Commercial Pathways and Supply Chain Readiness for Fusion Technologies

Role of Qualification and Codes and Standards

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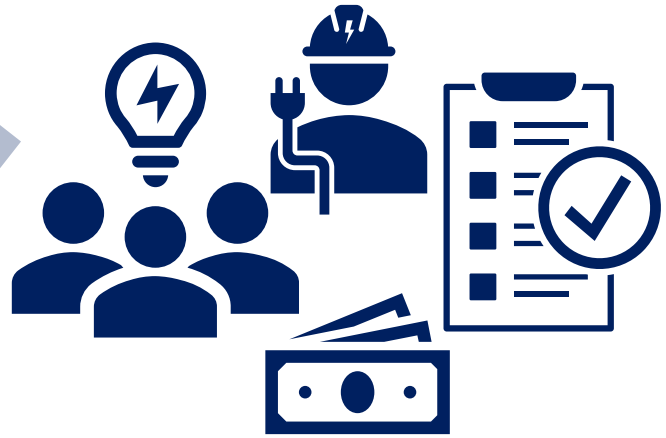
ASME BPV Section III Division 4 Workshop

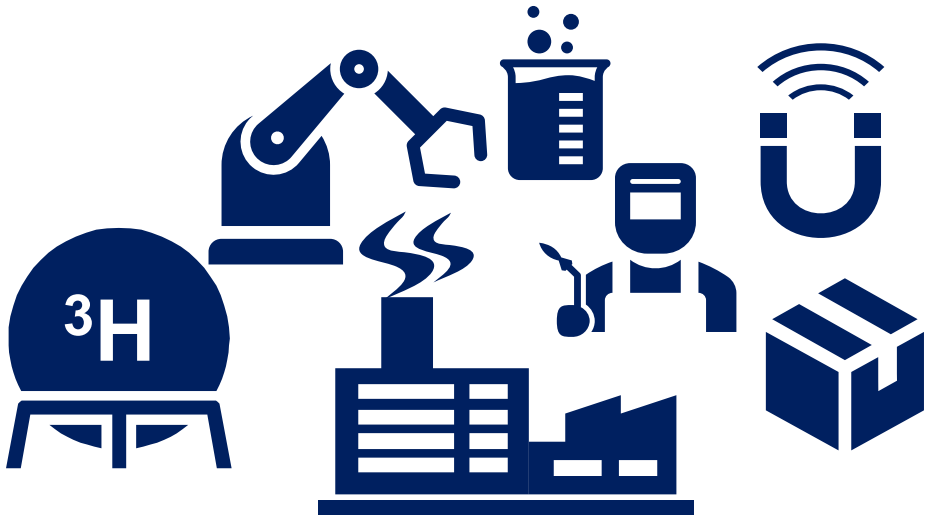
What will it take to commercialize fusion?

Demonstrated, Competitive
TECHNOLOGIES

Cost, Performance, Safety,
Construction Duration



Informed, Motivated
CUSTOMERS

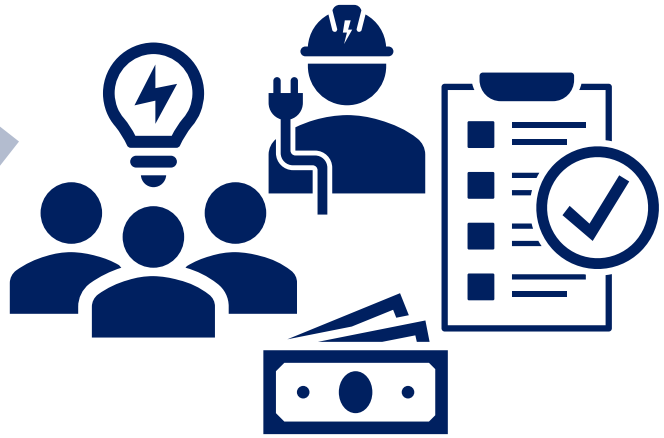


Mature, Robust
SUPPLY CHAINS

What will it take to commercialize fusion?

