Decentralised production in urban systems, the vision of the Institute of Energy Sciences of EPFL

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  - Heat pumps
  - Polygeneration and integrated systems
  - Advanced systems
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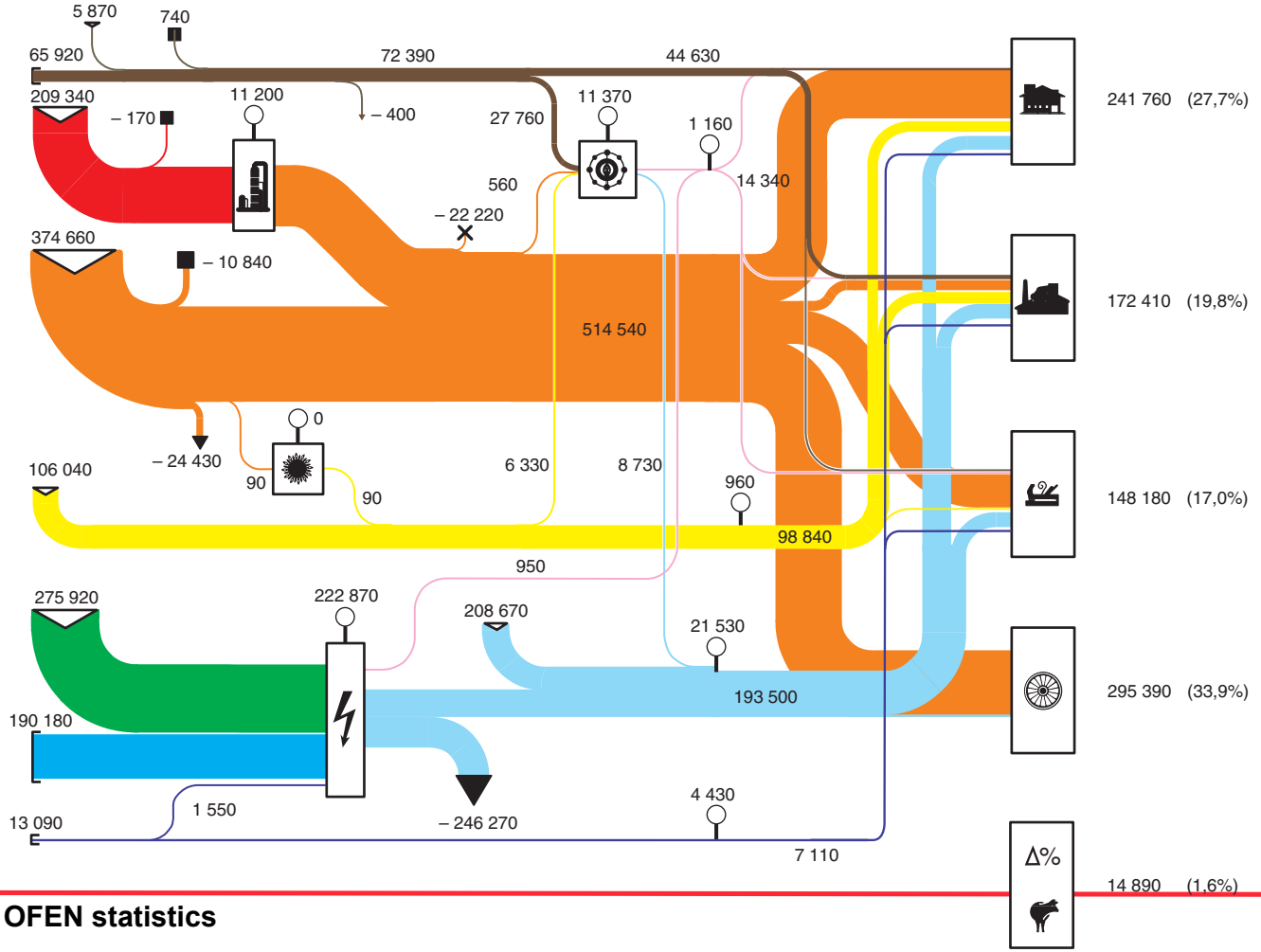
  - Integrated system design - energy conversion
  - Optimal management of energy services supply
- **Conclusions**

