



**IAEA**

International Atomic Energy Agency

*Atoms for Peace and Development*

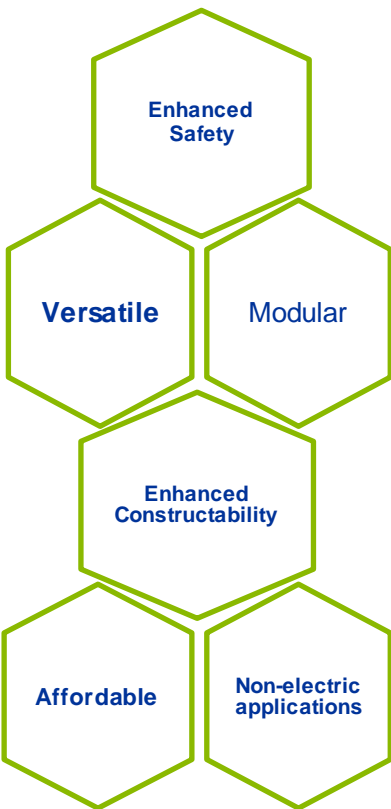
ABDAN-WNA Mini Course on SMR and Microreactors at Nuclear Summit 2022,  
26 – 28 April 2022 (Virtual Event)

# **Implementation and Deployment Issues: Technology Roadmap for SMR Deployment**

**Benoît LEPOUZÉ**

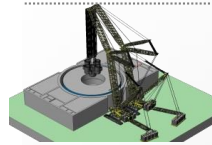
*Senior nuclear expert - Nuclear Power Technology Development*  
**Division of Nuclear Power, Department of Nuclear Energy**

