

Twitter Thread by Guerin Green



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Bringing Fusion to the Grid 'tweetstorm'

Key Takeaways

Recommendation: For the United States to be a leader in fusion and to make an impact on the transition to a low-carbon emission electrical system by 2050, the Department of Energy and the private sector should produce net electricity in a fusion pilot plant in the United States in the 2035–2040 timeframe.

Recommendation: DOE should move forward now to foster the creation of national teams, including public-private partnerships, that will develop conceptual pilot plant designs and technology roadmaps that will lead to an engineering design of a pilot plant that will bring fusion to commercial viability.

Conclusion: Successful operation of a pilot plant in the 2035–2040 timeframe requires urgent investments by DOE and private industry – both to resolve the remaining technical and scientific issues, and to design, construct, and commission a pilot plant.



Key Takeaways

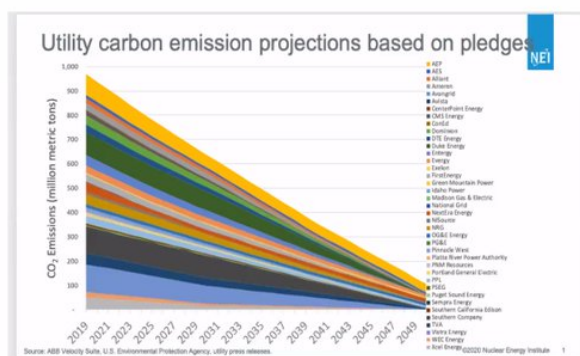
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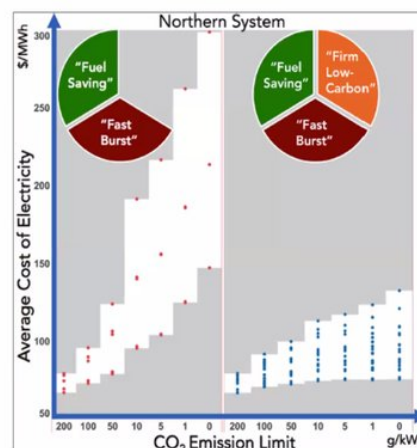
Conclusion: Successful operation of a pilot plant in the 2035–2040 timeframe requires **urgent investments by DOE and private industry** – both to resolve the remaining **technical and scientific issues**, and to **design, construct, and commission** a pilot plant.

#fusion would be key to future electrical generation mix

Role of the Pilot Plant: Future Electricity Generation Market



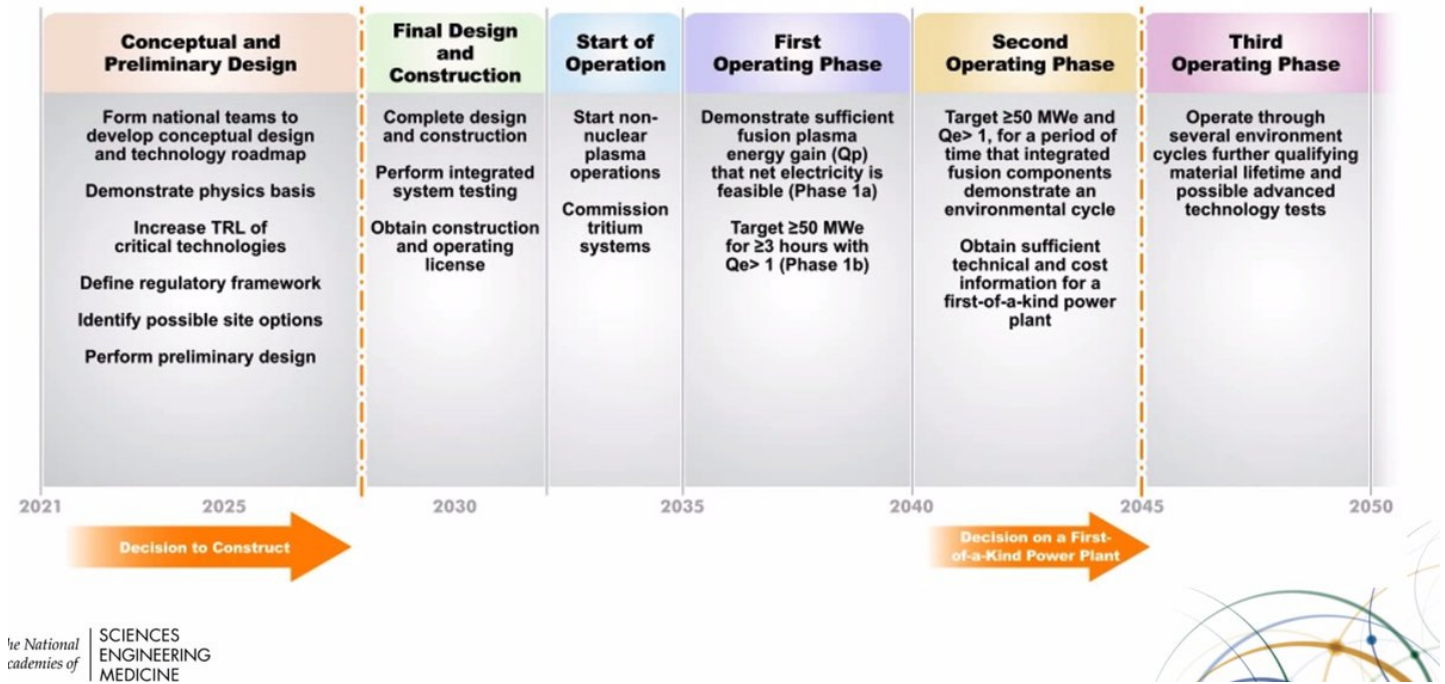
Utilities foresee a transition to low-carbon electrical generation by 2050.



