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The Small Turbine ORC company

Organic Rankine Cycle systems for low temperature heat to power generation

Energy Recovery and Power generation from Waste Heat
Institute of Energy Futures, Industry Day, Brunel University, February 25th 2016

Company Key Facts

Prototype, 2010, Bagnols/Cèze, France

First contract, Nanjing, China

Container ORC at Treviso, Italy

ENO-10MT ORC, Marseilles, France

ENOGIA designs and produces Organic Rankine Cycle micro-powerplants that valorize waste heat by converting it into electrical power.

→ a young innovative company

→ created in 2009 by four engineers

→ head office and facilities in Marseilles, France

→ 20 employees

→ 1 M€ turnover in 2015

→ References in 9 countries

Strategic backing by partner IFPEN for Rankine technological development :

Ing. Arthur Leroux
CEO
Former R&D project manager at Bertin Technologies

Ing. Antonin Pauchet
CFO
Former senior auditor at PriceWaterhouseCoopers

Ing. Nicolas Goubet
CTO
Former CNC machine technical designer at Forest Liné

Introduction : History of the ENOGIA company

- 2009 : ENOGIA was funded by four engineers
- 2010 : First expander prototype
- 2011 : First ORC module
- 2012 : Fundraidser with AM Business Angels
- 2013 : Partnership with ALSTOM for diesel train WHR
- 2014 : Strategic partnership with IFPEN
- 2015 : Full product range availability from 10 to 100 kW
- 2016 : 24 ORC references in 9 countries

2010,
Prototype, Bagnols, France
HFE7100 – 2 kW gross output

2012
First contract, Nanjing, China
R245fa – 5 kW gross output

2013
Container ORC at Treviso, Italy
R245fa – 5 kW gross output

2014
Two ENO-10LT during testing
R245fa – 10 kW gross output

2015
ENO-40LT during assembly
R245fa – 40 kW gross output

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Energy losses in the French Industry
ADEME

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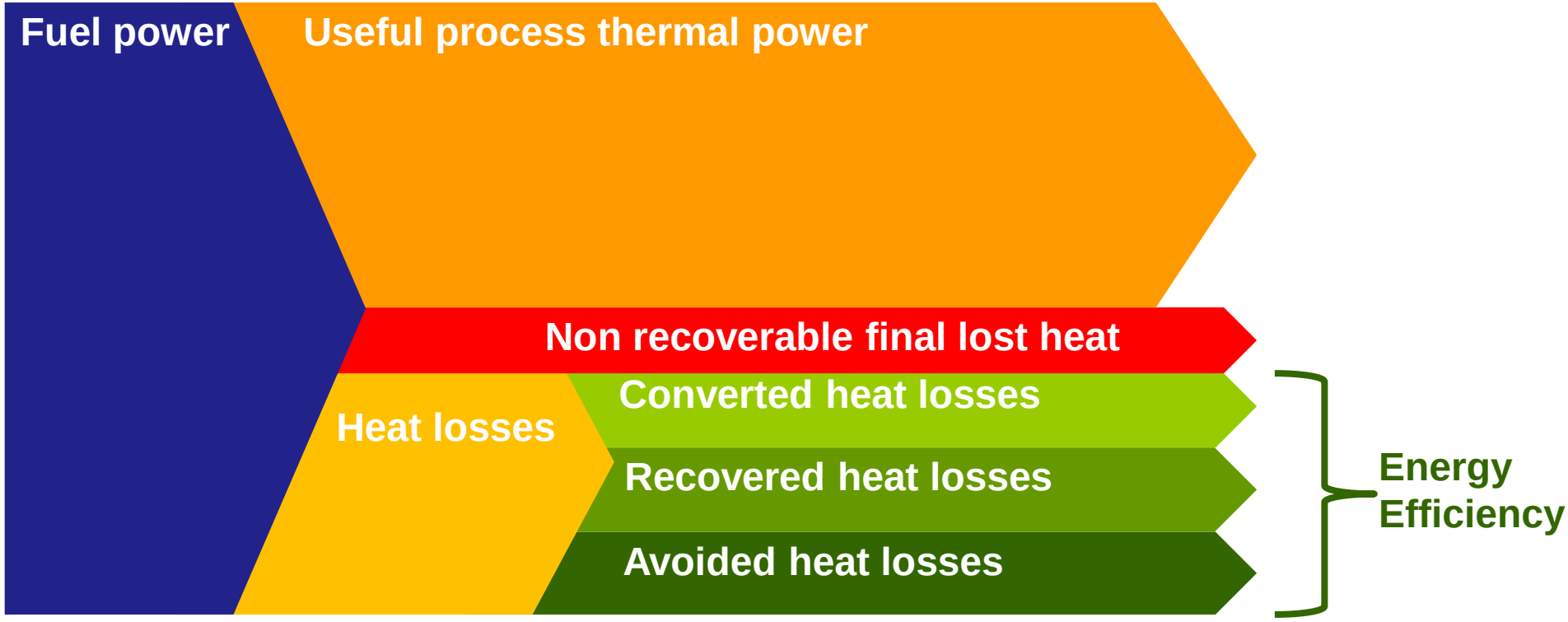
What can be done with industrial heat losses ?

