EPRI Fusion Program

Fusion Energy Strategic Program

Andrew Sowder, Sr. Technical Executive

April 30, 2026

Agenda

- EPRI's material development and testing programs
  - Traditional thermal (fossil) generation materials focus
  - Nuclear power materials focus
- EPRI's fusion energy program
  - Context and role for EPRI
  - Strategic focus areas
  - Current projects (especially related to materials, manufacturing, and supply chain development)
  - Collaborations (US, UK, Canada, Japan)

Agenda

- EPRI’s material development and testing programs
  - Traditional thermal (fossil) generation materials focus
  - Nuclear power materials focus
- EPRI’s fusion energy program
  - Context and role for EPRI
  - Strategic focus areas
  - Current projects (especially related to materials, manufacturing, and supply chain development)
  - Collaborations (US, UK, Canada, Japan)

EPRI Materials and Manufacturing R&D for Existing Generation – Fossil and Nuclear

Materials Challenges in Deploying Advanced Energy Systems

Code Qualification

Limited number of code qualified alloys

Environmental Effects

Irradiation | Corrosion | Compatibility

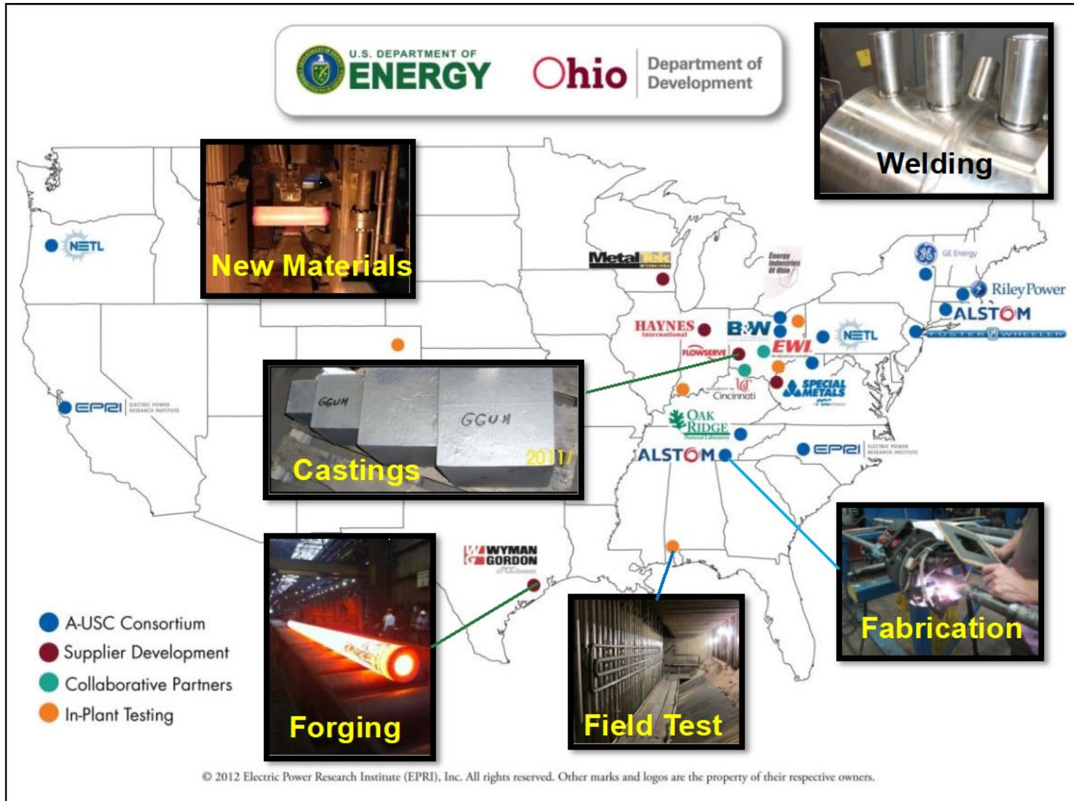
Materials Management

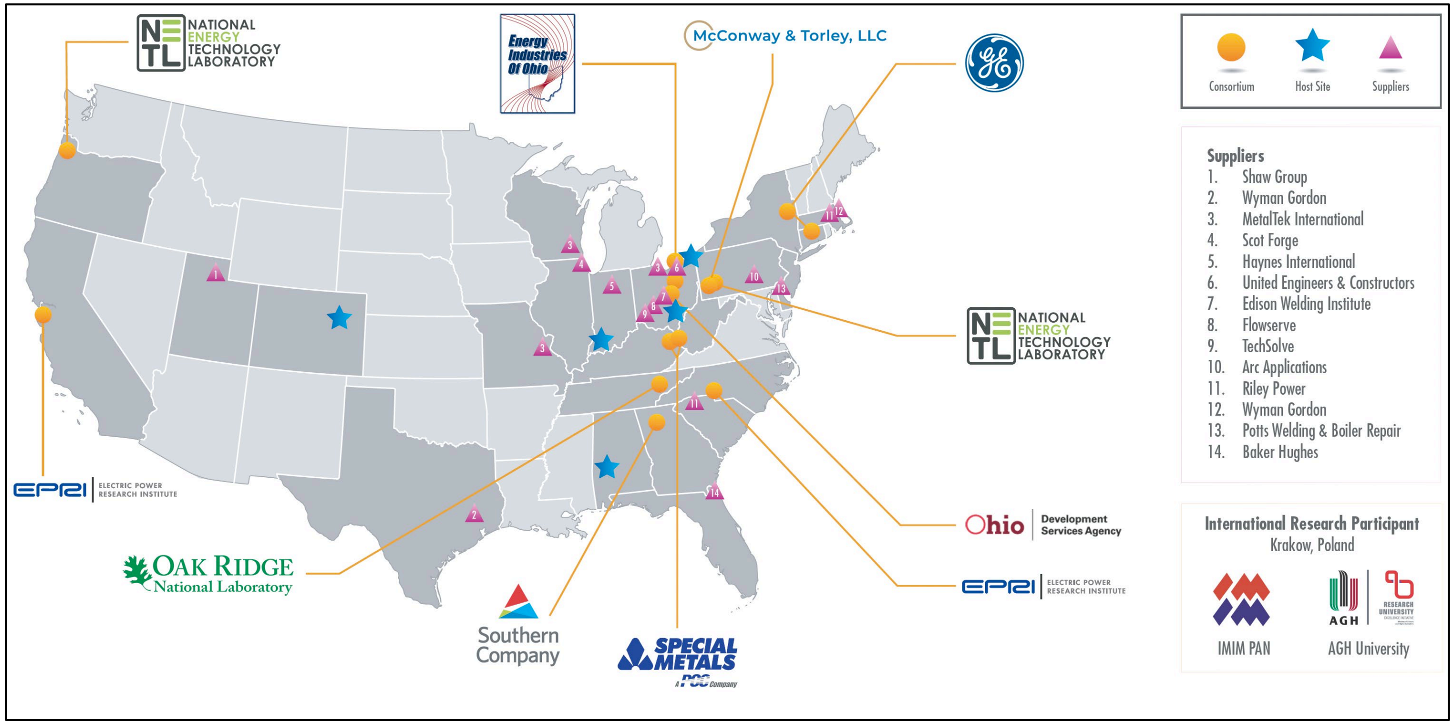
Critical data, monitoring and NDE to ensure safe, long-term operation

Supply Chain

Informed and capable fabrication and design of components

Advanced Ultra-Supercritical (A-USC) Boiler Consortium





Develop the materials technology to fabricate and operate an A-USC steam power plant with steam parameters up to 1400°F (760°C)

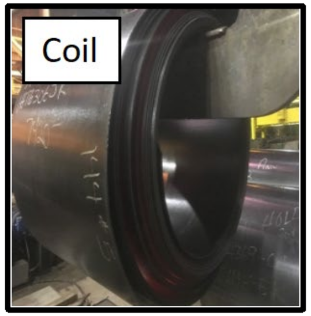
Complete the development of a qualified domestic supply chain to manufacture nickel superalloy components for A-USC power plant by fabrication of selected commercial scale A-USC components and parts

20 Year Industry Collaborative Approach Technically Led by EPRI

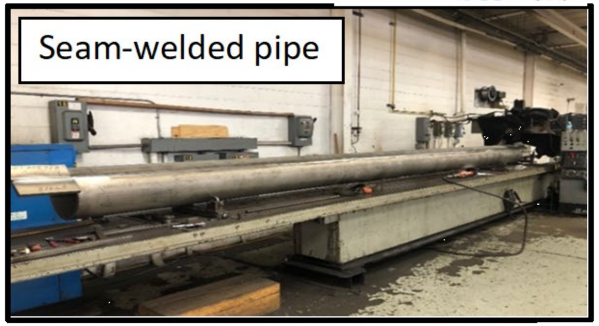
Successful manufacturing development and testing of welded tubing and seam-welded piping (Alloy 740H)

