Integrated Resource Plan (IRP) Update

Public Educational Webinar
July 25, 2024

TVA TENNESSEE VALLEY AUTHORITY

About Today's Meeting

A recording of this presentation and copy of these slides will be available on the TVA IRP website: www.tva.gov/IRP.

To view prior IRP Public Webinar recordings and materials, please visit the TVA IRP website, Public Meetings page; previous webinar topics have included:

- Public Scoping
- IRP Process Overview
- Scenarios and Strategies (original five scenarios and five strategies)

There will be an opportunity for questions at the end of the presentation using either the Q&A functionality of the Teams webinar or by submitting questions to IRP@tva.gov with the subject line "Public Webinar Q&A".

To allow sufficient time for Q&A, please note that some of today's presentation slides contain more detail than will be covered by the presenters. TVA is providing this additional detail to interested stakeholders to enhance and improve IRP engagement in the Draft IRP process.

IRP Public Webinar Agenda

Integrated Resource Plan (IRP) Overview

IRP Scenarios and Strategies Update

IRP Resource Assumptions

Stakeholder Engagement Update

Q&A

IRP Overview

Clifton Lowry; Director, Resource Planning & Strategy

TVA's Integrated Resource Plan

The IRP is a study of how TVA could meet customer demand for electricity between now and 2050 across a variety of futures.

A programmatic Environmental Impact Statement (EIS) accompanies the IRP to evaluate its environmental effects.

An updated IRP is needed to:

- Proactively establish a strong planning foundation for the 2030s and beyond
- Inform TVA's next long-range financial plan

The IRP provides strategic direction on how TVA will continue to provide low-cost, reliable, and increasingly cleaner electricity to the residents and businesses across the Valley region.

What TVA's IRP Does

The IRP will:

- Use least-cost planning criteria
- Incorporate resource capital, operating, fuel, and environmental compliance costs
- Evaluate strategies using metrics based on least-cost planning principles
- Assess socioeconomic and climate impacts of alternative strategies in the associated EIS

The IRP will not:

- Establish wholesale or retail electricity rates
- Identify specific sites for new resources
- Be a Distribution Integrated Resource Plan (DIRP)

Key Integrated Resource Plan (IRP) Milestones

The IRP study approach is intended to enable stakeholder involvement and ensure transparency

- Spring 2023 – Published Notice of Intent (NOI) and initiated public scoping
- Summer 2023 – IRP Working Group commenced
- Fall 2023 – Public scoping report published
- Modeling and environmental study
- Publish Draft IRP and EIS, public comment period begins
- Respond to Draft comments and develop Final documents
- Publication and TVA Board adoption of Final IRP and EIS

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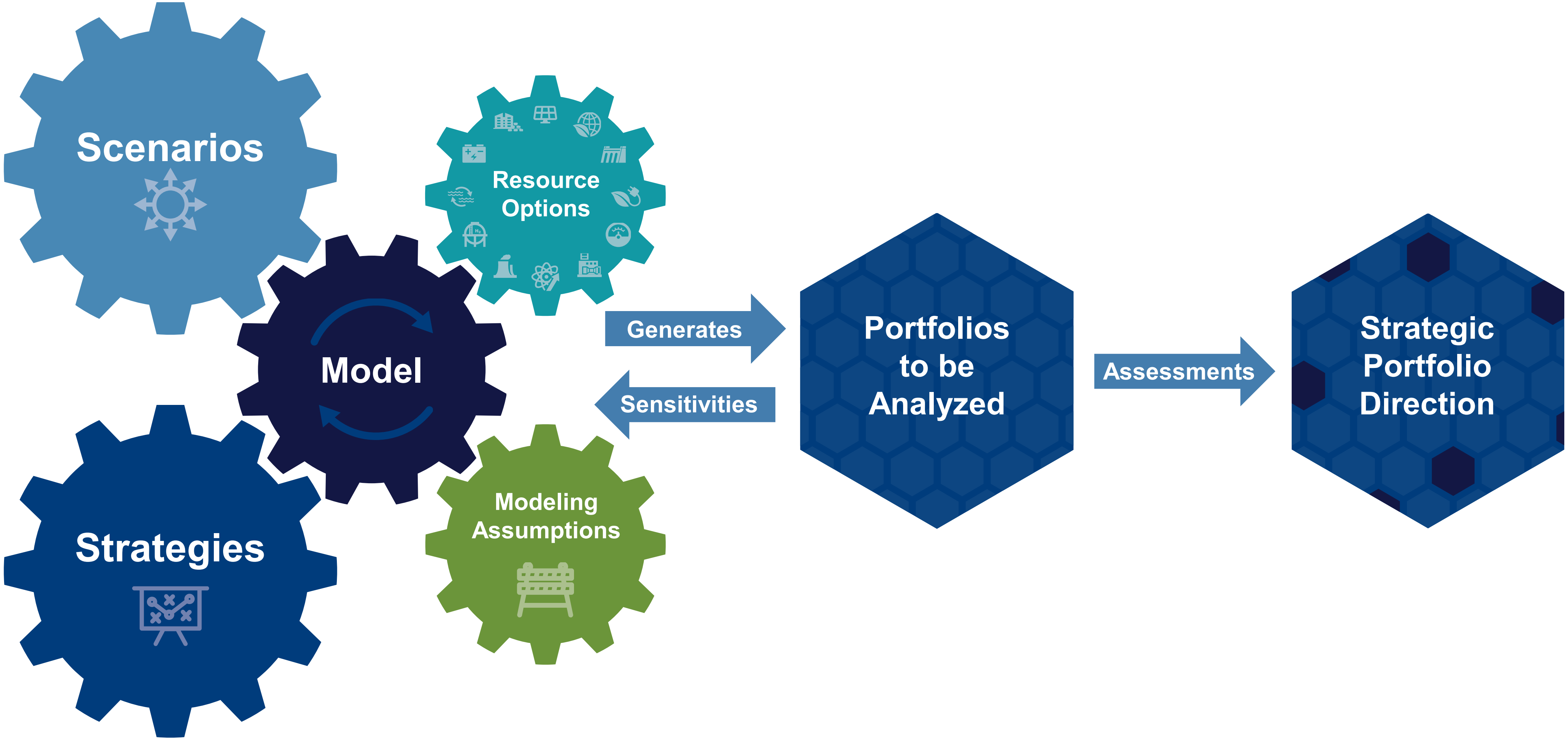
IRP Scenarios and Strategies

Candy Kelly; Sr. Manager, Resource Strategy

How the Integrated Resource Planning Process Works



Stakeholder feedback is a key component in the development of all model inputs.

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IRP Scenario Development Process

TVA collaborated with the IRP Working Group to develop scenarios for the IRP analysis, beginning in the summer of 2023.

