High-tech energy "ecosystems" for sustainable development

Chair:

Tim Yeo
Chairman
New Nuclear Watch Institute

Speakers:

Michel Bérthelemy
Nuclear Energy Analyst
OECD Nuclear Energy Agency

Shannon Bragg-Sitton
Integrated Energy Systems Lead,
Nuclear Sciences and Technology
Idaho National Laboratory

Sophie Macfarlane-Smith
Head of Customer Business
Rolls-Royce SMR

Egor Simonov
Regional Vice President, Director of
Rosatom Southeast Asia

28 October 2021

MEETING CLIMATE CHANGE TARGETS:
THE ROLE OF NUCLEAR ENERGY

Michel BERTHELEMY
Nuclear Technology Development and Economics Division
OECD Nuclear Energy Agency

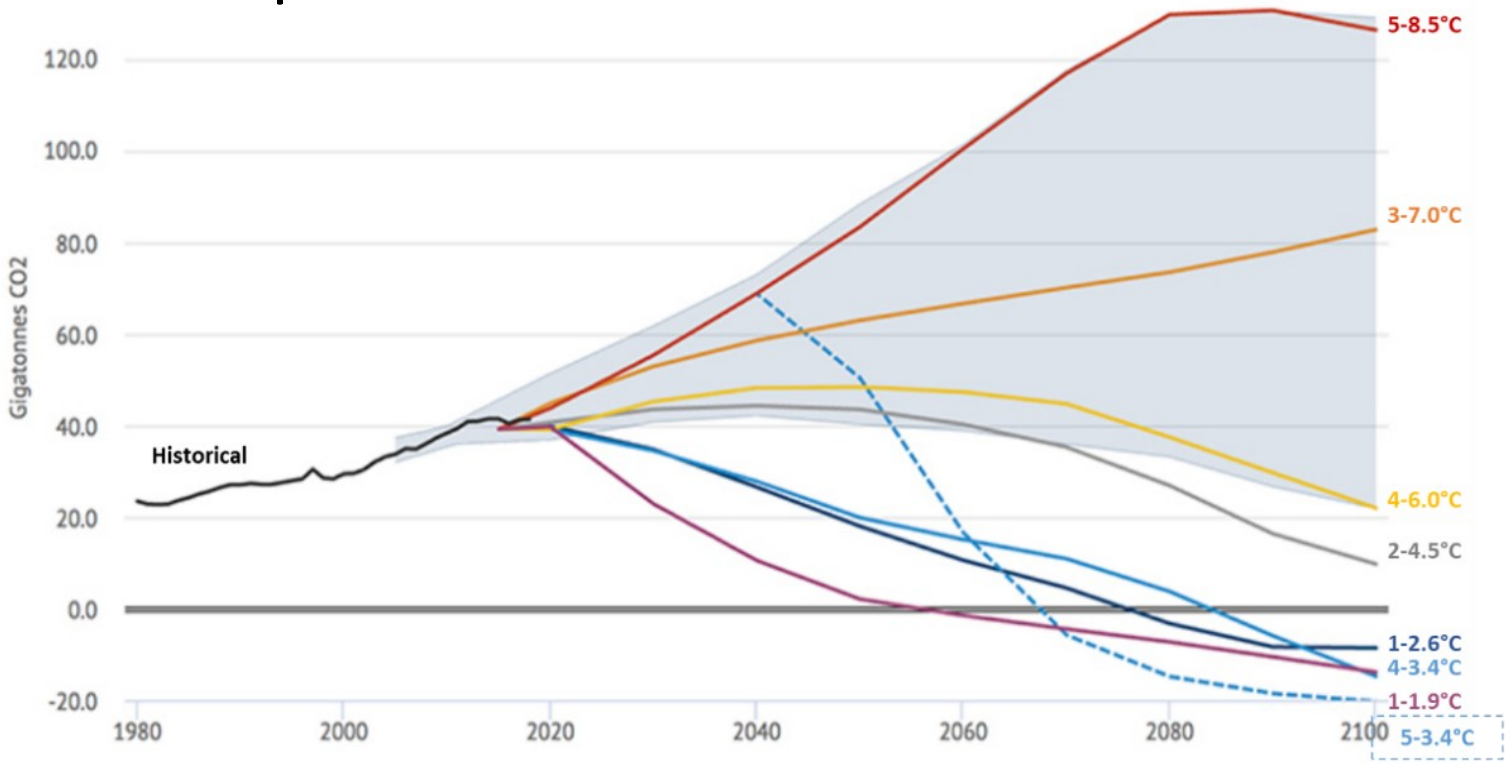
New Nuclear Watch Institute
28 Octobre 21, 2021

1. Context

Global Action Is Urgently Needed

- The magnitude of the challenge should not be underestimated
- The planet has a “carbon budget” of 420 gigatonnes of carbon dioxide emissions for the 1.5°C scenario
- At current levels of emissions, the entire carbon budget would be consumed within 8 years
- Emissions must go to net zero, but the world is not on track

Temperature outcomes for various emissions futures



Source: Carbon Brief (2019).

Pathways to Net Zero Emissions

- Pathways based on the world's carbon budget, emissions reductions targets and timelines have been modelled and published by various organisations
- None of the published pathways project aspirational scenarios for nuclear innovation
- All published pathways include levels of nuclear energy deployment based on currently available commercial technologies
- Nuclear innovation does not feature prominently because of a lack of specialised expertise in nuclear technologies among modelling teams

Samples of ambitious and aspirational pathways to net zero

Organisation	Scenario	Parameter	2020	2050	Growth rate (2020-50)
IIASA (2021)	Divergent Net Zero Scenario (1.5°C)	Cost of carbon (USD per tCO_2)	0	1 647	-
		Wind (in GWe)	600	9 371	1461%
		Solar (in GWe)	620	11 428	1743%
IEA (2021c)	Net Zero Scenario (1.5°C)	Hydrogen (MtH_2)	90	530	490%
		CCUS ($GtCO_2$)	<0.1	7.6	-
		Energy intensity (MJ per USD)	4.6	1.7	-63%
Bloomberg NEF (2021)	New Energy Outlook Green Scenario (1.5°C)	Wind (in GWe)	603	25 000	4045%
		Solar (in GWe)	623	20 000	3110%

Nuclear in Emissions Reduction Pathways

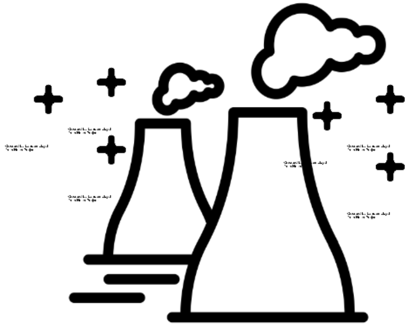
Organisation	Scenario	Climate target	Nuclear innovation	Description	Role of nuclear energy by 2050	
					Capacity (GW)	Nuclear growth (2020-50)
IAEA (2021b)	High Scenario	2°C	Not included	Conservative projections based on current plans and industry announcements.	792	98%
IEA (2021c)	Net Zero Scenario (NZE)	1.5°C	Not included but HTGR and nuclear heat potential are acknowledged.	Conservative nuclear capacity estimates. NZE projects 100 gigawatts more nuclear energy than the IEA sustainable development scenario.	812	103%
Shell (2021)	Sky 1.5 Scenario	1.5°C	Not specified	Ambitious estimates based on massive investments to boost economic recovery and build resilient energy systems.	1 043	160%
IIASA (2021)	Divergent Net Zero Scenario	1.5°C	Not specified	Ambitious projections required to compensate for delayed actions and divergent climate policies.	1 232	208%
Bloomberg NEF (2021)	New Energy Outlook Red Scenario	1.5°C	Explicit focus on SMRs and nuclear hydrogen	Highly ambitious nuclear pathway with large scale deployment of nuclear innovation.	7 080	1670%

All pathways require global installed nuclear capacity to grow significantly, often more than doubling by 2050.

2. The Role of Nuclear Energy

The Full Potential of Nuclear Energy to Contribute to Emissions Reductions


Created by Mask Icon
from Noun Project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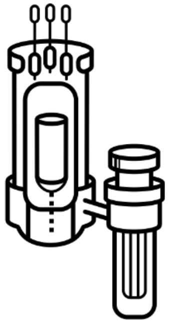
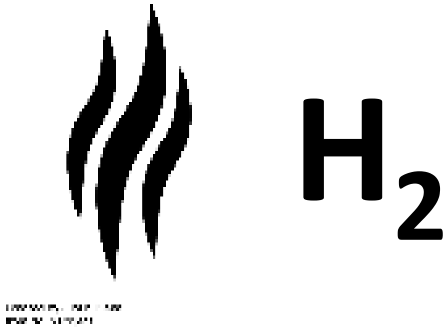
from Noun Project


Created by Olena Panasovska
from Noun Project



Long Term Operation

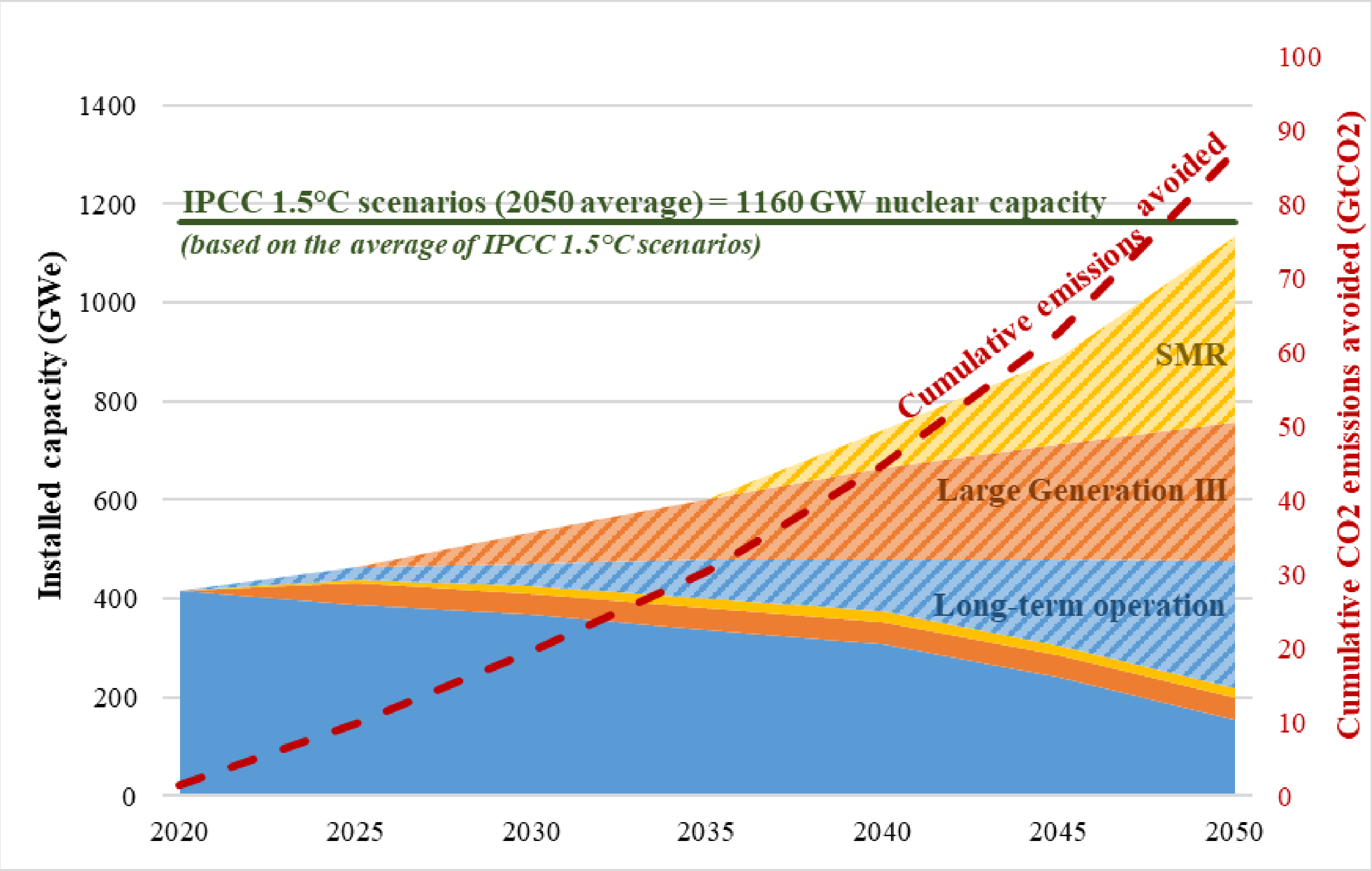
Gen-III Reactors

Small Modular Reactors

Non-Electrical applications

Full Potential of Nuclear Contributions to Net Zero

- The contributions from long-term operation, new builds of large-scale Generation III nuclear technologies, small modular reactors, nuclear hybrid energy and hydrogen systems project the full potential of nuclear energy to contribute to net-zero
- Reaching the target of 1160 gigawatts of nuclear by 2050 would avoid 87 gigatonnes of cumulative emissions between 2020 and 2050, positioning nuclear energy's contribution to preserve 20% of the world's carbon budget most likely de to be consistent with a 1.5°C scenario

