SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Definition of boundary conditions for industrial applications and industrial Peak Shaving

IEA SHC TASK 58 / ES Annex 33 | "Material Development for Compact Thermal Energy Storage"

Definition of boundary conditions for industrial applications and industrial Peak Shaving

This is a report from IEA SHC TASK 58 / ES Annex 33 | "Material Development for Compact Thermal Energy Storage"

and work performed in Subtask 1: "Energy Relevant Applications For An Application Oriented Development Of Improved Storage Materials"

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Solar Heating and Cooling Technology Collaboration Programme (IEA SHC)

The Solar Heating and Cooling Technology Collaboration Programme was founded in 1977 as one of the first multilateral technology initiatives ("Implementing Agreements") of the International Energy Agency.

Our mission is *"Through multi-disciplinary international collaborative research and knowledge exchange, as well as market and policy recommendations, the IEA SHC will work to increase the deployment rate of solar heating and cooling systems by breaking down the technical and non-technical barriers."*

IEA SHC members carry out cooperative research, development, demonstrations, and exchanges of information through Tasks (projects) on solar heating and cooling components and systems and their application to advance the deployment and research and development activities in the field of solar heating and cooling.

Our focus areas, with the associated Tasks in parenthesis, include:

- Solar Space Heating and Water Heating (Tasks 14, 19, 26, 44, 54)
- Solar Cooling (Tasks 25, 38, 48, 53, 65)
- Solar Heat for Industrial and Agricultural Processes (Tasks 29, 33, 49, 62, 64)
- Solar District Heating (Tasks 7, 45, 55)
- Solar Buildings/Architecture/Urban Planning (Tasks 8, 11, 12, 13, 20, 22, 23, 28, 37, 40, 41, 47, 51, 52, 56, 59, 63, 66)
- Solar Thermal & PV (Tasks 16, 35, 60)
- Daylighting/Lighting (Tasks 21, 31, 50, 61)
- Materials/Components for Solar Heating and Cooling (Tasks 2, 3, 6, 10, 18, 27, 39)
- Standards, Certification, and Test Methods (Tasks 14, 24, 34, 43, 57)
- Resource Assessment (Tasks 1, 4, 5, 9, 17, 36, 46)
- Storage of Solar Heat (Tasks 7, 32, 42, 58)

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- SHC Solar Academy
- *Solar Heat Worldwide*, annual statics report
- SHC International Conference

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Canada	International Solar Energy Society	Sweden
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China	Netherlands	Turkey
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Contents

1 Goal

The goals of this contribution can be summarized as:

(i) Definition of boundary conditions for industrial applications to enable the assessment of TES technologies with regards to their ability to be integrated in various industrial applications.

The assessment is focused on industrial application where the TES unit can serve to recover waste heat (batch processes) and where the TES unit can be used for peak shaving to reduce investment and operational costs. Below is an overview of the contributions received from the participating institutes.

2 Results

2.1 Overview of projects

2.1.1 FAFCO SA project – HSLU

The aim of this project is to find materials and possibilities that allow thermal storage at temperatures in the range of 8 to 15 ° C (PCM8-15) and 50 ° C (PCM50) in addition to today's ice storage.

Ice storage for storing latent heat for cooling purposes are now operated with water. For new applications in the field of air conditioning and heating, a higher temperature level is exergetically much cheaper. Based on the PCM with the phase transition temperature of 50 ° C, the storage density can be achieved in the useful hot water storage. This reduces the storage space of the thermal energy store. The material chosen has phase change occurring at 10°C.

This project has now been closed and had a duration of 42 months.

2.1.2 SUNAMP Ltd project – HSLU

The project aims to develop, test, and validate a thermal energy storage technology for refrigeration processes (-30C<T<-5 C). The proposed cold storage technology is characterized by a higher power output and more compact design compared to the products commercially available in the market today. The project scope includes validation of the technology performance and cost at industrial scale as to make the project outcome as close to a commercial product as possible.

TES allows to decouple production and supply of cold which can be beneficial for the efficiency of the system (cold can be produced when most beneficial, e.g. during night at low ambient temperatures). Furthermore, cooling utilities can be dimensioned smaller since demand peaks can be mitigated using the storage. Finally, storage allow a geographical decoupling of cold production and sink and may hence be utilized in transportation of to be cooled goods.

2.1.3 Industrienanlagen Hoffmeier GmbH – ZAE Bayern

Mobile energy storage systems working with Zeolite in an open sorption system can utilize industrial waste heat in cases where a pipeline bound connection is not cost sufficient.

