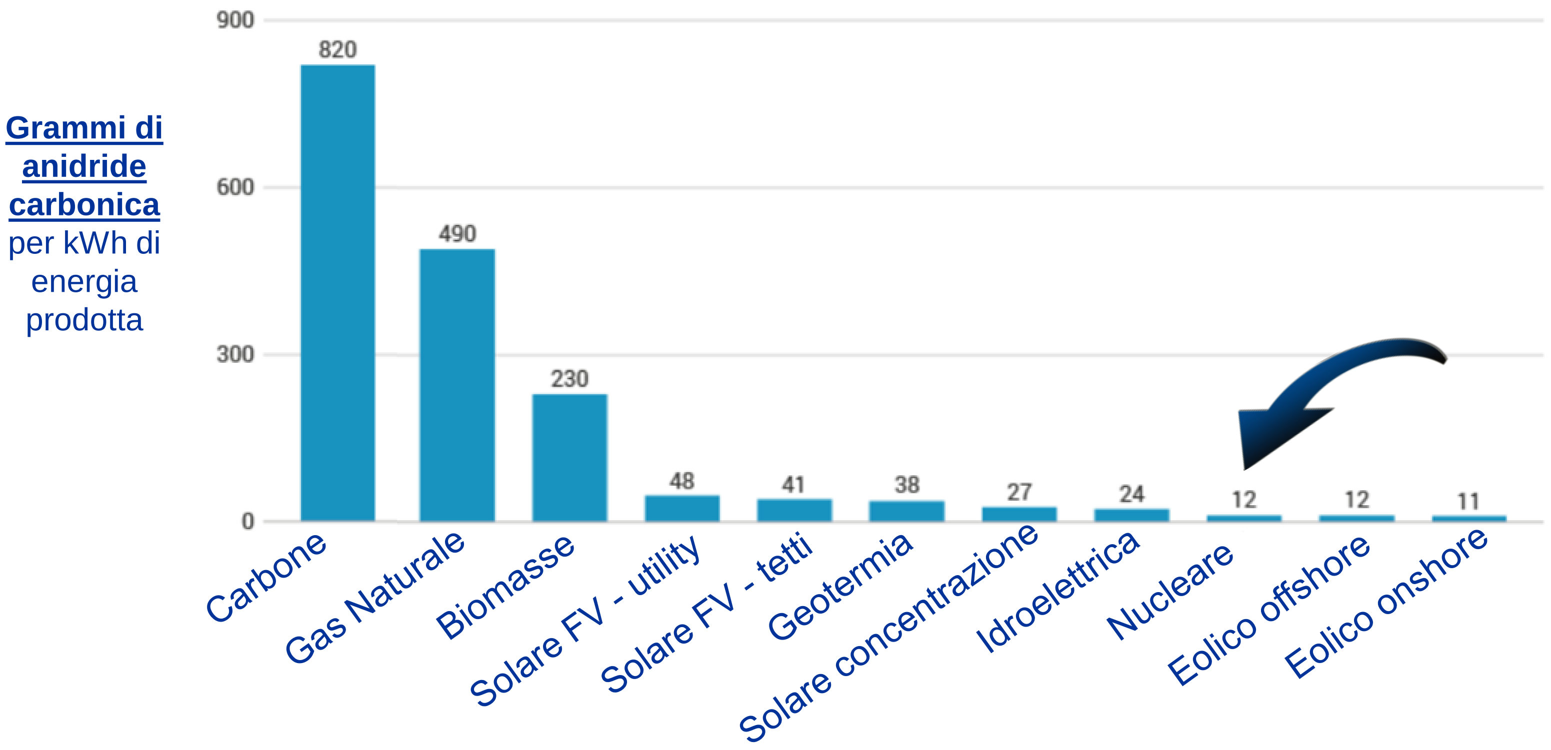
IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Webinar AIN: Il nucleare nel futuro prossimo della transizione energetica
7 maggio 2021

La roadmap verso i nuovi reattori avanzati

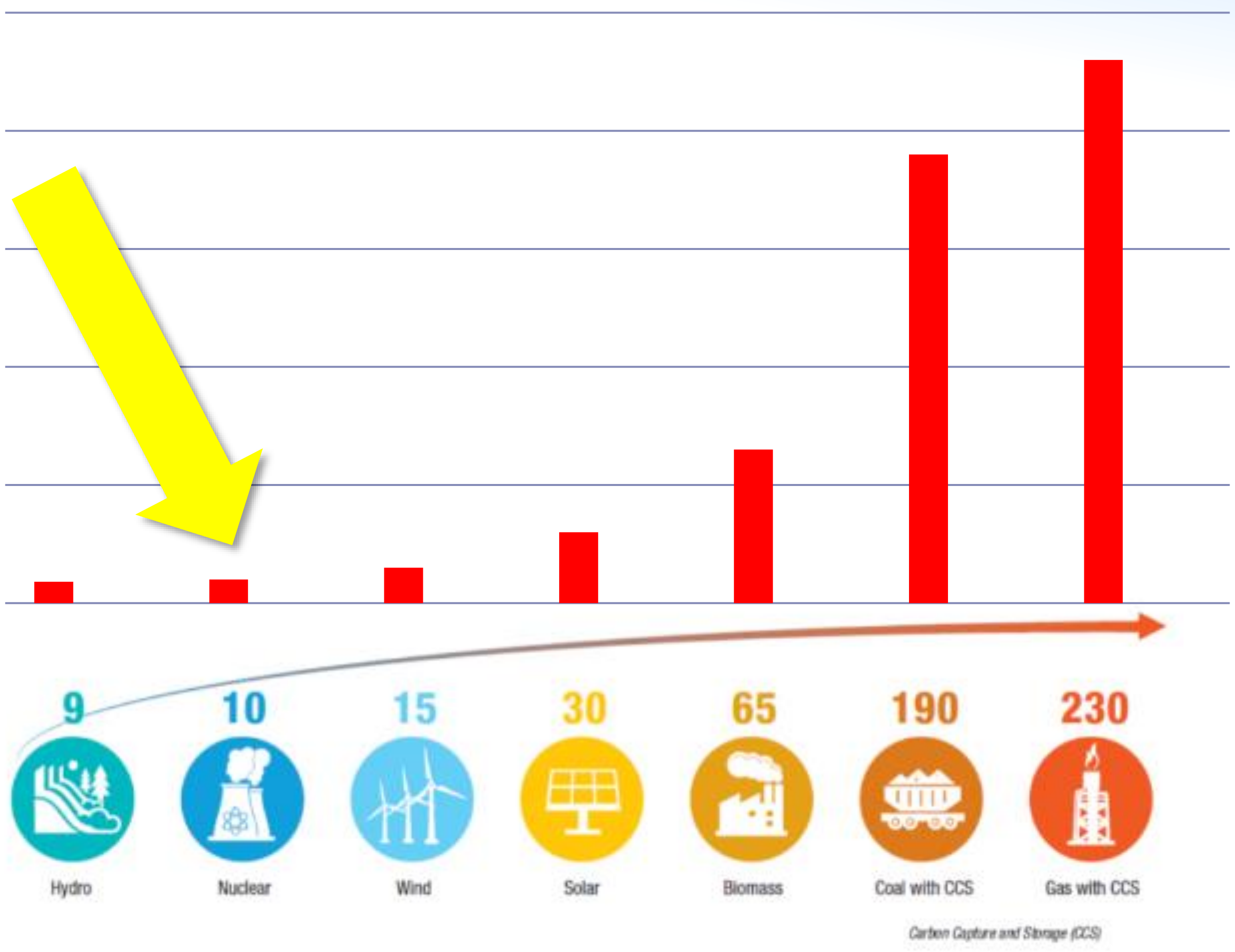
Stefano Monti
Nuclear Power Technology Development – Section Head
Department of Nuclear Energy

Greenhouse gas emissions from various primary energy sources



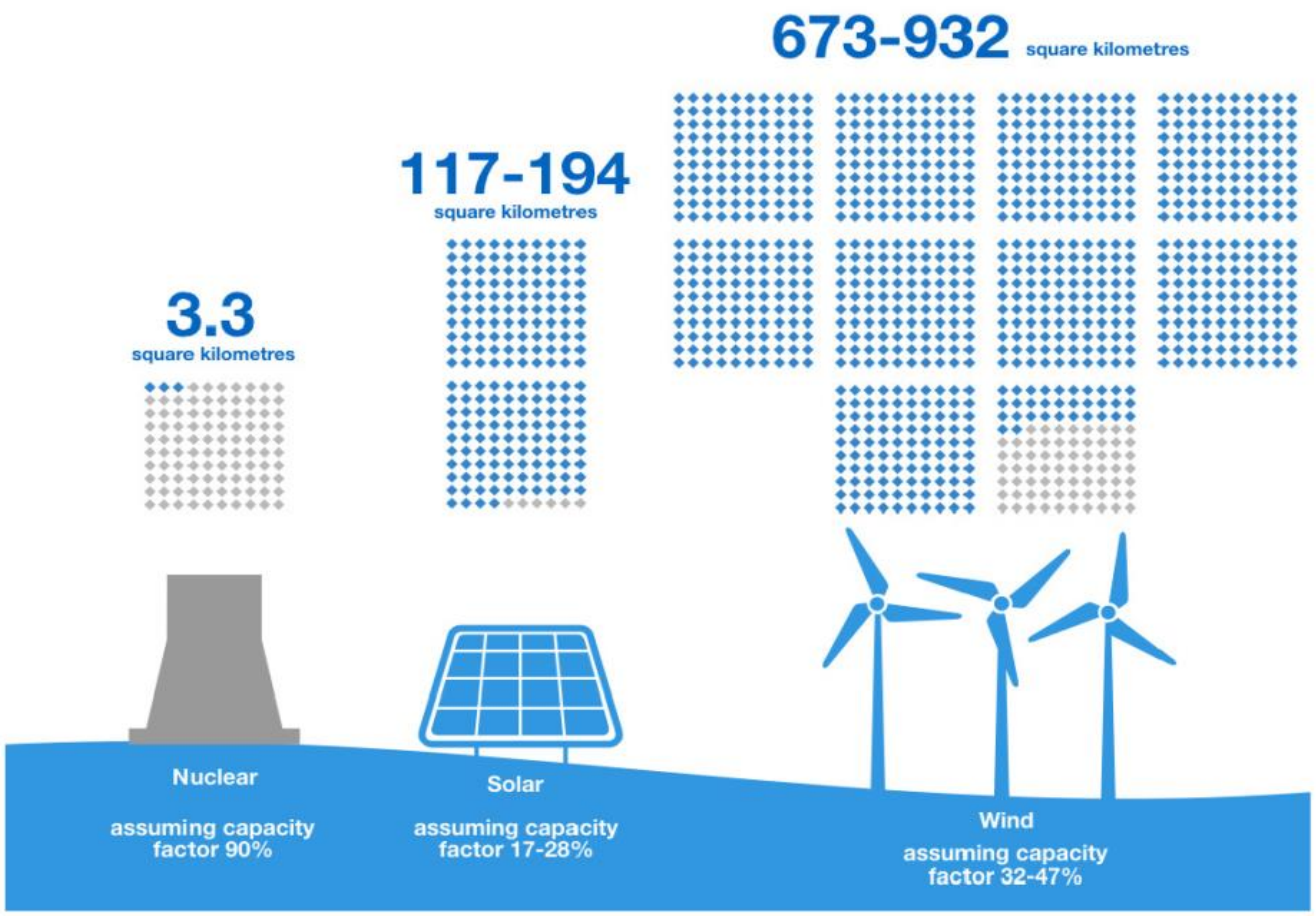
Emissioni di anidride carbonica media sul ciclo di vita per diverse fonti energetiche (fonte IPCC Panel Intergovernativo per i Cambiamenti Climatici)

