

## Hybrid Heat Pump :

### An efficient gas technology to compete against electricity

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#### Background

Regulation is the very first milestone to succeed because it gives the rules for the new investments which will be done by industrial and consumers. The Law, and the way it must be applied, orientates and organizes very deeply the new markets. In Europe and also in France, around one third (33%) of the energy consumption is due to buildings; acting on this sector is strategic to reach CO2 reduction objectives. In France, the main key driver is primary energy. The parameter is clearly declined in the thermal regulation (RT 2012). Now when a consumer wants to build a new house his dwelling must consume less than 50 kWh/M2/year of primary energy. In France, in 2012, the consumption of gas for heating and hot water will represent 50 kWh EP/M2.year. If we compare this figure to the 162 kWh EP/M2.year accepted before, the consumptions are divided by four.

PRIMARY ENERGY REPARTITION IN FRANCE	HOUSES BEFORE 2008 * (ep)	OBJECTIVES OF PRIMARY ENERGY		
		RT 2012 EXISTING HOUSE LOW CONSUMPTION (ep)	RT 2012 NEW HOUSE LOW CONSUMPTION (ep)	2017 POSITIVE ENERGY HOUSE Average
1. HEATING	142 kWh <sub>ep</sub> /m <sup>2</sup> .year	±40 kWh <sub>ep</sub> /m <sup>2</sup> .year	±15 kWh <sub>ep</sub> /m <sup>2</sup> .year	< 10 kWh <sub>ep</sub> /m <sup>2</sup> .year
2. HOT WATER	21 kWh <sub>ep</sub> /m <sup>2</sup> .year	±25 kWh <sub>ep</sub> /m <sup>2</sup> .year	±25 kWh <sub>ep</sub> /m <sup>2</sup> .year	±15 kWh <sub>ep</sub> /m <sup>2</sup> .year
3. COLD	12 kWh <sub>ep</sub> /m <sup>2</sup> .year	±15 kWh <sub>ep</sub> /m <sup>2</sup> .year	±10 kWh <sub>ep</sub> /m <sup>2</sup> .year	<10 kWh <sub>ep</sub> /m <sup>2</sup> .year
4. LIGHTING				
5 . ELECTRICAL AUXILIARY	30 kWh <sub>ep</sub> /m <sup>2</sup> .year	75 kWh <sub>ep</sub> /m <sup>2</sup> .year	60 kWh <sub>ep</sub> /m <sup>2</sup> .year	60 kWh <sub>ep</sub> /m <sup>2</sup> .year ↘
INTERNET & COMPUTERS				
WASHING - MACHINES	75 kWh <sub>ep</sub> /m <sup>2</sup> .year			
<b>Consumptions (1+2+3+4+5)</b>	±205 kWh <sub>ep</sub> /m <sup>2</sup> .year	<b>80</b> kWh <sub>ep</sub> /m <sup>2</sup> .year	<b>50</b> kWh <sub>ep</sub> /m <sup>2</sup> .year	<b>0</b>

The problem is that the current gas technologies need renewable energies to achieve the target of 50 kWh/M2/year.

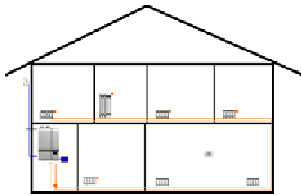
## Aims

### Aggregate two mature technologies : a gas boiler + an electrical heat pump

Hybrid heat pumps are combining a small electric heat pump with a boiler. With a smart control strategy that is able to choose the most efficient system by considering the primary energy. It is combining the benefits of both systems : at average outside temperature and average water temperature, the electric heat pump provides good efficiency by using a part of renewable energy, when the boiler provides better efficiency at low outside temperature and hot water production. The technology development using two well known technologies, the market launch is already starting in 2011 to answer to a short term product need. The global efficiency is around 120-125%

There are two configurations of hybrid heat pump :

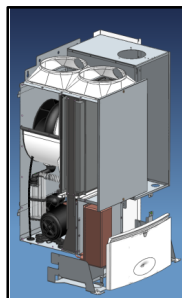
- Monobloc system, the boiler and the electric heat pump are integrated in the same bloc and installed inside the house.
- Bi-blocs system, the electric heat pump is installed outside the house and the boiler inside the house.