A demonstration plant using extraction steam from a waste incineration plant to charge the storage with 130 °C hot air and an industrial drying process as customer 7 km far away from the charging station was built, operated and monitored over one year. The storage contains 14 tons of Zeolite and uses at the discharging station exhaust air from the dryer with 60 °C and 0.09 kg/kg humidity to realize a storage capacity of 2.3 MWh, saves 616 kg carbon dioxide per cycle and shows no degradation within accuracy of the measuring equipment. Misdistribution through the packed bed of zeolite prohibits the desired power output. The prime energy costs can be reduced down to 73 €/MWh considering small-scale mass production [1].

2.1.4 Latherm GmbH Project – Uni Bayreuth

The project consists of using waste heat from a block-type thermal power station as source (see Annexe – Supplementary Material). The storage unit was mobile and built based on a sea container. The potential heat sinks are swimming pools, schools and low process heat. The melting point of the PCM (sodium acetat trihydrate) is 58.3 °C. About 20 t of the storage material were used. The max temperature is up to 95 °C.

2.1.5 Enolcon GmbH Project – Uni Bayreuth

A large test facility for sensible high temperature storage which was developed by enolcon. One application for the storage is the use of waste heat in a brick factory. The waste heat during the burning is stored and used later on for drying bricks. In small to middle brick factories this drying and burning process is more or less a patch process. Generally temperatures between 200 and 350°C are used and standard volume flows comprise of 8.000-10.000 m³/h. Charging is performed directly with the flue gas while discharging is performed with ambient air. Due to dew point, the temperature in the stack can never be below 100°C. On the other hand, if charging temperature gets too low (below 300°C), an existing backup burner can be used.

2.1.6 Technische Universität Münich TUM – Industrial Project 1

In the course of the "Energiewende," the German electricity market is undergoing major changes. The state-aided priority of renewable generation has led to a significant decline in electricity prices. This reduces the profit margin of cogeneration units and increases the necessity of flexible operation to avoid electricity production when spot prices drop below marginal costs. In this work, a 100 MWel combined-cycle (CC) power plant supplying heat and power to a paper mill is investigated. Currently, the plant is operated heat-controlled and is therefore unable to react to changing electricity spot prices. With the integration of heat storage, the plant is enabled to switch to power-controlled mode.

To evaluate the technical impact of the storage, the plant and a thermochemical MgO/Mg(OH)2 storage are modeled using the stationary process simulation tool EBSILON PROFESSIONAL. Different operation modes are investigated and results are used to derive a mixed integer linear programming (MILP) model to optimize the operation of the plant/storage system. Using this method, the overall economic impact of the storage on the plant operation is quantified [2].

2.1.7 Technische Universität Münich TUM – Industrial Project 2

In this study a novel buffer storage for the thermal decoupling of gas turbine (GT) and heat recovery steam generator (HRSG) during startups and shutdowns is presented to the scientific public. The storage consists of a matrix of metal plates, placed in the flue gas channel between GT and HRSG, which is heated up during startup and cooled down during shutdown thus reducing the thermal gradients in the actual HRSG. The limitation to fast startups in combined cycle gas turbine (CCGT) plants is usually fatigue induced damage in critical components in the HRSG.

To investigate the influence of the storage on the fatigue damage, a transient modeling strategy of both, storage and HRSG, is developed. It is found, that in the investigated plant such a storage is capable of reducing the cycling fatigue damage in the most critical part of the HRSG by up to 90% and therefore enables to act the GT as flexible as if no HRSG was connected to it [3].

2.1.8 German Aerospace Center DLR – Industrial Project 1

In the cogeneration plant in Saarland, Germany, process steam is produced by burning mine damp in a gas turbine and producing steam in a heat recovery steam generator. One of the customers requires a very constant delivery of high quality steam, for which a backup boiler is kept at warm load in order to assume steam production within two minutes if the gas turbine trips.

The goal of the storage integration is to reduce fossil fuel use by reducing the load of the backup boiler to cold load, from which it requires fifteen minutes to assume steam production. For these fifteen minutes, the latent heat storage unit will produce steam for the steam customer. Sodium nitrate is the storage material, and the mass of the storage unit, including storage material and insulation, will be approximately 60 tons. The storage unit will discharge with an evaporation of feedwater to steam in the tubes. During charging, the steam will not be condensed, so that it can also be sent to the steam customer.

