NEA workshop:
High temperature reactor and industrial heat application
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Recent HTR Developments in Poland

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Heat market for nuclear technologies in EU

No competition between LWR & HTGR;

The need for both

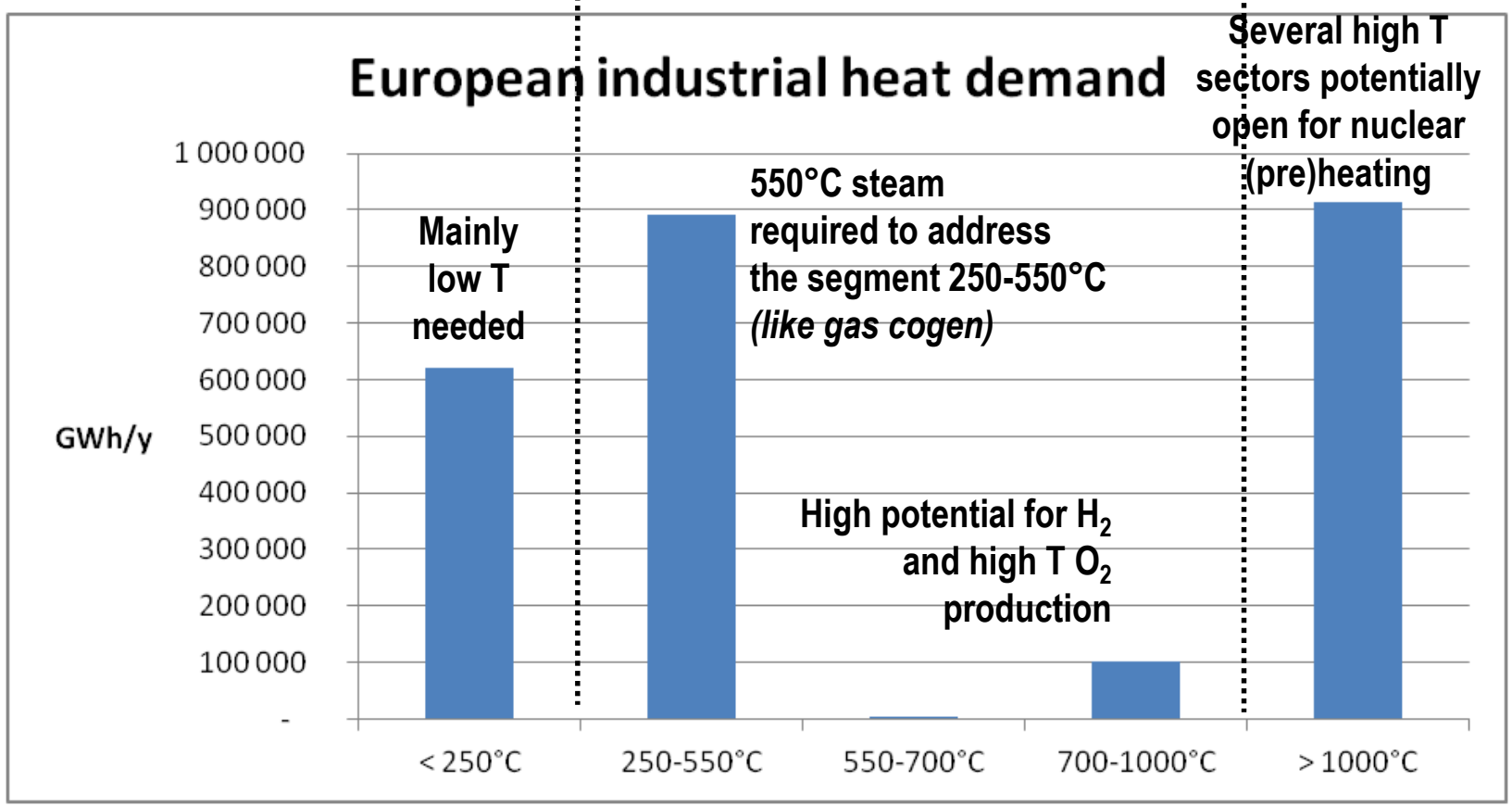
LWR

District heating, pulp & paper, desalination

HTGR

Chemicals, refining, H_2, steelmaking, soda ash, lime, glassmaking, industrial gases, etc.

