

Non-electric applications of nuclear reactors

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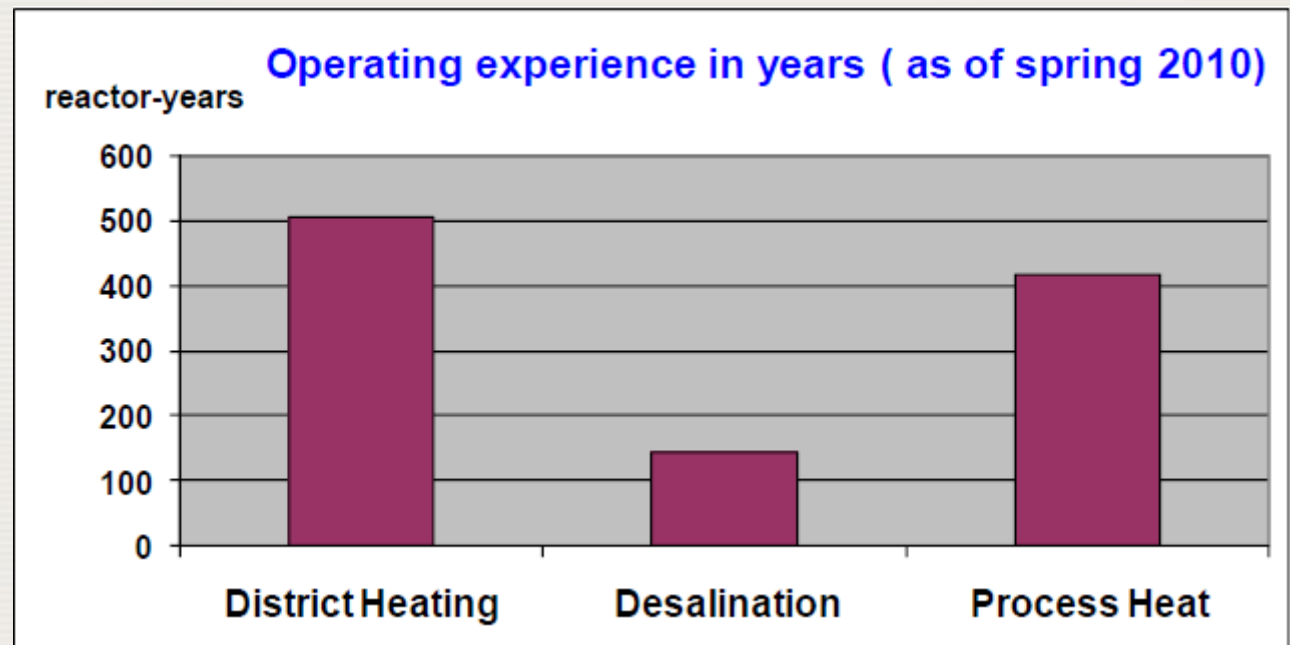


