



## Advanced Nuclear Technology (ANT) Program

### EPRI ANT Construction Projects for IAEA Construction Workshop

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## CRITICAL ISSUES FOR THE ELECTRICITY SECTOR

### The world expects electric utilities to:

1. Provide clean power
2. Produce it at a low-cost
3. Deliver it reliably
4. Help customers use electricity efficiently

### Research, Development & Demonstration are essential to meeting these expectations. The most important RD&D includes:

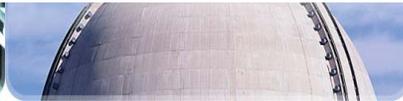
- Advanced nuclear power plants
- Innovative technologies:
  - Capture and store CO<sub>2</sub>
  - Reduce particulate emissions
  - Use less water
- Technology improvements to:
  - Component reliability
  - Lower operating costs
  - Extend their operating lifetimes
- Electric vehicle infrastructure and battery improvements
- Smart Grid to:
  - Accommodate renewable power
  - Improve transmission and distribution system capacity, stability, and efficiency
  - Manage demand response
- Hyper-efficient technologies to allow customers to use less energy

# EPRI Portfolio Spans the Entire Electricity Sector



## Generation

- Advanced Coal Plants, Carbon Capture and Storage
- Combustion Turbines
- Environmental Controls
- Generation Planning
- Major Component Reliability
- Operations and Maintenance
- Renewables



## Nuclear Power

- Material Degradation/Aging
- Fuel Reliability
- High-Level Waste and Spent Fuel Management
- Nondestructive Evaluation and Material Characterization
- Equipment Reliability
- Instrumentation and Control
- Risk and Safety Management
- **Advanced Nuclear Technology**
- Low-Level Waste and Radiation Management



## Power Delivery & Utilization

- Distribution
- Energy Utilization
- Grid Operations and Planning
- Substations and Asset Planning
- Transmission and Increased Power Flow



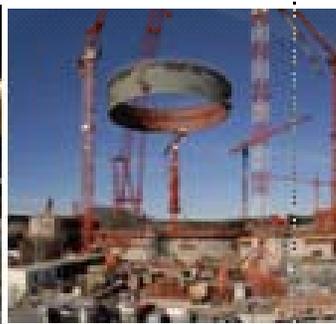
## Environment

- Air Quality
- Global Climate Change
- Land and Groundwater
- Occupational Health and Safety
- T&D Environmental Issues
- Water and Ecosystems

