

# Honeywell Energy Services

Atrium Hospital  
Tri-Generation Optimisation  
Heerlen  
Netherlands  
2003-2007 results  
Pascal Stijns

# Where is Heerlen ?



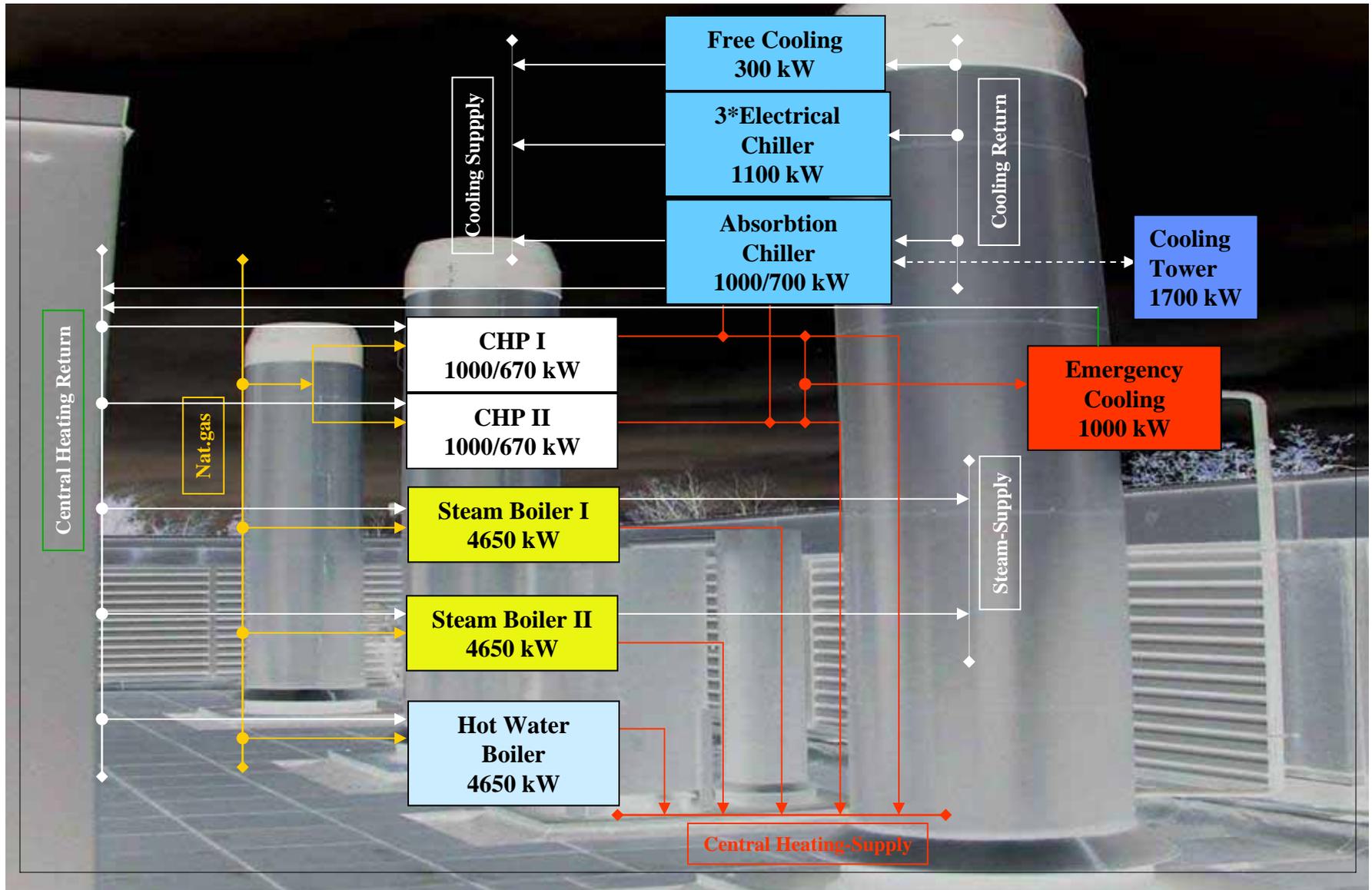
- 1230 Hospital beds
- 28.617 In patients
- 18.696 Out patients
- 435.984 Consultations

