



# Regional Energy Resource Council

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May 2-3, 2017  
Knoxville, Tennessee





# Term 2 RERC Members

**Lance Brown**

Partnership for Affordable Clean Energy

**Anne Davis**

Southern Environmental Law Center

**Wayne Davis\***

University of Tennessee

**Pablo Diaz**

Grenada Economic Development District

**Rodney Goodman**

Habitat for Humanity

**Wes Kelley**

Columbia (TN) Power & Water Systems

**Jennifer Kelvington**

State of North Carolina

**Doug Lawyer**

Knoxville Chamber

**Pedro Mago**

Mississippi State University

**Peter J. Mattheis**

Tennessee Valley Industrial Committee

**Robert Martineau, Jr.**

State of Tennessee

**Jeremy Nails**

Morgan County Economic Development Association

**Alice Perry**

State of Mississippi

**Joe Satterfield**

Blue Ridge Electric Members Cooperative (ret'd)

**Jack Simmons**

Tennessee Valley Public Power Association

**Stephen Smith**

Southern Alliance for Clean Energy

**John Warren**

Commonwealth of Virginia

**Lloyd Webb**

Olin Chlor Alkali

**Susan R. Williams**

SRW & Associates

\* RERC Chair



# Safety Moment



## Building Emergency Plan





# Today's Meeting

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# Agenda – May 2, 2016

- |              |  |   |
|--------------|--|---|
| <b>8:30</b>  | <b>DFO Welcome</b><br><b>RERC Chair Welcome</b> / Introduce New RERC Members | Dr. Joe Hoagland/ Designated Federal Officer (DFO)<br>Dr. Wayne Davis, RERC Chair |
| <b>8:40</b>  | <b>Introductions</b><br>Safety Moment / Agenda Review / Meeting Protocols    | Jo Anne Lavender, Facilitator and Council Members                                 |
| <b>8:50</b>  | <b>FACA / RERC Orientation</b>   | Khurshid Mehta, Office of the General Counsel                                     |
| <b>8:55</b>  | <b>Meeting Purpose</b><br><b>DFO Briefing</b>                                | Hoagland  |
| <b>9:10</b>  | <b>TVA and the Changing Marketplace</b>                                      | Al Berrong, Director Enterprise Forecasting and Analytics                         |
| <b>9:50</b>  | <b>Where we are headed: An Integrated Grid</b><br><i>Video</i>               | Hoagland  |
| <b>10:00</b> | <b>TVA's Research and Development Mission</b>                                | Gary Brinkworth   |
| <b>10:30</b> | <i>Break</i>   |   |
| <b>10:45</b> | <b>TVA's Research and Development Mission (con't)</b>                        | Brinkworth  |
| <b>11:45</b> | <b>Conclude Meeting</b> ( <i>Lunch for RERC Members</i> )                    |   |

# Agenda – May 3, 2017

**8:30 Welcome**

RERC Chair Davis

**Recap Day 1**

Lavender

**9:00 Public Comment Period**

**10:00 Break**

**10:15 How We Meeting the Research and Development Road Map**

Brinkworth

**11:00 RERC Discussion – Research and Development**

Lavender and Council

**11:50 Wrap Up and Next Steps**

Lavender / Hoagland

**12:00 *Conclude Meeting (Lunch for RERC Members)***

# RERC Meeting Protocols

## Agenda

- ◆ Agenda prepared and approved by the Designated Federal Officer (DFO) in consultation with Council Chair
- ◆ Agenda distributed to Council and published in the Federal Register prior to each meeting
- ◆ Topics may be submitted to the DFO by any member of the Council, or non-members, including members of the public

## Meeting Minutes

- ◆ DFO will ensure that minutes are prepared for each meeting, approved by the Chair, and made available to Council members

## Voting

- ◆ Any member of the Council may make a motion for a vote
- ◆ Recommendations to TVA Board shall require an affirmative vote of at least a simple majority of the total Council members present on that date
- ◆ Council members may include minority or dissenting views

## Discussion

- ◆ DFO (or his designee) will facilitate and ensure good order during all open discussions
- ◆ Only one speaker or attendee is permitted to comment at a time
- ◆ To be recognized by the Chair (or meeting facilitator) in order to provide comment, please turn your name card on its side





The Federal Advisory Committee Act  
and  
The Regional Energy Resource Council

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FACA Briefing—Second Term  
Khurshid Mehta, Attorney  
Office of General Counsel



# Key Elements of the Federal Advisory Committee Act

## Public access and transparency

- Meetings (reasonably accessible and timely notice required—generally open to the public)
- Records (available for public inspection, subject to limitations)

## Structured management

- Filed charters
- Expiration after two years
- Attendance of a federal officer



# Advisory Committees Today

- Play an important role in shaping programs and policies of the federal government
- Approximately 1000 committees with more than 60,000 members
- Advise the President of the United States and the executive branch
- Subject to FACA and General Services Administration (GSA) Regulations

# TVA's Regional Energy Resource Council

- Created by TVA in 2013 “to provide advice on its energy resource activities and the priorities among competing objectives and values”
- TVA's energy resource activities include:
  - > Constructing and operating various supply-side resources, including fossil-fueled power plants, nuclear plants, hydroelectric dams, and renewable resources
  - > The development and management of demand-side resources, including energy efficiency
  - > The design, construction, and operation of power delivery systems
  - > The integration of all of these energy resources into plans for meeting future demands for electricity in the TVA region



# Key Provisions of RERC Charter

- Council provides advice only
  - > Advice reported to the TVA Board's External Relations Committee
- Term of Council is two years
  - > Second term expires July 31, 2017
- Approximately two meetings per year
- Designated Federal Officer (DFO): Joe Hoagland, Vice President, Enterprise Relations and Innovation
- Balanced Membership





# DFO Briefing

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Joe Hoagland, Designated Federal Officer



# Meeting Purpose

- Welcome New RERC Members
- TVA Update
- Share Information on the Changing Electricity Marketplace
- Share Information on TVA Research and Development Work and Gain RERC Input
- Host a Public Input Listening Session

# TVA Update

- **Last RERC Meeting: May 2016**
- **TVA Updates**





# TVA and the Changing Marketplace

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# TVA's Mission of Service

## Energy

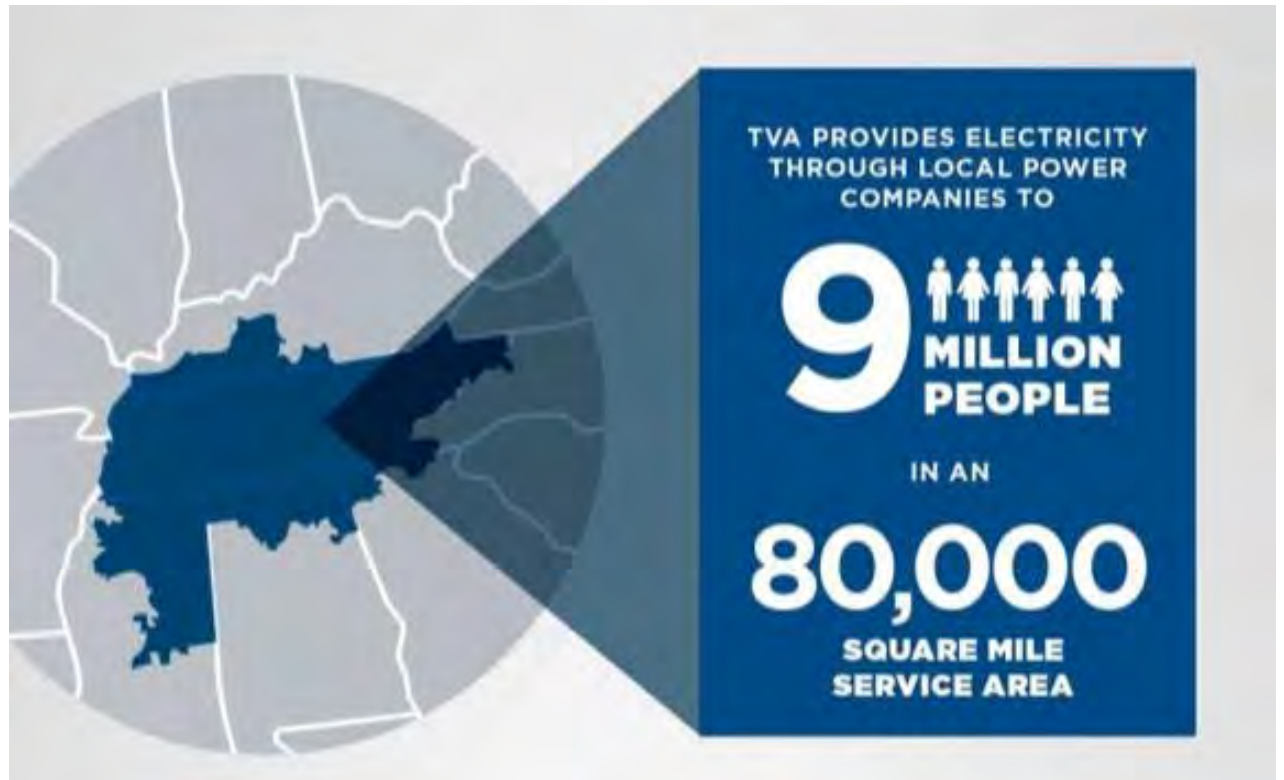
Delivering affordable,  
reliable power

## Environment

Caring for our region's  
natural resources

## Economic Development

Creating sustainable  
economic growth



# The Value of Public Power

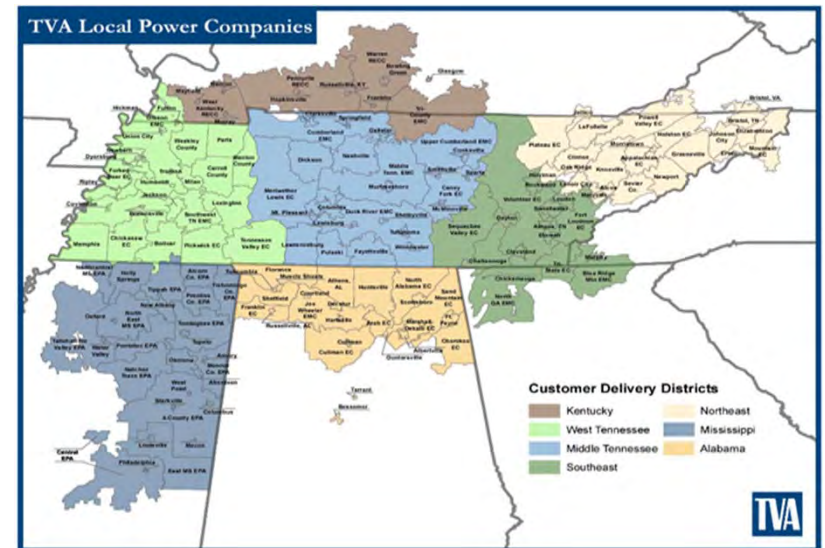
**TVA and 154 Local Power Company Partners make up the Public Power Model in the Tennessee Valley Region**

**Together we serve 9 Million people with reliable, low cost and cleaner energy**

**TVA also serves 58 Large Industrial Customers directly**

## **Benefits of Public Power**

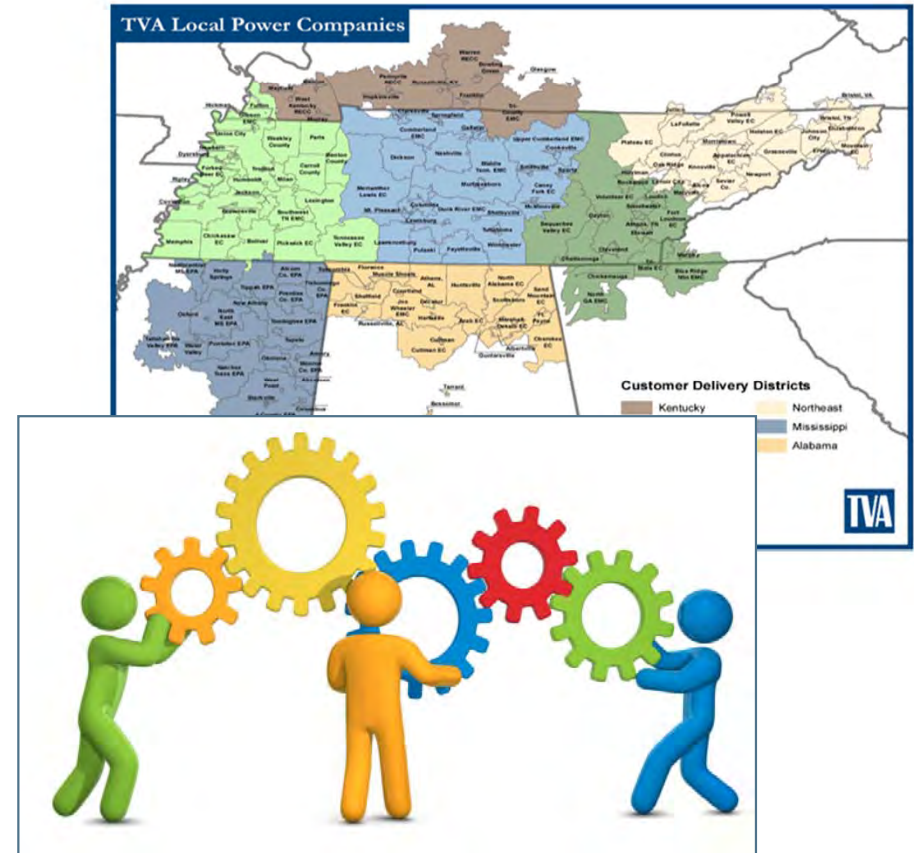
- *Non Profit – Stakeholders, not Shareholders*
- *Self –Governing*
- *Mission of Service*
- *Local Control*
- *Shared Goals: low cost and reliable power*





