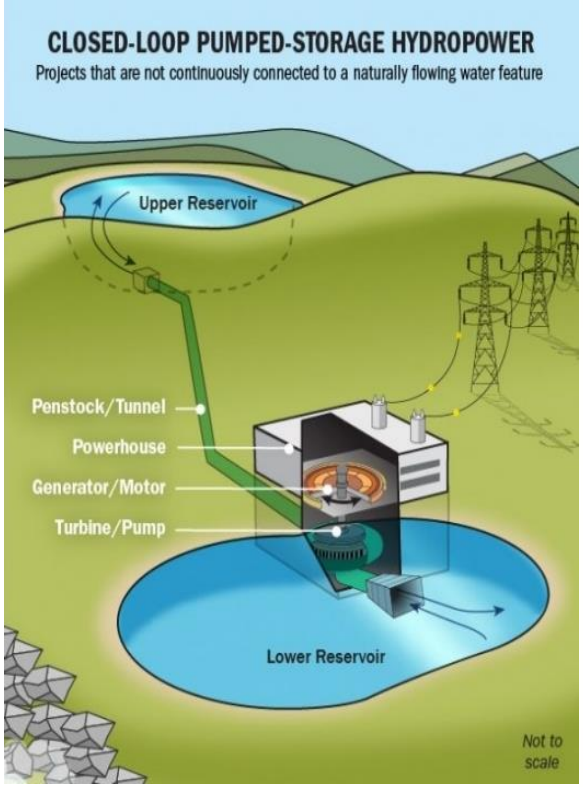


KINETIC POWER AND GRID FLEX

- Type of Technology – Energy Storage, Pumped Hydro

- Considerations
  - Large scale energy storage capability
  - Long lifetime
  - Water usage for initial charge and subsequent water usage to replace water lost to evaporation annually
  - Both commercially available

- Preliminary recommendation
  - Question about scaling and the effects on cost
  - Preliminary recommendation - Move along for modeling for IRP pending questions answered



NUSCALE POWER

- Type of Technology – Small Modular Nuclear Reactor (SMR)

- Considerations
  - Carbon free
  - 60 MW per module with the capability of a plant to go to 12 modules
  - Pre-commercial in regulatory approval (~2026)

- Preliminary recommendation
  - PNM's existing resource mix does would not accommodate additional nuclear and remain in compliance with the parameters of the Energy Transition Act (ETA)
  - Preliminary recommendation – Continue to monitor and not sent along for modeling in this cycle of the IRP

PACKETIZED ENERGY AND SHIFTED ENERGY

- Type of Technology – Behind the meter demand response
- Considered together as a general technology so not all characteristics are available for both companies

- Considerations
  - Software platform controlling various devices such as hot water heaters, thermostats, heat pumps, EV Chargers, pool pumps and residential energy storage
  - Load shaping, ancillary services
  - Commercially available
  - PNM does not have infrastructure for communications to devices or monitoring effects on distribution system during use
- Preliminary recommendations
  - Advisory committee feels this is a viable technology that should be considered at a point where PNM can get to some supporting infrastructure to support
  - Preliminary recommendation – Model in the IRP 5 years in the future

CONCLUSIONS

- Overall we received a wide range of technologies including both supply side and demand side resources
- We have recommended moving forward for modeling
  - The iron flow battery energy storage to compare against Lithium Ion and other battery technologies
  - Pumped hydro energy storage (pending questions on scaling)
  - Potential Energy storage (composite blocks)
- Recommended for future time frames
  - Demand Response technologies as a resource including the distributed energy management system
- Not modeling in this cycle
  - Demand side energy storage
  - Small Modular Nuclear Reactor
- Receiving presentations for more information
  - Microgrid technology
  - Multiple technology vendor providing concrete thermal storage, cryogenic carbon capture, and compressed air storage
  - Potential energy storage (composite blocks)

