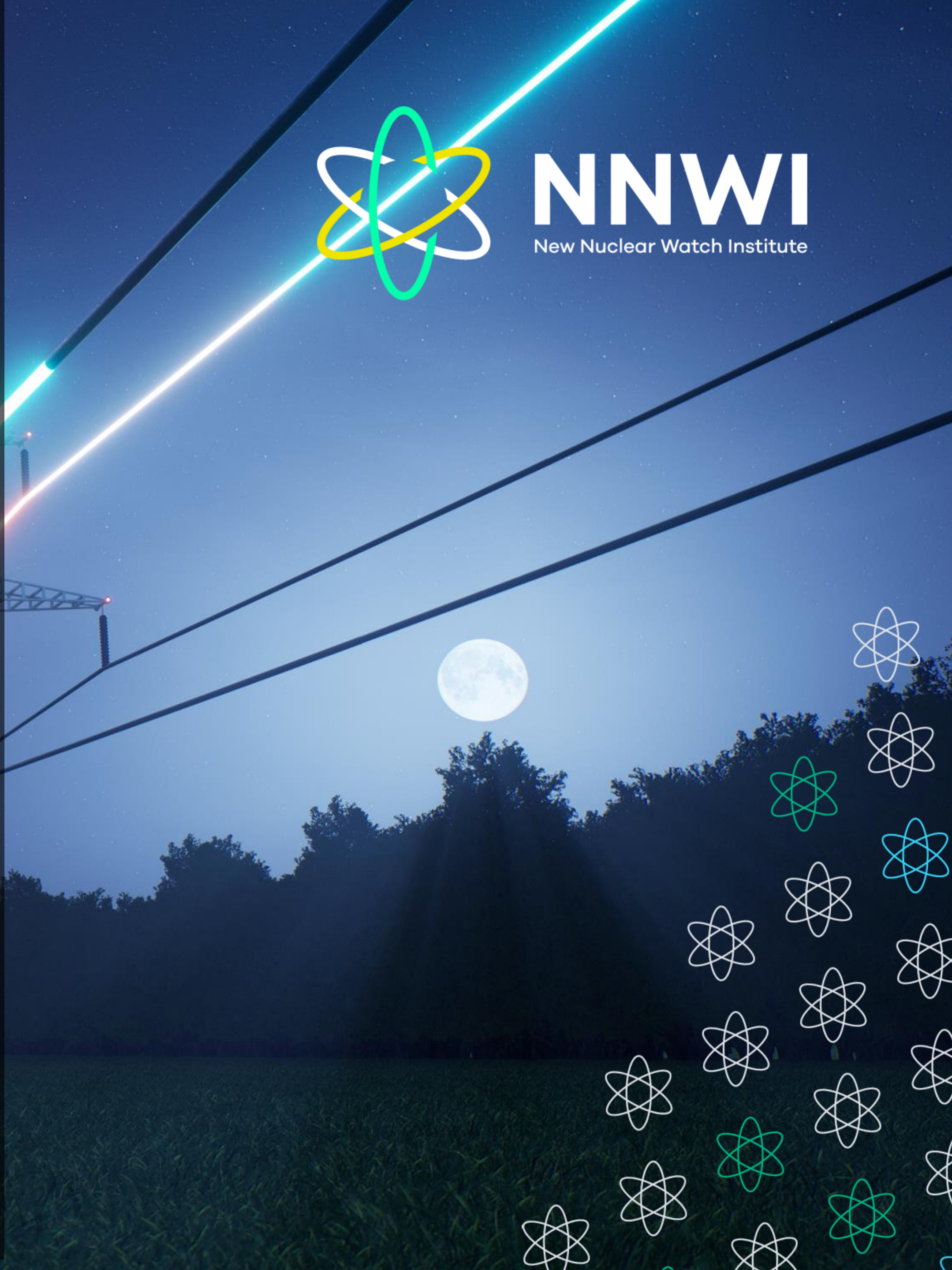
12 March 2024 • 09:00 – 10:30 UK time

SMR Deployment in the Context of European Energy Transition

Chaired by Tim Yeo, Chairman, NNWI

- Yves Desbazeille, Director General, nucleareurope
- Chirayu Batra, Chief Technology Officer, TerraPraxis
- Fredrik Vitaback, Director of Market Development, Europe, GE Hitachi Nuclear Energy
- Roman Romanowski, Vice President of Energy Systems, Westinghouse Electric Company



SMR DEPLOYMENT IN THE CONTEXT OF EUROPEAN ENERGY TRANSITION

12 March 2024

Yves Desbazeille – Director General, nucleareurope

nucleareurope

Membership

nucleareurope represents national nuclear associations

Corporate Members:

CEZ (Czech Republic)
Fermi Energia (Estonia)
Nuvia (France)
PEJ (Poland)
Rolls-Royce SMR (UK)
Urenco (Global)
KGHM (Poland)
NAAREA (France)

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What does nuclear contribute to the EU's economy?

