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ENO 2021 IRP Technical Meeting #2

April 29, 2021

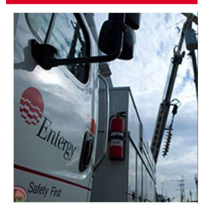
Goals and Agenda of Technical Meeting #2

Goals

- As described in the Initiating Resolution (R-20-257), the main purpose of this meeting is for ENO, the Advisors, and Intervenors to continue discussions regarding the Scenarios and Strategies with a goal of reaching consensus for inclusion in the IRP modeling.
- If necessary, the parties will discuss the Planning Scenario and/or Strategy that have been prepared by the Intervenors and provided to the parties in advance of this Technical Meeting.
- These discussions will support the finalization of Planning Scenarios and non-DSM inputs by May 24, 2021 as required under the Order issued by Judge Auzenne on April 7, 2021 that modified the procedural schedule.

Agenda

1. Updates to Proposed Planning Scenarios and Strategies
2. Business Plan 2021 (BP21) Supply-Side Alternatives
3. BP21 IRP Inputs and Assumptions
4. Timeline and Next Steps



Technical Meeting #1—Follow Ups

- **Planning Scenarios**
  - Provide additional description of drivers and expected impact
- **Supply-Side Resource Alternatives Selection**
  - Provide more detail on BP21 technology assessment and selected resources
- **Non-DSM inputs**
  - Review final BP21 inputs to be used in IRP modeling
- **Planning Objectives**
  - Further discussion of planning objectives in IRP analysis

Section 1
Updates to Proposed Planning Scenarios and Strategies

Proposed Scenario Purpose and Drivers

IRP analytics rely on macro market Scenarios designed to allow for the assessment of the total production cost and risk of resource portfolios across a reasonable range of possible future outcomes.

Scenarios	Key Drivers
Scenario 1 (Reference)	• Moderate distributed energy resources and demand side management penetration dampen peak load and energy growth • Coal economics continue to face pressure from low natural gas prices • Renewables and gas play balanced roles in replacing retiring capacity
Scenario 2 (Decentralized Focus - DSM & Renewables)	• **CHANGE SINCE TECH MEETING #1:** This Decentralized Focus Scenario replaces the Current Environment Persists Scenario originally proposed (see Appendix for comparison) • Social trends and corporate initiatives adapt to meet evolving technology, demanding high penetration of DERs, DSM, and EE • Moderate carbon mandates (legislatively- and consumer-imposed) drive coal plants to retire earlier than anticipated • The increased levels of energy efficiency, renewables, and DER along with a lower level of demand growth lessen the need for gas-fired generation as compared to Reference, however there is still a considerable need for gas-fired capacity to replace coal generation retirements (and provide flexible capability)
Scenario 3 (Economic Growth with Emphasis on Renewables)	• Economic growth contributes to recovery in peak load and energy projections • Political, environmental, and economic pressure on coal and legacy gas plants accelerates retirements • Market fills load growth needs with renewables due to slow expansion of natural gas pipeline infrastructure, economics and state pressure for fuel diversity

Proposed ENO Planning Scenarios—Updated

	Scenario 1	Scenario 2	Scenario 3
Description	Reference	Decentralized Focus (DSM & renewables) ***CHANGE***	Economic Growth with an Emphasis on Renewables
Peak / Energy Load Growth	Reference	Low	High
Natural Gas Prices (Levelized Real, 2021$/MMBtu)	Reference	Low	High
DR / EE / DER Additions	Medium	High	Medium
Market Coal Retirements	Reference (60 years)	Accelerated (55 years)	Accelerated (50 years)
Legacy Gas Fleet Retirements	Reference (60 years)	Accelerated (55 years)	Accelerated (50 years)
Magnitude of Coal & Legacy Gas Deactivations	23% by 2030 69% by 2040	49% by 2030 84% by 2040	67% by 2030 89% by 2040
CO2 Tax Assumption (Levelized Real, 2021$/short ton)	Reference	Reference	High

If necessary, a fourth Stakeholder Scenario will be modeled.

ENO Proposed Planning Strategies--Assumptions

	Strategy 1	Strategy 2	Strategy 3
Description	Least Cost Planning	But For RCPS (Reference)	RCPS Compliance
Resource Portfolio Criteria and Constraints	Meet long-term Planning Reserve Margin (PRM) target using least-cost resource portfolio of supply and DSM resources	Include a portfolio of DSM programs that meet the Council's stated 2% goal and determine remaining needs	Include a portfolio of DSM programs that meet the Council's stated 2% goal and determine remaining needs in compliance with RCPS policy goals
Objective	Assess demand- and supply-side alternatives to meet projected capacity needs with a focus on total relevant supply costs.	Design a portfolio that includes a set of potential DSM programs intended to meet the Council's stated 2% goal.	Design a portfolio that includes a set of potential DSM programs intended to meet the Council's stated 2% goal. Excludes resources that would not be RCPS compliant.
DSM Input Case	TBD	TBD	TBD

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Section 2
BP21 Supply-Side Alternatives

Supply-side Technology Resources

- The supply-side technology assessment analyzes potential supply-side generation solutions that could help ENO serve customers' needs reliably and at the most reasonable cost, including renewable, energy storage, and hydrogen-capable conventional generation.
- The technology assessment for the 2021 IRP explores in detail the challenges, opportunities, and costs of generation alternatives to be considered when designing resource portfolios to meet identified capacity needs.
  - Renewable energy resources, especially solar, have emerged as viable economic alternatives.
  - Trend to smaller, more modular resources (such as battery storage) provides opportunity to reduce risk and manage peak demand.
  - Deployment of intermittent generation has increased the need for flexible, diverse supply alternatives. New smaller scale supply alternatives can better address locational, site specific reliability requirements while continuing to support overall grid reliability.
  - Any large-scale future natural gas resources will be hydrogen capable.

Supply-side Alternatives: Screening Approach

Screening approach is designed to evaluate the cost-effectiveness and feasibility of deployment of potential resources, resulting in the selection of technologies to be included in the capacity expansion model.

TECHNICAL SCREENING

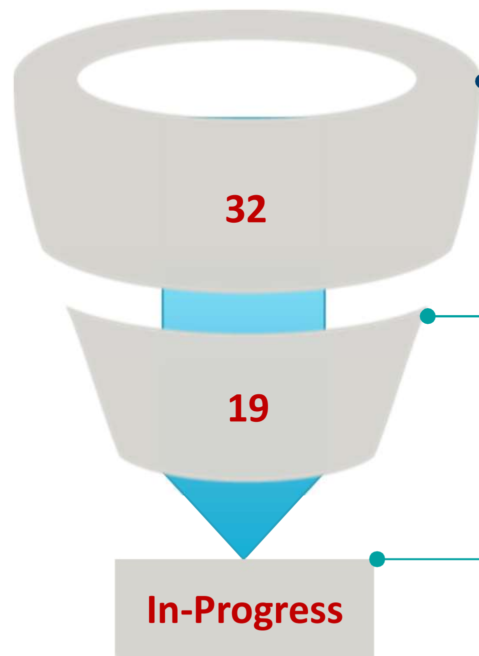
The technical screening process evaluates potential supply side alternatives based on technology maturity, environmental impact, fuel availability, and feasibility to serve ENO's generation needs. From this, generation alternatives are narrowed down for inclusion in the economic screening.

