U.S. DEPARTMENT OF ENERGY

Preliminary Milestone-Based PPP Framework

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NASEM Report Identified Activities in Support of an FPP - 1

Recommendation or Innovation Category	Immediate Action	Completed by			
		Conceptual Design	Preliminary Design	Final Design	Construction
Organization and design	Create national teams to initiate design from private sector, universities and national labs	Complete concept. Enhance teams.	Select and consolidate team(s) Define cost and schedule	Execute Fusion Pilot Plant design and construction	
Technology approach	Develop technology roadmaps	Conceptual design, Refine technology roadmaps	Preliminary design. Critical technology prototypes demonstrated.	Final design completed.	Complete construction
Public-private partnerships	Develop PPP models for fusion and tech development	Execute PPPs	Refine and expand PPPs		
Data/expertise access	Private sector access to ITER data Expand industrial access to labs and universities	Continued data and expertise sharing from labs/universities into private sector. Intellectual property agreements.			

NASEM Report Identified Activities in Support of an FPP - 2

Recommendation or Innovation Category	Immediate Action	Completed by			
		Conceptual Design	Preliminary Design	Final Design	Construction
Regulatory		Develop regulatory needs / framework	Finalize regulatory framework	Obtain required licenses	
Site			Develop site requirements and options	Develop site	
Workforce	Define Diversity, Equity and Inclusion (DEI) plan	Execute DEI improvement	Workforce growth consistent with DEI plan		
Plasma performance	Improve plasma performance and predictive capability		Demonstrate equivalent Q_p>1	Evolve and improve projections to $Q_n > 1$, $Q_e > 1$ and required availability	
Actuators		Define actuator needs	Develop actuator technology	Design and deploy actuators	
Heat exhaust		Define heat exhaust challenge	Demonstrate heat exhaust solutions	Implement solutions	
Tritium/fuel cycle		Define tritium/fuel cycle requirements. Design demonstration.	Demonstrate tritium/fuel cycle process technology		Demonstrate efficient tritium/fuel cycle processing
Blanket		Define blanket and test facility requirements. Design blanket test facility.	Operate blanket test facility. Obtain data.	Finalize design and build 1st generation	
Neutron material degradation		Design limited volume neutron source	Operate neutron source, obtain initial results	Acquire further data, confirm material and design	
Structural design requirements		Develop high temperature structural design requirements	Obtain requisite data	Implement requirements	
Plasma-facing components		Define PFC requirements	Design and test PFCs	Fabricate and install PFC	
Blackstart		Evaluate blackstart capability			

When is a Milestone-Based Program Most Appropriate?

- **For discussion in the breakout sessions consider:**
  - FPP design leading to construction
  - Test facilities & technology development
  - Other

Possible Near-Term Deliverables in Support of an FPP Design

Objectives are:

- **Identify commercialization goals and targets (approximate markets, cost metrics, etc.) and connection to selected FPP development path**
- **Develop pre-conceptual design of FPP including:**
  - Scientific and technical goals of FPP
  - Key scientific and technological innovations required in support of a decadal timeline
  - Basis for cost and schedule range
- **Develop technology roadmap in support of FPP development path**
  - Can be used to identify cross-cutting R&D needs and test facilities
- **Identify gaps to FPP including intermediate confinement demonstration requirements**
- **Identify gaps from FPP to fully commercial FOAK**
  - For example, cost reduction or higher plasma gain to improve efficiency
- **Identify supply chain issues**

Potential Metrics for FPP Design Teams – Project Team Metrics

- **Expertise of team to deliver on the scope of the projects**
  - Expertise includes scientific, technological, engineering, procurement, construction, operations, commercialization/financial/business
- **Energy justice and DE&I considerations**
- **Cost sharing**
  - Could consider multiple tiers tied to different TRLs with different cost sharing requirements