This work is being conducted in the project TESIN (Contract Nr. 03ESP011), which is partially funded by the German Federal Ministry for Economic Affairs and Energy [4]-[5]-[6]-[7].

2.1.9 German Aerospace Center DLR – Industrial Project 2

In combined-cycle gas turbine (CCGT) power plants, electricity and heat production are coupled. Combustion in the gas turbines generates electricity as a first step, then the exhaust gas is sent to a heat recovery steam generator (HRSG). The steam produced in the HRSG can either be sold directly to industrial clients or sent to a series of low- and high-pressure turbines to generate further electricity, raising the round-trip efficiency of the power plant. Gas turbines often serve as peaker power plants and during times of low power demand, it is not in the interest of the power plant to continue generating electricity. Thus the production of steam is also curtailed.

Integration of a thermal storage system can decouple the power and heat supply by charging the TES with excess heat during times of high power demand. Then, when power demand is low, thermal energy from the TES supports the steam boiler and heat is produced. This integration provides flexibility to compensate for fluctuations in variable renewable energy, supports grid stability and delivers balancing energy. A TES integrated into CCGT plant is a classic example of a retrofit application, in that it exploits a technical and economic potential in an already-existing process. The storage material selected constitutes of especially-engineered ceramic bricks and bulk storage from natural stone [4]-[8]-[9].

2.1.10 German Aerospace Center DLR – Industrial Project 3

In compressed air energy storages (CAES), electricity is used to compress ambient air which is then stored in an underground compressed air storage system consisting of a large cavern. During the initial compression process (shown in HP), heat is released as waste which contributes to a lower round-trip efficiency. Adiabatic compressed air energy storages (A-CAES) address this problem by reintegrating the compression heat into the discharging cycle.

During loading of the A-CAES (compression of ambient air), the TES system absorbs the compression heat and stores it until the A-CAES is discharged, at which point it is reintegrated and used to preheat the cavern air before entering the turbine. This increases the round-trip efficiency of the A-CAES storage process from 50% without TES to 70% with TES. By increasing the round-trip efficiency of the process, integration of the TES system contributes to reducing fossil fuel consumption of the power plant and subsequent emissions.

Although only 2 CAES installations currently exist in the world, this can be considered a retrofit integration because the TES system is being integrated following design of the power plant and CAES [4]-[10]-[11]-[12].

2.2 Summary

Table 1: Summary of data collected from running and closed industrial projects.

NR.	INSTITUTION	CONTACT PERSON	INDUSTRIAL PARTNER	SOURCE / SINK	CHARGING/ DISCHARGING TEMPERATURE (°C)	CHARGING/ DISCHARGING TIME	TYPE OF STORAGE	CAPACITY	POWER	CYCLING FREQUENCY
1	Hochschule Luzern HSLU	Rebecca Ravotti rebecca.ravotti@hslu.ch	FAFCO SA	Cooling unit/freezing process	20°C/ 7°C	14h /both	Latent	-	2 kW	-
2	Hochschule Luzern HSLU	Rebecca Ravotti rebecca.ravotti@hslu.ch	SUNAMP Ltd	Cooling unit/freezing process	-5°C/ -30°C	Approx 20 min/both	Latent	20-60 kWh Application dependant	-	Case dependant. Typically 1-5 cycles per day
3	Zentrum für Angewandte Energieforschung ZAE Bayern	Christoph Rathgeber	Industrienanlagen Hoffmeier GmbH	Incineration plant/industrial drying process	130°C/ 60°C	12h/16h	Sensible	2.3 MWh	225 kW (charging), 154 kW (discharging)	99 cycles in 1 year
4	Uni-Bayreuth	Andreas König-Haagen	Latherm GmbH	Waste heat from block-type thermal power station/Low process heat	95°C/ 58°C	7-14 h / 18 – 36 h	Latent	2.3 MWh	Max 250 Kw (discharging)	Case dependent typically about 200 cycles per year
5	Uni-Bayreuth	Andreas König-Haagen	enolcon GmbH	Waste heat from brick factory/	350°C/200°C	1h/both	Sensible	-	-	-
6	Technische Universität Münich TUM	Annelies Vandersickel	-	CC power plant/paper mill	245°C/265°C	6.5h/1h	Chemical	13.7 MW	-	-
7	Technische Universität Münich TUM	Annelies Vandersickel	-	Gas turbine/heat recovery steam generator	590°C/350°C	Response time of TES 15 min	Sensible	420 MW	Gross 127 MW	Cycle length min 80 min
8	German Aerospace Center DLR	Maike Johnson	-	heat recovery steam generator outlet/steam customer	103/ 350°C	Response time of TES 2 min	Latent	5.22 MWh	6 MW	Min cycle length over 15.25h, once per month
9	German Aerospace Center DLR	Maike Johnson	-	Exhaust gas turbine/heat recovery steam generator	400°C/600°C	Response time TES lower than 1 min	Sensible	3000 MWh	250 MW	Min cycle length over 4h, once per day
10	German Aerospace Center DLR	Maike Johnson	-	Compressor heat/Power block	400°C/600°C	Response time TES lower than 1 min	Sensible	340 MWh	34 MW	Min cycle length over 4h, once per day