ECONOMIC SCREENING

The economic screening process evaluates levelized cost of electricity metrics and key performance parameters.
From this, generation alternatives are narrowed down for inclusion in the capacity expansion.

TECHNOLOGY SELECTION

The technologies selected for inclusion in the capacity expansion model are those deemed to be most feasible to serve ENO's generation needs based on comparative LCOE and performance parameters, deployment risks (cost / schedule certainty), and emerging commercial, technical, and policy trends.



Technical Screening
Technology Maturity
Environmental Impact
Fuel Availability
Service Territory Feasibility

Economic Screening
Levelized Cost of Electricity
Capital Cost
Fixed and Variable O&M Cost
Emission Costs
Performance

Technology Selection
Levelized Cost of Electricity
Performance
Deployment Risk
Emerging Trends

Technical Screening

Evaluated 32 generation alternatives with 19 selected for economic screening

STORAGE
- Sodium Sulphur (4-hr)
- Compressed Air Energy (16-hr)
- Fly Wheel
- Flow -Vanadium Redox (4-hr)
- Lithium-Ion (4-hr)
- Lead Acid
- Ultra/Super Capacitor

CONVENTIONAL GENERATION*
- Aeroderivative CT
- CCGT (2x1 w/DF)
- CCGT (1x1 w/DF)
- CCGT (2x1 w/o DF)
- CCGT (1x1 w/o DF)
- Frame CT
- RICE

NUCLEAR
- Generation III+ (AP 1000)
- Small Modular Reactor
- Generation IV

WIND
- On-shore
- Off-shore, Fixed
- Off-shore, Floating
- On-Shore, Off System

SOLAR
- Mono & Bifacial
- Off System
- Concentrating Solar Power
- Off-shore (Anywhere except ocean)

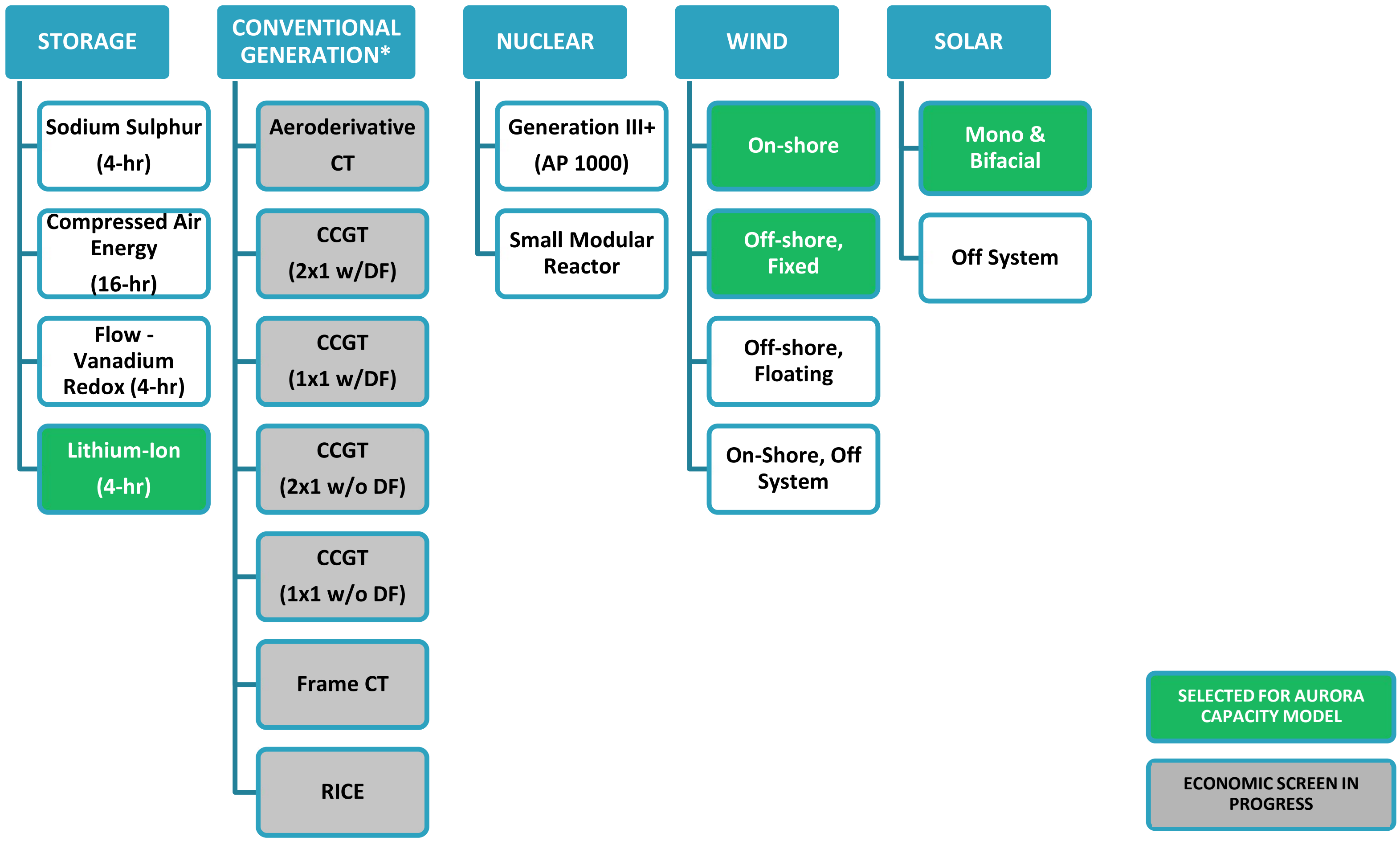
WATER
- Hydroelectric, New Stream
- Hydroelectric, non-powered dam
- Ocean Thermal Energy Conversation
- Ocean
- Tidal
- Wave
- Geothermal

SELECTED FOR ECONOMIC SCREENING

Notes:
* Any large-scale future gas resources will be hydrogen capable. Cost data for hydrogen capable generation resources are under-development.

Economic Screening

4 renewable/storage generation technologies have been selected for inclusion in the capacity expansion model. The economic screen for conventional generation technologies is in progress.



Notes:
*Any large-scale future gas resources will be hydrogen capable. Cost data for hydrogen capable generation resources are under-development.

