2024 IRP Working Group

Meeting 3: September 25-26, 2023
Franklin, TN

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Welcome and Safety Moment

Jo Anne Lavender; IRP Facilitator
Hunter Reed, IRP Project Manager

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Safety Moment

EMERGENCY ACTIONS

In case of Building Emergency

Exit through the closest external doors and gather in the parking lot

In case of Severe Weather

Exit the conference room, go across the hall to our room for meals

Agenda – September 25, 2023

Topic	Time (CT)	Presenter(s)	Notes
Lunch	11:00-12:00		
Welcome	12:00-12:15	Jo Anne Lavender; Hunter Reed	Welcome, safety moment, agenda review
High Growth and Stagnant Economy forecasts	12:15-1:15	Nathan Donahoe; Bob Roth; Nathan Mathis; John Collins	Review preliminary forecasts for high growth and stagnant economy forecasts
Break	1:15-1:30		
Scenario narratives alignment	1:30-2:30	Daniel Woolley; Jo Anne Lavender	Align on scenarios and narratives
Strategy narratives discussion	2:30-3:30	Daniel Woolley; Jo Anne Lavender	Discuss strategies and narratives
Break	3:30-3:45		
IRP metrics introduction and discussion	3:45-4:50	Daniel Woolley	What are metrics, why are they important, examples, etc.
Wrap-up and day two preview	4:50-5:00	Jo Anne Lavender	
Off-site dinner	6:00-8:00		

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 future scenarios.

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

An updated IRP is needed in order 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 10 million residents of the Tennessee Valley.

Overarching Objective of the IRP-WG

To provide stakeholder input to the framing and evaluation included in TVA's next IRP, which establishes TVA's resource strategy in developing the energy system of the future.

High Growth and Stagnant Economy Forecasts

Bob Roth; Sr. Specialist, Enterprise Forecasting
Nathan Mathis; Manager, Load Forecasting
John Collins; Sr. Specialist, Enterprise Forecasting

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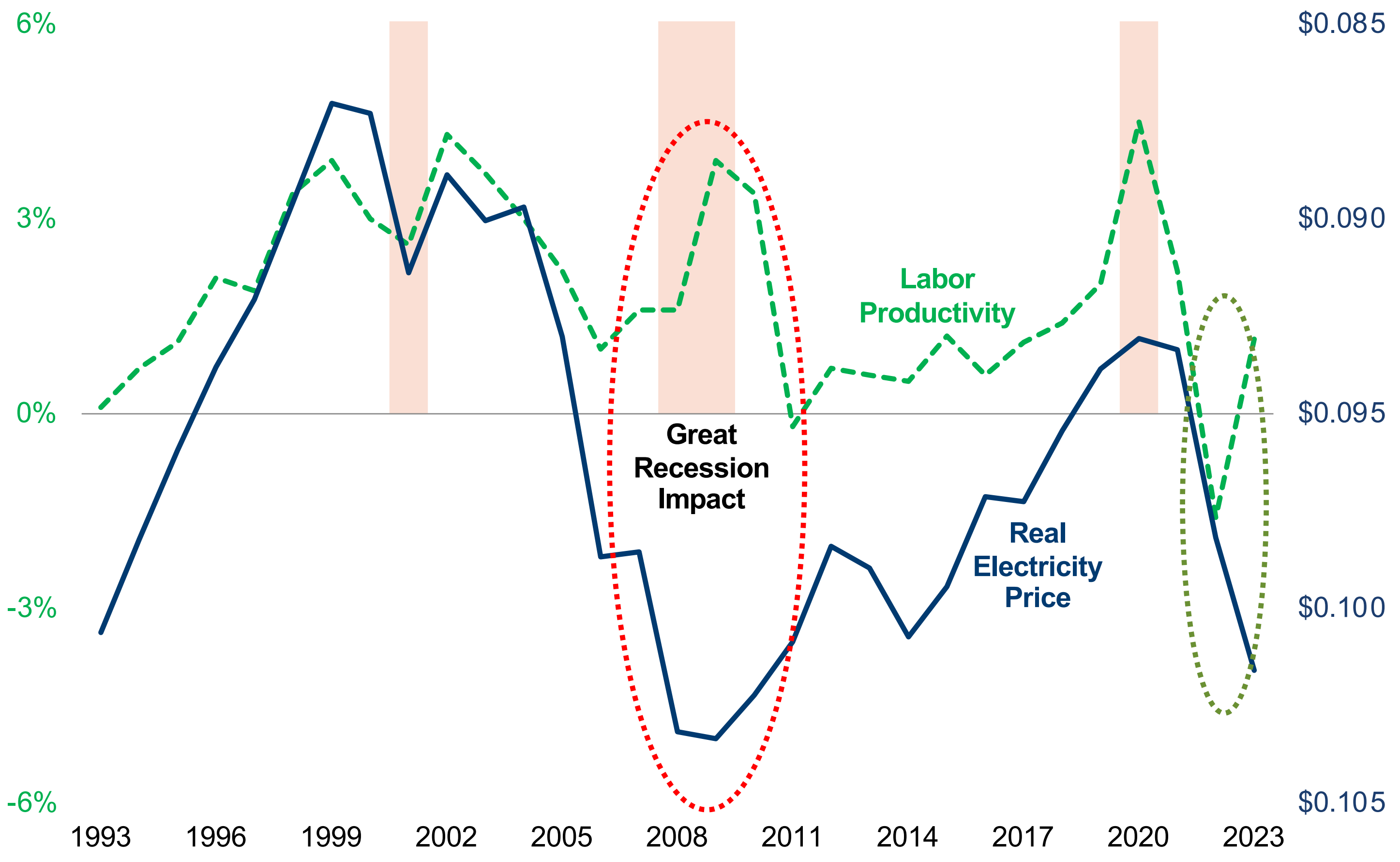
Growth and Stagnant Scenarios – Economic Forecast

Bob Roth; Senior Specialist, Enterprise Forecasting

U.S. Electricity Cost and Productivity

- Productivity is inversely correlated with the inflation-adjusted price of electricity; during the Great recession productivity spiked temporarily due to surge in unemployment / layoffs.
- There is a positive correlation between capital investment and productivity. Lower real electricity prices increase the returns on those investments.
- Productivity fell in 2022 as electricity prices surged due to fuel price spikes. Data for 2023 only reflects six months.



Source: Bureau of Labor Statistics, Energy Information Administration

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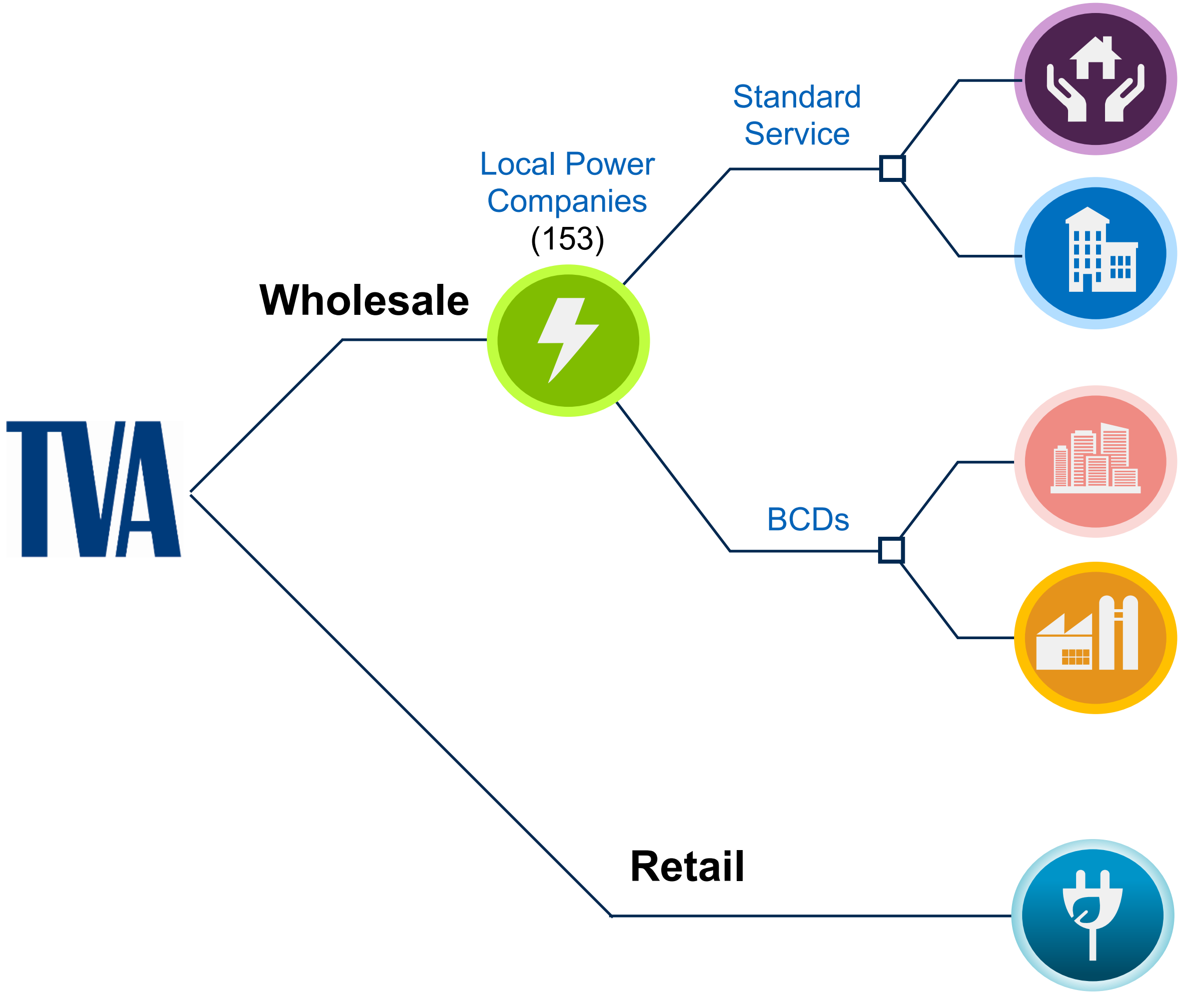
Growth and Stagnant Scenarios – Load Forecast

Nathan Mathis; Manager, Load Forecasting

Breakdown of TVA's Load



	Accounts	% of Energy Demand
Residential	4 Million	40%
Small Commercial & Industrial	700,000	33%
Large Commercial	~100	2%
Large Industrial	~400	12%
Directly Served	~60	13%

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Growth and Stagnant Scenarios - Commodity Forecast

John Collins, Senior Specialist, Enterprise Forecasting

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Executive Summary

Energy demand is tied to the economy

Commodity prices are sensitive to changes in economic activity

Significant uncertainty in future prices

Scenario results represent most likely high and low commodity long-run price boundaries

Higher price volatility expected in growth economy scenario

Energy Demand is Tied to Economic Activity

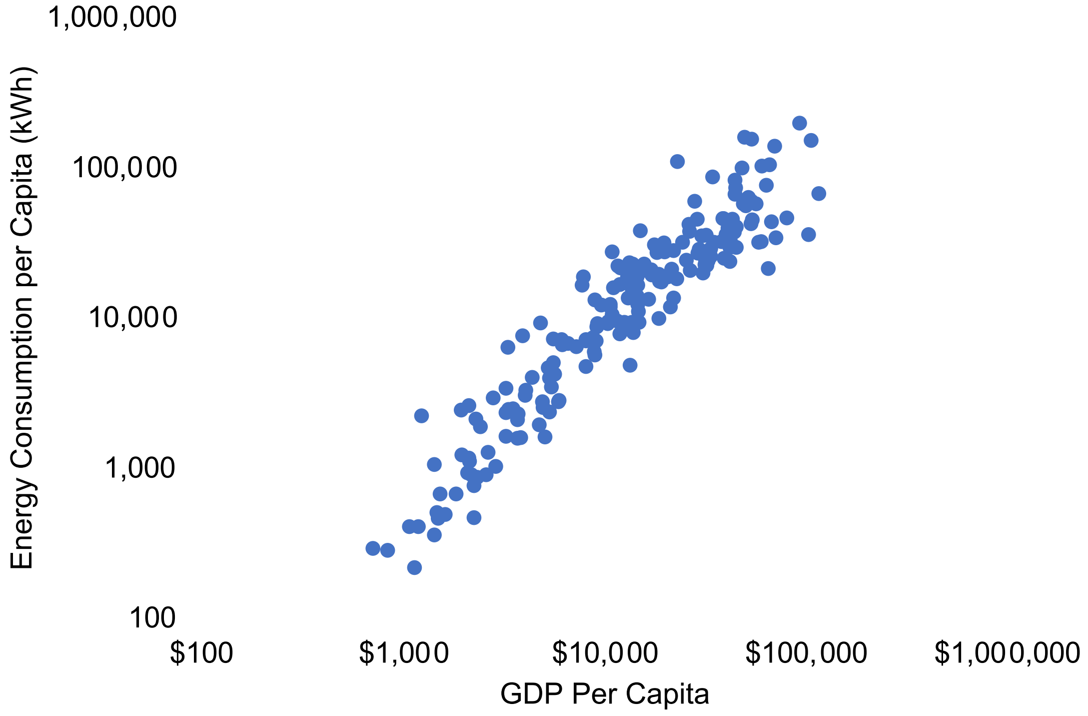
Energy Use Increases with Income

There is a strong relationship between gross domestic product (GDP) and energy consumption

The relationship between the US economy and energy consumption is well studied

GDP is the key variable for commodity demand in the alternative economic scenarios

Per Capita Energy Use vs. GDP, by Country (2021)



Source: World Bank

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Methodology

Literature review of academic articles to determine value of income elasticity

Commodity and sector specific estimates of income elasticity

Change in commodity demand estimated by multiplying new national income forecast by income elasticity

Scenario commodity demand input into models to generate new price forecast

Income elasticity (ε_I) of demand is the responsiveness of quantity demanded to a change in income

$$\varepsilon_I = \frac{\%\, change\ in\ quantity\ demanded}{\%\, change\ in\ income}$$

$$\Delta\, Demand = \Delta\, Income \times \varepsilon_I$$

Conclusions

Changes in the economic outlook significantly impact the demand for energy

Commodity prices are sensitive to changes in economic activity

There is significant uncertainty in future commodity prices

The price forecasts represent long-run price expectations and short-run fluctuations are highly likely to occur

These scenarios create a likely price range

Natural gas prices remain a key determinant of power prices

Other factors than the economy can influence future commodity prices

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Break

Scenario Narratives Alignment

Daniel Woolley; Sr. Specialist, Resource Strategy
Jo Anne Lavender; IRP Facilitator

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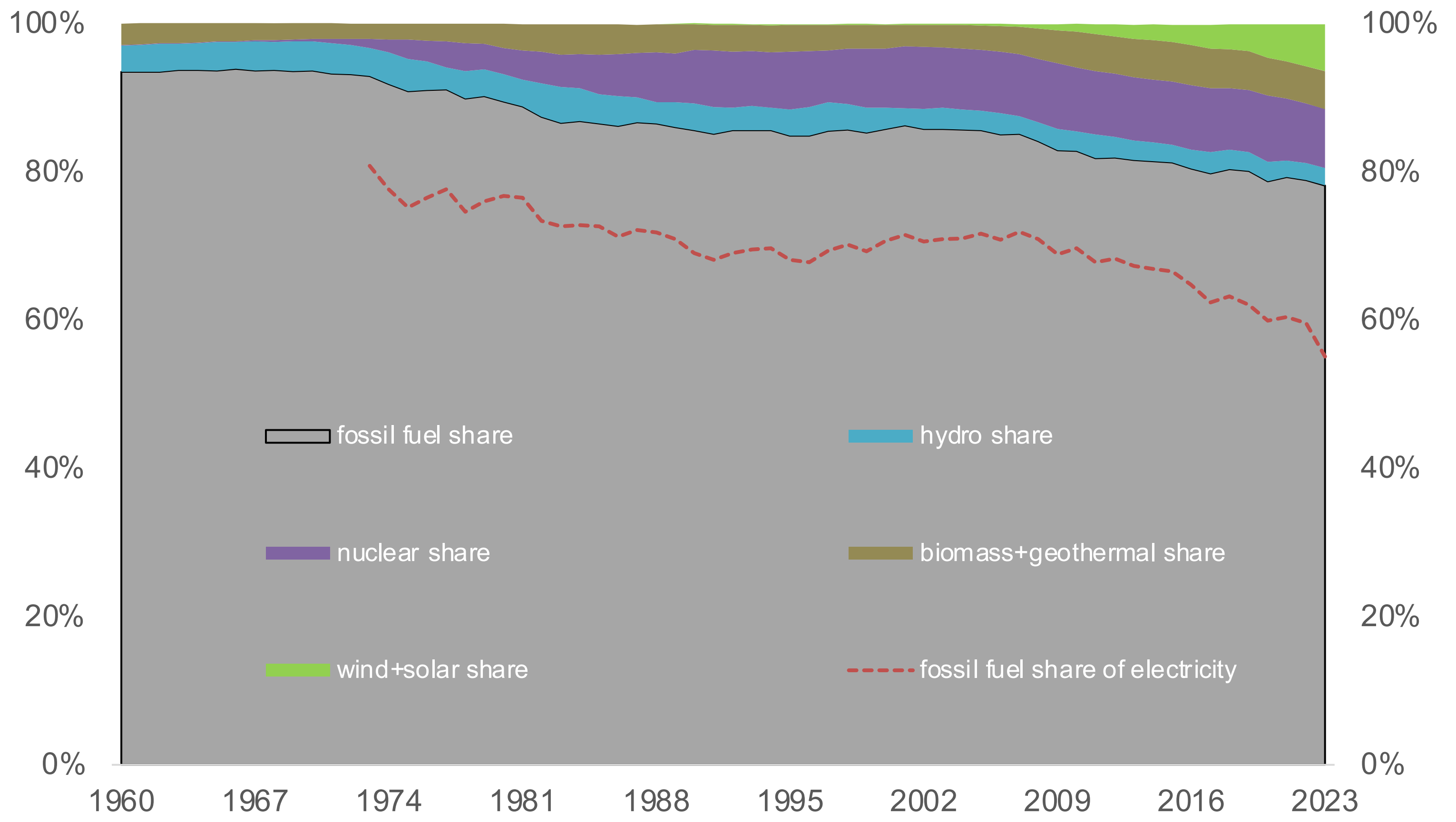
Scenario Discussion – Energy Economics

Bob Roth; Senior Specialist, Enterprise Forecasting

Fuel Shares for Total U.S. Energy Consumption

- The U.S. economies share of energy use tied to fossil fuel has slowly fallen since peaking in 1966.
- In 2022 ~78.8% of total energy use, and ~59.5% of electric power sector use, came from fossil energy sources.
- Policy efforts to accelerate this shift can negatively impact productivity and increase inflation.