Firm low-carbon/non-carbon electrical energy generation will be needed to decrease the cost.

Report suggests the beginning of #fusion operating plant as soon as end of the decade

Strategy and Roadmap



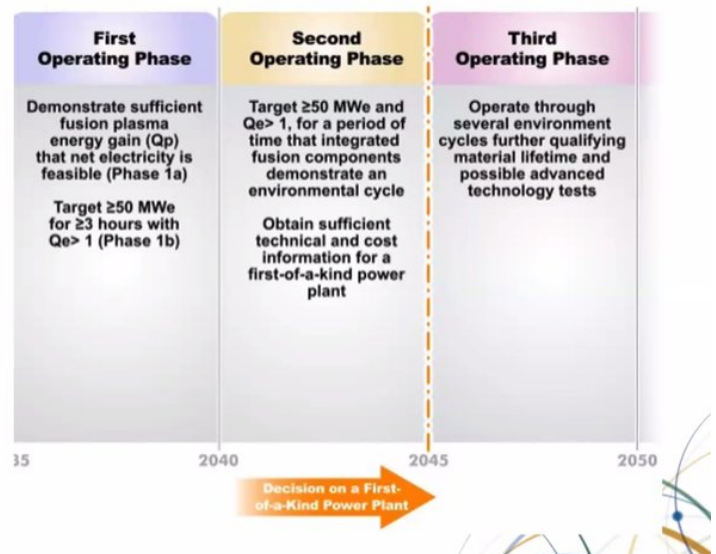
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<https://t.co/UMapDuWiTa>

Goals for a Fusion Pilot Plant: Overall Considerations for Operating Phases

Finding: The pilot plant design will need to be based on a vetted, well-established confinement physics basis for achieving net plasma gain well in excess of unity.

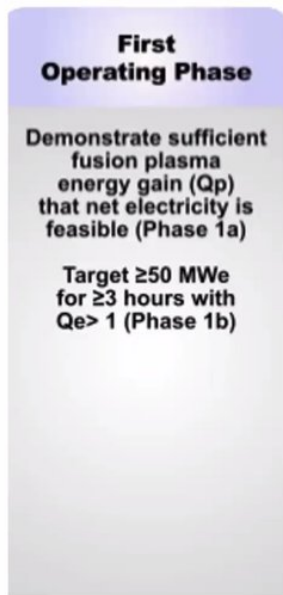
Conclusion: A pilot must produce an amount of fusion power and energy that is sufficiently representative of the market needs in order to meet the pilot's goal of demonstrated integrated performance and cost, while also demonstrating net electricity gain $Q_e > 1$ and produce peak net electrical power ≥ 50 MWe.