Life cycle GHG emissions

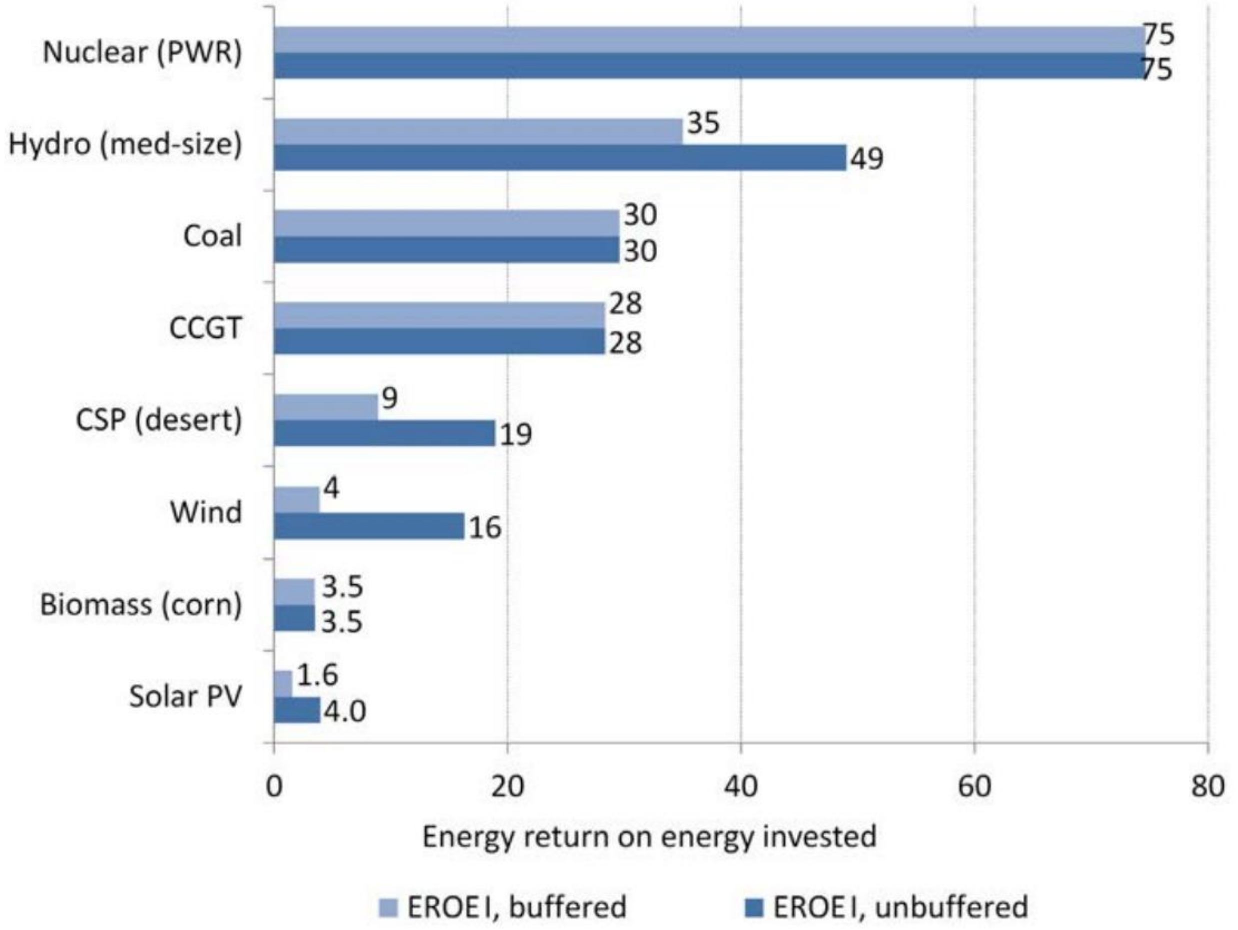


Land Footprint

For 1000 MW(e) installed capacity

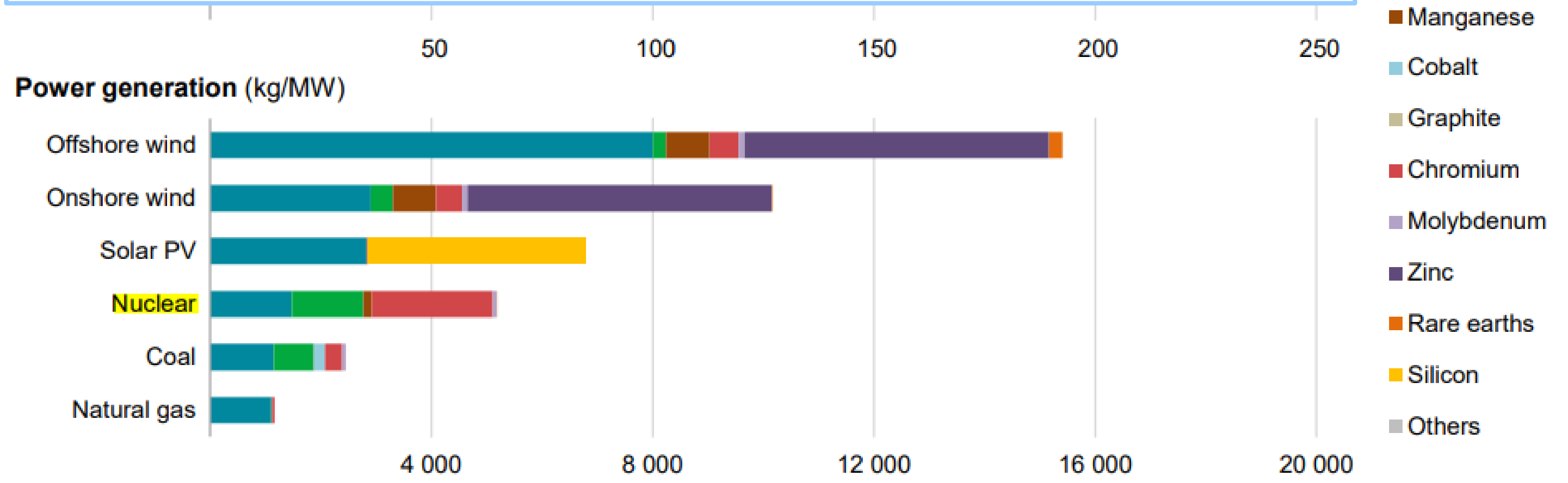


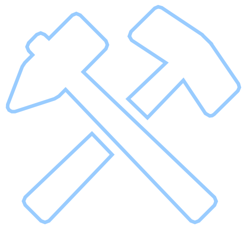
Energy return on energy invested



Mineral resources requirement

Offshore wind plant requires thirteen times more mineral resources than a similarly sized gas-fired power plant and three times more than Nuclear





Nuclear is also consuming a lot of Chromium, which other power plants don't require

Source: IEA

Critical mineral needs

	Copper	Cobalt	Nickel	Lithium	REEs	Chromium	Zinc	PGMs	Aluminium*
Solar PV	●	○	○	○	○	○	○	○	●
Wind	●	○	◉	○	●	◉	●	○	◉
Hydro	◉	○	○	○	○	◉	◉	○	◉
CSP	◉	○	◉	○	○	●	◉	○	●
Bioenergy	●	○	○	○	○	○	◉	○	◉
Geothermal	○	○	●	○	○	●	○	○	○
Nuclear	◉	○	◉	○	○	◉	○	○	○
Electricity networks	●	○	○	○	○	○	○	○	●
EVs and battery storage	●	●	●	●	●	○	○	○	●
Hydrogen	○	○	●	○	◉	○	○	●	◉

Notes: Shading indicates the relative importance of minerals for a particular clean energy technology (● = high; ◉ = moderate; ○ = low), which are discussed in their respective sections in this chapter. CSP = concentrating solar power; PGM = platinum group metals.

Clean energy technologies

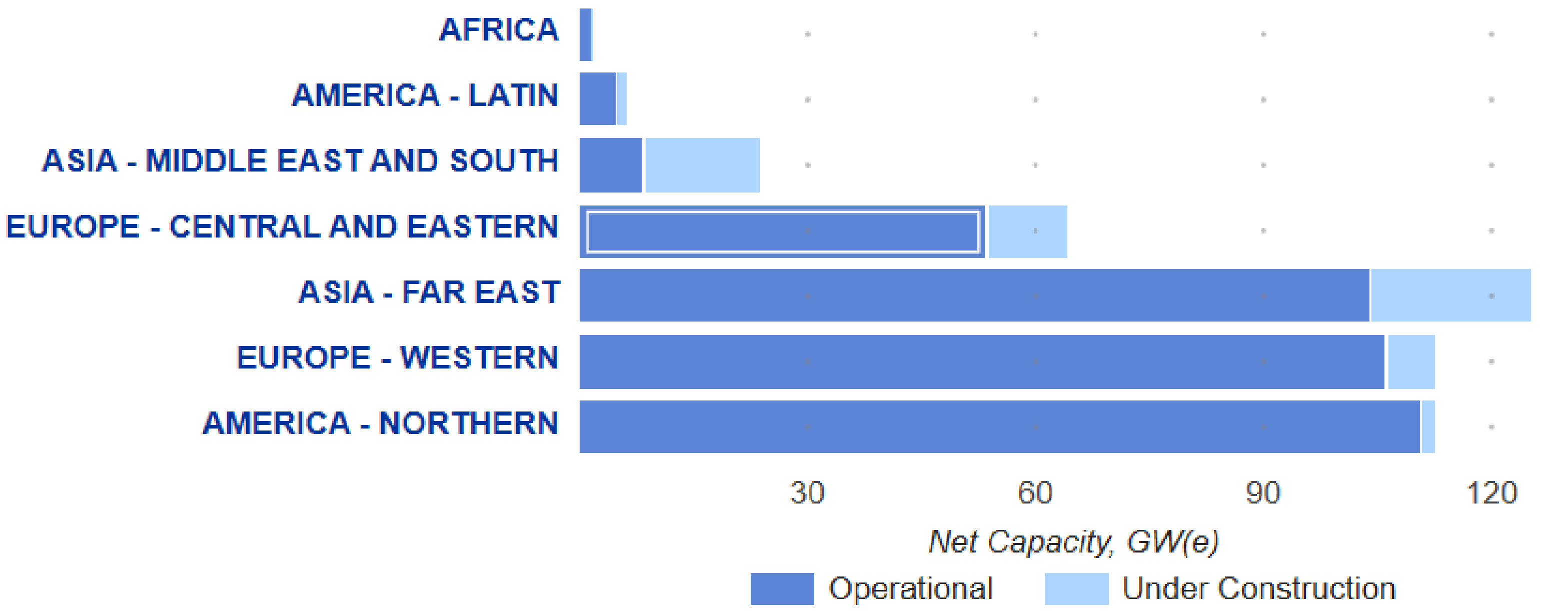
Nuclear: **Limited implications** for minerals due to low material intensity

Source: IEA

Regional Distribution of Nuclear Power Capacity – status at the end of April 2021

Source: IAEA Power Reactor Information System **(PRIS)**

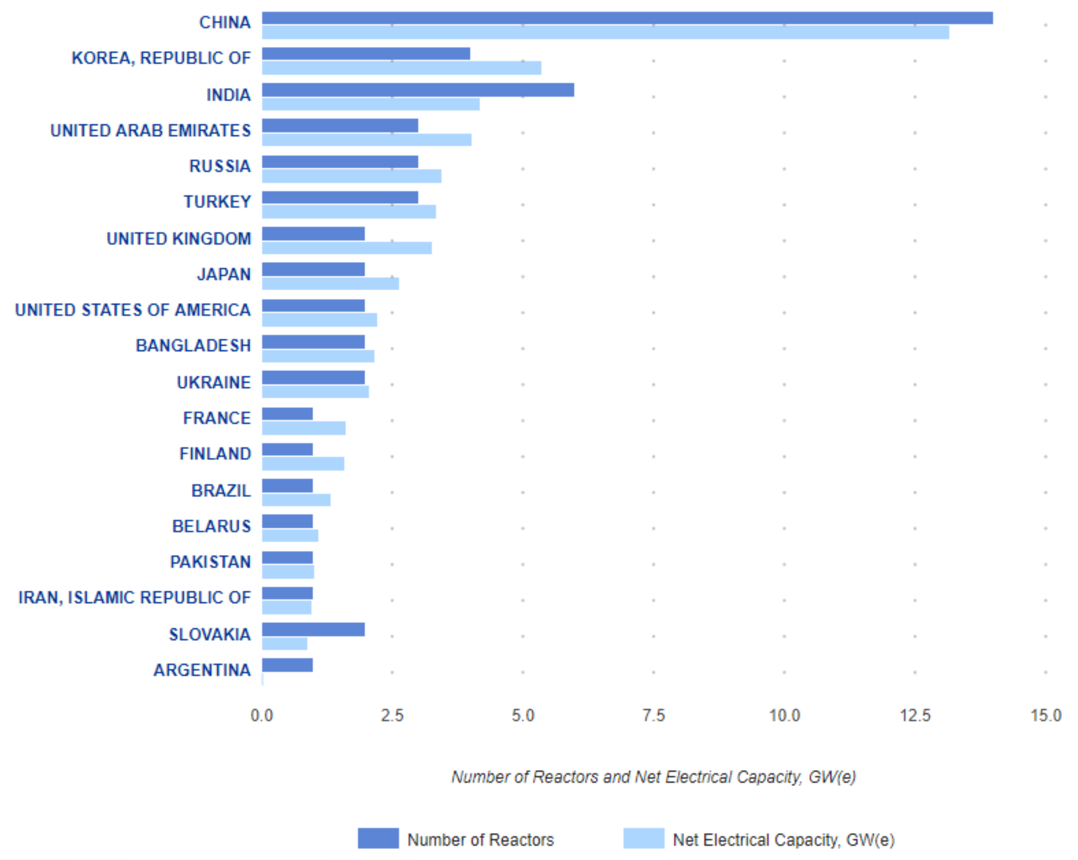
- **444** nuclear power reactors in operation/operable in **31** countries (with Barakah unit-1 in UAE came online)
- **394 098** MW(e) total net installed capacity
- **52** nuclear power reactors under construction in **19** countries
- **54 515** MW(e) the total capacities under construction



