



IAEA

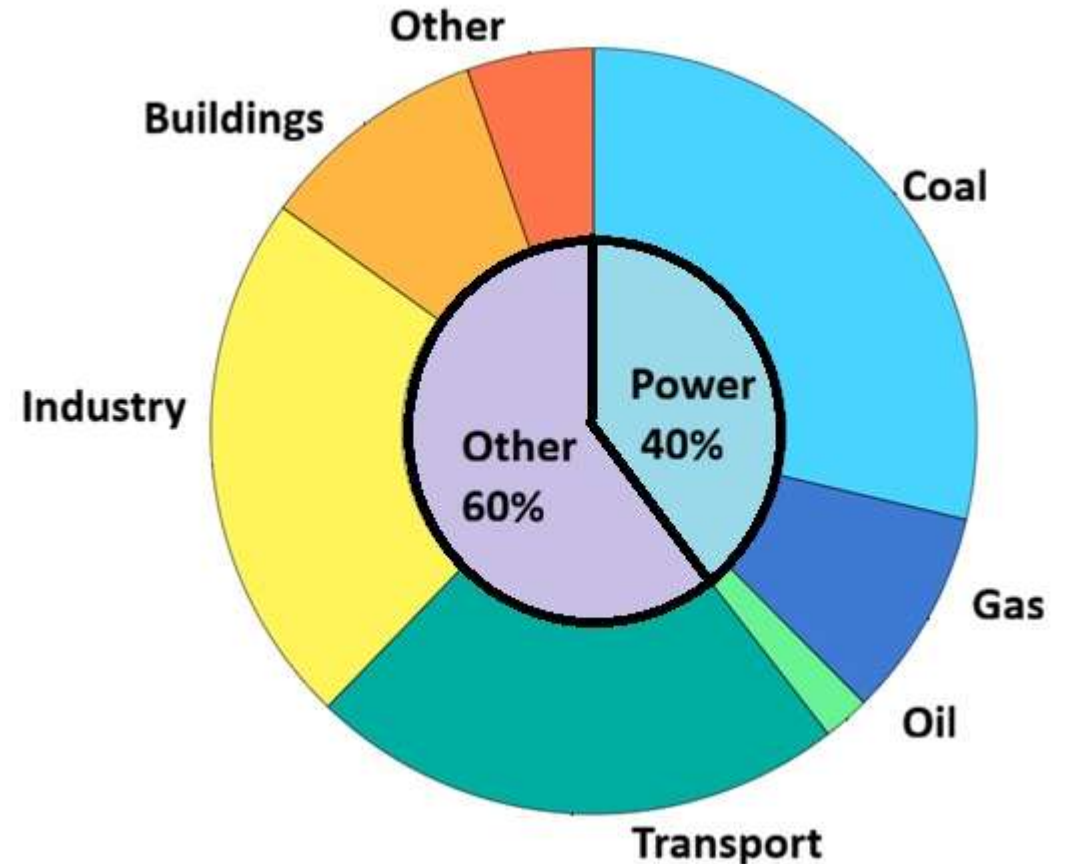
**26th INPRO Dialogue Forum on the
Deployment of Nuclear Energy Systems
for Applications Beyond Electricity
24 – 28 August 2026, Bangkok, Thailand**

Non-Electric Applications of Nuclear Energy

Nuclear Power Technology Development Section

Decarbonization of the complete energy sector – beyond electricity

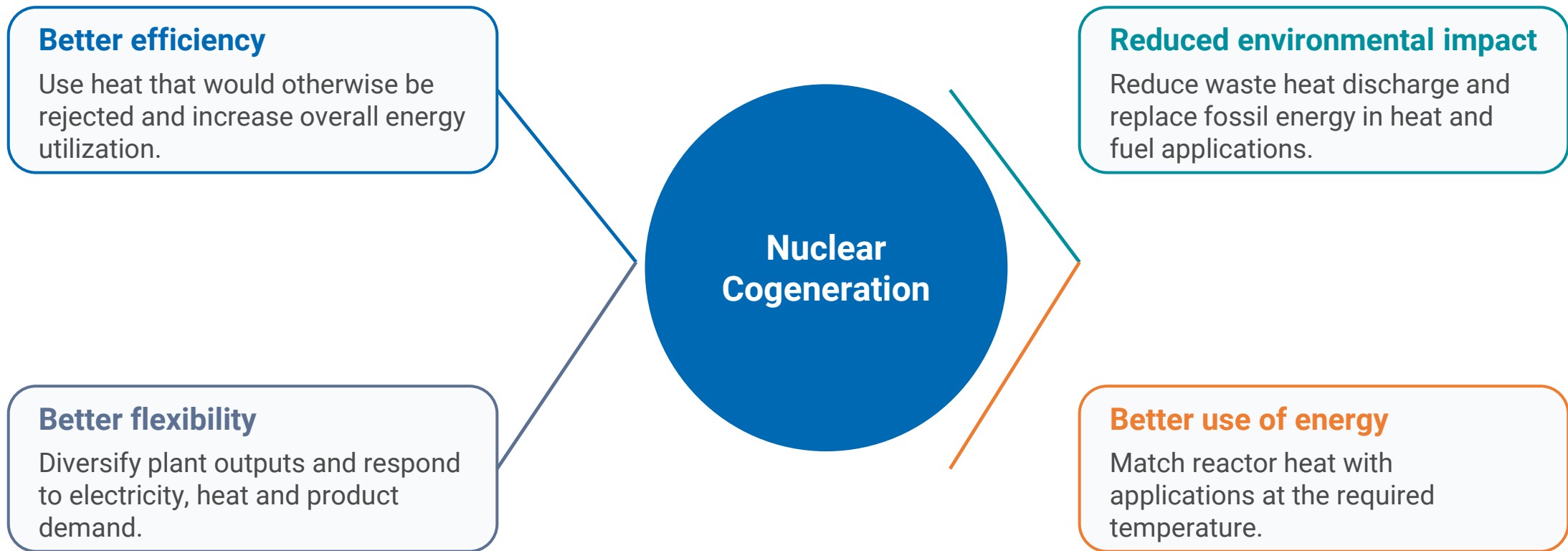
- **Decarbonizing the power sector** is essential to reach climate goals
- **Need to decarbonize other sectors**, representing 60% of emissions
 - Electrification with clean electricity
 - Low carbon heat sources
 - Low carbon fuels, including hydrogen, produced from clean energy
 - Maritime applications
 - Green steel, oil and gas, cement
- **Nuclear energy is a source of low carbon heat**
- Currently 1 % of nuclear heat has been used for non-electric applications



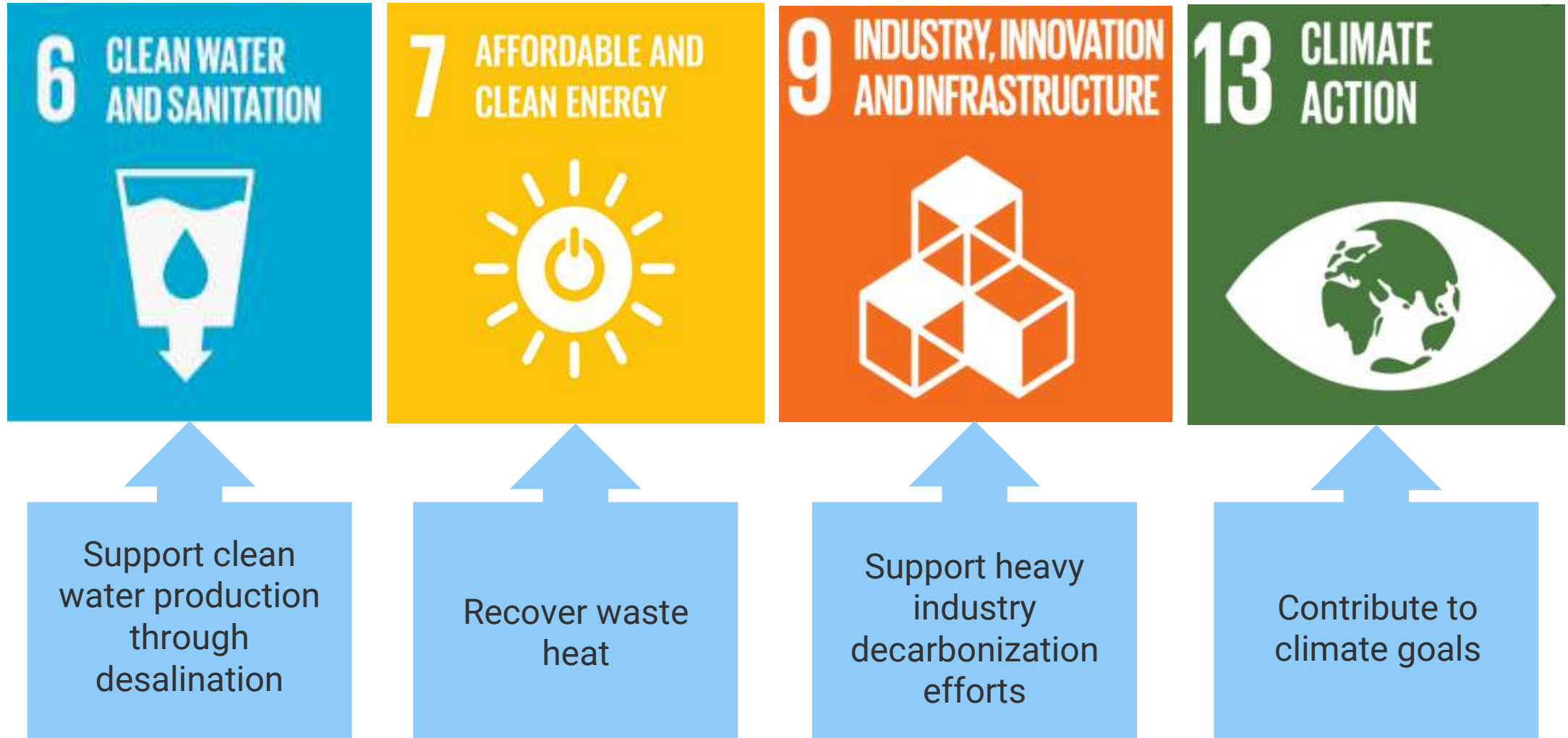
... mostly the harder to abate energy sectors – Innovation needed

