TVA Nuclear Generation Development

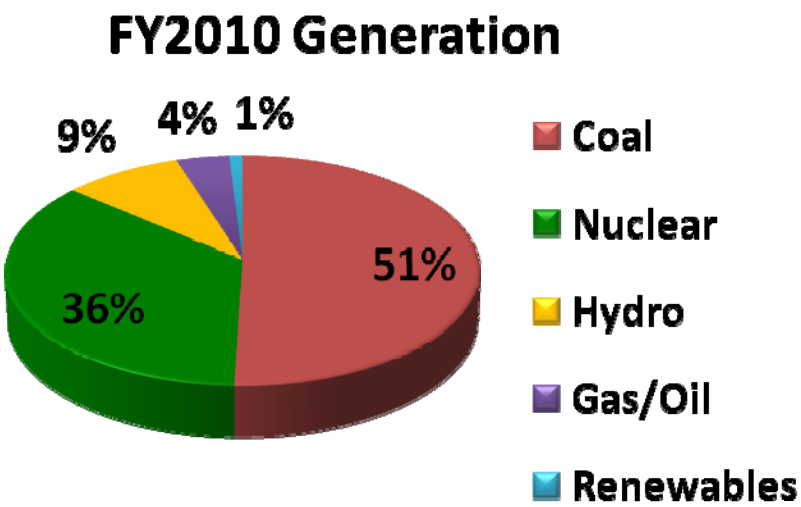
Presented by Jeff Perry

Senior Project Manager, Strategic Nuclear Expansion

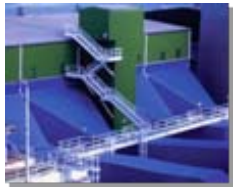
September 14, 2011

Customer Base and Generating Facilities

- 155 power distributors
- 56 direct served customers
- Over 9 million people in an 80,000 sq mile service area



