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Haute Ecole Spécialisée de Suisse occidentale
Fachhochschule Westschweiz
University of Applied Sciences Western Switzerland

COMBINED HEAT & POWER AND HEAT PUMP FOR RESIDENTIAL USE. System design for minimum CO_2 emissions and best economy.

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Outline

- The University of Applied Science of Western Switzerland
- The energy policy of the State of Geneva
- Principle of the HP-CHP combined system
- Design alternatives and results
- Conclusions

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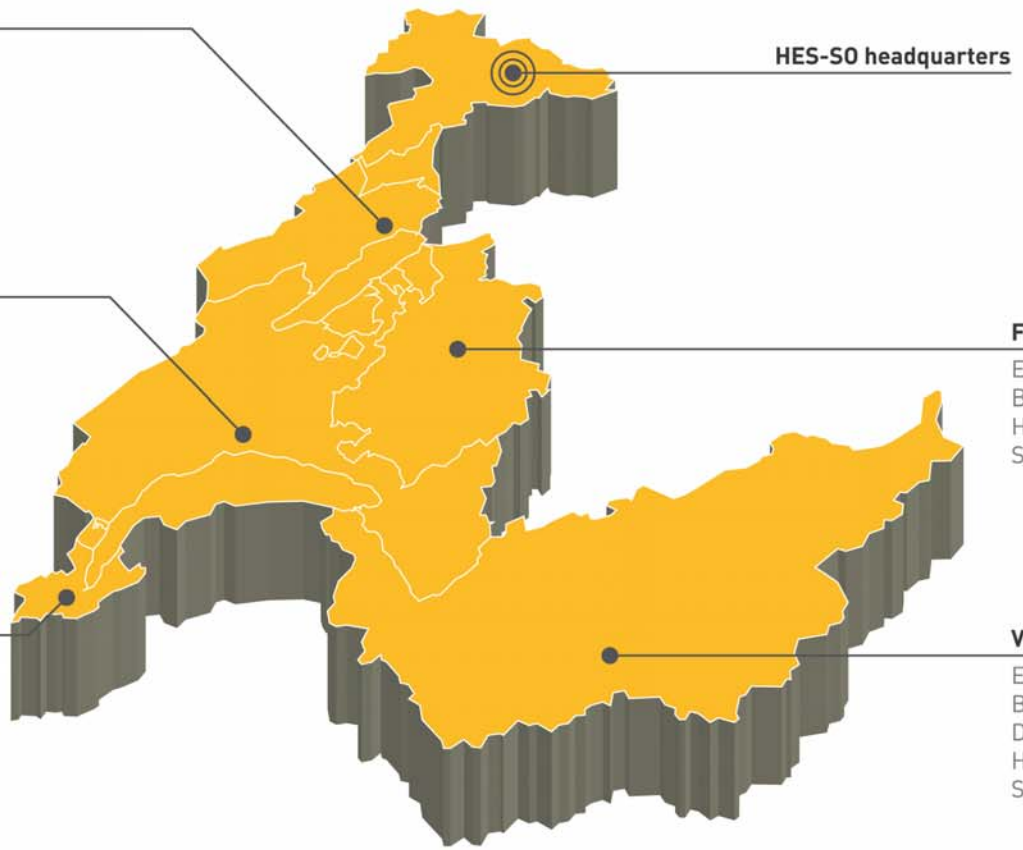
HES-SO Educational fields



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Engineering Sciences
Business, Management and Services
Design and Fine Arts
Health

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Design and Fine Arts
Health
Social Work
Music and Theatre

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Health
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Genève
Engineering Sciences
Business, Management and Services
Design and Fine Arts
Health
Social Work
Music and Theatre

Valais
Engineering Sciences
Business, Management and Services
Design and Fine Arts
Health
Social Work

Energy related R&D activities

Geneva and Yverdon

- HVAC systems
- CFD
- Wood combustion improvement
- Wind tunnel testing of eolian machines
- Combustion control systems

- Phase change materials and ice slurries (IEA working group)
- Magnetic cooling

Energy vision in Switzerland

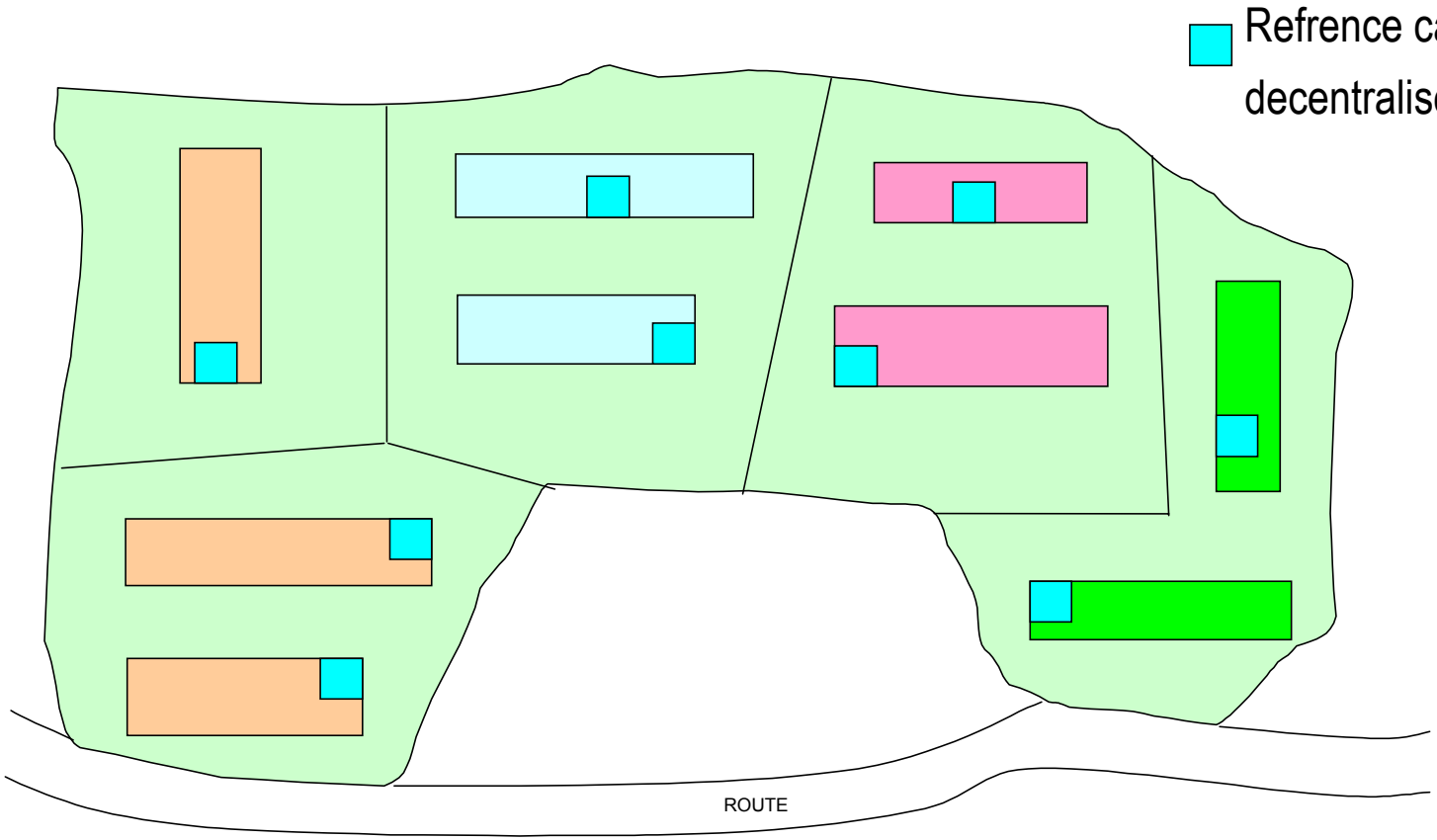
Within the next 50 years, Switzerland plans to:

- Divide by 3 the power requirement → 2 kW/person
- Divide by 6 the CO2 emissions to attain less than 1 ton/person/year

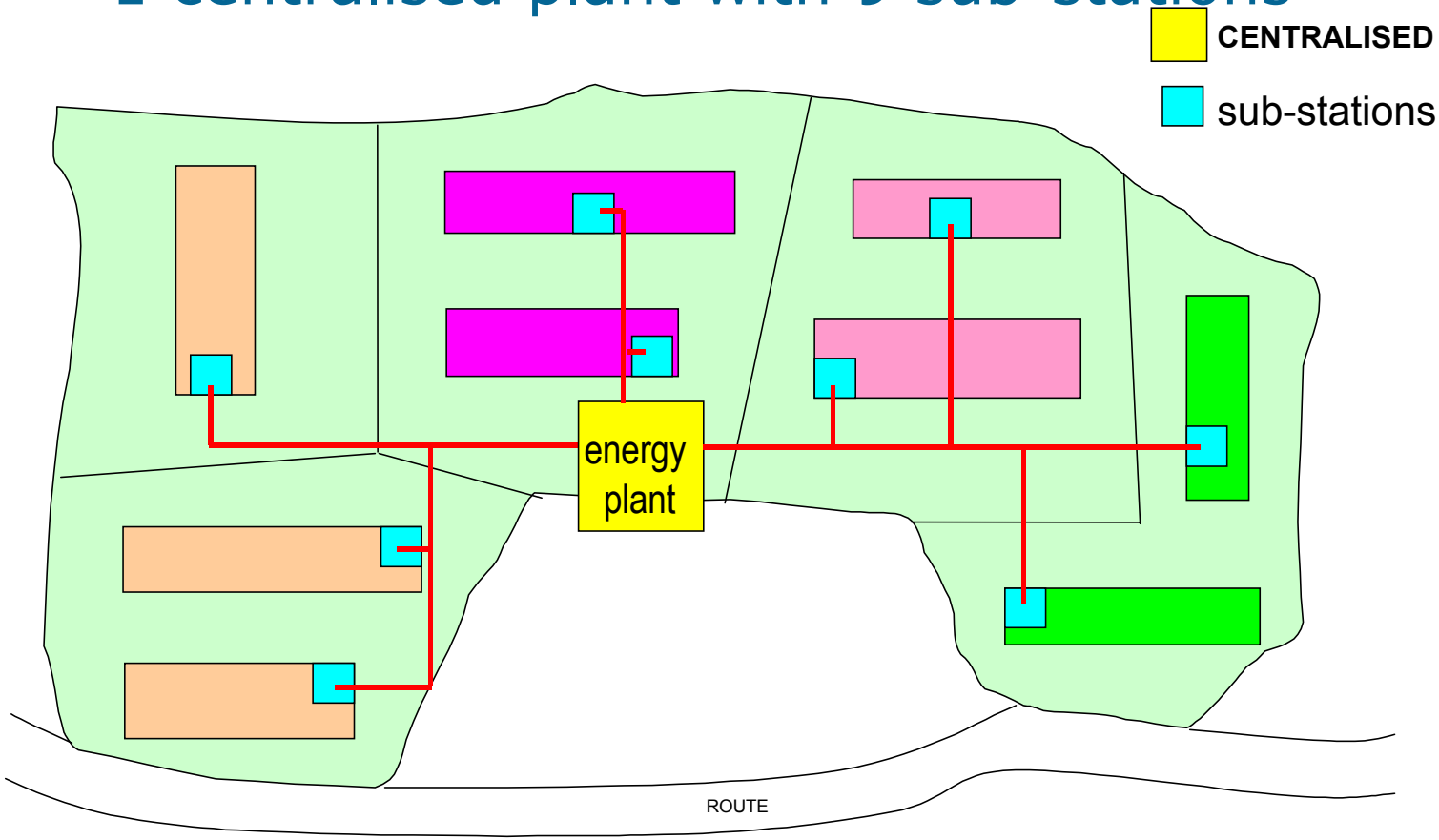
In Geneva several measures are used in the building sector:

- Improve buiding design by imposing construction standards and certificates
- Plan the energy supply at district level
- Promote the use of renewables and local energy sources: wood, solar, geothermal, wastes

Example of a local district plan
5 lots, 9 buildings, 9 gas heating plants



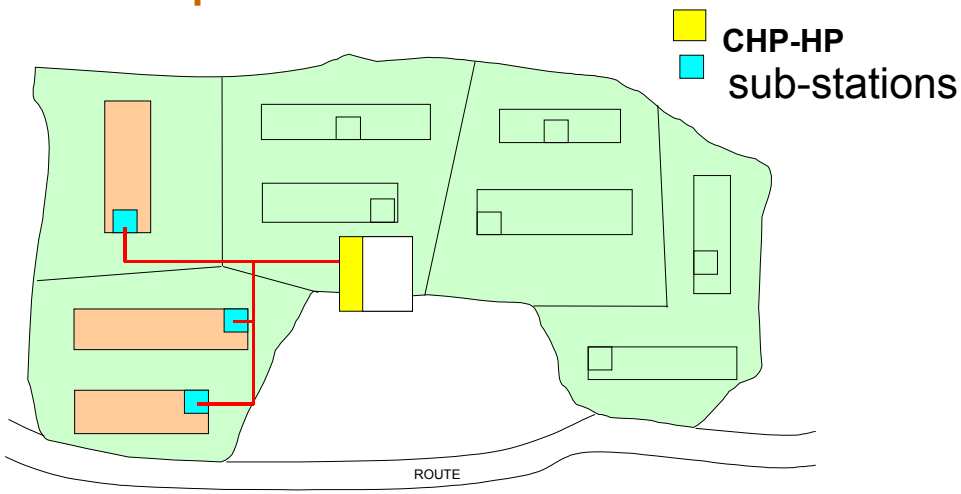
CHP-HP case:
1 centralised plant with 9 sub-stations