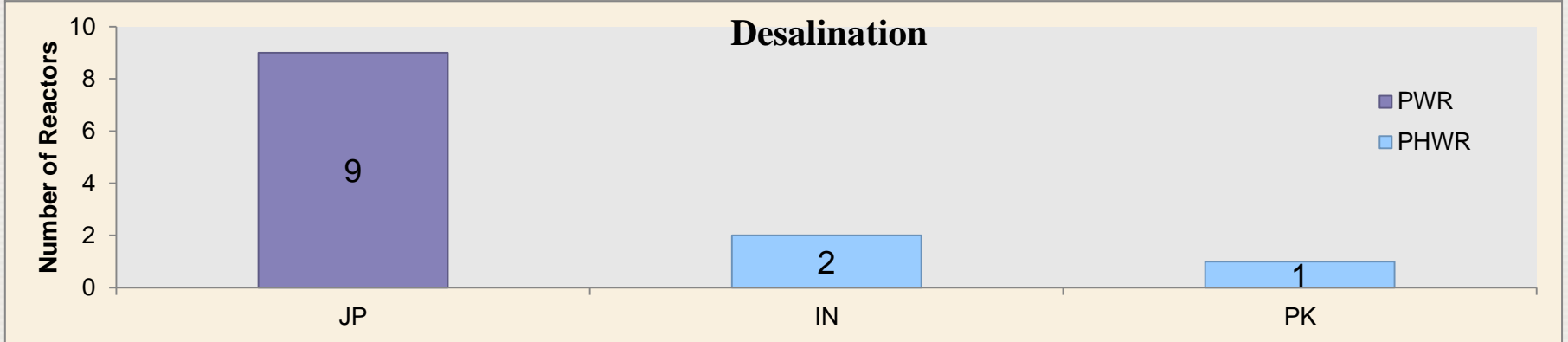
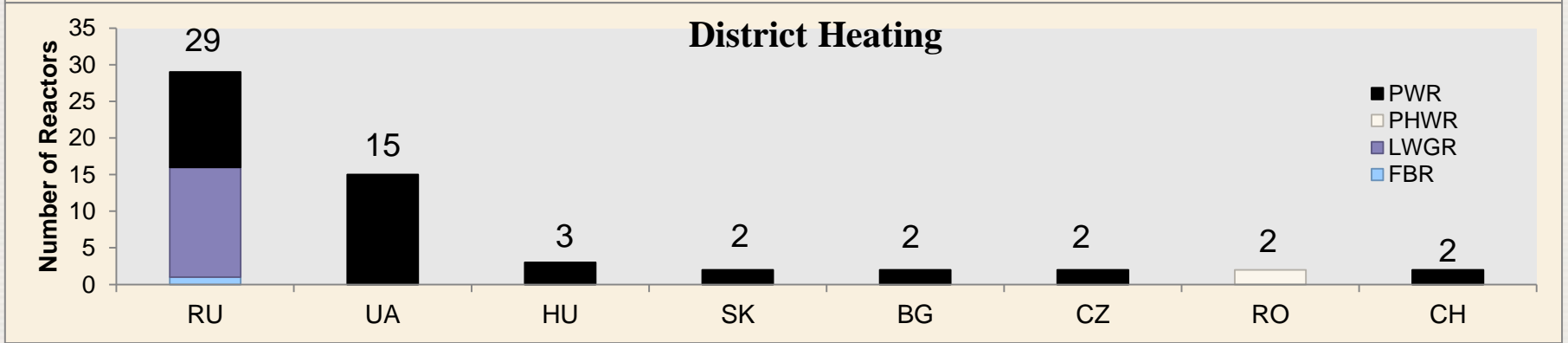
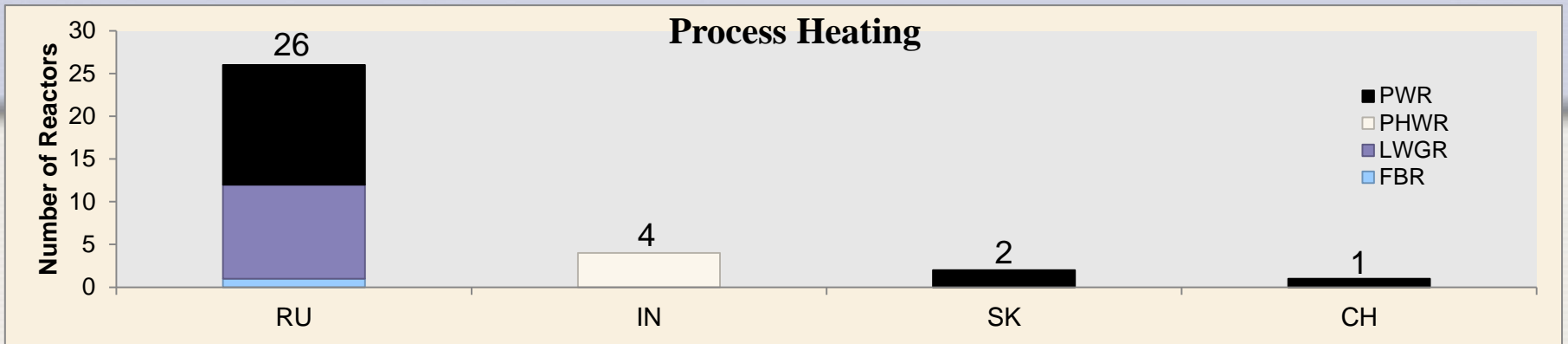
IAEA

