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The Efficiency Company

Organic Rankine Cycle Application Efficiency

Efficient ORC Products for the volume market

From technology development to (pre-series) product –
the ePack Hybrid

ASME ORC 2015, Brussels, 12. – 14.10.2015

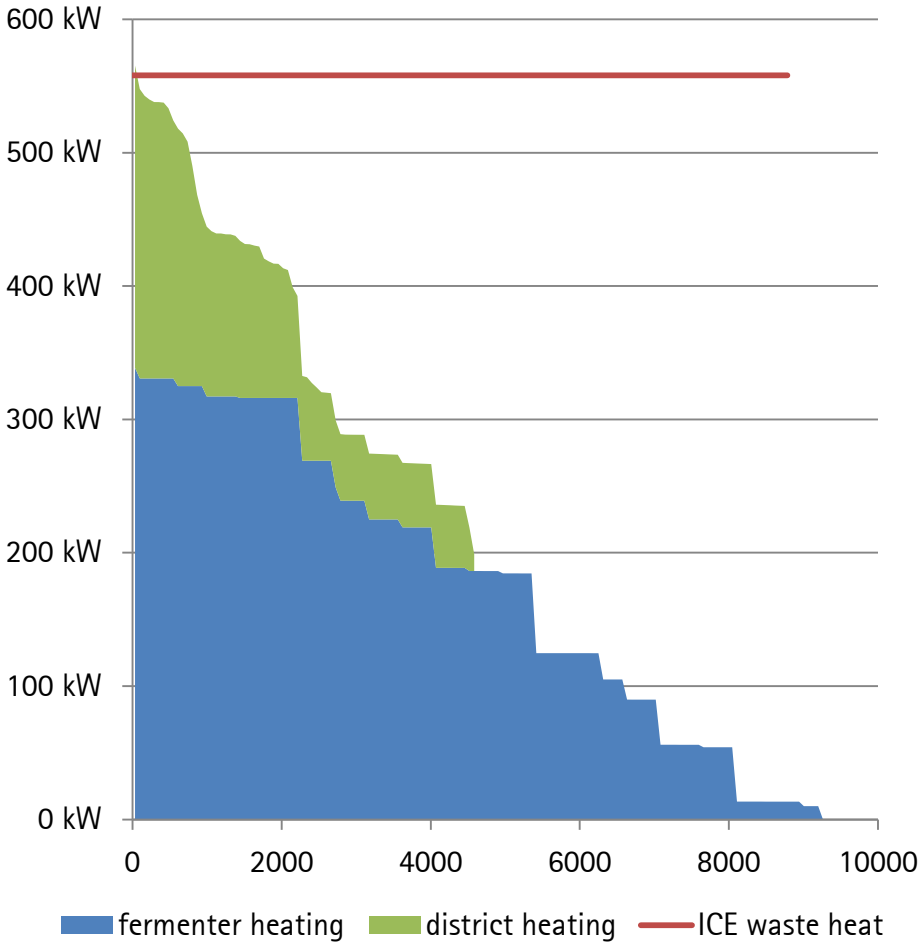
Introduction of Orcan Energy AG

Motivation

Concept and features of the ePack Hybrid

Operational experience

- 2004 start of technology development at TU Munich
- 2008 foundation of Orcan Energy as spin-off of TU Munich
- 2011 focus on product development
- 2012 focus on field validation of ePack
- 2013/14 market entry with series product and development of next generation ePack
- 2015 Technology proven in the field: >150'000 h of ORC-operation with availability of 95 %, > 2.2 GWh of produced power
- > 60 employees in the areas of R&D, Operations, Marketing and Sales, and G&A



- Market potential: small-scale waste heat sources of internal combustion engines in biogas plants or industry and heating processes
- Boundary conditions: small or seasonal heat demand compared to waste heat generation
- Market requirements:
  - Flexibility to use part of the waste heat for heating purposes (e.g. seasonal district heating, drying processes, fermenter heating)
  - High availability
  - Cost efficiency
  - Plug & play installation

A small-scale ORC module producing power from waste heat has to offer the flexibility in order to satisfy heating demands as well.