Benefits of nuclear cogeneration

Using nuclear heat for additional products can improve resource use and broaden the services provided by a nuclear plant



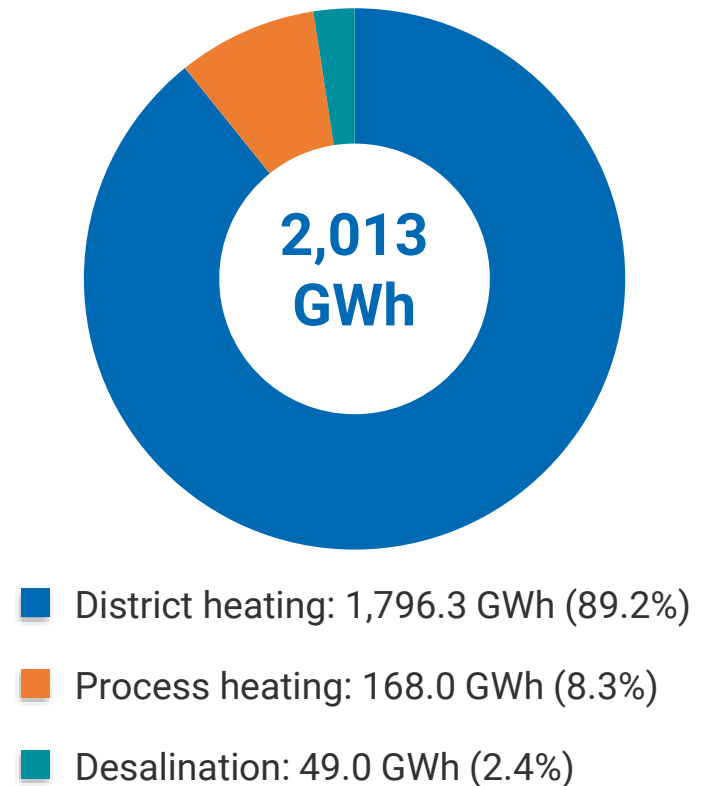
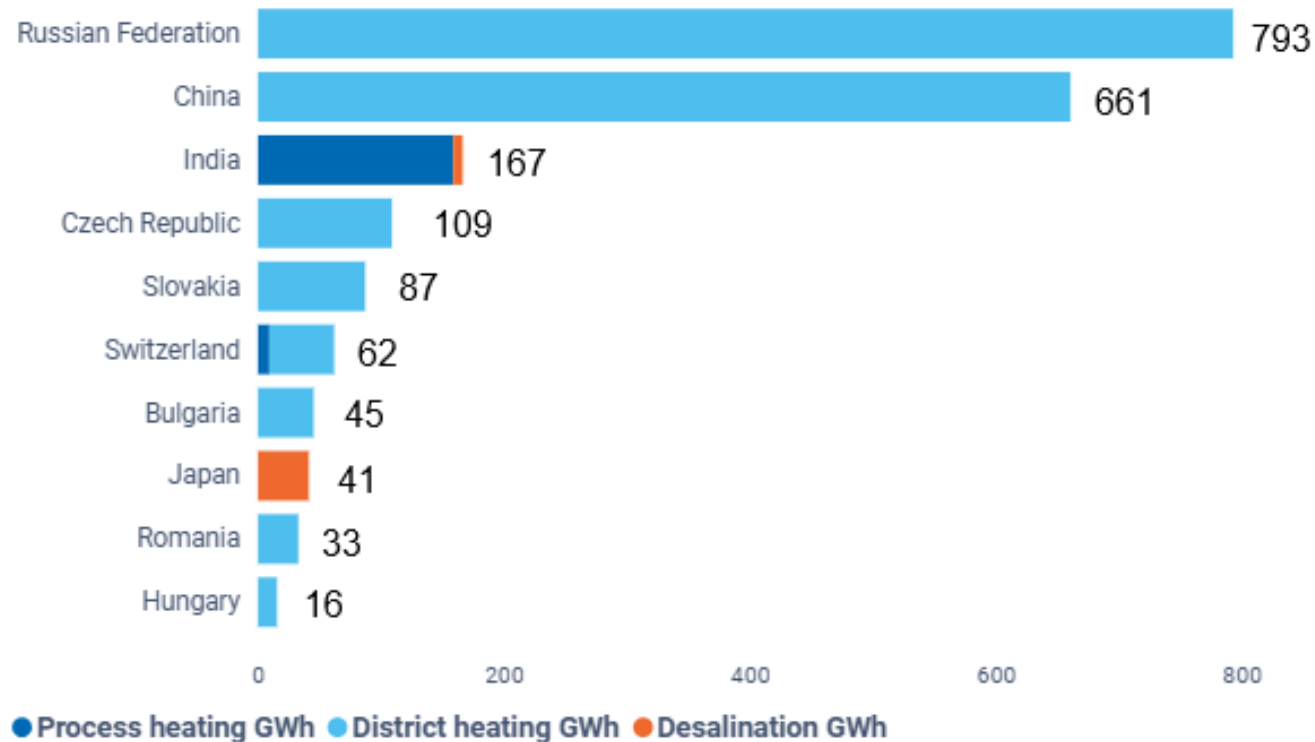
Nuclear cogeneration and the SDGs



Non-electric applications: global operating experience

Reported production 2,013 GWh across district heating, process heating and desalination

Production by application



District heating accounted for 89.2% of reported non-electric application production in 2025