F 1 : monobloc system



scheme 2 : bi-blocs system



Boiler + Heat Pump

### Optimize the powers for the gas boiler and the electrical heat pump

The major issue is to have a product which has the best efficiency between gas and electricity on "real time". Thanks to daily profiles of consumption during one year the CRIGEN had in its data bases, engineers could calculate the best power of each technology. It appears that the electrical heat pump power must be as low as possible with a COP high as possible. Threw different simulations the specifications are :


- A gas boiler
- An electric heat pump of 1 kW max and also which runs when the COP is higher than 3.

To obtain this figures, the CRIGEN had to make many simulations depending :

- The dwelling : surface, isolation, number of people, new or existing
- Climatic zone : cold, medium, or hot in France

### • Logement rénové 90m<sup>2</sup> 4 personnes

Situation géographique	
Département	06 - Alpes Maritimes
Altitude	< 200 m
Caractéristiques du logement	
Type d'habitation	Maison existante
Caractéristiques	Pavillon type 1982-1988
Le logement sélectionné présente les caractéristiques suivantes :	
Mitigeant	Accès à un grand été
Nb de niveaux	2 Niveaux avec combles non aménagés
Murs	Parpaing 20 cm iso 10 cm
Plancher bas	Plancher avec ou sans remplissage
Toiture	Bardeaux et remplissage
Vitrage	BATI BOIS DV 4.12.4
Type d'émetteurs initiaux	-
Type de ventilation	VMC Hygro B
Surface habitable (Shab)	90 m <sup>2</sup>



Zones climatiques RT 2005

## METHOD :

### Precise the specifications to the manufacturers

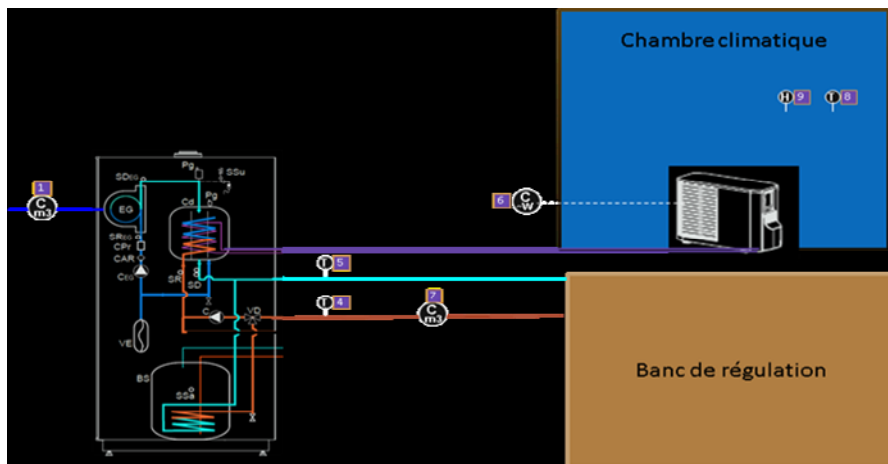
Thanks to historical partnerships, two manufacturers decided to work with GDF SUEZ and build products on GDF SUEZ's specifications. One manufacturer took the option of a monobloc technology, and the other one took the option of a bi bloc technology. In March 2011, GDF SUEZ wrote its specifications and proposed them to its partners. The main GDF SUEZ's specifications that each manufacturer had to reach :

- Hot Water production = 16 liter/min minimum at 60°C
- Gas boiler =
  - Condensing + Power from 4 to 24 kW and start at 4 kW
  - Efficiency = 107% on low calorific power - minimum
- Electric heat pump =
  - 3 kW thermal at +7°C external temperature
  - Electric power = 600W
  - Noise = 45 dBa maxi
- Controller on primary energy = Absolute Obligation in the specifications