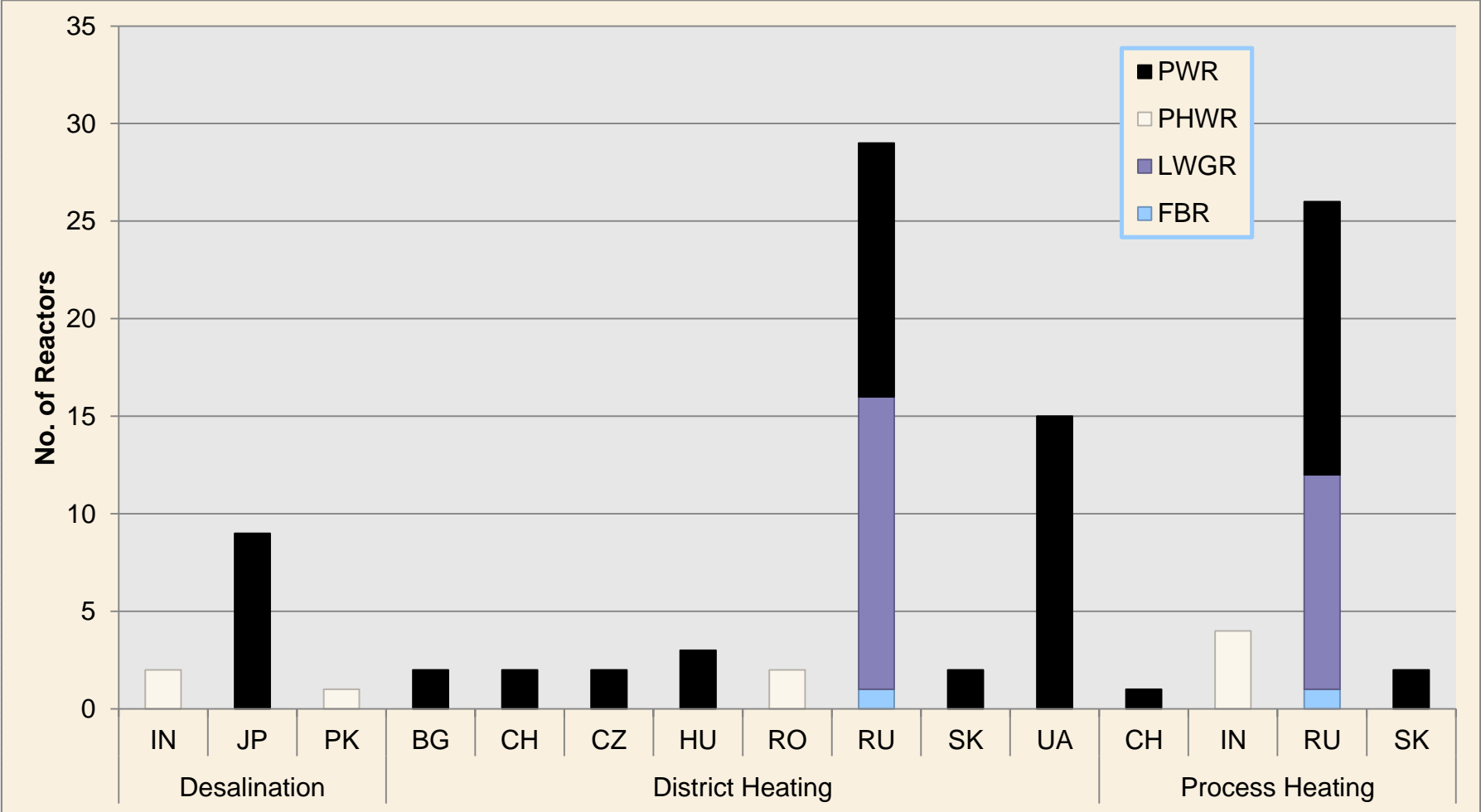
International Atomic Energy Agency