Fossil Plants



Combustion Turbines

Nuclear Plants

Hydroelectric Dams

Pumped-Storage

Green Power

TVA Renewed Vision

One of the Nation's Leading providers of low-cost and cleaner energy by 2020

Low Rates

High Reliability

Responsibility

Cleaner Air

More Nuclear Production

Greater Energy Efficiency

The Benefits of Nuclear Beyond Simple Economics

Competitive Stable Electric Price

~60% of Total Cost Fixed

Long-Term Costs Attractive

Economic Development

Creates Local and Regional Jobs

Thousands of Project Jobs During Construction and Hundreds During Operation

Clean Air Value

Zero Air Emissions

Protection Against CO2 Risk

Reliable Energy Supply

High Capacity Factors

Low fuel transportation Risk

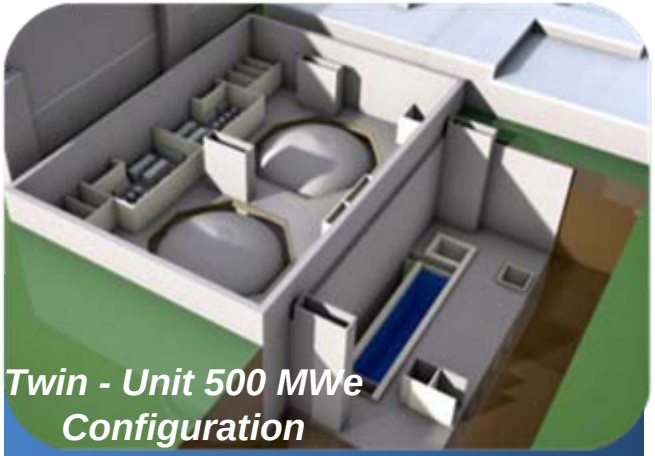
Supports a Diverse Portfolio

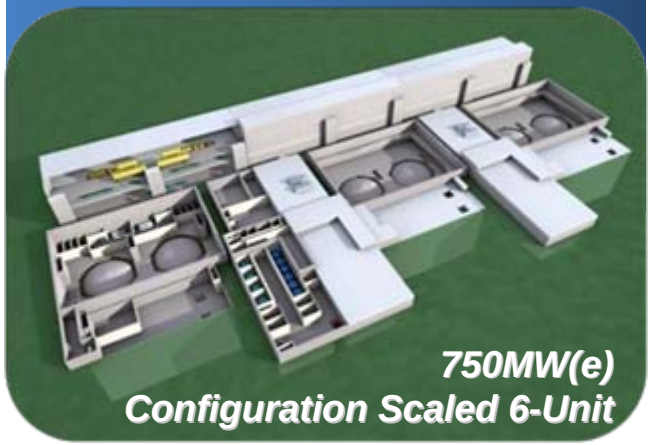
Nuclear Projects at TVA

	Under Construction	*Engineering/Licensing*	*Studies*
	Watts Bar 2	**Bellefonte 1**	**Clinch River**
Year Expected	**2013**	**2018-2020**	**TBD**
Total Nuclear Megawatts	**7,760 MWe**	**9,020 MWe**	**TBD**

Value in Developing SMR Option

- Increasing siting options
- Managing investment risk
- Re-establish US supply chain
- Engineering and manufacturing jobs
- Widespread opportunities including small and medium-sized utilities
- Potential for technology export to other countries





Light water SMRs offer unique near-term option

SMRs What? mPower™ Design

- Integral 125 MWe reactor
- Scalable modular plant
- Proven advanced LWR technology
- Simple, fully “passive safety” design
- “Industry standard” PWR fuel
- Underground spent fuel storage
- 4-5 year fuel cycle