Scenario development involves three primary steps:

1. Scenario design brainstorming - focusing on how the future might be shaped by changes in key uncertainties, such as economic cycles, electricity demand, consumer preferences, regulation, and technology
2. Scenario theme development - leading to potential scenarios that combine key uncertainties and correlated impacts while ensuring adequate diversity and robustness
3. Scenario forecast creation - resulting in correlated forecasts for inflation, electric load, fuel, and market purchases of power

IRP Scenarios (Future Conditions)

1 **Reference (without Greenhouse Gas Rule)**
Represents TVA's current forecast that reflects moderate population, employment, and industrial growth, weather-normal trends, growing electric vehicle use, and increasing efficiencies

2 **Higher Growth Economy**
Reflects a technology-driven increase in U.S. productivity growth that stimulates the national and regional economies, resulting in substantially higher demand for electricity

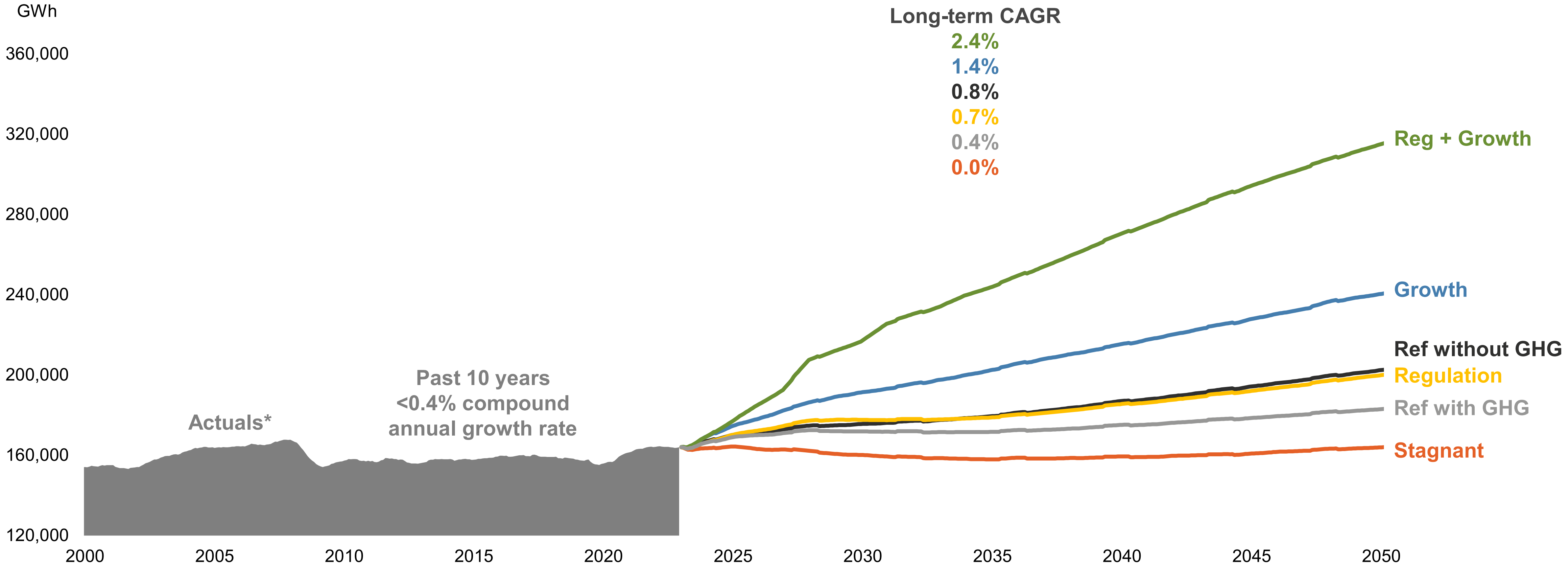
3 **Stagnant Economy**
Reflects rising debt and inflation that stifle consumer demand and business investment, resulting in weaker than expected economic growth and essentially flat electricity demand

4 **Carbon Regulation**
Reflects the impact of proposed greenhouse gas rules that target significant reductions in electric utility CO_2 emissions beginning in 2030 and potential future regulations striving for net zero by 2050

5 **Carbon Regulation Plus Growth**
Reflects impact of proposed and potential future regulations along with substantial advancements in clean energy technologies, spurring economic growth and extensive electrification

6 **Reference (with Greenhouse Gas Rule)**
Reflects TVA's current forecast and incorporates the impact of greenhouse gas rules finalized in May 2024 that target significant reductions in electric utility CO2 emissions beginning in 2030

IRP Energy Demand Forecasts



* Weather normalized actuals. Excludes USEC

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Strategy Design and Evaluation

The IRP will compare baseline-utility planning with alternate strategies that promote certain resource types to evaluate tradeoffs across least-cost planning principles – low cost, risk informed, environmentally responsible, reliable and resilient, diverse and flexible.

1. Develop baseline utility planning cases in all scenarios (no resources promoted)
2. Identify promotion of resource types to achieve objectives in each strategy
3. Run cases with resource promotions for alternate strategies in all scenarios
4. Evaluate tradeoffs across all scenarios and strategies using metrics

IRP Strategies (Business Approaches)

A

Baseline Utility Planning

Represents TVA's current outlook based on least-cost planning, incorporating existing programs and a planning reserve margin target. This reserve margin target applies in all strategies

B

Carbon-free Innovation Focus

Emphasizes and promotes emerging, firm and dispatchable carbon-free technologies through innovation, continued research and development, and strategic partnerships

C

Carbon-free Commercial Ready Focus

Emphasizes proven carbon-free technologies like wind, solar, and storage, at both utility-scale and through customer partnerships, along with strategic transmission investment

D

Distributed and Demand-side Focus

Emphasizes existing and potentially expanded customer partnerships and programmatic solutions to reduce reliance on central station generation and promote virtual power plants

E

Resiliency Focus

Emphasizes smaller units and the promotion of storage, along with strategic transmission investment, to drive wider geographic resource distribution and additional resiliency across the system

IRP Resource Assumptions

Hunter Reed; IRP Project Manager

IRP Resource Options

Nuclear
- Advanced pressurized water reactor
- Light water small modular reactor
- Gen IV small modular reactor

Hydro
- Hydro uprates

Coal
- Supercritical pulverized coal
- Supercritical pulverized coal w/ carbon capture

Gas
- Combined cycle
- Combined cycle w/ carbon capture
- Combustion turbine
- Aeroderivative
- Reciprocating engine
- Hydrogen blending
- Combined heat and power

Renewables
- Utility scale solar
- Distributed solar
- Midwest wind
- Southeast high-hub wind
- High Voltage Direct Current wind

Storage
- Pumped storage
- Lithium-ion battery
- Advanced chemistry battery
- Distributed storage

EE and DR
- Energy efficiency
- Demand response

Resource Options and Characteristics

To consider generating units, we need to know how they operate physically and economically.