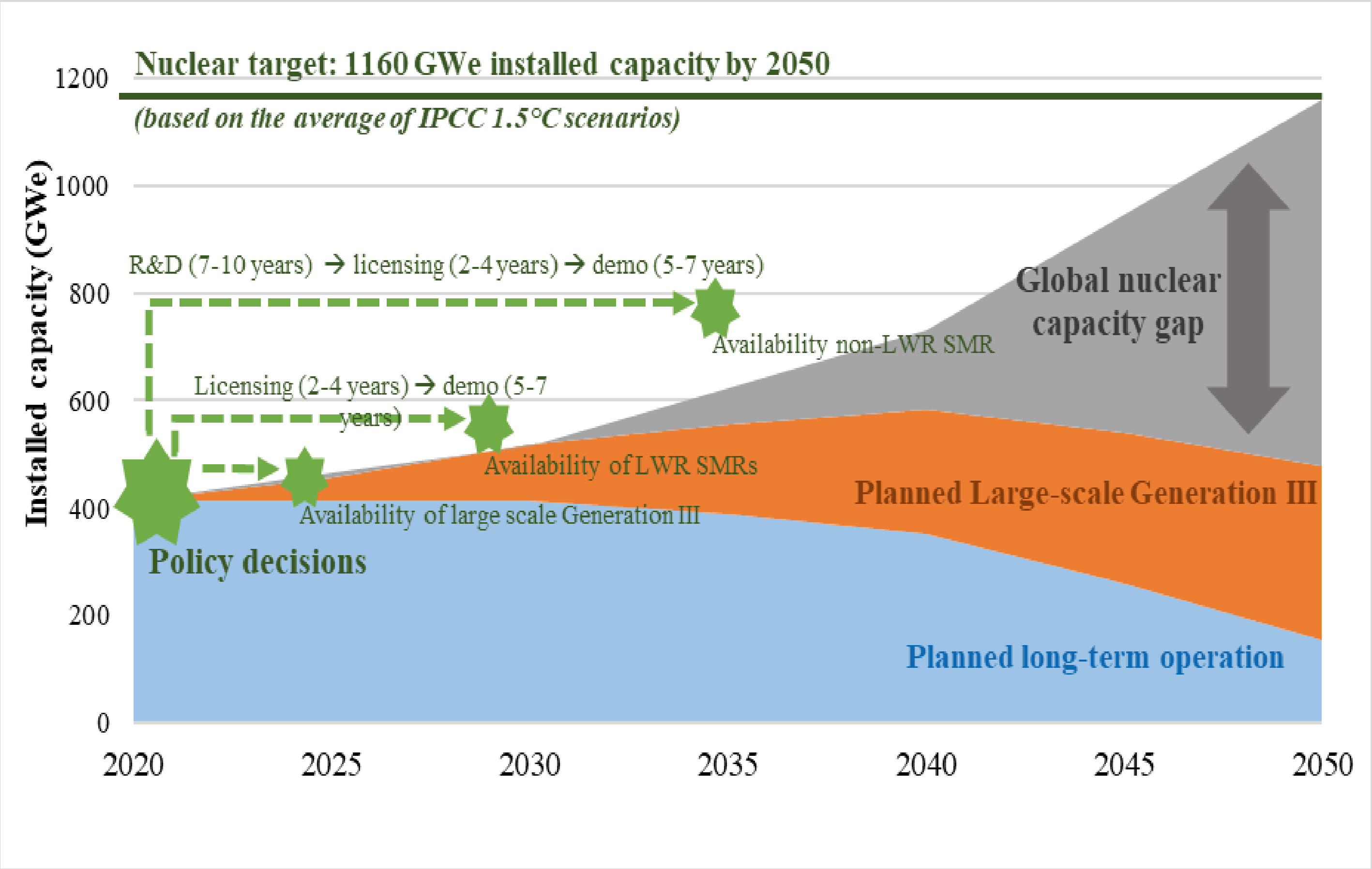


Source: NEA (forthcoming).

3. Challenges

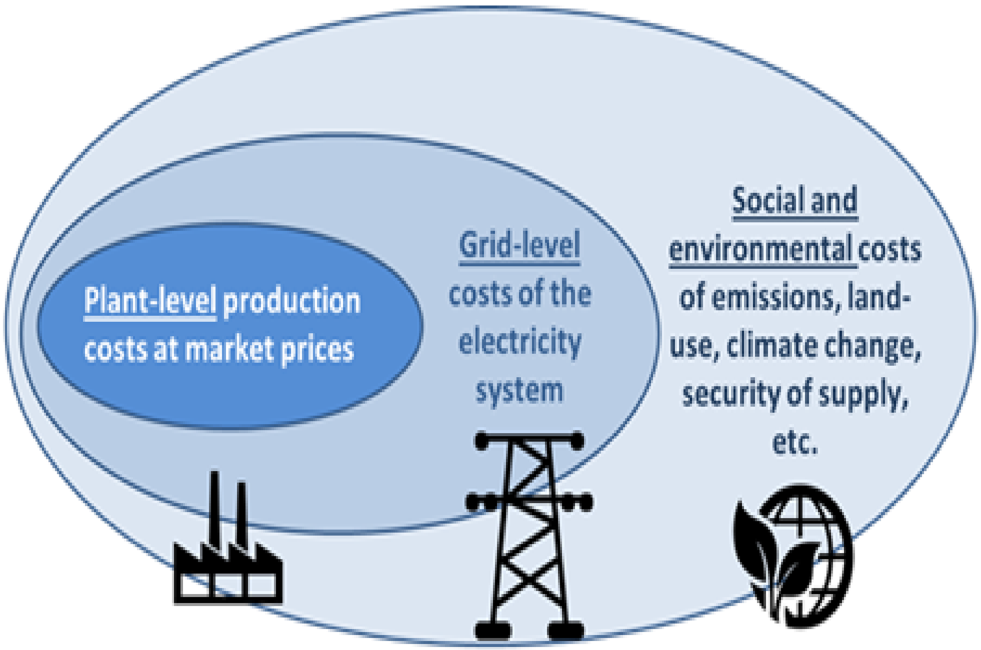
Global Installed Nuclear Capacity Gap

- Under current policy trends, nuclear capacity in 2050 is expected to reach 479 gigawatts – well below the target of 1160 gigawatts of electricity
- There is a projected gap between the *minimum required global installed nuclear capacity* and *planned global nuclear capacity* of nearly 300 gigawatts by 2050
- Owing to the timelines for nuclear projects, there is an urgency to action now to close the gap in 2030-2050



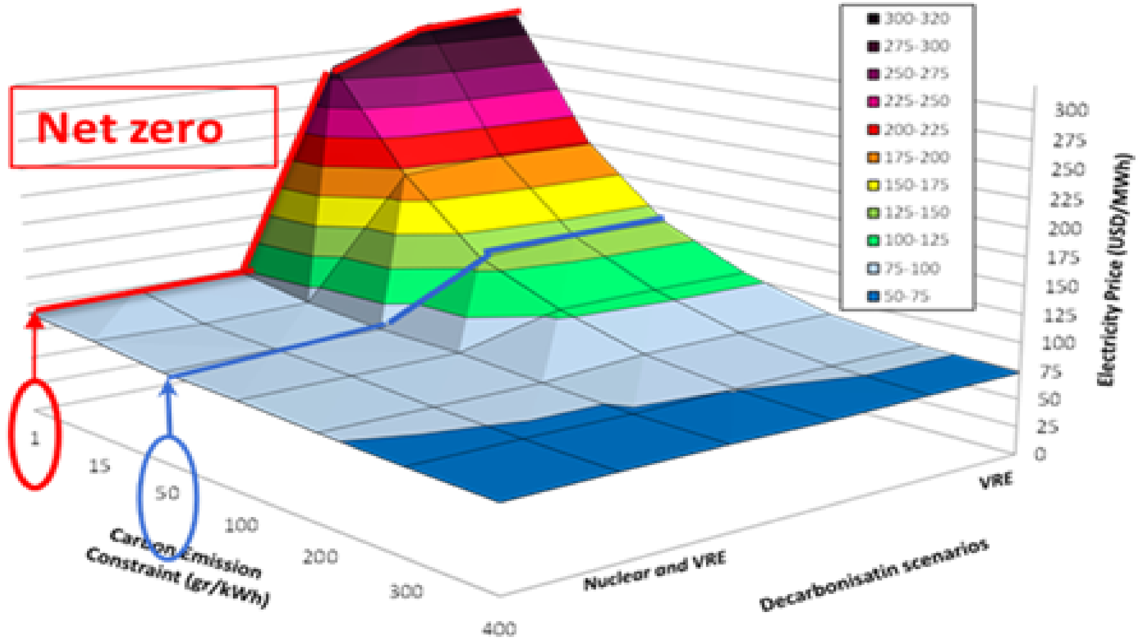
Source: NEA (forthcoming).

Understanding the costs of electricity provision



Understanding system costs of electricity

Source: Adapted from NEA (2012).



Total costs for different mixes of electricity (driving to net-zero)

Source: Based on Sepulveda (2016).

- To understand the costs of electricity provision requires systems level thinking combining plant-level costs, grid-level systems costs, and full social and environmental costs

- This 3-dimensional graph shows the effects on total costs as carbon emissions are increasingly constrained. The red line shows what happens to total costs when carbon constraints reach net-zero emissions.

5. UN Climate Change Conference (COP-26)

Recommendation for COP-26: Ensuring Full Representation at the Conference

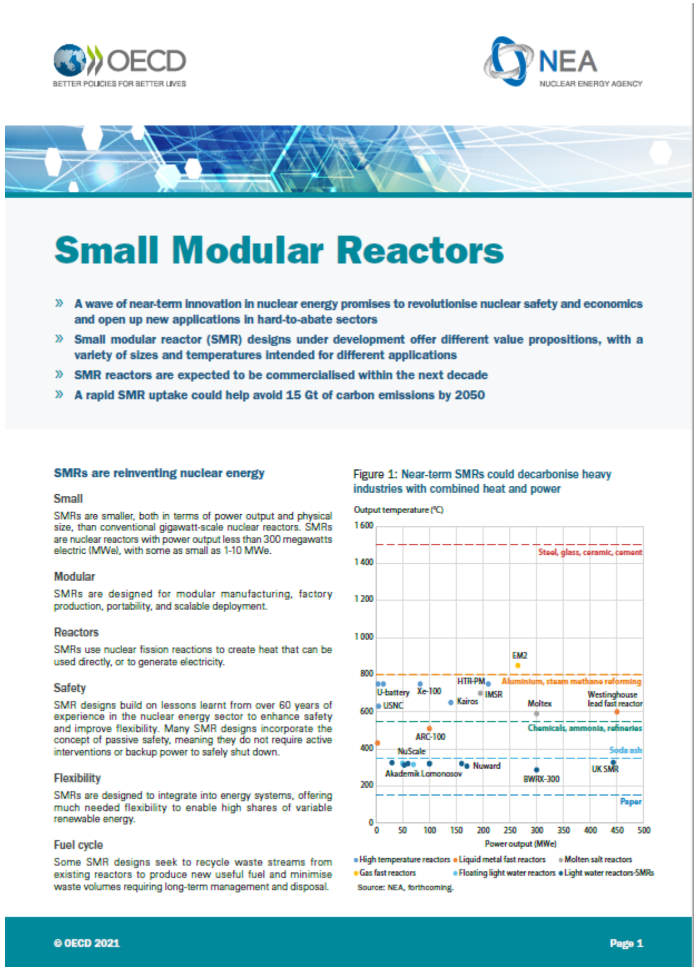
Governments should break the silence on nuclear energy at COP 26, raising the profile of nuclear energy alongside other non-emitting energy technologies. Three key messages are recommended:

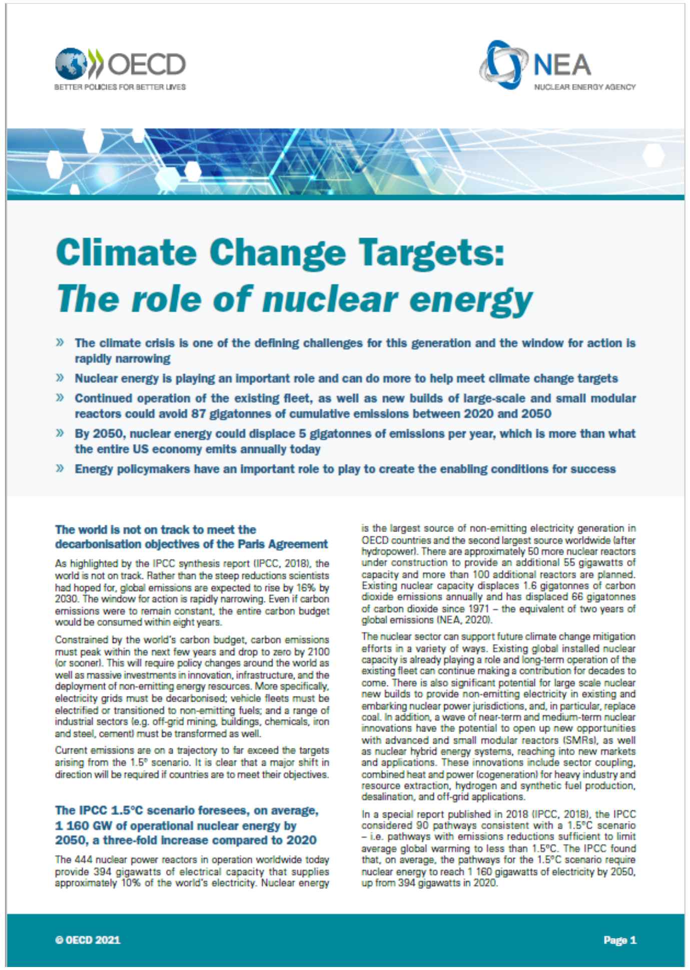
1. **Nuclear energy already makes an important contribution to emissions reductions and it needs to expand to meet Paris Agreement targets.**
   - Nuclear energy is the largest source of low-carbon electricity in OECD countries and the second largest source of low-carbon electricity around the world after hydropower. Nuclear displaces 1.6 gigatonnes of carbon dioxide annually. The average IPCC 1.5°C scenario requires nuclear to reach 1,160 gigawatts of electricity by 2050, up from 394 in 2020