# Our Unique Challenges

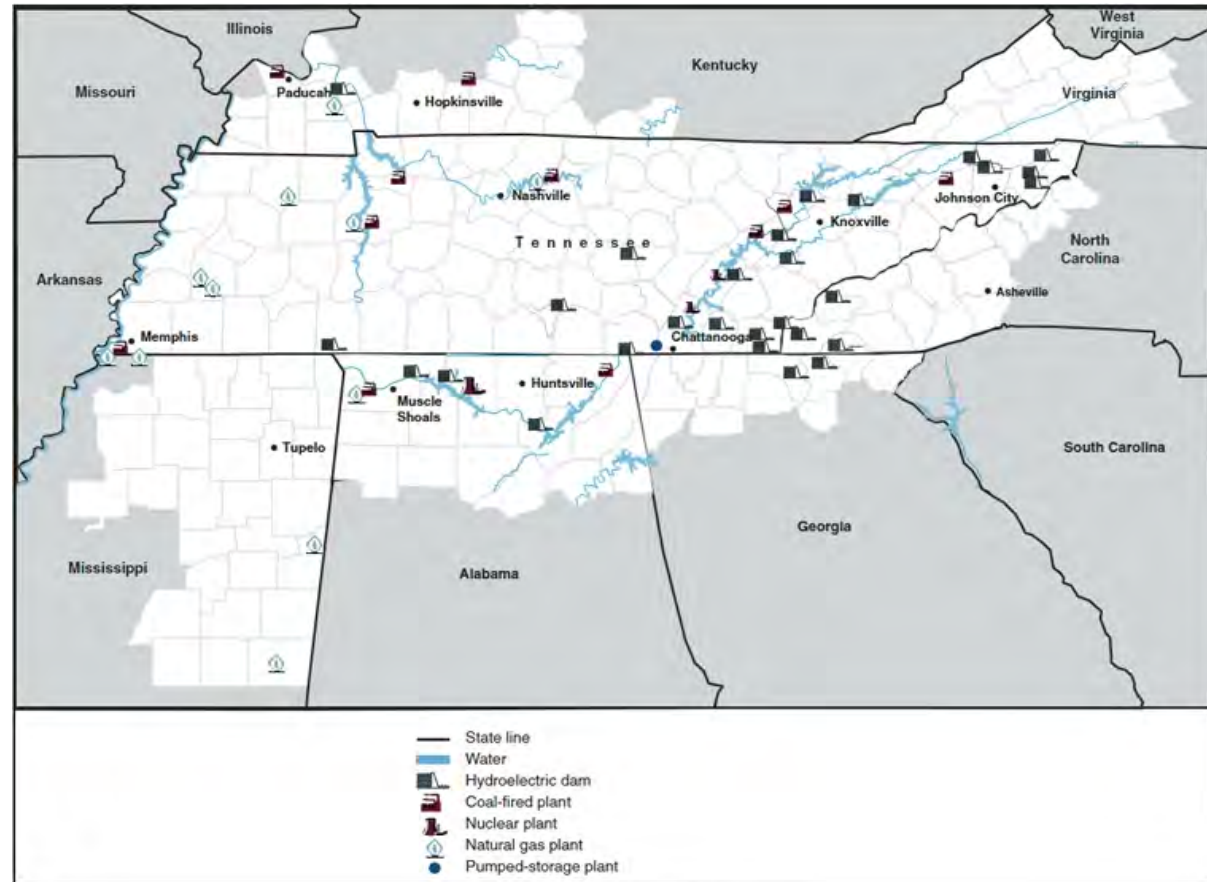
- 154 Distinct Distribution systems
- Infrastructure Technology Varies
- Local Control / Variety of Local Priorities
- Lack of comprehensive strategy to address evolving distribution system challenges (DER)
- TVA/LPC partnership must evolve so both parties remain relevant to customers



# TVA at a Glance

## In fiscal year 2016:

- Sold **155 billion kilowatt-hours** of electricity - about **\$10.5 billion** revenue.
- Average retail rate ranked **28<sup>th</sup> lowest** among the nation's largest utilities.
- Today's **power supply mix**:
  - 31% nuclear,
  - 29% coal,
  - 22% natural gas,
  - 9% hydro,
  - 3% wind & solar
  - 6% energy efficiency
- **17,000 Miles** of Transmission Lines
- **99.999% reliability** for the 17th year in a row.



Sources: GAO analysis of TVA information and data; MapInfo (map).

# TVA's Carbon Footprint

- Current Delivered Carbon Rate nearly 25% Lower than the Regional Rate
- By 2020 – 55% carbon free power supply
- Forecasted to decrease system CO<sub>2</sub> rate by 60% (2006 – 2020)







# Planning for the Public Power System

Al Berrong,  
Director, Enterprise Forecasting & Analytics



# Electric Utility Planning

Resource planning has to inform key capital investment decisions, including:

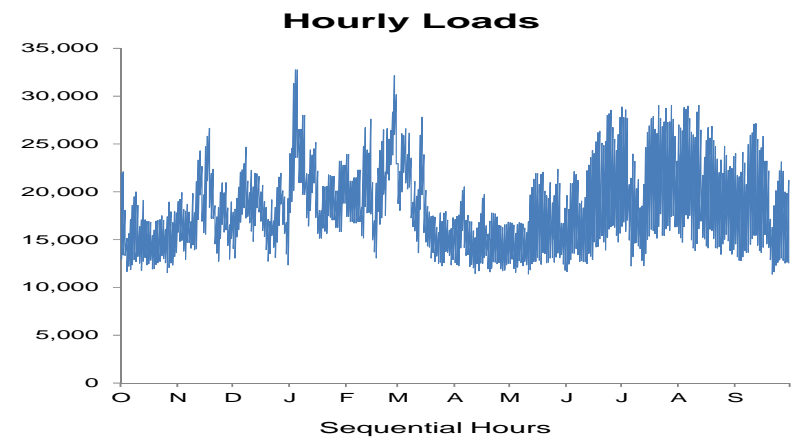
**What to build/retire?**

**When to build/retire?**

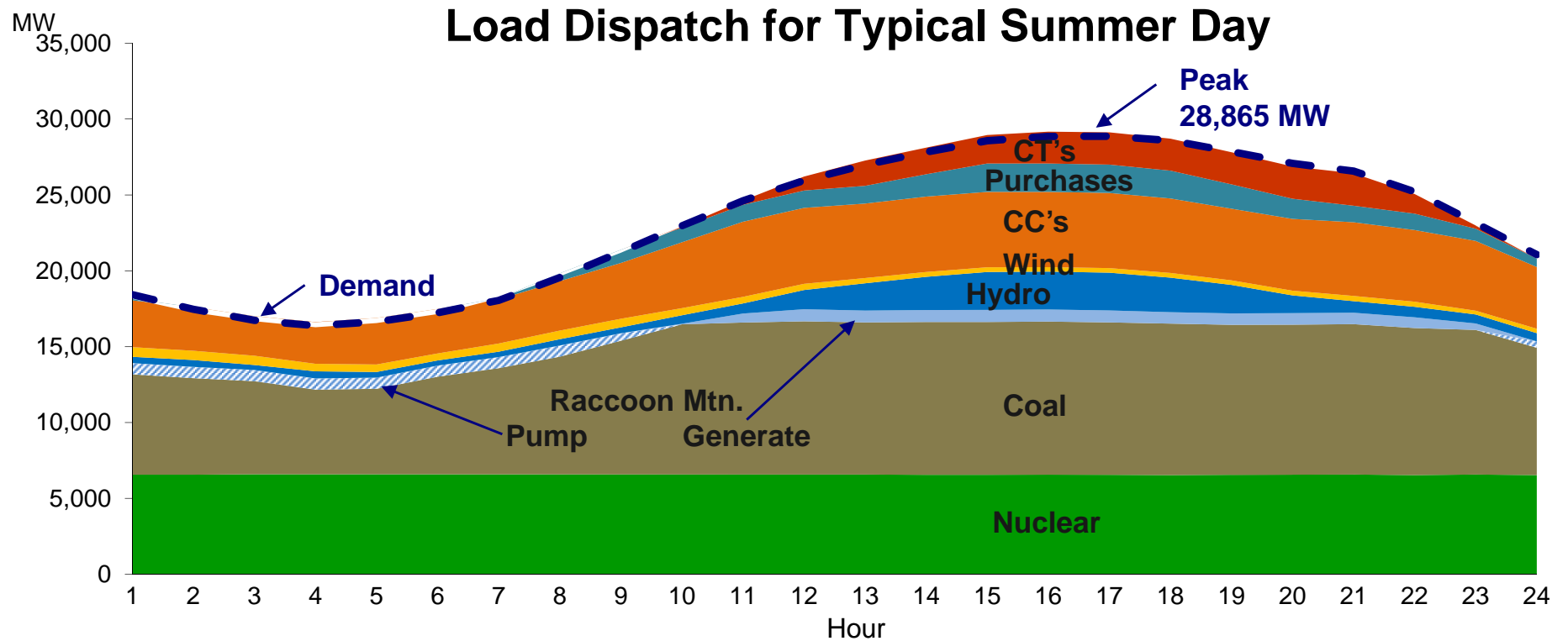
**Where to build/retire?**

**How much to build/retire?**

The ultimate goal of the planning process is to produce a resource plan that is based on holding costs to a minimum while meeting certain constraints



# Load Shapes: Understanding Resource Needs





# Resource Planning Considerations

- Integrated grid security & Interoperability
- Low income equity
- Electrification
- Data infrastructure & analytics
- Distributed generation (behind the meter)
- Distributed storage (LPC)
- Efficiency Standards

# Key Takeaways - Resource Planning

- Planning guides TVA in making decisions about energy resources used to meet future demand for electricity.
- Long-range resource plans enable us to provide affordable, reliable electricity to the people we serve.
- TVA's integrated, least-cost system planning process takes into account the demand for electricity, resource diversity, reliability, costs, risks, environmental impacts, and the unique attributes of different energy resources.
- Risk is managed by utilizing a diverse portfolio of supply and demand side resources





# Load Forecast and Portfolio

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Al Berrong,  
Director, Enterprise Forecasting & Analytics

