



# *Nuclear Cogeneration Industrial Initiative*

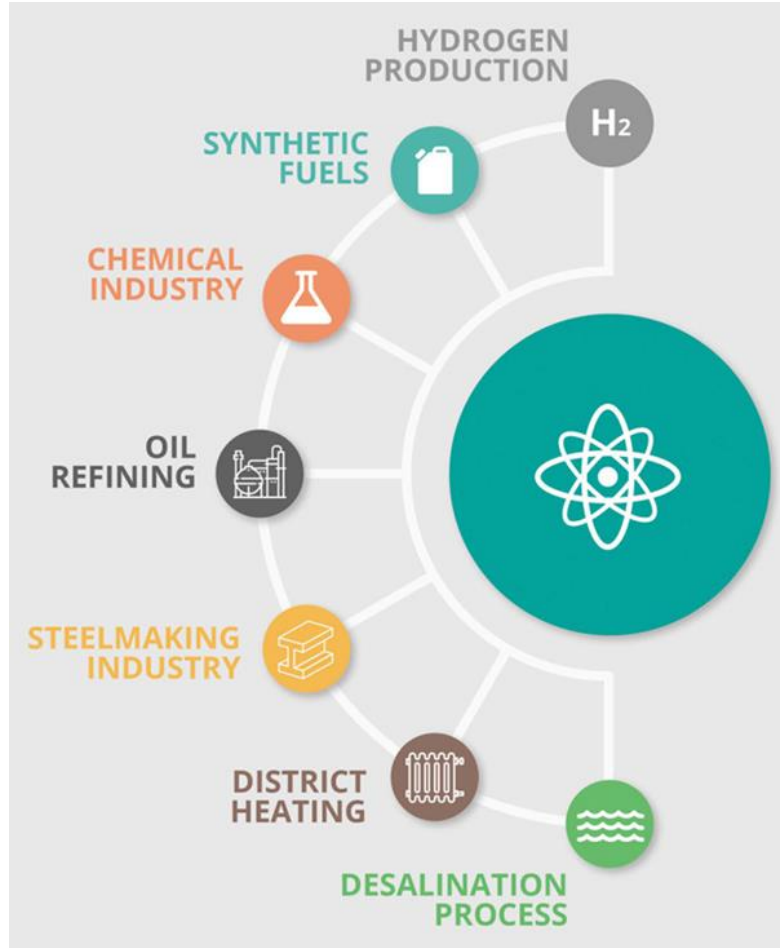
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*Dr. Józef Sobolewski*

*National Centre for Nuclear Research (NCBJ), Poland*

*Chairman of Nuclear Cogeneration Industrial Initiative (NC2I), Europe*

# NC2I mission



*Contribute to clean and competitive energy beyond electricity by facilitating deployment of nuclear cogeneration plants*

# NC2I vision: Low temperature applications

## *District heating, desalination, a few industrial applications*

- **Coupling with existing LWR reactors**
  - *so far limited deployment, but with very positive records,*
  - *interesting plans (Finland, UK, Czech Republic) already for a long time.*
- **Objectives of NC2I:**
  - *Identify conditions for larger scale deployment*
  - *Support initiatives that facilitate the growth of low temperature nuclear cogeneration*
    - *in particular application to cogeneration of LWR SMRs and other types of SMRs with enhanced safety features (small EPZ)*

# *NC2I vision: High temperature applications (1)*

## *Key target for 2030*

*Commission the first new High Temperature Gas-cooled Reactor (HTGR) in Europe as a heat source for industrial plants*

## *Actions*

*Cooperate with EC & authorities in target countries to:*

- develop international collaboration*
- prepare an appropriate licensing framework*
- define the most suitable technical options*
- select an appropriate site*
- develop a robust business model*
- build a team for the project & gather available expertise*