# Hospital Utility demands



Heating  
Cooling  
Electricity  
Steam  
Various gases  
Various waters

# Tri-Gen Plant lay out

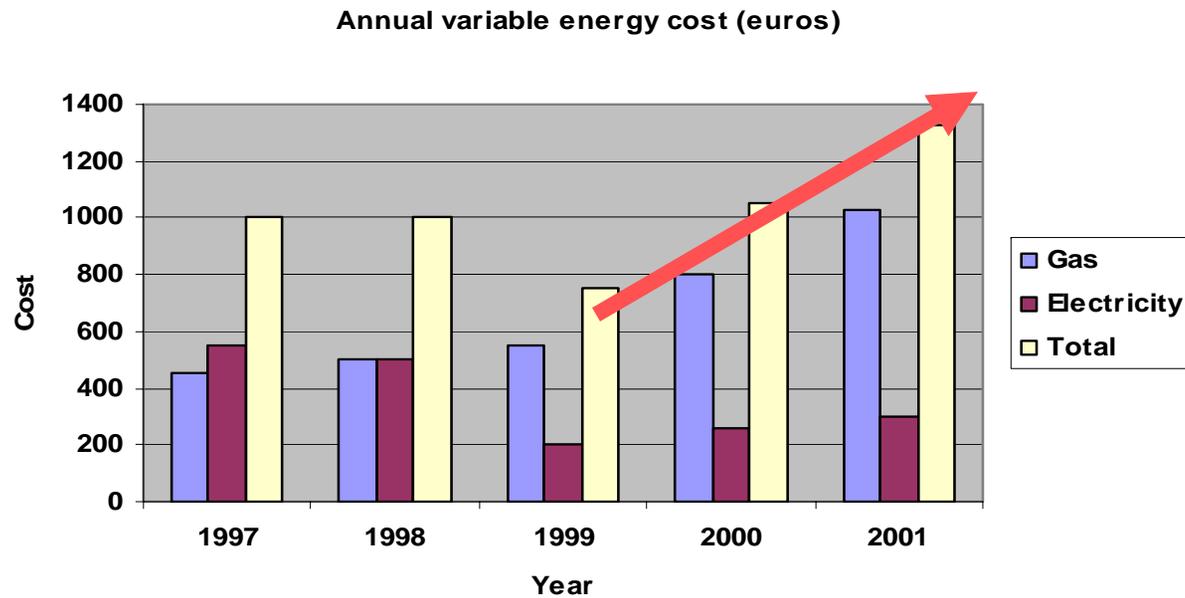


# Some pictures



# The challenge !

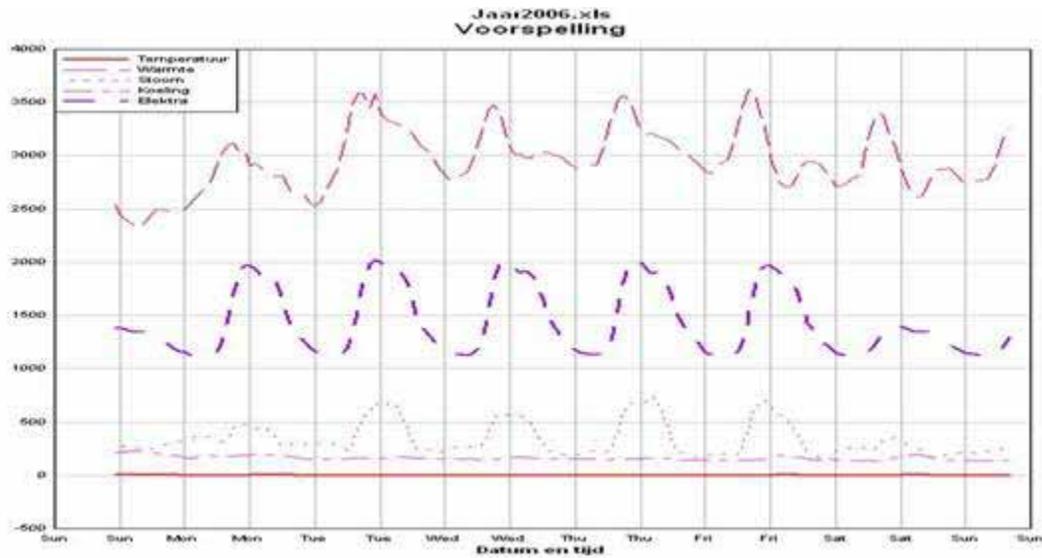
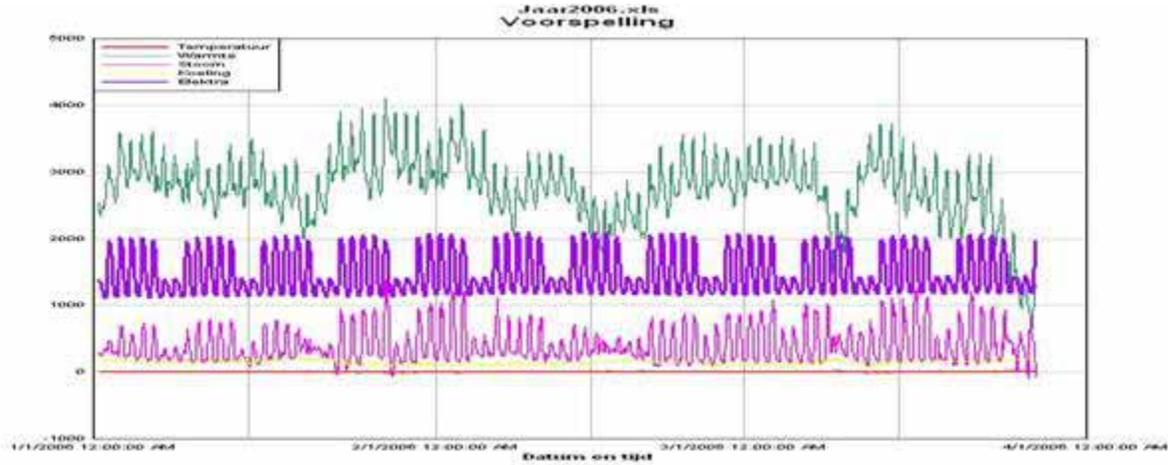
- 1) **Energy bill**
- 2) **Major expansion of the hospital capacity**
- 3) **Change in utility demands**
- 4) **Liberalisation of the energy market**
- 5) **Financial constraints (pay back and budget)**



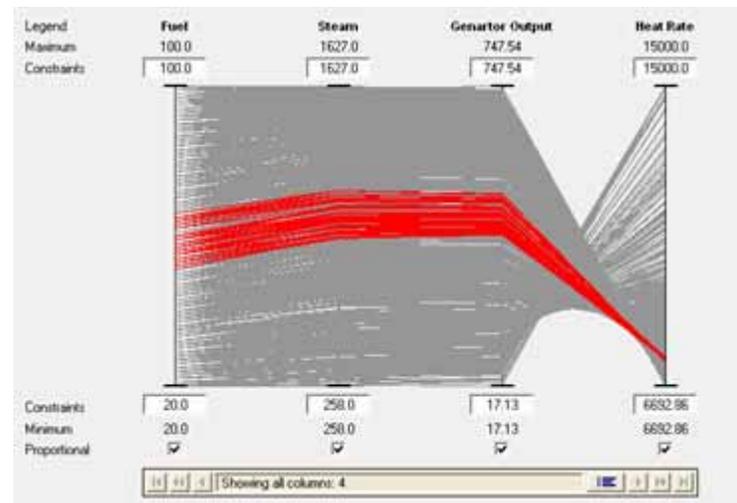
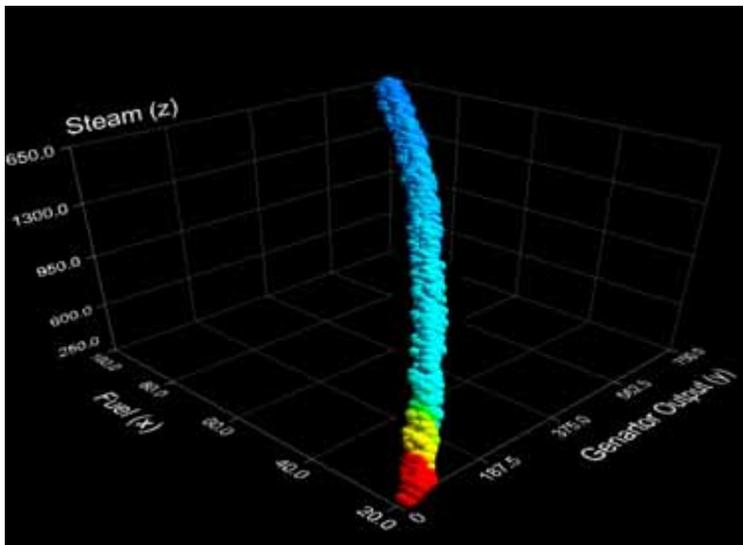
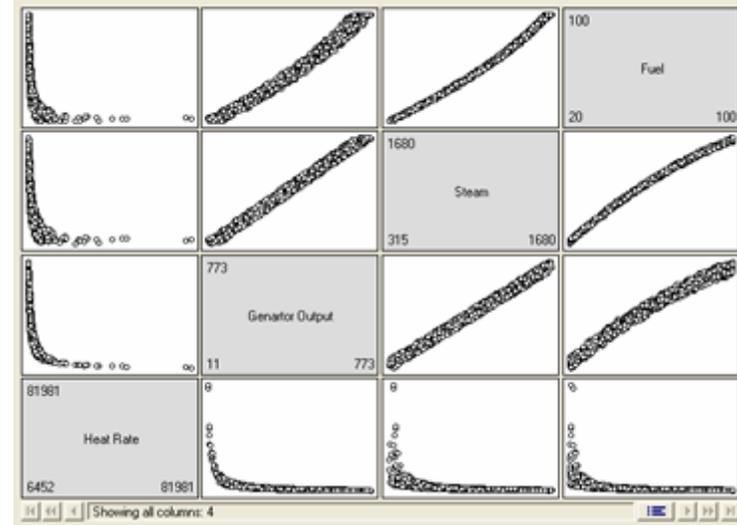
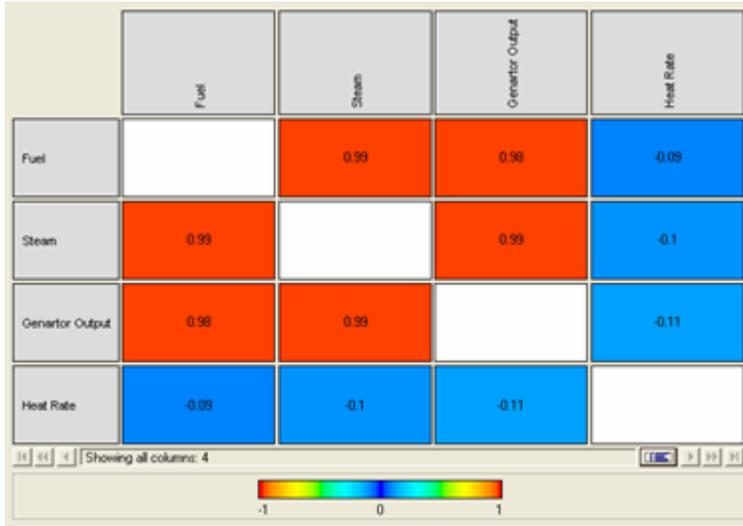
# The approach