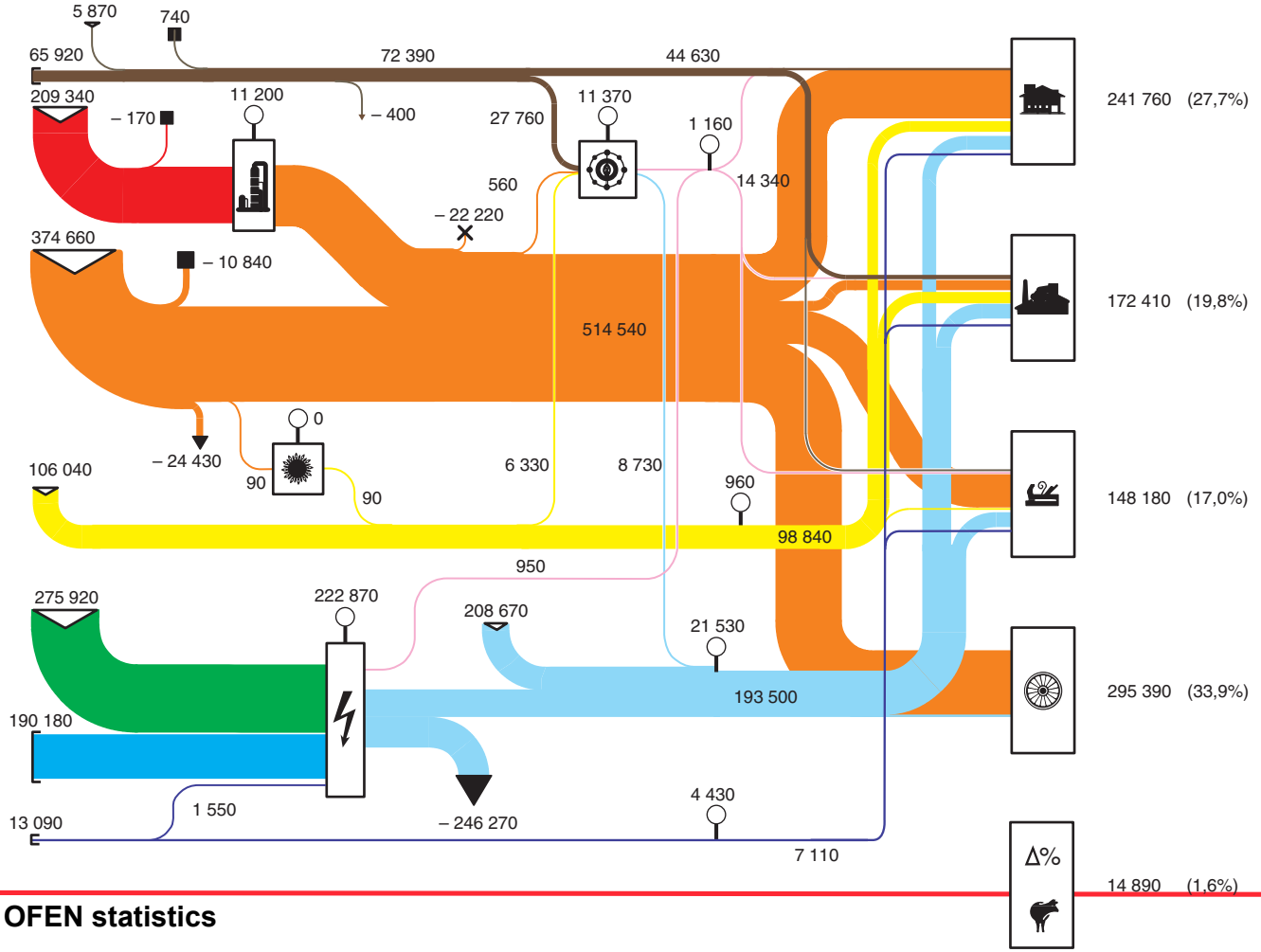
Energy conversion



Source : OFEN statistics

Energy conversion

Primary energy
5390 W/cap



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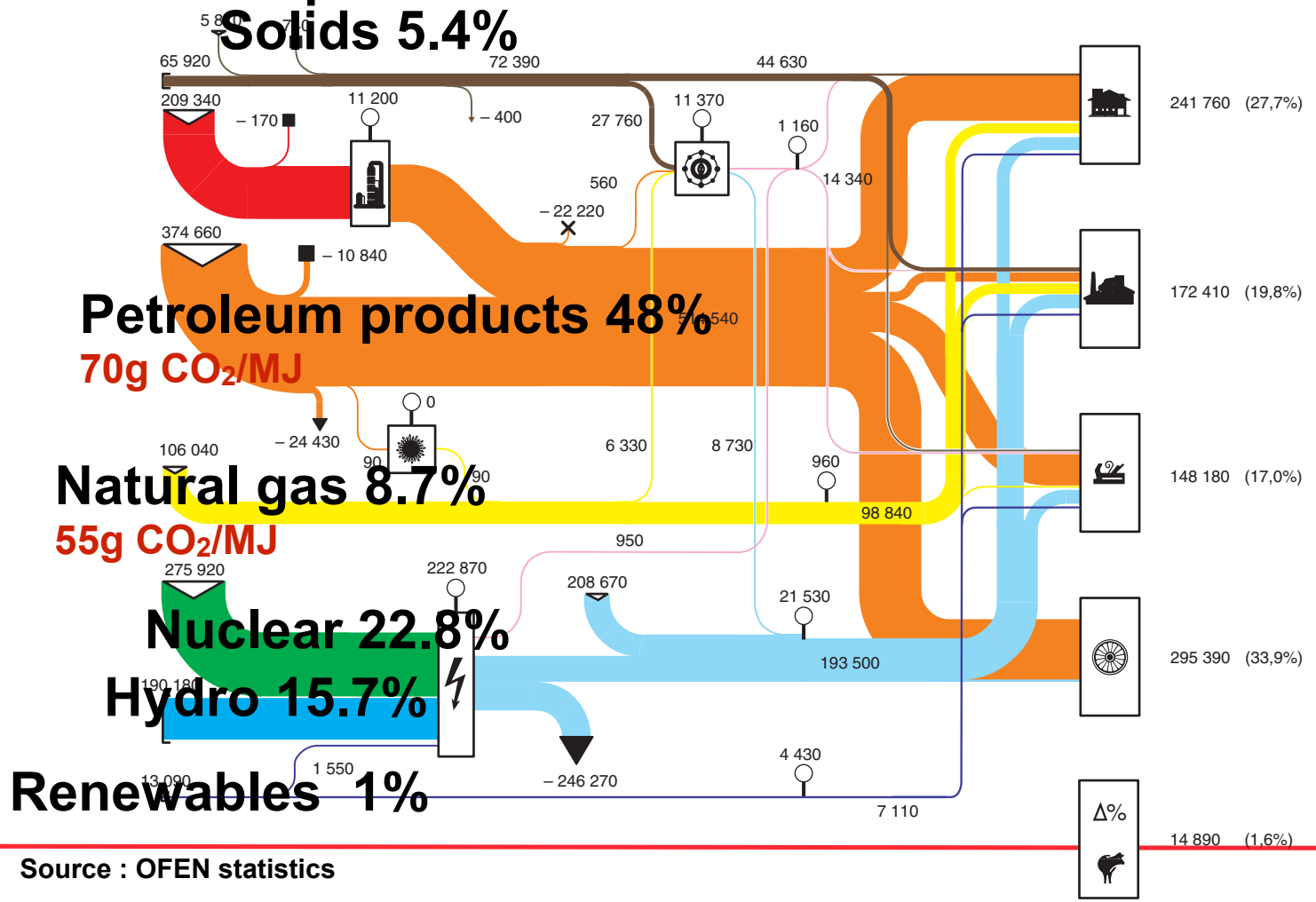

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Energy conversion

Primary energy
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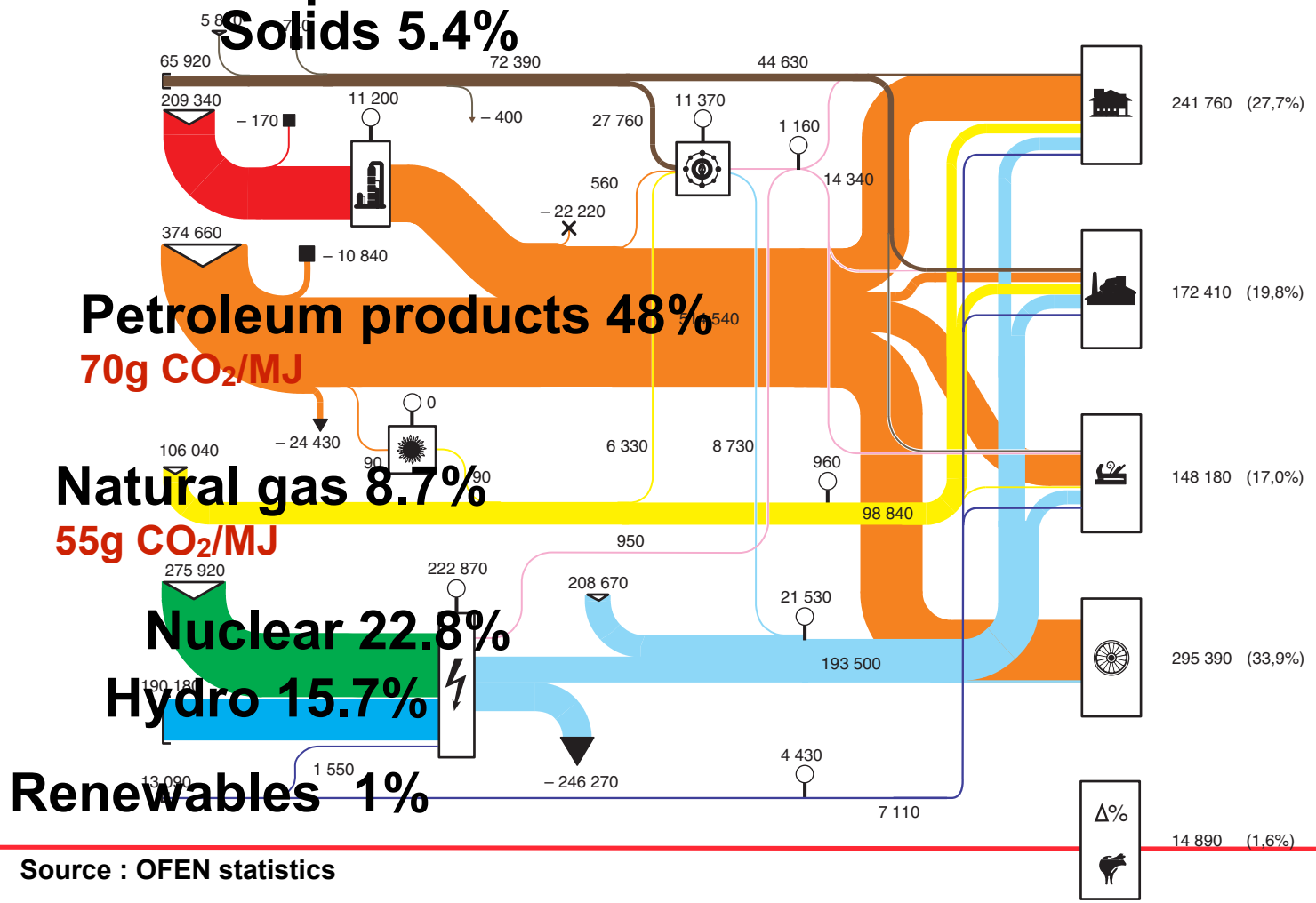
Energy services
3881 W/cap



