Categorizing Questions and Comments

1. Scenarios
2. Modeling run prioritization criteria and run requests
3. Analysis Framework
4. Inputs and Assumptions
5. Modeling Rules/Constraints
6. Outputs

Scenarios (could be basis for additional modeling runs)

- Decarbonize the grid much sooner than 2040. (A. Christodoulou)
- Model (from a clean slate) a PNM fully decarbonized grid with wind, solar, a 1500 MW/70-hour duration PSH, minimal transmission incremental build, and separate/distinct fast-response grid stability resources such as BESS. From any sort of “end case” optimized model (such as the one suggested immediately above), then determine the interim steps that get you to the desired end state in an efficient manner from a cost, reliability, and emissions standpoint. (T. Conroy)

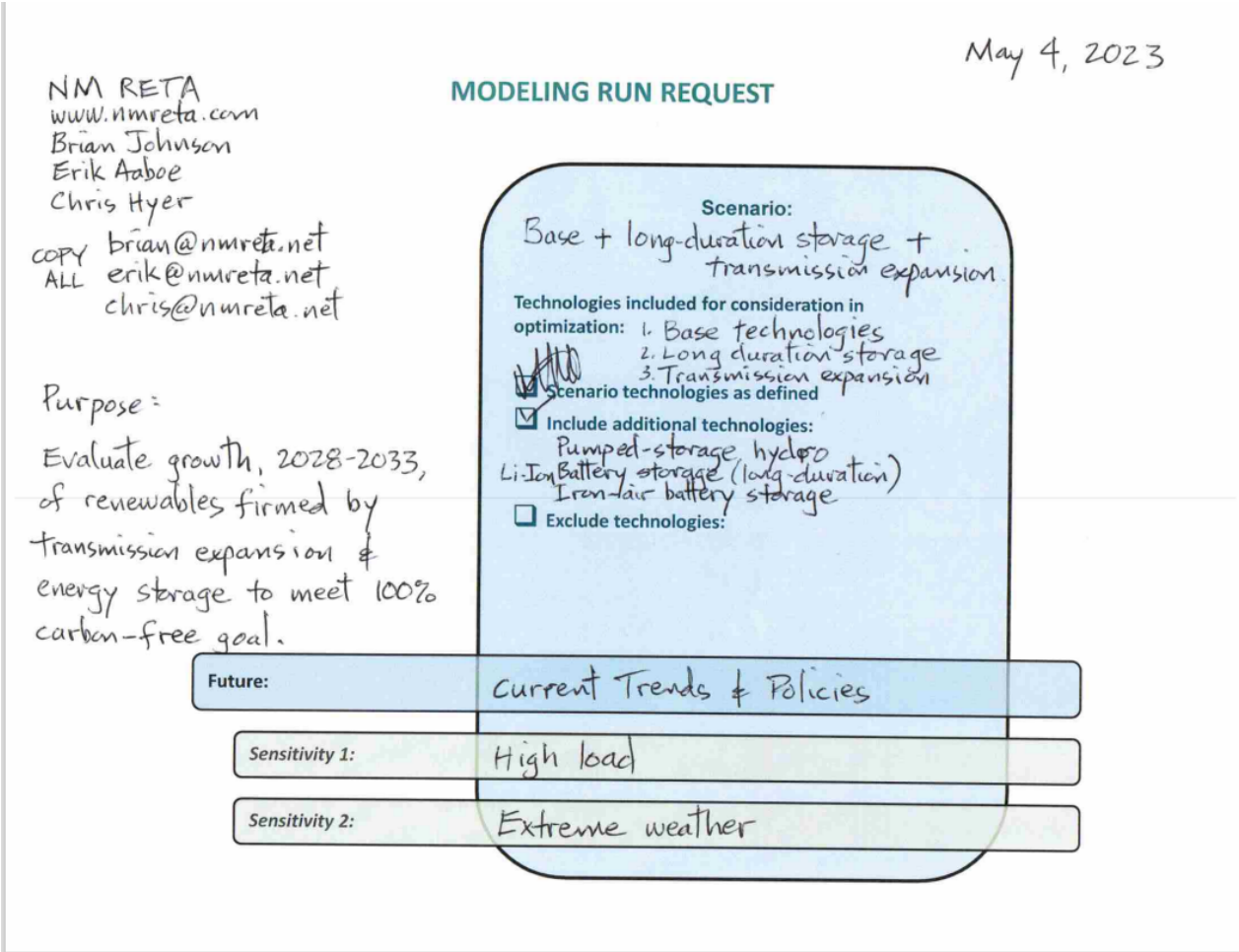
Modeling Run Prioritization Criteria and Run Requests

Candidate Prioritization Criteria (anonymous input)

1) Rank as determined by vote of modeling working group members
2) Alignment with Statement of Need
3) Delineation from existing scenarios
4) Runs that impact short term (within 10-year horizon) implementation rather than the long term interpretation (currently doing?)...This contradicts input from others that suggests at least one 20-year horizon scenario and resiliency analysis be conducted.