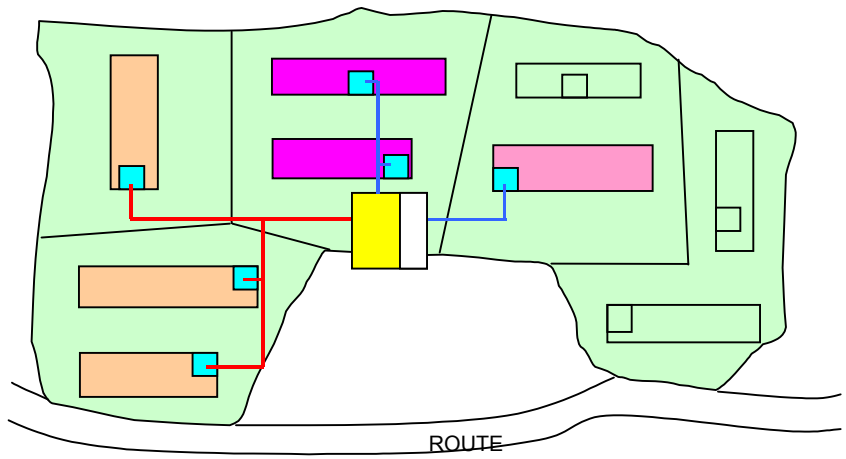
1st consequence : large energy gain
2nd consequence: large added-value to the lots
3rd consequence: defined construction steps
4th consequence: important reduction of pollutant emissions