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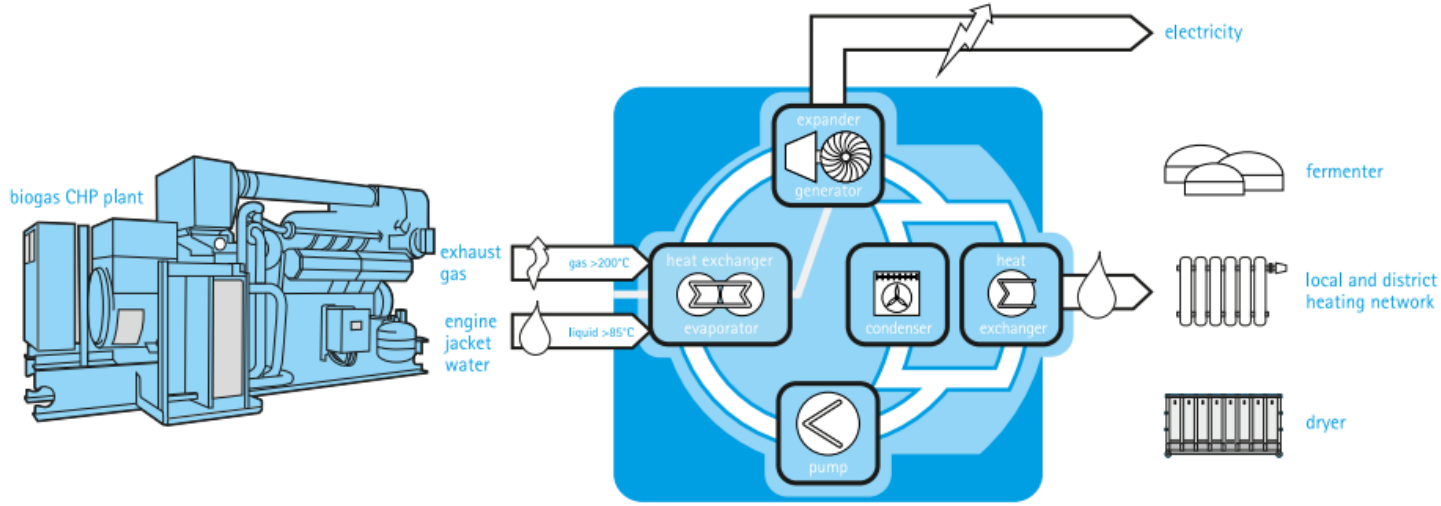
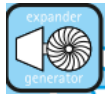
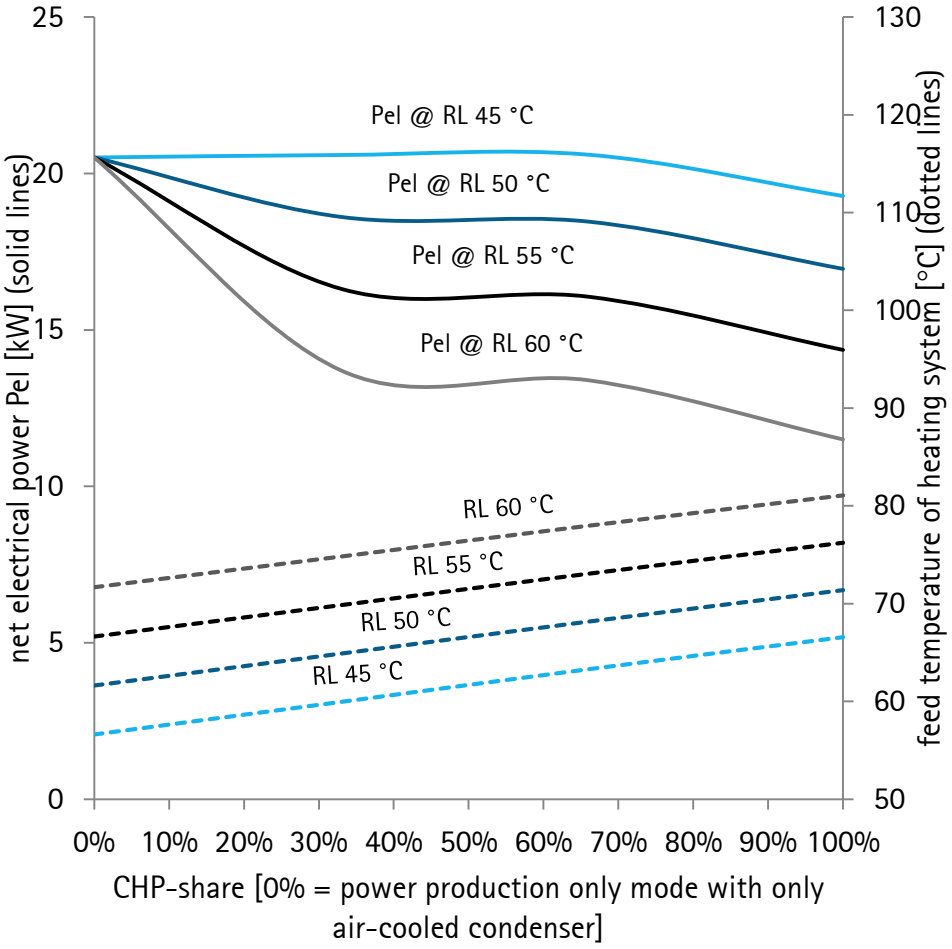