Source: U.S. Energy Information Administration

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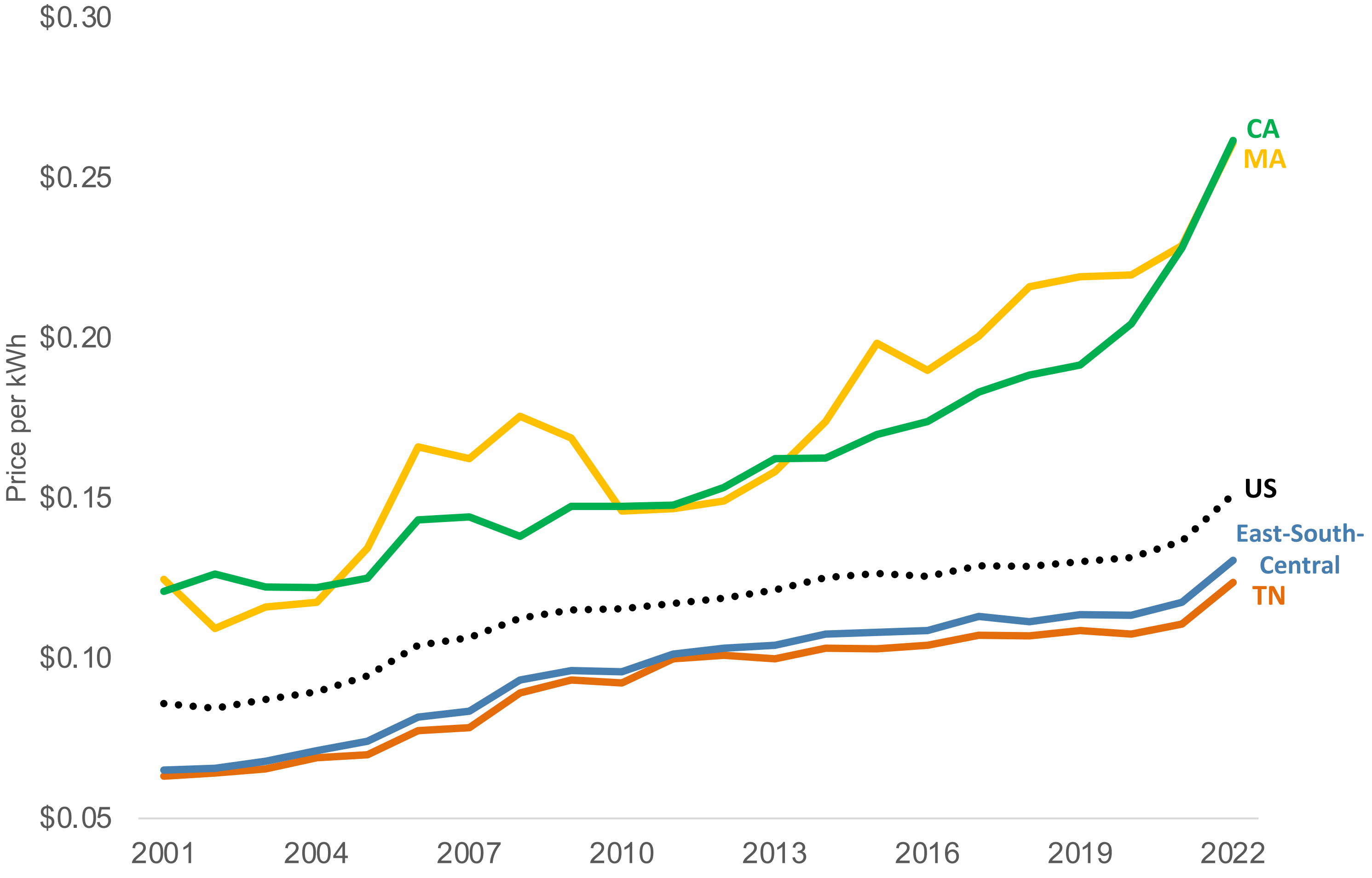
U.S. Electricity Prices – Residential by Region

- TVA region electricity prices have been ~14% LOWER than the U.S. average over the past 15 years.
- California and Massachusetts, both with active carbon trading programs (2013, 2009), have prices which have been 40% to 50% higher than the U.S. average over the past 15 years.
- Over the past five-years CA & MA prices have diverged even more; they are now 58% to 69% higher than U.S. residential prices overall.



Sources: U.S. Energy Information Administration.

Strategy Narratives Discussion

Daniel Woolley; Sr. Specialist, Resource Strategy
Jo Anne Lavender; IRP Facilitator

Planning is Grounded in Least-Cost Principles

In resource planning, TVA applies fundamental least-cost planning principles*:

- Low Cost
- Risk Informed
- Environmentally Responsible
- Reliable and Resilient
- Diverse
- Flexible

*In alignment with the Energy Policy Act of 1992

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Break

IRP Metrics Introduction and Discussion

Daniel Woolley; Sr. Specialist, Resource Strategy
Jo Anne Lavender; IRP Facilitator

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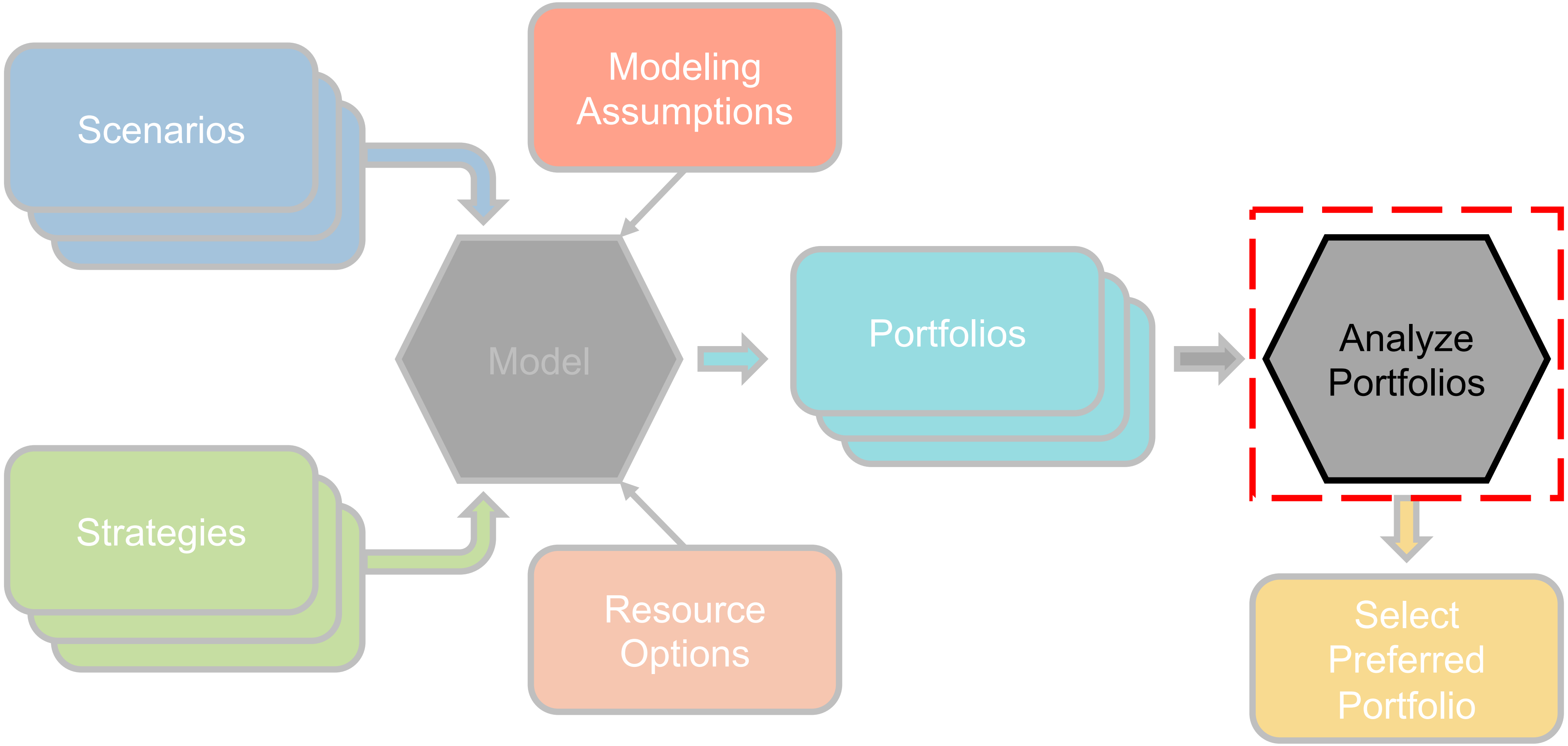
How the Integrated Resource Planning Process Works



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

Choosing the “Right” Resource Plan

The challenge is not insufficient data but rather sorting through all the results to identify the preferred resource plan.

So how do you know when the plan is “good”?

Metrics help focus evaluation of plan results by highlighting key tradeoffs and must be utilized in alignment with the Energy Policy Act of 1992.

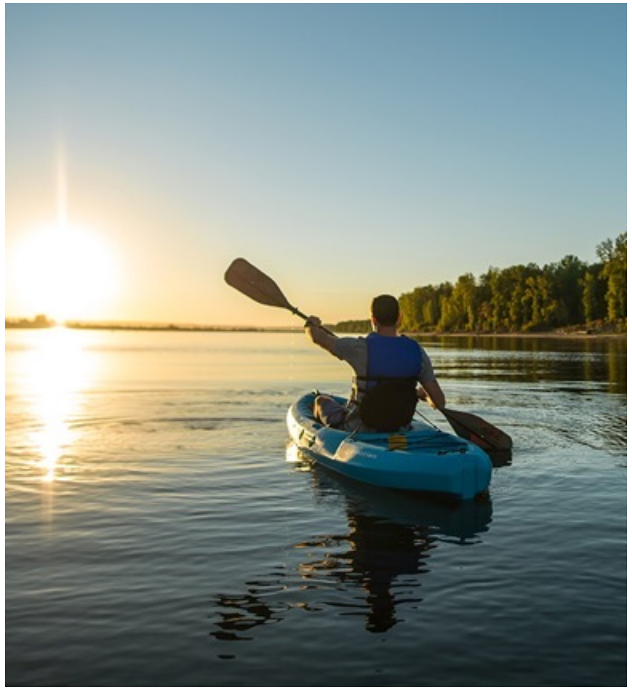
Metrics need to reflect the utility’s and stakeholder’s values and priorities.

Metrics need to be clear and easy for stakeholders and decision-makers to understand.

Metrics Tie to TVA's Mission

Energy | Environment | Economic Development

Provide affordable, reliable power.



Steward the Valley's natural resources.

Partner for economic growth.

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2019 IRP Metrics Scorecard

	IRP Scorecard Metrics	Low-Cost Reliable Power	TVA Mission Economic Development	Environmental Stewardship
Cost	PVRR ($Bn)	✓	✓	
	System Average Cost ($/MWh)	✓	✓	
	Total Resource Cost ($Bn)	✓		
Risk	Risk/Benefit Ratio	✓		
	Risk Exposure ($Bn)	✓		
Environmental Stewardship	CO2 (MMTons)		✓	✓
	CO2 Intensity (lbs/MWh)		✓	✓
	Water Consumption (MMGallons)			✓
	Waste (MMTons)			✓
	Land Use (Acres)			✓
Operational Flexibility	Flexible Resource Coverage Ratio	✓		
	Flexibility Turn Down Factor	✓		
Valley Economics	Percent Difference in Real Per Capita Income	✓	✓	
	Percent Difference in Employment		✓	

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Wrap-up and Day Two Preview

Jo Anne Lavender; IRP Facilitator

2024 IRP Working Group

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Franklin, TN

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Welcome

Jo Anne Lavender; IRP Facilitator

Agenda – September 26, 2023

Topic	Time (CT)	Presenter(s)	Notes
Breakfast	7:30-8:15		
Roundtable with Jeff Lyash	8:15-9:15		
Break	9:15-9:30		
Agenda and welcome	9:30-9:40	Jo Anne Lavender	
Demand-side program design	9:40-10:40	Lauren Mitchell; Kyle Lawson	Review of demand-side resources (EE/DR) available for selection
Break	10:40-10:55		
New nuclear overview	10:55-11:55	Brian McDermott; Alex Young	Review of advanced nuclear resource options
Lunch	11:55-1:00		
Resource planning 201	1:00-1:30	Hunter Reed	Overview of resource selection and modeling approach
Overview of expansion resource options, including Break	1:30-3:50	Kevin Cox (Horizons Energy); Roger Pierce	Review of supply-side resources available for selection, including costs and characteristics
Wrap-up	3:50-4:00		

Demand-side Program Design

Lauren Mitchell; Manager, Energy Services & Programs
Kyle Lawson; Sr. Program Manager, Commercial Energy Solutions Analytics

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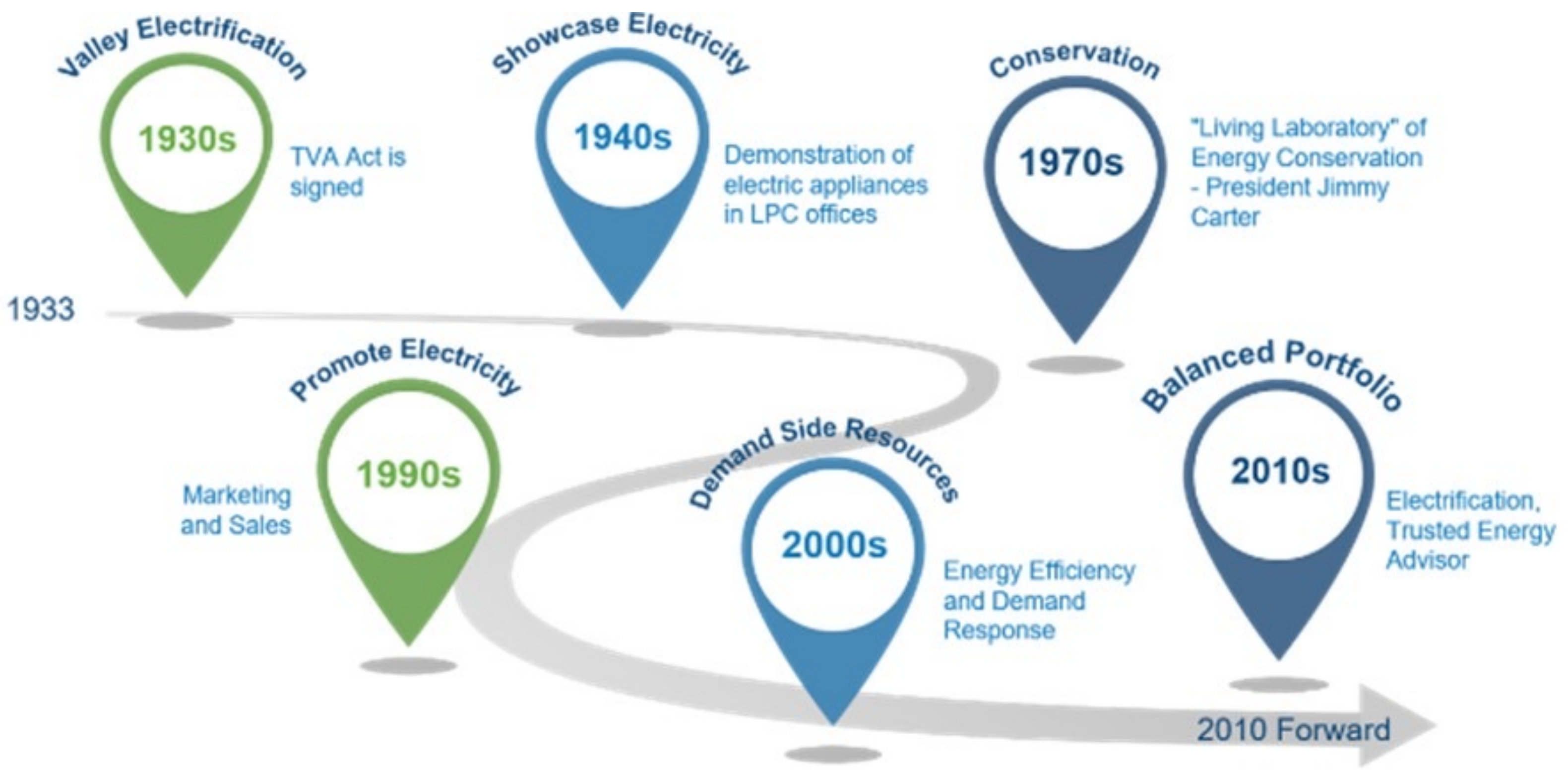
A History of Energy Programs at TVA



Virtual Power Plant

Diversified portfolio, focus on system needs, reducing carbon, and improving energy equity

Demand-Side Management Objectives

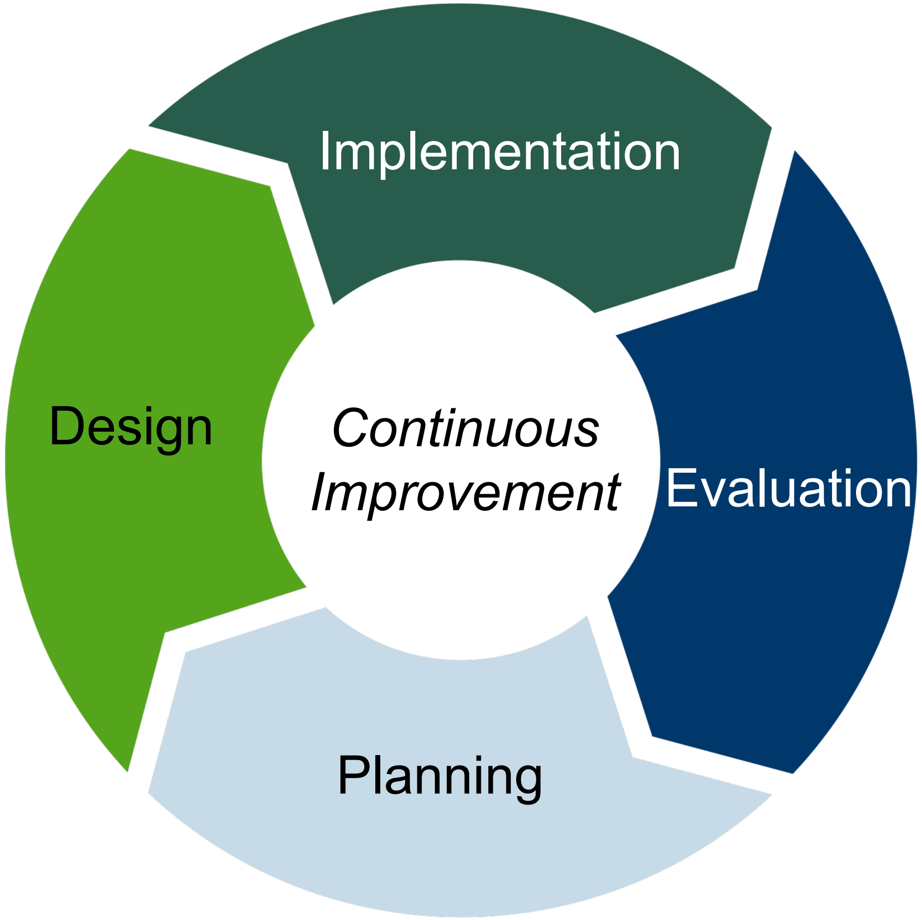
Provide demand management and clean energy services through partnerships with LPCs and end use customers to benefit the system and make life better for people of the Valley

