Chapter HEAT AND ELECTRICITY GENERATION AND SYSTEM INTEGRATION

Webinar consultation 24/05/2019

ETIP-DG
European Technology & Innovation Platform on **Deep Geothermal**

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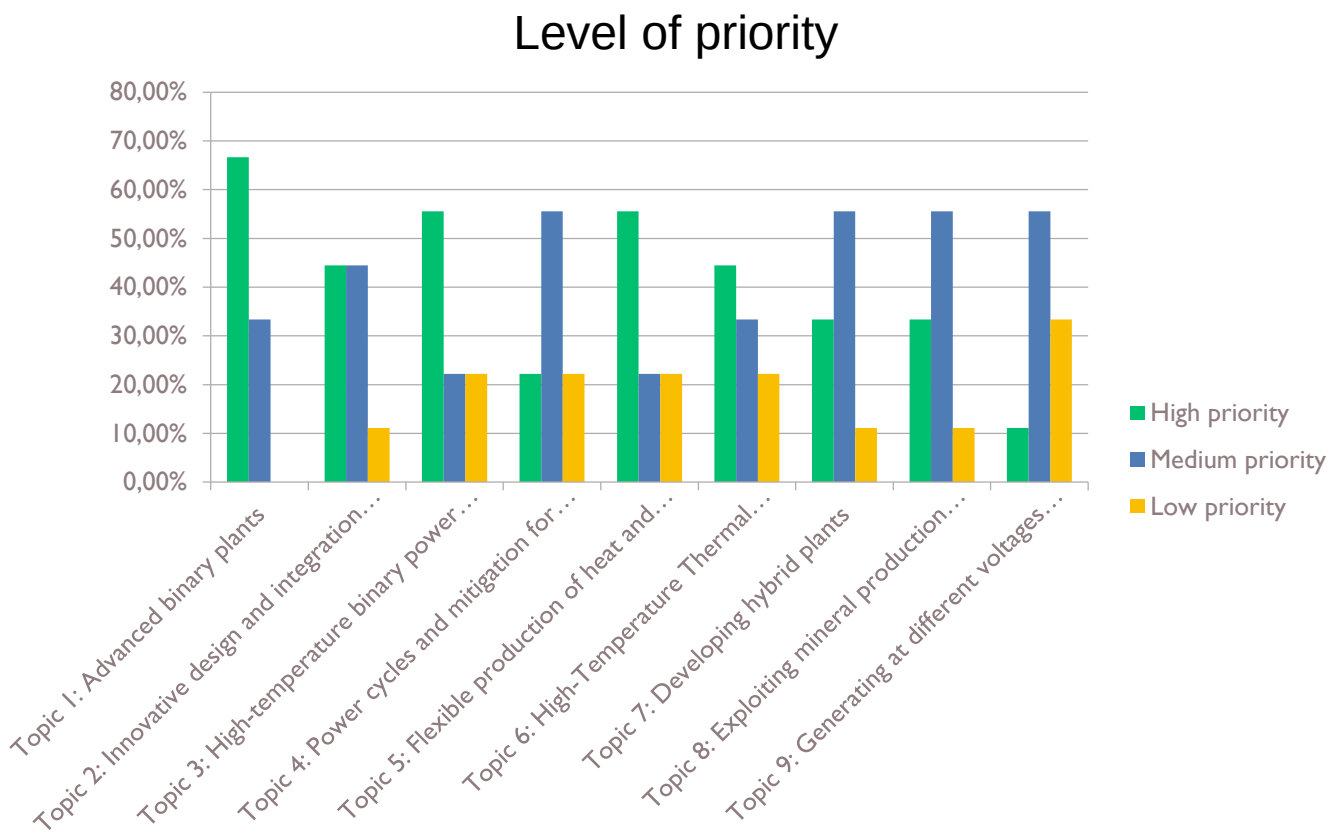
Steering Committee assessment



Merge suggestions:

Topic A: Turbines (topic 1+2+3+4)

Topic B: Flexible production (topic 5+9)

Topic C: Thermal storage (topic 6)

Topic D: Hybrid plants incl. Minerals (topic 7+8)

Topic 'MISSION' (topic 9)

topic 1: Developments in turbines

Objective

- develop advanced low to medium temperature binary plants by 2020-2023 (from TRL 5-6 to 8). flexible heat/cold and electricity supply from binary cycles, including an upscaling capacity of the binary plants (from TRL 5 to 7).
- Improve plant performance: focus on the working fluid and on specific components (improved heat exchanger, selecting material, surface structure and coating, hybrid cooling) of the binary cycle (from TRL 4-5 to 6-7 and then 8: Low TRL to medium (lab test), and then a first demo + other demo high TRL by 2030).
- develop advanced high temperature binary plants by 2020-2023 (from TRL 5-6 to 8). Improve geothermal heat to power conversion efficiency via the integration of binary plants as bottoming units to geothermal flash plants. (from TRL 5-6 to 8). Period 2020-2023)
- Extend the application of binary plant technology to the exploitation of high-temperature geothermal resources (from TRL 4-5 to 6-7 and then 8. 2020-2023).
- Develop power cycles and technologies for the mitigation of super high-temperature resources, and high-enthalpy steam direct expansion (from TRL 3-4 to 6-7 and then 8. 2023-2026-2030).