Fits TVA’s technology innovation mission

Nuclear Island Features

Nuclear Island fully underground

- Inherent security, external threat protection

Modular features will drive schedule certainty

- Expectation is 25%+ shorter project schedule

Only DC powered safety functions, controls

- Lower O&M and capital costs for safety systems

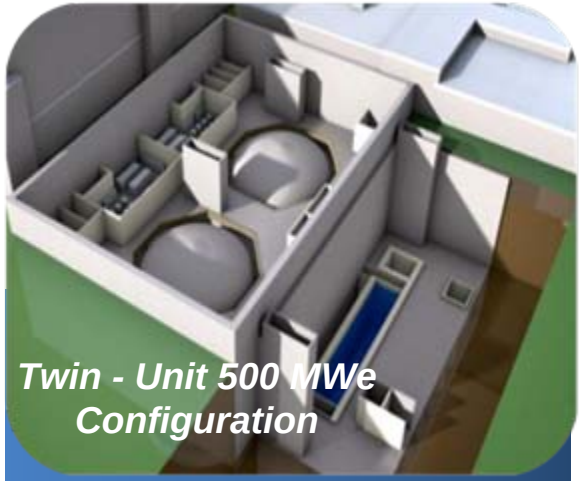
Spent fuel storage underground

- Operations not dependent on long-term solution

Simple solution for plant safety and spent fuel

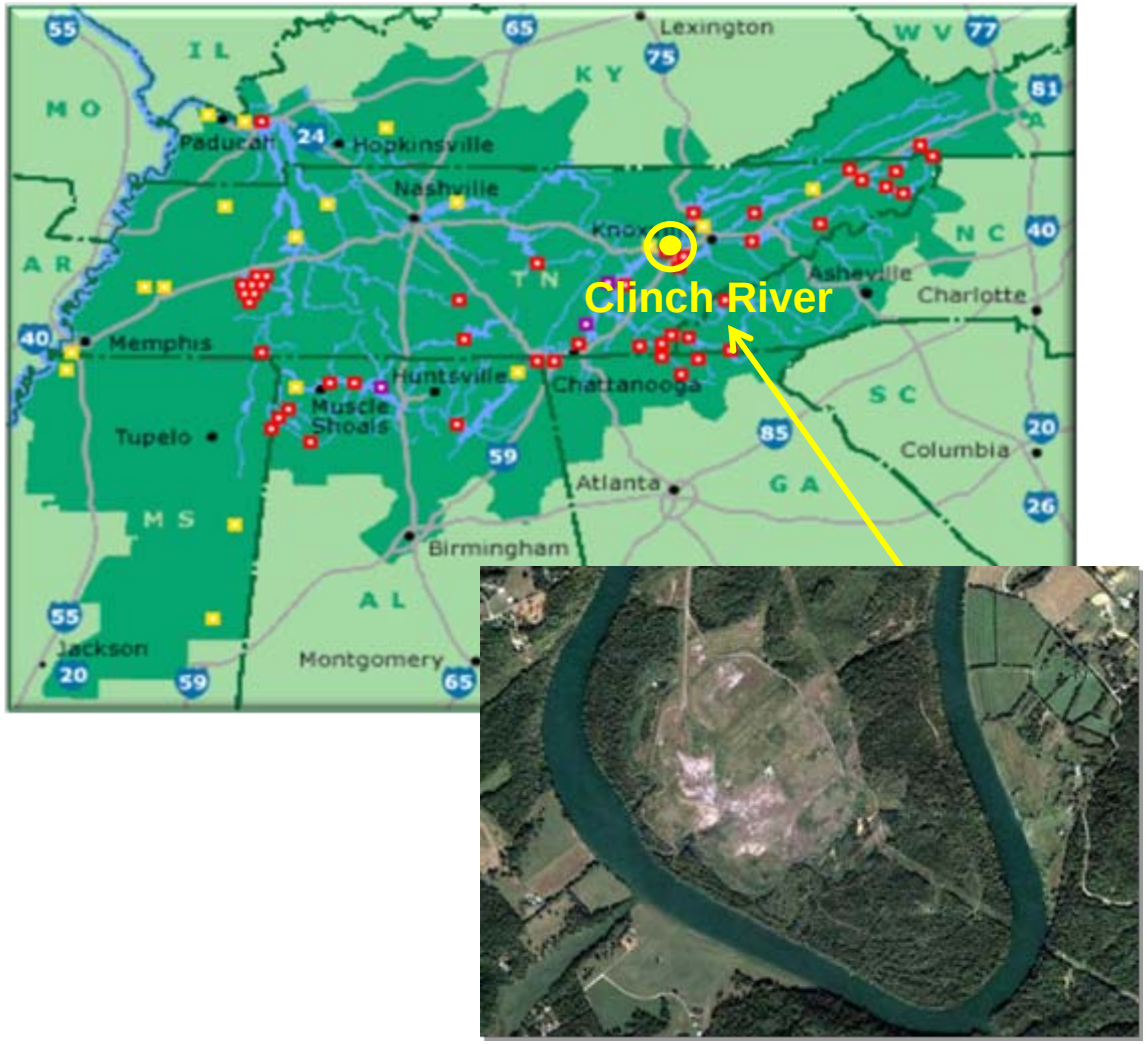
Key Challenges Driving SMR Financial Viability

- Licensing Efficiency
  - First of Class Deployment
  - Standardization
  - Risk-informed focus
- Economic Viability
  - Capital Costs
    - Design finalization
    - Modularization
  - O&M Costs
    - SMR fleet concepts (Regional Centers)



Outside the box thinking will be critical to proving viability

Where? Clinch River Site Located Adjacent to Oak Ridge Reservation



Started site characterization activities

Working with ORNL on potential site "clean energy" powering project

Notified Nuclear Regulatory Commission of expected construction permit application in 2012

Site Characterization Studies

- Previous site evaluation data
- Ecological surveys
- Cultural surveys
- Meteorological data collection
- Subsurface investigation
- Site layout plan
- Surface water level calculations
- Site infrastructure

