RECP Best Practice Catalogue

Upgrade in-house electricity supply with co-generation

Developed within the framework of MED TEST II

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

switchmed

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Best Practice - Upgrade in-house electricity supply with co-generation

SECTOR:	**Food & Beverage**
SUBSECTOR:	Bakery and farinaceous products
PRODUCTS	Bread, kaak, cakes, sweets, confectionary, ice cream, snacks
CATEGORY	Technology upgrade/Eco-innovation
APPLICABILITY	Utilities

COMPANY NAME	NOT DISCLOSED
COMPANY SIZE	SME

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Description of the problem (Base scenario):	This plant is connected to the electricity utility grid but has electricity generators in order to cope with the daily black-outs that may extend from 4 and up to 12 hours. The in-house electricity supply consists of the following generators (G1: 1275 KVA, G2: 1x1000 KVA, G3: 500 KVA, G4: 400 KVA, G5: 750 KVA). Daytime load requirements does not exceed 1600 KVA, therefore either G1 or G2 feed one part of the plant and a combination of the smaller ones feed another part. Nightime electrical load is half the daytime load therefore G1 or G2 may operate single feeding both parts of the plant. The generators are old, particularly G1 & G2 which have undergone many overhauls. The generators performance has been monitored since July 2016 thanks to the information system installed during the early stages of the MED TEST II project. More than 18 month of collected data has shown that the average efficiency of the in-house electricity generation does not exceed 28% while it absorbs 30% of the overall final energy demand of the plant. Another factor that contributes to low effficiency is the supply demand mismatch because of the lack of flexibility in in-house electricity supply management. The disparity in generators sizes and lack of a master synchronizer between generators do not favor good load matching. Currently the average load factor of the in-house electricity generation system does not exceed 45%. The resulting waste of fuel is considerable.

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Description of the problem (Base scenario):	However the problem is not limited to high fuel consumption, indeed the sudden power outages during daytime black-outs cause on many occasions disruptions in the production lines, mainly for potato chips, as well as early equipment breakdowns. Products are wasted, maintenance costs rise and the company suffers downtime to restart production, this results in losses estimated at more than 40,000 EUR/year. Overall, the condition of the electricity supply system in this company is not conducive to good RECP performance.

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Description of the solution	The main idea is to buy new generators adapted to the load, disconnect from the utility during dayshifts, implement heat recovery and replace generators every 5 five years. The proposal is as follows; - Replace all existing generators with 4x800 KVA prime rated 3 duty - 1 standby generators with synchronizer load management unit. The calculated average load factor is 75%. The target in-house average generation efficiency is 37% for the first 5 years. - Decouple the plant from the electricity utility network from 7 AM till 10 PM. Use the utility when available during remaining hours (10 PM till 7 AM). Because the plant production lines are not operating except for Arabic bread therefore co-generation can be used only for absorption machine. Furthermore the specific in-house generated electricity cost cannot compete with nightime utility electricity cost even with co-generation. - Install a 200 KW Heat Recovery Thermal Oil Exchanger (HRTOE) on the exhaust of each generator to supply thermal oil @ 300°C. The recovered heat will be used to heat the frying oil of the natural potato chips line (50% coverage factor). (See figures 1& 2 below) - Install a 100 KW Heat Recovery Steam Generator (HRSG) on the exhaust of each generator to deliver 110 kg/hr of steam at 6 bars for the 250 KWrefr double effect absorption chiller with 500 KW cooling tower (See figures 1 & 2 below) - Install a 100 KW Heat Recovery Generator (HRE) on the jacket cooling system of each generator to deliver hot water at 85°C for tray washing and other applications. - Replace generators every five years before major overhauls are due