100

Nuclear reactors in operation in the EU

1 million jobs

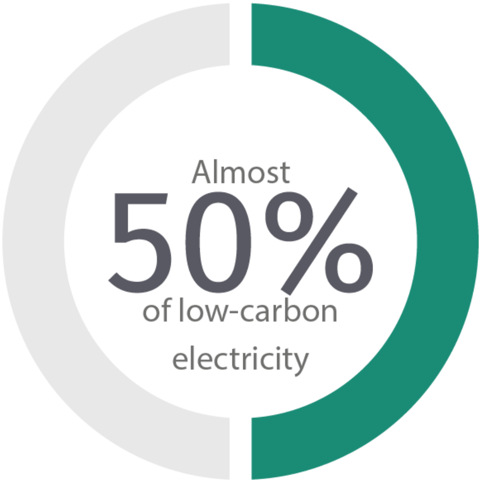
€ 100

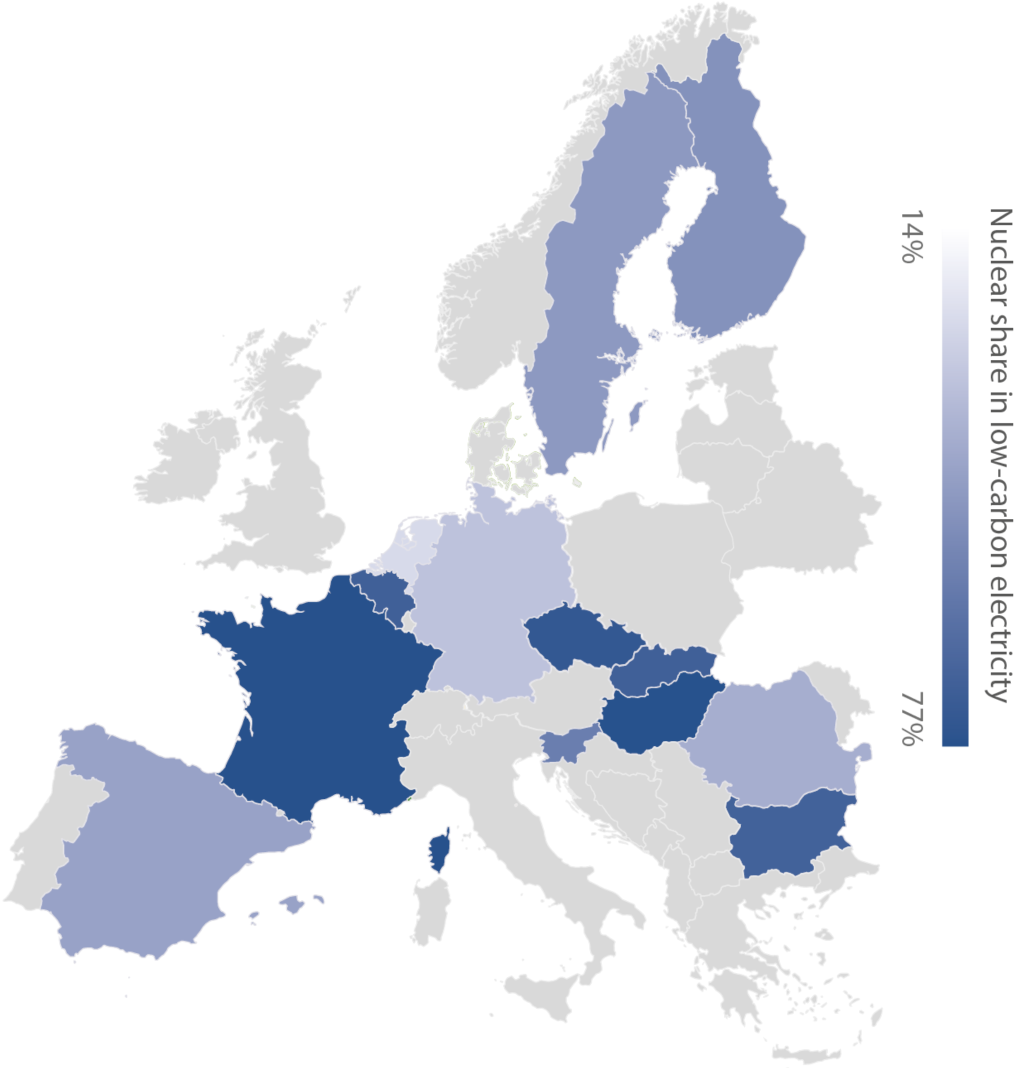
billion/year

25%

of the electricity production

Nuclear energy in the EU





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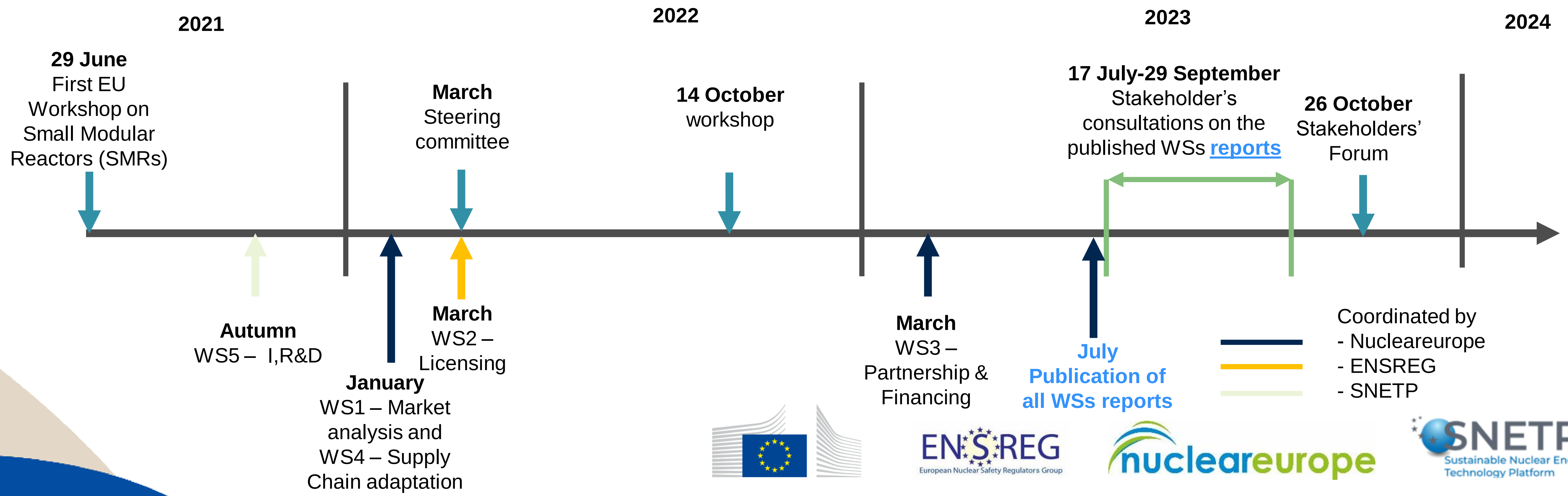
General Presentation (short)

European SMR pre-Partnership

General objectives

- **Identify enabling conditions and constraints, including financial ones,** towards safe design, construction and operation of SMRs in Europe in the next decade and beyond in compliance with the EU legislative framework in general and to the Euratom legislative framework in particular.

Timeline



ENSREG European Nuclear Safety Regulators Group

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SNETP Sustainable Nuclear Energy Technology Platform

Outcome of the pre-Prepartnership
European Industrial Alliance on SMRs: what for?

Accelerate SMRs' deployment (incl. for and with intensive end-users)

Ensure collaboration on SMR licensing across regulators

Bring together all stakeholders with a conducive framework @EU & national level

Ensure EU supply chain readiness (skills, capability & capacity)

Ensure R&D development and cooperation and prepare for the future with innovation

MS: bring support to industry / encourage projects / support regulators

EC: plays a pivotal role as a catalyser of all stakeholders, ensuring conducive/ supportive policies

Industry: develop projects / designs / energy solutions for end-users / Ensure Supply chain ramping up

R&D: develop the technological results and tools necessary for these projects

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SNETP
Sustainable Nuclear Energy Technology Platform

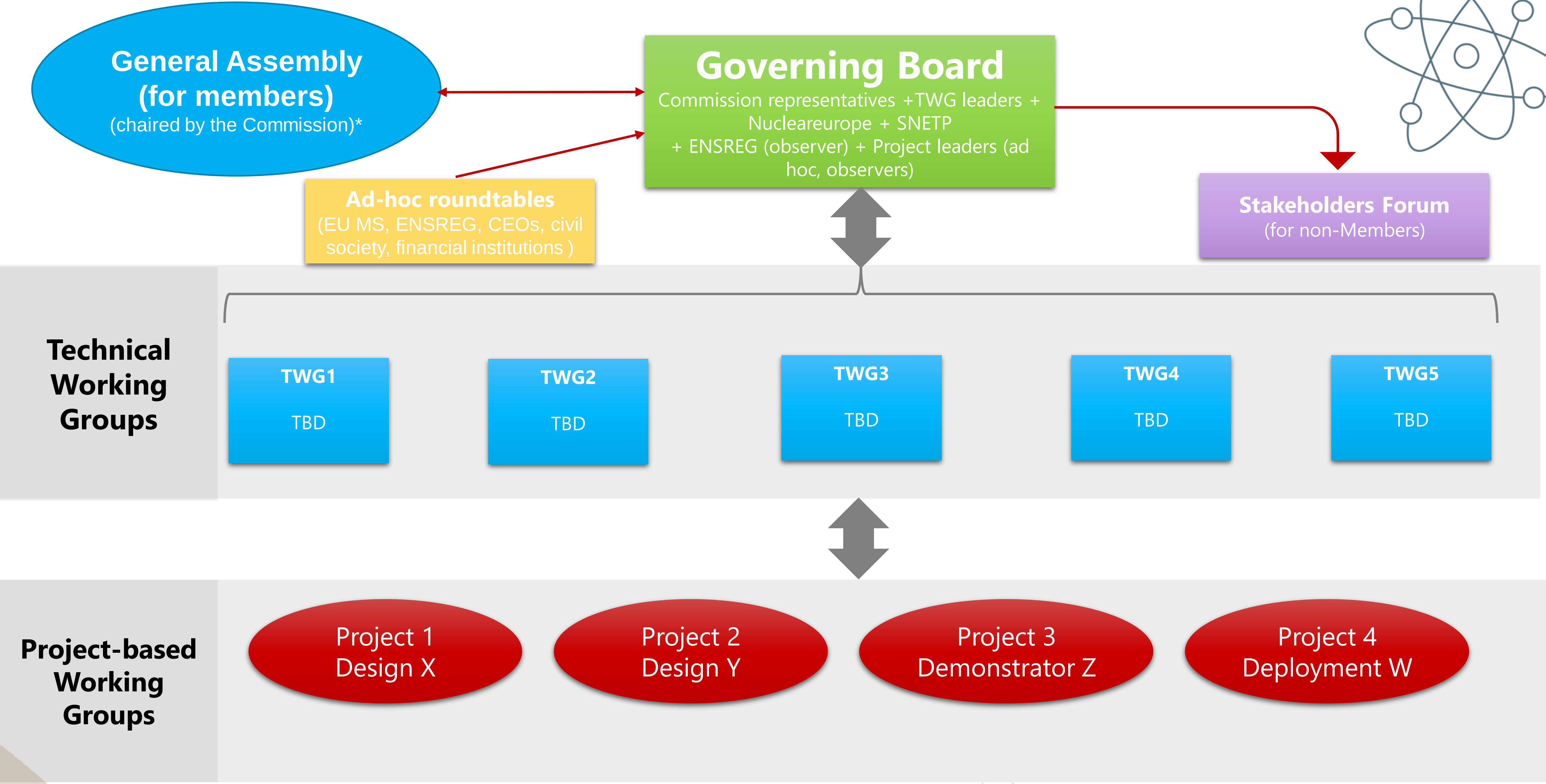
Industrial Alliance Main Objective

The main objective of the European Industrial Alliance on SMRs **is to facilitate and accelerate the development, demonstration, and deployment of the first SMRs projects in Europe in the early 2030s**, by assisting emerging SMRs projects to reach the demonstration and deployment phase.

Working Methods

The Alliance will **provide a framework for coordinating activities, preparing analytical studies, sharing best practices and developing and conducting joint actions aimed at fostering the deployment of SMRs in Europe**.

It will promote **collaborative actions between SMR project promoters**, public and private entities and associations, Member States, regions, social partners, regulators, research and technology organisations, education and training institutions, investors, civil society and NGOs.



*: The three Commissioners for Energy, for Internal Market, and for Innovation, Research, Culture, Education and Youth will co-chair the General Assembly meetings.

European Industrial Alliance structure

Technical Working Groups

- Groups for policy reflection and action in important aspects for which further work is needed (project development, project finance, supply chain, financing, safety research, public engagement, waste management, etc.) or not yet touched upon.
- Will be nourished by projects' feedback experience and will disseminate best practices across projects
- Will directly interact with EU & National decision-makers.

Project-based Working Groups

- Will be assisted under the SMR Alliance
- Will gather interested stakeholders through specific agreements.
- Depending on project nature & objectives, they could fall under different categories (IPCEIs, PPP, SRIA, etc,)
- Will run under strict commercial protection / non-disclosure agreements

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SNETP Sustainable Nuclear Energy Technology Platform

Working Methods – Technical Working Groups

INDICATIVE LIST

Project development	Project finance	Supply chain	Public engagement
Radioactive waste and spent fuel management	Research & Innovation	Skills	Safety, Security, and Safeguards

- Technical Working Groups assigned tasks by the Governing Board.
- Stakeholder collaboration: developers, vendors, utilities, research institutes, financial institutions, supply chain representatives, training centres, and civil society.
- European Commission could provide technical support, including research on safety, security and safeguards for SMRs.
- Working Groups may meet multiple times a year.
- Administrative support provided by an entity designated by the industry in agreement with the European Commission.