# Development Objectives of SMRs



## Economic

- Lower Upfront capital cost
- Economy of serial production



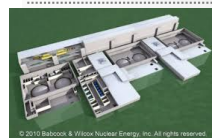
## Modularization

- Multi-module
- Modular Construction



## Flexible Application

- Remote regions
- Small grids

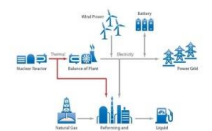


## Smaller footprint

- Reduced Emergency planning zone



## Replacement for aging fossil-fired plants



## Potential Hybrid Energy System

Better Affordability

Shorter construction time

Wider range of Users

Site flexibility

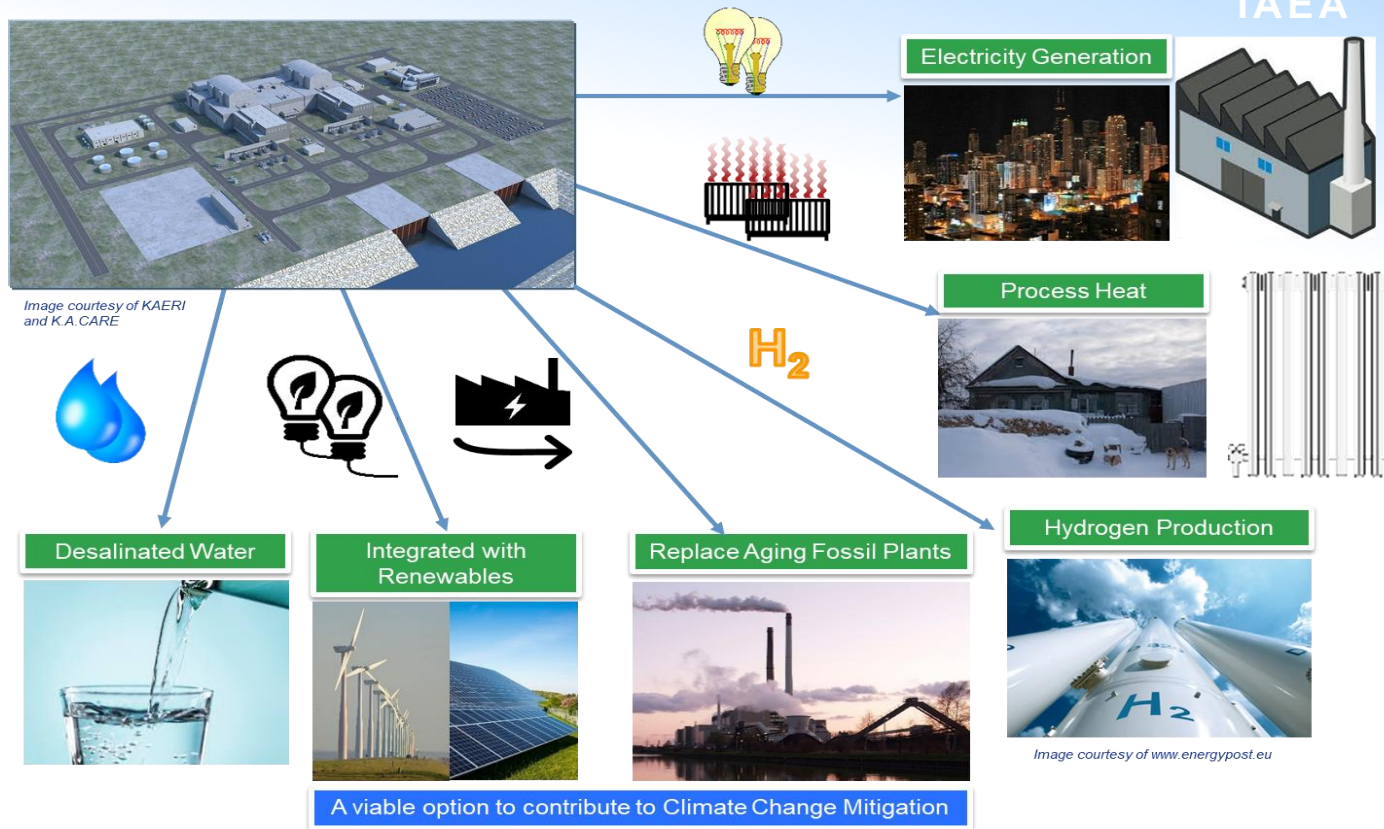
Reduced CO<sub>2</sub> production

Integration with Renewables

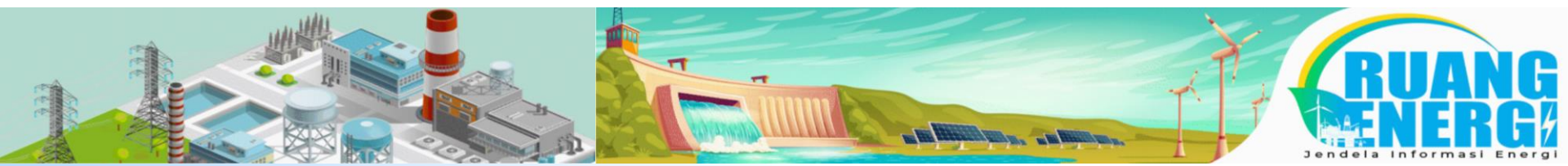
# Driving Factors & Opportunities for SMRs



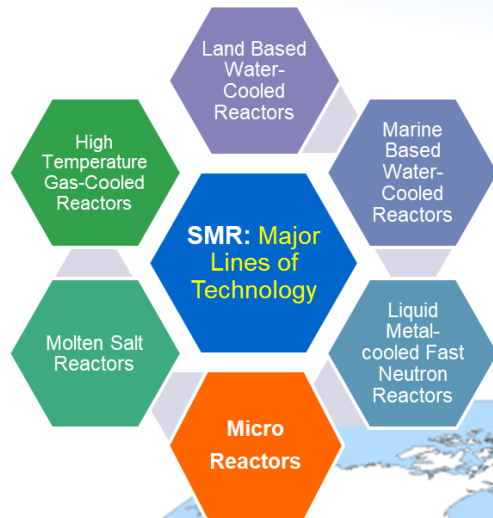
- Cost Affordability**  
Small Power, Innovation, Standardization
- Short Construction Span**  
Design Simplification, Modularization
- Energy Resilience**  
Flexibility and ensured energy supply
- Energy Sustainability**  
Hybrid with Renewables, Replace Retiring Fossil Plants