# NC2I vision: High temperature applications (2)

## Long-Term Targets

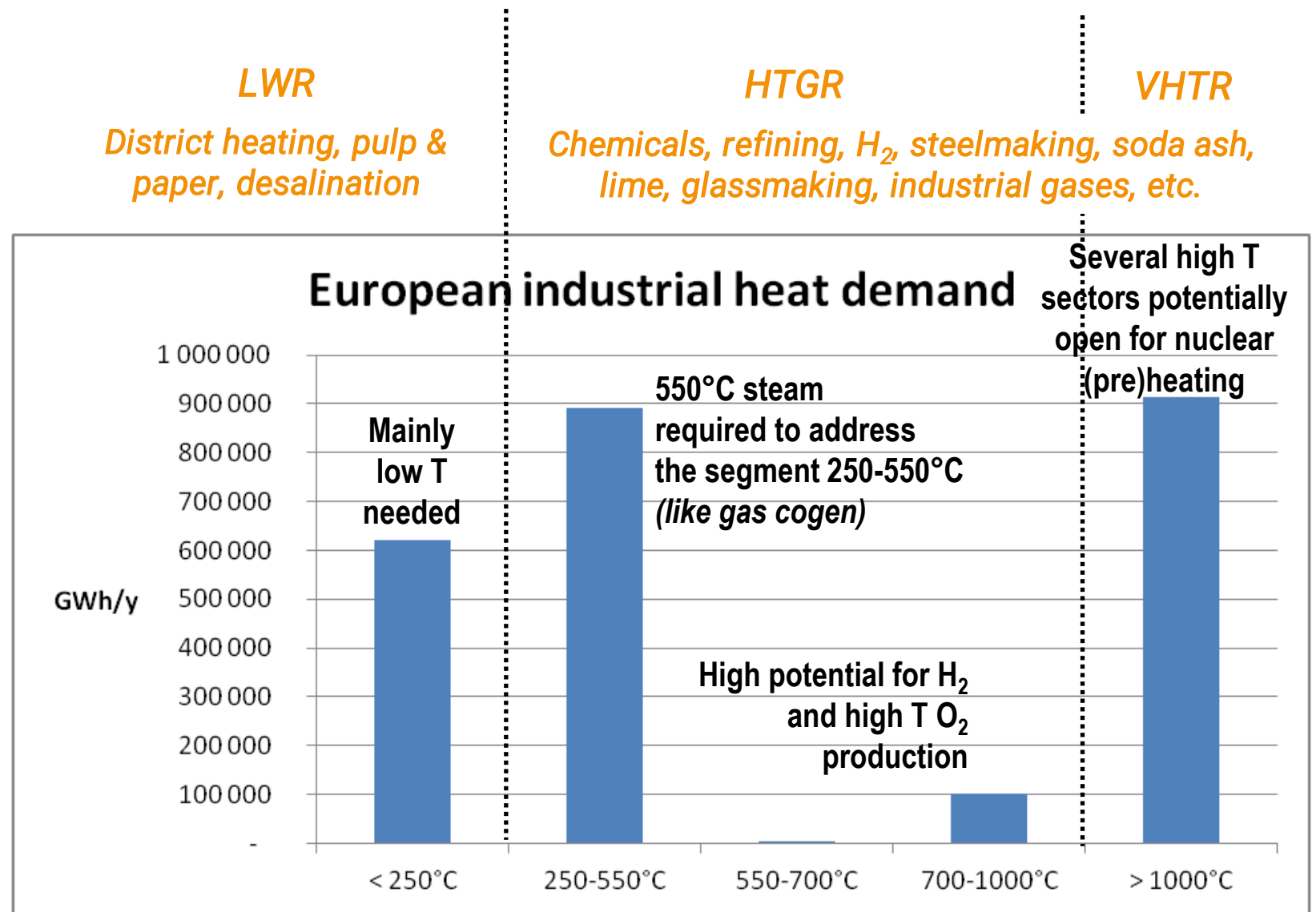
- *Prepare technologies for extending the heat market for high temperature nuclear cogeneration (preheating, advanced heat network technology, VHTR) and evolutions of heat applications*
- *Develop technologies allowing HTGR to produce emission free hydrogen (high temperature electrolysis, thermal splitting)*
- *Cooperate with other GEN IV systems (SFR, LFR, GFR, SCWR, MSR) and share HTGR experience to support their future use in cogeneration*