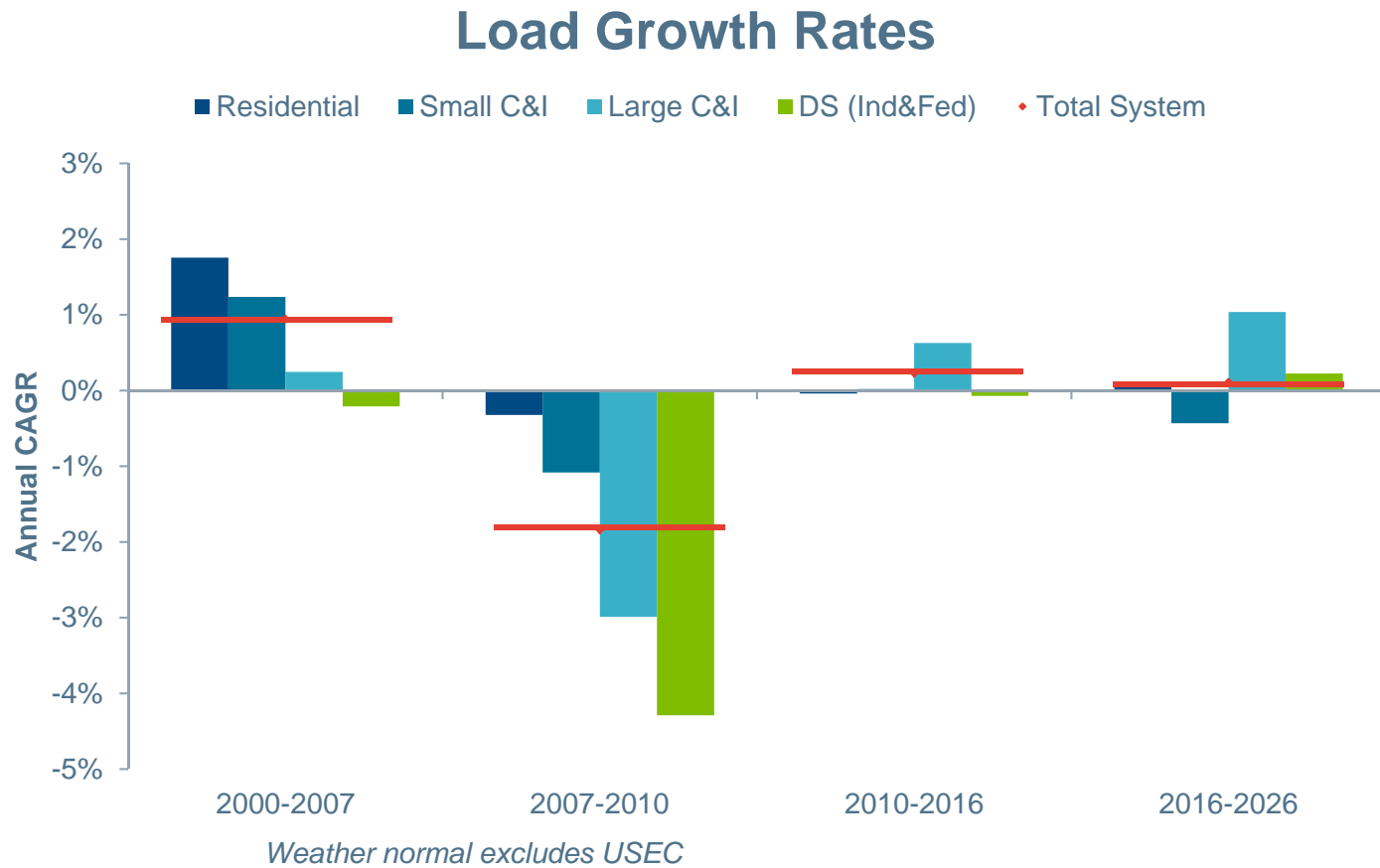


# TVA's Load Mix

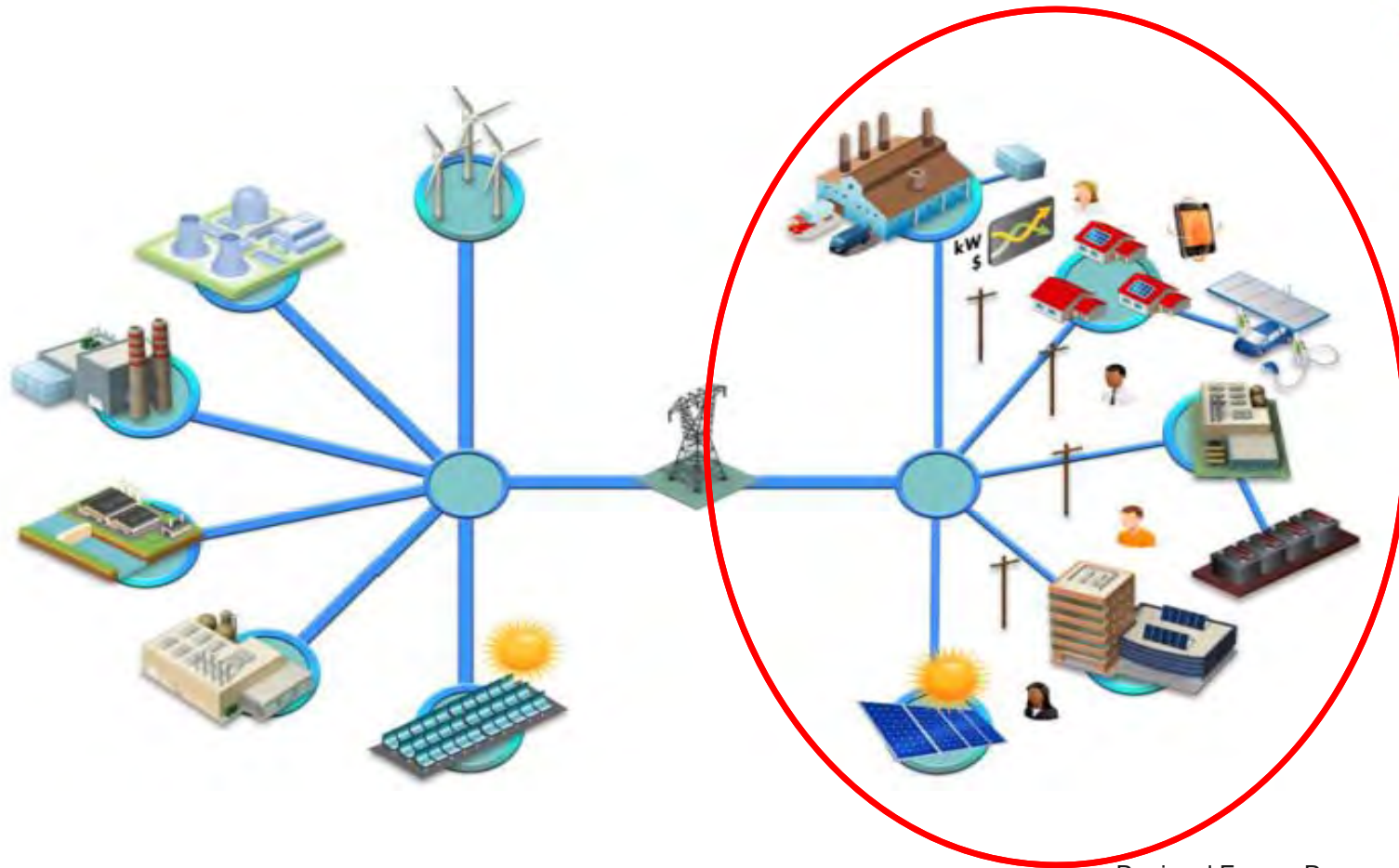


# Where are we?

- Structural change caused by economics and intensity
- The U.S. economy grew 8 percent between 2007-2015, but annualized electricity demand growth was zero over that same period
- Current forecast does not get back to 2008 level during the long-term planning horizon

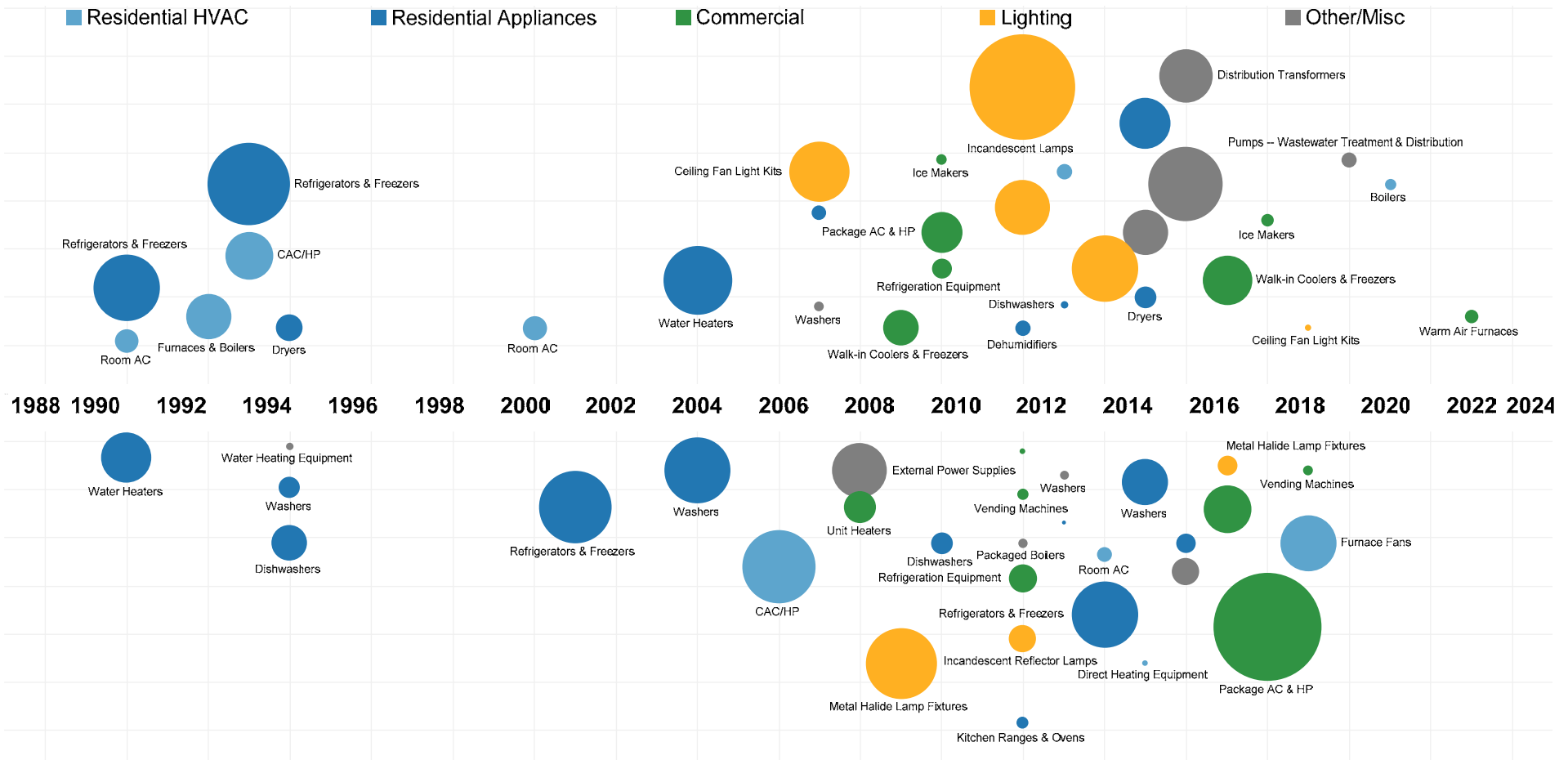


# Changing Marketplace





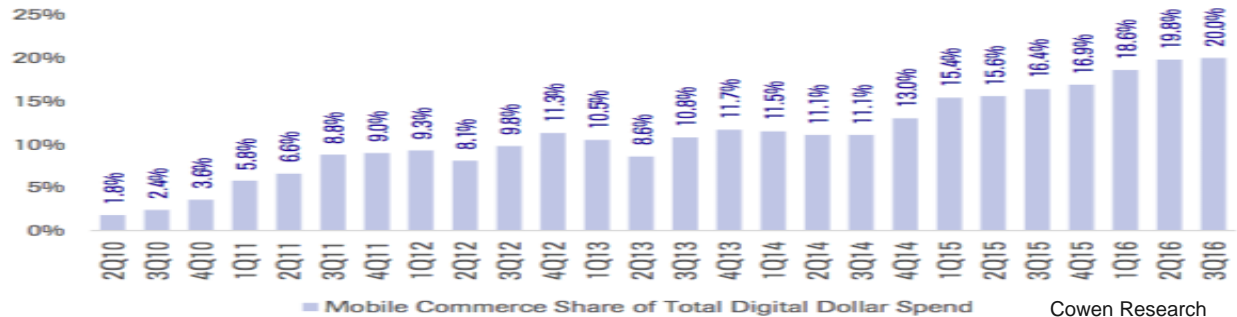
# DOE Standards are Growing in Volume



# Impact of Changes in Customer Behavior

## Retail Sector Example:

- 50% decline in visits to shopping malls 2010-2013 with the rise of e-commerce\*
- Energy is the second highest operating expense for US retailers\*\*



\* Business Insider, Cushman & Wakefield

\*\* Advanced Energy Design Guide for Medium to Big Box Retail Buildings, ASHRAE



# Key Takeaways – Load Forecast and Portfolio

- Weather-normalized energy has been essentially flat since 2009 and outlook is slightly contracting for the foreseeable future
- Marketplace factors are influencing how customers use electricity and what viable alternatives exist to meet their needs
- Economic factors present some potential for growth but more downside risk remains
- Efficiencies have eroded growth, and DOE standards and consumer behaviors continue to evolve (enabled by technology)
- TVA system is balanced, with no need for new generating sources for close to a decade but need to maintain current capacity sources
- Delaying long-term resource decisions and valuing portfolio flexibility help mitigate uncertainty and ensure reliability





# 2015 IRP Update

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Al Berrong,  
Director, Enterprise Forecasting & Analytics



