

# Towards K-DEMO in Korea

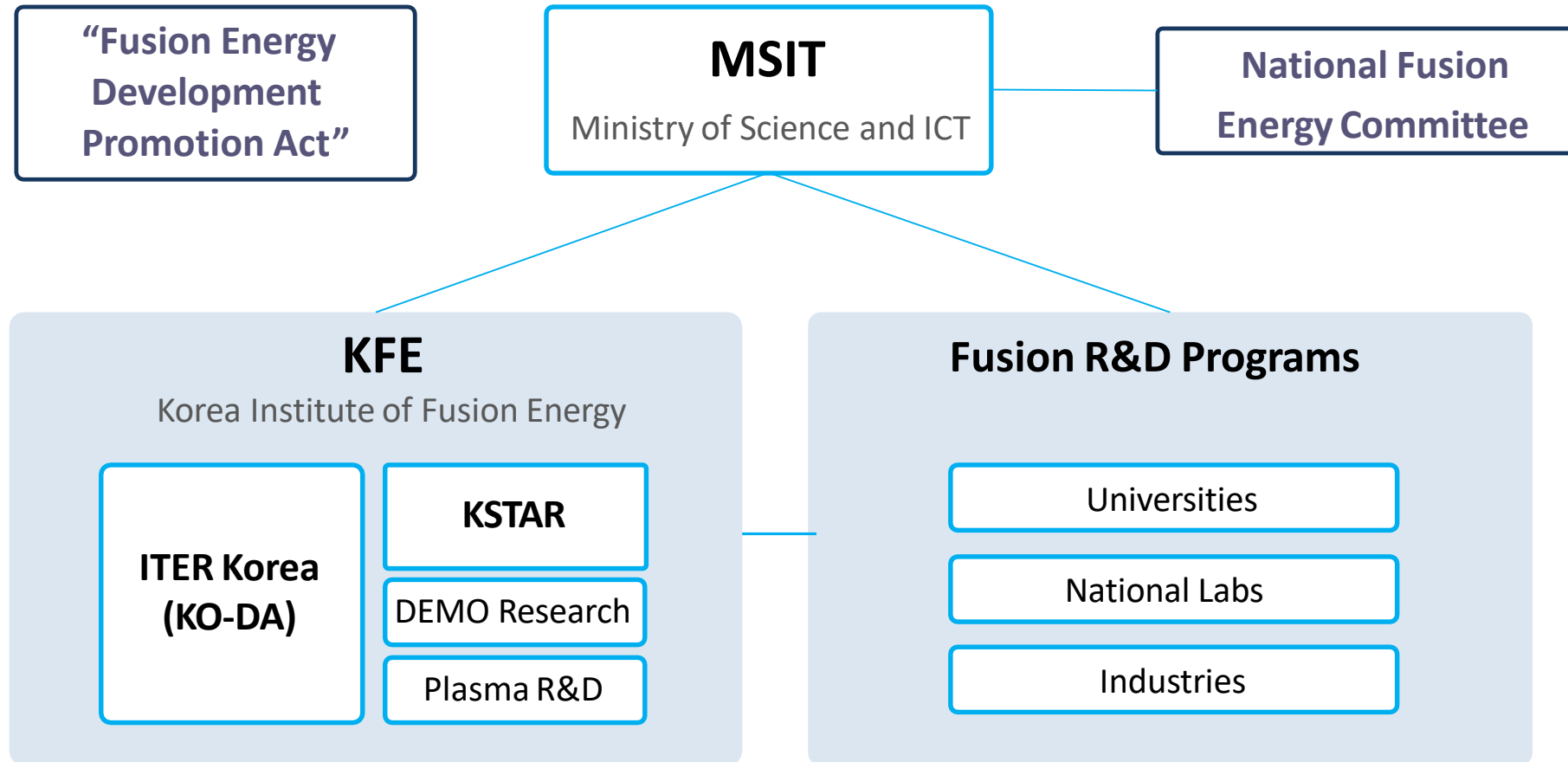
*FUSION, Future Vision of Green Energy*



**Fusion Power Associates  
44<sup>th</sup> Annual Meeting and Symposium:  
Pilot Plant fusion Power  
December 7<sup>th</sup> – 8<sup>th</sup>, 2023,  
Grand Hyatt Washington  
(hybrid in-person/remote webinar)**