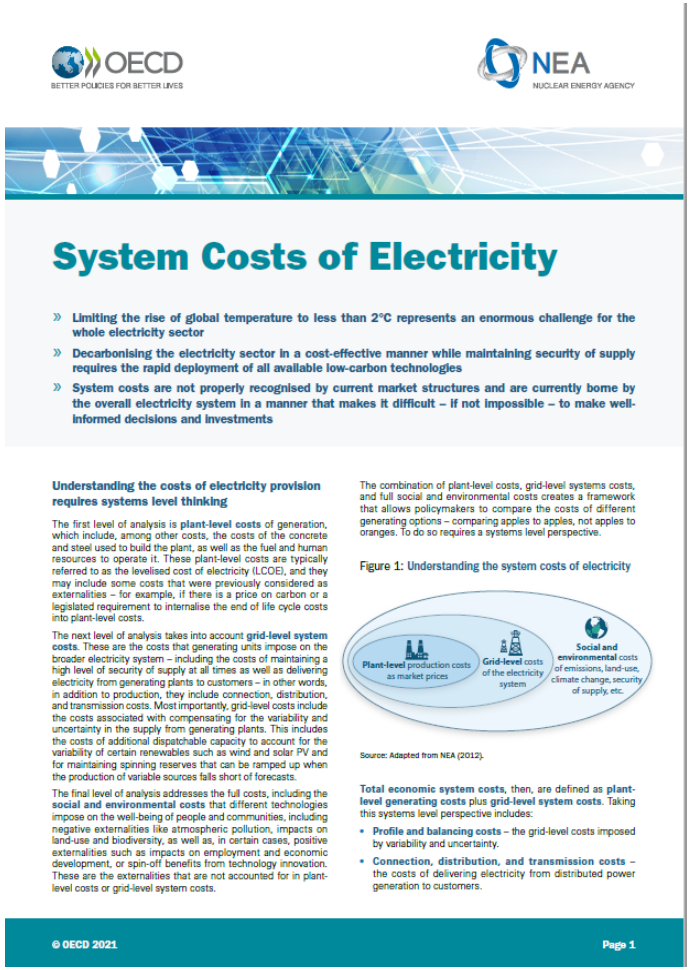
2. **Near-term nuclear innovations are expected to make significant contributions to emissions reductions targets.**
   - Advanced and small modular reactors (SMRs), as well as nuclear hybrid energy systems, including hydrogen, are advancing quickly, with several SMR designs expected to be commercially deployed within 5 to 10 years

3. **Policies should be technology-neutral, structured to incentivize desired outcomes such as emissions reductions and security of energy supply.**
   - Taxonomies, as well as criteria for access to climate finance, development finance and Environmental Social and Governance (ESG) finance should be applied consistently with similar levels of scrutiny across technology options, to allow technologies to compete on equal footing

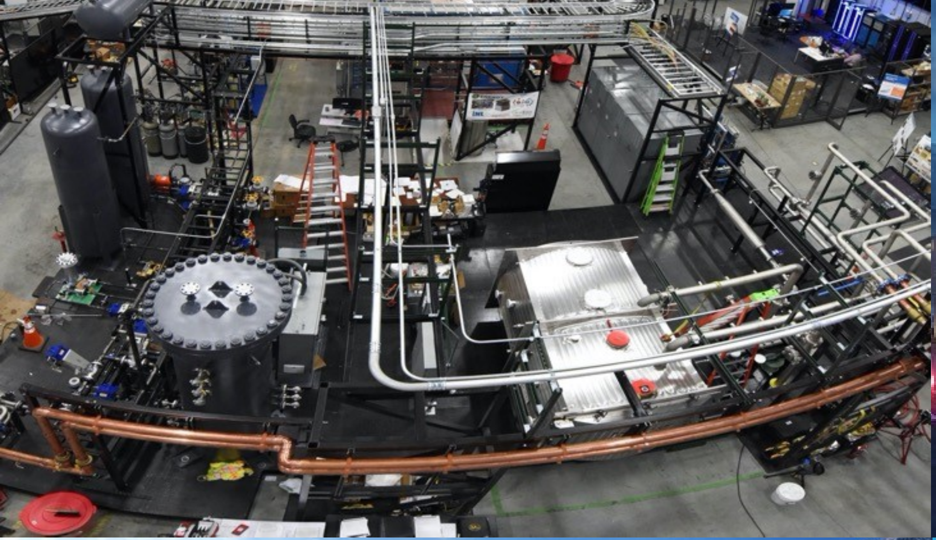
NEA @ COP26: brochures







Thank you for your attention



Webinar:

High Tech Energy Ecosystems for Sustainable Development

New Nuclear Watch Institute (NNWI)

Flexible, Clean Nuclear—Renewable Energy Deployment for a Net-Zero Future

28 October 2021

Shannon Bragg-Sitton, PhD
Lead, Integrated Energy Systems
Nuclear Science & Technology Directorate
shannon.bragg-sitton@inl.gov

Idaho National Laboratory

We need nuclear to reach net-zero

28% by 2040

Projected increase in world energy use by U.S. Energy Information Administration.*

2.7 degrees by 2040

Projected increase in atmospheric temperatures if global greenhouse gas emission continue at current rate by Intergovernmental Panel on Climate Change

We cannot reach our climate goals without contribution from nuclear energy!

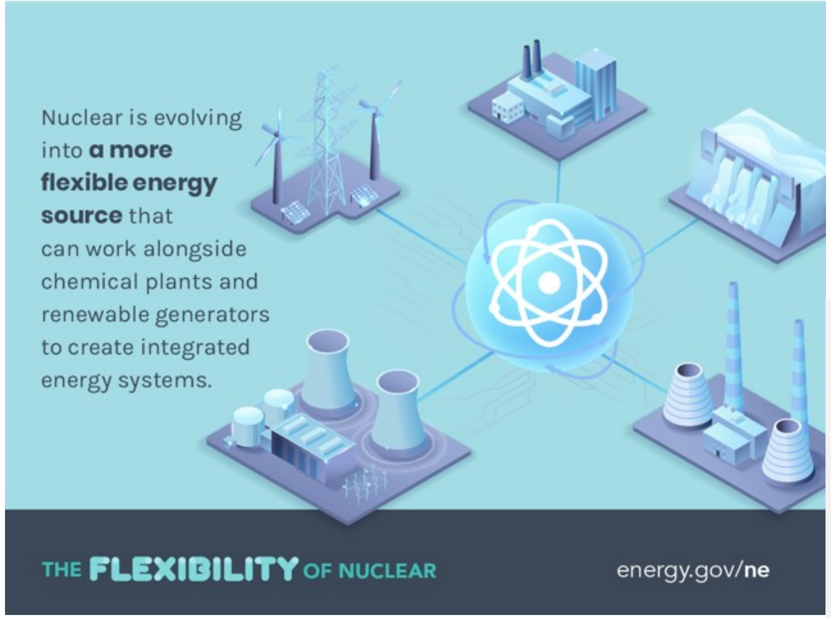
MIT Future of Nuclear Energy Study (2018)
Key finding: Without contribution from nuclear, the cost of achieving deep decarbonization targets increases significantly.

International Energy Agency, Nuclear Power in a Clean Energy System (May 2019)
Despite significant renewable energy growth over the last 20 years, the overall contribution of clean energy supply to electric generation has not changed… In many parts of the world, low-cost natural gas is displacing nuclear generation as a complement to variable wind, solar.

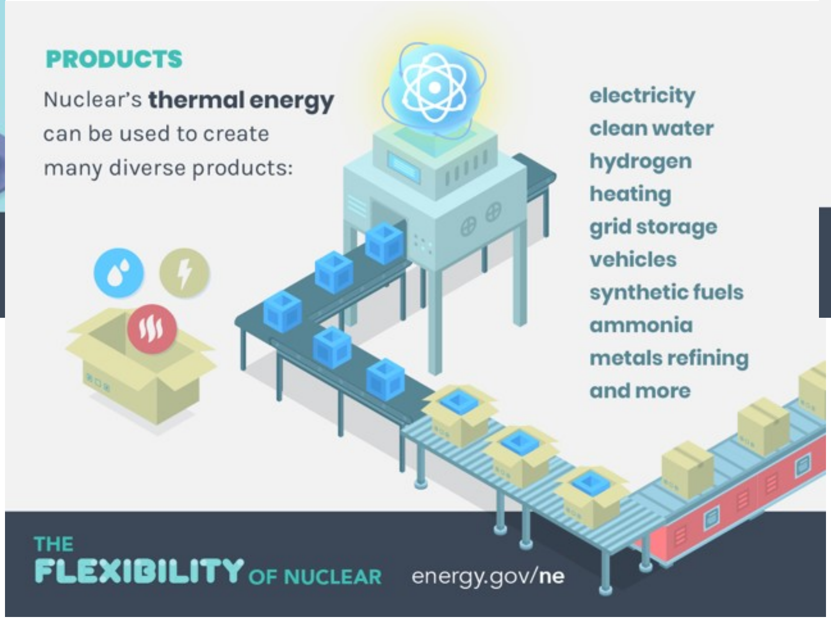
Clean Energy Targets are Trending *updated Dec 2020*
Clean energy commitments are rapidly gaining popularity. ThirdWay research for the U.S. identified a total of 153 portfolio standards and other commitments to clean energy since 1983; 67% were adopted since 2016.

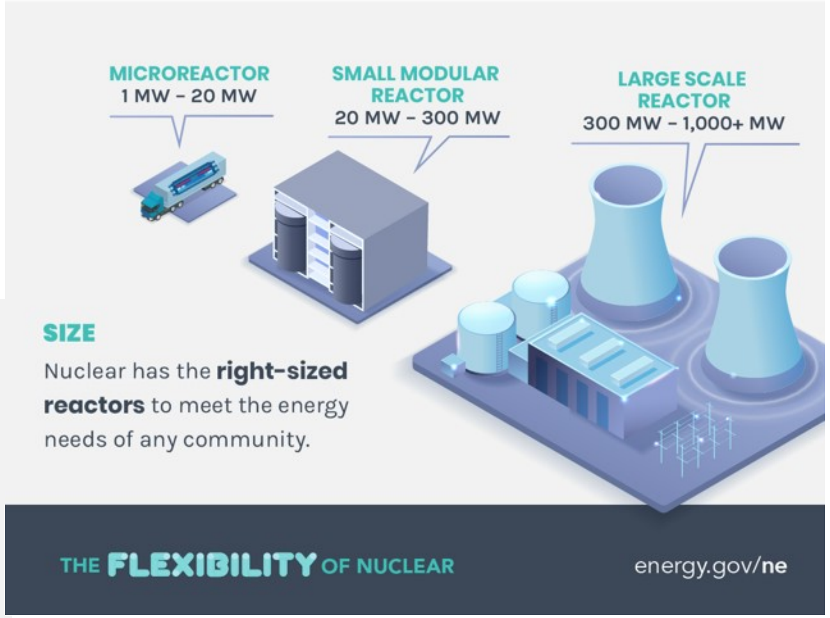
Climate leaders want more technology options to choose from. Prior to 2016, 90% of commitments in the U.S. were exclusive to renewable energy. That trend has almost completely reversed, with 73% of states, utilities, and major cities now embracing “technology-inclusive” commitments like **clean energy standards** that take advantage of nuclear power, carbon capture, and other carbon-free options.

Embracing new operational paradigms—nuclear energy flexibility



Nuclear flexibility can be key to enabling deployment of other clean energy generators.





- ***Operational*** **flexibility**
  - ***Product flexibility***
    - ***Deployment flexibility***

U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

NICE Future
Nuclear Innovation: Clean Energy Future

IES Integrated Energy Systems

Flexible Nuclear Energy for Clean Energy Systems, September 2020
https://www.nice-future.org/flexible-nuclear-energy-clean-energy-systems

Advanced reactor design concepts

Benefits:

- High-degree of passive safety
- Higher temperature operation for versatile applications
- Reduced waste
- Long operational lifetimes (~5-20 yr)
- Advanced manufacturing of components to reduce costs
- Modularity supports additional build-out on an as-needed basis
- Enhanced siting options, reduced site preparation

60+ private sector projects under development

SIZES

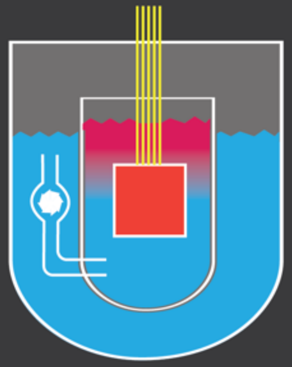
SMALL
1 MW to 20 MW
Micro-reactors
Can fit on a flatbed truck. Mobile. Deployable.

MEDIUM
20 MW to 300 MW
Small Modular Reactors
Factory-built. Can be scaled up by adding more units.