# Goals for Optimum Resource Planning

**Low Cost**

**Reliable**

**Risk Informed**

**Diverse**

**Environmentally  
Responsible**

**Flexible**

# Provides Directional Guidance

**THE IRP IS A COMPASS; NOT A GPS**

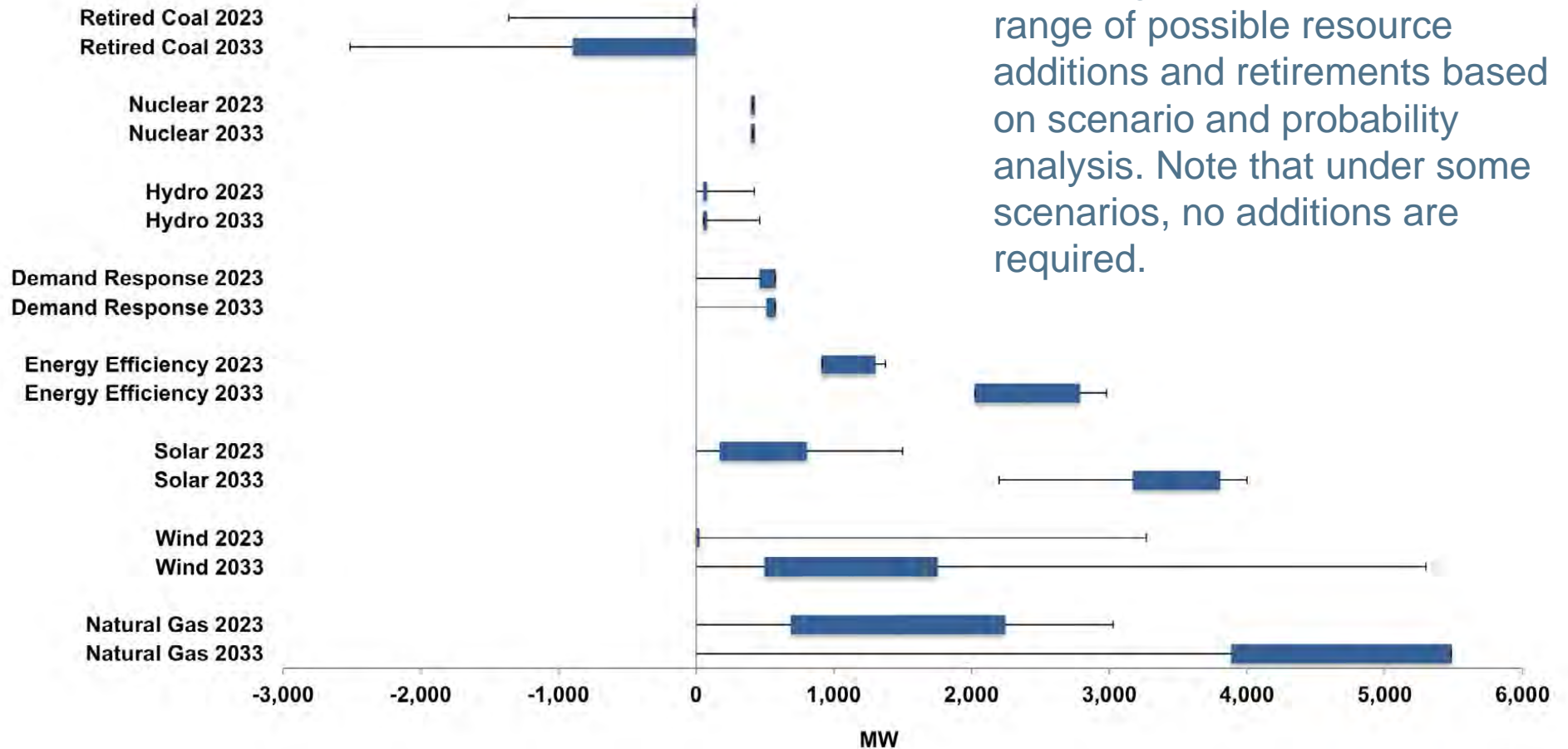


- Recommends directions and ranges
- Does not prescribe specific assets, rates, or programs



# Results of 2015 IRP

This diagram depicts the broad range of possible resource additions and retirements based on scenario and probability analysis. Note that under some scenarios, no additions are required.



# Asset Portfolio Plan

Prior to FY2017, TVA has:

- Retired 4250 MWs of coal (24 units at 5 plants)
- Built, acquired or entered into Power Purchase Agreements (PPAs) for 4300 MWs of NGCC
- Entered into PPAs for 1200 MWs of wind
- Added 230+ MWs of solar
- Reduced peak demand by 600MWs through energy efficiency programs

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Significant Asset Additions	WBN 2	Millington Solar											
	NextEra Solar	Allen CC										Capacity Addition	
	Paradise CC	BFN EPU	BFN EPU								Utility-Scale Solar		
	EE	Energy Efficiency											
Significant Asset Subtractions	PAF1-2	JOF 1-4				Non-Renewal of Two (2) Market CCs						Coal Retirement	
	Meridian Diesel	ALF 1-3											
Summer Reserve Margin (%)	19	18	19	19	19	20	17	17	17	15	15	15	15

# Integrated Resource Plan

- Current forecasts of gas prices and loads have fallen to the low end of the forecasts used in the IRP
- Resource portfolio expected to remain within range of IRP recommendations
- IRP update to be initiated no later than 2020
- Changes in the market, customer behavior and technology could drive need for alternative approach from traditional IRP





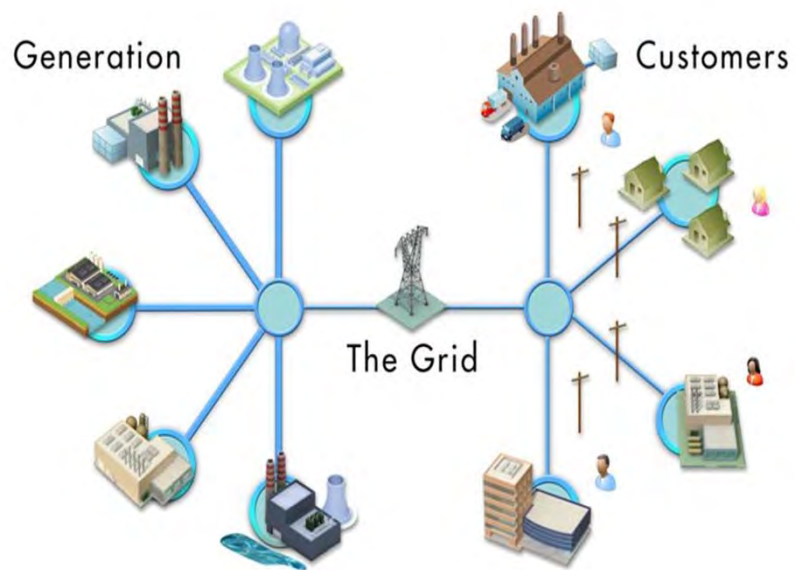
# Distributed Energy Resources

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Dr. Joe Hoagland  
Enterprise Relations and Innovation  
Distributed Energy Resources



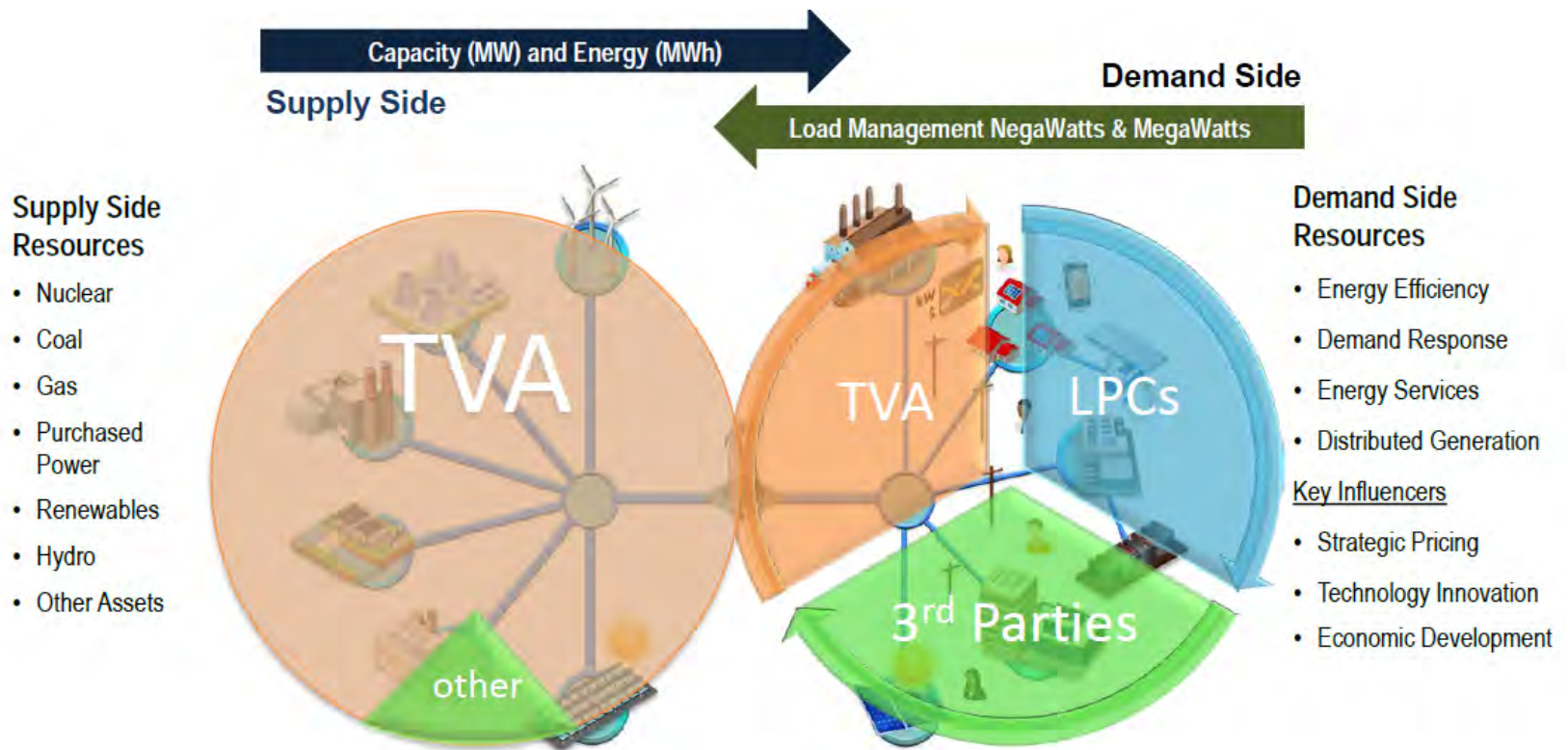
# Today's *Yesterday's* Power Grid



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# Change brings New Players



Source: EPRI



# Drivers of Change

➤ New Technology



➤ Customer Choice

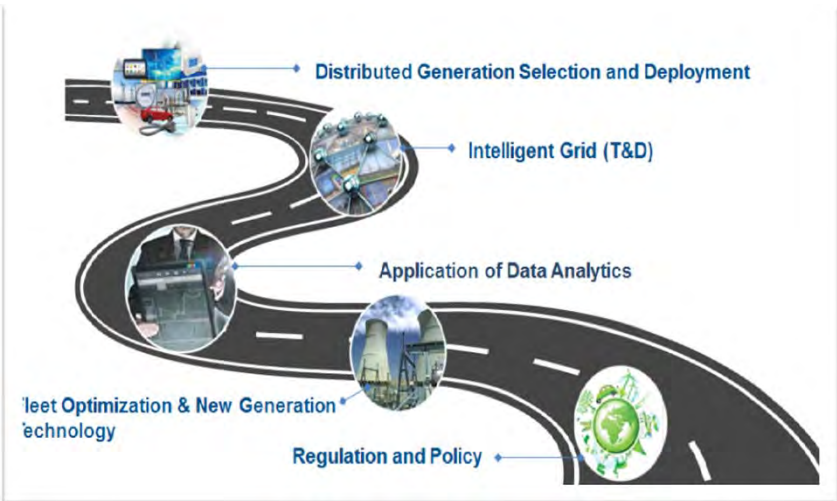


➤ Market Dynamics



# Response to Change

➤ Technology Innovation



➤ Engagement Strategy



# TVA DER Strategy Development

## Public Power Model

### TENNESSEE VALLEY AUTHORITY

#### GENERATION



#### TRANSMISSION



- Generation
- Transmission
- Reliability
- Balancing
- Regulator
- Wholesale Sales
- Energy Services

### LOCAL POWER COMPANY

#### DISTRIBUTION



- Distribution
- Load Management
- Consumer Relationship
- Retail Sales
- Energy Services

### END-USE CONSUMER



RESIDENTIAL CONSUMERS



COMMERCIAL & INDUSTRIAL CONSUMERS



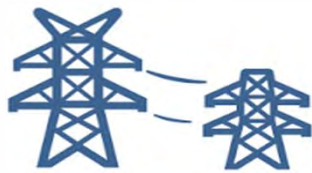
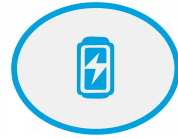
# TVA DER Strategy Development

## Distributed Energy Resources & Public Power Model

### TENNESSEE VALLEY AUTHORITY

GENERATION

TRANSMISSION



- Generation
- Transmission
- Reliability
- Balancing
- Regulator
- Wholesale Sales
- Energy Services

### LOCAL POWER COMPANY

DISTRIBUTION



- Distribution
- Load Management
- Consumer Relationship
- Retail Sales
- Energy Services



THIRD PARTY ENERGY SERVICES

### END-USE CONSUMER



RESIDENTIAL CONSUMERS



COMMERCIAL & INDUSTRIAL CONSUMERS

- Generation
- Load Management
- Third Party Energy Services





# Where We Are Headed: An Integrated Grid

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# Video: EPRI Integrated Energy Network



<https://www.youtube.com/watch?v=kqkw7VzL0oQ>





# Introduce Advisory Topic and Discussion Questions

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# RERC Advice Questions

1. Given TVA's Mission and Challenges, what is missing from TVA's R&D Roadmap ?
2. Who should TVA partner with to conduct and implement the research?
3. What should TVA's role be in the research and development space?





