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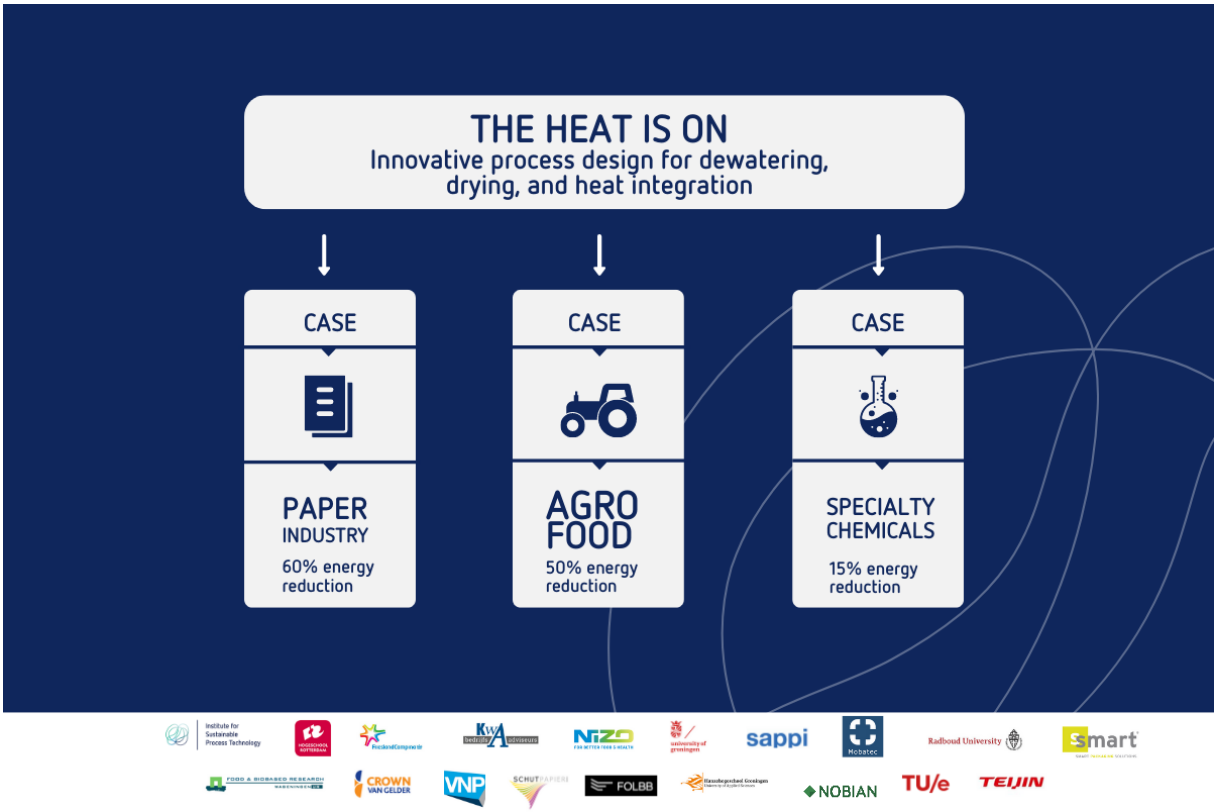

1. Public summary of basic principles, project goals and consortium partners

Basic principles

In industries like agrifood, paper and specialty chemicals industry about 40-80% of CO_2-emissions are related to energy for heat driven processes like separations and drying. Heat is mainly obtained through fossil fuels and processes proceed from high to low temperatures. Heat integration is about balance control between heat generation and use/re-use.

To achieve the Climate Agreement goals for CO2 reduction, the heat system must be converted to a system with maximum application of circular heat, upgrading instead of emitting to the environment, and primary generation must come from 100% sustainable sources. For the vision year 2030, the innovations are aimed at accelerating the applicability of heat pump technologies through a case-based approach for integration into the existing industry. This requires parallel efforts to be made to increase process efficiency in unit operations, through **efficient separation and drying processes** that decrease the amount of water to be evaporated and increase the **heat upgrading potential** and **smart process optimisation** and control through digital twins.