Tasks

The Alliance will elaborate a **Strategic Action Plan by Q1 2025** to deliver on the following tasks:

Task 1: The Alliance **will facilitate interactions** between vendors, project developers, suppliers, financial institutions, and investors **to explore investment possibilities and develop new cost-sharing financial models**.

Task 2: The Alliance will develop by **Q4 2024 technology roadmaps**

Task 3: The Alliance will promote **connections with potential end-users**

Task 4: The Alliance will **map and regularly assess the performance and completeness of the European supply chain**

Task 5: The Alliance will **map the availability of financial support, attract private investment, and facilitate the dialogue and matchmaking between producers and investors**

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SNETP Sustainable Nuclear Energy Technology Platform

Tasks

The Alliance will elaborate a **Strategic Action Plan by Q1 2025** to deliver on the following tasks:

Task 6: The Alliance will **identify and prioritise future needs for research, innovation, qualification, demonstration, and skills development** in cooperation with the SNETP to be addressed in the next European (including Euratom) and national R&D&I programmes

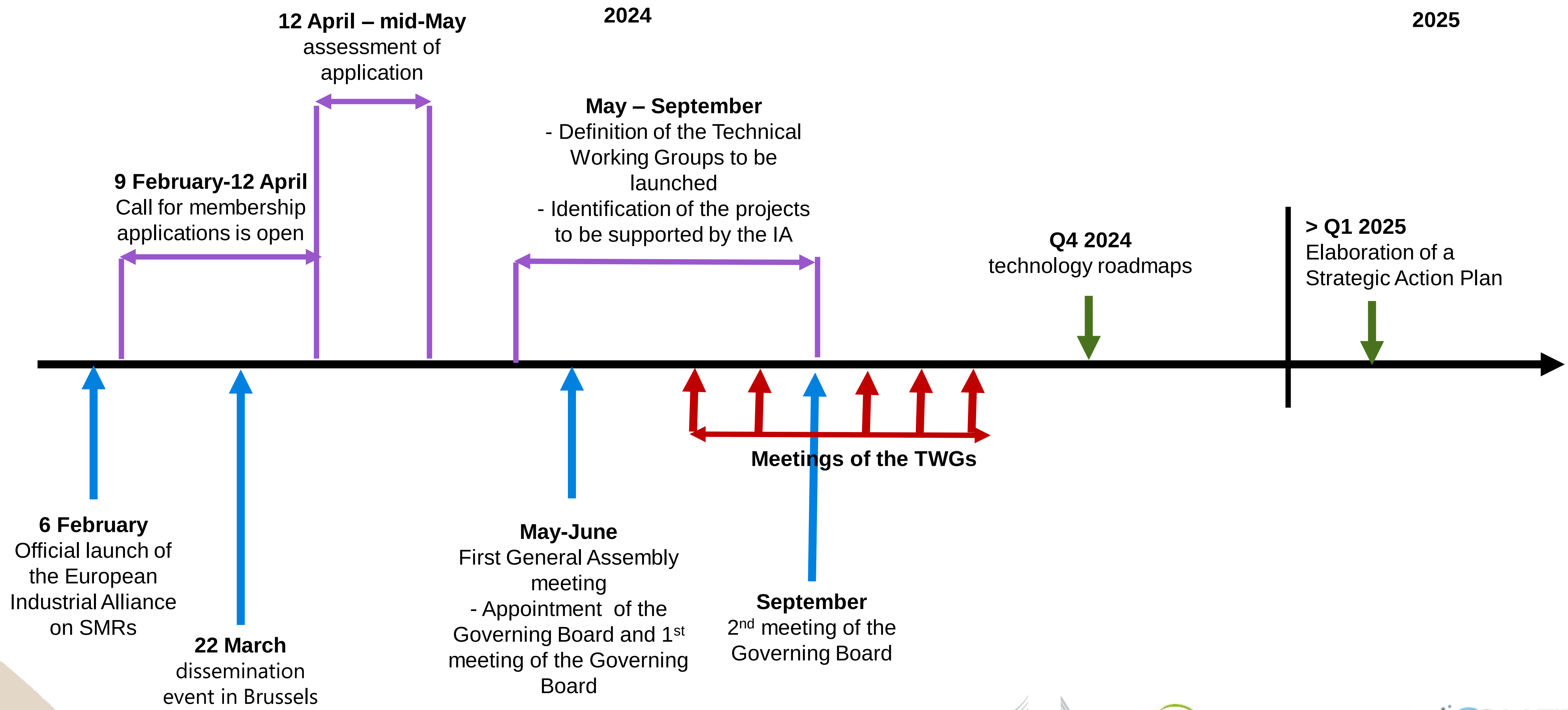
Task 7: The Alliance will **explore the skills and training needs for the SMR value-chain** and **suggest solutions to strengthen education, training, and skills development for a competent workforce**.

Task 8: The Alliance will **strengthen exchanges and contacts of project promoters with the European Nuclear Safety Regulators Group (ENSREG) and national regulatory authorities**

Task 9: The Alliance will facilitate cooperation between stakeholders, regarding standardisation issues related to design variability, supply chain availability, standardised quality control methods, verification and validation, thus facilitating the circulation of goods amongst Member States.

Task 10: The Alliance will also **engage in a dialogue with social partners, stakeholders, civil society organisations, NGOs** and citizens about SMRs and the costs risks and benefits of their deployment

Indicative timeline



Applications for Alliance membership

- Call for membership applications is open 9 February – 12 April
- Necessary steps for application

1. Read the Declaration and the Terms of Reference of the Alliance.

2. Fill in this application form online and submit it.

3. Have the Declaration of the Alliance signed (including the Annexes) by an authorised representative and send it to grow-EU-SMRS-ALLIANCE@ec.europa.eu

- If clarifications are needed, please check the Frequently asked questions section of the Alliance webpage which is regularly updated or send your question to the Alliance mailbox

Thank you!

Yves Desbazeille

Director General- nucleareurope

nucleareurope

NNWI WEBINAR:
SMR Deployment in the Context of European Energy Transition

REPOWER

Strategies to rapidly transition energy infrastructure to emissions-free energy sources to address climate change

Chirayu Batra

Chief Technology Officer

https://www.terrapraxis.org/

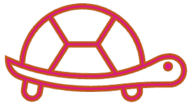
March 2024

TERRA PRAXIS

KEY RISKS TO THE ENERGY TRANSITION

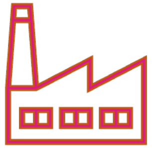
Massive Growth & Unmet Demand

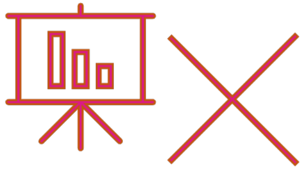
Slow Project Development



Cumbersome Permitting

Stranded Assets and Communities





Flawed Decarbonization Models

WHAT SHOULD THE SMR INDUSTRY DO?

