ROUNDTABLE REPORT

U.S. ITER Project Contributions to the U.S. Fusion Science and Technology Roadmap

Response[1] to the Roundtable Charge

August 2026

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Executive Summary

[1] Acknowledging discussion summarization support via internal AI tools

On June 29-30, 2026, at the request and under the auspices of the US Department of Energy's Office of Science, a Roundtable was held virtually to discuss US ITER Project Contributions to the U.S. Fusion Science and Technology Roadmap. Within the scope defined for this report, the roundtable finds key areas where the ITER Project specifically contributes to and aligns with the U.S. Fusion Science and Technology (FS&T) Roadmap - engineering design basis, manufacturing and supply-chain readiness, systems integration preparations, licensing experience, and workforce development. The roundtable also finds a key opportunity to maximize the ITER Project's value delivery through increased emphasis on dedicated, structured information and knowledge documentation and dissemination facilitated through AI tools.

On the path to plasma operations, the ITER Project is positioned to address gaps identified in the U.S. Fusion Science and Technology (FS&T) Roadmap through industrial plant engineering and system integration; industrial readiness, manufacturing and supply-chain maturation; nuclear-grade quality assurance (QA), codes, standards and licensing experience; large-scale diagnostic and component development and assembly; digital engineering and configuration control; and workforce development for large nuclear environment fusion-system delivery. There are also key FS&T Roadmap gaps that the ITER Project does not address, including confinement diversity, advanced plasma-facing components, high-temperature superconducting magnet technologies, breeding blanket self-sufficiency, low inventory continuous fuel cycles, and power conversion.

The roundtable identifies a potential risk with regard to the supply chains, production lines, specialist workforces and assembly teams that have been formed through ITER procurement activities. These new capabilities are extant and active now, but risk rapid decline if not exercised and hence risk not being available to support the private fusion sector when called upon in the future. Unique and valuable information—non-recurring engineering (NRE) effort (first-of-a-kind design, tooling, and qualification work needed to turn specialized fusion components into manufacturable products), supplier qualification history, manufacturing concessions, schedule and cost drivers, inspection methods, design-for-installation lessons, and requirements that proved unnecessarily restrictive—may be lost if not documented and disseminated in an efficient, accessible, and timely fashion. Industrial readiness is progressing, but there is risk of curtailment if the knowledge and capability generated are not bridged to be available when demand from private fusion companies materializes.

A focused pre-plasma value-capture program was identified as an area for potential increased emphasis, in the form of a searchable ITER-to-fusion pilot plant (FPP) engineering knowledge base; a supplier and capability atlas with appropriately protected or anonymized cost, schedule and NRE data; a living lessons-learned manual; expanded U.S. public and private-sector personnel embedded in assembly and commissioning; standards and licensing translation to the U.S. framework; and explicit pairing of ITER-derived methods and data with domestic testbeds and private demonstration facilities.

The following table summarizes the answers to the three charge questions:

Charge question	Direct answer
1. Complementarity with U.S. private-sector efforts	ITER complements, rather than substitutes for, the U.S. private fusion sector. Private fusion industry emphasizes speed, cost reduction, compact systems, high temperature superconductors (HTS), configuration diversity and rapid iteration. ITER socializes expensive FOAK learning in nuclear-environment manufacturing, large-scale integration, configuration control, quality assurance/quality control (QA/QC), licensing, assembly and global supply-chain execution.
2. Unique information and critical gaps best addressed	Key pre-plasma information centers on how to design, procure, manufacture, qualify, assemble and commission a highly coupled fusion facility at industrial scale. ITER is positioned before plasma to address the FS&T Roadmap's Fusion Plant Engineering and System Integration gaps, the path to codes and standards, industrial manufacturing/joining/QA at scale, and cross-cutting supply-chain and workforce needs. Pre-plasma ITER contributions also include tritium-system engineering, diagnostics and Instrumentation and Control (I&C), plasma-control software architectures, vacuum systems and pumping, cryogenics and low temperature superconducting magnets, structural-material qualification and large-scale joining.
3. Comparison with current and anticipated domestic capabilities	Existing U.S. efforts emphasize HTS and compact systems, alternative confinement concepts, liquid-metal utilization for high heat flux management, U.S. licensing, and cost optimization; additional proposed domestic capabilities add fusion-neutron materials testing, integrated blanket/fuel-cycle development, and power conversion technology research. ITER offers key experience in multi-system integration at commercial-scale, nuclear-environment project execution, global supply-chain formation, large-component assembly and commercial plant-scale workforce learning. The two are complementary and can be strategically coordinated as a portfolio to deliver maximum value.

Introduction

The Roundtable received the formal charge to assess how the U.S. ITER project has informed and may inform future fusion system innovations, including industrial readiness for fusion manufacturing and experience with large-scale integrated fusion systems relevant to an FPP. The charge requests responses to three questions: alignment with U.S. private-sector efforts; unique scientific, technical and supply-chain information and the gaps the ITER project is best positioned to address; and comparison with current or anticipated domestic capabilities.

This report applies a deliberately narrow, pre-plasma operations temporal boundary and considers contributions already made and expected contributions that arise from design, analysis, procurement, manufacturing, qualification, delivery, assembly, pre-commissioning and integrated commissioning through the beginning of plasma operation. The report excludes anticipated contributions that depend on operating plasmas in ITER. This exclusion impacts the emphasis and content of this report: deliberately, this assessment does not incorporate planned future contributions based on burning-plasma physics, alpha-particle measurements, DT fuel-cycle operation, or test blanket module (TBM) nuclear performance, as these contributions are captured in other reports.

