



U.S. DEPARTMENT OF
ENERGY

Office of the
**UNDER SECRETARY
FOR SCIENCE & INNOVATION**

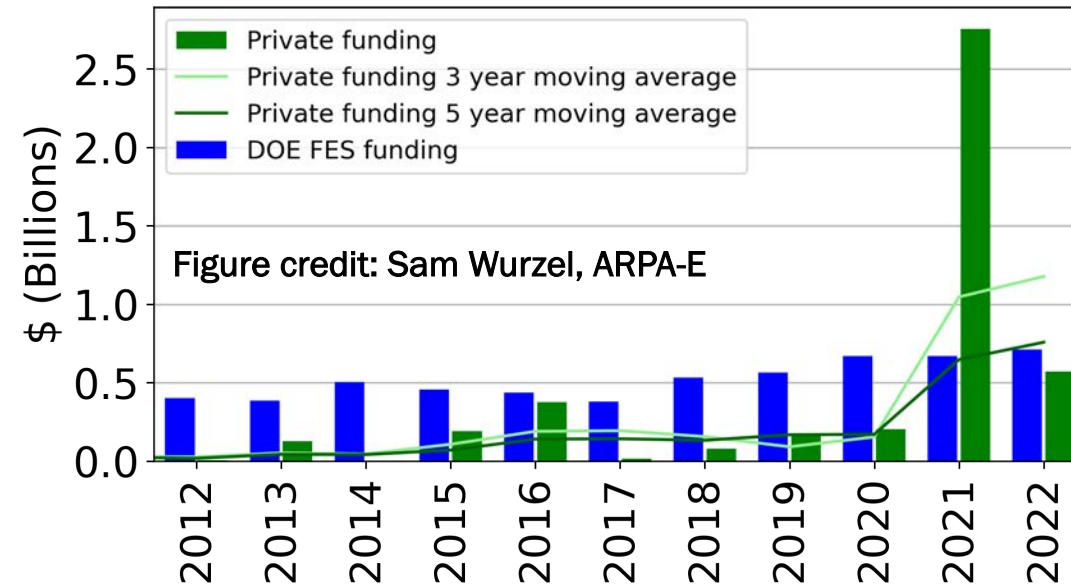
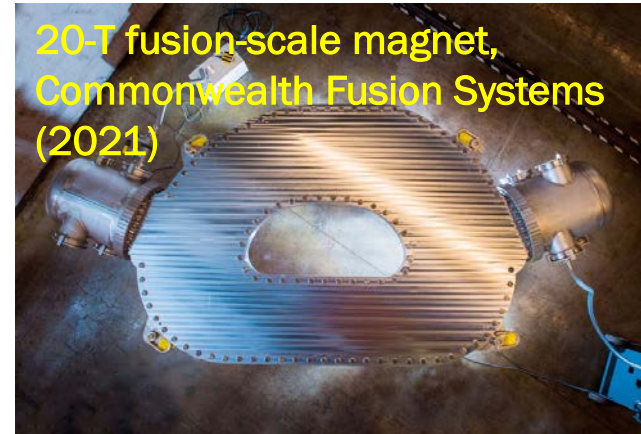
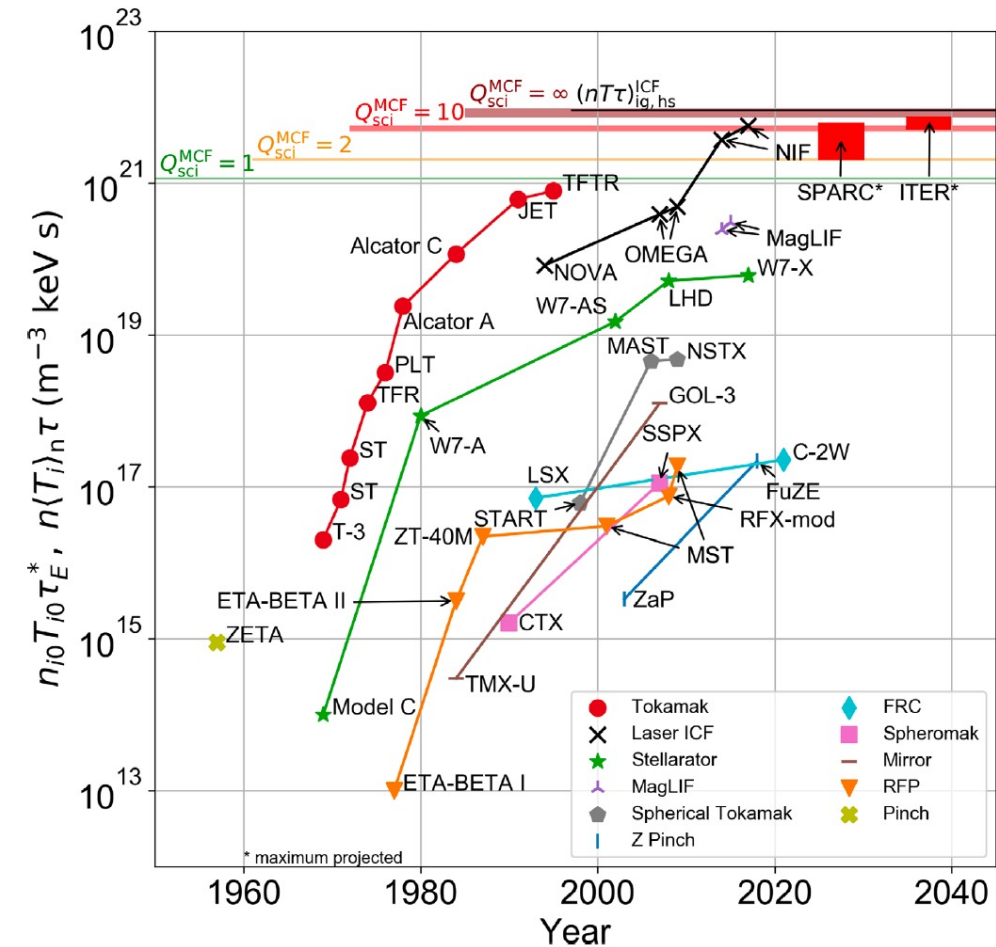
Bold Decadal Vision for Commercial Fusion Energy

