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SPOT

Sustainable Process Heating

The overall objective of this SPOT project is to start an innovation program on Industrial Heat Technology in order to achieve a coherent and consistent program that leads to significant reduction of the use of fossil energy carriers in industry. The goal is to reduce fossil energy use for industrial heat with at least 100 PJ/year in 2030. The associated CO_2-emission reduction is estimated at 6 Mton/year. Innovations within this program lead to new products with export potential for technology suppliers.

Dear Consortium partners

As a substitute to regular consortium meetings, we present a newsletter that provides you with an update on the progress within the several work packages of the SPOT project. Should you wish to know more or provide feedback, please get in touch with specific WP leader.

Work Package 1: Carbon free fuel for industrial high temperature applications

The objective of this work package is to determine which chain of technologies will provide industry with the most effective way of producing high-temperature heat that eventually originates from renewable electricity.

Progress

The basis for future projections are the Berenschot-Kalavasta 2050 scenarios. In these scenarios, four cases have been compiled, ranging from local to international scenarios. The development of industrial sectors, the application of specific technologies and the production of renewable electricity varies strongly between the scenarios.

Industrial heat demand

The production capacity is assumed to grow/decrease for the 4 different scenarios (taken from Berenschot). Starting from the industrial energy use data from 2019 (CBS), the heat demand is calculated in 2050 for the different industrial sectors. Only CO_2-free technologies are considered, so CCS is not taken into consideration. The demand for heat, electricity and hydrogen is calculated from regardless of whatever energy carrier (hydrogen, electricity, …) delivers this heat. The heat demand is split in T < 200°C and T > 200°C. As a result the industrial heat demand in 2050 was found to vary between 291 PJ/a and 668 PJ/a, depending on the scenario.

Supply of renewable electricity

Scenarios for the SPOT project were put together based on renewable electricity supply by wind onshore/offshore and solar. In addition, nuclear energy was added as an additional scenario. The ratio between installed power for solar and wind onshore/offshore is based on the Berenschot scenarios. The fifth scenario adds 9 GW of nuclear power to the Netherlands. The hourly pattern in the supplied electricity is based on historical generation patterns for the Netherlands for 2018 for solar and wind onshore and offshore, as provided by the ENTSO-E platform.

More information

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BHT

Standard Fasel

Corbion

DBS

SAPPI

DSM

Nuon

EMMTEC

Vattenfall

VDL

Work Package 2: Fuel cell based cogeneration of heat (steam) and power

The objective of this work package is to proof the viability of fuel cell cogeneration for steam and electricity production in industry as dual fuel CHP alternative in the energy transition.

Technology perspective

Effort has been put in getting background information on CHP use in Dutch industry. Using CBS as source, data is gathered for a range of CHP technologies in industrial sectors. Based on installed capacity the main use of CHP is found in the chemical/refinery and agricultural sector. For all cases, natural gas is the main fuel used in CHP units. In the chemical and refinery sectors a limited number (about 40) of high capacity CHP units are deployed, which are typically steam-turbines, STEG and gas-turbines. For the agricultural sector the overall installed capacity is similar to the chemical/refinery sector but is made up by a considerable larger number (about 2500) of CHP units. These units are typically gas engines used in greenhouses producing hot water instead of steam, limiting the field for the intended application within the SPOT project.

Technology assessment, selection and design

A report has been made describing fuel cell technology which can be used for co-generation of electricity and steam for industrial applications. As potential candidates Molten Carbonate Fuel Cells (MCFC) and Solid Oxide Fuel Cells (SOFC) are identified. MCFC as well as SOFC technology are already largely developed and more or less commercialized on respectively large scale (>MW) and small scale (<250 kW) for on-site CHP application. In nearly all cases electricity and hot water were the main products, no examples of steam production as commercialized technology could be found. With future operation of the fuel cell as electrolyser in mind, SOFC seems the preferred technology. Multiple SOFC manufactures have been contacted to ask their interest in supplying a fuel cell stack or micro-CHP system for converting to steam generation and lab testing at TNO.

More information

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Work Package 3: High temperature heat recovery and storage

The objective of this work package is to proof the technical feasibility of molten salt technology for heat transfer, storage and re use in the high temperature processes in the steel and chemistry sector.

Progress

The experimental facility for molten salt as heat transfer and thermal storage fluid is under construction at our facilities in Petten. We will use this test-rig, combined with a hot air supply system, to study the properties and applicability of molten salts in industrial heating processes. We aim to design a heat exchanger and test it for high-temperature waste heat source conditions, such as in TATA, in our experimental test rig; the purpose of such a test is to capture the heat from the waste stream in molten salt. We will use a non-dimensional analysis to scale-up the final heat exchanger design for TATA's full-scale application.

We have developed a database for thermal energy storage technologies. The database aims to identify, compare, and select potential thermal

Expected Results

- Future industrial heat demand;
- Required future energy storage and type thereof;
- Assessment of carbon-free fuel technology chains;
- Assessment of fuel cell cogeneration technology for industrial applications;
- Experimental results of a small scale cogeneration fuel cell;
- Techno-economic analysis of a full-scale cogeneration fuel cell;
- Requirements for high temperature heat recovery and storage;
- Market and energy saving potential for HT-recovery-storage;
- Heat transfer and thermal storage properties of molten salt
- Identification of future R&D needs on molten salt technology
- Assessment of the integration aspects of steam compression.
- Performance of different type of steam compressors
- Definition of pilot projects and future R&D needs
- Fact sheets for innovative industrial heating technologies
- Selection relevant innovations in heating systems for industrial processes in NL
- Impact assessment of industrial heating transitions on the national energy system

storage solutions for specific industrial needs. Matlab Structures store detailed information on the various thermal storage technologies, both existing and in development. We have already filled the database with many industrially relevant thermal storage systems. The Matlab program allows for detailed comparisons of the technologies and has considerable flexibility in graphical representations.

More information

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Work Package 4: Steam Compression

The objective of this work package is to assess the applicability, availability and feasibility of steam compression technology into existing processes and identify innovation and development needs.

Progress

Information on the steam use and required conditions in the drying section of a papermill were collected, and steam compression options in the drying sections are being explored. Specific attention is paid to keep as much of the steam re-used within the dryer section. Various steam compression integration options are being elaborated, to allow comparison and ranking of these options, taking into account the performance characteristics of available steam compressors.

The pilot testing of steam compressor technologies is being prepared. Operational conditions and requirements of both the DBS and StandardFasel steam compressors are collected. The necessary modifications on the existing heat pump test-rig are defined and basic engineering of these modifications currently ongoing.

More information

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Work Package 5: Future industrial heating technologies and energy systems

The objective of this work package is generating an overview of international innovations in industrial heating systems, selecting most relevant innovations for the Dutch industry and determining the impact on the national energy systems.

Progress

Different national (MIDDEN) and international (DOE, NEDO, IEA, CORDIS) sources are examined on relevant information concerning state-of-the-art and future heating technologies for industrial processes with a strong focus on heat supply, recovery and reuse, and future robustness regarding the energy transition. As ongoing activity (scouting and gatekeeping) an overview of identified technologies is made, where a subdivision is made in temperature level of the technology in question and in which sector(s) and or process(es) it can be applied. Matching identified technologies with industrial sectors and processes will make it possible to rank those technologies based on potential energy saving and CO2 emission reduction. For most relevant options Fact sheets will be made, describing the key characteristics.

More information

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