Project goals

The The Heat Is On project applies a case driven system approach wherein these three innovations are integrated to obtain substantial savings in the necessary amount of heat. The following more specific goals were determined:

- Efficient dewatering and drying by means of technologies for high solids that will result in 10% less water to be evaporated/dried and the forthcoming energy reduction.
- Innovative concepts for combined heat integration and drying that will result in 50% less use of fossil fuels for drying.
- Smart production solutions that will result in 10% energy savings by means of improved process control.
- Case agrifood: innovative process design for dewatering, drying and heat integration with as result 50% energy savings in 2030.
- Case Paper industry: innovative process design for dewatering, drying and heat integration will result in 60% energy reduction in 2030.
- Case specialty chemicals industry: innovative process design for dewatering, drying and heat integration with 15% energy reduction in 2030 .
- Cooperation in heat innovations.
- Exploitation: proposals pilot- or demonstration projects.
- Expected impact: 30% energy reduction in 2030 on average in the three industry branches (paper, agrifood and specialty chemicals); > 3,0 Mton CO_2-reduction in 2030 when implemented by all.

Consortium Partners:

CVG	Crown Van Gelder - till 23 January 2023, desired is to be followed up by Crown van Gelder International
FC	FrieslandCampina
HUAS	Hanze University of Applied Sciences / Hanzehogeschool Groningen
ISPT	Institute for Sustainable Process Technology
RUAS	Rotterdam University of Applied Sciences / Hogeschool Rotterdam
KWA	KWA Bedrijfsadviseurs
FBE (former MM)	Folding Boxboard Eerbeek
Mobatec	Mobatec
NIZO	NIZO food research
Nobian	Nobian Industrial Chemicals
RU	Radboud Universiteit Nijmegen
RUG	University of Groningen / Rijksuniversiteit Groningen
Sappi	Sappi
Schut	Schut Papier
SmartPS	Smart Packaging Solutions
Teijin	Teijin Aramid
TU/e	Technical University of Eindhoven / Technische Universiteit Eindhoven
VNP	Royal Association of Dutch Paper and Board Factories Koninklijke Vereniging van Nederlandse Papier en Kartonfabrieken
WFBR	Wageningen Food & Biobased Research

Associated Partners

Alliander	Alliander
Cargill	Cargill
Duynie	Duynie Feed
FME	FME

2. Description of the executed activities, obtained results per milestone, bottlenecks and perspective for future applications

The The Heat Is On project consists of three thematic work streams:

- Reducing water as a solvent or water removal other than by evaporation,
- Energy optimization in the production process, and
- Energy optimization through smart use of the latest information & modeling technologies for e.g., digital twinning.

The project is now halfway through its 4-year term.

Reducing water as a solvent or water removal other than by evaporation

This work stream consists of three sub streams, in all of which positive progress has been made:

Viscosity

By increasing the dry matter content in the solution, less solvent is required on paper to still apply the same amount of material (starch) to the paper. This reduces the amount of water to be evaporated. Seizing agent application trials under the guidance of NIZO are currently underway. In these trials, paper from different paper manufacturers (Crown van Gelder and Folding Boxboard) is combined with different forms of modified starch (from Cargill). These trials examine how the increase in dry matter content impacts viscosity and, as a result, affects the penetration of the starch into the paper. The tests so far show that viscosity increase (due to dry matter increase) is not such that it negatively affects the amount of starch absorbed.

Concentration

Laboratory trials at Wageningen Food & Biobased Research aiming to increase the concentration of dry matter through removal of water by forward osmosis are positive. Subsequent application trials are planned in the near future in close cooperation with FrieslandCampina,.

Mechanical dewatering

In an earlier stage of the project a long list and a short list of technologies that can promote mechanical dewatering were made. Based on the short list further steps have been made with selection of technologies:

- Ultrasound - around the removal of water by ultrasound, after a multidisciplinary expert session (paper experts, WFBR, TU/e, VNP) it was decided to start tests with ultrasound.
  Test activities are now executed in July 2023.
- Microwave - An expert session is planned with the technology provider, paper experts and WFBR (mid-September 2023) to investigate whether microwave technology could be applied in paper production. Several scenarios will be discussed and defined, such as increasing water temperature to reduce viscosity making transport through paper fibers easier during mechanical dewatering. For mitigating local wet spots on paper webs, local evaporation of water could be considered.

Energy optimization in the production process.