**Suk Jae YOO  
December 20<sup>th</sup>, 2023**

# Framework of Fusion Energy R&D in Korea



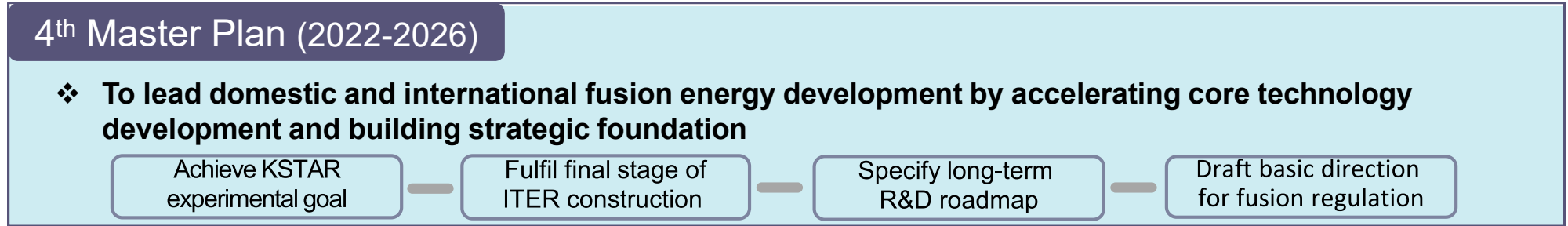
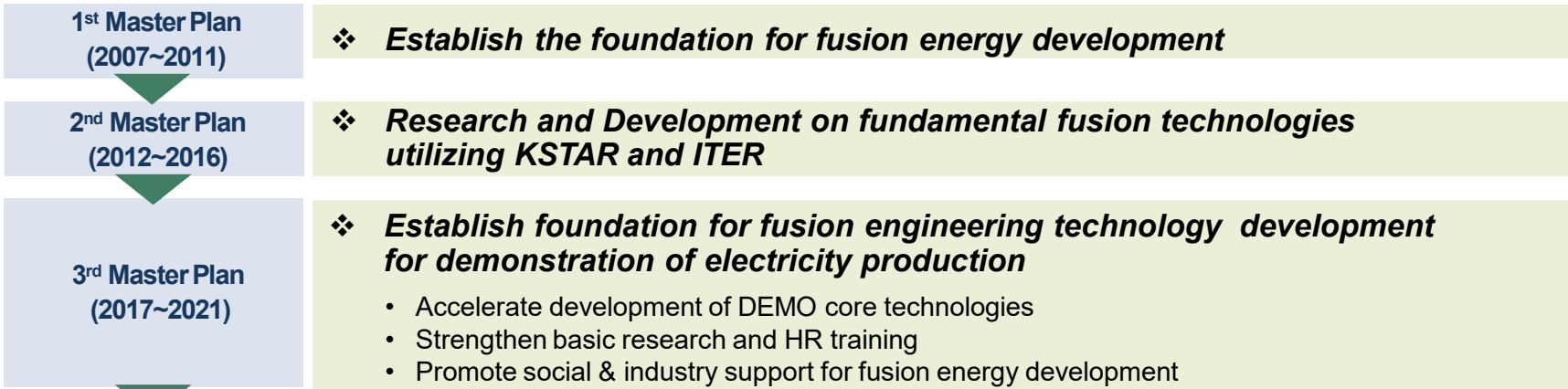
# Master Plans for Fusion Energy Development

Fusion Energy Development Promotion Act

**Article 4 (Establishment of Master Plans to Promote Development of Fusion Energy)**

- (1) In order to facilitate research and development of fusion energy, the Government shall establish a master plan...
- (2) The Minister of Science and ICT shall prepare a master plan every five years in consultation with the heads of relevant central administrative agencies and shall confirm such plan following the deliberation of the National Fusion Energy Committee under Article 6 (1).

Master Plans for Fusion Energy Development



# Important Tasks in the 4<sup>th</sup> Master Plan

## ▶ Establishment of 'DEMO Design TF' consisting of Academia, National Labs, and Industry

- DEMO design roadmap : Pre-CDA (~'26), CDA ('26~'30), EDA ('31~'35)
- More than 70 experts from industries, universities, and research institutes are expected to participate in the fusion DEMO design task force

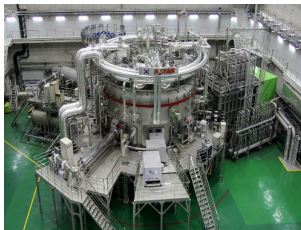
## ▶ Specify 'long-term R&D roadmap' towards K-DEMO

- To be approved by the National Fusion Energy Committee by the first half of 2024

## ▶ Development of 'gap technologies' between ITER and DEMO, and necessary facilities

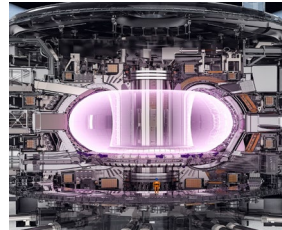
- Secure the gap and key technologies for K-DEMO

KSTAR



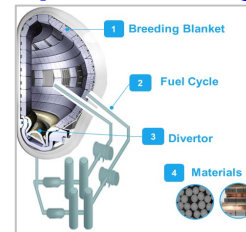
High Performance  
Plasma Control

ITER



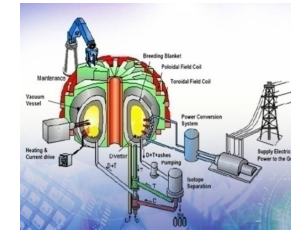
Burning Plasma  
Demonstration

Gap Technology



- ✓ Tritium self-sufficiency
- ✓ Energy extraction & conversion
- ✓ Upgrade of ITER Technology
- ✓ Safety & Licensing