NPPs under construction: Progress Milestones

52 nuclear power reactors under construction in **19** countries

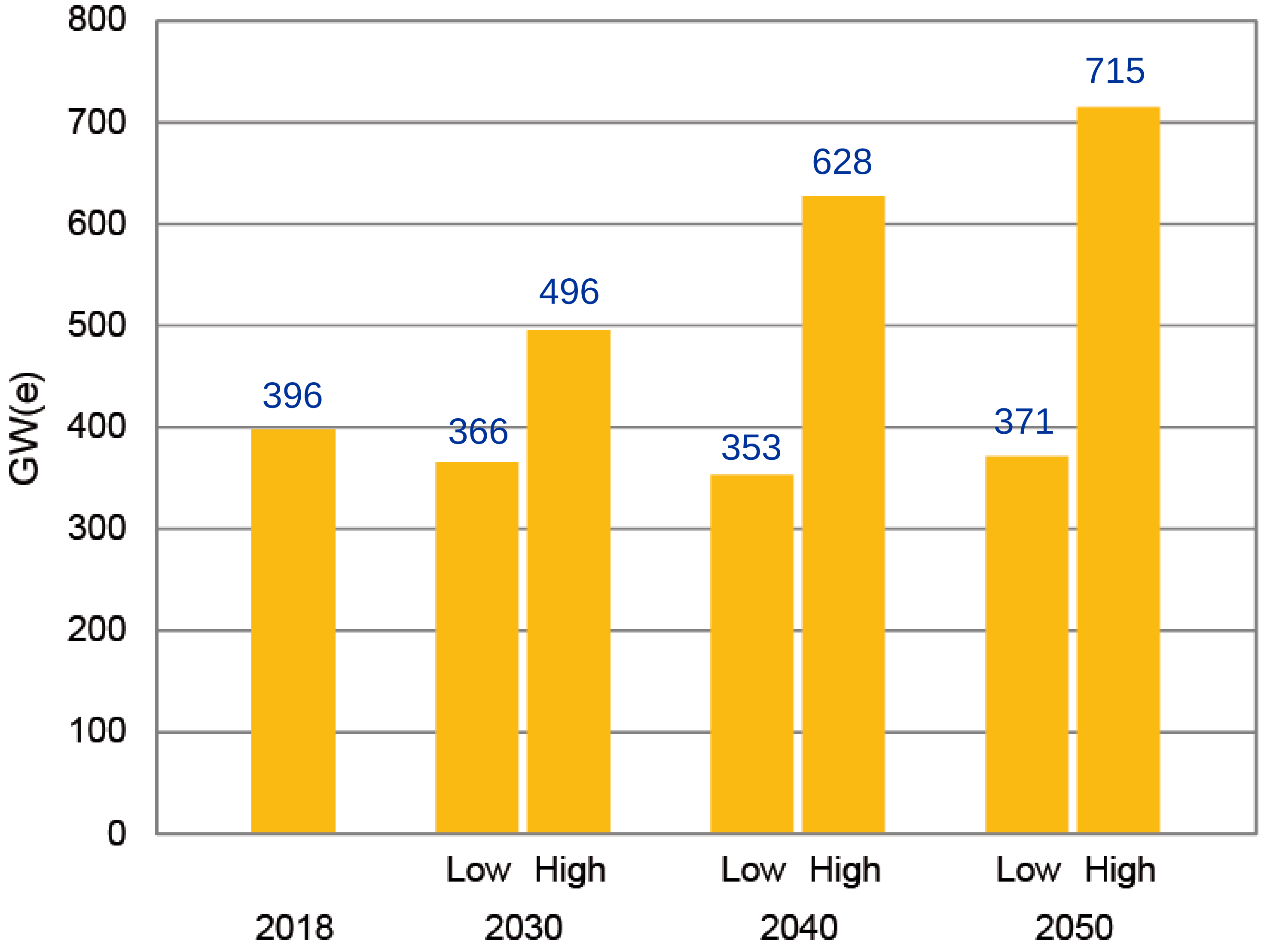
Source: IAEA Power Reactor Information System **(PRIS)**



Advanced Reactors Newbuild Projects in Embarking Countries – *sample*:

- **UNITED ARAB EMIRATES:** BARAKAH-1 connected to the grid (19/8) completion of 3 other units of **APR1400** for Barakah NPP
- **BELARUS**: 2 units of **VVER1200** performed fuel loadings for startup commissioning
- **BANGLADESH**: 2 units **VVER1200** for Rooppur NPP with Russian Federation
- **TURKEY**: 2 units of **VVER1200** for Akkuyu NPP with Russian Federation
- **EGYPT**: signed agreement with Russian Federation for potential 4 units **VVER1200** for El Dabaa NPP
- **SAUDI ARABIA**: to invite bids to vendor countries for the first 2 units, 3 GW(e), targeting 16 GW(e) by 2040

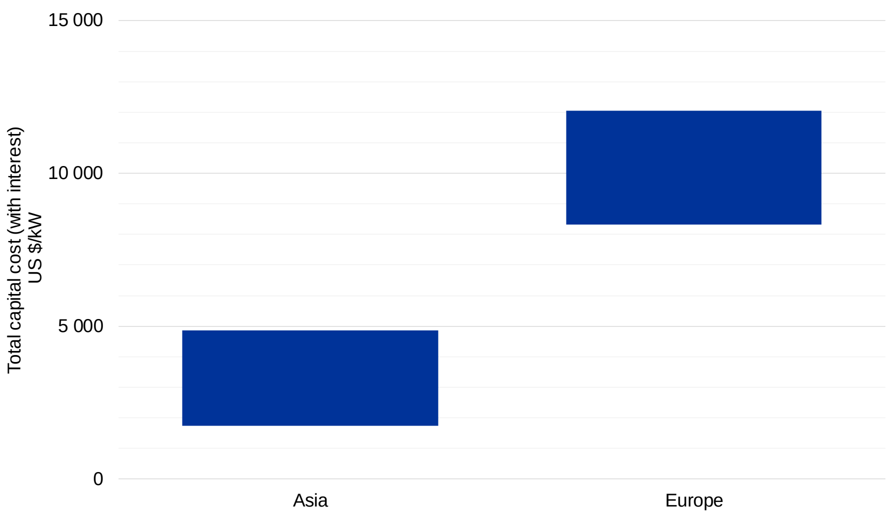
Global Nuclear Power Projections



Source: IAEA RDS-1 2019

De-risking NPP Newbuild Project

Long construction times, design and manufacturing complexity, and FOAK issues, are reasons behind the high construction costs and delivery times for nuclear newbuild.

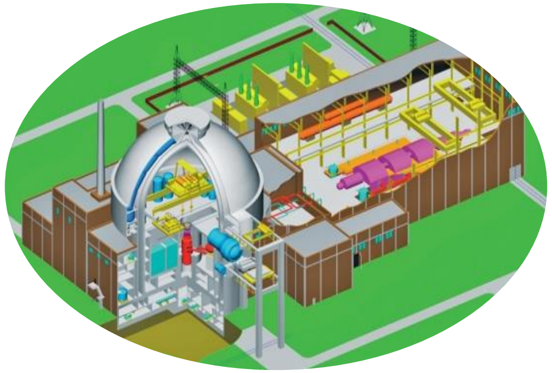


Construction cost ranges for recent nuclear newbuild projects in Western Europe (France, Finland and the UK) and Asia (the UAE, Japan, Republic of Korea and China). Source: *Climate Change and Nuclear Power 2020, IAEA.*

Key success factors:

- Robust supply chain
- Simple and proven designs (with an operating 'reference plant');
- Close cooperation with the regulator;
- Sensible, risk informed contracting models;
- Proven contractors with experienced teams;
- 'Lessons learned' from other NPP projects;
- State of the art approaches to project and risk management;
- Reliance on IAEA peer review missions and advisory services

Advanced Reactors



SMRs

CAREM, HTR-PM, KLT-40S, ACP100, AHWR, NuScale, SMART, 4S, EM^2

EVOLUTIONARY

ABWR, ACR-1000, AP1000, APWR, ATMEA1, EPR, ESBWR, WWER 1200, CAP1400, APR1400, HPR1000…

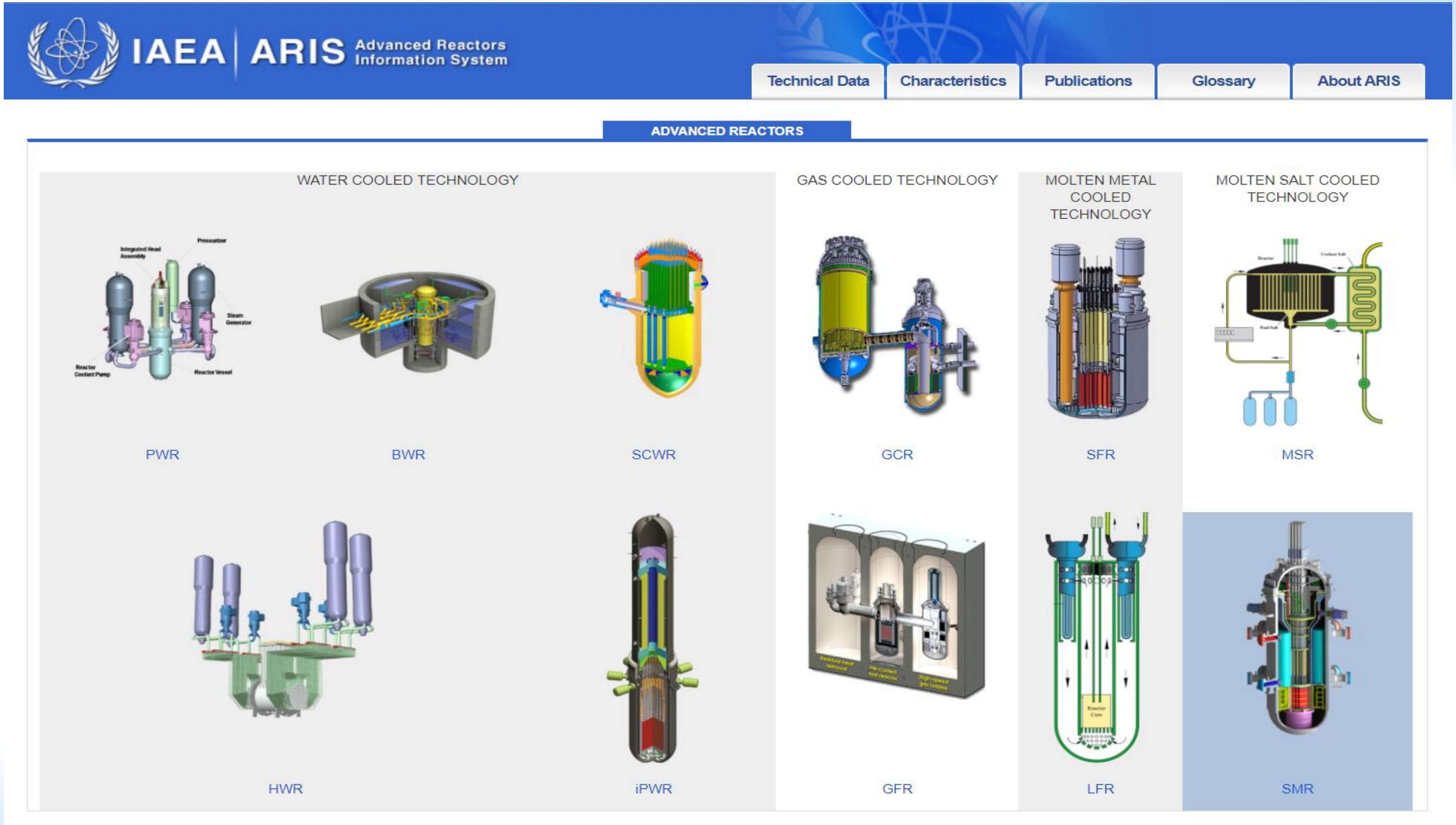
INNOVATIVE

LFR, GFR, SFR, SCWR, VHTR, MSR, ADS

Advanced Reactors:
Key Elements to Deployment

1. Understanding Technology
2. Regulatory Framework
3. Industrial Codes and Standards
4. Utility Requirements
5. Supply Chain
6. Business Case

IAEA ARIS database



Submissions made by vendors / design organizations

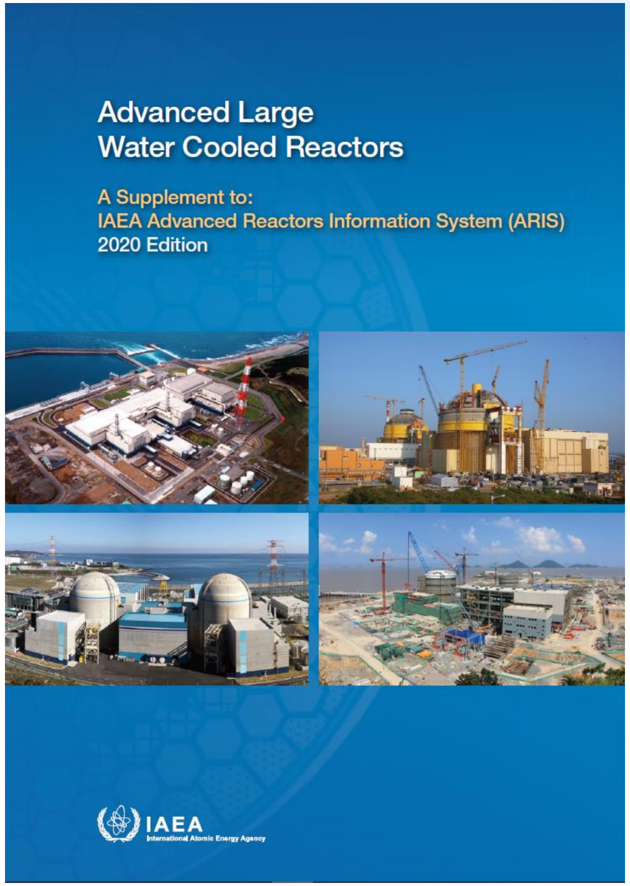
Advanced Evolutionary NPPs for Immediate Deployment