- 1) Demand reduction ( building )**
- 2) Generation optimisation ( utility )**
  - **Demand modeling**
  - **Physical Economical Model**
  - **Model & Demand validation**
  - **Scenario investigation and sensitivity analysis**
  - **Select solutions**

# Energy Study : Metering Data Collection



# Energy Study : Data Analysis



# Investigated Economical Solutions

- Smaller CoGen
- Smaller steam boiler
- Heat storage
- Cooling storage
- Variable speed drives
- Emergency Diesel Gen Sets

**Didn't passed financial or project/physical constraints in 2001**

# Solution : Flue Gas Condenser



Heat recovery : 3.2 GWh  
(since september 2002-2007)  
Total heat demand : 67 GWh

*Savings 3-4 % of total heat demand or  
350.000 Nm<sup>3</sup> of Gas savings or 65.000  
Euro/5 years or 393.750 kg CO<sub>2</sub>  
reduction.*



# Solution : free cooling during autumn/winter/spring time

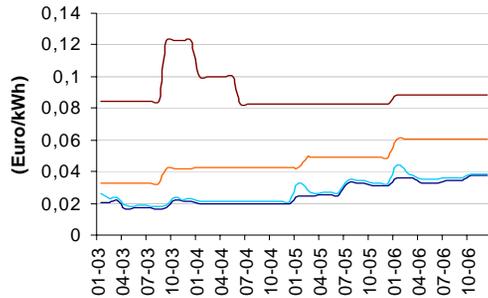


The system delivered 576.000 kWh of cooling in 2007 which is close to 15 % of the total. Savings close to 15.000 Euro/year.



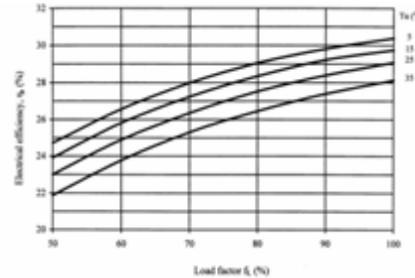
# How to produce at the lowest cost ?

Energy Supply



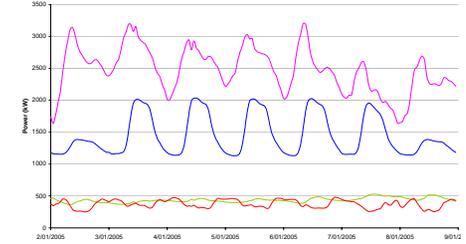
Gas en electricity (on/off peak)

Energy Plant

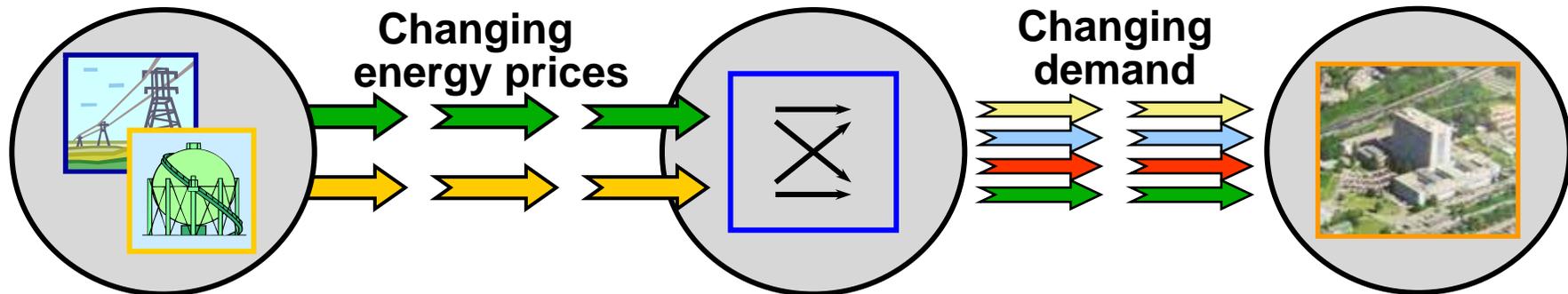


Equipment efficiencies vary with load

Energy Demand



Heat / Electricity / Steam / Cooling



Do we produce :

- Cooling by means of absorption or electrical chillers or free cooling ?
- Heating by means of steam or hot water boilers or Cogen ?
- Electricity by means of self generated cogeneration or do we import from the grid ?
- Can we forecast 48 hours ahead

?

?

