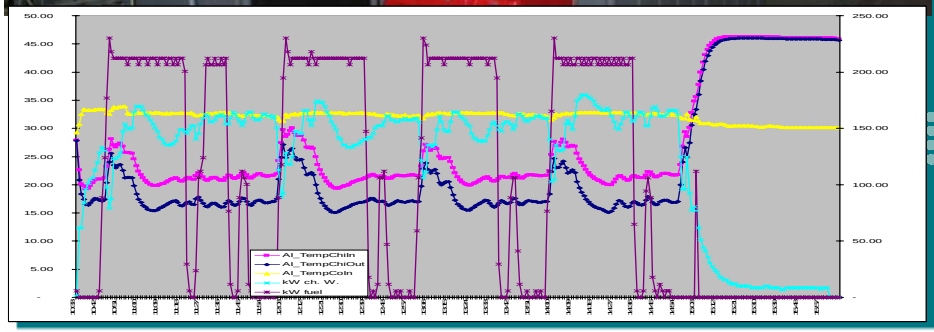


Evaluation of a BROAD chiller with 2 CAPSTONE C30 microturbines

Sébastien CASSEN (ElfER)

Overview of the presentation

- Context
- Technical configuration
- Pictures
- Measurement system layout
- Performances
- Costs
- Conclusion
- Partners
- Contact