Scott Hsu, DOE Lead Fusion Coordinator

Government-University-Industry Research Roundtable
Webinar: Unlocking New Possibilities for Commercial Fusion
National Academies of Science, Engineering, and Medicine
February 16, 2023



Increasing technical readiness and market pull warrant a new U.S. strategy for fusion research, development, and demonstration



White House Summit in March 2022 announced an “all-of-DOE” strategy to accelerate fusion energy RD&D in partnership with the private sector



WHITE HOUSE SUMMIT:
*Developing a Bold Decadal Vision for
Commercial Fusion Energy*

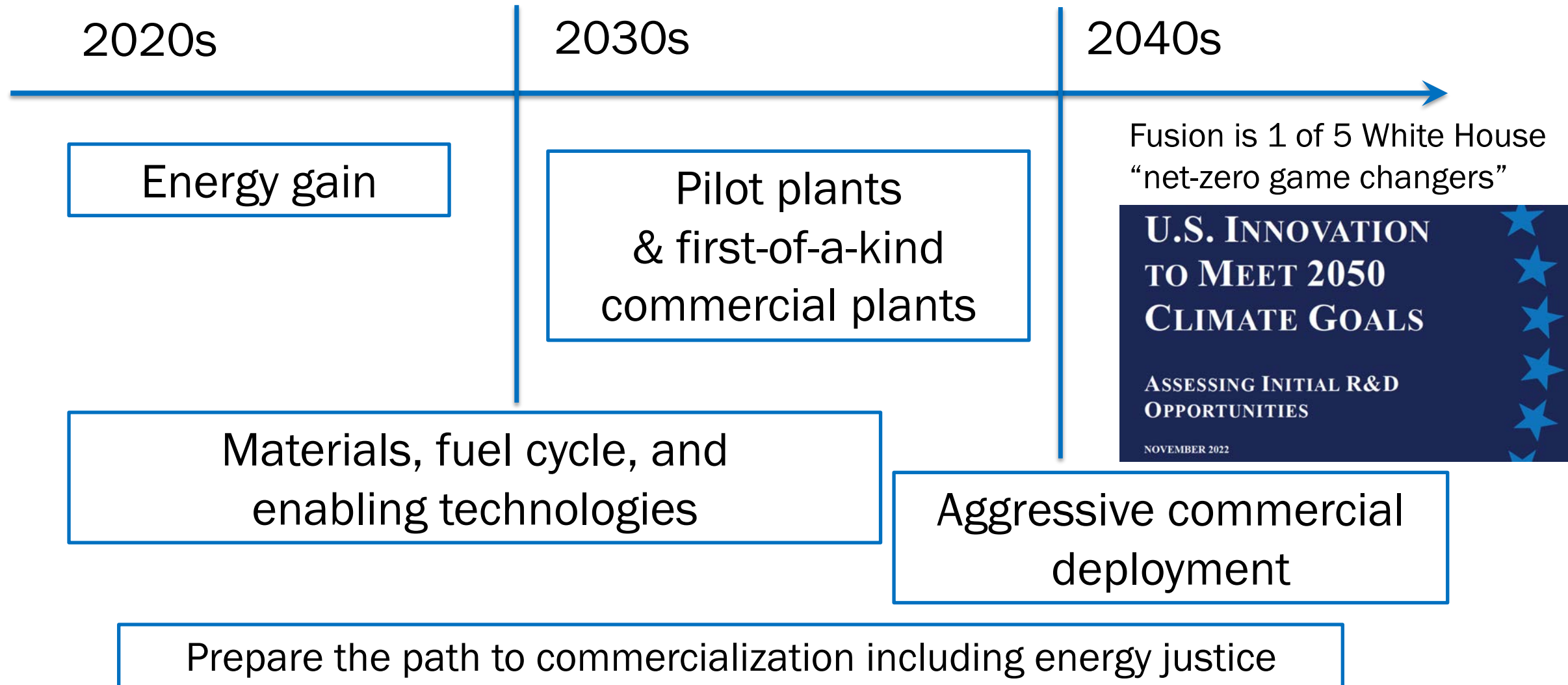
THURSDAY, MARCH 17, 2022

 **ENERGY.GOV**

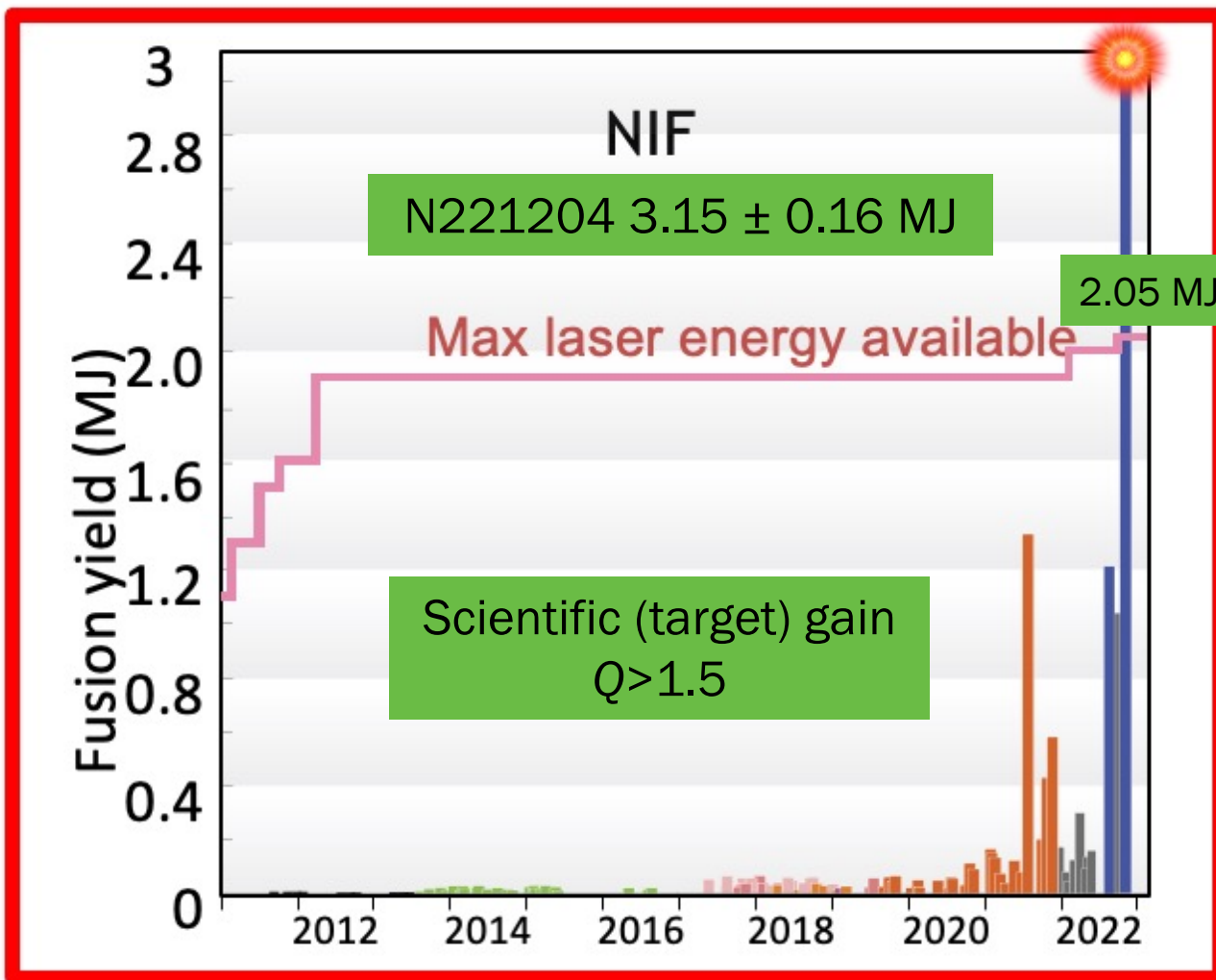
Inclusive conversations at the Summit:

- Net-zero, energy security/abundance, and U.S. technological leadership
- Decades of progress enabled by sustained public support
- Public engagement from the outset in support of energy justice
- Private sector working to deliver carbon-free energy on timescale that matters

The *Bold Decadal Vision* (BDV) seeks to partner with the fusion private sector to impact mid-century carbon-emissions targets



NIF achieves ignition and scientific energy breakeven!



Implications for NNSA mission

- Advance understanding of weapons science
- Supports stockpile modernization decisions
- Materials strength experimental platform
- Train next generation of nuclear weapons scientists/engineers

Implications for fusion energy

- Defining moment: scientific proof that controlled fusion is a potential source of clean energy for humanity
- Motivates accelerating our efforts to bring fusion to technical and commercial viability
- Supports starting an inertial fusion energy (IFE) R&D program [NASEM 2013]
- Proof-of-concept for private companies pursuing similar or related approaches

Significant remaining S&T challenges are well known and summarized in the 2020 FESAC LRP,* requiring robust publicly funded programs

Topics/disciplines

Predict, control, sustain a burning plasma

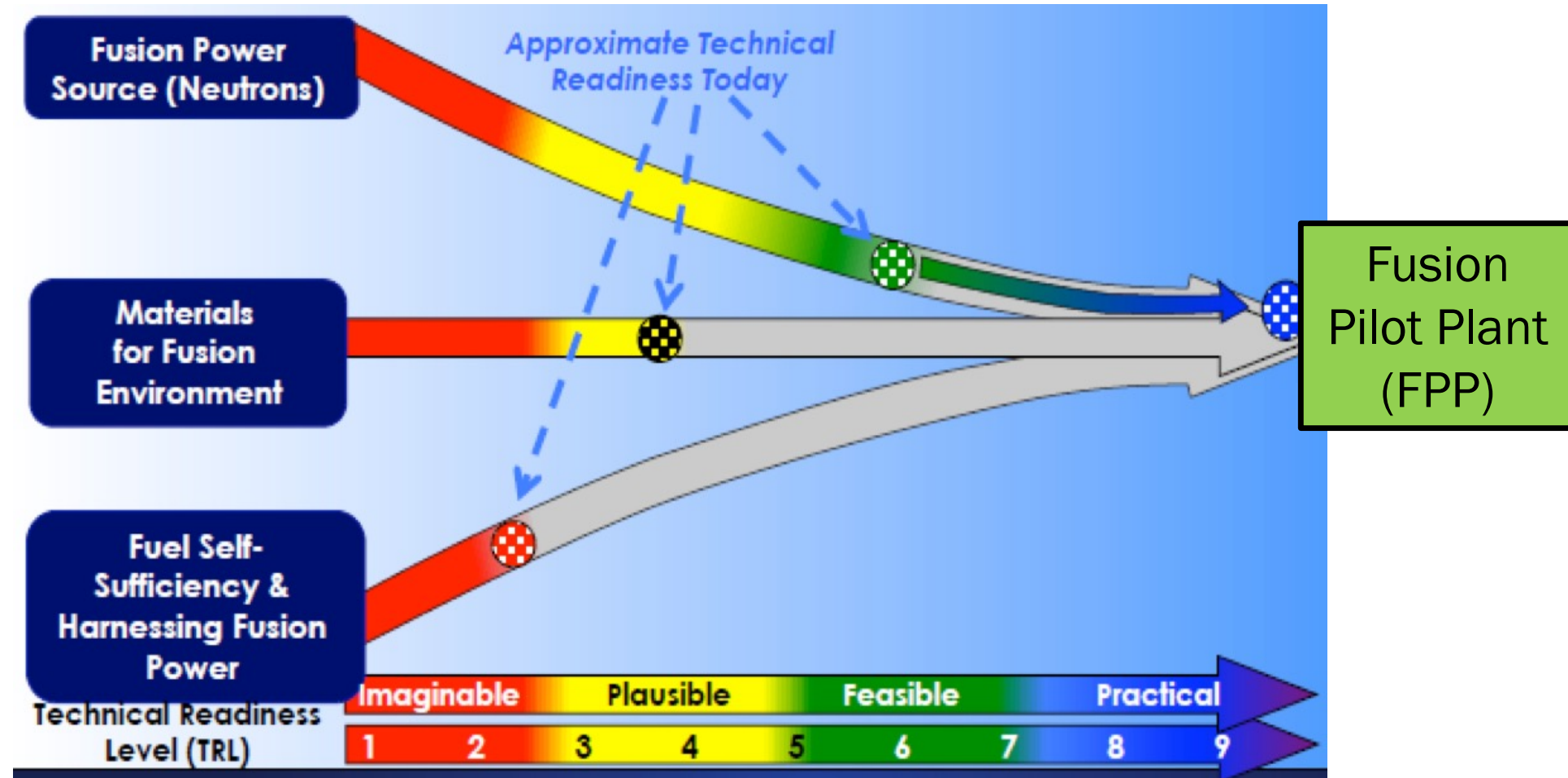
- Plasma science and HPC simulations; AI/ML; diagnostics; broad enabling technologies

Survive extreme heat and irradiation flux at the first wall