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Keyed to a particular fusion #fuelcycle

Goals for a Fusion Pilot Plant: Considerations for Phase 1



Phase 1a

- target 100-500 MW time-averaged thermal power for ≥ 100 s
- for pulsed concepts, operate at the design repetition rate for Phase 2

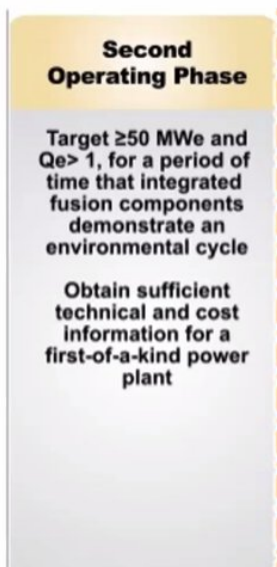
Phase 1b

- for D-T fusion, demonstrate production, extraction, and refueling of tritium on a timescale sufficient to maintain reasonable operations
- for pulsed concepts, these should be for a comparable time scale of ≥ 3 hours at the design repetition rate for Phase 2



<https://t.co/yd9hjFgLQS>

Goals for a Fusion Pilot Plant: Considerations for Phases 2 and 3

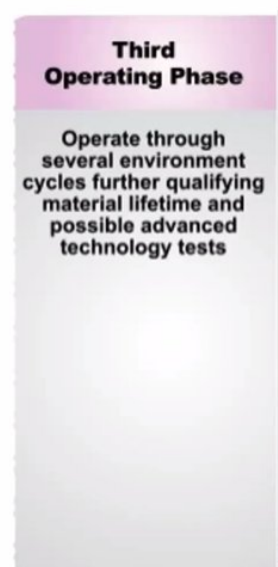


Phase 2

- demonstrate operation for an environmental cycle including maintenance
- require operation on the order of one full power year

Phase 3

- demonstrate and improve average availability for commercial fusion
- provide additional data on the mean time to failure and replacement time for materials/components
- use for testing advanced materials and technology and novel deployment of fusion to the grid



Key guidepost - pilot plant cost of \$5-6 billion

Goals for a Fusion Pilot Plant: Economic Considerations

Finding: On the basis of today's energy market and costs, the fusion **First-of-a-Kind power plant** will need to have a total overnight construction **cost less than \$5 billion to \$6 billion** in order to be viable in the present U.S. electrical marketplace with a projected **operation life of at least 40 years** for the plant.

Conclusion: A fusion pilot plant should have a **generating power >50 MWe** and total overnight construction cost **<5-6 B\$**.

Goals for a Fusion Pilot Plant: Additional Topics Addressed

- Integrated fusion and electric power performance
- Materials and manufactured components
- Fuel and Ash
 - D-T fuel cycle - need for tritium breeding
 - Alternative fuel cycles to D-T
- Reliability and availability
- Environmental and safety consideration
- Regulatory process

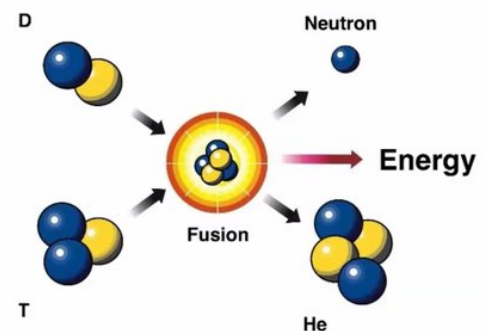


Image source: DOE

Innovation and Research Needs: Overall Innovation Strategy

Recommendation: To meet the challenge of having a viable design by 2028 and initial pilot plant operation in the 2035-2040, innovations in **fusion confinement concepts** and **technology to extract fusion power and close the fusion fuel cycle** should be **developed in parallel**. This will enable the engineering design of a pilot plant and the construction decisions to be accelerated by a combination of government and private funding.

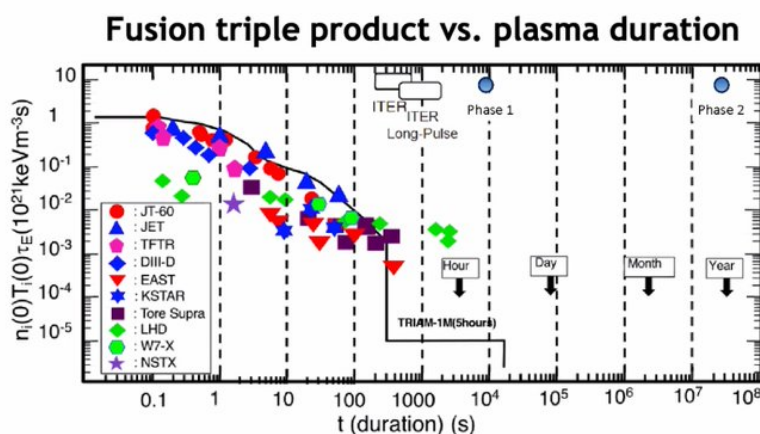
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Innovation and Research Needs: Fusion Plasma Confinement and Pulse Duration



Conclusion: Before proceeding to the final pilot plant design phase, a **DT fusion concept** should simultaneously demonstrate **temperatures of at least 100 million °C**, and a **triple product >2** (in units of 10^{21} keV s) corresponding to an **DT equivalent plasma energy gain >1**.