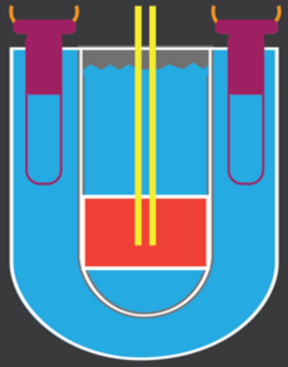
LARGE
300 MW to 1,000 + MW
Full-size Reactors
Can provide reliable, emissions-free baseload power

Advanced Reactors Supported by the U.S. Department of Energy

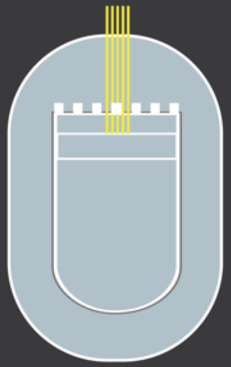
TYPES



MOLTEN SALT REACTORS – Use molten fluoride or chloride salts as a coolant. Online fuel processing. Can re-use and consume spent fuel from other reactors.



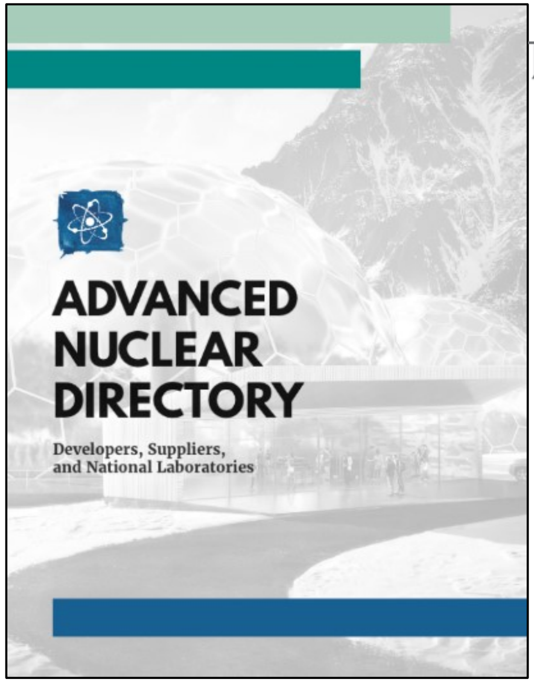
LIQUID METAL FAST REACTORS - Use liquid metal (sodium or lead) as a coolant. Operate at higher temperatures and lower pressures. Can re-use and consume spent fuel from other reactors.



GAS-COOLED REACTORS – Use flowing gas as a coolant. Operate at high temperatures to efficiently produce heat for electric and non-electric applications.

Enhanced private-sector interest in advanced nuclear is motivating a new "National Reactor Testing Station"

- New opportunities have resulted in significant private sector interest in advanced nuclear
- Facilities and capabilities needed to develop, test, and demonstrate promising advanced reactor concepts to *enable commercialization and deployment*, domestically and beyond



GAIN Gateway for Accelerated Innovation in Nuclear

framatome

OKLO

HolosGen™

U BATTERY Local Modular Energy

STARCORE NUCLEAR

TerraPower

Xe

Westinghouse

HOLTEC INTERNATIONAL

TOSHIBA Micro Nuclear

Kairos Power

GE HITACHI

National Reactor Innovation Center (NRIC)

- Launched by DOE in FY2020, authorized by the Nuclear Energy Innovation Capabilities Act (NEICA)
- Mission: Accelerate the demonstration and commercialization of advanced reactors by inspiring stakeholders, empowering innovators, and delivering successful demonstration reactors.
  - Partner with industry to bridge the gap between research and commercial deployment
  - Leverage national lab expertise and infrastructure
- Manage demonstrations to success

For more information on NRIC and to download resources, see https://nric.inl.gov/.

NRIC Enables Nuclear Reactor Demonstrations

NRIC advanced reactor testing infrastructure

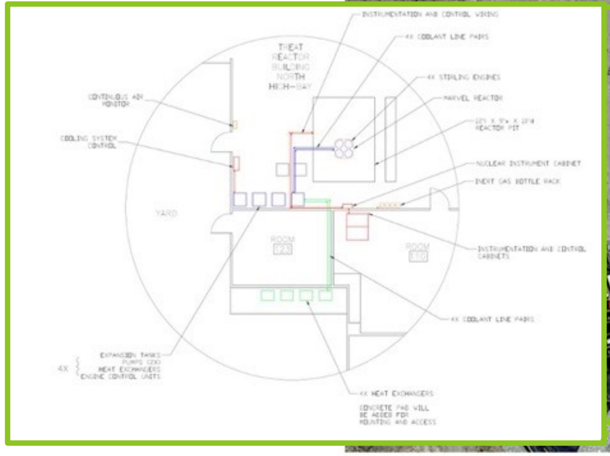
- Goal: Demonstrate two advanced reactors by 2025
- Strategy:
  - Repurpose two facilities at INL and establish two test beds to provide confinement for reactors to go critical for the first time
  - Build/establish testing infrastructure for fuels and components
- Capabilities:
  - NRIC DOME (Demonstration of Microreactor Experiments)
    - Advanced Microreactors up to 20 MWth
    - High-Assay Low-Enriched Uranium (HALEU) fuels < 20%
  - NRIC LOTUS (Laboratory for Operations and Testing in the US)
    - Up to 500 kWth experimental reactors
    - Safeguards category one fuels
  - Experimental Infrastructure
    - Molten Salt Thermophysical Examination Capability
    - Helium Component Test Facility

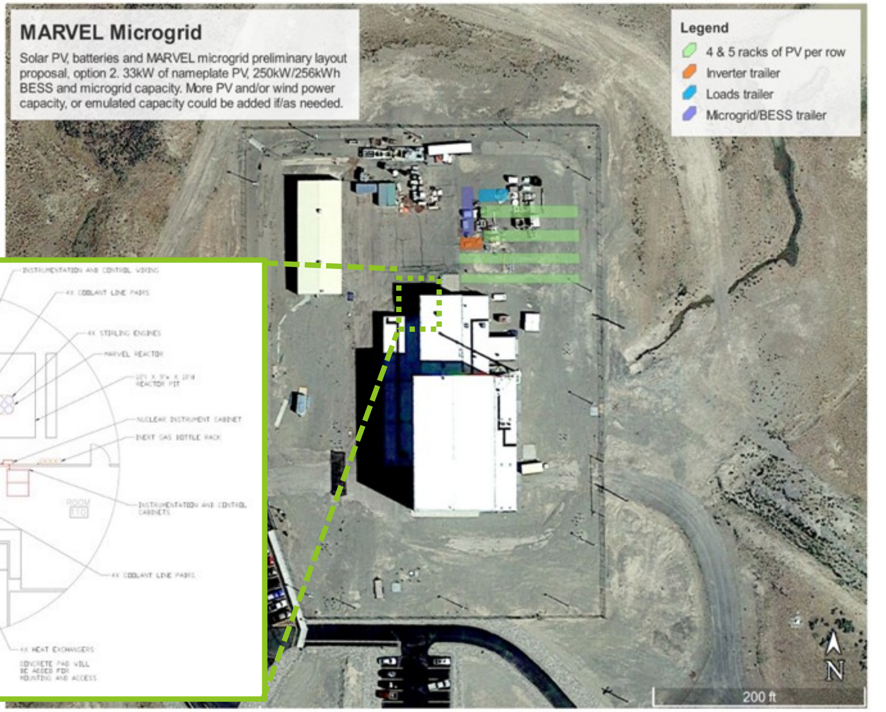
Anticipate initial reactor testing in ~2024. Flexible testbed to support testing of multiple reactor concepts using the same infrastructure ~annually.

Microreactor Demonstration Test Facility

MARVEL

- The U.S. has not built a new nuclear reactor in decades—but we are ready
- Microreactor Applications Research Validation and Evaluation (MARVEL) will pave the way to future commercial endeavors
- Full-scale, electrically heated prototype designed, fabricated, and assembly in less than nine months
- Sited at the INL Transient Reactor Test Facility (TREAT), operated as a part of a microgrid providing combined heat and power (CHP) alongside solar PV, batteries
- Demonstrate nuclear microgrid operations and provide opportunity to demonstrate operation with coupled energy users
- MARVEL Construction Complete: ~December 2022
- MARVEL Criticality: December 2023

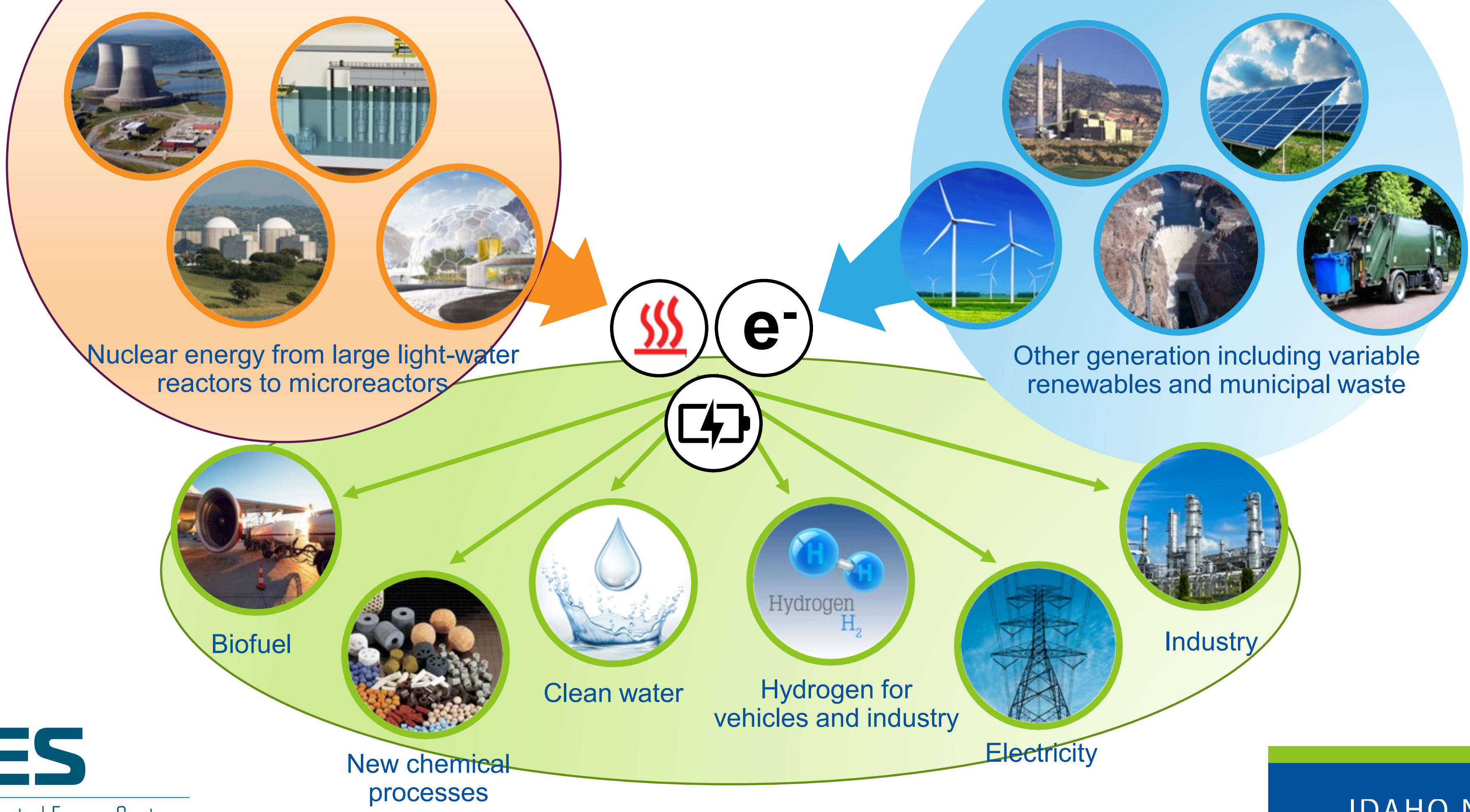




Product flexibility:
Cross-sectoral energy solutions for a resilient net-zero future

Future Energy System: Transforming the Paradigm

Integrated systems leverage contributions from all low emission energy generation options to support decarbonization of electricity, industry, and transportation



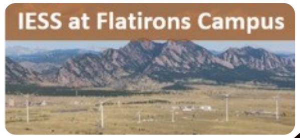
Goals

- Maximize energy utilization and generator profitability
- Minimize environmental impacts—decarbonization across all energy use sectors
- Maintain affordability, grid reliability and resilience

Demonstration of integrated energy systems (IES) (electrically heated)

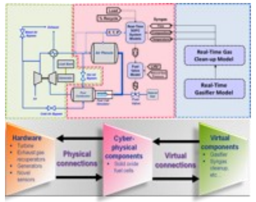
Human-in-the-Loop Operations

ARIES



NREL
Transforming ENERGY

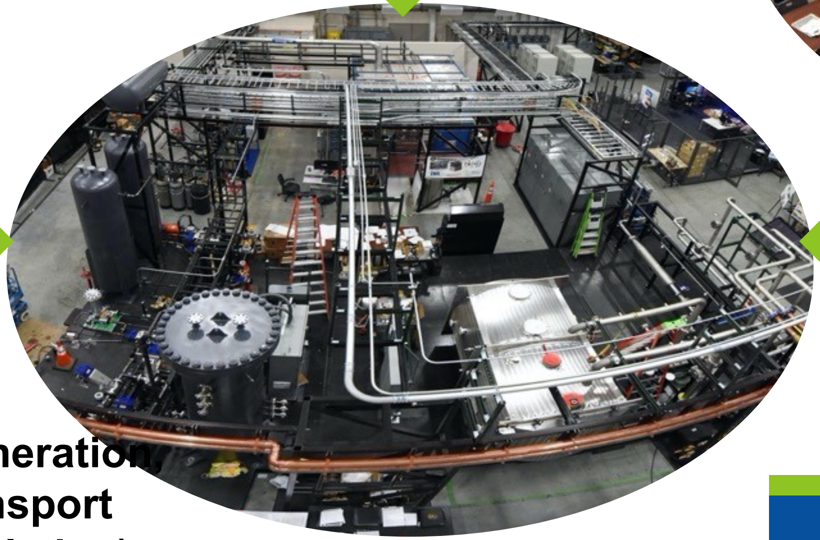
NATIONAL ENERGY TECHNOLOGY LABORATORY



Realtime connections to remote facilities enhance IES demonstration capabilities

Power Hardware and Grid-in-the-Loop, Microgrid

Hydrogen and other Flexible Industrial Processes



Thermal Energy Generation, Storage, and Transport (Microreactor Emulation)

