NC2I
Nuclear Cogeneration Industrial Initiative

GEMINI+ Project

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www.nc2i.eu

NC2I is one of SNETP's strategic technological pillars, mandated to coordinate the demonstration of high temperature nuclear cogeneration.

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The context

- The European legacy
  - The German programme
  - 15 years of European HTGR technology development + national projects
- The Polish initiative for developing HTGR technology
- The International PRIME project
  - Since 2011, interaction NC2I / US NGNP Industry Alliance

  ⇒In 2014, MoU creating the GEMINI initiative to work together for a demonstration of high temperature industrial cogeneration

    ✓ *Sharing design and development efforts*

    ⇒*Converging on technology and as much as possible on design*
  - GEMINI approached by JAEA and KAERI

  ⇒PRIME project launched in 2016 with similar objectives + long term research for developing VHTR
- The international context

Gemini+ objectives

- **To support the Polish project for industrial demonstration of high temperature nuclear cogeneration**
  - ⇒ To assemble an international partnership for supporting this project
  - ⇒ To define the design basis for a reference HTGR system for cogeneration
    - ✓ *Addressing the needs of Polish industry*
    - ✓ *Flexible enough to be adaptable to the needs of the global market*
    - ✓ *Converging as much as possible with the technological options of the NGNP Industry Alliance*
    - ✓ *Addressing the highest safety standards*
  - ⇒ To define a licensing frame for high temperature nuclear cogeneration systems
  - ⇒ To prepare the launching of a demonstration of high temperature nuclear cogeneration on an identified European industrial site
- **To gain credibility at the European level in order to get support for demonstration**

GEMINI+ in a nutshell

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INPUTS

The European legacy

- The historical German HTGR programme
- **18 years of HTGR related projects (FP4-7)**
  - **HTGR technology**
  - **Understanding industry process heat market needs**

International inputs

- **The HTGR experience of international partners**
- **GIF inputs**

European partners

- TSOs
- Nuclear industry
- Industrial end-users
- Research organisations

+ Innovation

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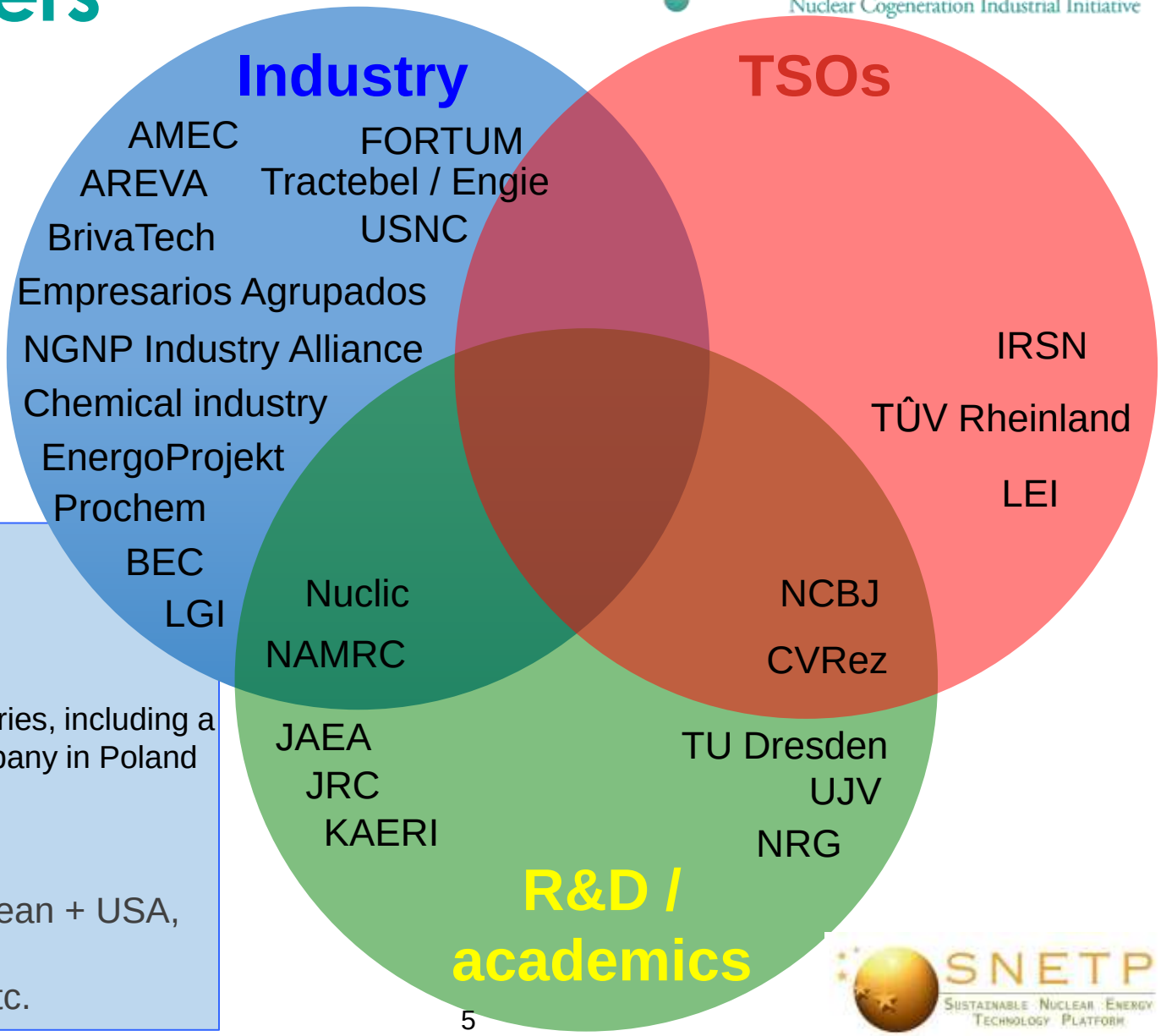
International partners