- Materials science, modeling, engineering, and testing; advanced manufacturing; novel liquid-metal concepts

Tritium breeding, processing, containment

- Breeding blankets; tritium extraction, separation, storage, process intensification



Fusion energy development via public-private partnerships (PPPs)

- Greater available financial resources to accelerate timelines
- Stakeholders committed/aligned by sharing cost
- Research/innovation pursued in relevant way for commercialization
- Price signals embedded throughout development path

DOE Workshop on Fusion Energy Development via Public-Private Partnerships

June 1 - 3, 2022

Capital Hilton, 1001 16th Street NW, Washington, DC

*Hosted by the Office of the Under Secretary
for Science and Innovation*

Sponsored by the Office of Science

Decadal needs
beyond the science
& technology

Aligning public-
and private-
sector R&D

New PPP program
to realize a fusion
pilot plant

Previously existing PPP programs in U.S. fusion energy development



ALPHA, BETHE, GAMOW programs (2015—present)

DOE funds teams including fusion companies, universities, national laboratories on potentially transformative applied R&D

Model: DARPA



DOE funds national laboratories and universities on R&D proposed by fusion companies

Model: DOE Nuclear Energy (NE) GAIN program

New DOE Milestone-Based Fusion Development Program is a first step of the BDV to realize a fusion pilot plant (FPP) on a decadal time scale via PPPs