## Actions

- *Cooperate with EC and interested countries and organisations (like GIF) to have research actions launched for progressing towards these objectives*
- *Support such actions*

# Heat market for nuclear technologies

No competition between LWR & HTGR;  
need for both



**LWR**  
District heating, pulp & paper, desalination

**HTGR**  
Chemicals, refining, H<sub>2</sub>, steelmaking, soda ash, lime, glassmaking, industrial gases, etc.

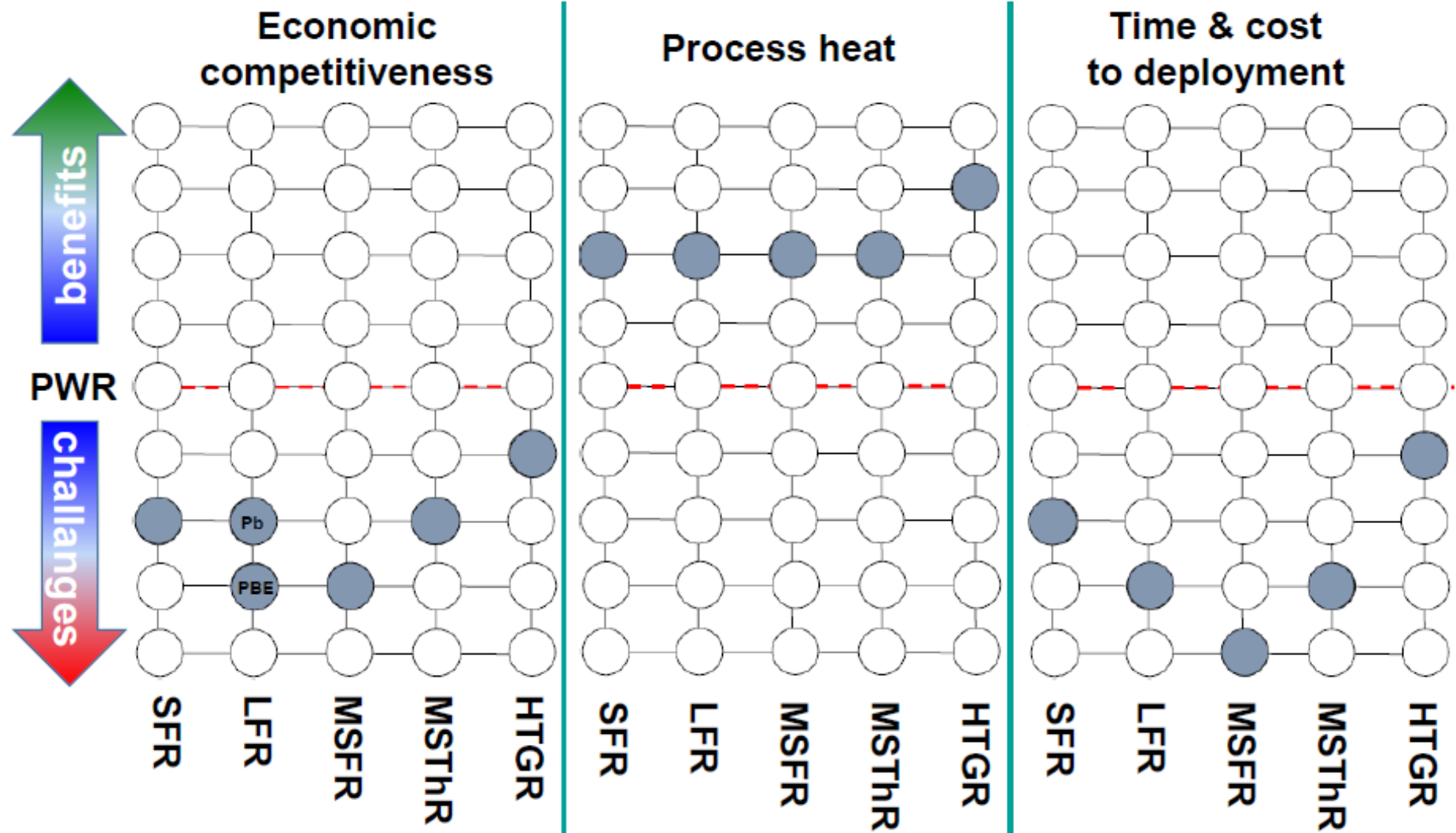