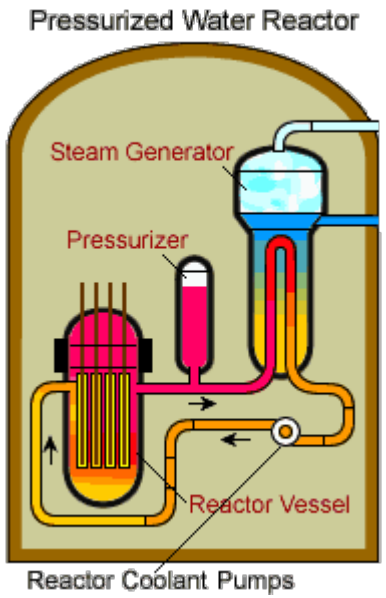
Key construction permit site activities are underway

Site Characterization Studies

Site Characterization Studies

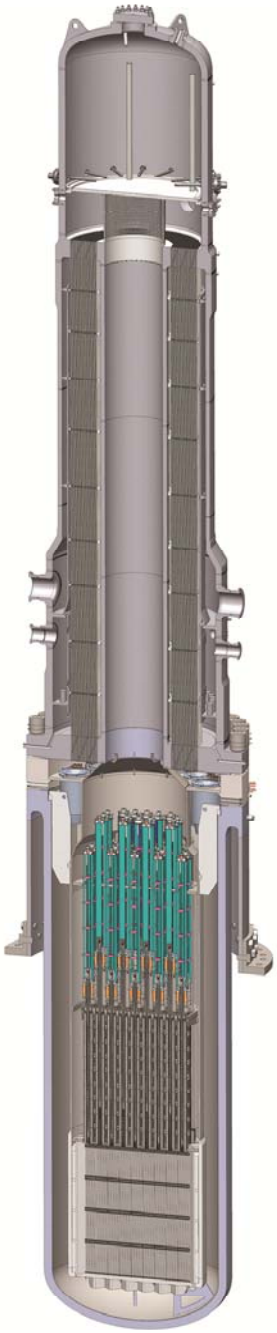
Site Characterization Studies

Why would SMRs Perform differently from existing LWRs?



- SMRs are small-sized reactors generating <350 MWe. Although the designs are based on commercial LWRs, they aren't scaled LWRs.
- SMRs are based on military applications

- Although the fuel is based on standard fuels, the operating conditions include long cycles without periodic fuel shuffles.



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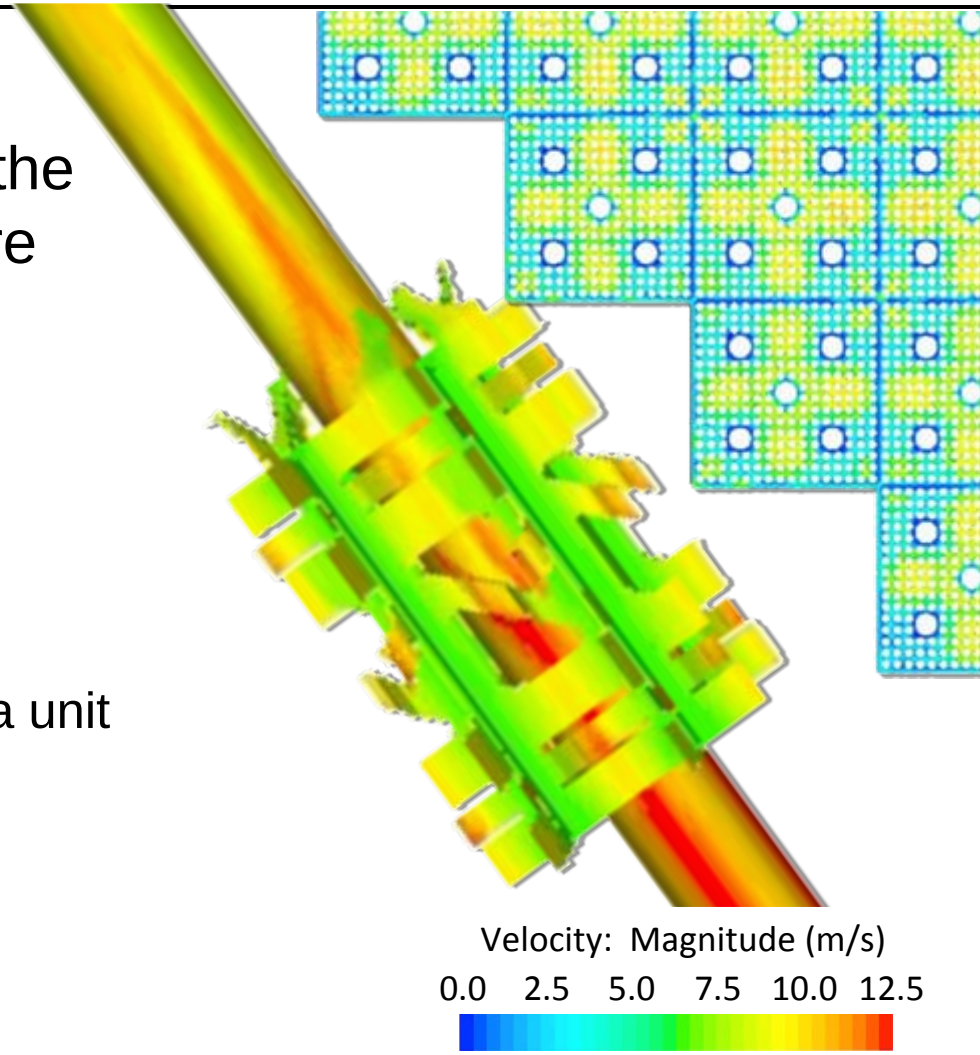
Understanding Operational Experience