Partnerships enable nuclear—H_2 production demonstrations

Three projects have been announced for demonstration of hydrogen production at nuclear power plants

- Demonstrate hydrogen production using direct electrical power offtake from a nuclear power plant
- Develop monitoring and controls procedures for scaleup to large commercial-scale hydrogen plants
- Evaluate power offtake dynamics on NPP power transmission stations to avoid NPP flexible operations
- Produce hydrogen for captive use by NPPs and first movers of clean hydrogen

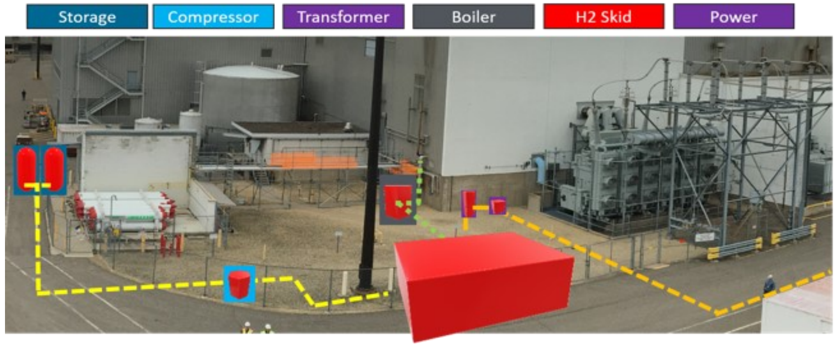
Schedule:

- Exelon: Nine-Mile Point NPP; LTE/PEM Vendor 1; using "house load" power; PEM skid testing is underway at NREL; H2 production beginning ~January 2022
- Energy Harbor: Davis-Besse NPP; LTE/PEM Vendor 2; power provided by completing plant upgrade with new switch gear at the plant transmission station; installation to be made at next plant outage; contract start anticipate by October 2022
- Xcel Energy: HTE/SOEC Vendor 1; Project negotiations are being finalized. Tie into plant thermal line engineering has been completed; official project start anticipated by January 2022

Davis-Besse Nuclear Power Plant LTE-PEM Vendor 1

Nine Mile Point Nuclear Power Plant LTE/PEM Vendor 2

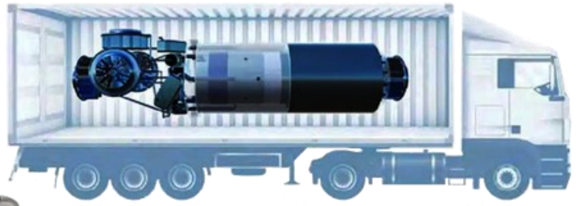
Thermal & Electrical Integration at Xcel Energy Nuclear Plant HTE/Vendor 1