- Transport of engine waste heat by hot water intermediate cycle  into ORC-module
- Preheating, evaporation and superheating of pressureized ORC working fluid and transport to expansion machine
- Generation of mechanical energy in screw expansion machine  by working fluid vapor
- Driving of hermetically coupled generator in order to generate electrical energy
- Condensation of working fluid after expansion either by air cooled condenser  (no use of heat) or water cooled condenser  (in case of heat demand)
- Pressurizing working fluid after condensation by fluid feed pump 

- Integrated air cooled condenser → lower installation costs and times
- Use of industry standard components → high availability > 95 % and high cost efficiency with payback times < 2 a
- Dynamic and part load operation under various operating conditions
- Flexible module for ICEs from 400 kW to 2 MW due to stack-functionality
- Variable CHP mode from 0-100 % → suitable for various applications
- 100 % factory tested, immediatly ready for operation, unmanned operation
- Working fluid non-flamable and harmless for environment and health
- CE certified

The ePack is the first ORC PRODUCT for the mass market.



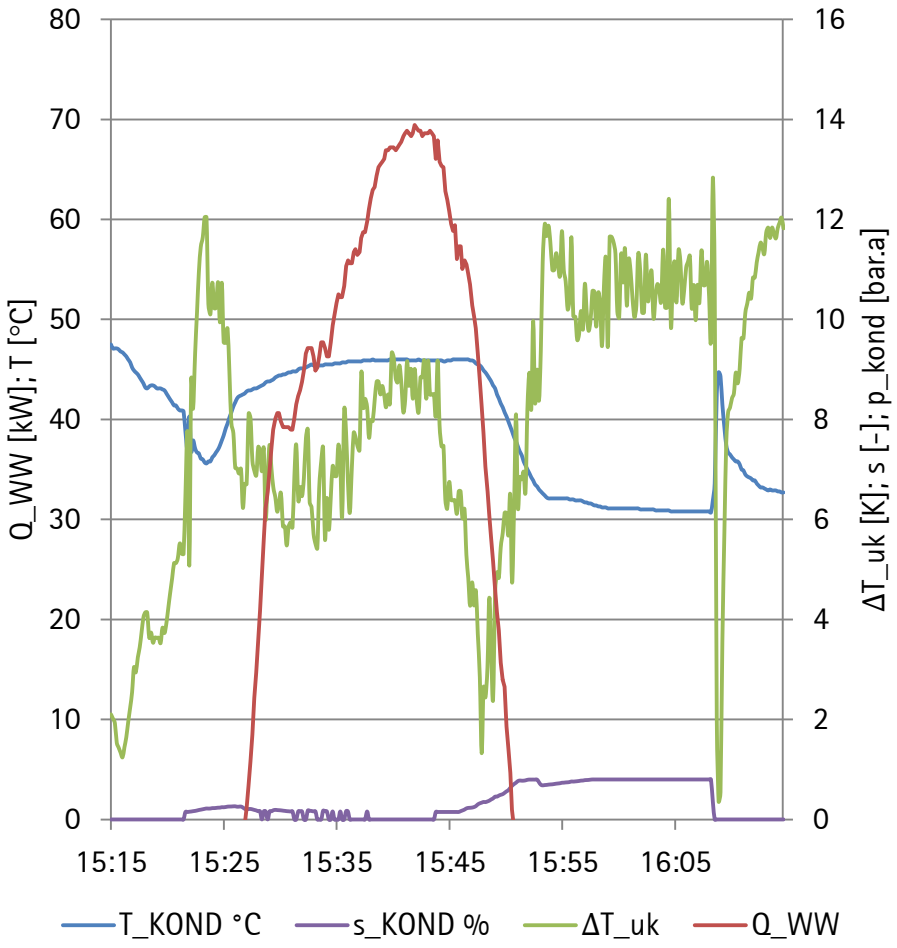
Operation modes of the ePack Hybrid

- No heat demand, electricity production only → only ventialtors are in operation
- High heat demand, low electricity production → only water cooled condenser in operation
- Low heat demand with medium electricity production → both condensers are in operation

→ All operation modes are only enabled and controlled by the rotational speed of the fans and by using thermodynamic effects

Challenges for save operation in every mode

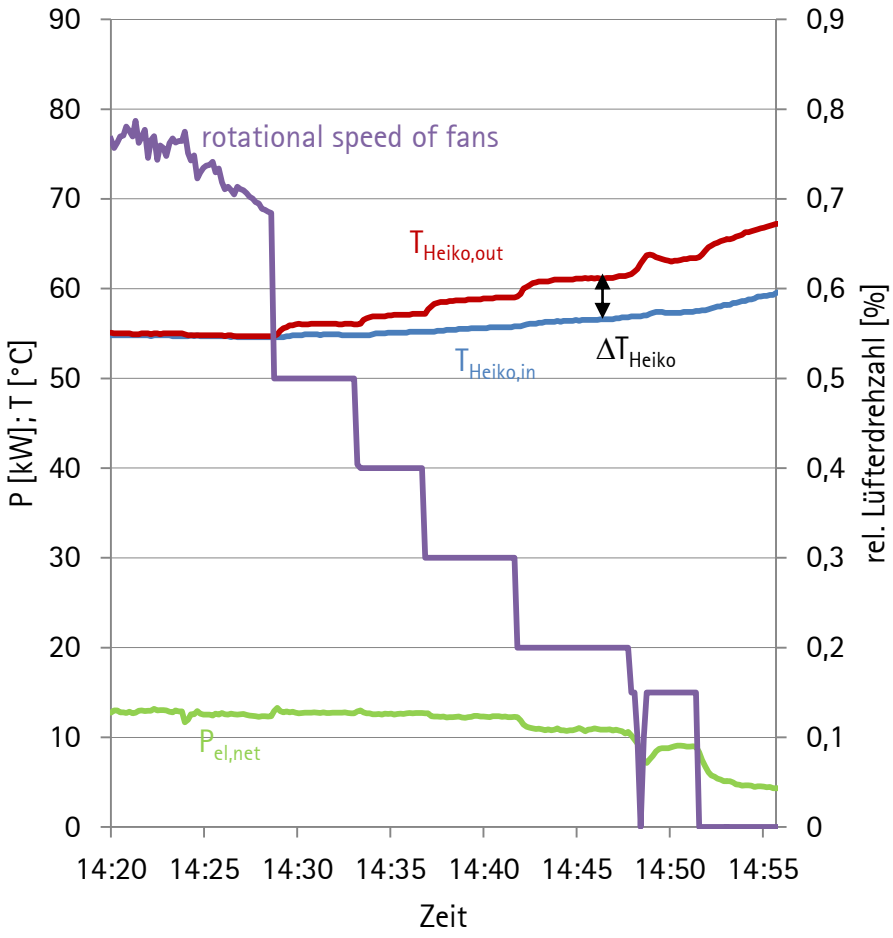
- Suitable distribution of working fluid in both condensers
- Ensure sufficient subcooling of working fluid before feed pump to avoid cavitation