Canada	
EC6	740 MWe
ACR1000	1165 MWe

China	
HPR1000	1000 MWe
CAP1400	1400 MWe

France	
EPR	1630 MWe
ATMEA1	1200 MWe

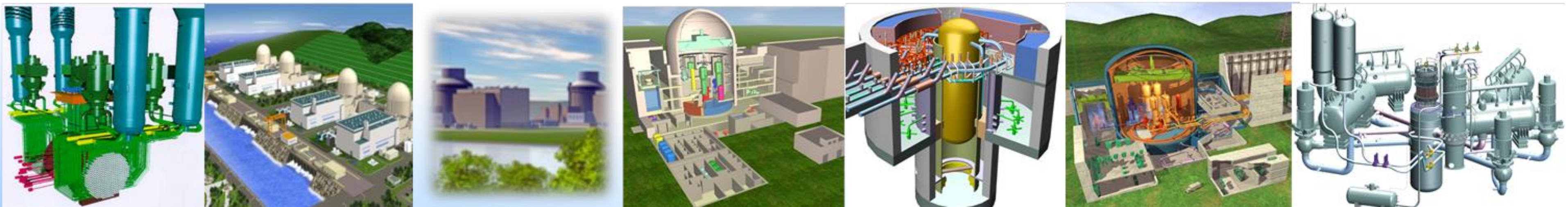
Japan	
ABWR	1315 MWe
ATMEA1	1200 MWe
APWR	1700 MWe



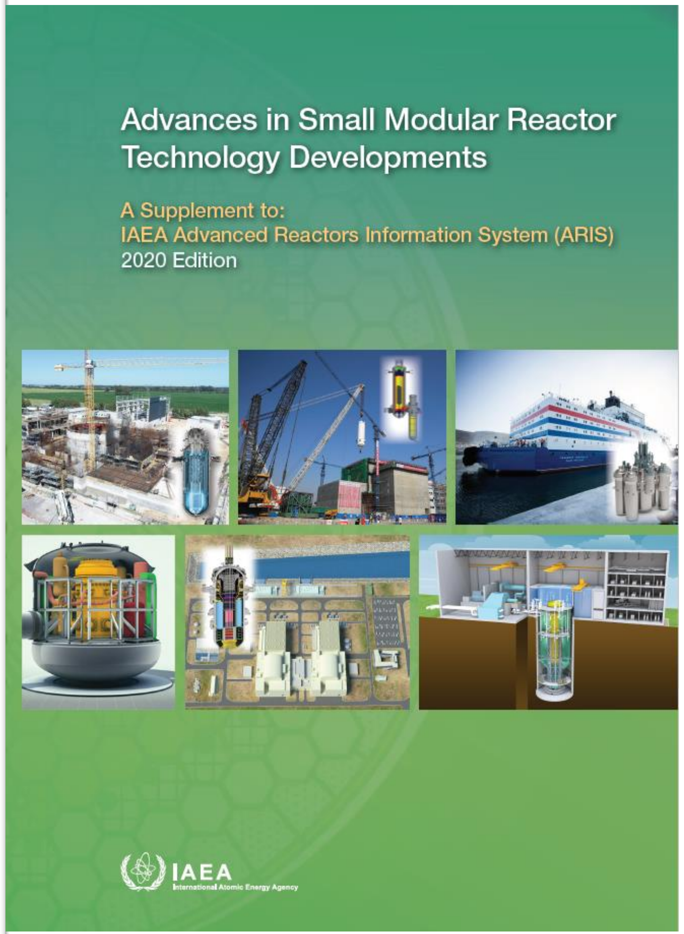
Republic of Korea	
APR1400	1416 MWe
OPR1000	993 MWe

Russian Federation	
VVER-1000	917 MWe
VVER-1200	1114 MWe
VVER-TOI	1175 MWe

United States of America	
ABWR	1315 MWe
AP1000	1117 MWe
ESBWR	1520 MWe



IAEA-ARIS SMR Booklet 2020



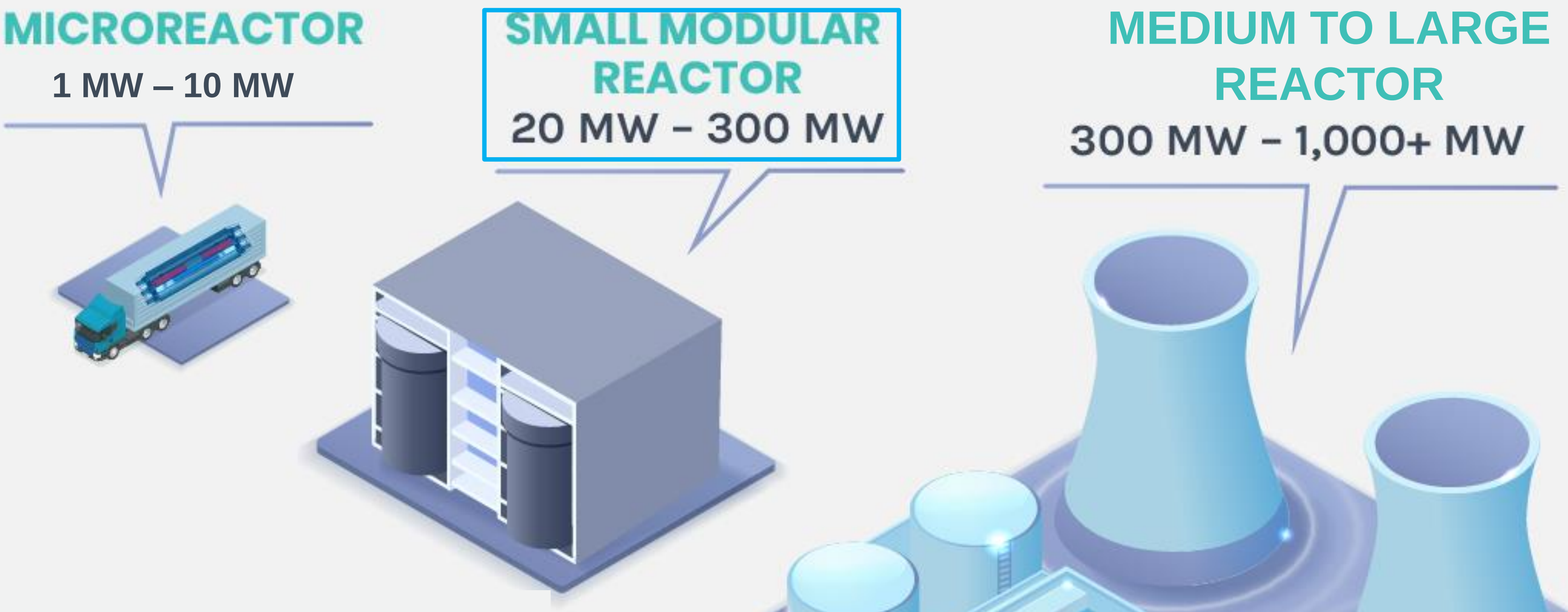
IAEA 2020 SMR Booklet

IAEA SMR Booklet, 2020 Edition	
Number of reactor designs:	72 *(16 more than 2018-edition)*
Member states involved:	18 countries
Reactor types included:	• Water-cooled Land Based • Water-cooled Marine Based • High temperature Gas cooled • Fast Neutron Spectrum • Molten Salt • Microreactors • Test Reactors (HTGR only)
Distinguishing features	• Special coverage on **fuel cycle** approach, **waste management/technology** • Insightful annexes with various charts and tables
Status	Published, hardcopies available
Downloadable version	https://aris.iaea.org/Publications/SMR_Book_2020.pdf

1. Introduction

The IAEA 2020 SMR Booklet is a bi-annual publication supplement to the IAEA Advanced Reactor Information System (ARIS) Database. It provides a brief yet comprehensive design description of 72 different reactor designs. The 2020 version is an updated version of the 2018 booklet. It includes 16 more designs and a more comprehensive set of annexes.

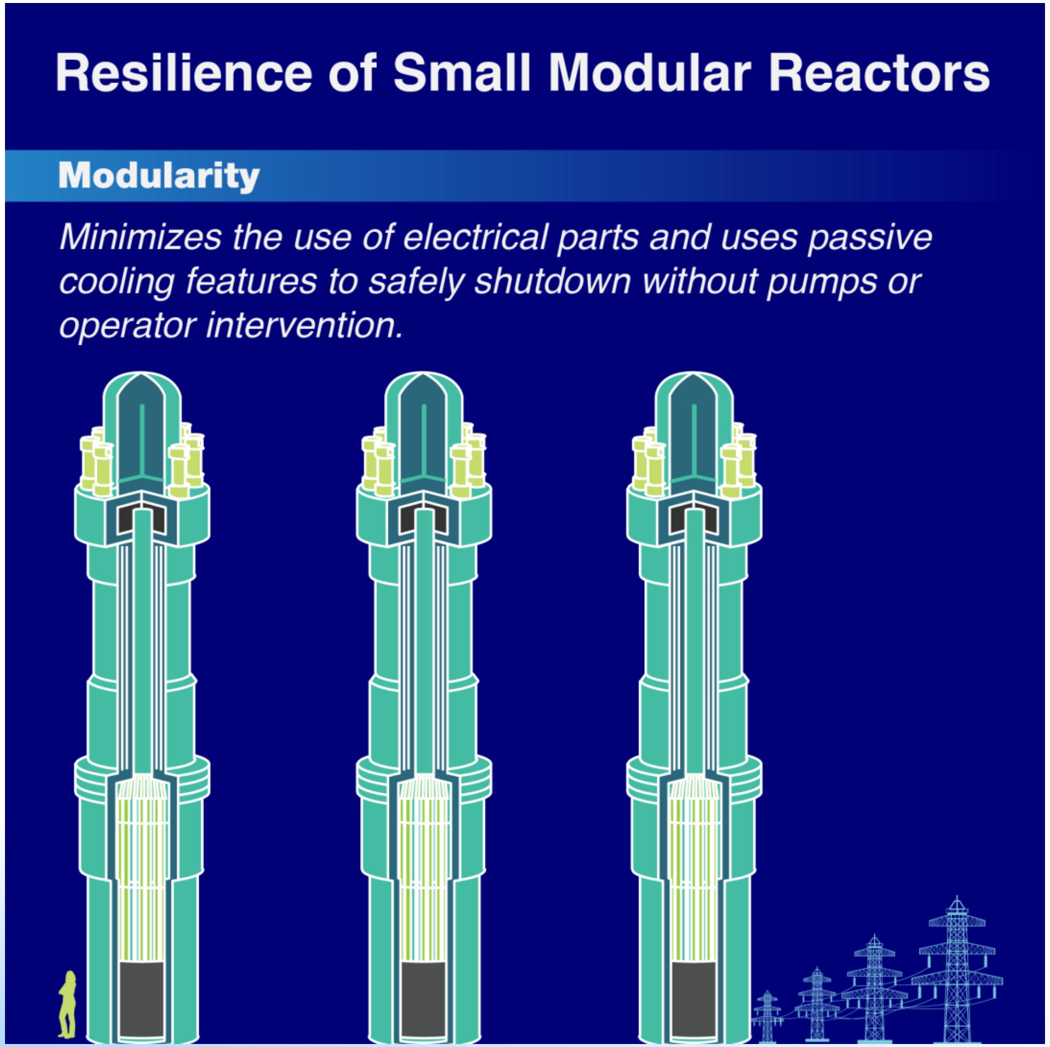
SMR Definition: Size



- Two important factors: **Size** and **Modularity**
- Nuclear power plants provide flexibility in terms of power
- SMRs provide electric power in the range of 20-300 MW(e)

Source: energy.gov/ne

SMR Definition: Modularity



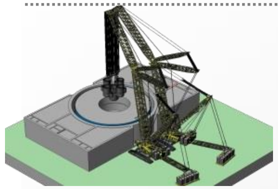
- Modular construction
- "Ability to fabricate major components of the nuclear steam supply system in a factory environment and ship to the point of use"
- Limited on-site preparation
- Substantially reduce the lengthy construction times
- Multi- module as per energy demand

Key Attributes of SMRs

- Enhanced Safety
- Versatile
- Modular
- Waste Management
- Affordable
- Non-electric applications