Response to Charge Question 1

Given the current investments, innovation, and research by the U.S. private sector, how does the ITER project complement and/or align with these efforts to close S&T gaps and advance progress on the FS&T Roadmap?

ITER complements U.S. private-sector efforts by providing a public, industrial-scale learning platform (that is, a mechanism for converting large-scale fusion design, manufacturing, qualification, integration, and commissioning into reusable industrial know-how) for the parts of fusion development that are unusually capital intensive, slow to learn, difficult to test incrementally and broadly reusable across companies. This role does not substitute for private investments, nor does the U.S. private fusion sector anticipate that ITER operations will be a pacing item for first-generation U.S. FPP decisions.

The U.S. private fusion sector is pursuing rapid iteration across multiple confinement concepts, technologies and business models. The private fusion sector emphasizes speed, cost pressure, design freedom, high temperature superconductor (HTS) development, compactness and risk appetite to test alternative technical paths. ITER's comparative advantage is complementary and distinct: the ITER Project has already passed through stages not yet confronted by most private fusion developers but stages that are key stepping stones on their respective future development paths—requirements definition, supplier qualification, design revision, nuclear-environment manufacturing QA and licensing, multi-system interface control, international logistics, site selection and installation and assembly of large components.

The ITER project addresses key capital and technical risks associated with first-of-a-kind (FOAK) development through several mechanisms:

Strengthening the U.S. Industrial Base

ITER directly reinforces the domestic supply chain by distributing over $1.5 billion across more than 800 domestic companies, national laboratories, and universities.

- Mastering Nuclear Quality: The U.S. supply chain has developed precision nuclear welding, heavy component machining, and stringent global Quality Assurance/Quality Control (QA/QC) protocols in addition to experience with fusion-specific design-for-manufacture and design-for-installation.
- Supplier Reuse: Private fusion developers are already leveraging this matured vendor base by reusing ITER-qualified suppliers, creating a bridge between public megaproject learning and private company execution. Further value could be gained through broader sharing of newly developed knowledge around unit cost scaling as a function of design and manufacturing complexity plus associated trade-offs in systems integration.
- NRE De-risking: ITER contracts provide the initial investment needed for new manufacturing lines and Non-Recurring Engineering (NRE), which lowers the entry barrier for private-sector fusion components and equipment demands.

Establishing Standards and Regulatory Precedents

As a licensed nuclear facility in the French system under rigorous oversight, ITER is forging the path to formal codification of international engineering standards specifically for fusion.

- Codification of ASME Codes: ITER's experience directly informs the ASME Boiler and Pressure Vessel Code (BPVC) Sec. III, Div. 4, which establishes fusion-specific rules for in-vessel components and electromagnetic loading.
- Vital Regulatory Precedents: ITER successfully petitioned the French nuclear regulator (ASNR) to recognize that electromagnetic forces—not coolant pressure—drive vessel design. This establishes a vital precedent that, if utilized by the U.S. NRC, offers the potential to reduce regulatory overhead for future domestic pilot plants[2].

Direct Knowledge and Technology Transfer

The ITER project provides key "digital and physics scaffolding" that private companies can utilize to validate their designs.

- Document Access: ITER has shared tens of thousands of technical documents with over 20 U.S. private fusion companies to ensure public megaproject learning informs nascent private designs. Further value could be gained through increased visibility into existing documents and transparent and efficient means of accessing.
- The ITER Handbook: The ITER project is actively disseminating the *ITER Engineering Basis Handbook* (and developing a second comprehensive follow-on), providing private

[2] U.S. NRC's proposed rule on the *Regulatory Framework for Fusion Machines* states that: "Each applicant would need to provide specific design information and proposed radiological materials that will be used or generated (quantity and form), which would further shape the NRC's understanding of potential hazards that can impact safety, security, and emergency preparedness. This information may result in the need for specific license conditions."

developers with immediate access to proven design methodologies and "know-how-not" Lessons Learned.
- Open-Source Software: Private companies can access the Integrated Modeling & Analysis Suite (IMAS[3]), a standardized framework for data analysis and code verification.
- Private Sector Fusion Engagement (PSFE): ITER hosts public-private workshops and technical visits to facilitate direct interfaces with industry.

A further area of alignment is information access. The U.S. ITER project reported that more than 20 companies—mostly U.S. firms—had requested information and that tens of thousands of ITER documents had been shared. Private-sector engagement mechanisms, document pathways, technical visits, software access and the ITER Engineering Basis Handbook(s) are useful beginnings. The roundtable's concern is not absence of information; it is that access remains too passive and dependent on knowing what to ask for.

Resolving the "Integration Deficit"

Private fusion prototypes are generally designed to de-risk single variables, which limits access to infrastructure development for an integrated, combination of effects that will be realized in nuclear operations of a fusion plant. ITER addresses this gap by serving as a vehicle where key pilot plant challenges coexist operationally and must therefore be prepared for, which includes knowledge, capability, and technology development for:

- Robust, radiation-ready plasma diagnostics for machine health, research data, and control for burning plasma dynamics with accompanying port integration
- Industrial-scale, high-throughput fuel loops.
- Multi-ton robotic remote maintenance systems.