Evolution of the construction

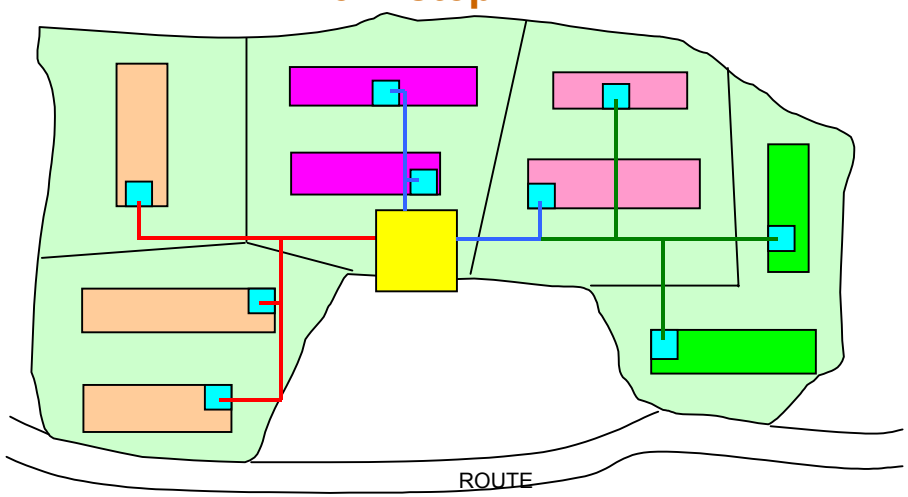
1st step



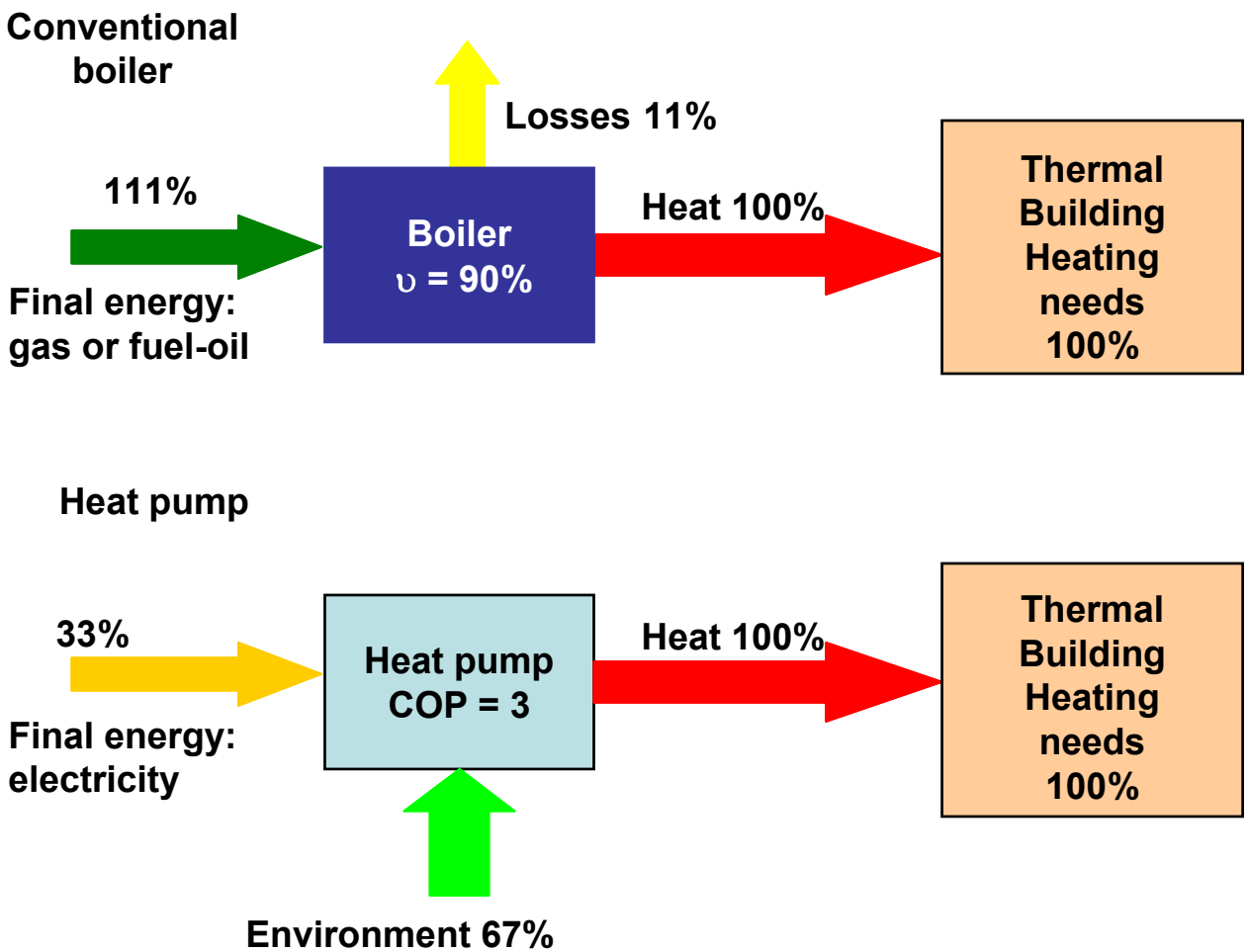
2nd step



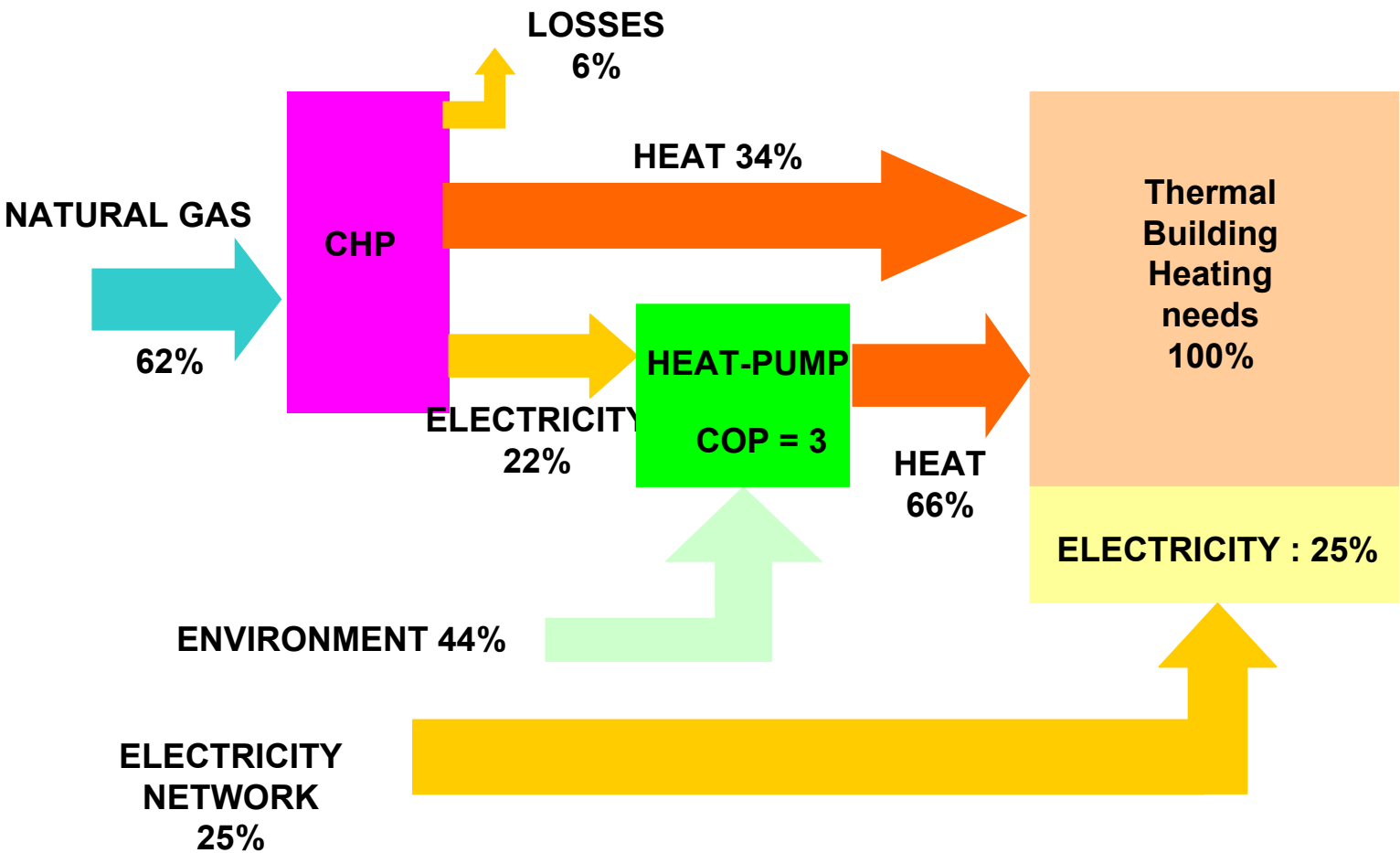
3rd step



Some technical reminders

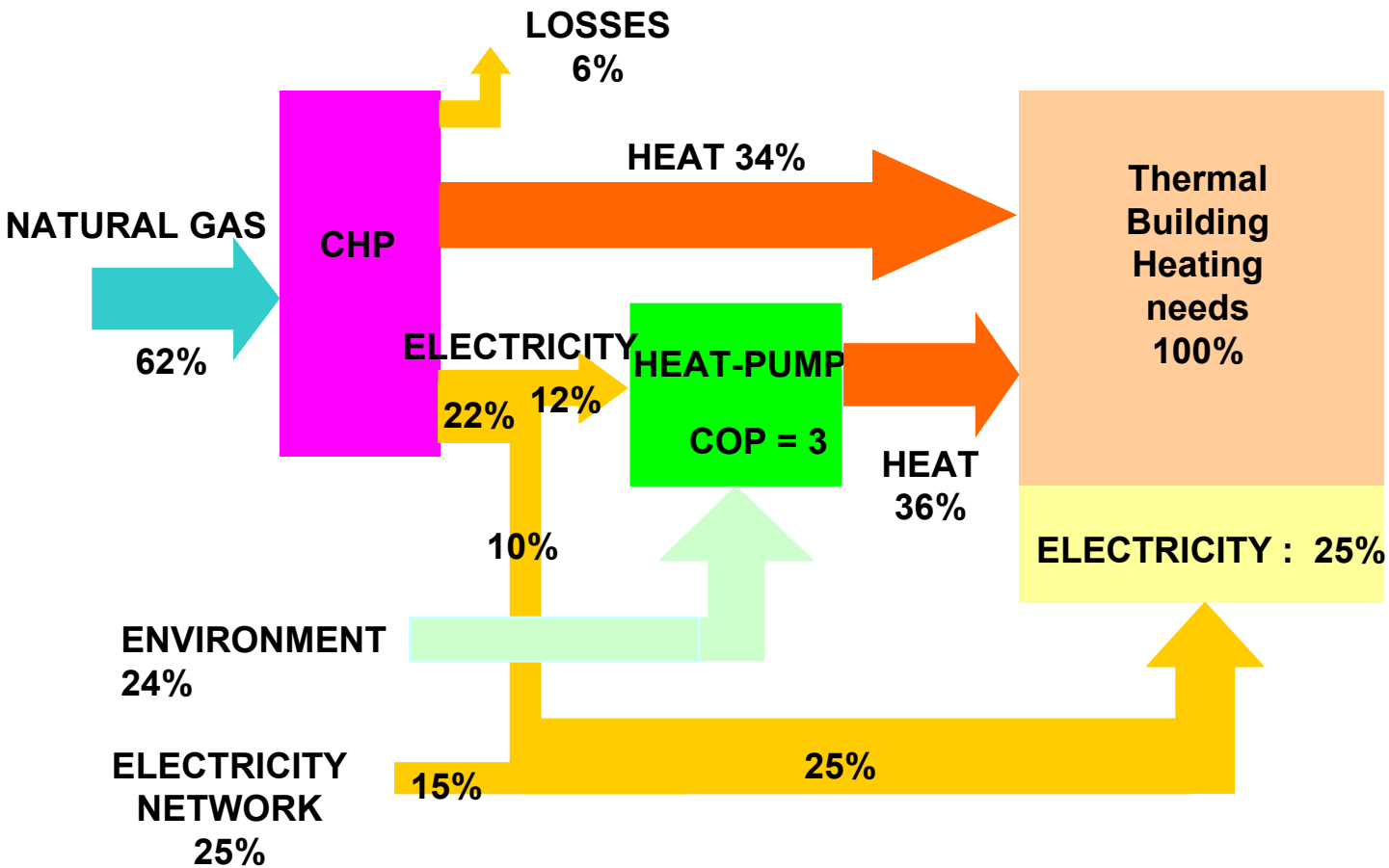


Combined Heat-Pump with a CHP plant



Use of CHP power to cover 100% of the Heat-Pump needs