K-DEMO



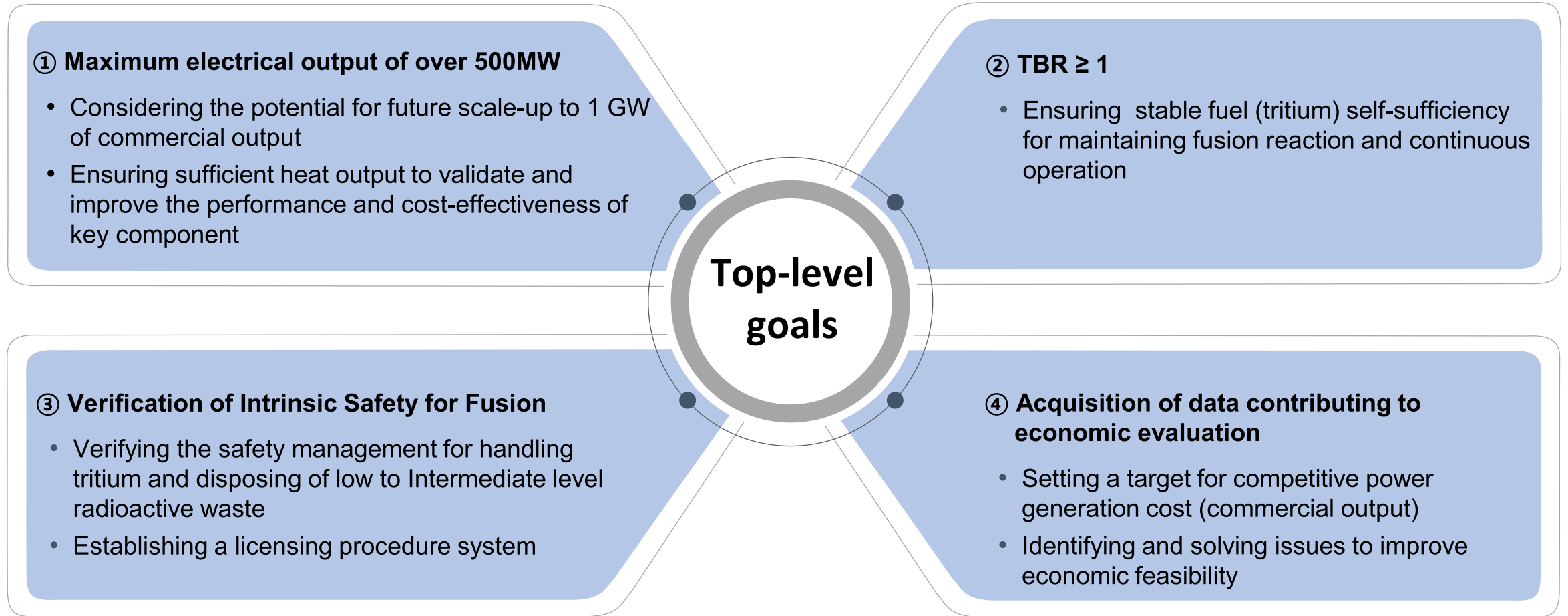
Net electricity DEMO  
Commercial Feasibility

## ▶ Establishment of 'Policy and Strategy Support Center' for Fusion Energy R&D'

- Support for ① analyzing the status of patents, personnel, and industries etc., ② establishing policies for technology development, regulatory systems etc., ③ commercializing achievements, ④ promoting international cooperation
- To be included in the fusion energy promotion act in 2024

# K-DEMO Basic Concepts

- Approved by National Fusion Energy Committee on February 2023
- To be revised and improved every 5 years as design process progresses



# Key Design Criteria and Parameters for K-DEMO

## ❖ Key design criteria

- ① Tokamak diameter :  $\leq 7$  m (to be confirmed later)
- ② Device availability :  $\geq 60\%$  (about 90% for commercial plants)
- ③ Design lifespan :  $\geq 40$  years (similar to nuclear plant)
- ④ Seismic safety standard : 7.0 (major accident criteria)

## ❖ Key design plasma parameters

Parameters	Designed	Remarks
Major radius, $R_0$	6.8 m	$< 7$ m
Minor radius, $a$	2.2 m	
Elongation, $\kappa$	$\sim 2.0$	$\kappa_{95}$
Triangularity, $\delta$	$\sim 0.6$	$\delta_{95}$
Plasma shape	SN	Backup: DN
Density ( $\langle n_e \rangle / n_G$ )	$\sim 1.2$	$n_G \sim 0.82 \times 10^{20} \text{ m}^{-3}$
Temperature ( $\langle T \rangle$ )	$> 13$ keV	
Plasma current, $I_p$	12~13 MA	
Toroidal field, $B_0$	6.5~7.5 T	
$\beta_N$	$\sim 3.5$	
Blanket	HCCP	Helium Cooled Ceramic Pebble
Heating/CD	50~60 MW	