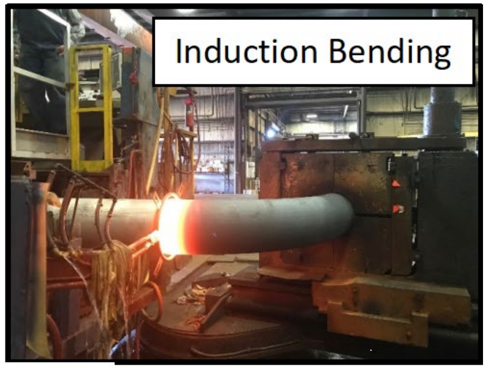
Manufacturing Development

- Supply chain engagement



SPECIAL METALS
A PCC Company

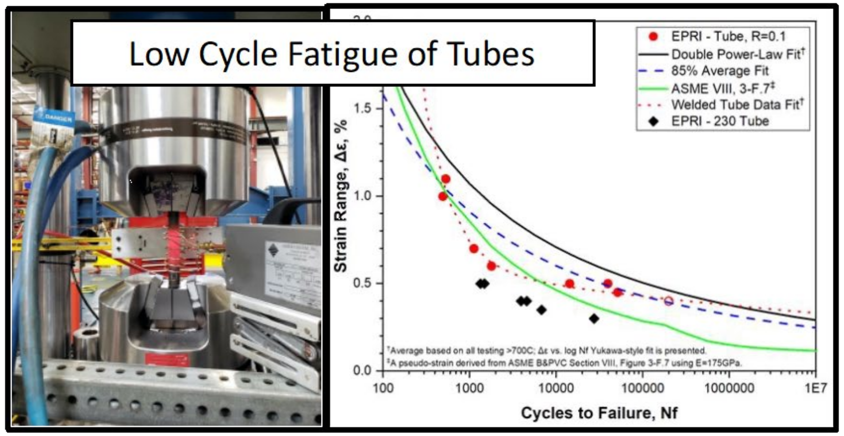


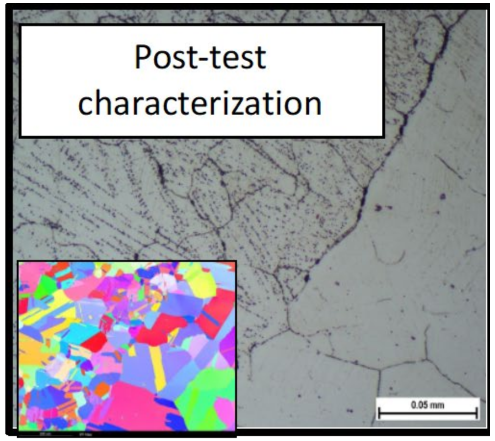


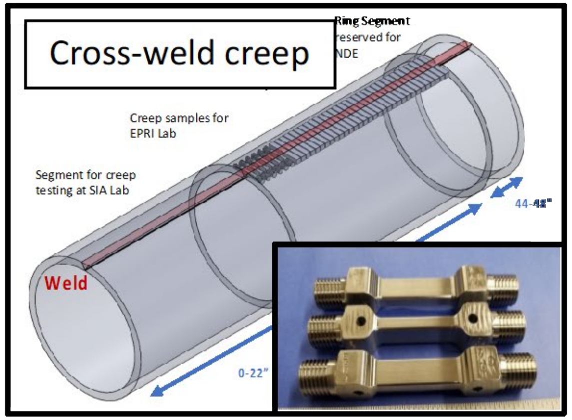
Shaw Swepco GTC Greenville Tube Company RathGibson A PCC Company

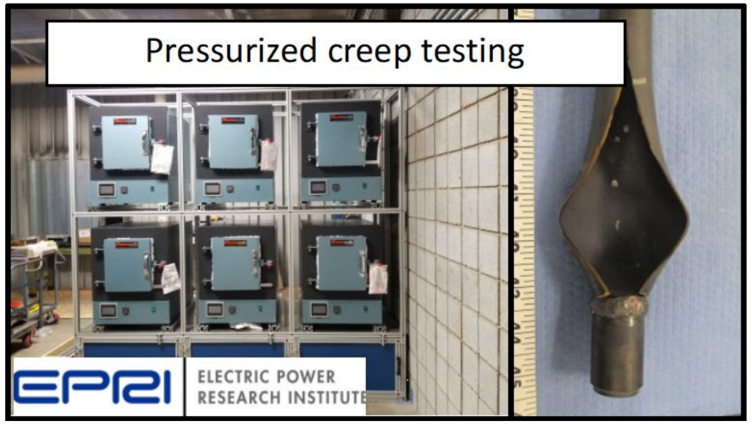
High-Temperature Testing & Analysis

- Relevant testing product forms (welded structures)
- Incorporation into ASME B&PV Code







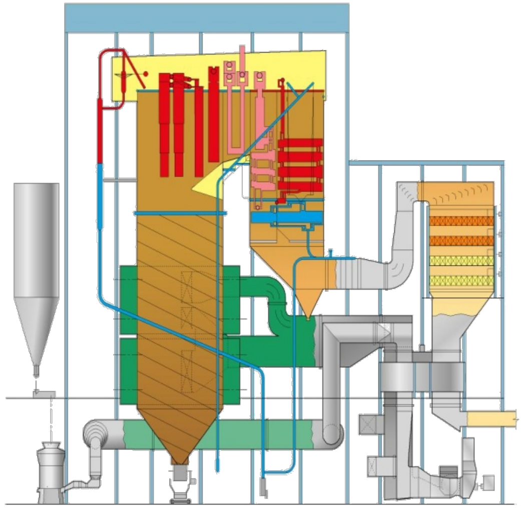


EPRI

A-USC Tasks Completed

- Materials for A-USC Turbines (DOE): (link, link)
- Boiler materials for A-USC (DOE) (final report)

General design studies show favorable economics



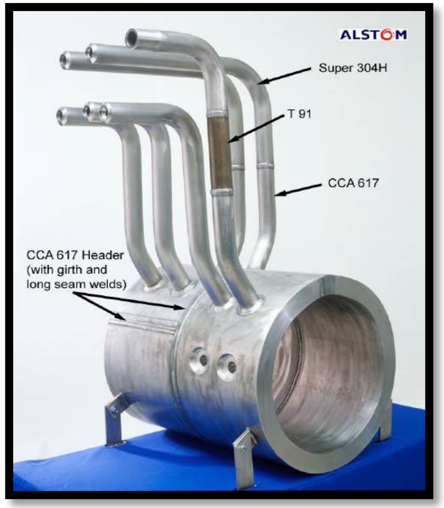
Steam-Side Oxidation

Welding Technology Developments

Fireside Corrosion (In-Plant Testing)

ASME Code Cases approving (Inconel®740H)
Developed collaboratively

Fabrication Processes



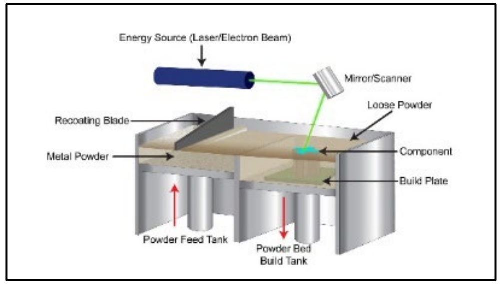
Component Scale-up
World's Largest 282 Casting
(at the time)

Advanced Manufacturing Methods
(in process of demonstration & qualification for fission applications)

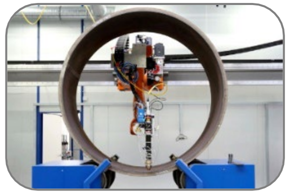
- Powder Metallurgy-Hot Isostatic Pressing: PM-HIP

- Directed Energy Deposition AM: DED-AM

- Powder Bed Fusion AM: L-PBF or EB-PBF

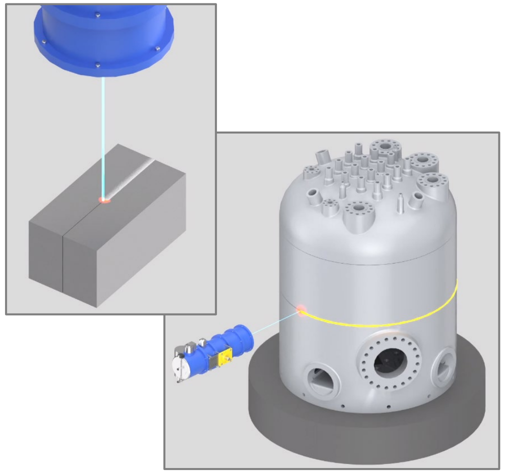


- Advanced Cladding Processes:
  - e.g., diode laser cladding, hot wire laser welding, friction stir additive, cold spray & laser assisted cold spray, PM-HIP



Courtesy of NAMRC

- Electron Beam Welding: EBW
  - For large components (RPVs, SGs, pressurizers, fusion components, etc.)



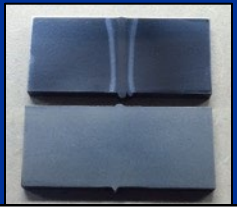
- Other AMMs of interest:
  - Additional advanced welding technologies, cold spray, machining techniques, surfacing technologies

Demonstrations: *Advanced Manufacturing for SMRs*

- Powder Metallurgy - Hot Isostatic Processing
  - Produces near-net shaped components
  - Eliminates 1000’s of hour of machining
  - No welds to inspect
  - Forging: 2-5yr lead time; PM-HIP component produced in 6-12 months
- Electron Beam Welding
  - 10x reduction in typical weld times
  - Demonstrate EBW by fabricating reactor sections
- Diode Laser Cladding
  - Reduces cladding material by > 50%
  - No machining required after application
- **40% Cost Reduction Potential**

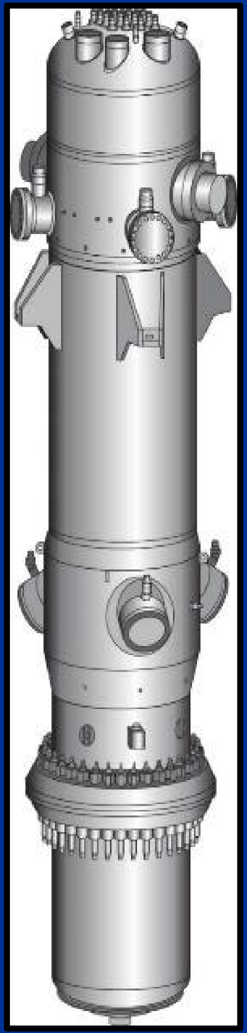
PM-HIP: No Welds!

1.8m Flange & Head Welds: 47 minutes!