1. Deliver on Promise

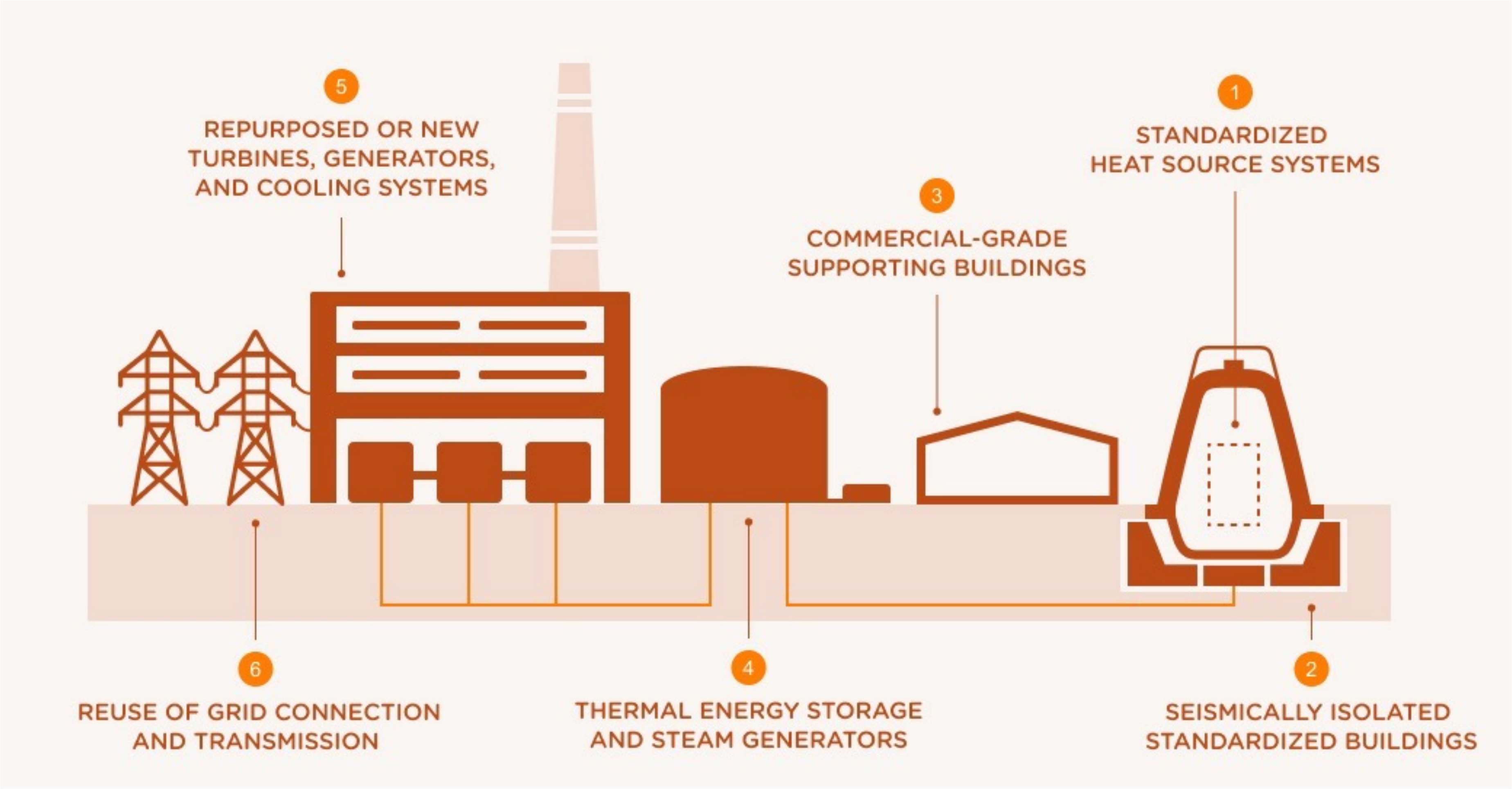
2. Streamline Regulations

› **Make a Product** ›

- Think in terms of cost↓, speed↑ and, scale↑.
- Standardize most of the structure, system and components along with the supply chain to deliver them → Modular by design (DfMA).
- Design for a large enough set of sites but with sufficiently common characteristics to enable highly standardized design.
- Design special features to isolate the plant from the variation in the set of chosen sites.
- Design to be repeatable with no safety relevant variation.

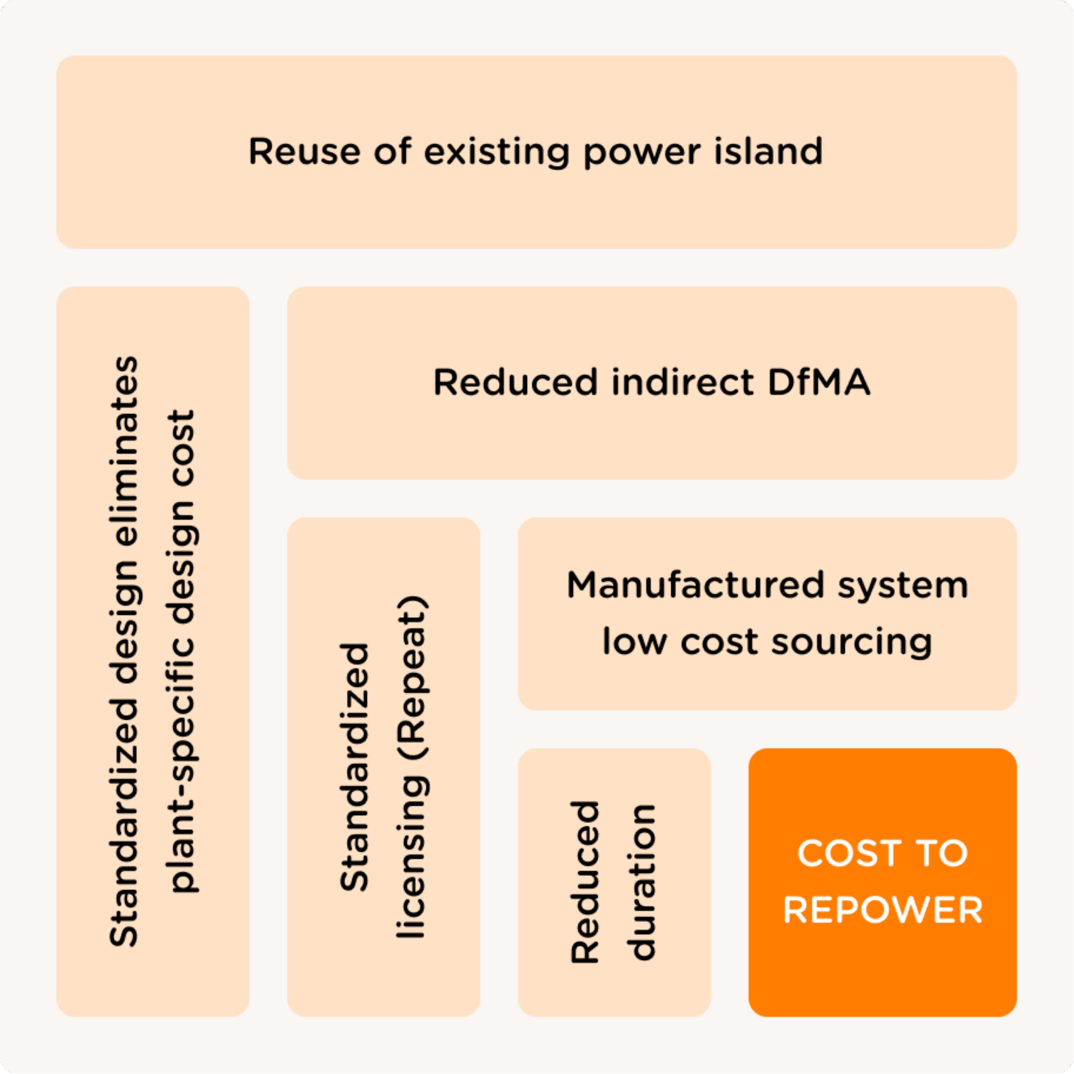
EXAMPLE: REPOWERING COAL

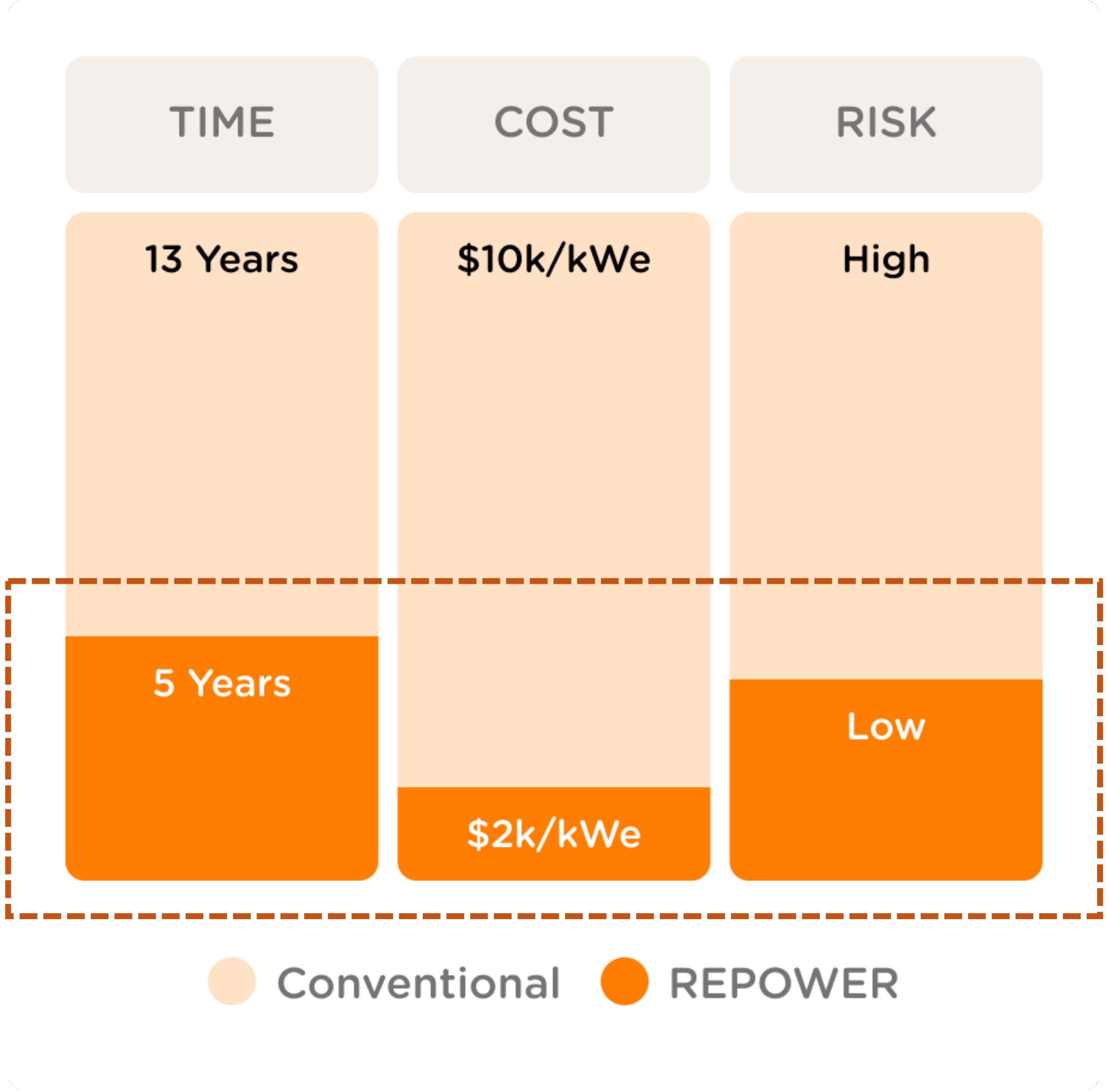
Built Systems Must Enable Scale and Speed



2TWe
2050

FASTER DELIVERY, LOWER COMMERCIAL RISK





TRANSITION REQUIRED BEYOND THE POWER SECTOR

- Seventy-five percent of primary energy use is outside the power sector (e.g., data centers, steel, cement, aviation, marine shipping).
- Developing emission-free substitute fuels and decarbonizing other high-carbon sectors will require an enormous amount of emissions-free energy.
- The project's scale necessitates energy models that go beyond cost optimization, representing feasible solutions and influencing policy and investment for large-scale decarbonization.