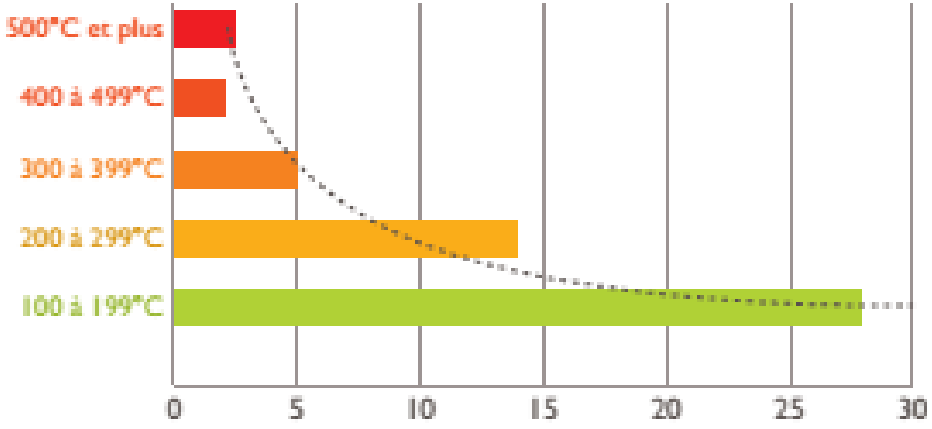
ADEME

Agence de l'Environnement
et de la Maîtrise de l'Energie



Industry heat losses

Heat available from process losses in French Industry



TWh / year

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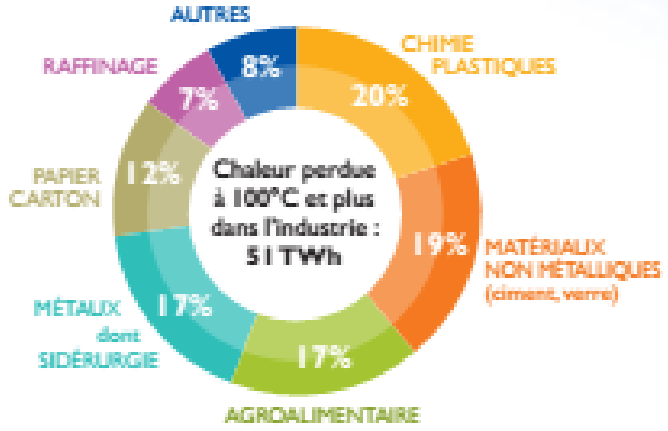
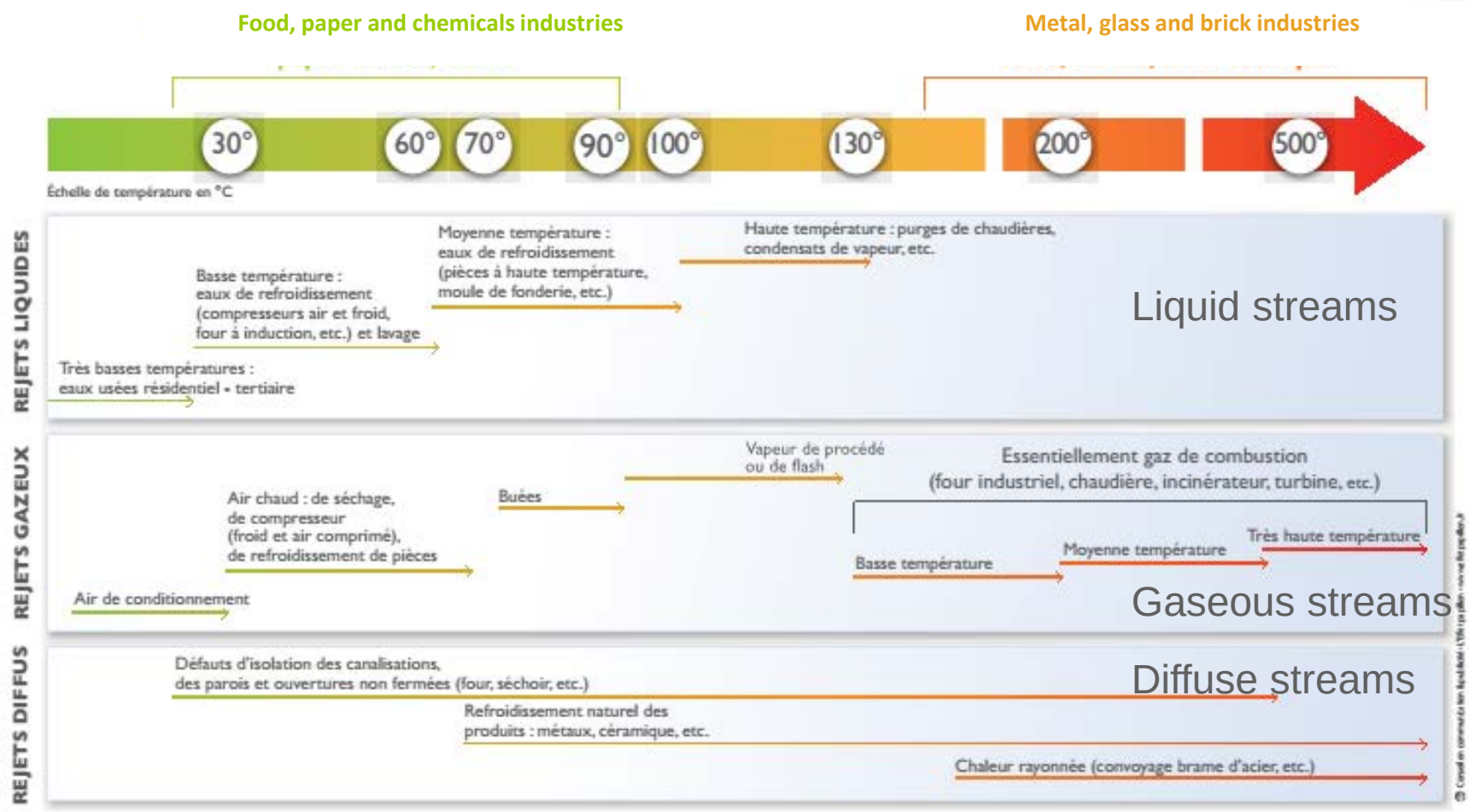
Agence de l'Environnement et de la Maîtrise de l'Energie



By industrial activity