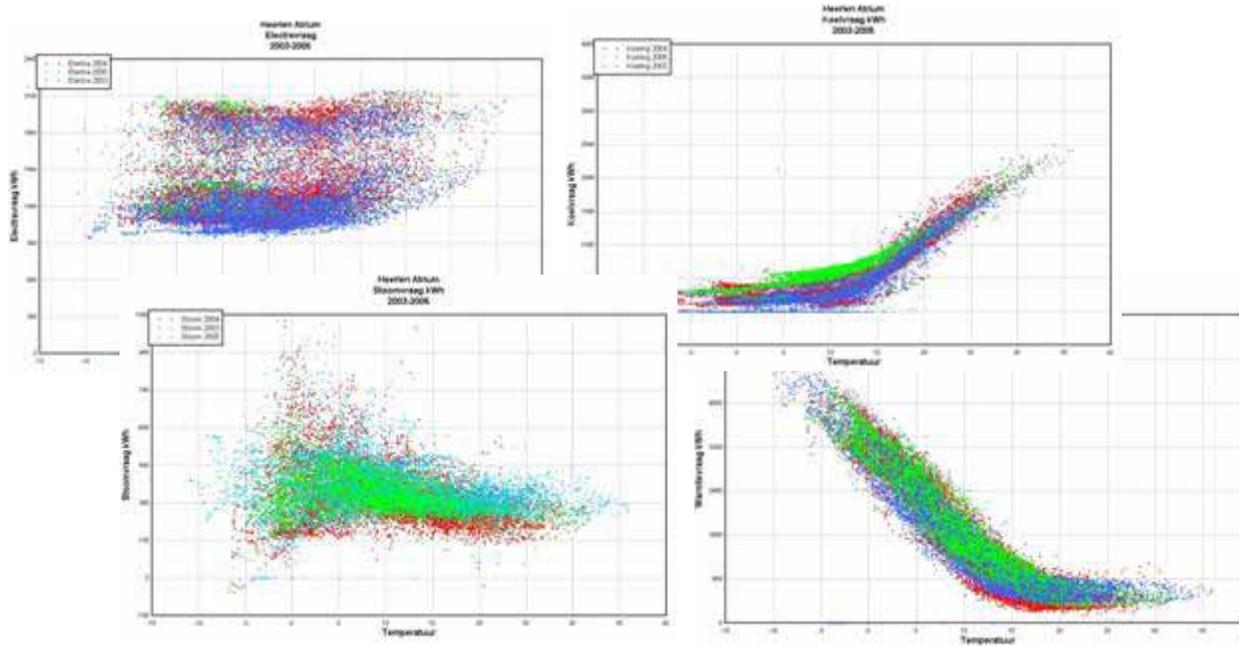
# Economical Optimisation : Model

| omschrijving                    | Minimum | Optimale Waarde | Maximum | Konstanten                            |
|---------------------------------|---------|-----------------|---------|---------------------------------------|
| CV gasfictie (Nm3/h)            | 0       | 8.00            | 600     | WKK gasprijs Euro/Nm3 9,275           |
| CV fictie aan/uit               | 0/1     | 0/1             | Aan     | Max WKK gasprijs Euro/Nm3 9,275       |
| Stroomketal 1 gasfictie (Nm3/h) | 0       | 47.83           | 600     | Stroomketal 1 gasprijs Euro/Nm3 9,275 |
| Stroomketal 1 aan/uit           | 0/1     | Aan             | Aan     | Stroomketal 1 gasprijs Euro/Nm3 9,275 |
| TSA 1 gasfictie (Nm3/h)         | 0       | 34.41           | 600     | Stroomketal 2 gasprijs Euro/Nm3 9,275 |
| TSA 1 aan/uit                   | 0/1     | Aan             | Aan     | Stroomketal 2 gasprijs Euro/Nm3 9,275 |
| Stroomketal 2 gasfictie (Nm3/h) | 0       | 8.00            | 600     | Stroomketal 2 gasprijs Euro/Nm3 9,275 |
| Stroomketal 2 aan/uit           | 0/1     | 0/1             | Aan     | Stroomketal 2 gasprijs Euro/Nm3 9,275 |
| TSA 2 gasfictie (Nm3/h)         | 0       | 8.00            | 600     | Stroomketal 2 gasprijs Euro/Nm3 9,275 |
| TSA 2 aan/uit                   | 0/1     | 0/1             | Aan     | Stroomketal 2 gasprijs Euro/Nm3 9,275 |
| WKK1 gasfictie (Nm3/h)          | 0       | 8.00            | 220     | WKK1 gasprijs Euro/Nm3 9,275          |
| WKK1 aan/uit                    | 0/1     | 0/1             | Aan     | WKK1 gasprijs Euro/Nm3 9,275          |
| WKK2 gasfictie (Nm3/h)          | 0       | 220.00          | 220     | WKK2 gasprijs Euro/Nm3 9,275          |
| WKK2 aan/uit                    | 0/1     | 0/1             | Aan     | WKK2 gasprijs Euro/Nm3 9,275          |
| Absorptiekooling (%)            | 0       | 8.00            | 100     | Absorptiekooling (%) 8,00             |
| Absorptiekooling aan/uit        | 0/1     | 0/1             | Aan     | Absorptiekooling (%) 8,00             |
| Kompresorkooling (%)            | 0       | 7.14            | 100     | Kompresorkooling (%) 7,14             |
| Kompresorkooling aan/uit        | 0/1     | Aan             | Aan     | Kompresorkooling (%) 7,14             |
| Rookkooling (%)                 | 0       | 8.00            | 100     | Rookkooling (%) 8,00                  |
| Rookkooling aan/uit             | 0/1     | 0/1             | Aan     | Rookkooling (%) 8,00                  |
| Input (MW)                      | 0       | 775.25          | 10000   | Input (MW) 775,25                     |
| Kosten                          |         | 89.29           |         |                                       |

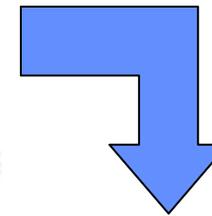
- MicroSoft Office based
- Physical properties add-ins
- Mathematical add-ins
- OLE/OPC

| Tijdstip (h:m)  | Productie | Gasfictie | CV  | WKK1 | WKK2 | TSA1 | TSA2 | WKK1 (%) | WKK2 (%) | WKK1 (MW) | WKK2 (MW) | Stroomketal 1 | Stroomketal 2 |
|-----------------|-----------|-----------|-----|------|------|------|------|----------|----------|-----------|-----------|---------------|---------------|
| 1908/2002 09:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 09:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 09:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 09:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 09:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 11:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 12:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 13:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 14:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 15:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 16:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 17:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 18:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 18:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 18:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 18:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 21:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 22:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 1908/2002 23:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 2008/2002 00:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 2008/2002 01:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 2008/2002 02:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 2008/2002 03:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |
| 2008/2002 04:00 | OK        | Gevoel    | 100 | Aan  | 100  | 100  | 100  | 0.00     | 100      | 0.00      | 100       | 100           | 100           |

# Economical Optimisation : Demand Forecasting

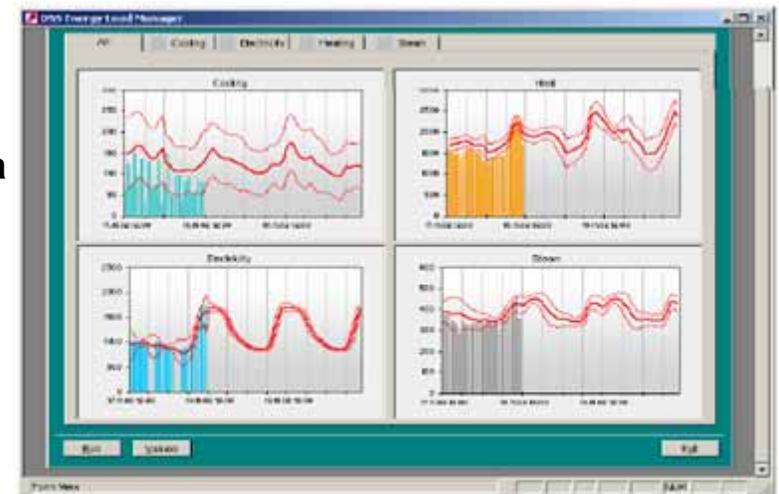
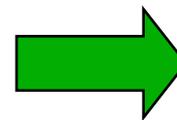