VHTR



Reactors mature + experience in cogen

Proven reactor technology, high potential for cogen

Long-term

Source: EUROPAIRS study on the European industrial heat market

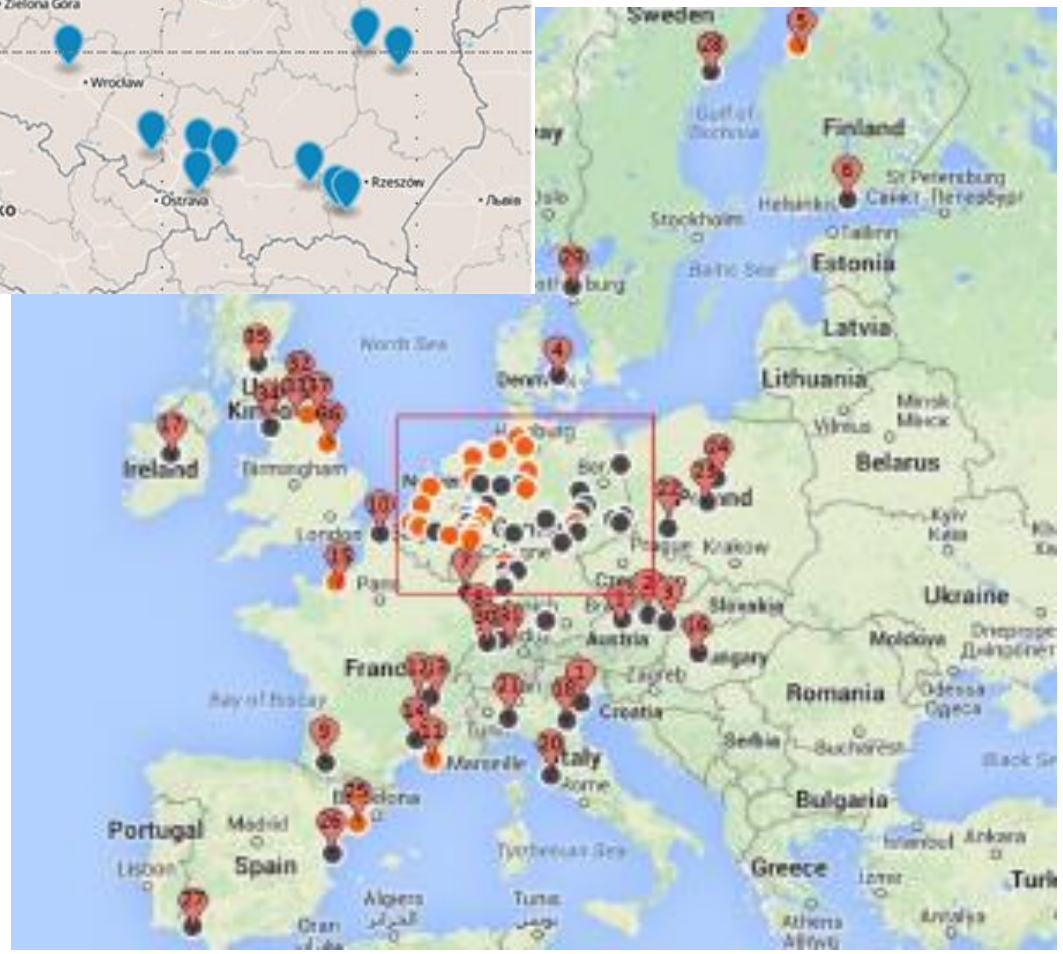
End-user needs in EU and Poland

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

Primary target for HTGR is the Polish heat market.

- Today, 100% of the heat market is served by fossil fuels; mostly coal in district heating, and coal and gas in industrial heat generation.
- 13 largest chemical plants need 6,5 GWth at T=400-550°C.

Secondary target is hydrogen production.



Narodowe Centrum Badań Jądrowych
National Centre for Nuclear Research
ŚWIERK

Advanced nuclear technologies in Poland – new opportunities for climate change mitigation

Although priority of Poland is to implement nuclear power programme based on large scale reactors we are aware of potential future benefits of HTR. As a result we initiated the R&D project on HTGR's (especially for industrial cogeneration) with the following objectives:

Decreasing dependence on fossil fuel import

HTGR may be an alternative to replace fossil fuels for industrial heat production. With expected growth of CO_2 tax and low discount rate, the cost of the steam from HTGR could be comparable to that from gas, while having more secure availability and more predictable prices.

Decreasing sensitivity of economy to environmental regulations

Industry dependent on fossil fuels might become less competitive in case of stronger environmental regulations (CO_2 tax, emission limits, etc.). HTGR being a zero emission technology is immune to that.

Synergy with multi-GW LWR programme .

Increasing scientific and industrial potential, upgrading the regulatory framework, developing human resources and creating a supply chain, will be beneficial for both HTGR and LWR projects.

Status of nuclear cogeneration activities

Formal basis for HTR technology

- Minister of Energy appointed Committee for deployment of high-temperature nuclear reactors in Poland in July 2016. Report with results of the Committee's works 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, contain e.g.: Deployment of HTR for industrial heat production. The project for this action is: Nuclear cogeneration – preparation for construction of the first HTR of 200-350 MWth supplying technological heat for industrial installation.