Physical

Item	Measure
Output (capacity)	MW (max dependable) MW (minimum)
Availability	Outage rates
Flexibility	Ramp rate
Duty Cycle	Base, intermediate, peaking
Dispatchability	Dispatchable, intermittent
Fuel	Types of fuel, limits
Emissions	Lbs./kWh
Other	Regulations, constraints

Economic

Item	Measure
Capital Cost	Installed cost ($), including transmission
Efficiency	Heat rate (Btu/kWh)
Operating Cost	Fixed ($) Variable ($/kWh)
Fuel Cost	$/Btu
Emissions Cost	$/lb. (as applicable)
Build Schedule	Years
Book life	Years

Resource Assumptions Overview

The IRP considers a full range of supply-side and demand-side resource options.

Resource costs incorporate the impacts of applicable tax credits, inflation assumptions and technology maturity over time, which vary by scenario.

Overnight capital cost trends in this presentation summarize the Reference Case scenario assumptions and are provided in nominal dollars.

The primary source for utility-scale resource costs was the moderate case from NREL's Annual Technology Baseline, except for the Carbon Regulation Plus Growth scenario that assumed the advanced case.

Small modular reactor (SMR) costs are informed by direct experience exploring designs for the Clinch River Nuclear Site; TVA used refined SMR cost estimates that are higher than NREL moderate estimates.

Solar and wind costs reflect recent proposals in the short-term, then blend into NREL moderate case costs.

Hydro expansion costs are based on internal estimates specific to opportunities on the TVA system.

Distributed generation adoption was modeled based on consumer payback, and demand-side EE and DR resources were modeled based on TVA program experience and the recent potential study.

Inflation Reduction Act (IRA) Tax Credits

All IRP scenarios incorporate tax credits available through the IRA.

Section 45Q credits are available for sequestered CO_2 at CCS plants under construction before 2033.

Most scenarios assume a 40% investment tax credit (ITC) for all eligible resources.

Carbon Regulation scenario (4) assumes power sector emission declines trigger the IRA phase-out in 2034.

Carbon Regulation Plus Growth scenario (5) assumes the maximum amount of the ITC (50%) is achievable for all eligible resources, and the ITC and Section 45Q credit availability are extended through the full study period.

Nuclear Resources

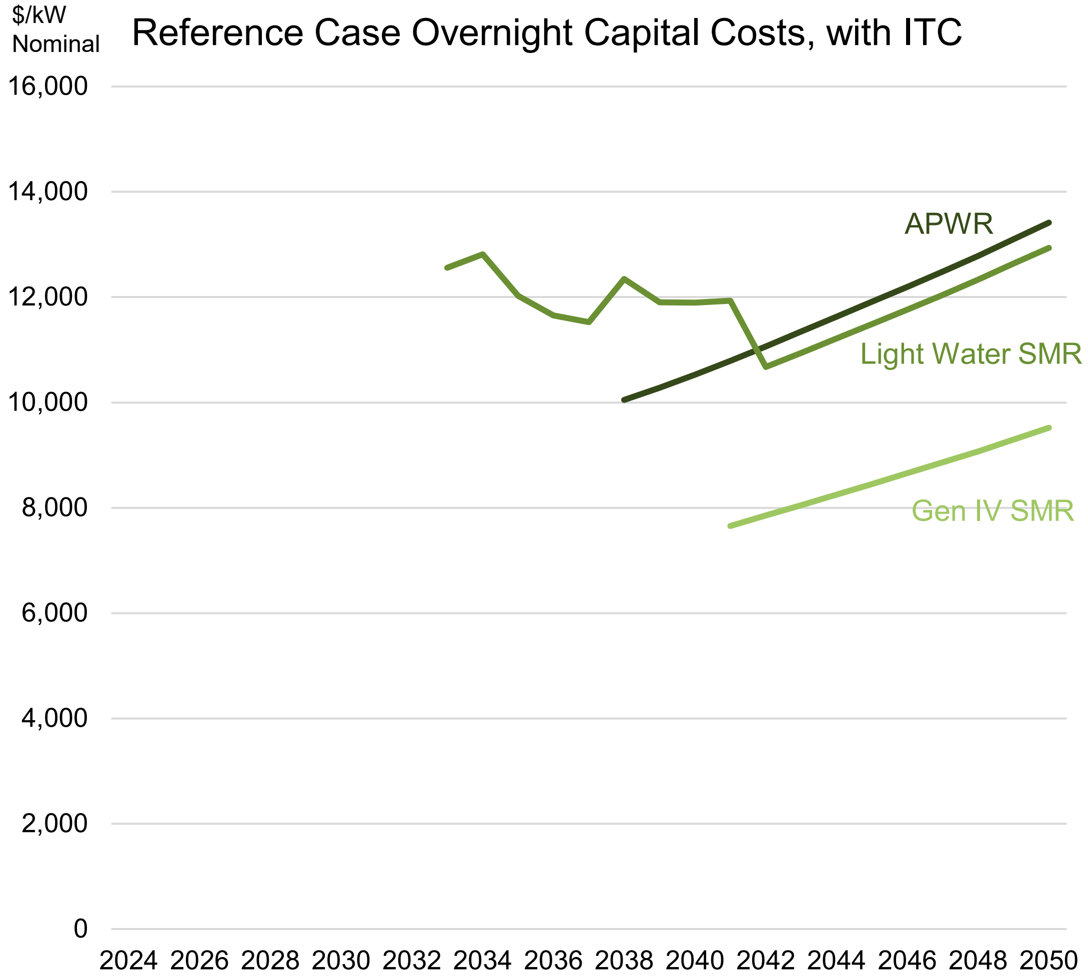
Advanced Pressurized Water Reactor (APWR) – Conventional reactor with advanced passive safety systems and modular design

Light Water SMR – Light water-cooled SMR that leverages proven technology and is furthest along from a licensing perspective

Gen IV SMR – Non-water-cooled (e.g., liquid sodium, molten salt) SMR with an integrated thermal energy storage system

Resource Option*	APWR	Light Water SMR	Gen IV SMR
Summer Net Dependable Capacity (MW)	1,150	285	345 500 with storage
Unit Availability (First Year)	2038	2033	2041
Annual Build Limit (Units)	1	1	1
Book Life (Years)	60	60	60
Overnight Capital Cost ($/kW)	12,928	17,949 (12,471^)	9,175
Summer Full-load Heat Rate (Btu/kWh)	10,132	10,713	8,308
Annual Outage Rate (%)	8	5	10
Variable O&M ($/MWh)	1.35	1.10	4.22
Fixed O&M ($/kW-year)	127.90	147.73	272.64

* Cost information is shown in 2024$ before tax credits.
^ Cost reduction with nth-of-a-kind units