Historical demands/data



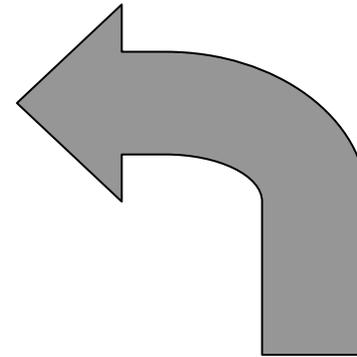
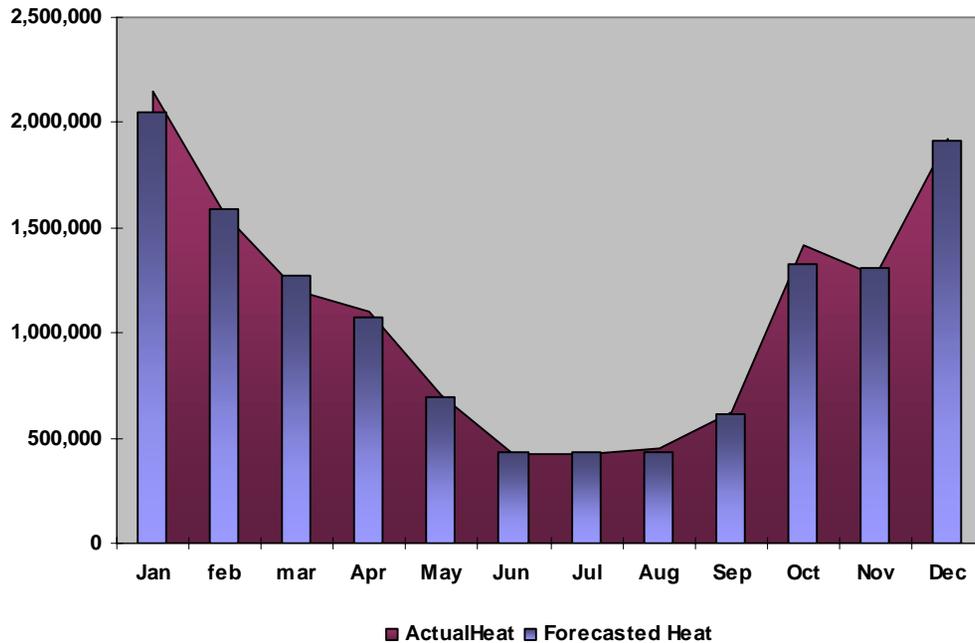
| Mon    | Tue           | Wed    | Thu    | Fri    |
|--------|---------------|--------|--------|--------|
| 14 Jan | 15 Jan        | 16 Jan | 17 Jan | 18 Jan |
|        |               |        |        |        |
| Sunny  | Partly Cloudy | Sunny  | Sunny  | Sunny  |
| 70°F   | 66°F          | 65°F   | 65°F   | 63°F   |
| 47°F   | 46°F          | 48°F   | 45°F   | 47°F   |

Forecasted temperature data from Web



# Monthly Heat demand

Heerlen 2003 Actual versus Forecasted Heat Demand

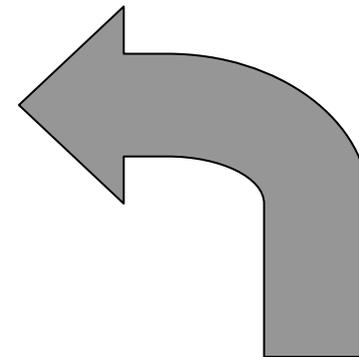
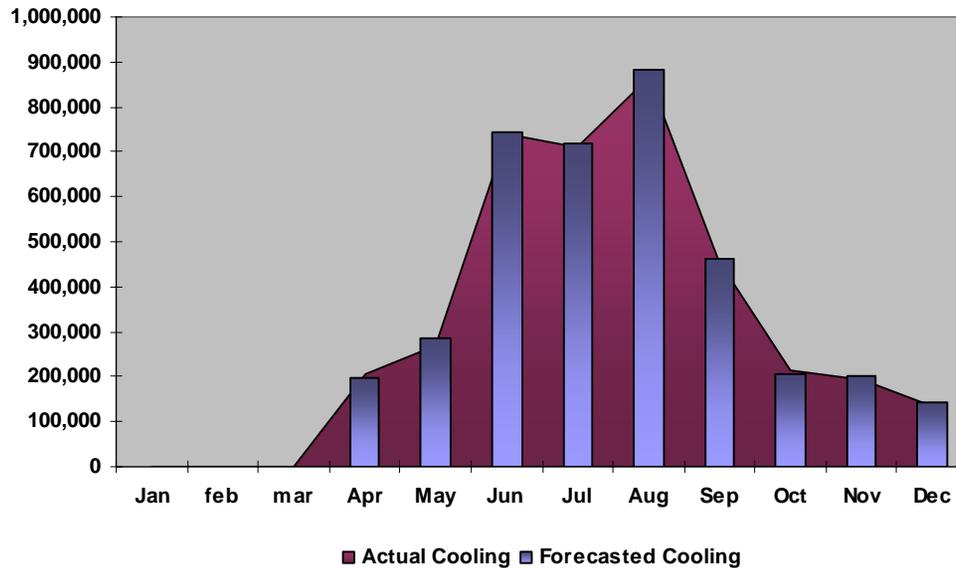


Total Heat :  
**13,246,264 kWh**

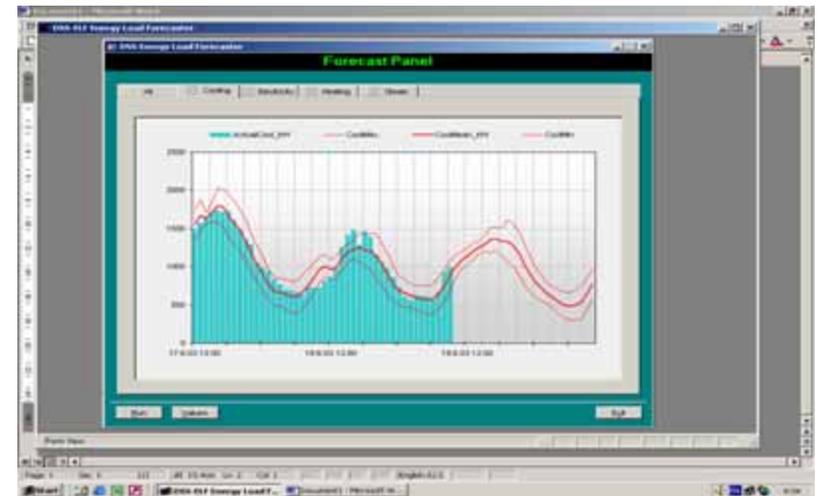


# Monthly Cooling demand

Heerlen 2003 Actual versus Forecasted Cooling Demand (kWh)

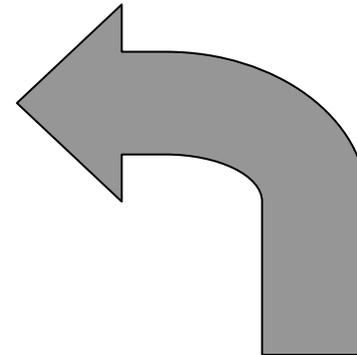
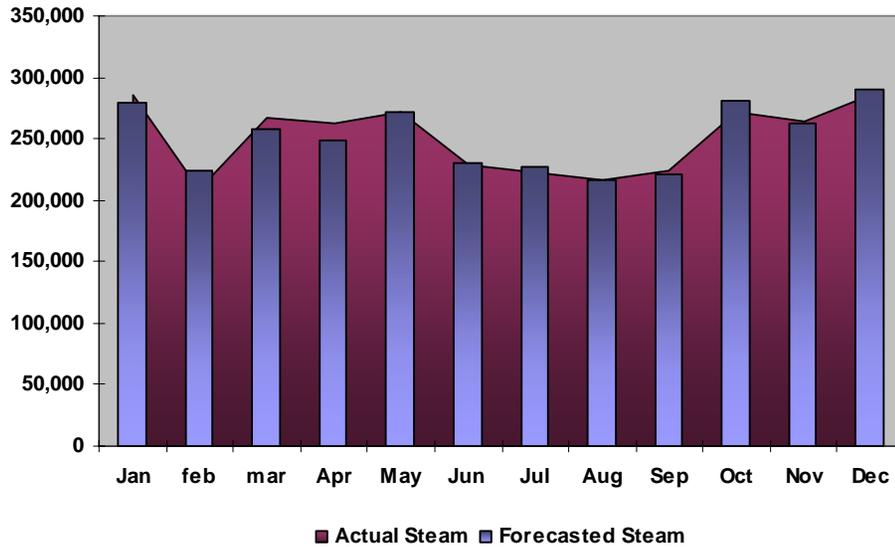