**VHTR**

Reactors mature + experience in cogen

Proven reactor technology, high potential for cogen

Long-term

# Comparison of technologies



Gregg Butler,  
University of  
Manchester

SMR UK  
Summit 2016

# High Temperature cooled Reactor (HTGR)

TRISO fuel

Leak tight to fission products  $> 1600^{\circ}\text{C}$

Pebble-bed or prismatic core

Intrinsic safety - In case of accident, cools down by conduction & radiative heat transfer

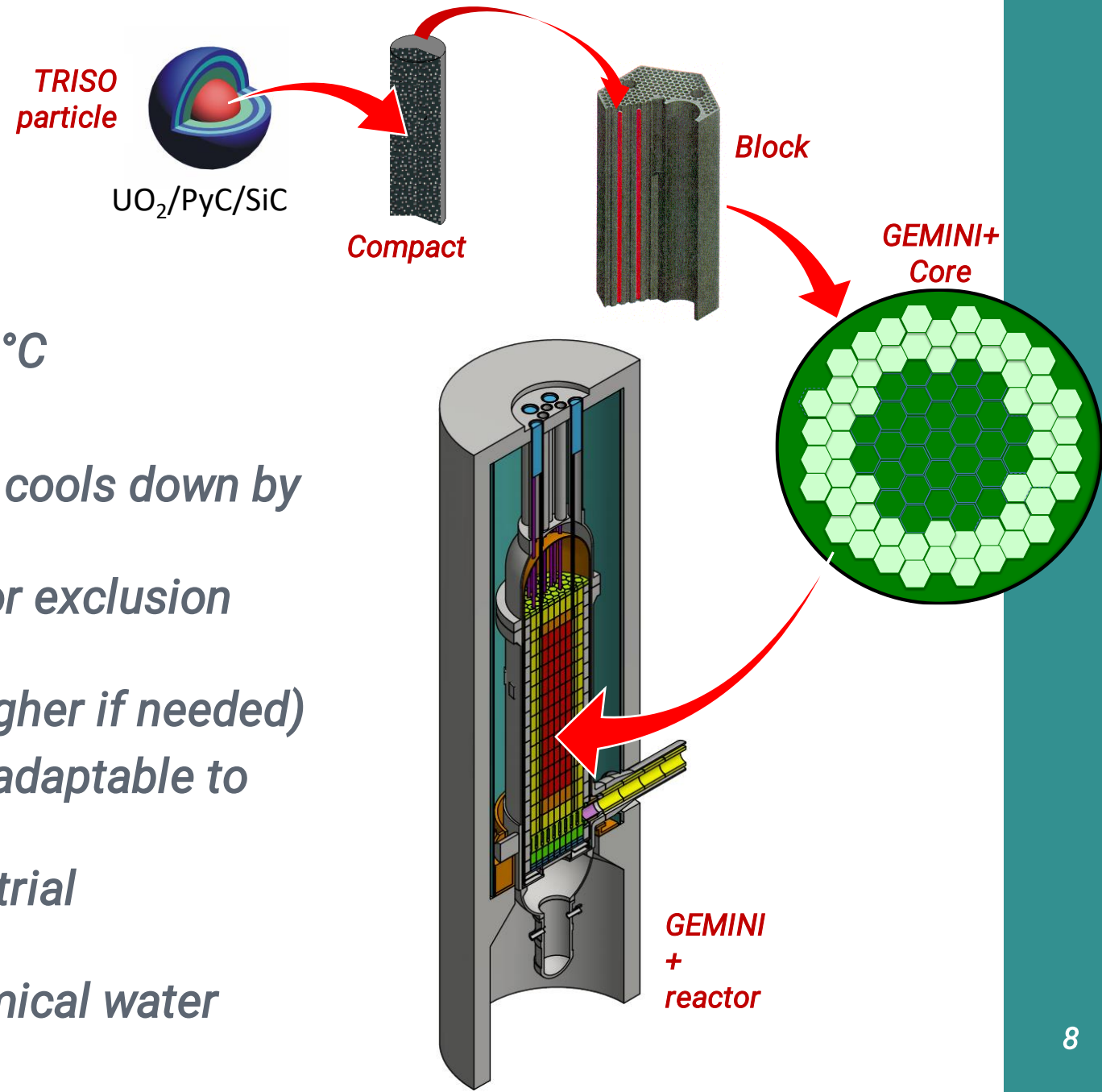
No core damage possible, no need for exclusion zone