Demonstrated, Competitive
TECHNOLOGIES

trust,
confidence,
understanding



Informed, Motivated
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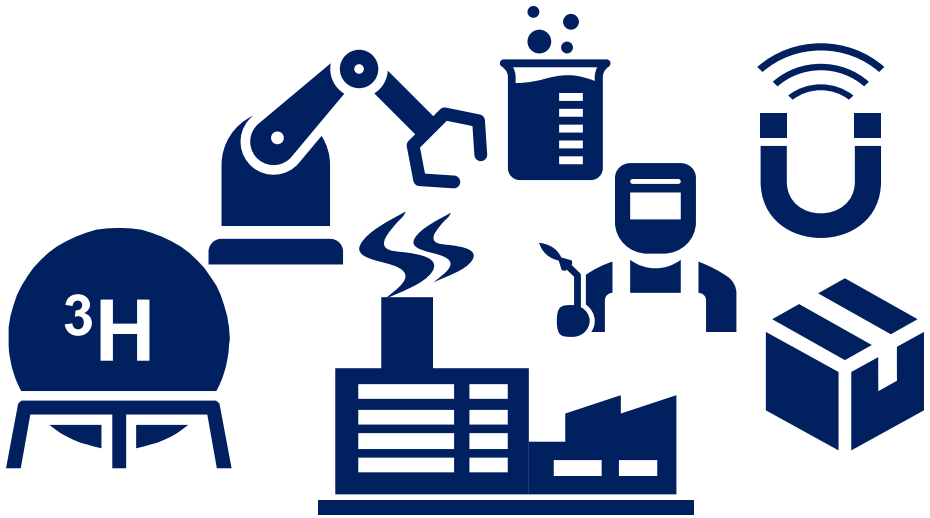
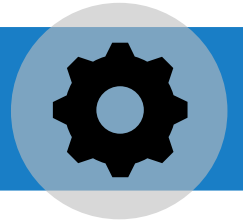


Mature, Robust
SUPPLY CHAINS

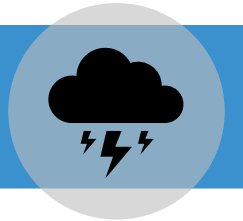
Common Challenges for Advanced Energy Systems

Code qualification



- Significant time & resources to qualify materials & methods

Environmental effects



- Performance with irradiation, corrosion & compatibility issues

Materials management

- Key data, monitoring & NDE for reliable, economic operation

Supply chain

- Informed & capable suppliers for production of materials & components

Establishing New Supply Chains Can Take Decades

- Can suppliers provide materials and components…
  - of quality
  - on timelines
  - at scales

  …needed?
- Are they willing to?
- At what price?

- Change materials, manufacturing methods, components, quality, timelines, or scales?
  A new supplier may be needed.