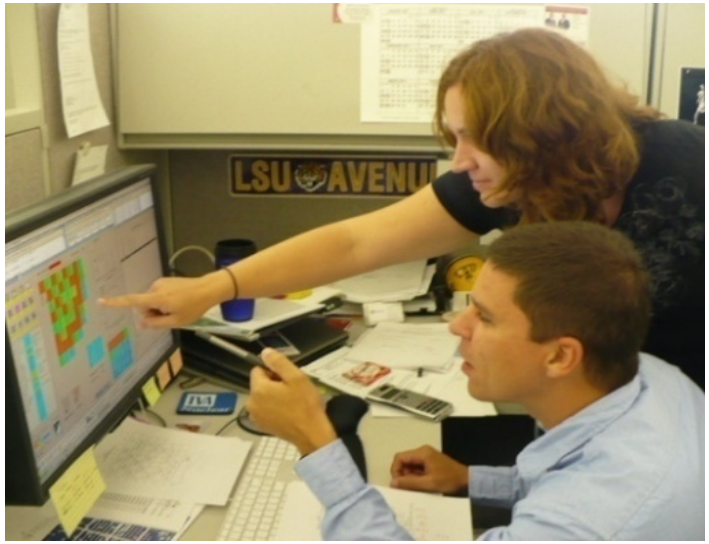
- Need to better understand the issues to better inform future simulation
  - Thermal hydraulics
  - Fuel Performance
  - Performance of the LWR as a unit
  - Maintenance Issues



Better understanding of known issues and identifying those we haven't thought of . . .

Framing The Problem

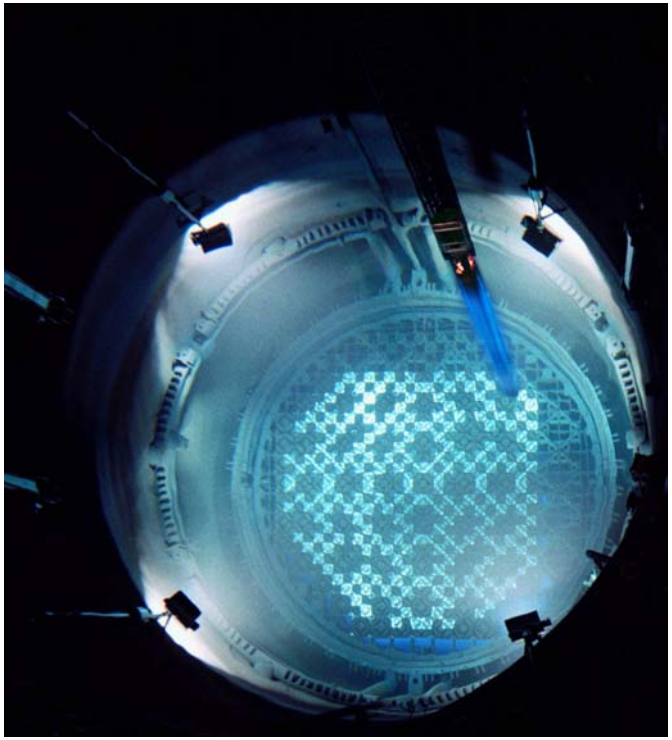
- Ability to do simulations in-house as well as access to expert simulations for special cases
- Training simulators for SMRs



