



# E-RATIONAL

VALUE FOR HEAT

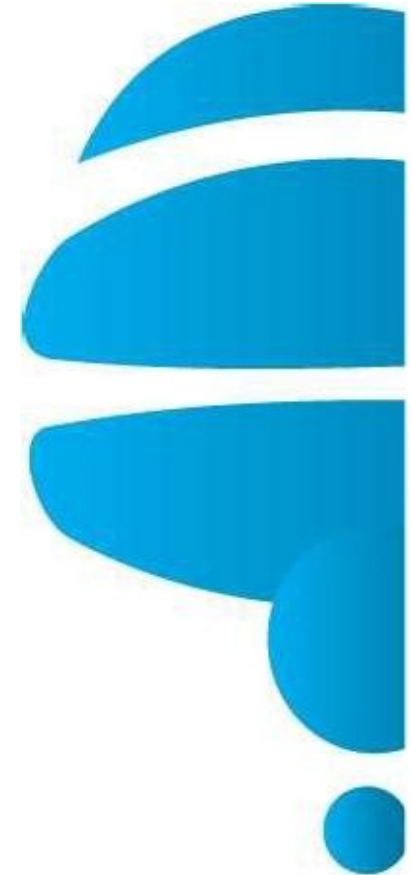
**LOCAL PARTNER:**

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# **Turning waste heat into Clean Energy**



# BEP Europe



- BEP Europe is part of an international group with HQ in US, global sales network and production facilities in US, China and Belgium.
- BEP Europe in Brugge, Belgium :
  - >100 people
  - 7500 m<sup>2</sup> production facilities, including machining, welding, assembly, testing
  - Automotive, Clean Energy
  - Approx. 35 M€ turnover/year

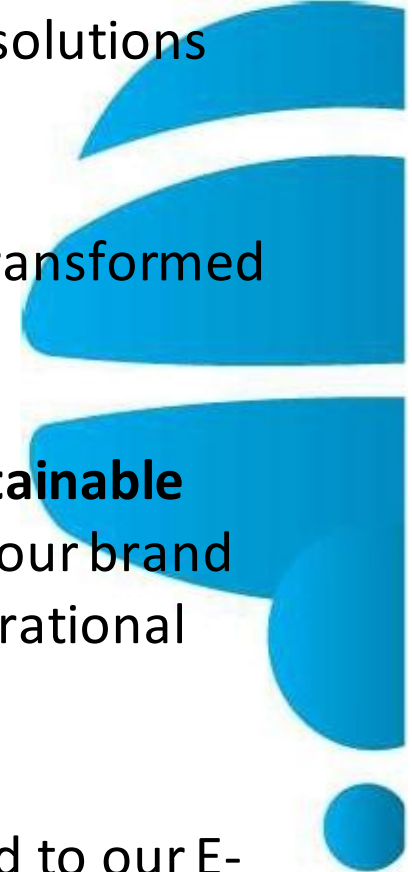


**BEP ENERGY's mission** is to provide sustainable energy solutions based on common sense: No Heat To Waste!

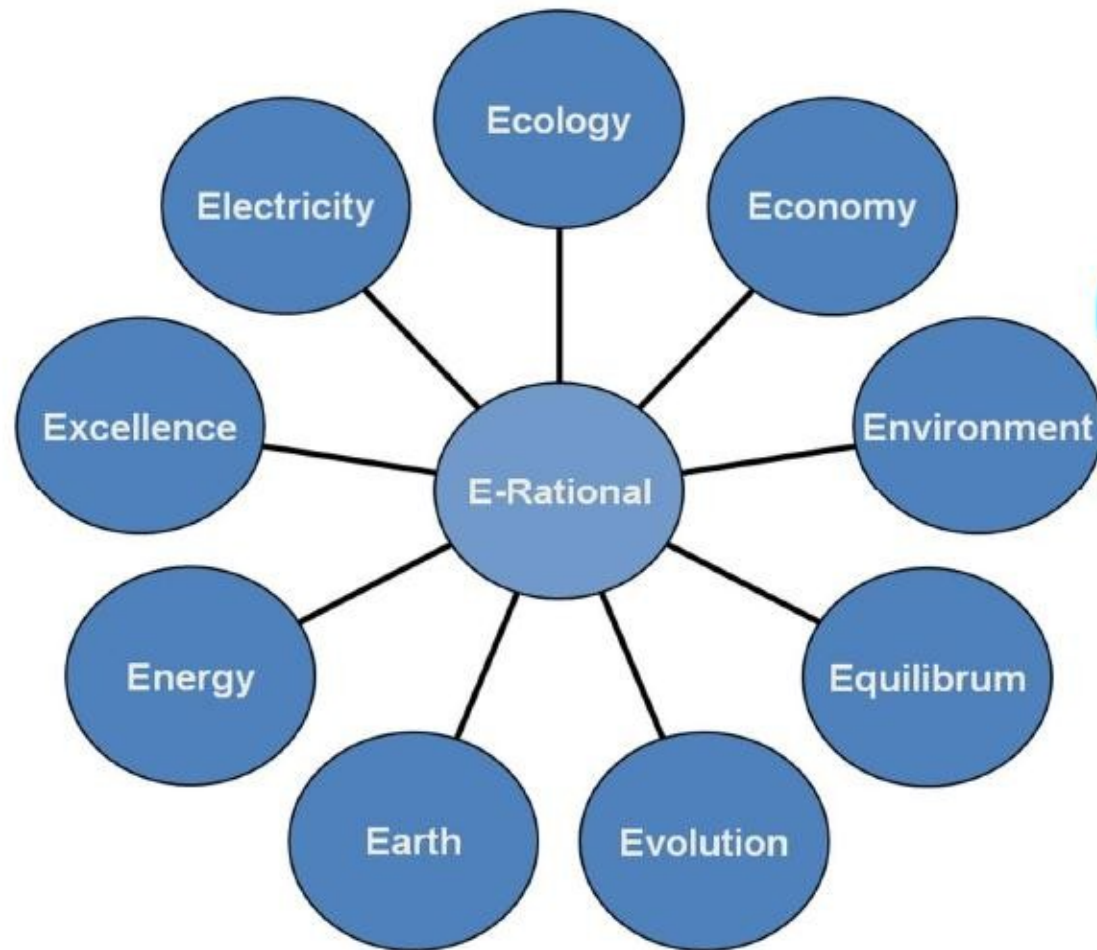
With our E-rational machines, low grade waste heat is transformed to virtually free green electricity