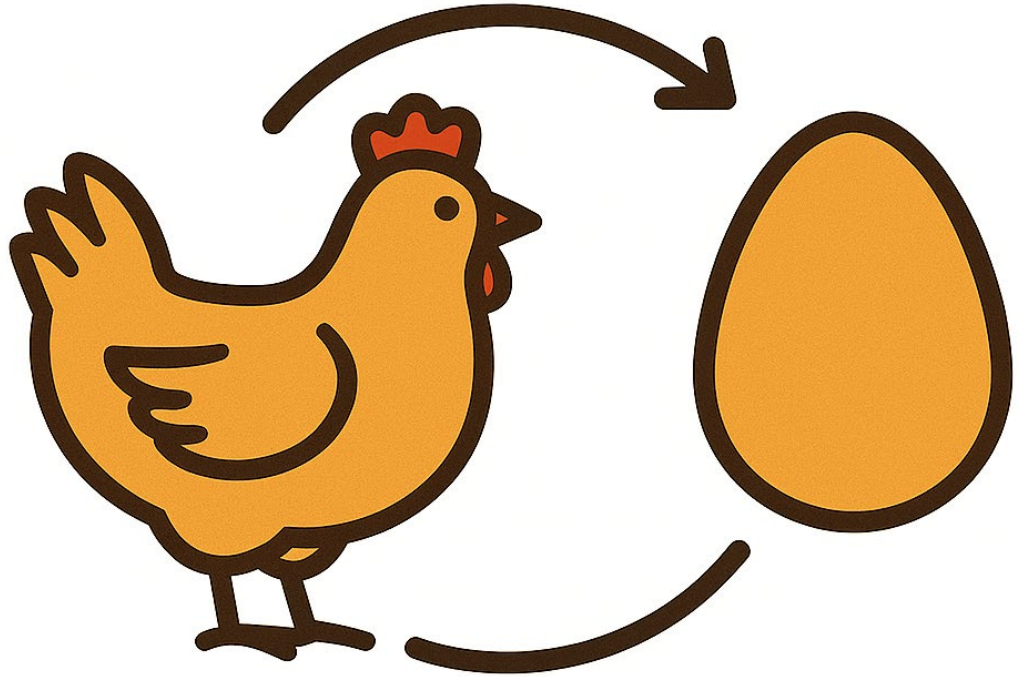
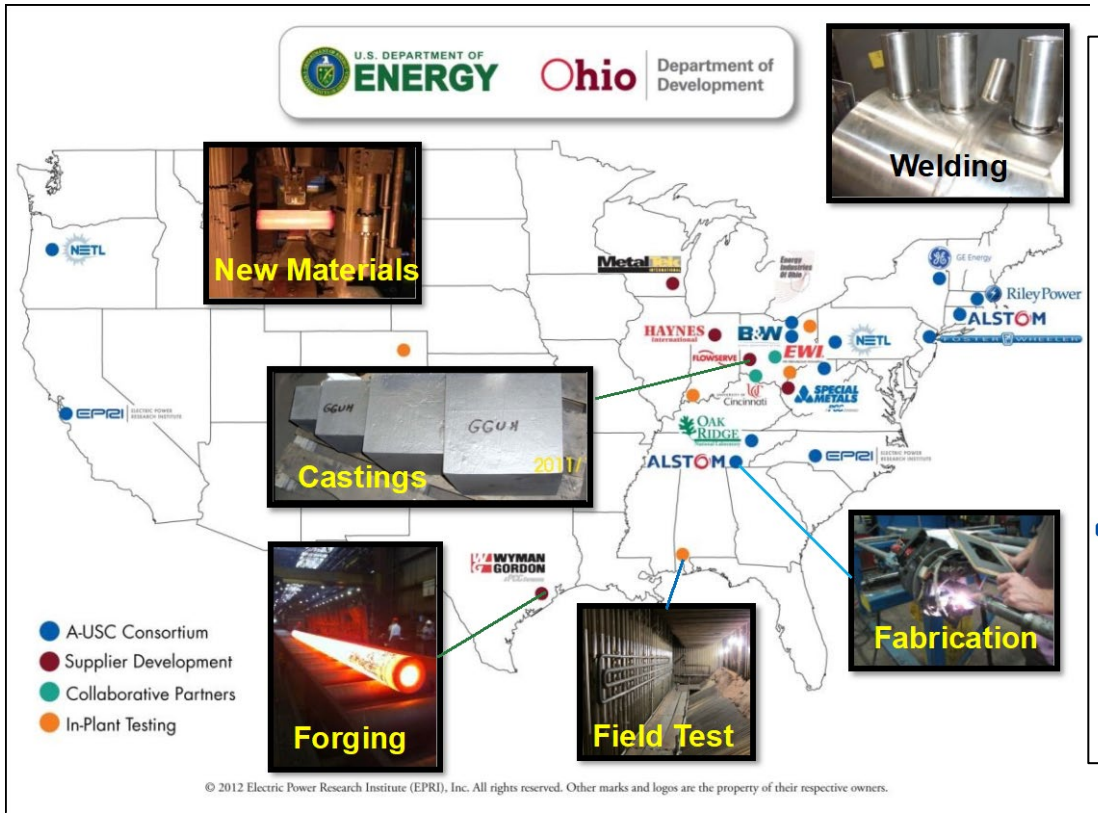