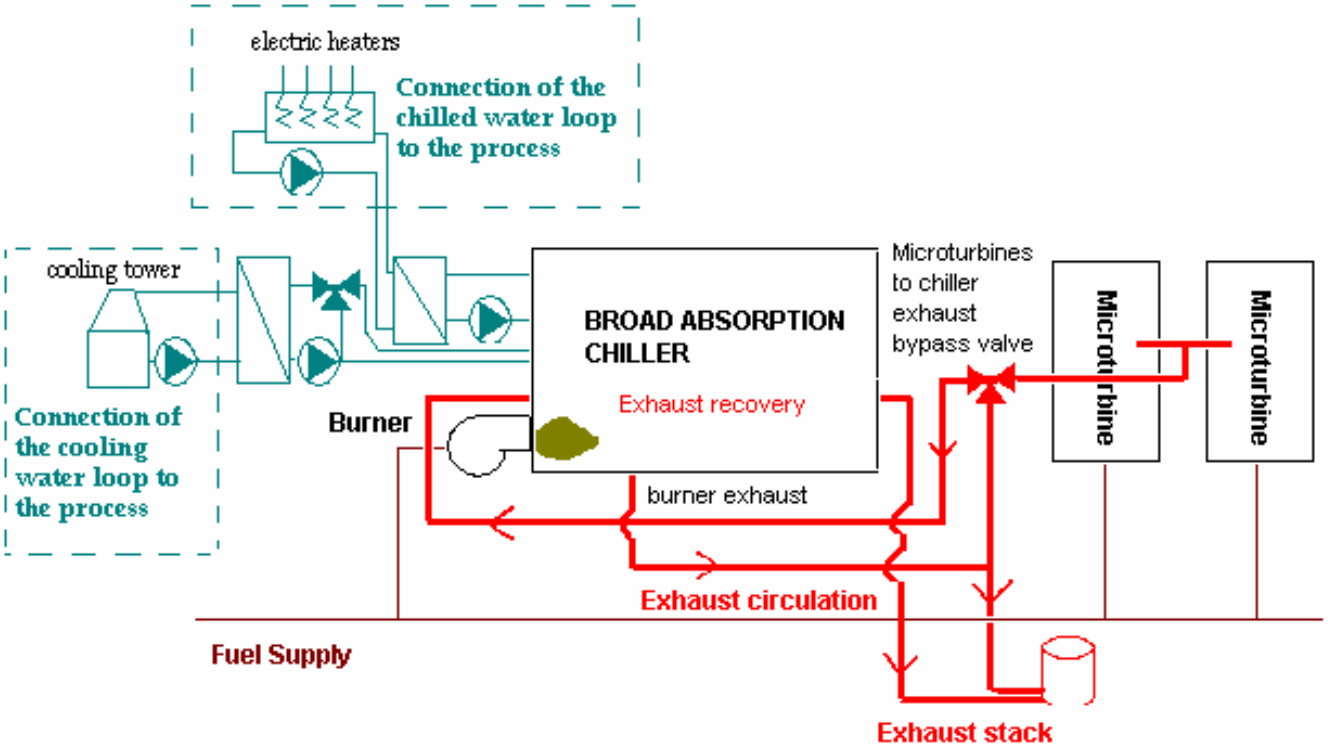
Context

The growth of the electricity demand in French overseas territories is much quicker than in the other parts of France. In these territories where EDF is the only provider, the production costs are high while the selling prices are set by law to the same level than in the rest of France. In this regulated market, the utility has to think of efficient ways to limit the growth of the demand. Promoting energy efficiency is therefore a must.

Our scope for this project : how to develop CCHP systems tailored for the Caribbean ?

Technical configuration of the test bench

Double-effect BROAD absorption chiller direct-fired + exhaust recovery from 2 CAPSTONE C30 liquid fuel microturbines

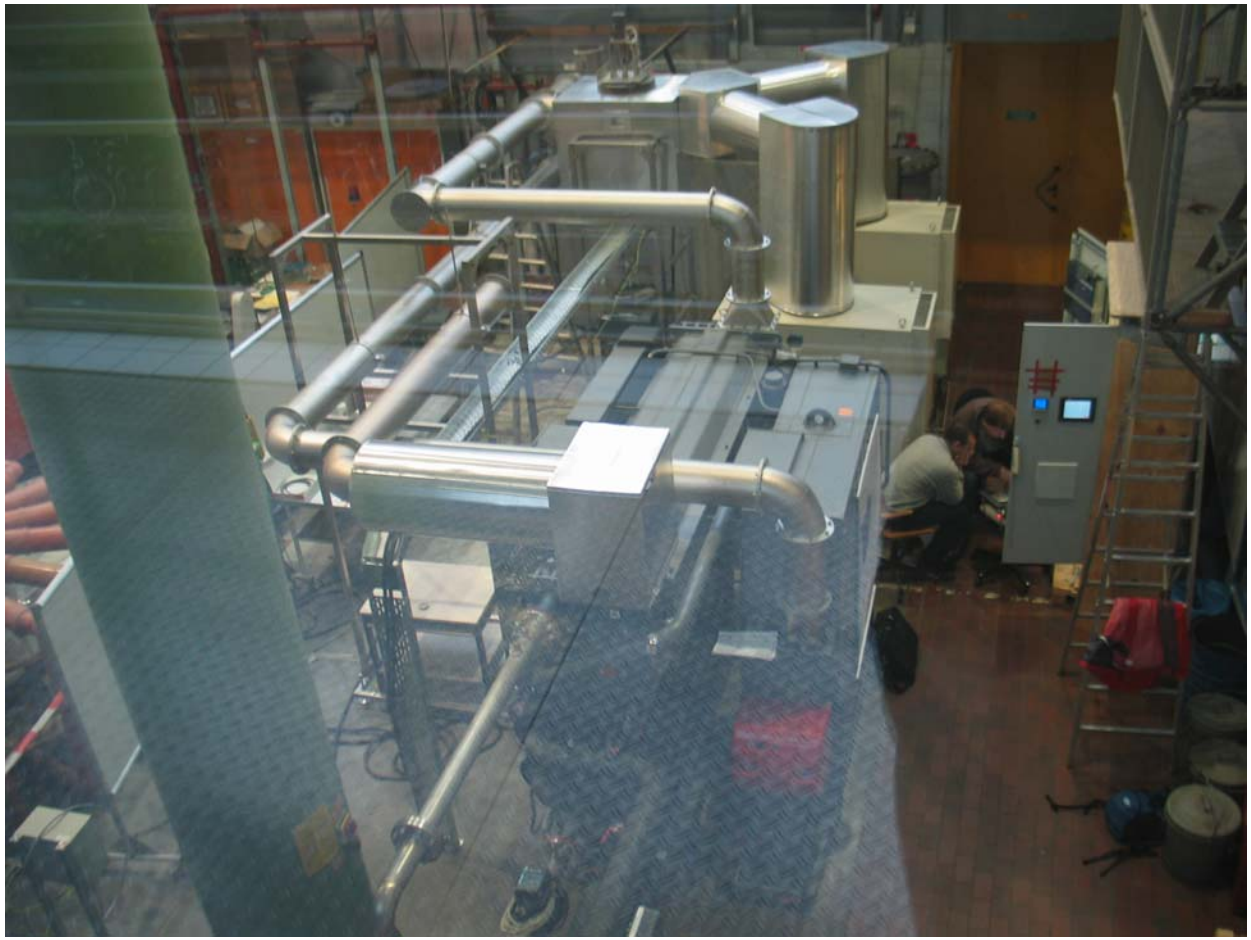


Microturbines + exhaust recovery absorption chiller

Technical configuration (details)