Exploring Digital Engineering

The aspirational convergence of Model-Based Systems Engineering (MBSE) and digital twins at ITER could serve to reinforce the fusion ecosystem's move toward AI-enabled science.

- Genesis Mission Alignment: ITER's initial effort to pursue development of as-manufactured digital twins could provide a comprehensive validation dataset for the Genesis Mission, aiding the development of foundation or "world" models with the potential to accelerate design cycles for the entire U.S. fusion community.
- Open-Source Access: The dissemination of the ITER Engineering Basis Handbook(s) and global access to the Integrated Modeling & Analysis Suite (IMAS) can ensure that public megaproject learning directly informs nascent private designs.

Workforce Maturity and Training Pathways

ITER serves as a multi-generational and timely "proving ground" for a workforce that private industry can leverage for its own execution. There are existing examples of ITER Organization

[3] Further information can be found here: https://www.iter.org/node/20687/release-imas-infrastructure-and-physics-models-open-source

and Design Agency staff transitioning to the private fusion industry to serve as subject matter experts and mentors with opportunity to continue to facilitate and expand.

- Plant-Scale Experience: ITER offers unique operational training through mechanisms like Master of Science (MSc) stays, ITER Scientist Fellows (PhD), and physics operator training, which cannot be replicated by smaller domestic facilities.
- Bridging the Talent Gap: While the private sector emphasizes concept-specific milestones, ITER can offer training opportunities to a national talent pool in broad plant assembly and integrated commissioning.

The complementarity is strongest when ITER is used as a forward-looking risk-reduction asset. A historical “lessons learned” review completed after major U.S. FPP design choices would be too late. The roundtable repeatedly emphasized that the opportunity is time limited because suppliers, production lines and subject-matter experts are active now.

A summary of ITER-private sector complementarity and alignment is provided in Table I of Appendix A.

Response to Charge Question 2

How is ITER project providing, now and in the future, unique scientific, technical, and supply chain information to address the gaps identified in the U.S. FS&T Roadmap? Which critical gaps is the ITER project best positioned to address?

Within the pre-plasma scope, ITER's uniquely valuable information comes from the scale and coupling of the project. ITER is best positioned to address the FS&T Roadmap's plant engineering and integration gaps (excluding FPP relevant blankets), the path to fusion-relevant regulatory codes and standards, manufacturing/joining/QA at scale, and cross-cutting industrial readiness and supply-chain development. It also provides distinctive pre-plasma engineering information for diagnostics/port integration/Instrumentation & Control (I&C), tritium systems, large low temperature superconducting magnets and cryogenic systems, machine protection, plasma-control architecture, structural-material qualification, and large-component assembly.

The integrated nature is key. Domestic capabilities provide tests of material coupons, single to few magnets, pumps, a control algorithm or a plasma scenario more quickly than ITER. However, few programs manage thousands of interfaces among safety-class and non-safety systems, maintain configuration control across years of design evolution, qualify multinational suppliers, assemble components measured in hundreds of tonnes, and prepare a nuclear-regulated facility for integrated commissioning. ITER's most unique pre-plasma information is how those problems and subsequent solutions interact. By addressing this "integration deficit", ITER supports the U.S. transition from "lab-scale" science to the industrial-scale systems integration required for an FPP.

Sustained Burning Plasma and Predictive Modeling (Gap C-4)

ITER is the only designed and under-construction facility designed to demonstrate a dominant self-heating, burning plasma at city-power scale (500 MW).

- Current Deliverables: ITER has established the "physics scaffolding" for the U.S. by providing the Integrated Modeling & Analysis Suite (IMAS), a global standard for data analysis and code verification and making that publicly available through open-source release. It has also established comprehensive baseline database profiles for gyrokinetic and magneto-hydrodynamic (MHD) simulation verification.
- Future Actions: Leading up to first plasma, ITER will integrate U.S. open-source AI/ML predictive models directly into its modeling pipeline and develop a physics and engineering grounded digital twin (a "world fusion model") to accelerate research preparation. This allows U.S. researchers to bridge the chronological mismatch by using ITER's engineering baselines to finalize FPP designs before ITER begins high-power operations.

Integrated Reactor-Grade Control (Gaps C-6, F-5)

Managing a massive burning core requires moving away from isolated control loops toward a highly coupled environment.

- Current Deliverables: ITER has designed and developed the core plasma control system (PCS) framework for a uniquely integrated, industrial-scale burning-plasma control environment, including coupled multi-variable actuator sharing and multi-tier exception

handling, a complex multi-input multi-output (MIMO) environment. It has also established the architectural rules for plant-wide machine protection via the ITER Control, Data Access, and Communication (CODAC) system and the Central Interlock System (CIS).

- Future Actions: Integrated pre-plasma staging will utilize digital twins and hardware-in-the-loop (HIL) environments to validate PCS, CODAC, CIS network architectures. Integrated ITER-plasma commissioning (targeted for 2033) will validate the interoperability of complex cryoplants, vacuum heating, and remote handling control systems in addition to full validation of the ITER MIMO in nuclear environment operating conditions. Standardizing and disseminating the CODAC software, framework, interface definitions, and interlock rules would broaden the value proposition to the wider fusion community.

Full-Throughput Closed DT Fuel Cycle (Gap D-2)

While domestic, civilian infrastructure handles tritium in gram or smaller quantities, ITER is expected to provide first-of-a-kind industrial-scale experience with an integrated DT fuel-processing and recycle chain, including exhaust pumping, tokamak exhaust processing, isotope separation, storage/delivery, detritiation, analytics, and return of recovered fuel to the fueling system. However, ITER's fuel cycle is not a continuous, self-sufficient commercial DT loop; tritium breeding, minimized-inventory direct recycling, and high-throughput continuous accountancy remain FPP-relevant gaps.