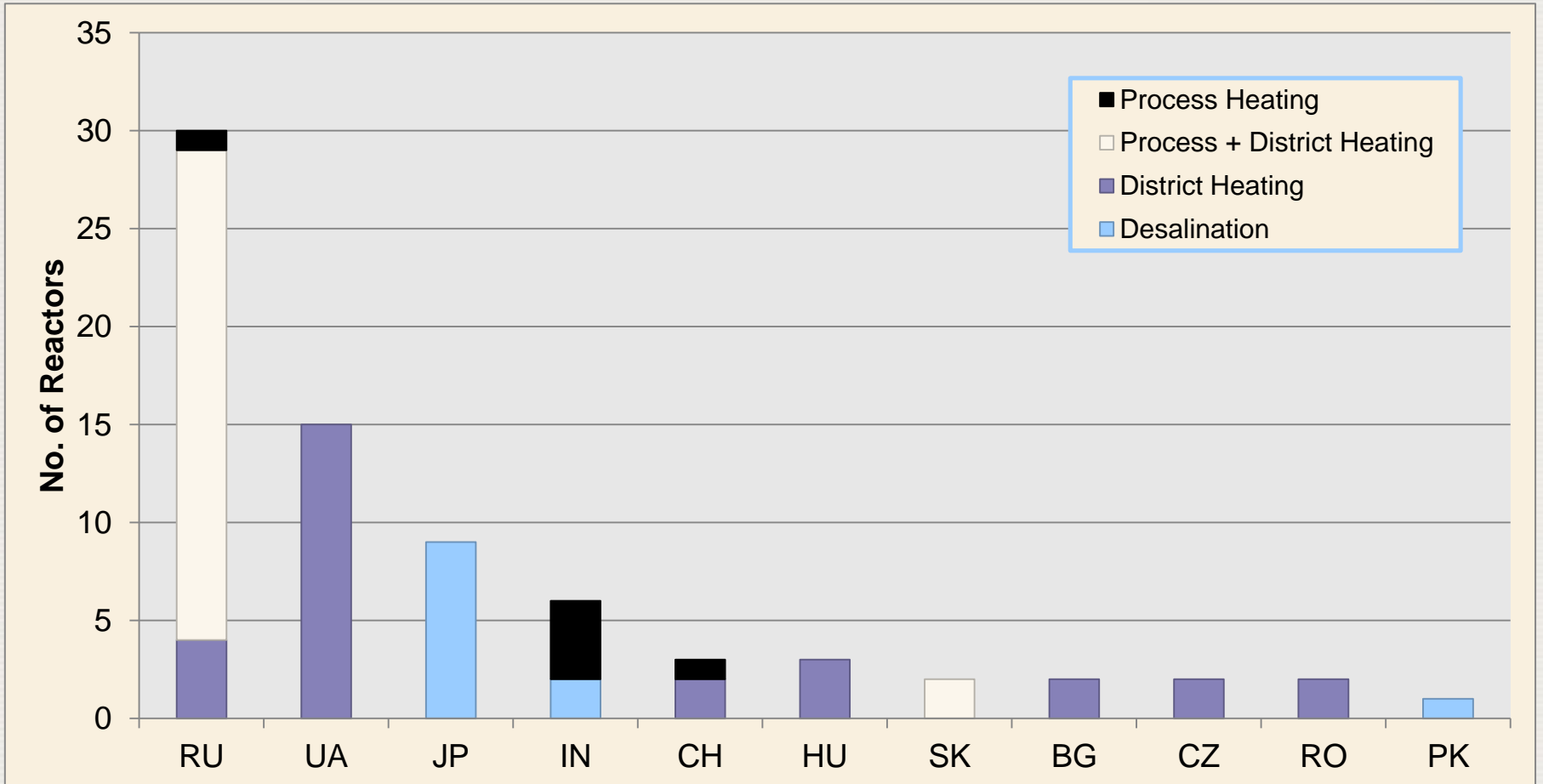
Non-Electrical Applications (NEA)