- ✓The fuel for the chiller and the turbines is diesel oil
- ✓The exhaust recovery is on the single-effect stage of the chiller
- ✓The chilling load is simulated with electric heaters
- ✓A 3-way valve controls the temperature of the cooling water in the chiller to simulate conditions on site
- ✓The exhaust pipes were not insulated for the tests

Pictures



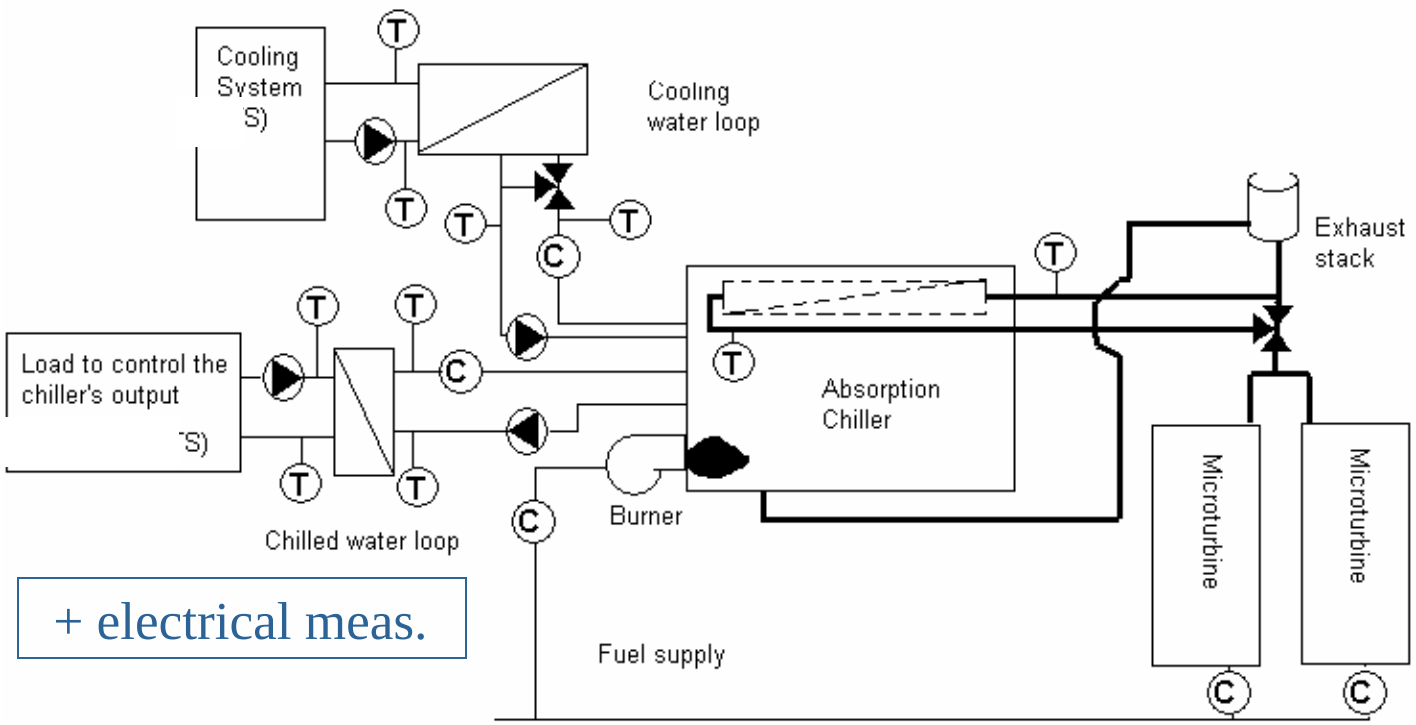
Microturbines, chiller & exhaust ducting