ENERGY MODELS TO ASSESS THE RISK TO THE TRANSITION

Feasibility/Reality Check

Land
Transmission
Critical minerals
Project development process

Repurpose Assets

Use existing infrastructure

Diversify Pathways

Decisions under uncertainty
Quantifying risk
Diversification of energy sources

TRANSFORMING MODELING: MODELING INDUSTRIAL DECARBONIZATION

- **Companies are the actors of decarbonization..**

- **But this is not the vision of most models.**
  - Because of hypotheses and simplifications
    - No management of risk
    - No consideration for supply chain
    - Capacity expansion « happens » exactly when needed, and does not require anticipation etc. This includes transmission lines etc. which generates risk for companies
  - Because of the questions asked to models
    - ***What policy is right assuming that industry will adapt?***

      as opposed to
    - ***What can policy do to facilitate transition by industry?***

- **Modeling the decision-making for companies requires specific considerations and models.**

  → Gap in existing models

- **Our approach:**
  - Centered around incorporating such concerns into modeling

- Is Industrial end-user representation accurate (based on their needs)?
- Investment Decisions: Are they modelled and based on realistic assumptions?
- Are there realistic assumptions on capacity expansion with planning time?
- Do end-users depend on grid power exclusively or own source?
- Model Design: Academic exercise or industry tool?
- Is the risk to transition mapped according to the industrial end-user?

A joint paper with the IAEA endorsing this method will be published in Q3 2024

CLIMATE X PROSPERITY

Thank you

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TerraPraxis.org

TERRA PRAXIS

GE Hitachi Nuclear Energy

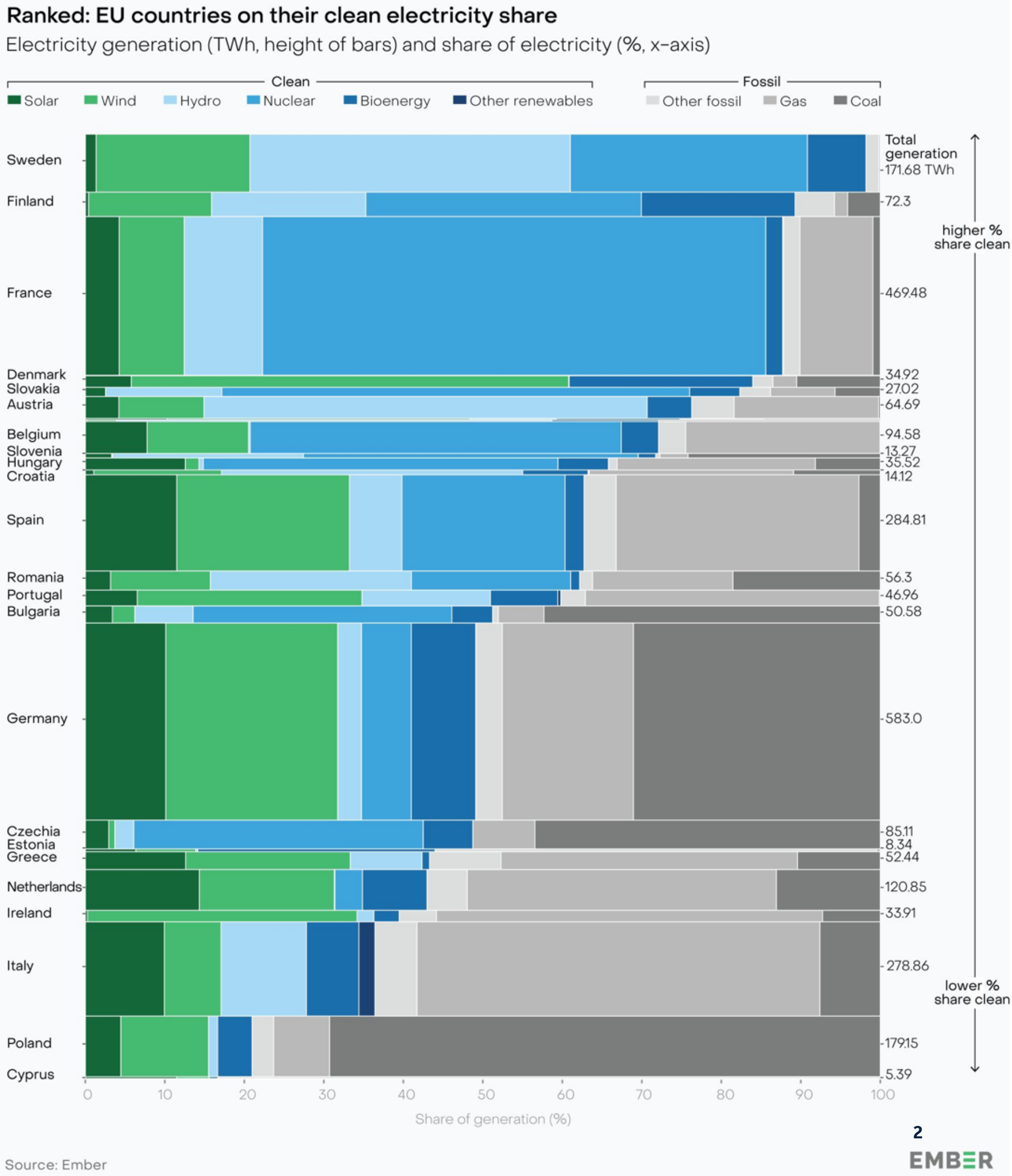
Energy Transition

March, 2024

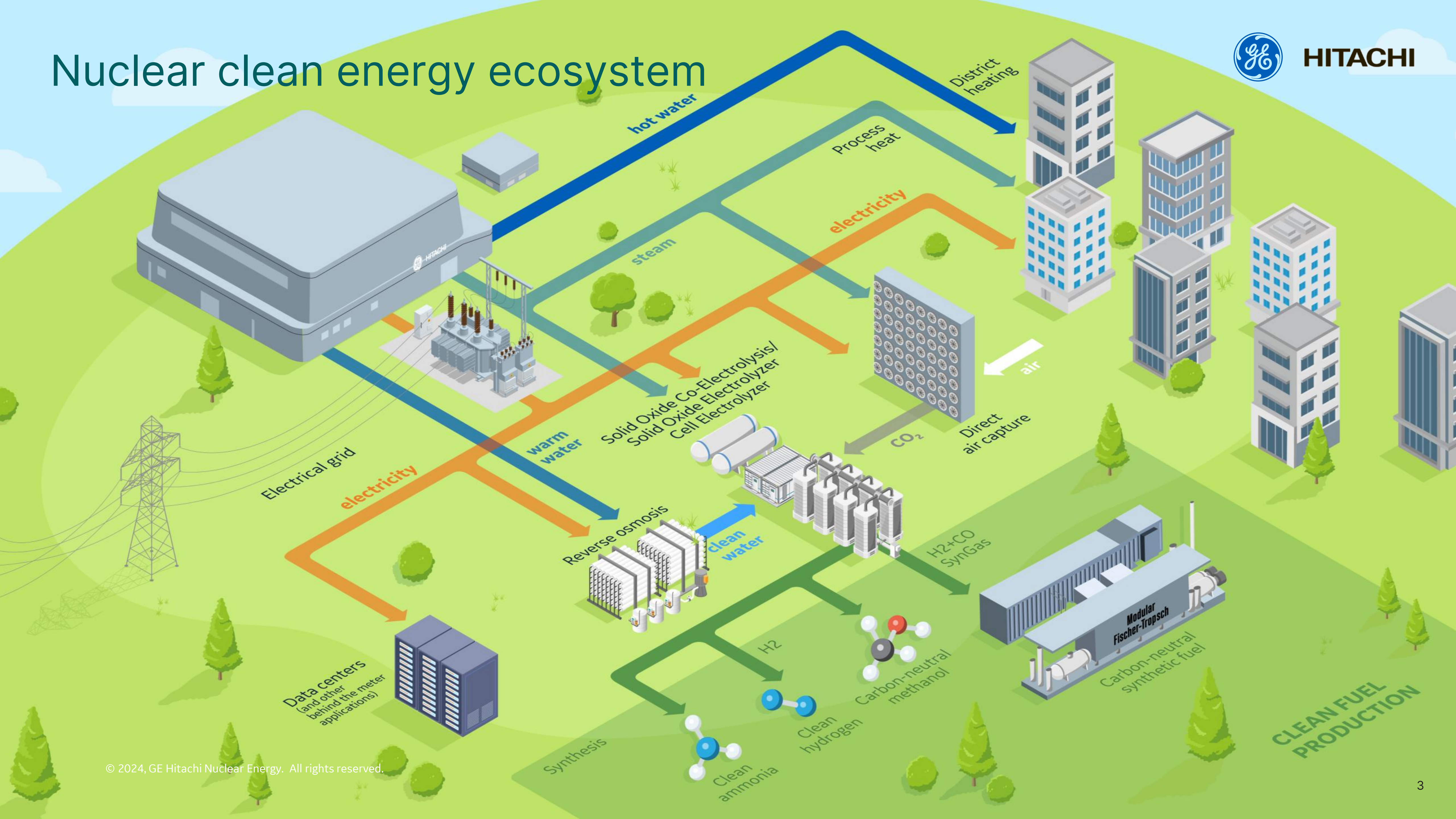
Different driver in each market -electricity is not offtake alone