Typically up to 300 MWe, High Degree of Modularity, Option to Energy Supply in Countries with Smaller Grids; Contribute to Climate Change Mitigation



# 70+ SMR Designs in the World



**Land Based Water Cooled Reactors**

CAREM	SMART	RUTA-70	DHR400
ACP100	UNITHERM	NuScale	RITM-200
CAP200	VK-300	mPOWER	NUWARD
IRIS	KARAT-45	W-SMR	BWRX-300
DMS	KARAT-100	SMR-160	HAPPY200
IMR	ELENA	UK-SMR	CANDU SMR

**Micro Reactors**

IHTR	MMR-5
IMSB	MMR-10
eVinci	AURORA
U-Battery	MoveluX

**Fast Reactors**

4S	W-LFR	SSTAR LFR
BREST-OD-300	SEALER	URANUS
SVBR-100	LFR-AS-200	ARC100
EM <sup>2</sup>	LFR-TL-X	

**High Temperature Gas-cooled Reactors**

HTR-PM	MHR-100	XE-100	HTTR-30
DPP-200	PBMR-400	A-HTR 100	HTR-10
GT-MHR	HTMR-100	MMR	RDE
MHR-T	SC-HTGR	GTHTR300	StarCore

**Marine Based Water Cooled Reactors**

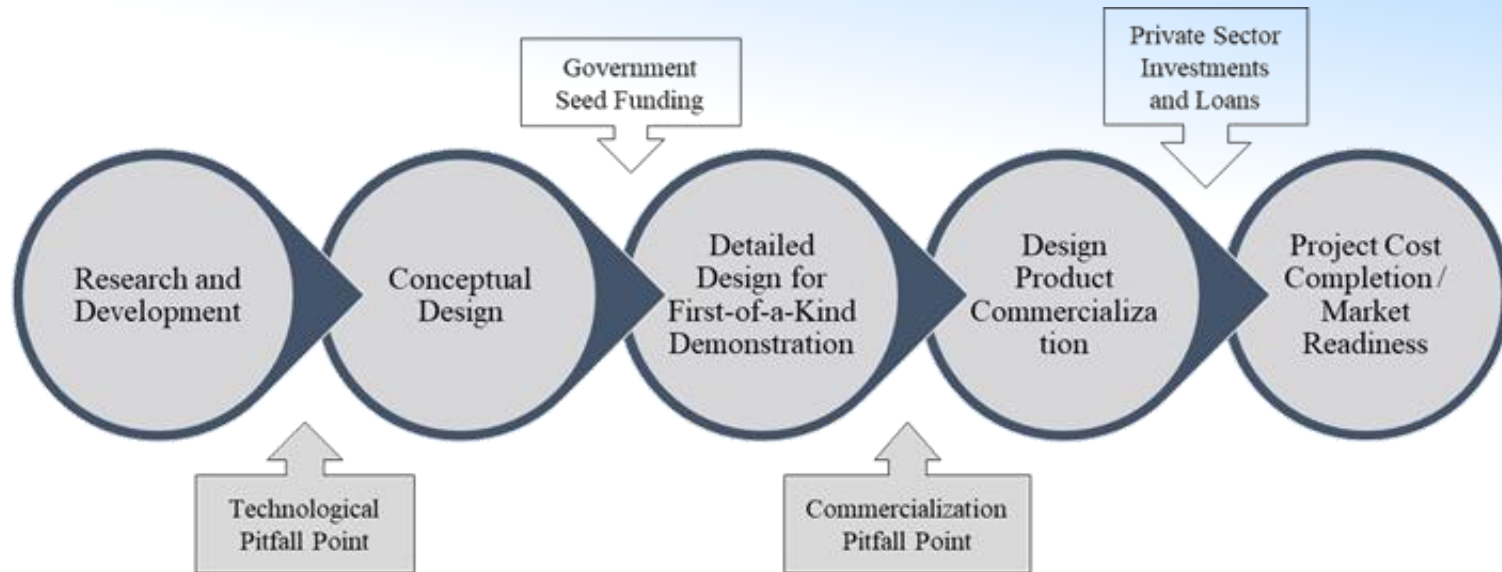
ACPR50S	VBPR-300
KLT-40S	ABV-6E
RITM-200M	SHELF