Lines of Effort	Goal
Develop and maintain the Virtual Power Plant (VPP) Balance system needs by lowering costs, shaping energy usage, and increasing capacity	Clean, reliable, low-cost power
Optimize Community Energy Efficiency Maintain impactful energy equity programs in the Valley	Reduced energy bills for low-income and underserved communities
Promote Clean Energy Services Provide programs and services to meet increased consumer demand for clean energy, electric vehicle, and resiliency-based offerings	Alignment with TVA strategic direction; Trusted energy advisor recognition

Energy Program Planning Process

Program Lifecycle

The program lifecycle is a continuous process, and the program may cycle through these stages multiple times with each iteration refining the program to achieve greater energy savings and cost effectiveness



1. **Planning** involves assessing the potential energy savings, identifying the target market, and establishing the program's performance metrics
2. **Design** involves creating programs to deliver the appropriate energy-efficient technologies, developing marketing/outreach materials, and implementation partners
3. **Implementation** involves outreach and marketing to the target market, providing technical assistance, delivering incentives, and report verified impacts
4. **Evaluation** involves a third-party audit that measures the energy savings achieved, assessing the program's cost-effectiveness, and identifying areas for improvement

Planning: Setting Strategic Direction

High-level Strategy

Understanding TVA's strategic direction and needs through processes such as the Integrated Resource Plan, and **identifying system and market needs** through enterprise forecasting and market research

Long-term Planning

Determining the best path forward through **strategic studies and analysis** such as the Energy Programs Potential Study and Energy Program historical results and trends. Long–term plans will evolve with signposts and as we gain experience operating a changing fleet

Power Supply Plan

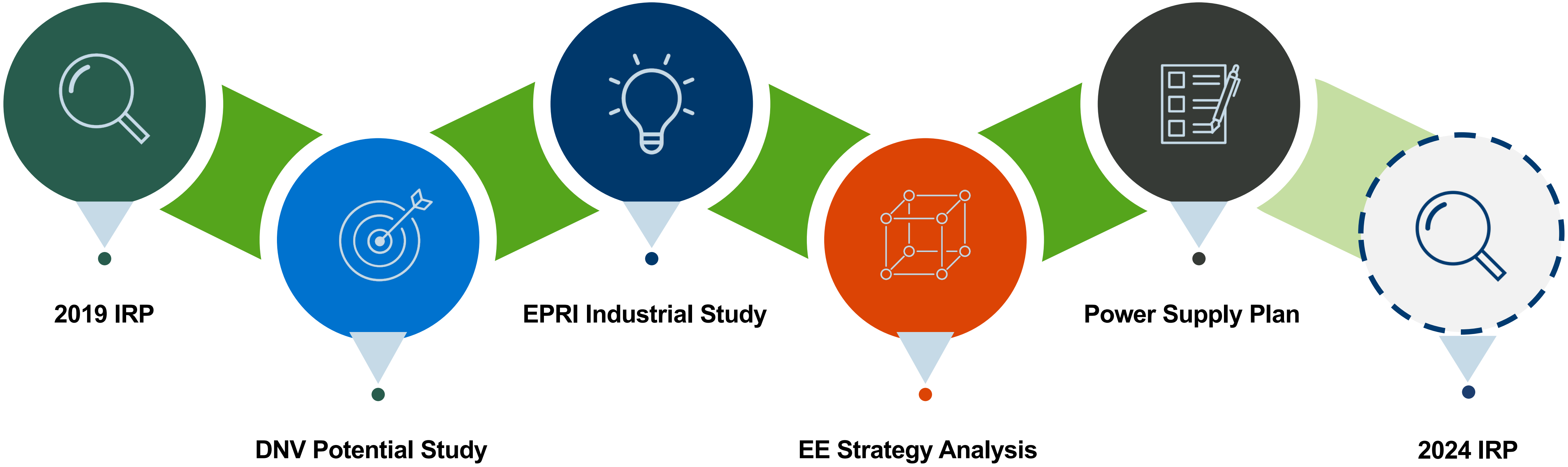
Defining asset additions and reductions through time, along with the **planned operation of these assets**. Volumes of Energy programs are further defined through this process

Contracting Plan

Executing on a near-term direction through the delegation and **approval for programmatic activities** over the 3-year business planning horizon. Approved by the TVA Board in August of each Fiscal Year

Key Planning Inputs

Over the last 24 months (Summer 2021 – Summer 2023), TVA's Enterprise Planning (EP) and Commercial Energy Solutions (CES) teams have undertaken a collaborative planning process to define, evaluate, and optimize a 10-year strategy for TVA's current execution of the demand management portfolio.



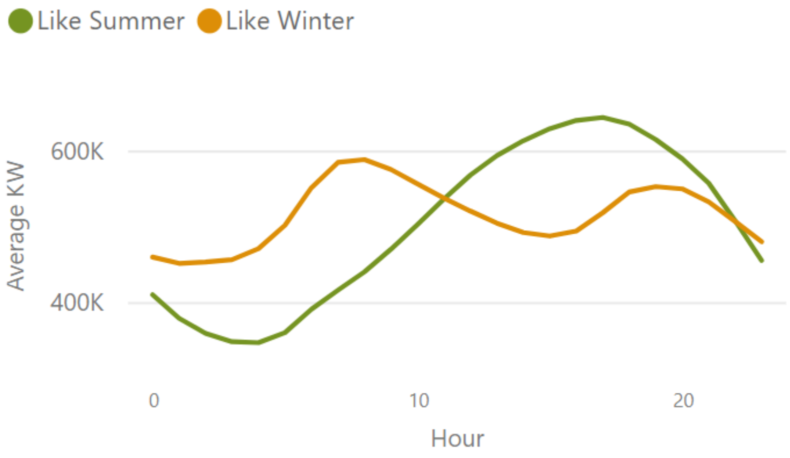
Energy Program Modeling Process

Load Shapes

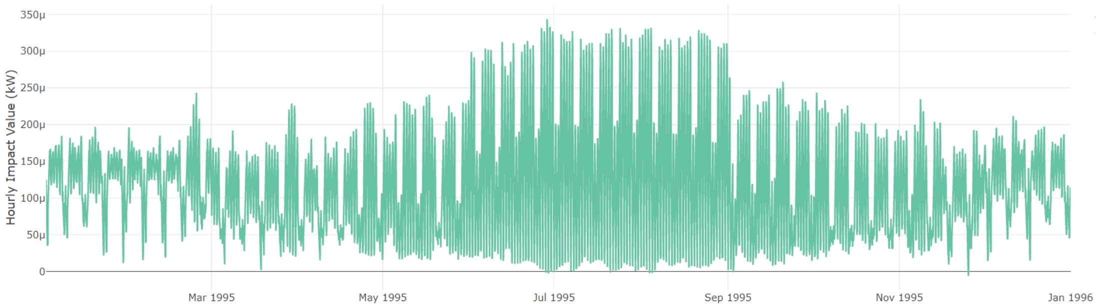
A **load shape** is a demand profile for an electric load, typically expressed as an 8760 hourly shape.

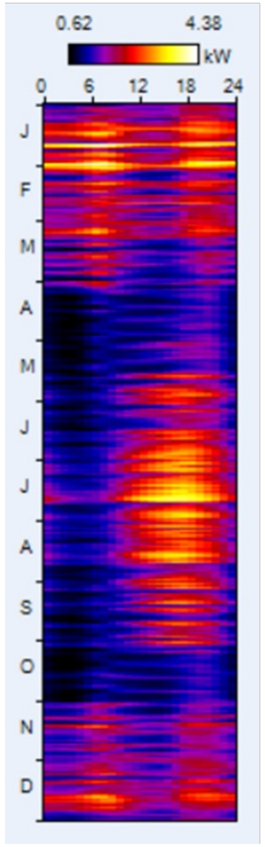
Load shapes can be based on load/usage (like TVA's system shape), or energy savings (i.e., an EE shape represents the demand reduced at each hour).

Weather-sensitive shapes tend to follow a pattern based on season.



Load shapes can be represented visually as line charts (below) or energy prints (right).





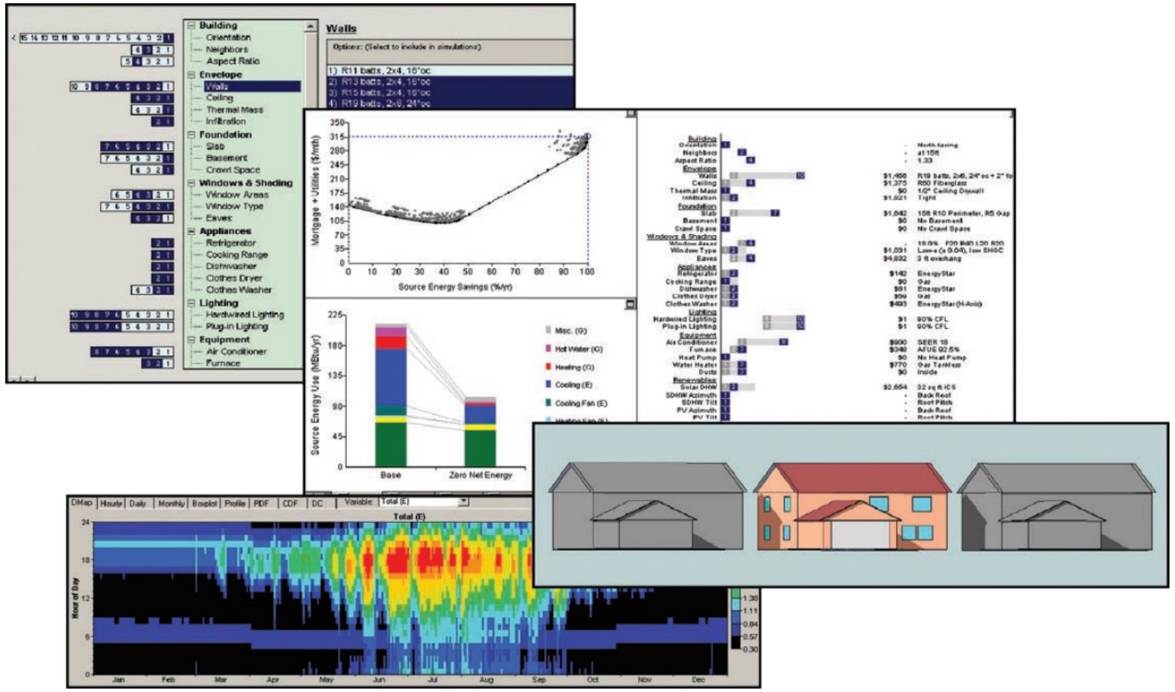
Modeling process – How Load Shapes are Developed

Calibrated Energy Simulation Modeling with hourly end-use outputs: DOE 2.1, eQuest, EnergyPlus, Beopt, etc.

Evaluation of past program participants or pilot efforts

Whole facility or sub-metering of target customers or implementors

Engineering calculations coupled with known end-use characteristics



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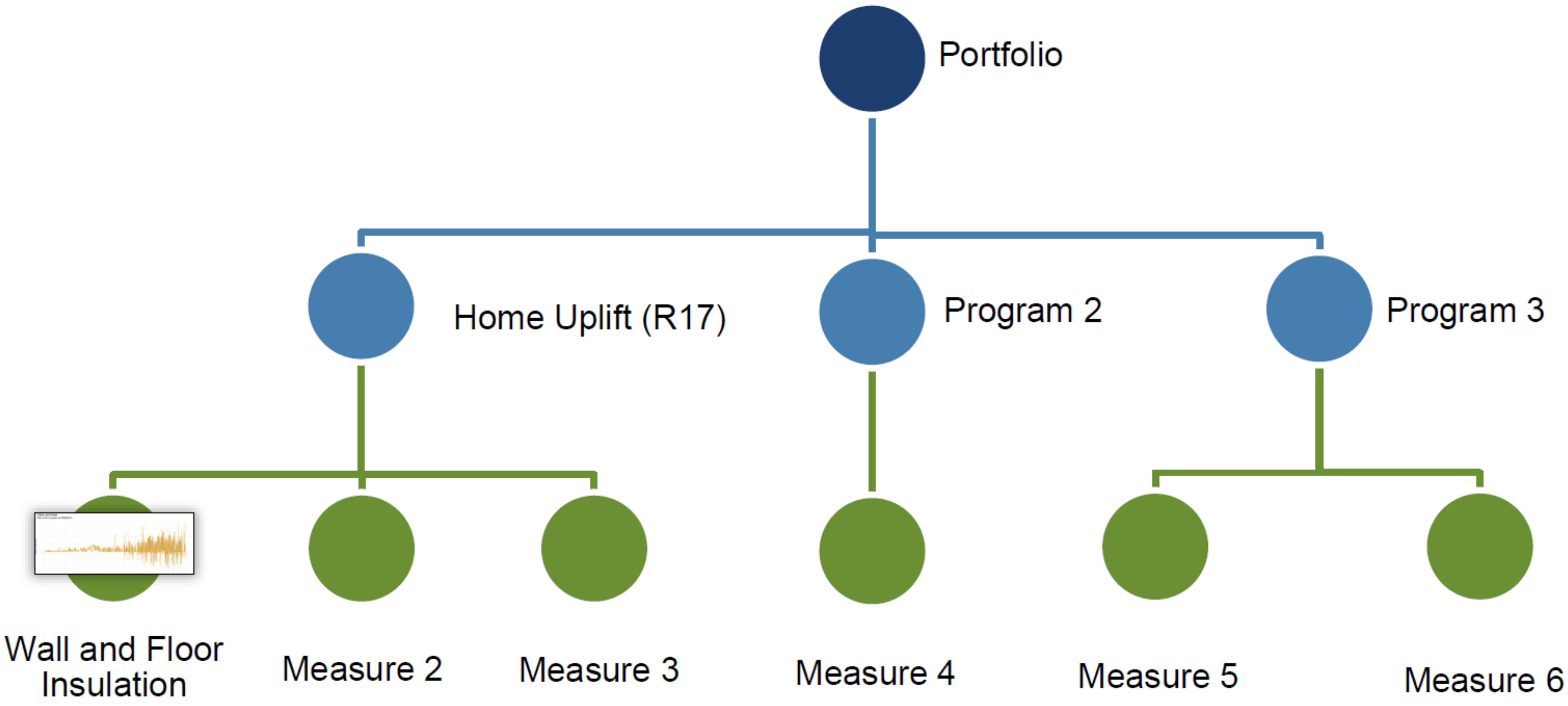
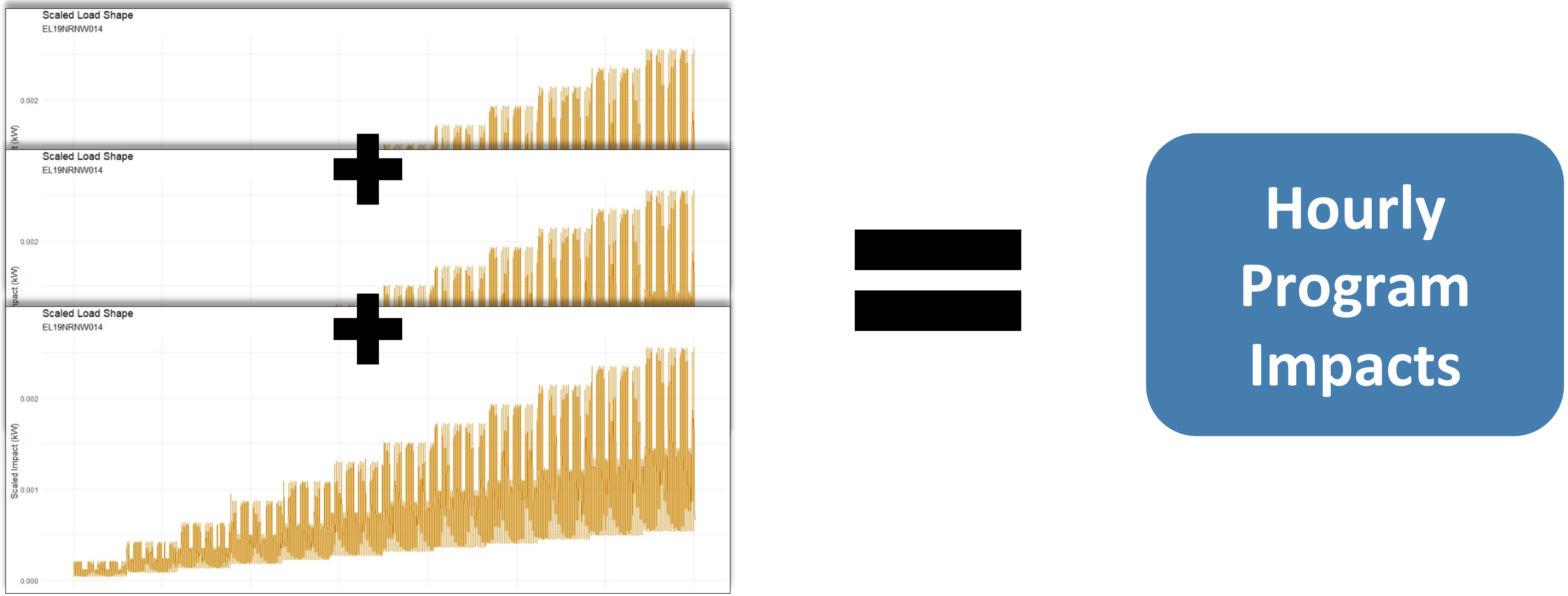
Measure-level Forecasts are Aggregated to Higher Levels



Aggregated Measure-level Forecasts represent Hourly Cumulative Program Impacts



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Break

New Nuclear Overview

Brian McDermott; Director, Licensing and Planning
Alex Young; Sr. Project Manager, Clinch River Nuclear Project