IRP MODELING SCENARIOS CONSTRUCTION & EVALUATION

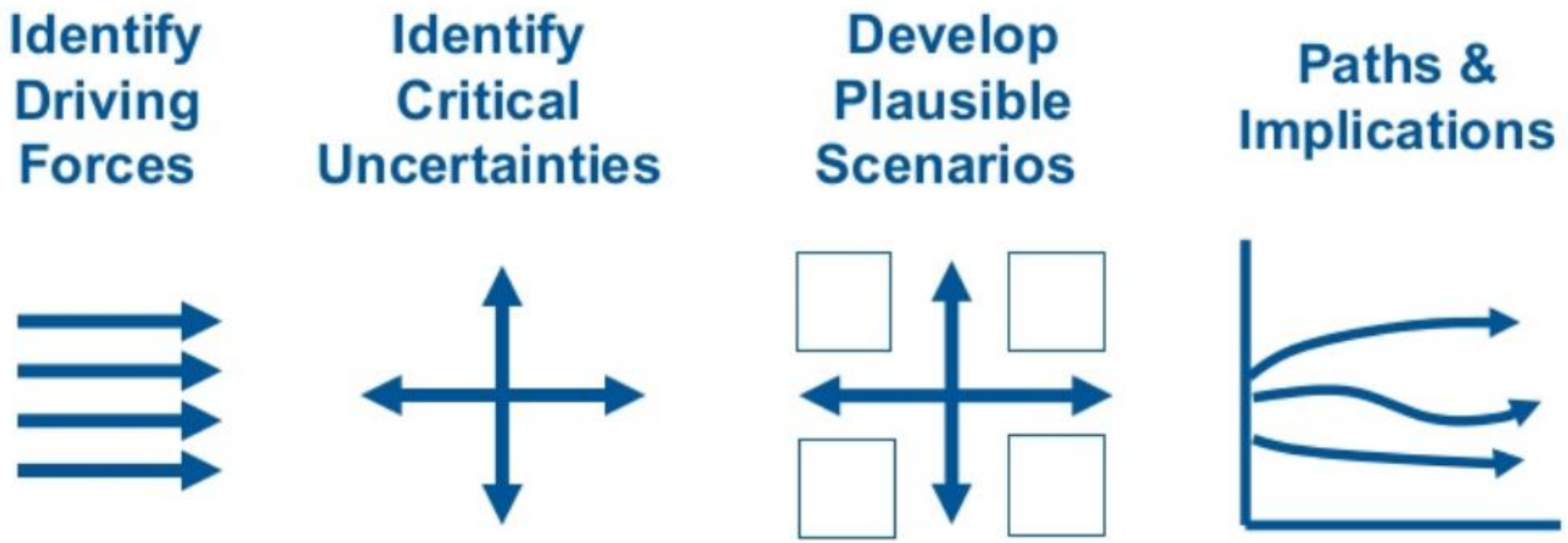
NICK PHILLIPS

SCENARIOS AND SENSITIVITIES ANALYSIS

- All Portfolios Must Meet Applicable State and Federal Laws and Regulations and Maintain System Reliability

- Scenario Definitions
  - Process of Analyzing Future Events by Considering Alternative Possible Outcomes (“Alternative States of the World")
  - Think Macro Level First, What is the State of the World/Big Picture
    - Example: Business as Usual, High Economic Growth, Accelerated Technology Advancements, etc.
  - Major Policy Assumptions
    - Exmaple: Early Plant Retirements, Technology Restrictions, New Federal/State Regulations
  - Broad Risk Assessment