Economic
- Lower Upfront capital cost
- Economy of serial production

Better Affordability

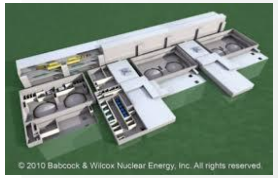


Modularization
- Multi-module
- Modular Construction

Shorter construction time

Flexible Application
- Remote regions
- Small grids

Wider range of Users

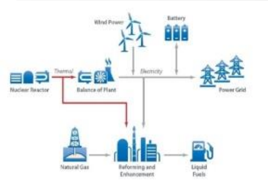


Smaller footprint
- Reduced Emergency planning zone

Site flexibility

Replacement for aging fossil-fired plants

Reduced CO_2 production

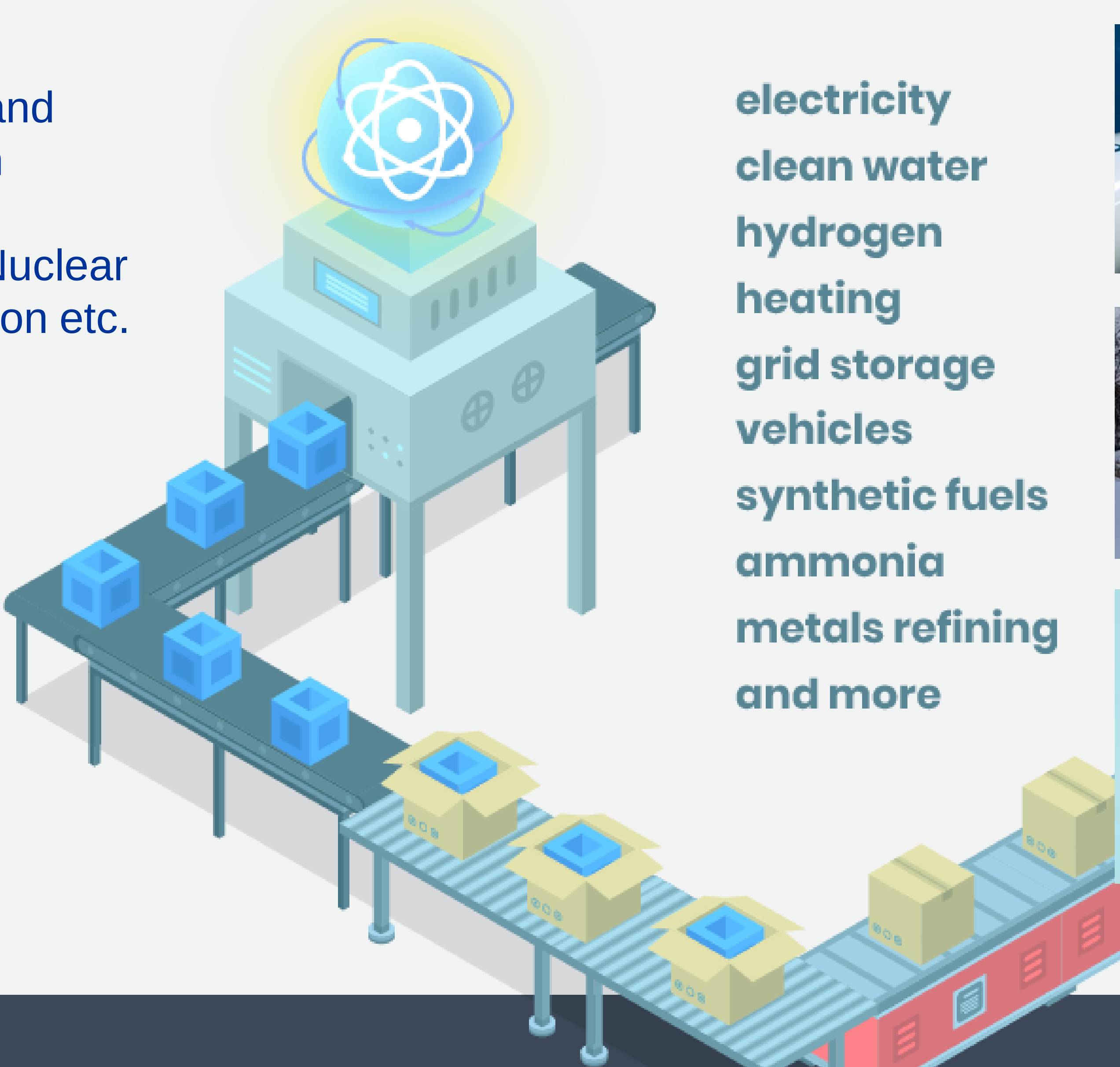


Potential Hybrid Energy System

Integration with Renewables

Multi-purpose Applications

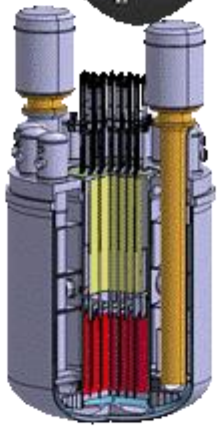
- SMRs provide options for wide and versatile applications other than electricity production
- District Heating, Process heat, Nuclear Desalination, Hydrogen production etc.

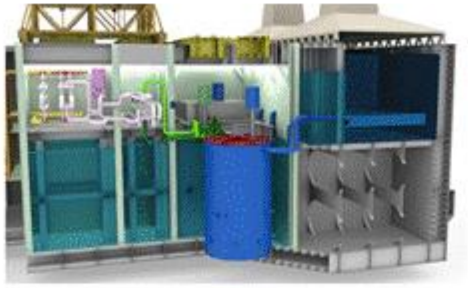


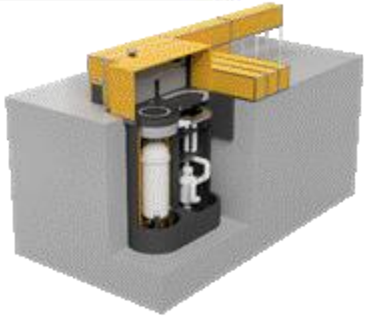
electricity
clean water
hydrogen
heating
grid storage
vehicles
synthetic fuels
ammonia
metals refining
and more

Co-generation

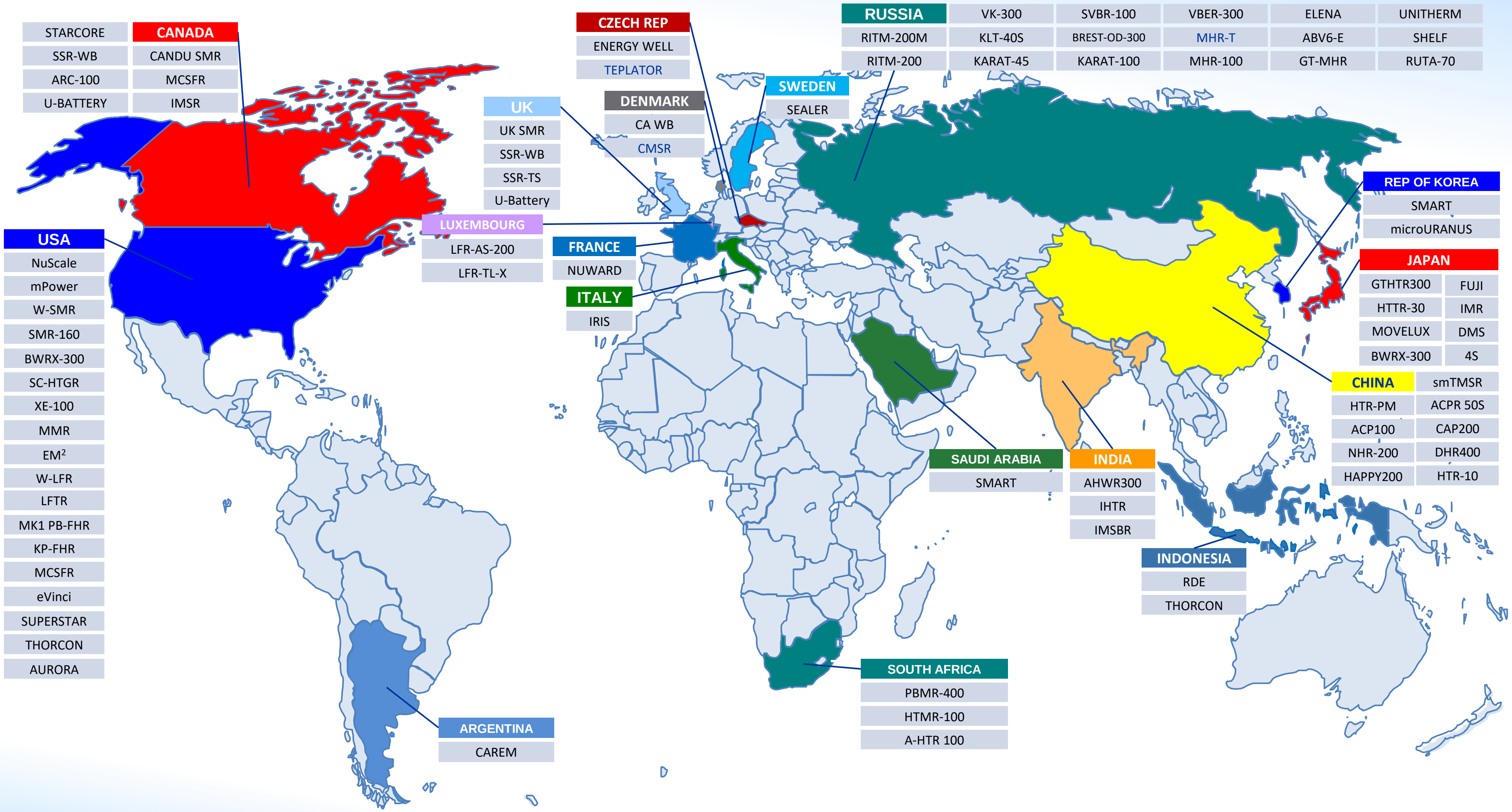
Categorization of Technology







Global SMR Technology Development



IAEA

SMR 10-year Deployment Horizon

Overview: African Nuclear Market

8 | African countries formed in 2015 the "West African Integrated Nuclear Power Group" (Benin, Burkina Faso, Ghana, Mali, Niger, Nigeria, and Senegal)

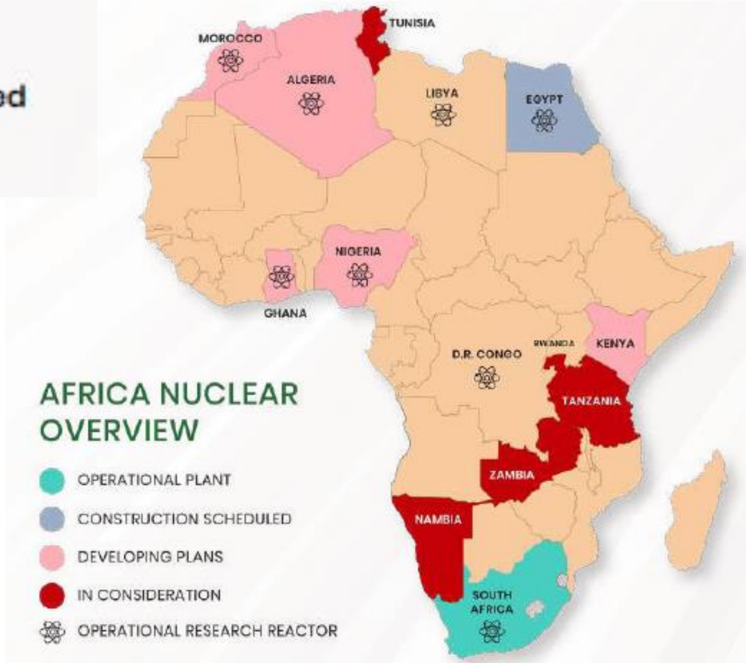
700 | Terawatt-hours (TWh) is the current electricity demand in Africa

11 | African countries currently considering adding nuclear power and are at various stages of infrastructure development

1,600 | TWh estimated electricity demand in Africa by 2040*

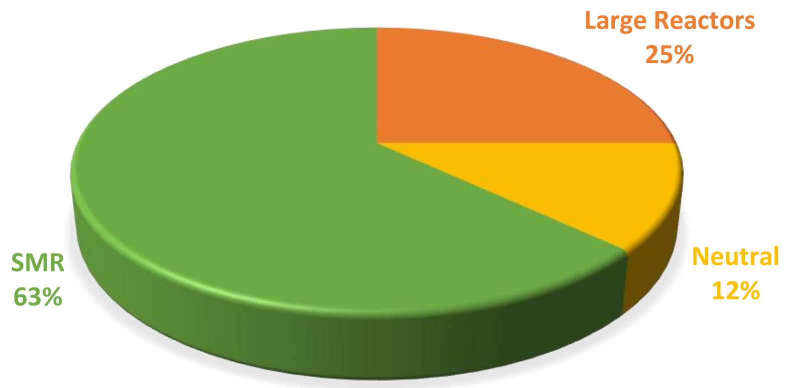
500 | 500m of the 1.6b people in the world without access to electricity live in Africa

16,100 | MW new nuclear power envisioned by African countries

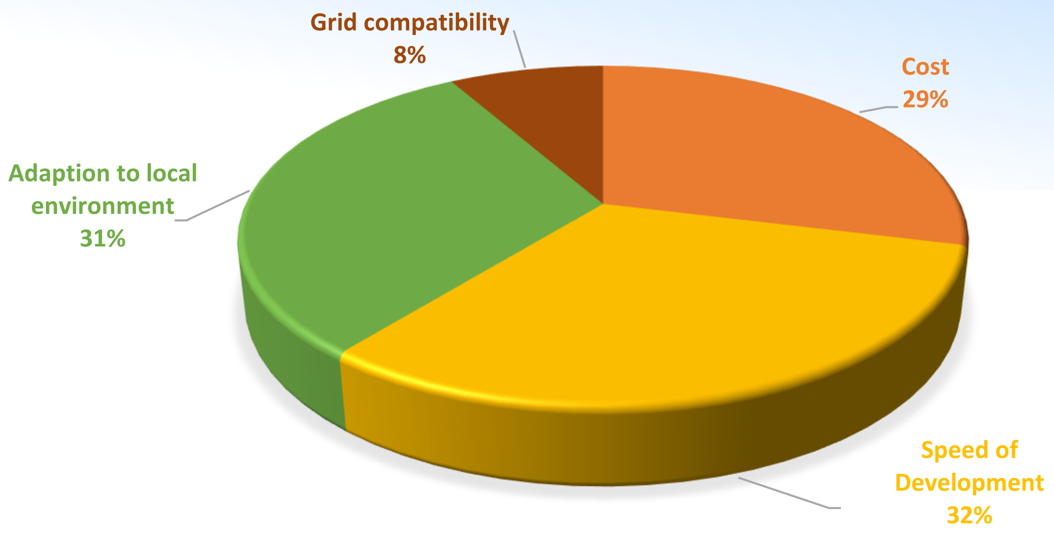


Survey Results in Africa (but largely applicable to many regions of the world)

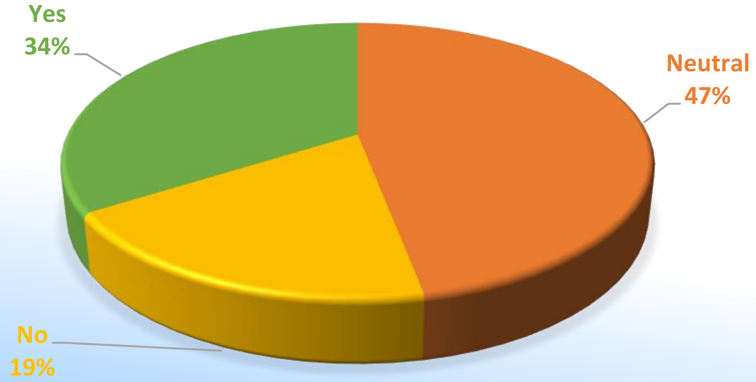
WHAT TYPE OF NUCLEAR REACTOR TECHNOLOGY WOULD YOUR COUNTRY BE KEEN TO PRIORITISE?