- Current Deliverables: The U.S. has designed and is fabricating the Tokamak Exhaust Processing (TEP) system. This process has enabled the U.S. supply chain to master specialized skills, such as brazing thin Pd-Ag membranes at a scale relevant to an FPP.
- Future Actions: Full delivery of the TEP (2030) is anticipated to provide industrial-scale design, modeling, manufacturing, and potentially commissioning experience for tritium-compatible exhaust processing and can also inform process modeling, inventory tracking, and accountancy architectures. Establishing the extent of direct U.S. participation in commissioning can support realizing these benefits.

Core-Edge and Divertor Exhaust Integration (Gaps A-5, B-2, C-5)

ITER forces a plant-relevant core plasma to coexist with an industrial-scale, actively-cooled, solid tungsten (W) wall and divertor.

- Current Deliverables: The project has re-engineered and qualified the precision machining and QA/QC workflows for full-tungsten armor. It has advanced the global understanding of impurity transport and pedestal physics specifically within an all-metal environment.
- Future Actions: Placement of vacuum vessel sectors in the Pit (mid-2027) will provide irreplaceable experience in the assembly realities of solid, high-Z, components intended for high heat flux environments.

Nuclear-Grade Licensing and Standards (Gaps A-4, F-2)

Sited as a nuclear installation under French law, ITER is forcing the formal codification of fusion-specific engineering standards.

- Current Deliverables: In April 2026, regulators approved a landmark request recognizing that electromagnetic forces—not coolant pressure—drive vessel design, establishing a

vital precedent for domestic FPP licensing. ITER's data is directly informing the ASME BPVC Division 4 standards for fusion energy devices.
- Future Actions: Engineering and procurement data packages from ITER today can be extracted to inform U.S. domestic standards which may differ from French and EU regulatory approaches.

Supply Chain, Workforce Maturity

U.S. ITER has distributed over $1.5 billion across 800+ domestic companies, laboratories, and universities.

- Supply Chain: This investment has enabled the U.S. industrial base to master precision nuclear welding and heavy component machining. Major contractors like Westinghouse are currently performing robotized vacuum vessel welding at an unprecedented scale.
- Workforce: ITER provides unique training through MSc stays, Scientist Fellows (PhD), and physics operator tracks. However, a "participation deficit" remains: the U.S. funds 9% of construction but provides only 4% of the personnel, creating a talent gap in core operational areas like the Plasma Control Group.

The roundtable also identified an information asymmetry

ITER and its respective Project Offices have gained significant experience with establishing new production lines, achieving required tolerances, qualifying special processes, documenting nonconformities, and moving from one-of-a-kind R&D piece-part to repeatable component production. Information and lessons learned from these experiences could provide value to U.S. FPP teams as their respective technologies develop and scale. Yet much of this information is not available in a format that allows rapid use by U.S. fusion developers. A curated supplier capability atlas and anonymized NRE/cost/schedule benchmark database could materially strengthen FPP design confidence in materials, procurement schedules and make-or-buy decisions.

Some of the information on blanket technology inaccessible due to U.S. withdrawal from the TBM program could be recovered through bi-lateral agreements with selected ITER parties still engaged in the TBM program.

A short summary of the unique, pre-plasma ITER contributions to the FS&T Roadmap is provided in Table II of Appendix A.

Response to Charge Question 3

In what ways do similar domestic capabilities, either current or anticipated in the future, compare to advances provided or anticipated from the ITER project?

Domestic capabilities and ITER are complementary rather than interchangeable. Current and planned U.S. capabilities aim to be agile and enable design decisions of first-generation U.S. FPPs. ITER, due to its maturity, is less agile but uniquely deep in industrial-scale systems integration, nuclear-quality project execution, global supply-chain management, large-component assembly and the training of personnel in the realities of a plant-scale fusion project. ITER provides a combination of physical scale and multi-system nuclear environment integration not currently available domestically. Proposed U.S. infrastructure will seek to progressively address combined effects and integrated testing, but no currently defined domestic public facility is intended to reproduce the full breadth and scale of ITER's integrated systems.

The comparison also highlights the schedule issue. The FS&T Roadmap's near-, mid- and long-term infrastructure pathway is designed to support private-sector scale-up through the mid-2030s aiming for first-generation FPP design decisions before ITER plasma operations. These first-generation FPP decisions therefore need to be informed by existing operational facilities and facilities proposed to be operational within a short window of time, such as DIII-D, NSTX-U, SPARC and other private fusion devices, MPEX and HHF testing, AI/HPC infrastructure, and in the future, Blanket Component Test Facility (BCTF), Tritium-Blanket technology Development Platform (TBDP), fuel-cycle test facilities, Volumetric Neutron Source (VNS)/Fusion Prototypic Neutron Source (FPNS), and blanket-fuel test capabilities. ITER's pre-plasma contribution should be used immediately as an engineering baseline and risk register, and manufacturing knowledge base. Future ITER plasma results remain crucial but are not part of this report's charge.