Figure 1: schematic of proposal

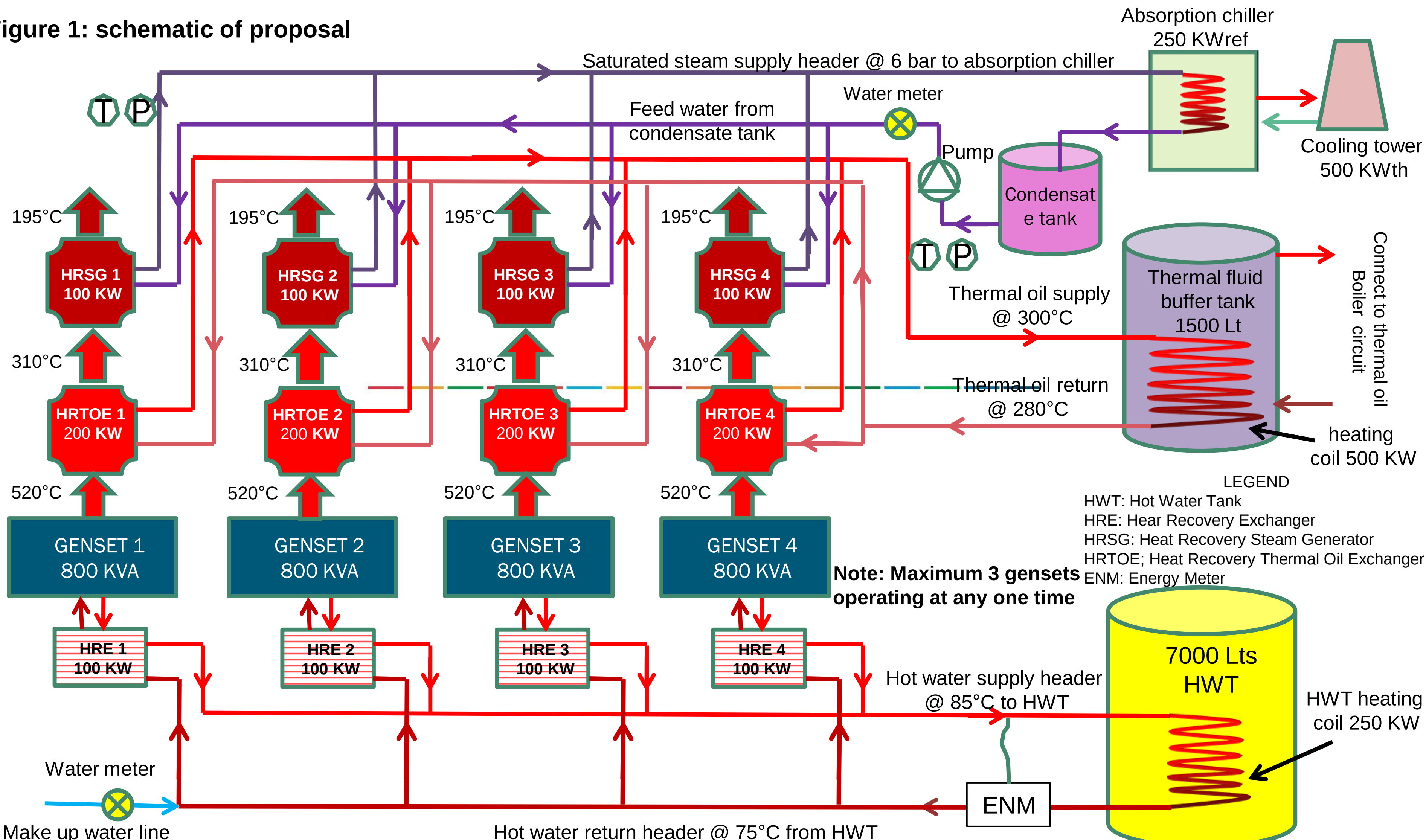