Source : OFEN statistics

Energy conversion

Primary energy
5390 W/cap

Solids 5.4%

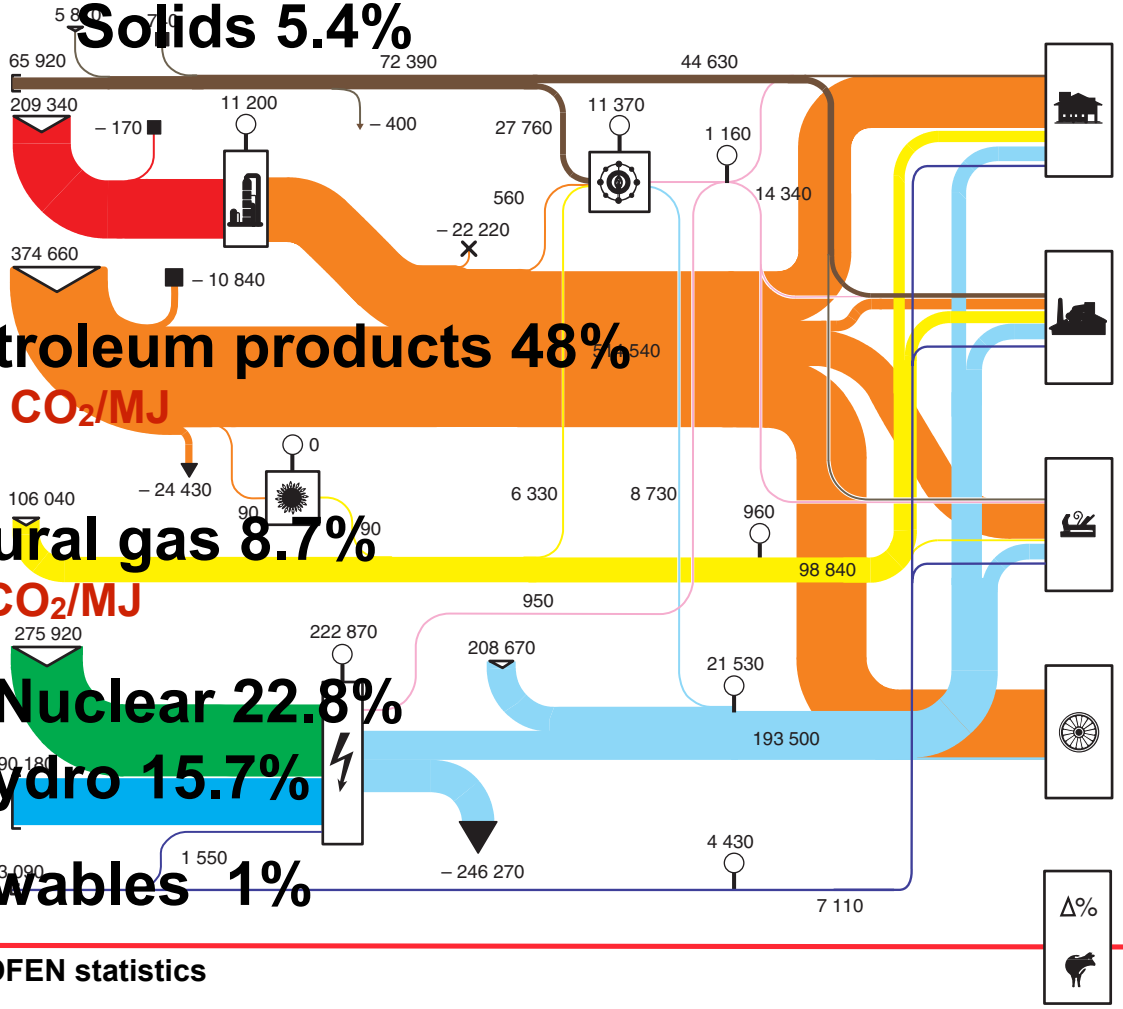
Petroleum products 48%
70g CO_2/MJ

Natural gas 8.7%
55g CO_2/MJ

Nuclear 22.8%

Hydro 15.7%

Renewables 1%



Energy services
3881 W/cap

Household 27,7%
241 760 (27,7%)

Industry 19.8%
172 410 (19,8%)

Services 17.0%
148 180 (17,0%)

Transport 33.9%
295 390 (33,9%)

14 890 (1,6%)

Source : OFEN statistics

Energy conversion

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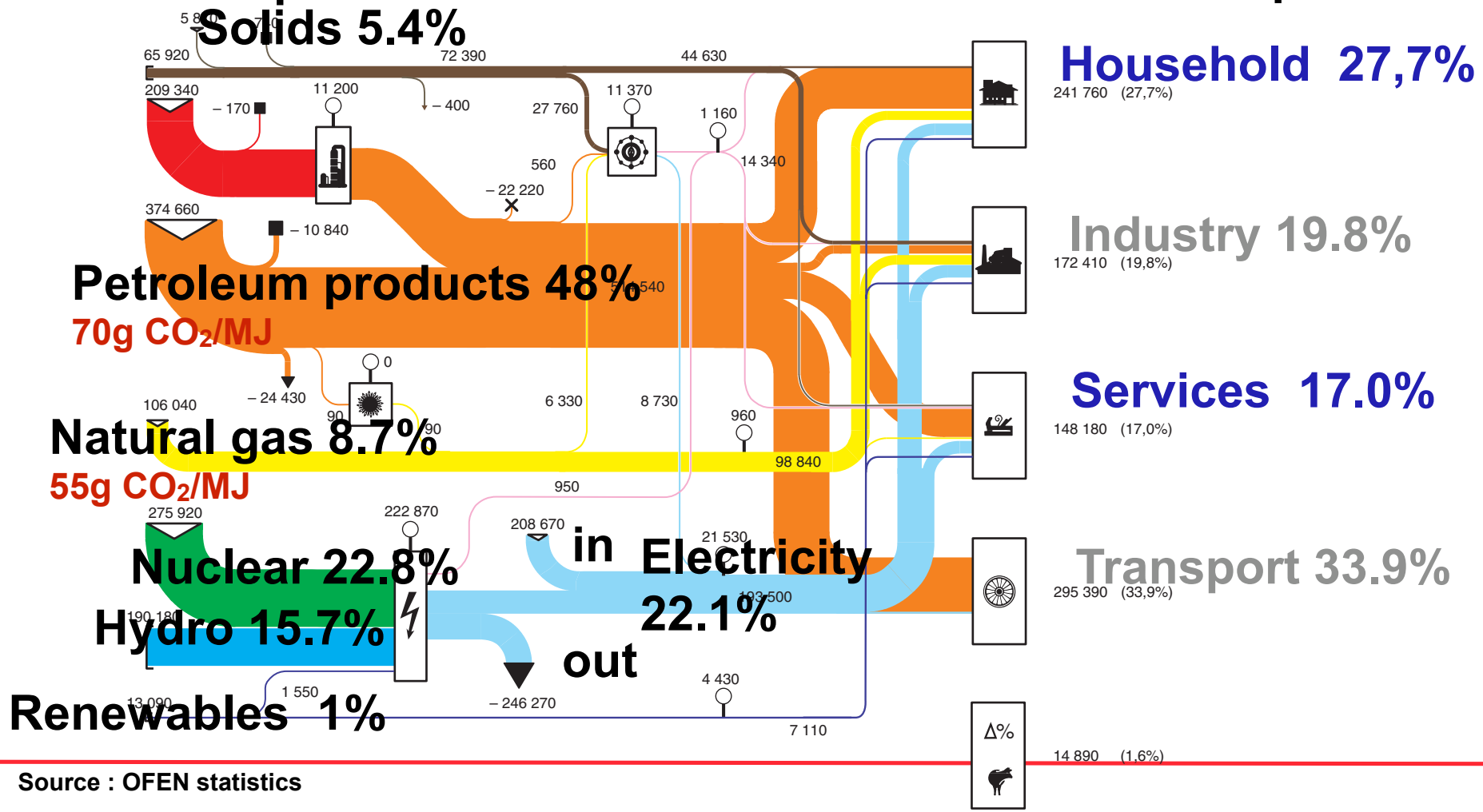
3881 W/cap