The domestic program also covers several areas where ITER has structural limitations: HTS, non-tokamak configurations, liquid metal utilization for high heat flux environments, high-fluence materials qualification, self-sufficient breeding blankets, low-inventory continuous fuel cycles, commercial duty cycle, power conversion and U.S. regulatory pathways. These are not criticisms of ITER; they are important boundaries that allow the U.S. program to allocate responsibilities clearly. While existing and near-term anticipated U.S. infrastructure—comprising both public national facilities and private prototypes—generally provide more agile, targeted testing and concept development, ITER currently remains unique in the breadth and physical scale at which multiple fusion systems and nuclear-relevant effects are designed for and built within a single facility.

Table III in Appendix A details capability comparison across key scientific and technical dimensions.

Summary and Conclusions

The roundtable's response to the charge is that the U.S. ITER Project has contributed significantly to "seeding" the U.S. fusion ecosystem, aligned with Key Actions 6 (Seed Fusion Supply Chains) and 7 (Foster Talent) of the FS&T Roadmap. Furthermore, by addressing Gap A-4 (Codes and Standards), Gap A-5 (Industrial Manufacturing/QA), and Gap F-1 (Plant-level Integrated Modeling), U.S. ITER Project has matured the U.S. industrial base, supporting reduction of FOAK power plant construction capital risk toward manageable engineering challenges. U.S. ITER continues to serve as a driver of the "Grow" strategy, generating regional economic impacts and workforce capabilities essential for the transition to an American-led, grid-ready fusion industry.

On the first charge question, ITER complements the private sector by socializing expensive FOAK learning and strengthening the industrial and workforce foundations on which private speed and innovation depend. The strongest alignment is in plant integration, manufacturing, supply chain, QA, licensing, digital engineering and workforce. Active, deliberate, and timely knowledge capture and transfer is urgently needed to maximize accrued value of that alignment.

On the second charge question, the unique pre-plasma information comes from scale, coupling, and accumulated project experience. ITER is well-positioned to address Fusion Plant Engineering and System Integration; regulatory codes, standards and licensing discipline; manufacturing, joining and QA at scale; and industrial readiness and supply-chain developments. ITER also contributes important engineering knowledge in tritium systems, structural materials, superconducting magnets, diagnostics, I&C and plasma-control architecture. The central plasma, blanket, PFC and fuel-cycle performance gaps are outside the scope of the charge considered here.

On the third charge question, domestic capabilities are indispensable because they offer increased design flexibility and timeline-wise align with first-generation U.S. FPP decisions. Domestic capabilities lead HTS, compactness, configuration diversity, liquid metal plasma facing components (PFCs), fusion-neutron materials, full blanket/fuel-cycle development, power conversion, U.S. licensing and commercial cost/availability. ITER remains uniquely strong in multi-system integration, nuclear-quality execution, large-component assembly, large-scale commissioning, global supply-chain formation and plant-scale workforce experience. The optimal strategy connects these synergies directly to fully leverage the complementary nature.

Looking ahead, the roundtable finds that the highest-value pre-plasma return from U.S. participation in ITER will be best realized if the U.S. captures engineering and industrial knowledge while it is being generated, transfers it into domestic programs and private projects, and clearly assigns to domestic capabilities the gaps that ITER cannot close on U.S. timelines.

Table IV in Appendix A summarizes a list of roundtable findings to convert time-bound project experience into durable national capability.

Appendix A: Summary Tables

Summary Table I: Pre-Plasma, ITER-Private Sector Complementarity and Alignment

Complementarity area	ITER contributions	Efforts to leverage alignment
Reinforcing the industrial base	ITER contracts have enabled U.S. suppliers to develop precision machining, superconducting-magnet manufacturing, nuclear-grade vessel production, RF transmission components, NDE, welding and project-management capability.	Maintain continuity of work and make supplier capabilities visible to private developers.
Providing a standards and licensing bridge	ITER has forced decisions about how to apply or adapt fission-derived codes and standards to fusion-specific vacuum, cryogenic, cyclic, electromagnetic and high-heat-flux conditions.	Separate broadly reusable engineering discipline from ITER-specific French regulatory prescriptions; map lessons to U.S. risk-informed licensing.
Socializing expensive FOAK learning	ITER absorbs learning costs that are difficult for individual firms to justify: nuclear QA, configuration control, large-component qualification, integrated safety cases, long-lead procurement and assembly logistics.	Convert lessons into reusable U.S. guidance before private projects reach procurement and installation.
Advancing systems engineering	ITER provides experience in MBSE, interface management, plant-wide controls, interlocks, digital configuration and as-built integration at a scale not available on domestic plasma experiments.	Translate methods into modular reference architectures and digital workflows suited to smaller U.S. plants.
Supporting digital and AI convergence	ITER is consolidating massive engineering datasets and experimenting with LLM tools for traceability and knowledge access.	Connect transferable engineering data and methods to the FS&T Roadmap's AI-Fusion Digital Convergence Platform and domestic digital twins.
Creating workforce pathways	Design, procurement, assembly and commissioning of a large fusion facility develop engineers and project leaders with experience that cannot be reproduced through classroom training alone.	Increase U.S. placements and industry secondments while assembly and commissioning are active.

