Catalyzing market transformation for industrial energy efficiency and accelerate investments in best available practices and technologies in the Former Yugoslav Republic of Macedonia:

Steam System Energy Assessment and Optimization

Typically over 85% of the lifetime costs of a steam system are energy related. This case study reviews the optimization opportunities identified and those implemented in a steam system within the branch Energetika, one of the 7 subsidiaries of the Joint Stock Company (JSC) Power Plants of N. Macedonia (AD ESM), in order to address potential energy savings. The steam system energy assessment carried out revealed saving opportunities as follows: financial 324 764 EUR/yr, water 17 828m3/yr, energy 7 825 MWh/yr savings per annum.

Energetika AD ESM Snapshot
Production capacities are located in the industry complex ,,Zelezarnica"- Skopje and date since 1967. After restructuring of the company, since 1997, it is a part of JSC ESM.

Industry:
Production, distribution and supply of heat (hot water and process steam) and electricity
Location:
City of Skopje, N. Macedonia
Product and Services:
Production, distribution and supply of electricity and heat as regulated public service.
Production, distribution and supply of process steam and feed water as unregulated service.
Technology:
Natural gas-based combined heat and power plant
URL:
http://www.elem.com.mk/?page_id=3582&lang=en

Energy System Assessed: Steam System

Identified Optimization Benefits:
Financial savings: 324 764 EUR/yr
Water savings: 17 828m3/yr
Energy savings: 7 825 MWh/yr

Optimization Benefits Achieved :
Financial savings: 190 925 EUR/yr
Water savings: 17 791m3/yr
Energy savings: ~1 824 MWh/yr
Implementation cost: 161 457 EUR
GHG reduction: ~365 tCO2eq/yr
Payback time: **0.845yr**

N. MACEDONIA
A Case Study of "Energetika"
JSC Power Plants of N. Macedonia (AD ESM)

Steam System Optimization (SSO) Project in Energetika AD ESM

The GEF-UNIDO-REC Project, aims to reduce greenhouse gas emissions (GHG) originating from the industry in the R. Macedonia by accelerating transformation of the local market for industrial energy efficiency (IEE) by addressing existing barriers, in particular through strengthening policy, regulatory and institutional frameworks for IEE and supporting increased diffusion of and investment in best available IEE practices and technologies. The Project is funded by the Global Environment Facility (GEF), implemented by UNIDO and executed by the REC Country Office Macedonia (REC COM) in collaboration with the Ministry of Environment and Physical Planning, the Ministry of Economy, the Energy Agency of the Republic of Macedonia and the Macedonian Bank for Development and Promotion. The project runs from February 2015 till December 2020.

Energetika AD ESM has joined the GEF-UNIDO-REC Project in June 2015 to implement Energy Management System (EnMS) in line with ISO 50001, which resulted in establishing the Significant Energy Uses (SEU) and identifying a set of Energy Conservation Opportunities (ECO), most of which were closely related to the optimization of its steam system. Following the good cooperation throughout the EnMS implementation, the top management of Energetika AD ESM offered to serve as a host plant for the UNIDO Steam System Optimization (SSO) Expert training. This decision brought additional expertise to the staff included in the SSO training and deepened their knowledge for further energy efficiency measures that could lead to additional energy savings and financial benefits for the company.