# TVA's Research Direction

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Gary Brinkworth,  
Director, Technology Innovation



# Technological Innovation – It's In Our DNA



*1933 Franklin D. Roosevelt Signing the TVA Act*

## TENNESSEE VALLEY AUTHORITY ACT

AN ACT

To improve the navigability and to provide for the flood control of the Tennessee River; to provide for reforestation and the proper use of marginal lands in the Tennessee Valley; to provide for the agricultural and industrial development of said valley; to provide for the national defense by the creation of a corporation for the operation of Government properties at and near Muscle Shoals in the State of Alabama, and for other purposes.

### TVA Missions in the TVA Act of 1933:

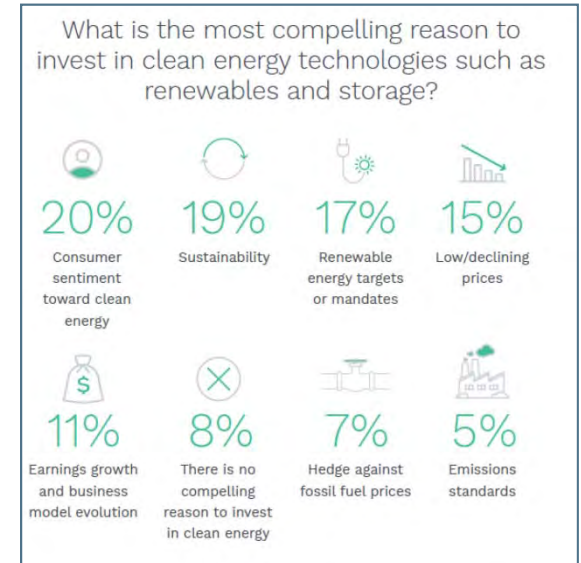
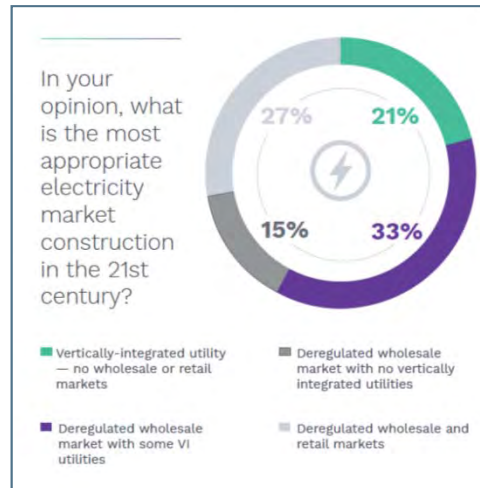
- ◆ Provide low-cost power
- ◆ Improve navigation and provide for flood control
- ◆ Provide for reforestation and the proper use of marginal lands
- ◆ Provide for agricultural and industrial development
- ◆ Provide for the national defense
- ◆ **Technological innovation**
- ◆ Environmental stewardship

# Utility Industry Evolution Continues

## (2017 State of Electric Utility Survey)

Utility respondents ranked physical and cyber security, distributed energy policy, rate design reform, aging grid infrastructure and reliable integration of renewables and DERs as the top five sector priorities.

THE GROWING COMPLEXITY OF THE POWER SECTOR AND A RAPID INFLUX OF EMERGING TECHNOLOGIES ARE COMBINING TO CREATE NEW CONCERNS FOR ELECTRIC UTILITIES, WHILE LONG-STANDING ISSUES REMAIN UNRESOLVED.



.....The overall trajectory of the utility industry in 2017 looks remarkably similar to the course noted in previous years: Utilities still overwhelmingly expect to add more renewables and gas, retire baseload generators and reform their business models to suit the new energy economy.

**72%** OF UTILITY PROFESSIONALS SAID PHYSICAL AND CYBER SECURITY IS EITHER “IMPORTANT” OR “VERY IMPORTANT” TODAY, **MAKING IT THE MOST PRESSING ISSUE FOR THE SECTOR IN 2017.**



# New Players & Opportunities

## Value Propositions are changing

Businesses (customers) are becoming more committed to **100% renewable electricity**, working to massively increase **corporate demand for renewable energy**. Increased interest in **resiliency** of generation sources is also changing value propositions.



## More Competition

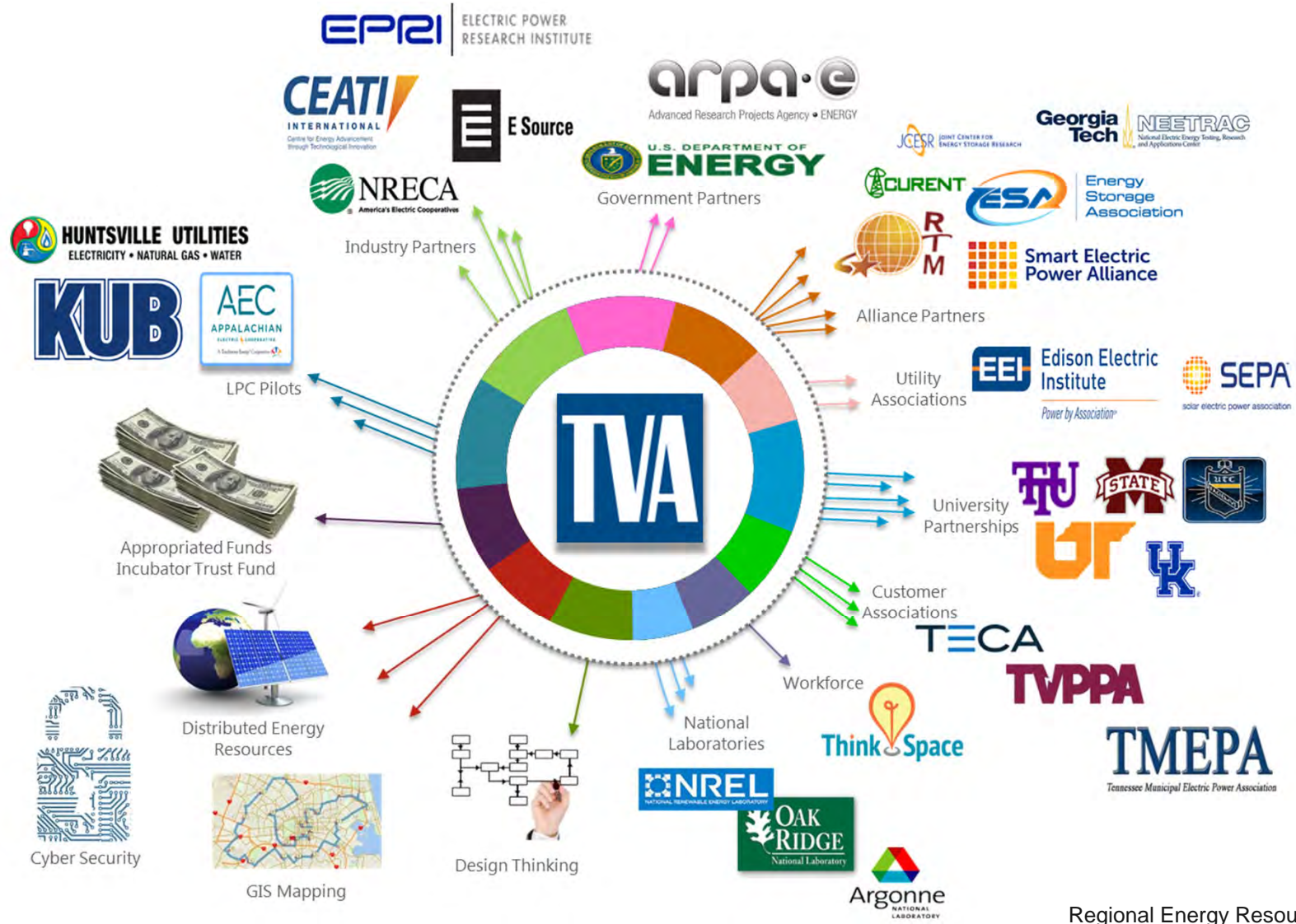
The commercial onsite energy sector is fast growing as retailers are looking to **add resiliency** and renewables, as well as **manage electricity costs**. These companies are in direct **competition** with traditional central station utilities.



## More & Cheaper Technology

As customers seek renewable and resiliency solutions, the technology from which they can choose from is becoming **cheaper and more readily available**.









# A Changing Customer Landscape

- Customer demographics are changing, and so are preferences for how they want to engage with the utility
- Customers are also investigating new devices that can help them use energy in ways (and times) that support their lifestyle
- But customers still expect reliable, resilient and reasonably-priced electricity



-  Smart thermostats
-  Smart appliances
-  Smart lighting
-  Battery storage
-  Home energy management systems



# Glimpsing Our Utility Future



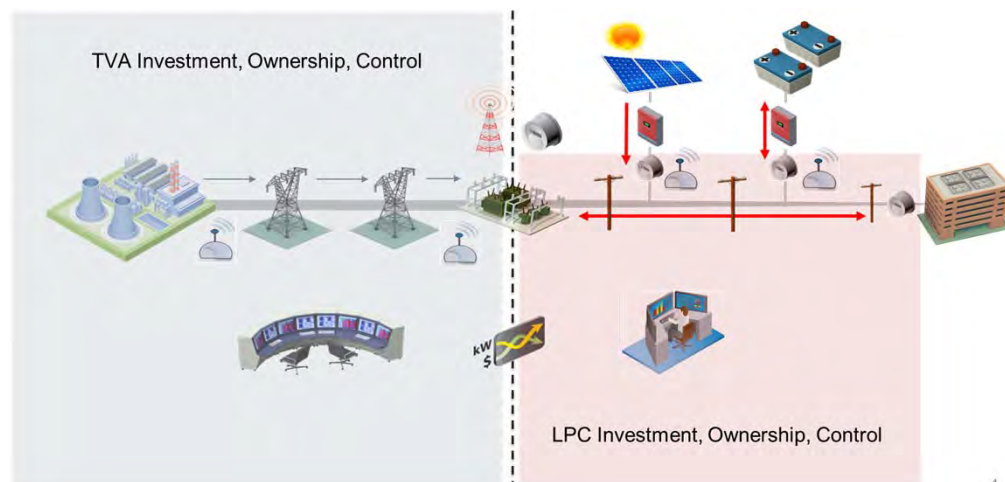
- Customer-centric
- Diverse and distributed
- Flexible and resilient
- IoT and connected devices
- Low carbon footprint
- More options; simpler & easier service
- Still economic & reliable



# Our Strategic Response

- Technology innovation will be critical in the evolving DER marketplace
- R&D efforts must meet the needs of both sides of the grid (supply side & demand side)
- Creation of a more flexible portfolio and grid system is a TVA priority
- Creation of a “smarter” distribution system is a LPC priority

The old paradigm is changing ....