Summary Table II: Pre-Plasma, ITER Project Contributions to the U.S. FS&T Roadmap

Critical Roadmap Gap	ITER's Position	Potential Key Actions (Now to 2034)
Sustained Burning Plasma (C-4)	Only facility designed to demonstrate 500 MW self-heating; critical for code validation.	Providing IMAS framework; developing "world fusion model" for AI agent training.
Integrated Control (C-6, F-5)	World's first multi-variable reactor-grade Plasma Control System (PCS).	Validating MIMO loops and plant-wide machine protection interlocks (CODAC/CIS).
Industrial Fuel Cycle (D-2)	Likely first industrial-scale, continuous-cadence DT fuel processing loop. Expertise in design and supply of tritium-compatible vacuum and fueling systems.	Full delivery of U.S. TEP (2030); pre-plasma integration and commissioning experience.
Core-Edge Integration (C-5, B-2)	Forces a massive core to coexist with a full-tungsten industrial divertor.	Qualified full-tungsten armor machining; VV sector placement in Pit (2027).
Nuclear Standards (A-4, F-2)	Licensed nuclear facility forcing codification of international standards.	Informing ASME BPVC Div. 4; regulatory precedent for electromagnetic-driven design.
Industrial Readiness (A-5, F-1)	Heavy industrial testbed that socializes FOAK manufacturing risks.	Energized SSEN grid routing; Westinghouse robotized VV welding; ITER Handbook.
Workforce & Supply Chain (Key Action 6, 7)	Unique plant-scale operational training and $1.5B+ industrial engagement.	800+ U.S. suppliers qualified; training a generation of project execution experts.

Summary Table III: Comparison of Domestic vs. ITER Capabilities

Capability	Current/anticipated domestic position	ITER pre-plasma position	Assessment
Project/facility systems integration	Domestic facilities are smaller size-scale and generally optimized for research or targeted technology demonstrations.	80-meter high building height with 30-meter height tokamak scale and coupling of magnets, cryogenics, vacuum, power, cooling, I&C, safety and assembly.	ITER strength; actively transfer interface, configuration and assembly lessons.
Speed and commercial iteration	Private projects and PPPs can redesign, prototype and reprioritize on a rapid timescale.	Large international governance and nuclear project processes are slower.	Domestic strength; ITER progress is not considered a pacing item.
HTS and compact high-field magnets	Strong U.S. private and public focus on REBCO/HTS, compact high-field systems and associated QC.	ITER is based on low-temperature superconductors.	Domestic capability strength; ITER contributes general magnet industrialization lessons, including production of large-scale cryogenic systems requisite for HTS
Confinement diversity	U.S. portfolio includes advanced tokamaks, spherical tokamaks, high-field tokamaks, stellarators, mirrors, Z-pinches, IFE and other concepts.	ITER is a conventional tokamak.	Domestic strength and concept risk diversification.
PFCs, PMI and HHF	DIII-D, NSTX-U, MPEX, domestic HHF initiatives, liquid-metal research facilities and private platforms can target specific gaps rapidly.	Pre-plasma ITER contributes tungsten procurement/qualification and component engineering, not plasma validation.	Domestic capability leads near-term gap closure; ITER provides manufacturing and integration references.
Materials under fusion neutrons	FS&T Roadmap proposes fission/ion/proton surrogates, VNS/FPNS, plus additional private neutron producing sources.	ITER does not provide power-plant-level structural fluences, and no irradiations before plasma operations commence.	Domestic capabilities will be necessary to address.
Blanket and fuel self-sufficiency	Future TBDP, IB-FCTF, allied facilities and private blanket programs target tritium breeding, extraction and integrated testing.	Pre-plasma ITER provides interfaces, neutronics methods and TBM integration planning; no breeding performance.	Domestic/allied programs anticipated to lead first-generation FPP design decisions.
Fuel-cycle technology	Domestic tritium laboratories, test loops and Fuel Cycle FIRE can pursue low inventory, DIR, continuous processing and accountancy.	ITER provides uniquely large engineering and supplier experience in tritium-compatible systems, but operational proof is outside this report.	Complementary: domestic innovation plus ITER engineering baseline.
Power conversion and grid delivery	U.S. FPP and test programs must co-design blanket, coolant, tritium control, turbine/power cycle and grid interfaces.	ITER is a net power consumer and does not generate electricity.	Domestic responsibility.
Licensing and regulation	U.S. fusion licensing is developing under a distinct, technology-inclusive U.S. framework.	ITER is licensed under French nuclear rules.	ITER offers process discipline and safety-analysis lessons, but may have limited direct

Capability	Current/anticipated domestic position	ITER pre-plasma position	Assessment
			translation to differential U.S. policies. U.S. framework must be developed domestically.
Industrial supply chain and nuclear QA	Growing but uneven; private fusion companies have not yet moved from prototypes to nuclear-quality, industrial-scale repeatable production.	Large active supplier network with extensive qualification, QA/QC and special-process experience.	ITER strength today; time-sensitive knowledge transfer opportunity to accrue further value.
Workforce	Strong scientific, academic and facility-scale workforce; growing private fusion industry engineering teams.	Unique physical plant-scale assembly, installation, commissioning and multinational project experience.	ITER strength if U.S. participation and personnel placements are increased.
AI and digital twins	U.S. leads rapidly evolving AI, HPC and digital platforms through the FS&T Roadmap and Genesis Mission.	Broad range of physical engineering data, configuration history and integrated-facility context.	Complementary; accrue additional value via strengthened connection between data and methods with appropriate controls.