**E-rational stands for a rational, logical approach of sustainable energy production.** With a subtle hint of irrationality in our brand name, we want people to start thinking about current irrational energy approaches and use again their common sense.

Consistent reasoning combined with proven facts has led to our E-rational product range



# The multiple “E” of E-Rational





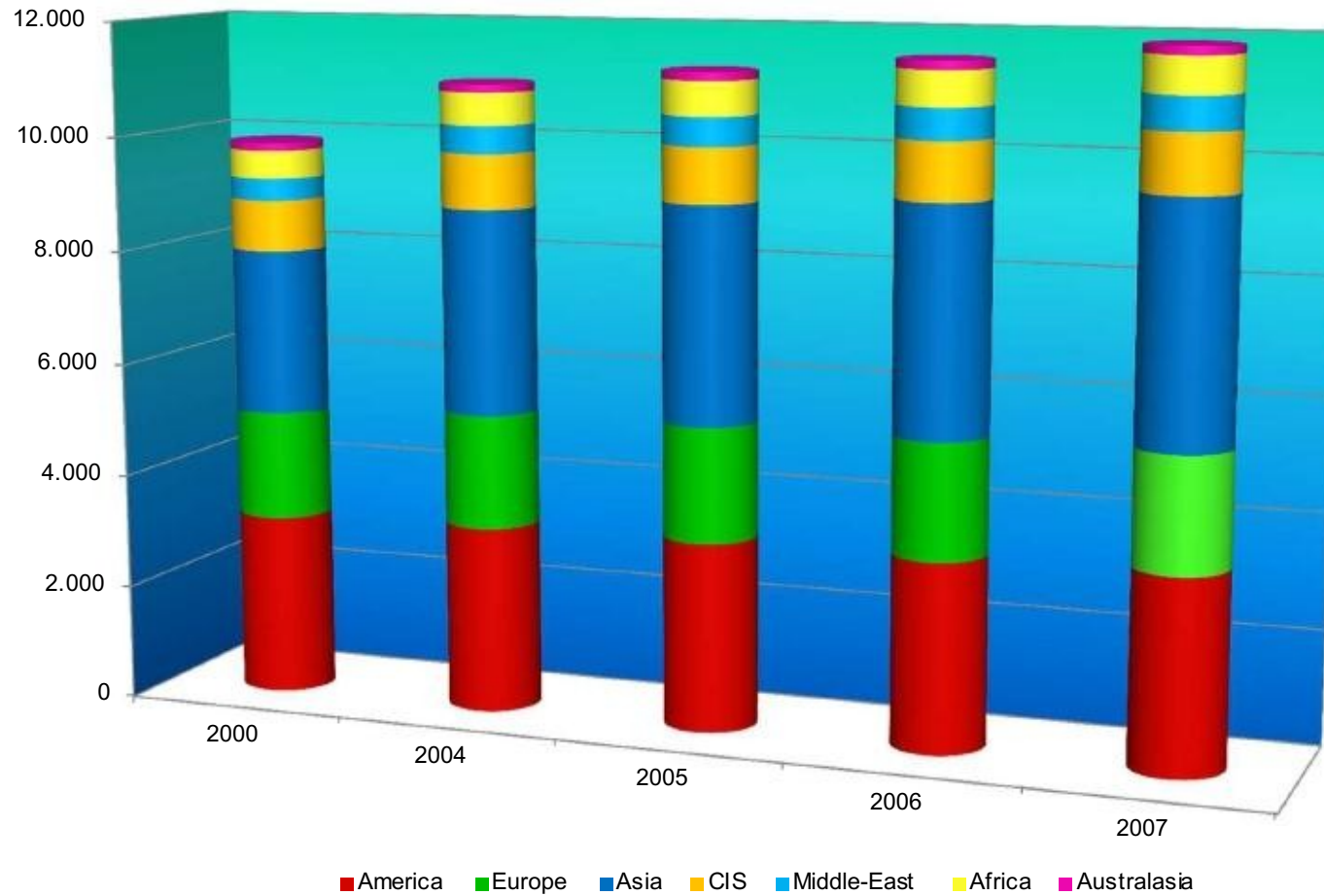
Long Track record as equipment manufacturer

- Automation projects
- End of line testing equipment for automotive industry
- “Wheel and tyre” assembly
- Equipment for energy recovery



