Innovation Type:
Concept

Development stage:
Theoretical concept studies

*Remaining uncertainties at current stage: **Few***

TRL: 3-4

Status: In progress, 2022

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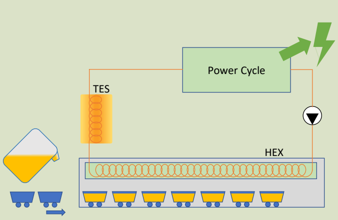
HighEFF Overall Goals		
	Energy use & emissions	X
	New solutions	X
	New methods and tools	

Relevant Sectors	
Oil, Gas and Energy	**Metal and Material**
Food and Chemical	Industry Clusters



Simple concept sketch

Energy recovery with integrated thermal storage

The significant quantities and high temperature of the heat rejected during ferroalloy casting makes it an interesting source for energy recovery. The heat released during casting is rarely utilized today.

Challenge

The casting processes in all Norwegian ferroalloy plants are performed batch-wise, while all common forms of heat utilization needs a continuous supply. Furthermore, the initial temperatures of the liquid metal during casting are very high, and heat transfer will dominantly occur via radiation. A heat recovery solution will therefore somehow have to surround the metal during solidification. Combined with demand for efficient production and plant logistics, this adds significant complexity to both heat capture and practical power production.

Solution

A new system concept has been proposed and is currently under evaluation and further refinement. The system utilises an actively cooled tunnel to efficiently absorb heat radiation from casting moulds, as well as thermal energy storage to buffer the intermittent heat for consistent and smooth export to heat-to-power conversion, either in a standalone system or integrated into an existing cycle.

Potential

A 2021 HighEFF case study showed heat recovery potential for a single plant of up to 46 GWh/y captured above ~300 °C. With identical applicability across the whole Norwegian ferroalloy sector, this would equate to over 500 GWh/y.

Reference

Andresen et al., 2020. Dynamic Analysis of Energy Recovery Utilizing Thermal Storage from Batch-wise Metal Casting. IIR Rankine Conference 2020

Coming in 2022: New case study in PhD thesis of Brede Hagen

HighEFF definition of innovation:

Innovation can be a product, a technology, a component, a process or sub-process, a model or sub-model, a concept, an experimental rig or a service that is new or significant improved with respect to properties, technical specifications or ease of use. Innovation can also be new application of existing knowledge or commercialization of R&D results.

The innovation should be adopted by somebody, or be ready for utilization provided that it is made probable that the innovation will be utilized within a limited timeframe

List:

- Product
- Technology
- Component
- Process
- Sub-process
- Model
- Sub-model
- Concept
- Experimental rig
- Service
- New application
- Methodology
- Organisation
- Market

Kilde	No	Title	Short description	W	Responsi	Success probabil	Potential impact	R&D parters	User partners	Category of innovation	T
WS2019	I3.1.1	Low and medium temperature H2P cycles	Competitive low and medium temperature power cycle concepts with cross-sectorial applicability	3.1	SINTEF ER	Med	Med	SINTEF ER; NTNU		Process	I
WS2019	I3.1.2	Energy recovery systems with integrated thermal energy storage	Energy recovery concept with integrated thermal buffering for mitigation and/or utilization of transient conditions	3.1, 3.3	SINTEF ER	Med	Med-High	SINTEF ER	FFF	Concept	R
OWP2020	I3.1.3	FlexCS	World-class cycle optimization model for energy recovery concept design and analyses	3.1, 2.1	SINTEF ER	High	Med	SINTEF ER		Model	I
AWP2020	I3.1.4	1 kWel TEG module	Concept and electrical architecture of a novel 1 kWel TEG module	3.1	SINTEF IND	Low-Med	Med	SINTEF IND		Concept	R
WS2019	I3.2.1	Steam producing heat pumps	High-efficient HTHP cycle concepts for upgrading surplus heat to 10 bar steam, displacing fossil fuel	3.2	SINTEF ER	Med	Med-High	SINTEF ER	EPCON	Technology	I
WS2019	I3.2.2	Propane-Butane HTHP	Integrated heat pump system for combined heating and cooling solutions.	3.2	SINTEF ER	Med	Med-High	NTNU; SINTEF ER	TINE, CADIO, DORIN	Process	I
AWP2020	I3.2.3	Brayton heat	temperature heat pump with turbo compressor and expander	3.2	SINTEF ER	Med	Med-High	SINTEF ER	GE (Baker Hurst)	Technology	R
WS2019	I3.3.1	Large scale cold TES	Large-scale cold TES for food industry to balance between high cooling demand and varying availability of low-cost electricity from renewable sources	3.3	SINTEF ER	Med	Med-High	NTNU, SINTEF ER	REMA	Technology	R
WS2019	I3.3.2	Steam thermal energy storage	Methodology for choosing the correct TES technology to enable cost-efficient steam production based on renewable electricity	3.3	SINTEF ER	Med	Med-High	SINTEF ER	HYDRO, Elkem	Methodolog y	R
WP-leader	I3.3.3	TES for industrial waste heat recovery in District Heating	dimensioning and operation of a TES tank in a DH system based on utilization of industrial waste heat	3.3	SINTEF ER	High	Med-High	SINTEF ER	MIP	Methodolog y	I