Fusion Licensing and Rulemaking Strategy for Fusion Energy Systems

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Bold Decadal Vision

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- Objectives:
  - Realize an operating fusion pilot plant on a decadal timescale and prepare the path broadly to fusion commercialization and scale-up.
  - Leverage fusion technologies to realize transformative civil, defense, and space capabilities and dominance.
  - Identify strategic interagency collaborative opportunities.
- 2021 Reports:
  - National Academies report *Bringing Fusion to the U.S. Grid*
  - U.S. Fusion Energy Sciences Advisory Committee long range strategic plan

Status of the Technology and Performance Challenges

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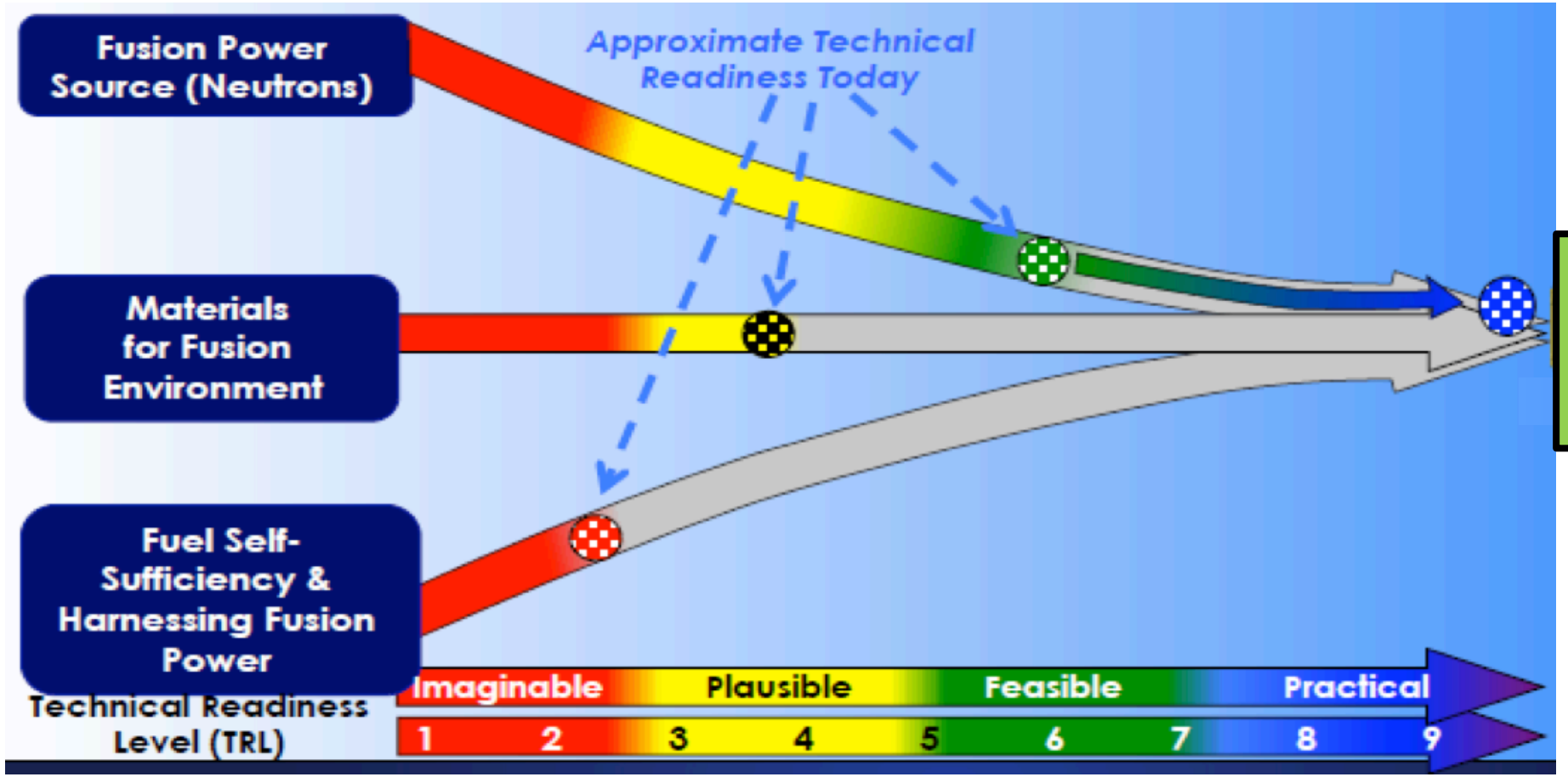