Goal: proof stable operation of ePack Hybrid while changing operation mode

- Start in CHP mode → fans not in operation, ~ 70 kW heat output of water cooled condenser (15:35 – 15:45)
- Increasing rpm of fans → decreasing CHP heat to 0 & decreasing subcooling from 9 K to 2 K for short time, but still stable operation (15:45 – 15:50)
- Electricity only mode with higher subcooling of 11 K and lower condensation temperature (air temperature lower than cooling water temperature) → fluid has moved from water cooled condenser to air cooled condenser (15:50 – 16:05)

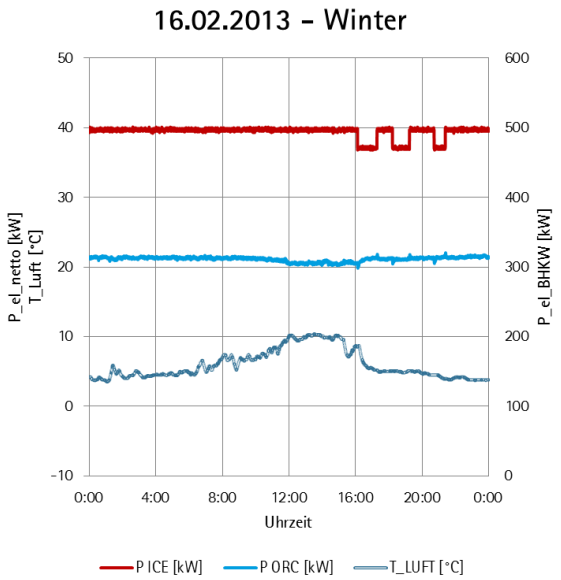
Stable operation during changes of operation mode of ePack Hybrid is validated at test bench.

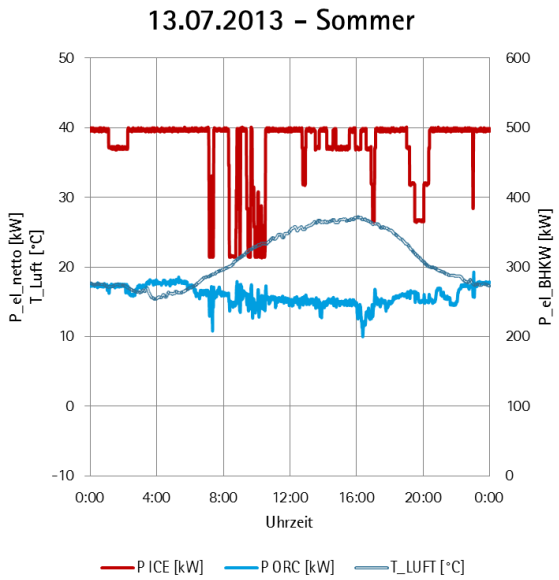


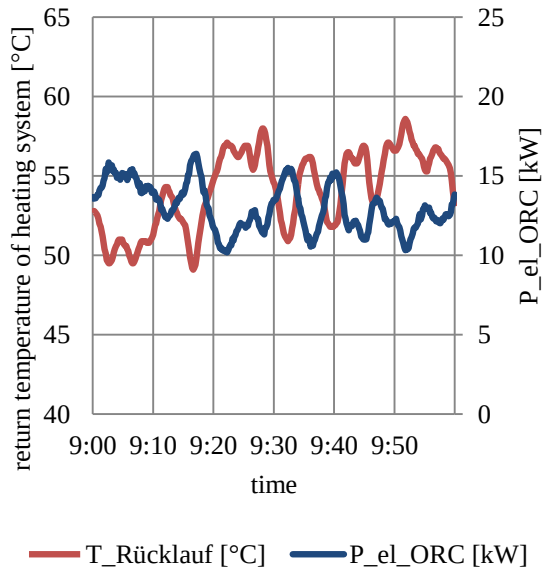
Change of operation mode from electricity only generation to CHP mode

- Immediate start of heat „production" in water cooled condenser with decreasing fan rpm
- The lower the fan rpm, the higher the heat output to the heating system of the water cooled condenser (increasing ΔT_{Heiko})
- With increasing return temperatures of the heating system, the power output decreases

The ePack Hybrid is also working stable under field conditions.