# K-DEMO Design Activities

## ❖ Establishment of DEMO Design TF consisting of Academia, Laboratory and Industry

- ✓ Steering Committee : TF coordination. overall supervision of DEMO design
- ✓ Design Integration Team : establishing and operating design integration/change system, conceptualizing integrated systems, managing projects
- ✓ Design Advisory Committee : providing advice on DEMO design
- ✓ Working Groups : defining device-specific design requirement, executing designs

## ❖ Secure core fusion technology and achieve design objectives according to the long-term plan with Step-by-step goals

### Phase 1: ~2026

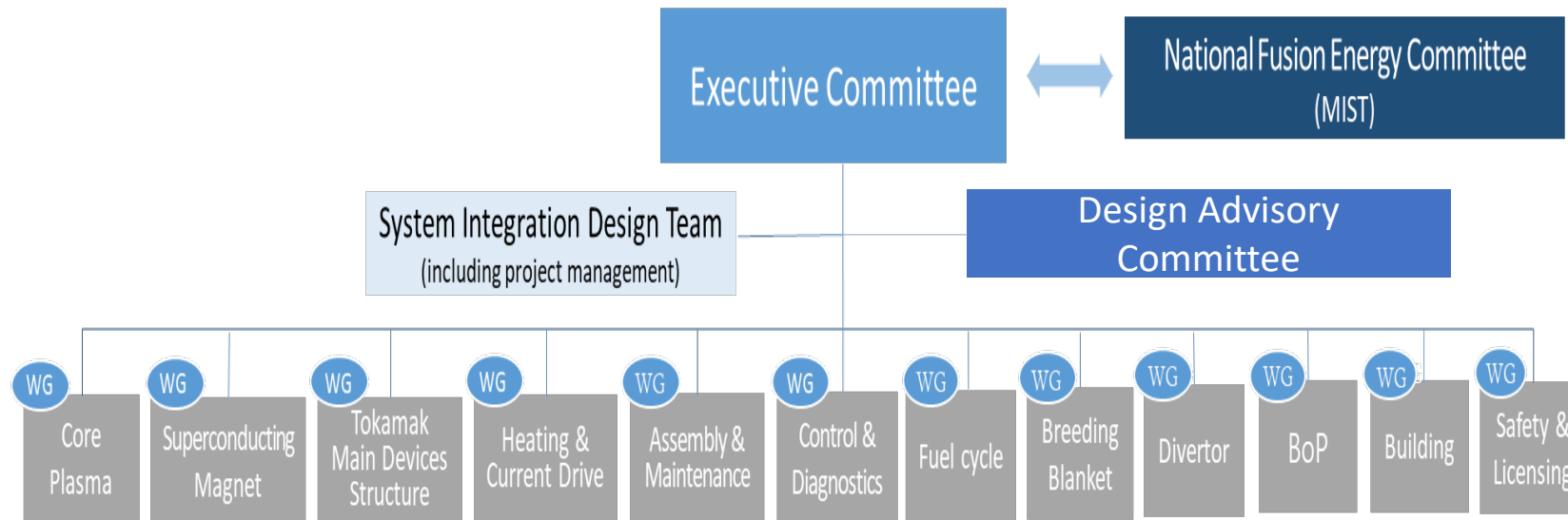
- Completion of Preliminary conceptual design and establishment of licensing system

