Waste heat recovery systems for the Glass Industry

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Why Waste Heat Recovery in the glass industry?

- **Since 2008 the operating margin in many glass markets (except Asia) is almost zero**
- **Focus to the main production cost drivers**
- **Energy costs roughly are about 25 % of the total glass production costs**
- **Only 15 - 20 % of the primary energy input in a glass melter is effective for glass creation**

=> More than 80 % of the primary energy input is wasted!

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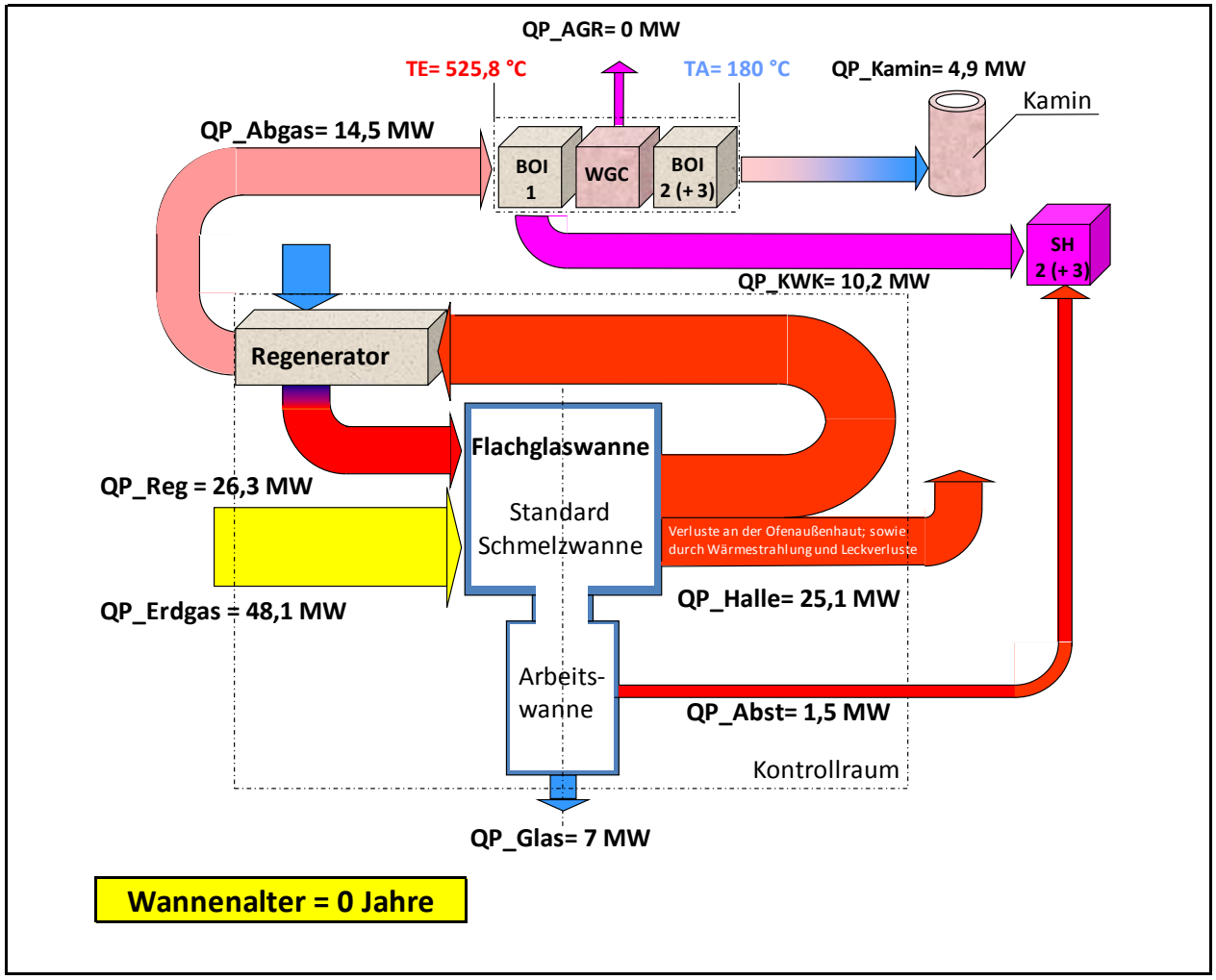
Waste heat potential (sample: 700 tpd glass melter)