- NGNP Industry Alliance
- JAEA
- KAERI

OUTPUTS

- A licensing framework
- A large industrial site selected
- A Polish team trained for demo.
- A design base
- Feasibility of demo. on the selected site
- A business plan for the demo.
- International partnership to support demo.

Partners



- 27 partners
  - Industry
    - ✓ Nuclear
    - ✓ Utility
    - ✓ Conventional Industries, including a large chemical company in Poland
  - R&D + academics
  - TSOs
- 12 countries (9 European + USA, JP, KR) + JRC:
  PL: 4, DE: 4, FR: 3, etc.

Structure of the project

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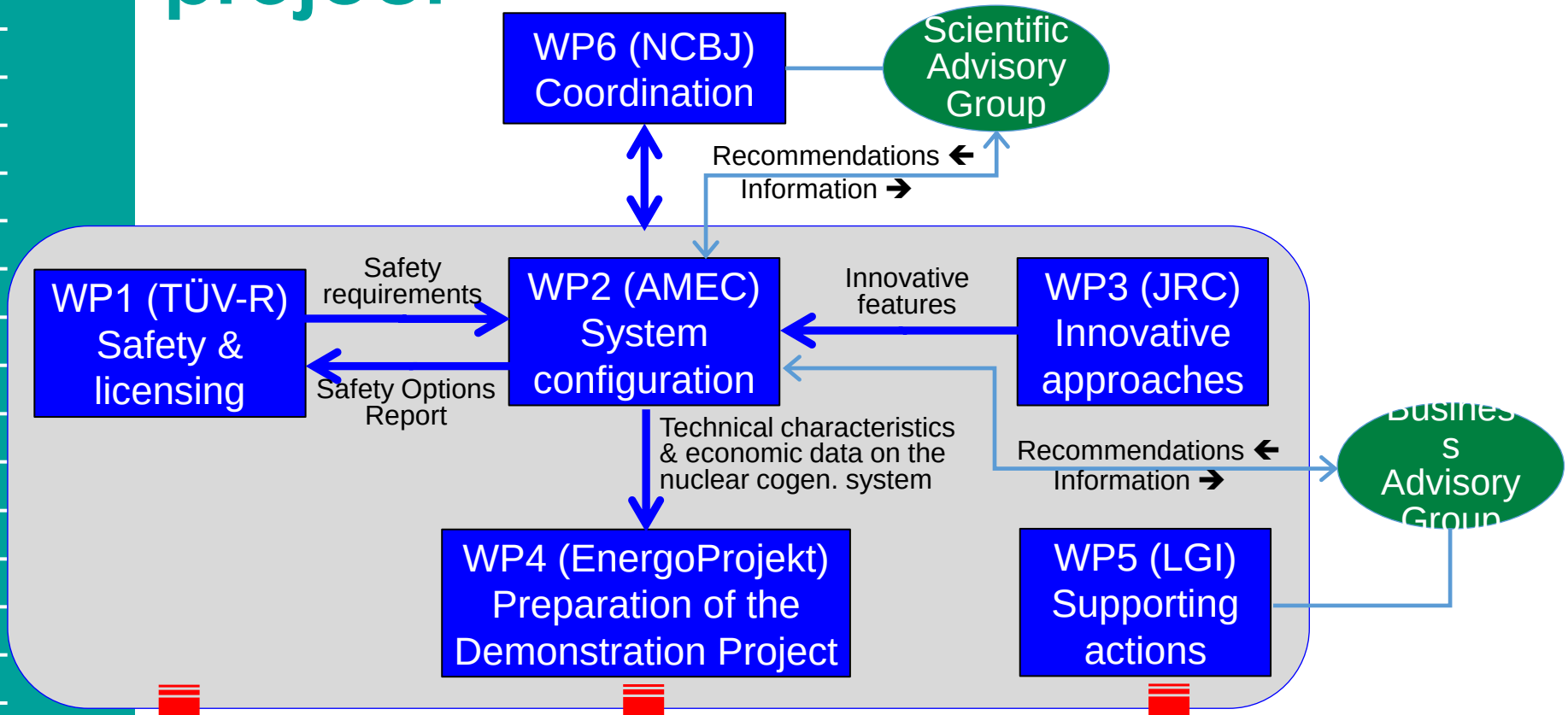