### Phase 2: ~2030

- Completion of conceptual design and establishment of design criteria

### Phase 3: ~2035

- Completion engineering design and promotion of licensing



\* Forming WG (Working Groups) reflecting the 8 core technologies

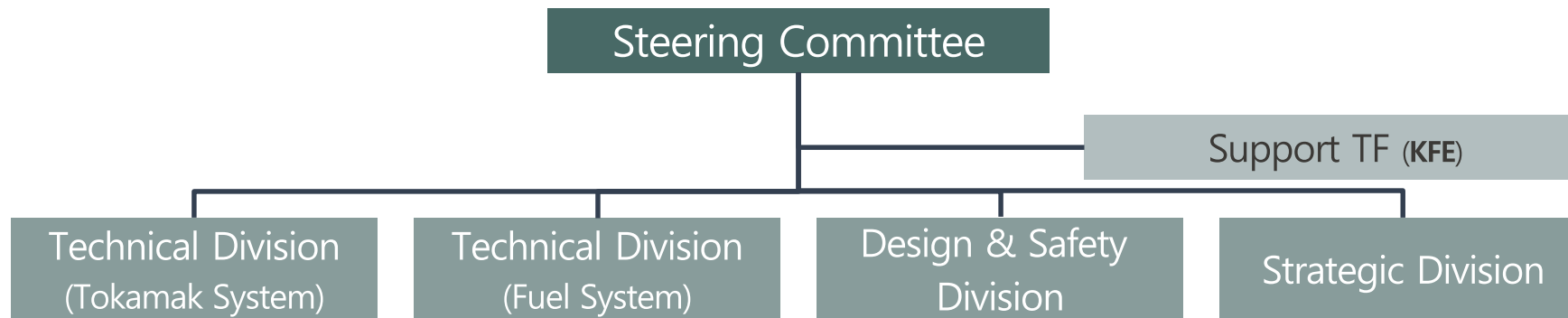
# Long-term R&D Roadmap

## ❖ Specify 'long-term R&D roadmap' towards K-DEMO

- ✓ Developing a strategy for acquisition of gap technologies based on the basic concept of K-DEMO
- ✓ Establishing Gap Technology Roadmaps through the preparation of technical reports for the Eight Core Technologies\*  
\*Core Plasma, Blanket, Material, Fuel cycle, Divertor, Heating Current drive, Superconducting magnet, Safety Approval
- ✓ To be approved by the National Fusion Energy Committee by the first half of 2024

## ❖ Committee Composition

- ✓ Joint Chairmanship of Government(MSIT) and Private Sector representative
- ✓ Operating the Steering Committee and the Expert Committee(4 Divisions)

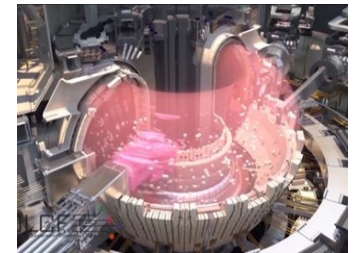
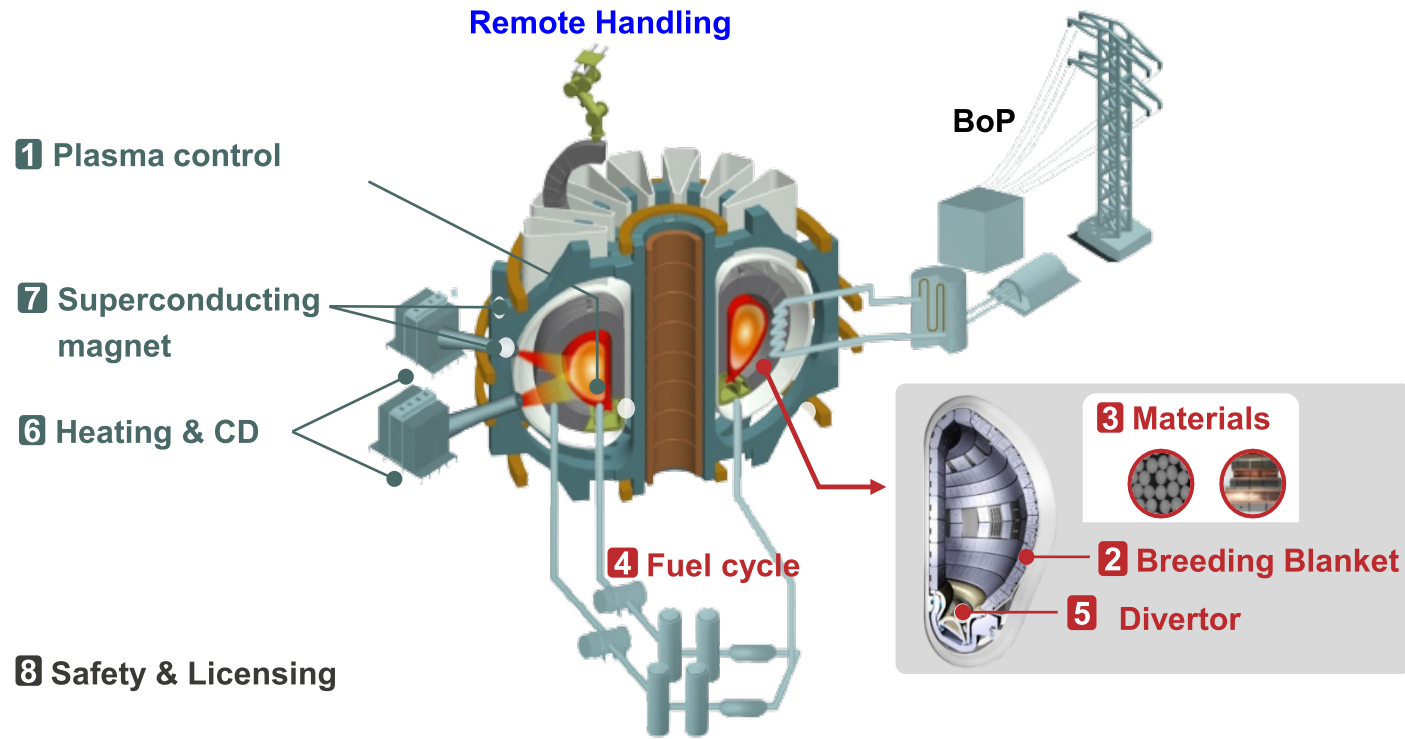




# Key Technologies to be Developed for K-DEMO

❖ 8 gap and key technologies\*, Remote handling, Virtual KSTAR for long-term development of Virtual DEMO