$EBW + HT = 0\,Weld$

DLC: no machining

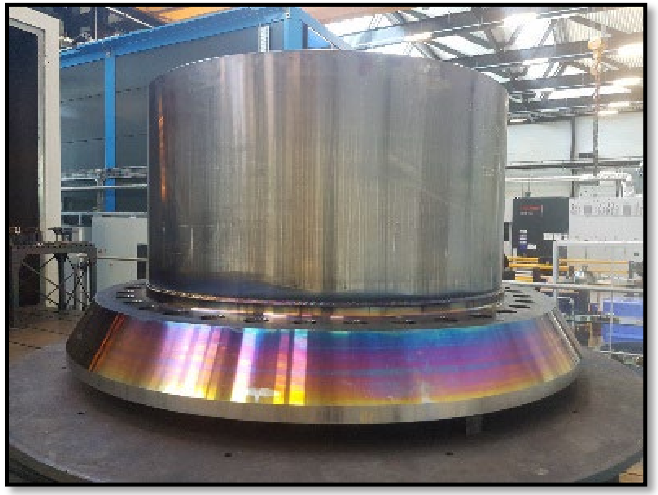


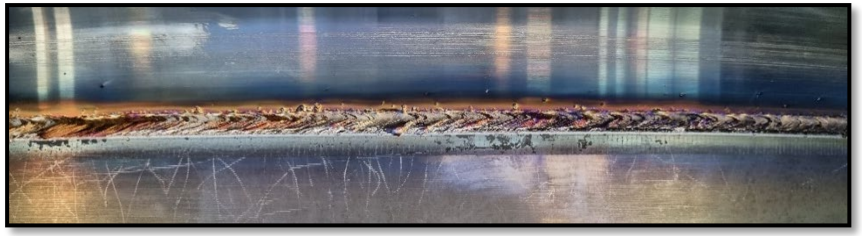
Representative Model of NuScale Power RV

DOE Project DE-NE0008629

Electron Beam Welding – SMR Demonstration

< 60 minutes of welding time for 1.8m diameter vessel weld





Photograph provided courtesy: AMRC

Representative Model of NuScale Power Reactor Vessel

- Completed in a single pass
- 10x reduction in typical weld times
- Up to 50% savings in welding costs
- Potential to eliminate in-service inspection via heat treatment
- No filler metal required
- Minimal heat effected zone

NUCLEAR AMRC

NUSCALE™ Power for all humankind

EPRI

EPRI Supply Chain Workshops for Advanced Energy Systems

June 2022 — 3002025254

Understanding the landscape

- Manufacturing & materials requirements
- Identification of needs/gaps
- Industry 'pinch points'
- Defining EPRI and industry focus

April 2023 — 3002027773

Discussing key issues

- Build collaboration in AES supply chain
- Begin to address key topics:
  - Workforce
  - Supplier capabilities
  - AE/EPC perspective
  - Qualification
  - Codes & standards

Dedicated Fusion Sessions (April 2024 – Sept. 2025)

April 2024 — 3002029870

Focusing on key topics

- How other industries address supply chain
- Role of government
- Advanced manufacturing of large components
  - Energy end-user
  - Existing users
  - Feedstocks
  - AM suppliers

Sept. 2025 — In publication

Driving solutions & expanding the collaborative

- Commercialization progress (e.g EBW)
- More fission & fusion developers & stakeholders
- Codes & standards
- Traditional (cast), advanced (PM-HIP), and evolving (convergent) manufacturers

EPRI Supply Chain Workshops for Advanced Energy Systems

June 2022	April 2023	April 2024	Sept. 2025
3002025254	3002027773	3002029870	Early 2026!
Understanding the landscape	Discussing key issues	Focusing on key topics	Driving solutions & expanding the collaborative
70 attendees	97	95	161
48 organizations	66	56	76
35 presentations	35 + 7 panelists	41	41

Dedicated Fusion Sessions (April 2024 – Sept. 2025)

EPRI

EPRI Fusion Energy Strategic Program R&D

Fusion Energy At-a-Glance

Overview

70 years of public investment in R&D has built a deep understanding of fusion fundamentals and key challenges, but…

- Without ignition or net energy gain
- With increasing scale of fusion machines
- With deep and endemic pessimism

Current State

Evolving fusion landscape warrants a fresh look at technology as a potential/ emergent clean, firm, scalable energy option:

- Accelerating progress in enabling technologies
- Achievement of key milestones…including ignition at NIF!
- $>10B in private sector funding
- Favorable regulation

Outlook

Diversity of fusion concepts and approaches offers many shots on goal.

Government support shifting to private-public partnerships and increasing alignment with commercial endpoints.

Operation of fusion pilot plants by 2040 is emerging as a common target.

EPRI's Role

Leverage core strength:

- Foster understanding and alignment between fusion community & industry
- Enable fusion supply chain via testing and qualification R&D for advanced materials and manufacturing
- Safety-in-design methodology
- Technoeconomic assessment

State of the Fusion Energy Industry

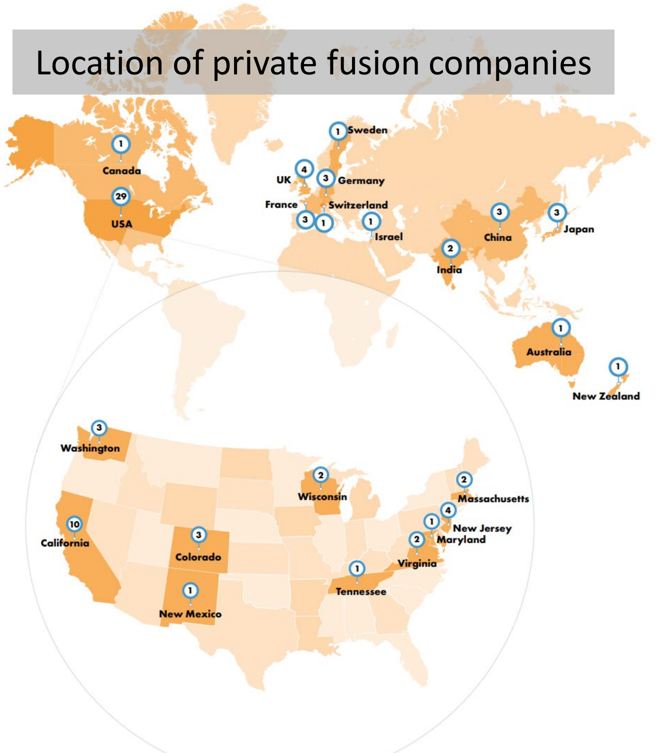
Private sector:

- 53+ companies, diversity of technology approaches
- >$10 billion in private investment
- multiple private fusion developers with $1 billion+
- Many companies planning pilot plants in the 2030s
- Acceleration and accumulation of technical milestones
  - magnets, confinement temperatures, new experiments, major construction projects, AI enabling technology

Public sector:

- U.S.
  - Aligning on R&D priorities and roadmap
  - Launched Fusion Innovation Research Engines
  - Desire to align public program with private industry needs
- International
  - Aligning on regulatory schemes
  - Acceleration of research funding opportunities

Location of private fusion companies



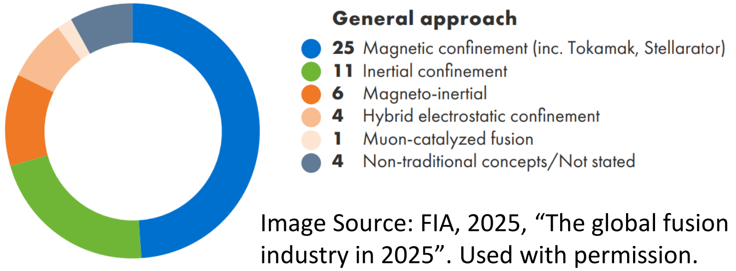
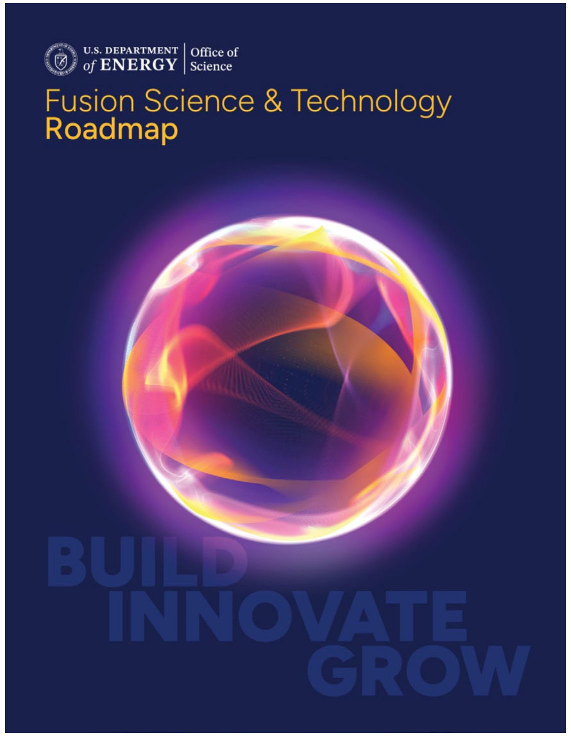


Image Source: FIA, 2025, "The global fusion industry in 2025". Used with permission.



Transition occurring to accelerate development of materials, blanket, fuel cycle, and power plant concepts (R&D beyond plasma physics)

Fusion Role and Benefits

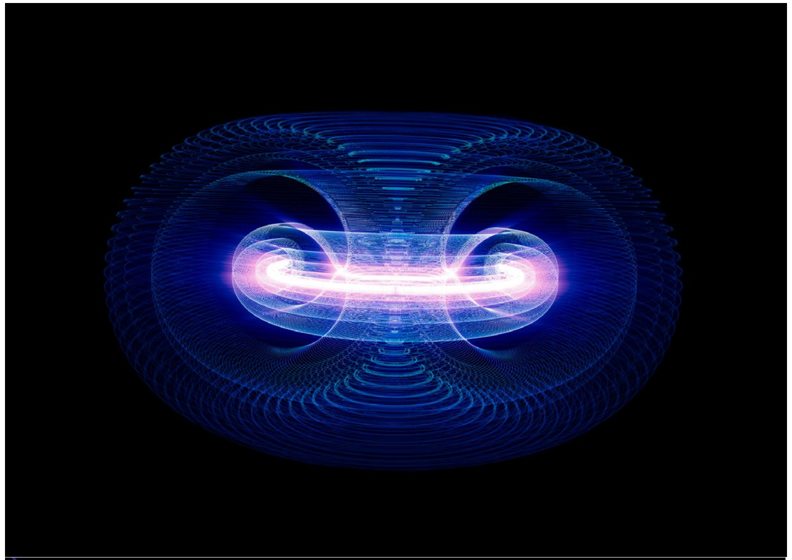
Fusion offers a promising option for firm, non-emitting, scalable energy generation to support resilient, low-carbon energy systems

