



Advanced Reactor Supply Chain Challenges and Opportunities

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EPRI Research & Development

TECHNOLOGY INNOVATION
Driving thought leadership, advanced R&D, and technology scouting and incubation to sustain a full pipeline of solutions



Nuclear Power



Energy Supply and Low-Carbon Resources



Electrification and Sustainable Energy Strategy



Transmission and Distribution Infrastructure



Integrated Grid and Energy Services

STRATEGIC RESEARCH



Low-Carbon Resources



End-Use/
Economy-Wide Carbon Reduction



Electric System Reliability/Resilience



Electric System Flexibility



Market Transformation/
Policy/Regulatory Education

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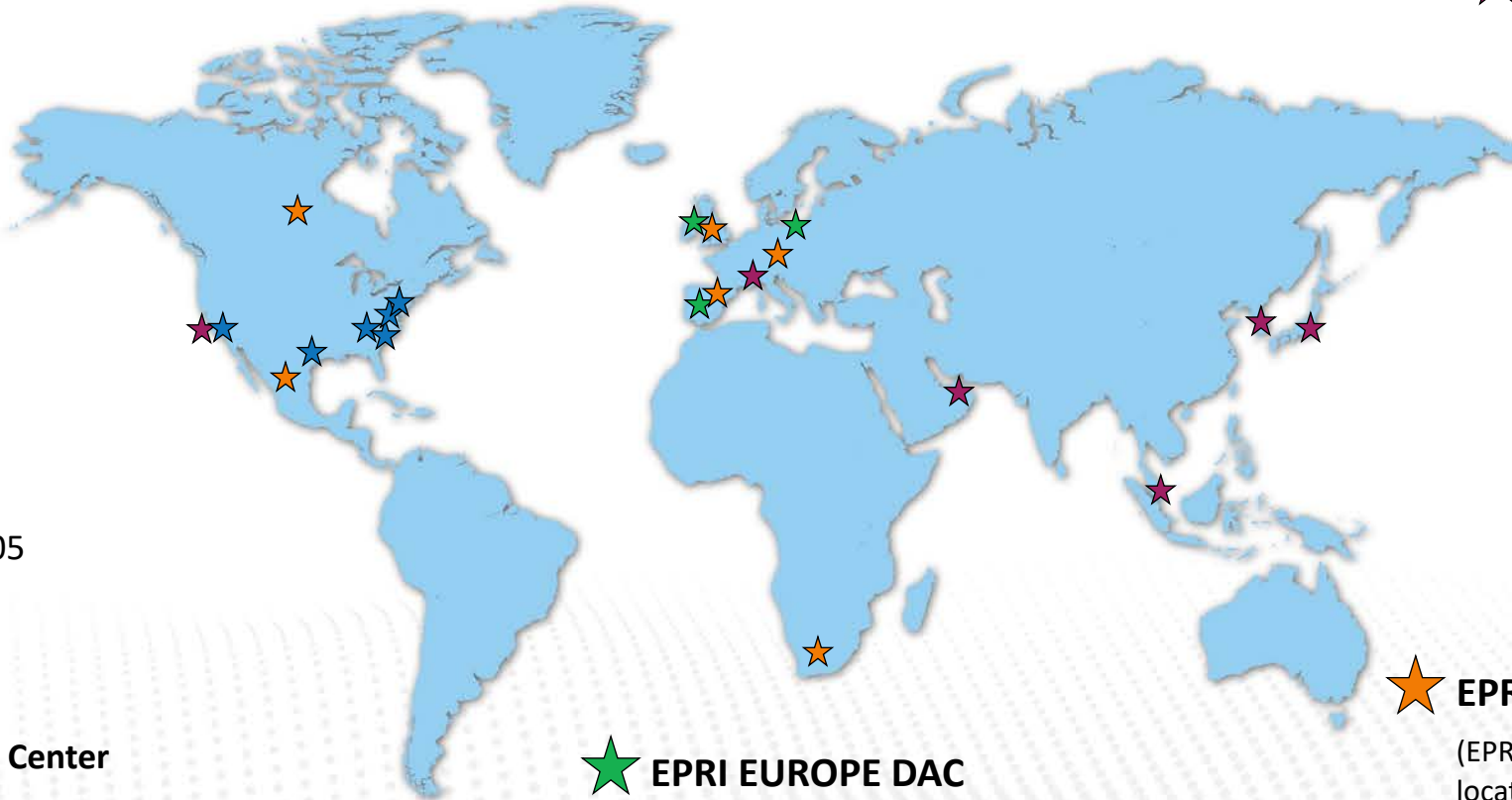
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Dallas Office and