Pictures

Water pipes

Exhaust 3-ways valve

Measurement system layout



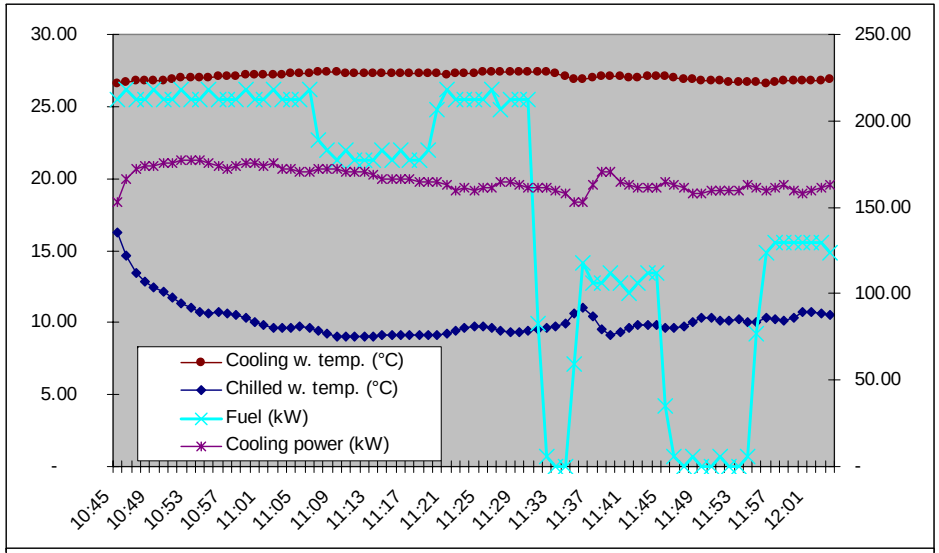
+ electrical meas.

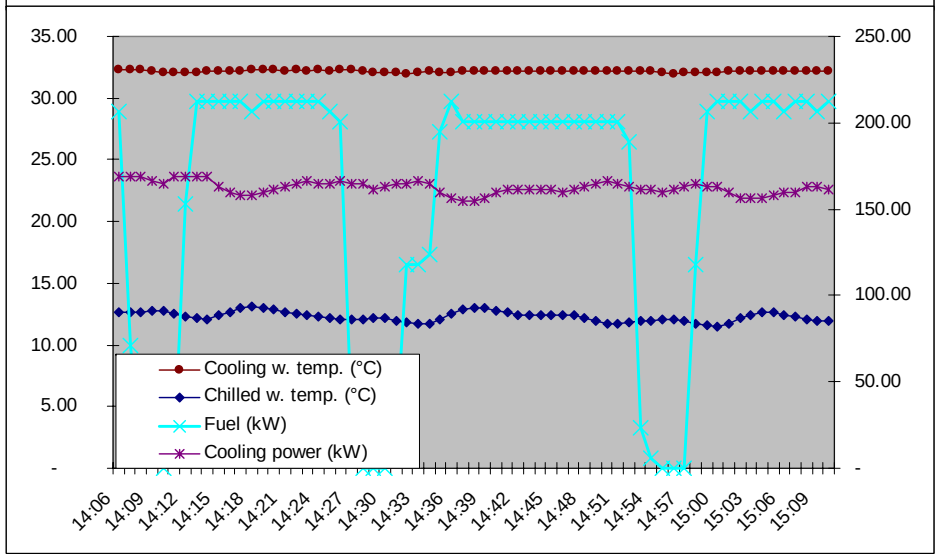
T = Temperature sensor / C = counter or flow meter

Measurement system (details)

- ✓ the input and output power have been recorded for
  - both turbines (fuel input, electrical output)
  - the chiller (fuel and electrical input, cooling power, …)
  - the circulation pumps (electrical input)
- ✓ the 2 turbines exhaust mass flow has not been measured