Alternative case: Partial Use of CHP to cover the heat-pump needs

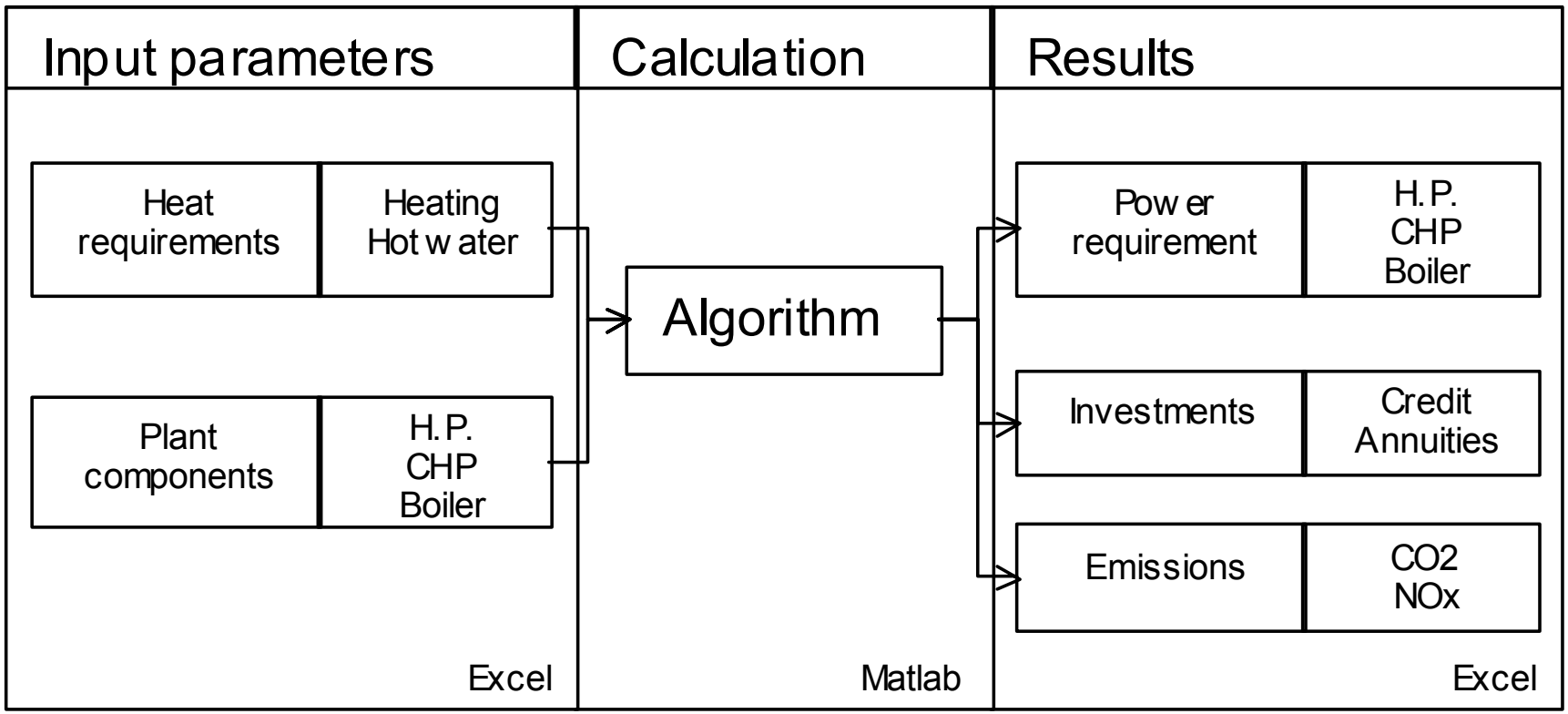


Possibility to use the tariff difference peak vs. off-peak hours

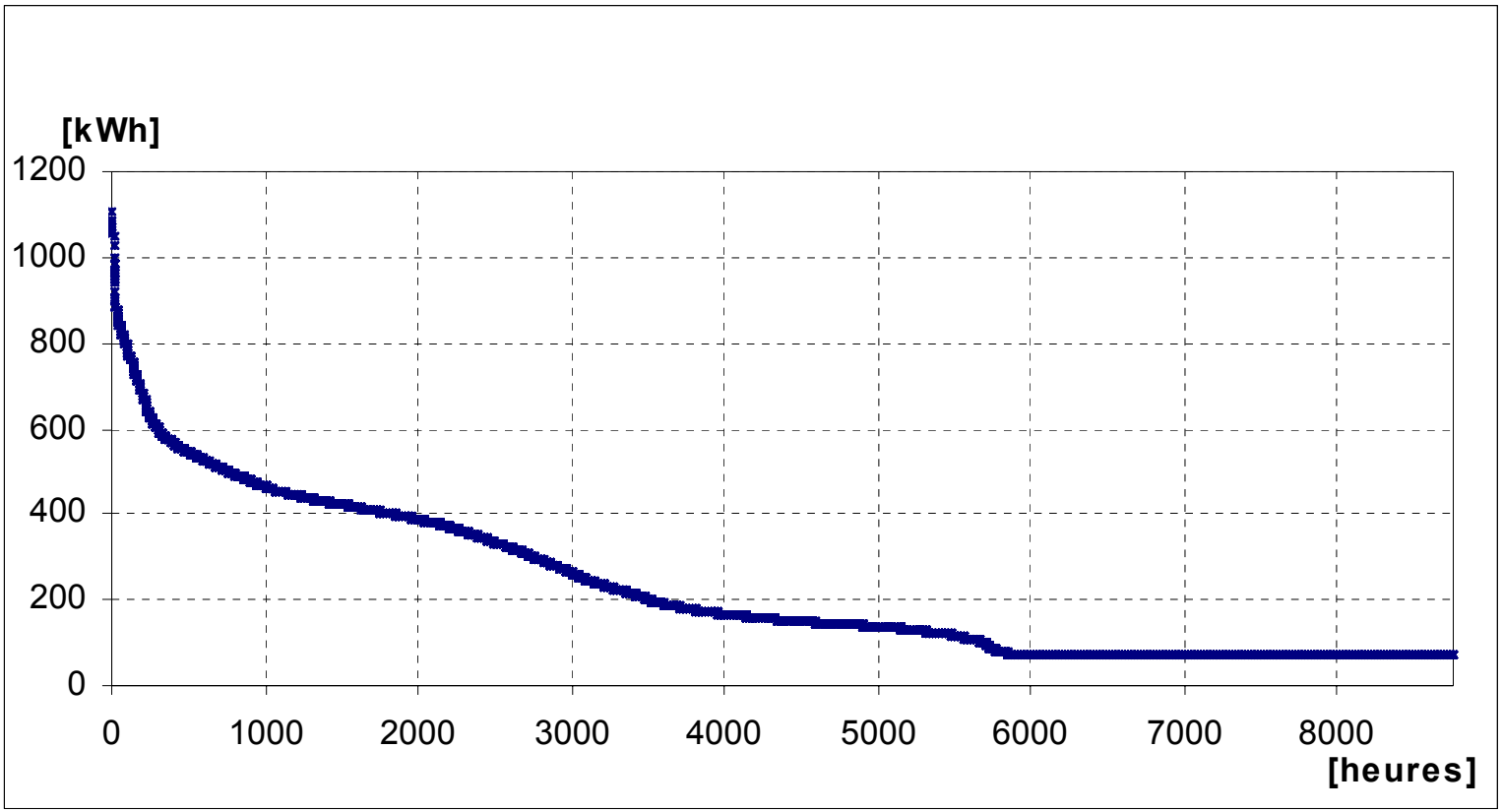
Design hypotheses

- New building lots with staged construction
- Additional cost is capitalised for comparison of several options (5% /annum)
- Installation lifetime of 20 years
- Heat pump does not produce warm water
- CHP power used in priority by heat pump
- Warm water is produced first by CHP then by auxiliary boiler
- Heat is produced first by heat pump then by CHP then by auxiliary boiler
- Heat-pump performance varies with cold source temperature
- CHP turn-down ratio= 50% , HP turn-down ratio= 20%