Fusion Pilot Plant (FPP)†

†As defined in the 2021 NASEM report *Bringing Fusion to the U.S. Grid*, i.e., >50 MWe net electricity for >3 continuous hours with timely path to 1 full-power year; on the path to commercial viability. Figure adapted from presentation by M. Wade at APS-DPP community planning workshop (2019).

Participating Agencies

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- Department of Energy
  - Lead agency in fusion energy R&D and coordinating the path to commercialization
- Department of State
  - Coordination on international collaborations and cooperation
- Nuclear Regulatory Commission
  - Fusion regulatory framework, licensing, and public engagement on public safety and energy justice
- Department of Commerce
  - Export control and standards
- National Science Foundation
  - Partnerships on staffing & training and workforce development
- Department of Education
  - Partnerships on fusion-related educational curricula
- Supporting Agencies: Department of Defense and NASA

Background

- The Nuclear Energy Innovation and Modernization Act (NEIMA; Public Law 115-439) requires NRC to establish a **technology inclusive regulatory framework** for fusion energy systems by December 31, 2027
  - Definition of advanced reactor includes “fusion reactor”
- On January 3, 2023, staff submitted SECY-23-0001, “Options for Licensing and Regulating Fusion Energy Systems,” with rulemaking plan enclosed (ML22273A178)
  - Three options
  - Proposed rulemaking would be limited in scope that includes definitions, content-of-application requirements, and other targeted augmentations

Challenge – Diversity of Designs and Hazards

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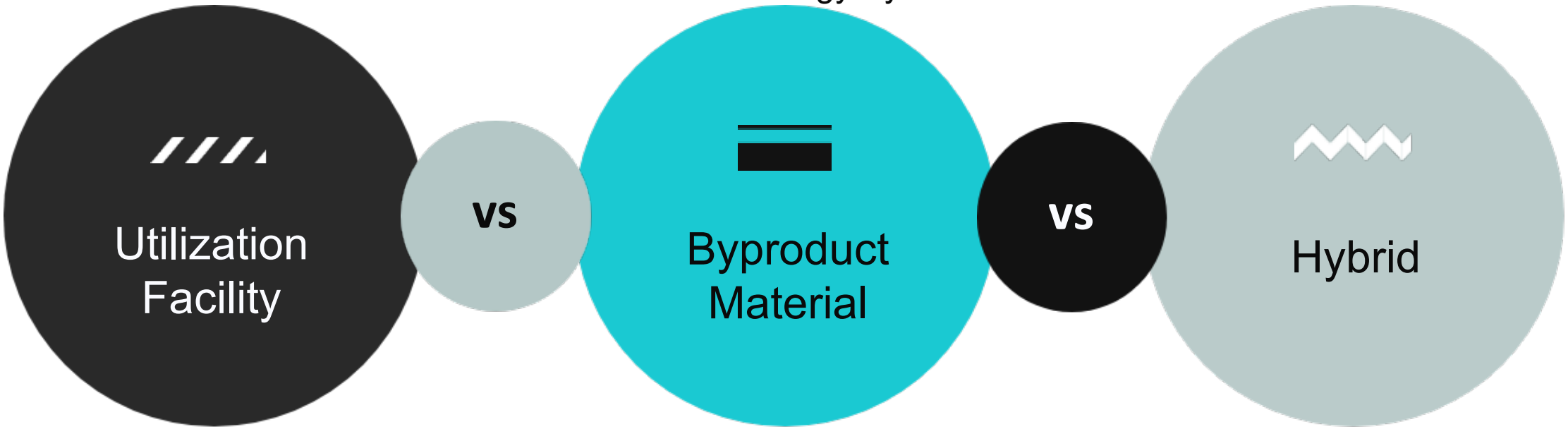
Fusion Reactions (Fuel)
- **Deuterium – Tritium (DT)**
- Proton – Boron 11
- Deuterium – Helium 3