**Molten Salt Reactor**

IMSR	SSR-WB	CA WB
CMSR	SSR-TS	KP-FHR
THORCON	LFTR REACTOR	MCSFR
FUJI ITMSF	MK1 PB-FHR	



# Technology Roadmaps for SMR Deployment



## IAEA Nuclear Energy Series NR-T-1.18: Technology Roadmap for SMR Deployment

Organization	Department of Nuclear Energy, Nuclear Power Technology Development Section
Objective	To provide Member States with several 'model' technology roadmaps to be adapted for their specific SMR deployment projects
Structure and content	<ul style="list-style-type: none"> <li>Current status of SMR deployment, the importance of infrastructure development, and summary of different types of technology roadmap</li> <li>Impediments to deployment of SMR Technology</li> <li>Presents Roadmaps that can be either followed or adopted with adjustment to suit specific needs of Member States</li> </ul>
Publication date	August 2021: <a href="https://www.iaea.org/publications/14861/technology-roadmap-for-small-modular-reactor-deployment">https://www.iaea.org/publications/14861/technology-roadmap-for-small-modular-reactor-deployment</a>

# NE Series No. NR-T-1.18 (8/2021)



IAEA Nuclear Energy Series

No. NR-T-1.18

## Technology Roadmap for Small Modular Reactor Deployment

Basic  
Principles

Objectives

Guides

Technical  
Reports



## SMRs and the Technology Roadmap

Current Deployment Status, Nuclear Power  
Infrastructure, Techno Roadmap Concept



## Prospects, Impediments & Indicators

Issues, Impediments, Indicators of SMR Deployment,  
Stakeholders, Regulatory Frameworks



## Technology Roadmap for Near Term Deployable Small Modular Reactor Technology

Generic Roadmaps for: (1) Owner/Operating  
Organization and (2) Designer/Supplier

Limited Hardcopies are available. Public download from this link:

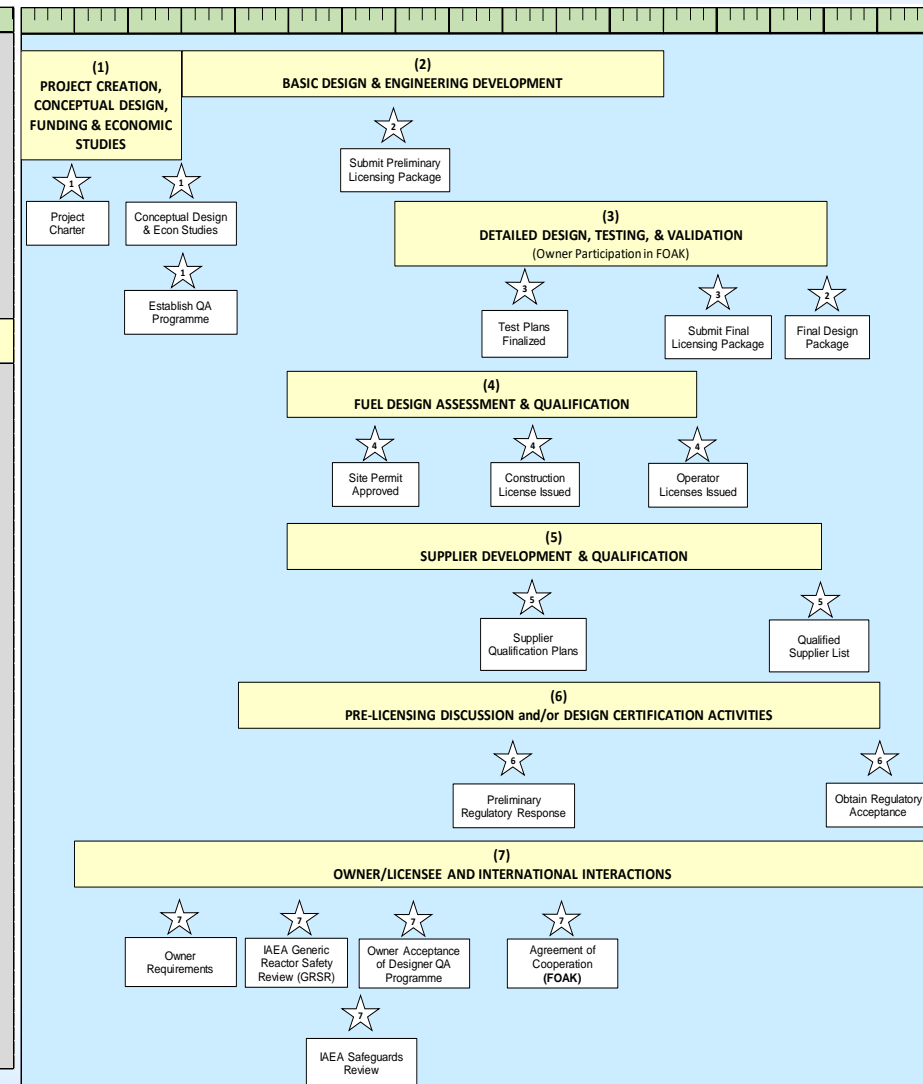
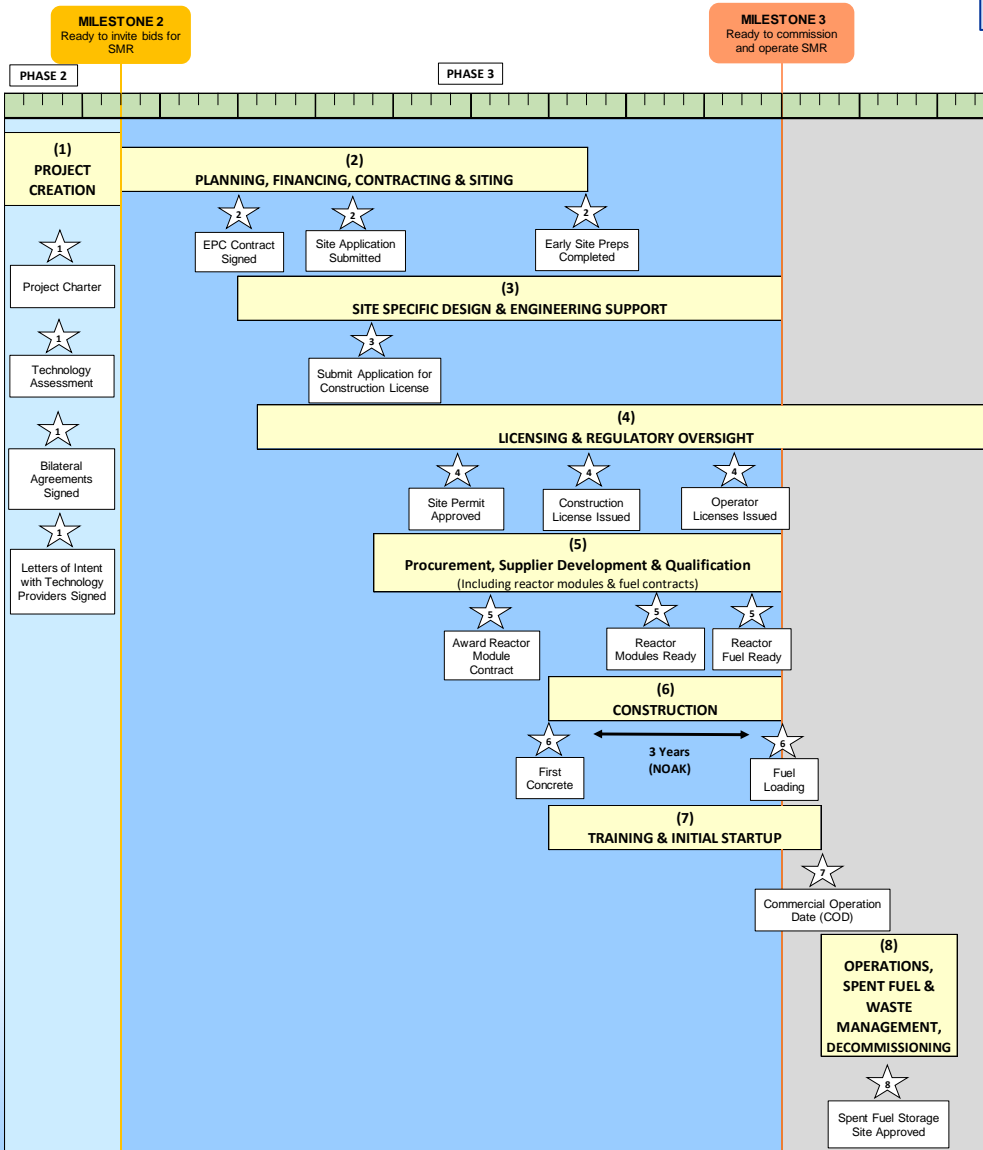
<https://www.iaea.org/publications/14861/technology-roadmap-for-small-modular-reactor-deployment>