..... But we must remain relevant

# Our Future: An Integrated Grid

*How do we make the transition?*



Power System that is Highly Flexible, Resilient, and Connected and Optimizes Energy Production and Delivery



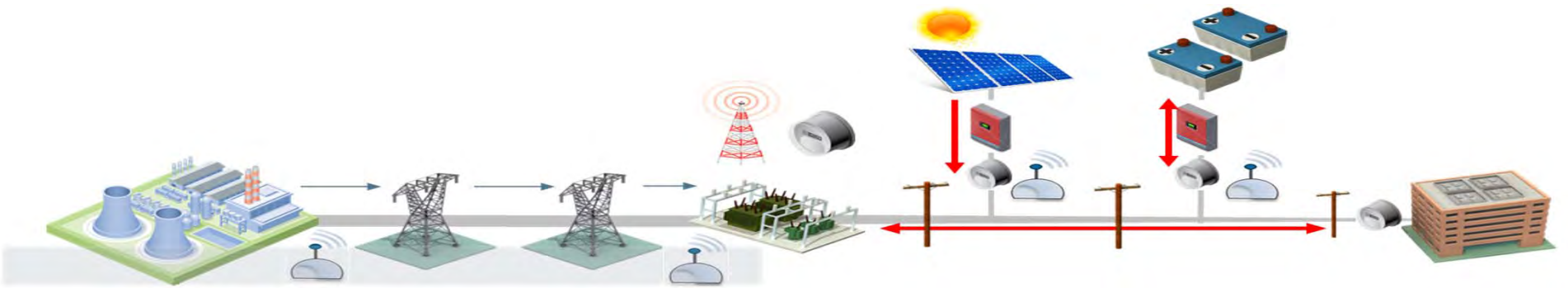
*R&D findings provide insights that help inform the choice of the preferred pathway to move the Valley toward the integrated grid vision*

Coordinated & Disaggregated Power System



# TVA's R&D Scope and Priorities

To achieve an Integrated Grid: A Power System that is Highly Flexible, Resilient, and Connected and Optimizes Energy Production, Delivery and Use



Regulations & Sustainability

Fleet Evolution

T&D Grid Modernization

Grid Edge Engagement

Data Applications & Cyber Security

New Business & Grid Services

Local Power Company (LPC) R&D Collaboration

External Research Partners (EPRI, DOE, Universities, etc)

# Innovation Scouting: A Key Function

- Scan the horizon for emerging technologies; deeper dives on useful or threat technologies
- Briefs help TVA position properly to respond to emerging technologies, or inform our LPC partners about opportunities
- Key opportunities identified from scouting become part of the research plan that supports the integrated grid vision



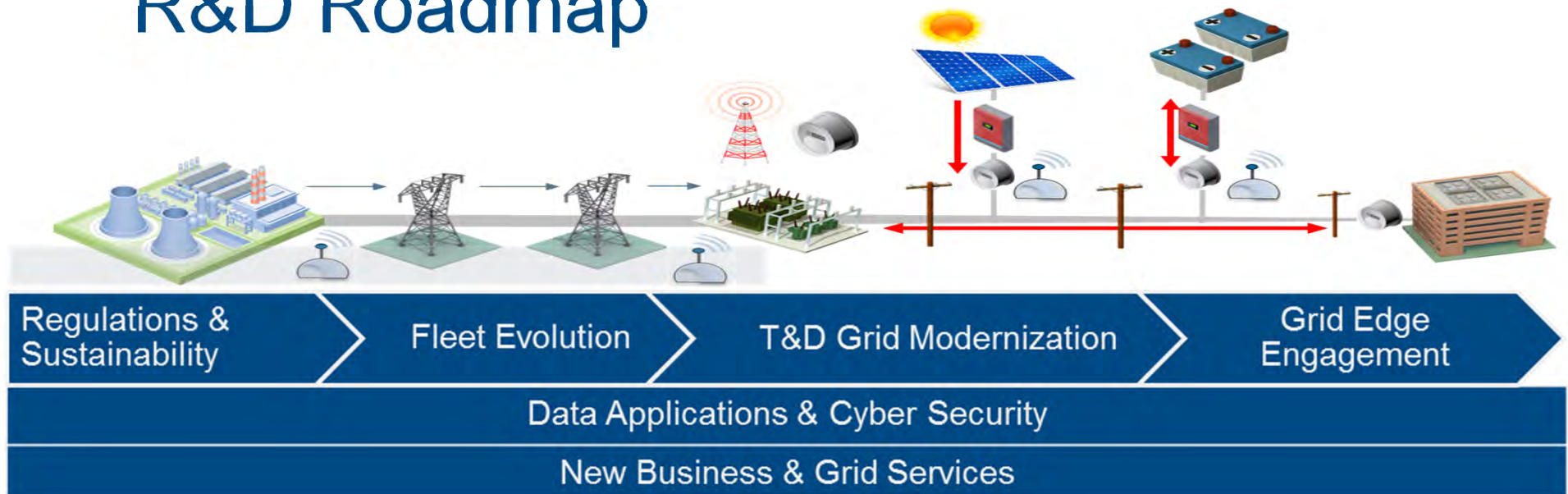


# Research Investment Plan

- Built around the key priority areas
- Aligned with TVA mission and goals
- Includes an R&D roadmap supporting the vision of the integrated grid, and outlines commitments of resources, funding & engagement strategies with key research partners



# R&D Roadmap



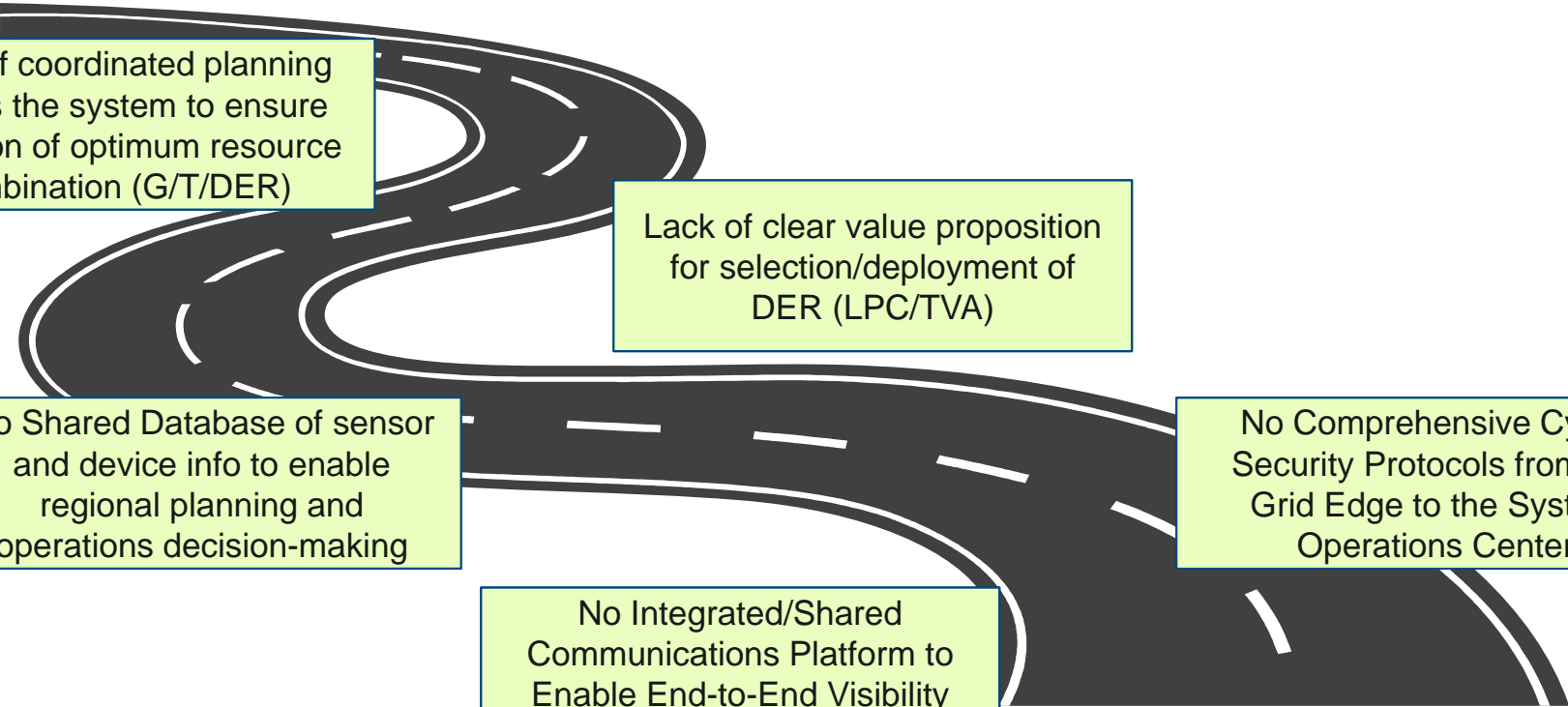
- Organizes research efforts in each of the 6 priority areas
- Identifies what success looks like across the research portfolio in support of the integrated grid vision
- Endorsed by the R&D exec steering committee and managed by TI with support from research advisors across TVA

# R&D Roadmap Objectives

R&D Priorities	Grid Edge Engagements	T&D Grid Modernization	Data Applications & Cyber Security	Fleet Evolution	Regulations & Sustainability	New Business & Grid Services
Vision Statement	<p>An integrated and cost effective suite of options delivered in partnership with local power companies that provide distributed energy resources and services that direct serve and retail consumers support</p>	<p>Reliable, flexible, efficient and integrated transmission &amp; distribution networks that allow for secure two way power flow and communications</p>	<p>A secure, resilient and integrated power system that utilizes appropriate data and information to improve decision making throughout the power system</p>	<p>Resilient, Adaptive and Efficient Power Generation, Transmission &amp; Delivery</p>	<p>Reasonable environmental and energy regulatory requirements and a sustainable energy future</p>	<p>Beneficial electrification and services that grow TVA revenue, support economic development, and enhance environmental stewardship</p>



# Some of TVA's Roadmap Challenges (Roadblocks to Success)



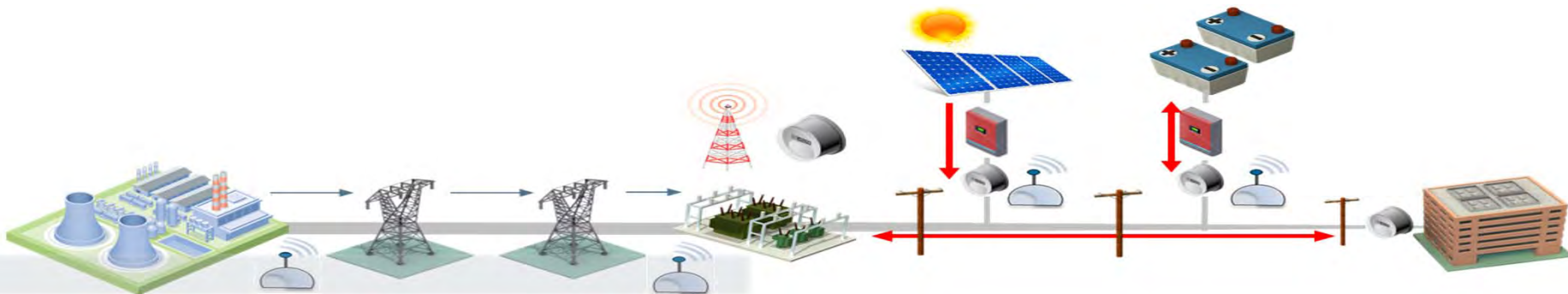
Lack of coordinated planning across the system to ensure selection of optimum resource combination (G/T/DER)

Lack of clear value proposition for selection/deployment of DER (LPC/TVA)

No Shared Database of sensor and device info to enable regional planning and operations decision-making

No Comprehensive Cyber Security Protocols from the Grid Edge to the System Operations Center

No Integrated/Shared Communications Platform to Enable End-to-End Visibility and Control



Regulations & Sustainability

Fleet Evolution

T&D Grid Modernization

Grid Edge Engagement

## Reasonable Environmental and Energy Regulatory Requirements and a Sustainable Energy Future

### Informed Regulations and Policy Development

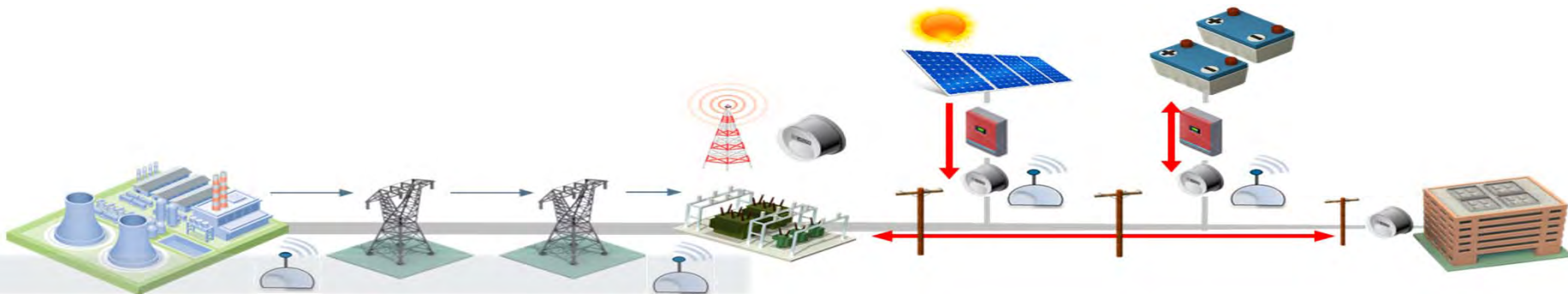
Conduct scientific research and demonstrations to inform rulemaking, policy development, and litigation