- Sea-water desalination
- Hydrogen production
- District heating
- Process heat for industrial applications









Prospects for Non-Electric Applications of nuclear Power

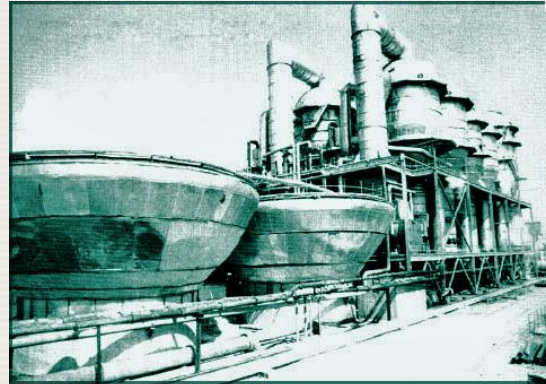
- *Increased interest of MSs in NEA applications*
- *Easy to extend current experience with NPPs to NEA*
- *Market for heat and transportation is huge.*
- *NEA helps alleviate Environmental concern*

Characteristics of the Nuclear Desalination

- Sound technically and economically

- Available experience

MED & MSF at Aktau Kazakhstan



A Soviet-era desalination plant, which we shamelessly stole from Wikipedia and inserted here to make the strongest case possible against desalination. See how ugly it is?



MED at Genkai, Kyushu

- Cogeneration: Nuclear heat and/or electricity

Recent Demonstration Projects

INDIA:

- The 6,300 m³/d MSF-RO Hybrid Nuclear Desalination Plant at Kalpakkam, India, consists of 4,500 m³/d MSF plant (has been commissioned in 2010) and 1,800 m³/d SWRO plant (operating since 2002).

Pakistan:

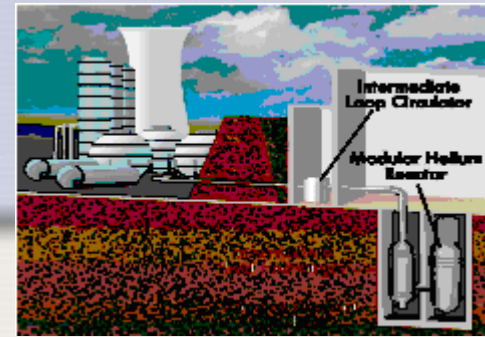
- MED thermal desalination demonstration plant of capacity up to 4,800 m³/d at KANUPP was also commissioned in 2010.

Challenges to nuclear desalination ND

- Disparity (lack of infrastructural)
- Economics
- Public perception
- Socio-environmental aspects

Nuclear hydrogen

- There is an increased interest in hydrogen as a carbon-free fuel of future.
- Demand for hydrogen is large and keeps growing (at rate of 6-10 % /year).
- Reforming of hard coal and oil (gasification):
96% of current annual hydrogen production