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Waste Heat Recovery solutions

- **Production facility cooling water heat recovery (for central heating system)**
- **Water or steam based cooling energy and heat energy generation**
- **Water / Steam based electrical power generation by a turbine/generator unit**
  - Standard WHR solution
  - Advanced WHR solutions from qpunkt
- **ORC based electrical power generation by a turbine/generator unit**

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Typical client WHR requirements

=> Top priority for the glass production (quality and quantity)

=> Minimized influence of the WHR system to the furnace pressure characteristics

=> High WHR utilization grade (technological & process related)

=> Maximized electrical power output

=> Independent electrical power supply

=> Short ROI

=> System implementation during operation (not only at cold repair)

=> Additional heat and/or cooling energy utilization

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qpunkt WHR concept basics

Optimization potential of standard WHR systems in the Glass Industry:

- Unreliable initial WHR design data
- Over-expected power generation
- Over-expected utilization grade
- Furnace pressure characteristics
- Return of investment
- Electrical energy costs after pay back period
- Combination of electrical and heat/cooling energy production

Objective of our patent registered qpunkt WHR concept is improvement of this identified weak points, and provision of a unique high performance WHR system to our potential customers.

qpunkt WHR concept basics
Initial WHR design data check or how operates qpunkt?

- Provision of an initial data sheet to the client
- Plausibility check of the received data
- Site survey (if required)
- WHR potential analysis
- Local supply part check
- Provision of qpunkt/Oranje Kracht quotation

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qpunkt WHR performance – Influence to the glass production process

WHR systems could cause furnace pressure peaks originated by boiler or emergency shut-down modes, and also higher ID-fan electrical power demand.

Glass production influences by qpunkt WHR system:

- **Only 50 – 70 % pressure drop compared with standard WHR solutions**
- **Significant reduced furnace pressure peaks by implementation of patent registered EQM system, by additionally reduction ID-fan electrical power demand down until 50 %**
- **Continuous and uninterrupted electrical power supply of the float glass production line even in case of main power failures**
- **Dedicated chimney and chimney connection design by qpunkt avoids also furnace pressure peaks caused by emergency shut down procedures of the WHR / WGC system**

=> qpunkt WHR system particular in combination with EQM and a dedicated chimney design improves furnace pressure progress with additional savings and further advantages!

qpunkt WHR performance - Utilization

The WHR utilization depends on:

a) System reliability

- Granted by considering nameable and experienced WHR equipment suppliers.

b) Required cleaning and maintenance works

- Due to dust polluted waste gas, the boilers have to be cleaned periodically during operation. Usage of automatically working boiler cleaning systems do not cause any WHR system downtime
- The WHR system requires only one yearly check with 3-4 days downtime (no extra downtime in case of existing waste gas cleaning system!)

c) Process related waste gas conditions

- Waste gas condition variation (temperature and volume) caused by furnace age, product change, melting capacity variation, etc., cause underperformance and also downtime at standard WHR solution
- The qpunkt WHR system always operates with highest performance grade at all waste gas conditions.

=> Utilization grade of the qpunkt - WHR system >= 97 %

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qpunkt WHR performance – Return on invest & Electrical output

	ORC WHR	Standard WHR	qpunkt WHR Type 1	qpunkt WHR Type 2
Available waste heat energy [MW_{th}]	9	9	9	9
Electrical net energy generation [MW_{el}]	1,8	1,9	3,1	2,75
WHR utilization [%]	96	92	97	97
Total investment costs [Mio. €]	5	5,6	6,5	6,7
Market electrical energy costs [€/MW]	80	80	80	80
Electrical energy production costs [€/MW]	6,6	6,5	23,2	15,6
Natural gas costs [€/MW]	25	25	25	25
WHR natural gas demand [m^3/h]	0	0	240	125
Av. plant electrical energy demand [MW_{el}]	3	3	3	3
Pay back period except any cooling or heating application [years]	**4,1**	**4,6**	**4,1**	**4,2**
Yearly electrical energy costs after pay back period	**991.418**	**977.402**	**604.926**	**598.554**

