2021 IRP Data Posting

Entergy Arkansas, LLC

February 2021 (May 2021 Update)

Creating sustainable value for all

2021 IRP Data Posting Outline

2021 Integrated Resource Plan ("IRP") Status Updates

- Modeling Framework
- Market Futures
- Load Scenarios
- Portfolio Deactivation Sensitivities
- ICF DSM Potential Study Outline & Timeline
- Technology Assessment Summary

2021 IRP Stakeholder Timeline

- Stakeholder engagement will be a cornerstone of the 2021 EAL IRP process
- Future Stakeholder meetings and data postings will be communicated via email
- In-person meetings remain TBD due to COVID-19

Activity/Milestone	Date
Stakeholder Engagement: Information Posting	June 26
Stakeholder Engagement: Meeting 1	August 25
Stakeholder Engagement: Data Posting	January 2021
Stakeholder Engagement: Meeting 2	July – August 2021
Filing	October 29, 2021

Timeline of Major Milestones

Future dates are preliminary and subject to change.

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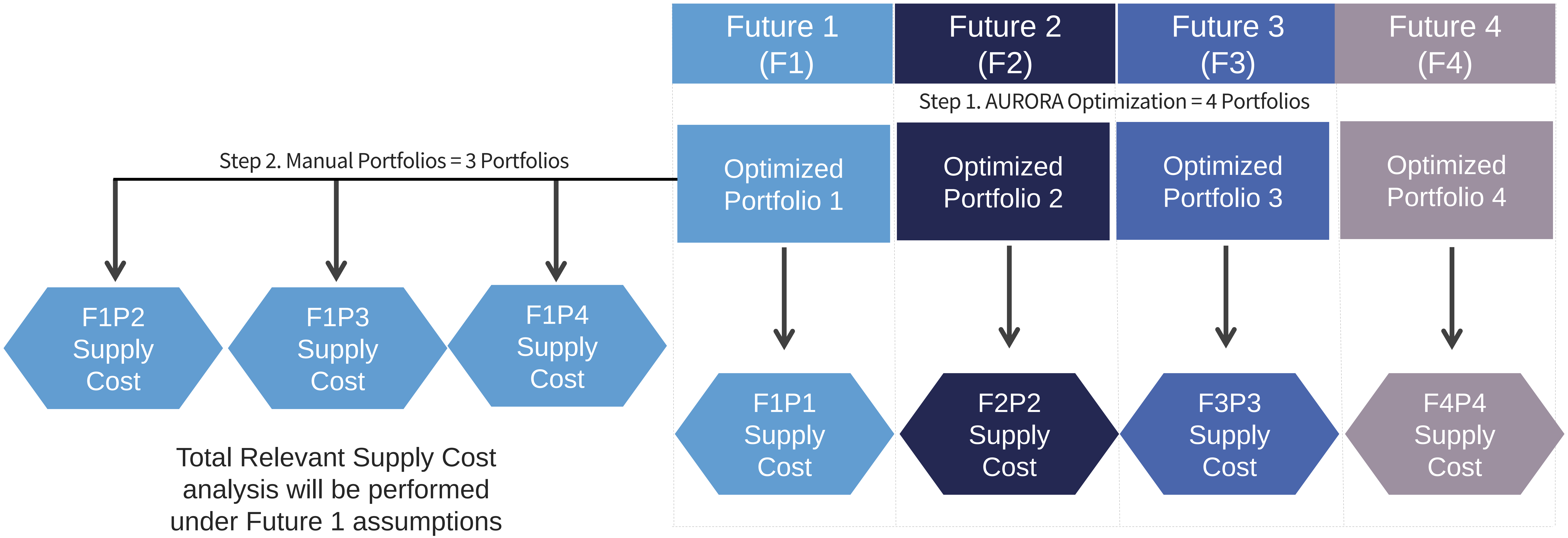
IRP Modeling Framework

The modeling will result in 7 future portfolios

Total relevant supply cost analysis will be performed for each portfolio and will be compared



Total Relevant Supply Cost analysis will be performed under Future 1 assumptions with modified deactivation dates for White Bluff and Independence

Market Build for 2021 EAL IRP

1) Turn off MISO-S 1st Tier Markets & Separate EAL from Market

2) Develop an Energy Market Model for Each Future with Attributes that Correspond to that Future

Futures Assumptions				
	Progression Towards Resource Mix (reference)	Current Environment Persists (gas centric)	Decentralized Focus (DSM & renewables)	Economic growth with an emphasis on renewables (growth & renewables)
Peak / Energy Load Growth	Reference	Reference*	Low	High
	[See slide 8 for details related to Load Scenarios and Levers for each Future]			
Natural Gas Prices	Reference	Low	Low	High
DR / EE / DER Additions	Medium	Low	High	Medium
Market Coal Retirements	Reference (60 years)	Reference (60 years)	Accelerated (55 years)	Accelerated (50 years)
Legacy Gas Fleet Retirements	Reference (60 years)	Reference (60 years)	Accelerated (55 years)	Accelerated (50 years)
Magnitude of Coal & Legacy Gas Deactivations	23% by 2030 69% by 2040	23% by 2030 69% by 2040	49% by 2030 84% by 2040	67% by 2030 89% by 2040
CO2 Reduction Target	Reference	None	Reference	High

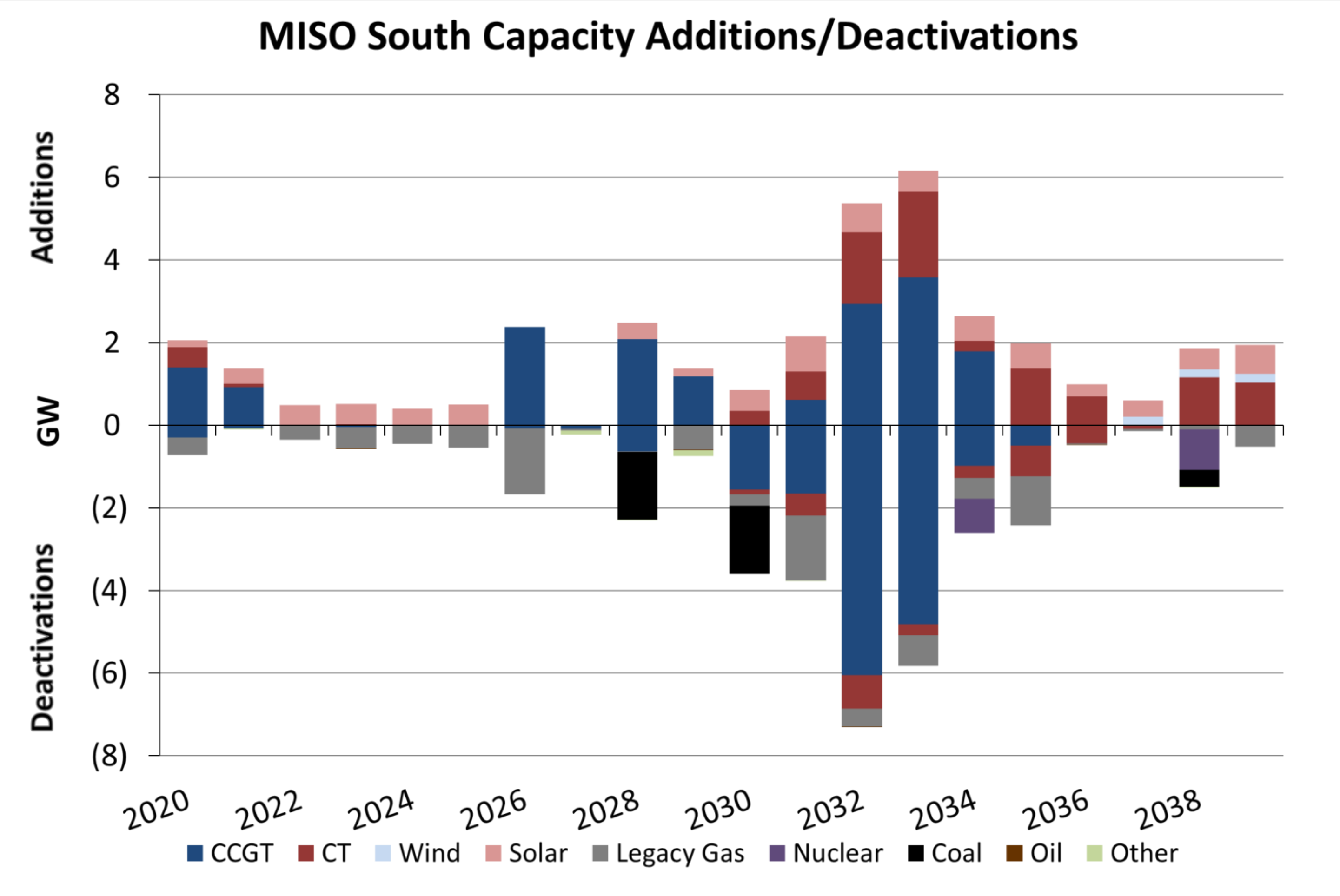
3) Model Resource Alternatives & Build Constraints

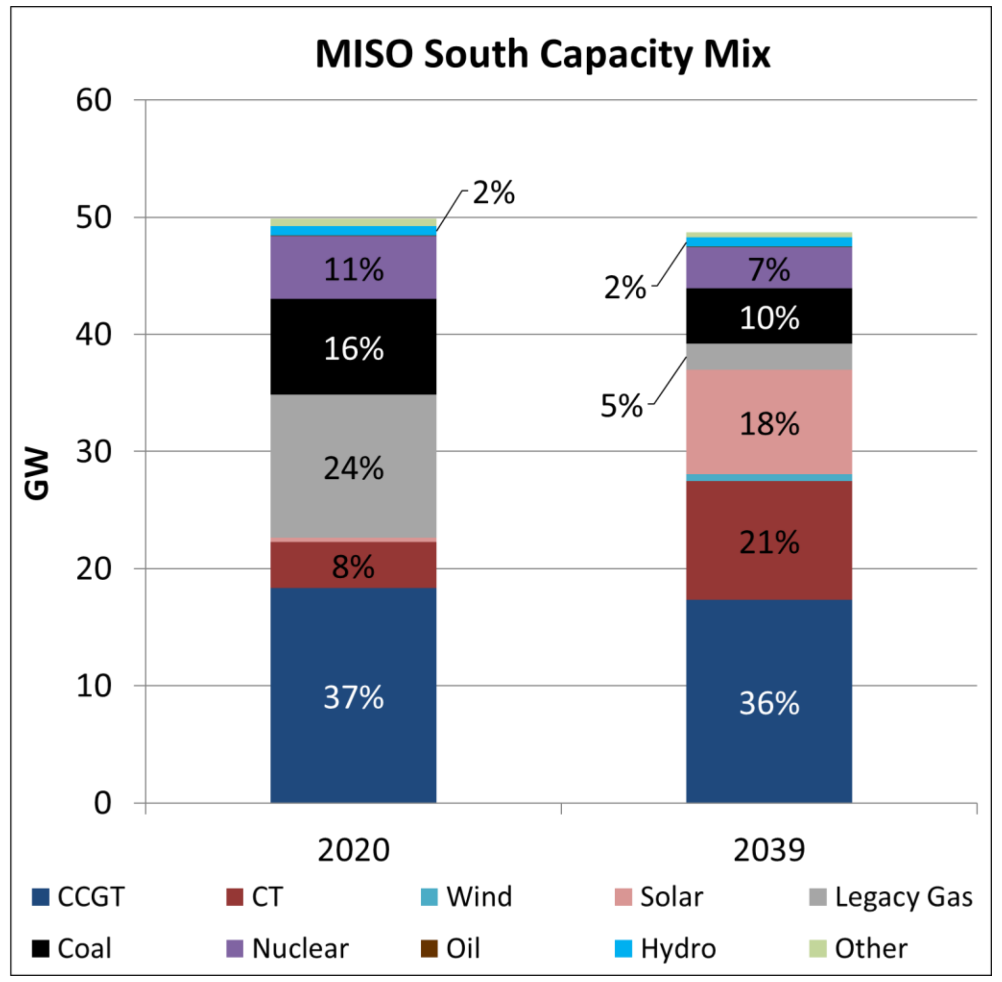
Illustrative resource alternatives and attributes

Type	Capacity (MW)	Installed Cost ($/kW)	Heat Rate (Btu/kWh)
CT	380	812	9,192
CCGT	1,333	909	6,343
Solar	100	1,287	n/a
Wind	200	1,470	n/a
Battery	20	1,633	n/a