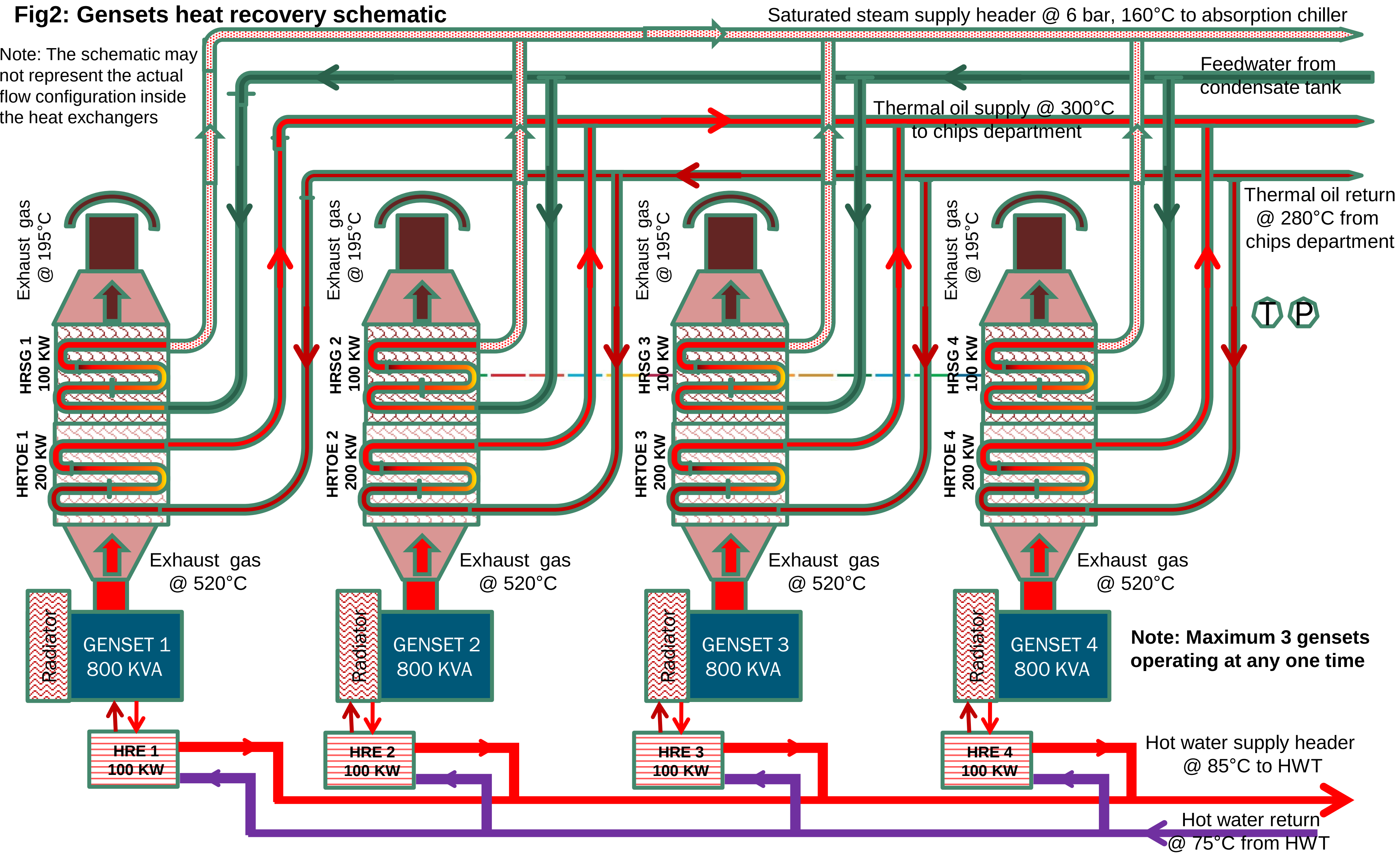