Total Cooling :  
**3,789,013 kWh**



# Monthly Steam demand

Heerlen 2003 Actual versus Forecasted Steam Demand ( kWh)

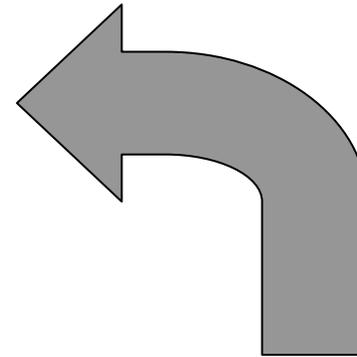
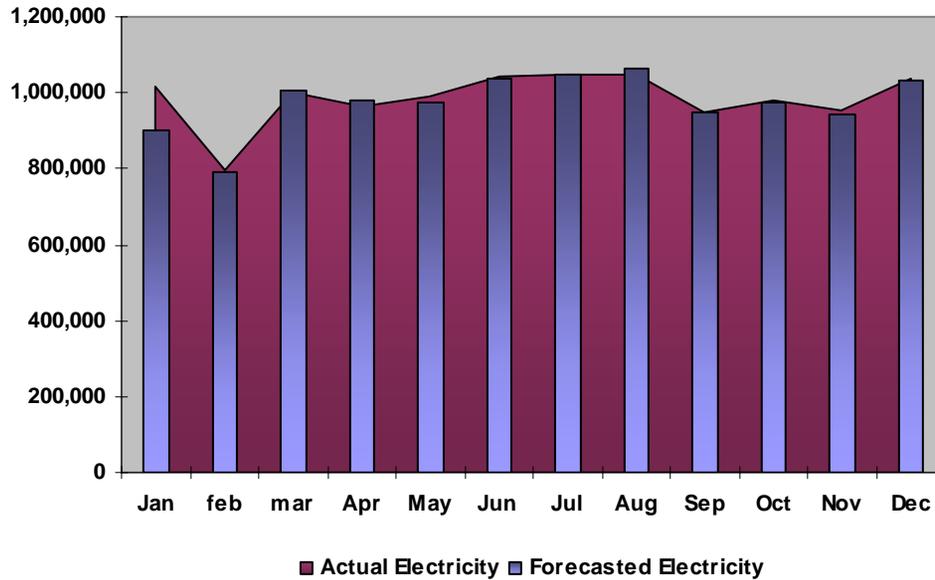


Total Steam :  
**3,007,116 kWh**

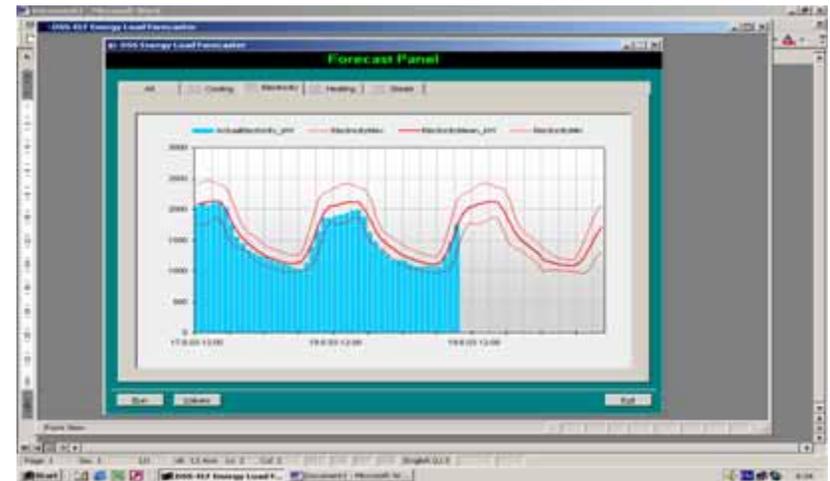


# Monthly Electrical demand

Heerlen 2003 Actual versus Forecasted Electricity Demand (kWh)