Characteristics of hydrogen production

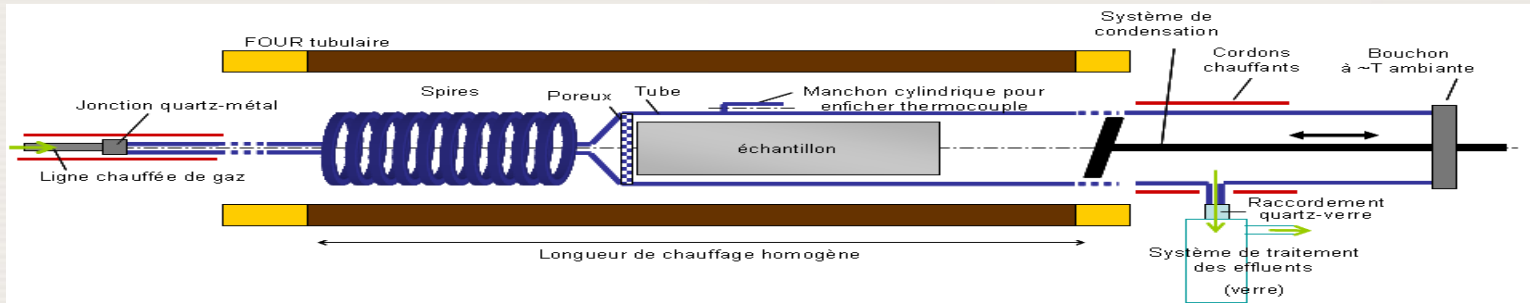
- Promising
- Still under R&D
- Safety of coupling is still an issue of concern
- Cost of under development processes will be a major factor

Advances on nuclear hydrogen production

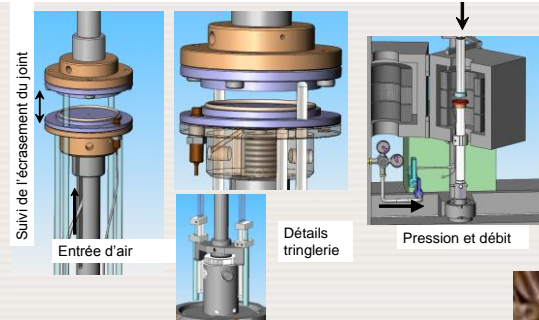
- Increase in overall efficiency
- Progress on continuous H₂ production,
- Advances in material development,
- Advances in design of heat exchangers,
- Breakthrough on $H_{\text{high}} T_{\text{emp}} S_{\text{team}} E_{\text{lectrolysis}}$

Breakthroughs on HTSE

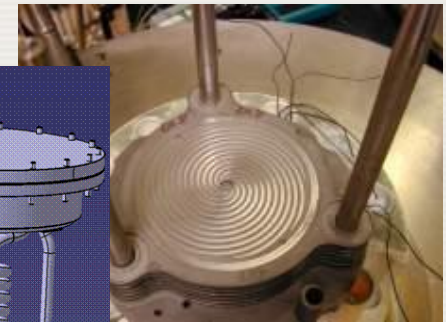
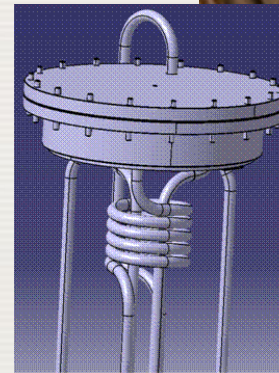
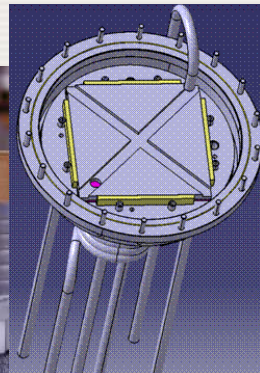
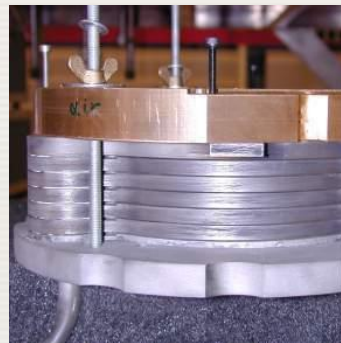
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on seals
and leaks management
systems