Coolant: Helium  $\sim 750^{\circ}\text{C}$  (possibly higher if needed)

Flexibility: T, power, heat/electricity adaptable to industry needs, hydrogen production

Now: steam  $550^{\circ}\text{C}$  for existing industrial installations

Future: VHTR  $\sim 1000^{\circ}\text{C}$ , thermo-chemical water





# End-user needs in EU and Poland

*In the range 250-550°C, the European heat market represents more than 100 GWth.*

## Poland

- *13 largest chemical plants need 6.5 GWth at 400-550°C.*
- *They use 200 TJ/year, equivalent to burning of > 5 Mt/year of natural gas or oil.*
- *200-350 MWth reactor size fits the needs.*



# Nuclear cogeneration activities in Poland (1)

- *Minister of Energy appointed “Committee for Deployment of High-Temperature Nuclear Reactors” in Poland in July 2016. Committee report with results published in January 2018. Minister accepted the report, took note that deployment of HTGR reactors in Poland is desirable and requested Ministry to prepare further steps.*
- *Strategy for Responsible Development - the governmental program for Polish economic development - adopted in February 2017. It contains, i.a: Deployment of HTR for industrial heat production. The project for this action is: Nuclear cogeneration – preparation for construction of the first HTR supplying process heat for industrial installations.*

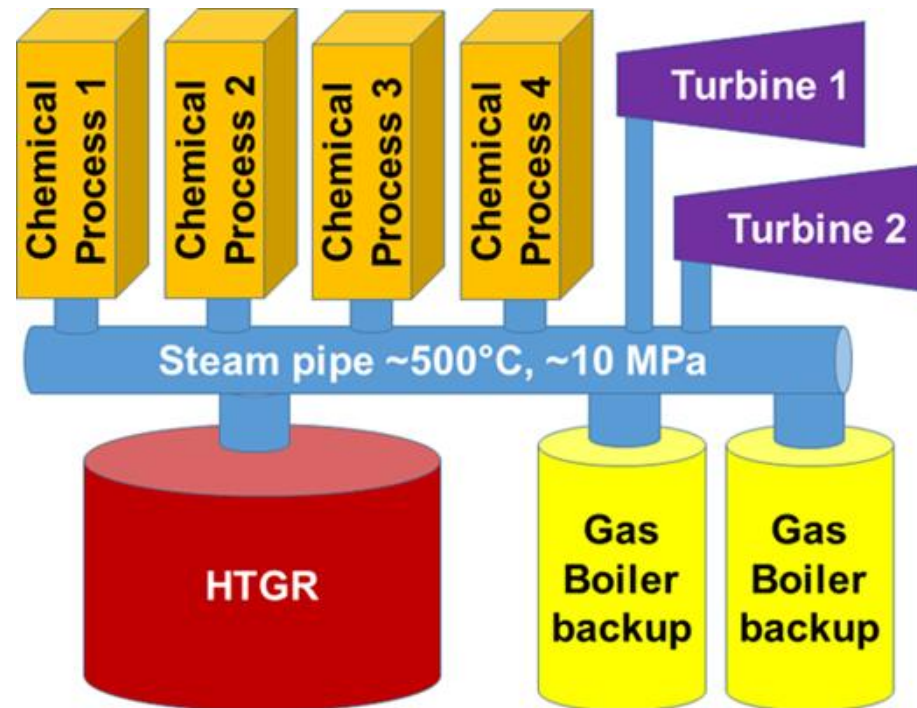
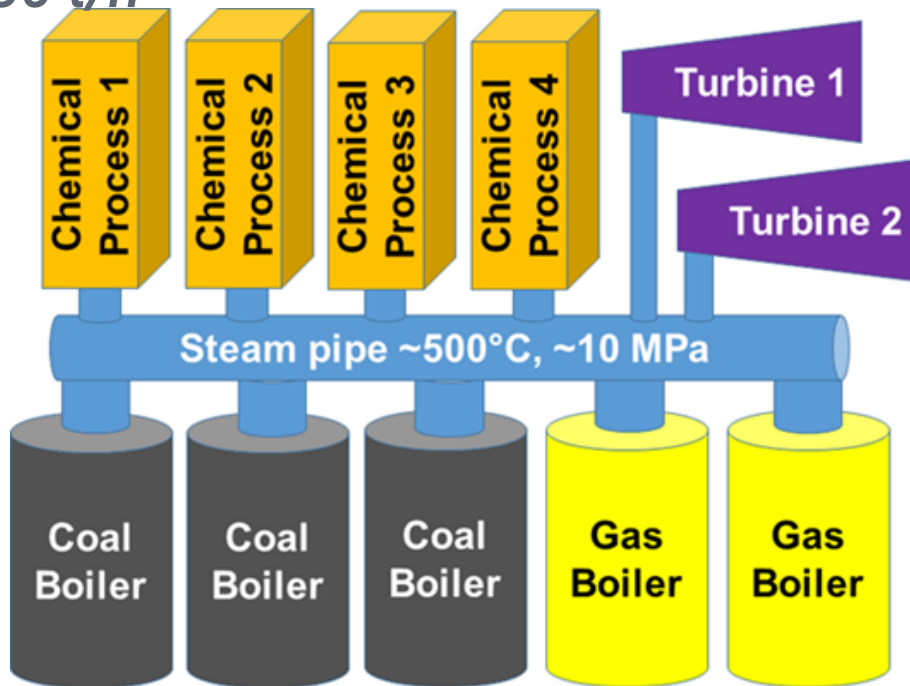