Source: PRIS, data 2025: country totals aggregate all reported application types

Heat market – Large NPPs or SMRs

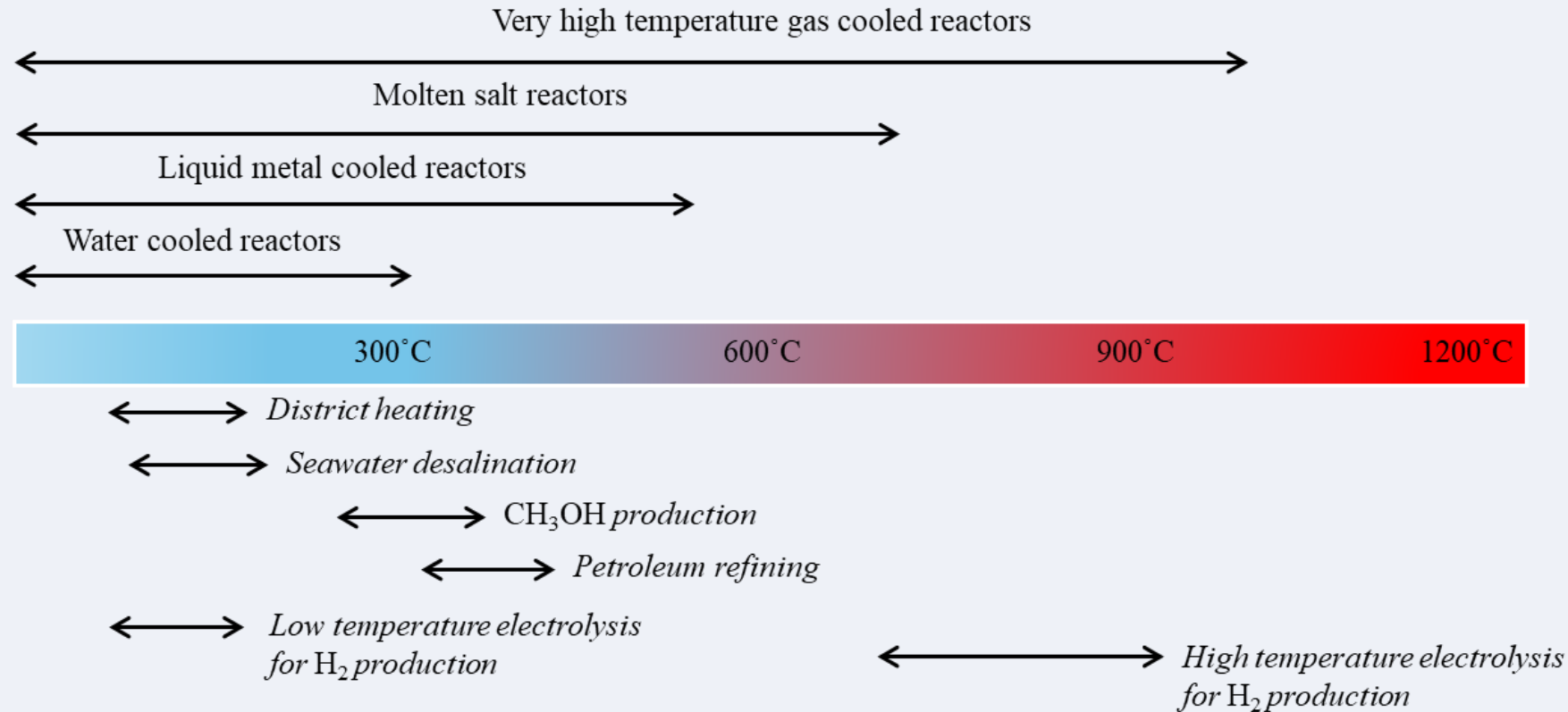
The nature of the heat market is highly fragmented, and therefore suitable for SMRs

- 50% of the users for processes require less than 10 MWth
- 40% require between 10 and 50 MWth
- 99% of the users are included in the 1 to 300 MWth range, which accounts for about 80% of the total energy consumed

However, large reactors have a place

- Individual large users with energy intensive processes (desalination, petrochemical, district heating...etc) cover the remaining portion of the heat market with requirements up to 1000 MWth, and exceptionally even more

SMRs for Non-Electric Applications



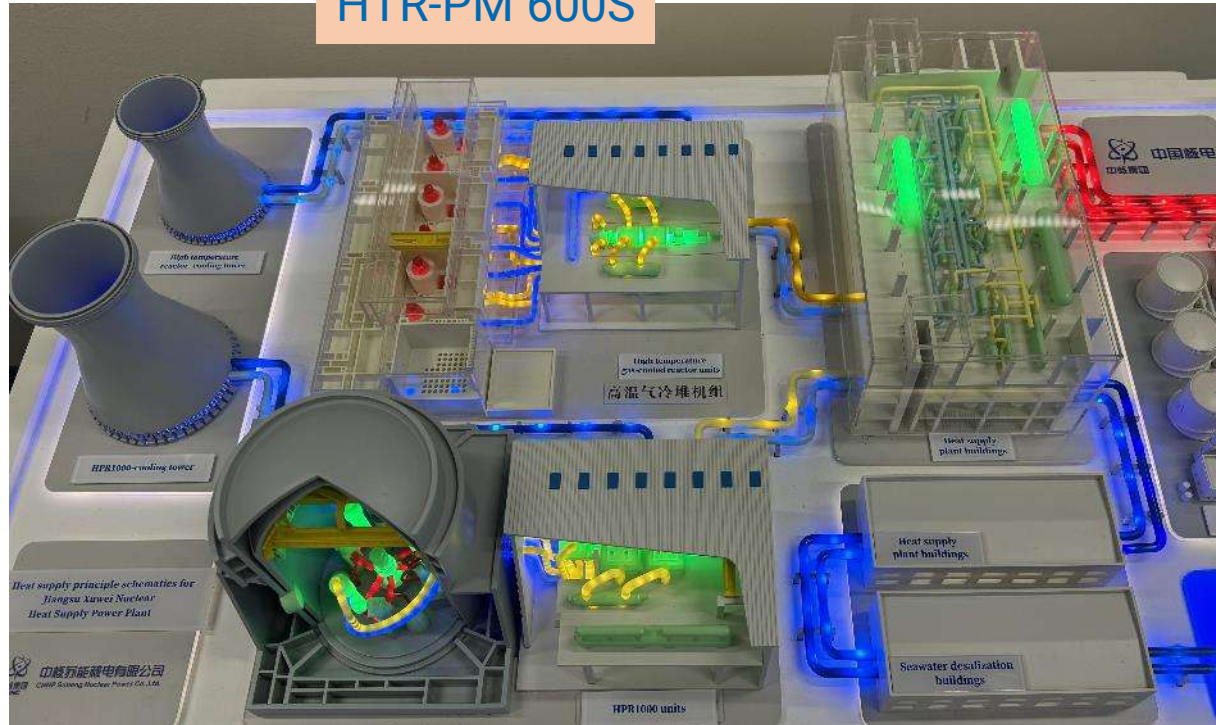
SMRs clearly can play an important role... This market is larger than the existing electricity / power market



Depending on the exit temperature of the coolant there is a wide range of associated non-electric applications

China: Xuwei cogeneration plant

HTR-PM 600S



Hualong One

China National Nuclear Power: The Phase I project of the Xuwei Nuclear Heating and Power Plant in Jiangsu has been approved by the State Council for nuclear energy.

Breakings - Aug 19 14:01



2x Hualong One + HTR-PM 600S with 6x250MWt units
FCD of Unit 1: 16 January 2026

For HTR-PM 600S: licensing/procurement activities are ongoing; FCD expected in the coming months