Summary Table IV: Roundtable Observations on Knowledge and Technology Transfer

Opportunity for increased emphasis	Potential approach to leverage opportunity
Establish a U.S. ITER Pre-Plasma Value Capture Program.	Create a formally owned, DOE-led, milestone-driven effort focused on transferring engineering, manufacturing, assembly, commissioning, cost/schedule and supply-chain learning into the domestic commercial ecosystem. Require periodic releases aligned with the design and construction stages of U.S. FPP developers.
Build an ITER-to-FPP engineering knowledge base and AI-assisted access layer.	Organize transferable requirements, interfaces, design choices, nonconformities, manufacturing records, inspection methods, installation constraints, commissioning lessons and "know-how-not." Use AI tools to improve discovery, but retain expert curation, provenance, export-control/IP screening and technical validation.
Publish a supplier capability atlas and protected NRE benchmark database.	Document U.S. and allied suppliers, qualified processes, component classes, tolerances, materials, inspection capabilities, production-line status and lessons. Where commercial sensitivities prevent disclosure, provide anonymized ranges for NRE, lead time, yield, rework and schedule risk.
Produce a living lessons-learned manual for FPP design and construction.	Focus on the stage where FOAK lessons occur: between conceptual design and successful build/install. Cover requirements maturity, design-for-manufacture, design-for-installation, configuration control, interface management, change control, nonconformance resolution, codes/standards, procurement, site logistics and assembly sequencing.
Expand support and mechanism to embed U.S. personnel - public, private, academic - in assembly and commissioning.	Create dedicated funding and mechanisms for long-duration placements from national laboratories and universities, and encourage private companies to support employee secondments. Prioritize plasma control, I&C, machine protection, vacuum, cryogenics, tritium systems, remote handling, welding/NDE and integrated commissioning.
Create an ITER-to-domestic capabilities validation bridge.	Map ITER methods, models, interfaces and failure modes to DIII-D, NSTX-U, MPEX, HHF facilities, TBDP, tritium test loops, neutron-source programs, private demonstrations and the AI-Fusion DCP. Use domestic facilities to test or adapt ITER-derived approaches on U.S. timelines.
Translate standards and licensing lessons to the U.S. framework.	Extract broadly reusable safety, QA and qualification lessons while avoiding direct transplantation of French prescriptive requirements. Develop risk-informed guidance, fusion-specific failure modes, probabilistic approaches and machine-protection practices relevant to U.S. licensing.
Preserve supplier continuity and pursue requirement harmonization where practical.	Avoid losing specialized skills between isolated contracts. Explore follow-on work, cross-program procurement and common support-system form factors where this reduces NRE and enables repeat production without undermining competitive innovation.

Appendix B: Roundtable Charge

Roundtable on US ITER Project Contributions to the U.S. Fusion Science and Technology Roadmap

Charge

The focus of this roundtable is to consider how the U.S. ITER project has informed and may inform future fusion system innovations. This should include industrial readiness for fusion manufacturing and industrial experience with large-scale integrated fusion systems relevant for advancing a fusion pilot plant. The roundtable is encouraged to identify connections between key technology development needs (e.g., plant engineering and system integration, materials, breeding blankets, and fusion fuel cycle) and enabling technology needs (e.g., advanced manufacturing) identified in the U.S. FS&T Roadmap and specific ITER project contributions.

- Given the current investments, innovation, and research by the U.S. private sector, how does the ITER project complement and/or align with these efforts to close S&T gaps and advance progress on the FS&T Roadmap?
- How is ITER project providing, now and in the future, unique scientific, technical, and supply chain information to address the gaps identified in the U.S. FS&T Roadmap? Which critical gaps is the ITER project best positioned to address?
- In what ways do similar domestic capabilities, either current or anticipated in the future, compare to advances provided or anticipated from the ITER project?

Background

ITER will be an experimental platform to study magnetically confined burning plasmas of relevance to the development of fusion energy in the mid-to-late 2030s. Prior Department of Energy, Fusion Energy Sciences Advisory Committee (FESAC), and National Academies of Sciences, Engineering, and Medicine (NASEM) reports and assessments in the 2016 to 2024 time period (see references listed below) carefully examined the need for a robust burning plasma device to support development of fusion power. ITER is designed to provide the scientific foundation for a sustained fusion power source (burning plasma) for hundreds of seconds at 500 megawatts at an industrial scale.

There have been significant developments in the U.S. Fusion ecosystem even since the most recent reports and assessments. Today, the U.S. private fusion sector has invested over $10B collectively to innovate along several approaches to fusion energy. DOE has also recently

released the U.S. Fusion Science & Technology (FS&T) Roadmap. The FS&T Roadmap sets out a path for the U.S. public and private sectors to work together toward closing S&T gaps and achieving fusion energy scale-up in the 2030s. The Roadmap is founded on a strategy of Build-Innovate-Grow that has both public-private and international partnerships as key elements for success. We are seeking an assessment of how U.S. participation in ITER aligns to achieving the Roadmap, which Roadmap S&T gaps U.S. ITER is positioned to best address, and where U.S. contributions to ITER can provide the most complementary impact as part of this U.S. overall strategy. The Roadmap outlines the need for additional key investments required in materials, breeding blankets, and tritium fuel cycle R&D and developmental testbeds.