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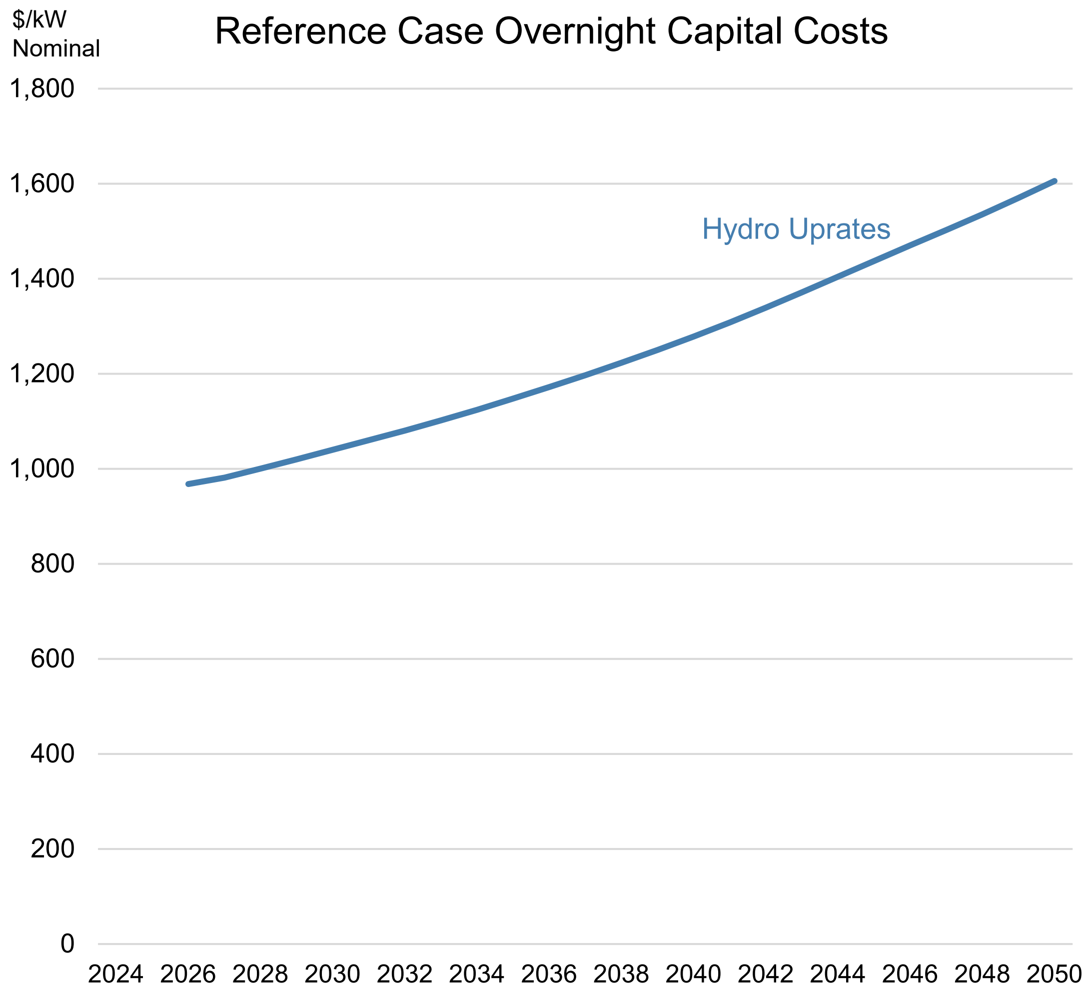
Hydro Resources

Hydro Uprates – Improvements to existing design capabilities with incremental investment at existing TVA hydroelectric dams

- Potential hydro uprates were identified based on TVA's Hydro Life Extension program assessments and are specific to opportunities across the TVA system
- Based on a model that simulates river system and hydro unit operations, about 70% of the combined hydro capability is anticipated to be available at the summer peak

Resource Option*	Hydro Uprates
Summer Net Dependable Capacity (MW)	200
Unit Availability (First Year)	2026
Book Life (Years)	30
Overnight Capital Cost ($/kW)	942
Variable Operating and Maintenance ($/MWh)	2.61
Fixed Operating and Maintenance ($/kW-year)	N/A

* Cost information is shown in 2024$ before tax credits.



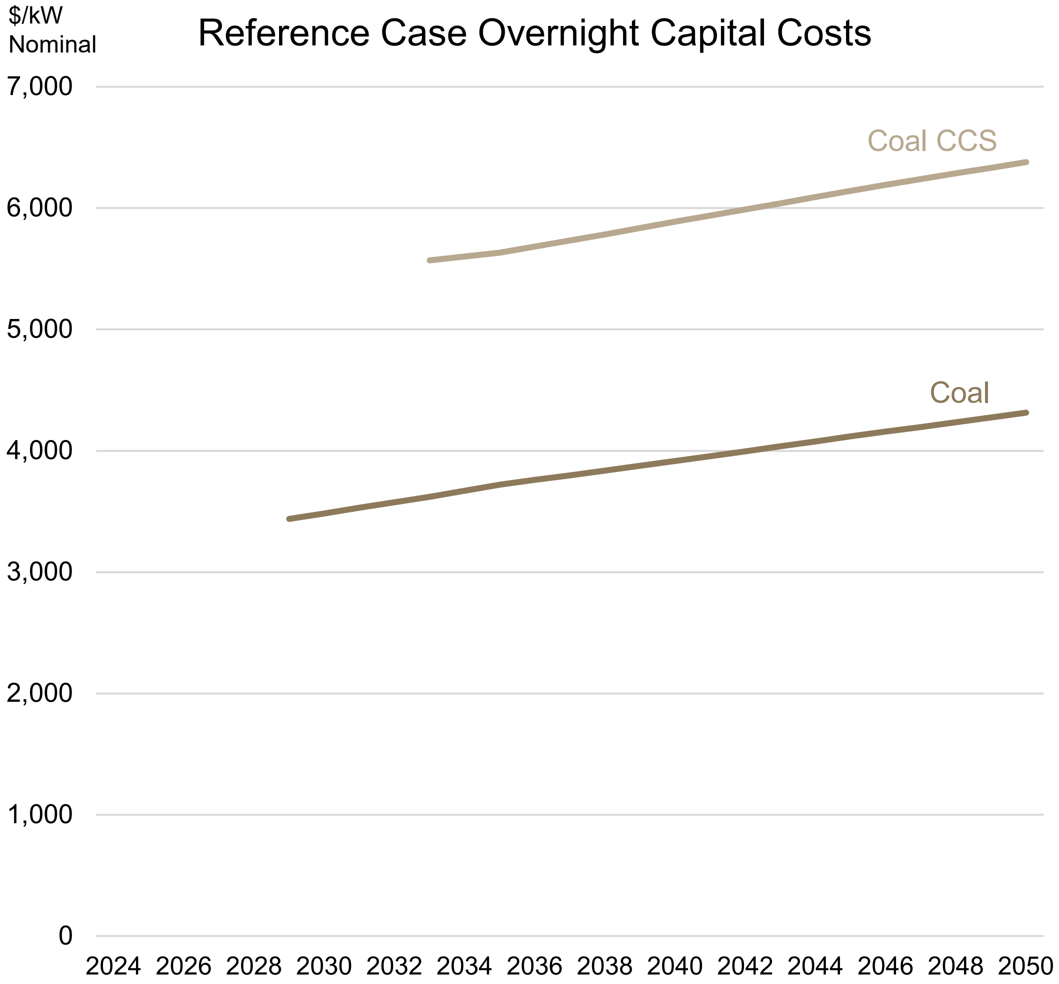
Coal Resources

Supercritical Pulverized Coal – Coal-fired plant using pulverized coal and supercritical fluid water to generate steam at high temperatures and pressures