Steam supply: 4082 t/h
460°C at 4.9MPa
340°C at 3.8 and 2.8 MPa

Generation capacity: 1653 MWe

Serving the Lianyungang petrochemical park

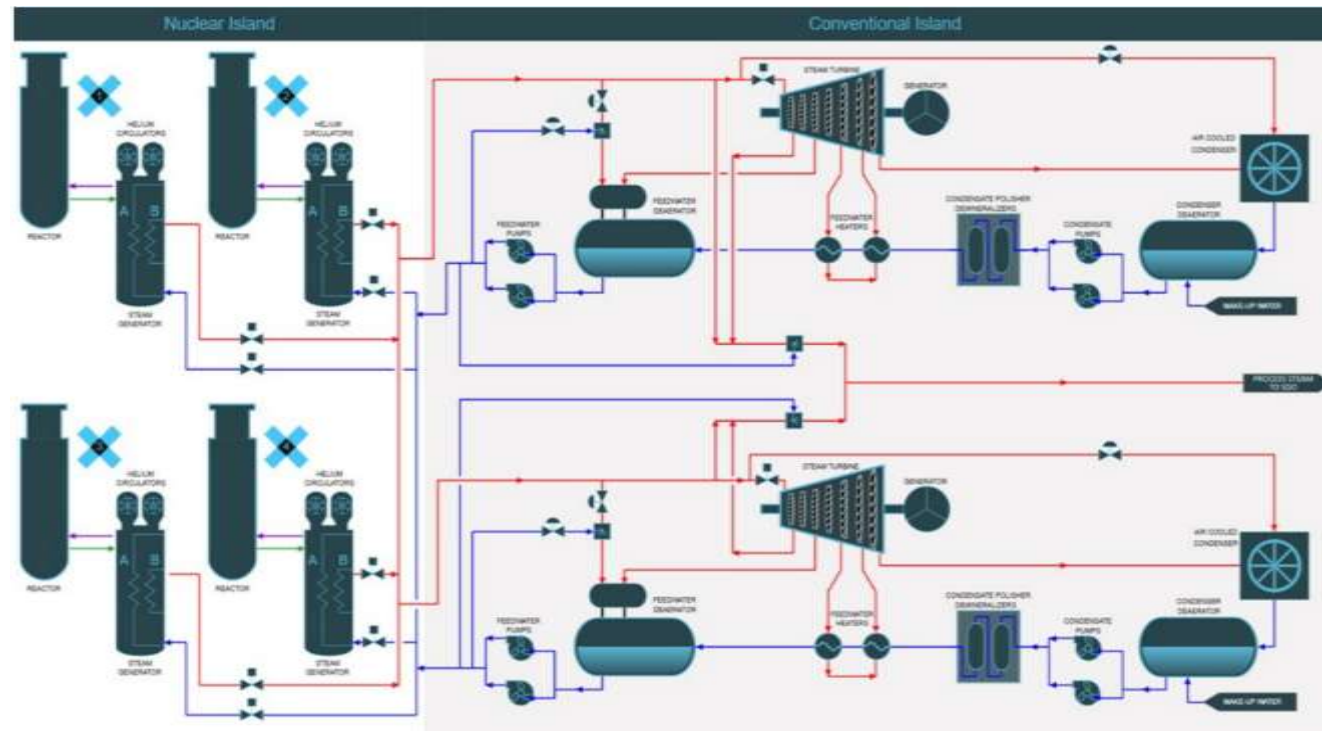
Steam supply ~ Oct 2030

- 32.5 Mt/yr of industrial steam
- Reduce carbon dioxide emissions by 19.6 Mt/yr

USA: Dow and X-energy industrial heat

4 Xe-100 pebble-bed HTGR SMRs (200 MWt each) to replace Dow's gas-fired cogeneration facility at their Seadrift, Texas site. The SMRs will provide heat and electricity to the facility. Circulating helium transfers heat to a single steam generator designed to produce high-grade, superheated steam at 565°C. When operating at 100 percent turbine bypass mode, with maximum steam flow sent to the SDO facility, each Xe-100 reactor can generate 75.57 kg/s of steam.

Project Status: Construction Permit Application submitted to the country's nuclear regulator.



Nuclear energy for cooling AI data centres

- AI data centres require large amount of cooling, roughly matching the IT load:
 - Typically, in the tens of MW electrical, up to more than 100 MW for large data centers, >1 GW in the future.
- AI data centres are densely packed and need active cooling – conventional air cooling may not be sufficient for more advanced and dense data centres.
- Nuclear energy, and SMRs, can facilitate data centres cooling
 - Existing access to cooling infrastructure: cooling towers and water usage rights needed by both, nuclear and data centres.
 - Nuclear waste heat can drive adsorption/absorption chillers to provide efficient cooling for data centres.
 - Data centres with advanced cooling will have a competitive advantage, allowing higher workloads.
 - Using nuclear waste heat for cooling will increase the overall efficiency of the combined systems and increase sustainability.



District heating using nuclear energy

Using steam or hot water produced at the NPP and distributing it through a network of underground pipes

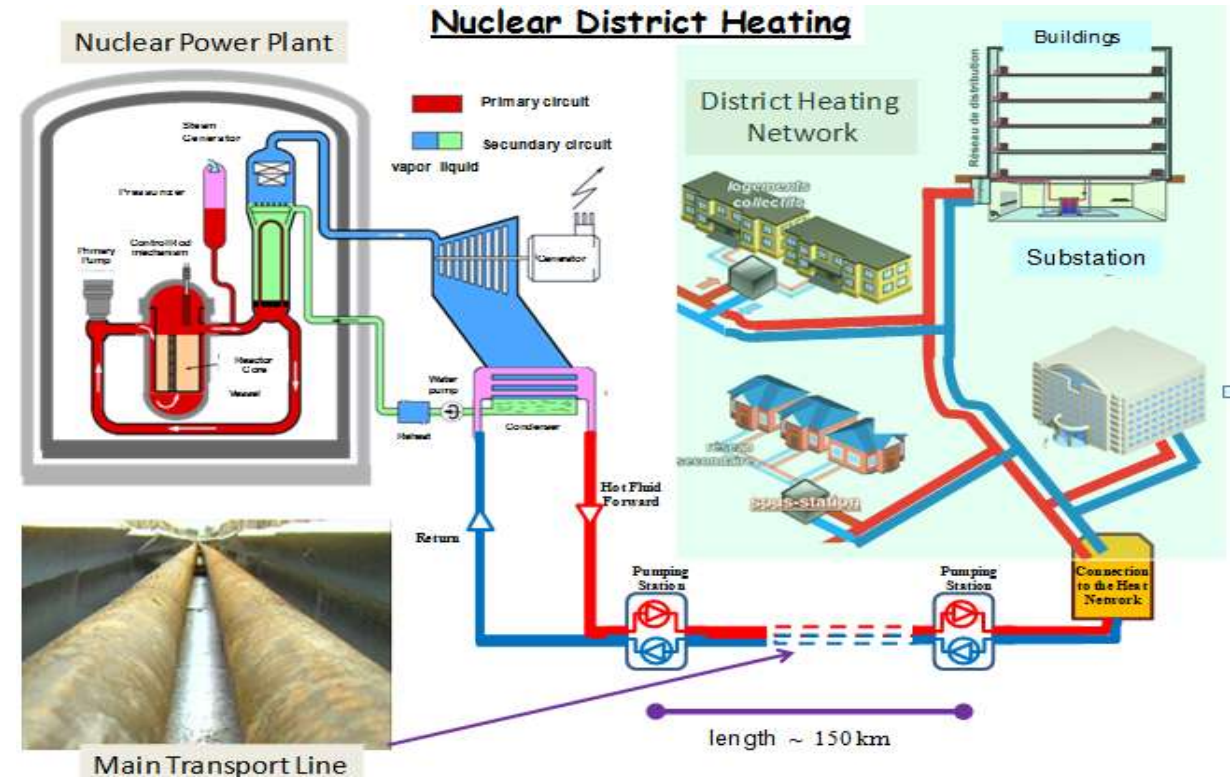
Demonstrated at industrial scale and currently operating in Bulgaria, China, Czech Republic, Hungary, Romania, Russia, Slovakia, Switzerland and Ukraine

Technical features:

- Steam or hot water: 80-150°C
- Typical distribution: 10-15 km

District heat needs

- Typically, up to 600-1200 MWth for large cities



Industrial process heat applications

Nuclear heat can be used in most industrial processes

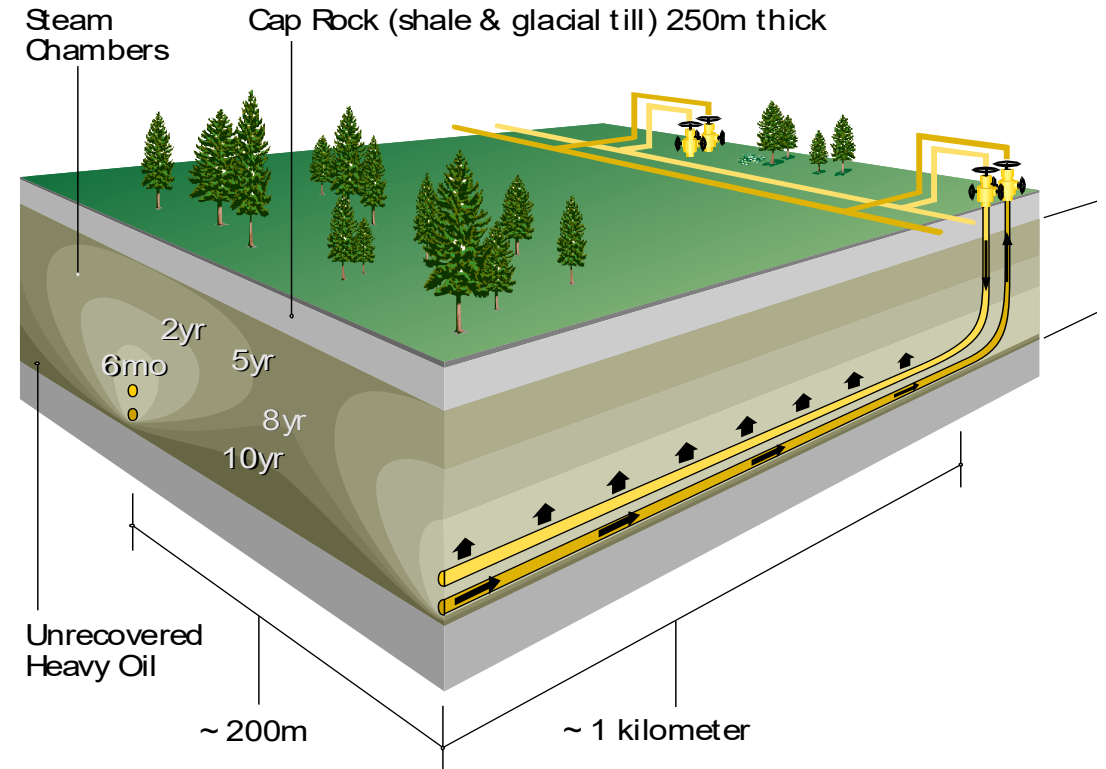
Demonstrated with a variety of industrial facilities including a salt refinery in Germany, a paper factory in Norway, a cardboard factory in Switzerland and a petrochemical plant in China

Example applications:

- Heat supply to oil refineries
- Coal liquefaction and gasification
- Steel, cement, fertilizer, aluminium, asphalt and petrochemical industries

Main requirements:

- Location close to user and high reliability



Example of future nuclear application in Canada: Replace burning of natural gas for mining oil sands using steam assisted gravity drainage

Nuclear energy for desalination

Thermal processes: Multi-stage flash (MSF) distillation; multiple effect distillation (MED)

- Benefits include
 - Easier maintenance & pre-treatment
 - Industrial quality water

Electrical processes: Reverse osmosis (RO)

- Benefits include
 - Increased availability
 - No lost power generation as in MSF and MED
 - Utilizing waste heat to preheat feedwater by 15°C increases water production by 13%

KAZAKHSTAN: BN-350 FR at Aktau supplied up to 135 MWe of electric power while producing 80 000 m³/d of potable water over 27 years, until 1999 with MED

PAKISTAN: 4800 m³/d MED plant, coupled to the Karachi Nuclear Power Plant (KANUPP-1, 125 MWe PHWR), commissioned in 2009 and shut down in 2021 when KANUPP-1 NPP was shut-down

JAPAN: Desalination facilities (both RO & MSF) coupled to PWRs operating for electricity production, ~ 14 000 m³/d of potable water

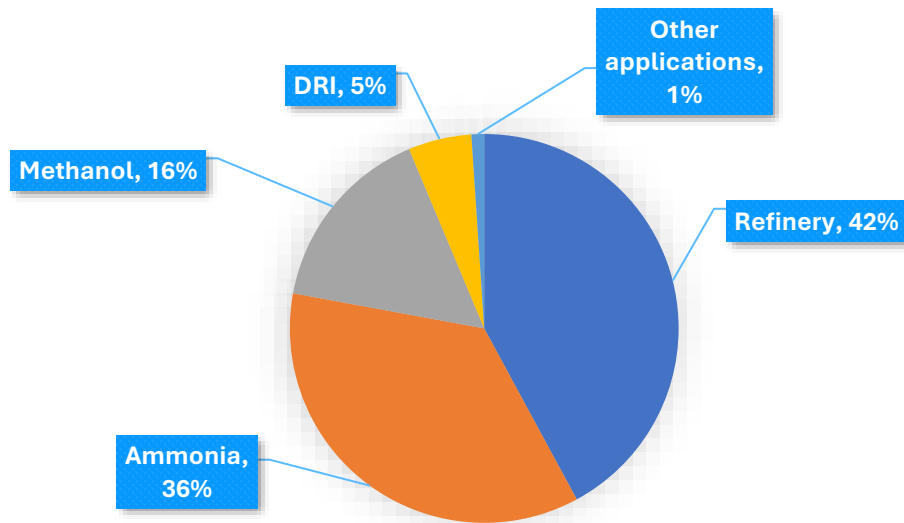
INDIA: Developed MED technology and plan to use it at various sites with different plant capacities; 6300 m³/d MSF-RO hybrid plant at Kalpakkam (4300 m³/d MSF + 1800 m³/d RO) Madras NPP; Experience operating the MVC-MED desalination plant connected to VVER-1000 MWe Kudankulam

JORDAN: Planning to install SMR exclusively to desalinate 300 Mm³/y and pump it 400 km to the capital

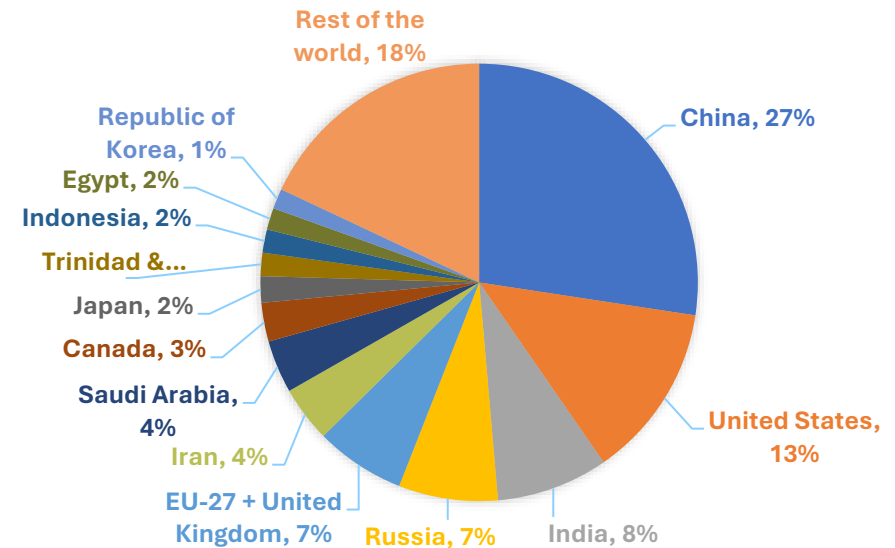


Current hydrogen market

- Global hydrogen consumption is approximately 95 Mt
- Main market for hydrogen is industrial applications
- High transport and storage costs for hydrogen
 - Most hydrogen is produced near the consumption site
 - Less than 0.3% of the total hydrogen consumed is traded in the global market



Current hydrogen market, as of 2022 (source: IAEA)



Hydrogen consumption by country (source: IAEA)

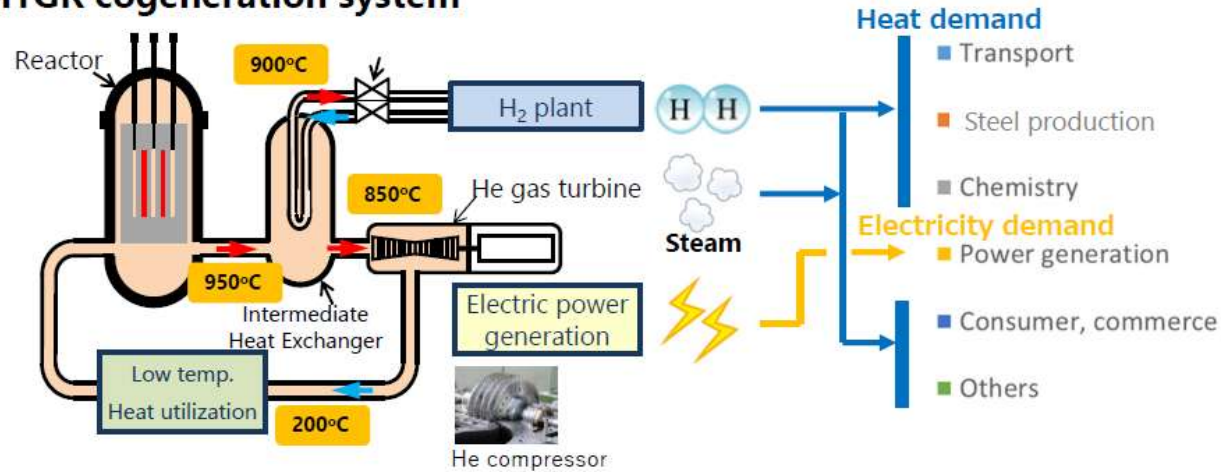
Hydrogen production using nuclear energy

- Nuclear energy is in a good position to support the envisioned hydrogen economy
- It can produce large quantities and high-quality hydrogen without any GHG emissions
- All types of nuclear reactors can be used for hydrogen production through electricity and heat production
 - LWRs and SMRs can be used for hydrogen production through low temperature electrolysis and high temperature electrolysis (HTSE) (with heat recuperators)
 - High temperature reactors are an attractive option for processes needing high temperature heat (e.g. thermochemical water splitting)
- Economic viability, some technological and licensing challenges, as well as policy support must be addressed in order to deploy commercial scale nuclear hydrogen projects