Status of nuclear cogeneration activities

Technical activities

- GEMINI+ (2017 – 2021). The main design options for HTGR fitting the requirements for cogeneration use in Europe.
- The NOMATEN Centre of Excellence has received 7 years (2018-2025) of joint financial support (€37M) from the Foundation for Polish Science (FNP) and the European Commission. NOMATEN focus on the studies and development of novel materials, specifically those designed to work under harsh conditions – radiation, high temperatures and corrosive environments.
- In the frame of national strategy program GOSPOSTRATEG the National Centre for Research and Development accepted the grant of about €4,5M for joint project of MoE, NCNR and INChT for preparation of law, organization and technical instruments to deploy the HTR reactors in years 2019 – 2022.
- National Centre of Nuclear Research (NCNR) is gaining knowledge on HTGR technology by strengthening collaboration with Japan Atomic Energy Agency (JAEA).

Status of nuclear cogeneration activities

Now

- The largest Polish private chemical company SYNTHOS has started cooperation with American nuclear companies working on solutions related to the generation of electricity (BWR-SMR) and industrial steam (HTR-MMR).
- Action Plan for the Implementation of the Strategic Partnership between the Government of the Republic of Poland and the Government of Japan for the years 2021-2025 seeks cooperation in the field of High Temperature Gas-cooled Reactors (HTGR) between the NCNR and JAEA, as well as other relevant entities towards possible deployment of industrial HTGR's.
- We start the first phase of EUHTER (EUropean High Temperature Experimental Reactor) program (design and construction of small experimental HTGR, being also the technology demonstrator). Financing will be based on national resources.
  - Phase I – basic design + preliminary safety report for licensing (2021-2024)
  - *Phase II – detailed design + licensing + construction + commissioning (2024 – 2030)*
  - *Phase III - preparation (2023 on) for commercialization and FOAK construction (2030 on)*

synthos green energy

Ministerstwo Edukacji i Nauki

EUHTER Programme – Phase I

Contract No 1/HTGR/2021/14 between the National Centre for Nuclear Research and the Ministry of Education and Science entitled “Technical description of the HTGR gas-cooled high-temperature research nuclear reactor” signed on May 12, 2021 in Świerk. It is intended for the implementation of another batch of design works for the research HTGR, being also the technology demonstrator.

The contract determines that the conditions for the construction of a high-temperature research reactor in Poland will be created within three years and that the conceptual design and further most of the basic design of such a device will be prepared. The reactor will be a prismatic type HTGR using TRISO fuel producing approximately 30-40 MWth at an outlet temperature of 750 ^{o}C.

Time: 1.06.2021 – 1.06.2024.

Value: approximately €14M

EUHTER Programme – Phase I

Scope of the project:

- Preparation of laboratory facilities with the necessary accreditations and a quality management system necessary to perform research work in the process of licensing materials for HTGR technology.
- Performing tests of materials that can be used for the construction of HTGR, in terms of compliance with the requirements of HTGR technology.
- Development of the basic design of the HTGR reactor (basic / preliminary design according to IAEA-TECDOC-881, Fig. 4.1, page 36, LOD = Level Of Details according to BIM = Building Information Modeling; PN-EN ISO 19650 standard) – LOD minimum 200.
- Performing verification simulations for the project and preliminary HTGR safety report in accordance with the requirements of the Regulation of the Council of Ministers of August 31, 2012 (Journal of Laws, item 1043).
- Preparation of selected elements of the preliminary safety report (CSR) for HTGR in accordance with the Regulation of the Council of Ministers (as above, item 1043, 2012) on the scope and method of conducting safety analyzes conducted before applying for a license to build a nuclear facility, and the scope of the preliminary safety report for a nuclear facility.

EUHTER Programme – Current status

Conceptual and basic design supported by the results of the Gemini+ results rescaled from 180 MWth commercial reactor to 30-40 MWth research/demo.

Pre-conceptual phase due to Gospostrateg-HTR project (“TeResa" - 40MWth research reactor in Świerk) – almost finished.

Work on the conceptual design (detailing the mission and functions of the reactor, the basic characteristics of the core and fuel, the primary cooling cycle as well as the elements of equipment and construction, design of power processing devices, control system and other components and systems with auxiliary devices) – till 31.08.2022.

Collaboration and support from JAEA (Japan Atomic Energy Agency) and its business partners on the basic design of the reactor bearing in mind local Polish requirements (e.g. demand for the process heat, possibility of radiopharmaceutical production) and conditions (adaptation of HTGR into the Polish Atomic Law and other legal acts) against “upgraded HTTR” design (agreement signed in 2019, being updated currently).

Collaboration with the Polish experts and industry on the design and construction.

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Thank you