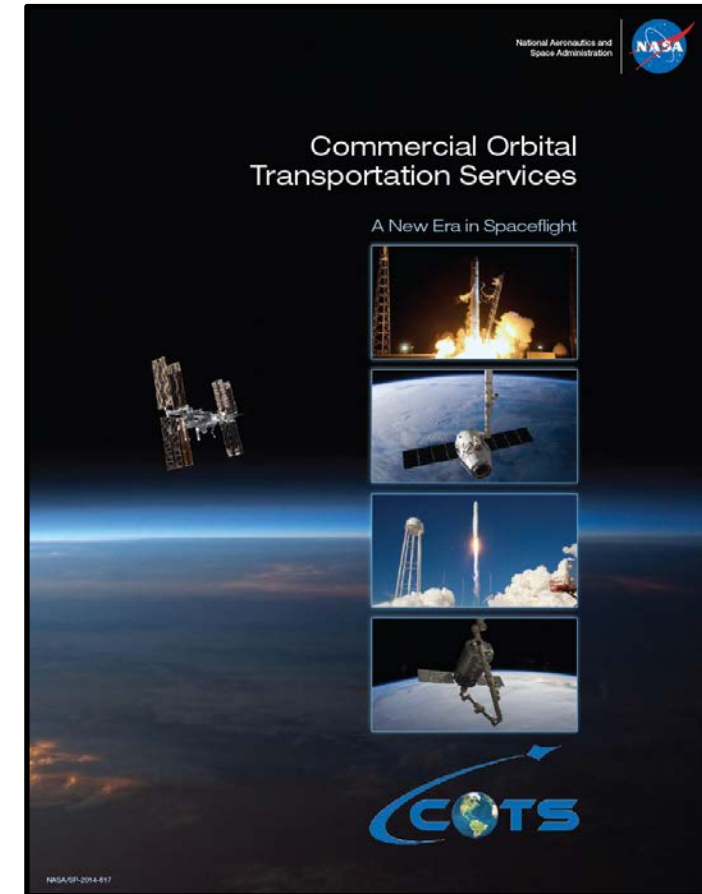
Modeled in part after NASA program that enabled SpaceX and commercial launch industry

Awardees will:

- Deliver FPP pre-conceptual designs and technology roadmaps within 18 months
- Pursue R&D to resolve S&T up to delivering FPP preliminary designs over 5 years
- Receive Federal fixed payments upon milestone completion, with significant non-Federal contributions
- Implement Community Benefit Plans in support of community/labor engagement, the American workforce, and DEIA (diversity, equity, inclusion, accessibility)



Dr. Colleen
Nehl,
FES Program
Manager



Next steps

- Milestone Program selections
- New public-sector R&D programs, aligned with FESAC LRP, to support the Milestone Program and enable commercially relevant FPP designs
- Test facilities such as a Fusion Prototypic Neutron Source
- Broad activities beyond FPP development to support eventual fusion commercialization



FESAC #1 facility priority is a Fusion Prototypic Neutron Source (FPNS) to accelerate materials development/testing and eventual licensing

Parameter	Capability Requirement by 2028 or earlier	Capability Requirement by 2032 or earlier
Damage rate	5 to 11 <u>dpa</u> /calendar year (Fe equivalent)	15 <u>dpa</u> /calendar year (Fe equivalent)
Spectrum	Gaseous and solid <u>transmutant</u> generation rates consistent with 14 MeV fusion neutron	Gaseous and solid <u>transmutant</u> generation rates consistent with 14 MeV fusion neutron
Sample volume in high flux zone	$\geq 50 \text{ cm}^3$	$\geq 300 \text{ cm}^3$
Temperature range	~300 to 1200°C	~300 to 1200°C
Temperature control	3 independently monitored and controlled regions	4 independently monitored and controlled regions
Flux gradient	$\leq 20\%/cm$ in the plane of the sample	$\leq 20\%/cm$ in the plane of the sample

Report available at <https://www.epri.com/research/products/000000003002023917>



Beyond resolving the remaining S&T challenges, we must work together with many stakeholders to enable timely fusion commercialization

- Workforce development, training, and retraining
- Regulatory, licensing, export control
- Nuclear security and nonproliferation
- Public engagement and acceptance
- Energy and environmental justice
- Supply chains and fuel supplies
- Manufacturing capabilities and scaleup
- Waste disposition/recycling
- Cybersecurity, intellectual-property protection
- Consent-based siting
- Demonstration/deployment assistance, facilitating market entry
- International coordination





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