- *A licensing framework*
- *An assessment of the acceptability of the safety approach proposed by the designer*

- *The configuration of the nuclear cogeneration system with an acceptable safety approach*
- *A possible site*
- *A business plan for demonstration*

- *A team prepared for a demonstration project*
- *Technical documents available in a database*
- *International support*

Conclusion

GEMINI+ comes at the right time to give a European dimension to the Polish demonstration project

- It will gather European HTGR expertise around the project
- It will propose design options for the project
- It will develop a European licensing framework for the project
- It will help getting European support to the project

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Back-up slides

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Description of WPs (1)

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WP1: safety and licensing

- Updated safety requirements for modular HTGRs, taking into account cogeneration
- Adaptation of severe accident methodology
- Need to adapt European licensing frameworks?
- Key safety issues for modular HTGR: dust production in a prismatic block reactor
- Preliminary safety analysis
- Review of the Safety Options Report

For the reference configuration defined in WP2

WP2: system configuration

- Design requirements
- Definition of the key options of the reference configuration
- Safety option report
- Support studies for the definition of the reference configuration:
  - Core design
  - Economic analysis
  - Flexibility assessment
  - Feasibility of modular manufacturing
  - Waste issues

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Description of WPs (2)

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WP3: innovative approaches

- Review of innovative design options
- Potential for extended market
  - Applications that cannot be fed by steam distribution networks
  - Preheating of very high temperature applications
- Innovative uses of nuclear energy
  - Stabilization of the electric grid in particular in conjunction with intermittent renewables

WP4: preparation of the demonstration project

- Selection of a site for demonstration and preliminary site studies
- Coupling studies with the actual processes on the selected site
- Supply chain study
- Identification of residual technology gaps and qualification needs
- Planning for the demonstration
- Business plan for the demonstration

WP5: support actions

- Training: formation of a team for the demonstration project
- International relations: consolidating partnership with US, Japan, Korea
- Communication for getting the support of European stakeholders

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Technical synergies HTGR/GFR

Dominique Hittner

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What HTGR & GFR may have in common ? (1)

- He coolant

  ⇒Some similarities in He technologies (leak-tightness, tribology, etc.)

  ☞But no graphite in GFR

  ⇒Different chemistry (possible impurities are different)

- Same temperature range (> 500˚C)

  ☞But different neutron spectrum

  ⇒Materials could be the same for parts of the system that are not submitted to high neutron flux

What HTGR & GFR may have in common? (2)

⇒Possibility to have similar design for part of the structures and components

- Circulator
- Valves
- Vessel?
- Cross duct?
- Primary heat exchanger?
- Power conversion?
- …

⇒Need to have an in-depth analysis of possible synergies

Possible joint developments to be explored

- Common test facilities in helium atmosphere
  - Helium loop for component qualification
  - Specialized test benches (e.g. for testing He leak tight seals, for tribology in He atmosphere, etc.)

  ☞Need to take into account the chemical conditions of both types of systems in the design of facilities

- Developing and qualifying jointly some components and looking for common supply chain for these components

- Common qualification of materials?