# Technology Roadmaps for SMR Deployment



## Roadmap #1 for Owner/Licensee of SMR

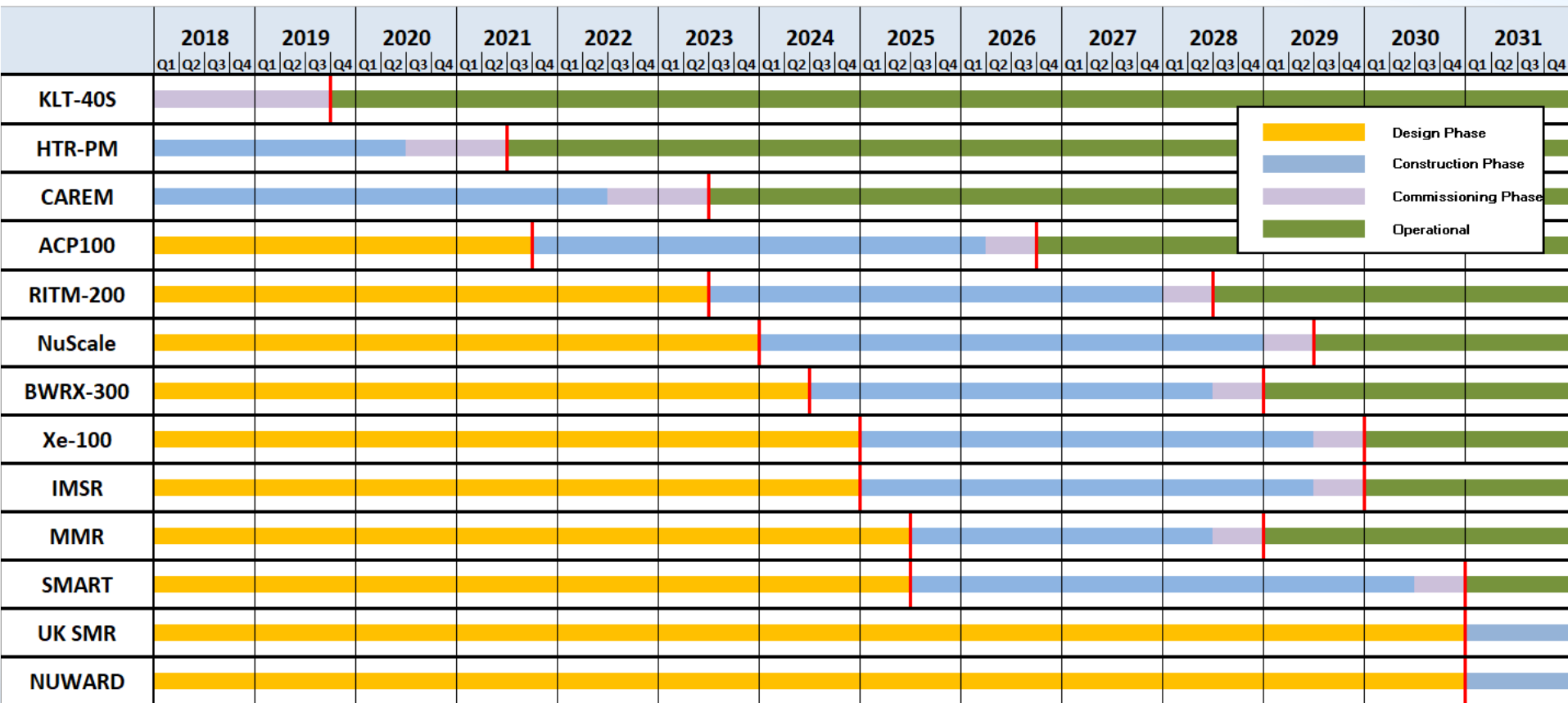
## Roadmap #2 for designer/vendor of SMR