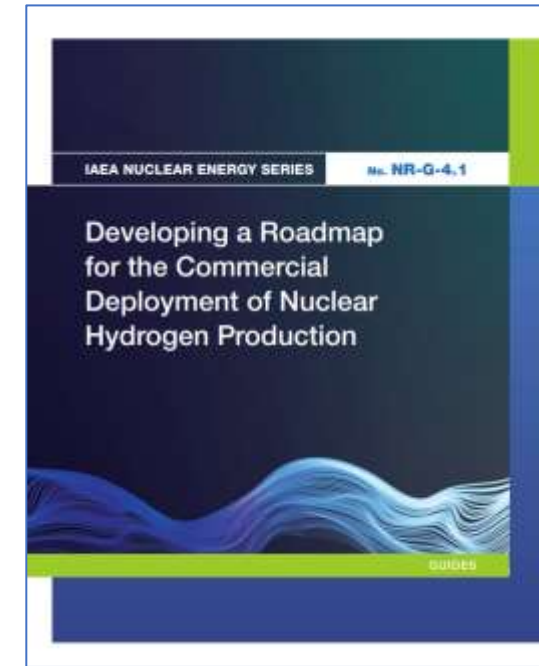


Hydrogen production using HTGR - Options

HTGR cogeneration system

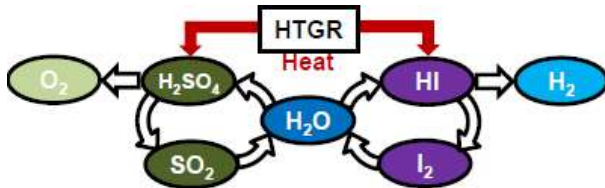


• Heat utilization rate is about 80%

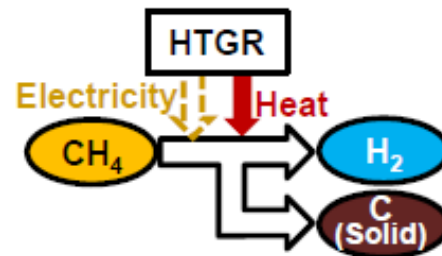


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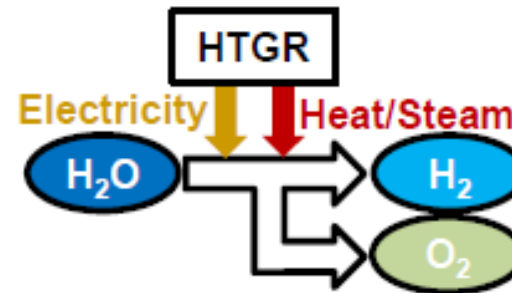
Thermochemical sulphur-iodine (S-I) process



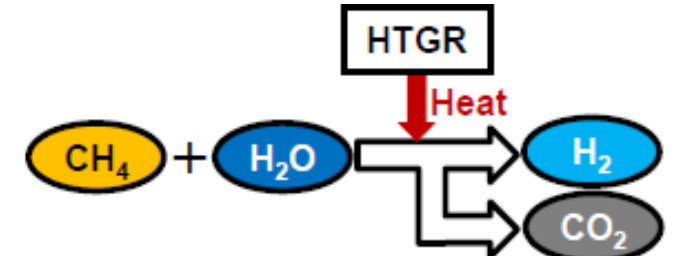
Methane pyrolysis



High temperature steam electrolysis

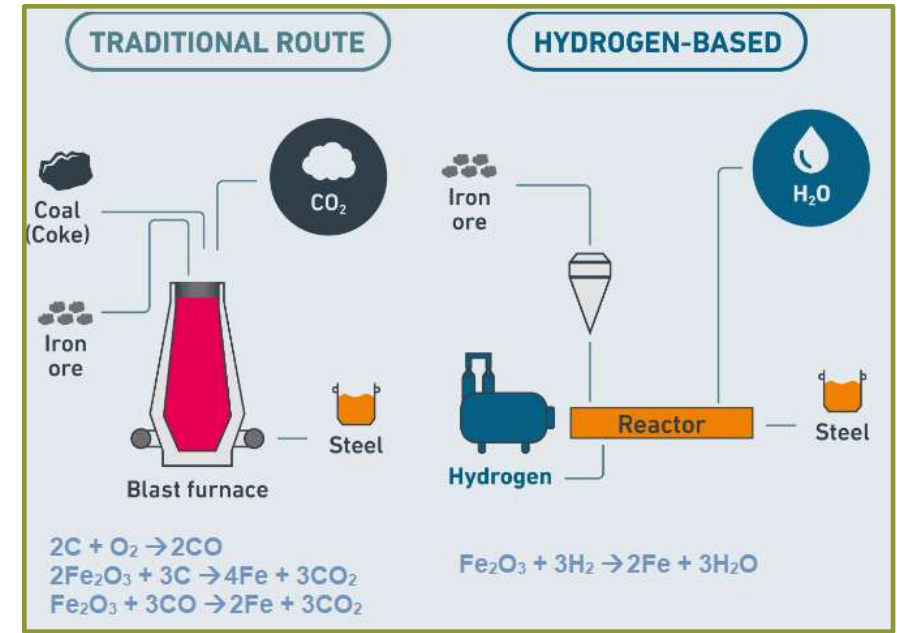


Steam methane reforming



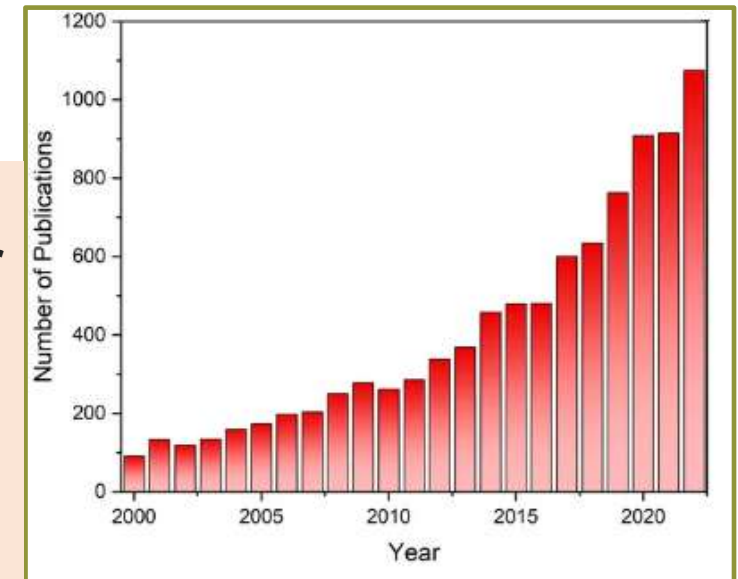
Steel industry today

- ~ 2 billion t steel produced annually, and demand is projected to rise by more than 1/3 by 2050
- The steel industry is currently responsible for ~7.2% of global CO₂ emissions, primarily due to the reduction of iron from iron ore via coal (conventional blast furnace).
- Current emissions are about 1.9 t of CO₂/ton of steel.
- Direct Reduction Iron (DRI) provides a demonstrated alternative to decarbonize iron production using hydrogen instead of coal.
- The key problem with DRI is the production of a sufficient amount of hydrogen at a price that keeps steel competitive.
- R&D and demonstration of DRI is well advanced: SSAB HYBRIT (demonstration plant running in Luleå, Sweden, with 4 MW alkaline electrolyzers), POSCO HyREX.



Number of publications per year on the hydrogen-based reduction of iron oxides

(Source: *Sustainability* 2023, 15(17), 13047)



Chinese industrial nuclear steam project commissioned

Thursday, 20 June 2024

China's first industrial-use nuclear energy steam supply project, at the Tianwan nuclear power plant in China's Jiangsu province, has entered operation following commissioning tests. The project will supply steam to a nearby petrochemical plant.



(Image: CNNC)

South Korea's first nuclear hydrogen project to be built by 2027 by eight partners, including Hyundai and Samsung

The 10MW pilot, announced today, is due to be followed by 'a large-capacity commercial plant'



District heat scheme planned for Mochovce plant

Monday, 20 January 2025

Slovenské elektrárne has outlined details of a scheme to deliver heat for the town of Tlmače from the Mochovce nuclear power plant.



US to deploy molten salt reactors to turn wastewater into freshwater

Each module of a small modular reactor can produce up to 300 MWe of energy.

Updated: Jan 30, 2025 08:57 AM EST



Ameya Paleja

6 days ago



Small modular reactors can use their waste heat to power desalination processes.