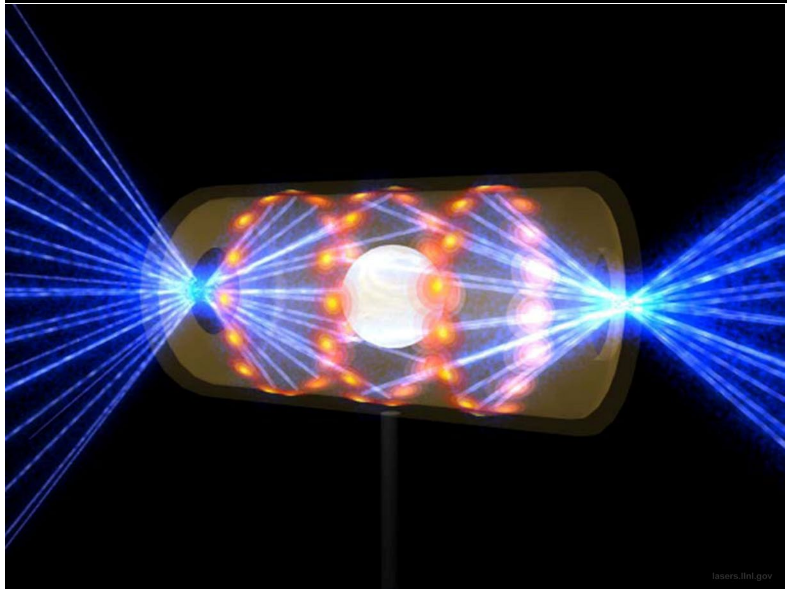
Most concepts are thermal sources and are compatible with existing balance-of-plant technologies

Fusion offers compelling safety benefits:

Driven reactions require external energy + fuel

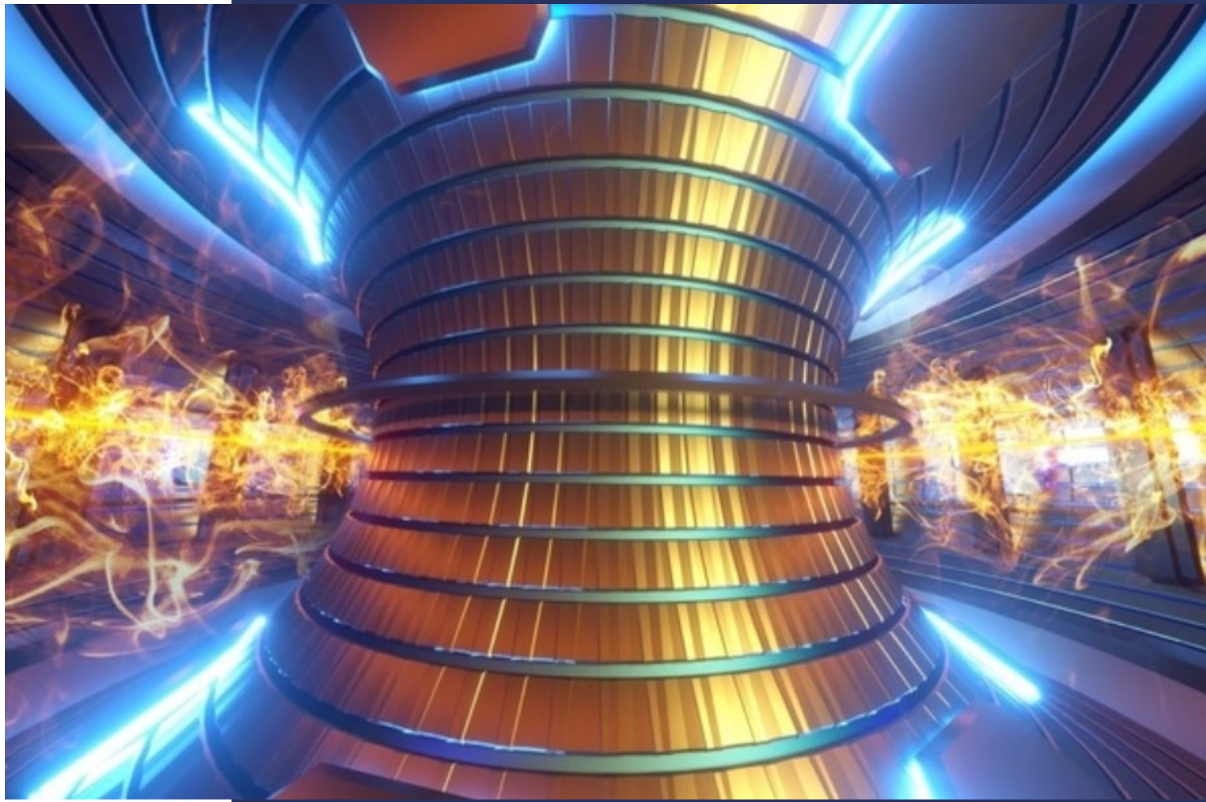
Fusion is hard to initiate and easy to stop.





EPRI Fusion R&D Objectives

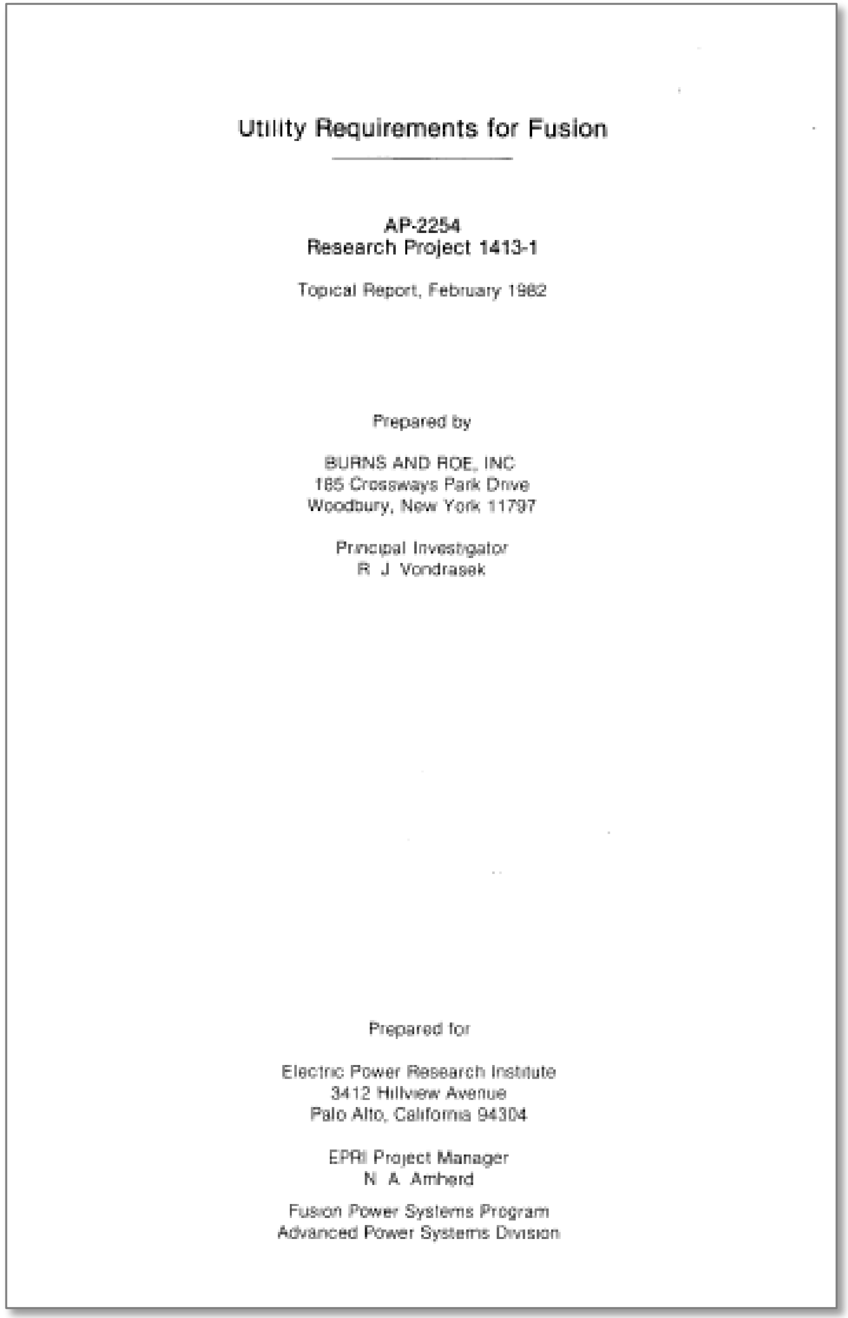
- Inform EPRI and its members on technology, challenges, opportunities
- Provide value to fusion stakeholders through R&D products and resources
- Target broadest benefit for the public interest: safe, reliable, affordable, and sustainable energy generation and delivery



Fusion is not a new topic for EPRI.