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Energy conversion

Primary energy
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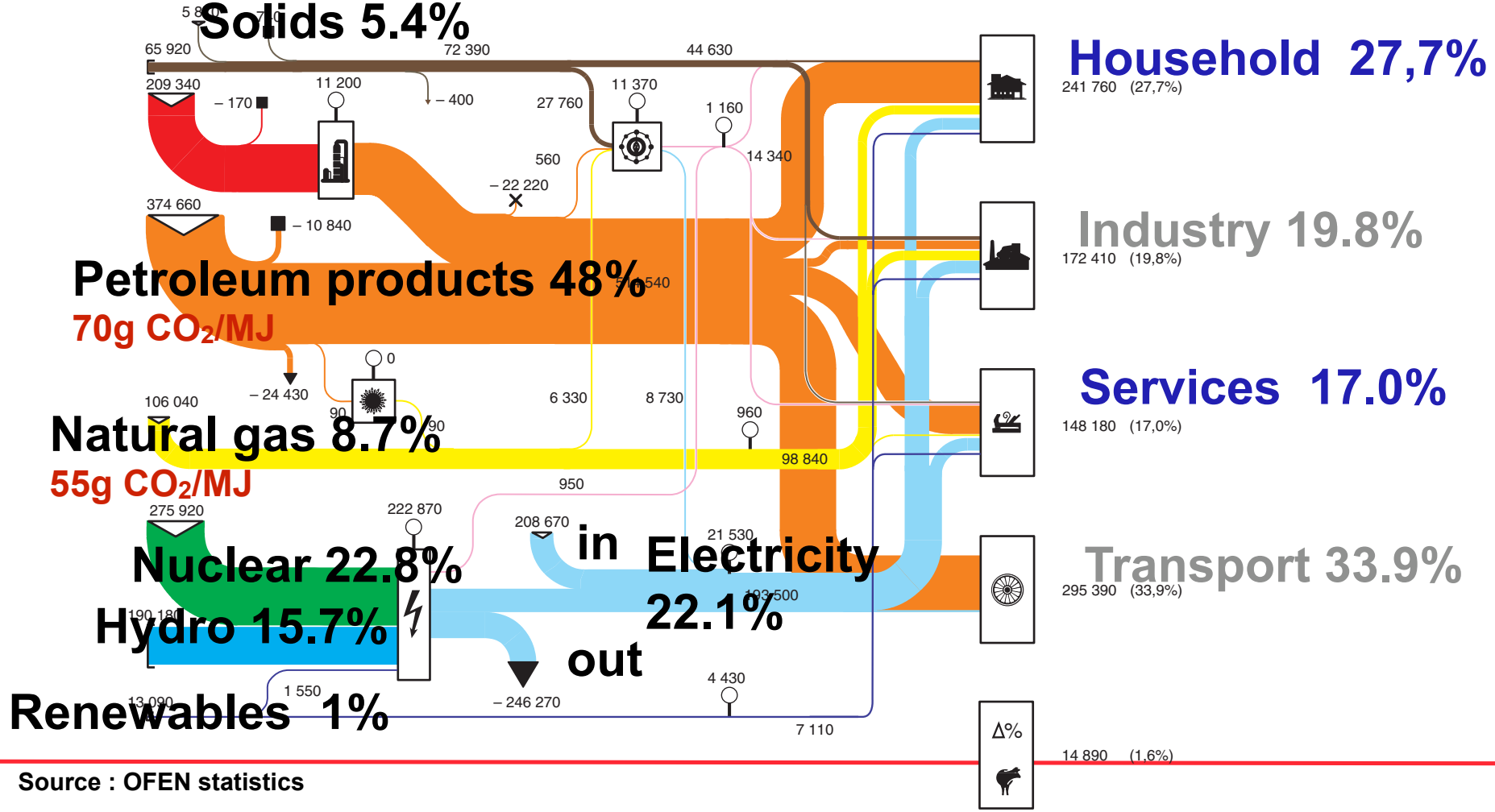
Efficiency 72%

Energy services
3881 W/cap



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Energy conversion

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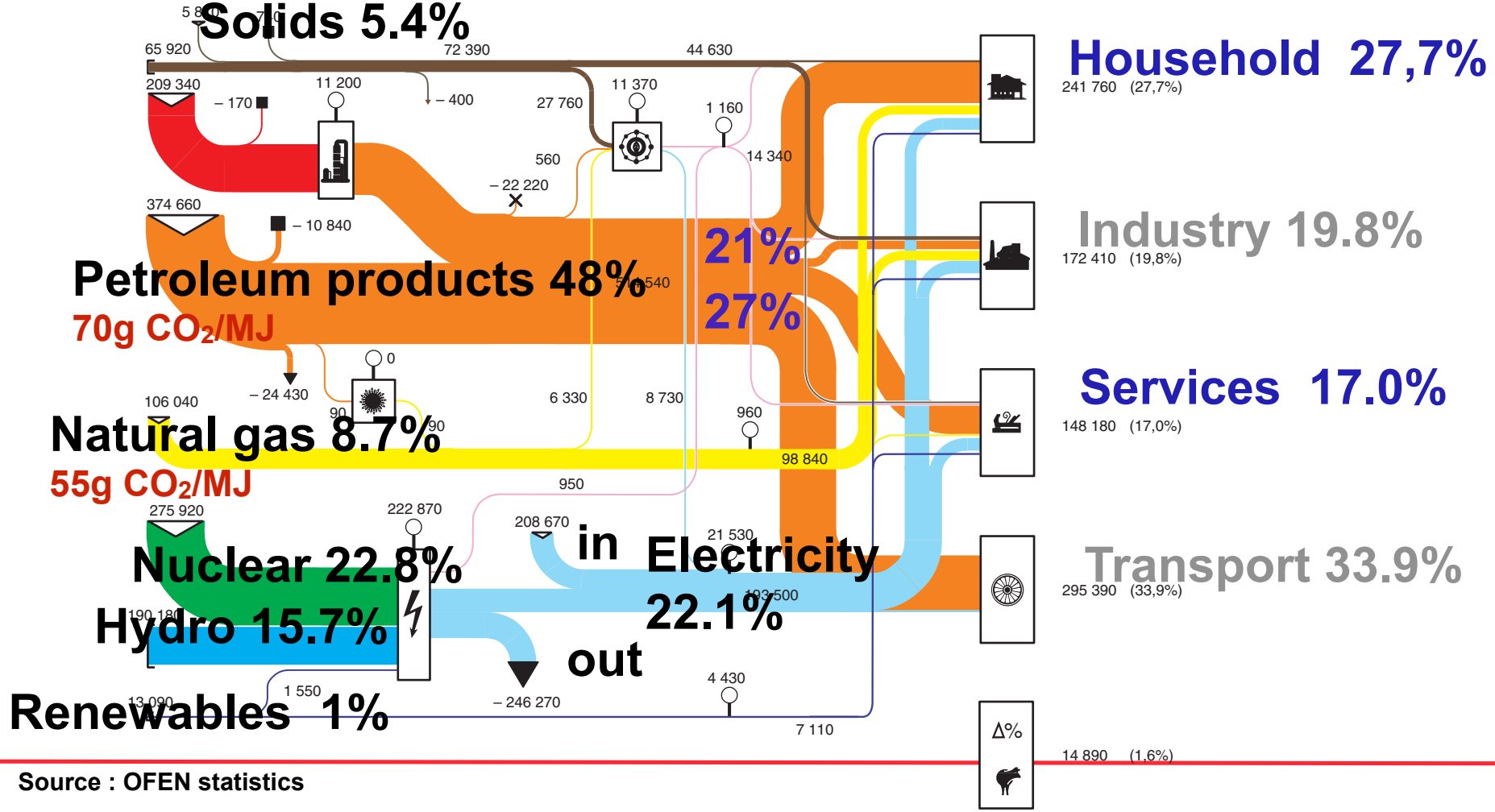