Customer Assistance Center

Dallas, TX 75062



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EPRI Nuclear Research Areas, Programs and Initiatives

Research Area	Programs
Materials Management	Steam Generator Management Program
	Materials Reliability Program
	BWR Vessel and Integrity Program
	Welding and Repair Technology Center
	International Materials Research
	Nondestructive Evaluation
Fuels and Chemistry	Fuel Reliability Program
	Nuclear Fuel Industry Initiative
	Water Chemistry
	Decommissioning
	Radiation Safety
	Used Fuel and High-Level Waste

Research Area	Programs
Plant Performance	Nuclear Maintenance Application Center
	Plant Engineering
	Instrumentation and Control
	Risk and Safety Management
Strategic Initiatives	Advanced Nuclear Technology
	Plant Modernization Initiative
	Long-Term Operations
	Flexible Operations
	Data Driven Decision Making (3DM)
	Nuclear Beyond Electricity



Cumulative Expertise from our Global Nuclear Network

GLOBAL PARTICIPANTS



> **360** reactors worldwide

GLOBAL BREADTH & DEPTH



> **83%** of the world's commercial nuclear units

Participants Encompass Most Nuclear Reactor Designs

Potential Scale of Advanced Reactor Build-out

- US Utilities' decarbonization goals⁽¹⁾

>90% of US Fleet expects to operate for at least 80 years

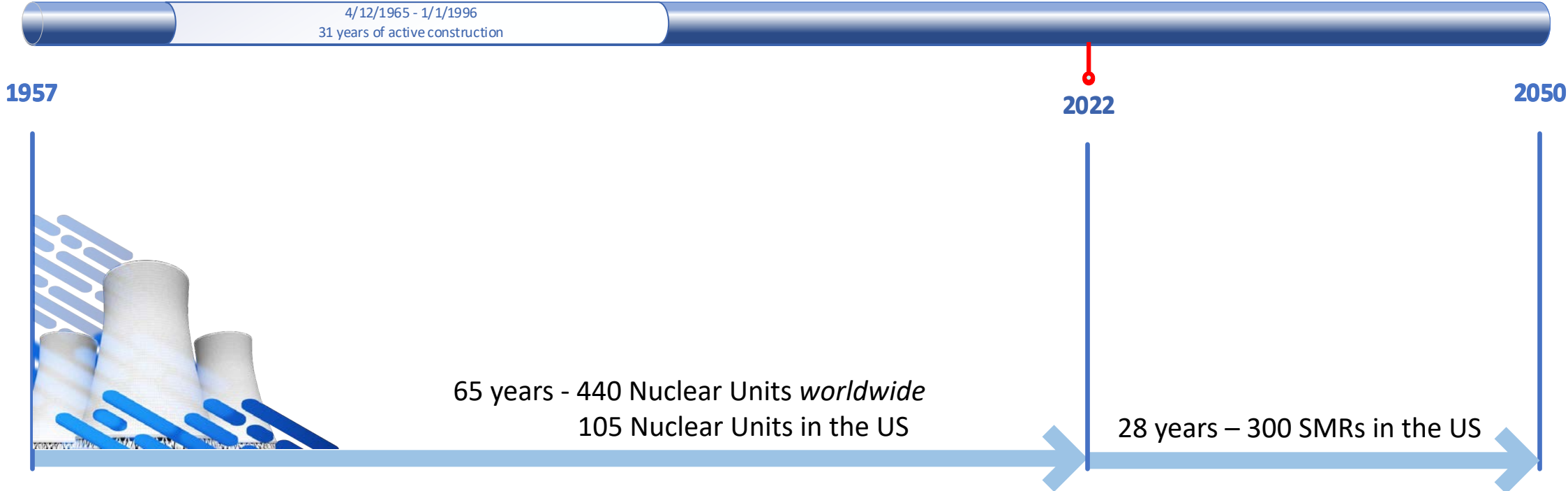
90 GW of new nuclear opportunity by 2050's

Translates to around 300 SMR-scale facilities (300 MW)