Supercritical Pulverized Coal (SPC) with CCS – SPC plant fitted with carbon capture technology to capture 90% of CO_2 emissions (CCS is eligible for Section 45Q carbon sequestration credit)

Resource Option*	Supercritical Pulverized Coal	Supercritical Pulverized Coal w/CCS
Summer Net Dependable Capacity (MW)	650	650
Unit Availability (First Year)	2029	2033
Annual / Cumulative Build Limit (Units)	2	1 / 11
Book Life (Years)	30	30
Overnight Capital Cost ($/kW)	3,176	4,762
Summer Full-load Heat Rate (Btu/kWh)	10,548	10,548
Annual Outage Rate (%)	25	25
Variable Operating and Maintenance ($/MWh)	2.12	19.39
Fixed Operating and Maintenance ($/kW-year)	103.56	162.74

* Cost information is shown in 2024$ before tax credits.



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Gas Resources

Combined Cycle (CC), 2x1x1 – Two sets of one gas turbine and one steam generator featuring higher fuel efficiency and increased power output

CC with CCS – CC fitted with carbon capture technology to capture 90% of CO_2 emissions (CCS is eligible for Section 45Q carbon sequestration credit)

Frame Combustion Turbine (CT) – Simple cycle gas turbine, typically used in peaking operations (3x and 4x)

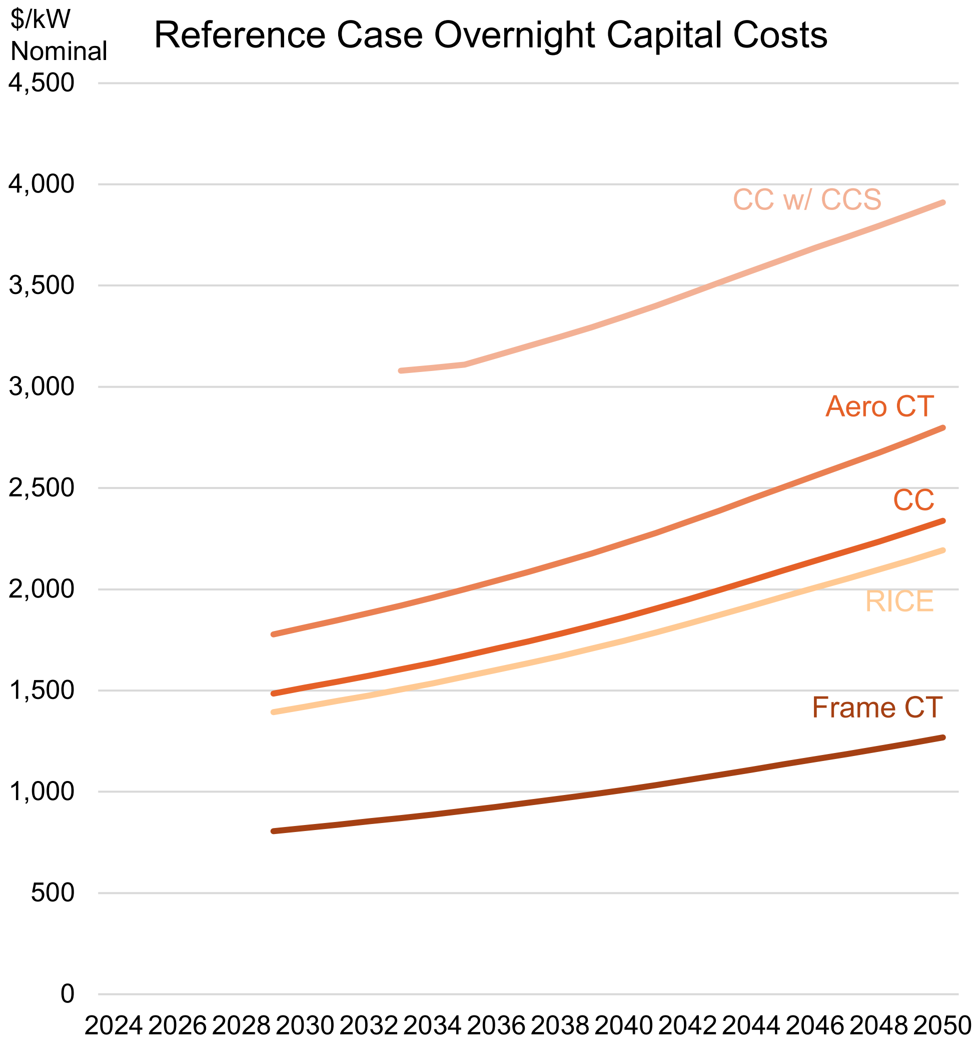
Aero CT – Smaller gas turbines derived from jet engines (2x, 4x, 10x, 20x)

RICE – Reciprocating internal combustion engines (1x, 2x, 6x, 12x, 24x)

Resource Option*	CC	CC w/CCS	Frame CT^	Aero CT	RICE
Summer Net Dependable Capacity (MW)	1,430	1,430	884	1,060	426
Unit Availability (First Year)	2029	2033	2029	2029	2029
Annual / Cumulative Build Limit (Units)	2	1 / 11	2	2	1
Book Life (Years)	30	30	30	30	30
Overnight Capital Cost ($/kW)	1,372	3,017	744	1,642	1,287
Summer Full-load Heat Rate (Btu/kWh)	6,665	7,832	10,087	9,392	8,607
Annual Outage Rate (%)	9	9	9	9	9
Variable Operating and Maintenance ($/MWh)	0.90	5.00	0.00	8.12	6.67
Fixed Operating and Maintenance ($/kW-year)	42.24	94.01	5.50	21.93	41.22

* Cost information is shown in 2024$ before tax credits. New gas units would be capable of burning natural gas or hydrogen. T able shows assumptions for the largest configuration of each resource type, which is the most cost-effective.