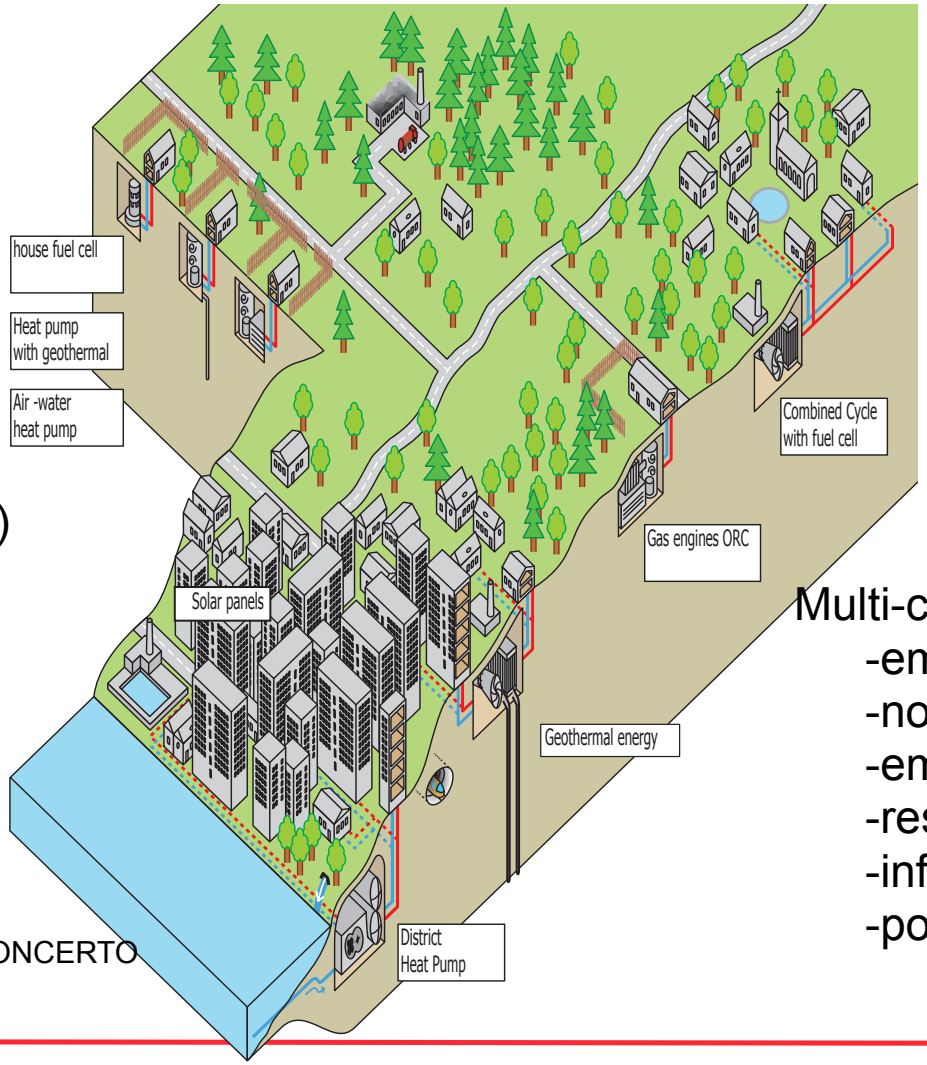
Source : OFEN statistics

Holistic vision of a urban system

Who is investing what, where , for which services to be produced when for which customer ?

Multi-resources
- -solar
- -waste
- -biomass
- -geothermy
- -fuels

Multi-technologies

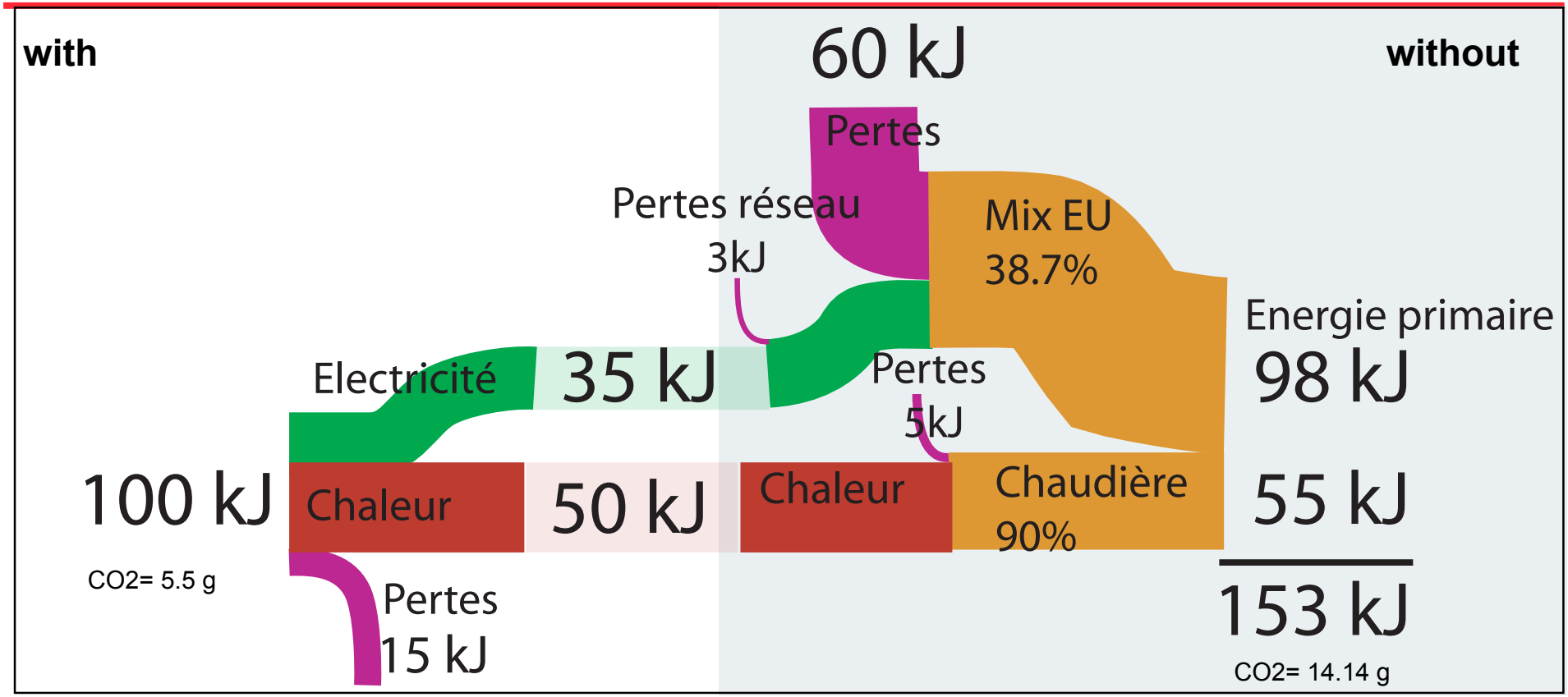


Multi-services
- -heating
- -cooling
- -electricity
- -water
- -waste
- -transport

Multi-scale (network)
- -building
- -district
- -city
- -...

Multi-constraints
- -emission
- -noise
- -emissions
- -resources
- -infrastructure
- -politics