(1) Based on results of a Nuclear Energy Institute Survey

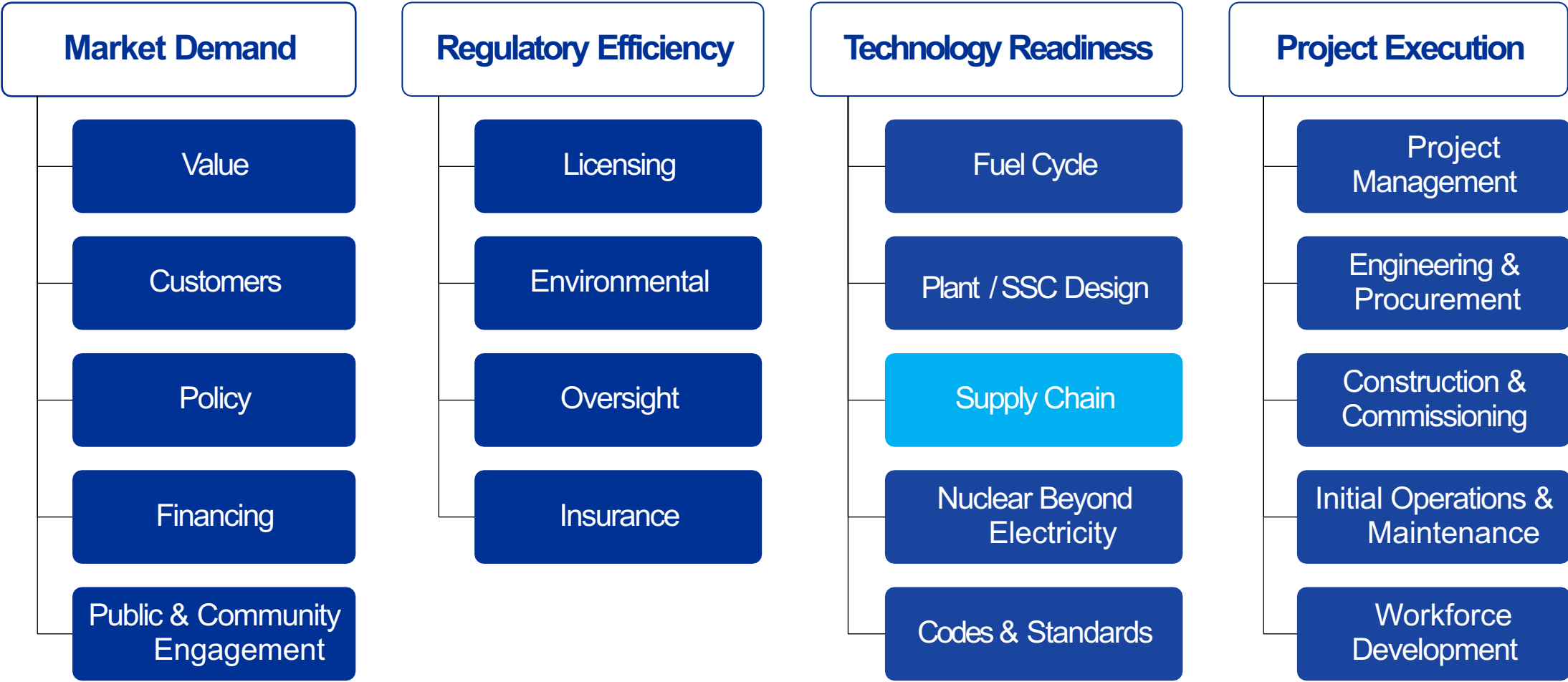
Perspective

Nuclear Facility Construction Timeline



An exciting proposition . . . but not without challenges

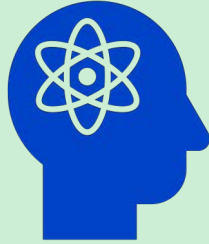
Strategic Considerations



Fundamental Demands on the AR Supply Chain

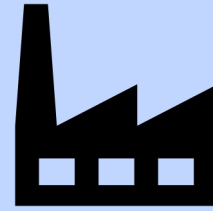
Skilled Workforce

- Equipment manufacturers
- Engineering, Procurement and Construction
- Nuclear facility staff



Expanded Supplier Base

- Incentives / recruiting suppliers
- Construction commodities
- Nuclear fuel, components and associated raw materials
- Mechanical, Electrical, Digital I&C



New Technology

- Advanced Reactor Design
- Specialty materials and components
 - Many yet to be determined
- Advanced manufacturing methods and materials **AM3**



Vigilance

- Accurate specifications, technical and quality requirements
- Require and assure quality of purchased equipment and services
- Barriers to prevent counterfeit and fraudulent items