Technology Selection

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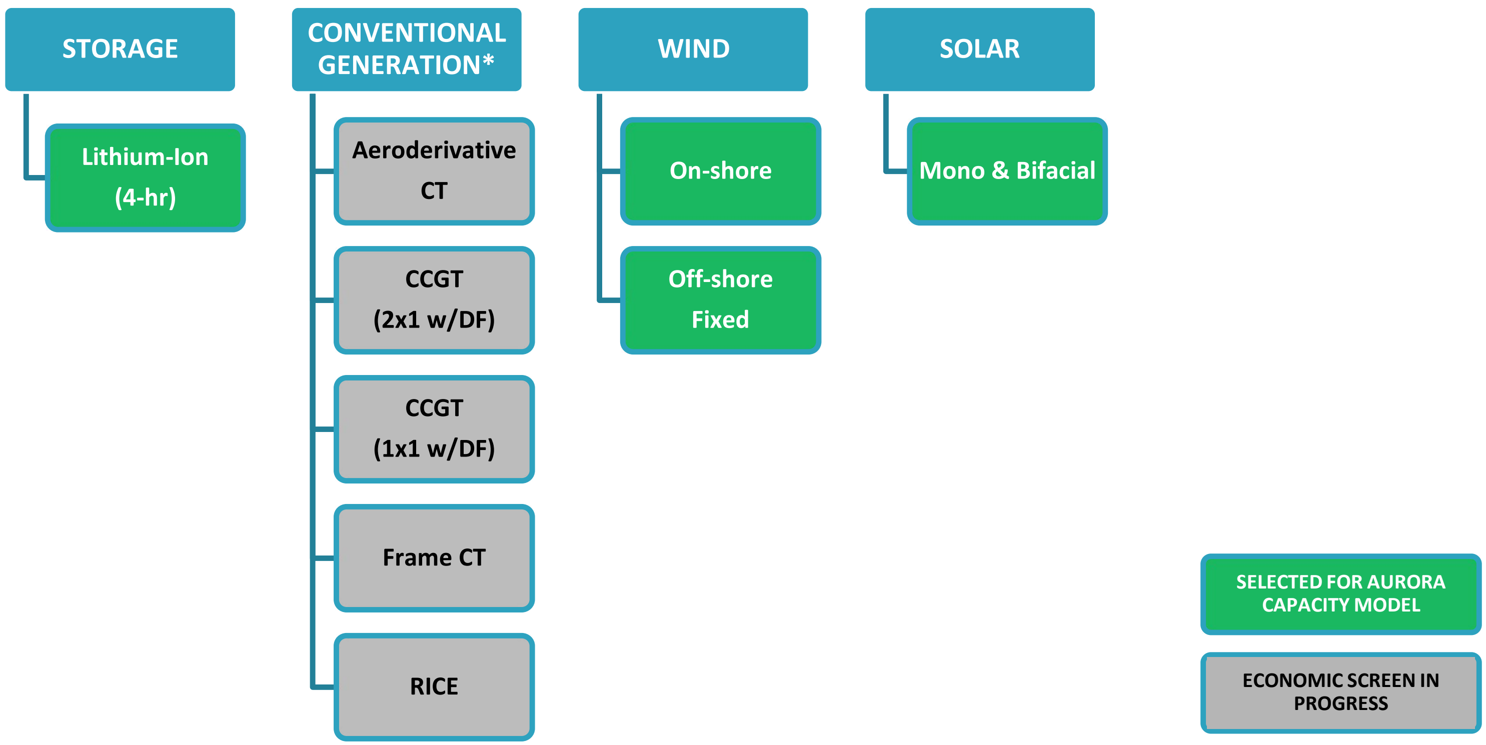
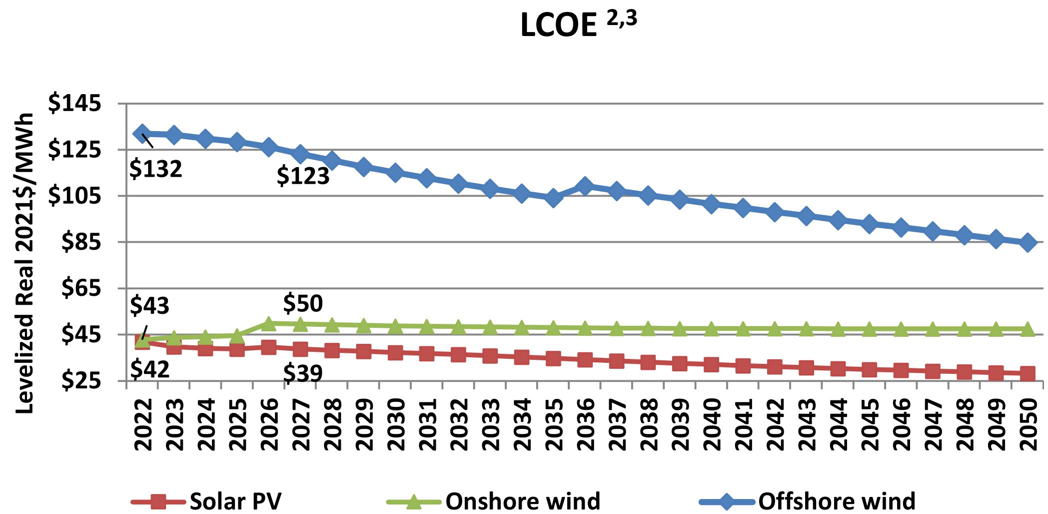


Notes:
*Cost data for hydrogen capable generation resources are under-development

Renewable Resource Assumptions (Solar PV & Wind – MISO S.)

Other Modeling Assumptions

	Solar	On-shore Wind	Off-shore Wind
Size (MW)	100MW	200MW	600MW
Fixed O&M (Levelized R. 2021$/KWac-yr)[1]	$10.31	$37.59	$88.71
Useful Life (yr)	30	30	25
MACRS Depreciation (yr)	5	5	5
Capacity Factor	24.8%	29.6%	37.1%
DC:AC	1.30	N/A	N/A
Hourly Profile Modeling Software	PlantPredict	NREL SAM	NREL SAM



Notes:

1. Solar and Wind Fixed O&M excludes property tax and insurance; Solar includes inverter replacement in year 16.
2. LCOE is calculated as levelized total cost over the book life divided by the levelized energy output over the book life. (based on 12.2020 ENO WACC)
3. ITC normalized over useful life and assumes an extended ITC for Solar, PTC for On-shore Wind, and ITC for Off-shore Wind.
    - Assumes solar projects online between 2021 and 2023 receive 30% ITC. Assumes solar projects online between 2024 and 2025 receive 26% ITC. Solar projects online beginning 2026 and beyond receive 10% ITC.
    - Assumes on-shore wind projects online in 2021 receive 80% PTC. Assumes on-shore wind projects online between 2022 and 2025 receive 60% PTC. On-shore wind projects online in 2026 or beyond are not eligible for tax credits.
    - Assumes off-shore wind projects online between 2021 and 2035 receive 30% ITC.

Source:

 ATB NREL 2020: Offshore Wind only.

Grid-Scale Battery Storage Alternatives

- As battery storage technology continues to improve it is important to assess the costs and benefits associated with its deployment to meet long-term needs in the proper context.