Cogeneration



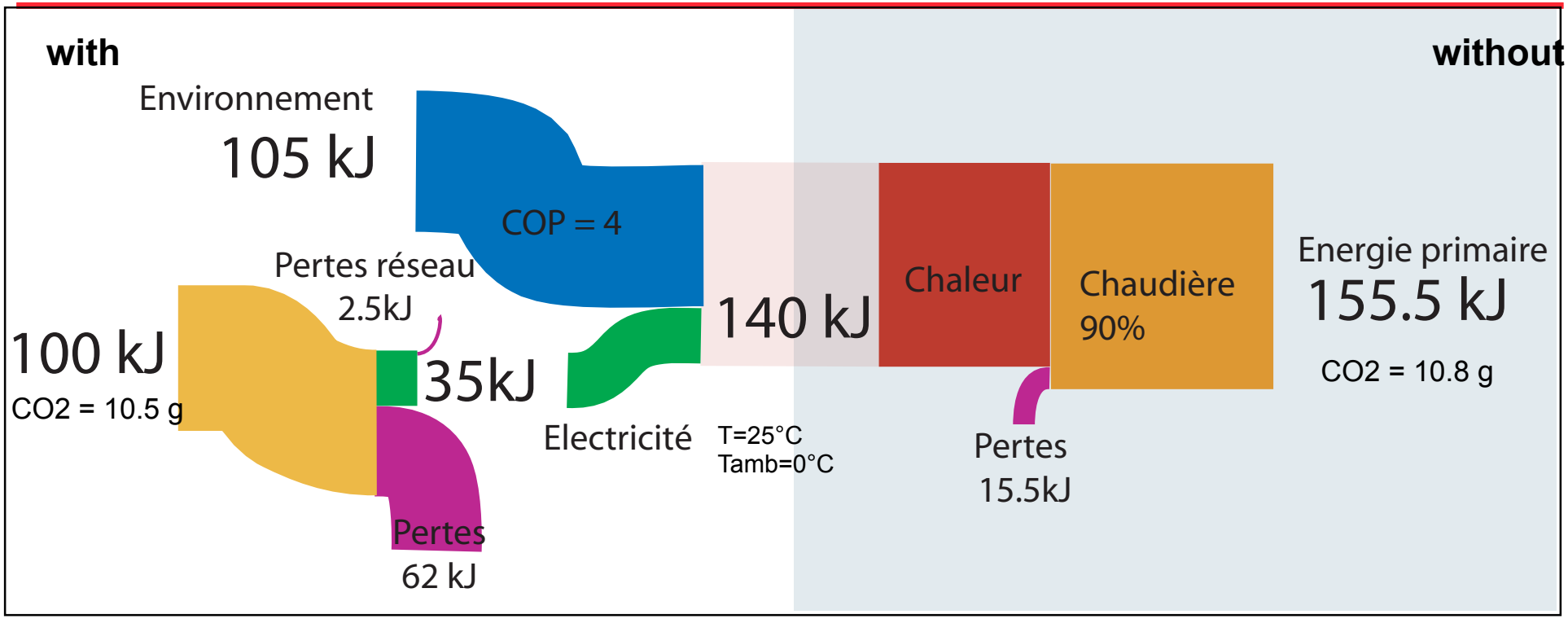
Energy saving = 30 %

CO_2 emissions =- 60% (Mix EU + fuel substitution Mazout/GN)

Exergy efficiency = 39.5 %

Mix EU : 105 g/MJe, eff= 38.7% . source enerdata/IEA

heat pump

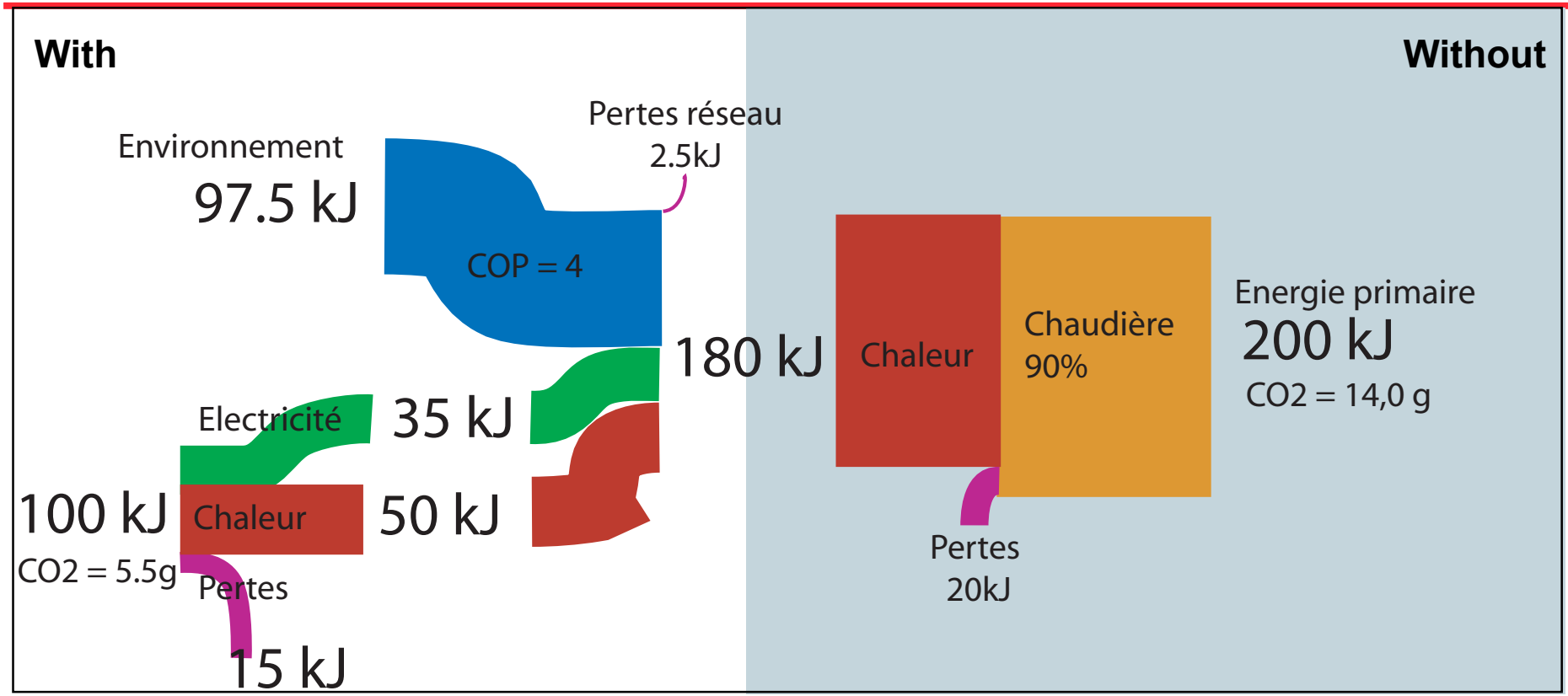


Energy saving = 30 % (EU mix) - 53.1 % (Suisse mix)

CO_2 emissions = 0 % (EU mix) - ~100% (Suisse mix ?)

Exergy efficiency = 12 % (EU mix) - 16 % (Suisse mix)

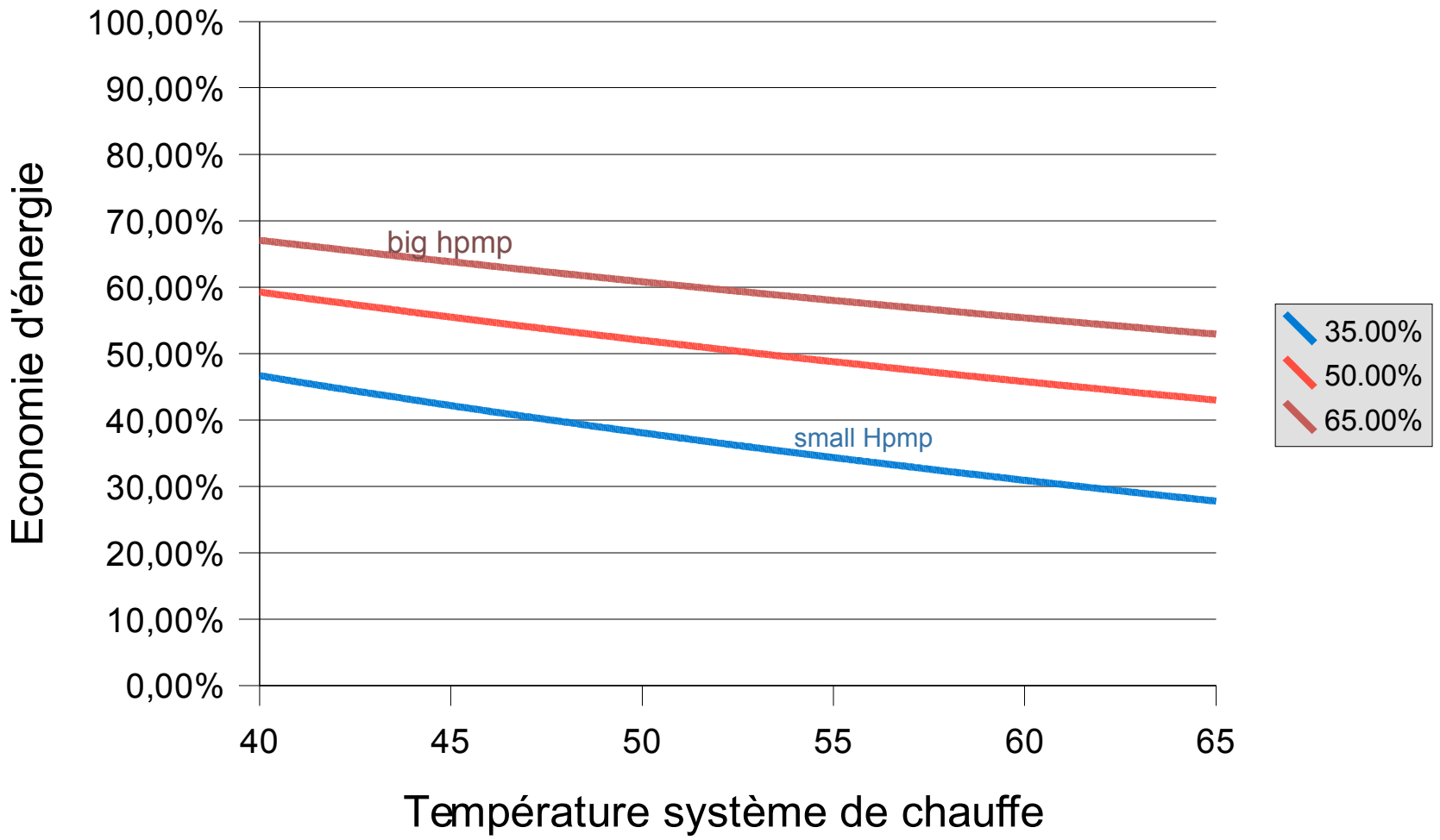
Heat pump and cogeneration



Energy savings = 50 %

CO_2 emissions = -60% (Fuel substitution Mazout/GN)