Advanced Reactor Supply Chain Challenges

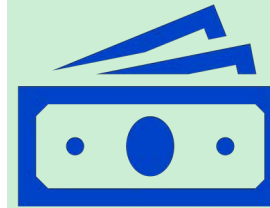
Harmonization

- Standards for new technology (digital I&C)
- Advanced manufacturing materials and methods
- Quality Management / Assurance



Supplier Incentives

- Competing with other advanced energy system build-outs
- Accurate and timely estimates of items required and quantities
- Minimize nuclear equipment and quality requirements



Commercial-Grade Items

- Standardized approach to accepting commercial / industrial-grade items
 - Commercial-grade dedication
 - Licensee use of commercial standards as a baseline for application of nuclear quality activities



Quality Management

- Selection and qualification of suppliers
- Source verification during fabrication of major components
- Advanced manufacturing



Other Considerations



Conflict and Politics

- Supply chain disruption
 - Raw Materials
 - Products from impacted regions
 - Logistics challenges – getting products from, through or around impacted regions

Concurrent Demand

- Non-nuclear advanced energy systems
 - Solar
 - Wind
 - Electric vehicles
 - Delivery Infrastructure



Coordination

- Identify, aggregate, and quantify needs at industry-level
- Prioritize and plan development of needed capabilities
- Recruit and incent suppliers and workers

A global effort may be needed to support AR builds



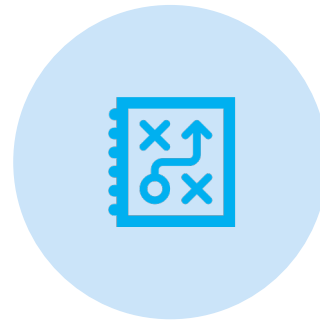
Standardization and harmonization to the extent possible



Active use and exchange of operating experience, successes and failures



Realistic commitments, goals, and milestones
- time and budget



Planning, coordination, and targeted initiatives

EPRI Advanced Energy Systems (AES) Supply Chain Workshop

held in Dallas, TX June, 2022

Workshop Objectives

- Communication and assembly of **manufacturing and materials requirements** by AES developers and manufacturers
- **Identification of needs/gaps** from the entire industry supply chain
- Identification of specific industry **pinch-points that need to be addressed near-term**
- Discussion of areas **where further manufacturing and development is necessary** to enable the energy transformation

Diverse Supply Chain Representation



Voice of the Customer – Utilities



Advanced Energy Systems Developers



Materials Suppliers



Heavy Product Form Suppliers



OEMs and Component Fabricators



Advanced Manufacturing Suppliers



Decision Makers from Across Industry

70 attendees from 48 organizations

Key Takeaways (Challenges and Opportunities Abound)