Electrical energy costs without WHR: ca. 2,1 Mio.€ p.a.
(Investment costs based on Western European prices)

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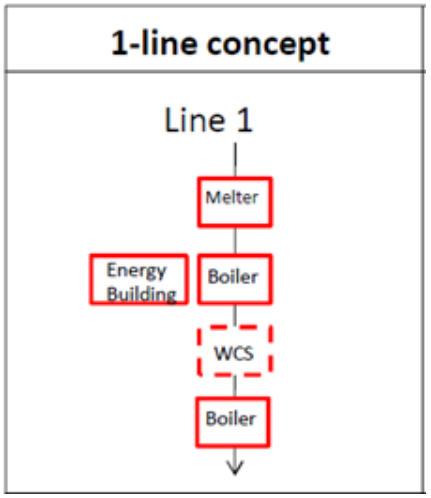
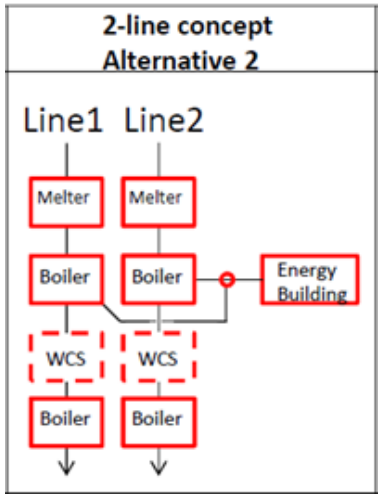
qpunkt WHR performance – System application and implementation

- Float and container glass plants (100 – 1.200 tpd)
- Regenerative or oxyfuel melter systems
- Natural gas or oil fueled
- Single line or multi-line implementation:





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qpunkt WHR performance – System implementation

- **WHR systems generally could be implemented into:**
  - New plants
  - Existing plants with waste gas cleaning systems
  - Existing plants without waste gas cleaning systems
  - Existing plants with later to implement waste gas cleaning systems

- **WHR systems could be implemented at new plant installation, during cold repair and in many cases also during operation.**

- **Corresponding connections for integration of the boilers should be prepared or have to be prepared under "hot work" conditions.**

=> **Implementation of the qpunkt - WHR system is possible in most cases, even during operation**

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qpunkt WHR performance – System implementation

Combined WHR and Waste Gas Cleaning system

Typical WHR system space requirement:

For the boiler system: ca. 25 x 30 m

For the turbine house: ca. 15 x 20 m

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qpunkt WHR performance – Heat and cooling utilization

- **Additional to the electrical energy generation the waste heat also could be utilized for:**
  - Heating of buildings or storage areas
  - Cooling energy
  - Process uses (i.e. cullet drying, sand storage heating, etc.)

- **The qpunkt – WHR concept provides available heating temperatures up to 60 °C. A 700 tpd float glass plant provides ca. 8 MW heat power without any reduction of the electrical power generation.**

- **By only electrical power reduction of ca. 250 kW, more than 2 MW cooling energy (cold water at 7 °C) could be generated!**

- **Additional use of heat power could be made adaptable for neighbored greenhouses (extra benefit by selling idle heat energy at 60 °C)**

=> **The qpunkt WHR system utilizes a huge amount of heat and cooling energy, and is adaptable for each particular customer heat & cooling demand.**

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Summary

	Requirements	qpunkt - WHR system	Result
Top priority for glass production	Top priority	Top priority	✓
Influence on the furnace pressure	Minimized	Minimized / Improved *1)	✓
Short ROI	< 5 years	2,5 - 5 years	✓
Electrical power output	Maximized	Maximized	✓
WHR utilization time	Maximized	>= 97 %	✓
Heat & Cooling utilization	Customized solutions	Customized solutions	✓
Electrical efficiency grade	Maximized	up to 25 %	✓
Accumulated savings	Maximized	Maximized	✓
System implementation	during operation	during operation	✓

***1) Improved by EQM© (reduces furnace pressure peaks ans reduces ID fan electrical power consumption up to 100 kW)**

The advanced qpunkt – WHR system complies with all typical requirements, and provides also further saving and process optimization potential (i.e. by the patent registered EQM system).

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Thank you for your attention.