- Battery storage includes a range of unique attributes that should be considered, such as:
  - ➢ The ability to store energy for later commitment and dispatch (energy and capacity value)
  - ➢ Ability to discharge in milliseconds and fast ramping capability (ancillary services)
  - ➢ Potential deferral of transmission and distribution upgrades
  - ➢ Rapid construction (on the order of months)
  - ➢ Modular deployment provides potential scalability
  - ➢ Portability and capability to be redeployed in different areas
  - ➢ Small footprint (typically less than an acre), allowing for flexible siting
  - ➢ Low round-trip losses compared to other storage technologies (such as compressed air)

- These attributes should be considered in light of possible limitations and impacts:
  - ➢ Batteries are not a source of electric generation
  - ➢ Useful life can be much shorter than other grid-scale investments (replacement cost)
  - ➢ Market rules not yet established to govern participation in wholesale markets
  - ➢ Discharge less electricity than required to charge due to losses
  - ➢ Cost of environmentally sound disposal

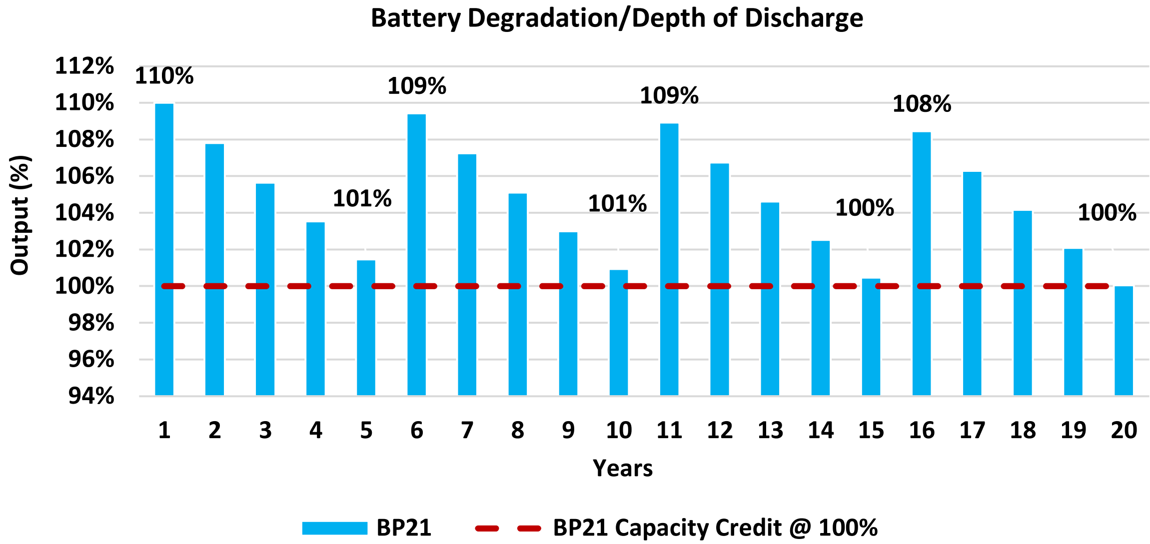
Storage Assumptions (4hr BESS – U.S. Generic)

Installed Capital Cost w/ Augmentation (Nominal, $/KWac) [1]

	2022	2023	2026	2029	2032	2035	2038	2041
Battery Storage	$1,380	$1,327	$1,183	$1,142	$1,123	$1,121	1,126	$1,138

Other Modeling Assumptions

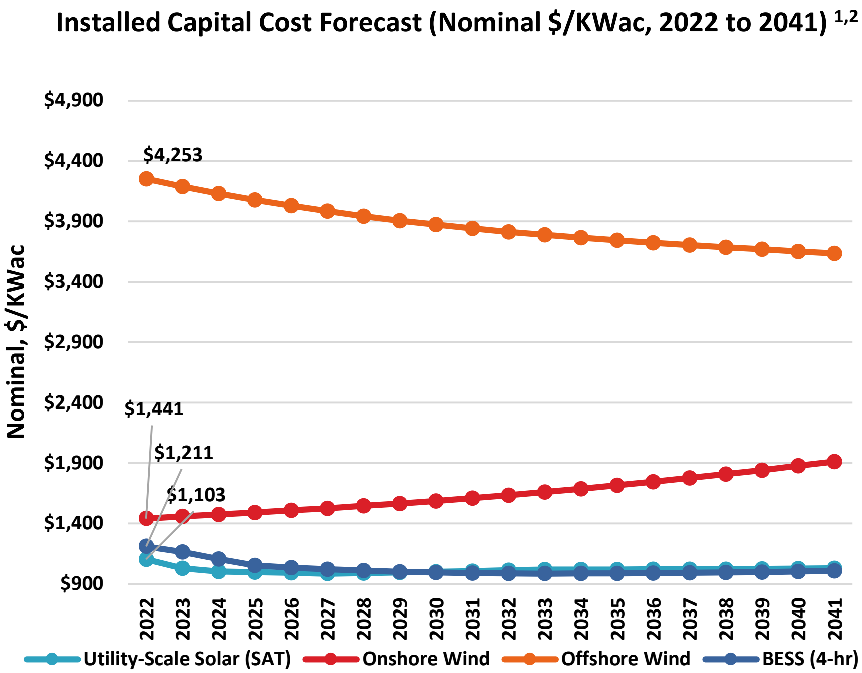
	Battery Storage
Energy Capacity : Power [2]	4:1
Size (MW/MWh)	50MW/200MWh
Fixed O&M (Levelized R. 2021$/KWac-yr) [3]	$13.17
Useful Life (yr)	20
MACRS Depreciation (yr)	7
Round-trip efficiency	86%
Hourly Profile Modeling Software	Aurora



Notes:
1. BESS Installed Capital Cost includes 10% initial oversizing in year 1 to account for Depth of Discharge (DoD), followed by an additional 10% augmentation every five years (year 6, 11, & 16). This corresponds to a degradation rate of 2% of BESS capacity per year.
2. Current MISO Tariff requirement for capacity credit
3. Battery Fixed O&M excludes property tax and insurance cost; includes recycling cost of $1.00 (2021$) in year 20.

Source:

Renewable & Storage Installed Capital Forecast



Notes:

1. Utility-scale Solar PV is an average between mono and bi-facial with Single Axis Tracking.
2. Battery Installed Capital Cost does not include augmentation.