### Compliance Options

Evaluate needs, and identify and demonstrate compliance technologies

### Sustainable Integrated Energy Network (IEN)

Conduct scientific research and demonstrations to identify environmental and safety-related benefits and challenges of the IEN



Regulations & Sustainability

**Fleet Evolution**

T&D Grid Modernization

Grid Edge Engagement

**Resilient, Adaptive, & Efficient Power Generation, Transmission & Delivery**

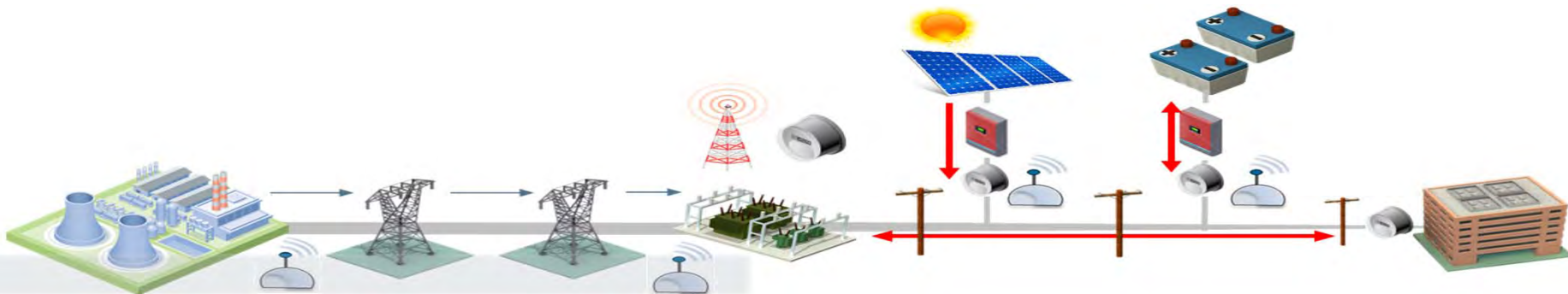
**G&T Optimization**  
 Improve Fleet Operation & Energy Delivery

**Nuclear Ops & Planning**  
 Improve Nuclear Power Operations & Integrate Long-Range Planning

**New Generation Assessment**  
 Investigate Future Generation Alternatives & Capabilities

**Energy Supply Planning**  
 Support Assessment, Analysis, & Planning





Regulations & Sustainability

Fleet Evolution

**T&D Grid Modernization**

Grid Edge Engagement

**Reliable, flexible, efficient and integrated transmission & distribution networks that allow for secure two way power flow and communications**

**Technologies**

Identify, demonstrate, and encourage evolving grid technologies

**Communication Platforms**

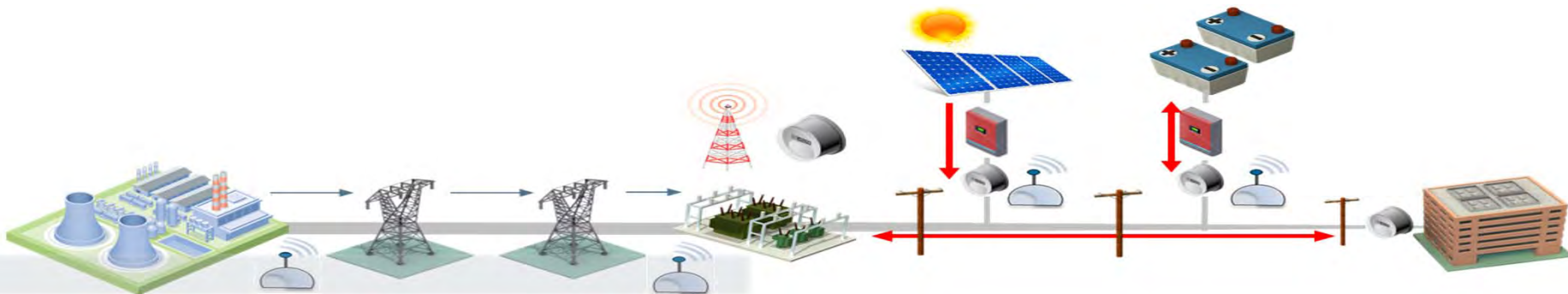
Identify and promote standards based end to end connectivity platforms

**Integration**

Integration of smart grid components and technologies and modeling/analysis to plan for the strategic integration of DER

**Cyber Security**

Investigate and inform requirements, regulations and best practices



Regulations & Sustainability

Fleet Evolution

T&D Grid Modernization

Grid Edge Engagement

**An integrated and cost effective suite of options delivered in partnership with local power companies that provide distributed energy resources and services that direct serve and retail consumers support**

**Technologies**

Identify and Characterize DER Technologies

**Market Evolution**

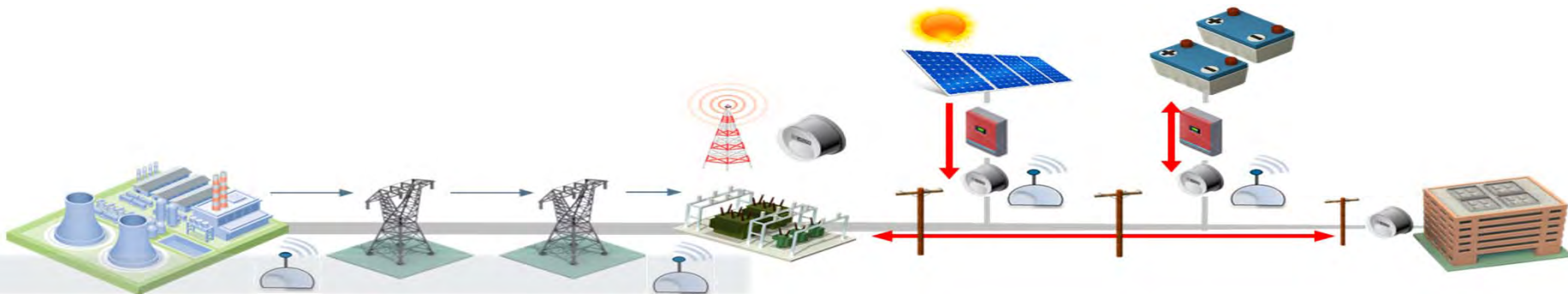
Seek to understand consumer preferences for DER and energy services

**Impacts and Valuation**

Determine the value of DER to consumers and the power system

**Development**

Support planning, evaluation, and deployment of DER options



Regulations & Sustainability

Fleet Evolution

T&D Grid Modernization

Grid Edge Engagement

## Data Applications & Cyber Security

**A secure, resilient and integrated power system that utilizes appropriate data and information to improve decision making and performance**

### Data and Information Awareness

Identify, assess, and select appropriate system data

### Data Analytics and Application Tools

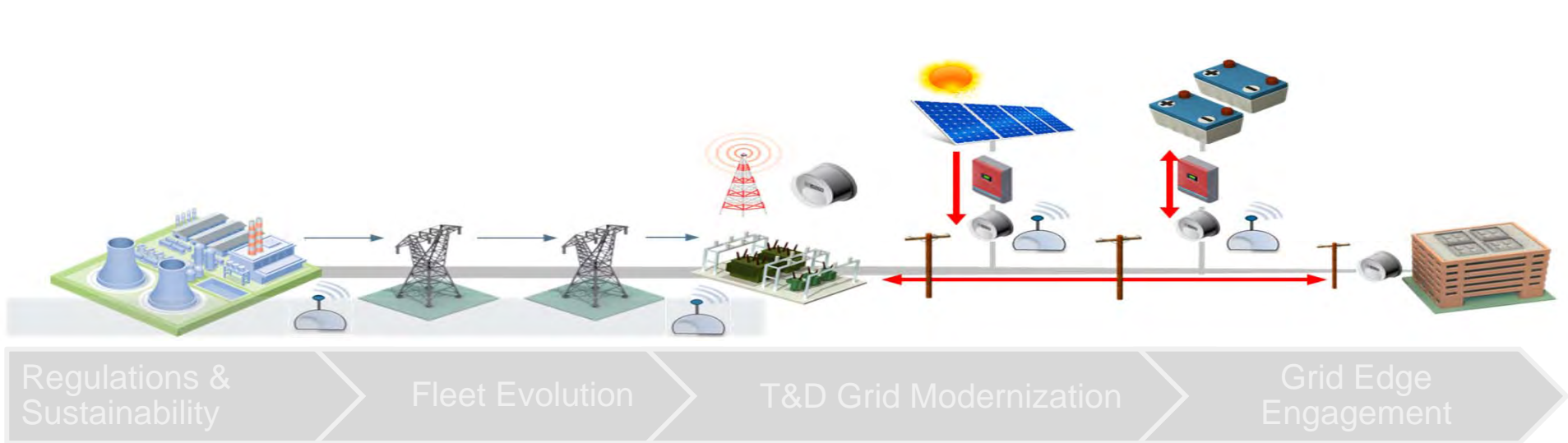
Identify and develop analytics and tools to gain innovative insight into power system operations and customer behavior

### Information Integration

Develop and enhance analytic tools to improve system visibility, control, and decision making

**Supporting cyber security initiatives across the power system, including connections to the distribution system and the interface with connected devices**





## New Business & Grid Services

Beneficial electrification and services that grow TVA revenue, support economic development, and enhance environmental stewardship

**Electrification**  
Identify partnerships, technologies, tools, and demonstrate value to customers/LPCs

**New Business Development**  
Evaluate new revenue opportunities in collaboration with LPCs

# Strategic Questions

To achieve an Integrated Grid: A Power System that is Highly Flexible, Resilient, and Connected and Optimizes Energy Production, Delivery and Use

Given TVA's Mission and Challenges, what is missing from TVA's R&D Roadmap ?

Who should TVA partner with to conduct and implement the research?

What should TVA's role be in the research and development space?





# Wrap-Up Day 1

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Conclude

Lunch for RERC Members





# Regional Energy Resource Council

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May 2-3, 2017  
Knoxville, Tennessee







# Agenda – May 3, 2017

<b>8:30</b>	<b>Welcome</b>	RERC Chair Davis
	<b>Recap Day 1</b>	Lavender
<b>9:00</b>	<b>Public Comment Period</b>	
<b>10:00</b>	<b>Break</b>	
<b>10:15</b>	<b>How We Meeting the Research and Development Road Map</b>	Brinkworth
<b>11:00</b>	<b>RERC Discussion – Research and Development</b>	Lavender and Council
<b>11:50</b>	<b>Wrap Up and Next Steps</b>	Lavender / Hoagland
<b>12:00</b>	<b><i>Conclude Meeting (Lunch for RERC Members)</i></b>	





# Recap Day 1 and Preliminary Discussion

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Jo Anne Lavender and Group



# Public Comment Period

- **Public participation is appreciated**
- **This is a listening session; responses are typically not provided**





BREAK TIME







# TVA's Research Direction

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Gary Brinkworth,  
Director, Technology Innovation



# Take-Aways from Day 1

- TVA's R&D work is focused on providing insights to help us transition to an integrated grid
- There are 6 research priority areas:
  - Regulations & Sustainability
  - Fleet Evolution
  - T&D Grid Modernization
  - Grid Edge Engagement
  - Data Applications & Cyber Security
  - New Business & Grid Services
- Each priority has an objective and key focus areas to guide research work





# **TVA** Potential Technology Game Changers

## **Energy Storage**

Large Scale energy storage, including batteries of various chemistries and other technologies, capture energy produced at one time for use at a later time.



## **Electrification**

Customer use of electricity in non-traditional areas including electric vehicles, trans modal shipping, manufacturing, and home use all designed for greater efficiency and lower fossil emissions.



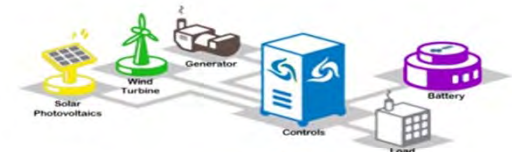
## **Cogeneration**

The application and use of heat energy to produce electricity and steam to support manufacturing, heating and cooling, as well as supporting better resiliency for customers.



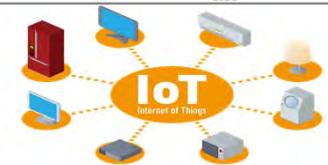
## **Microgrid**

A discrete energy system consisting of distributed energy resources and loads capable of operating in parallel with, or independently from, the main power grid.



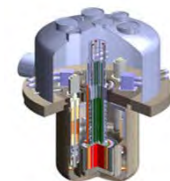
## **Internet of Things (IoT)**

Devices that can communicate and be controlled through connection to the Internet including; thermostats, water heaters, outlets, lighting, and appliances at a residential and commercial level.