4) Model Economic Capacity Expansion for the Market by Future

Illustrative example of resulting market build and market composition





IRP Futures & Load Scenarios

Futures for 2021 EAL IRP

Market Futures Assumptions				
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	Future 1	Future 2	Future 3	Future 4
Generation Focus	Gas & Renewables	Gas	DSM & Renewables	Renewables

*Load levers for this future are expected to result in peak and energy levels slightly lower than reference, however the profile/shape will vary due to different underlying assumptions

IRP Load Scenarios

IRP Load Scenarios and Levers

	Item	Future 1: Reference Case	Future 2: Current Environment Persists; Gas Centric	Future 3: Decentralized Focus; DSM and Renewables	Future 4: Economic and Renewables Growth
Traits	Policy Traits		Renewables are not encouraged; Decreasing utility DSM; No incentives for BTM solar	Significant increase in BTM solar + battery; Increased utility DSM; Increased EV adoption	Higher EV and non-EV electrification; More utility DSM; Utility-scale solar favored over BTM solar
Traits	Other Traits		Lower residential and commercial growth; Flatter Large Ind. growth	Healthy economic conditions; Res/Com and Ind growth	Higher economic growth and technology adoption
Results	Peaks	Reference	Lower: Slower growth in customer counts offsets declines in DSM; Industrial growth softens	Higher: Increased EV adoption is somewhat offset by increases in BTM solar and increased OpCo DSM	Higher: High EV adoption and building electrification, higher growth in Res/Com/Ind offset increased BTM solar
Results	Energy	Similar to Reference			
Results	Load Shapes	Similar to Reference	Similar to 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
Inputs	BTM Solar	ICF Reference	ICF Low	ICF High + Batteries	ICF High + Batteries
Inputs	Electric Vehicles (EVs)	Reference EV (2075)	Reference EV (2075)	Higher EV (2055)	High EV (2040)
Inputs	Building Electrification	Reference	Reference	Reference	High
Inputs	OpCo DSM	Reference	Reference	Reference	Reference
Inputs	Res. & Com. Growth	Reference	Lower	Reference	Higher
Inputs	Refinery Utilization due to EVs	Reference	Reference	Lower (opposite of EVs)	Lower (opposite of EVs)
Inputs	Industrial Growth	Reference	Lower	Reference	Higher

IRP Portfolio Deactivation Sensitivities

Proposed Deactivation Sensitivities

Sensitivity 1 White Bluff Deactivation	Sensitivity 2 White Bluff Deactivation	Sensitivity 3 Independence Deactivation
White Bluff Unit 1: 2023	White Bluff Unit 1: 2026	Independence Unit 1: 2026
White Bluff Unit 2: 2026	White Bluff Unit 2: 2026	Independence Unit 2: 2026
Independence Unit 1: 2030	Independence Unit 1: 2030	White Bluff Unit 1: 2028
Independence Unit 2: 2030	Independence Unit 2: 2030	White Bluff Unit 2: 2028

Stakeholder Feedback Response, December 16, 2020:

"…as part of its 2021 IRP modeling, EAL will include portfolio scenarios that assume deactivation dates that are earlier than EAL's current planning assumption for its White Bluff and Independence generating units. The IRP Report will include an assessment of the impacts of those earlier dates on total supply costs compared to alternative portfolios, as well as the viability of earlier deactivations."

ICF DSM Potential Study

Demand-Side Management (DSM) Potential Study

- EAL has retained ICF to conduct a forecast of the achievable potential of selected demand response (DR) program types and distributed energy resource (DER) technologies on EAL's system from 2023-2042.
- Event-based DR programs will be analyzed for residential, commercial and industrial customers.
- The following behind-the-meter DER technologies to be forecasted:

	Residential	Non-Residential
Solar PV	✓	✓
Standalone Battery	-	✓
Solar + Battery	✓	✓

- Output from the ICF study will be used as inputs to the IRP modeling:
  - Reference, high and low hourly DER load shapes will be mapped to the respective Future load forecast, resulting in various levels of load reduction.
  - The DR programs for the reference, high and low hourly load shapes will be included for selection in the AURORA capacity expansion model using the program cost associated with the demand savings.

Timeline of DSM Deliverables

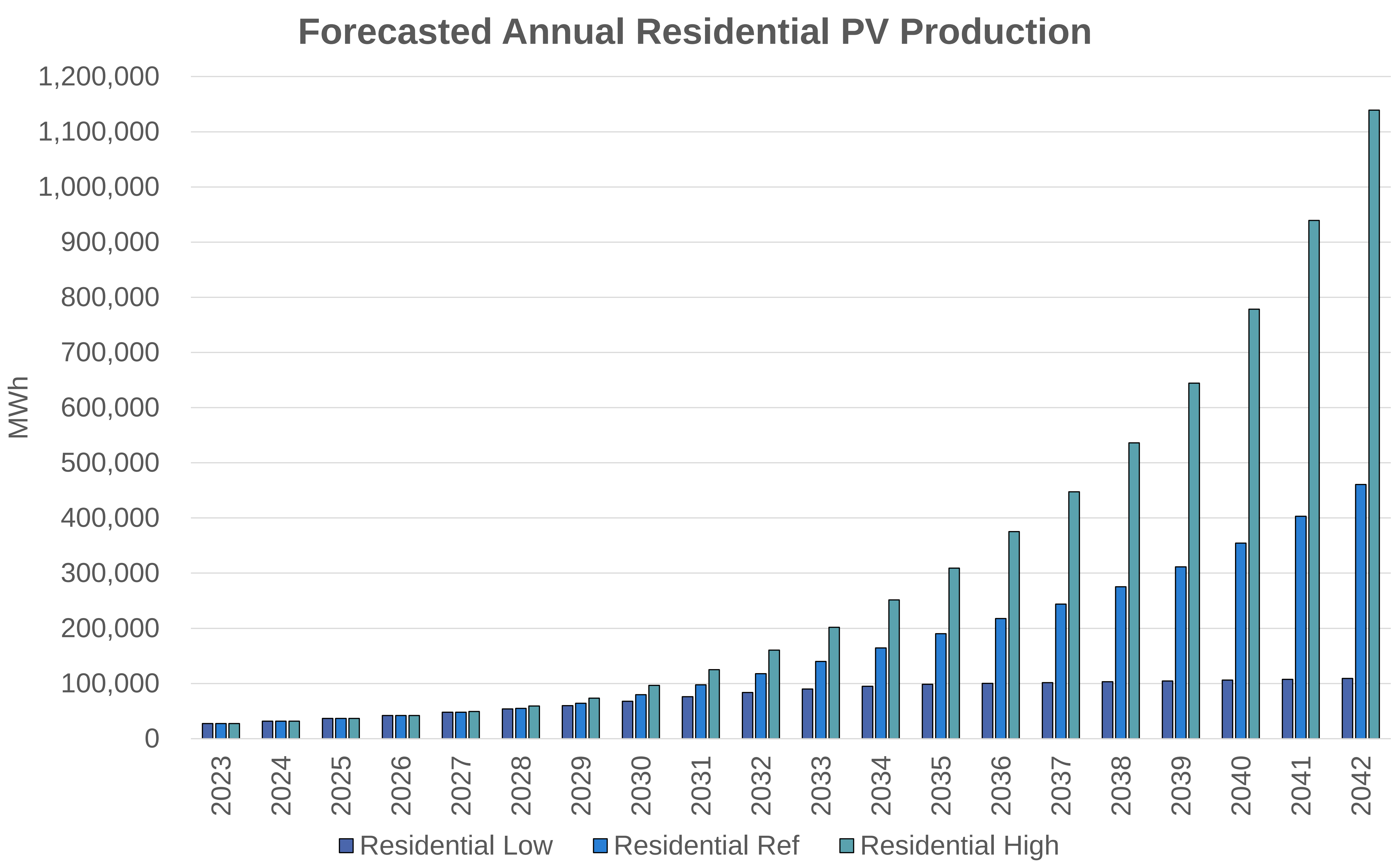
2020

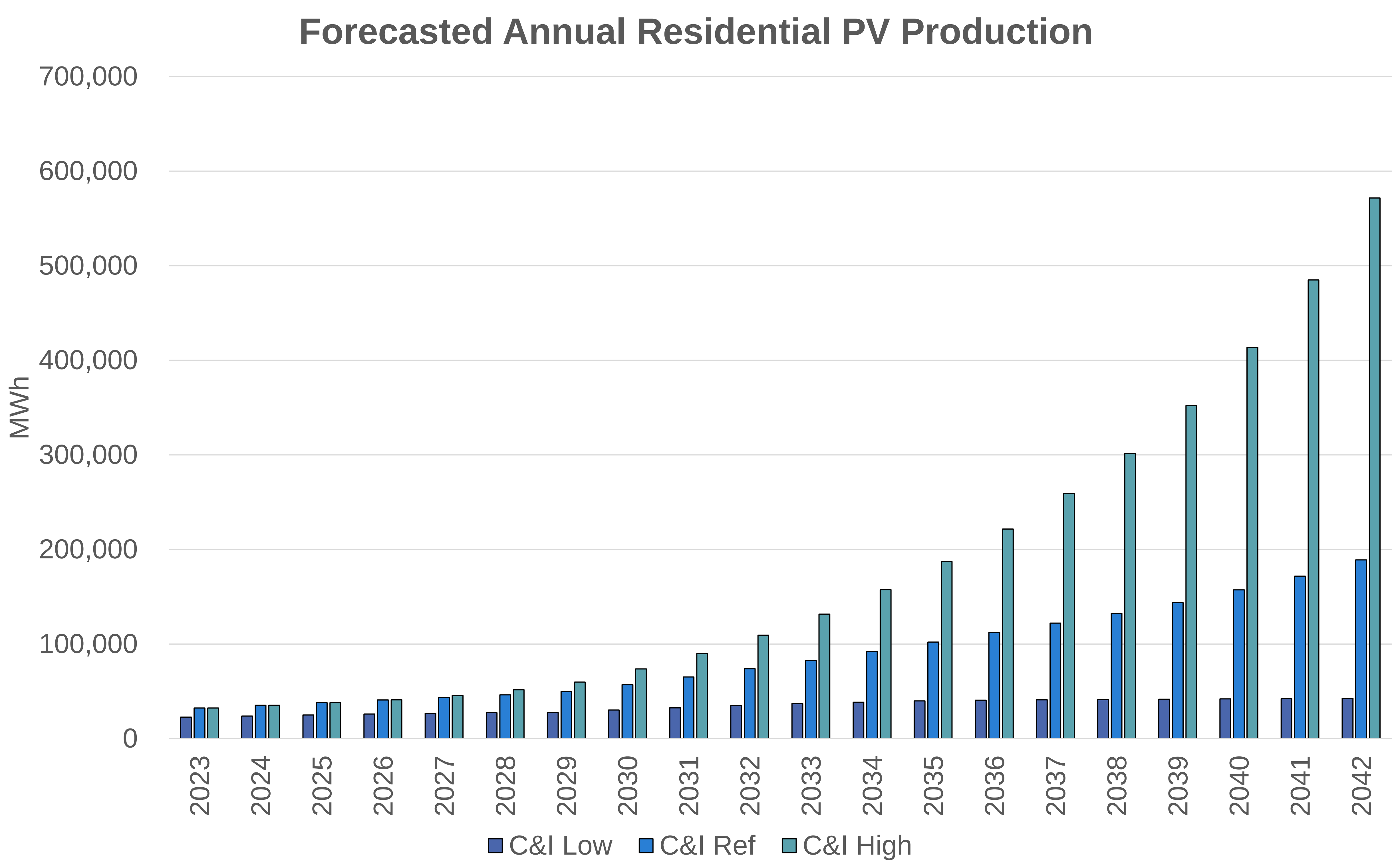
- Oct — ICF initiates data request to EAL
- Nov — Finalize input assumptions
- Dec — DER preliminary results
- Jan — DER final results
- Feb — DR results / Final report

2021

- ICF has completed the DER portion of the study on schedule; the DR portion is in process and is expected in February
- Timeline is subject to change

Preliminary DER Potential Study Results
PV Energy Production





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BP21 Refresh Technology Assessment Summary

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- **Overview**
  - Background
  - Continous Technology Monitoring: Four Lenses
  - Technology Assessment: Screening Method

- **Technology Assessment**
  - Technical Screening
  - Economic Screening
  - Technology Selection