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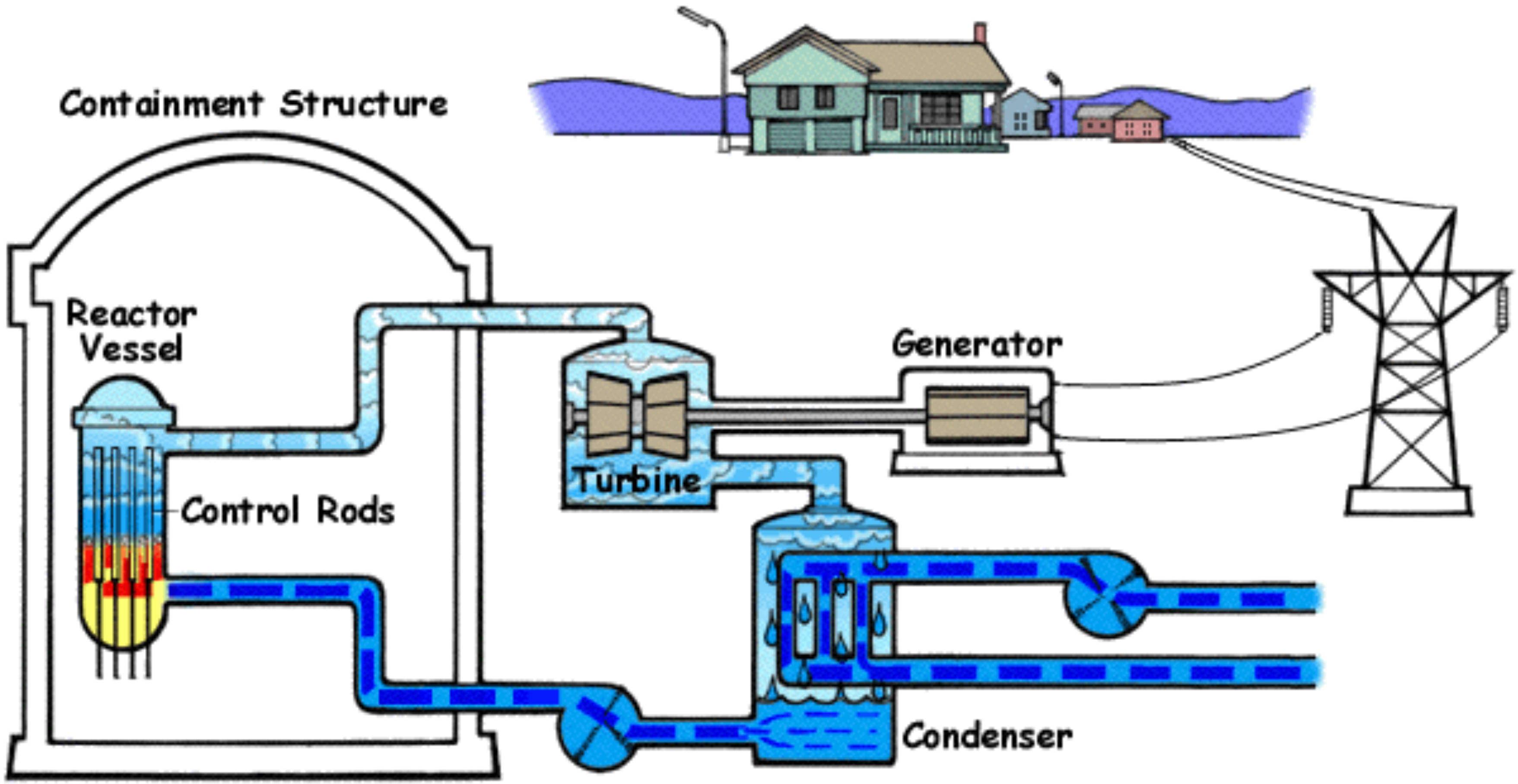
Recommended Reading

Pathways to Commercial Liftoff: Advanced Nuclear, Department of Energy (2023)

New Nuclear

How Nuclear Power Works

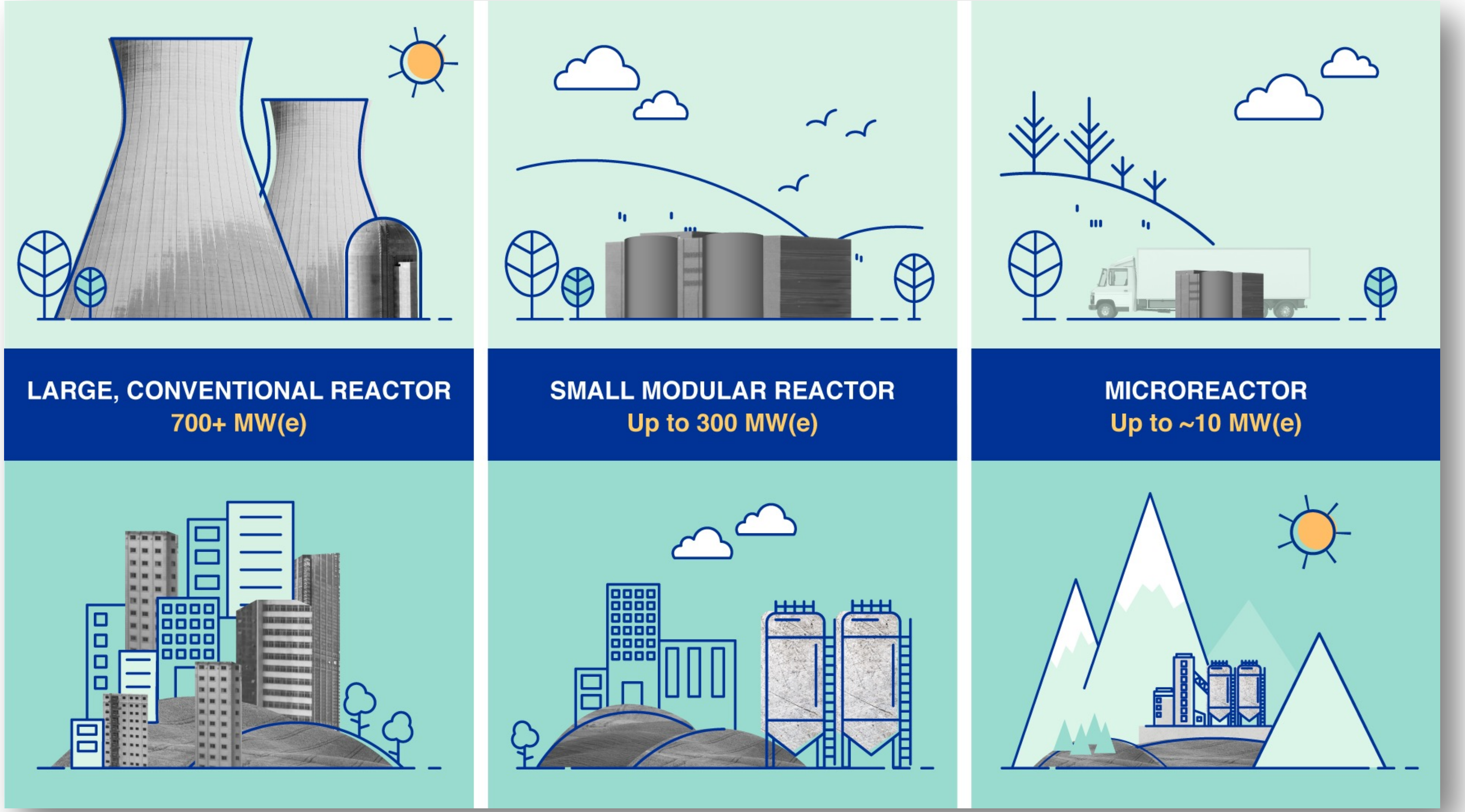
SPLITTING URANIUM ATOMS TO GENERATE HEAT



The Boiling Water Reactor (BWR) | NRC.gov

Types of Nuclear Power

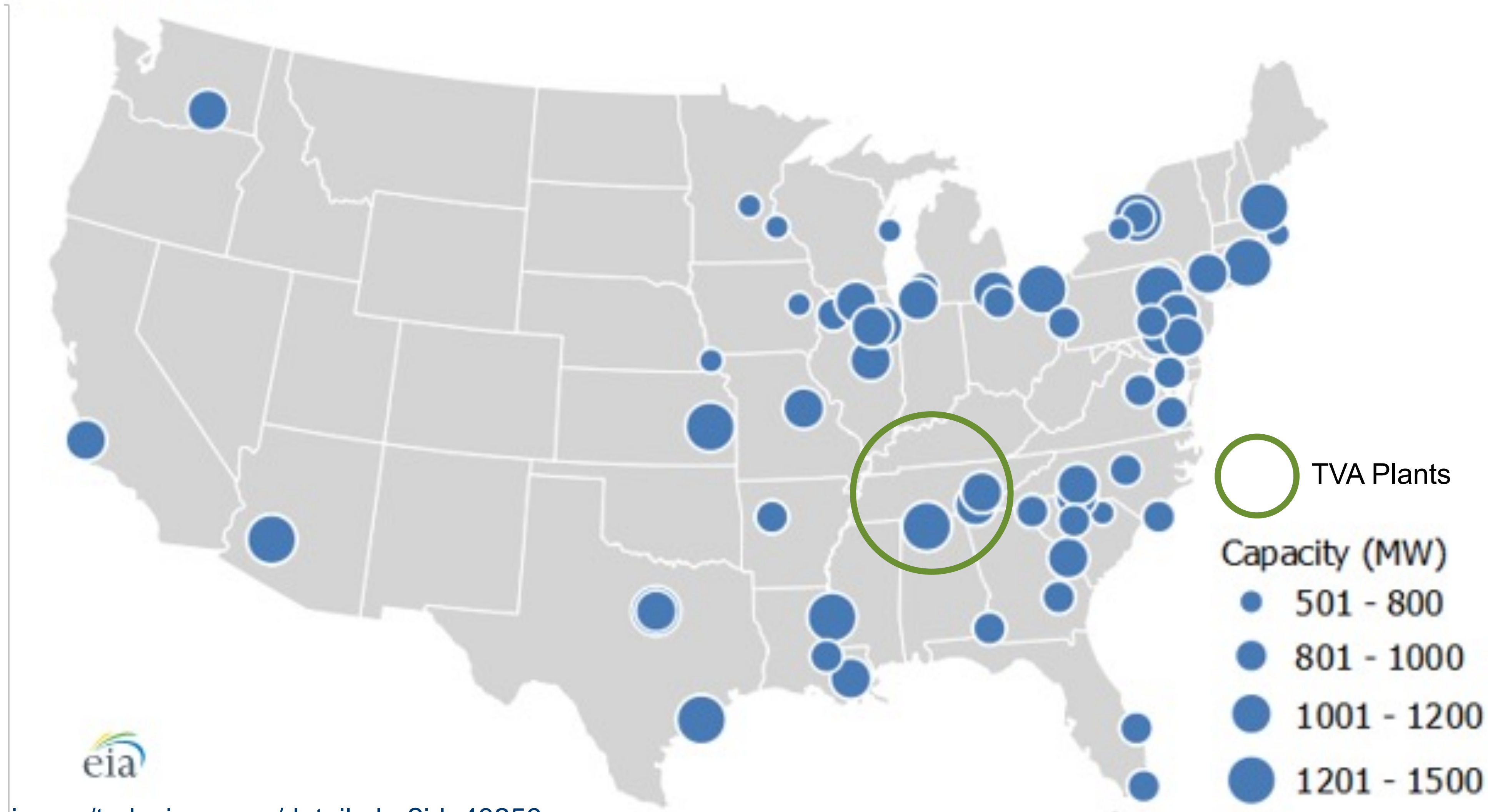
MULTIPLE OPTIONS FOR SCALING



[What are Small Modular Reactors (SMRs)? | IAEA]

US Commercialization of Nuclear Power

US INSTALLED NUCLEAR CAPACITY BY REACTOR MEGAWATTS (MW)



eia.gov/todayinenergy/detail.php?id=43256

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Fast Facts on Spent Nuclear Fuel

SAFE STORAGE | VOLUME | RECYCLING POTENTIAL

Recent US New Nuclear Construction

Plant	Vogtle 3 & 4 (AP-1000)	Watts Bar 2 (PWR)
Location	Waynesboro, GA	Spring City, TN
MW	2200 (2-unit total)	1150 (1 unit)
Construction Start	2013	1973/2007
Commercial Operation Date	2023 (Unit 3) 2024 (Unit 4)	2016

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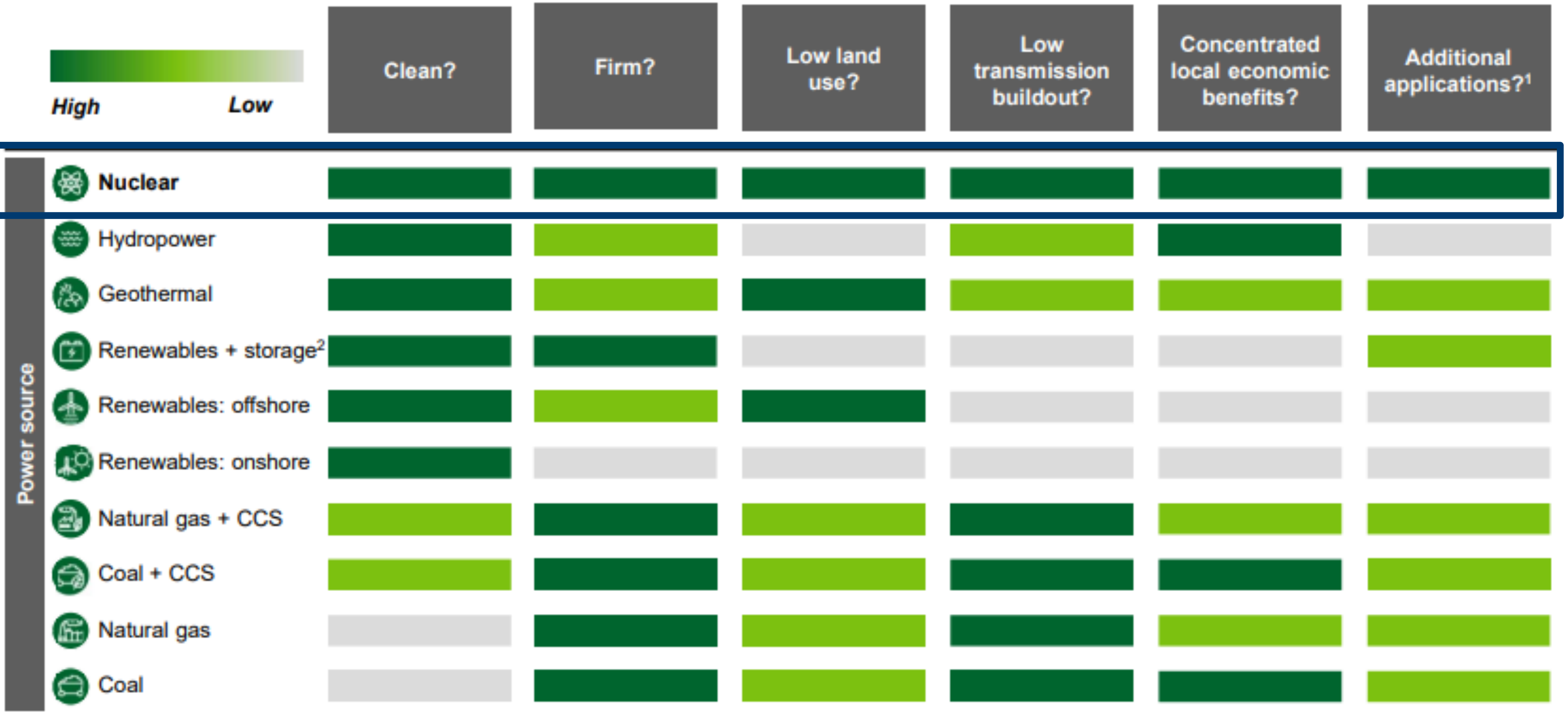
New Nuclear Power Considerations

SIX FEATURES FOR DIFFERENTIATED VALUE PROPOSITION



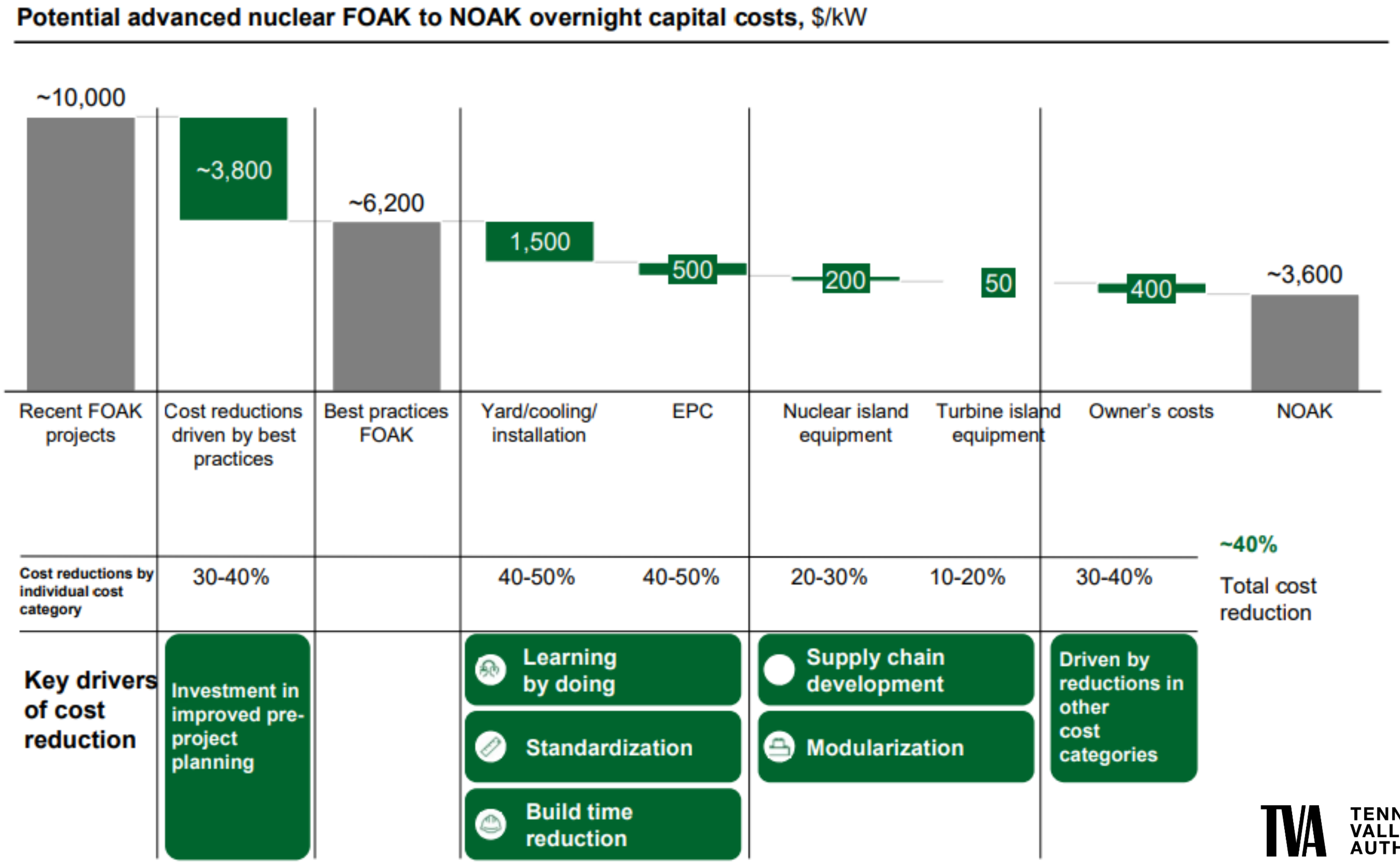
1. Additional applications include clean hydrogen generation, industrial process heat, desalination of water, district heating, off-grid power, and craft propulsion and power
2. Renewables + storage includes renewables coupled with long duration energy storage or renewables coupled with hydrogen storage

 Pathways to Commercial Liftoff: Advanced Nuclear, Department of Energy (2023)

Illustrative New Nuclear Technology Costs

FIRST-OF-A-KIND (FOAK) TO NTH-OF-A-KIND (NOAK)

Categorizations for How Advanced Nuclear Costs Could Decrease from FOAK to NOAK Deployments



[Pathways to Commercial Liftoff: Advanced Nuclear, Department of Energy (2023)]

Inflation Reduction Act and New Nuclear

INCENTIVES FOR EARLY START, ENERGY COMMUNITIES, DOMESTIC CONTENT

IRA provision	Description	Adders	Notes
48E: investment tax credit (ITC)	Provides 30% of the capital cost for a nuclear plant back in tax credits	+10% for siting in energy communities +10% for use of domestic content	**Facility eligible for both adders would get 50% effective ITC**
45Y: production tax credit (PTC)	Provides an inflation adjusted $25/MWh in tax credits for every MWh of power produced by a nuclear plant	+10% for siting in energy communities +10% for use of domestic content	**Must choose ITC or PTC (not both)**
Section 50173 Availability of High-Assay Low-Enriched Uranium	Provides $500M for development of HALEU production capacity, including research, development and demonstration	N/A	

Figure 20: Summary of benefits of the Inflation Reduction Act to advanced nuclear power

Pathways to Commercial Liftoff: Advanced Nuclear, Department of Energy (2023)

TVA New Nuclear

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TVA & New Nuclear Technology

FEBRUARY 2022 TVA BOARD DIRECTION

Approved funding up to $200 million for a program to:

1. Perform design engineering, scoping, estimating, and planning associated with potential future deployment of an advanced reactor at Clinch River
2. Develop new nuclear license applications
3. Continue to study potential, future advanced reactor technologies
4. Study potential for advanced nuclear deployments at other sites

CLINCH RIVER NUCLEAR PROJECT INFORMS POTENTIAL FLEET DEPLOYMENTS

NEW NUCLEAR PROGRAM PLANNING FOR POTENTIAL FLEET DEPLOYMENT

What are TVA's New Nuclear Options?