# Advanced Nuclear Technology

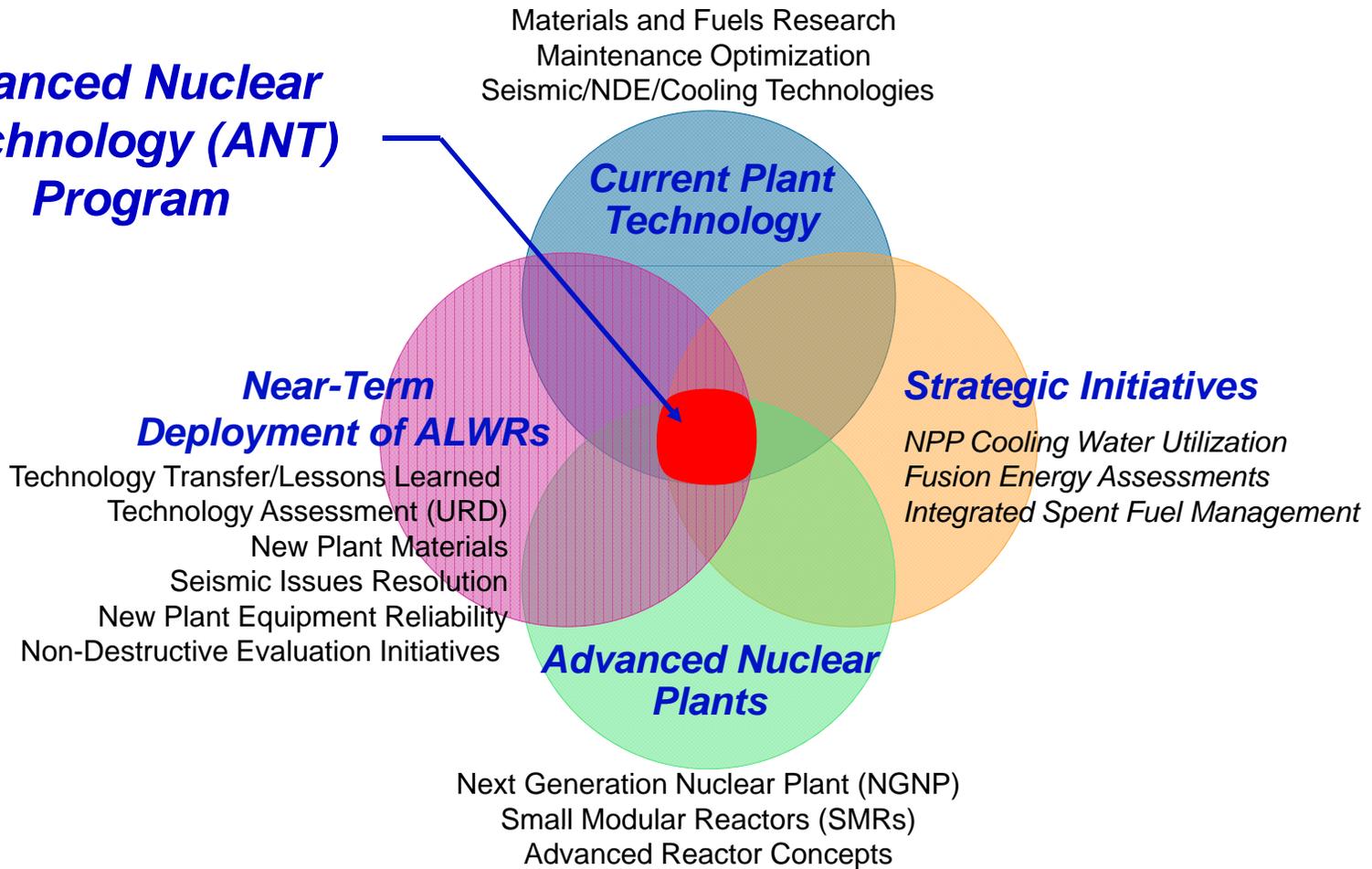
## *Program Objectives*

- New nuclear power plants must overcome a number of regulatory, economic, technical, and social challenges prior to becoming a reality
- Program efforts focused around:
  - Facilitating standardization across the new fleet
  - Transferring technology to new plant designs
  - Ensuring top plant performance from start of operations
  - Reduce overall deployment risk and uncertainty
  - Supporting development of advanced nuclear plants and associated strategic initiatives