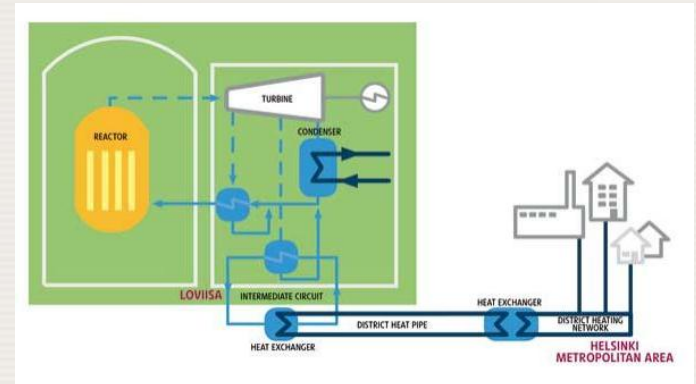


Progress on
Designs and
tests on stacks



NUCLEAR DISTRICT HEATING

- Well proven (Bulgaria, China, Czech Republic, Hungary, Romania, Russia, Slovakia, Sweden, Switzerland and Ukraine)
- Technical features:
 - Heat distribution network
 - Steam or hot water 80-150°C
 - Distribution up to 10-15 km
 - District heat needs:
 - Typically up to 600-1200 MW_{th} for large cities
 - Annual load factor < 50%
 - Usually produced in a cogeneration mode



Challenges for Non Electric Applications (NEA) of nuclear Power

- **Safety issues**
 - Coupling of process production plant with NPP
- **Technology**
 - Process system design, control and integration
 - Demonstration of production processes at large scale
- **Economics**
 - Demonstrating production on an industrial scale
 - Building and operating a very large number of NPPs with low energy generation costs
- **Public perception**

IAEA Activities on NEA

Support deployment of demonstration plant(s)

- Establish an info-exchange forum (TMs, Workshops, CRPs,...)

- Publications (Technical Reports, Journal Papers, Newsletter..)

- Provide tools: DEEP, DE-TOP, HEEP, Toolkit

- Address issues of global concern:

➤ *Prospects of current nuclear reactors for NEA*


➤ *Prospects for cogeneration (including hybrid technologies)*

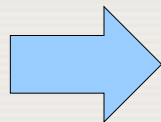
➤ *Enhance Viability of NEA*

➤ *Establish close cooperation/collaboration on NEA*

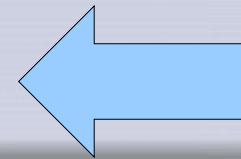
Current and future IAEA activities on seawater desalination using nuclear energy

Underway:

- **TECDOC document** on technical and economic aspects of feasibility study on using nuclear energy both exclusively for seawater desalination, as well as for cogeneration options (e.g. electricity, seawater desalination, hydrogen production, etc.) **under development**,
 - **DEEP & DE-TOP.**  **Just released**
 - **CRP on New technologies for seawater desalination using nuclear energy**, **ongoing**
 - **TECDOC on Management for Efficient water use and consumption in NPPs**, **completed and under review.**
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- ***Int. Conference*** on Non-electric applications, 3-6 Oct, Czech Rep. 2011
 - ***TM for the TWG-ND***, 27-28 April, Vienna



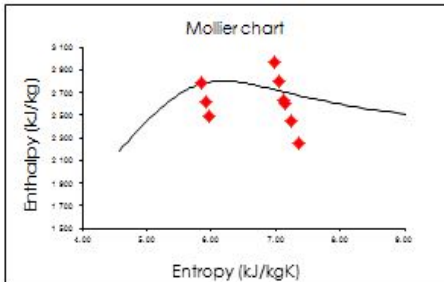
DEEP & DE-TOP



Main Power Plant parameters

Heat thermal input	3 002 MWh
Live steam temperature	283 °C
Live steam pressure	67 bar
reheat steam temperature	260 °C
Condenser pressure	0.056 mbar
Feedwater final temp	218.000 °C
Preheating stages	5 Units
Reset to initial values	