SCENARIOS AND SENSITIVITIES ANALYSIS



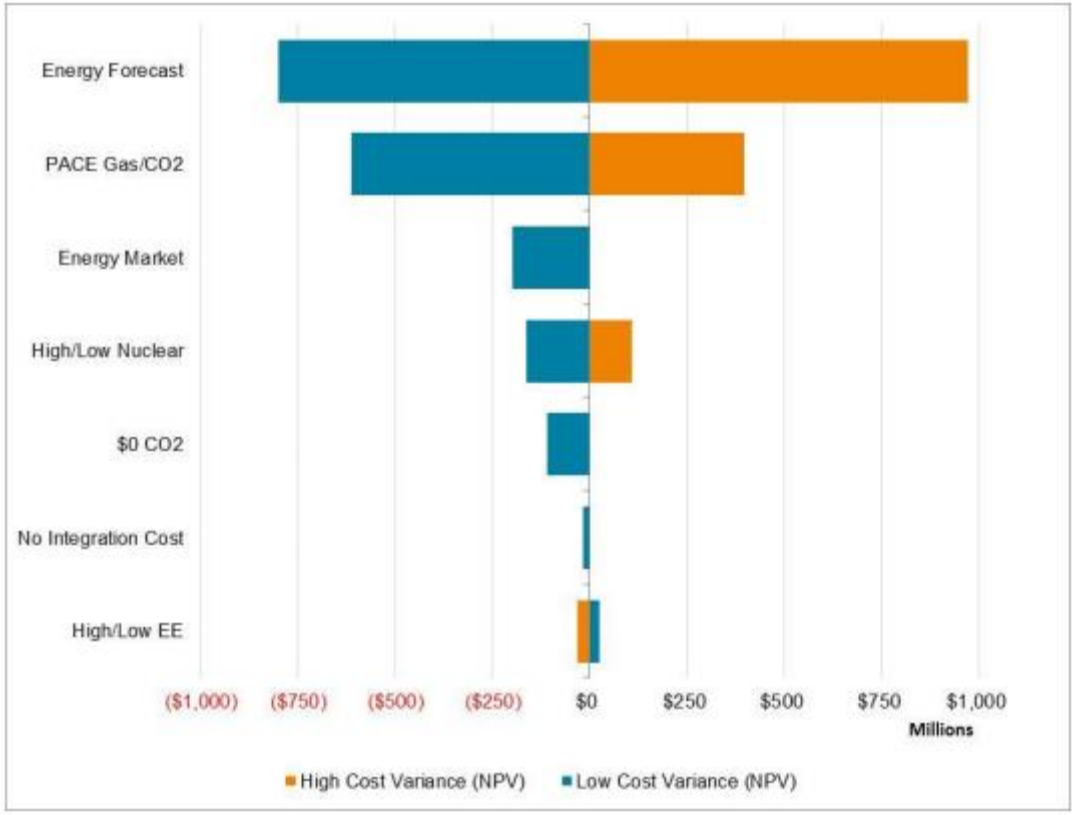
SCENARIOS AND SENSITIVITIES ANALYSIS

- Sensitivities Analysis
  - Uncertainty and Risk Analysis by Analyzing How the Output of the System Changes due to a Change in Input Assumption
    - Typically a Single Input is Tested at a Time
    - Increases Understanding of Relationships Between I/O
  - Example: Moving from Base Case to High Load or Gas Prices

We have received a few recommendations for simulations but we are hoping to receive more.

- For next meeting try to have ideas mapped out so we can work on refining them together.
- We have to keep in mind what can actually reasonably be modeled and what is the scope of the IRP.

SCENARIOS AND SENSITIVITIES ANALYSIS



FUTURE MEETINGS

NEAR TERM SCHEDULE

TENTATIVE MEETING SCHEDULE THROUGH MAY 2020

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 Day
November 19:	Battery Technology & Energy Storage
January 14:	Technology Review
February 4:	Load Forecast & Price Projections / Finalize Scenarios
March 10:	Process Update
April 14:	Process Update / Public Draft
May 12:	Advisory Group Comments

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 Schedule:

Tuesday, February 4, 2020, 9 a.m. to 4 p.m.

Tuesday, March 10, 2020, 9 a.m. to noon.

Thank you