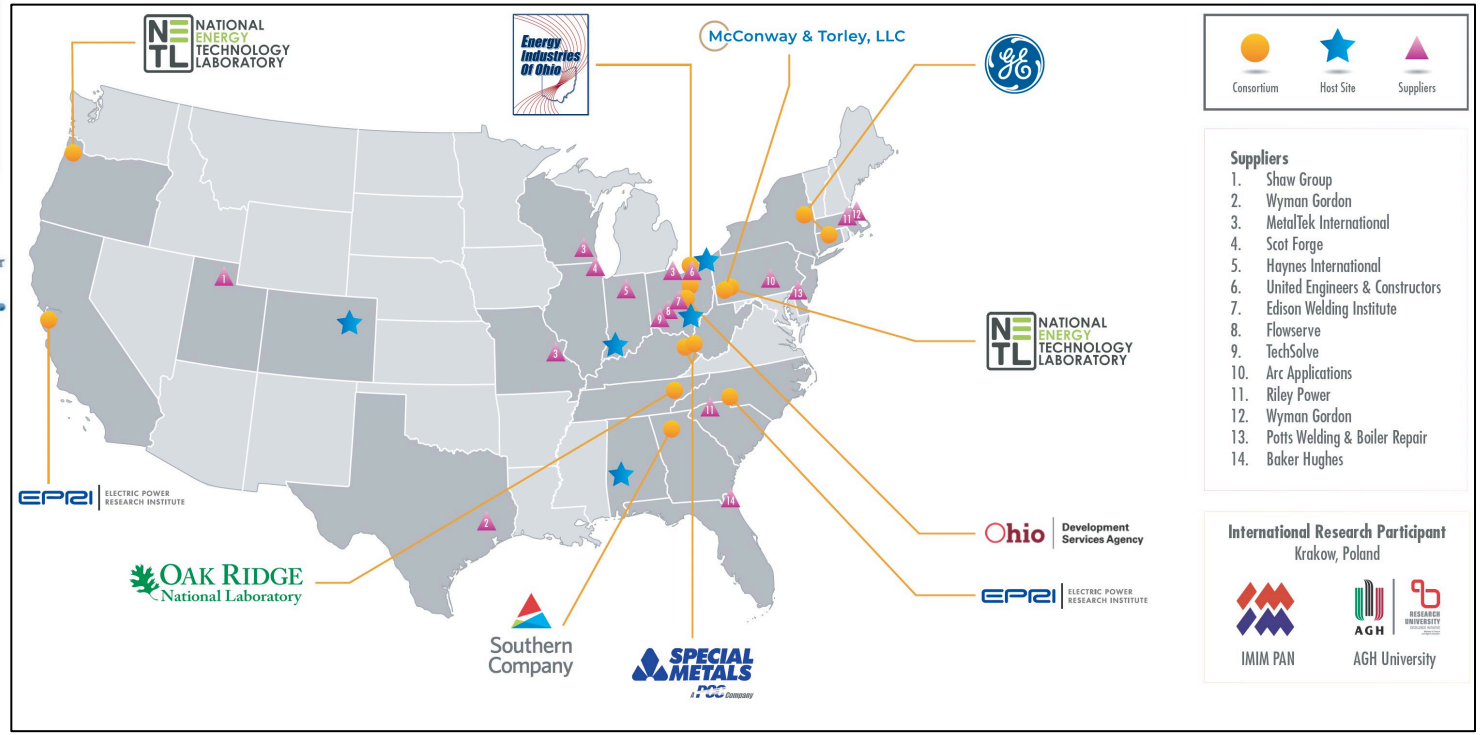