High temperature material availability and new material qualification



Forging size and throughput (& machining) inadequate to handle potential demand



Supply Chain for nuclear components needs to be expanded



Capital investments hindered without clear market



Lack of skilled labor



Test beds for demonstration and qualification



De-risking FOAK components and projects



Maximize factory fabrication and modularity



Engagement of supplier early in design



Design for manufacturability



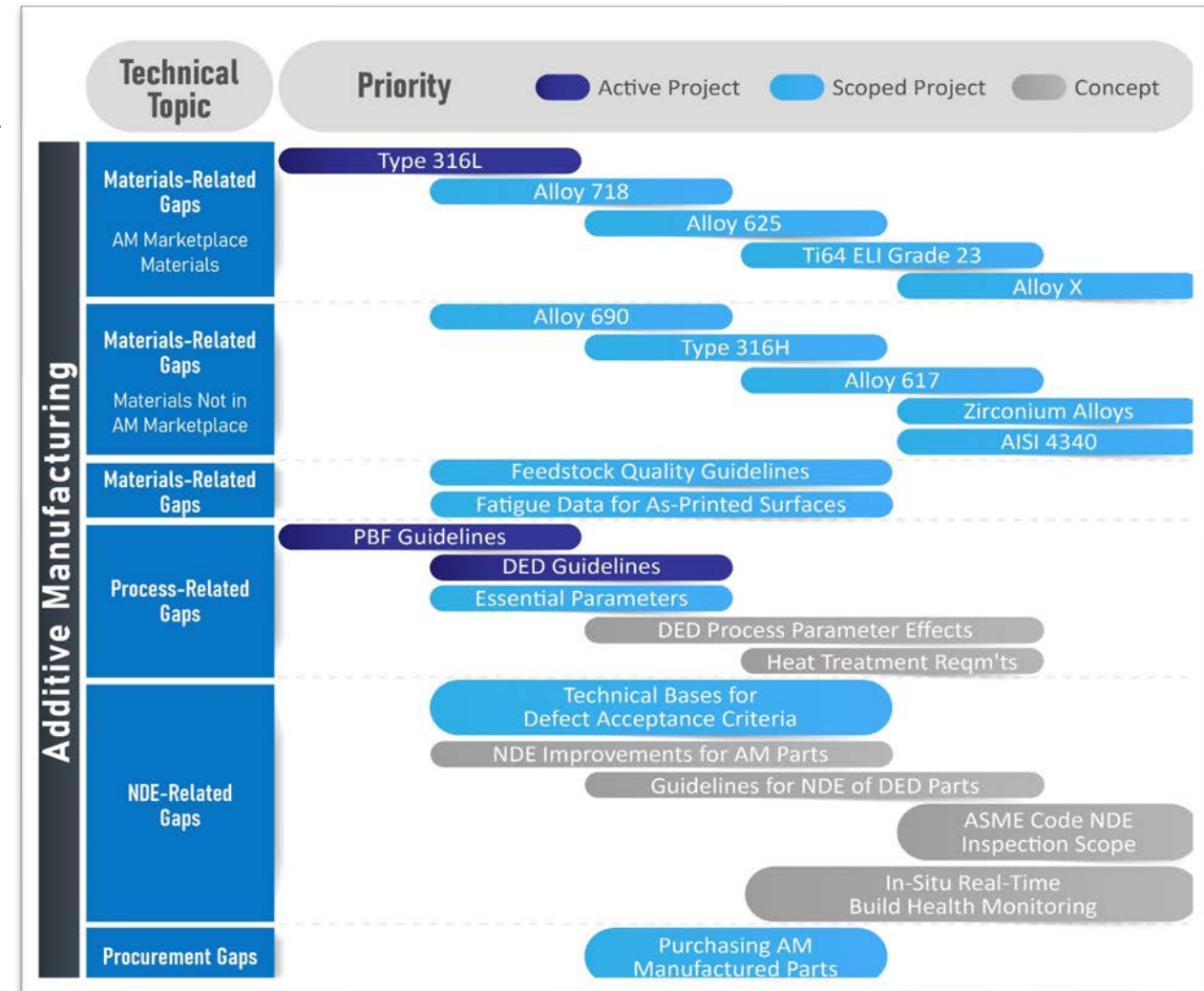
Commercialization of advanced manufacturing



Collaboration & cooperation between competitors

Next Steps

- Detailed Workshop Summary Document – 3002025254
- Joint industry qualifications
- **AM3** - *Advanced Manufacturing Methods and Materials*
- AR Materials Development Initiative
- Future Supply Chain Workshops
 - Focused **component** topics
 - e.g., Heat exchangers
 - Focused on **specific gaps**
 - e.g., Workforce development
 - Focused **collaboration** topics
 - e.g., Joint industry qualifications



Advanced Manufacturing



EPRI is working to
RE-INVENT
the nuclear supply chain

EPRI | ELECTRIC POWER
RESEARCH INSTITUTE

Advanced Manufacturing

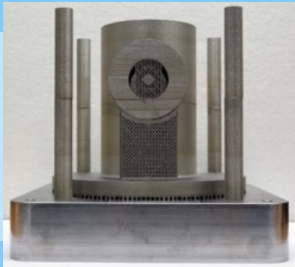


GOAL
& VALUE

Identify, develop, qualify and implement more economical manufacturing technologies that enable:
Higher Quality Components | Reduced Lead Times | Alternative Supply Chains | Cost Competitiveness



Additive Manufacturing



316L LPBF AM Data Package & Code Case



DED-AM Component Demo & Code Case



Additive Roadmap 3002018276

Advanced Manufacturing Demonstration Project

PM-HIP



EB Welding



Diode Laser Cladding



Heat Treatment

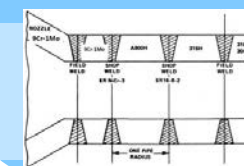
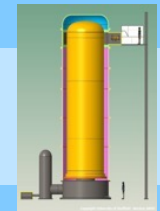
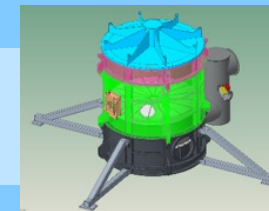