## RESULTS

### Tests in a climatic room

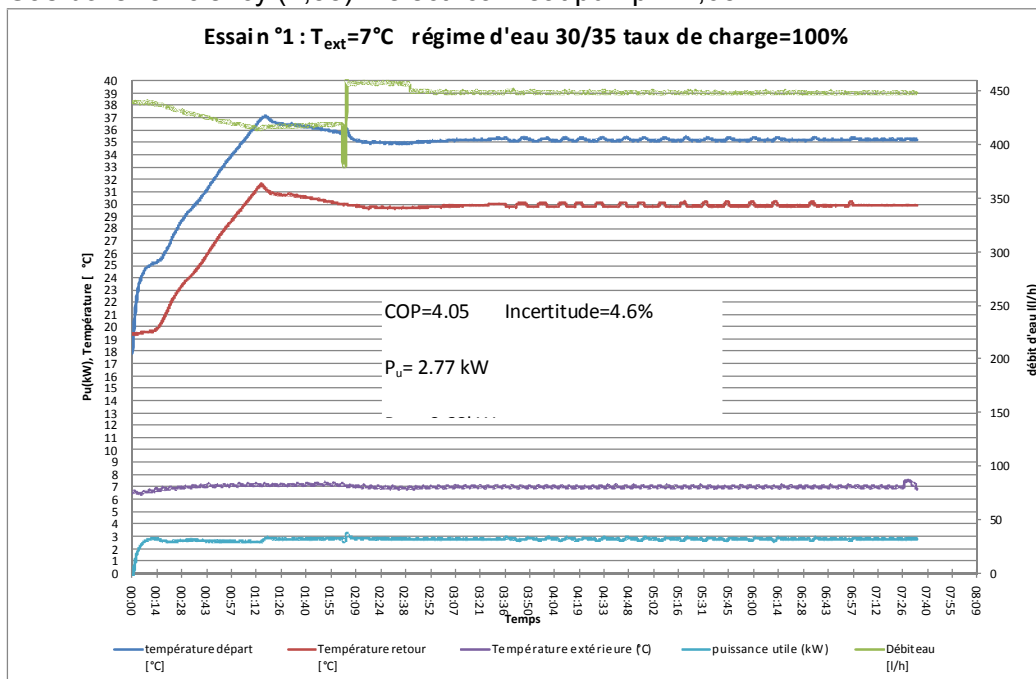
Between October and December 2011, GDF SUEZ tested in its climatic room the two hybrid heat pumps to see if the specifications were respected and also to know as precisely as possible at which external temperature solution is the best : gas or electricity.



After a period of two months of tests on the two technologies the results shows three majors points on the hybrid heat pump technology :

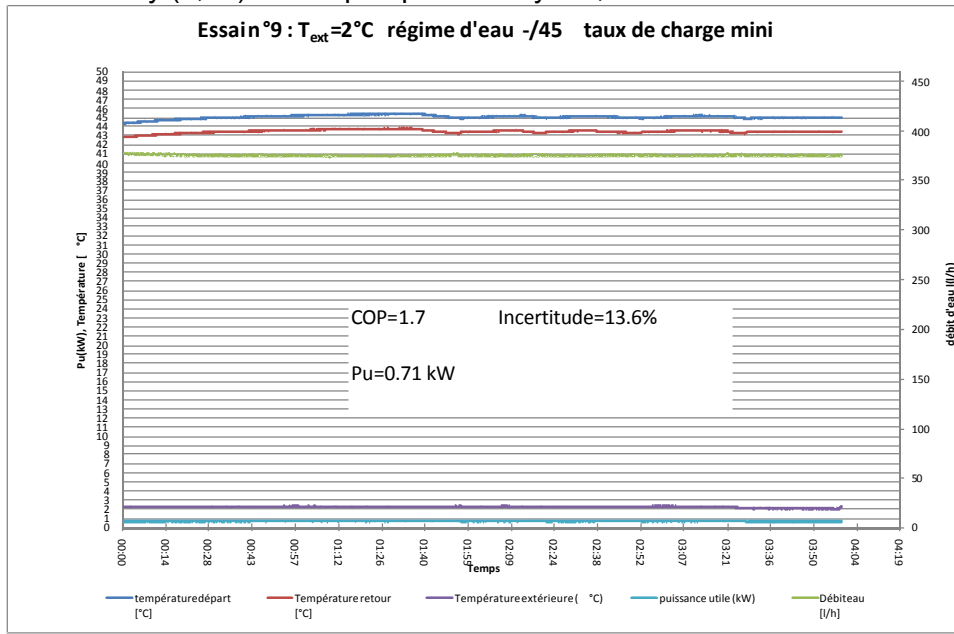
- With a hot water for heating at 30/35°C, the efficiency of the electric heat pump is better than the gas efficiency – on primary energy - when external temperature is upper than 4-5°C