Source:
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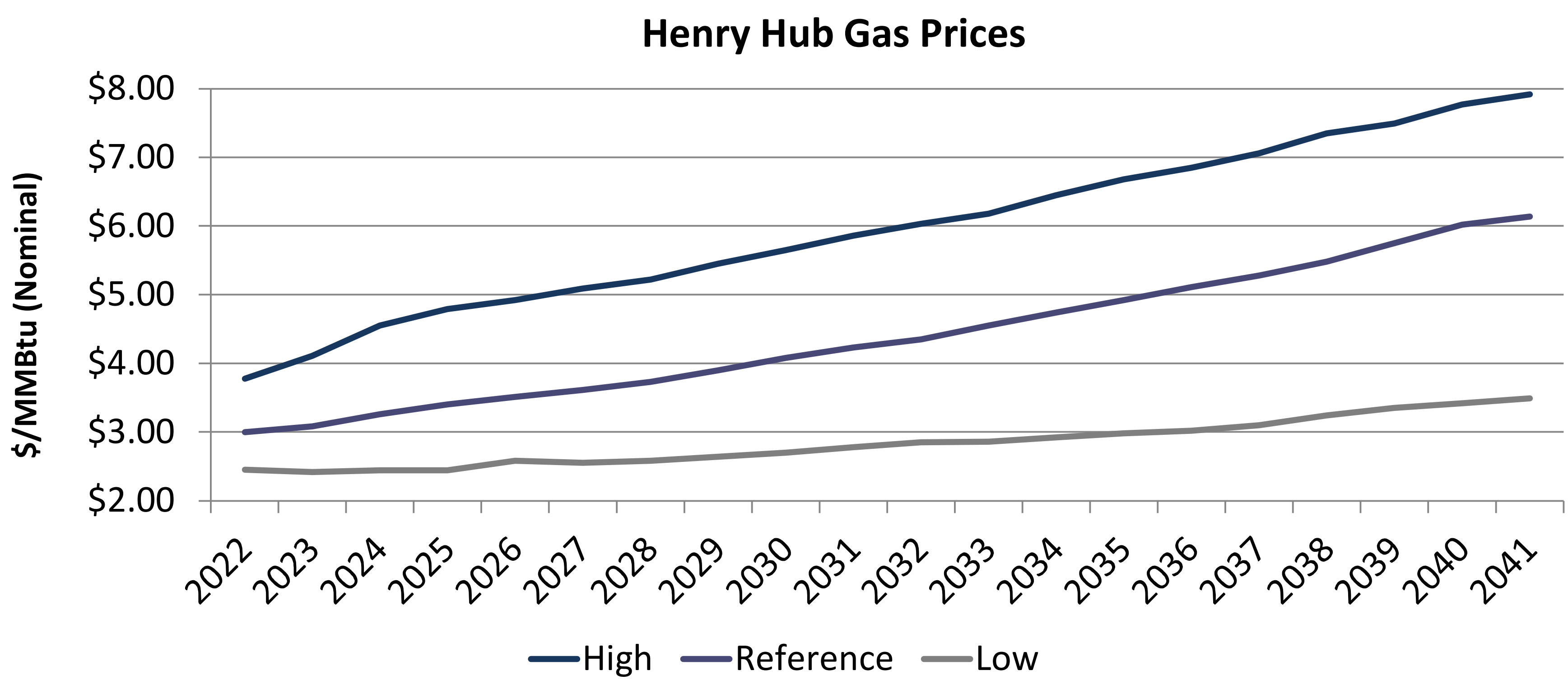
	Utility-Scale Solar (SAT)	On-shore Wind	Off-shore Wind	BESS (4-Hr)
2022	$1,103	$1,441	$4,253	$1,211
2023	$1,028	$1,458	$4,189	$1,163
2024	$1,001	$1,474	$4,130	$1,106
2025	$996	$1,490	$4,077	$1,053
2026	$991	$1,507	$4,028	$1,034
2027	$986	$1,525	$3,983	$1,020
2028	$990	$1,545	$3,943	$1,009
2029	$995	$1,565	$3,906	$1,001
2030	$1,000	$1,586	$3,872	$994
2031	$1,006	$1,609	$3,841	$989
2032	$1,012	$1,634	$3,813	$987
2033	$1,018	$1,660	$3,787	$986
2034	$1,018	$1,687	$3,764	$986
2035	$1,019	$1,715	$3,742	$987
2036	$1,020	$1,745	$ 3,722	$989
2037	$1,020	$1,775	$3,703	$991
2038	$1,022	$1,806	$3,685	$994
2039	$1,023	$1,838	$3,668	$997
2040	$1,025	$1,876	$3,651	$1,001
2041	$1,028	$1,911	$3,635	$1,007

Section 3
Inputs and Assumptions

2021 IRP Inputs and Assumptions

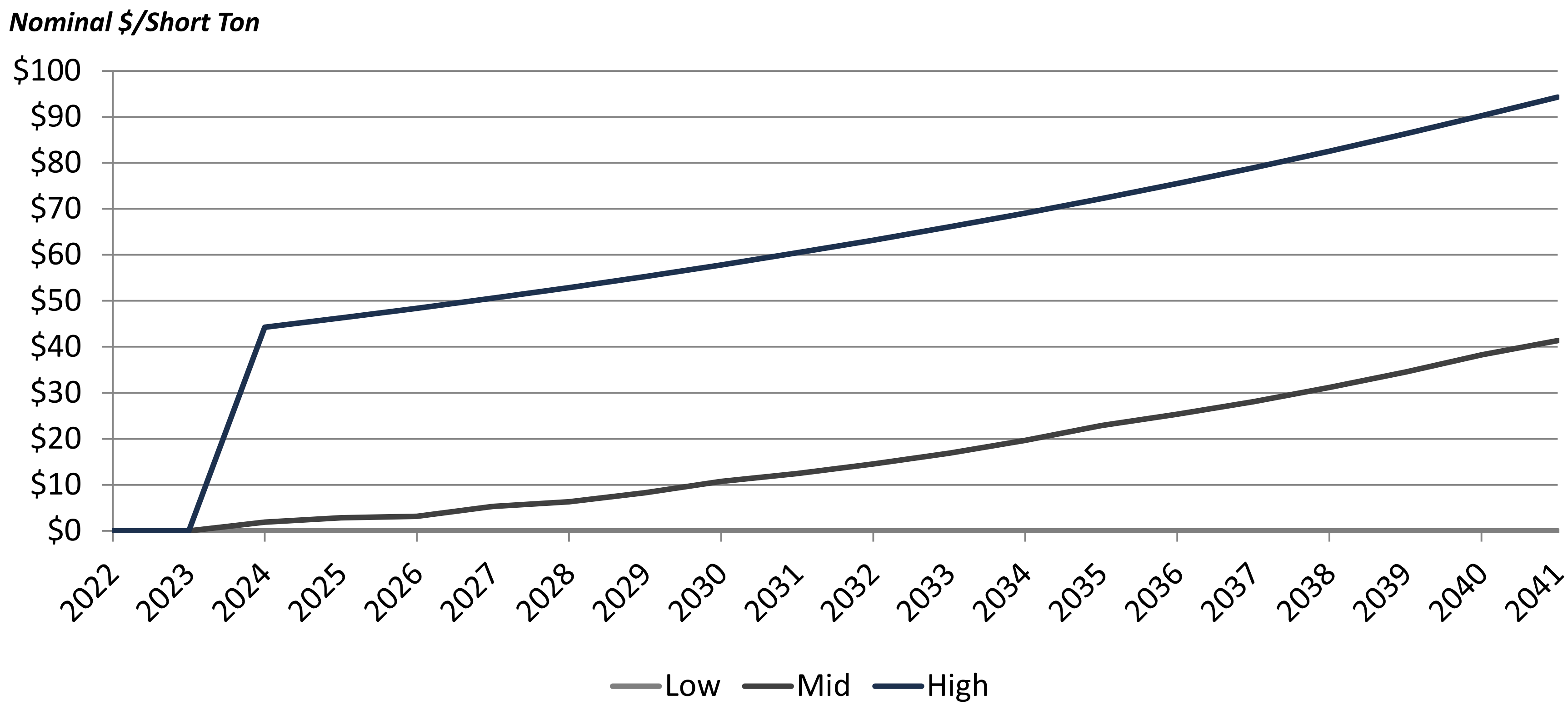
Input/Assumption	MISO Market Modeling	Portfolio Development	Total Relevant Supply Costs
Planning Scenarios	✓	✓	✓
Gas Price Forecast	✓	✓	✓
CO2 Price Forecast	✓	✓	✓
Load Forecast	✓	✓	✓
Planning Strategies		✓	✓
Capacity Value		✓	✓
Supply-Side Resource Alternative Costs		✓	✓
ENO's Long-Term Capacity Need		✓	✓
DSM Potential Study Results		✓	✓
Input Sensitivities			✓