Introduction

- Entergy leads ongoing cross-functional efforts to monitor and assess the cost & performance of certain supply-side alternatives for modeling purposes

- Cost & performance estimates are intended to be generic in support of long-term planning and modeling analyses

- Site and project-specific factors will impact costs and performance with related factors incorporated within project specific scenarios

- This process relies on internal sources, including: CP, PG, & third-party consultants (B&V, WP, IHS and EPRI), and publicly available information (WM, EIA, ES, LNBL & NREL)

  - Gas, Coal, Biomass, Hydrogen, and Nuclear: EPRI (main source), WP, CP, PG, and EIA

  - Wind, Solar, Hydroelectric, and Battery: IHS (main source), WM, ES, LNBL, NREL, and DOE

B&V = Black &Veatch | WP = Worley Parsons | IHS = Information Handling Service (CERA) | EPRI = Electric Power Research Institute | WM = Wood Mackenzie | EIA = Energy Information Administration | ES = Energy Sage | LNBL = Lawrence Berkeley National Laboratory | NREL = National Renewable Energy Laboratory | CP = Entergy Capital Projects | PG = Entergy Power Generation

Updated

Purpose: Technology Assessment

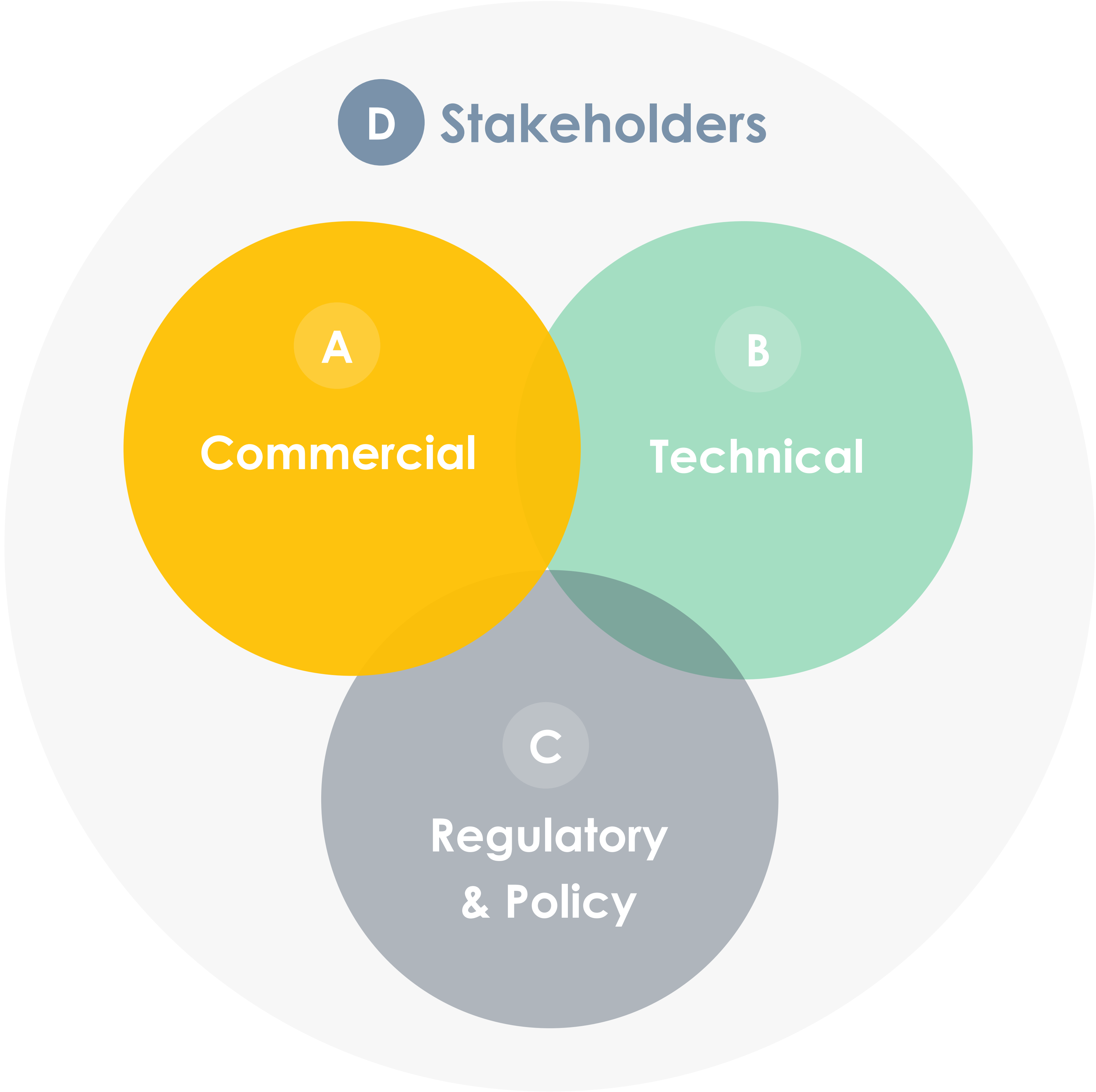
- Growth in load forecast, reserve requirements, and planned unit retirements or expiration (and non-renewal) of purchase power agreements (PPA's) mandate additions of new generation.
- Part of new generation need is met via DSM resources and the rest by a potential range of supply-side resources.
- Potential supply-side resources considered include technologies with different fuels and renewable technologies, including:

STORAGE	CONVENTIONAL GENERATION*	NUCLEAR	COAL	SOLID FUEL	WIND	SOLAR	WATER

Notes:
* Any large-scale future gas resources will be hydrogen capable.

Technology Assessment: Four Lenses

As part of an on-going process, Entergy evaluates existing, new and emerging technologies to meet supply-side resource needs.



A COMMERCIAL
What are a technologies **cost** and **market** indicators?

B TECHNICAL
What are the **operational**, **environmental**, and **internal capability** factors associated with a specific technology?

C REGULATORY & POLICY
How do **regulatory bodies** and **federal + state policies** encourage or disincentivize deployment?

D STAKEHOLDERS
How does the technology deliver on the **needs** and **expectations** of our four key stakeholders? **Customers, Communities, Employees, and Shareholders**.

TA Updates and Corporate Sustainability Commitments

- In this IRP, we adopted a screening approach to evaluate the cost-effectiveness and feasibility of deployment of potential resources. This screening consist of quantitative and qualitative criteria that have informed a final selection of supply-side generation alternatives to be included in capacity expansion models.
- EAL continues to focus on balancing affordability, reliability, and environmental stewardship, which includes efforts to reduce emissions profile of supply-side resources over time. These efforts in environmental stewardship are supported by increasing emphasis on decarbonization in state and federal policy conversations as well as increasing announcements of customer climate-related goals. Incorporation of new technologies is one of the ways that protect customers against long-term risks and enable customers to meet their own sustainability objectives. The company is committed to ensuring that the investments we make today continue to serve our customers long into the future.
- For this reason, all future conventional generation plants will be hydrogen capable, allowing these highly efficient machines to transition to hydrogen fuel when it is in the best interest for customers.
  - In alignment with our recent public commitments, we have updated our future new conventional generation alternatives to reflect hydrogen- capability.
  - The OpCo build for capacity expansion will include only conventional generation that is hydrogen-capable.

Supply-side alternatives: Screening Approach

Screening approach is designed to evaluate the cost-effectiveness and feasibility of deployment of potential resources.

TECHNICAL SCREENING

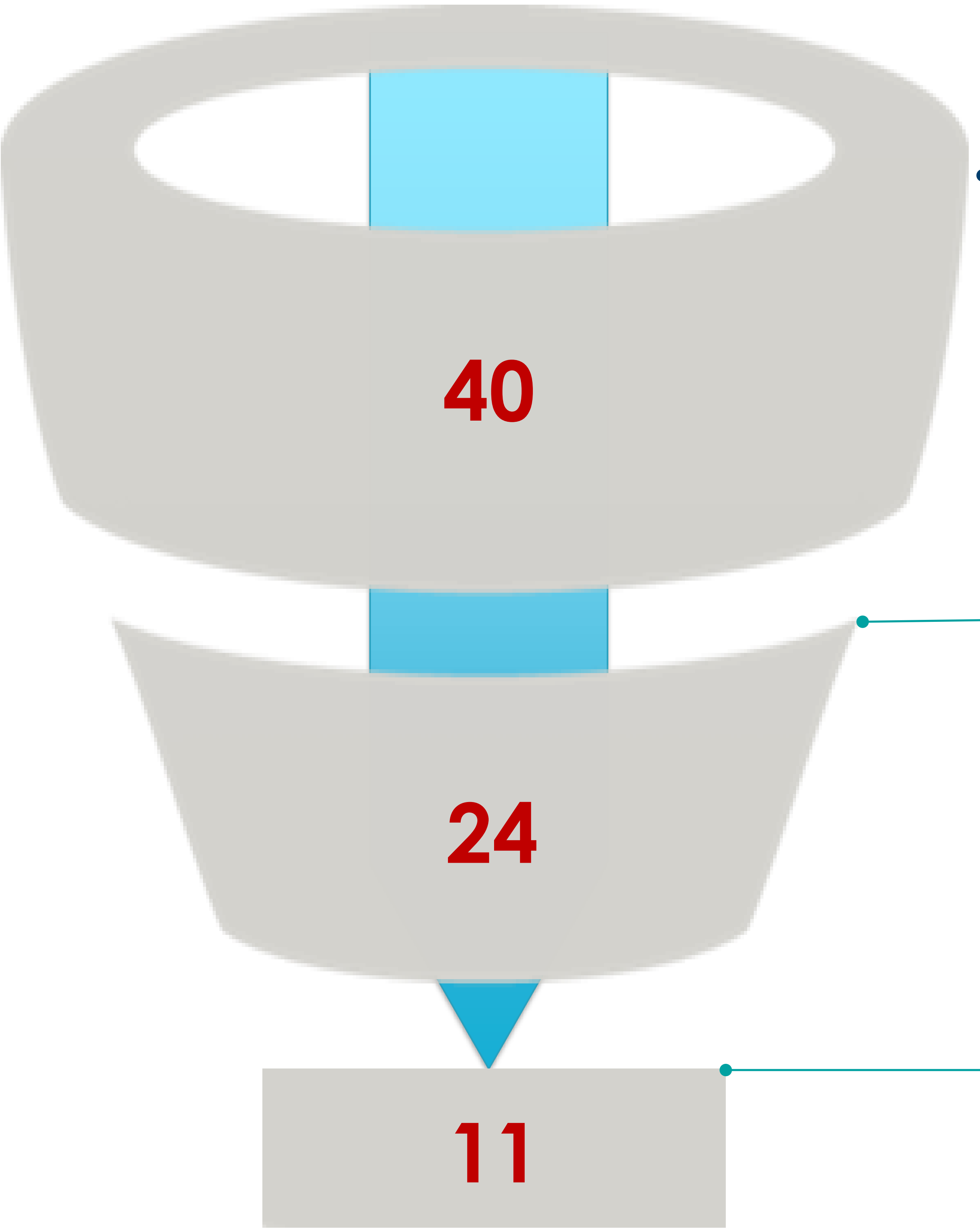
The technical screening process evaluates potential supply side alternatives based on technology maturity, environmental impact, fuel availability, and feasibility to serve EAL's generation needs. From this, generation alternatives are narrowed down for inclusion in the economic screening.

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 EAL'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

Generation Alternatives: Expansion in 2021 IRP Cycle

- In this 2021 IRP cycle, Entergy evaluated 40 generation alternatives to meet load projections and planning criteria.
- Below is a comparison between the generation alternatives evaluated in the 2018 and the ones in the 2021 IRP cycles included through the economic screening. Alternatives under consideration include conventional generation*, renewables, and storage alternatives.

