
Project
supported by
LIFE EU
Programme
H·REII
Heat Recovery in
Energy Intensive Industries
DEMO
www.hreii.eu/demo

Background & objectives

A considerable amount of heat is wasted in many industrial plants employing thermal processes. Many industrial processes need a cooling system, like in the treatment of exhausted gases. This equipment involves additional investments and operation and maintenance costs. Waste heat recovery solutions have been developing since many years, both for thermal users and power generation. If certain quantity and quality requirements of the waste heat are met, it can be economically convenient to install an Organic Rankine Cycle (ORC) – a closed cycle working with an organic fluid in order to produce electricity. In the last ten years, many ORC turbines have been installed to recover heat from industrial processes, such as cement kilns, metallurgy processes, flat glass plants, gas turbines and internal combustion engines. This application can be considered an excellent example of energy efficiency measure because companies that have made these investments have reduced their electricity consumption, with no additional use of primary energy. Please find below a simplified scheme of a heat recovery system (fig. 1).

FIGURE 1: Heat recovery scheme

On January 2010 the first European project on mapping the potential for heat recovery with ORC systems in energy intensive industries (in a pilot area) started. This project, funded by the LIFE + program (LIFE08 ENV/IT/000422 acronym "H-REII"), had the goal of promoting policy and governance actions that would support waste heat recovery for power generation in energy intensive industries and quantify the potential CO_2 savings.

The **H-REII DEMO project (LIFE10 ENV/IT/000397)** is the continuation and implementation of the H-REII project aiming at:

- **developing the first prototype of ORC heat recovery plant from EAF (Electric Arc Furnace)** in the steel industry completely integrated in a fumes treatment cleaning system;
- **promoting EU policy and governance actions for incentivizing waste heat recovery** for power generation, reducing CO_2 emissions by the valorization of process effluents in Energy Intensive Industries.

Partners

The project partners are Turboden, project leader and coordinating partner, CO.ME.CA as technological partner, FIRE (Italian Federation for Energy Efficiency) as associate partner.

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TURBODEN
a group company of MITSUBISHI HEAVY INDUSTRIES, LTD.

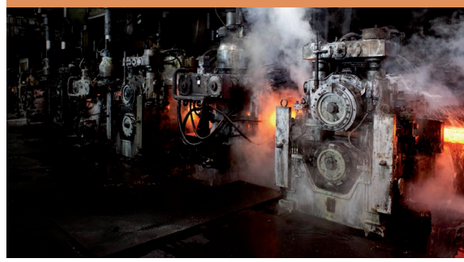
Turboden, a Mitsubishi Heavy Industries company, is a global leader in the design, manufacture and service of Organic Rankine Cycle (ORC) turbogenerators, which harness heat to generate electric and thermal power from renewable sources (biomass, geothermal, solar energy) and waste heat from industrial processes, engines and gas turbines. Turboden has more than 280 plants in 32 countries and offers turbogenerators from 200 kWel to 15 MWel.

COMECA S.p.A.
COSTRUZIONI MECCANICHE & CARPENTERIA

CO.ME.CA. S.p.A. has been operating in the mechanical structural steel work field for the iron and steel industry since 1969. Since the very beginning, the company has continuously updated its in-house machinery, technologies and machining processes to state-of-the-art levels, with the maximum satisfaction of all its customers in mind. The experience of its highly specialized technical personnel has made CO.ME.C.A. S.p.A. one of the most qualified and appreciated suppliers in its sector.

FIRE
FEDERAZIONE ITALIANA PER L'USO RAZIONALE DELL'ENERGIA

FIRE (Italian Federation for Energy Efficiency) is a non-profit organization established in 1988 to promote the efficient use of energy. Since 1992 FIRE manages the Italian energy manager network on behalf of the Ministry of Economic Development, promoting their role through various initiatives.
FIRE also encourages in collaboration with the relevant institutions a positive development of the legislative and regulatory framework in order to foster an efficient use of energy.



Milestones

The project's main milestones can be summarized as follows:

1 Installation of a DEMO Plant involving an innovative integrated system of fumes depuration and heat recovery from process with ORC (Organic Rankine Cycle) technology in a leading steelmaking company – Elbe Stahlwerke Feralpi - Feralpi Group S.p.A, located in Germany.

2 Evaluation of the potential waste heat recovery for electricity valorization of the different energy intensive sectors under analysis, by extending the potential estimated for one or more enterprises to an entire industrial sector.

3 Promotion of heat recovery at the policy and regulatory level, through monitoring existing legislation and producing a model for the environmental and energy authorization process for heat recovery plants, aimed at standardizing an uncertain and fragmented regulatory scenario at EU level.