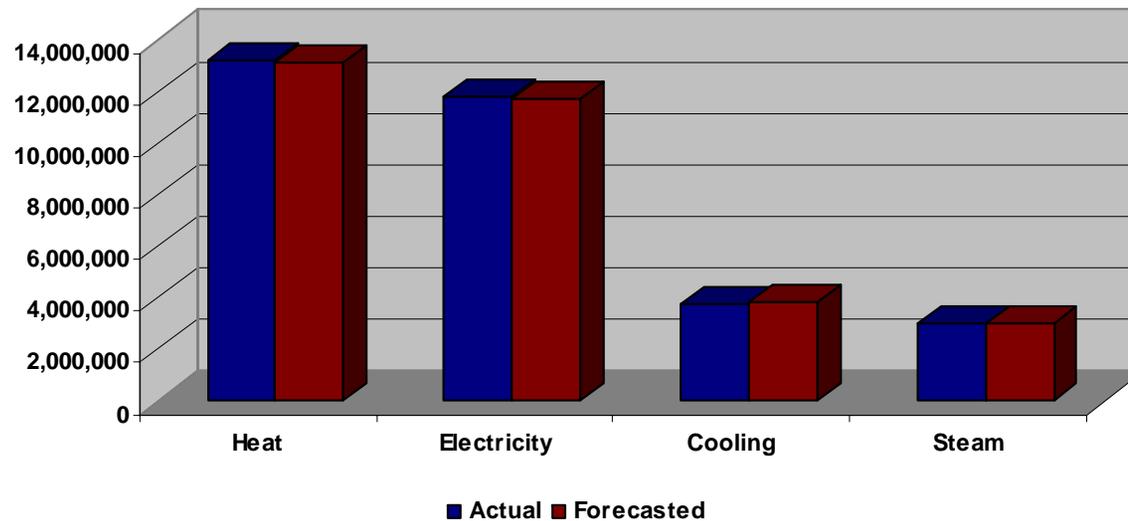


Total Electrical :  
**11,825,947 kWh**



# Actual versus Forecasted Demand

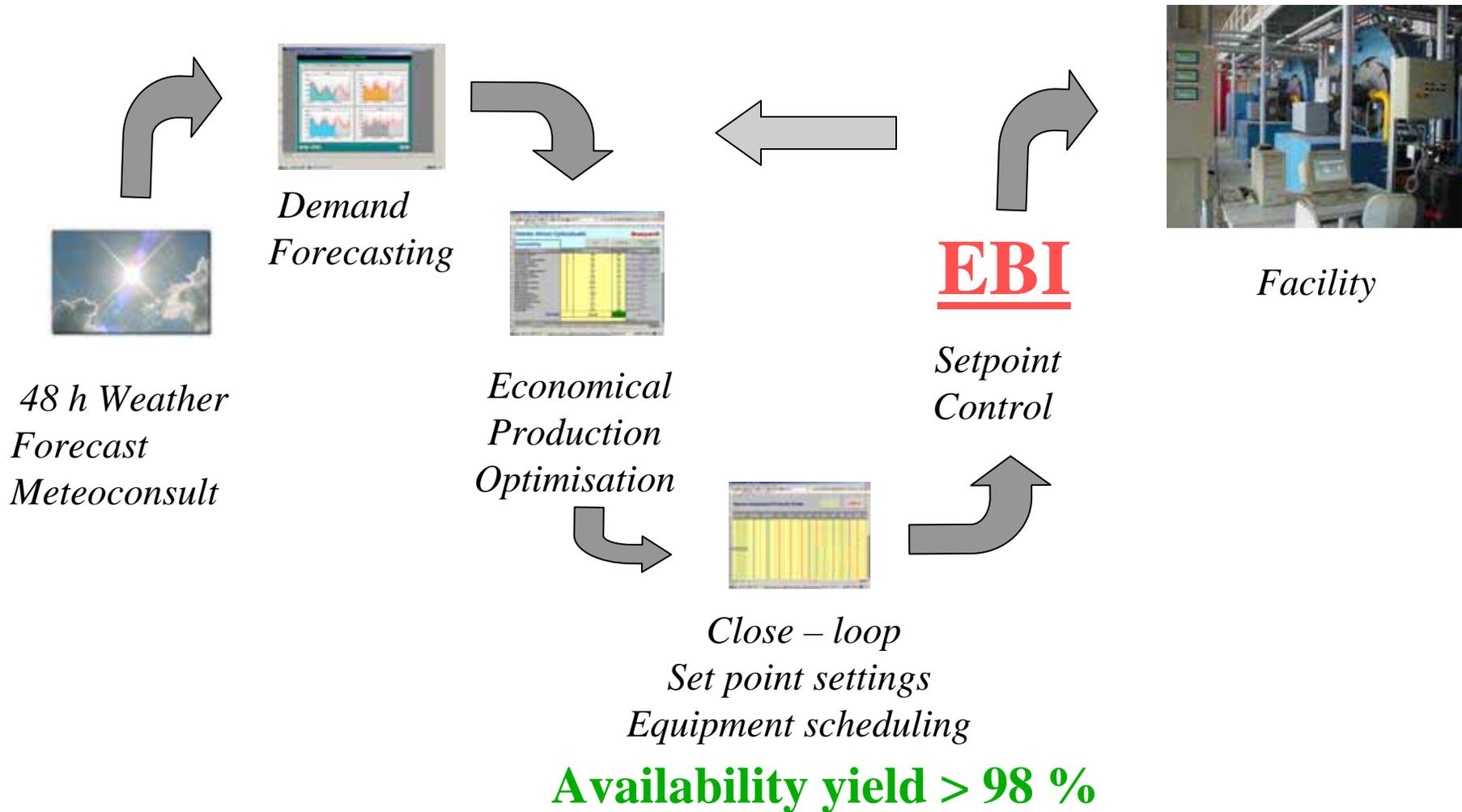
Heerlen 2003 Actual versus Forecasted demands



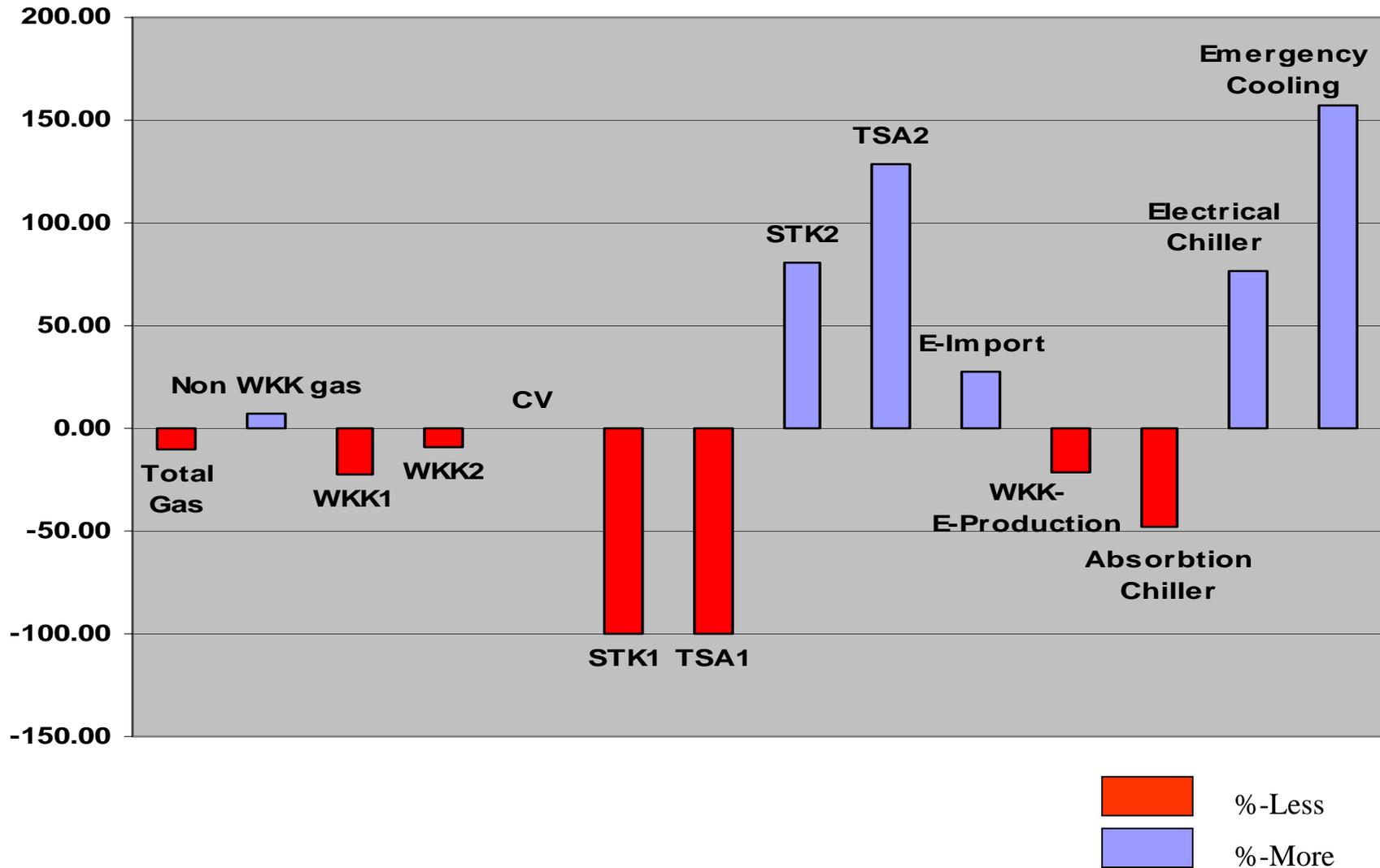
Differences (%) :