Table 1 - Summary of Steam System Optimization Measures

	Energy Saving Opportunity (ESO)	Energy Savings MWh/yr	Financial Savings (EUR/yr)	Capital costs (EUR)	Simple Payback (yrs)
	Identified ESO				
1	Upgrading combustion control to air trim control via implementing burner management system (reducing ox. content in flue gases from 16 % to 5% results in increase of boiler plant efficiency from 79% to 86%, i.e. reduced flue gases energy loss by approx. 7.0 %)	**6438 MWh**	**138000**[2]	TBD	NA
2	Installing speed controllers (VFD[4]) on the primary rotary equipment where possible (based on predefined priority) (**Sum 21+22+23**)	**495 MWh**	**21505**	TBD	NA
2	1. Circulation pumps in MDHS[4]	300.81	13055	133650	10.24
2	2. Static pressure and booster-pumps	10.51	450	TBD	NA
2	3. Intake and fluegas fans	183.38	8000	TBD	NA
3	Initiating steam trap & leak management programme and reducing failures (saving ~15%)	**385 MWh**	**10500**	No cost	not yet applied
4	Improving condensate recovery and reducing boiler blow-down rate (minimizing losses via improving MP recovery by at least 5%)	4141 m3/y[3]	**46500**	No cost	Immediately[1]
5	Reducing make up water in the DH[4] system (on time leakage detection)	13650 m3/y[3]	**94309**	No cost	Immediately[1]
6	Reconstructing heat exchangers in MDHS[4]	**149MWh**	**4991**	**13983**	2.80
7	Installing 2 new condensate return pumps (in the boiler plant)s	**126MWh**	**4470**	**4228**	0.95
8	Insulate bare steam&condensate valves at the process area to reduce heat losses (by ~10%)	**232MWh** 36.7m3/y[3]	**4489**	TBD	NA
	Total potential savings	**7825MWh** 17828m3/y[3]	**324764**	TBD	NA
	Implemented ESO				
1	Upgrading combustion control to air trim control via zirconium probes resulting in reduced ox. content of approx. 10% (partially implemented O1.)	**1248 MWh**	**27600**	9596	0.347
2	Installing speed controllers 1. Circulation pumps in MDHS[4] (implemented only O2.1.)	**300.8 MWh**	**13055**	133650	10.24
4	Improving condensate recovery and reducing boiler blow-down rate (from water savings)	4141 m3/y[3]	**46500**	No cost	Immediately[1]
5	Reducing make up water in the DH[4] system (on time leakage detection)	13.650 m3/y[3]	**94309**	No cost	Immediately[1]
6	Reconstructing heat exchangers in MDHS[4]	149MWh	**4991**	**13983**	2.801
7	Installing 2 new condensate return pumps (in the boiler plant)s	126MWh	**4470**	**4228**	0.945
	Total from implemented ESO	**1823.8MWh** 17791m3/y[3]	**190925**	**161457**	**avg. 0.845yr**

[1] for unceasing benefits from this measure, necessary is to implement the measure continuously 24/7/year

[2] assumed average price of natural gas is 200eur/1000Nm3 (12.3MKD/Nm3)

[3] this activity refers to water savings rather than energy savings, although it includes chemical and thermal preparation and the energy engaged thereby, and electricity for running e.g. the booster pumps

[4] HD – district heating, MDHS – Main district heating station, VFD – variable frequency drives

Case Description

The herein presented work is a result of a system approach for energy performance analysis which resulted in identifying opportunities towards optimization of the steam and condensate system of the combined heat and power plant Energetika, AD ESM, located in Skopje, N. Macedonia. The boiler plants provide superheated steam that is used (1) for electricity production, (2) as process steam for industrial customers and (3) for hot water preparation intended for the local district heating system.

The main operational cost of the plant is natural gas consumption. Thus, the focus was to implement a set of energy efficiency measures that would lead to reducing natural gas consumption, and in turn decrease the overall negative impact on the environment of the plant.

The plant is equipped with the following primary equipment:

- Three gas-fired superheated-steam boilers (assigned as G32, m. TPK – Zagreb in the late 60-ties, originally designed as utilizers of metallurgical off-gas waste energy, with natural circulation and production capacity 3x32 t/h superheated steam at p=60 bar and t=500 °C. Through reconstruction, in the late 90-ties, natural gas is introduced as the primary fuel and heavy fuel oil is kept as alternative.
- Reconstructed back pressure turbines (10.2 MWe and 10.4 MWe);
- 2 x 110 kV substations (110/35/6kV and 110/6kV);
- Main district heating station with four heat exchangers 'steam-hot water' (4 x 18.6 MWth).

Optimization Measures & Results

The optimization measures identified through the steam system energy assessment at Energetika ESM and those subsequently implemented are presented in Table 1.

Lessons Learnt

In addition to savings energy, water and money, improving the efficiency of the energy conversion processes at Energetika ESM assisted in achieving:

- more reliable energy supply,
- reduced emissions of greenhouse gases and cleaner environment,
- more competitive businesses and
- higher living standard of residential customers and dwellers and employed in the public buildings (e.g. schools) connected to this district heating, resulting from the improved quality of the heat-supply.

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