Winter day

- Low ambient temperature → high power output > 20 kW

Summer day

- High ambient temperature up to 28 °C and dynamic operation of ICE (heat source)

→ Stable ORC operation with still high average power output of ~ 17 kW

Varying temperatures in heating system

- ePack follows the highly fluctuating temperature with fluctuating power output
- Still stable operation possible

Stable and reliable operation under various and dynamic operating conditions proofen.

+ First product installed in 2012
+ More than 20.000 hours on longest running unit
+ Optimized for gas engines
+ Focus on German market

+ First product installed in 2014
+ Higher efficiency than pre version
+ Lower footprint (integrated condenser)
+ Designed for mass production
+ Designed for worldwide market

Biogas
Dragsdorf
ePack

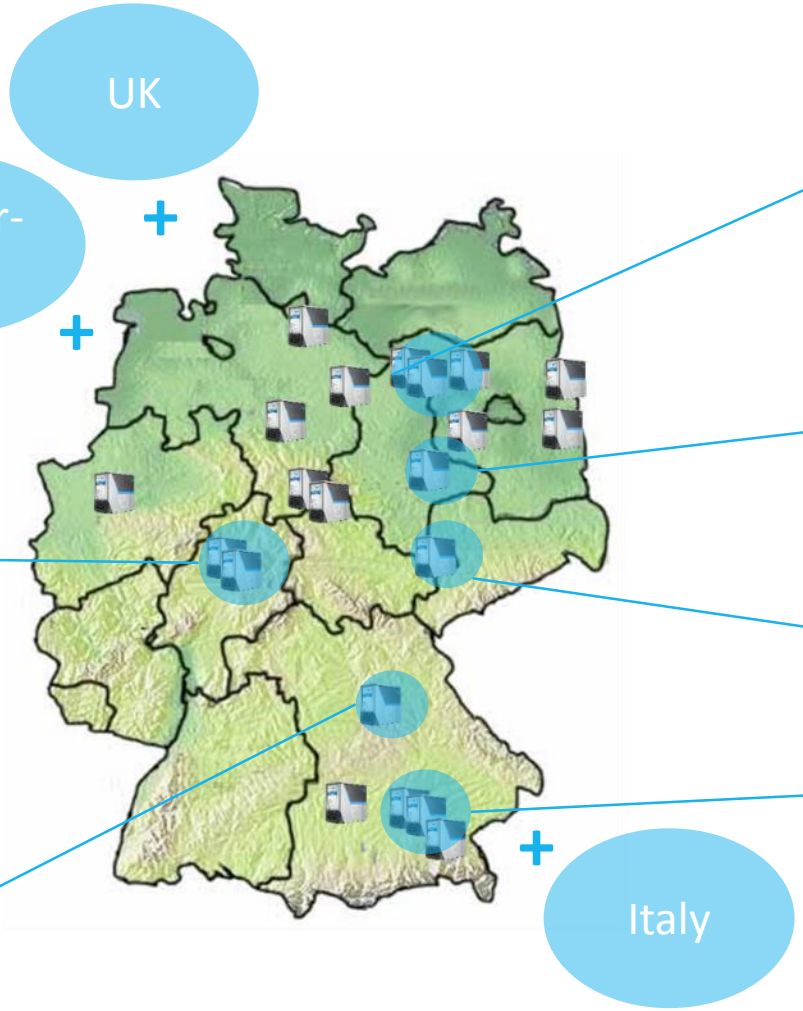
Biogas
Oldendorf
ePack-Stack

Industry
Kirchhain
ePack-Stack

Biogas
Plätz II
ePack

Biogas
Hilpoltstein
ePack

Biogas
Plätz III
ePack



Biogas
Mehrin
ePack

Biogas
Belleben
ePack

Biogas
Sauen
ePack

Industry
München
ePack-Stack

Biogas
Werbig
ePack

Status – September 2015

- Cumulated Runtime: >150'000 h
- >2.2 GWh_{el} CO2-free electricity generated
- Average Availability: > 95 %

Thanks for your attention!

Questions?