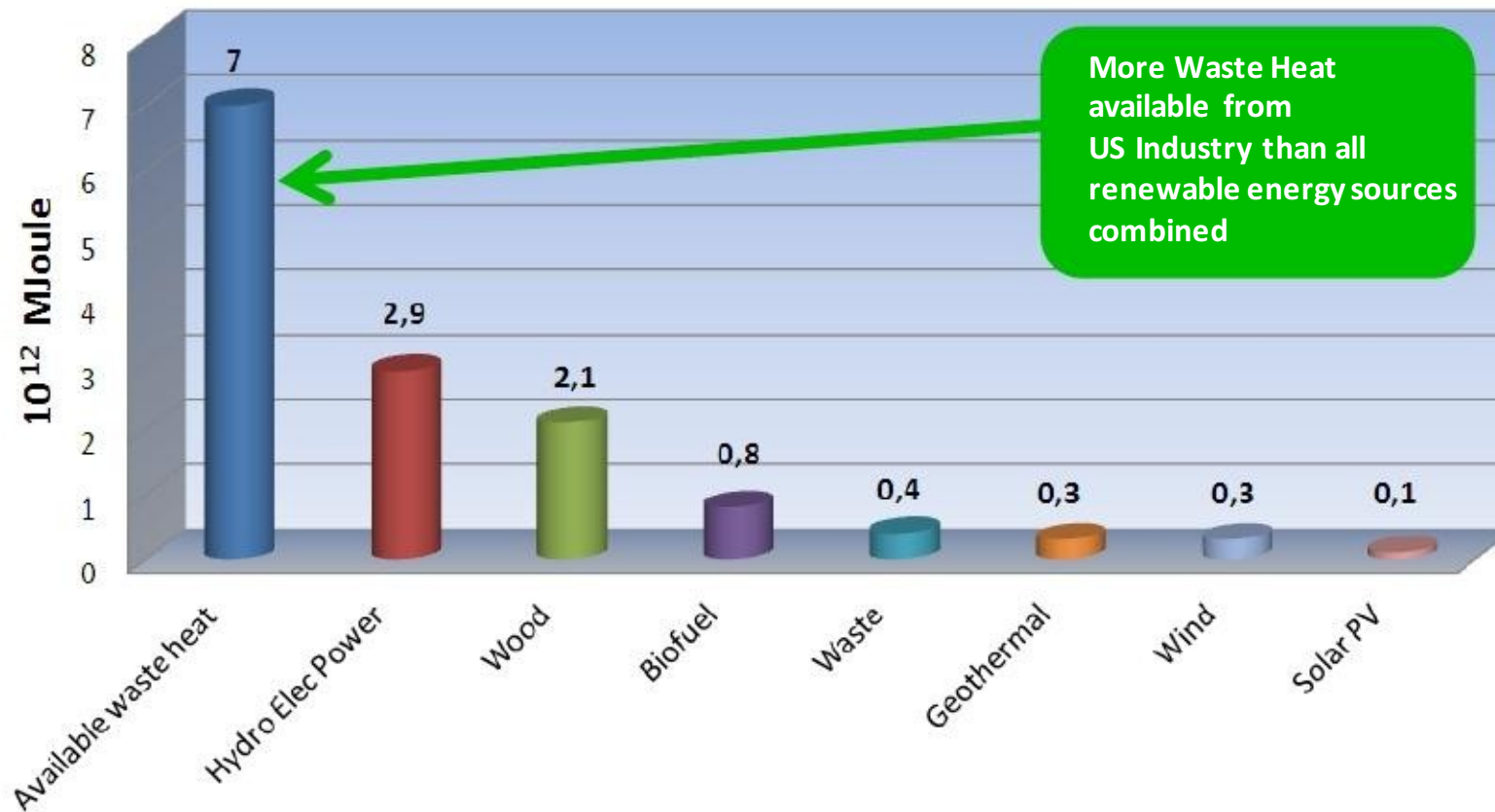


# Worldwide Energy consumption



# Energy concern

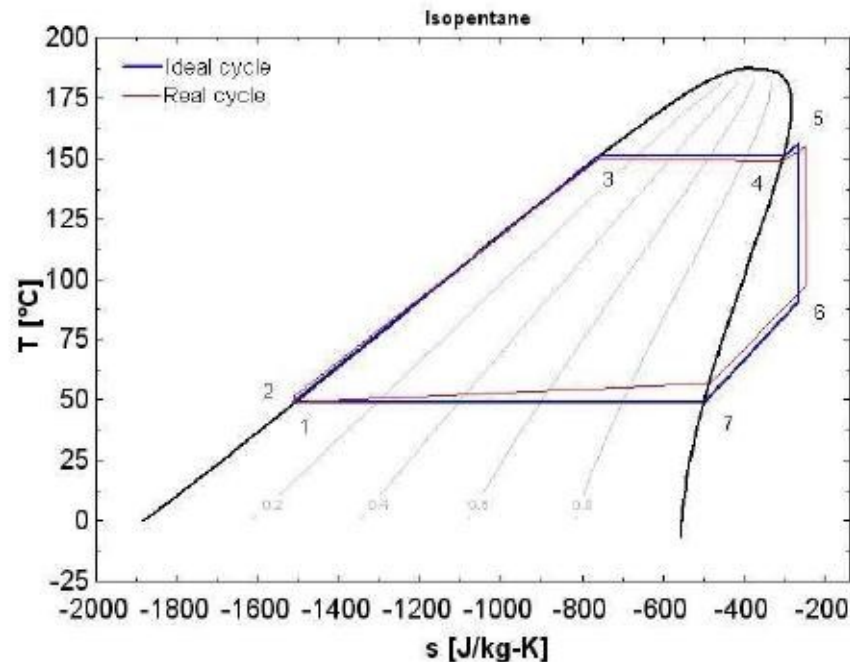
**Renewable energy Consumption by Source**  
(US DOE-EIA Energy Survey 2006)