HTE/SOEC efficiency is 20-30% higher than LTE/PEM

Accelerating advanced reactor demonstration and deployment

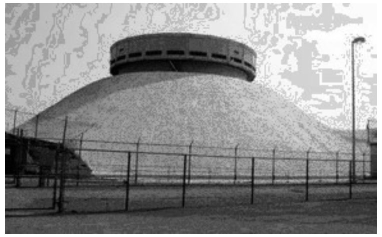
MARVEL
DOE
2022-2023

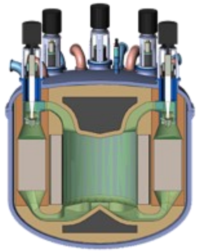


Project Pele Microreactor
DoD
2023-2024

DOME Test Bed
NRIC
2023-2024

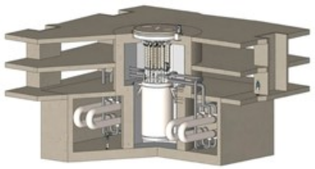
LOTUS Test Bed
NRIC
2024





MCRE
Southern Co. & TerraPower
2025

TerraPower
Southern Company

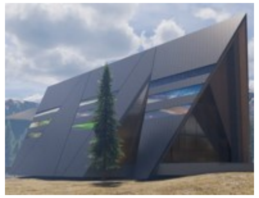


Hermes
Kairos
2026

Kairos Power

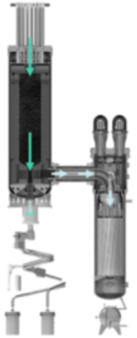
Aurora
Oklo Inc.
TBD

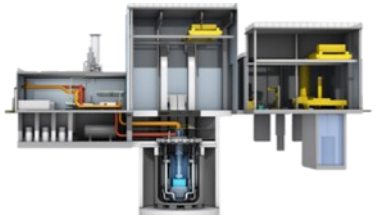
OKLO



Xe-100
X-energy
2027

energy





Natrium Reactor
TerraPower & General Electric
2028

TerraPower
GE HITACHI

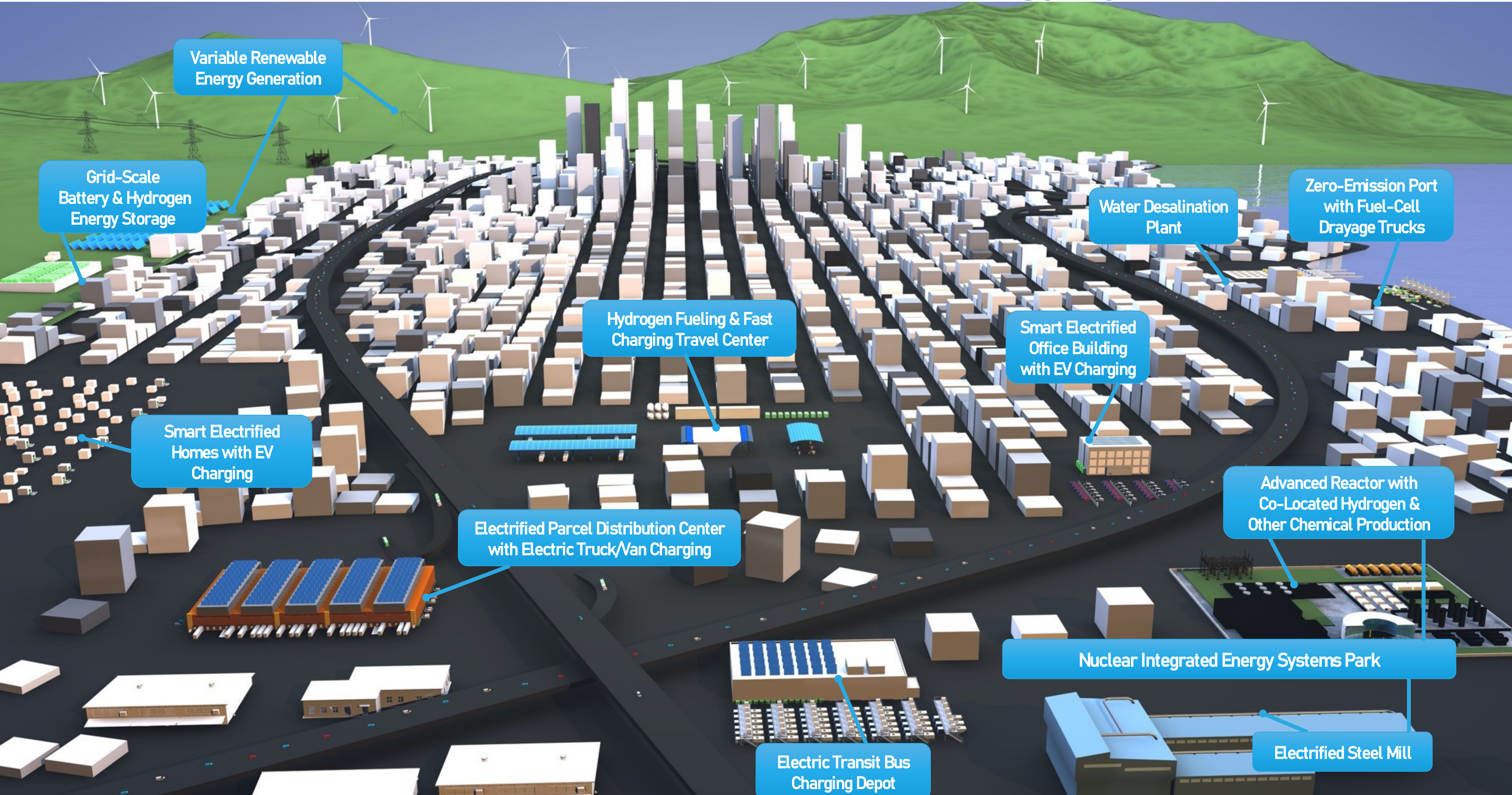
SMR
UAMPS &
NuScale
2029

UAMPS
NUSCALE

2030

NRIC National Reactor Innovation Center

A vision for net-zero distributed energy systems

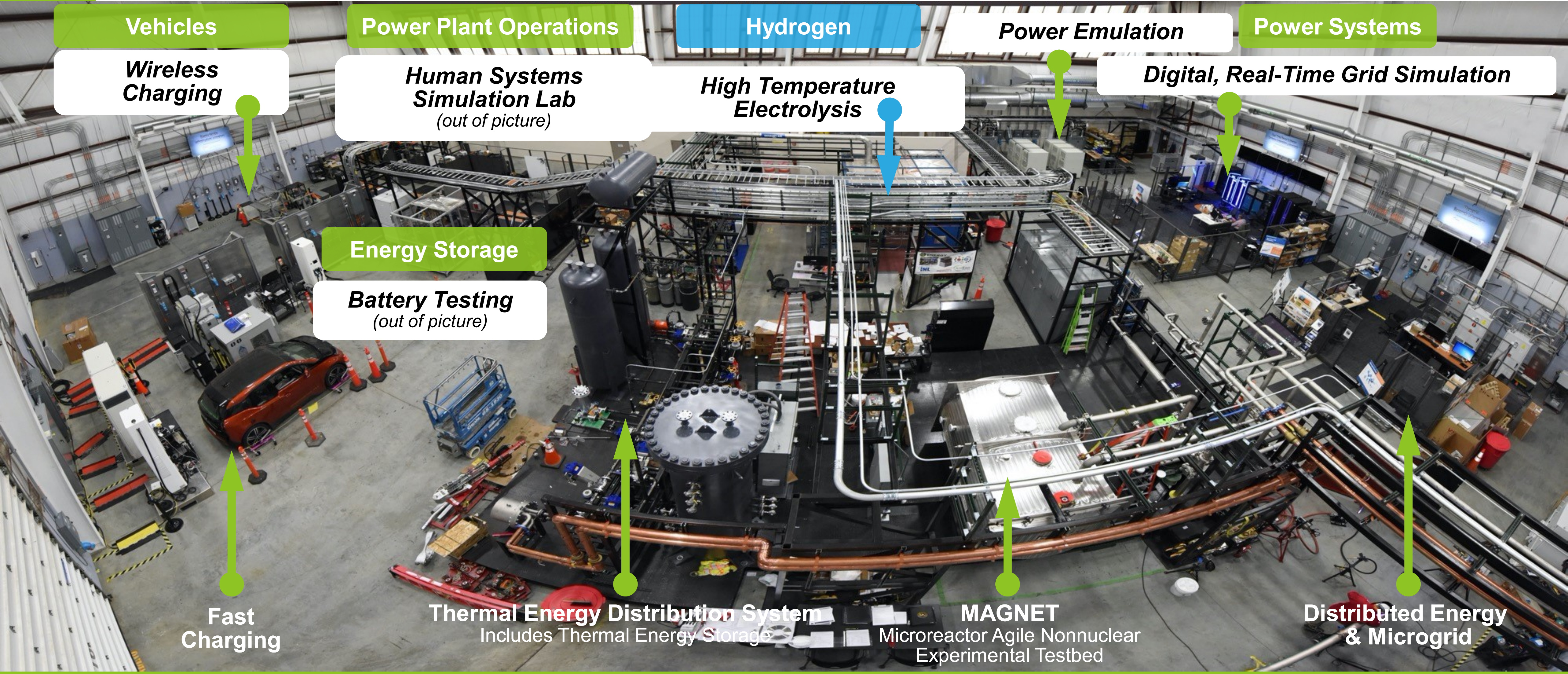


INL

Idaho National Laboratory

WWW.INL.GOV

Integrating systems for the nation's net-zero future



Rolls-Royce SMR

NNWI

28 October 2021

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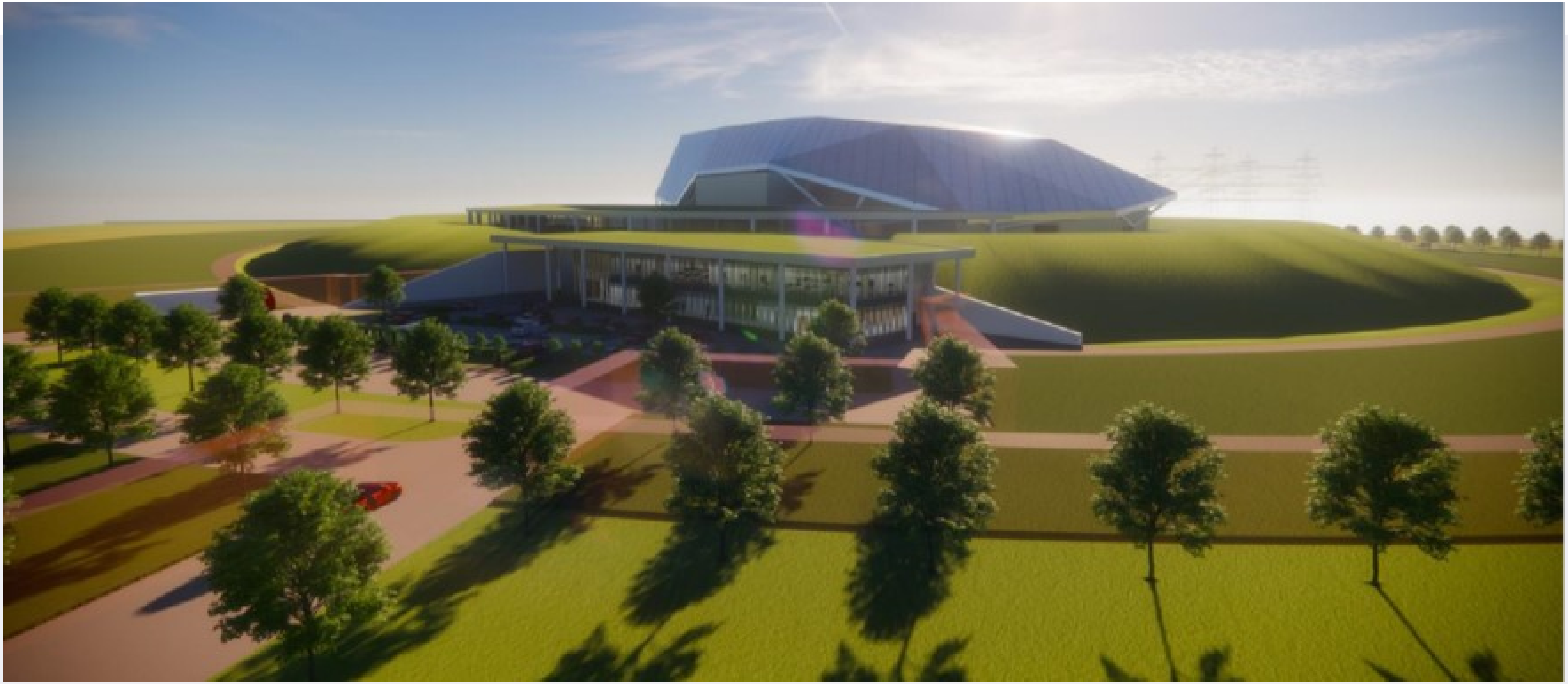
SMR Video

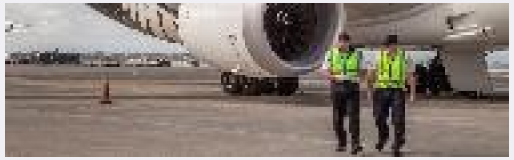
https://vimeo.com/551457837/0735106fb6



Rolls-Royce is **one of the world's leading industrial technology companies pioneering cutting-edge technologies that deliver clean, safe and competitive solutions**

- Rolls-Royce has a strong nuclear heritage with roots in defence and civil development
- Rolls-Royce has been designing, manufacturing and supporting Royal Navy submarines' small reactors for over 50 years
- Thanks to their 100+ years of experience and operations in 50+ countries, Rolls-Royce are a globally recognised and trusted partner

Civil Aerospace	Power Systems	Defence

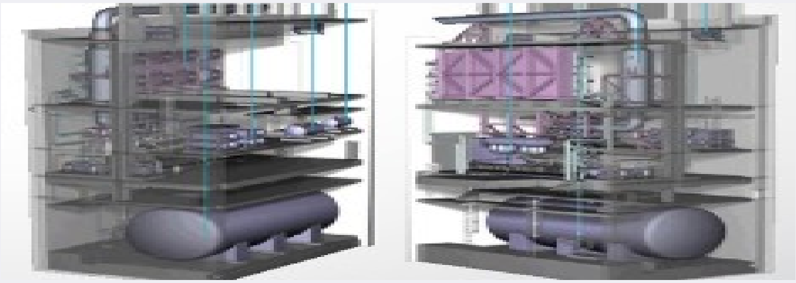


Strong nuclear heritage with roots in defence and civil development

Nuclear Business Experience

Defence Nuclear	Civil Nuclear
Submarines	Nuclear Services and Projects

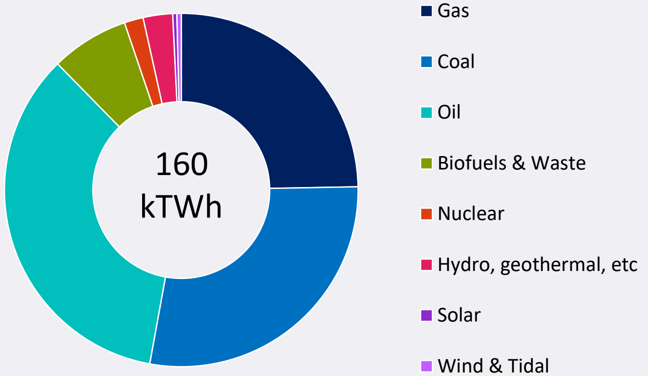
- Sole technical authority for over 50 years
- Reactor plant design and supply
- Operation of licensed sites
- Fuel fabrication
- Through life services
- Through-life 24 hour global operational support
- 6 generations of reactors

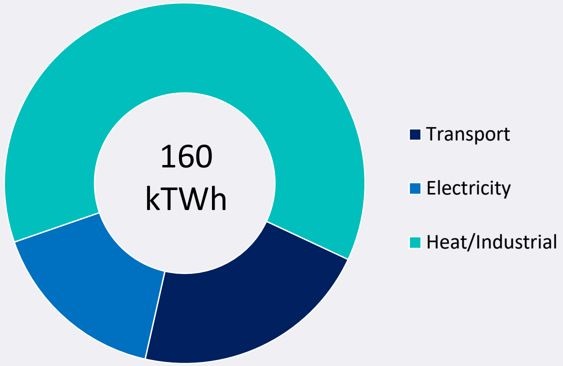


- Emergency diesel generator system
- Waste treatment systems
- Services: Inspection, predictive maintenance, inventory management
- Complex components supply

Tomorrow's energy market will look fundamentally different as the world transitions to a low carbon environment

Only 13% global energy is low carbon

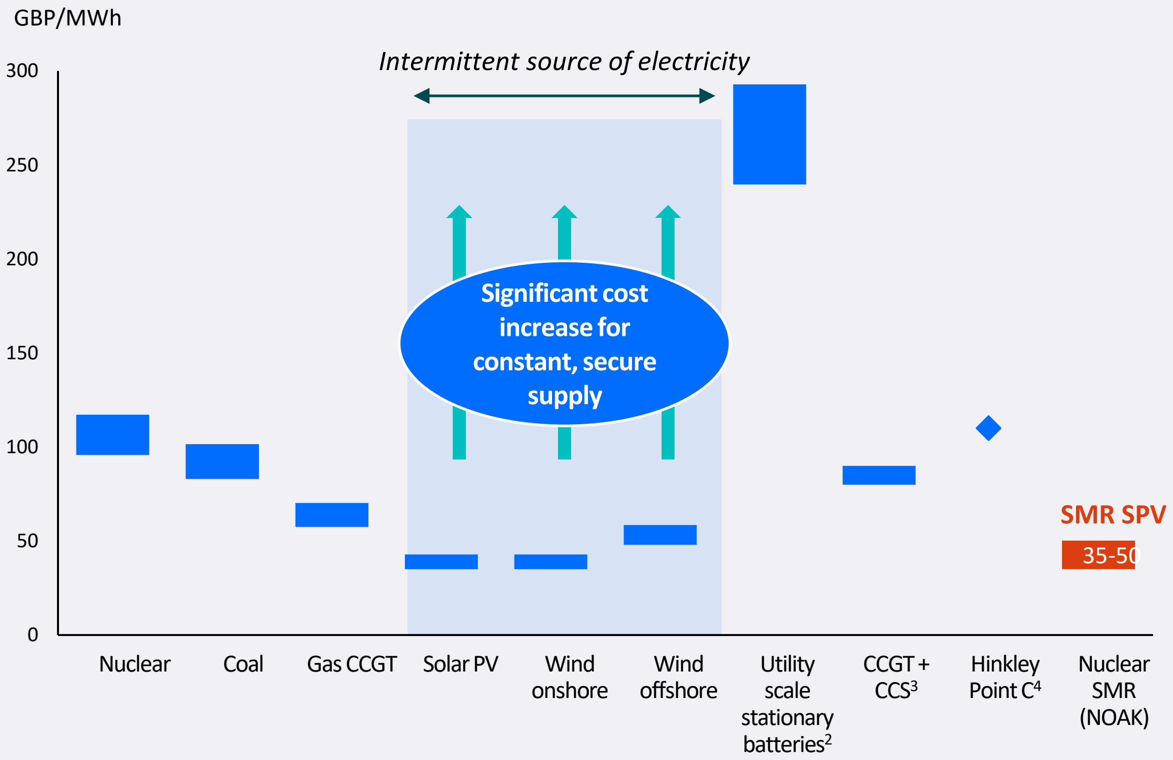




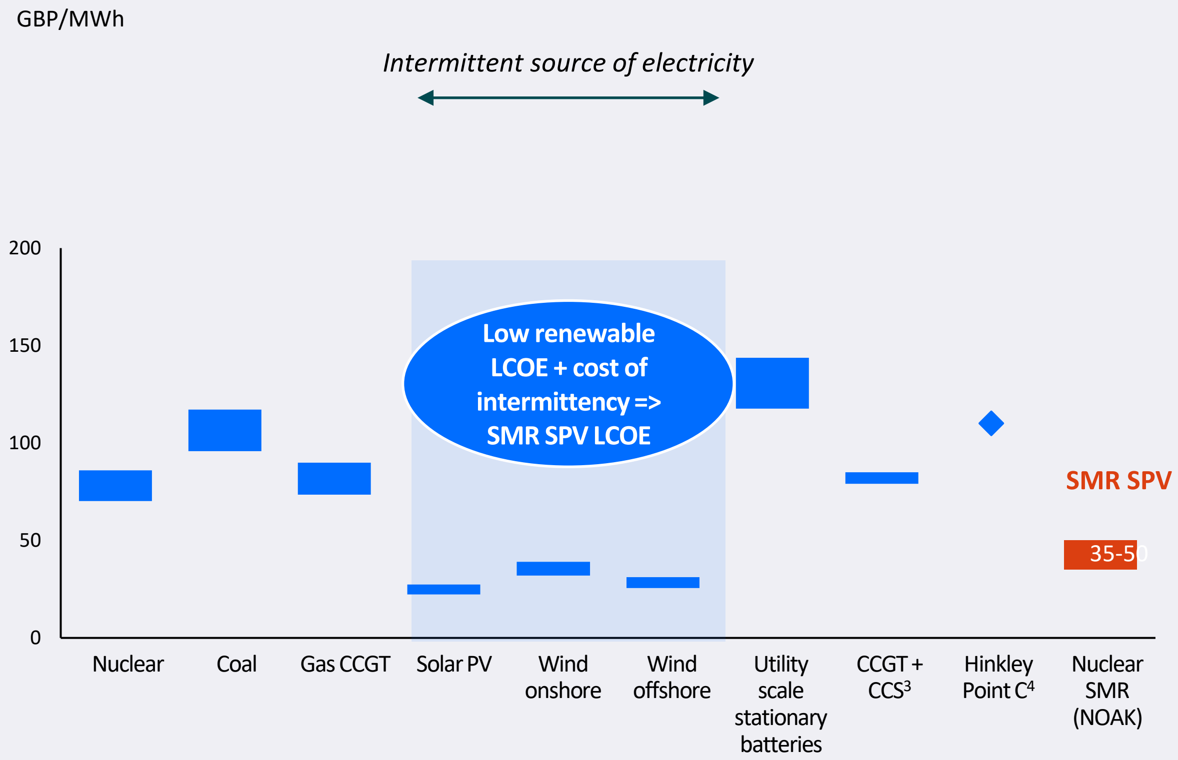
- The challenge is huge, covering transport and heat as well as grid electricity
- Decarbonisation obligations are having a material impact on energy policies
- There are a limited number of solutions to decarbonising many sectors. Most need more clean electricity
- The demand for clean electricity is set to grow considerably in any scenario
- Industrial companies are seeking to decarbonise production quickly and economically
- Our SMR provides a low cost, investible, and deliverable solution to predictable clean electricity at a scale unmatched by other clean sources

The LCOE for SMRs is similar to renewable LCOEs and is significantly cheaper once storage costs for renewables are included

European LCOE / Levelised Cost of Storage ("LCOS"), by technology for indicative assets[1] commissioning in 2019



European LCOE / LCOS, by technology for indicative assets[1] commissioning in 2040