# Technology Roadmap for SMR Deployment



## IAEA Nuclear Energy Series NR-T-1.18: Technology Roadmap for SMR Deployment

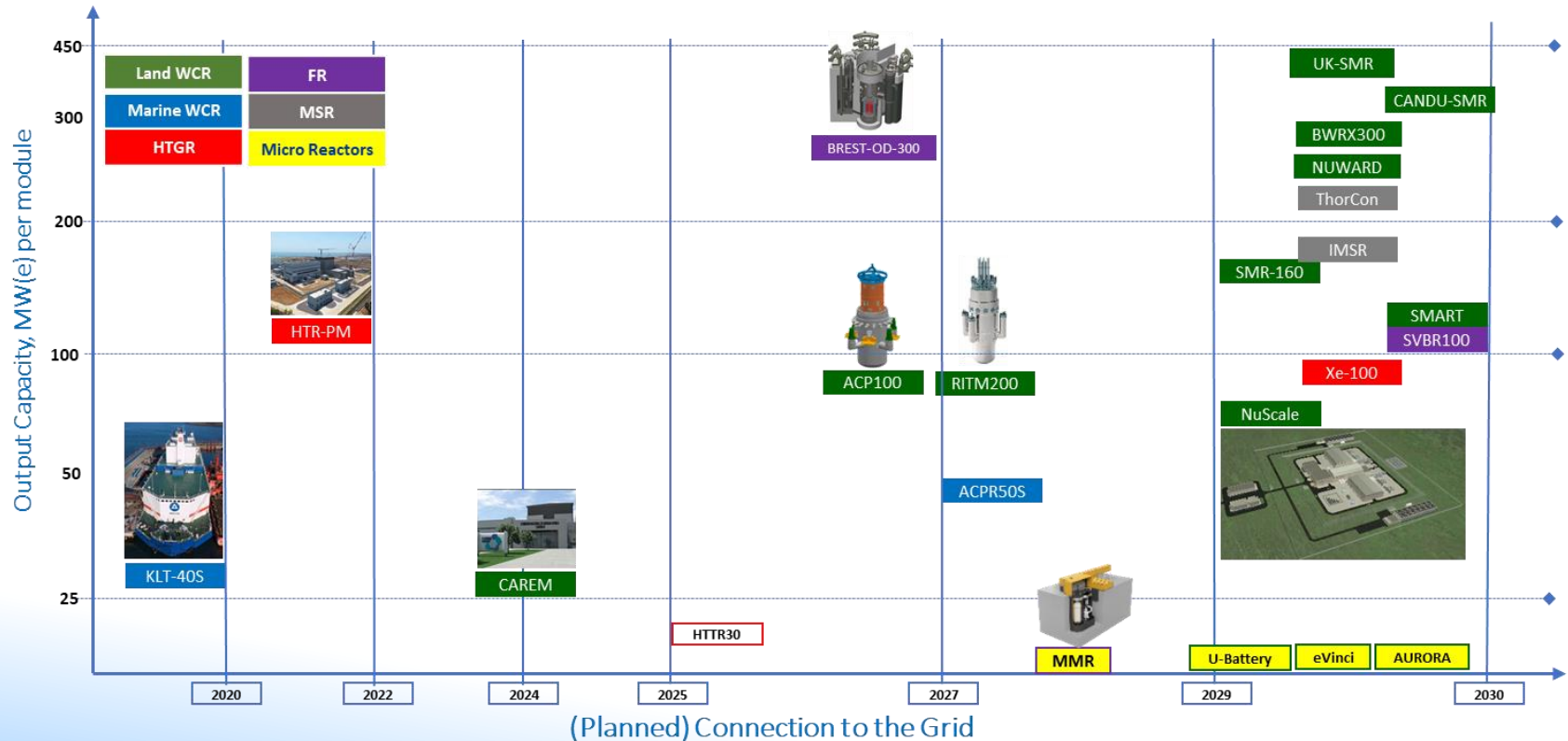


Timeline of Deployment of some SMR designs up to 2030/2031 that reflects the Technology Roadmaps for Owner/Licensee and Technology Developer



# First 10-year Deployment Horizon

The four (4) SMR Forerunners: 2 in operation, 2 under construction



# Codes & Standards – Applicability to SMRs



## Key Advantage #1: Enabling Design Simplification

- Minimized number of systems and components without compromising safety;
- Simplification to improve economics, maintainability and availability of components – without compromising safety.

## Key Advantage #2: Confirm a robust supply chain:

- Assure 'diverse' supply for replacement by manufacturers other than the original manufacturers;
- Improve the assurance of sustainable operation of the nuclear power plant.

## Findings on Standardization:

- Standardization alone will not solve all issues in advanced reactor product development;
- *Excellence* in applying *advanced manufacturing* and *NDE techniques* are often proprietary; not readily shareable or standardized because it would benefit competitors
- The biggest challenge to quality product is to having the capability of designing, manufacturing and delivering, within time and budget, products that meet the requirements

SMR Development should increasingly apply codification and standardization of Advanced Manufacturing Techniques to realize high degree of Modularity

# Prospects and Actions for Deployments

Demonstration of Safety and Operational Performance of FOAK, Novel Designs & Technologies

Continuity of Orders, cost competitiveness against alternatives, robust supply chain, and viable financing Option

## SMR Deployment Competitiveness

Regulatory framework, licensing pathways: global deployment, need of harmonization?

Development of Nuclear Infrastructure for near-term deployment particularly in Embarking countries





# IAEA

International Atomic Energy Agency



8 December 1953



1 to 23 October 1957



11 December 1957



1959



10 December 2005



1958 to 1979



23 August 1979

## *Thank you for your attention!*

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*Atoms for peace and Development...*