Nature Resources, iStock

Conclusions

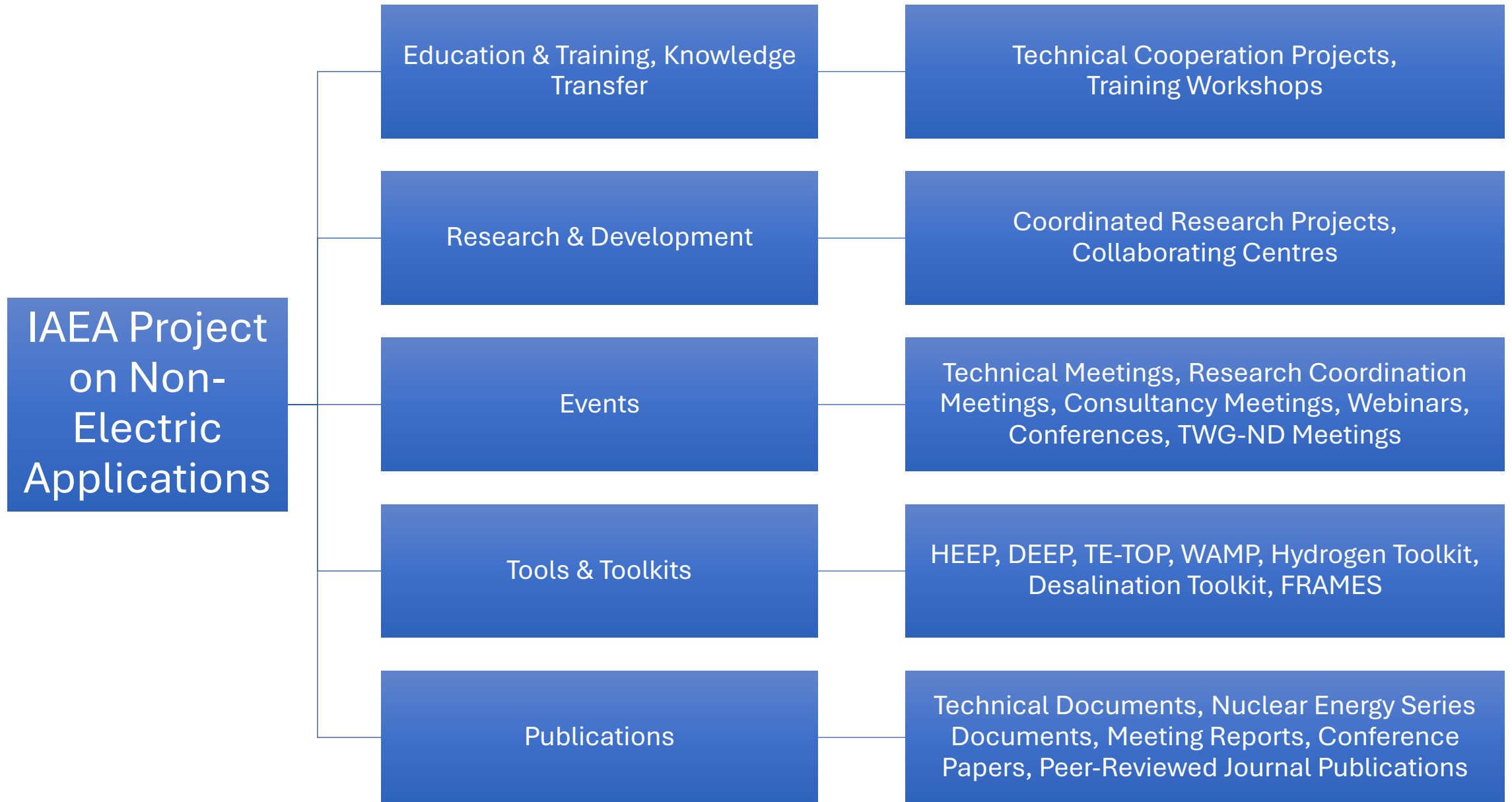
- Nuclear energy can provide clean energy (through electricity and heat) to sectors currently using fossil fuels :
 - Water desalination
 - District heating
 - Hydrogen production
 - Various industrial processes
- This can provide market growth, diversification, and other benefits to the nuclear facility, and security of supply, lower emissions, and other benefits to the user, including stable costs
- Nuclear cogeneration is still a limited practice, but current context (climate, energy security) is a driver towards development of this option

Challenges remain:

- Economic viability and business model selection by industry.
- Site selection including the transport of electricity, heat and products.
- The ability to license cogeneration with ensured safety.
- Timing of technology availability to reach commercialization and climate goals.

IAEA Activities

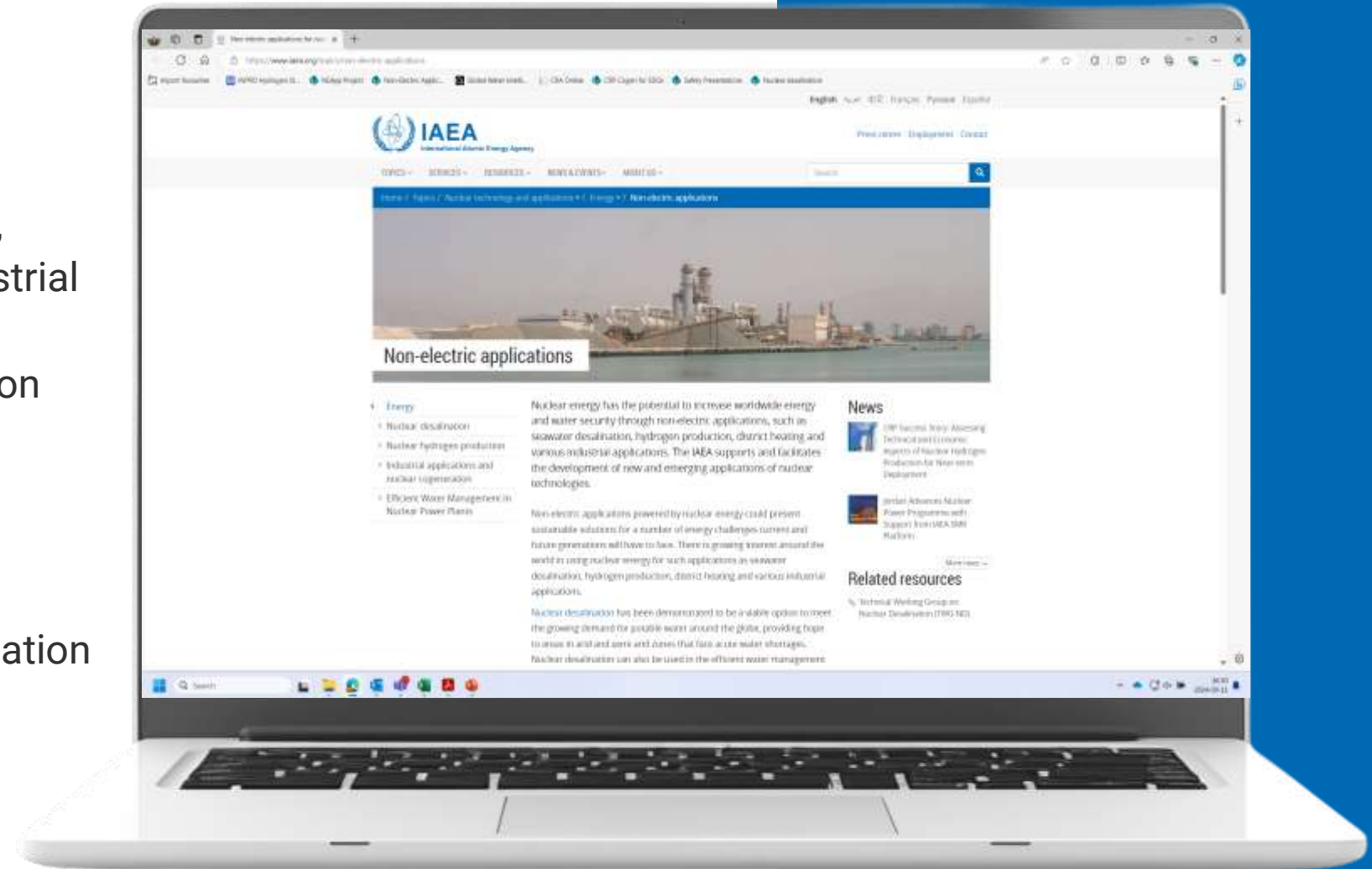
IAEA Activities on Non-Electric Applications



IAEA Resources

IAEA Webpage

- Specific pages on desalination, hydrogen production, and industrial
- Codes: Desalination Economic Evaluation Program, Desalination Thermodynamic Optimization Program, Hydrogen Economic Evaluation Program, Hydrogen Calculator
- Toolkits: Hydrogen and desalination
- Related New Stories
- Related Publications



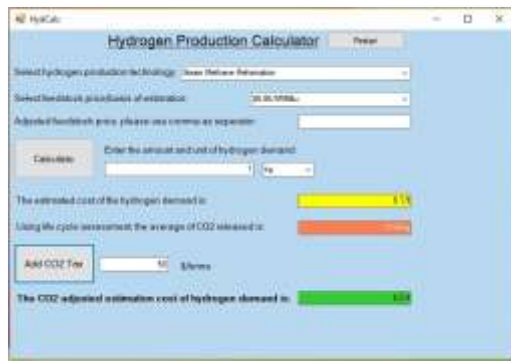
Tools and Toolkits: Portfolio Overview

Analytical tools and knowledge resources supporting Member State assessment of non-electric applications

HYDROGEN

- HEEP
- HydCalc
- Nuclear Hydrogen Toolkit

Techno-economic assessment of hydrogen generation options, hydrogen production cost calculation, and access to nuclear hydrogen knowledge resources.



DESALINATION

- DEEP
- DE-TOP
- Nuclear Desalination Toolkit

Performance and cost evaluation of power and seawater desalination configurations, plus thermodynamic optimization of cogeneration systems.