Run Requests

- We would like to see a run with base technologies, current policy trends & high penetration of EVs and electrification of space heating, given the incentives from Congress that we are going to be administering and adding to our own state programs. (J. Waite)
- Scenario with significant increase in demand response (several stakeholders).
- My early research results point to higher costs for wind generation resources due to likely long term wind "droughts" not anticipated in PNM's models. That motivates a desire for running scenarios or sensitivities with alternate treatment of wind resources either through their ELCC input to capacity expansion modeling or through the extreme weather data used as inputs for both Capacity Expansion and PCM models. (G. Wilke)



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MODELING RUN REQUEST

Purpose:

Evaluate growth, 2028-2033, of renewables firmed by transmission expansion & energy storage to meet 100% carbon-free goal.

Scenario:
Base + long-duration storage + transmission expansion

Technologies included for consideration in optimization:
1. Base technologies
2. Long duration storage
3. Transmission expansion

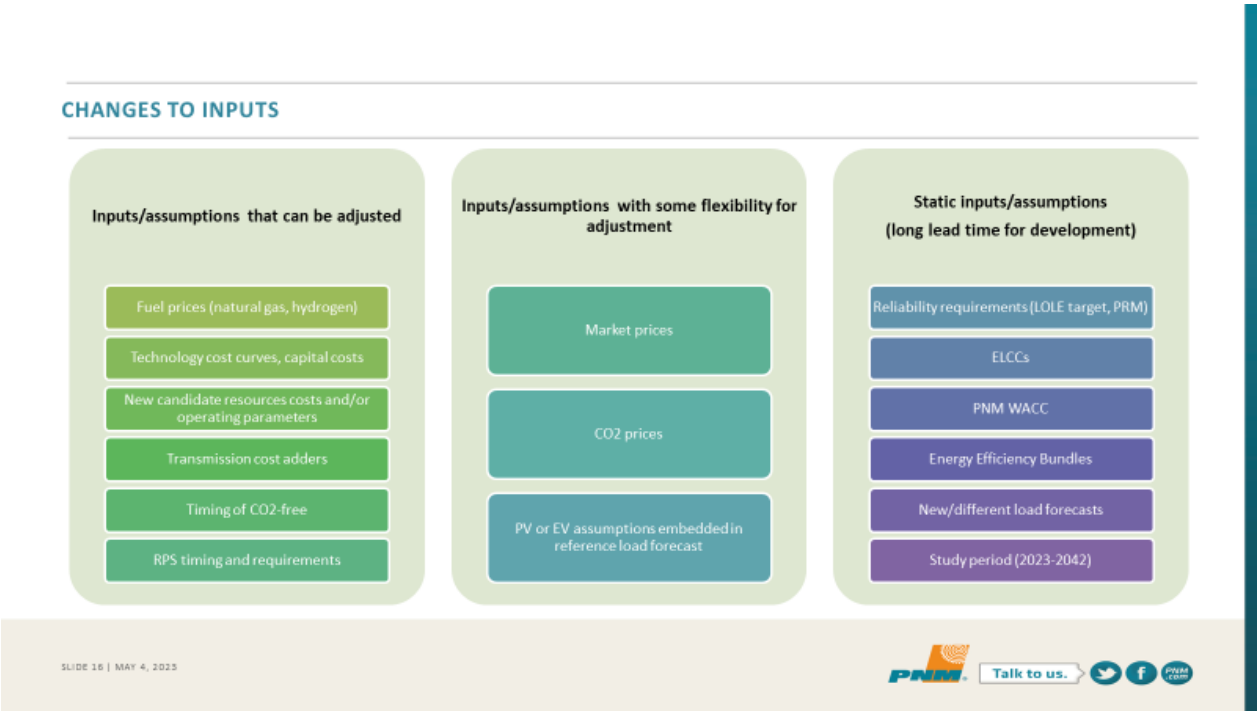
☑ Scenario technologies as defined
☑ Include additional technologies:
Pumped-storage hydro
Li-Ion Battery storage (long-duration)
Iron-air battery storage
☐ Exclude technologies:

Future: Current Trends & Policies
Sensitivity 1: High load
Sensitivity 2: Extreme weather

Analysis Framework

- Need a process for forecasting complete replacement of the grid vs forecasting the implementation of incremental dispatchable resources onto an existing system. (T. Conroy)
- Consideration of assets that are owned by 3rd parties instead of utility-owned. (T. Conroy)

Inputs and Assumptions



- Review ELCCs for solar, wind, storage and combinations (C. Mitchell) and reflect synergies among them (C. Leger). Suggested reference on this offered by E. Aaboe: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/20230210_irp_e3_astrape_updated_incremental_elcc_study.pdf
- Be explicit regarding Demand Response and Energy Efficiency , and consider a model run with significant increases in both (several stakeholders)
- Use of LCOE for resource costs (instead of what? Capital costs?) (C. Mitchell)
- Review reliability of fossil resources as in the past, they were modeled as more reliable than warranted. (C. Leger)
- Market availability and transmission interconnections must be adequately considered. (C. Leger)

Questions and Comments

From J. Waite, EMNRD, 5/8/23

- How is long-duration v. short duration storage modelled? For example, we are trying to understand if there costs associated with deferring long-duration storage now and having the short-duration storage (batteries) left as stranded assets later?
- What types of energy security events or impacts are modeled and cost out with LOLE? Are any cascading impacts to human health and economic function embedded in the model? Does the modeling include potential for sabotage (physical attacks) or cyberattacks?

From C. Beadles, WRA, 5/13/2023

- Should other types of gas plants should be considered in the modeling and not just aeroderivative. I'm wondering whether the emissions and operational performance of existing gas could be improved cost-effectively to avoid new gas that should be depreciated faster to avoid or reduce stranded investment risk in the future. Response captured by A. Gould based on 5/11/2023 meeting… Aeroderivative is used as a generic asset in the IRP as it is the combustion technology most likely to meet the portfolio needs; such as size, start time, ramp time, etc. When an RFP is issued for actual resources, technology other that aeroderivative can be submitted and will be considered, at which point (in CCN/PPA filings) intervenors can question issues such as potential stranded investment risk of new investment vs. existing generation assets.

From T. Conroy, 5/8/23, regarding seasonal duration storage

1. For all seasonal duration energy storage technologies except PSH, there are technology, cost, and commercial risks which must be considered and projected.
2. PSH has permitting timeline, construction timeline, and construction cost risks, but as a 100-year-old technology does not have meaningful technology or commercial risks.
3. Approx. 50% of PSH project capital costs will be spent locally, as compared to the approx. 5% to 10% spent locally on solar, wind, and BESS technology projects. It is unclear if these local construction jobs impact should be included in any analysis. For the Carrizo PSH project at $3.6 billion capital in 2020$, the local construction spending is estimated at $1.8 billion. Construction jobs are estimated at 673 direct/2,196 total jobs for a 5-year period.
4. Note that PSH projects are expected to remain in service for more than 100 years. The first PSH project in the U.S. (Rocky River Plant) was built 96 years ago and remains in service at 29MW nameplate.
5. Note that the Carrizo project is located on Navajo lands and is therefore expected to qualify for a 50% ITC remuneration level.
6. There is a great deal of uncertainty in projecting PSH construction/capital expenses since no plants have been built in the U.S. for decades. The attached whitepaper which Kinetic power wrote to NREL to inform their future technologies and costs projections defines the cost estimation process used for the Carrizo project. We feel that our empirical based, adjusted to 2020$ approach is the most accurate possible approach to PSH cost estimations today.
7. PNM IRP timeline and interest rate projections:
    a. The Carrizo project license (pre-construction) timeline is expected to be 3 to 4 years.
    b. The (subsequent) construction timeline to COD is expected to be 4 to 5 years.

   Construction and technology inflation and interest rate assumptions will presumably be crucial to make consistent for PNM asset choices to be deployed in future years.