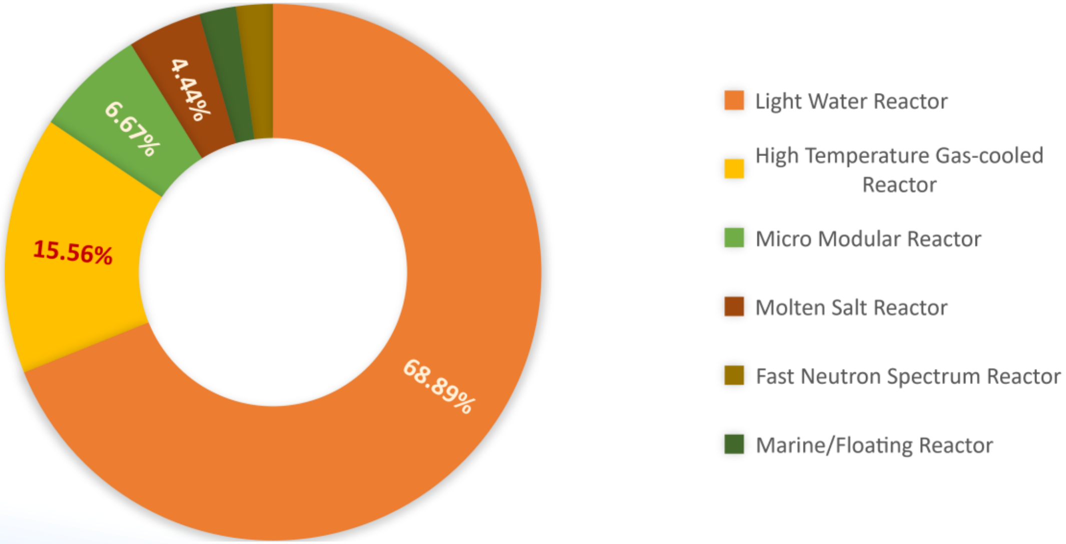
WHAT ARE YOUR CURRENT KEY CONCERNS ABOUT SMR TECHNOLOGY?



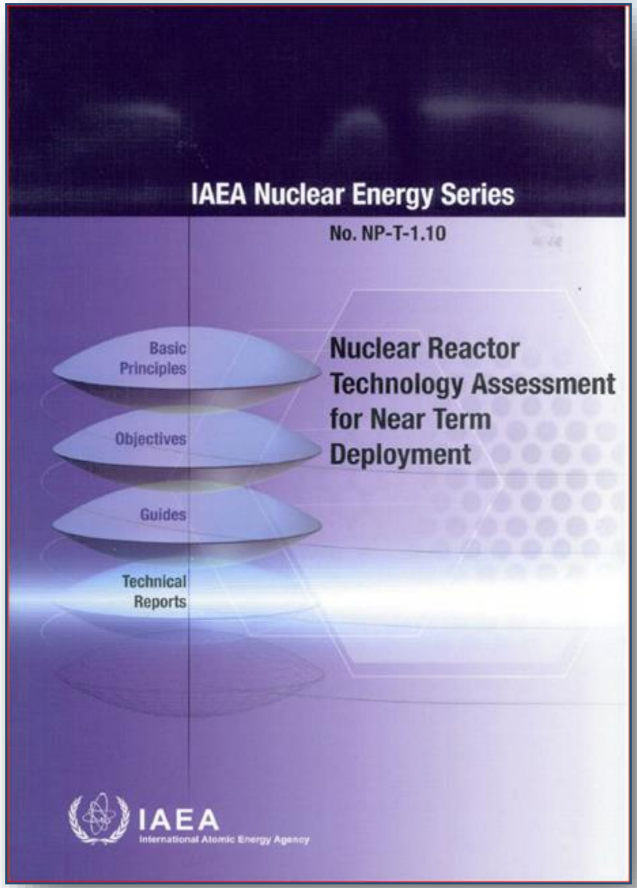
ARE YOU OPEN TO BEING THE FIRST OF A KIND (FOAK) SMR TECHNOLOGY ADOPTER?



WHICH OF THE FOLLOWING IS YOUR MOST PREFERRED SMR TECHNOLOGY DESIGN?



A new Toolkit to help embarking countries in applying the IAEA methodology on Reactor Technology Assessment → *also for SMR*

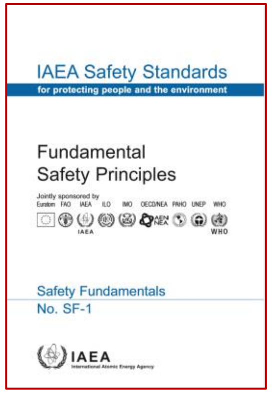


Applicability of the IAEA Safety Standards to SMRs

- Safety Standards are expected to be classified into three broad categories

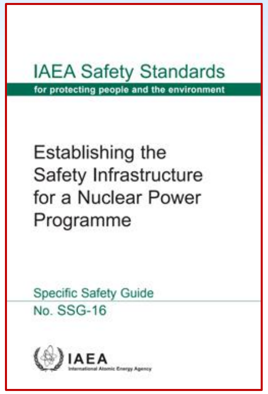
1. Technology neutral and applicable to all types of reactor technologies.
2. Technology neutral in principle, but their implementation may be different for some or all types.
3. Technology specific, and therefore may not be directly applicable to some or all types.

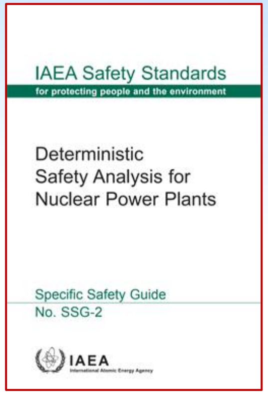
IAEA works on the Safety of SMRs


IAEA Safety Standards
for protecting people and the environment
Fundamental Safety Principles
Safety Fundamentals
No. SF-1
IAEA


IAEA Safety Standards
for protecting people and the environment
Safety of Nuclear Power Plants: Design
Specific Safety Requirements
No. SSR-2/1 (Rev. 1)
IAEA


IAEA Safety Standards
for protecting people and the environment
Safety of Nuclear Power Plants: Commissioning and Operation
Specific Safety Requirements
No. SSR-2/2 (Rev. 1)
IAEA


IAEA Safety Standards
for protecting people and the environment
Establishing the Safety Infrastructure for a Nuclear Power Programme
Specific Safety Guide
No. SSG-16
IAEA


IAEA Safety Standards
for protecting people and the environment
Deterministic Safety Analysis for Nuclear Power Plants
Specific Safety Guide
No. SSG-2
IAEA

**Technology Neutral Safety and Regulatory Framework:
Applicability of the IAEA Safety Standards to Advanced Reactors**

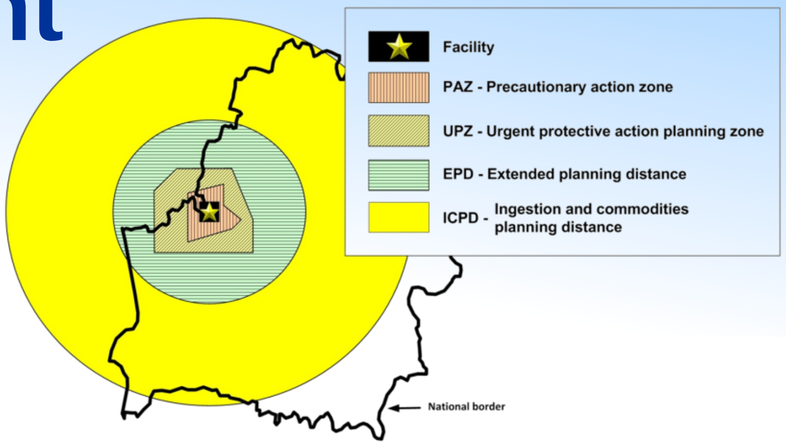
Organization	Department of Nuclear Safety, Division of Nuclear Installation Safety
Background	Different types of SMR using innovative technologies must meet the objective of ensuring the protection of people and environment;
Justification	IAEA Safety Standards applicable to *a limited range* of SMRs. Hence, additional overarching guidance would be useful to fill the gap and help relevant stakeholders in evaluating the safety of SMRs;
Objective	to envisage a **roadmap document** for application of selected IAEA safety standards, as part of a technology neutral safety and regulatory framework to SMRs
Publication date	Q4 / 2021 as an IAEA Technical Document

IAEA acting as the Secretariat for

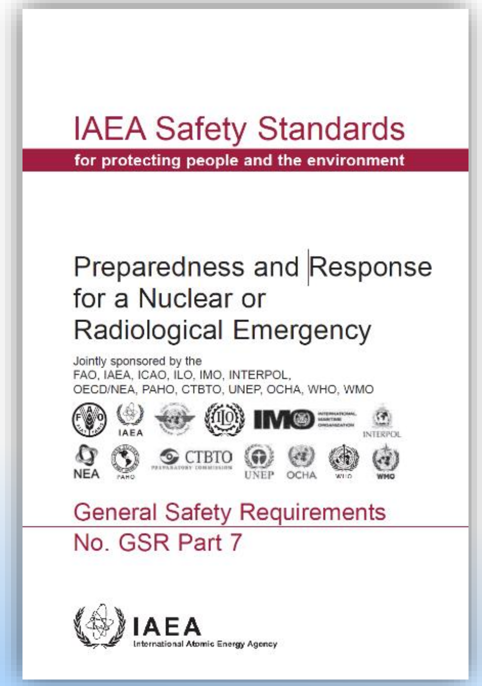
- Canada
- China
- Finland
- France
- Korea
- Russian Federation
- Saudi Arabia
- United Kingdom
- United States

SMR REGULATORS' FORUM

CRP on EPZ for SMR deployment



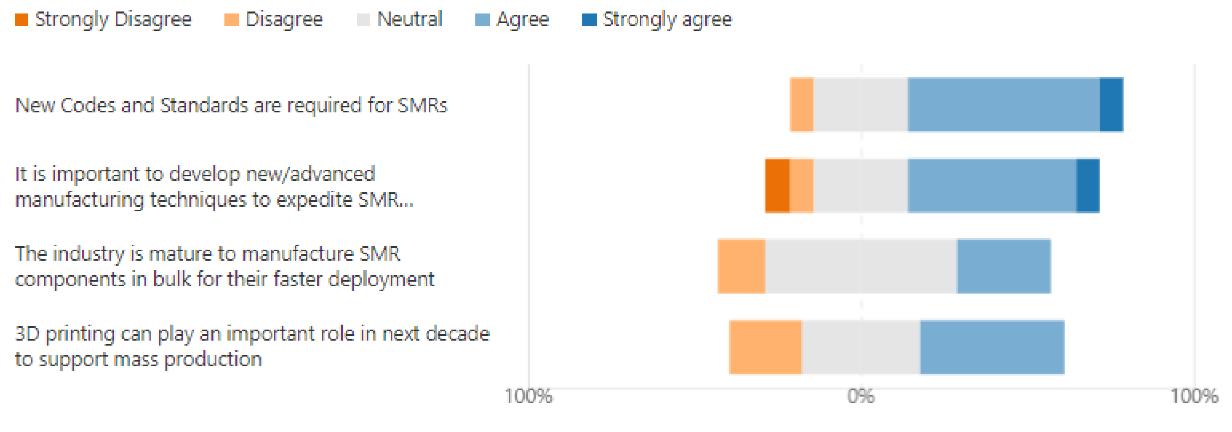
- SMR features that may enhance EPZ sizing
  - Strengthened safety features
  - Lower probability of releases
  - Time of onset and duration of the release
- Risk-informed approach: estimating the environmental dose exposure in a post-accident scenario to establish scalable EPZs for SMRs



- To develop approaches and methodologies for determining the need for off-site EPR including the size of EPZs for SMRs (using IAEA requirements as the basis)
- Project duration: 1 January 2018 – 31 December 2021
- 19 participants from 14 MS: Argentina, Canada, China (3), Finland, Indonesia, Israel, Japan, Korea, Netherlands (JRC-Petten), Pakistan, Saudi Arabia, Tunisia, UK (2), USA (3)
- TECDOC under development

Codes and Standards for SMRs

- Key discussion points:
  - Are the existing international nuclear codes and standards adequate to facilitate the development and licensing of SMR technologies worldwide?
  - What are the key issues, prospects and impediments on design engineering, manufacturing process and technology qualification of novel components for SMRs?
  - How can SMR industries learn from other industrial sectors to support a diversified/ larger supply chain and enable factory modular construction?
  - What significant changes are foreseen for In-Service Inspection (ISI) and component In-Service Testing (IST) for SMRs compared to existing large reactors?



Experts' Survey result

Codes & Standards – Applicability to SMRs

IAEA

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:

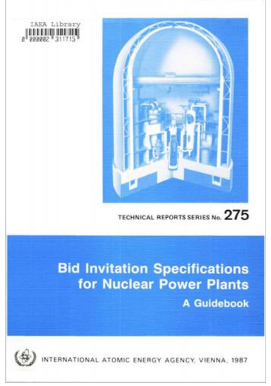
- Assure ‘diverse’ supply for replacement by manufacturers other than the original manufacturers;
- Improve the assurance of sustainable operation of the nuclear power plant.