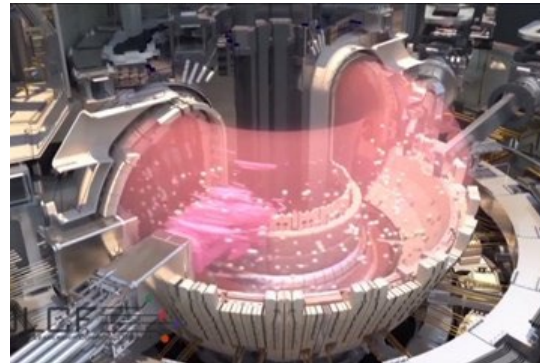
1	Plasma Control
2	Breeding Blanket
3	Materials
4	Fuel Cycle
5	Divertor
6	Heating & CD
7	Superconducting Magnet
8	Safety & Licensing



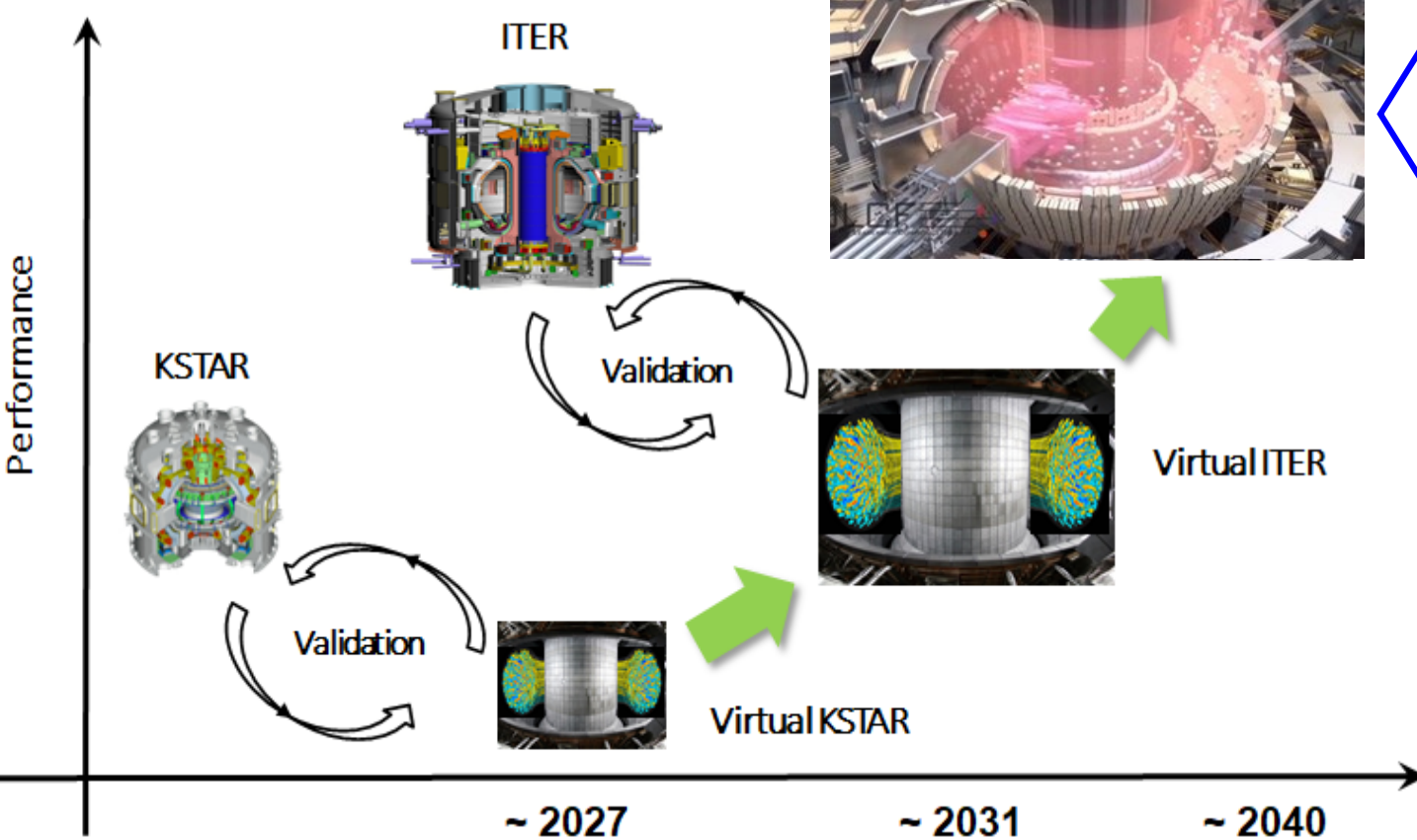
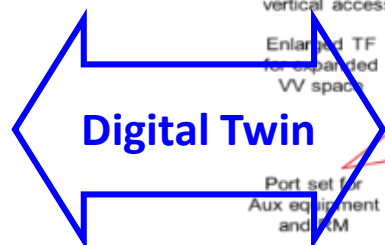
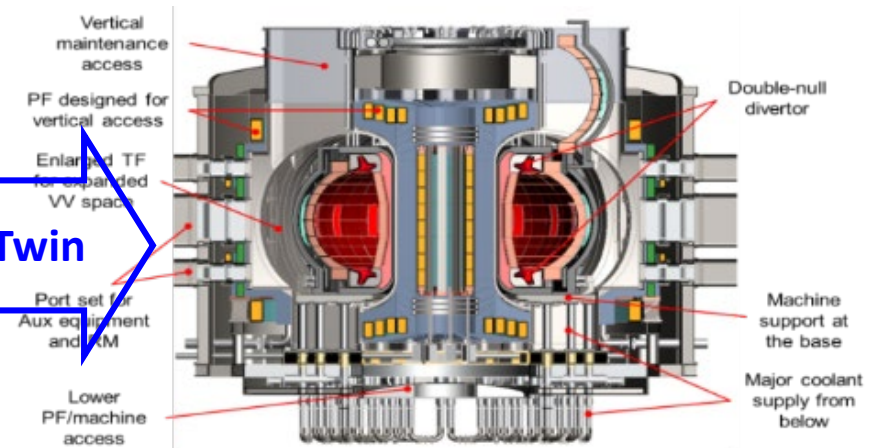
\*The 8 gap and key technologies were selected in the 4<sup>th</sup> Master Plan