Performances : chiller alone, no exhaust recuperation





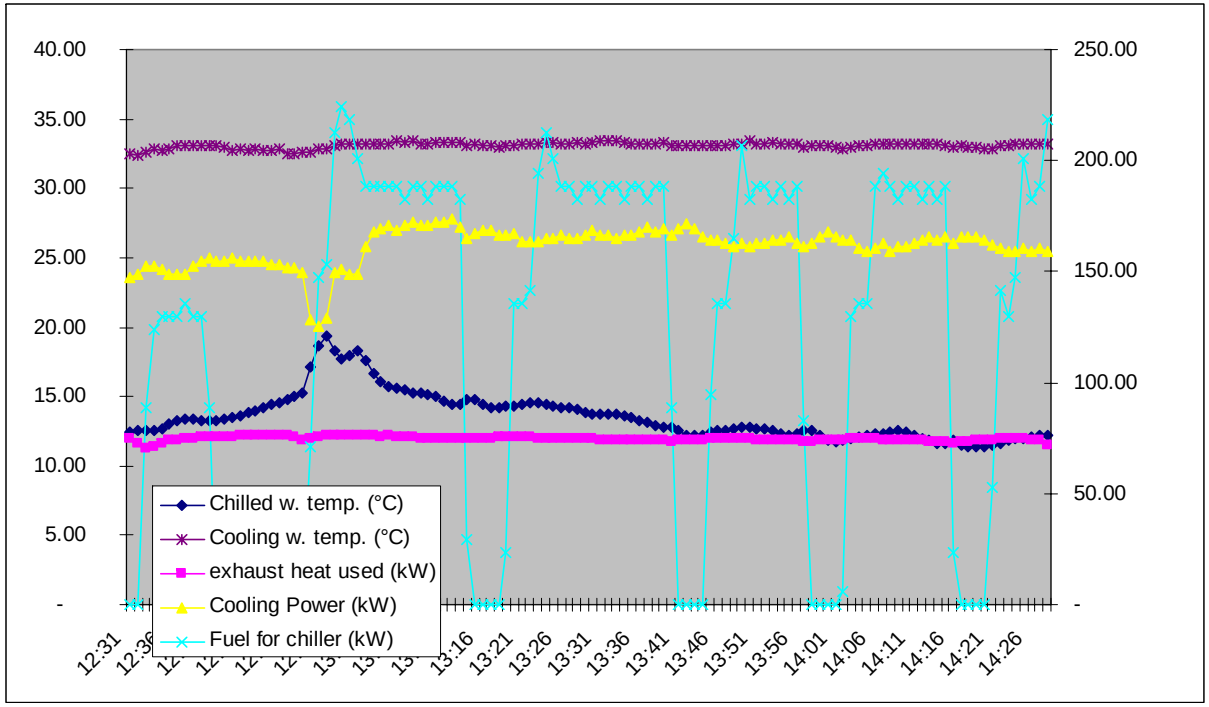
	Mean values
Chilled w. temp.	11°C
Cooling w. temp.	27°C
Fuel cons.	153 kW
Elec. cons.	1.3 kW
Cooling power	164 kW
COP	**1.06**
Typical error	**(+/-0.07)**

	Mean values
Chilled w. temp.	12.4°C
Cooling w. temp.	32°C
Fuel cons.	147 kW
Elec. cons.	1.4 kW
Cooling power	164 kW
COP	**1.11**
Typical error	**(+/-0.07)**

The COP value is related to the load as well as to the chilled and the cooling water temperatures but its variations are within the measurement typical error range.