Potential Metrics for FPP Design Teams – Technical Metrics

- **Ability of concept to generate fusion power**
  - Possible metrics: present triple product, required triple product for FPP and FOAK
- **Wall-plug/engineering gain**
- **Sustainable fuel cycle**
- **Required TBR of FPP and FOAK for DT systems**
- **Startup fuel supply**
- **Reliability and maintainability**
  - Remote handing approach
- **Heat exhaust**
  - PFC components
  - Divertor
- **Balance of plant considerations**
- **Proposed power cycle**
  - Connection to grid

Potential Metrics for FPP Design Teams – Commercial Metrics

- **Eventual commercial viability**
  - Projected overnight capital cost, fusion power performance, LCOE, and/or other relevant commercial metrics for FOAK
- **Fusion concept technology description for a FPP and FOAK**
  - Differences between FPP and FOAK (cost, scale, etc.)
- **Fusion concept, size, critical technologies and innovations to reduce cost and accelerate time to deployment**
- **Safety and licensing considerations**
- **Supply chain considerations**
- **Innovations to make fusion construction economical**

Possible Near-term Deliverables for Test Facilities Programs

- **The scope of test facilities will come out of technology roadmaps and depend, in part, on what approaches will be pursued**
- **Already some needs have been identified (e.g., LRP, NASEM report)**
  - Point neutron source test facility
  - HTS magnets
  - High heat flux testing platforms
  - Structural and functional materials for FW and VV components
- **Identification of team proposing test facility**
- **Pre-conceptual design of test facility**
- **Identify scientific and technical goals of test facilities**
  - Key scientific and technological innovations required in support of a decadal timeline
  - Basis for cost and schedule range
- **How test facility will support FPP teams**
- **Is there interest in a public-private partnership using a milestone-based program?**

Possible Metrics for Test Facilities

Project Team Metrics

- **Expertise of team to deliver on the scope of the facility**
  - Expertise includes scientific, technological, engineering, procurement, construction, operations, commercialization/financial/business
- **Energy justice and DE&I considerations**
- **Cost sharing**

Key technical issues

- **What FPP issues will be addressed and what FOAK issues will be addressed?**
- **Requirements for a point neutron source facility and other test facilities**
- **Enabling decadal timeframe and addressing needs of multiple concepts a priority**
- **Innovations to reduce cost and accelerate time to deployment**

Business Issues Associated with Test Facilities

- What is the short- and long-term business model for construction and operation?
- Financing model
- Cost sharing
- Safety considerations
- Energy justice and DE&I considerations
- What is the level of commercial interest?

Contractual options for various program types

Program Type	Payment mechanism	Reporting burden	Intellectual Property	Examples
Milestone-based using OTA	Payments made upon completion of mutually agreed upon milestones	Low	Remains with company	NASA COTS
Cooperative Agreement	Verified costs reimbursed as progress is made; can also be milestone-based but more as stage-gates for proceeding rather than a trigger for payment	Medium-High	Remains w/company, however Gov't has march-in rights. See Bayh-Dole act	ARPA-E programs NE ARDP Some FES programs
Prize	Payment made upon successful completion of prize goal	Low	Remains w/company	X-Prize
Grants	May be upfront payment, may be verified cost reimbursement; progress monitored via submission of progress reports	Low-Medium	Remains w/company, however Gov't has march-in rights. See Bayh-Dole act	SC grants
Contract between national laboratory and private company	Varies depending on the terms of the contract	Medium-High	Remains w/ company	CRADA, SPP (Strategic Partnership Project, formerly Work for Others)

With thanks to Sam Wurzel

Other Important Considerations

- **Intellectual property rights**
  - Need to address the rights of private industry when significant cost sharing takes place
  - Need to address the rights of public participants
- **Social Acceptance and Economic Justice**
  - For government support and eventual commercialization, this has to be addressed from the beginning
- **Safety and regulatory considerations**
  - Need to ensure appropriate regulatory framework for fusion
  - Safety is a line responsibility and that has to be clear
  - Consequence of a significant safety issue will affect all of us.

Q&A