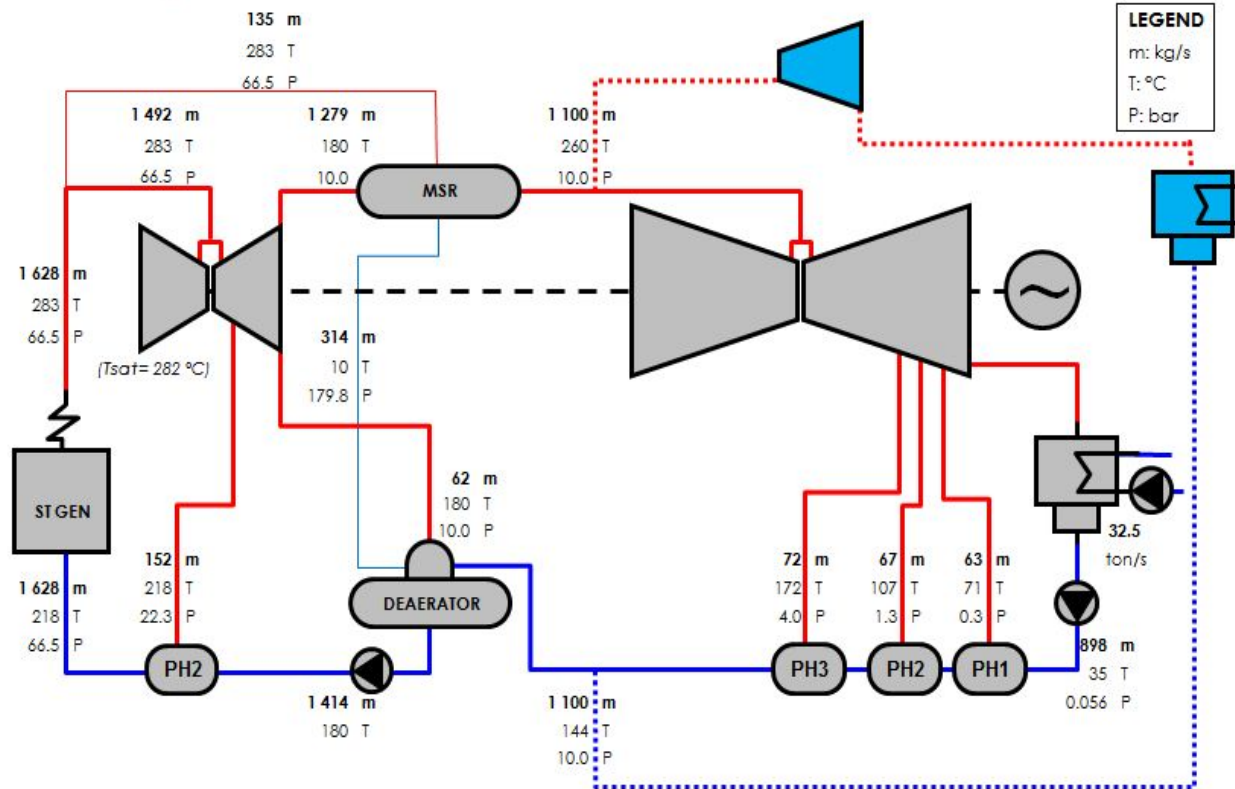
System alerts:



Gross efficiency
36.1%

Gross Mechanical output
1 084 MW

Net Power output
1 064 MWe



[Back to Reference Plant Results](#)

Current and future IAEA activities on hydrogen production using nuclear energy

Underway:

- **TECDOC document on Status of hydrogen production using nuclear energy, completed and under review**
 - **HEEP (released beta version),**
 - **toolkit on hydrogen production using nuclear energy (start 2011)**
 - **CRP on Benchmarking and validation of HEEP (start 2012)**
 - **TECDOC on Advances in nuclear power for process heat applications (Results of the a completed CRP in 2009, completed and final review).**
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- ***Int. Conference* on Non-electric applications, Czech Rep. 2011**





...Thank you for your attention