→ Most of the heat available is from low temperature heat sources !
→ All industry sectors have heat losses !

Heat loss temperature levels



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Low Temperature small ORC systems development

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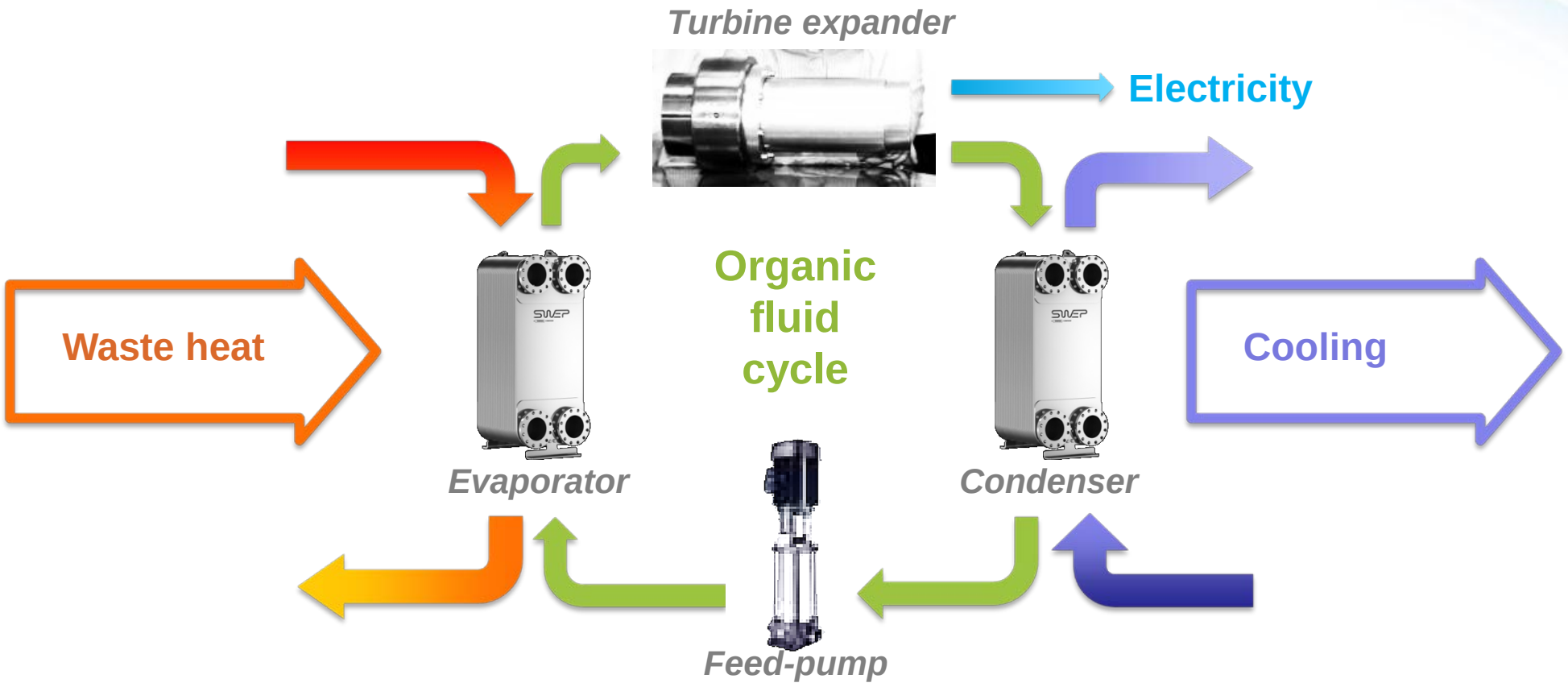
ORC : it can convert low temperature waste heat into useful electricity