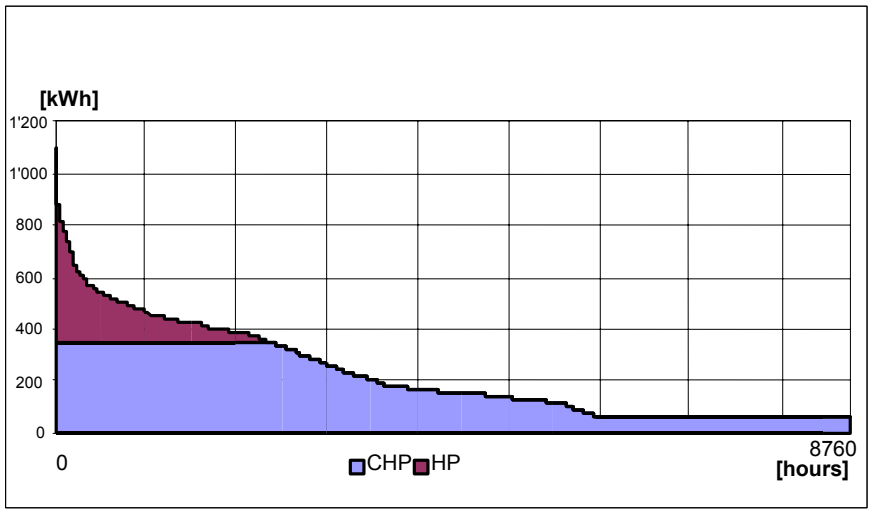
Program outline



Yearly consumption distribution

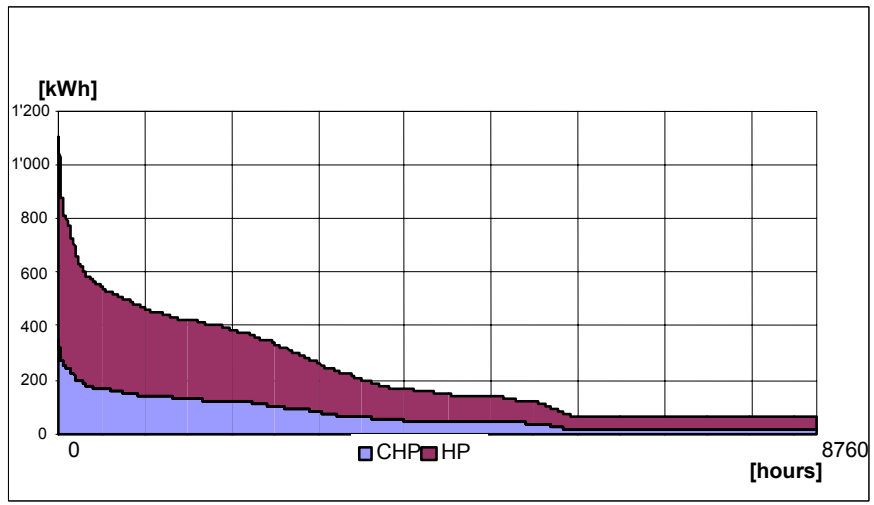


Dimensioning of CHP –HP



1) The CHP operates at full power. Excess electricity is sold to the grid

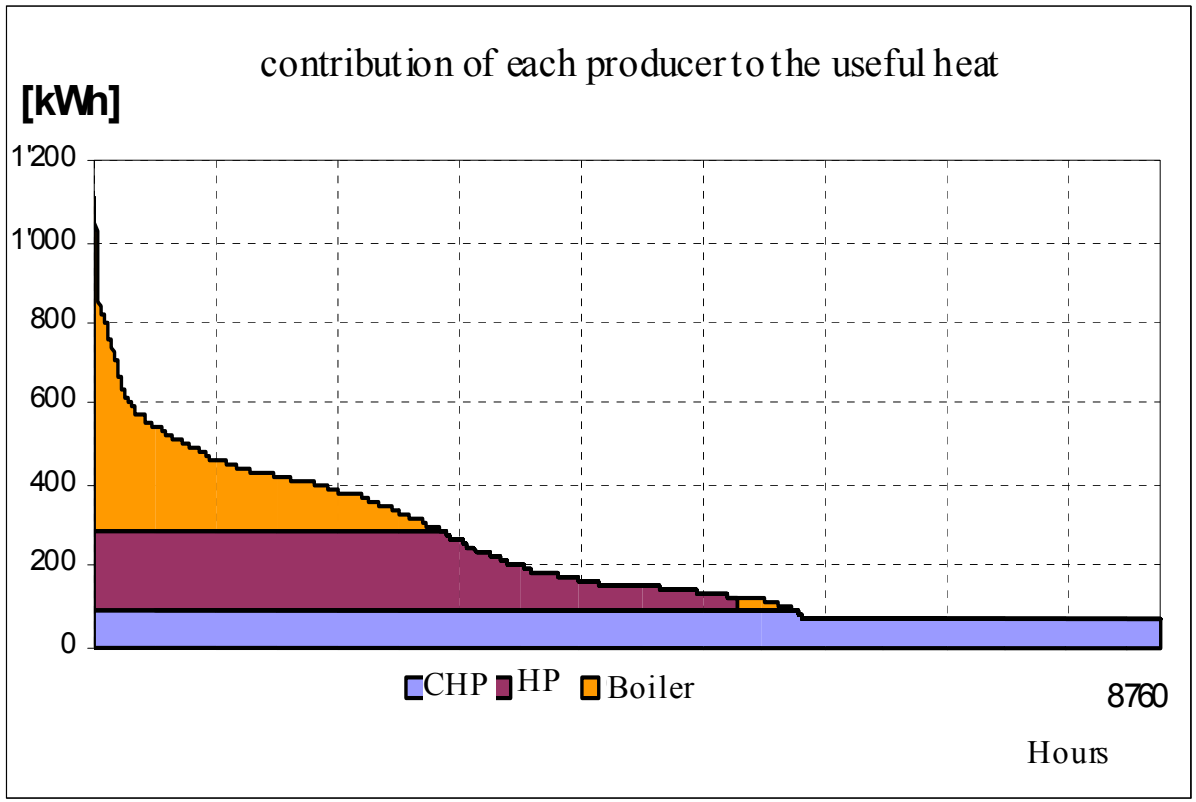
CO2 = 730 tons/year



2) The CHP operates in a proportional mode – In practice it cannot go below 50% turn-down