BWRX-300 adresses new segmets with

- Reduced cost of capital
- Smaller footprint at locations closer to demand
- Close integration of applications



Nuclear clean energy ecosystem

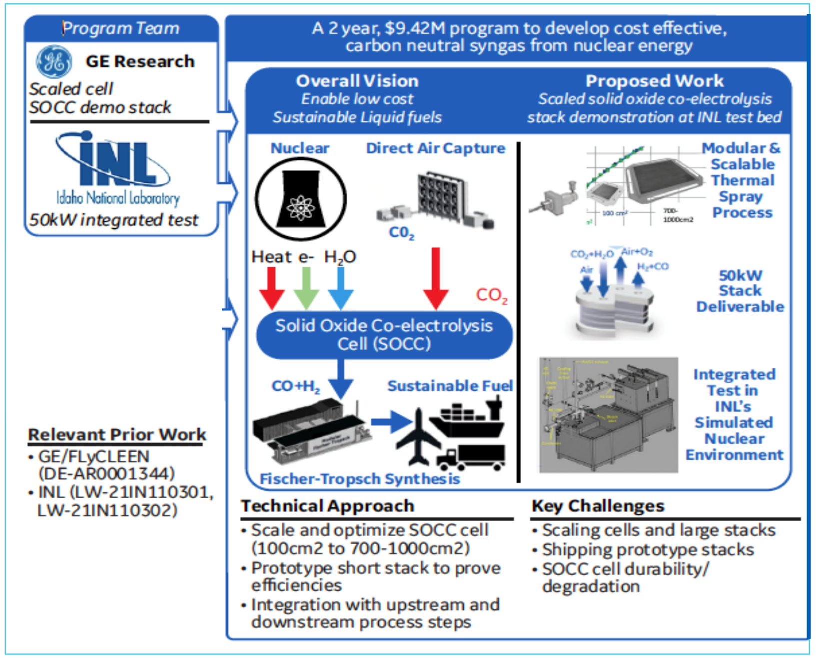


Commercialization of SMR applications

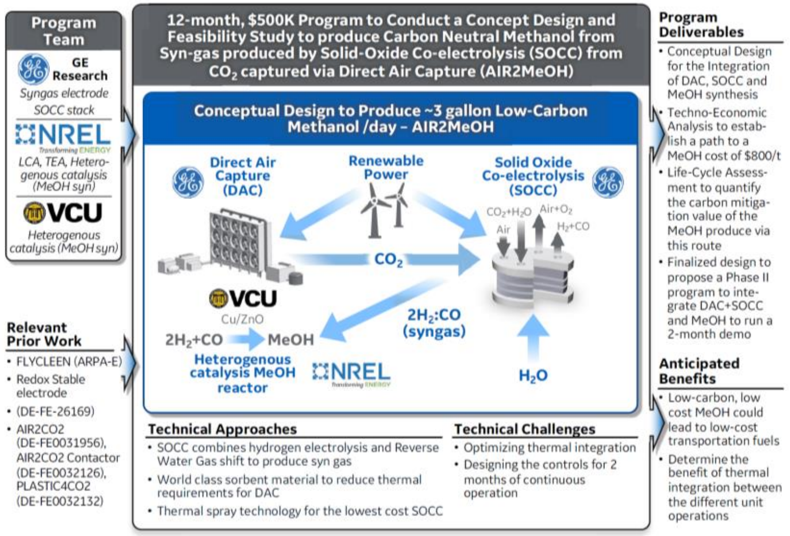
Prove that SOCC scales to large area.

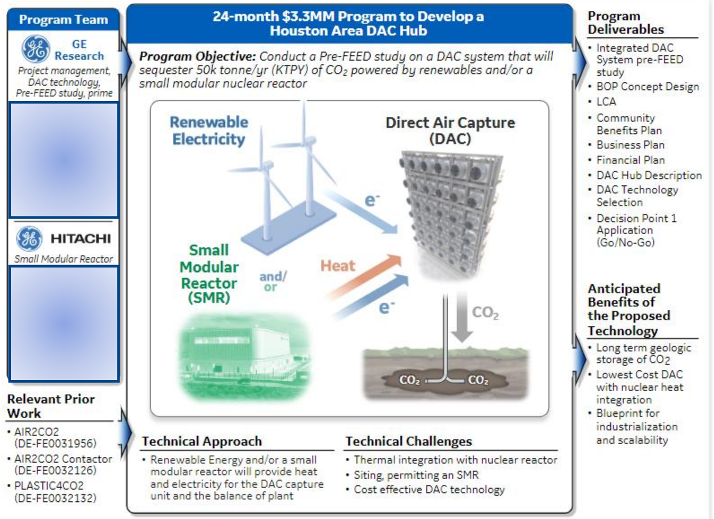
Develop conceptual design for methanol synthesis using SOCC.

DAC Hub with option for carbon utilization



Ref https://www.energy.gov/sites/default/files/2023-05/ne-abstract-ARD-22-28700.pdf





Thank you

Westinghouse

NNWI
New Nuclear Watch Institute

AP300™ SMR

The ONLY SMR based on Nth of a Kind Operating Plants

March 12, 2024

SMR deployment in the context of European Energy Transition

Westinghouse Overview

Established nuclear solutions provider

- Founded by George Westinghouse in 1886
- USS Nautilus (commissioned 1954)
- World’s first commercial pressurized water reactor
- (PWR) in 1957 in Shippingport, Pennsylvania, U.S.
- Responsible for some of the world’s greatest advances and innovations in energy technology
- Key partner in solving the global energy challenge

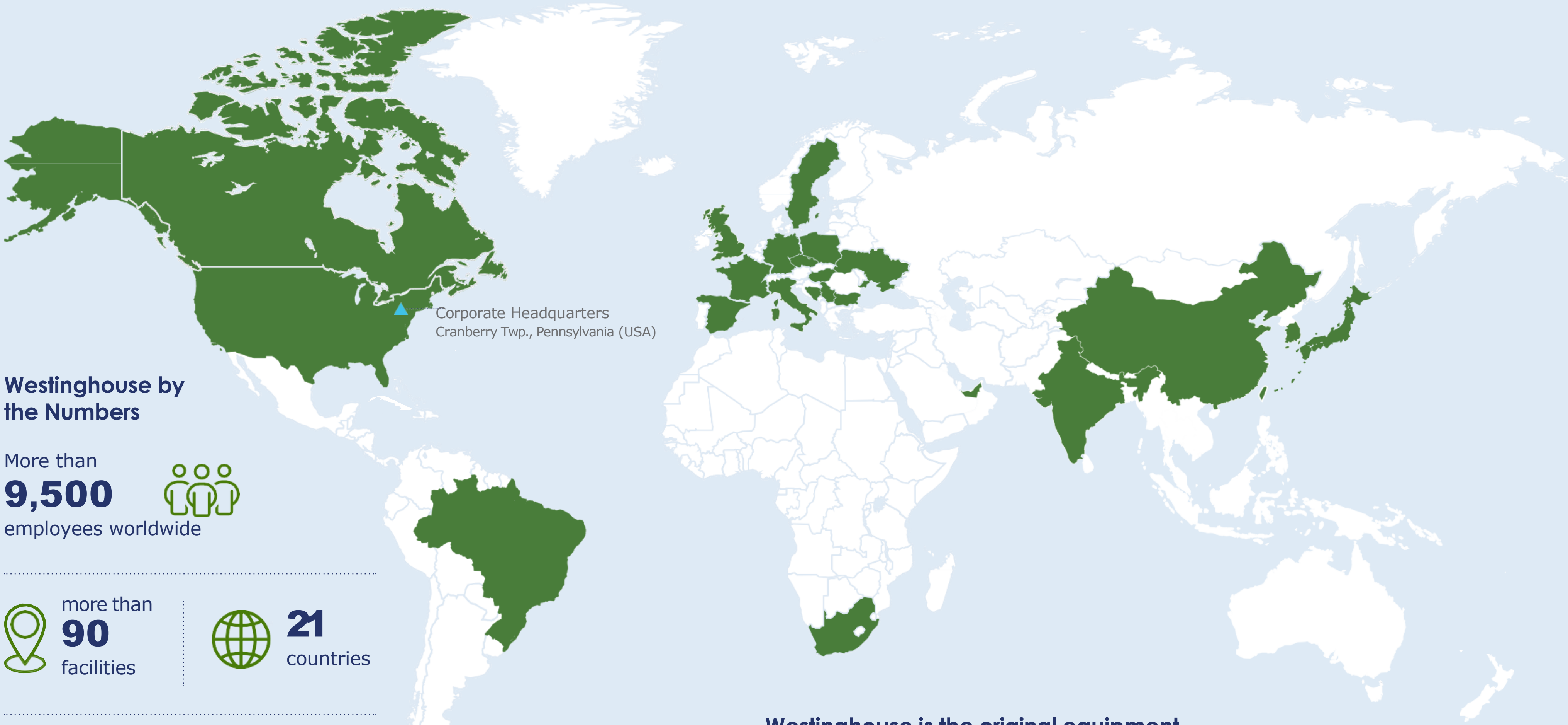
More Than

137

Years of Innovation

Westinghouse

global presence



Westinghouse by the Numbers

More than
9,500
employees worldwide

more than
90
facilities

21
countries

3 fuel fabrication facilities

Westinghouse is the original equipment manufacturer or a technology provider to:

~50% of the global nuclear reactor fleet, delivering capacity of ~190,000 carbon-free MWe

Emissions-Free Power

Approximate emissions reduction equivalents*

	Approximate Emissions Avoided	Equivalent Vehicles Off the Road	Homes Powered Annually
AP1000 Power Plant 1100+ MWe	**7 million** metric tons of CO_2	**1.5 million** cars off the road	**750,000** homes powered
AP300 SMR 300 MWe	**1.85 million** metric tons of CO_2	**400,000** cars off the road	**195,000** homes powered
eVinci Microreactor 5 MWe	**55,000** metric tons of CO_2	**10,000** cars off the road	**5,000** homes powered

Source: data calculated using Westinghouse research and epa.gov emissions comparatives

Westinghouse

Today's Energy Landscape

The world is recognizing the need for nuclear & is seeking proven solutions

CUSTOMER CHALLENGES

- **Emission-free Energy**
- **Energy Security**
- **Energy Price Stability**
- **Grid Stability**

THE SOLUTION

CUSTOMERS CONTINUE TO SELECT WESTINGHOUSE

- **China has 4 AP1000 reactors in operation & 8 units under construction**
- **U.S. has 1 operating AP1000 and 1 in final commissioning**
- **Poland contracts for 3 AP1000 reactors**
- **Ukraine contracts for 9 AP1000 reactors**
- **Bulgaria selects 2 AP1000 reactors**
- **India selects 6 AP1000 reactors**

AP300 SMR

Only SMR based on deployed, operating & advanced reactor technology

Proven Technology

21 AP1000 reactor-years of safe operations

Based on the fully licensed & operating AP1000 technology.

Advanced Safety

More than **30** years licensing advanced passive technologies with global regulators

We pioneered passive safety systems. AP300 utilizes identical passive safety systems used in the AP1000 reactor to maintain safe shutdown condition.

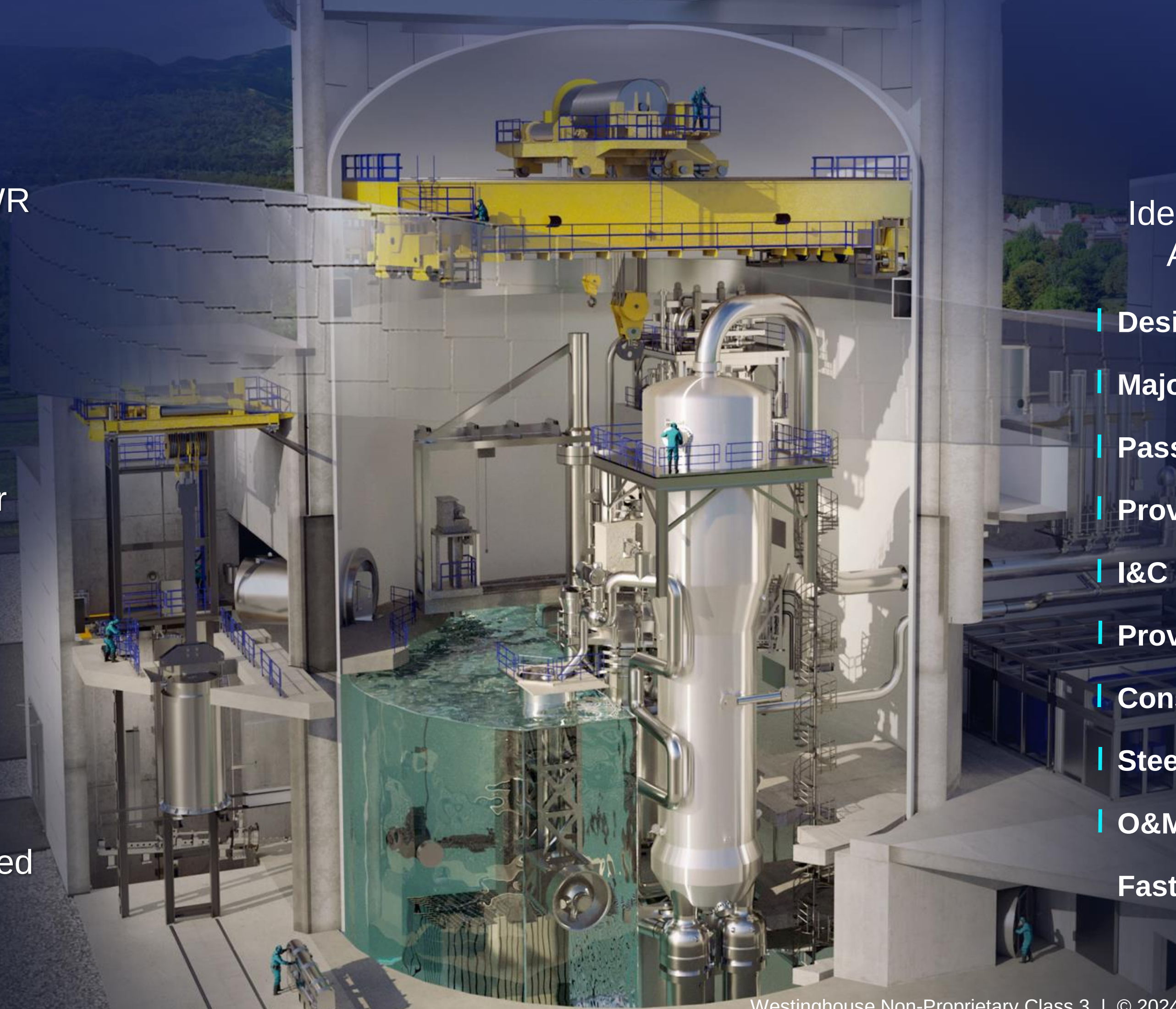
Readily Deployable

Approximately **0.4** acres needed for safety related buildings

Ultra-compact, simplified design reduces construction timeframes. Maximizes use of established supply chain.

Proven Technology

Leveraging AP1000 technology with demonstrated industry leading reliability



300MWe (990MWth) 1-loop PWR with demonstrated reliability

Westinghouse AP1000 reactor passive safety technology

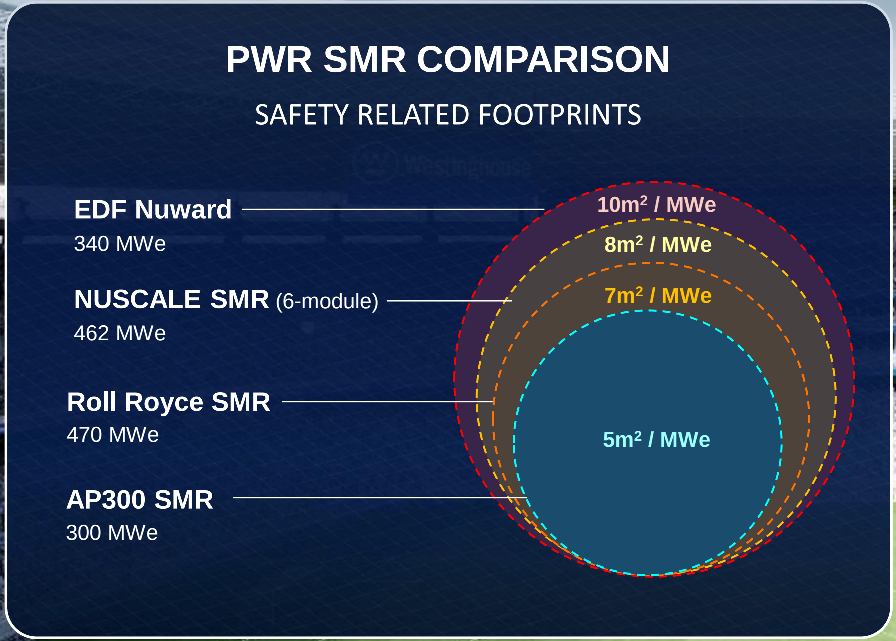
Reduces overall components creating a simpler plant compared to other SMRs

Identical Technology as AP1000 including:

- Design & licensing methodologies
- Major equipment & components
- Passive safety systems
- Proven Fuel
- I&C systems
- Proven Supply Chain
- Constructability lessons learned
- Steel-Composite structural modules
- O&M procedures & practices
- Fast load follow capabilities

Ultra Compact Footprint

AP300 SMR’s smaller safety related footprint reduces construction, operating & maintenance costs



Rolls Royce power output and footprint per ONR Project Assessment Report Generic Design Assessment of the Rolls-Royce SMR – Step 1 summary (ONRW-2019369590-1908 Rev 0) | NuScale power output and footprint per NuScale Standard Design Approval Application (www.nrc.gov/docs/ML2300/ML23001A016.pdf) | Nuward power output and footprint per IAEA Advances in Small Modular Reactor Technology Developments (2020 Edition)