Why the expander is critical and difficult

- For low temperature waste heat to power, the expander needs to be :

→Efficient

→Small

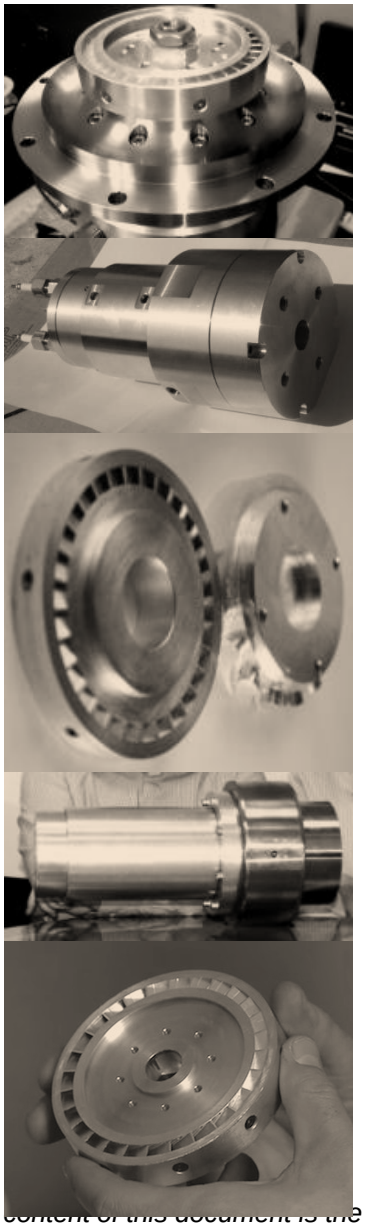
→Cheap

→Reliable

- Most of these parameter are antagonist !

- One must reach a compromise with the highest total lifetime electricity production / total lifetime ownership cost (best payback)

ENOGIA choose Kinetic Technology



Why the kinetic turbogenerator ?

→ Proven concept on larger ORC units

→ No friction, no wear

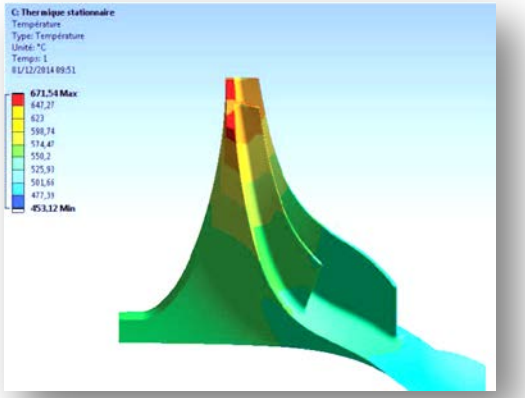
Hermetic turbogenerator with PMG generator inside