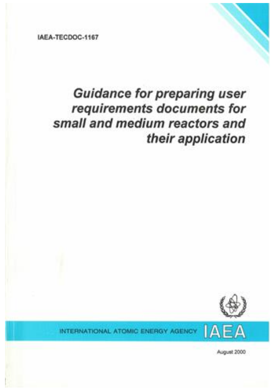
Findings on Standardization:

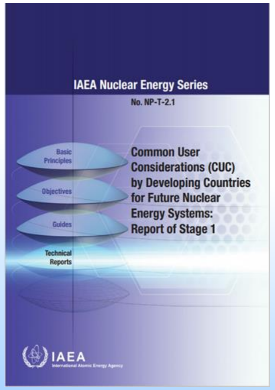
- Standardization alone will not solve all issues in advanced reactor product development;
- *Excellence* in applying *advanced manufacturing* and *NDE techniques* are often proprietary; not readily shareable or standardized because it would benefit competitors
- The biggest challenge to quality product 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

IAEA Generic User Requirements and Criteria for SMRs







- **Definition:** a comprehensive statements that reflects key policy of Member State on the expectations of its user/owner/operator on SMR technology for their nuclear power plant(s);
- **Rationale:** User organizations in developing countries embarking on NPP with SMRs do not necessarily have access to the established utility requirements from advanced countries aforementioned;
- **Key Benefit for Member States**:
  - Facilitate embarking countries in conducting reactor technology assessment and eventually developing a tender document;
  - Provide a basis for SMR designers and technology developers to offer a licensed SMR product that addresses/incorporates specific needs of embarking countries.
  - provide a basis for strong investor confidence that risks associated with the initial investment to complete and operate the first SMR can be minimized.
- **Nature:** Complementary to Reactor Technology Assessment and Technology Roadmap for SMR Deployment;
- **Interdisciplinary** subjects; **cross-cutting** between **Reactor Technology** with: *Engineering, Infrastructure, Nuclear System Sustainability, Economics & Financing, Fuel Cycle & Waste Management, Safety Assessment, Regulatory Oversight & Licensing, Siting, Environment, and so forth*.

CM on GURC; Results of Survey

Top 15 GURC Elements for SMR Technology
1. Economics 2. Nuclear Safety 3. Fitness and Time to Market 4. Reference Plant 5. Public Acceptance (Social Licence) 6. Financing and Project Management 7. Adaptability to Integrated Energy System 8. Adaptability to Non Electric Applications 9. Physical Protection 10. Nuclear Security (incl. Cybersecurity) 11. Manufacturability of Modular Components 12. Constructability through Modularization 13. Plant Standardization 14. Robust Regulatory Framework 15. Project Schedule Capability
Will be Updated in Technical Meeting on GURC-SMR on 24-27 May 2021 (with 40+ MS participations)

CRP on Economic Appraisal of SMR Projects: Methodologies and Applications


wnn
world nuclear news

Energy & Environment | New Nuclear | Regulation & Safety | Nuclear Policies | Corporate | Uranium & Fuel | W

IAEA launches project to examine economics of SMRs

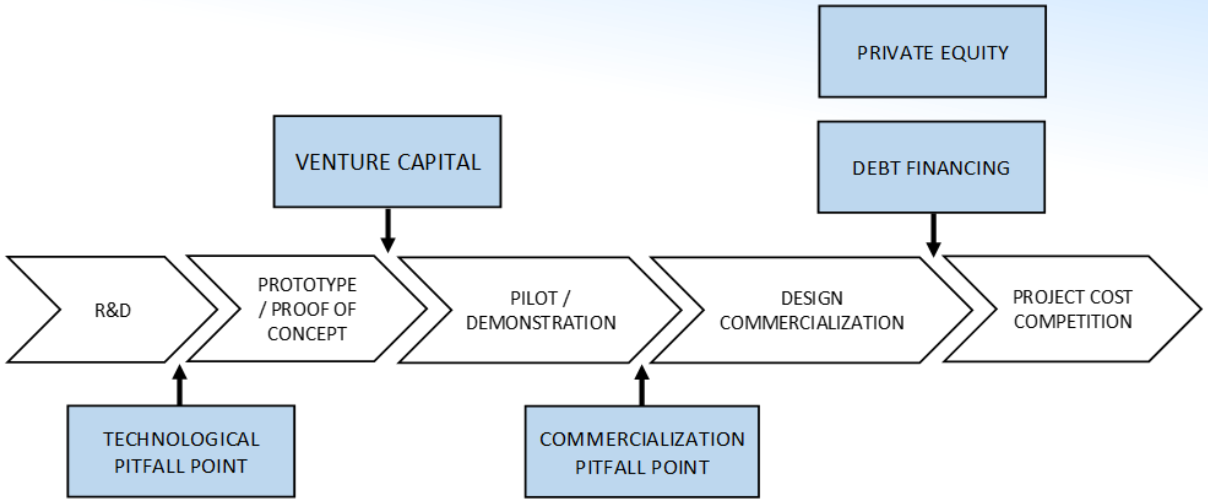
26 March 2020

Share

The International Atomic Energy Agency (IAEA) is launching a three-year Coordinated Research Project focused on the economics of small modular reactors (SMRs). The project will provide Member States with an economic appraisal framework for the development and deployment of such reactors.

- Areas of investigation
  - Market research
  - Analysis of the competitive (non-nuclear) landscape
  - Project planning, cost forecasting and analysis
  - Project structuring, risk allocation and financial valuation
  - Business planning and business case demonstration
  - Economic cost-benefit analysis

Technology Roadmap for SMR Deployment



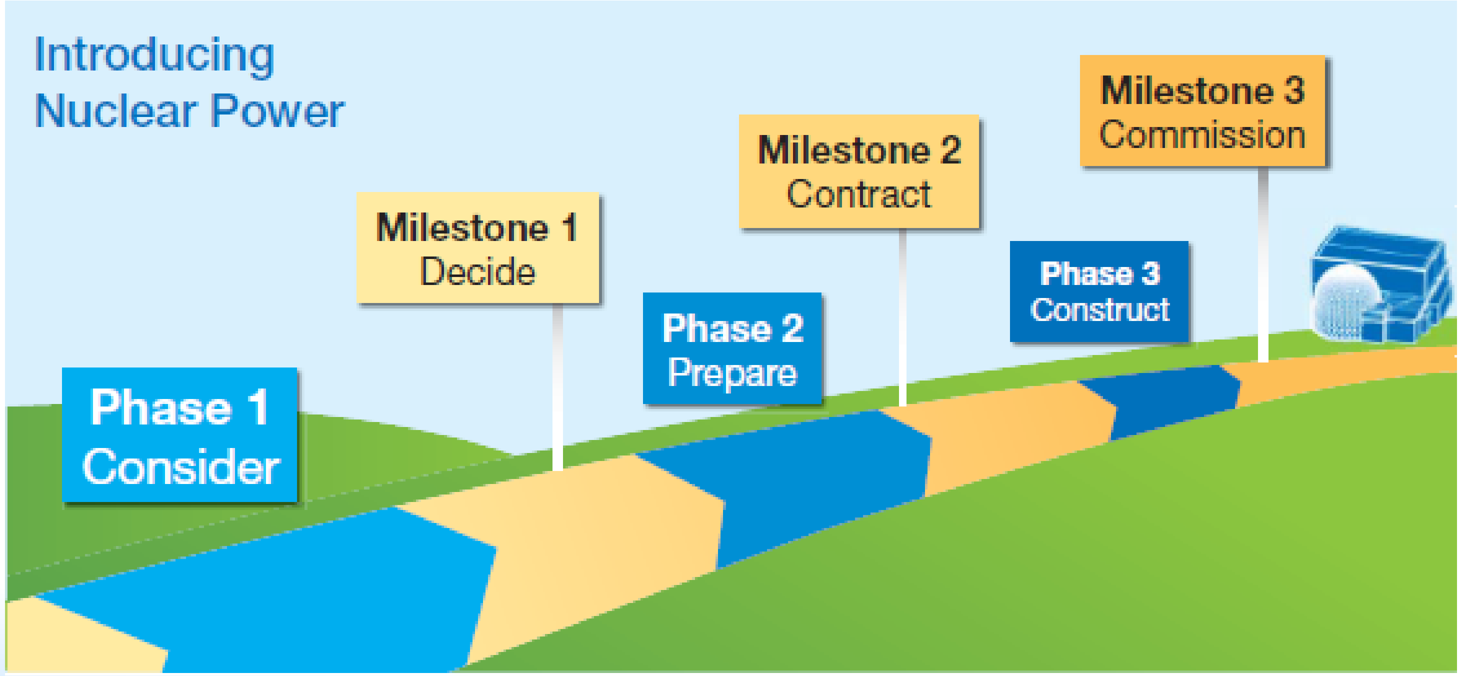
IAEA Nuclear Energy Series NR-T-1.18: Technology Roadmap for SMR Deployment

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	• Current status of SMR deployment, the importance of infrastructure development, and summary of different types of technology roadmap • Impediments to deployment of SMR Technology • Presents Roadmaps that can be either followed or adopted with adjustment to suit specific needs of Member States
Publication date	Advance Publishing Copy

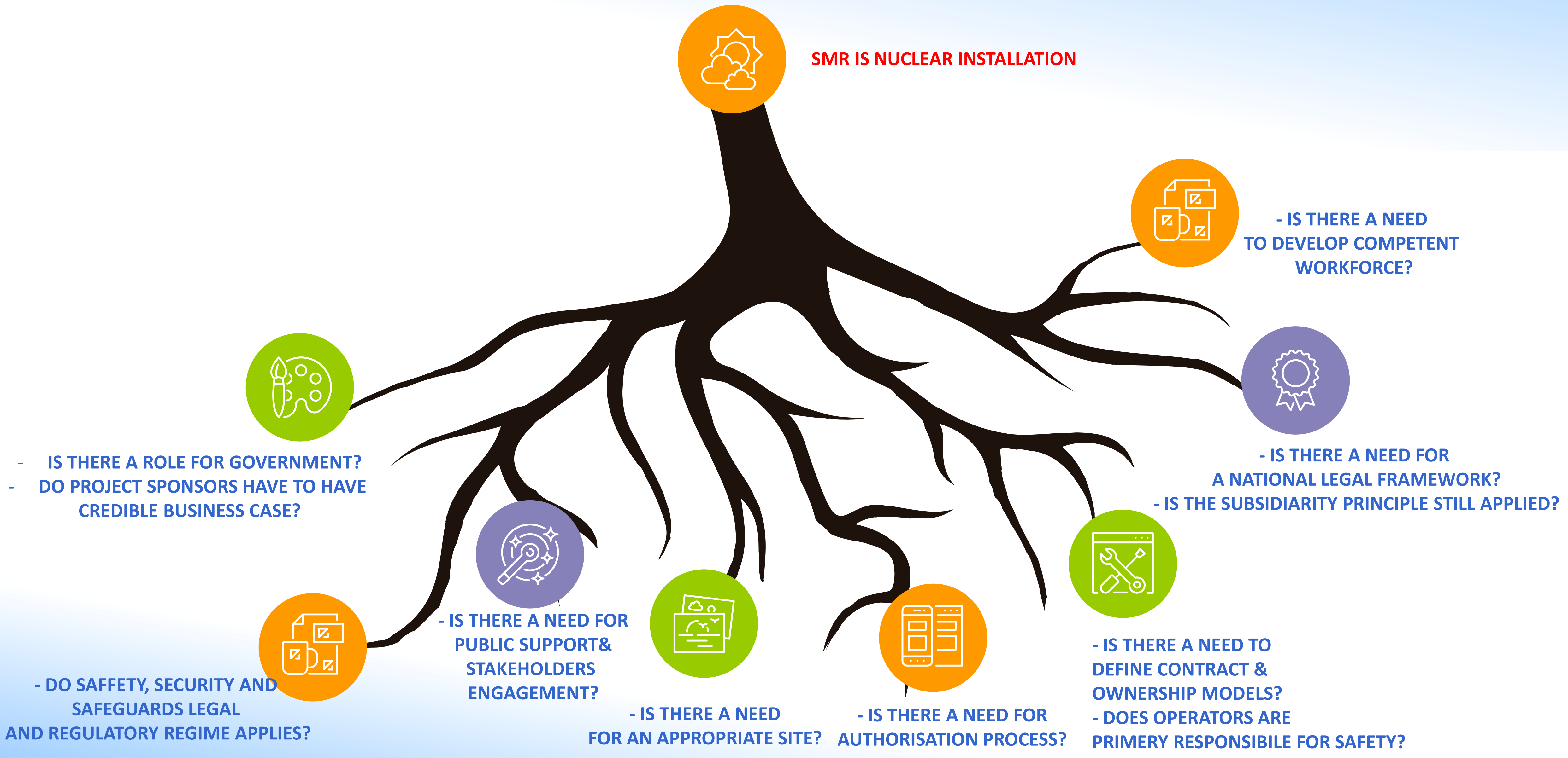
The IAEA Milestones Approach

The IAEA Milestones Approach **nuclear programme management guide** covering the infrastructure elements that **should** exist to **create an enabling environment leading to successful nuclear programme and mitigating the project risks**

- ❸ **Phases (Consider – Prepare – Construct)**
- ❸ **Milestones (Decide – Contract – Commission)**
- ⓳ **Infrastructure Issues**



Are the Milestones Approach embedded principles still valid in case of SMRs?