# Development of Virtual DEMO

## Virtual DEMO

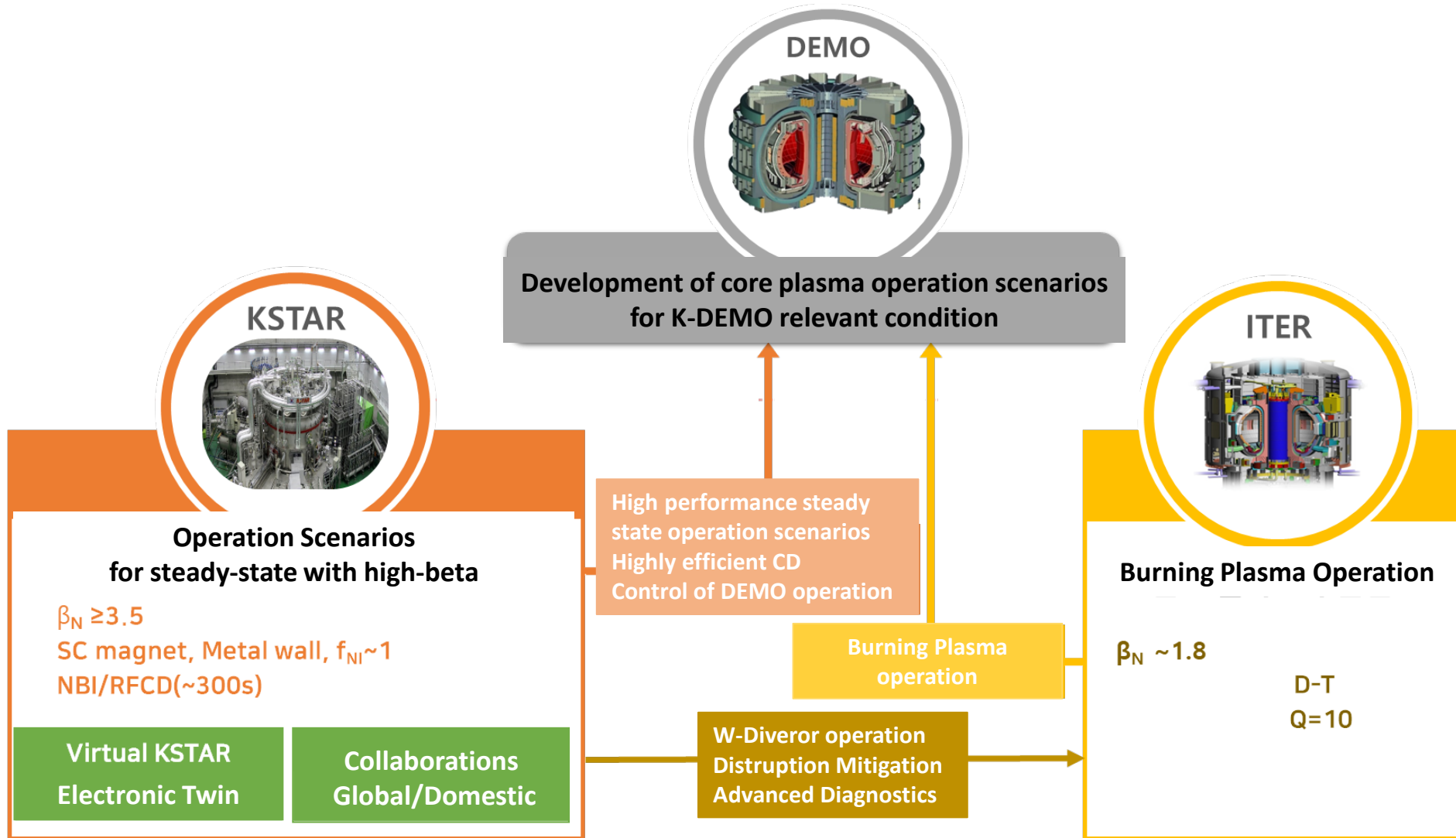


## Real DEMO



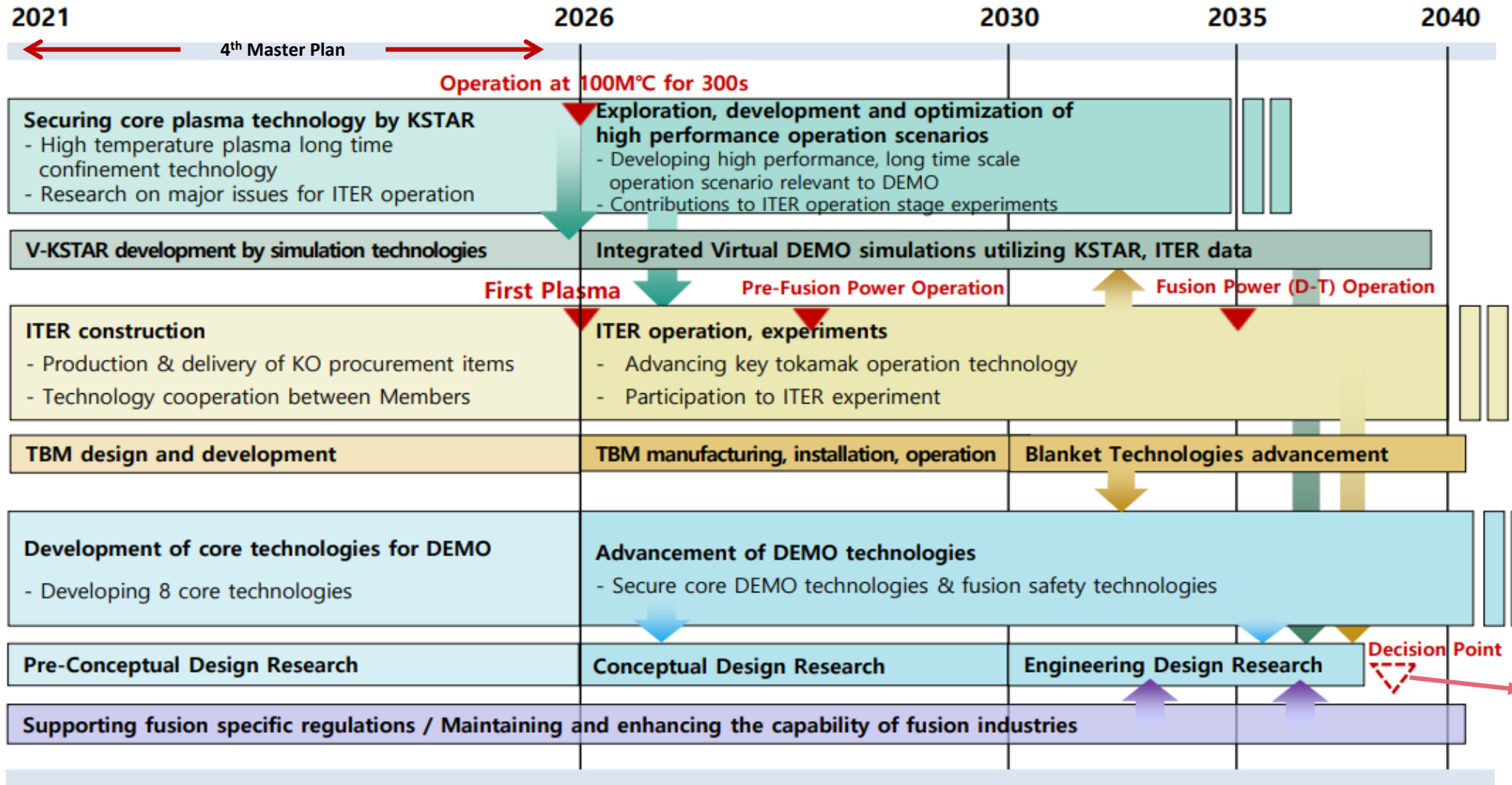
- Optimization of DEMO design (simulations), Reduction of construction risks and costs

# KSTAR's Strategic Role for K-DEMO



# Summary: Timeline for Fusion Energy Development

- Rolling plan for fusion electricity demonstration by 2050s (to be established every five years)



Based on the ITER achievement (Q=10), K-DEMO construction will be determined.

에너지강국

# 해가 답입니다.

바닷물로 만드는 해

핵융합에너지가 에너지 문제 해결의 답입니다

*Artificial Sun, producing energy from seawater,  
is the **Solution** to the energy problem*

*Thank you for your attention*