Fig2: Gensets heat recovery schematic



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Economic Benefits

The economic benefits take into consideration the following major components:

1. Increase in in-house average electricity generation efficiency from 28% to 37%.
2. Heat recovered to displace part of the diesel oil used to fire the thermal oil boiler to heat the frying oil for the natural potato chips line.
3. Heat recovered to displace part of the vapor compression air conditioning equipment that uses electricity and replace with absorption chiller that uses steam.
4. Heat recovered to displace all of the diesel oil used to fire the boiler to produce hot water for utensils washing and other housekeeping operations.
5. Reduced equipment breakdown, product loss and production downtime costs related to blackouts during production shifts.
6. Reduced generators maintenance and downtime costs.
7. Generators operation between 7 AM and 10 PM displaces low cost utility electricity (0.055 EUR/KWhre) between 7 AM and 6.30 PM when available and high cost utility electricity (0.19 EUR/KWhre) between 6.30 PM and 9.30 PM.
8. It is assumed that resell value of generators will offset the costs of maintenance. Alternatively generators could be leased, lease could be funded from the savings achieved.

The new generators have longer periods of operation compared to base case, their fuel consumption will be higher even though their efficiency is much better. However they are displacing utility electricity which is unreliable and results in additional operating costs.

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Economic Benefits	Base case electricity production in-house: 2,400 MWhre Base case diesel fuel consumed to produce in-house electricity: 8,400 MWhrth/year (thermal equivalent) Base case utility electricity consumption: 4,500 MWhre/year Proposal diesel fuel consumed to produce in-house electricity: 16,000 MWhrth/year Proposal utility electricity consumption: 1500 MWhre/year (Occuring between 10 PM – 7 AM at low rate) Market price diesel fuel: 600 EUR/Tonne equivalent to 54 EUR/MWhrth Price utility electricity combined rate: 90 EUR/MWhre (weighted rate over 24 hours) Price utility electricity low rate (7 AM – 6.30 PM) : 55 EUR/MWhre Base case Cost on generators overhaul and maintenance: 27 EUR/Mwhre (over new generators costs) Proposal cost saving diesel fuel to produce in-house electricity: (8,400 – 16,000)*54 = - 410,000 EUR/year Proposal cost savings in utility electricity: 4,500*90 – 1500*55 = 322,000 EUR/year Proposal cost saving on generators overhaul and maintenance: 2,400*27 = 65,000 EUR/year Proposal diesel fuel savings for cooking oil heating(HRTOE): 1,300 MWhrth (29% coverage) Proposal cost saving diesel fuel for cooking oil heating(HRTOE): 1,300*54 = 70,000 EUR Proposal electricity savings for air conditioning: 400 Mwhre (35% coverage) Price electricity: 140 EUR/Mwhre (Combined utility/in-house generation cost at base case) Proposal cost saving electricity for air conditioning: 400*140 = 56,000 EUR/year Proposal diesel fuel savings for hot water heating(HRE): 500 MWhrth (100% coverage) Proposal cost saving diesel fuel for hot water heating(HRE): 500*54 = 27,000 EUR/year Proposal cost saving for loss of product, downtime, breakdowns: 40,000 EUR/year

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Economic Benefits

Proposal water consumption in cooling tower: 1600 m^3/year
Proposal electricity consumption to run equipment included in proposal: 15 Mwhre/year
Market price of water: 2.5 EUR/m^3
Proposal cost of water for cooling tower: 1600*2.5 = 4000 EUR/year
Proposal cost of electricity: 15*110 = 1700 EUR/year

Saving component	EUR/year	% saving w/r to base case expenditure
utility electricity	322,000	80%
generators overhaul and maintenance	65,000	100%
diesel fuel for cooking oil heating	70,000	29%
electricity cost savings for air conditioning	56,000	35%
diesel fuel for hot water heating	27,000	100%
loss of product, downtime, breakdowns	40,000	100%
diesel fuel to produce in-house electricity	- 410,000	-200%
Water and electricity cost	- 5,700	NA
Net savings	164,000	

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ENVIRONMENTAL BENEFITS/NEGATIVE IMPACTS				
	Diesel saving	Electricity saving	CO2 emissions	Water saving
Components of savings	MWhrth/year	Mwhre/year	Tonnes CO_2/year	m³/year
utility electricity	NA	3,000	3,000	NA
generators overhaul and maintenance	NA	NA	NA	NA
diesel fuel for cooking oil heating	1,300	NA	317	NA
electricity cost savings for air conditioning	NA	400	400	NA
diesel fuel for hot water heating	500	NA	122	NA
loss of product, downtime, breakdowns	10	1	23	20
diesel fuel to produce in-house electricity	-7,600	NA	-1800	NA
Water and electricity to operate heat recovery	NA	-15	-15	-1600
Net savings	-6,600	3,400	2000	-1600

Avoided CO2 emissions: 2,000 TonnesCO2/year
Base case overall CO2 emissions: 7,700 Tonnes/year
Percentage reduction in CO2 emissions with respect to base case: 2000/7700 = 26%
Base case overall water consumption: 89,000 m³/year
Percentage increase in water consumption with respect to base case: 1600/89,000 = 2%

Specific emission for base case electricity grid: 1 Tonne CO_2/ MWhr
Specific emission for diesel fuel 0.24 Tonne/MWhrth