TECHNOLOGY EVALUATION FOR LIGHT & NONLIGHT WATER

	Light Water Reactors	Nonlight Water Reactor – Gen IV (sodium, gas, salt coolants)
Nuclear Fuel	Same as operating nuclear fleet	Need supply chain, testing, and licensing
Supply Chain	Ready; quickly scalable	Need suppliers and component testing
Operational Characteristics	High availability; compatible with renewables	Unproven availability; compatible with renewables; industrial process heat capable, improved efficiency
Timeframes	First commercial deployments by 2028 (OPG)	First commercial deployments from late 2030s to early 2040s

Technologies and their potential for commercial scale deployment were assessed:

- ✓ Technology – evaluates subsystem development / maturity
- ✓ Licensing – progress towards and probability of regulatory approval
- ✓ Economic – estimated levelized cost of electricity (LCOE)
- ✓ Manufacturing – maturity and viability of fabricating the plant / subsystems / major components
- ✓ Risk – combination of safety, implementation and operability risks

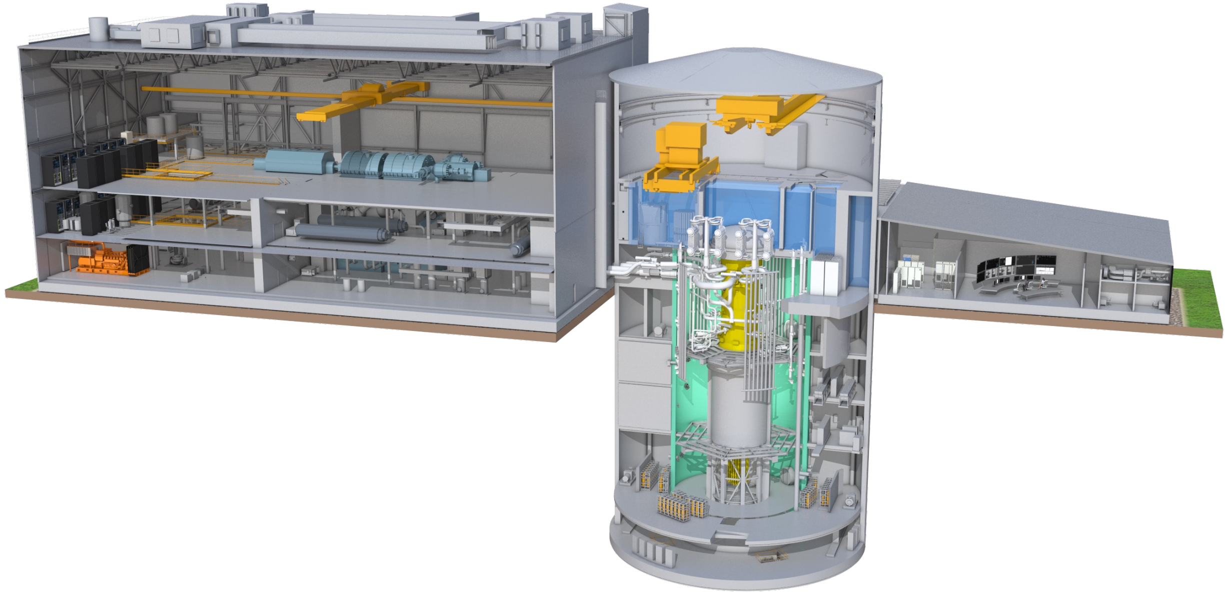
GE-Hitachi BWRX-300

BUILT ON EXISTING TECHNOLOGY

TVA identified GEH's innovative BWRX-300* reactor design as the most promising for near-term deployment.

BENEFITS OF THIS DESIGN INCLUDE

- **10** GENERATIONS OF DESIGN HISTORY
- EXISTING SUPPLY CHAINS
- AMERICAN FUEL
- NRC LICENSING PATHWAY



This provides confidence the technology can be **deployed** on a **predictable schedule** with **acceptable risk**.

*TVA has not yet decided to deploy an SMR. Any decisions will be subject to support, risk sharing, required internal and external approvals, and completion of all necessary environmental and permitting reviews

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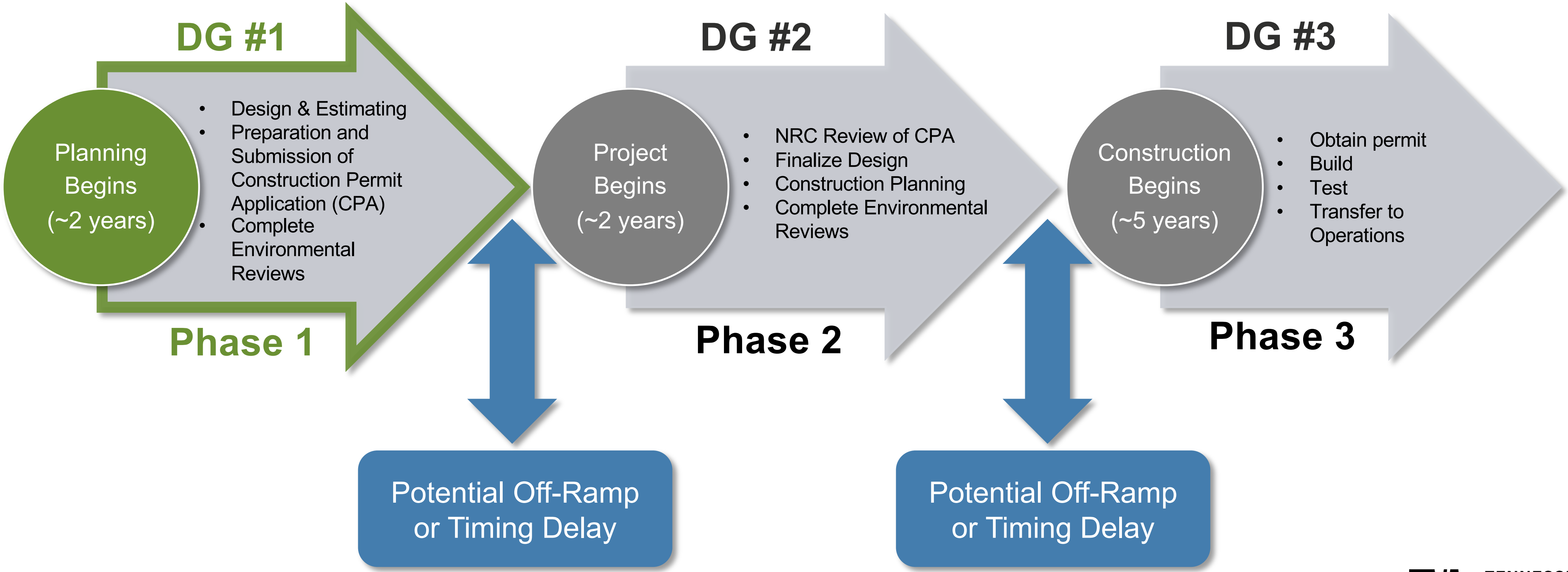
Clinch River Nuclear Decision Gate Process*

PHASED DECISION APPROACH TO REDUCE RISK AND COSTS

Board Authorization required to proceed beyond Decision Gate (DG) for each phase.
Enterprise evaluation criteria to support recommendation to the CEO and Board.



*The Decision Gate process is a broad overview and subject to change as needed, based on new information and Board decision making.

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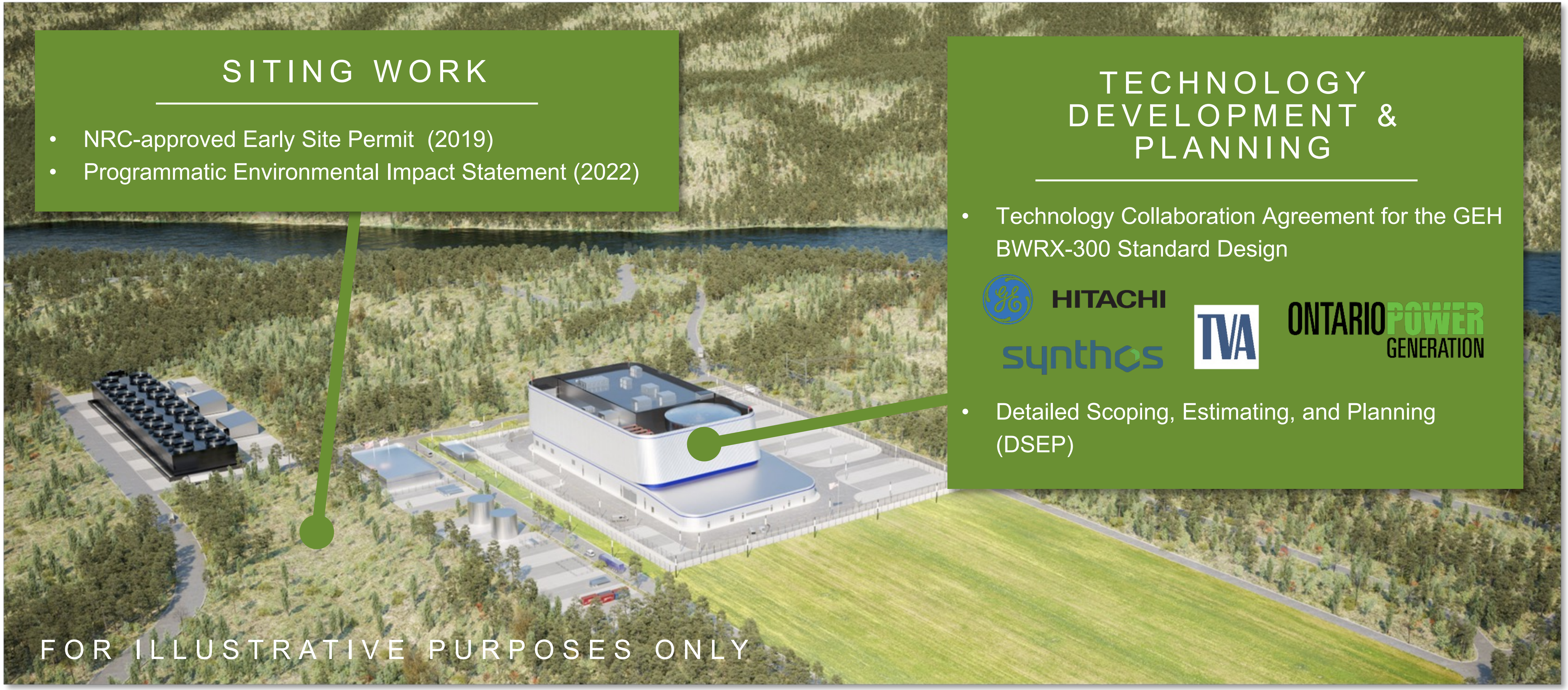
Clinch River Nuclear Project

PRELIMINARY WORK FOR SITING, TECHNOLOGY, AND PLANNING



SITING WORK

- NRC-approved Early Site Permit (2019)
- Programmatic Environmental Impact Statement (2022)

TECHNOLOGY DEVELOPMENT & PLANNING

- Technology Collaboration Agreement for the GEH BWRX-300 Standard Design

HITACHI | synthos | TVA | ONTARIO POWER GENERATION

- Detailed Scoping, Estimating, and Planning (DSEP)

* TVA has not yet decided to deploy an SMR. Any decisions will be subject to support, risk sharing, required internal and external approvals, and completion of all necessary environmental and permitting reviews.

TVA Vision for New Nuclear

STRATEGIC PATH FORWARD FOR THE PEOPLE OF THE VALLEY

Technology	Nuclear technology is a reliable, resilient, 24/7, carbon-free power.
Leadership	TVA's leadership in technology innovation provides a pathway to net-zero carbon emissions.
Experience	TVA has the nuclear and construction experience and talent to support small modular reactor (SMR) development and deployment.
Approved Site	The Nuclear Regulatory Commission approved an Early Site Permit for TVA's Clinch River site, meaning that it is suitable for SMRs.
Strategic Approach	TVA's Decision Gates will ensure the timing of deployment is right.
Future-Looking	TVA's New Nuclear Program will inform future SMR decisions and potential deployment locations across the Tennessee Valley.

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Discussion

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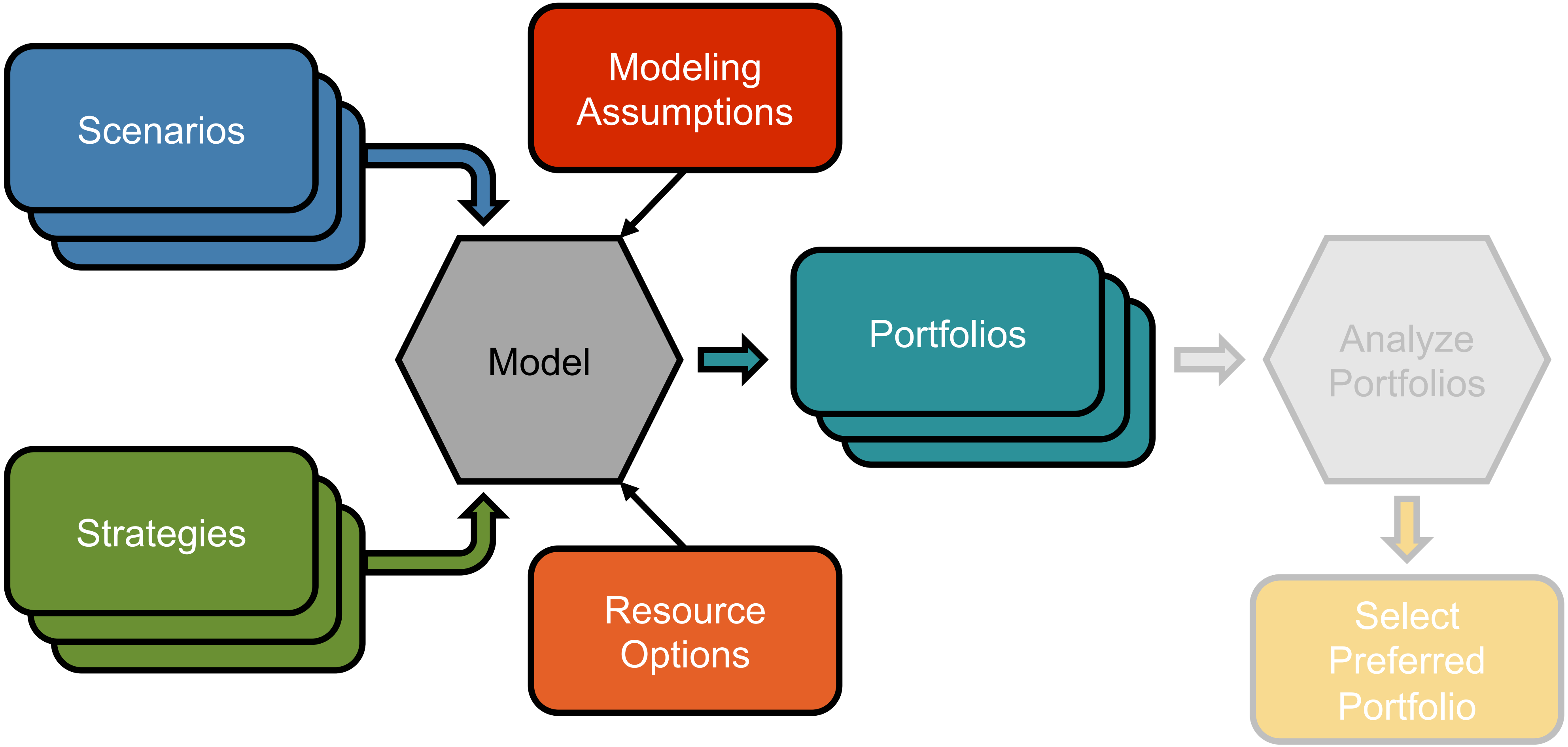
Lunch