→ No fluid leaking

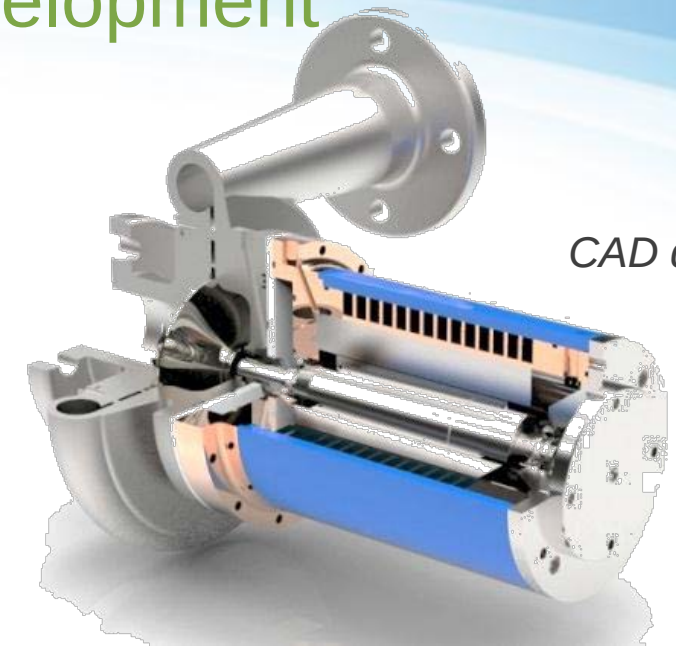
→ Reduced maintenance

Can reach full power with 80°C hot water at evaporator side (can cope with larger volumic flows than volumetric technology → better for low temperature ORC)