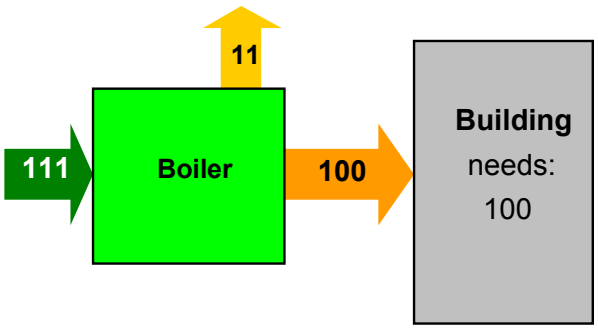
CO2 = 268 tons/year

Dimensioning of CHP –HP with auxilary boiler

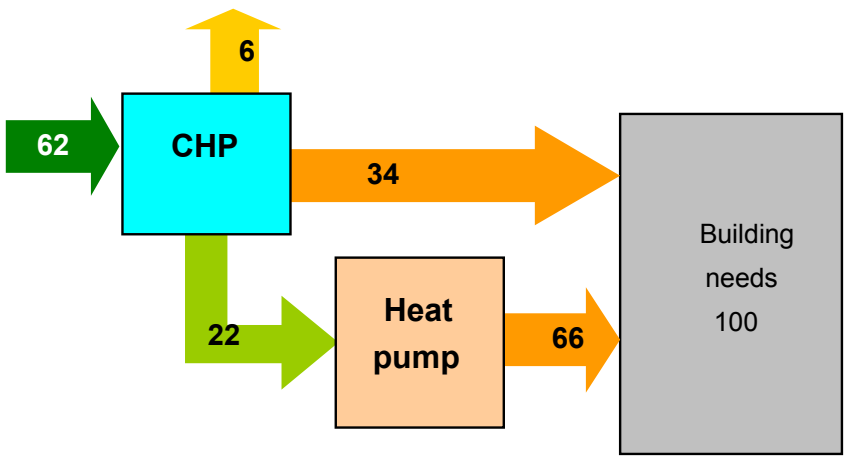


CO2 = 400 tons/y i.e. 25% reduction compared to reference

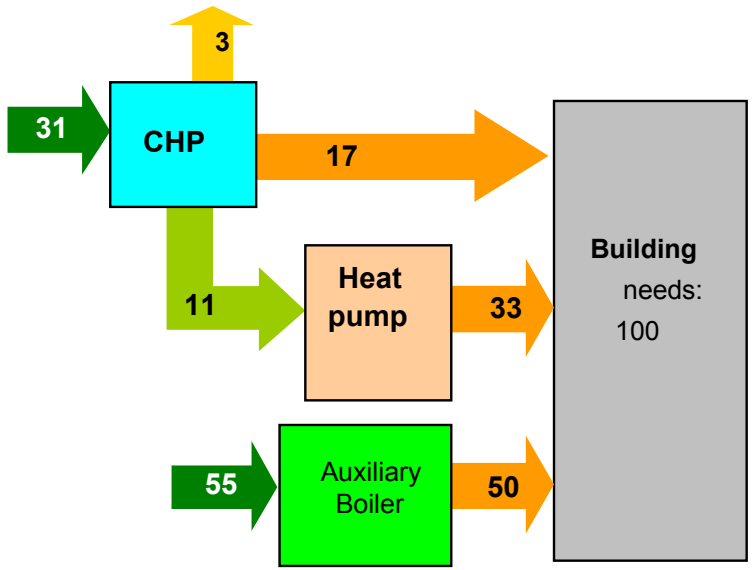
Summary



Case 1: 530 tons CO2/y

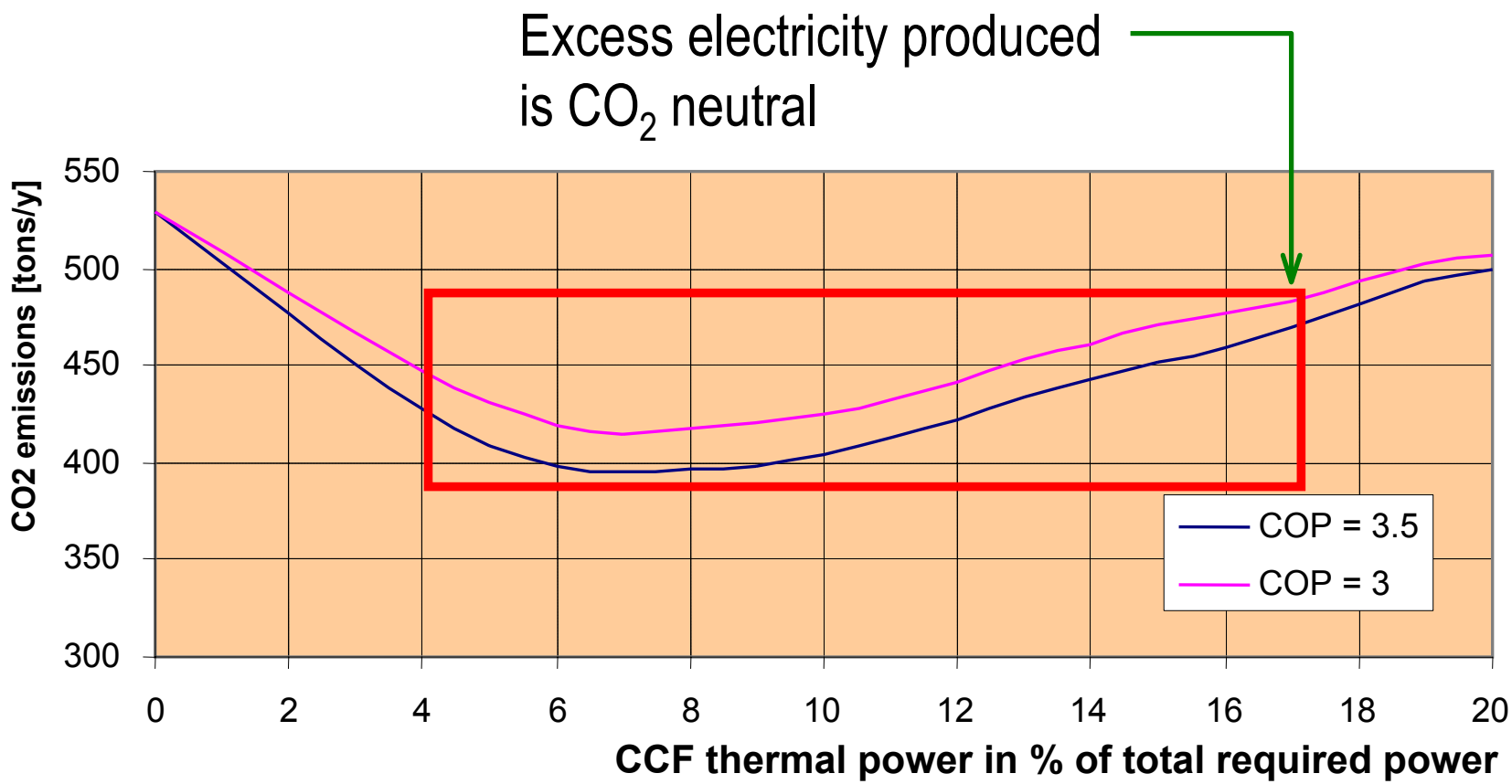


Case 2: 268 – 730 tons CO2/y

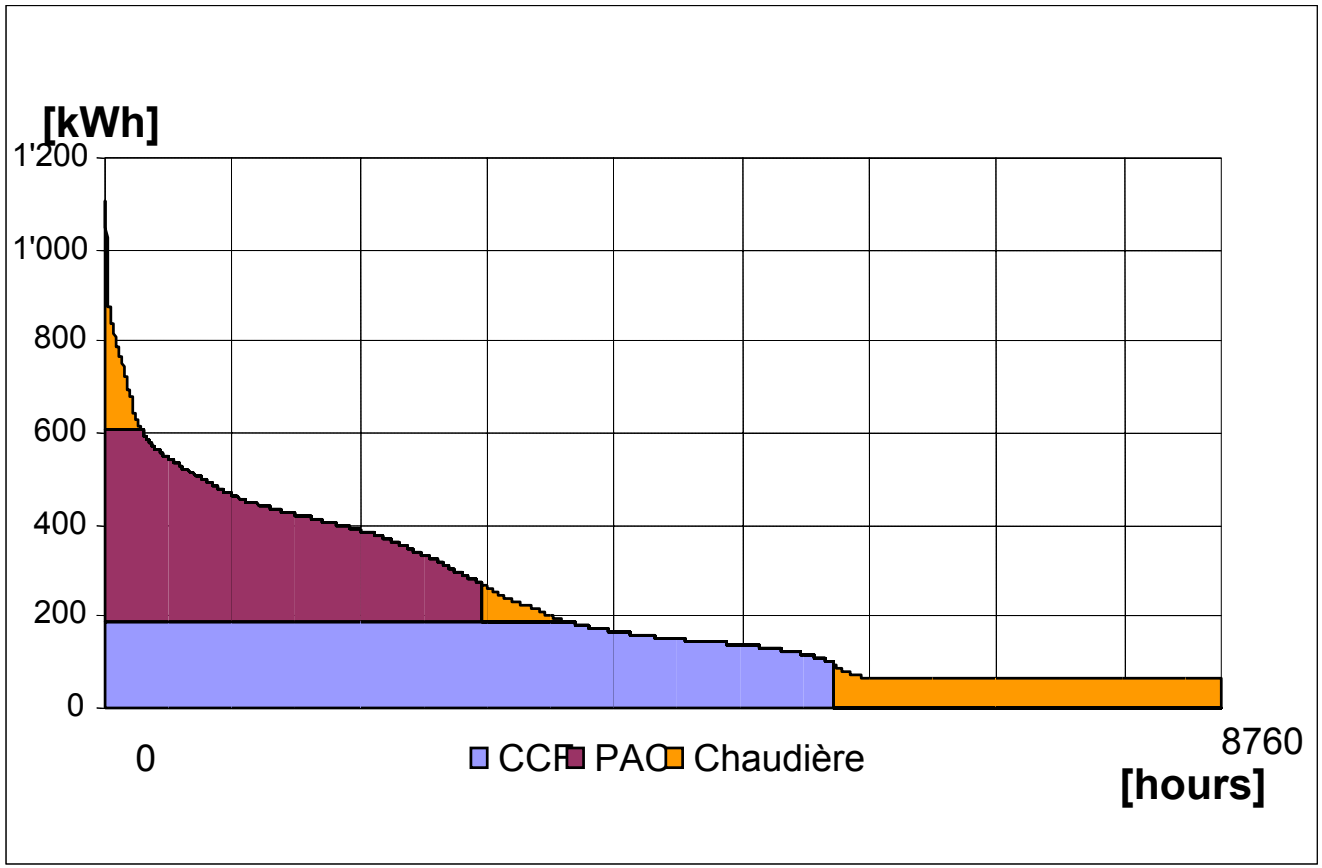


Case 3 : 400 tons CO2/y

CO2 emissions vs. CHP thermal power



Case of CHP producing electriciy for the network – Boiler heat production minimum



Conclusions

- The concept of HP-CHP system has a strong potential for overall economy and reduced CO2 emissions
- It is applicable within an overall district planning of energy supply in cities
- It requires government incentives to facilitate project finance
- It leads to increased renting cost that can be compensated by the lower energy bills.
- Simple computer program developed to compare various options.

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