Resource Planning 201

Hunter Reed; IRP Project Manager

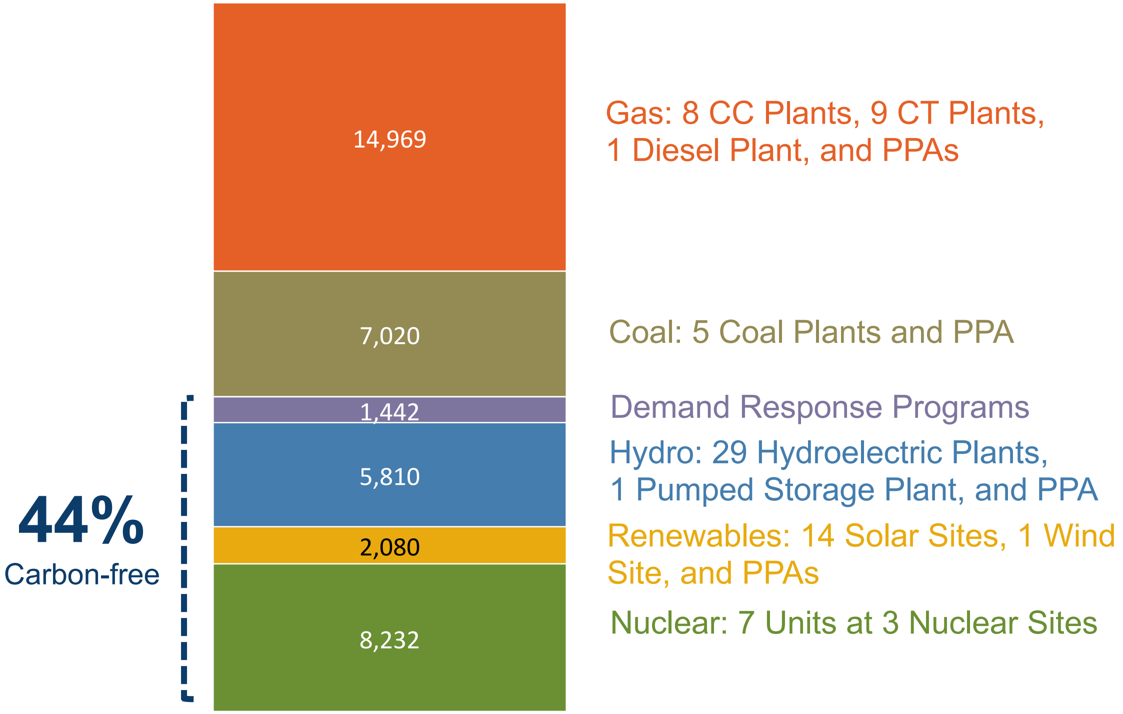
How the Integrated Resource Planning Process Works



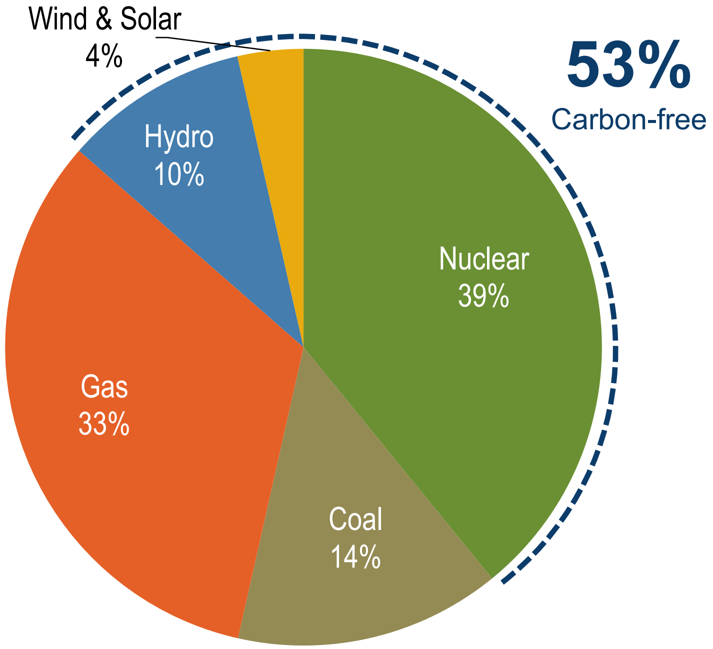
Stakeholder feedback is a key component in the development of all model inputs

Today's Resource Portfolio

FY22 Capacity
39,553 MW



FY22 Energy
165 TWh



Capacity aligns to FY22 10-K Net Summer Capability, adjusted to include demand response programs. Planning capacity is lower, as it accounts for Hydro and Renewable expected generation at peak, fuel blend derates, and other factors.

In addition to power supply sources included here, TVA offers energy efficiency programs that effectively reduced 2022 energy needs by about 2,200 GWh or 1.3% (Net Cumulative Realized at System basis, 2007 base year).

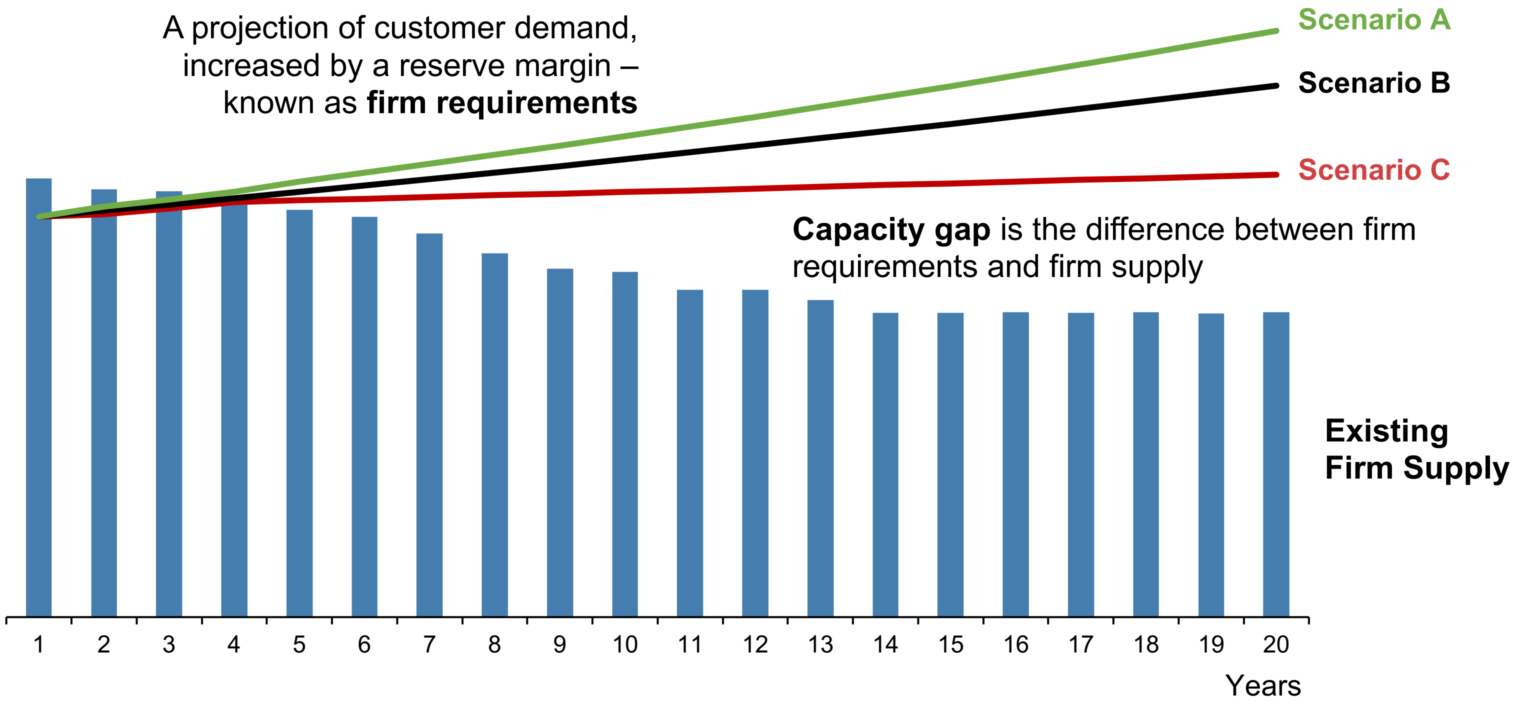
Resource Planning for Future Capacity Needs

Resource planning is about optimizing the mix of future capacity.

Projections of capacity needed are filled by the most cost-effective resources.

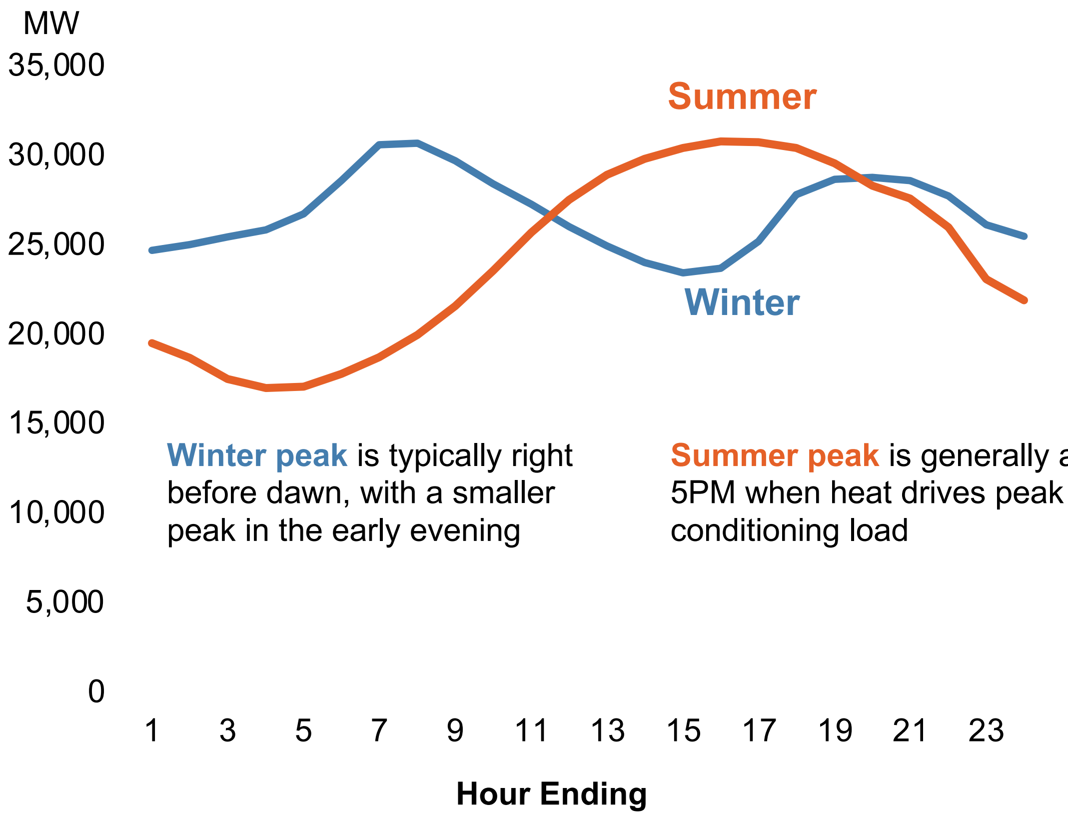
Multiple scenarios will be explored, reflecting different levels of forecasted demand.

Illustrative Capacity Gap Chart



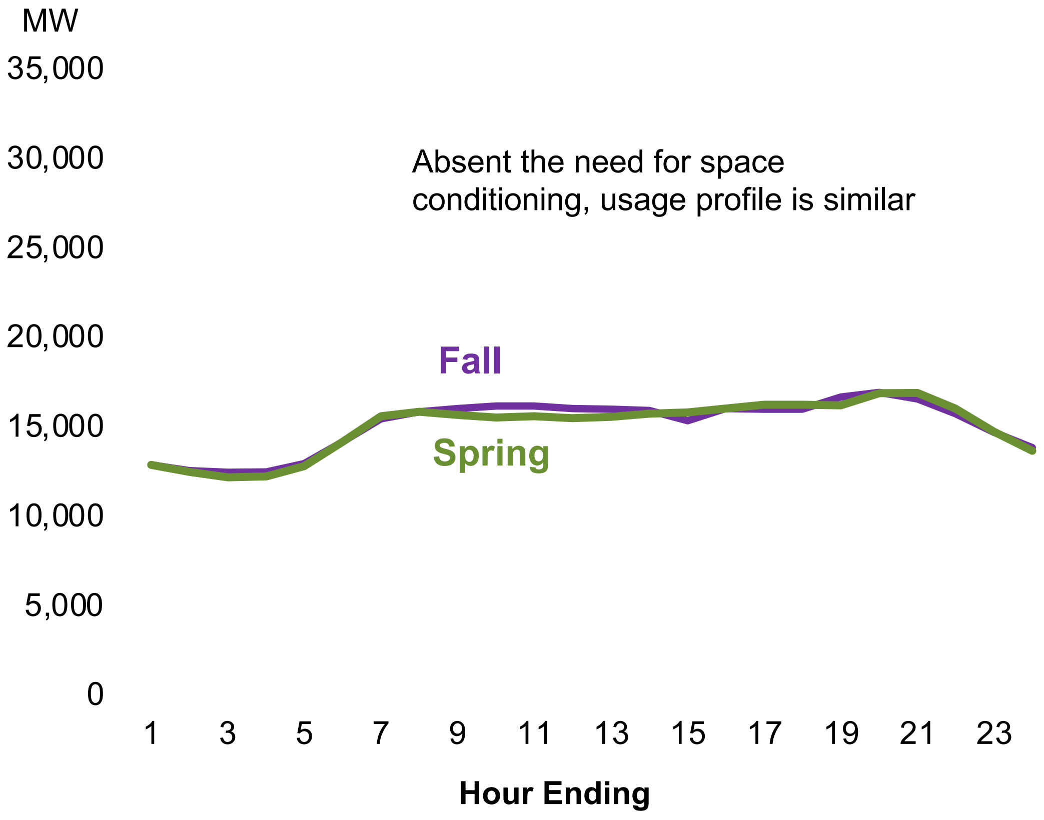
Recommended path provides low cost, reliability, diversity and flexibility

Winter and Summer Have Distinct Profiles



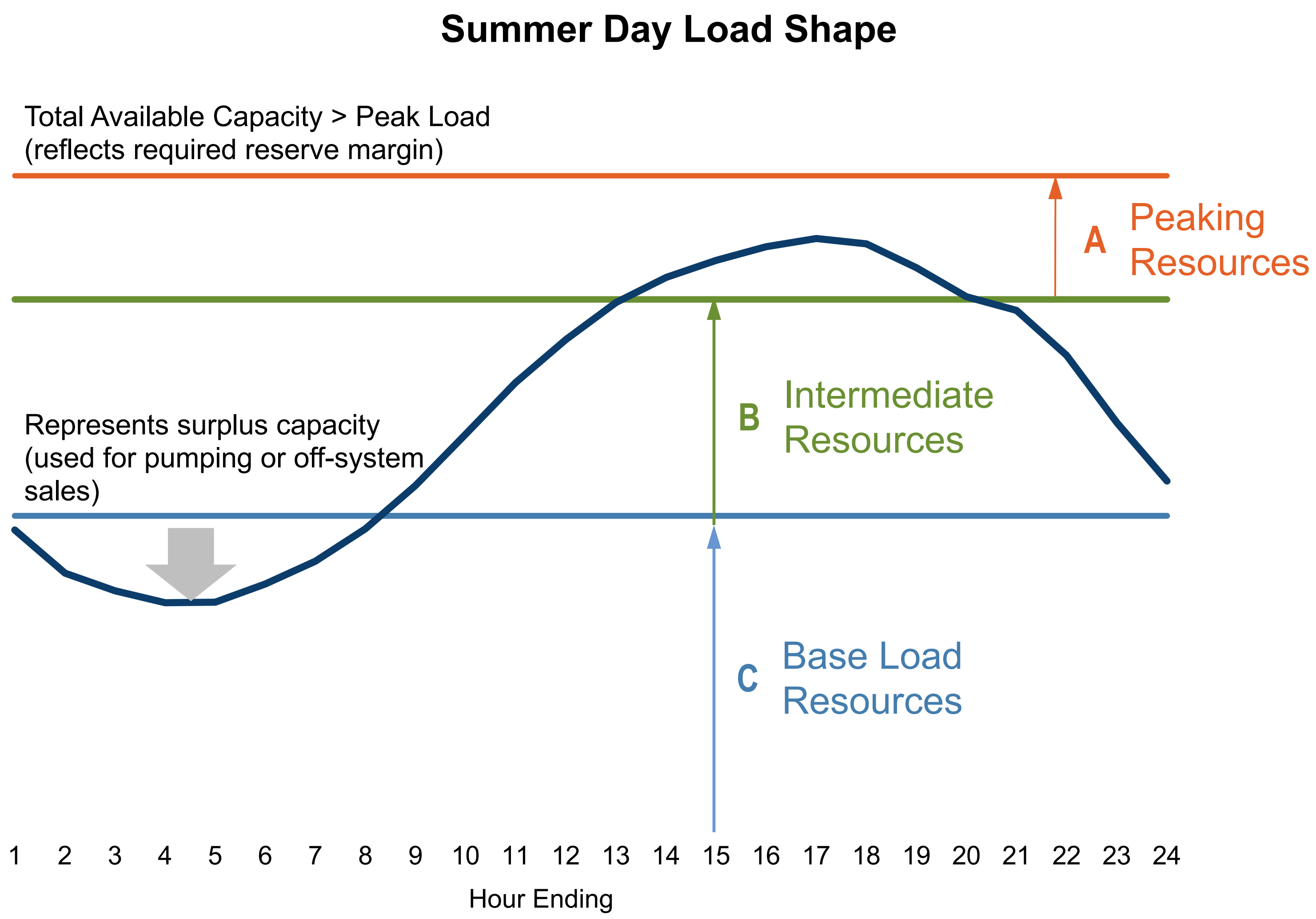
Winter peak is typically right before dawn, with a smaller peak in the early evening