Gas Price Forecast (BP21)



Case	2022	2029	2034	2041
Low	$2.45	$2.64	$2.92	$3.49
Reference	$3.00	$3.90	$4.74	$6.14
High	$3.78	$5.45	$6.45	$7.92

CO2 Price Forecast (BP21)



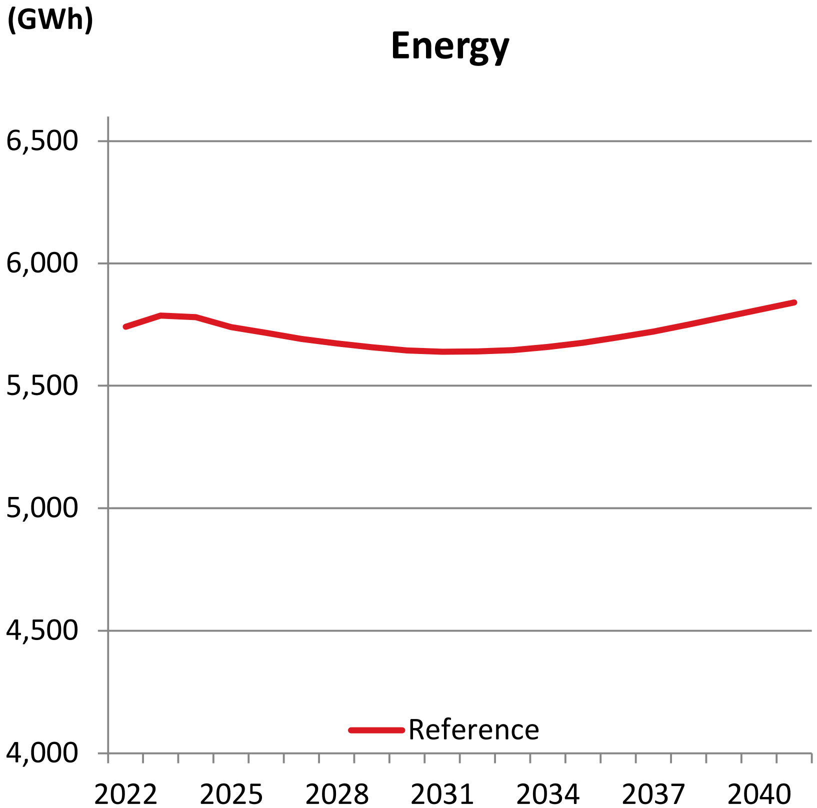
Case	2024	2030	2035	2041
Low	$0.00	$0.00	$0.00	$0.00
Reference	$1.87	$10.72	$22.86	$41.39
High	$44.26	$57.81	$72.21	$94.31

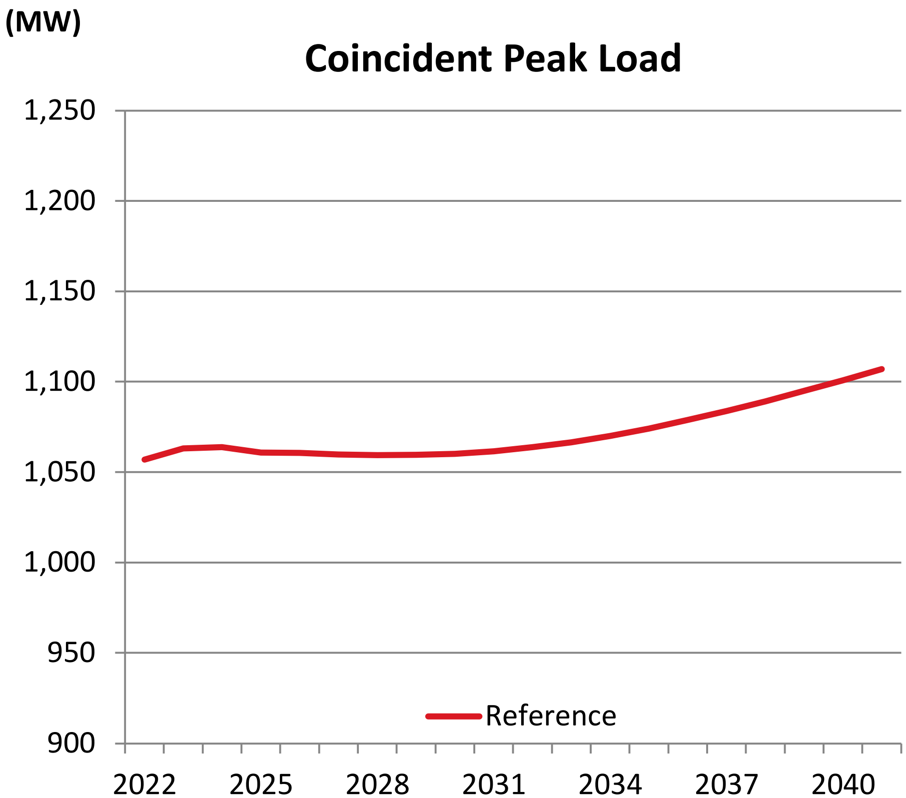
Load Forecast Levers

Item	*Scenario 1* Reference Case	*Scenario 2* Decentralized Focus (DSM and Renewables)	*Scenario 3* Economic and Renewables Growth
Policy Traits		More utility DSM; More BTM solar; Lower battery costs due to incentives; Increased EV adoption	More utility DSM; Utility-scale solar favored over BTM solar; Higher EV and non-EV electrification
Other Traits		Healthy economic conditions; Res & Com growth	Higher economic growth; High CO2 costs and power prices
Peaks	Reference	Lower: Increased EV adoption is offset by increases in BTM solar and increased OpCo DSM	Higher: High EV adoption, higher building electrification, higher growth in Res/Com/Ind offset increased BTM solar adoption
Energy	Reference		
Load Shapes	Reference	Intra-day shifts due to higher EV and higher BTM solar	Higher with intra-day shifts due to higher EV and higher BTM solar
BTM Solar	Reference	High	High
Electric Vehicles (EVs)	Reference (2100)	Higher (2055)	High (2040)
Building Electrification	Reference	Reference	High
Organic EE and OpCo DSM	Reference	Higher	Higher
Res. & Com. Growth	Reference	Reference	Higher
Refinery Utilization due to EVs	Reference	Lower (opposite of EVs)	Lower (opposite of EVs)
Industrial Growth	Reference	Reference	Higher