SMR Range determined by financing mechanism

Sources: IEA WEO 2020, BEIS Electricity Generation Cost Report 2020

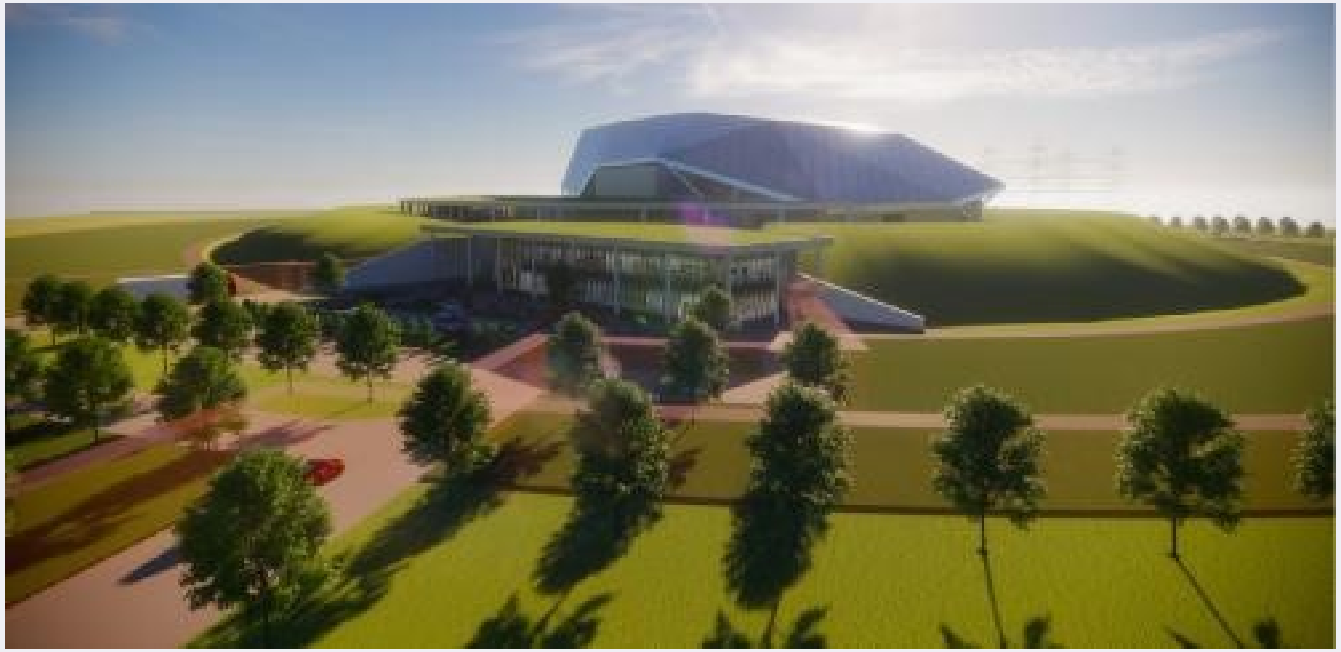
Notes: CCGT = Combined Cycle Gas Turbine; CCS = Carbon Capture and Storage; USD = United States Dollar

1. Data from IEA WEO 2020, converted from USD to GBP (0.7) with +/-10% range applied
2. IEA Data – 2020 base year
3. Data from BEIS Electricity Generation Cost Report 2020 – Refers to 2025 LCOE as this is the first estimated deployment date of this technology
4. GBP92.5 CFD agreed price, scaled by CPI to 2019, as per CFD agreement

Rolls-Royce SMR is a revolutionary nuclear product; factory fabricated, road transported and site assembled.

The RR SMR approach is a holistic, integrated power station and not just a nuclear reactor design.

- ~470 MWe output
- 50 Hz design
- Proven PWR Technology & Standard Fuel
- Power station delivery as a turnkey project
- 4 yr Construction (Nth unit)



- Enhanced Gen III+ levels of safety and security
- 1st unit on grid early 2030s
- Capital cost under £1.8 Bn*
- Adaptable, multi-use power & heat output
- LCOE £35-£50 per MWh*

Rolls Royce SMRs – Low cost, Deliverable, Investable Low Carbon Power

Our whole design has been driven by market requirements from conception

Those that we can control within the design

Those that we must recognise as key influencing factors on design and technology choices

Regulatory / Safety

Proliferation Resistant

Market Timing

Code Compliance

Reduce capital & Op Cost

Remove / Reduce Risk

Minimise Time to Build

$$\text{Cost of Electricity } (£/\text{MWhr}) = \frac{(\text{capital + total O\&M + decom + fuel costs + financing cost})}{\text{Power Generating potential x Capacity factor}}$$

Maximise power

Maximise reliability

Maximise efficiency

Compatibility with support Infrastructure and Sites

Public Perception

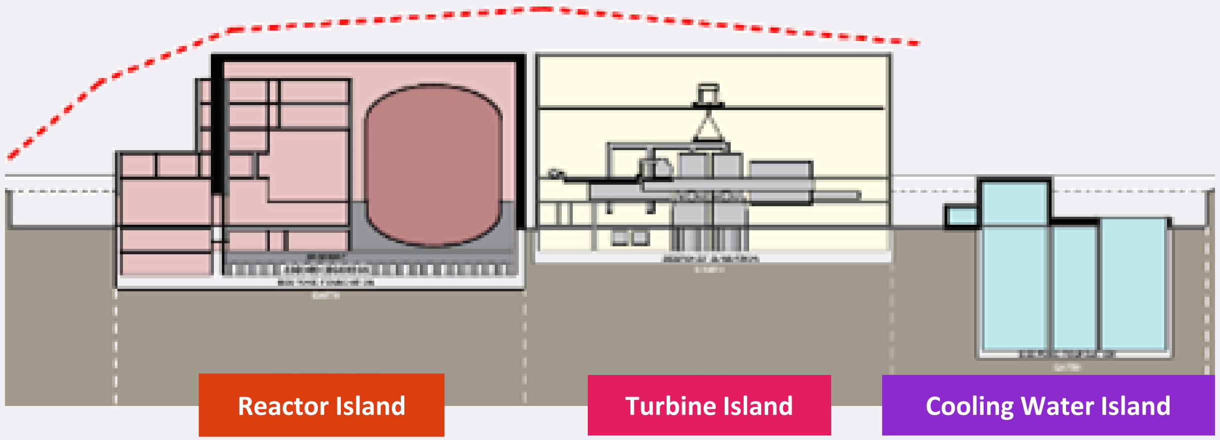
Utility Familiarisation / Selection of Technology

Delivery Partnership Potential

Global Market

Power Station Basic Design

A compact, cohesive layout that encompasses all the needed facilities for a nuclear power station

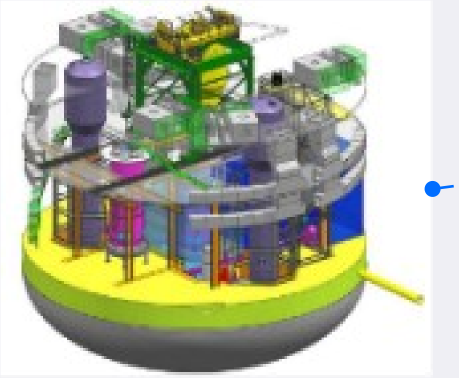


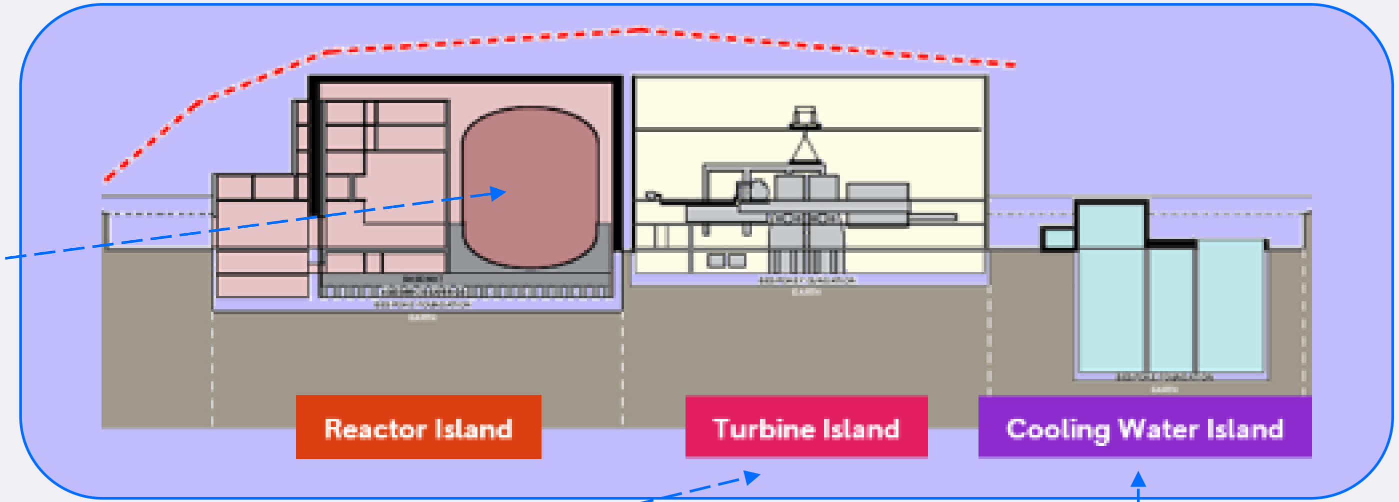
- Designed for installation on an **extensive range of in-land and coastal sites**, including **international context**
- **Aseismic bearing** insulates all modules from site conditions enabling **repeatable** product manufacture and deployment
- Enabled through design features such as **seismic isolation** for safety related areas
- **470MWe** and is capable of load following and operation on house load where required
- **Passive safety systems**, remove reliance on grid power for safety related functions
- **Design can be configured to support other heat-requiring or cogeneration applications**

Rolls-Royce SMR plant: Key Features

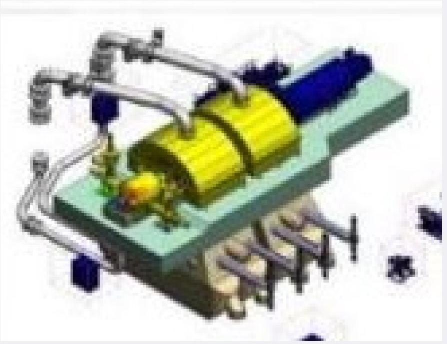
Reactor Systems

- A robust and licensable design incorporating:
  - A 3-loop PWR
  - 3 reactor coolant pumps (one in each loop)
  - 3 vertical **u-tube** steam generators
  - Steam pressurised using a **pressuriser**
- Nuclear fuel is industry standard 17x17 assembly **UO_2 enriched up to 4.95%**,
- **Boron free design** to enable a **low environmental impact and eliminate handling hazards.**





Turbine Island
- Comprises a commercially available turbine and generator set



Cooling Water Island
- Indirect cooling system utilises modular cooling towers to remove heat from the turbine island

Our product approach represents a completely different way of building new nuclear power plants

Key differentiators from conventional nuclear and SMR competitors:

- ✓ **SPV will provide a full turnkey solution to the market**
- ✓ **90% of the plant is factory fabricated**
- ✓ **Many risks traditionally associated with new nuclear have been removed**
- ✓ **No longer consider a “mega EPC project”**

Groundworks and bearing

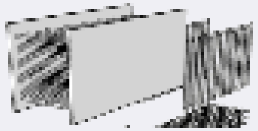
Whole plant factory fabrication

90% power station factory fabricated across 3 main factories:

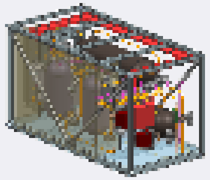
Road transportable factory products taken to site

Primary plant

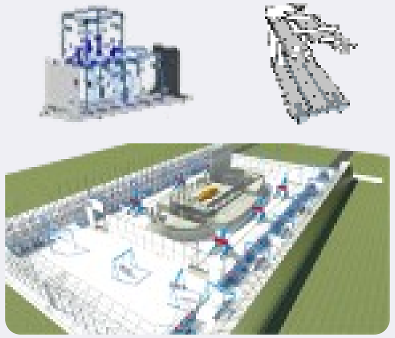
Civil modules



Systems modules



Modules designed to expedite site assembly and installation

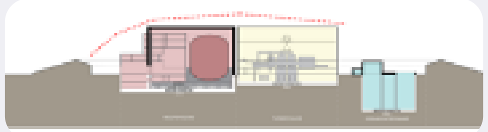


Site factory for build certainty

In a controlled environment under Site Canopy/4th factory to remove risk

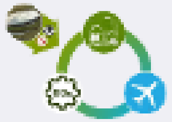
Designed for a compact footprint

Assembly on an aseismic bearing to enable repeatability without cause for site specific redesign



Operation
Low cost power for a net zero world

To provide low carbon power in a flexible manner for electrical grid, hydrogen production, or synthetic fuels



Turning nuclear into a product not a one-off mega infrastructure project

EPC (mega project) vs. EMA (factory product)

SMR – Risk impact reduction

SMR – Risk probability reduction

Conventional EPC (e.g. Large nuclear)

- Mega project GBP10bn+
- High probability of interface failure
- High impact across multiple parties with cross-dependency
- Long build duration

Plant design

- Lower Capex
- Factory fabricated
- Repeatable product
- Logistics

Site activity

- Much smaller footprint
- Site factory
- Quicker to build
- Options to decouple civil ground works from factory scope

Interfaces

- Simpler contracting structure
- Factory build is normal procurement activity
- Greatly reduced site complexity, #parties