4 Proposal of guidelines in order to amend the existing BREFs with the addition of heat recovery with ORC technology.

5 An intense dissemination at EU level.

Processes	Heat source temp [°C]	Industrial Plants	ORC - Power Estimated [MWe]
Glass - Flat Glass	500	58	79
Cement - Clinker Prod.	350	241	574
Steel - EAF	250[1]	190	438
Steel - Rolling mills	400	209	310
Oil & Gas - GCS		500	1 155
Total			2 556

TABLE 1: Temperature, number of plants and ORC potential in the five industrial sectors considered
[1] Steam from heat exchanger

Sectors	Energy Recovery [GWhh/yr]		Emission avoided [10^3t CO_2/yr]	
	5000h	8000h	5000h	8000h
Glass - Flat Glass	393	628	140	225
Cement	2 870	4 592	1 213	1 940
Steel	3 740	5 984	1 351	2 162
Oil & Gas - GCS	5 775	9 240	2 062	3 299
EU 27	12 778	20 444	4 766	7 626

TABLE 2: Energy savings potentials and emission avoided at 5000 h/yr and at 8000 h/yr in EU27 industries

ENERGY SAVINGS IN EUROPE
5000h/year - 8000h/year

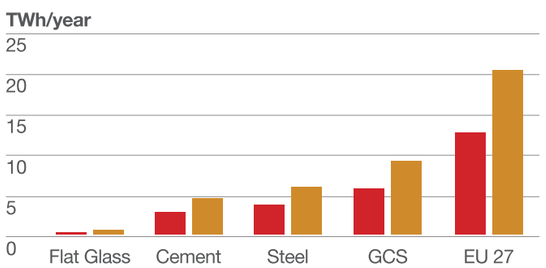


FIGURE 2: Estimated Energy Recovery in Europe (operating plants at 5000h/year – 8000h/year)

CO_2 EMISSIONS AVOIDED IN EUROPE
5000h/year - 8000h/year

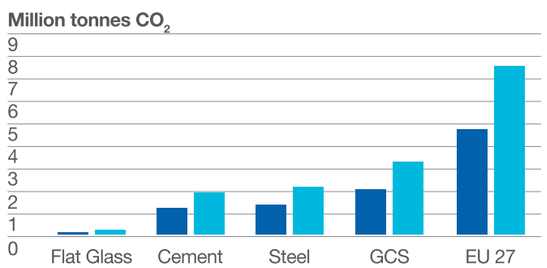


FIGURE 3: Estimated Emission CO_2 Avoided in Europe (operating plants at 5000h/year – 8000h/year)

Results

TECHNICAL RESULTS:

- Innovative waste heat recovery system using ORC (Organic Rankine Cycle) technology in Electric Arc Furnace (EAF).
- Strong reduction of the electric consumption of the fumes treatment system.
- Increase know-how for applications in different Energy Intensive Industrial processes, so to consolidate the European leadership in integrated fume extraction plants with heat recovery, promoting the development of the market of environmental technologies.

FIGURE 4: H-REII DEMO concept

POLICY AND REGULATORY RESULTS:

- Implementation of the Local Pilot Observatory on waste heat recovery.
- Quantification of the potential EU's contribution of EII to reach greenhouses gas (GHG) reduction objectives by 2020 using heat recovery. The estimated EU27 potential for the investigated sectors accounts for approximately 20 TWh of electric energy. This value represents 4.8% of total electricity consumption of EU industry in 2009 and implies avoided emissions of almost 7.5 million tonnes of CO_2.
- Contribution to BREF (Best Available Techniques Reference Document) and BAT (Best Available Technologies) concerning waste heat recovery in EII.
- Contribution to the European Energy Efficiency Action Plan.
- Contribution to the National Plan for Energy Efficiency.
- Contribution to map legislative and license bills necessary to commissioning heat recovery power plants and to oversimplifying practices.
- Contribution to define standard instruments to support energy efficiency investments in EII.
- Dissemination: several events attended, articles and papers, more than 13,000 website visits.