- SMR simulation capability
- Flexibility to evaluate steady state and transient events

Flexibility for use in different applications

Opportunities for Virtual SMRs



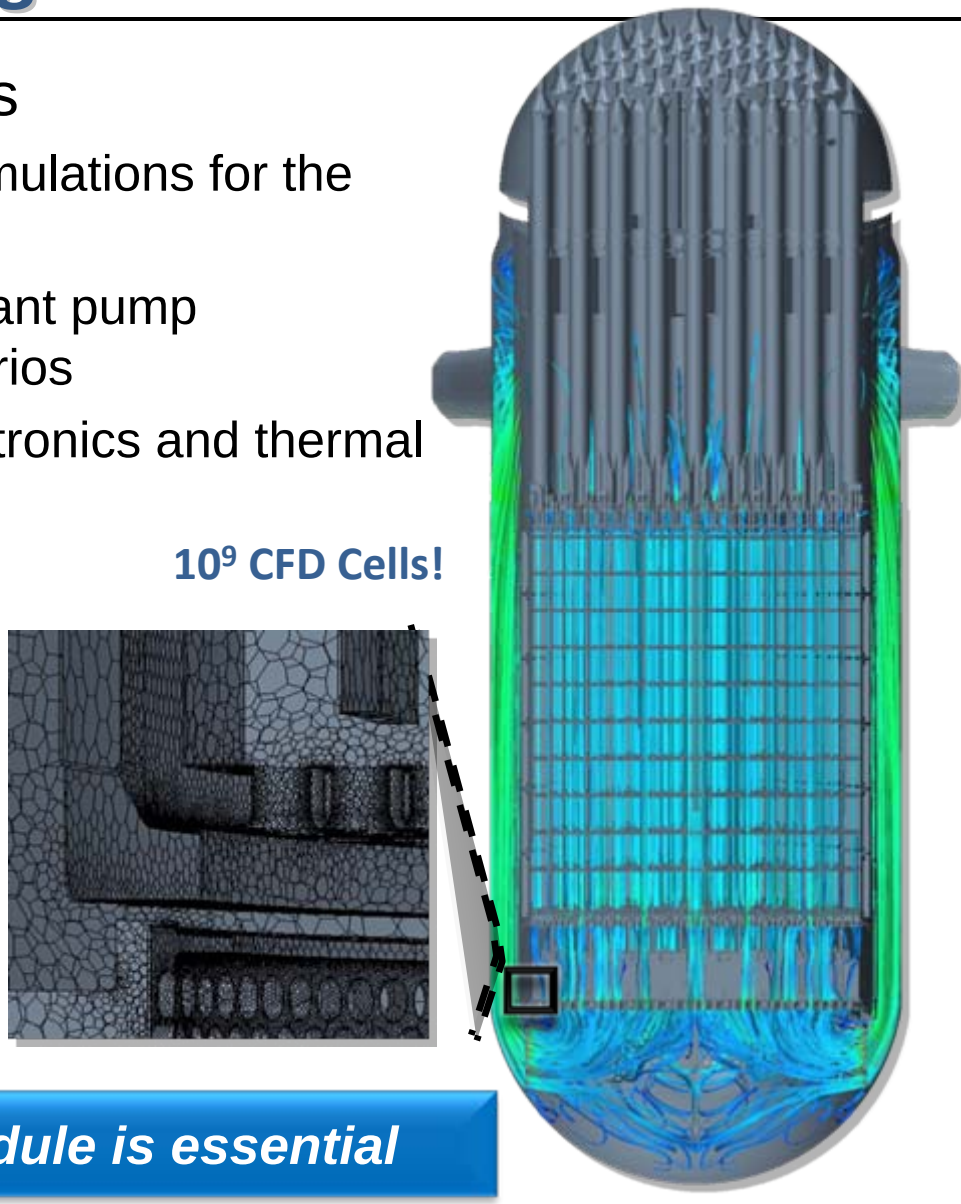
- Where Can HPC facilitate the Project?
  - Answers to Licensing questions
    - Fuel performance
    - Overall system performance
  - Higher fidelity evaluation of Safety analyses
    - Simulating abnormal events (transients)
    - More precise Dose predictions
  - Probabilistic Risk Assessment
    - Unique design and integration features