EXPANSION OF GENERATION ALTERNATIVES

GENERATION ALTERNATIVES (2018 IRP)

NATURAL GAS	RENEWABLES + STORAGE
1x1 CCGT M501JAC w/ Duct Firing	Solar, Mono PV *(Utility-scale)*
2x1 CCGT M501JAC w/ Duct Firing	Onshore Wind
CT M501JAC	Lithium-Ion Battery
LMS100PA	
RICE	

GENERATION ALTERNATIVES (2021 IRP)

CONVENTIONAL GENERATION*	RENEWABLES + STORAGE
1x1 CCGT M501JAC w/o Duct Firing + H2*	Solar, Mono & Bifacial *(Utility-scale)***
1x1 CCGT M501JAC w/ Duct Firing + H2*	Solar, Off System, ERCOT
2x1 CCGT M501JAC w/o Duct Firing + H2*	On-shore Wind
2x1 CCGT M501JAC w/ Duct Firing + H2*	On-shore Wind, Off System, SPP
CT M501JAC (Fast) + H2*	Off-shore Wind, Fixed, GOM
LMS100PA + H2*	Off-shore Wind, Floating, GOM
RICE + H2*	Hydro, New Stream
2x1 CCGT 9HA.02 + 98.5% CCS	Hydro, Non-Powered Dam
Solid-Oxide, Fuel Cell	Nuclear, Small Modular Reactor (SMR)
	Nuclear III+ AP 1000 (PWR)
	Lithium-Ion Battery
	Sodium Sulfur
	Vanadium Redox
	Pumped Storage Hydro
	Compressed Air

Notes:

*Any large-scale future gas resources will be hydrogen capable.

***Only solar, bifacial new to 2021 IRP*

Supply-side alternatives: Screening Approach

Screening approach is designed to evaluate the cost-effectiveness and feasibility of deployment of potential resources.

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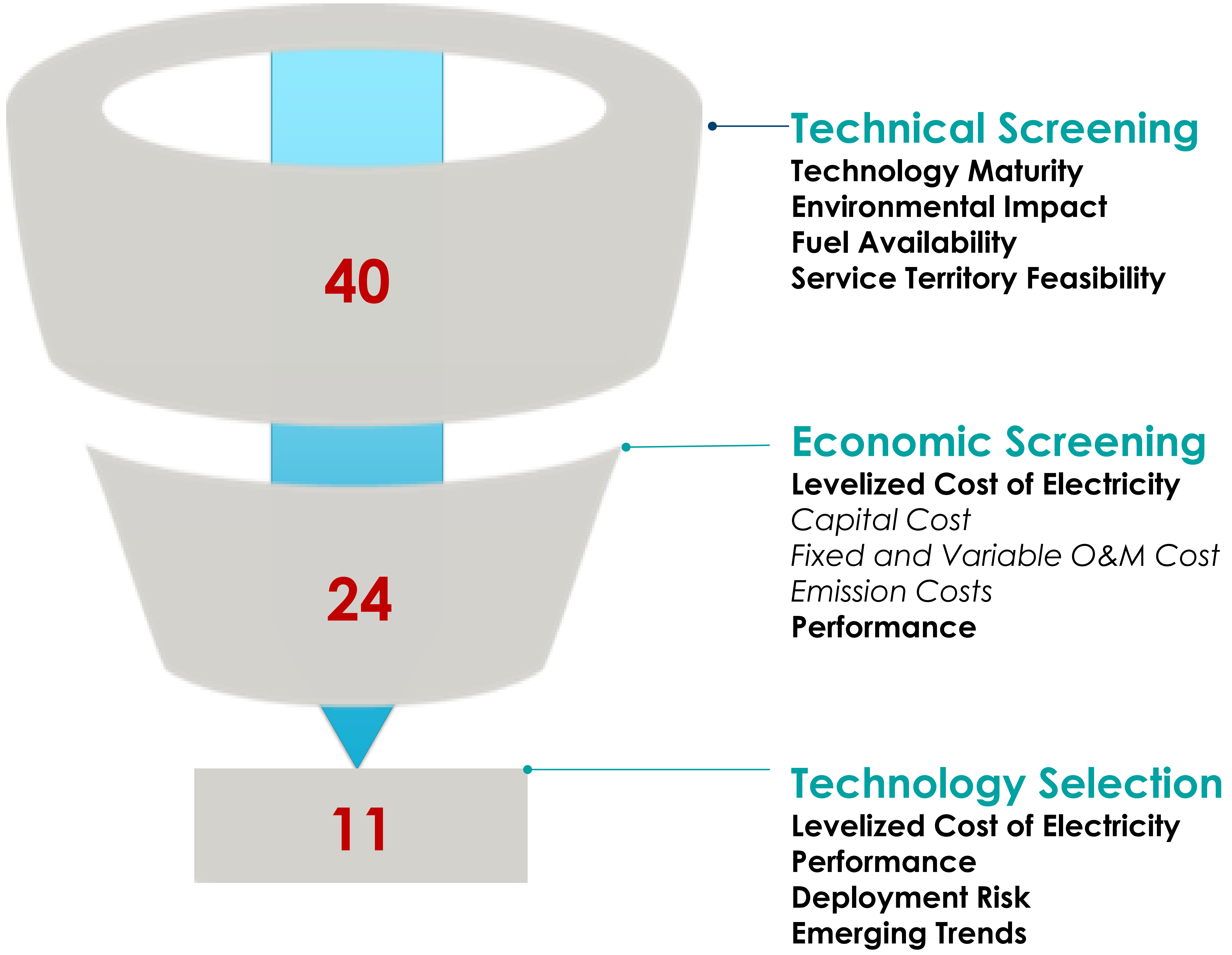

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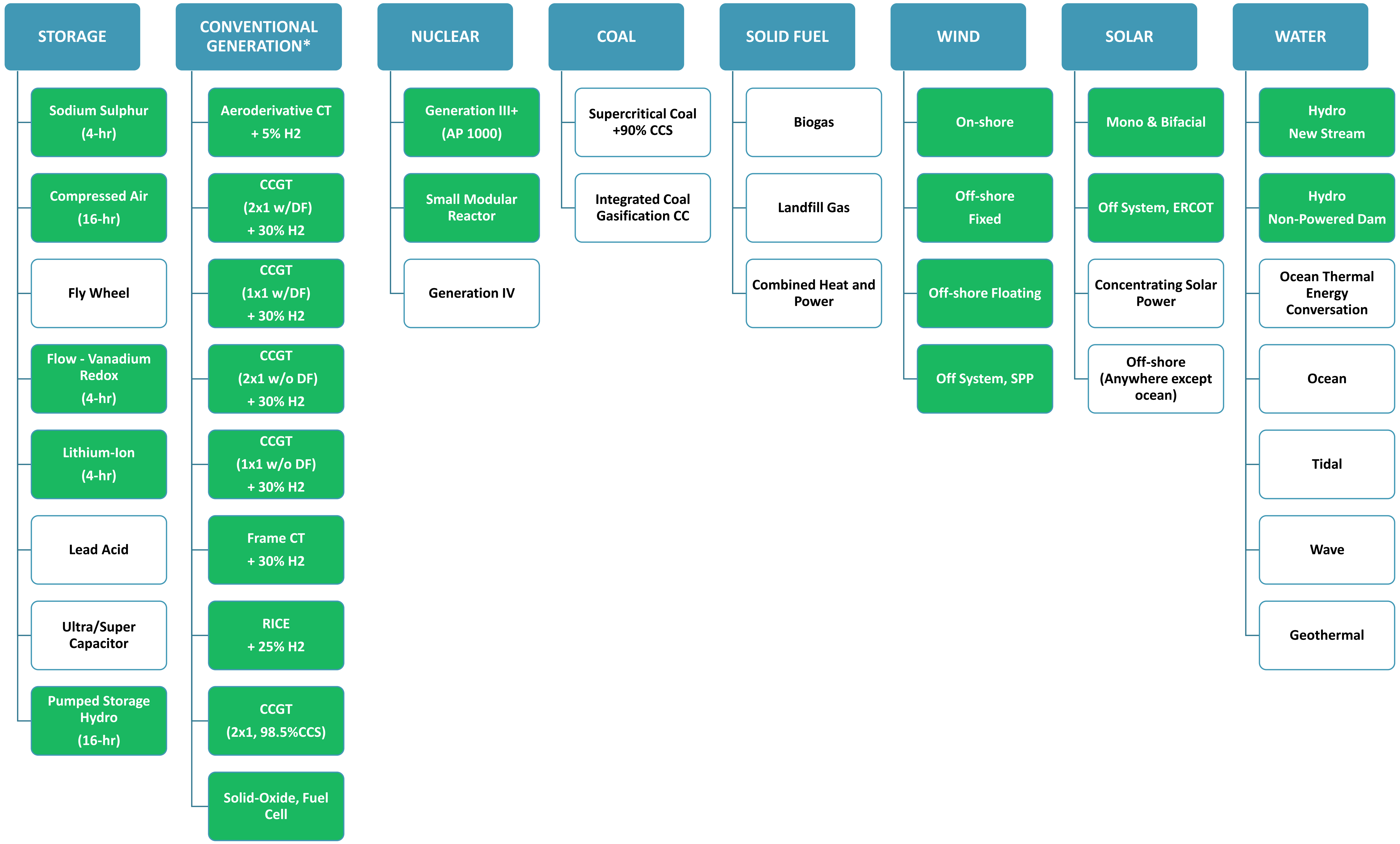
Technical Screening

Evaluated 40 generation alternatives with 24 selected for the economic screening:



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SELECTED FOR ECONOMIC SCREENING

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Technology Maturity Level: Definitions

RESEARCH:

1) Basic principles observed: Scientific observations made and reported. Examples could include paper-based studies of a technology's basic properties.

2) Technology concept formulated: Envisioned applications are speculative at this stage. Examples are often limited to analytical studies.

3) Experimental proof of concept: Effective research and development initiated. Examples include studies and laboratory measurements to validate analytical predictions.

DEVELOPMENT

1) Technology validated in lab: Technology validated through designed investigation. Examples might include analysis of the technology parameter operating range. The results provide evidence that envisioned application performance requirements might be attainable.

2) Technology validated in relevant environment: Reliability of technology significantly increases. Examples could involve validation of a semi-integrated system/model of technological and supporting elements in a simulated environment.

DEMONSTRATION

1) Technology demonstrated in relevant environment: Prototype system verified. Examples might include a prototype system/model being produced and demonstrated in a simulated environment.

DEPLOYMENT:

1) System Prototype demonstration in operational environment: A major step increase in technological maturity. Examples could include a prototype model/system being verified in an operational environment.

2) System complete and qualified: System/model produced and qualified. An example might include the knowledge generated from the above being used to manufacture an actual system/model, which is subsequently qualified in an operational environment. In most cases, this represents the end of development.

3) Actual system proven in operational environment/market: System/model proven and ready for full commercial deployment. An example includes the actual system/model being successfully deployed for multiple missions or sustained operations by end users.

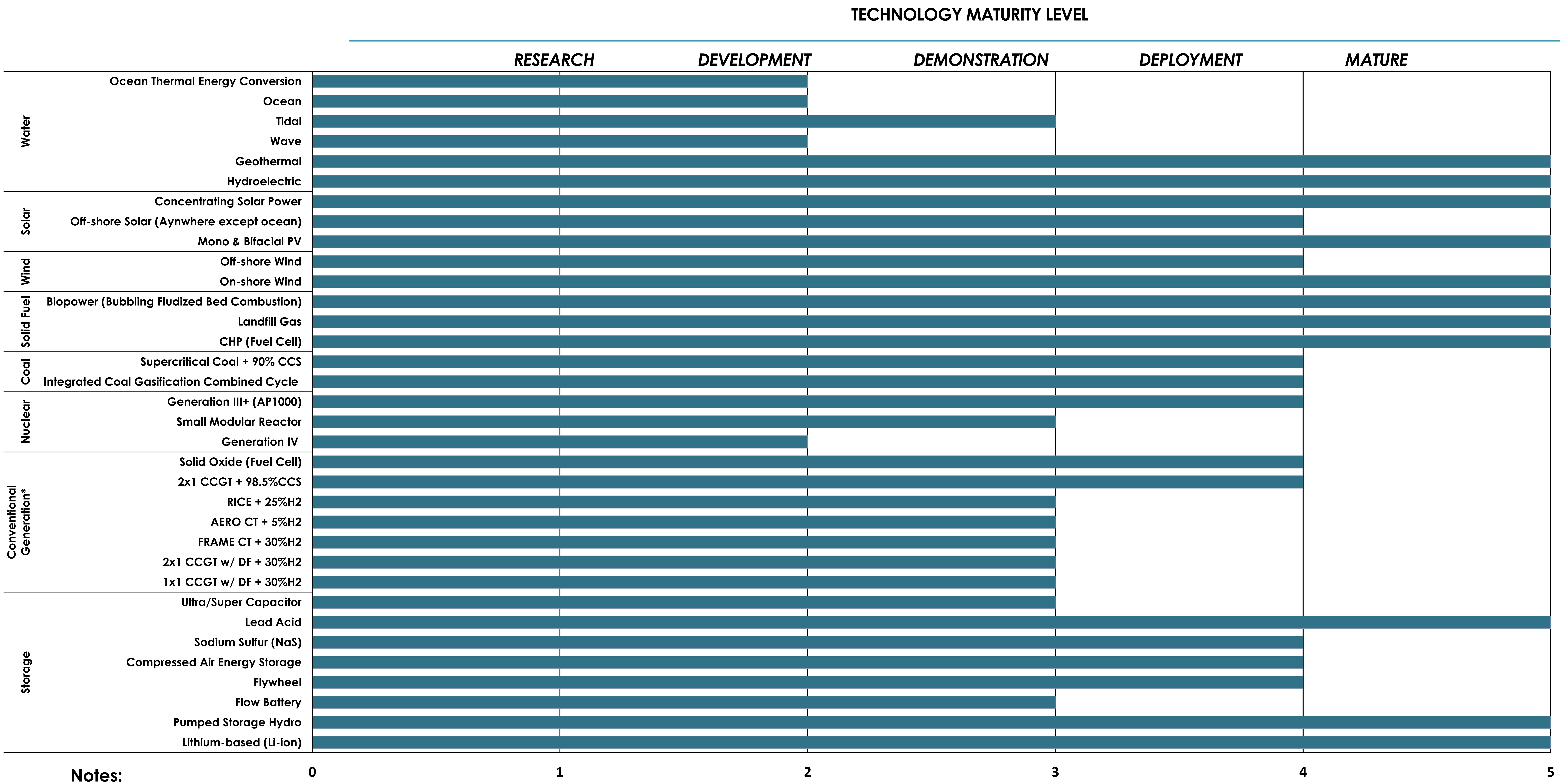
ESTABLISHED/MATURED:

1) The proven technology: It has achieved vast commercial success. An example, the cost and performance information is readily only after a technology has been used at many different sites and the result fully documented is that technology considered.