Performances : effect of the exhaust recuperation

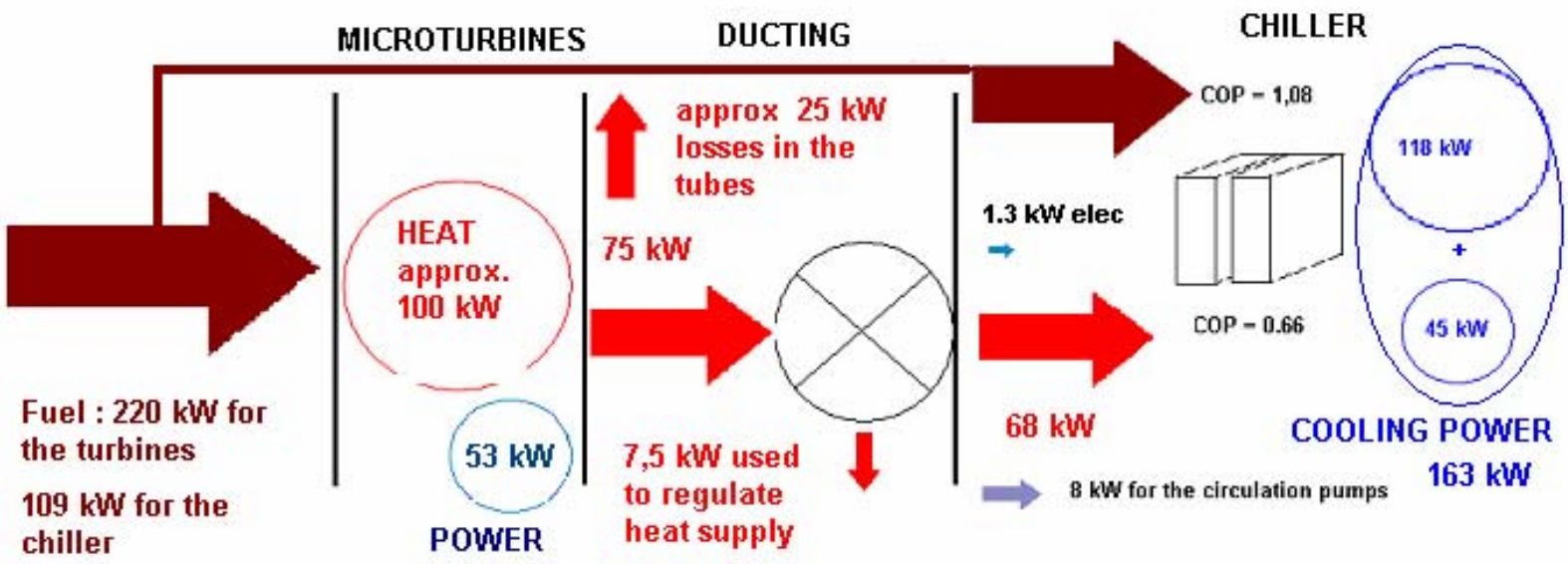
With exhaust recuperation



	Mean values
Chilled w. temp.	10.2°C
Cooling w. temp.	28.4°C
Fuel cons.	110 kW
Elec. cons.	1.3 kW
Heat recup. *	76 kW
Cooling power	160 kW
* approximation	