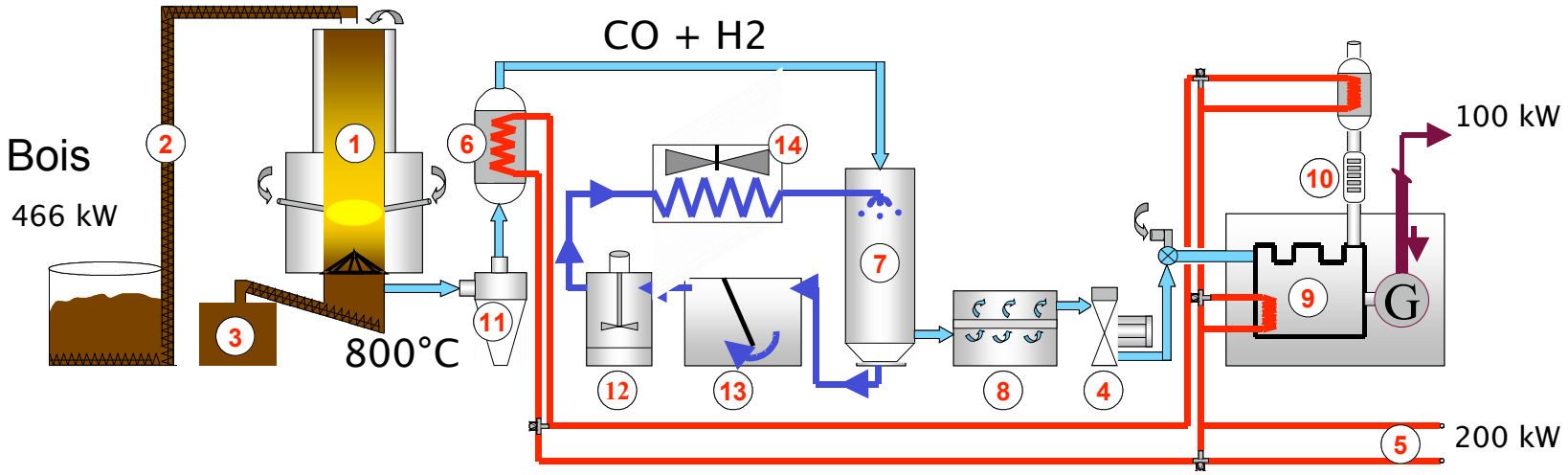
Energy savings Hpmp + Cogen



Elec 35.00% Thermique 50.00% : Chaudière90.00% Température source froide 4°C

Cogénération : Energie renouvelable

COMPOSANTS



Légende :

1. Réacteur
2. Chargement du bois
3. Evacuation des cendres
4. Ventilateur
5. Circuit de chauffage
6. Echangeur de chaleur
7. Colonnes de lavages
8. Filtrations
9. Moteur à gaz et génératrice
10. Catalyseur
11. Cyclone
12. Cuve de floculation
13. Décanteur
14. Aéro-refroidisseur

MENAG MANAGEMENT SA
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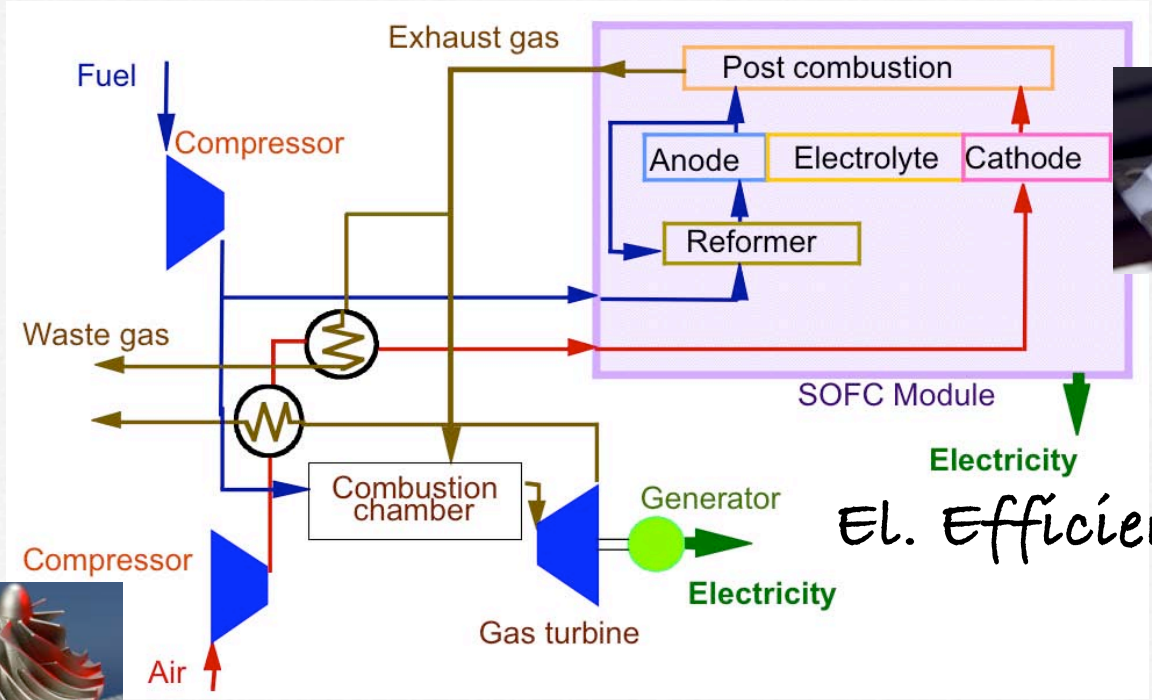
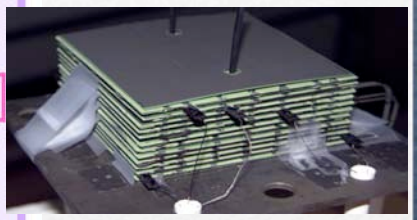
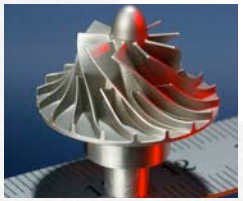
En Budron A12
1052 Le Mont-sur-Lausanne