Source: TWI UK

Updated

Technology Maturity Levels



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Evaluation: Water

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
HYDRO (NPD & NSD)	Higher initial cost relative to lower-cost renewables in the market with environmental impacts on water cycle/health condition and fishery. It is impacted by downstream drought condition and deployment limited by geographical location. Normally provides peaking support, sometimes baseload (run-of-river) with black start capabilities. Produces no air pollution.	Mature	**YES**
WAVE	Wave technology span from early-stage research and development to precommercial demonstration.	Development	**NO**
TIDAL	Tidal energy has had some pre-commercial success globally and approaching commercialization in some projects due to similar engineering attributes with wind. Its small relative size is limiting deployment and slowing industry maturation.	Demonstration	**NO**
OCEAN	Ocean has only been validated at the laboratory and/or prototype scale; no prototypes have yet been deployed in open ocean.	Development	**NO**
OCEAN THERMAL ENERGY CONVERSION	The scale of Ocean Thermal Energy Conversion (OTEC) power plants must grow to 100MW to realize cost reductions large enough for commercialization and technological success. Deployments to date have been at a scale 1/100th of that size.	Development	**NO**
GEOTHERMAL	High initial cost relative to lower-cost renewables in the market and deployment limited by geographical location.	Mature	**NO**

Notes:

Comprehensive and detailed narrative around technologies to be included in the IRP document.

Evaluation: Solar

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
MONO & BIFACIAL PV (Utility-scale)*	Capital cost and fixed O&M cost have fallen dramatically in the last decade. Solar adds fuel diversity to gas-centric resource portfolios and provide a hedge against at risk coal capacity. Deployment can be scaled up or down to meet capacity needs more easily relative to conventional alternatives. Solar also offers customers protection against uncertainty related to potential CO_2 costs.	Mature	**YES**
OFF-SHORE SOLAR (Anywhere except Ocean)	Little to no costs involved with location, reduction in evaporation losses, ease of deployment, water available for cleaning, increased efficiency from cooling effect of water, and helps ecosystem. Risks and challenges include electrical safety and longevity of equipment, possible environmental impact from light reduction, maintenance (may require boats and divers), and as of now, only deployed in Europe and Asia.	Deployment	**NO**
CONCENTRATING SOLAR POWER	High initial cost relative to lower-cost renewables in the market. Mostly ideal for U.S. Southwest.	Mature	**NO**

- Off-system solar (ERCOT) is also contemplated.

Notes:

Comprehensive and detailed narrative around technologies to be included in the IRP document.

Evaluation: Wind

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
ONSHORE*	Capital and fixed O&M costs have consistently fallen over the last decade. Current research focuses more on improving performance rather than cost through larger, taller turbines and improved control technologies (e.g., turbine alignment sensors, integrated battery storage). Off-system wind such as SPP region and North West of Arkansas territory could play a role in the energy mix but requires significant high voltage direct current (HVDC) projects to be completed.	Mature	**YES**
OFFSHORE	When compared to on-shore, off-shore turbines cost, on average, 20% more with towers and foundations costing an additional 2.5x for a project of similar size to on-shore. In addition, the cost of offshore foundations, construction, installation, and transmission connection are generally higher than onshore. The nearest geographical location for a potential off-shore installation would be the Gulf of Mexico, making transmission upgrades and interconnection costs potentially prohibitive.	Deployment	**YES**

- On-shore, Off-system (SPP) is also contemplated.

Notes:

Comprehensive and detailed narrative around technologies to be included in the IRP document.

Evaluation: Solid Fuel

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
BIOPOWER (BUBBLING FLUIDIZED BED COMBUSTION)	High initial cost relative to lower-cost renewables in the market.	Mature	**NO**
LANDFILL GAS	High initial cost relative to lower-cost renewables in the market.	Mature	**NO**
COMBINED HEAT AND POWER (FUEL CELL)	High initial cost relative to lower-cost renewables in the market.	Mature	**NO**

Notes:

Comprehensive and detailed narrative around technologies to be included in the IRP document.

Evaluation: Coal

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
INTEGRATED COAL GASIFICATION COMBINED CYCLE	High initial cost relative to lower-cost renewables in the market. Coal price is almost the same or higher than the gas price.	Deployment	**NO**
SUPERCRITICAL COAL + 90% CCS	High initial cost relative to lower-cost renewables in the market. Acidification of streams during the extraction process. Coal price is almost the same or higher than the gas price.	Deployment	**NO**

Notes:

Comprehensive and detailed narrative around technologies to be included in the IRP document.

Evaluation: Nuclear

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
SMALL MODULAR REACTOR	Relatively lower capital and staffing costs with flexible and (quick start capabilities.	Demonstration	**YES**
GENERATION III+ (AP1000)	High initial cost relative to lower-cost renewables in the market with mediocre time lag period between planning and operation. Added risks for weapons proliferation, meltdown, waste, health, impact of natural disasters, and human error or attacks.	Deployment	**YES**
GENERATION IV	High initial cost relative to lower-cost renewables in the market with long time lag period between planning and operation. Added risks for weapons proliferation, meltdown, waste, health, impact of natural disasters, and human error or attacks.	Development	**NO**

Notes:

Comprehensive and detailed narrative around technologies to be included in the IRP document.

Updated

Evaluation: Conventional Generation*

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
COMBINED CYCLE GAS TURBINE (1x1) + 30%H2	Relatively moderate capital and staffing costs, lowest heat rates, synergies with existing and planned fleet (e.g., parts, staff).	Demonstration	**YES**
COMBINED CYCLE GAS TURBINE (2x1) + 30%H2	Moderate capital and staffing costs, lowest heat rates, and synergies with existing and planned fleet (e.g., parts, staff).	Demonstration	**YES**
FRAME COMBUSTION TURBINE FAST + 30%H2	Relatively low capital and staffing costs, existing operating expertise, flexible and quick start capability.	Demonstration	**YES**
RECIPROCATING INTERNAL COMBUSTION ENGINE + 25%H2	Low heat rates, highest flexibility, no gas compression needed, and ability for modular additions.	Demonstration	**YES**
AERODERIVATIVE COMBUSTION TURBINE + 5%H2	Higher flexibility with high reliability and moderate heat rates.	Demonstration	**YES**
COMBINED CYCLE GAS TURBINE + CARBON CAPTURE SEQUESTATION (98.5%)	High initial cost relative to lower-cost renewables in the market and acidification of streams during the extraction process. Currently, CCS would cost as much as the generator and the land requirements would be as much as the generator. Also, there is no full-scale CCGT in the world that utilizes CCS to manage emissions. Generator loses 20% of its efficiency. CCGT +CCS also has similar process to Coal with CCS.	Deployment	**YES**
SOLID-OXIDE (FUEL CELL)	High initial cost relative to lower-cost renewables in the market and high fixed o&m cost due to stack replacement costs. Stacks are multiple individual fuel cells combined into a single unit in order to generate larger amounts of power than possible with a single fuel cell. Solid-Oxide Fuel Cell (SOFC) is not yet fully proven at a commercial scale, but promising technology.	Deployment	**YES**

Notes:

* Any large-scale future gas resources will be hydrogen capable. Comprehensive and detailed narrative around technologies to be included in the IRP document.

Updated

Evaluation: Storage

TECHNOLOGY	KEY EVALUATION POINTS	MATURITY LEVEL	ECONOMIC SCREENING
PUMPED STORAGE HYDRO	Over 90% of worlds storage capacity is from pumped storage hydro plants. On a 16-hour basis, PSH are more cost-effective, providing bulk power and ancillary service to the grid at a low $/KW rate.	Mature	**YES**
LITHIUM-BASED (Li-Ion)	Capital cost and fixed O&M cost have constantly fallen in the last decade. Also, the li-ion industry is mature relative to the solar industry. Batteries are best suited to discharge times that are 4 hours or less.	Mature	**YES**
SODIUM SULFUR (NaS)	Currently, cost is twice more than the price for a project of similar size BESS. Also, it has mediocre round-trip efficiency with BESS.	Deployment	**YES**
COMPRESSED AIR ENERGY STORAGE	Ongoing efforts to reduce costs for these assets. At this time, changes within the next few years are not expected to lead to significant cost reductions. CAES involve long-range development timelines rendering a substantial reduction in costs unlikely in a relatively short number of years. On a 16-hour basis, CAES are more cost-effective compared to battery storage technologies in year 2025, while on 4-hour basis batteries are competitive.	Deployment	**YES**
FLOW BATTERY	Currently, high capital costs relative to alternatives (i.e., lithium-ion). However, there are promising developments that would reduce costs.	Demonstration	**NO**
FLYWHEEL	Ongoing efforts to reduce costs, however no changes within the next few years (2020 after) are not expected to lead to significant cost reductions due to their maturity.	Deployment	**NO**
LEAD ACID	Despite lead-acid batteries having a high technology readiness level, manufacturing readiness level and mediocre round-trip efficiency, their cycle life is limited, leading to a life of less than 3 years assuming one cycle per day.	Mature	**NO**
ULTRA/SUPER CAPACITOR	Provides high round trip efficiency and there are ongoing efforts to reduce costs for these assets, any changes within the next few years (2020 after) are not expected to lead to significant cost reductions due to their maturity. In addition, It also requires separate Power Conversion System compared to other alternatives	Demonstration	**NO**

Notes:

Comprehensive and detailed narrative around technologies to be included in the IRP document.

Economic Screening

Screening approach is designed to evaluate the cost-effectiveness and feasibility of deployment of potential resources.