saves 40 kWh/h on chiller fuel consumption

Performances : measured energy flows



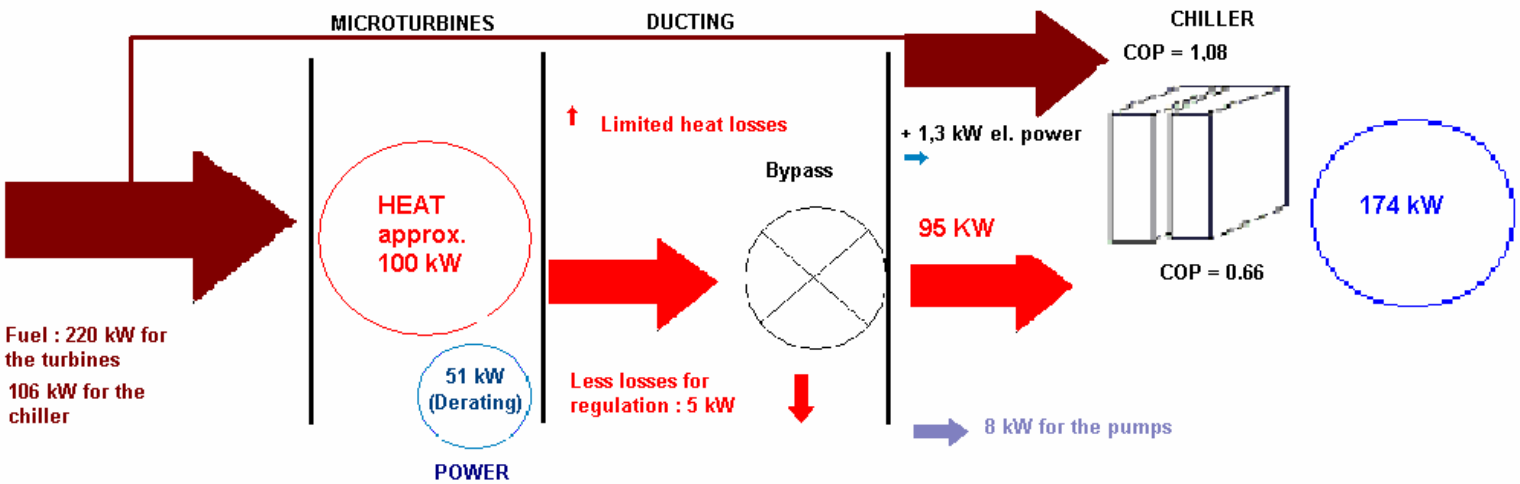
For the whole system

Fuel power : 329 kW LHV

Electrical power : 52 kW (44 kW net including pumps) => 16% efficiency

Cooling power : 163 kW => 50% efficiency

Performances : expected numbers on site



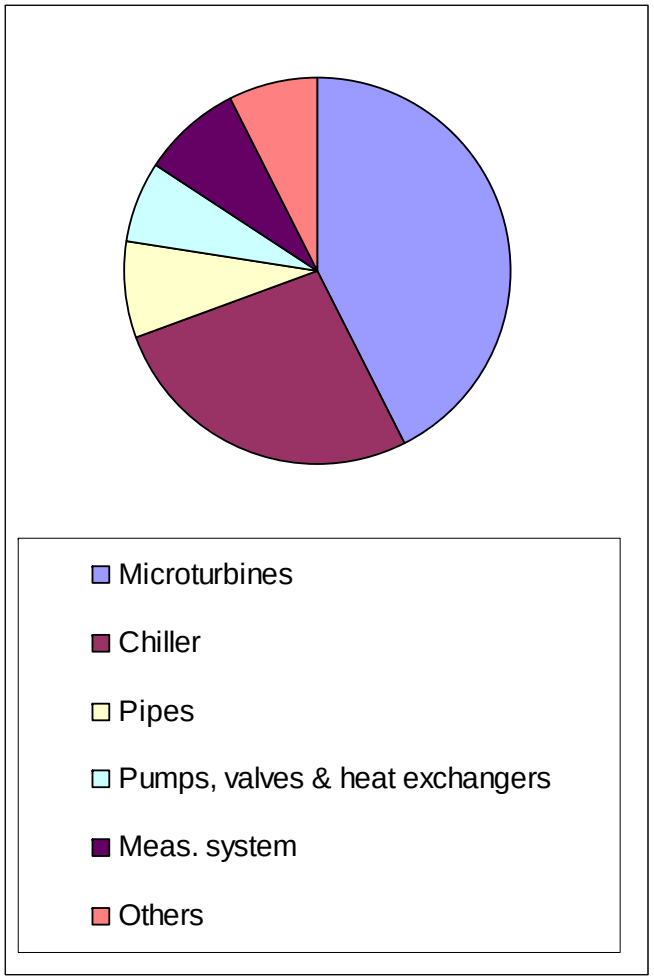
For the whole system

Fuel power : 326 kW LHV

Electrical power : 51 kW (44 kW net including pumps) => 16%

Cooling power : 163 kW => 53%

Costs of the test installation



Microturbines	75.6 k$
Chiller	47.4 k$
Piping	14.3 k$
Pumps,valves& HX	12.1 k$
Meas. system	14.8 k$
Others	13.3 k$
Total (materials only)	*177.4 k$*

(Manpower + engineering + project management ~ 100 k$ for this phase)

Conclusions

Using directly the exhaust heat of microturbines in a Direct-Fired Absorption Chiller is quite easy / the main point is the design of the piping.

Even with such an hybrid configuration, the fuel savings are real.

With such an hybrid configuration, operation of the chiller and of the microturbines are not linked.

Another microturbine like the C65 could improve the performances of such a system because the exhaust temperature is higher (but no “liquid fuel” C65 is yet available) .

Now let’s run this system on site !

Thanks to our partners

Institut für thermische Strömungsmaschinen (University of Karlsruhe)

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Forschungsuniversität • gegründet 1825

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Contact

Sébastien CASSEN

Phone : 0049 721 6105 1326

Fax : 0049 721 6105 1332

E-mail : sebastien.cassen@edf.fr

European Institute for Energy Research

(http://www.eifer.org/)

Universität Karlsruhe (TH) EIfER EDF