3 References

[1] Krönauer, A.; Lävemann, E.; Hauer, A.; Mobile Sorption Heat Storage in Industrial Waste Heat Recovery, En. Proc., 2015, 73, 272-280, DOI: 10.1016/j.egypro.2015.07.688

[2] Angerer, M.; Djukow, M.; Riedl, K.; et al.; Simulation of Cogeneration-Combined Cycle Plant Flexibilization by Thermochemical Energy Storage, J. En. Res. Tech., 2018, 140, 1-12, DOI: 10.1115/1.4038666

[3] Angerer, M.; Kahlert, S.; Spliethoff, H.; Transient Simulation and Fatigue Evaluation if Fast Gas Turbine Startups and Shutdowns in a Combined Cycle Plant with an Innovative Thermal Buffer Storage, En., 2017, 130, 246-257, DOI: 10.1016/j.energy.2017.04.104

[4] International Energy Agency IEA; Applications of Thermal Energy Storage in the Energy Transition – Benchmarks and Developments, Public Report of IEA ECES Annex 30, September 2018, Available at: https://www.eces-a30.org/wp-content/uploads/Applications-of-Thermal-Energy-Storag-in-the-Energy-Transition-Annex-30-Report.pdf

[5] Johnson, M.; Vogel, J.; Hempel, M.; et al., Design of High Temperature Thermal Energy Storage for High Power Levels, Sust. Cit. and Soc., 2017, 35(November), 758-763, DOI: 10.1016/j.scs.2017.09.007

[6] Johnson, M.; Vogel, J.; Hempel, M.; et al. High temperature latent heat thermal energy storage integration in a co-gen plan, En. Proc., 2015, 73 (June), 281- 288, DOI: 10.1016/j.egypro.2015.07.689

[7] Dengel, A.; M. Seitz, M.; Johnson, M.; et al.; Hochtemperatur-Wärmespeicher in der dezentralen Energiewirtschaft, VGB Power Tech, 2015, 5, 74-79. ISSN 1435-3199

[8] K. Stahl, K.; Zunft, S.; Kessler, S.; Siebert, M.; Entwicklung eines Hochtemperatur-Wärmespeichers zur Flexibilisierung von GuD-Kraftwerken, Kraft. Band 4 Sich. und Nach. Energ., 201, 777-784

[9] Zunft, S.; Dreißigacker, V.; Krüger, M.; Einsatz von Hochtemperaturspeichern in der Kraftwerkstechnik und ihre Entwurfsaspekte, Kraftwerkstechnik, 2014, 637–646

[10] Jakiel, C.; Zunft, S.; Nowi, A.; Adiabatic compressed air energy storage plants for efficient peak load power supply from wind energy: the European project AA- CAES, Int J Energy Technol Policy, 2017, 5(3), 296–306, DOI: 10.1504/IJETP.2007.014736

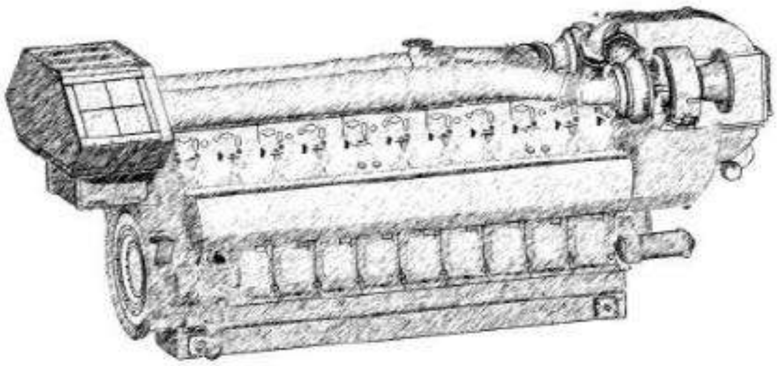
[11] Wolf D.; Methods for design and application of adiabatic compressed air energy: storage based on dynamic modeling. Oberhausen: Laufen; 2011, ISBN: 978-3-87468-264-0