Among other things, this work stream has successfully focused on the application of heat pump applications. Heat integration studies have been done for the three THIO sectors:

Paper sector - In the pass-through section of the paper machine, a lot of water is evaporated to dry the paper. This water vapor is extracted with air through a fume hood. At both Crown van Gelder and Folding BoxBoard, applications have been proposed to use the latent heat of the moist air coming out of the fume hood as a heat source for the heat pump. Using this heat pump, steam is generated which is brought to the correct pressure with mechanical vapor recompression. This steam then goes back to the drying section of the paper machine. This thus closes the circuit.

The electrical energy to drive the heat pump and vapor recompression is then the external energy that remains necessary. In both the Folding BoxBoard and Crown van Gelder cases, the application of a heat pump is technically feasible and falls within the investment criteria. At the moment, the calculations and supplied data are being validated in order to provide a solid basis for the investment process in these two organizations. A third location (Sappi) and fourth location (Smart Packaging Solutions) are currently working on the base case which will be identical to the first two cases.

Food sector - For FrieslandCampina, the initial work in The Heat is On project led to a collective insight. A good overview of the energy flows in the complex plants is an essential prerequisite for effectively determining where optimal heat recovery could take place. This mapping and identification of energy saving opportunities is well underway.

Chemical sector - In chemistry, and thus also at Teijin Aramid, heat recovery, integration and optimization have been an integral part of the design process for some time. This immediately translated into the results of The Heat is On - the initial heat integration scan showed that further heat integration within the identified unit was not possible. After a side-step regarding heat storage, it has now been decided to move forward again with heat integration and recovery. Now the focus will be more on cross-border unit integration.

Quick scan heat integration model - Specifically for the paper industry, this scan was made by the Rotterdam University of Applied Sciences. Only very limited information is needed to apply this model. By combining the task (estimate) of the moist airflows from the vapor cap with the heat demand (steam flow and pressure), the most optimal heat recovery can be determined for different scenarios. Because it is now very easy to quantitatively compare different scenarios, the model will thus be able to contribute concretely to (internal) discussion and decision making. This model is now being tested at Sappi and Smart Packaging Solutions.
The modeling of an entire paper production line has taken place at Wageningen Food & Biobased Research. In this application, various scenarios can be used to determine whether energy optimization is possible by changing steam pressure settings, air inlet conditions and/or leakage air. The model is based on validated assumptions, nevertheless also here a local validation is applied in close contact with Folding BoxBoard. Despite the fact that both models have specific areas of interest, a mid-September consultation is planned to maximize synergy and uniformity for the industry. Further industry-wide rollout of the Hogeschool Rotterdam model is in initial development together with the VNP.

Energy optimization through smart process optimization and control through digital- twins.
For the dairy industry (FrieslandCampina case), the Radboud University worked with Eindhoven University on modeling fouling processes in heat exchangers. The modeling was done in gPROMS. Because it is now possible to better predict fouling, this will contribute in the future to energy savings through higher production efficiency, more efficient and effective cleaning (CIP). Because this is a fundamental solution, this improvement will serve a large application area.
In the specialty chemicals industry (Nobian), the focus area is operational optimization of evaporation crystallizers. For this case, the University of Groningen is now working on the conditions to actually start testing and applying the simulation results in order to validate in practice whether the predictions by the models produce savings and confirm operation of the model.

The data analysis of Sappi Maastricht is taking place in close cooperation with Radboud University and Hanze Hogeschool Groningen and is in full swing. The first results are beginning to emerge.
In addition, Eindhoven University is still working on more fundamental contributions, namely:
a new method to model the development of fouling.
One of the lessons learned so far is that the main challenge is not in the area of systematics and/or models, but in obtaining complete, relevant, reliable data. Before any actual work on optimization could take place, a serious effort was necessary to meet the pre-conditions of data quality.

3. Description of the contribution of the project to the objectives of the MOOI regulation

This project contributes in several ways to energy reduction and consequently to the reduction of CO_2 emissions during production processes. In this project the paper, dairy and chemical industries cooperate in a project consortium together on these objectives.

4. Spin-off within and outside of branches

At this moment it is too early in the project to pinpoint specific spin-offs of the project, and this will be identified in the second part of the project.

Within the The Heat is On project, insights in the area of implementation of these applications were obtained in addition to the technical applications. Several challenges can be identified in the areas of technical implementation overview, planning, decision making and resource management.

5. Overview project's publications and sources

- The Heat is On project page on ISPT website: https://ispt.eu/projects/the-heat-is-on/

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