^Based on typical operating conditions, Frame CTs do not include a variable O&M charge, rather they incur a larger per start cost to account for ongoing maintenance needs



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Renewable Resources

Single-axis Tracking Solar – Large solar farms with panels that follow the path of the sun

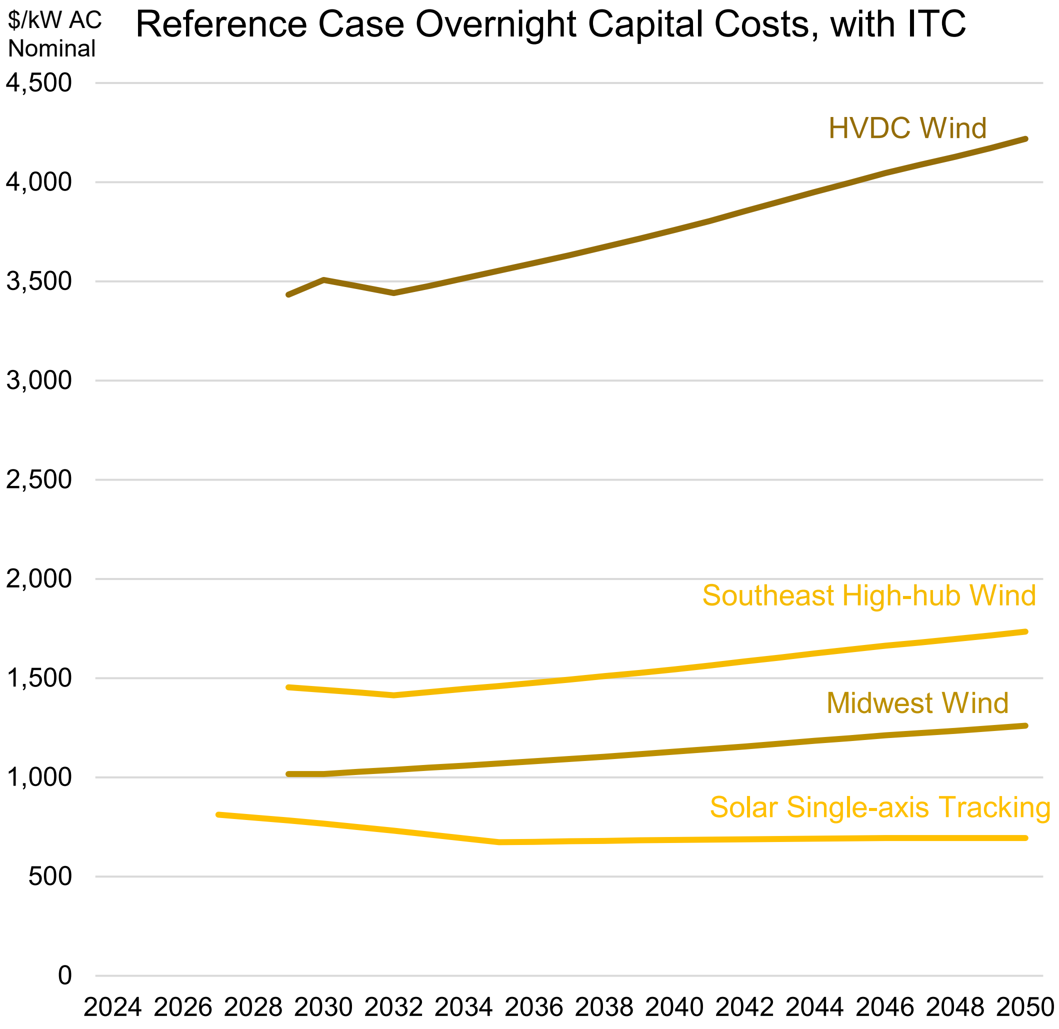
Midwest Wind – Midcontinent Independent System Operator (MISO) wind primarily from large wind farms in the Midwest

Southeast High-hub Wind – Regional wind farms with higher hub heights due to the relatively lower wind speeds in the Southeast

High Voltage Direct Current Wind (HVDC) – Wind option that requires a third party to permit and build a direct current bulk transmission line that reduces power losses

Resource Option*	Single-axis Tracking Solar	Midwest Wind	Southeast High-hub Wind	HVDC Wind
Nameplate Capacity (MW)	50	200	200	200
Summer Net Dependable Capacity (MW)	25	28	28	28
Winter Net Dependable Capacity (MW)	0	62	62	62
Capacity Factor (%)	25	40	30	55
Unit Availability (First Year)	2027	2029	2029	2029
Annual / Cumulative Build Limit (MW)	1,000	1,000	1,000	3,000/3,000
Book Life (Years)	20	20	20	20
Overnight Capital Cost ($/kW)	1,300	1,625	2,358	3,171

* Net dependable capacity information is shown in 2024 MW. Solar annual limit is increased to 1,850 MW in the highest promotion cases. Cost information is shown in 2024$ before tax credits and operating/maintenance is included in PPA cost.



Storage Resources

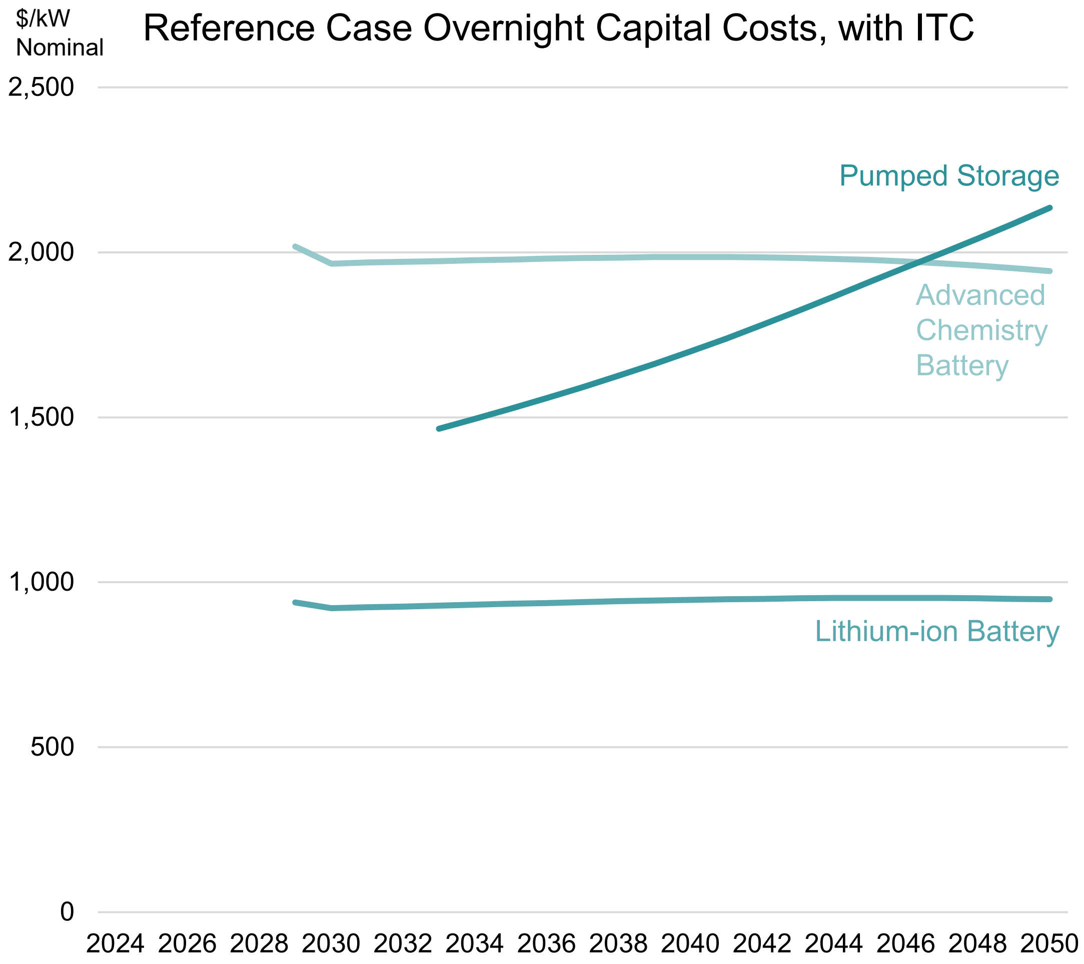
Pumped Storage – Reversible turbine generators pump water up to an upper reservoir during periods of excess power and use water flowing down to a lower reservoir to power the turbines when energy is needed