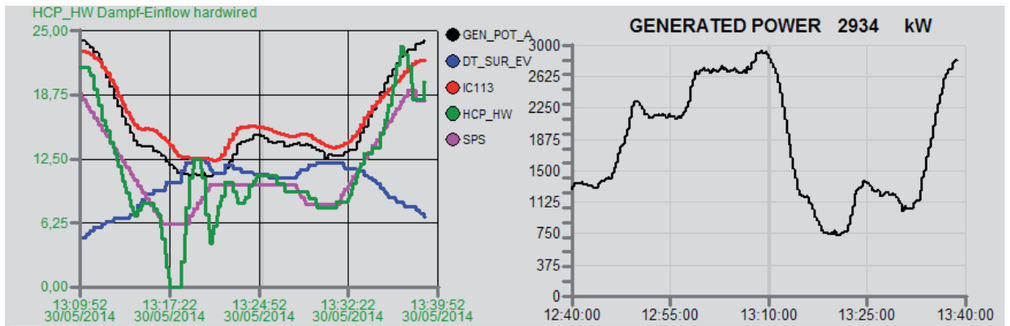


FIGURE 5: Screenshot test on site during commissioning (May 2014)

FIGURE 6: Waste heat boiler

FIGURE 7: Waste heat boiler

FIGURE 8: ORC Turboden

Studies and papers

Several studies have been conducted both at national and EU level to evaluate the impact of ORC technology applied to the industrial sectors under discussion. These include:

Ademe
"WASTE HEAT RECOVERY FOR POWER GENERATION. PANORAMA OF PUBLIC POLICIES SUPPORTING POWER GENERATION FROM INDUSTRIAL WASTE HEAT"
[France], October 2012

AGICI, OIR
"THE HEAT RECOVERY AND BIOMASS COGENERATION: TWO TOOLS FOR RELAUNCHING THE ITALIAN INDUSTRY"
[Italy], 2013

Baresi M., Di Santo D., Forni D., Rossetti N., Vaccari V.
"HEAT RECOVERY FOR ELECTRICITY GENERATION IN INDUSTRY"
[Sweden], ECEEE, 2012

Baresi M., Bianchi M., Branchini L., Campana F., De Pascale A., Fermi A., Peretto A., Rossetti N., Vescovo R. University of Bologna and Turboden S.r.l.
"ORC WASTE HEAT RECOVERY IN EUROPEAN ENERGY INTENSIVE INDUSTRIES. ENERGY AND GHG SAVINGS"
[Italy], Energy Conversion and Management Elsevier, December 2013

Bause T., Campana F., Filippini L., Foresti A., Monti N., Pelz T.
"COGENERATION WITH ORC AT ELBE-STAHLWERKE FERALPI EAF SHOP"
[Indianapolis, USA], AISTech, May 2014

Campana F., Di Santo D., Forni D.
"INNOVATIVE SYSTEM FOR ELECTRICITY GENERATION FROM DISPERSED HEAT RECOVERY"
[Sweden], ECEEE, 2014

Confindustria
"SMART ENERGY PROJECT"
[Italy], September 2013

Ecofys, Department of Energy and Climate Change, Ecofys BV, Imperial College
"THE POTENTIAL FOR RECOVERY AND USING SURPLUS HEAT FROM INDUSTRY. APPENDIX FOR FINAL REPORT FOR THE HEAT STRATEGY AND POLICY TEAM"
[United Kingdom], 4th March 2014

Energy&Strategy Group, Politecnico di Milano
"ENERGY EFFICIENCY REPORT"
[Italy], November 2012

Energy&Strategy Group, Politecnico di Milano
"ENERGY EFFICIENCY REPORT"
[Italy], November 2013

Benefits

Throughout the project implementation several aspects linked to environmental, industrial issues and innovation have arisen, making it possible to identify heat recovery system in energy intensive industries as:

- The opportunity for greater environmental and energy sustainability of industrial processes with positive implications in terms of increased market competitiveness of energy intensive industries.
- The occasion to develop industrial policy relaunching investments in manufacturing sectors, involving different actors of the industrial supply chain.
- An effective tool to meet the objectives of energy efficiency and environmental protection at national and European level.
- The opportunity to promote specific actions of research and development aimed at strengthening a position of European leadership, turning into high export potential.

Box 1

Founded in 1968, Feralpi Group produces 5 Mtons of steel per year and employs 1,300 people in Italy, Germany, Czech Republic, Hungary and Romania.

- Long tradition of steel production in Riesa (since 1843)
- Riesa steel plant acquired by Feralpi Group in 1991
- EMAS (Eco Management and Audit Scheme) certification since 2012
- ESF Elbe-Stahlwerke Feralpi GmbH produces reinforcing steel in the form of bars and coils
- Steel shop for steel billets as semi-finished product (up to 1 million tons of steel billets)
- Hot rolling mill (up to 0.8 million tons of reinforcing steel per year)

FIGURE 9: ESF Elbe-Stahlwerke Feralpi GmbH headquarters

FIGURE 10: ESF Electric Arc Furnace

FIGURE 11: ESF continuous casting

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