## **Advanced Nuclear Technology**

The evolution of nuclear generation technologies that are inherently safer, more cost effective, and flexible to support baseload emission free power generation.



# Energy Storage



**Energy Storage:** Large Scale energy storage, including batteries of various chemistries and other technologies, capture energy produced at one time for use at a later time

- **Why is TVA interested/ engaged:** Energy storage is emerging as the pivotal technology that can reshape the energy sector by providing load leveling, frequency regulation, voltage support, grid stabilization with renewables integration.
- **What TVA is doing:** Working with LPCs and Internal organizations to develop demonstration projects to value energy storage applications on the distribution and bulk power systems and maintaining awareness of energy storage technologies and advancements.
- **What is developing:** There is large scale project development in California/Hawaii to support peaking capacity and renewables integration. Driven by manufacturing efficiency and scale, Lithium-ion battery costs continue to decline.
- **Key Takeaway:** As costs continue to decline for lithium-ion batteries, distributed energy storage is showing value as a quickly developed asset for renewables firming, peaking capacity and distribution system benefits (deferral, voltage regulation, etc.); however, the TVA-LPC-Customer arrangement currently presents a challenge to maximizing the multiple “stacking” value streams needed to make investments cost effective.



# Electrification & Electric Vehicles

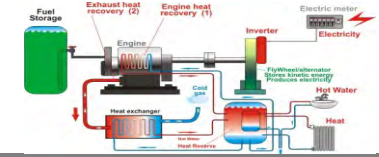


**Electrification**-Customer use of electricity in non-traditional areas including electric vehicles, trans modal shipping, manufacturing, and home use all designed for greater efficiency and lower fossil emissions.

- **Why is TVA interested/engaged:** Utilizing electricity instead of fossil fuels can increase utility revenues, decrease environmental impacts and improve end-use efficiency, cost and productivity/quality, and support customer wants and needs
- **What TVA is doing:** Evaluating emerging technologies for potential benefits, helping develop impact strategies for programmatic options and future integration as flexible distributed energy resources
- **What is developing:** Growing consideration of electrification for environmental reasons; improvement in electric vehicle choice and performance (more vehicles with longer ranges), larger format electric transportation options (buses, forklifts, airports, etc.), compelling C&I electric options to replace fossil fuels
- **Key Takeaway:** With the growing consideration of electrification as a path to greenhouse gas reduction, improvements in electric transportation (electric vehicles, busses, airports, etc.) choice and performance, and a renewed focus on C&I electric options, electrification provides an opportunity to increase utility revenue and provide benefits to consumers.



# Cogeneration/CHP

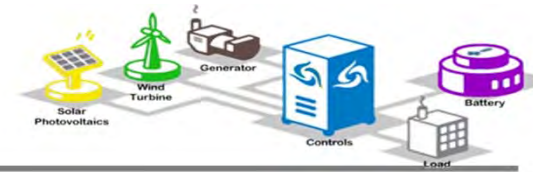


**Cogeneration**, The application and use of heat energy to produce electricity and steam to support manufacturing, heating and cooling, as well as supporting better resiliency for customers.

- **Why is TVA interested/ engaged:** Potential for significant load and revenue erosion if electric customers adopt CHP also less energy is wasted.
- **What TVA is doing:** Developing potential products and business models that TVA or LPC's could utilize to meet customer needs and have CHP as a resource for the portfolio.
- **What is developing:** Developing pilots with LPC's to test the interoperability and economics of CHP options.
- **Key Takeaway:** Combined heat and power applications can provide efficiency and cost benefits to large commercial and industrial consumers that significantly decrease utility revenues. TVA owned CHP is not an opportunity to grow the business; it would be a defensive move to preserve some revenue (i.e., lose less money than we would with customer owned CHP).



# TVA Microgrids



**Microgrid** - A discrete energy system consisting of distributed energy resources and loads capable of operating in parallel with, or independently from, the main power grid.

- **Why is TVA interested/ engaged:** The Increase in frequency and duration of outages due to extreme weather events along with the acceleration of distributed energy resource deployments have resulted in increased interest in microgrids from customers which represent a potential threat to the traditional utility business model or an opportunity for new utility services/solutions.

- **What TVA is doing:** A cross-organization team has begun developing a strategic approach and methodology to consistently assess microgrid opportunities based on information gathered through a feasibility study of the Cherokee Farms microgrid site in Knoxville.

- **What is developing:** Microgrid interest has increased across the county and in the Tennessee Valley. The Naval Air Station at Meridian and Redstone Arsenal have both recently expressed interest in microgrids based on mandates; while Hitachi Corporation has been investigating a private microgrid at the Cherokee Farm site in Knoxville. Research and Development continue on both the technical challenges associated with microgrids as well as the value proposition to utilities and customers.

- **Key Takeaway:** Due to Valley economics and regulatory structure, microgrid feasibility remains limited, but Utility microgrid services could serve niche applications for facilities that need enhanced reliability, resiliency, power quality, etc. or serve as solutions compared to costly infrastructure upgrades in troubled transmission/distribution areas.

# Internet of Things (IoT)



The **Internet of Things** ('IoT') - Devices that can communicate and be controlled through connection to the Internet including; thermostats, water heaters, outlets, lighting, and appliances at a residential and commercial level

- **Why is TVA interested/ engaged:** The Internet of Things represents an opportunity to improve end-use/load visibility, provide granular control and enhance consumer engagement with innovative products and services many consumers expect. By leveraging multiple varied end-use devices, services for the distribution system can be performed including regulation services, demand response and load leveling.
- **What TI is doing:** Pilots have been underway that look to understand the ability of internet connected smart thermostats and controllable water heaters to provide energy services for the consumer and utility.
- **What is developing:** Consumers are adopting internet connected devices such as smart thermostats, TVs, lighting control systems and voice controlled “hubs” that link various energy devices together. Throughout the US, utilities are engaging to gather insights and aggregate these distributed devices, enhance efficiency, manage loads, and provide energy services and consumer-Utility engagement.
- **Key Takeaway:** Consumer/convenience driven adoption of connected devices is creating an opportunity for Utilities to engage consumers and offer innovative customer services; however, aggregation and coordination of many varied end-use devices will be needed to generate utility value in power system operations.





# Advanced Nuclear Reactor Technology

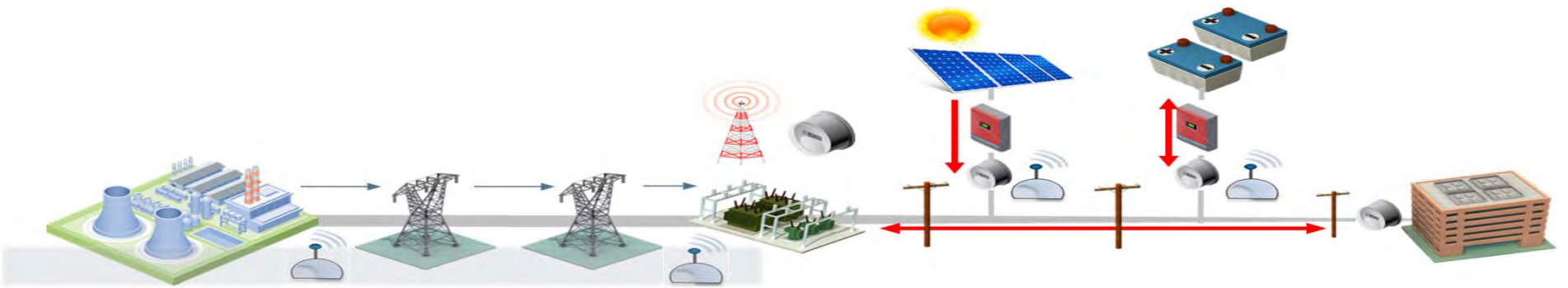


**Advanced Nuclear Technologies:** The evolution of nuclear generation technologies that are inherently safer, more cost effective, and flexible to support baseload emission free power generation

- **Why is TVA interested/ engaged:** As TVA's operating nuclear plants age, options for replacement should be developed. Advanced reactors offer faster construction, enhanced safety, more flexible operations, and lower incremental costs compared to available large reactors
- **What TVA is doing:** Licensing the Clinch River Site in Oak Ridge, Tenn. for potential future deployment of SMRs under an Agreement with DOE who funds 50%. TVA is playing a leadership role within industry by addressing regulatory uncertainties with the NRC. TVA is also a member of Advanced Reactor working group, staying abreast of technology developments beyond SMRs.
- **What is developing:** Dozens of start-up companies are in various stages of conceptual designs, many backed by venture capital funding or philanthropists (e.g. Bill Gates has invested \$400M). Two developers received small grant funding from DOE, a molten chloride salt reactor led by Southern Company and TerraPower and a pebble bed high temperature gas reactor led by X-Energy.
- **Key Takeaway:** While TVA pursues SMRs it will remain aware of advanced reactor developments, to ensure no obviously superior technology emerges that should be pursued instead. TVA will provide non-monetary support for all advanced reactor developments.

# TVA's R&D Scope and Priorities

To achieve an Integrated Grid: A Power System that is Highly Flexible, Resilient, and Connected and Optimizes Energy Production, Delivery and Use



Regulations & Sustainability

Fleet Evolution

T&D Grid Modernization

Grid Edge Engagement

Data Applications & Cyber Security

New Business & Grid Services

Local Power Company (LPC) R&D Collaboration

External Research Partners (EPRI, DOE, Universities, etc)



# Partnerships & Engagement

- TVA is leveraging external partners across multiple categories to develop solutions that support an integrated grid
- Partner categories currently include:
  - Government
  - Alliances
  - Utility Associations
  - Universities
  - Customer Associations
  - National Labs
  - Industry
  - and our LPCs



# Partnerships & Engagement

## Government

- Partnering on proposals from DOE
- Participation in demo projects (ARPA-e)
- Potential for expanded engagement



## National Labs

- Close working relationship with ORNL across many topic areas
- Participation as utility partner and industry advisor
- Potential to host research projects





# Partnerships & Engagement

## Alliances

- National and regional groups that include utilities and solution providers/vendors
- Leveraging knowledge from across the industry
- Conferences and research reports



## Utility Associations

- National organizations that provide access to key industry leaders
- Conferences, research reports, and surveys provide input to the development of TVA strategies and programs



# Partnerships & Engagement

## Industry

- Key research partner category
- Provides access to significant network of researchers and utility members
- Tech transfer from these partners have made significant improvements to TVA operations



## Universities

- Endowed universities funded to conduct research of value to TVA
- Refocusing this network and aligning to the R&D roadmap
- Expanding our engagement with universities in our region to expand ability to research key topic areas





# Partnerships & Engagement

## Customer Associations

- Engagement with these associations helps to leverage broader national and regional networks focused on our customer's issues (LPCs)
- Access to research projects that give direct learnings to our LPCs for implementation

TECA

TVPPA

TMEPA  
Tennessee Municipal Electric Power Association

NRECA  
America's Electric Cooperatives

## Local Power Companies (LPCs)

- Key partner category – vital to our ability to achieve the integrated grid vision
- Host utilities for many demonstration programs that inform new program offerings and help us understand impacts on the distribution system

Middle Tennessee Electric  
Membership Corporation



KUB  
KENTUCKY UTILITIES

AEC  
APPALACHIAN  
ELECTRIC COOPERATIVE  
A Tennessee Energy Cooperative

HUNTSVILLE UTILITIES  
ELECTRICITY • NATURAL GAS • WATER

# Partnerships & Engagement

- Partnerships allow TVA to expand the reach of our R&D work by expanding the team
- Engagement provides benefit to both TVA and the external partners
- If TVA can network our Valley partners together we could address more significant issues by leveraging the skills of each partner



# The Role of TVA in Grid & Market Transformation?

## Catalyst

- Changes in market rules, structure
- New opportunities for service offerings

## Advisor

- Share scouting insights
- Recommend offerings based on research findings

## Partner

- Jointly develop and deploy programs, demos
- Provide tech and/or financial support

## Provider

- Introduce offerings to compete with 3<sup>rd</sup> parties
- Solutions for direct served customers



# Strategic Questions

To achieve an Integrated Grid: A Power System that is Highly Flexible, Resilient, and Connected and Optimizes Energy Production, Delivery and Use

Given TVA's Mission and Challenges, what is missing from TVA's R&D Roadmap ?

Who should TVA partner with to conduct and implement the research?

What should TVA's role be in the research and development space?



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# Council Discussion and Advice

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# RERC Advice Questions

1. Given TVA's Mission and Challenges, what is missing from TVA's R&D Roadmap ?
2. Who should TVA partner with to conduct and implement the research?
3. What should TVA's role be in the research and development space?





Wrap Up and Adjourn

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*Thank you and please travel safely!*

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