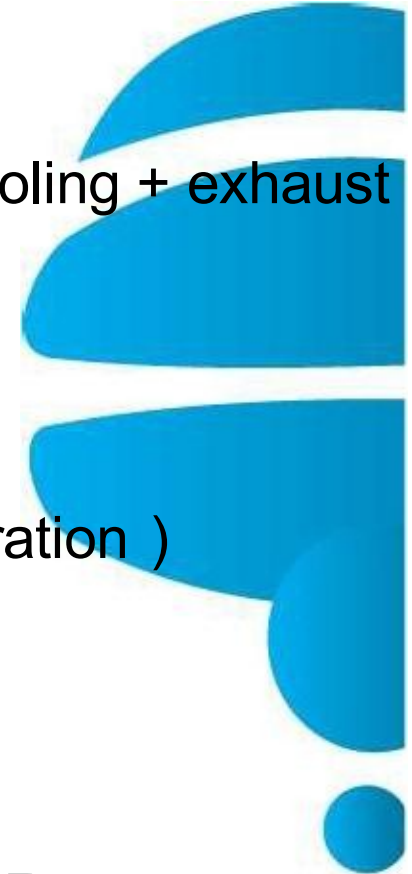
# Organic Rankine Cycle

- Rankine cycle: Steam cycle: high temperature and pressure
- Organic: use of cooling fluid ☞ Low temperature
- Waste heat transformed into electricity
- Working range ORC medium: 80-150°C



# “Fuel” for ORC?

- Waste heat which is lost anyway:
  - Engines, CHP (gas, bio gas, diesel, ...): jacket cooling + exhaust gas
  - Low pressure (waste) steam
  - Industrial processes:
    - Steel, glass industry
    - Combustion processes (bio fuel, waste incineration )
    - Exothermic processes in chemical industry
    - Petrochemical industry: cool down distillates
    - Power plants
- Geothermal applications, District heating, CSP
- Fluids and gases



# Efficiency of E-Rational ORC

## Parameters for efficiency

- “Carnot” Efficiency : only theory
- Hot side
- Cold side: the colder the better
- Efficiency of ORC components: fluid, expander, generator, ...
- Real ORC efficiency : fraction of Carnot : 30-60%
- Optimise external users: cooling circuit, pumps

Carnot Efficiency  $\eta = 1 - \frac{T_2}{T_1}$

Whereas

T1 is Hot Side (K)

T2 is Cold Side (K)