Lithium-ion Battery (4-hour) – Prevalent battery technology today, best suited for shorter durations

Advanced Chemistry Battery (10-hour) – Developing battery technology that would allow for longer durations of storage

Resource Option	Pumped Storage	Lithium-Ion Battery (4-hour)	Advanced Chemistry Battery (10-hour)
Nameplate Capacity (MW)	1,600	50	50
Unit Availability (First Year)	2033	2029	2029
Annual / Cumulative Build Limit (MW)	1,600/1,600	500	500
Book Life (Years)	40	20	20
Overnight Capital Cost ($/kW)	2,088	1,445	3,106
Storage Efficiency (%)	81	85	85
Annual Outage Rate (%)	7	5	5
Variable Operating and Maintenance ($/MWh)	2.80	0.00	0.00
Fixed Operating and Maintenance ($/kW-year)	8.13	35.30	35.30

* Storage annual limit is increased to 650 MW in the highest promotion cases. Cost information is shown in 2024$ before tax credits.



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Distributed Generation Resources Methodology

The IRP includes unique assumptions for behind-the-meter (BTM) distributed solar, storage, and Combined Heat and Power (CHP) adoption in each scenario and strategy portfolio.

BTM adoption forecasts are developed using an internal process based on NREL's Distributed Market Demand Model.

Key input assumptions include the forecasted price of electricity in each scenario, the forecasted installation cost of the distributed generation resource, and any incentives offered in each strategy.

Key inputs are run through the model and adoption uptake is driven by the number of years it would take a participant would see a payback on their investment.

Step 1: Model Base Level of Adoption in Each Scenario

Step 2: Determine Incentive Level to Apply in a Strategy

Step 3: Develop New Adoption Level based on Economics

Step 4: Enforce New Adoption Level in Expansion Model

Step 5: Optimize Balance of Resources for the Portfolio

Demand-side Programs Modeled in the IRP

Energy Efficiency (EE)

Residential EE
- New Homes
- Residential Services

Commercial EE
- Custom Commercial
- Standard Rebate Commercial

Industrial EE
- Custom Industrial
- Standard Rebate Industrial

Local Power Company EE
- Conservation Voltage Regulation

Demand Response (DR)

Residential DR
- Smart Thermostat

Commercial DR
- Aggregated Commercial

Industrial DR
- Aggregated Industrial

Local Power Company DR
- Dispatchable Voltage Regulation

Demand-side Resources Methodology

TVA leveraged an updated potential study and historical experience to estimate load changes and costs of potential EE and DR programs.

A key driver of energy program adoption by customers is the level of financial incentive offered.

To simulate this effect in modeling, TVA created several tiers of EE and DR program levels that included increasing numbers of participants along with increasing incentives required to achieve higher participation.

In each year, the model could select a level of program participation above Tier 0, or base level, based on TVA system needs.

Tier 1

Near-term EE incentive increases are maintained, generally in line with 50% incentive achievable potential*

Low-level of DR expansion above base

OR

Tier 2

High levels of EE, generally in line with 75% incentive achievable potential*

Mid-level of DR expansion above base

OR

Tier 3

Maximum levels of EE, approaching 100% incentive achievable potential*

High-level of DR expansion above base

Tier 0 – FY23 base levels of EE and DR programs, including announced growth in the near term

* Based on 2022 Energy Programs Potential Study

Resource Assumptions Summary

The IRP considers a full range of supply-side and demand-side resource options.

All IRP scenarios incorporate tax credits available through the IRA.

The combination of IRP scenarios, strategies, and resource options will help TVA and stakeholders evaluate a broad range of potential future conditions, business strategies, and portfolios.

Metrics will be used to assess the performance of the different strategies across the scenarios.