Advanced Welding Techniques

Adaptive Feedback Welding

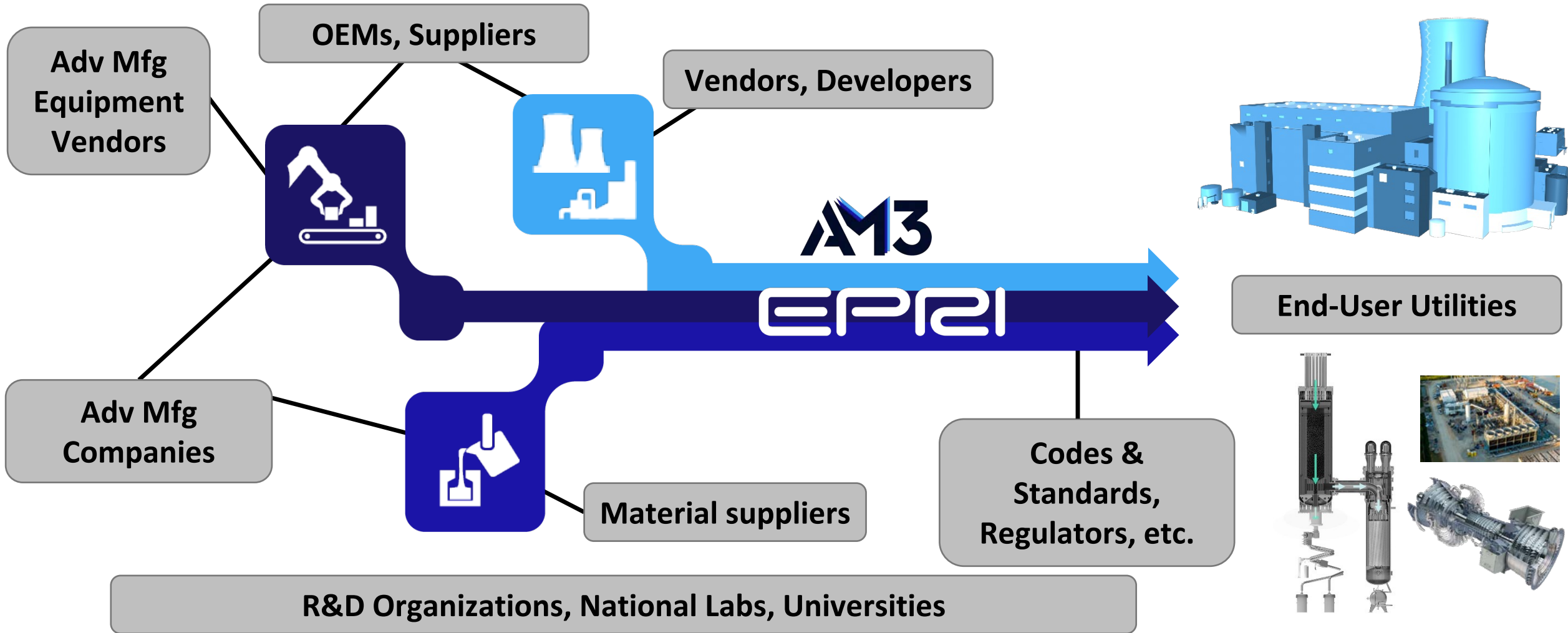


Modular In-Chamber EBW



Dissimilar Metal Welds (PM-HIP, DED-AM)

Collaboration is Key



Engaging the entire supply chain will accelerate technology adoption

Supply Chain Opportunities

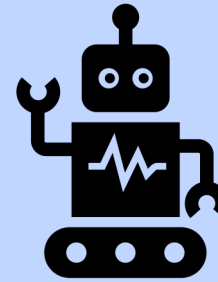
Readiness to Start Operations

- Contractual requirements for information
 - Equipment, bills of material, and inventory data loaded (typical spares)
 - Initial maintenance plans and demand
 - Consolidation of commodities



Use of New Technology

- AI for inventory tracking/planning
- Open ledger / blockchain
 - Settlement
 - Order Status
 - Traceability
 - Authenticity



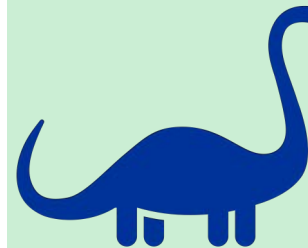
Preventing counterfeit and Fraudulent items

- Contractual requirements
 - Approved distributors
 - Photographs and other identifying information
 - Hardware-based reference signatures for electrical/electronic equipment



Obsolescence Management

- Contractual requirements:
 - Advance notification when products are discontinued
 - Information required for tracking and collaboration





Together...Shaping the Future of Energy®