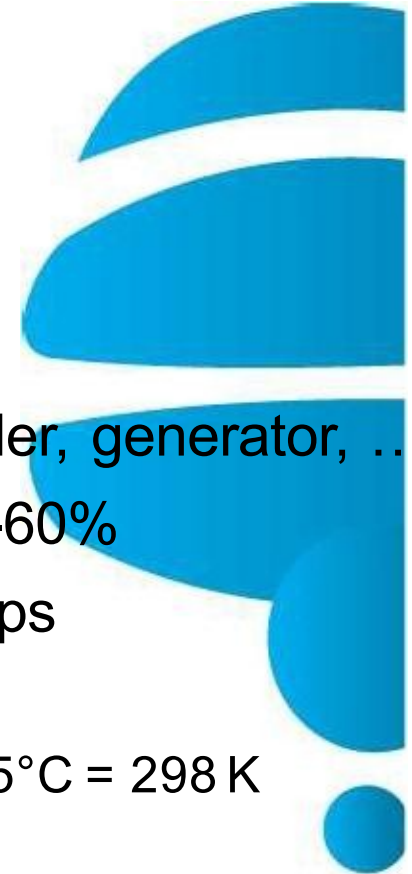
Carnot for cold side: 25°C = 298 K

400°C: 55,7%

200°C 36,9%

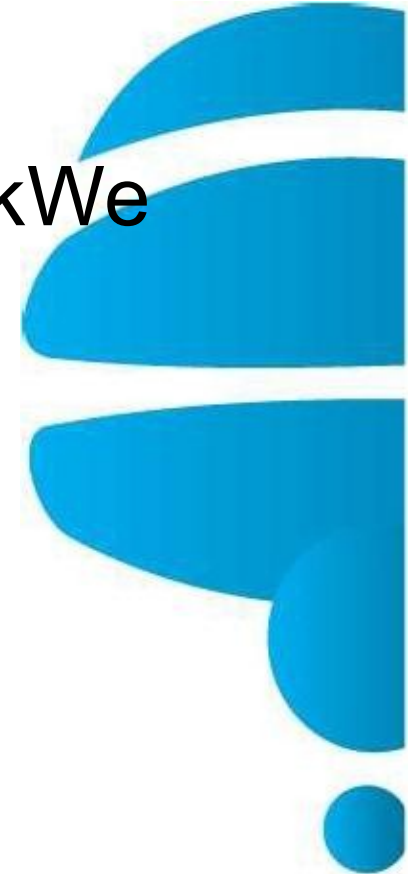
120°C 24,3% => ORC: 8,5 – 11%

90°C 17,9% => ORC: 6-8%

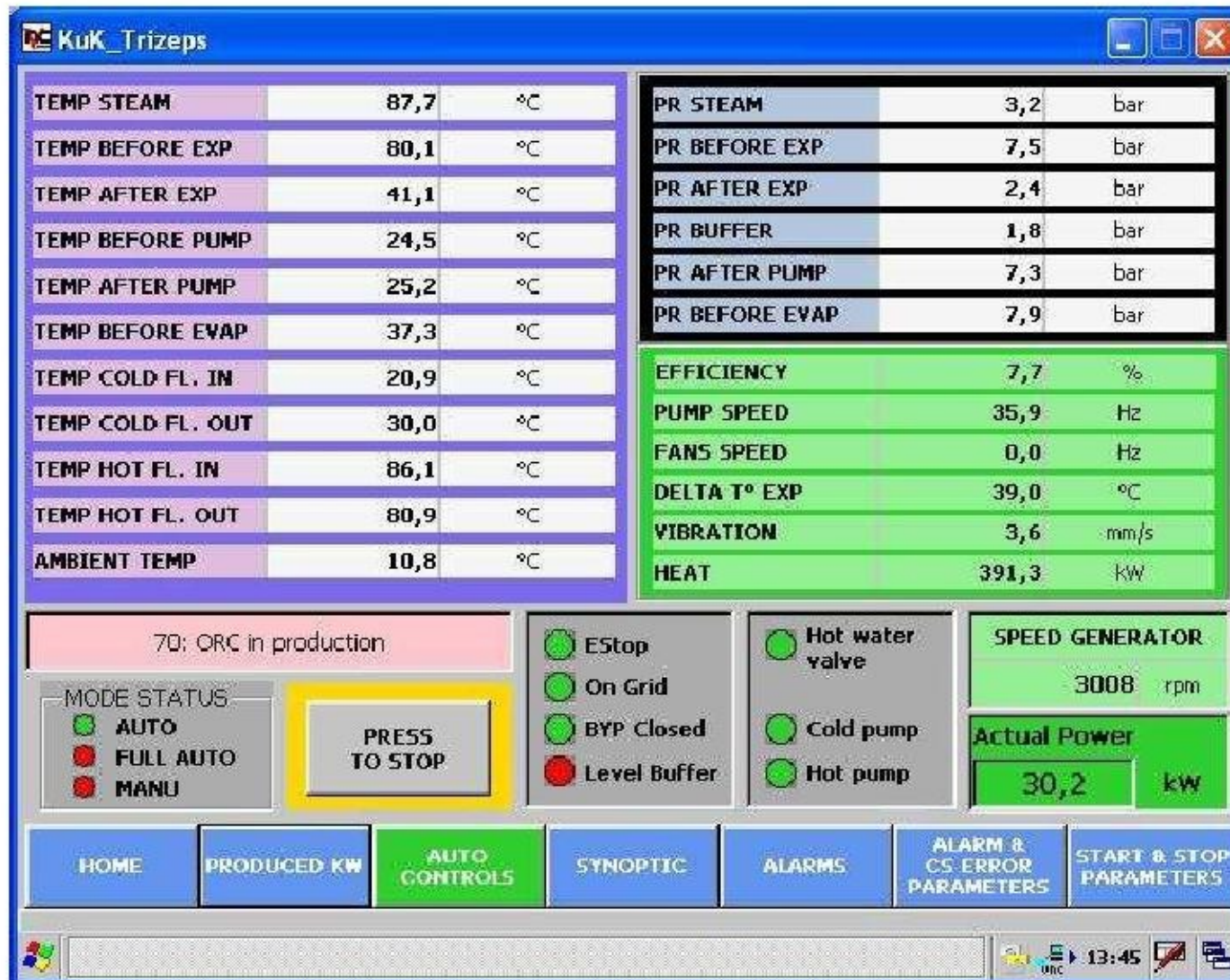


# E-Rational ORC Units

- Range scalable from 50 kWe – 450 kWe
- Modular design
- Expander using Z-screw technology
- Use of standard components:
  - Optimised cost
  - Reliable and durable concept
  - Low maintenance