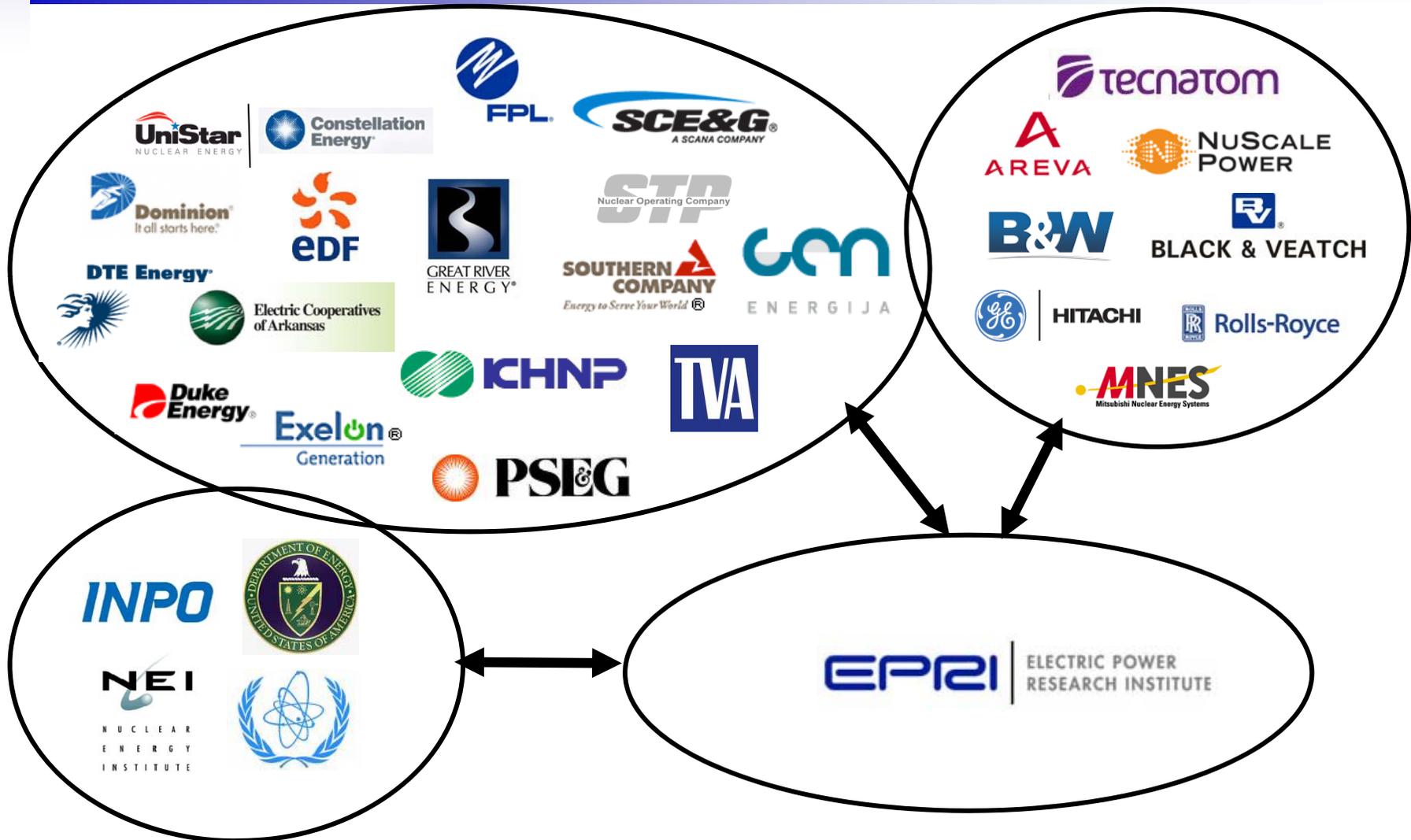


# EPRI's Response ...The ANT Program

## Advanced Nuclear Technology (ANT) Program

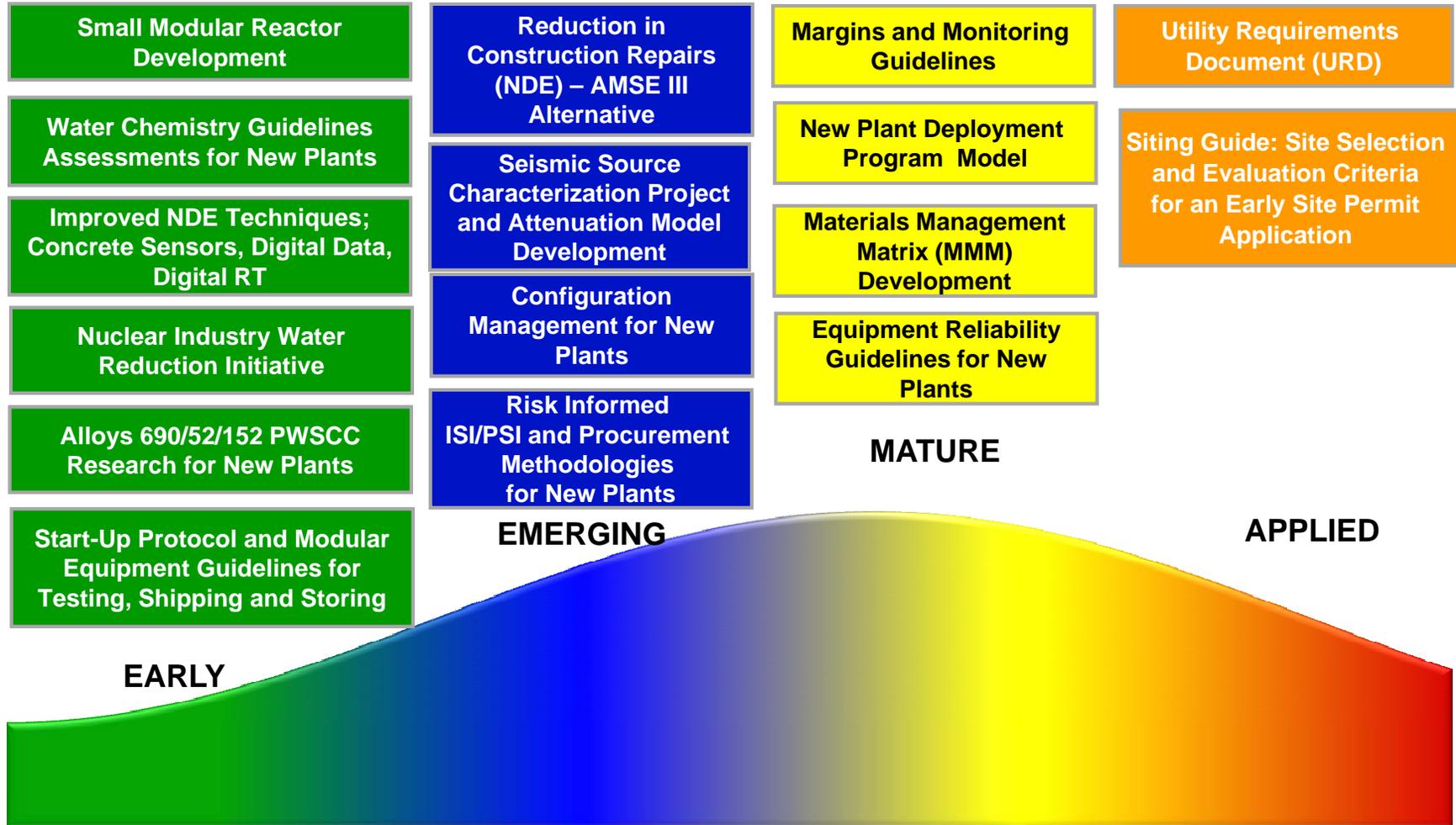


# EPRI's ANT Program...Leveraging the Industry



# Advanced Nuclear Technology

## 2010 Program Portfolio



# EPRI's Focus on New Plant Construction

- Validate/apply construction technologies and processes developed since the last nuclear build
  - Address past construction issues with new technology
  - Develop models for verification and use in design software
  - Develop appropriate code cases (as needed) to update construction codes

# Recent EPRI Construction Related Projects

- Modularization of Equipment for New Nuclear Applications - *Testing and Preservation* (EPRI Report 1021178)
  - Identifies the type of the testing and inspection to be performed on modules and the subsequent activities that should be performed on the module systems, structures, and components
- Concrete Civil Infrastructure in United States Commercial Nuclear Power Plants (EPRI Report 1020932)
  - Describes historical issues encountered in the concrete civil infrastructure of U.S. commercial nuclear power plants. A description of degradation mechanisms is presented and nondestructive evaluation (NDE) methods are discussed