TECHNICAL SCREENING

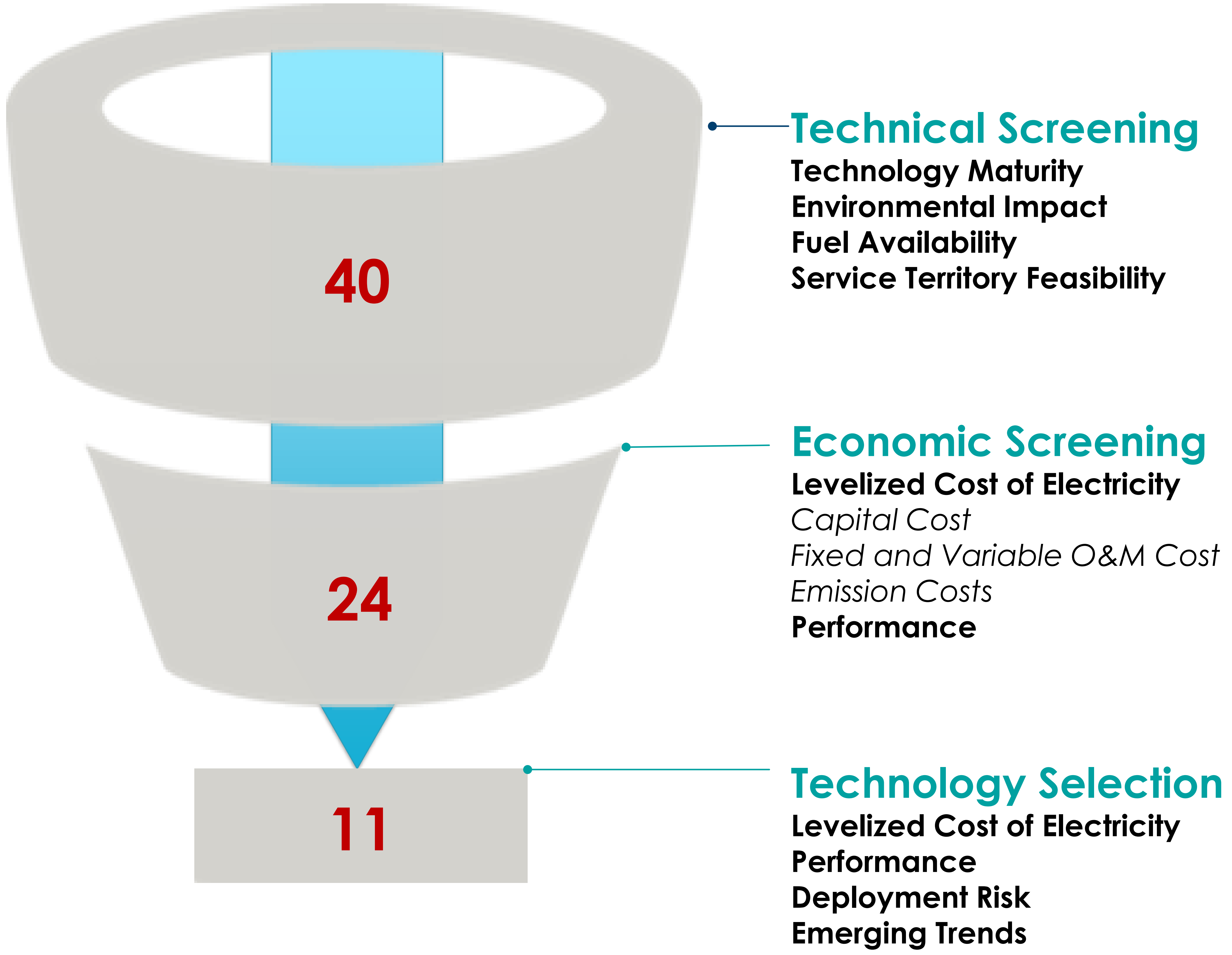
The technical screening process evaluates potential supply side alternatives based on technology maturity, environmental impact, fuel availability, and feasibility to serve EAL's generation needs. From this, generation alternatives are narrowed down for inclusion in the economic screening.

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.

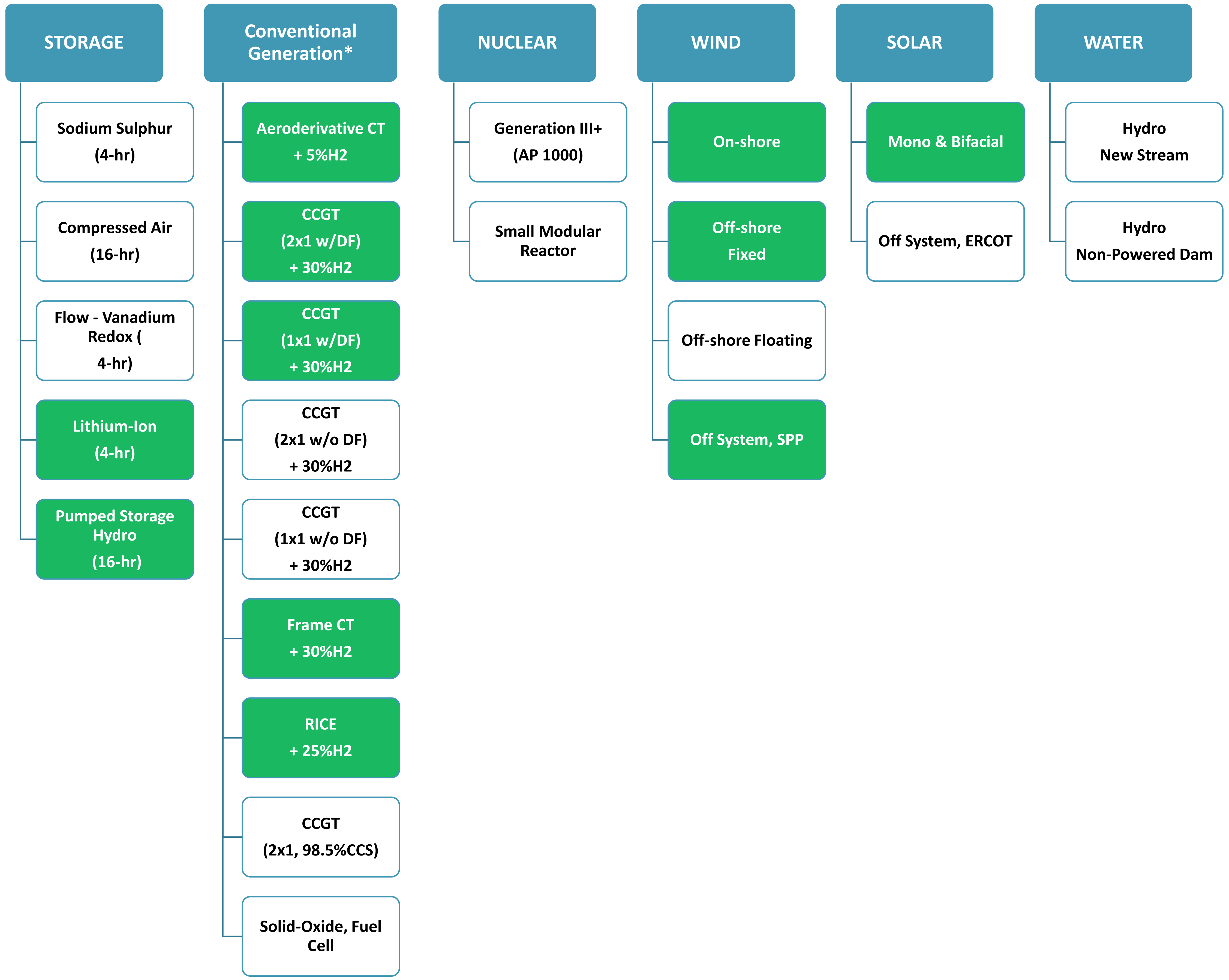
TECHNOLOGY SELECTION

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



Economic Screening

Economic screening evaluated 24 generation alternatives with 11 selected for EAL capacity expansion

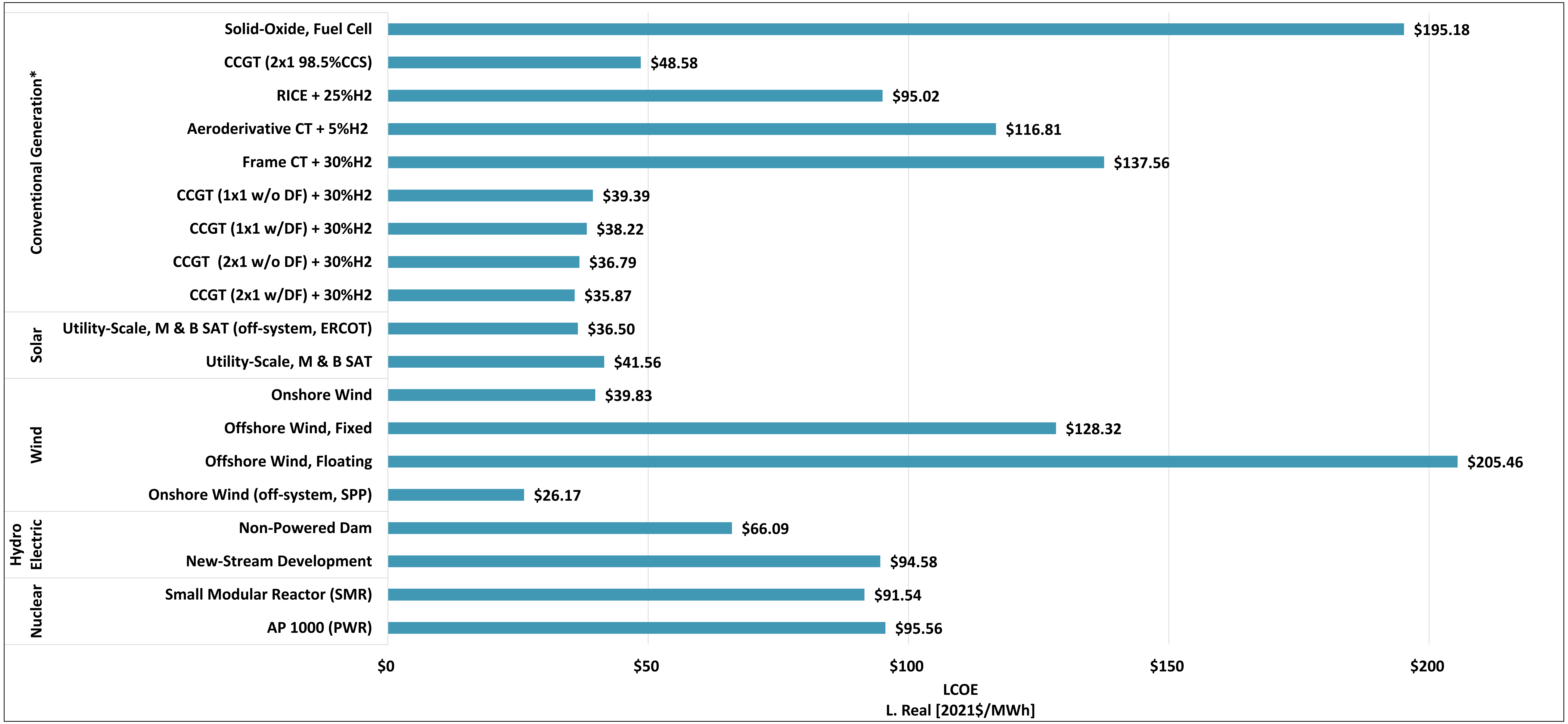


Notes:

* Any large-scale future gas resources will be hydrogen capable.

SELECTED FOR CAPACITY EXPANSION

Overview: Levelized Cost of Electricity



*Any large-scale future gas resources will be hydrogen capable. (H2 gas technologies show the installed capital cost to burn H2, but not the actual cost to burn H2. Currently under development to produce both the ICC and fuel cost associated with burning hydrogen and the reduction in emission cost.)

- 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 EAL WACC)
- LCOE for storage is not shown because as storage just moves MWh from one time to another there is no actual 'output' of energy therefore it's undefined.
- Both solar off-system (ERCOT) and wind off-system (SPP), does not include transmission cost.
- 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, between 2024 and 2025 receive 26% ITC, beginning 2026 and beyond receive 10% ITC. Assumes on-shore wind projects online in 2021 receive 80% PTC, between 2022 and 2025 receive 60% PTC, in 2026 or beyond are not eligible for tax credits. Assumes off-shore wind projects online between 2021 and 2035 receive 30% ITC.