Stakeholder Engagement Opportunities

Althea Jones; Director, Public and Community Engagement

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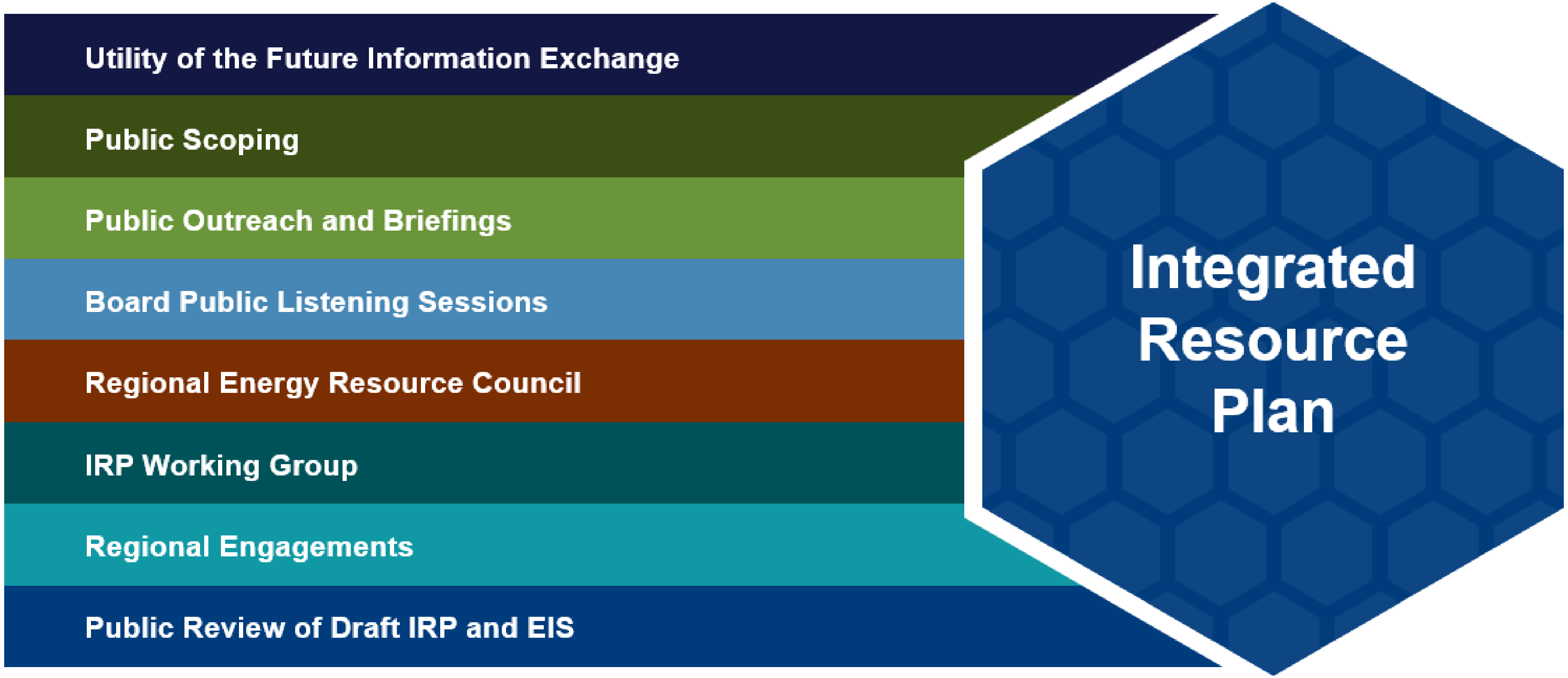
IRP Public Engagement Opportunities

A key element of TVA's IRP process is to ensure public involvement and direct engagement with a diverse group of stakeholders. The IRP process is utilizing past effective engagement venues as well as leveraging several new dynamics and initiatives.



Online: ***tva.com/IRP*** / *Email:* ***IRP@tva.gov*** / *Channels:* ***@TVA @TVANews***

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IRP Working Group

Diverse representation creates support and credibility for TVA’s long-term resource plans

Eight customer representatives, including:

- Three from Local Power Companies (LPCs)
- Five from customer associations

16 stakeholder representatives, including:

- Three from research or academic institutions
- Three from energy or environmental non-governmental organizations
- Four from state or federal government
- Six from community, sustainability, or other special interests

IRP Public Open Houses

TVA will host 12 open houses across the service territory once the draft IRP and EIS are published. The 10 in-person open houses will be held in the cities listed below with two virtual options also being offered.

Virtual Meetings

1. After Business Hours
2. During Lunch Hour

Unable to make it to a virtual or in-person meeting?

- Visit TVA's IRP website at: www.tva.com/irp for registration information.
- Taped webinars will be available as well.

In-Person Meetings *at 6 PM Local Time*

- NC — Murphy, NC
- TN — Oak Ridge, TN
- VA — Bristol, VA
- TN — Chattanooga, TN
- GA — Rossville, GA
- KY — Hopkinsville, KY
- TN — Nashville, TN
- AL — Huntsville, AL
- MS — Starkville, MS
- TN — Memphis, TN

Opportunities to Stay Involved

TVA Website www.tva.gov/IRP.

Attend future periodic public educational webinars

Add your name to the IRP mailing list at www.tva.gov/IRP to be notified when documents are released.

Submit comments on the Draft IRP/EIS Report, expected to be available later this year.

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Q&A

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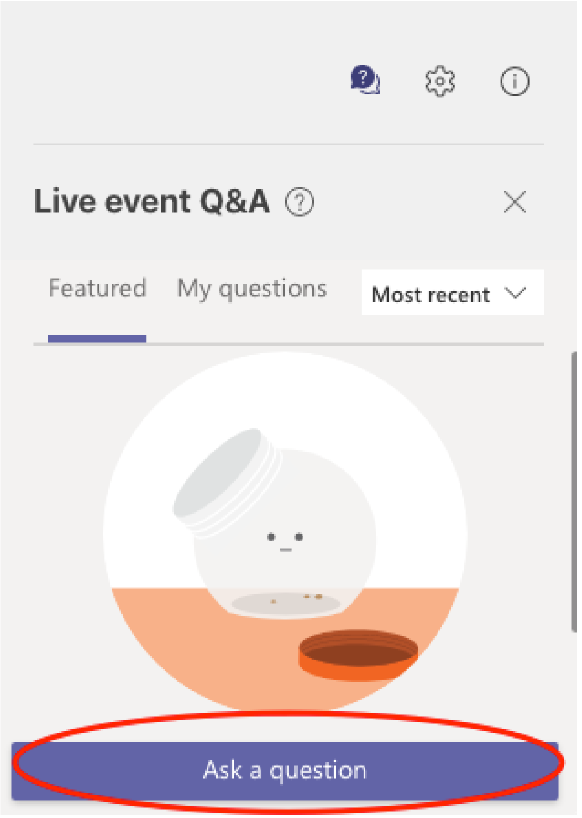
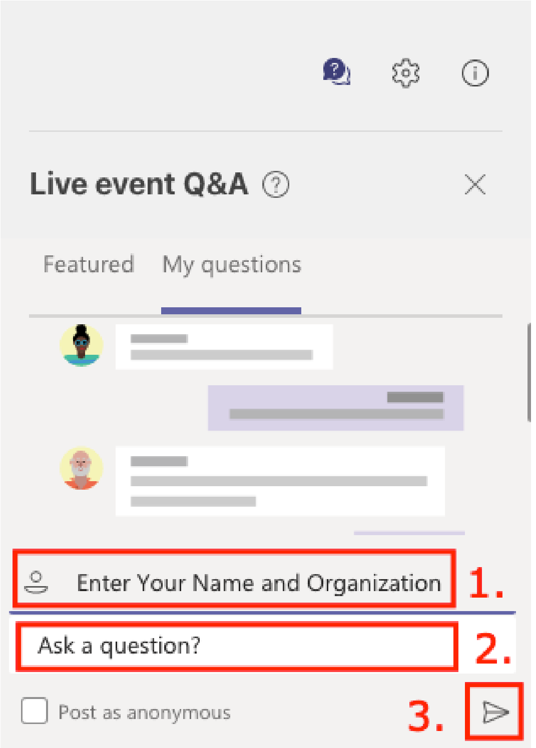
Q&A Operation

1. Click the Q&A button

2. Click "Ask a Question"



3. Please enter your name and organization in box 1, your question in box 2, then the arrow to submit



Use the Q&A box or email your question to IRP@tva.gov

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