# Recent EPRI Construction Related Projects

- Welding and Fabrication Critical Factors for New Nuclear Power Plants (EPRI Report 1019209)
  - Identifies important welding and fabrication processes for specific materials, assesses their effects on potential degradation mechanisms, and identifies process enhancements that can improve long-term asset management of new nuclear plant components
- Materials Management Matrices for ESBWR, AP-1000, ABWR, EPR, APR1400 and APWR (ANT Project 2008-05)
  - Comprehensive assessment of Class 1 components reviewing materials of construction, fabrication practices used during manufacturing, and opportunities for improvements based upon lessons learned

# Active ANT Construction Projects

- **Nondestructive Evaluation (NDE) and Reduction of Repairs in Nuclear Construction (2008-06)**
  - Nuclear power plants must comply with ASME Section III requirements for construction inspection and Section XI requirements for pre-service and in-service volumetric inspection of the primary pressure boundary.
  - EPRI is developing technical guidance that is aimed at permitting a “fitness for purpose” philosophy to be allowed by Section III of the ASME Code.
  - To support the fitness-for-purpose approach, industry and regulatory confidence in the volumetric NDE methods used to detect and size fabrication flaws will be required. Through this project, EPRI will establish and operate the ultrasonic examination qualification programs necessary to assure accurate, reliable construction inspections of primary pressure boundary components and welds.
- **Evaluation and Associated Guidelines for Embedded Sensors in Civil Infrastructure in New Nuclear Plants (2010-10)**
  - Identify structures that will benefit from having embedded sensors, such as structures having limited or no accessibility; and/or structures susceptible to degradation that require frequent inspections.
  - Identify the main parameters that need to be monitored and the frequency of monitoring in each of the structures identified above. In determining the data to be collected, an assessment of the best use of the data will be performed.
  - Evaluate the best sensor technology available (2012) that can be used to monitor these structures accounting for an operating period of 60+ years.
  - For structures that cannot be monitored with today’s technology, identify technology gaps and recommended R&D.

# Active ANT Construction Projects

- Use of High Density Polyethylene for Above-Ground Piping Systems, Code Case development (2010-12)
  - Determination of damping values for design of HDPE piping systems subject to seismic and other dynamic loads.
  - Determination of the Modulus of Elasticity at seismic strain rates (existing data was taken at static conditions).
  - Fire testing of HDPE piping (including pipe supports) to develop and qualify protective wraps.
  - Evaluation of pipe analytical design tools.
  - Seismic qualification testing of HDPE vent and drain valve configurations.
- KHNP Support of EPRI Construction Technology Experience Project
  - Identify and document the best technologies and techniques that have previously been used or are being demonstrated to shorten and maintain aggressive construction schedules

# Perceived Construction “Gaps”

- Comprehensive understanding of long term concrete and other critical materials aging mechanisms
- Availability of high resolution concrete NDE techniques and sensors
  - Real time void detection and correction during concrete placement
  - Detection of aging mechanisms
- Appropriateness of high strength rebar in safety structures
- Acceptance of cable splices in nuclear applications
- Application of base isolation to address increasing seismic hazards

# Proposed R&D to Close Gaps

- Probe development for void detection during concrete placement
- Modeling efforts focused on long-term reactions between Portland cement and water containing boric acid
- Laboratory evaluation of aging in post-tensioned concrete containment structures.
- Development of NDE probes and methods for imaging of voids, cracks, and other internal features in concrete structures (including SC construction)
- Exploration of instrumentation suitable for spent fuel pool leakage and structural monitoring
- Engineering analysis for the use of Seismic Base Isolation Guidelines for Critical Structures
- Code Case development for High Strength Rebar use in Nuclear Power Plants
- Exploration of cable splicing in nuclear plant applications
- Materials Management projects for Small Module Reactors (SMRs)



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