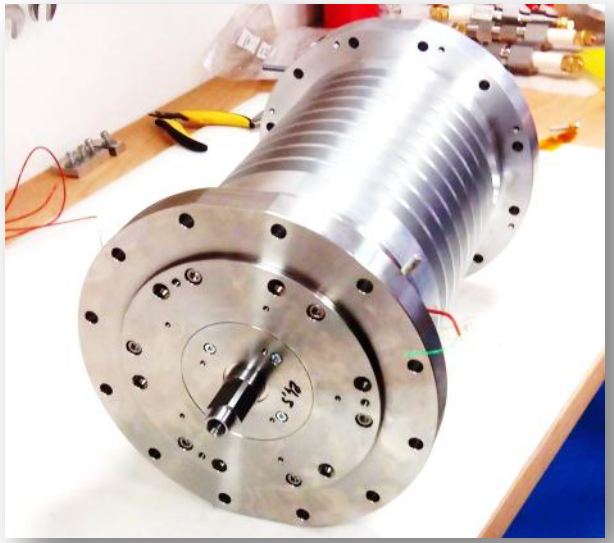
Micro-Turbine Expander development



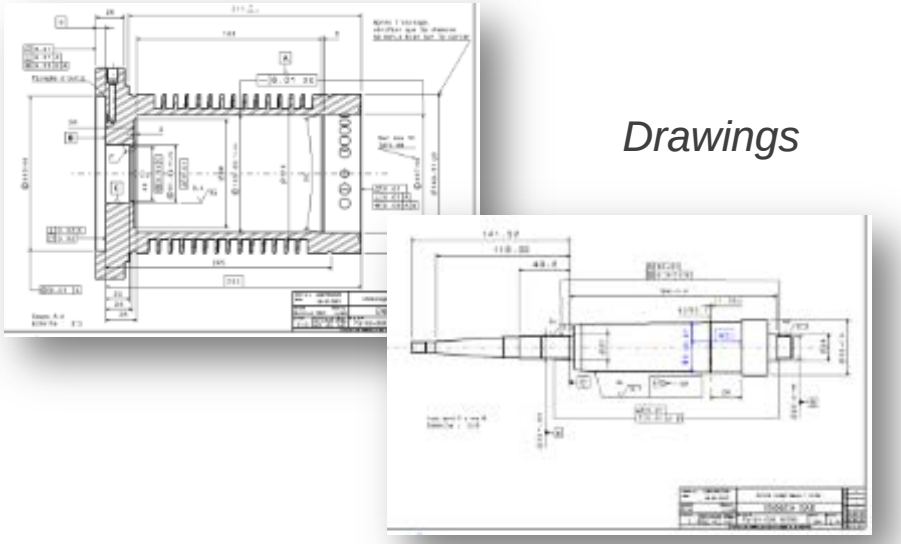
Preliminary design, CFD, FEA



CAD design



Prototype manufacturing

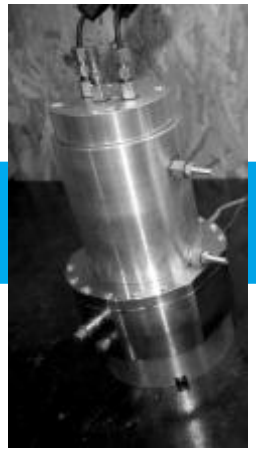


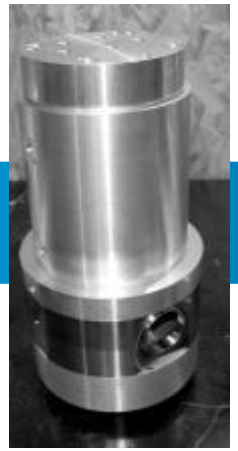
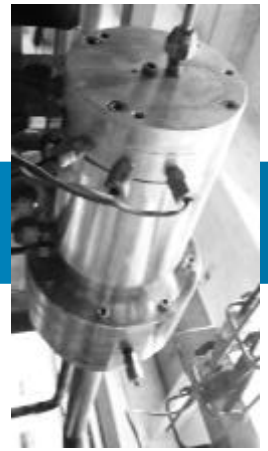
Drawings

Micro-Turbine Expander development

- 2009-2015, 6 generations of small 10 kWe turbine expanders !