Several recent reports have iterated the important role of ITER. The Report of the FESAC Facilities Construction Projects Subcommittee (2024), ITER was evaluated as "absolutely central" for its potential to contribute to world-leading science and/or close fusion technology gaps in the next decade and as one of four facilities that "best serves" fusion. The FESAC Long Range Plan (2020), Community Process Planning of the U.S. fusion community, and the NASEM report "Bringing Fusion to the U.S. Grid" (all published before 2021) listed ITER as an essential platform to de-risk burning plasma science. ITER research operations will begin in 2034 and first nuclear operations (Deuterium-Deuterium) will begin in 2035 with full power (Deuterium-Tritium) operations starting in 2039. Plasma measurements and scientific investigations will begin at the start of research operations in 2034.The future science opportunities when ITER is operational were assessed by the community in 2022 (https://science.osti.gov/-/media/fes/pdf/2022/USIRT_workshop_2022.pdf).

The U.S. ITER project is over 54% complete, with multiple technical systems fully delivered and other hardware progressing through design, manufacturing and deliveries to support ITER assembly. Most U.S. ITER funding for hardware contributions goes to domestic U.S. industry, universities, and national laboratories. To date, over 800 companies have contributed to U.S. ITER and more than $1.5B has been awarded. ITER engagement has nurtured fusion supply chain development, industrial capabilities in fusion engineering and technology, and fusion workforce development, while also providing industrial-scale fusion manufacturing and integration experience. ITER is also demonstrating licensing experience relevant for a future fusion power plant. The U.S. contributes 9.09% of construction costs and 13% during operations.

References

Unless otherwise linked below, the following reports are available here: iterresearch.us - Resource Library

- U.S. DOE SC Fusion Science & Technology Roadmap, 2025
- Report of the FESAC Facilities Construction Projects Subcommittee (2024, "FESAC FCP Report")
- Report on U.S. ITER Research Needs (2022, "community workshop")
- NASEM Bringing Fusion to the U.S. Grid (2021, "NASEM Report")
- FESAC Long Range Plan (2020, "FESAC LRP")
- DOE Report on U.S. Participation in ITER (2016, "Moniz report")

Hyperlinks:

iterresearch.us - Resource Library

U.S. DOE SC Fusion Science & Technology Roadmap

Report of the FESAC Facilities Construction Projects Subcommittee

DOE Report on U.S. Participation in ITER

Appendix C: Roundtable Agenda

Office of Science (SC) Roundtable
ITER Project Contributions to the U.S. Fusion Science and Technology Roadmap
June 29-30, 2026

All times indicated are Eastern*

Day 1: June 29, 2026
ZOOM info: https://www.zoomgov.com/j/1652223254?pwd=ECM3NLaD0rV6UEi91YIl60hjbl7u9A.1

10:45 – 11:00 AM **Remote Participants Log-In/Sound check**

11:00 – 11:15 AM Welcome and Roundtable Charge (15 min)
Linda Horton, Associate Deputy Director for Science Programs & Acting Director for Office of Science, Fusion Energy Sciences

11:15 – 11:30 AM Welcome, Roundtable Goals, and Logistics – Roundtable Co-Chairs (15 min)
Laura Berzak Hopkins, Princeton Plasma Physics Laboratory
Andrea Garofalo, General Atomics

11:30 – 12:00 PM *Plenary Session I*

Invited talk 1: ITER Director General, Pietro Barabaschi

ITER Status Update & Recent Achievements

12:00 – 12:30 PM *Plenary Session I Q&A* (30 min)

12:30 – 1:00 PM *Plenary Session II*

Invited talk 2: Interim Project Director, Kevin Freudenberg, ORNL

The Value of ITER for U.S. Fusion

1:00 – 1:30 PM *Plenary Session II Q&A* (30 min)

1:30 – 2:00 PM **Lunch** (30 min)

2:00 – 3:00 PM *Plenary Session III* Panel of U.S. ITER vendors (30 min, short presentations)

3:00 – 3:30 PM *Plenary Session III Q&A*

3:30 – 5:00 PM *Plenary Session III – Participant-only Session*

5:00 PM Set up homework and **Adjourn**

Day 2: June 30, 2026

ZOOM info: https://www.zoomgov.com/j/1652223254?pwd=ECM3NLaD0rV6UEi91YIl60hjbl7u9A.1

10:45 – 11:00 AM **Remote Participants Log-In/Sound check**

11:00 AM – 1:00 PM *Plenary Session IV – Participant-only Session*

1:00 – 1:30 PM **Lunch** (30 min)

1:30 – 2:30 PM *Plenary Session V* U.S. National Laboratory perspectives: ITER Project top contributions to U.S. national fusion program

Stephen Streiffer, DIrector ORNL

Steven Cowley, Director PPPL

15 min presentations + discussion

2:30– 3:00 PM *Plenary Session V Q&A* (30 min)

3:00 – 5:00 PM *Plenary Session VI – Participant-only Session*

5:00 – 5:30 PM *Participant-only Session*

Summary and Next Steps

Closing Remarks/Adjourn

5:30 PM **Adjourn**

Appendix D: Roundtable Participants

Laura	Berzak Hopkins (Co-Chair)	PPPL
Andrea	Garofalo (Co-Chair)	General Atomics
Larry	Baylor	Type One Energy
Pattrick	Calderoni	Idaho National Laboratory
Michael	Dunne	Inertia Enterprises
Brenda	Garcia-Diaz	Savannah River National Laboratory
David	Gates	Thea Energy
Michael	Ginsberg	Tokamak Energy
Diana	Grandas	EPRI
Brian	Grierson	General Atomics
Tammy	Ma	LLNL
Eugenio	Schuster	Lehigh University
Derek	Sutherland	Realta Fusion
Brian	Wirth	UTK