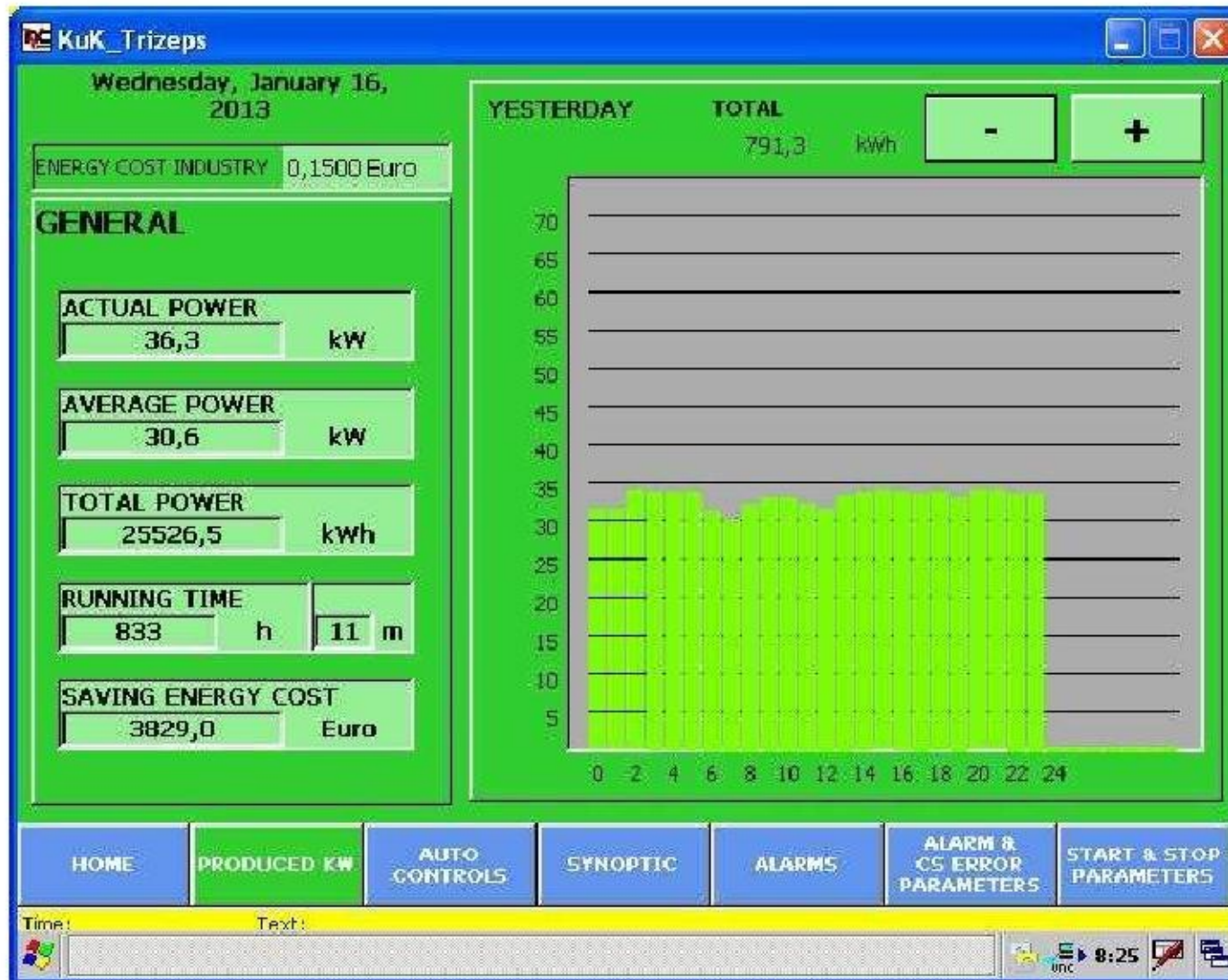


# ORC Software control





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# ORC Software control

SETUP PARAMETERS: ONLY FOR TRAINED PERSONNEL

DELTA PR SHUTDOWN 0,5 bar	MIN SPEED PUMP 25,0 hz	START T BEF EXP 50,0 °C
MAX PR BEF/AFT EXPANDER 14,0 bar	S.P. SPEED PUMP 25,0 hz	MAX T BEF EXP 120,0 °C
MAX PR BUFFER 3,0 bar	START SPEED GENERATOR 2900 rpm	MAX T AFT EXP 70,0 °C
MAX VIBRATION 10,0 mm/s	MAX SPEED GENERATOR 3200 rpm	ENERGY COST INDUSTRY 0,0200 Euro
BACK TO DEFAULT PARAMETERS	SAVE PARAMETERS	RESTORE SAVED PARAMETERS

MANUAL MODE  

TOGGLE PUMP  

DISABLED

TOGGLE GENERATOR  

DISABLED

TOGGLE BYPASS  

DISABLED

●

HOME

PRODUCED KW

AUTO CONTROLS

SYNOPTIC

ALARMS

LOGGING CHART

PARAMETER SETUP

Title:                      Text:  
 07/29/2010 11:47:22 EG Cabinet: Emergency stop 1

# E-Rational ORC1000

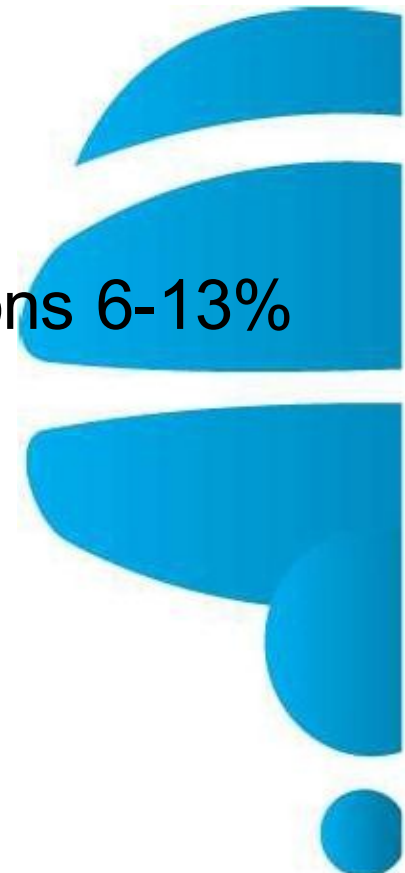
- Thermal power up to 1000 kWth
- Asynchronous generator 400V AC 50Hz
- Hot side powered with Low pressure steam, hot water or oil
- ORC medium: Honeywell r245fa or Solkatherm
- Input Temperature: 80-150°C
- Extended software control
- Controlled and Seamless connection on the grid
- Size: 2300 x 2300 x 1800 mm (LxHxW)
- Weight: 4000 kg
- Built according to PED 97/23/EG