WATER MANAGEMENT

- WAMP

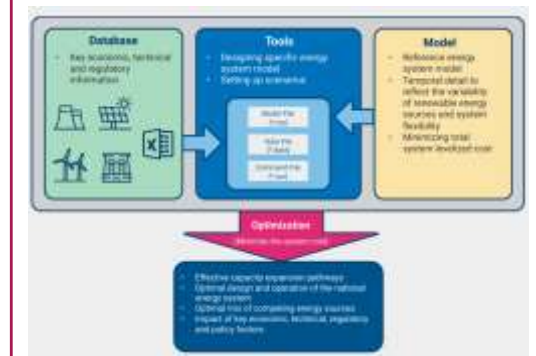
Estimation of water needs in nuclear power plants and comparative assessment of cooling systems.



INTEGRATED SYSTEMS

- FRAMES

Integrated modelling capability for electricity, hydrogen and heat systems, supporting policy-relevant analysis of nuclear and non-electric applications



Tools and toolkits translate technical knowledge into practical assessment capability for Member States.

IAEA E-learning Courses

E-Learning on Non-Electric Applications of Nuclear Power

Course on Nuclear Cogeneration

This course provides broad understanding of the concept of nuclear cogeneration and its related technologies, as well as the available IAEA tools and toolkits to support Member States interested in cogeneration and non-electric applications using nuclear energy.



Duration: approx. 30 min

Interactivity: Self-study

Languages: English

Certificate: N/A

Target audience: Young professionals, stakeholders, and new entrants to the area.

Course on Hydrogen Production

Hydrogen is experiencing a growing momentum worldwide as a clean versatile energy solution. This IAEA e-learning course provides an outlook on the status and progress of the different hydrogen technologies and the potential of the available energy sources, with focus on nuclear energy, for hydrogen production. The course has the following learning outcomes:

- The different technologies for potential deployment of large-scale hydrogen production.
- The role of nuclear energy for clean hydrogen production along with other energy sources.
- The IAEA role in nuclear hydrogen production and its related topics.



Duration: approx. 90 min

Interactivity: Self-study

Languages: English

Certificate: N/A

Target audience: all interested in hydrogen production and using nuclear energy for hydrogen production.

Tutorial on the IAEA Hydrogen Economic Evaluation Program (HEEP)

The IAEA tutorial on the IAEA Hydrogen Economic Evaluation Program (HEEP) has the following learning outcomes:

- Understand HEEP features and be familiar with its user interface and necessary input data and parameters.
- Create scenarios of nuclear hydrogen production using built-in library to estimate the cost of produced hydrogen.
- Build new case studies for specific scenarios of nuclear and hydrogen technologies.



Duration: approx. 90 min

Interactivity: Self-study

Languages: English

Certificate: N/A

Target audience: Students and professionals interested in assessing cost of hydrogen production using HEEP.

How to enrol?

- CLP4NET course enrolment requires a valid NUCLEUS account.
- <https://elearning.iaea.org/m2/course/view.php?id=630>

IAEA Publications

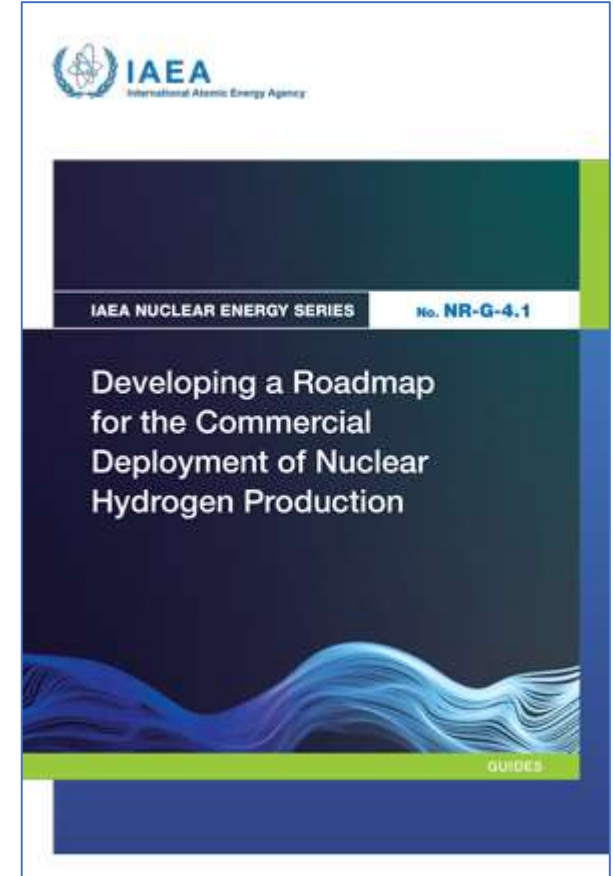
Most recent

- [Vendor and User Requirements and Responsibilities in Nuclear Cogeneration Projects, IAEA Nuclear Energy Series No. NR-T-2.17](#) (2023)
- [Assessing Technical and Economic Aspects of Nuclear Hydrogen Production for Near-Term Deployment, TECDOC-2075](#) (2024)
- [Nuclear Cogeneration towards Climate Change Mitigation and Sustainable Development Goals, IAEA-TECDOC-2056](#) (2024)
- [Developing a Roadmap for the Commercial Deployment of Nuclear Hydrogen Production, IAEA Nuclear Energy Series No. NR-G-4.1](#) (2025)
- [Specific Infrastructure Considerations for Nuclear Cogeneration Applications, IAEA-TECDOC-2121](#) (2026)



Developing a roadmap for commercial deployment of nuclear hydrogen

- Provide a useful management tool for evaluating, planning and strategizing the development of nuclear hydrogen projects by interested Member States
- Increased understanding of the technologies readiness level for different hydrogen production systems where nuclear energy is capitalized
- Identify the main challenges to be addressed in deployment of hydrogen production using nuclear energy and ways to address these challenges
- Milestones and actions needed by various stakeholders to accelerate deployment of hydrogen production using nuclear energy



[Developing a Roadmap for the Commercial Deployment of Nuclear Hydrogen Production | IAEA](#)

Developing a roadmap for commercial deployment of nuclear hydrogen

6 main chapters, 196 p



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Current publications and knowledge-product pipeline

NES

Design and Operational Considerations for Nuclear Energy Applications Beyond Electricity Production

- In publication.

NES

Opportunities for Nuclear Desalination

- In final drafting.
- Finalize and publish in 2027.

NES UPDATE

Hydrogen Production Using Nuclear Energy, NP-T-4.2

- Under development.
- Confirm missing chapters, authors, reviewers and timeline to submission.

CRP OUTPUT

CRP I35008 Final Report / TECDOC Role of Nuclear Cogeneration within the Context of Sustainable Development

- Final contributions to be collected
- Finalize TECDOC, complete evaluation.

KNOWLEDGE PRODUCT

Cogeneration catalogue

- Status, location and ownership to be confirmed.
- Confirm categories, source data and intended output format.

The current pipeline combines publications, CRP outputs and structured knowledge products supporting Member State deployment.

Other major activities

- Support to Member States upon specific request
 - Conducted a workshop on Nuclear Desalination using SMRs in 2022
 - Expert Mission on Nuclear Desalination using SMRs in Oct 2023
- Engagement with specific industrial sectors for decarbonization
 - June 2023 meeting with oil and gas sectors
 - Attended zero carbon steel event in Stockholm in Oct 2023
 - Technical Meeting on decarbonizing industry in Oct 2025 in China
- Practical aspects for cogeneration coupling
 - Kick-off Consultancy Meeting in July 2023; 2nd Consultancy in Feb 2025; Technical Meeting in Aug 2025
- Desalination using nuclear energy
 - Technical Working Group on Nuclear Desalination
 - Technical Meeting on Producing Potable Water Using Small Modular Reactors in Nov 2025



Engagement with International Organizations

- Working Group on Hydrogen Value Chains (H2-VAL) (NEA/OECD)
- IEA H2-TCP Task 44: Hydrogen from Nuclear Energy
- GIF – Non-Electric and Cogeneration Applications of Nuclear Energy Working Group (NECA)
- UNECE – UN European Commission on Energy – H2 Task Force, IAEA nominated representative
- TANDEM Project – IAEA represented in the Scientific Advisory Committee
- Nuclear Hydrogen Initiative – Technology Working Group
- IDRA (International Desalination & Water Reuse Association) – Collaboration for 2024 World Congress & TWD-ND member
- SNETP (Sustainable Nuclear Energy Technology Platform) – Nuclear Cogeneration Industrial Initiative - NC2I (Practical Arrangement with IAEA)





Thank you!