[12] Zunft, S.; Dreißigacker, V.; Bieber, M.; et al.; Electricity storage with adiabatic compressed air energy storage: Results of the BMWi-project ADELE-ING, in Proc. 2017 International ETG Congress, Bonn, Germany, 1-5

4 Annexe – Supplementary Material

4.1 Uni-Bayreuth Latherm Project – Block-type thermal power station

Jenbacher gas engines
Technical Specification



JMS 620 GS-B.L
Biogas 2.433kW el.

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Tel. +43 5244 600-0
Fax +43 5244 63255

http://information.jenbacher.com
jenbacher.info@ge.com

JMS 620 GS-B.L
Biogas 2.433kW el.

CO-GEN Module data:		
Electrical output	kW el.	2.433
Recoverable thermal output (180 °C)	kW	2.743
Energy input	kW	6.205
Fuel Consumption based on a LHV of 5 kWh/Nm³	Nm³/h	1.241
Electrical efficiency	%	39,2%
Thermal efficiency	%	44,2%
Total efficiency	%	83,4%
Heat to be dissipated (LT-Circuit)	kW	
Emission values: NOx < 250 mg/Nm³ (5% O2)		

Additional information:		
Sound pressure level (engine, average value 1m)	dB(A)	101
Sound pressure level exhaust gas (1m, 30° off engin	dB(A)	123
Exhaust gas mass flow rate, wet	kg/h	15.128
Exhaust gas volume, wet	Nm³/h	11.757
Max.admissible exhaust back pressure after engine	mbar	60
Exhaust gas temperature at full load	°C [8]	467
Combustion air mass flow rate	kg/h	14.019
Combustion air volume	Nm³/h	10.845
Max. inlet cooling water temp. (intercooler)	°C	60
Max. pressure drop in front of intake-air filter	mbar	10
Return temperature	°C	60
Forward temperature	°C	90
Hot water flow rate	m³/h	78,5

Engine data:		
Engine type		J 620 GS-E22
Configuration		V 60°
No. of cylinders		20
Bore	mm	190
Stroke	mm	220
Piston displacement	lit	124,75
Nominal speed	rpm	1.500
Mean piston speed	m/s	11
Mean effe. press. at stand. power and nom. sp	bar	16,00
Compression ratio	Epsilon	11,0
ISO standard fuel stop power ICFN	kW	2495
Spec. fuel consumption of engine	kWh/kWh	2,49
Specific lube oil consumption	g/kWh	0,30
Weight dry	kg	12.000
Filling capacity lube oil	lit	670
Based on methane number	MZ	100

Alternator:		
Manufacturer		STAMFORD
Type		LVSI 804 W
Type rating	kVA	3.555
Efficiency at p.f. = 1,0	%	97,5%
Efficiency at p.f. = 0,8	%	96,6%
Ratings at p.f. = 1,0	kW	2.433
Ratings at p.f. = 0,8	kW	2.410
Frequency	Hz	50
Voltage	V	690
Protection Class		IP 23
Insulation class		H
Speed	rpm	1.500
Mass	kg	6.752

Technical parameters:

Applicable standards:	Based on DIN-ISO 3046	
	Based on VDE 0530 REM with specified tolerance	
Standard conditions:	Air pressure:	1000 mbar or 100 m above sea level
	Air temperature:	25°C or 298 K
	Relative Humidity:	30%
Engine output derating:	for plants installed at > 500m above see level and/or intake temperature > 30°C, the reduction of engine power is determined for each project.	
Gas quality:	according to TA 1000-0300	
	Gas flow pressure:	80 - 200 mbar (Lower gas pressures upon inquiry)
	Prechamber gas pressure: 2,9-4,0 bar	
	Max. variation in gas pressure: ±10%	

All data are based on engine full load at specified media temperatures and are subject to change.
The technical Instruction TA 1100-0110 "PARAMETER FOR GE Jenbacher GAS ENGINES" must be strictly observed.