# E-Rational ORC1000

## **ORC1000 Power Range**

- One main platform
- Efficiency Depending on working conditions 6-13%
- Power range: Expander/generator sets
  - 55kWe
  - 70 kWe
  - 90 kWe
  - 110 kWe
- Asynchronous generator 400 VAC 50 Hz



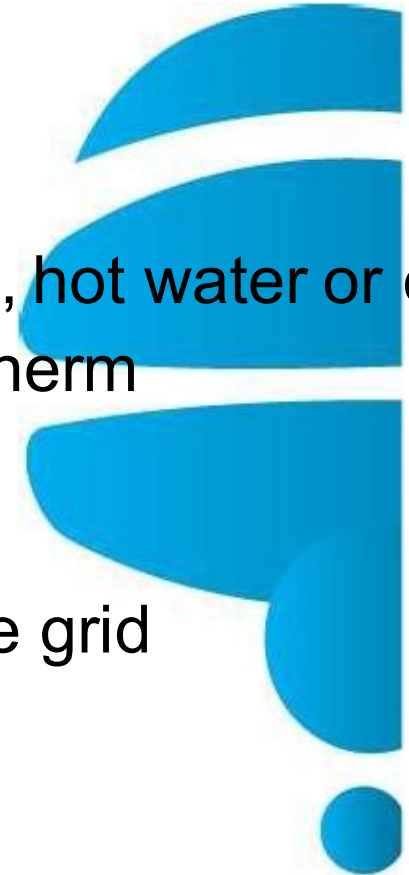


# E-Rational ORC1000 Unit



# E-Rational ORC4000

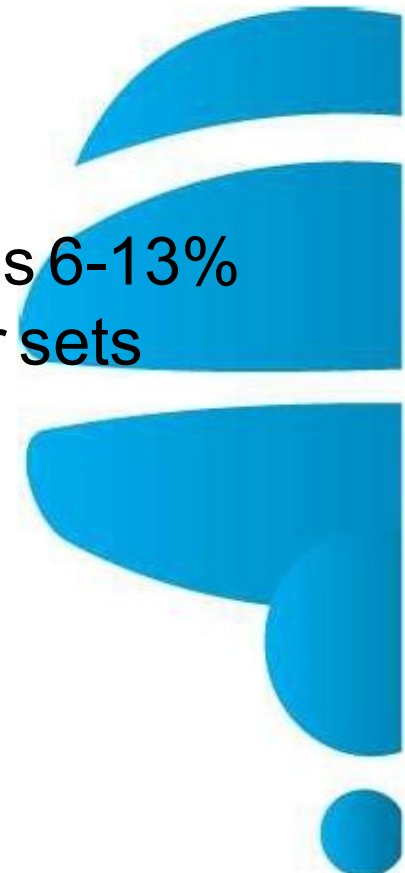
- Thermal Power up to 4000 kWth
- Bruto 250-450 kW<sub>e</sub>- 400V AC 50Hz
- Hot side powered with low pressure steam, hot water or oil
- ORC medium: Honeywell r245fa or Solkatherm
- Input Temperature: 80-150°C
- Extended Software control
- Controlled and seamless connection on the grid
- Size: 20 ft container (6m x 2,5m x 2,6m)
- Weight 25000 kg
- Built according to PED 97/23/EG



# E-Rational ORC4000

## **ORC4000 Power Range**

- One main platform
- Efficiency Depending on working conditions 6-13%
- Power range: different expander/generator sets
  - 250 kWe
  - 315 kWe
  - 370 kWe
  - 400 kWe
  - 450 kWe
- Option: ATEX 250 kWe
- Asynchronous generator 400 VAC 50 Hz





# E-Rational ORC4000



# E-Rational production

Example (values per year)

$$50 \text{ kW}_e * 8\,000 \text{ h} = 400\,000 \text{ kWh} = 400 \text{ MWh}_e$$

$$250 \text{ kW}_e * 8\,000 \text{ h} = 2\,000\,000 \text{ kWh} = 2\,000 \text{ MWh}_e$$

Compare:

4 000 m<sup>2</sup> PV    320 MWh    224 Tonnes CO<sub>2</sub>    91

50 kW ORC    households

250 kW ORC    400 MWh    280 Tonnes CO<sub>2</sub>    114  
households    2 000 MWh    1 400 Tonnes CO<sub>2</sub>    570  
households



# E-Rational Applications

## Proviron Base Chemicals, Ostend Belgium

- Exothermic chemical process
- Waste Steam recovery:
  - Low pressure waste steam 3,5 bar max 3,5 T/h
  - Cooling: cold water
  - Power production: 200 kWe net
  - Yearly production > 1500 MWhe
  - > 1000 Tonnes CO<sub>2</sub> Reduction per year
  - Water saving > 27000 m<sup>3</sup>/year
- Type: E-Rational 4000-250 kWe ATEX