Methodology: Levelized Cost of Electricity

- LCOE is a metric that measures the cost of generating energy for a particular system. LCOE is often cited as a convenient summary measure of the cost of different generating technologies. However, it is important to note that LCOE does not measure the distinct benefits of each generating technologies nor does it capture all the factors that contribute to actual investment decisions.
- Key inputs to calculating LCOE include installed capital cost, fixed o&m cost, variable o&m cost (emissions & fuel cost), applicable subsidies (ITC & PTC factored in the revenue requirement calculation) and revenue requirement (tax & discount rate), and assumptions regarding capacity factor, useful life, and efficiency.
- Following below is a simple way of showing the calculation method of LCOE.

$$\frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

I_t = Investment expenditures in year t (including financing)
M_t = Operations and maintenance expenditures in year t
F_t = Fuel expenditures in year t
E_t = Electricity generation in year t
r = Discount rate
n = Life of the system

Source: Department of Energy (2015)

Assumptions: Extended PTC & ITC

Required Construction Start [yr.]	Required Online Date [yr.]	PTC [%]	ITC [%]
Solar			
2016 – 2019	2021 – 2023	N/A	30%
2020 – 2022	2024 -2025	N/A	26%
Any	2026 - Beyond	N/A	10%
On-shore Wind			
2017	2021	80%	24%
2018	2022	60%	18%
2020 or 2021	2023-2024	60%	18%
2021	2025	60%	18%
N/A	2026- Beyond	N/A	N/A
Off-shore Wind			
2017 – 2025	2021 -2035	N/A	30%
N/A	2036 – Beyond	N/A	N/A

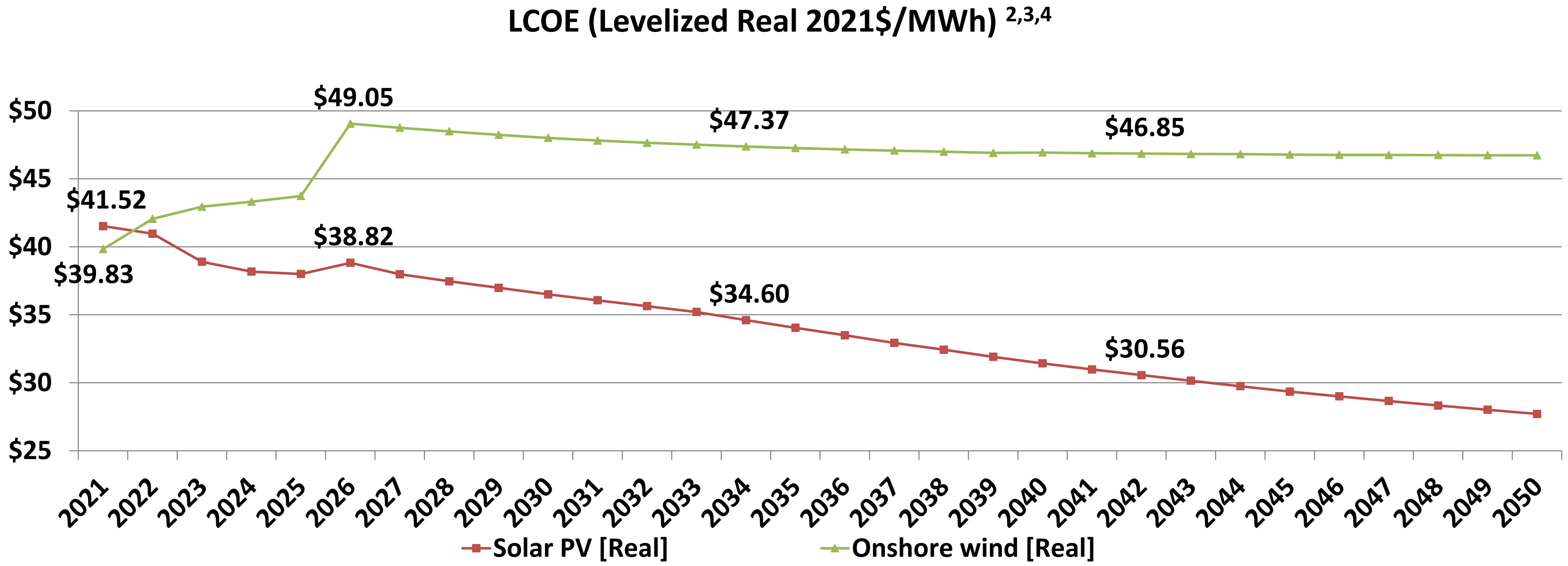
Note

Production Tax Credit (PTC) and Investment Tax Credit (ITC) assumptions included in the EAL IRP evaluation will assume eligibility that is most favorable for each technology and online date. As resources are procured, eligibility will be determined on a project-specific basis.

Assumptions: Renewables (Solar PV & Wind – MISO S.)

Modeling Assumptions

	Solar	Wind
Size (MW)	100MW	200MW
Fixed O&M (Levelized R. 2021$/KWac-yr) [1]	$10.31	$37.59
Useful Life (yr)	30	30
MACRS Depreciation (yr)	5	5
Capacity Factor	25.5%	36.8%
DC:AC	1.30	N/A
Hourly Profile Modeling Software	PlantPredict	NREL SAM

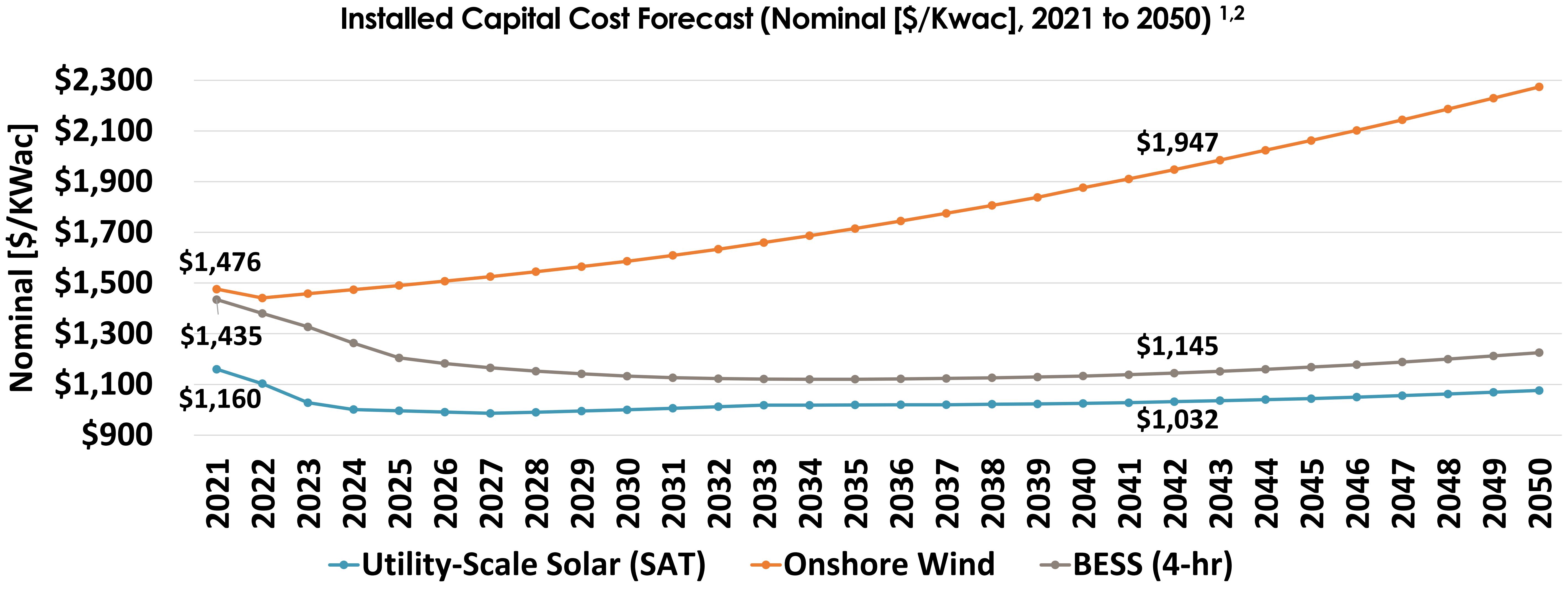


Note:

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 EAL 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.
4. Assumes solar projects online between 2021 and 2023 receive 30% ITC, between 2024 and 2025 receive 26% ITC, beginning 2026 and beyond receive 10% ITC. On-shore wind projects online in 2021 receive 80% PTC, between 2022 and 2025 receive 60% PTC, in 2026 or beyond are not eligible for tax credits. Off-shore wind projects online between 2021 and 2035 receive 30% ITC.

Source:

Assumptions: Installed Capital Cost, Renewables & Storage



	Utility-Scale Solar (SAT)	On-shore Wind	BESS (4-Hr)
2021	$1,160	$1,476	$1,435
2022	$1,103	$1,441	$1,380
2023	$1,028	$1,458	$1,327
2024	$1,001	$1,474	$1,263
2025	$996	$1,490	$1,205
2026	$991	$1,507	$1,183
2027	$986	$1,525	$1,165
2028	$990	$1,545	$1,152
2029	$995	$1,565	$1,142
2030	$1,000	$1,586	$1,133
2031	$1,006	$1,609	$1,127
2032	$1,012	$1,634	$1,123
2033	$1,018	$1,660	$1,121
2034	$1,018	$1,687	$1,120
2035	$1,019	$1,715	$1,121
2036	$1,020	$1,745	$1,122
2037	$1,020	$1,775	$1,124
2038	$1,022	$1,806	$1,126
2039	$1,023	$1,838	$1,129
2040	$1,025	$1,876	$1,133
2041	$1,028	$1,911	$1,138
2042	$1,032	$1,947	$1,145

Note:

1. Utility-scale Solar PV is an average between mono and bi-facial with Single Axis Tracking.
2. Battery Installed Capital Cost include augmentation.

Source:

IHS 12.2019 (Solar & Wind), IHS 01.2020 (BESS):

Updated

Cost: Conventional Generation*

Technology	Installed Capital Cost Nominal [2021$/kW]	Fixed O&M L. Real[2021$/kW-yr.]	Variable O&M L. Real [2021$/MWh]	Levelized Cost of Electricity L. Real [2021$/MWh]	Source
CT M501JAC + 30%H2	$935	$6.53	$14.45	$137.56	(1)
1x1 CCGT M501JAC w/o Duct Firing + 30%H2	$1,237	$18.07	$3.40	$39.39	(1)
1x1 CCGT M501JAC w/ Duct Firing + 30%H2	$1,143	$15.39	$3.40	$38.22	(1)
2x1 CCGT M501JAC w/o Duct Firing + 30%H2	$1,077	$11.84	$3.41	$36.79	(1)
2x1 CCGT M501JAC w/ Duct Firing + 30%H2	$995	$10.09	$3.41	$35.87	(1)
Aero-CT LMS100PA + 5%H2	$1,735	$6.34	$3.14	$116.81	(1)
RICE 7x Wartsila 18V50SG + 25%H2	$1,673	$22.89	$7.90	$95.02	(1)

Sources:
(1) Entergy Capital Projects

Notes:
***** Any large-scale future gas resources will be hydrogen capable.

Updated

Performance: Conventional Generation*

Technology	Net Max Summer Capacity [MW-ac] [1]	Full HHV Summer Heat Rate [Btu/KWh] [2]	Life [Yr.]	Capacity Factor [%]	DC:AC Ratio [%]	Degradation [%]	Round-trip Efficiency [%]	Source
CT M501JAC + 30%H2	380	9,192	30	10%	X	X	X	(1)
1x1 CCGT M501JAC w/o Duct Firing + 30%H2	557	6,271	30	85%	X	X	X	(1)
1x1 CCGT M501JAC w/ Duct Firing + 30%H2	667	6.343	30	85%	X	X	X	(1)
2x1 CCGT M501JAC w/o Duct Firing + 30%H2	1,114	6.271	30	85%	X	X	X	(1)
2x1 CCGT M501JAC w/ Duct Firing + 30%H2	1,333	6.343	30	85%	X	X	X	(1)
Aero-CT LMS100PA + 5%H2	102	9,397	30	20%	X	X	X	(2)
RICE 7x Wartsila 18V50SG + 25%H2	129	8,464	30	30%	X	X	X	(1)

Sources:
(1) EPRI 2019, Entergy Capital Projects + Power Generation
(2) Worley Parsons 2017, Entergy Capital Projects + Power Generation

Assumptions and notes
1. 1x1 CCGT w/ DF: 380 MW (Gas) + 171 MW (ST) + 116 MW (DF)
   2x1 CCGT: 760 MW (Gas) + 354 MW (ST)
   2x1 CCGT w/ DF: 760 MW (Gas) + 341 MW (ST) + 232 MW (DF)
2. CCGT w/ Duct Firing heat rate is reflective of the base capacity without duct firing

* Any large-scale future gas resources will be hydrogen capable.

Entergy WE POWER LIFE℠

Cost: Solar

Technology	Installed Capital Cost Nominal [2021$/kW] [1,2]	Fixed O&M* L. Real [2021$/kW-yr.] [3]	Variable O&M L. Real [2021$/MWh]	Levelized Cost of Electricity L. Real [2021$/MWh]	Source [4]
Utility-Scale, Solar (Mono & Bi-facial) Single Axis Tracking	$1,160 (MISO South)	$10.31 (U.S. Generic)	X	$41.56	(1)
Utility-Scale Solar, Off-system (Mono & Bi-facial) Single Axis Tracking	$1,163 (ERCOT)	$10.31 (U.S. Generic)	X	$36.50	(1)

Sources:

Assumptions and notes

1. Installed year of 2021 (COD)
2. Installed Capital Cost includes estimates for interconnection costs.
3. Solar Fixed O&M excludes property tax and insurance; Solar includes inverter replacement in year 16.
4. IHS does not separate Mono (SAT) and Bi-facial (SAT) when it comes to cost and performance but assumes a mixture.