Gas boiler efficiency (2,58) < electrical heat pump = 4,05

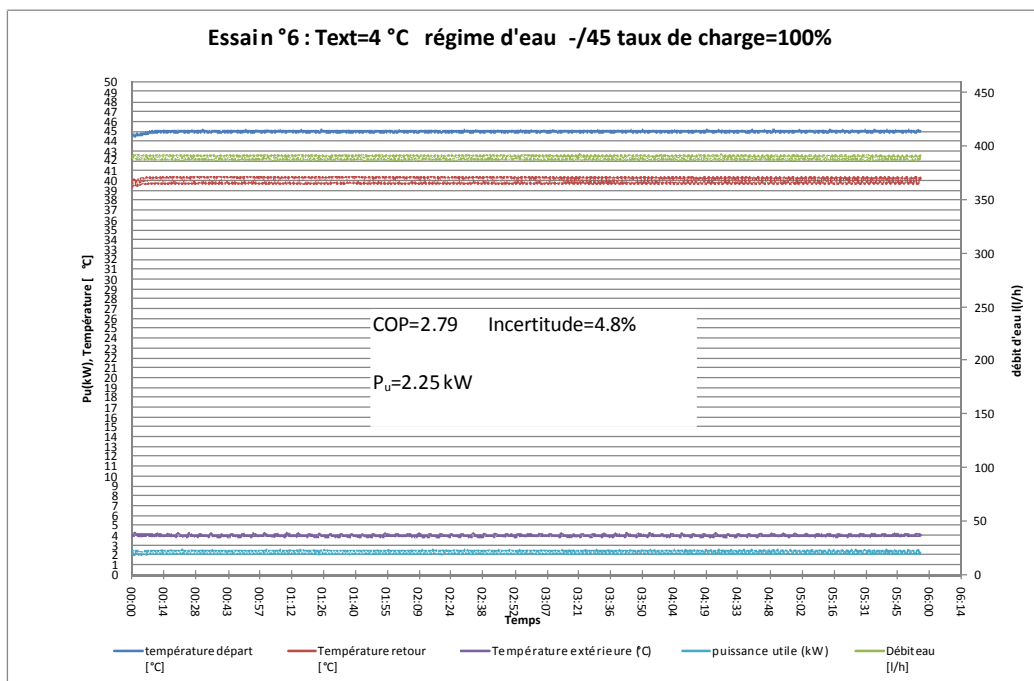


- With a hot water for heating at 40/45°C, the efficiency of the electric heat pump is not proved : the efficiency – on primary energy – of the gas boiler is sometimes upper or the same.

Gas efficiency (2,58) > heat pump efficiency = 1,7



Gas efficiency (2,58) < heat pump efficiency = 2,79



## CONCLUSIONS

Hybrid heat pump is a technology which tests in climatic room have shown :

- At low temperature of heat – 30/35°C – and when external temperature is up to 4-5°C, the electrical heat pump has a better efficiency on primary energy than gas boiler, if we take the conversion coefficient of 2,58 used for France.
- At higher temperature of heat, from 40/45°C to more, the efficiency between gas and electricity depend mainly on the capacity of the controller to choose the best energy in real time.

We think, that for medium temperatures and high temperatures (60°C) gas boiler must be chosen by the controller.

In France, the two products, hybrid heat pump monobloc and bi bloc will be launched on the market at the beginning of February 2012. The target price is nearly the same as a boiler with a hot water tank of 150 liters.



Sortie air PAC  
électrique

ventouse