# E-Rational Applications





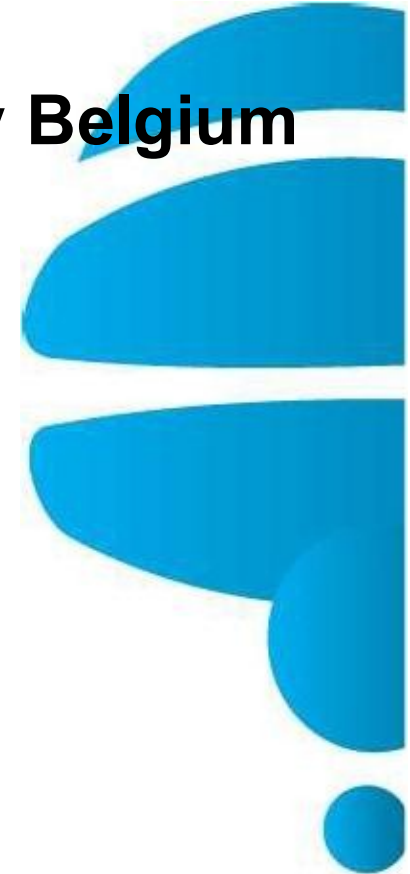
# E-Rational Applications



# E-Rational Applications

## **Vanheede Environmental Services, Quévy Belgium**

- Digester+ biogas Engines
- Waste heat recovery:
  - Hot water 88°C
  - Cooling: air condenser
  - Power production: 40 kWe net
  - Yearly production > 340 MWhe
  - > 240 Tonnes CO<sub>2</sub> Reduction per year
- Type: E-Rational 1000-55kWe





# E-Rational Applications



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# E-Rational Applications



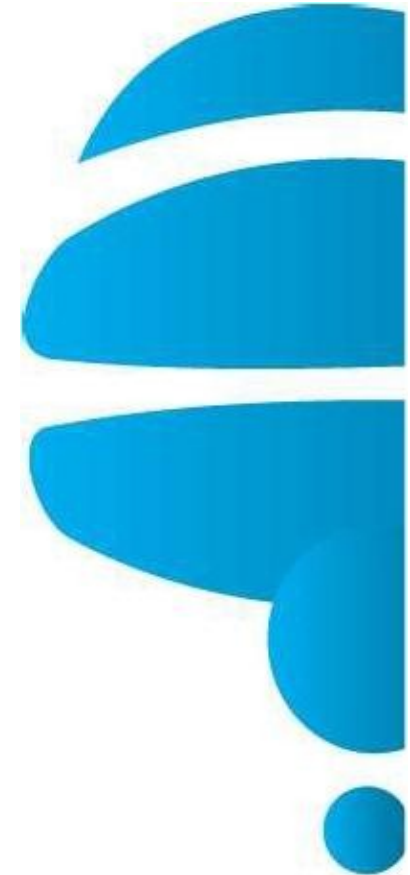
# E-Rational Applications

## Howest, Kortrijk Belgium

- Technical highschool
- Research and testing on energy applications including ORC
- ORC test unit
  - Hot water variable 70°C-150°C
  - Power production: max 11kWe
  - Simulation of working conditions
- R&D machine, special development

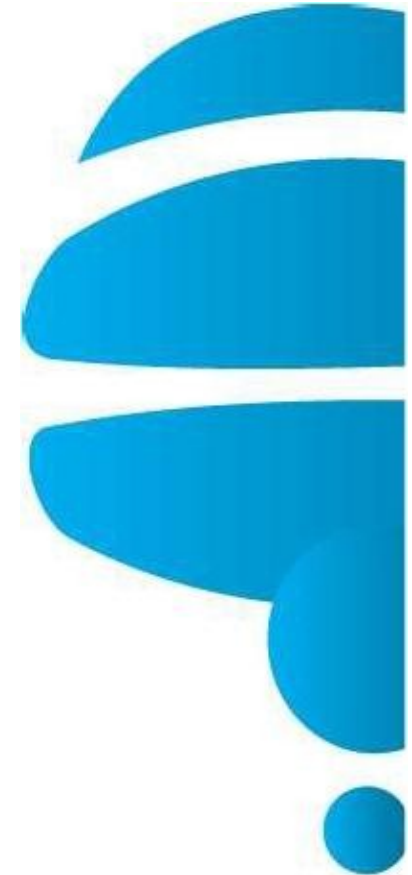


# E-Rational Applications



# E-Rational Benefits

- Generated power can be used or sold
- Best ROI in industry, High IRR
- Very Low operational costs
- Plug and Play skid concept
- Machine easily moveable
- Fast installation and start-up
- Good partial load performance







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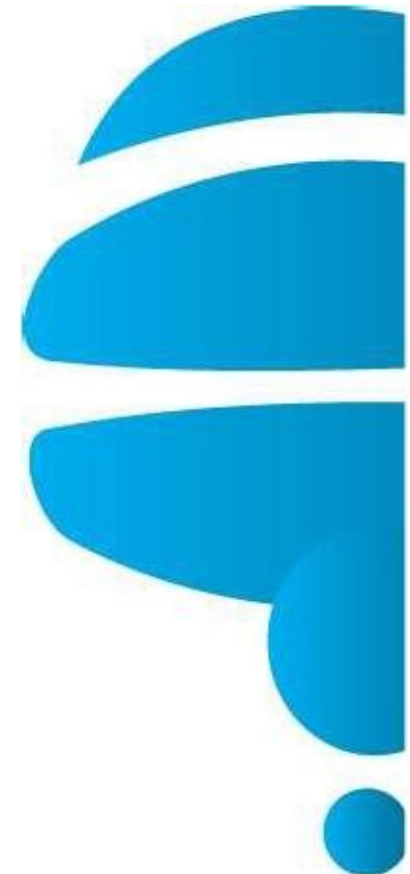
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