Fusion Technologies
- Magnetic
- Inertial
- Magneto-Inertial

Radiological Hazards
- Potential Accident Scenarios
- Offsite Dose Consequences
- Activation

Regulatory Framework Options

for Fusion Energy Systems



- Defined in Atomic Energy Act (AEA)
- Covers certain facilities significant to public health and safety or common defense and security
- New, tailored regulations needed to address hazards
- Precludes Agreement States
- Implements other AEA requirements

- Addresses anticipated hazards of proposed near-term facilities
- Used for current research and development facilities
- Scalable requirements

- Combines both utilization facility and byproduct material approaches
- Leverages decision criteria
- Addresses all potential fusion technologies
- Can evolve at pace with industry

Commission Direction

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- On April 13, 2023, the Commission issued SRM-SECY-23-0001 "Options for Licensing and Regulating Fusion Energy Systems" (ML23103A449) directing the staff to implement a byproduct material approach to fusion energy system regulation (Option 2)
  - Modify existing 10 CFR Part 30 to include a Fusion Energy Systems framework
  - Develop a new volume of NUREG-1556, "Consolidated Guidance About Materials Licenses," dedicated to Fusion Energy Systems
  - Rulemaking plan approved – no regulatory basis document needed

Specific considerations from the SRM

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- Scope limited to currently known fusion energy system designs
- The staff should consider existing fusion energy systems already licensed or under review (Agreement States)
- The staff should evaluate whether controls-by-design approaches, export controls, or other controls are necessary for near-term fusion energy systems.
- If a design presents hazards sufficiently beyond near-term technologies, staff should notify the Commission and make recommendations for appropriate action.

Licensing with NUREG-1556 Guidance Documents

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- Wide range of materials uses under Part 30 - regulations would be complex and burdensome to maintain without licensing guidance documents
- Provides specific instructions to *applicants and reviewers* on what requirements are expected to be addressed in an application and information to be provided for a radioactive material license
- Applicant/Licensee submittals to regulatory agency based on licensing guidance documents can be used as ***legally binding requirements (LBRs)*** when incorporated into license as a tie-down condition
  - LBRs can be enforced the same as regulations
  - Provides the licensee flexibility

Scope of Fusion Rulemaking Activities

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- Based on 11e.(3) definition in AEA of byproduct material
  - Radioactive material for research, commercial or medical purposes
  - Accelerator-produced
- Limited-scope rulemaking in 10 CFR Part 30 to cover only near-term, known fusion energy system designs:
  - Definitions
  - Content-of-application requirements specific to fusion - Use standard Part 30 processes where applicable
  - Other targeted augmentations if needed to address specialized topics
  - Compatibility determinations part of rulemaking process

Scope of Fusion Rulemaking Activities

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Guidance:

- New NUREG-1556 licensing volume
  - Well established structure
- Focus on topics that distinguish fusion from other uses of radioactive materials
- Address range of fusion technologies – technology inclusive
- Use standard content from guidance documents to the extent possible
  - NRC, State, and DOE
  - No other licensing guidance development anticipated
- Inspection guidance
- Training for NRC and Agreement State staff

Augmentation Examples

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- Radioactive material inventory
  - Activation Products
  - Tritium Production
  - Financial Assurance
- Facility design requirements and shielding
- Tritium handling systems
- Security
- Offsite emergency preparedness evaluation
- Environmental review

Since the SRM…

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- Program and Technical Lead shifted to NMSS
- Proposed rulemaking efforts underway
  - Identified NRC and Agreement State staff
  - Developing outreach schedule
  - Started work on specific topics
- Commission receives proposed rule and draft guidance: Fall 2024

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