- EPRI developed and published utility requirements for fusion in 1982, emphasizing "timeless" criteria for the future:
  - Economics
  - Public Acceptance
  - Regulatory Simplicity

- 10 years <u>BEFORE</u> the Utility Requirements Document for Advanced Light Water Reactors (URD) is published



Utility Requirements for Fusion

AP-2254
Research Project 1413-1

Topical Report, February 1982

Prepared by

BURNS AND ROE, INC
185 Crossways Park Drive
Woodbury, New York 11797

Principal Investigator
R J Vondrasek

Prepared for

Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

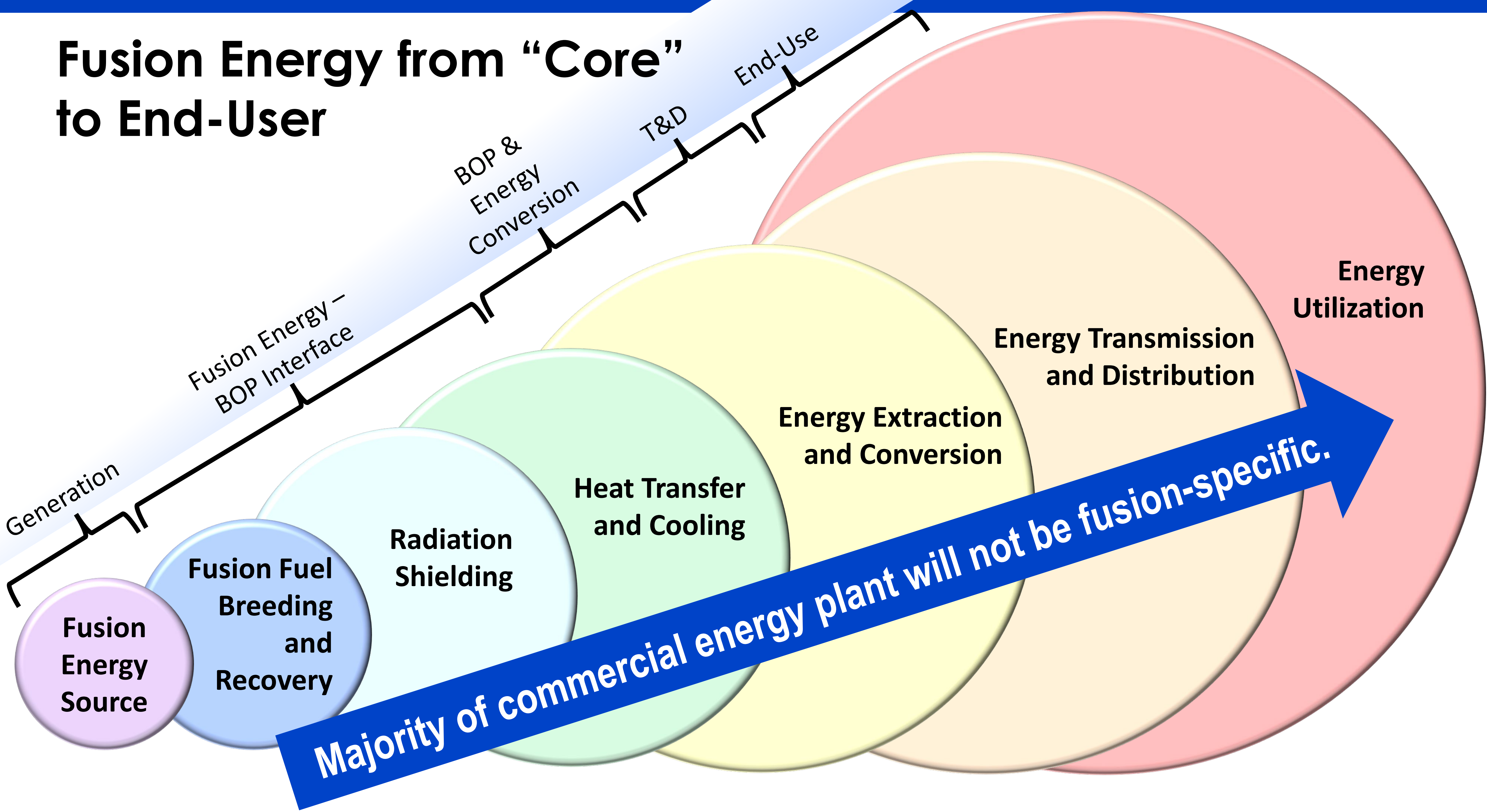
EPRI Project Manager
N A Amherd

Fusion Power Systems Program
Advanced Power Systems Division

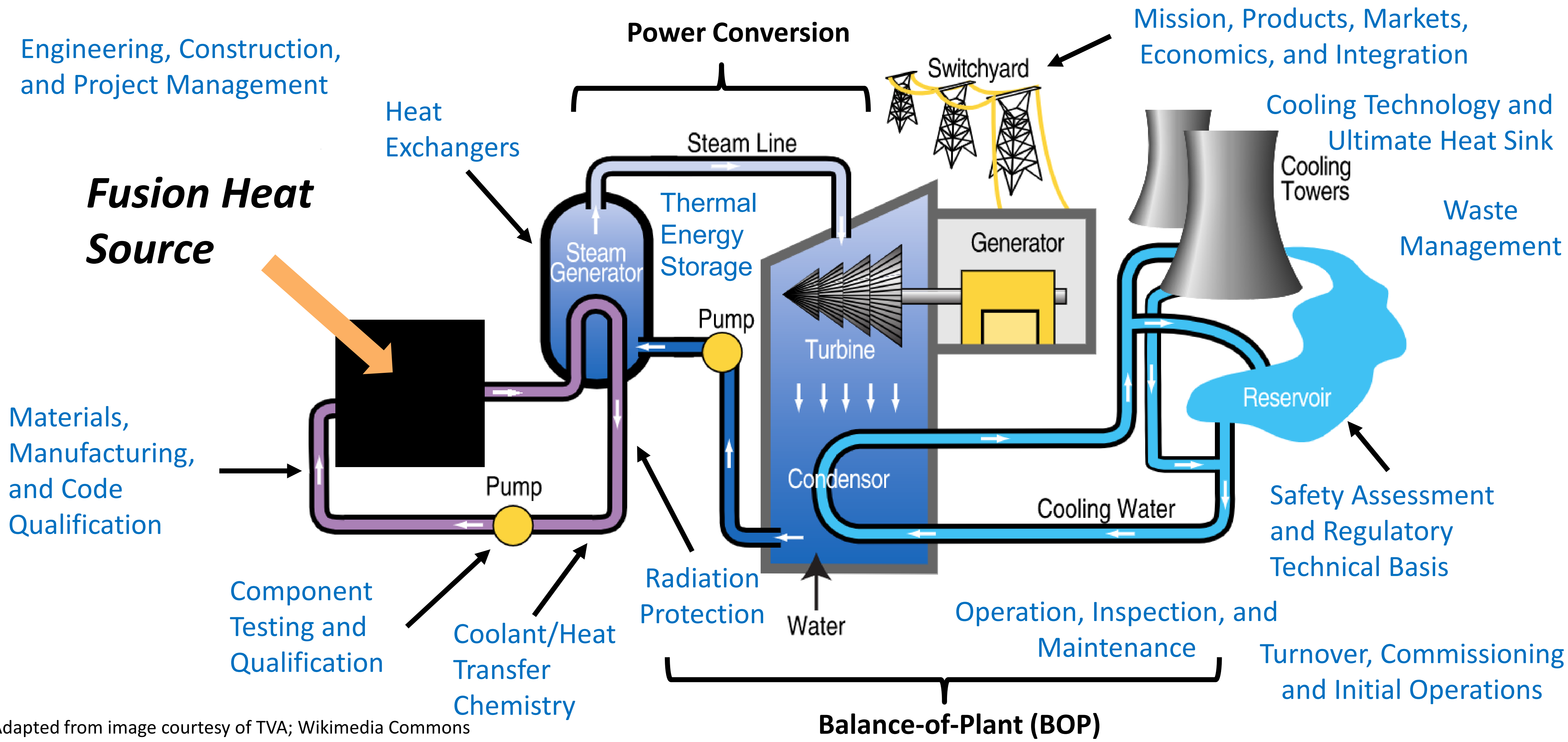
Utility Requirements for Fusion (EPRI AP-2254, 1982). 3002023912.
https://www.epri.com/research/products/000000003002023912

EPRI

Fusion Energy from "Core" to End-User

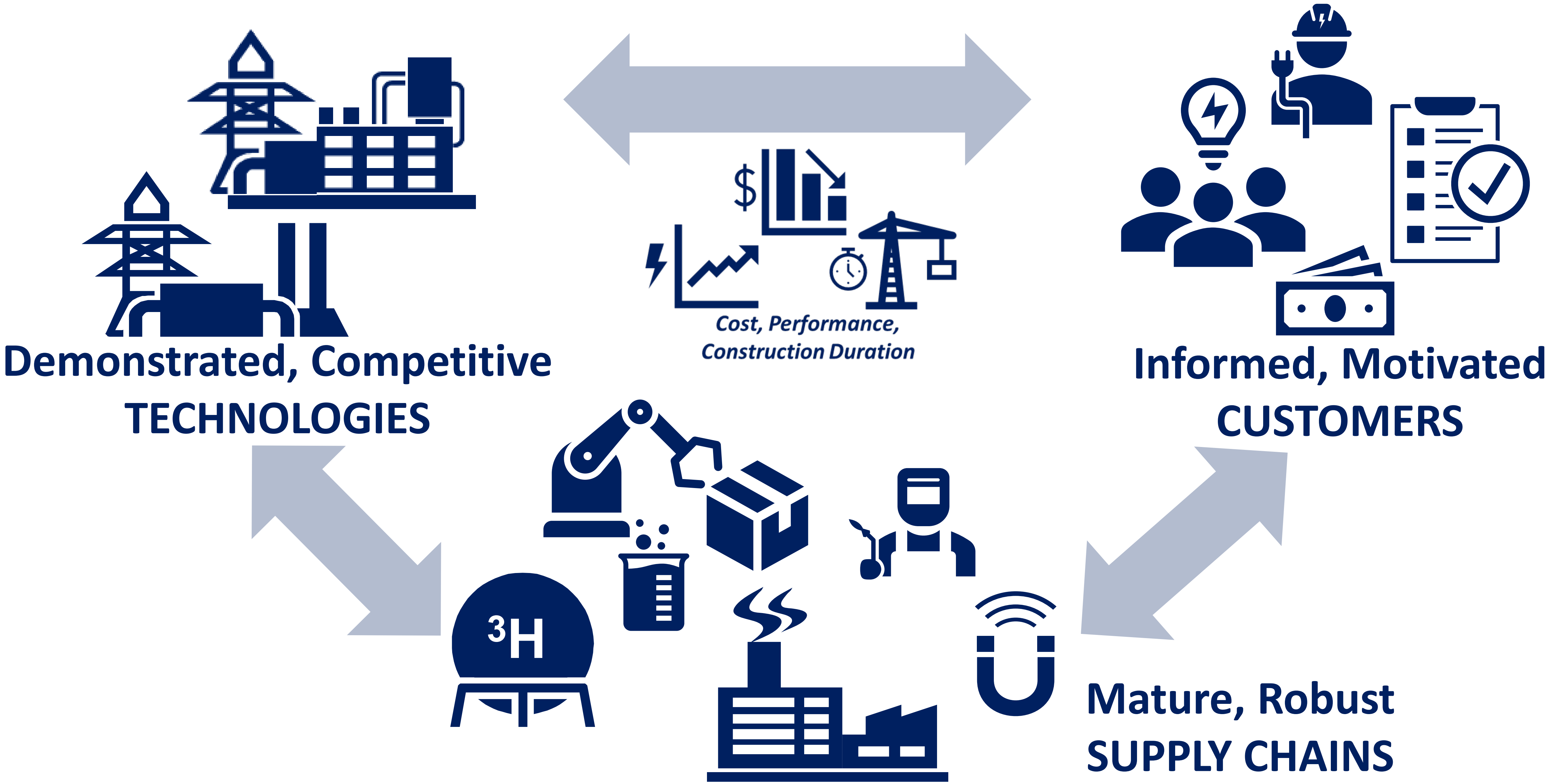


Experience and Expertise from Power Generation Applies



Adapted from image courtesy of TVA; Wikimedia Commons

What will it take to commercialize fusion?