- Heat +0.9
- Electricity +1.02
- Cooling - 1.31
- Steam - 0.14

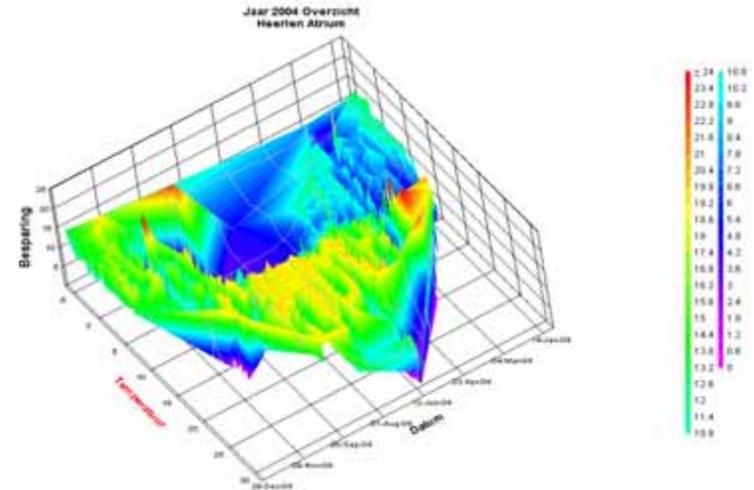
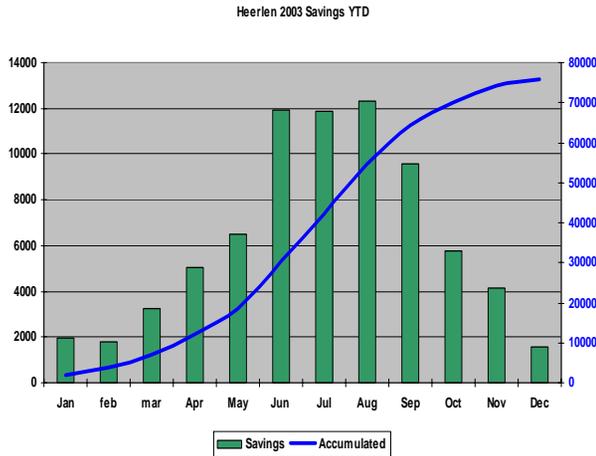
# Economical Optimisation : closing the loop



# Optimum versus base line



# Year 2003-2007 Savings



Year 2003 : 75.000  
Year 2004 : 90.000  
Year 2005 : 100.000  
Year 2006 : 120.000  
Year 2007 : 140.000

---

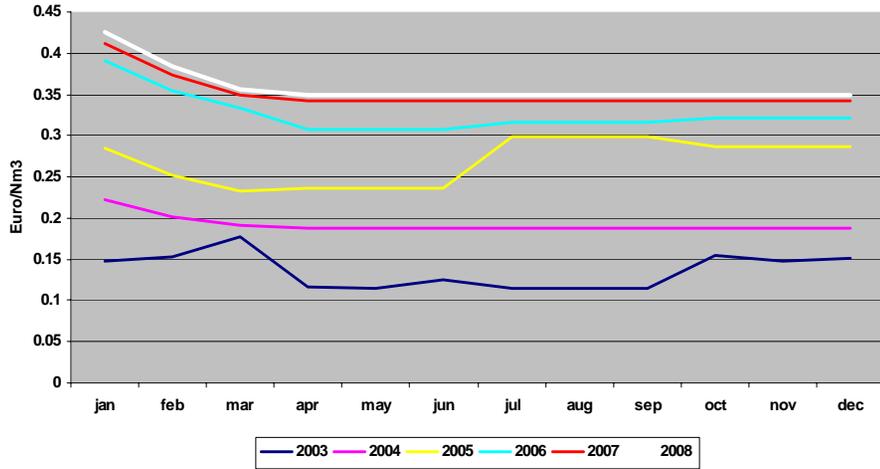
525.000 Euro

## ***Pay back time : 3-5 years***

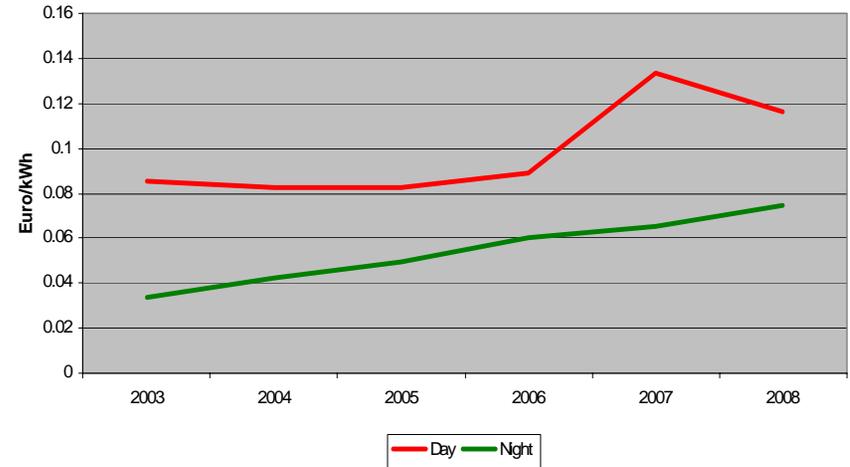
- Study
- Metering
- Control
- Economical Optimisation
- Condenser
- Free Cooling
- HVAC Heat recuperation

# Have we made the right decisions in 2001 ?

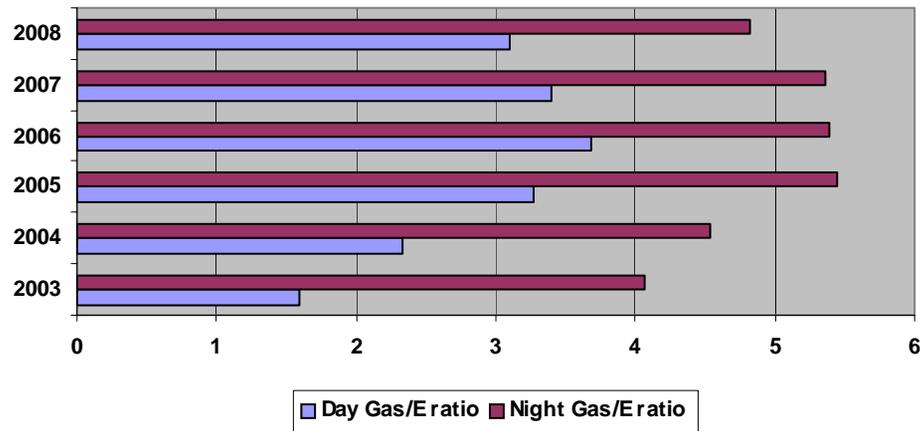
Natural Gasprice Evaluation



Electricity Price Evaluation



Gas/Electricity price ratio



# Economical Optimisation : The right decision at any time

**“Not only this project is financially attractive but it allows the Hospital to envisage the future deregulation of the energy market and the future change of the demand side in the most efficient manner”**

Andre Dumont, Facility Manager

# Honeywell

Thank you for your attention

[psme.stijns@Honeywell.com](mailto:psme.stijns@Honeywell.com)

[www.honeywell.com](http://www.honeywell.com)