Peak Load & Energy Forecast (BP21)

Reference (Scenario 1) case forecast for ENO. Low (Scenario 2) and High (Scenario 3) load forecasts are being developed.



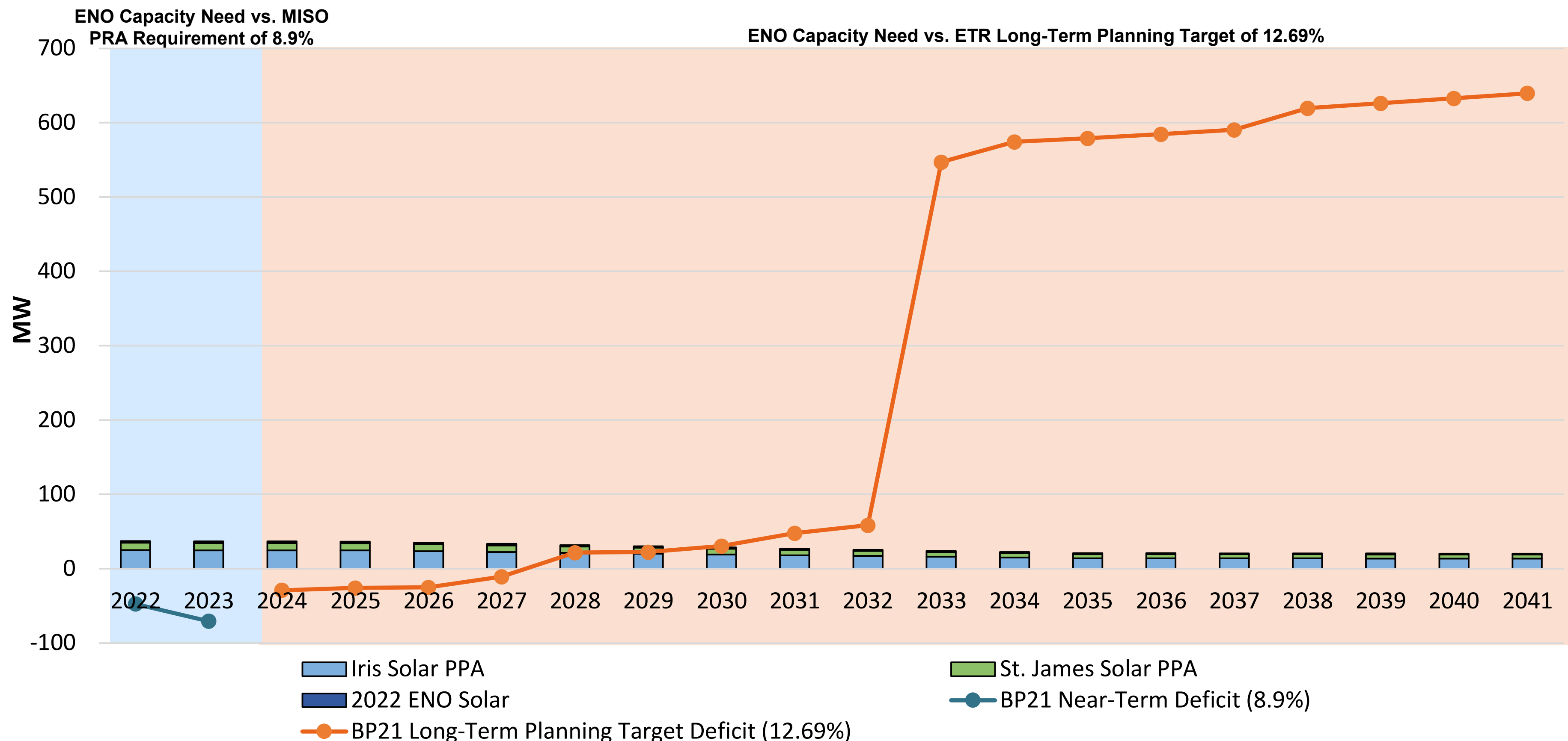


10 Year CAGR (%)	2022-2031	2032-2041
Reference	-0.20%	0.39%

Peak Load (MW)	2022	2026	2031	2036	2041
Reference	1,057	1,061	1,062	1,079	1,107

ENO's Long-Term Capacity Need (BP21) - Updated

To maintain long-term system reliability, ENO uses a long-term planning reserve margin applied to ENO's coincident peak with MISO



Assumptions:

- *Requirements are based on ENO's peak coincident w/ MISO and resources are represented by UCAP accreditation ratings*
- *Chart assumes a 50% capacity credit for solar resources through 2025, then decreases 2% each year beginning in 2026 until 30% minimum is reached to align with MISO MTEP 2021 futures*

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Section 4
Timeline and Next Steps

Current Timeline

Description	Target Date	Status
Public Meeting #1- Process Overview	September 2020	✓
Technical Meeting #1 Material Due	November 2020	✓
Technical Meeting #1	December 2020	✓
Technical Meeting #2 Material Due	April 2021	-
Technical Meeting #2	April 2021	-
Planning Scenarios and Non-DSM Inputs Finalized	**May 2021**	-
DSM Potential Studies Due	**July 2021**	-
Technical Meeting #3 Material Due	July/August 2021	-
Technical Meeting #3	August 2021	-
IRP Inputs Finalized	**August 2021**	-
Optimized Portfolio Results Due	December 2021	-
Technical Meeting #4 Material Due	January 2022	-
Technical Meeting #4	January 2022	-
Final IRP Report due	**March 2022**	-
Public Meeting #2 Material Due	April 2022	-
Public Meeting #2 - Present IRP Results	April 2022	-
Public Meeting #3 Material Due	April 2022	-
Public Meeting #3 - Public Response	April/May 2022	-
Technical Meeting #5 Material Due	April 2022	-
Technical Meeting #5	April/May 2022	-
Intervenors and Advisors Questions & Comments Due	May 2022	-
ENO Response to Questions and Comments Due	June 2022	-
ENO File Reply Comments	June 2022	-
Advisors File Report	July 2022	-