EPRI Strategic R&D Themes

Generation planning & project execution
- Stakeholder education/awareness
- Industry scouting
- Owner-operator requirements
- Siting Guide
- Understanding role of fusion in future energy markets

Design & engineering
- Technical bases for safety cases (Safety in Design)
- Model based systems engineering
- Collecting, curating operational experience for design and assessment

Supply chain development
- Advanced materials and manufacturing
- Fusion codes and standards
- Advanced non-destructive examination & sensors
- Workforce development

NOW

Future

Operations & maintenance
- OE for component reliability
- RIM/RAMI programs
- Plant chemistry
- Grid integration (incl. experimental machines)

Institutional Cross-cut

- Training
- AI/ML/Advanced computing
- Quantum technology

EPRI Fusion R&D Projects for 2026

- Revisiting EPRI Utility Requirements for Fusion (from 1982)
- Fusion Siting Guide

Owner-Operator Requirements & Deployment Considerations

- Fusion Industry Scouting
- Fusion in Utility Capacity Expansion and Resource Planning

Technology and Performance Assessment

- **Non-destructive Examination for Fusion Energy Technologies**
- **Fusion Materials Gap Analysis**
- **Support/inform ASME Sec. III Div 4 Code Development**
- **Investigating materials & component testing capabilities**

Advanced Materials and Manufacturing

- **Safety-in-Design for fusion – methodology body of knowledge (Rev 1)**
- **Safety-in-Design demonstration/pilot for fusion application(s)**

Safety Assessment

- **Tritium Operating Experience (DOE INFUSE Award with SRNL)**

Fuel Cycles

Fusion Commercialization Timeline & EPRI Roles

	R&D	Demo/Pilot	Commercial
	Now	2030+	2040+
Priorities	**Enabling Technology**	**Evidence of Performance**	**Operation**
EPRI Roles	• Materials and manufacturing • Project development and execution (many products)	• Engineering and construction • Commissioning and initial operations • Collecting and curating operating experience	• Operations and maintenance • Inspection/NDE • Waste management

Opportunities accelerate if developers meet their aggressive targets

EPRI Fusion Program Strategy

Programmatic

- TI Fusion Energy Strategic Program 2023 - 2027
- Fusion Planning & Project Execution Supplemental 2026
- One or More Topical Fusion Supplementals 202X +
- Fusion ARP Program 203X

Topical: What are we building towards, what drives funding

- Operating experience user groups
- Maintenance and engineering program for fusion plants
- Workforce training and development
- Non-destruction evaluation (NDE)
- Fusion Materials and Manufacturing for Code Qualification, Materials Testing Collaborative
- Irradiation Technology Evaluation & Demonstration (MIT, U Wisconsin)
- Component Test Loops (FLiBe, Li, Pb-Li) (Cross-cut w/ ANT)
- Plant Chemistry, Rad Protection, Byproduct Matl Management

Big Ideas

- Fusion Materials & Component Testing Capabilities (FPNS+)
- Fusion Centers of Excellence (materials testing, NDE, chemistry)
- MIT PSFC cyclotron
- Commissioning, initial operations, maintenance, repair expertise

EPRI Fusion Forum

- Since 2021, EPRI has hosted representatives from fusion and EPRI communities to share updates on technology milestones and perspectives on commercialization.
- **Join us! The Fusion Forum is open to all who are interested!**

Fusion Forum Goals:

1 Introduce EPRI and its members to the fusion community

Private fusion technology development companies, national laboratories, and fusion trade organizations.

2 Introduce fusion community (and technology) to EPRI and its members

EPRI members exploring emerging technologies and EPRI staff researching common needs for driving innovations towards commercialization.

Fusion Forum materials can be found at https://www.epri.com/fusion

To join, contact Diana Grandas (dgrandas@epri.com) or Andrew Sowder (asowder@epri.com)

Thought Leadership via EPRI's Convening Power

- From September 2022 to January 2026, EPRI has hosted eight (8) major fusion workshops on behalf of the fusion community and US Department of Energy

May 2023 Fusion Fuel Cycle & Blanket Technology Workshop

- Back-to-back workshops organized by fusion community and hosted by EPRI
- Addressed two key technological barriers (fuel cycle and blankets) by:
  - identifying and prioritizing challenges;
  - determining project and infrastructure timelines to achieve them; and
  - generating roadmaps to inform R&D
- Attended by 200 of leading fusion experts

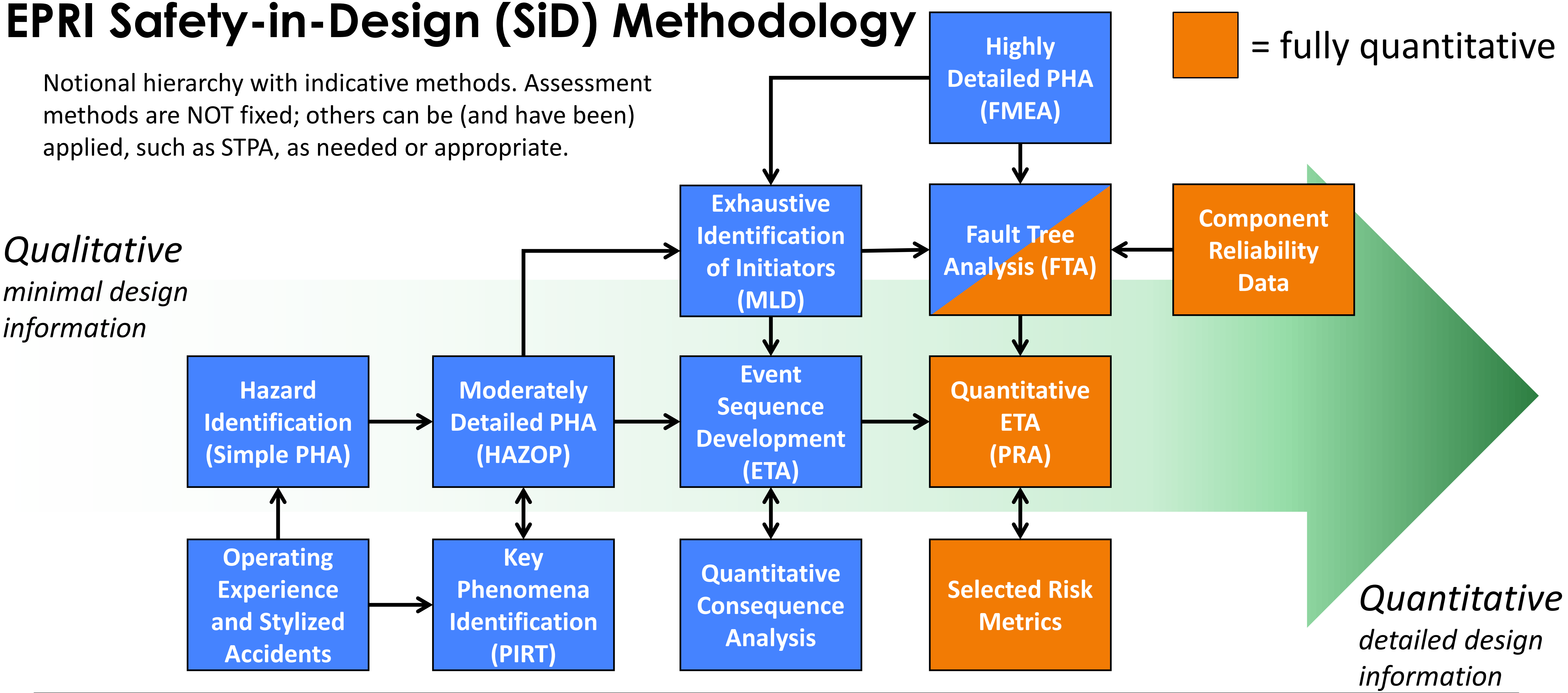
November 2023 Fusion Materials Road Mapping Workshop

- Organized by U.S. Fusion Material Coordination Committee and hosted by EPRI
- Intended to inform the U.S. Department of Energy's Fusion Energy R&D planning and program for materials development
- Product will document roadmaps outlining development needs for fusion materials and capabilities
- Attended by 120 experts

EPRI engagement with and visibility among leading fusion experts, decision-makers.

EPRI Safety-in-Design (SiD) Methodology

Notional hierarchy with indicative methods. Assessment methods are NOT fixed; others can be (and have been) applied, such as STPA, as needed or appropriate.