# Feedback from Polish industry

Need to exchange many old fossil-fired boilers with HTGR

Electric island already there

HTGR parameters matching standard boilers: Steam at 540°C, 13.4 MPa, 165 MWth, 230 t/h



# Nuclear cogeneration activities in Poland (2)

- *With support of 4.4 M€ from the Euratom Programme H2020, the GEMINI+ project (2017-2021) (European NC2I+ US NGNP IA + Japan + South Korea) developed the main design options for an HTGR plant.*
- *The NOMATEN Centre of Excellence has received 7 years (2018-2025) of joint financial support (37 M€) from the Foundation for Polish Science (FNP) and the European Commission. NOMATEN focuses on studies and development of novel materials, specifically for harsh conditions: radiation, high temperatures and corrosive environments.*
- *In 2019, Ministry of Entrepreneurship and Technology (now Ministry of Development) qualified HTR in the list of National Smart Specializations. This opens a way for NCNR to conduct research in this field with i.a. support from EU funds.*



[www.gemini-initiative.com](http://www.gemini-initiative.com)

**NOMATEN**

Centre of Excellence in Multifunctional Materials  
for Industrial and Medical Applications

<http://nomaten.ncbj.gov.pl/>



Ministerstwo Rozwoju,  
Pracy i Technologii

# Nuclear cogeneration activities in Poland (3)

- *In the frame of the national strategy program GOSPOSTRATEG, the National Centre for Research and Development received about \$5 million (2019 – 2022) for a joint project of MoE, NCNR and INChT for preparation of legal, organizational and technical instruments to deploy HTGR reactors.*
- *National Centre of Nuclear Research is building knowledge on HTGR technology by strengthening collaboration with the Japan Atomic Energy Agency.*
- *New version of National Strategic Energy Program (PEP2040) containing elements of HTGR program (under preparation).*
- *Preparation of European High Temperature Experimental Reactor (EUHTER) program (design and construction of small experimental HTGR, also as technology demonstrator) for implementation based on Polish national funding.*



Narodowe Centrum Badań Jądrowych  
National Centre for Nuclear Research  
ŚWIERK

instytut kategorii A+, JRC collaboration partner

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