Bridging the Gap between SMR Developers and End Users

- Small Modular Reactors (SMRs) are expected to be a viable nuclear solution to meet energy supply security, both in newcomer and expanding countries
- There is an abundance of insights from SMR Developers but there is an absence of insights and perspectives from the end users and prospective buyers
- Need to fill in the gap both in newcomer and expanding countries
- Rationale:
  - *How familiar are the customer countries with SMR technology?*
  - *What is the current level of Human Resources capability in the customer countries to embrace nuclear technology?*
  - ***Will these countries be keen on having a regional SMR manufacturing facility/ hub in their country?***

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

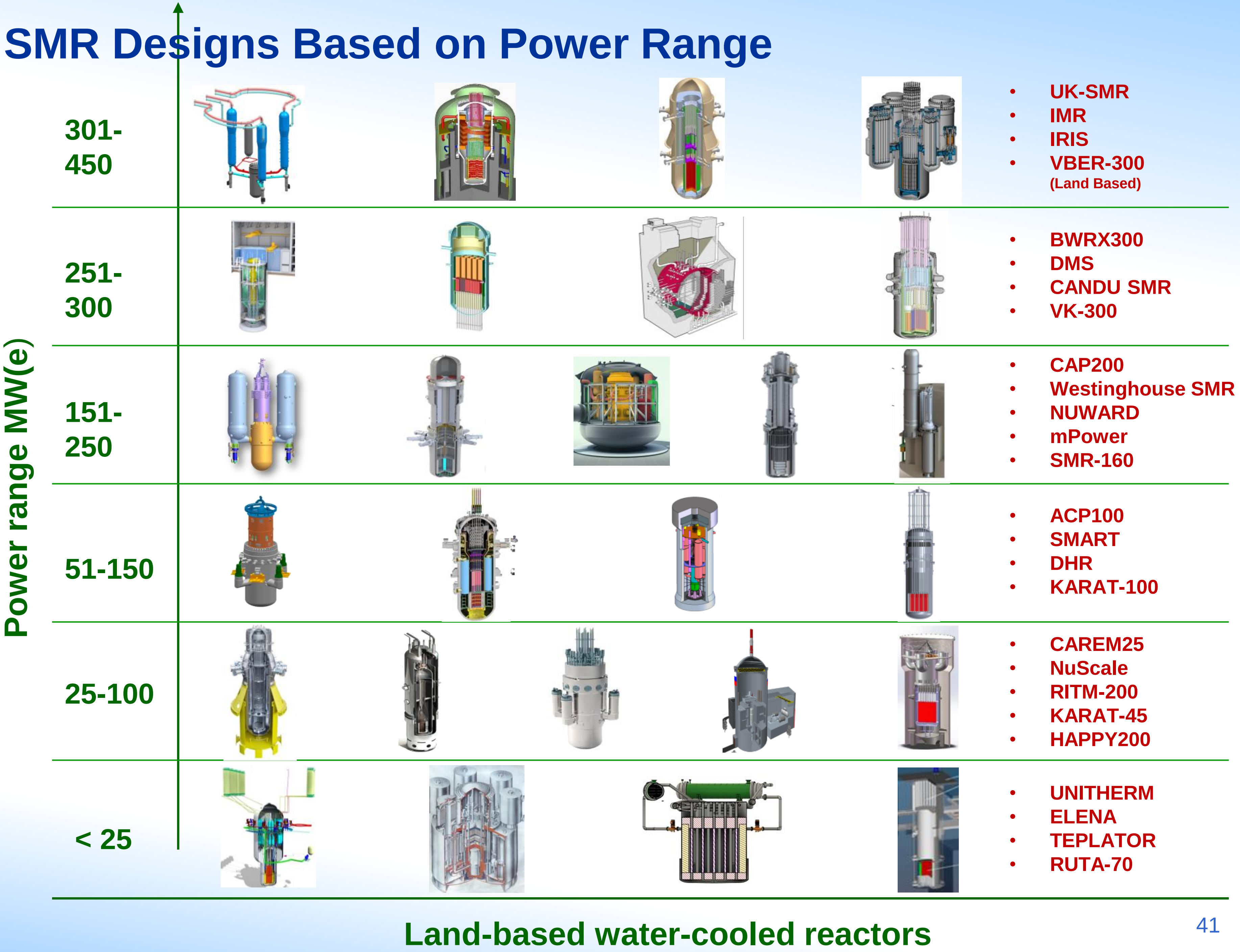
Thank you for your attention!

Contact:
Stefano MONTI
S.Monti@iaea.org

Atoms for peace and Development…

SMR@iaea.org

SMR Designs Based on Power Range



SMRs: Under Construction

CAREM

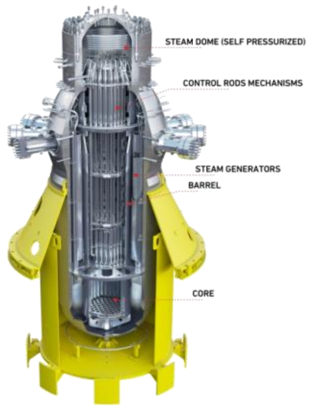


Image Courtesy of CNEA, Argentina

Under Construction

Integral PWR type SMR

Natural circulation

- 30 MW(e) / 100 MW(th)
- Core Outlet Temp: 326°C
- Fuel Enrichment: 3.1% UO_2
- In-vessel control rod drive mechanisms
- Self-pressurized system
- Pressure suppression containment system
- First Criticality: 2023

KLT-40S

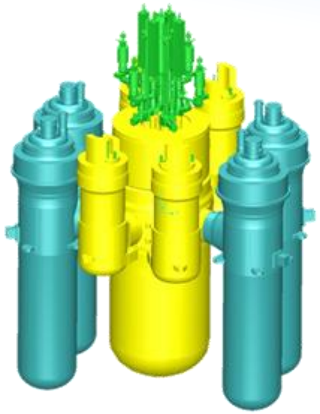


Image Courtesy of Afrikantov, Russia

Under Operation

Floating PWR type SMR

Forced circulation

- 35 MW(e) / 150 MW(th)
- Core Outlet Temp: 316°C
- Fuel Enrichment: 18.6% UO_2
- Floating power unit for cogeneration of heat and electricity; onsite refuelling not required; spent fuel take back to the supplier
- Commercial Start-up: May 2020

HTR-PM

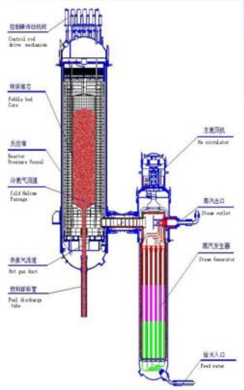


Image Courtesy of Tsinghua University, China

Under Commisioning

HTGR type SMR

Forced circulation

- 210 MW(e) / 2x250 MW(th)
- Core Outlet Temp: 750°C
- Fuel Enrichment: 8.5% TRISO coated particle fuel
- Inherent safety, no need for offsite safety measures
- Multiple reactor modules can be coupled with single steam turbine
- Commercial operation: 2021
- The HTR-PM 600 (6 modules) are under design and several potential sites identified

SMRs: Near Term Deployable

NuScale

Image Courtesy of NuScale Power, USA

Under regulatory review

Integral PWR type SMR

Naturally circulation

- 60 MW(e) / 200 MW(th) per module
- Core Outlet Temp: 314°C
- Fuel Enrichment: <4.95% UO_2
- 0.5g peak ground accelerations
- Modules per plant: 12
- Containment vessel immersed in reactor pool that provide unlimited coping time for core cooling
- Multi-purpose Energy use: Electricity and process heat applications

SMART

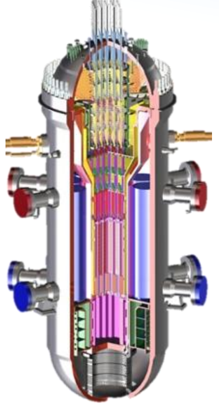


Image Courtesy of KAERI, Republic of Korea

Standard design approval (2012)

Integral PWR type SMR

Forced circulation

- 100 MW(e) / 330 MW(th)
- Core Outlet Temp: 323°C
- Fuel Enrichment: <5% UO_2
- Coupling with desalination and process heat application
- Pre-project engineering agreement between Korea and Kingdom of Saudi Arabia for the deployment of SMART in the Gulf country
- Design update (increased power and more passive safety features) to be submitted for design approval

ACP-100

Image Courtesy of CNNC(NPIC/CNPE), China

Basic Design Completed

Integral PWR type SMR

Forced circulation

- 125 MW(e) / 385 MW(th)
- Core Outlet Temp: 319°C
- Fuel Enrichment: <4.95% UO_2
- In-vessel control rod drive mechanisms
- nuclear island underground
- Preliminary safety assessment report (PSAR) finished
- An industrial demonstration plant with one 385 MW(t) unit is planned in Hainan Province
- IAEA conducted a generic safety review

Advantages, Issues & Challenges

IAEA

Technology Issues
- Shorter construction period (modularization)
- Potential for enhanced safety and reliability
- Design simplicity
- Suitability for non-electric application (desalination, etc.).
- Replacement for aging fossil plants, reducing GHG emissions

Non-Techno Issues
- Fitness for smaller electricity grids
- Options to match demand growth by incremental capacity increase
- Site flexibility
- Reduced emergency planning zone
- Lower upfront capital cost (better affordability)
- Easier financing scheme

Technology Issues
- Licensability (FOAK designs)
- Non-LWR technologies
- Operability and Maintainability
- Staffing for multi-module plant; Human factor engineering;
- Supply Chain for multi-modules
- Advanced R&D needs

Non-Techno Issues
- Economic competitiveness
- Plant cost estimate
- Regulatory infrastructure
- Availability of design for newcomers
- Physical Security
- Post Fukushima action items on institutional issues and public acceptance

IAEA Activities on SMRs

Development and Deployment Status
- ARIS Database
- SMR Booklet

Technology Roadmap
- Provide Member States with 'model' technology roadmaps for specific SMR projects

Economics
- Economic Appraisal of SMR Projects: Methodologies and Applications

Safeguards-by-Design
- Incorporate facilitation of safeguards inspection early in reactor design stage

Infrastructure Development
- The IAEA Milestones Approach applicable to SMR
- Integrated Work Plan for Embarking Countries

Safety
- SMR Regulators' Forum
- Applicability of the IAEA Safety Standards to SMRs

Generic User Requirements and Criteria
- Key policy of Member State on the expectations of its users on SMR technology

Reactor Technology Assessment
- Updated Method incorporates SMR

IAEA Support: Key areas

Exchange of Information through Meetings and Dialogue Forums	Design and Technology Development, Advanced R&D	Supply Chain for Manufacturing of Structures, Systems & Components	Construction Technologies	Economics, Financing, Market & Deployment Competitiveness
Methodologies, Road-mapping and Best Practices	Application of Milestone Approach to Newcomer Countries	SMR in Integrated Energy Systems (VRE and Non-Electric App)	Associated Fuel Cycles	Waste Technology
Decommissioning approach	Supports to Safety, Security and Safeguard	Nexus with Climate Change and SDGs	Knowledge Management and Preservation	Education & Training

International Technical Working Group on Small and Medium-Sized or Modular Reactors (SMR)

- To advice and support IAEA programmatic planning and implementation in areas related to technology development, design, deployment and economics of SMRs and their applications (e.g. *non-electric applications and hybrid energy systems*)

- Three technical subgroups established:
  - **SG-1:** Development of Generic Users Requirements and Criteria (GURC)
  - **SG-2:** Research, Technology Development and Innovation; Codes and Standards
  - **SG-3:** Industrialization, design engineering, testing, manufacturing, supply chain, and construction technology

- Three General Meetings conducted so far: 2018, 2019, 2020 (virtual)

- Information at:
https://nucleus.iaea.org/sites/htgr-kb/twg-smr/SitePages/Home.aspx

Technical Working Group on SMR

IAEA

Argentina Comisión Nacional de Energía Atómica (CNEA)	**Australia** Australian Nuclear Science and Technology Organisation (ANSTO)	**Canada** Canada's National Nuclear Laboratory (CNL)	**China** Tsinghua University
Finland VTT Technical Research Centre	**France** Commissariat à l'énergie atomique et aux énergies alternatives (CEA)	**India** Bhabha Atomic Research Centre (BARC)	**Indonesia** National Nuclear Energy Agency (BATAN)
Iran Atomic Energy Organization of Iran AEOI	**Italy** Politecnico di Milano POLIMI *(The Chair for 2018 – 2021)*	**Japan** Japan Atomic Energy Agency (JAEA)	**Jordan** Jordan Atomic Energy Commission (JAEC)
Kenya Kenya Nuclear Energy Board (KNEB)	**Republic of Korea** Korea Atomic Energy Research Institute (KAERI)	**Pakistan** Pakistan Atomic Energy Commission (PAEC)	**Russian Federation** OKBM Afrikantov
Saudi Arabia King Abdullah City of Atomic and Renewable Energy (K.A.CARE)	**South Africa** Department of Energy	**Ukraine** Energoatom	**United Kingdom** Department for Business, Energy and Industrial Strategy (BEIS)
United States of America, Department of Energy (DOE)	**Morocco** *Office National de l'Electricité et de l'Eau Potable (ONEE) - Observer*	**EC-JRC** *Observer*	**OECD-NEA** *Observer*

Members: 21 countries = 15 countries with nuclear power + 6 countries without nuclear power including embarking countries;
Observers: 1 country (Morocco), 2 international organizations (EC-JRC, OECD-NEA)