PHA – Process Hazards Analysis

FMEA – Failure Modes and Effects Analysis

MLD – Master Logic Diagram

FTA – Fault Tree Analysis

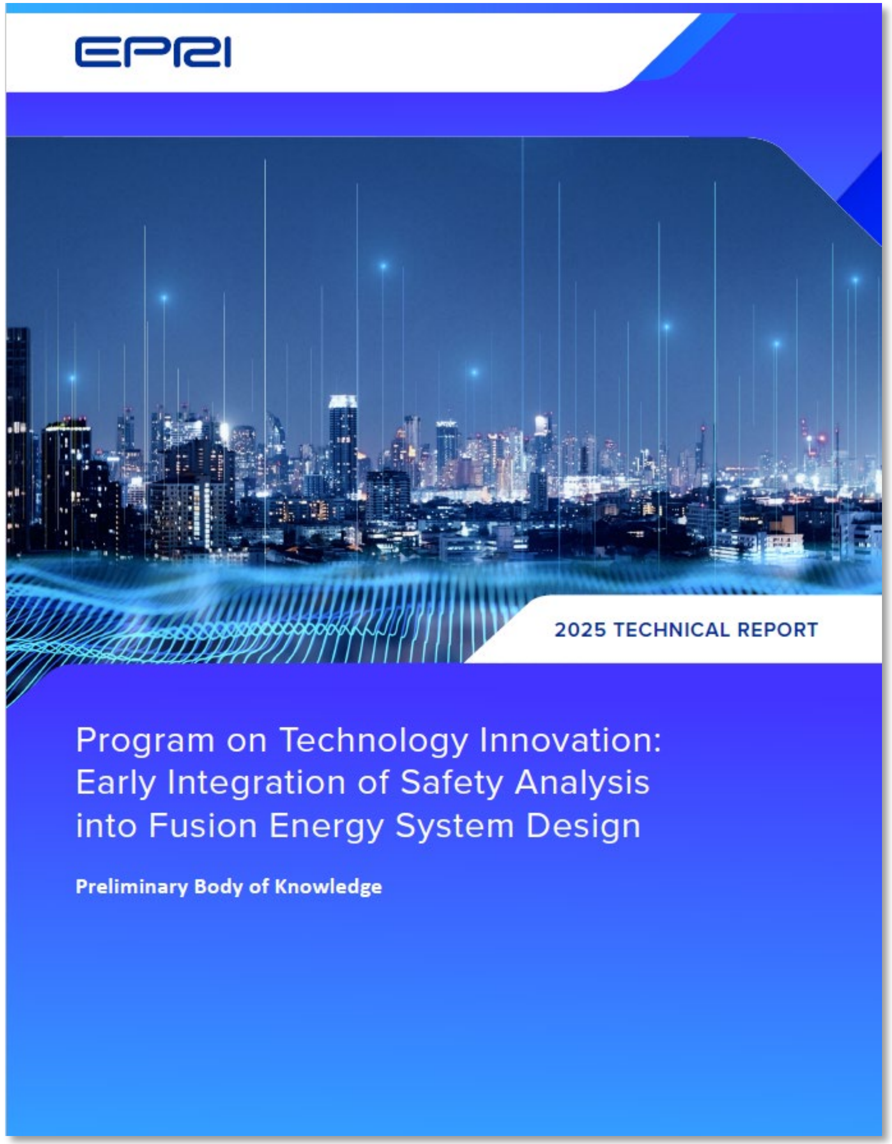
HAZOP- Hazards and Operability [study]

ETA – Event Tree Analysis

PRA – Probabilistic Risk Assessment

PIRT – Phenomenon Identification and Ranking Table

EPRI SiD Body-of-Knowledge (BoK)



- Curated summary of relevant work and experience to date published in 2025
  - Provides an accessible compilation of technical information for early safety and design efforts and stakeholder engagement
  - **Provides a fusion-specific starting point for applying SiD to fusion plants and facilities**
- > 100 articles screened, reviewed
- BoK insights derived from:
  - Public vs. private investment and activities
  - Regulatory engagement and framework development
  - Non-fusion experience with tritium, accelerators, and radioactive material management
  - Fission experience
  - Operational experience from global fusion experiments

https://www.epri.com/research/products/000000003002031117

EPRI Fusion BoK Topic Areas

- **Fusion Technology** provides a brief introduction to the current state of fusion designs, providing an overview and discussion of various systems, with emphasis on those systems shared between design concepts, and their associated hazards.
- **Safety Analysis of Fusion Systems** discusses the methods and results of previous safety analyses that have been conducted for fusion systems.
- **Reliability** introduces the role of the collection and potential use of reliability data in a safety case, and availability evaluations, for fusion power.
- **Non-Fusion Risk Analysis** compiles key safety assessment experience from other facilities—advanced reactors, accelerators, fission fuel cycle facilities, etc.—and discusses their potential applicability to fusion power.
- **Fusion Regulations & Standards** summarizes the status of international fusion regulation, discussing the various approaches that governments are taking to their interactions with their respective domestic fusion industries.
- **Safety, Environment, Fuel Cycle, & Decommissioning** outlines the safety-significant systems within a theoretical fusion plant, with a focus on radiological hazards throughout the plant's entire lifecycle—through decommissioning.
- **Industrial Hazards** discusses the hazards posed by systems and materials in a fusion plant (e.g., magnets, electrical energy, hazardous chemicals) where the extensive experience in other industries may be helpful.
- **Commissioning & Operations** compiles references associated with the available experience commissioning and operating fusion machines in practice.
- **Expert Judgement** introduces the use of expert elicitation in safety assessments, for peer review and informing analysis, on topics with little prior experience.

2024 DOE FES INFUSE Award (with Savannah River National Lab)

Documenting Tritium Operating Experience

Tritium management is an established practice across many industries with many decades of collective operating experience (OE) and lessons learned.

Project Objective: Curate existing information on tritium handling experience to develop a resource for private-sector fusion energy technology developers and regulators. Understand the extent to which tritium may be a hazard and how to appropriately manage risk.

Strategy: Leverage information from existing industrial-scale tritium use-cases to inform practices for fusion facilities.

- Nuclear fission applications/byproducts
- Exit sign/lighting manufacturers
- Defense applications

Image generated using MS Copilot

Approach:

- Engagement with tritium facilities in the US and Canada (initially) as a starting point for a Tritium OE Body of Knowledge
- Development of a common template for document OE
- Atmospheric modeling to assess impacts and site boundaries of potential fusion-relevant tritium releases
- Communication with fusion industry and other key stakeholders

This work is supported in part by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences under INFUSE 2024 Award "Building a Tritium Facility Operating Experience Body of Knowledge to Support Commercial Fusion Power Plant Safety Case Development and Licensing" (CR-24-005)

Documenting Tritium Operating Experience: Current Status

Tritium OE Database

- Project team sourcing information on historical tritium release events from:
  - Public databases:
    - NRC ADAMS
    - CNSC databases, including CNL reports
    - DOE Occurrence Reports
    - Tritium exit sign manufacturers
  - Discussions with individuals at relevant operating facilities
- Fusion relevant events being analyzed for event description, release quantity, dose received, event impact, and corrective actions

Atmospheric modeling

- Illustrating bounding cases for tritium release scenarios subject to various environmental and atmospheric conditions.
- Investigating downwind doses and distances to various dose limits
- Parameterizing scenarios based on total tritium quantity released and oxidation ratios at various locations
- Lower quantity release scenarios to correspond with more “typical” release in plant operation scenarios.

This work is supported in part by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences under INFUSE 2024 Award “Building a Tritium Facility Operating Experience Body of Knowledge to Support Commercial Fusion Power Plant Safety Case Development and Licensing” (CR-24-005)

1982 EPRI Utility Requirements for Fusion

Describes, defines, and assesses the relative importance of utility requirements associated with selection of fusion options.

- Requirements defined (with factors and metrics)
- Requirements refined via questionnaire mail survey sent to 100 utilities, manufacturers, architect engineering firms. 43 respondents.


This product has been made available again from the EPRI archives for reference purposes only. It has not undergone any additional reviews to assess quality or accuracy.

Utility Requirements for Fusion

AP-2254
Research Project 1413-1

Topical Report, February 1982

Prepared by

BURNS AND ROE, INC.
185 Crossways Park Drive
Woodbury, New York 11797

Principal Investigator
R. J. Vondrasek

Prepared for

Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

EPRI Project Manager
N. A. Amherd

Fusion Power Systems Program
Advanced Power Systems Division

Final set 23 of requirements ranked from “vital” to “slightly important”. Requirements determined to be “unimportant” were eliminated.

Vital	Very Important	Important	Moderately Important	Slightly/Not Important
•Plant Capital Costs •Financial liability •Plant safety •Licensability	•Outage Rates •Plant Construction Time •Flexibility of Siting •Waste Handling and Disposal •Plant Operating Requirements •Plant Maintenance Requirements •Electrical Performance •Hardware Materials Availability •Industrial Base (supply chain readiness) •Fuel and Fertile Material Availability	•Plant Operating, Maintenance, and Fuel Costs •Plant Life •Decommissioning •Weapons Proliferation •Startup Power Requirements	•Unit Rating •Capability for Load Change •Part Load Efficiency •Minimum Load	•None rated Slightly Important (indicates conservatism and importance of non-cost-of-energy issues) •Unimportant & dropped (all captured in other requirements): •Plant Efficiency •Dependence on Other Systems •Natural Resource Requirements

Utility Requirements for Fusion (EPRI AP-2254, 1982). EPRI, Palo Alto, CA: 1982. 3002023912.