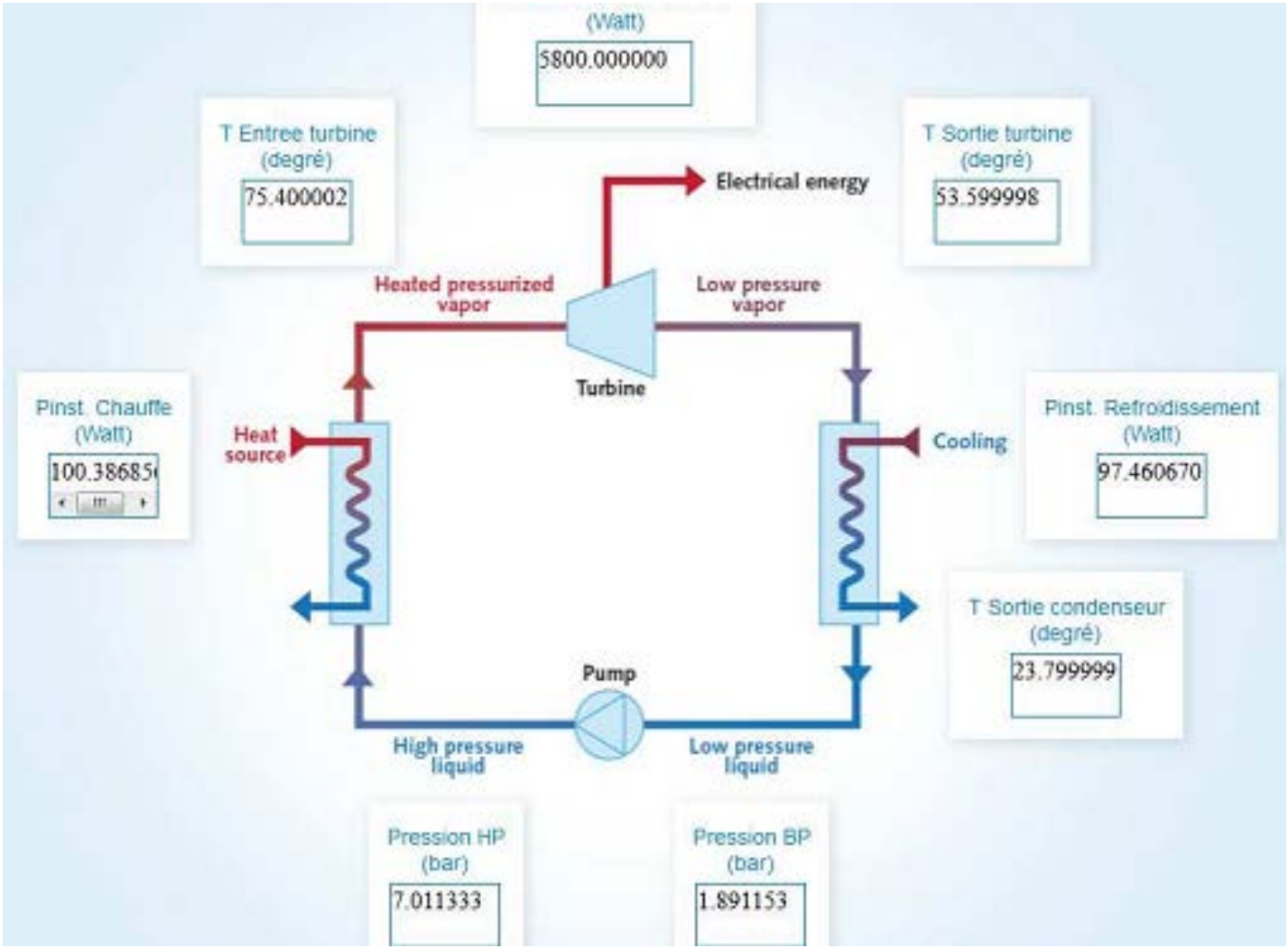



Small low temperature ORC

- 10 kW turbine is useful for small CHP waste heat to power
- Many references in Anaerobic Digestion

ORC for farm biogas : operational experience

- Satisfying performance : 5 to 7 % efficiency depending on inlet and outlet conditions (80-90°C hot water inlet)



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A New Challenge

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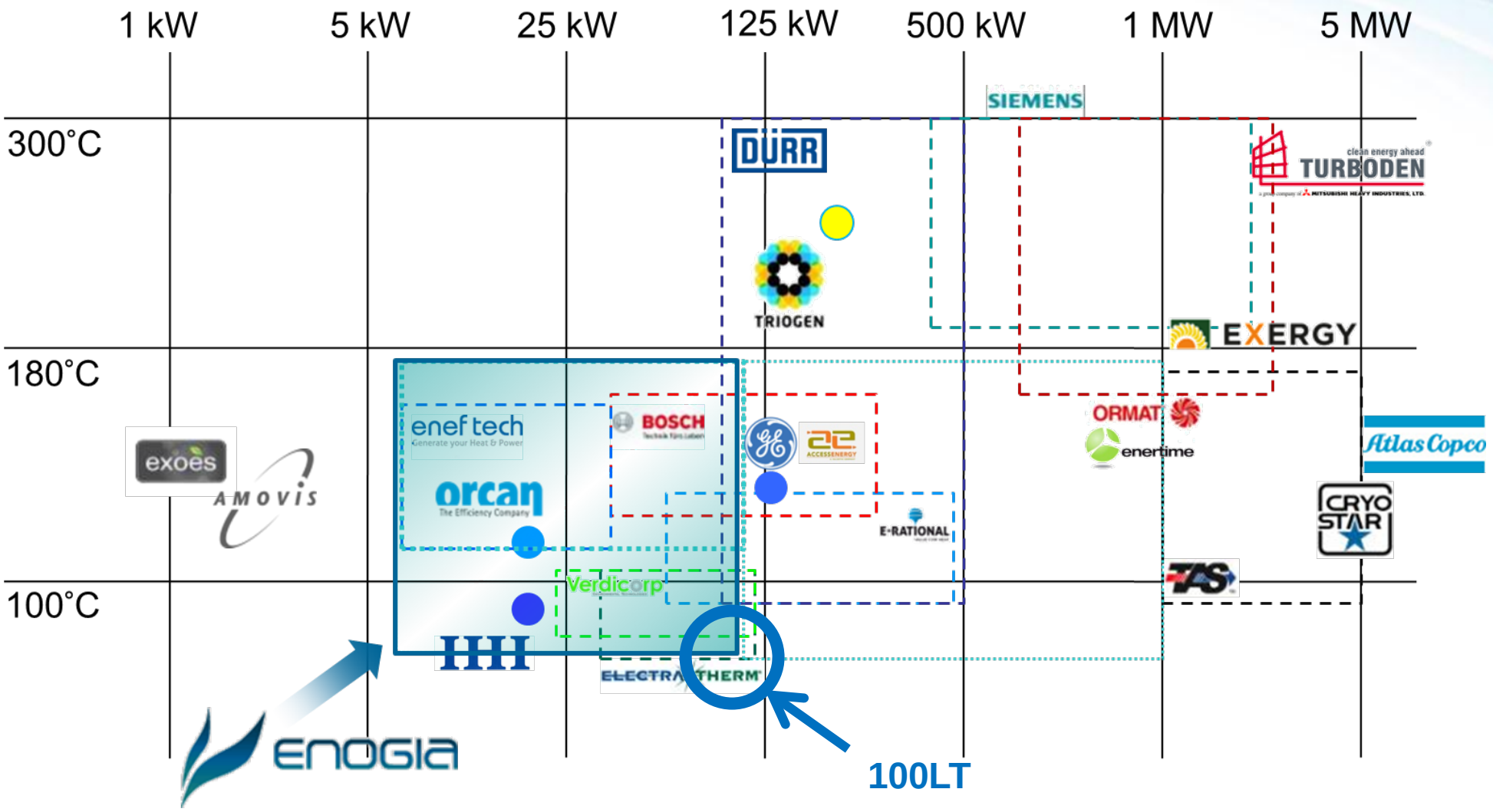
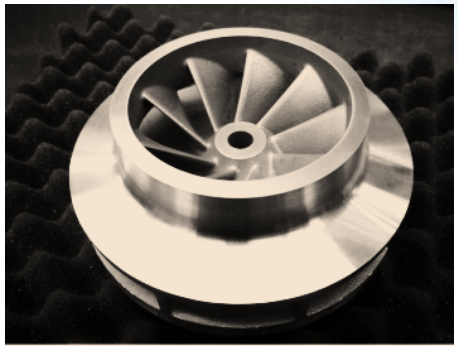
10kW is too small for industry. Is a 100kW Low Temperature available on the ORC market?