Summer peak is generally around 5PM when heat drives peak air conditioning load



Absent the need for space conditioning, usage profile is similar

Daily Load Shape and Resource Dispatch



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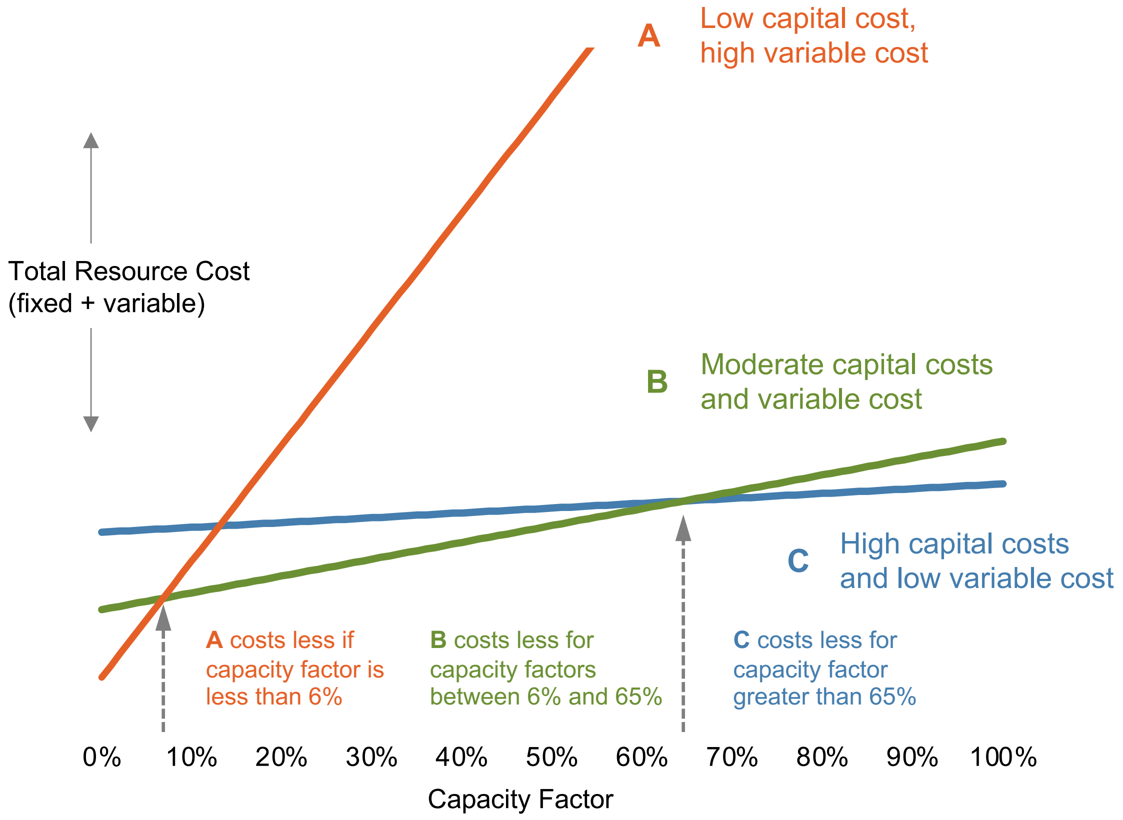
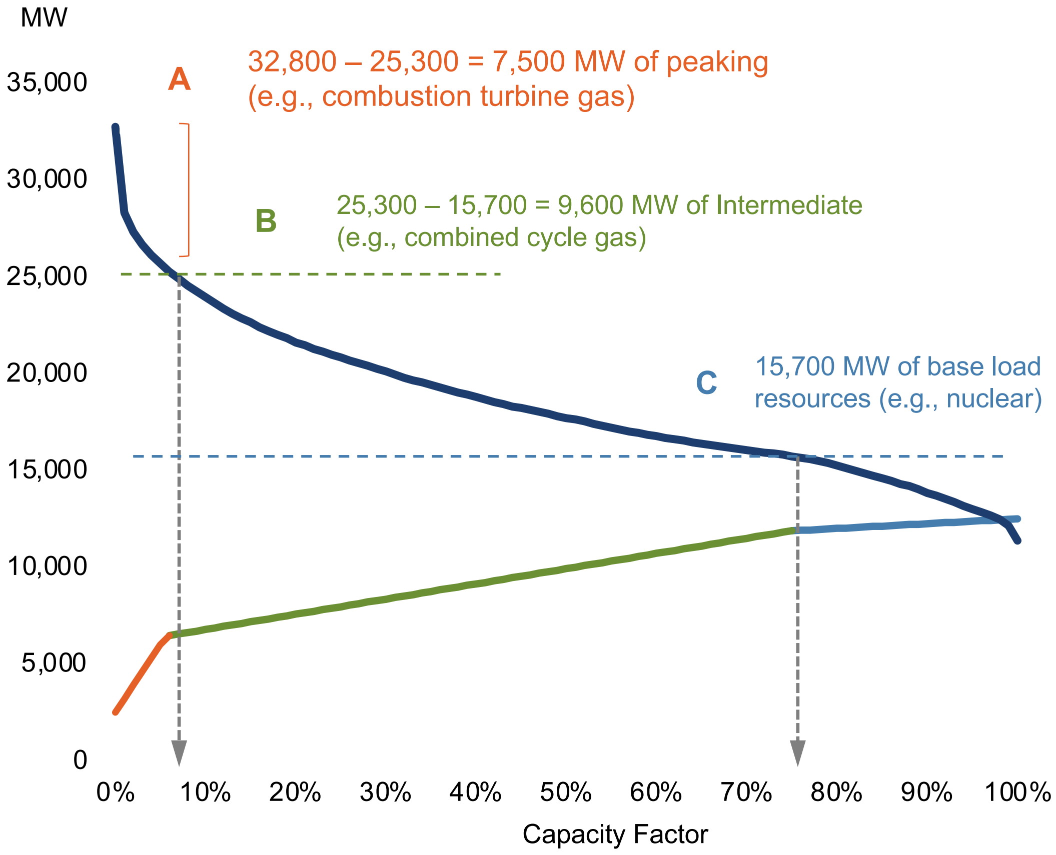
Selecting Appropriate Resource Type

Resource selection is complex and considers physical and cost characteristics and portfolio fit





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Resource Characteristics

Physical and economic characteristics matter for resource evaluation and portfolio fit

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

TVA Operates in Multidirectional Environment

Capacity (kW) and Energy (kWh)

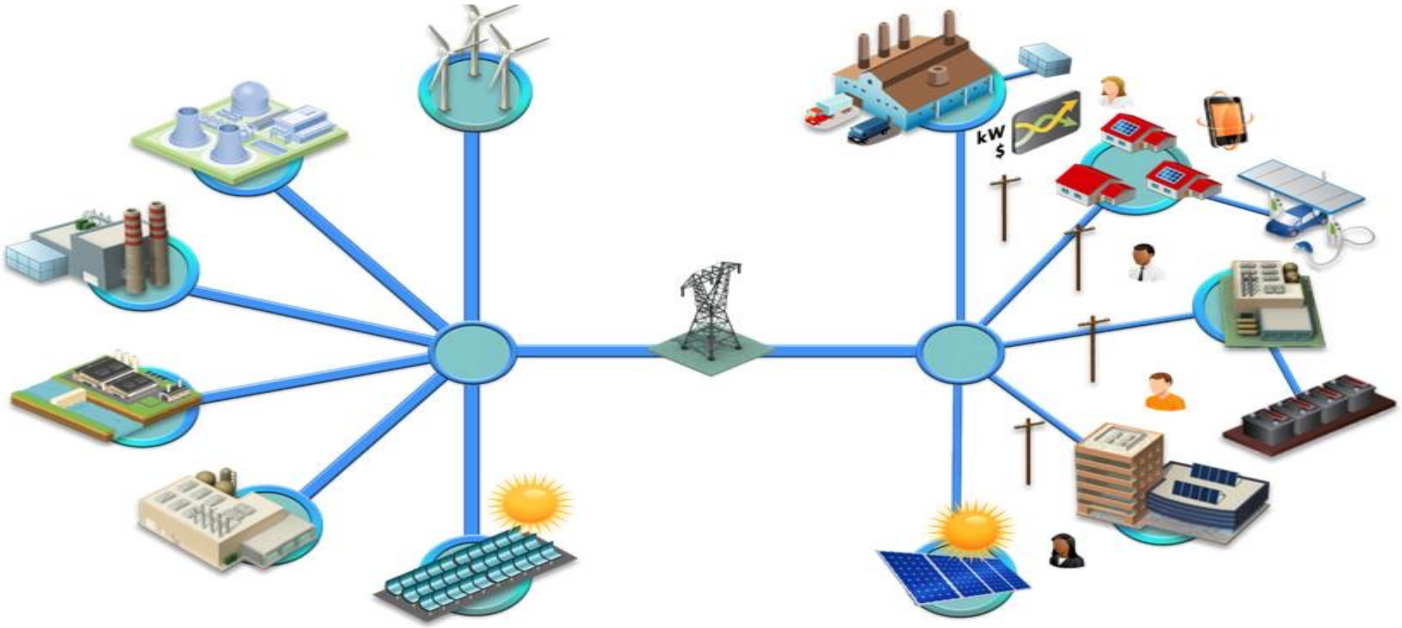
Demand Side

Supply Side

Load Management Demand Reduction and Generation

Supply Side Resources

- Nuclear
- Coal
- Gas
- Purchased Power
- Renewables
- Hydro
- Storage
- Other Assets



Demand Side Resources

- Energy Efficiency
- Demand Response
- Energy Services
- Distributed Generation

Overview of expansion resource options

Kevin Cox; Utility Services Director, CDG Engineers
Roger Pierce; Sr. Specialist, Resource Strategy

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Expansion Options - Independent Review

Kevin Cox; Utility Services Director, CDG Engineers

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Independent Review of TVA Generation Expansion Modeling

TVA engaged Horizons Energy in June 2023 to review TVA Resource Expansion Characteristics and Costs

Objectives:

- Review size, efficiency, fuel costs, emission rates, overnight capital costs of Thermal and Renewable resources
- Review Energy Efficiency program costs and penetration and incremental costs
- Review modeling setup of existing and expansion resources

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Horizons Energy and CDG Engineers Review Team

Horizons Energy was founded in 2016 and its analysts have over 50 years of experience in generation planning and analysis

CDG Engineers was established in 1992 and has been providing resource planning consulting for over 10 years

Kevin Cox P.E.

Greg Turk

Kathy Jones

Independent Review Process

- TVA provided raw files from its EnCompass database to Horizons Energy
- Horizons Energy reviewed and developed a deep understanding of TVA expansion modeling
- Horizons Energy developed generic resources based on published estimates (EIA, NREL, PNNL)
- Initial findings presented
- Preliminary report submitted
- TVA provided Nuclear and Energy Efficiency datasets
- Final report submitted

Generation Additions Reviewed

Natural Gas Combined Cycle

Natural Gas Combustion Turbine

Natural Gas Aeroderivative Combustion Turbine

Solar PV Power Purchase Agreement

Battery Energy Storage

Pumped Hydro Energy Storage

Nuclear Small Modular Reactor

Nuclear Pressurized Water Reactor

Energy Efficiency Programs

Overall Conclusions

- Horizons provided TVA with a report providing an independent review of TVA's EnCompass database and generation characteristics.
- In general, the generation characteristics are reasonable for generic resources.
- Nuclear overnight construction costs were significantly higher than industry estimates.
- Any noted discrepancies in overnight construction costs for natural gas generation were provided and can be attributed to site specific costs estimates compared to generic resources.
- Energy Efficiency programs, costs, and modeling were setup consistent with other utility IRPs.
- Identified modeling setup issues were conveyed and are to be resolved.

2024 IRP Expansion Options

Roger Pierce; Sr. Specialist, Resource Strategy

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Nuclear

Nuclear power generates large amounts of electricity that's safe, clean, reliable, and cost-effective. TVA continues to evaluate emerging nuclear technologies, including small modular reactors, as part of technology innovation efforts aimed at developing the energy system of the future.

Advantages:

- Dispatchable and carbon-free
- Low production/operating costs

Considerations:

- Relatively high construction and fixed costs
- Cost and timeline uncertainty associated with new nuclear

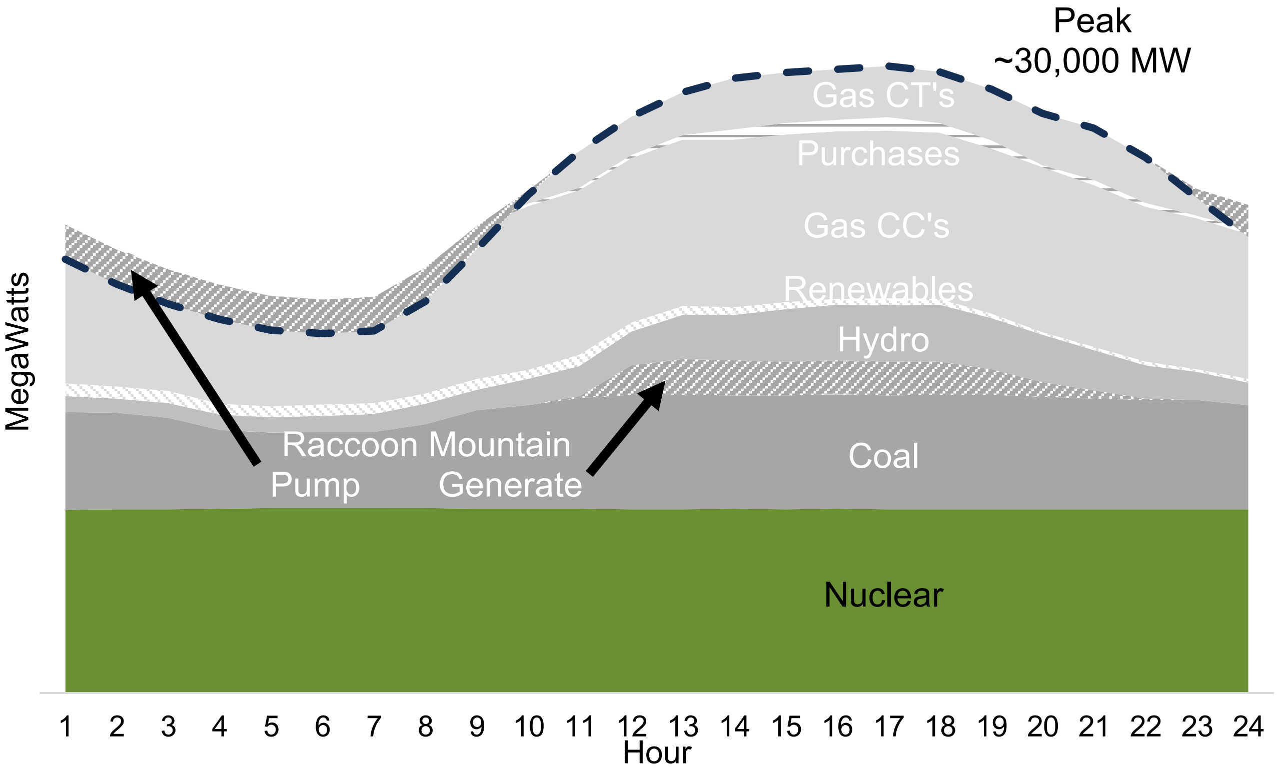

Chart is illustrative and for educational purposes only; Reflects a typical summer day

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Solar

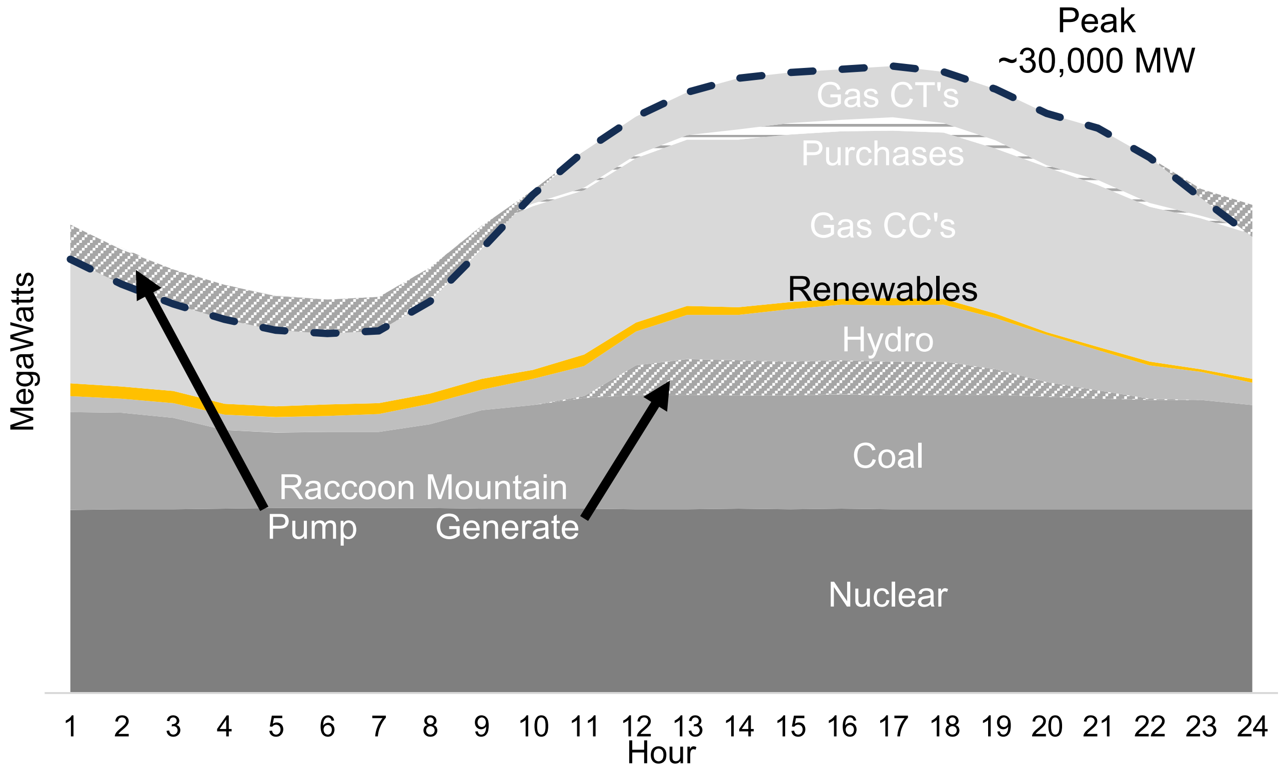
Solar is a growing component of TVA's renewable portfolio, being added to meet customer and system needs. Solar is becoming a cost competitive source of carbon-free energy; however, generation is restricted to daylight hours and is intermittent in nature, limiting firm capacity contribution.