2026 Update: Fusion Owner-Operator Requirements

- **Motivation:** Significant growth of fusion industry coupled with energy system transformation prompts need to refresh alignment between fusion developers and potential future owner-operators

- **Methodology**
  - Engagement with utility members and large energy end-users (e.g., hyperscalers) via interviews over Summer and Fall 2025
  - Results reviewed with EPRI Technical Stakeholders Meeting in October 2025
  - Interviews continue
  - July 2026 workshop to review and finalize content
  - Revision to be published in December 2026

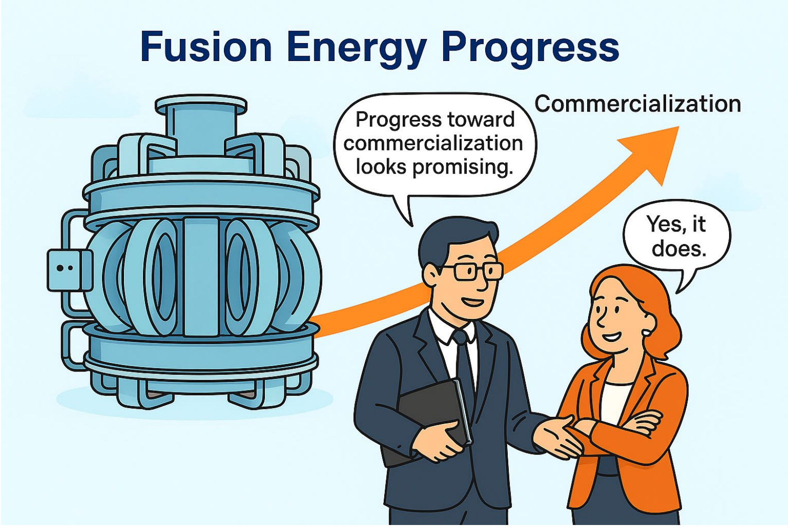


Image generated using MS Copilot

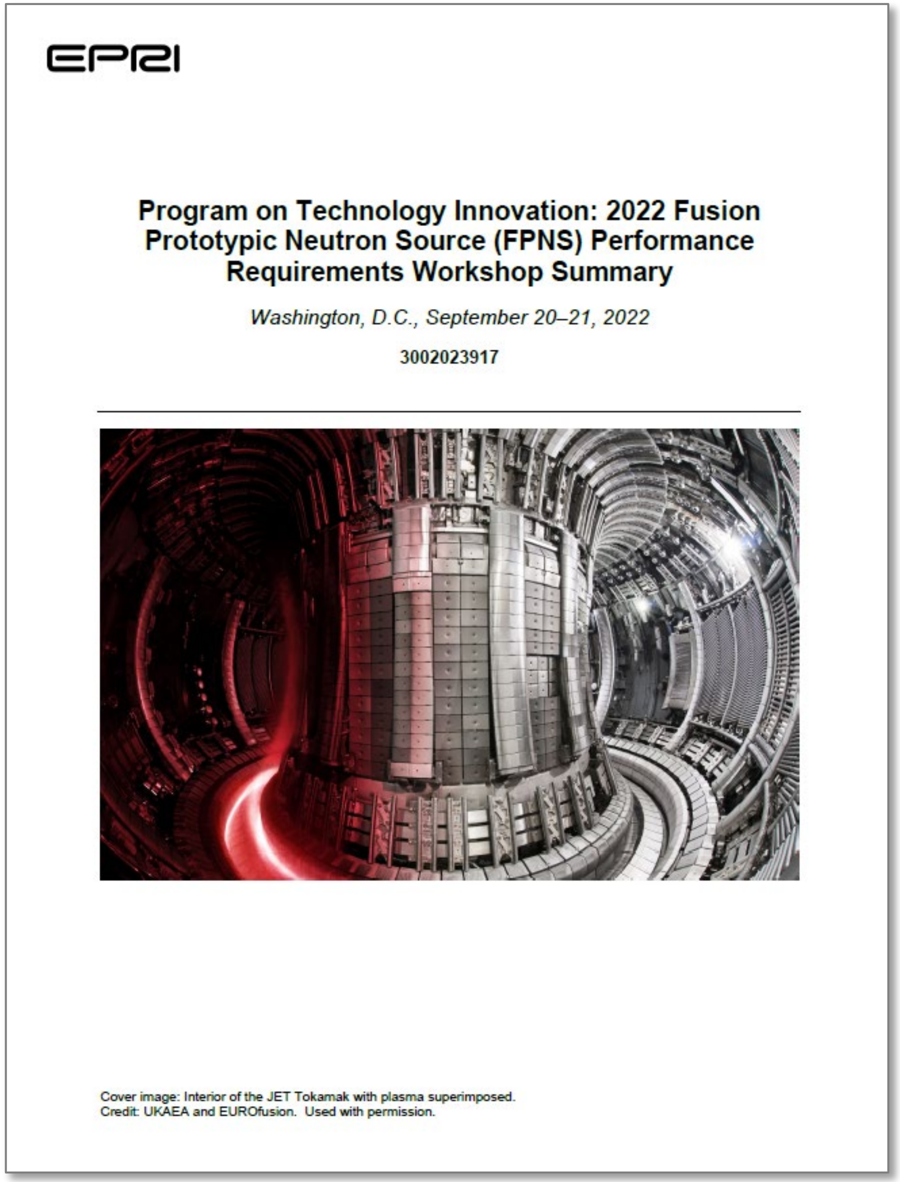
Fusion Irradiation Infrastructure

2022 Workshop on Fusion Neutron Source Requirements

- Commercial fusion plant will require structural and plasma-facing materials with dimensional stability and resistance to fusion neutron degradation
  - Data from existing neutron irradiation sources are relevant for material performance at lower neutron energies, but…
  - **Data lacking for fusion neutron energies (14 MeV) and damage rates (10's of dpa)**

- EPRI-hosted workshop produced industry consensus around need for a fusion prototypic neutron source (FPNS)

- Supports U.S. administration's *Bold Decadal Plan for Fusion* and sustains momentum for a path to commercial fusion energy


EPRI

Program on Technology Innovation: 2022 Fusion Prototypic Neutron Source (FPNS) Performance Requirements Workshop Summary

Washington, D.C., September 20–21, 2022

3002023917

Cover image: Interior of the JET Tokamak with plasma superimposed.
Credit: UKAEA and EUROfusion. Used with permission.

EPRI Partnership with MIT on Fusion Material Irradiation

- EPRI grant funding supports construction of MIT's Schmidt Laboratory in Nuclear Technologies (LMNT)
- Uprated commercial cyclotron offers near-term capability in absence of a fusion prototypic neutron source for material testing
- Next steps: EPRI to participate in R&D to correlate proton and neutron irradiations and establish optimal operating parameters
- EPRI also industry advisor on MIT FIRE project
- **Future: Potential role for EPRI to administer user group for commercial access to facility**

MIT News

ON CAMPUS AND AROUND THE WORLD

New facility to accelerate materials solutions for fusion energy

MIT Plasma Science and Fusion Center to establish the Schmidt Laboratory for Materials in Nuclear Technologies.

Julianna Mullen | Plasma Science and Fusion Center

June 9, 2025

Prototypical material irradiation data are hard to come by and key to commercialization.

FIRE Collaborative With University of Wisconsin-Madison: Fusion Neutrons for Integrated Blanket Technology Development Through Advanced Testing and Design

- **Collaborative Goal:** development and validation of integrated blanket technology in prototypical environments, particularly under the irradiation of 14 MeV D-T neutrons and with high-magnetic fields

- **Task Groups:**
  - Tritium Breeding
  - Lead-Lithium cooling and performance under magnetic fields
  - Advanced manufacturing and testing of blanket materials
  - **Volumetric Neutron Source (VNS) development and deployment considerations**

- **EPRI Role:**
  - **Define functional requirements for VNS, investigate siting and deployment considerations for VNS, and launch initial efforts to establish VNS deployment consortium**

Image: WHAM facility at UW-Madison/Realta Fusion. Used with permission

- **Participants**: UW-Madison, MIT, SHINE, Realta Fusion, EPRI, Rockwell Automation, UIUC, LLNL, UNM, ANL, PPPL

EPRI Global Engagement and Strategy for Fusion

EPRI Global Fusion Strategy

- National R&D policy shifts to more industry-centric role in fusion offer increasing opportunities for public-private partnerships

- Converting engagements into collaborations:
  - Canada: OPG, CNL, Fusion Fuel Cycles, Inc.
  - UK: UKAEA, U. Birmingham, U. Sheffield/AMRC, Tokamak Energy
  - Japan: Kyoto Fusioneering, J-Fusion, National Institutes for Quantum Sciences & Technology (QST)

EPRI Japan Workshop on Fusion Energy Technology

Organized in collaboration with Kyoto Fusioneering (KF)

Tuesday, 20 May 2025. 1300 – 17:30 hrs

EPRI Global Fusion Strategy

- National R&D policy shifts to more industry-centric role in fusion offer opportunities for public-private partnerships

- Converting engagements into collaborations:
  - Canada: OPG, CNL, Fusion Fuel Cycles, Inc.
  - UK: UKAEA, U. Birmingham, U. Sheffield/AMRC, Tokamak Energy
  - Japan: Kyoto Fusioneering, J-Fusion, National Institutes for Quantum Sciences & Technology (QST)

- Leveraging UK Center for Doctoral Training funding at U. Birmingham for participation on <u>four</u> Ph.D. fusion materials projects

- Funded participation on UKAEA-led project w/ Tokamak Energy, ATI, U. Birmingham on accelerated qualification of vanadium alloys for fusion (***completed March 31, 2026***)

- Collaborating with OPG and CNL on tritium safety OE to support USDOE funded INFUSE award with Savannah River National Lab

Advanced Materials and Manufacturing

Focus on Materials, Manufacturing, and Supply Chains

Advanced Materials | Manufacturing Methods | Modern Codes & Standards

- Improved or new materials/alloys and manufacturing methods are needed
- Development of nondestructive evaluation (NDE) methods is integral to material and manufacturing development (not as an after-thought)
- Fusion irradiation infrastructure for testing material/component performance is lacking
- Supply chains needed for scaling of fusion take years to establish
- Fusion-specific codes and standards (C&S) are most relevant for informing and supporting supply chain development (vs. safety and regulation)
  - Existing commercial codes and standards likely adequate for fusion demonstrations and pilot plants

1 — Develop Testing and Qualification Methodology

- Common approach for fusion material and component qualification

2 — Mature Codes and Standards Framework

- ASME Sec. III Div. 4
- ASTM Standards
- AWS (welding) Standards

3 — Demonstrate Qualification Process

- Industrially-produced materials (3-heats)
- Defined manufacturing processes
- Relevant forms/geometries

EPRI

EPRI Fusion NDE Activities

- Development of nondestructive evaluation (NDE) methods is integral to material and manufacturing development (not as an after-thought)
- 2023: Fusion Device NDE Scoping Study
- 2025: Statistical Process Control (SPC) Chart Development
  - provide criteria for manufacture and operation of key components in fusion devices (what to look for using NDE)
  - nearer term: reduce supply chain bottlenecks by streamlining optimization of manufacturing processes
  - longer term: support development of aging management programs (AMPs) and Issue Management Tables (IMTs) for fusion
- 2026: Fusion NDE Supplemental Project offering

TOGETHER...SHAPING THE FUTURE OF ENERGY®

www.epri.com