Anticipating project needs is essential to providing value

High Performance Computing Challenges for SMRs

- Integrated Design Challenges
  - Integrated thermal hydraulic simulations for the entire flow path
  - Flow patterns with reactor coolant pump reduced/limited capacity scenarios
  - Simultaneous solutions for neutronics and thermal hydraulic effects
- Meshing for Complex Geometries
  - Grid sizes can exceed ~1 billion elements at the fuel assembly level
- Integrated Test and Evaluation

10^9 CFD Cells!



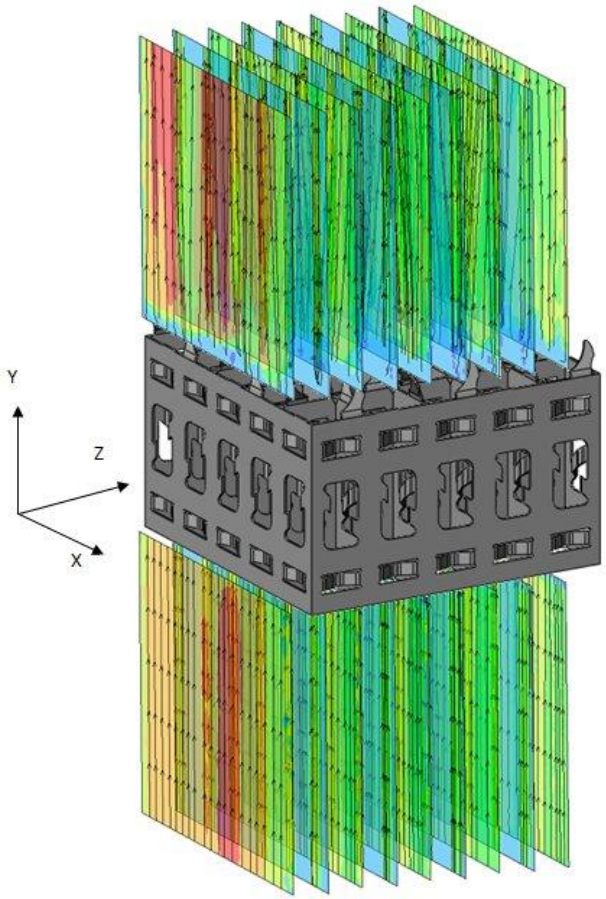
Coordination with project schedule is essential

Summary

- TVA's Vision aspires to implement more nuclear generation capability as part of a balanced supply portfolio.
- TVA is exploring several nuclear options for achieving its Vision.
  - Modernizing and completing partially completed units
  - Developing a new small modular reactor option
  - Developing new large reactors

- Producing large amounts of clean, reliable, safe, and competitively priced energy requires that nuclear be part of the mix.

Summary (cont.)



- High Performance Computing can have a positive impact on commercialization of Small Modular Reactors
- Key inputs require advance planning and integration with project development
- There are many challenges and opportunities in HPC with respect to new reactor design and licensing