Commercial simplification

- Single contract to SMR SPV
- Fewer parties
- Simplified structure

Capability

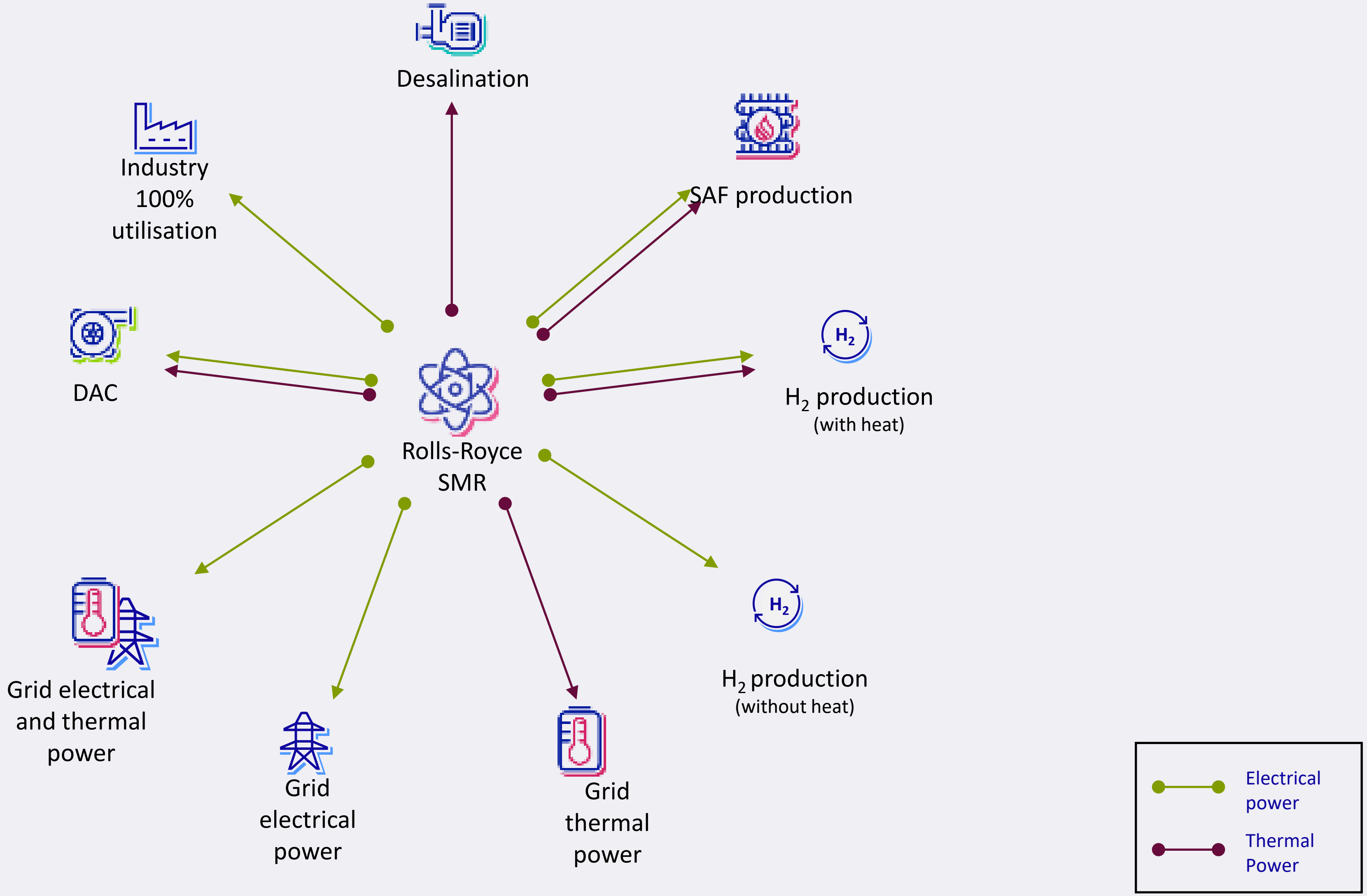
- SMR SPV turnkey supply

Source: Company information

The heat and power from SMRs supports a range of industrial uses. Shared usage minimises the cost of plant ownership and maximises the economic efficiency of the low carbon energy.

One Rolls-Royce SMR and associated plant can. . . .

- Power a million homes
- Produce 170 tonnes of H_2 per day
- Produce 280 tonnes of net zero synthetic fuel per day
- Heat or cool a city the size of Sheffield (pop c580,000)



Questions

Sophie Macfarlane-Smith

Head of Customer Business

Sophie.Macfarlane-Smith@rolls-royce.com

M +44 (0)7976193127

ROSATOM

Rosatom vision on energy solutions for net-zero clusters of the future

Egor Simonov

Director, Rosatom Southeast Asia

High-tech energy “ecosystems” for sustainable development

28.10.2021

ROSATOM AT A GLANCE

ROSATOM

138.3 Bn USD
10-YEAR PORTFOLIO OF OVERSEAS ORDERS

16.7 Bn USD
REVENUE*

RUSSIAN DESIGNED NPPs AVOIDED
213 M tonnes of CO_2eq

35 UNITS
OVERSEAS NPP PORTFOLIO

R&D INVESTMENT
4.5% of revenue

0 INES
LEVEL–2 INCIDENTS

>250 000
EMPLOYEES

GLOBAL FOOTPRINT -
> 50 countries

** Source: Rosatom IFRS, annual report*

NUCLEAR TECHNOLOGIES CONTRIBUTE TO UN SUSTAINABLE DEVELOPMENT GOALS

ROSATOM

Contribution to the UN Sustainable development goals is a key principle for Rosatom activities. In 2020 Rosatom became a member of the UN Global Compact network

- **Nuclear power plants – clean** and **affordable energy, combat climate change**, **industry** and **economic growth**
- **Nuclear Medicine & Isotope products – good health and well-being**
- **Desalination and water treatment – clean water & sanitation**
- **Multipurpose irradiation centers – zero hunger** and **good health and well being**
- **Centers for Nuclear Science &Technologies – innovation, infrastructure and industry development, good health and well-being** and **education**

Source: Climate change and nuclear power 2018 IAEA

NET-ZERO CLUSTERS

ROSATOM

- Clean energy sources as a tool in achieving net-zero production
- Decrease of CO2 emissions
- Eco-friendly industries
- Lower costs
- High production efficiency and economic viability

NET-ZERO CLUSTERS

- New clean standards
- Integration of different industries around a single clean energy source
- SMRs, wind power plants as potential energy sources, depending on size and geography of clusters

MODERN SMR SOLUTIONS

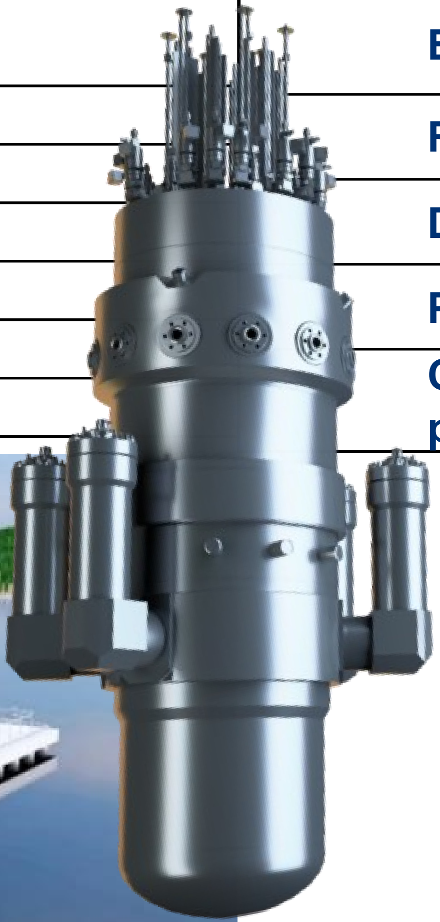
ROSATOM

Floating NPP

Electrical capacity	100 MW
Refueling cycle	up to 10 years
Design life	60 years
Displacement	16 680 tons
Length	112 m
Beam	30 m
Draught	5 m

Land-based solution

Electric capacity	>110 MW
Refueling cycle	up to 6 years
Design life	60 years
Plant area	0,06 km^2
Construction period	3-4 years



WORLD'S ONLY FLOATING NUCLEAR POWER PLANT

ROSATOM

2 x KLT-40S

Electrical capacity	70 MW
Thermal capacity	300 MW
Fuel cycle	3 years
Design life	40 years

APRIL 2019	Comprehensive dockside tests of the floating power unit "Akademik Lomonosov" were completed
JUNE 2019	Operation license was issued
DECEMBER 2019	FNPP was connected to the grid
MAY 2020	FNPP was put into commercial operation

WIND ENERGY SOLLUTIONS

- Zero pollution to the environment
- Minimal power transmission loss
- Fast installation, low maintenance and operating costs
- Five Rosatom wind farms operating in Southern Russia, with an installed capacity totaling 660 MW
- The portfolio of wind power plants to be built by ROSATOM by 2027 in Russia totals 1.7 GW

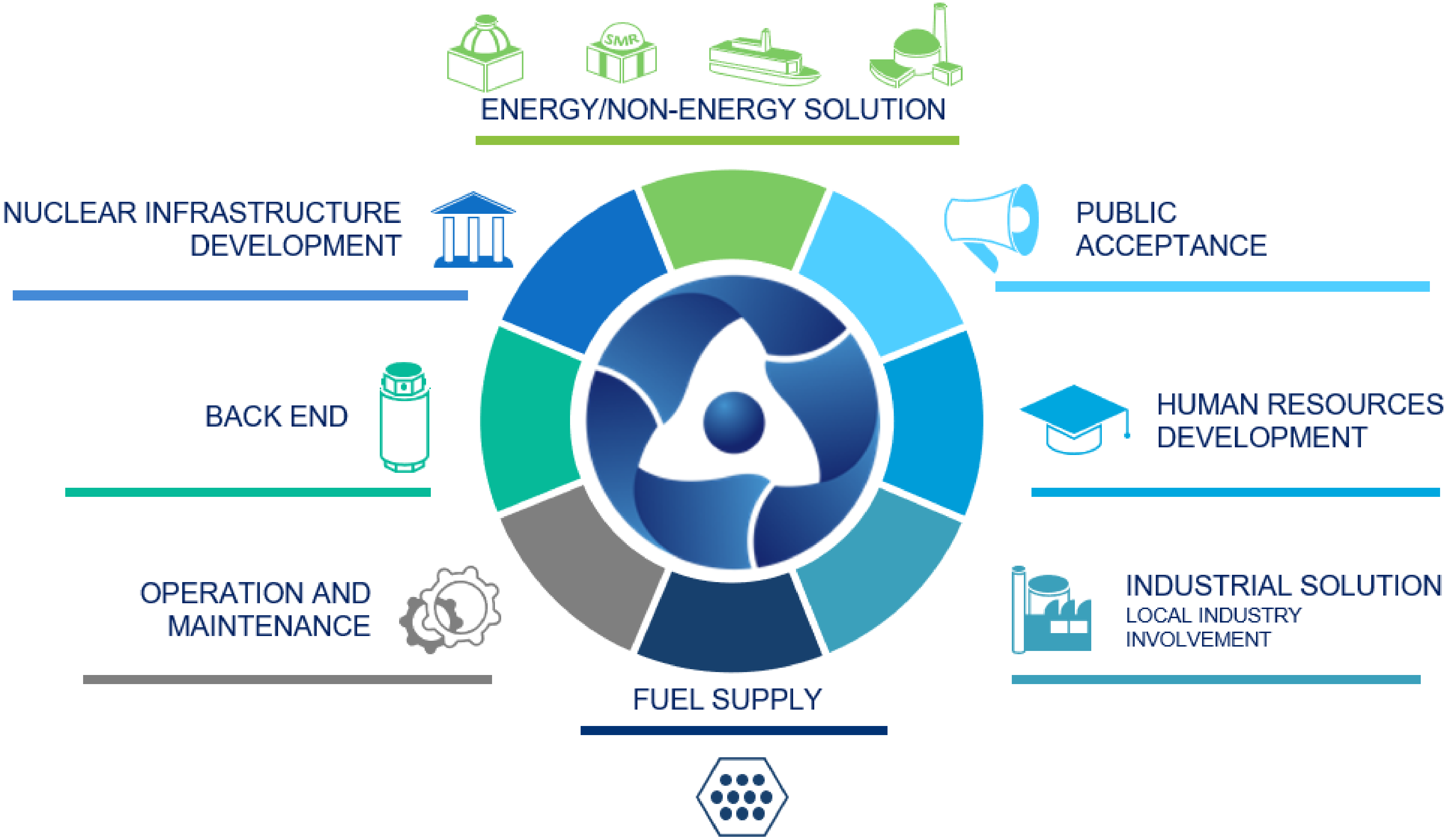
ENERGY STORAGE SYSTEMS

ROSATOM

- Lithium-ion batteries are energy storage systems for renewable energy, power systems and electric transport
- Energy storage systems on lithium-ion batteries significantly reduce equipment costs and increase its efficiency
- Not explosive
- Environmentally friendly

HYDROGEN SOLUTIONS

INTEGRATED OFFER



Thank you!

High-tech energy "ecosystems" for sustainable development

Chair:
Tim Yeo
Chairman
New Nuclear Watch Institute

Speakers:

Michel Bérthelemy
Nuclear Energy Analyst
OECD Nuclear Energy Agency

Shannon Bragg-Sitton
Integrated Energy Systems Lead,
Nuclear Sciences and Technology
Idaho National Laboratory

Sophie Macfarlane-Smith
Head of Customer Business
Rolls-Royce SMR

Egor Simonov
Regional Vice President, Director of
Rosatom Southeast Asia