Image generated using MS Copilot

Example: Establishing supply chain for Ni superalloys
Advanced Ultra-Supercritical (A-USC) Component Test Project (ComTest)

- Technology challenge: construction and operation of A-USC power plant for 760°C steam
- Approach: 20-year industrial consortium led by Energy Industries of Ohio and EPRI, supported by U.S. Department of Energy and Ohio Coal Development Office
- Outcome: development of a qualified supply chain for commercial scale manufacture of nickel superalloy





*DOE Contracts: DE-FG26-01NT41175, DE-FE0000234; OCDO Grants: CDO-D-05-02(A), CDO-D-05-02(B)

Supply chain needs evolve with technology maturity

- R&D to demonstration (Prototyping & Validation):
  - Need for agility, flexibility, and close collaboration between developers and suppliers
  - Linear chains utilizing more localized and/or specialized suppliers for rapid iteration
  - Prioritizing of technology validation and design maturity over cost or efficiency

- Early commercialization (Scaling & Production):
  - Need for cost reduction and higher volume production
  - Multi-sourcing improves resilience and avoids single vendor dependencies

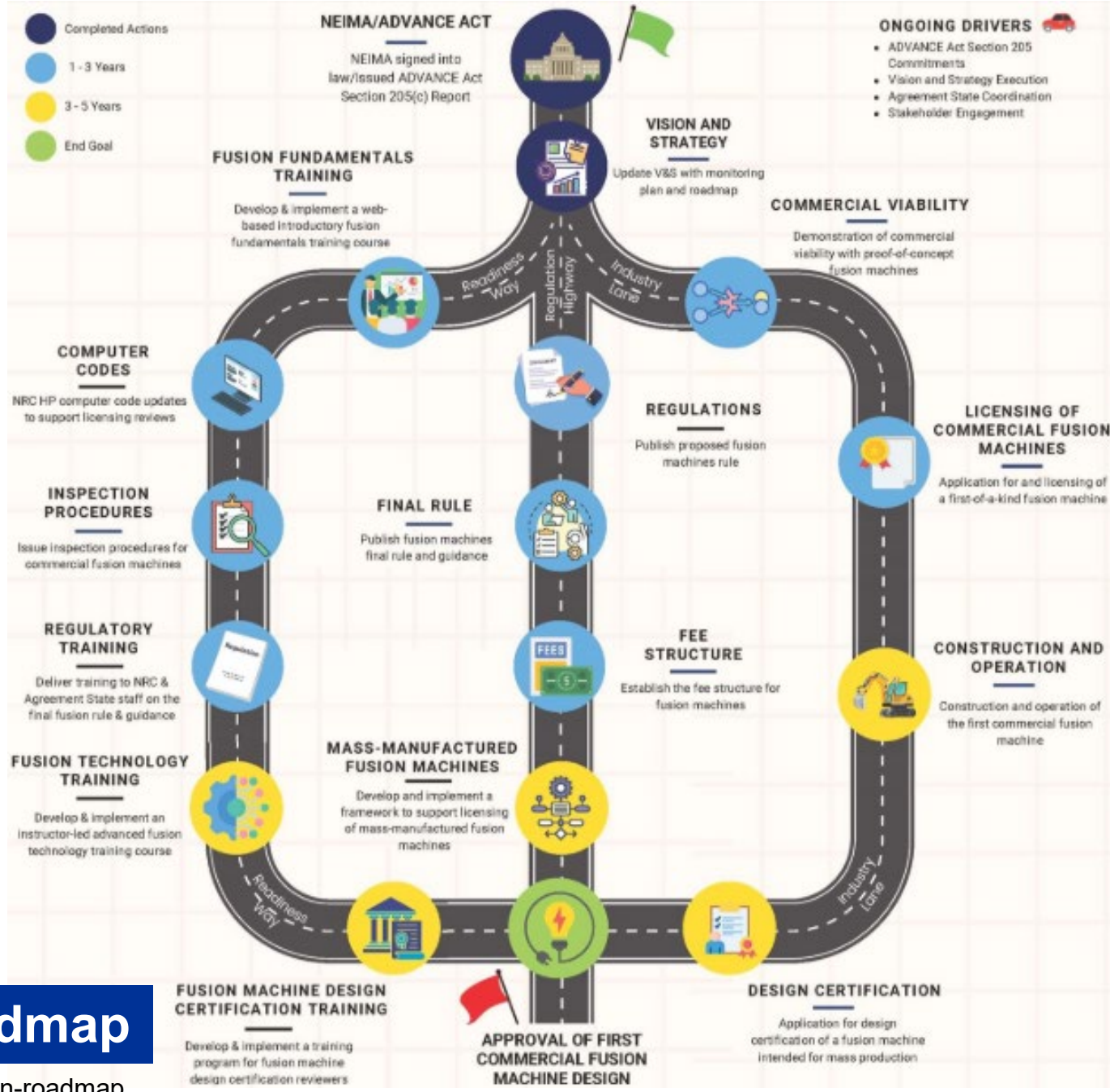
- Fleet deployment in mature markets (Optimization):
  - Need for efficient, sustainable, rapid manufacturing
  - Shift toward regional sourcing and shortening supply chains to enhance stability, minimize delays, and maximize scaling

CustomPartNet, https://www.custompartnet.com/library/procurement/supplier-selection

Regulatory drivers for qualification vary by framework and jurisdiction

- Material-based nuclear/radiological safety regulation (e.g., U.S. 10 CFR Part 30) may not explicitly require material qualification
  - Need for qualification appears later in concert with streamlined licensing