Performance: Solar

Technology	Net Max Summer Capacity [MW-ac]	Full HHV Summer Heat Rate [Btu/KWh]	Life [Yr.]	Capacity Factor [% in year 2021] 1,2	DC:AC Ratio [%] 3	Degradation [%]	Round-trip Efficiency [%]	Source
Utility-Scale, Solar (Mono & Bi-facial) Single Axis Tracking	100	X	30	25.5% (MISO South)	1.30	0.5% per year	X	(1)
Utility-Scale Solar, Off-system ERCOT (Mono & Bi-facial) Single Axis Tracking	100	X	30	29.1% (ERCOT)	1.30	0.5% per year	X	(1)

Sources:

(1) IHS 12.2019:

Assumptions and notes

1. Utility-scale solar CF is sourced from Plant Predict and IHS.
2. Arkansas territory has a capacity factor of 24.8%.
3. At a rate of 0.5% degradation per year (compounded), the solar is assumed to operate at 86.5% output in year 30.

Cost: Wind

Technology	Installed Capital Cost Nominal [2021$/kW] [1,2]	Fixed O&M L. Real[2021$/kW-yr.] [3]	Variable O&M L. Real [2021$/MWh]	Levelized Cost of Electricity L. Real [2021$/MWh]	Source
On-shore	$1,476 (MISO South)	$37.59 (U.S. Generic)	X	$39.83	(1)
Off-shore, Fixed	$4,323 (MISO South)	$88.71 (MISO South)	X	$128.32	(2)
Off-shore, Floating	$6,220 (MISO South)	$68.90 (MISO South)	X	$205.46	(2)
On-shore, Off- System (SPP)	$1,387 (SPP)	$37.59 (U.S. Generic)	X	$26.17	(1)

Sources:
(1) IHS 12.2019: SAM NREL
(2) ATB NREL 2020

Assumptions and notes
1. Installed year of 2021 (COD)
2. Installed Capital Cost includes estimates for interconnection costs.
3. Wind Fixed O&M excludes property tax and insurance.

Performance: Wind

Technology	Net Max Summer Capacity [MW-ac]	Full HHV Summer Heat Rate [Btu/KWh]	Life [Yr.]	Capacity Factor [% in year 2021]	DC:AC Ratio [%]	Degradation [%]	Round-trip Efficiency [%]	Source
On-shore	200	X	30	36.8%	X	X	X	(1)
Off-shore, Fixed	600	X	25	37.1%	X	X	X	(2)
Off-shore, Floating	600	X	25	30.1%	X	X	X	(2)
On-shore, Off- System (SPP)	200	X	30	49.6%	X	X	X	(1)

Sources:

(1) IHS 12.2019: SAM NREL

(2) ATB NREL 2020

Updated

Cost: Storage

Technology	Installed Capital Cost Nominal [2021$/kW][1,2]	Fixed O&M L. Real [2021$/kW-yr.][3]	Variable O&M L. Real [2021$/MWh]	Levelized Cost of Electricity L. Real [2021$/MWh]	Source
Lithium Ion (4-hr)	$1,260 (w/o augmentation U.S. Generic) $1,435 (w/ augmentation U.S. Generic)	$13.17 (U.S. Generic)	X	N/A	(1)
Sodium Sulfur (4-hr)	$2,132 (U.S. Generic)	$14.28 (U.S. Generic)	X	N/A	(2)
Vanadium Redox (4-hr)	$4,225 (U.S. Generic)	$37.74 (U.S. Generic)	X	N/A	(2)
Compressed Air Energy (16-hr)	$1,759 (MISO South)	$15.04 (MISO South)	$2.16 (MISO South)	N/A	(3)
Pump Storage Hydro (16-hr)	$2,799 (U.S. Generic)	$16.87 (U.S. Generic)	X	N/A	(4)

Sources:
(1) IHS 01.2020:
(2) EPRI 2020
(3) EPRI 2021
(4) DOE 2019

Assumptions and notes
1. Installed year of 2021 (COD)
2. 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).
3. Battery Fixed O&M excludes property tax and insurance cost; includes recycling cost of $1.00 (2021$) in year 20.

Performance: Storage

Technology	Net Max Summer Capacity [MW-ac]	Full HHV Summer Heat Rate [Btu/KWh]	Life [Yr.]	Capacity Factor [% in year 2021]	DC:AC Ratio [%]	Degradation [%]	Round-trip Efficiency [%]	Source
Lithium Ion (4-hr)	50MW/ 200MWh	X	20	X	X	0% per year (365 cycles / year)	86%	(1)
Sodium Sulfur (4-hr)	24MW / 48MWh	X	20	X	X	0% per year (365 cycles / year)	75%	(2)
Vanadium Redox (4-hr)	24MW / 48MWh	X	20	X	X	0% per year (365 cycles / year)	67.5%	(2)
Compressed Air Energy (16-hr)	180MW / 2,880MWh	X	40	X	X	0% per year (365 cycles / year)	52.0%	(3)
Pump Storage Hydro (16-hr)	500MW / 8,000MWh	X	50	X	X	0% per year (365 cycles / year)	80.0%	(4)

Sources:

(1) IHS 01.2020:

(2) EPRI 2020

(3) EPRI 2021

(4) DOE 2019

Cost: Water

Technology	Installed Capital Cost Nominal [2021$/kW]	Fixed O&M L. Real[2021$/kW-yr.]	Variable O&M L. Real [2021$/MWh]	Levelized Cost of Electricity L. Real [2021$/MWh]	Source
Non-Powered Dam	$4,334	$44.07	X	$66.09	(1)
New-Stream Development	$5,949	$31.26	X	$94.58	(2)

Sources:

(1) ATB NREL 2020

(2) ATB NREL 2020, EIA 2020

Performance: Water

Technology	Net Max Summer Capacity [MW-ac]	Full HHV Summer Heat Rate [Btu/KWh]	Life [Yr.]	Capacity Factor [%]	DC:AC Ratio [%]	Degradation [%]	Round-trip Efficiency [%]	Source
Non-Powered Dam	10+	8,904	50	60%	X	X	X	(1)
New-Stream Development	10+	8,904	50	54%	X	X	X	(2)

Sources:
(1) ATB NREL 2020
(2) ATB NREL 2020, EIA 2020

Cost: Nuclear

Technology	Installed Capital Cost Nominal [2021$/kW]	Fixed O&M L. Real[2021$/kW-yr.]	Variable O&M L. Real [2021$/MWh]	Levelized Cost of Electricity L. Real [2021$/MWh]	Source
Small Modular Reactor (SMR)	$7,036 (MISO South)	$128.45 (MISO South)	$0.62 (MISO South)	$91.54	(1)
Nuclear III+ AP 1000 (PWR)	$7,648 (MISO South)	$127.61 (MISO South)	$2.42 (MISO South)	$95.56	(1)

Sources:
(1) 2021 EPRI

Performance: Nuclear

Technology	Net Max Summer Capacity [MW-ac]	Full HHV Summer Heat Rate [Btu/KWh]	Life [Yr.]	Capacity Factor [%]	DC:AC Ratio [%]	Degradation [%]	Round-trip Efficiency [%]	Source
Small Modular Reactor (SMR)	720 (12x60)	11,370	40	90%	X	X	X	(1)
Nuclear III+ AP 1000 (PWR)	1,117	10,663	40	90%	X	X	X	(1)

Sources:
(1) 2021 EPRI

Technology Selection

Screening approach is designed to evaluate the cost-effectiveness and feasibility of deployment of potential resources.

TECHNICAL SCREENING

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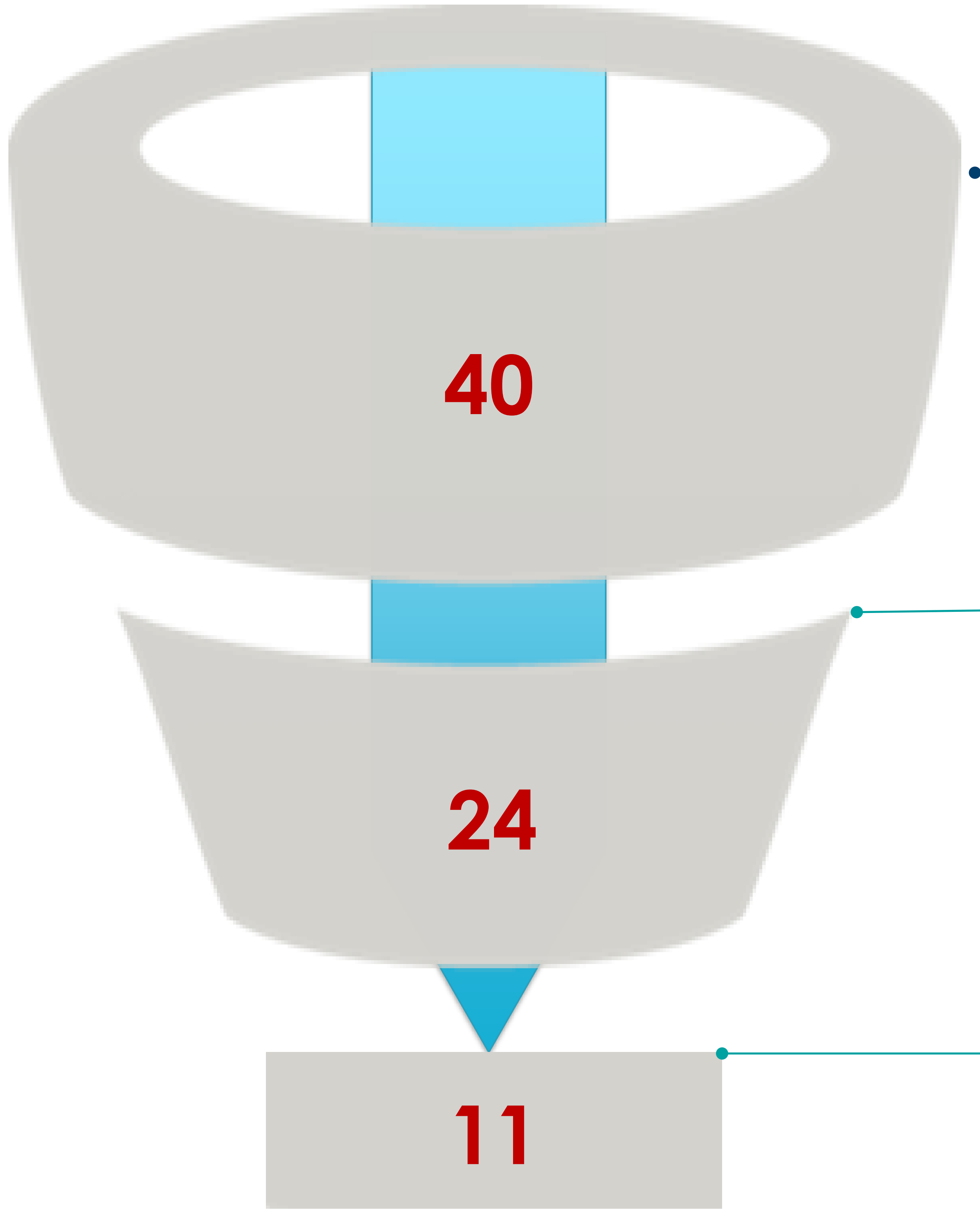

Technical Screening
Technology Maturity
Environmental Impact
Fuel Availability
Service Territory Feasibility

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

Updated

Technology Selection

Selected generation alternatives include renewables, storage, and hydrogen-capable conventional generation

- **STORAGE**
  - Lithium-Ion (4-hr)
  - Pumped Storage Hydro (16-hr)
- **CONVENTIONAL GENERATION***
  - Aeroderivative CT + 5%H2
  - CCGT (2x1 w/DF) + 30%H2
  - CCGT (1x1 w/DF) + 30%H2
  - Frame CT + 30%H2
  - RICE + 25%H2
- **WIND**
  - On-shore
  - Off-shore Fixed
  - Off System, SPP
- **SOLAR**
  - Mono & Bifacial

Notes:

* Any large-scale future gas resources will be hydrogen capable.