>>> Scope of supply genset - JGS 620 GS-B.L

Basic engine equipment:
*Exhaust gas turbocharger, Intercooler
*Motorized carburator for LEANOX control
*Electronic contactless high performance ignition system
*Lubricating oil pump (gear driven)
*Lubricating oil filters in main circuit
*Lubricating oil sump; Lubricating oil heat exchanger
*Jacket water pump
*Fuel-, lubricating oil and jacket water pipe work on engine
*Flywheel for alternator operation; Exhaust gas manifold
*Viscous damper
*Knock sensors

Engine accessories:
*Electric starter motor
*Electronic speed governor
*Electronic speed monitoring device including starting and
overspeed control
*Transducers and switches for oil pressure, jacket water temp.,
jacket water pressure, charge pressure and mixture temperature
*One thermocouple per cylinder

Supplied loose:
Gas train according to DIN-DVGW consisting of:
*Manual stop valve, fuel gas filter, two solenoid valves,
Leakage control device, gas pressure regulator
Prechamber Gas Train

Documentation:
*Operating and maintenance manual
*Spare parts manual
*Drawings

Assembly, painting, testing in Jenbach/Austria

Module equipment:
*Base frame for gas engine,
alternator and heat exchangers
*Internal pole alternator with excitation alternator and
with automatic voltage regulator; p.f. 0,8 lagging to 1,0
*Flexible coupling, bell housing
*Anti-vibration mounts
*Air filter
*Automatic lube oil replenishing with level control
*Wiring of components to module interface panel
*Crankcase breather
*Jacket water electric preheating

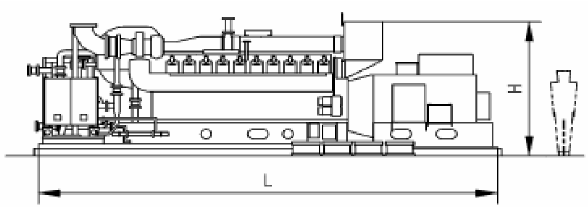
Module control panel:
*Totally enclosed , single door cubicle, wired to terminals and
ready to operate, protection IP 41 outside,
IP 10 inside, according to VDE-standards

Control equipment:
*Engine-Management-System dia.ne (Dialog Network)
**Visualisation (industry PC-10" color graphics display): Operation data,
controller display,Exh. gas temp.,Generator electr. connection,etc.
**Central engine- and module control: Speed-, Power output-,
LEANOX-Control and knock control, etc.
*Multi-transducer
*Lockable operation mode selector switch
Positions: "OFF", "MANUAL", "AUTOMATIC"
*Demand switch

>>> Scope of supply module - JMS 620 GS-B.L

Identical to Genset except that heat recovery is included.
*jacket water heat exchanger mounted on module frame
*exhaust gas heat exchanger mounted as separate heat recovery module
*all heat exchangers with complete pipework
*Heat exchangers and all inherent auxiliaries

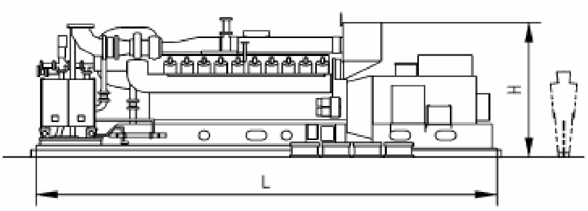
Genset



Main dimensions and weights (approximate value)		
Length L	mm	8.900
Width B	mm	2.500
Height H	mm	2.800
Weight empty	kg	26.200
Weight filled	kg	27.200

Connections (at genset)		
Jacket water inlet and outlet	DN/PN	100/10
Exhaust gas outlet	DN/PN	600/10
Fuel gas (at gas train)	DN/PN	100/16
Intercooler water connection:		
Low Temperature Circuit	DN/PN	65/10

Module



Main dimensions and weights (approximate value)		
Length L	mm	8.900
Width B	mm	2.500
Height H	mm	2.800
Weight empty	kg	26.800
Weight filled	kg	27.800

Connections (at module)		
Hot water inlet and outlet	DN/PN	100/10
Exhaust gas outlet	DN/PN	600/10
Fuel gas (at gas train)	DN/PN	100/16
Intercooler water connection:		
Intercooler water-Inlet/Outlet 2nd stage	DN/PN	65/10

Heat recovery module

Main dimensions and weights (approximate value)		
Width B	mm	1.962
Height H	mm	5.800
Length L	mm	6.750

Connections (on heat recovery module)		
Hot water inlet and outlet	DN/PN	100/10
Exhaust gas outlet	DN/PN	600/10
Condensate drain	DN/PN	50/10
Drain line	½"	½"

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