Challenges of 100LT turbine design

- Small enthalpy drop for an ORC turbine

→ yet high enthalpy drop for a single stage !



- Subsonic axial turbine design proves difficult

→ Radial inflow stage is preffered because of its ability to withstand high enthalpy drop without supersonic operation

- No off-the-shelf electric generator fits the specifications

→ Partner companies IFPEN and Mavel to develop a custom unit

Result → the ENOGIA 100LT turbo-generator

- Most compact unit (only 60x30cm, <100kg)

- Promising measured performance (70% Is x Mec x El efficiency at nominal conditions)

100kW ORC on 80°C jacket water

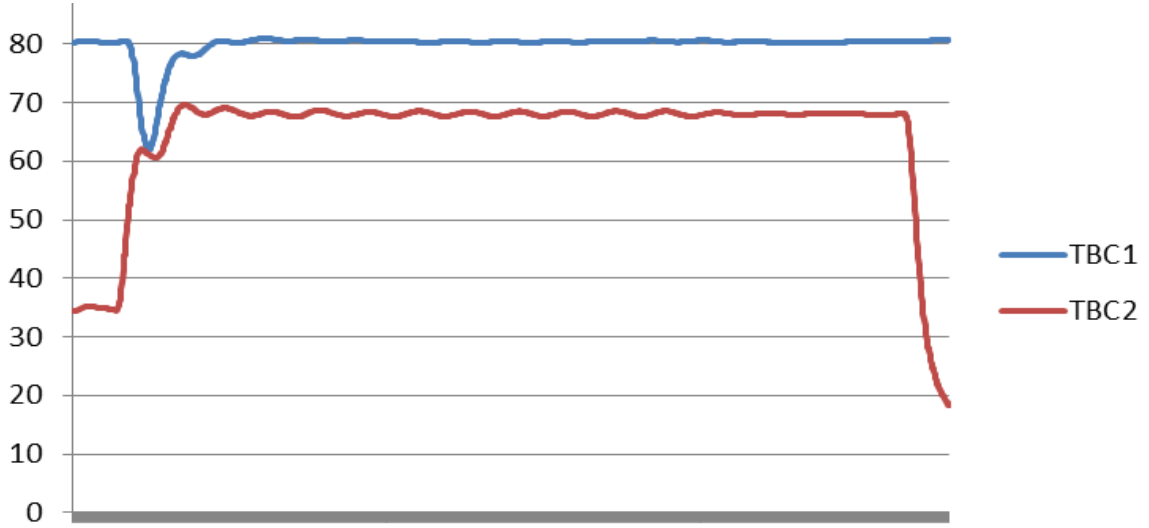
Easy and fast installation, stable operation !

Electrical power cable and data

Hot water hoses

Regulated return temperature to engine (TBC2 : 68°C)

→ Mandatory for engine lifetime



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Current product offering

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2016 Low Temperature ORC range

ENO-10LT : 1x10 kW

Full power setting from 80 to 120°C

ENO-20LT : 1x20kW

Full power setting from 80 to 120°C

ENO-40LT : 2x20kW

Full power setting from 80 to 120°C

ENO-100LT : 1x100kW

Full power setting from 80 to 100°C

ENO-40LT container near Paris

Conclusion

- The highest number and power of waste heat streams can be found at low temperatures (<200°C)
- A cost efficient and high performance ORC unit has been developed for 80-90°C hot water, with 100kW electrical output
- It is now part of ENOGIA's product range as « ENO-100LT » unit
- We look forward any project of low temperature to electricity generation !

Contact information, thanks for your attention !

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