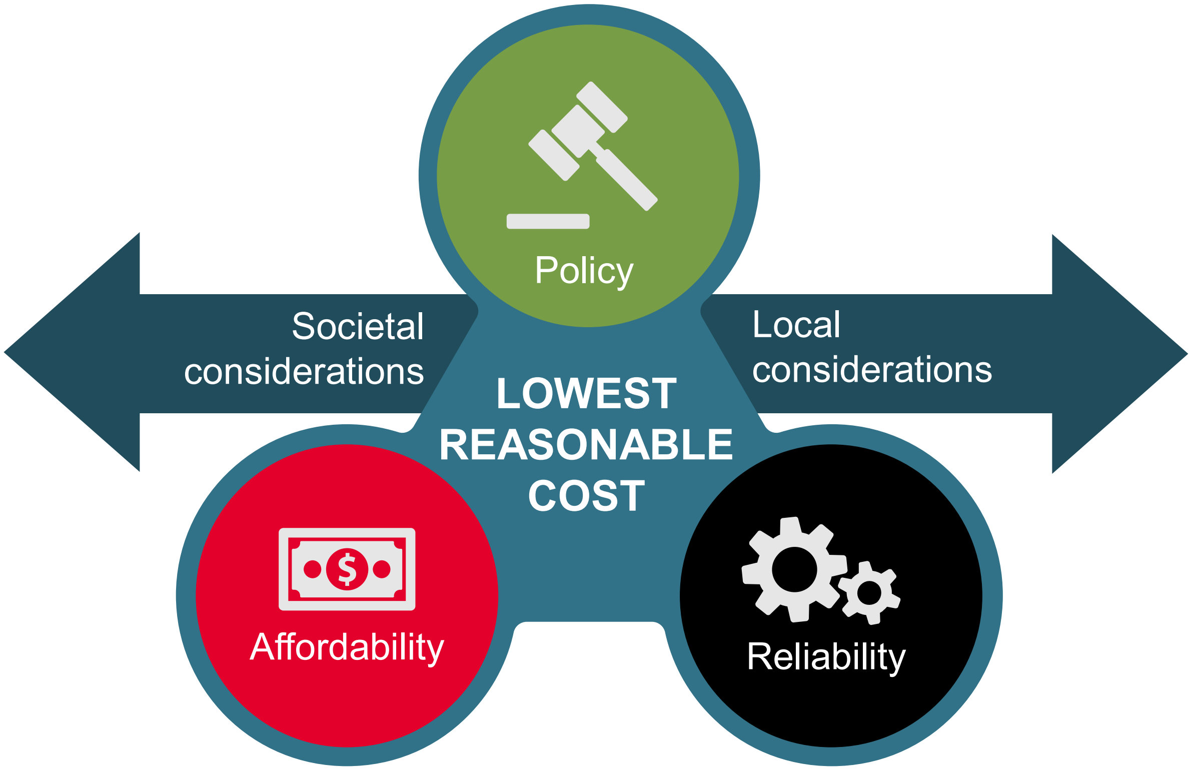
Appendix

Comparison of Old Scenario 2 to New Scenario 2

	Old Scenario 2	New Scenario 2
Description	Current Environment Persists (gas centric)	Decentralized Focus (DSM & renewables)
Peak / Energy Load Growth	Reference	Low
Natural Gas Prices (Levelized Real, 2021$/MMBtu)	Low	Low
DR / EE / DER Additions	Low	High
Market Coal Retirements	Reference (60 years)	Accelerated (55 years)
Legacy Gas Fleet Retirements	Reference (60 years)	Accelerated (55 years)
Magnitude of Coal & Legacy Gas Deactivations	23% by 2030 69% by 2040	49% by 2030 84% by 2040
CO_2 Reduction Target (Levelized Real, 2021$/short ton)	None	Reference

ENO Planning Objectives

The 2021 IRP process seeks to identify a range of possible approaches to serving the electricity needs of ENO customers over the period 2022-2041 while addressing three main planning objectives: **reliability, affordability, and policy considerations**

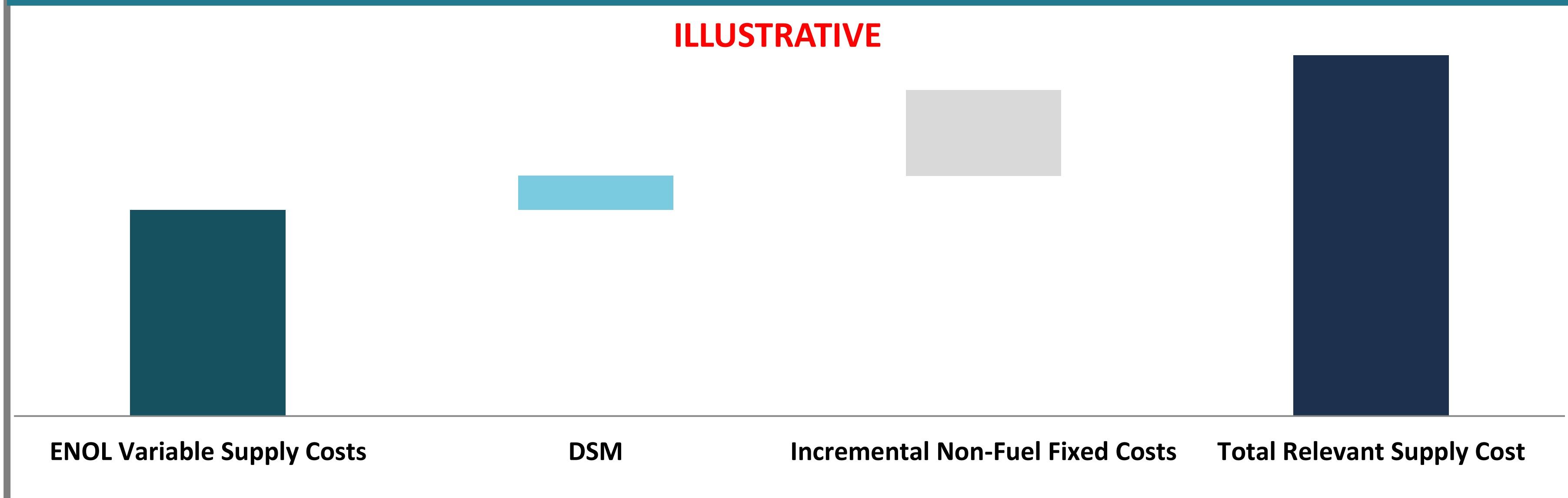


Measuring Customer Economics & Affordability

ENO Total Relevant Supply Cost results consist of 3 major components:

ENO Variable Supply Costs
\+ Demand Side Management (DSM) Costs
<u>+ Non-Fuel Fixed Costs[1]</u>
Total Relevant Supply Cost ("TRSC")

Components of ENO Total Relevant Supply Cost



[1] Non-fuel Fixed Costs include an adjustment for applicable tax credits and capacity purchases/sales