Passive Safety Pioneers

AP300 SMR uses the identical proven AP1000 fully passive safety systems

Fail Safe

Automatically achieves safe shutdown without the need for operator action

Self Sufficient

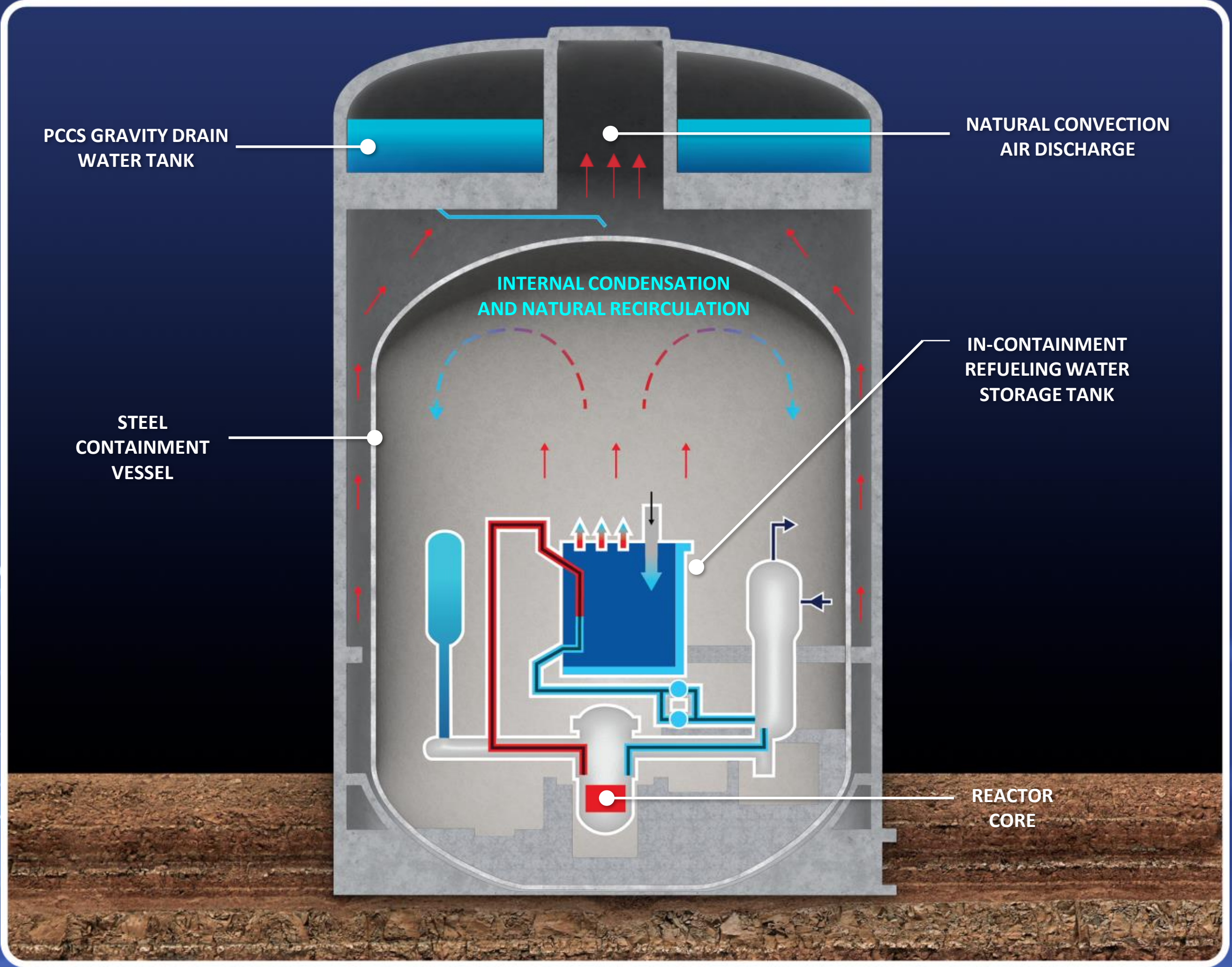
Passive approach to safety eliminates the need for backup power & cooling supply

Hazard Proof

Protected by a robust containment designed to withstand extreme external hazards

Defense in Depth

Multiple layers of defense for accident mitigation



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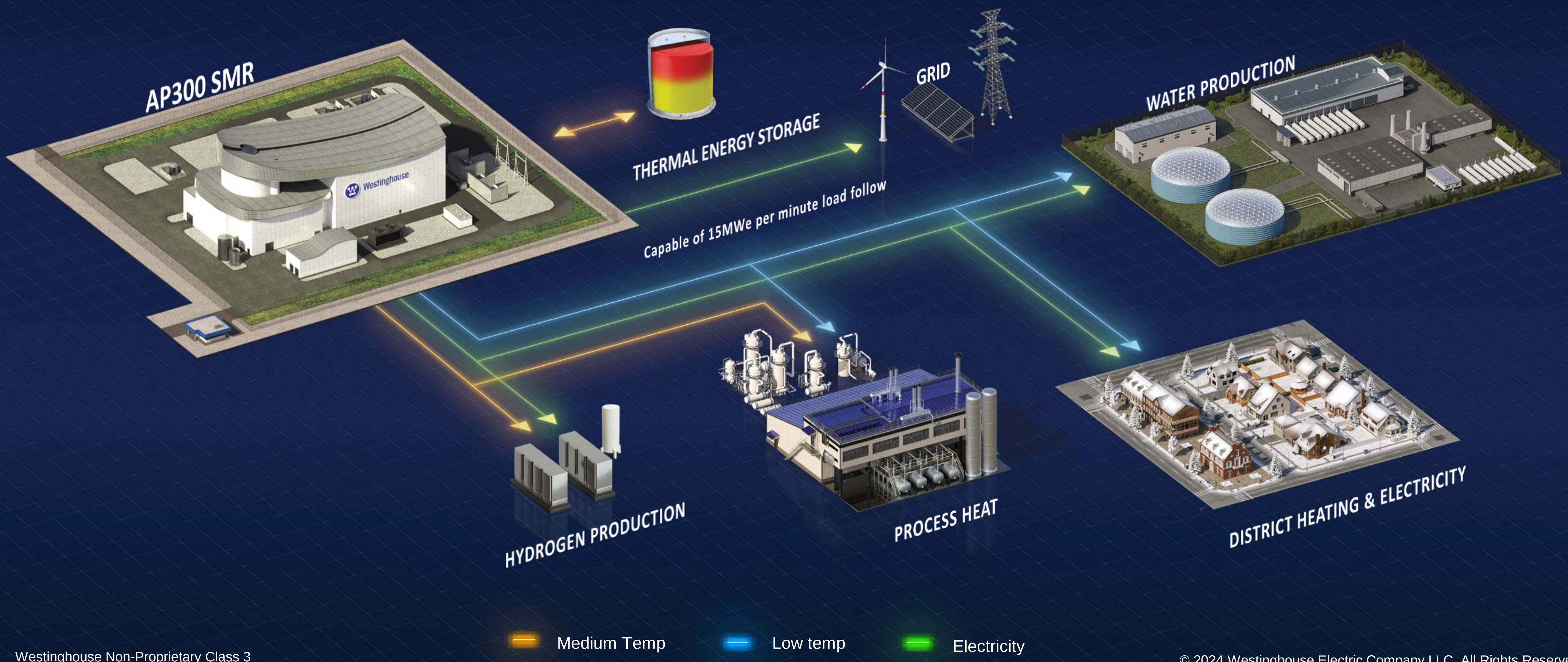
Versatility of Application

AP300 SMR is the backbone of a community clean energy system



AP300 SMR Roadmap

Leverages our AP1000 reactor design and licensing experience to achieve deployment by early 2030's

AP1000 Design & Licensing Completed

1999 - 2012

- Design Certification
- Passive Safety System Testing & Demonstration
- Deployment & operation of AP1000 reactors

AP300 Design & Licensing

2022 - 2027

- NRC design certification
- Standard plant ready for initial deployment

Project Preparation

2027-2030

- Site specific design & licensing
- Long lead time procurement

Ready for Construction

2030

- 36 months for construction

NOAK target overnight cost $3400 per kWe … ~$1B per unit

Readily Deployable by 2030’s

Proven pedigree throughout the plant lifecycle ensures deployment & operations success

Technology Readiness

Tens of millions of hours dedicated to AP1000 reactor development

5 AP1000 reactors operating, 1 nearing completion, more pending

Licensing Certainty

Based on licensed & operating AP1000 technology, the only technology to be fully licensed by the U.S NRC

Established Supply Chain

Incumbent AP1000 suppliers can deliver major equipment

Demonstrated capability to localize supply chain

Modular Construction

Simplified, modular, ultra compact nuclear island (costliest portion of any reactor) reduces construction costs/schedule

Reliable O&M

Record setting AP1000 operational & outage performance

Targeting **+80-year** life cycle

Thank You


Westinghouse
Westinghouse Electric Company
@WECNuclear
Westinghouse Electric Company
wecchinanuclear
westinghousenuclear.com

NNWI
New Nuclear Watch Institute

Q&A Discussion

SMR Deployment in the Context of European Energy Transition

Chaired by Tim Yeo, Chairman, NNWI

- Yves Desbazeille, Director General, nucleareurope
- Chirayu Batra, Chief Technology Officer, TerraPraxis
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