- **NOTE: codes and standards are often mandated at state/regional and local levels for public, worker, and environmental health and safety**

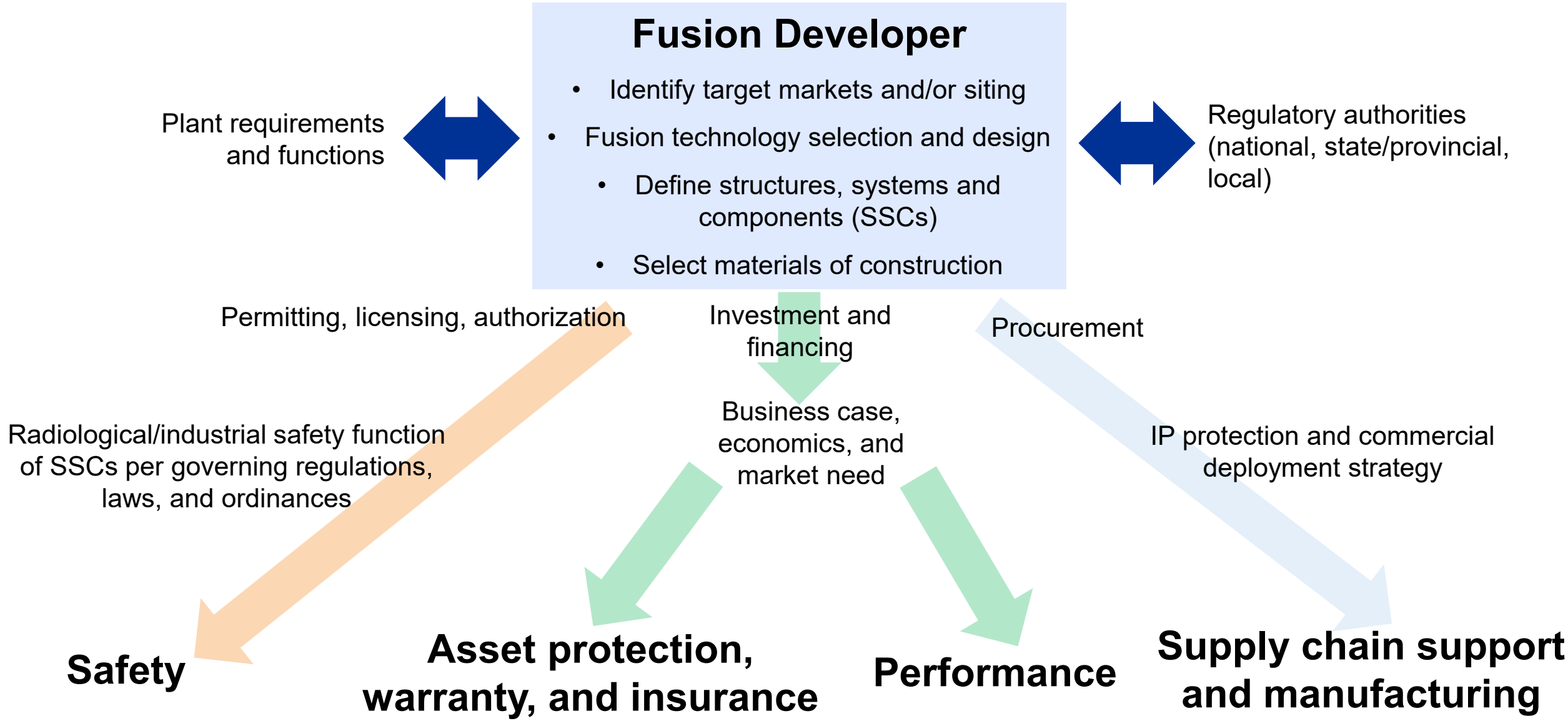


USNRC Fusion Roadmap

https://www.nrc.gov/materials/fusion/fusion-roadmap

Beyond Nuclear/Radiological Safety and Licensing

Drivers for Qualifying Fusion Materials of Construction



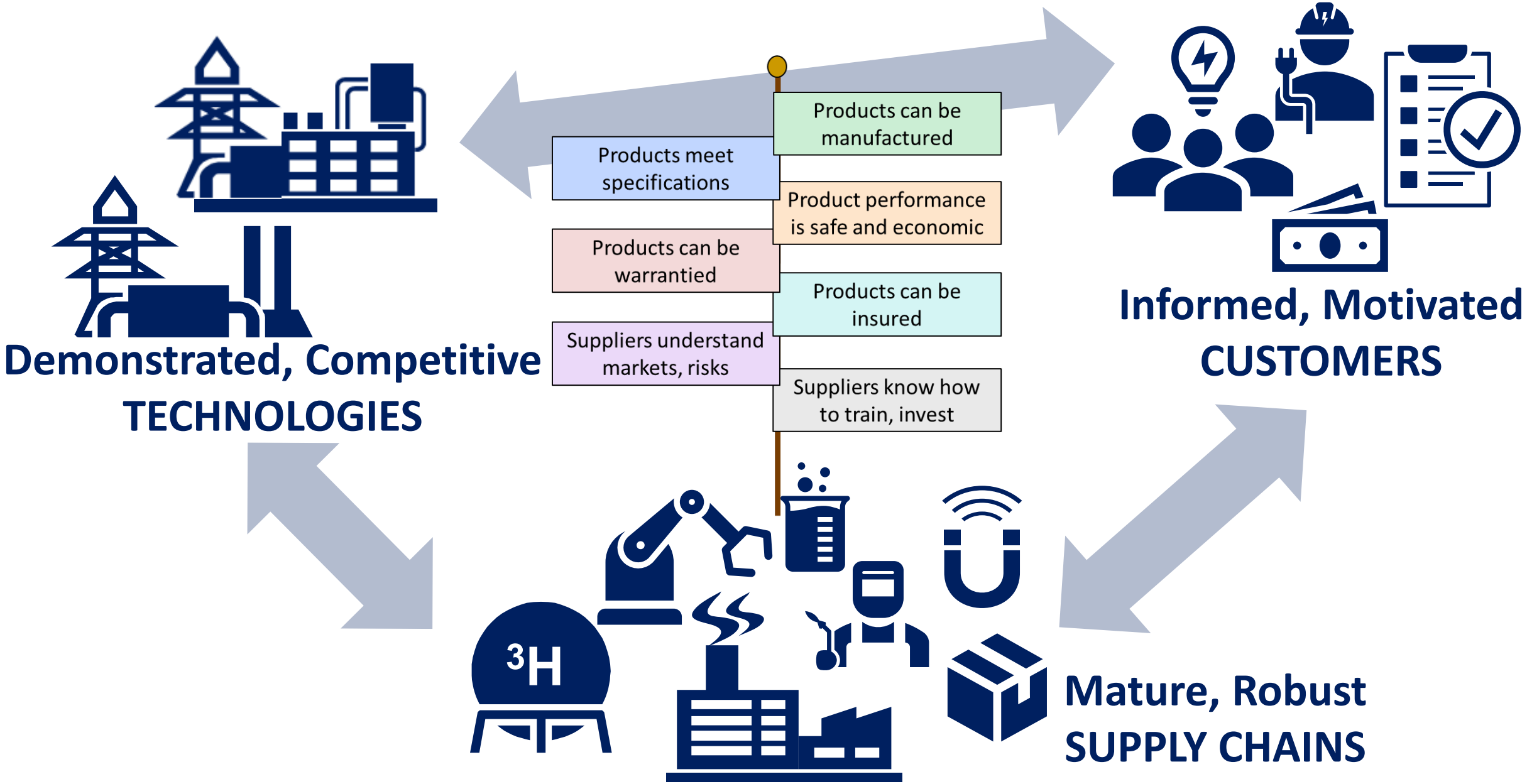
Code compliance and qualification ensure minimal requirements met…not long-term performance

Appendices:

A. Background information
B. Scope, Codes and Standards, & References
C. Chemical Composition
D. Microstructure
E. Mechanical Properties
F. Material Forming & Manufacturing Processes
G. Welding
H. Repair
I. Heat Treatment
J. Inspection and NDE
K. Hardness
L. Ferritic dissimilar welds
M. Austenitic dissimilar welds
N. Torch or flame heating
O. Surface Preservation

EPRI Report No. 3002029866. December 2024.
https://www.epri.com/research/products/000000003002029866

C&S and qualification support supply chains, commercialization



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