Conclusion: For alternate fuels, equivalent parameters needed for net plasma energy gain must be demonstrated.

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significant hurdles include basic science and materials needs

Innovation and Research Needs:

Additional Topics Addressed

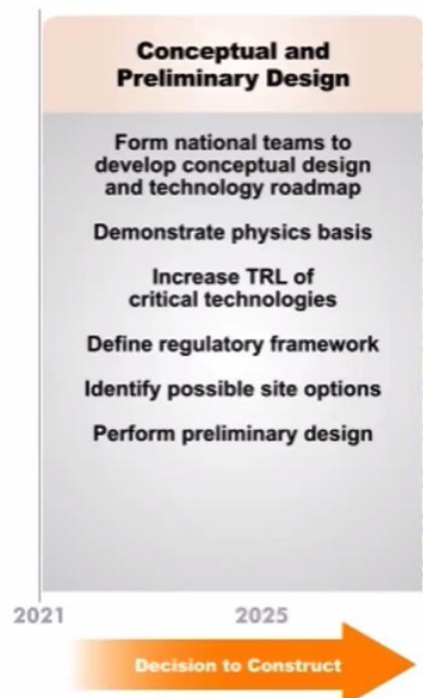
- Scientific and technical innovations and research advances
 - Fusion performance and plasma confinement
 - High heat flux challenge: plasma facing components
 - High temperature superconducting magnets
 - Structural and function materials: neutron degradation assessment
 - Closing the fuel cycle: tritium processing, developing a breeding blanket
- Many technological elements are at a low level of technical readiness
- Participants in developing a pilot plant
 - Workforce issues including Diversity, Equity and Inclusion
- Models for Public-Private Partnerships
- ITER contributions to a pilot plant



<https://t.co/O5WP346Z5m>

Strategy and Roadmap

Recommendation: The Department of Energy should move forward now to foster the creation of national teams, including public-private partnerships, that will develop conceptual pilot plant designs and technology roadmaps and lead to an engineering design of a pilot plant that will bring fusion to commercial viability.



<https://t.co/lexcg30Uku>

Strategic Risks and Opportunities

Risks

- Level of scientific and technological readiness resulting in schedule risk
- Schedule will not support the electricity transition
- U.K. or China will be first to put fusion on the grid
- Obtaining public and private funding

Opportunities

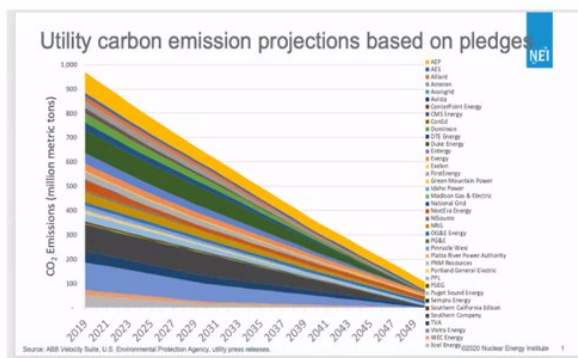
- Engagement of the private sector
- Impact the transition to low-carbon emission electricity
- Be a leader in the development of fusion energy

Mitigation

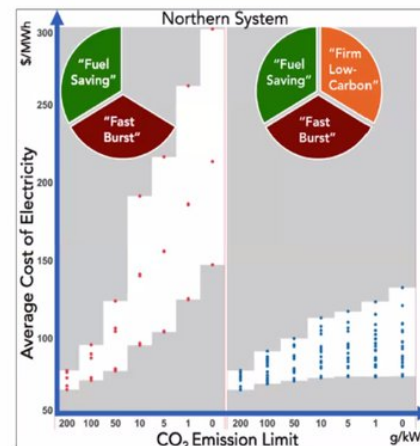
- Perform R&D in parallel with design
- Decision points to evaluate progress

<https://t.co/0pd9a8xCBY>

Role of the Pilot Plant: Future Electricity Generation Market



Utilities foresee a transition to low-carbon electrical generation by 2050.



Firm low-carbon/non-carbon electrical energy generation will be needed to decrease the cost.

Availability of #tritium - very limited worldwide supply - key hurdle and need for urgency

@threadreaderapp unroll #fusion #NAS #fusiontweetstorm