Advantages:

- Carbon-free
- Zero fuel cost

Considerations:

- Non-dispatchable
- Supply chain and permitting challenges



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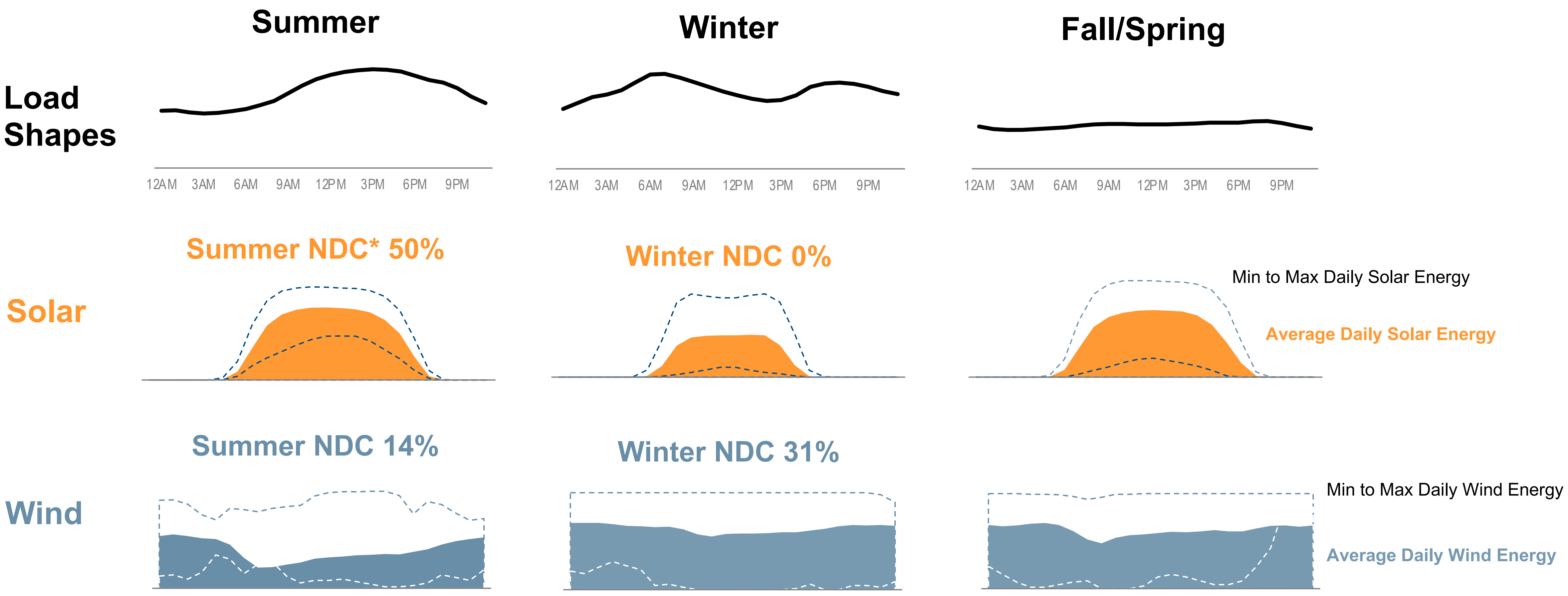
Solar and Wind Generation Profiles



*Net Dependable Capacity

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Natural Gas

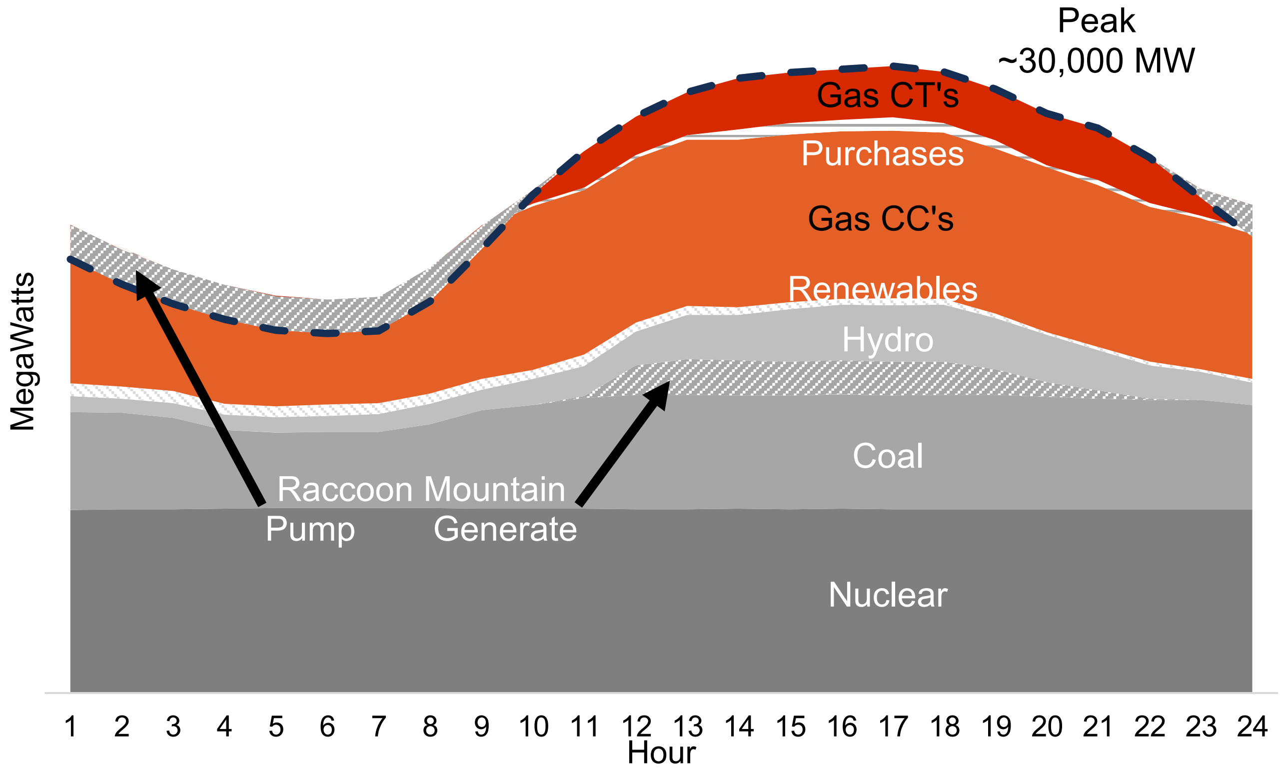
Natural gas serves an increasingly important role in TVA's mission to provide clean, reliable energy to the people and businesses of the Tennessee Valley. Natural gas produces lower levels of emissions than coal, helping TVA to improve air quality while meeting the growing demand for power in our region.

Advantages:

- Serves large energy across many hours (Combined Cycle)
- Helps quickly meet demand during peak periods (Combustion Turbine)
- Enables renewable integration and grid support

Considerations:

- Carbon-emitting
- Increasing challenges to procuring air permits and pipeline development



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Wind

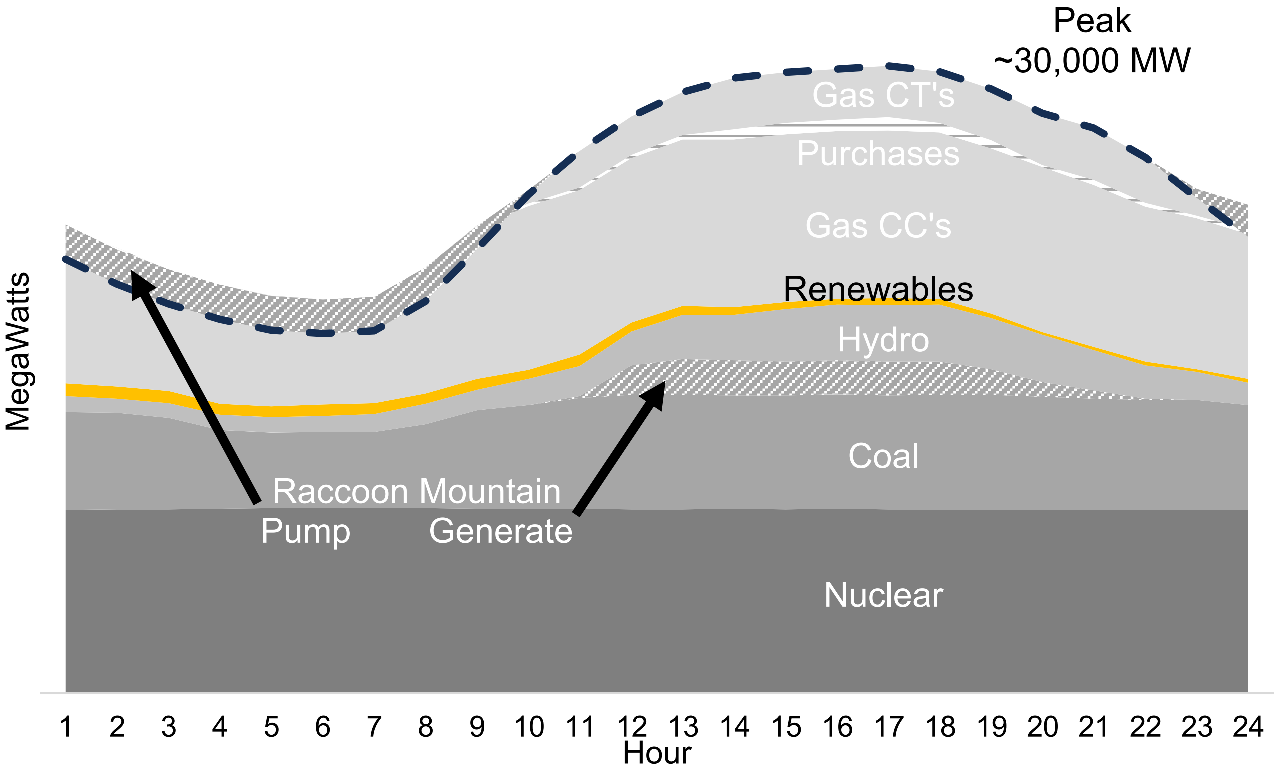
Wind energy is a major source of renewable energy and TVA’s second largest source of renewable energy today. Lower wind speeds in the Tennessee Valley have traditionally required TVA to utilize imports from neighboring systems, however technology advancements are improving in-Valley prospects.

Advantages:

- Carbon-free
- Low variable costs and zero fuel cost

Considerations:

- Non-dispatchable
- Valley weather and topography traditionally not well-suited to wind
- Importing to the Valley requires additional infrastructure and reliance on outside resources



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Storage

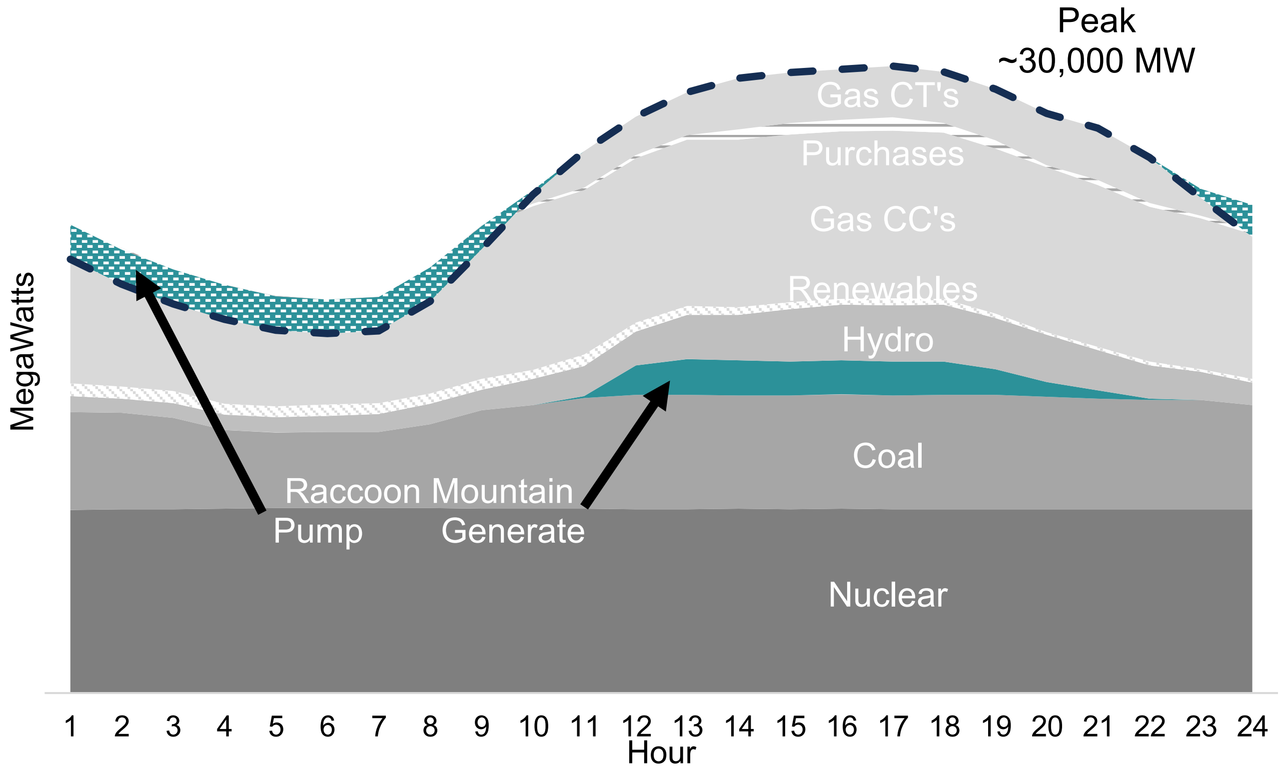
Storage resources act as a buffer between electricity supply and demand variations, increasing the flexibility of the grid and helping to enable use of renewable resources like solar, wind and other forms of distributed generation. TVA has a long history of bulk energy storage with its Raccoon Mountain pumped storage facility and has several battery storage projects under construction.

Advantages:

- Allows for more efficient system operation
- Enables intermittent resources

Considerations:

- Energy-limited based on hours of duration
- 10-15% efficiency loss



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Hydro

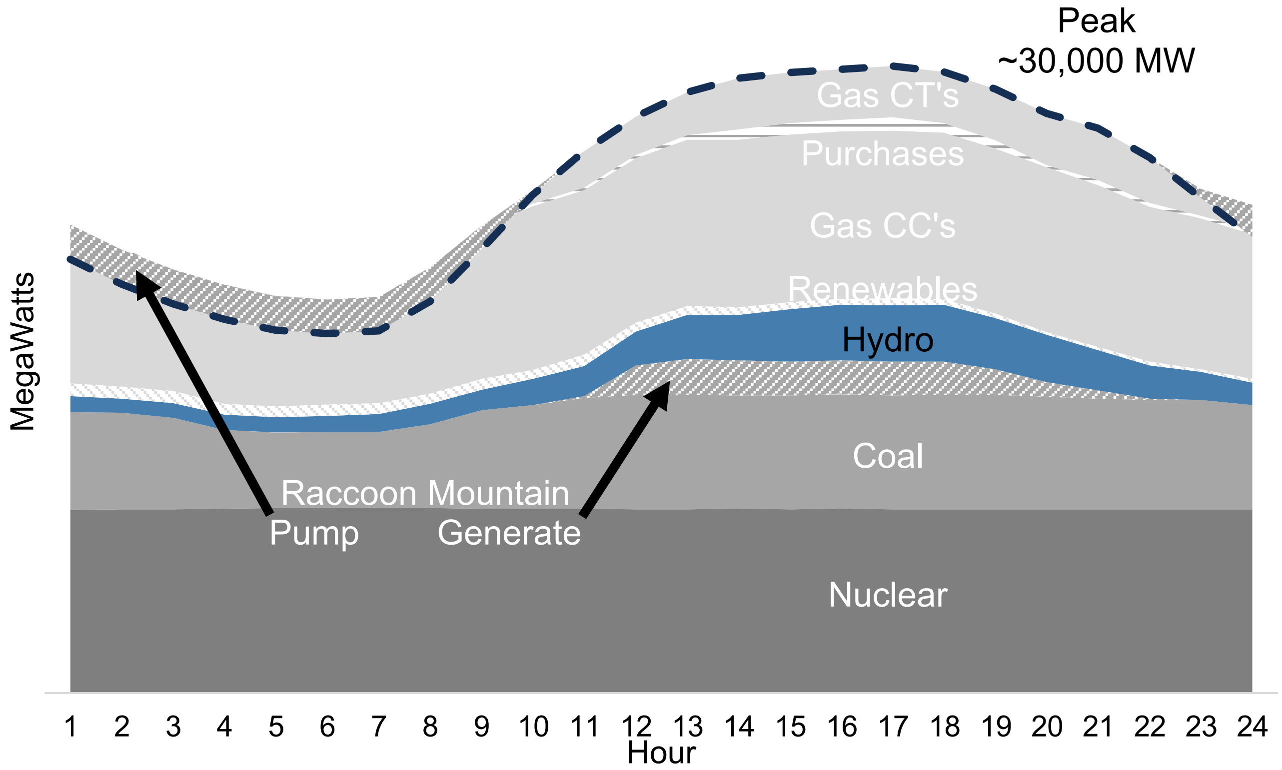
Hydroelectric power is TVA's original, and largest source of renewable energy. Dams operated by TVA along the Tennessee River system serve multiple missions, including flood control, navigation, generation of electricity, and recreation.

Advantages:

- Dispatchable and carbon-free
- Low variable costs and zero fuel cost

Considerations:

- Energy limited due to water availability and multi-function mission
- Relatively high construction cost



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Coal

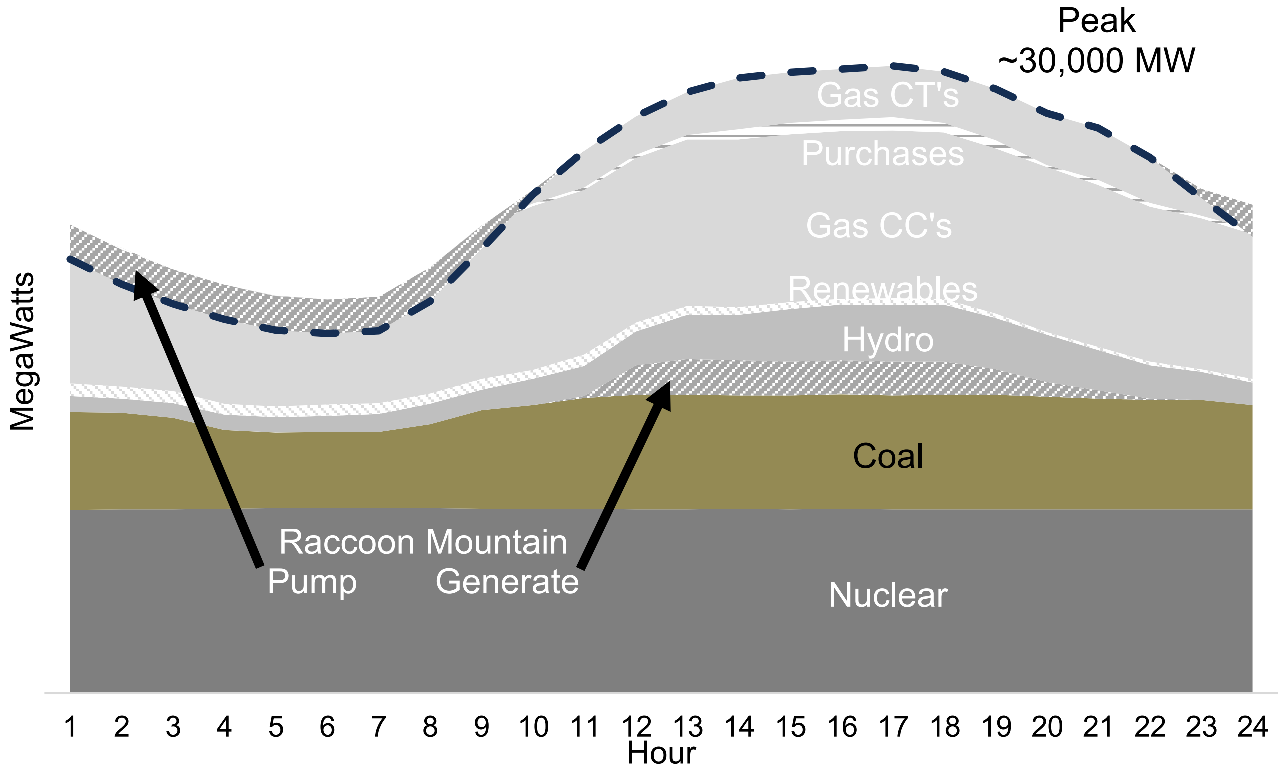
Coal-fired plants have formed the backbone of the TVA power system since it first started using them in the 1950s. TVA's coal fleet is one of the oldest in the nation and TVA has already retired over half of the units it once operated with plans to retire all remaining units by 2035.

Advantages:

- Serves large energy across many hours
- Provides regional grid support

Considerations:

- Carbon-emitting
- Waste disposal (Coal combustion residuals, wastewater)
- Economic and environmental risks



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Meeting Wrap-Up

Jo Anne Lavender; IRP Facilitator