Target

- reduce overall plant costs
- maximise plant efficiency: *Improve the overall conversion efficiency, including the bottoming cycle, of geothermal installations at different thermodynamic conditions by 10% by 2030 and 20% by 2050*
- upscaling binary plants to 20 MWe, including for EGS: demo sites
- new and more readily available organic non-flammable working fluids, i.e. refrigerants.
- new components: heat exchanger, material, surface structure and coating, hybrid cooling.

Topic 2: Flexible production of heat and power and integration for smart grids

Objective

- Demonstrating the technical and economic feasibility of responding to the grid operator's requests, at any time
- Demonstrate the automatic generation control (load following/ride-through capabilities for grid specifications) and develop the ancillary services of geothermal power plants.
- Increase the flexible operation of the binary plants, novel or adapted turbines and expanders will need to be developed (in combination with topic 1). This will be done together with a more modular approach (smaller, cascaded, and controlled units).

Target

- Adapting the expanders/turbines and other components to increase flexibility: *Demonstrate the technical and economic feasibility of responding at any time to commands from a grid operator to increase or decrease output ramp up and down from 60% - 110% of nominal power.*
- Improving the modular design of power plants to better adapt to electricity needs and heat demand without reducing overall electrical efficiency and annual production
- Optimising the connection configuration between the geothermal source, the binary plant and the district heating in order to increase electricity production, taking into account the heat profile and temperature regimes of the district heating network
- Generating different voltages for smart grids with specific applications, such as for an island or island mode, is key for flexible geothermal power production

Topic 3: High-Temperature Thermal Energy Storage (HT-TES)

Objective

- Develop technologies and workflows to reduce costs and improve heat-storage and production performance.
- Combining surface structures (i.e. waste heat source, heat exchangers, distribution network systems including different energy storage technologies and advanced demand-side management) and subsurface characterisation and management (i.e. reservoir modelling, tracer tests, drilling and well integrity preservation) into a unique source-to-sink system.

Target

- Integration of thermal energy storage to cope with daily, weekly and seasonal variations in heat demand and available heat from the geothermal power plant. Integration of a medium/long term storage system
- Development of appropriate control systems to manage heat and electricity production, heat demand and storage
- Adapting the return temperature from the surface site to the subsurface temperature and to the regulatory frameworks
- Identifying, characterising and monitoring reservoirs for UTES, manage geo-mechanical effects of the reservoir linked to the seasonal injection/production operations. Characterising and monitoring water-rock interaction at reservoir level
- Design and optimisation of the distribution network

Topic 4: Developing hybrid plants and Exploiting mineral production from geothermal sources

Objectives

- Couple geothermal with other renewable energy sources to generate power and heat but also storage facilities.
- Demonstrate the technical and economic feasibility for hybrid plants of responding to commands from a grid operator at any time (see topic 2).
- Develop novel and potentially disruptive technological solutions for metals as well as non-metallic materials in a single interlinked process.

Targets

- New and unprecedented plants using residual heat or non-geothermal RES to increase the temperature of the geothermal brine.
- Using geothermal to stabilise the supply of variable sources: Hybrid plants (e.g. combining geothermal with waste heat, biomass, concentrated solar thermal or green gas)
- Demonstrating the applicability of geothermal combined with other sources for district heating and cooling at industrial and/or residential sites, including the use of high-temperature heat pumps and Underground Thermal Energy Storage (UTES) at elevated temperatures, and for integration into smart thermal grids.
- Increasing the selectivity and efficiency of the separation techniques for minerals and geothermal brines; including developing new, potentially disruptive technologies to separate and transform chemical components from geothermal brines into more valuable products
- Developing a new type of future facility that is designed

« Mission » system approach

- Addressing the specific problems of geothermal power production in isolated energy networks (islands), such as grid infrastructure and demand-side management.
- develop adequate transmission and distribution infrastructure and to interconnect this with other flexibility options (e.g. demand-side management and storage), and to test dispatchability.

Overall targets & KPIs

- Increase the efficiency, and reducing losses and internal consumption on energy conversion processes;
- Improve reliability and durability (resistance to corrosion, abrasion) of surface system equipment; > lifetime
- Reduce the overall cost for heat and power generation;
- Adapt plants to be base load and dispatchable to facilitate larger shares of renewables in the energy system and Improve integration of geothermal energy through an enhanced interaction with energy storage, demand response and smart interconnection with other technologies.

SET Plan targets:

- 2. Improve the overall conversion efficiency, including the bottoming cycle, of geothermal installations at different thermodynamic conditions by 10% by 2030 and 20% by 2050
- 3. Reduce the production costs of geothermal energy (including from unconventional resources, EGS, and/or from hybrid solutions which couple geothermal with other renewable energy sources) to below €0.10/kWhe for electricity and €0.05/kWhth for heat by 2025
- 6. Demonstrate the technical and economic feasibility of responding at any time to commands from a grid operator to increase or decrease output ramp up and down from 60% - 110% of nominal power.

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