From K. Gould, NM AREA, 5/8/23

- Has Gridworks facilitated IRPs for other utilities? I am curious because maybe your expertise can help in navigating how the modeling inputs should be presented for a transparent review by stakeholders. It is my understanding that in other jurisdictions the third party modelers (Ascend and Astrape in this case) present a table of sorts an the outset, stating all the assumptions they have used and what the sensitives in the models are aka which assumptions

really drive the modeling. It would be extremely helpful in deciding what to ask PNM to model to have these assumptions at the outset. For starters, can we get:
(1) What are the key assumptions PNM has changed in this IRP from 2020?
(2) What are the cost assumptions PNM is using for all the technologies and how did it derive these cost assumptions? MLT REFERRED HER TO https://gridworks.org/wp-content/uploads/2023/05/2023.05.12-Candidate-resources.pdf.
(3) Are there any artificial MW limits to any of the technologies or MW grouping, like wind has to be added in 400MW bundles ect?
(4)What is the import limit during the highest need hours?
(5)What is PNM modeling to be the high need hours /months or its coincident peak? Is PNM using 3S1W or modified 3S1W or something else?
(6) How is PNM treating the expiration of Reeves and Valencia in the models?
(7) What is PNM modeling for the forced outage rates of PNM's existing plants and how did it derive those figures?
(8) How is PNM modeling interruptible load?
(9) How is PNM modeling the ETA carbon limit - is it assuming this number is an annual number?
(10) How many MW of battery/ solar/ wind is PNM modeling in its base case?
(11)What is PNM's current mix of resources that has been approved by the Commission?
(12) Has PNM modeled any coordination with regional utilities to pool planning reserves?
(12) Can PNM model a possible scenario of PNM joining an RTO with either CalISO or SPP?
(13) Can PNM run models with averages of actual costs from its RFPs?

NM AREA is not likely going to run its own models this year but would still like to know how long it would take for PNM to set up a VM or to give us access to the models with all the input information. MLT REPLIED THAT VM WILL NOT BE AVAILABLE DURING THIS IRP CYCLE.

From M. Ballantine (5/11/2023)

- Curious about LOLE (%) vs cost of resource options.

From H. Gopalakrishnan (5/11/2023)

- Why not run 8760 MIP in Capacity Expansion (i.e.: fitted chronology) with either 1 year steps with no overlap or 2 year steps with 1 year overlap. This helps avoid the uncertainties associated with ELCC methodology.

From R. Wilson (5/11/2023)

- There are additional tax credits that PNM might take advantage of, including those relating to % of domestic content and projects cited in Energy Communities. Will those be modeled for different technologies?" (R. Wilson)

From G. Wilke (5/11/2023)

- How would the capacity expansion model incorporate feedback from PCM regarding likely long-term outages of Li-Ion units?

- Regarding purchase of hydrogen does the carbon intensity law limit PNM to 100% green hydrogen while restricted to 0 carbon intensity.

From C. Ho, Sandia National Labs, 5/11/23

- During the 5/11 meeting, Nick mentioned the possibility of using EUE in addition to LOLE in the future. How will you weight or combine multiple reliability metrics to form the basis for your decisions? Also, it would be helpful to present a definition and/or illustration of these reliability metrics (e.g., LOLE, LOLH, LOLP, EUE, NEUE) and how they will be used.
- I would like to see a table of input parameters and their uncertainty distributions. In other words, what parameters are you treating stochastically (probabilistic) vs. discretely (sensitivity)? In particular, I would like to see more information about uncertainties in generation (wind, solar), storage, and load."
- Extreme weather considerations (C. Ho, E. Roesler, T. Nguyen, and J. Ellison)
  Conclusions from Sandia National Labs (contained in SANDIA REPORT SAND2022-0583 Printed January 2022). “Results for the extreme climate-change scenario show that the projected wind power may decrease by ~13% due to projected decreases in wind speed. Projected solar power may decrease by ~4% due to decreases in irradiance and increases in temperature in NM. Uncertainty in these climate-induced changes in wind and solar resources was accommodated in probabilistic models assuming uniform distributions in the annual reductions in solar and wind resources. Uncertainty in battery storage performance was also evaluated based on increased temperature, capacity fade, and degradation in round-trip efficiency. The hourly energy balance was determined throughout the year given uncertainties in the renewable energy resources and energy storage. The loss of load expectation (LOLE) was evaluated for the 2040 No New Combustion portfolio and found to increase from 0 days/year to a median value of ~2 days/year due to potential reductions in renewable energy resources and battery storage performance and capacity. A rank-regression analyses revealed that battery round-trip efficiency was the most significant parameter that impacted LOLE, followed by solar resource, wind resource, and battery fade. An increase in battery storage capacity to ~25,000 – 30,000 MWh from a baseline value of ~14,000 MWh was required to reduce the median value of LOLE to ~0.2 days/year with consideration of potential climate impacts and battery degradation.”