Tél. +41 (0)21 651 69 69

Technology integration



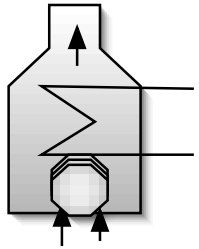




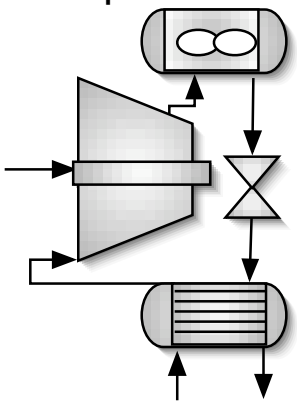
El. Efficiency > 60%

Advanced systems : tri-generation

Boiler

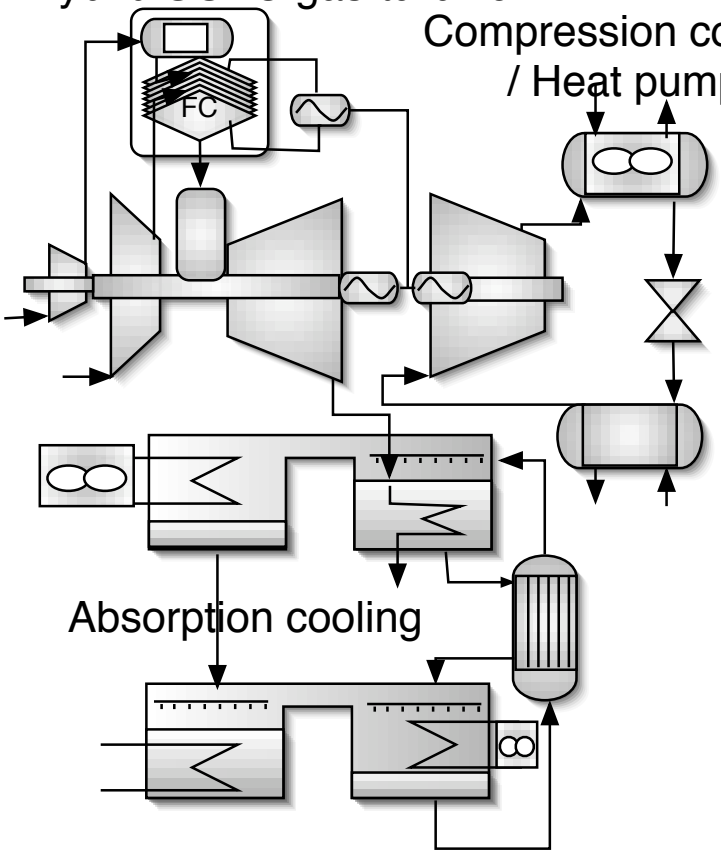


Compression cooling



Hybrid SOFC gas-turbine

Compression cooling / Heat pump



Conventional solution

Heating mode : 1.052 MW_{LHV}/MW_{th}

Cooling mode[1] : 0.585 MW_{LHV}/MW_{frg}

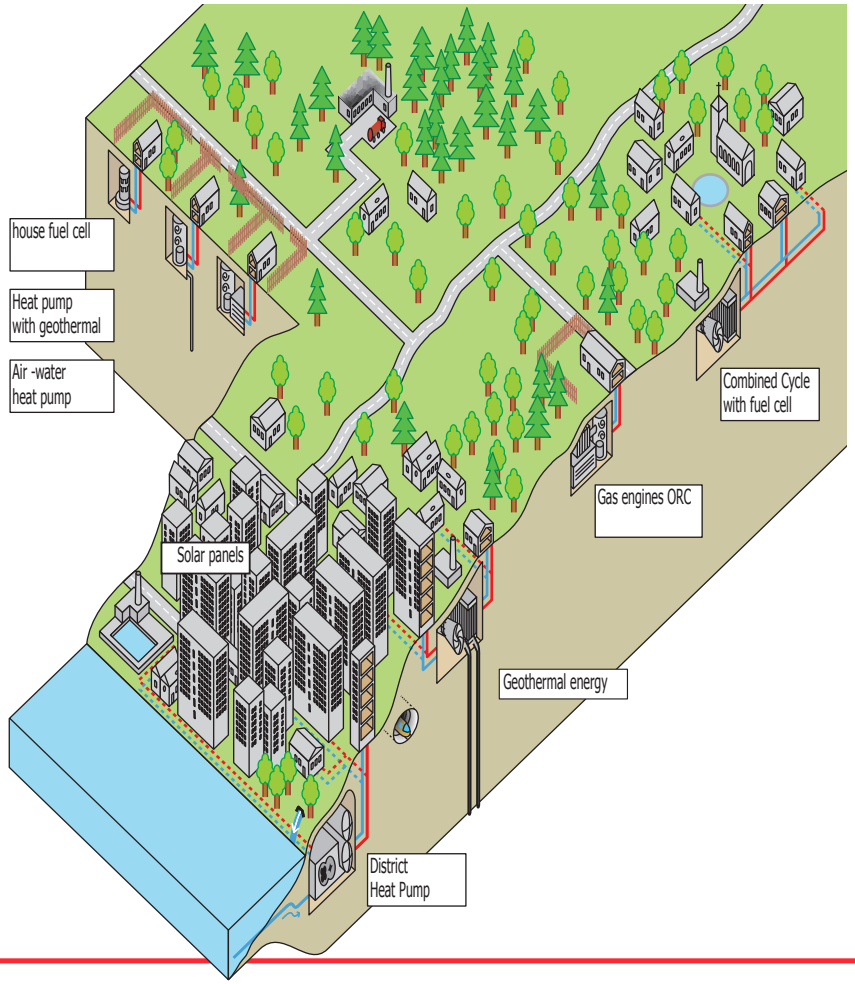
Advanced system

Heating mode : 0.409 MW_{LHV}/MW_{th} (38%)

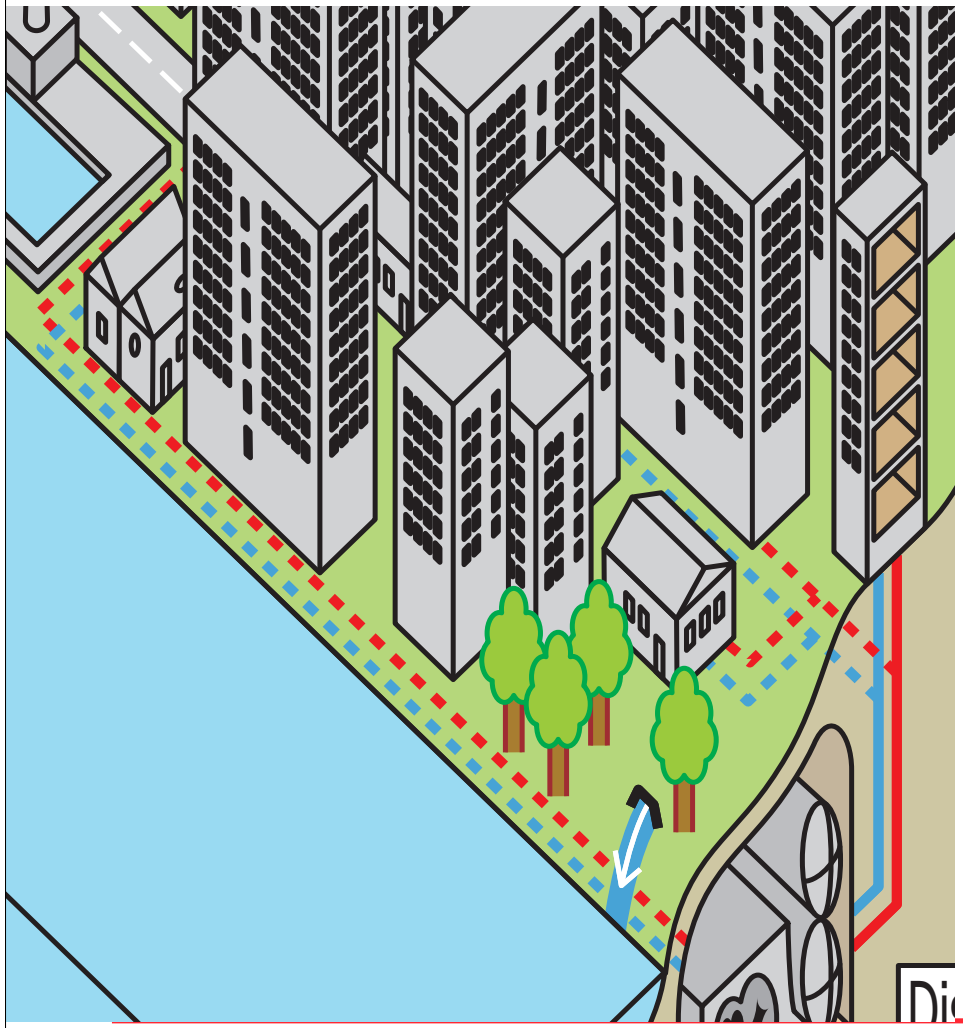
Cooling mode : 0.1985 MW_{LHV}/MW_{frg} (33%)

[1]Mix efficiency : 42%

Decentralised Energy conversion



Decentralised Energy conversion

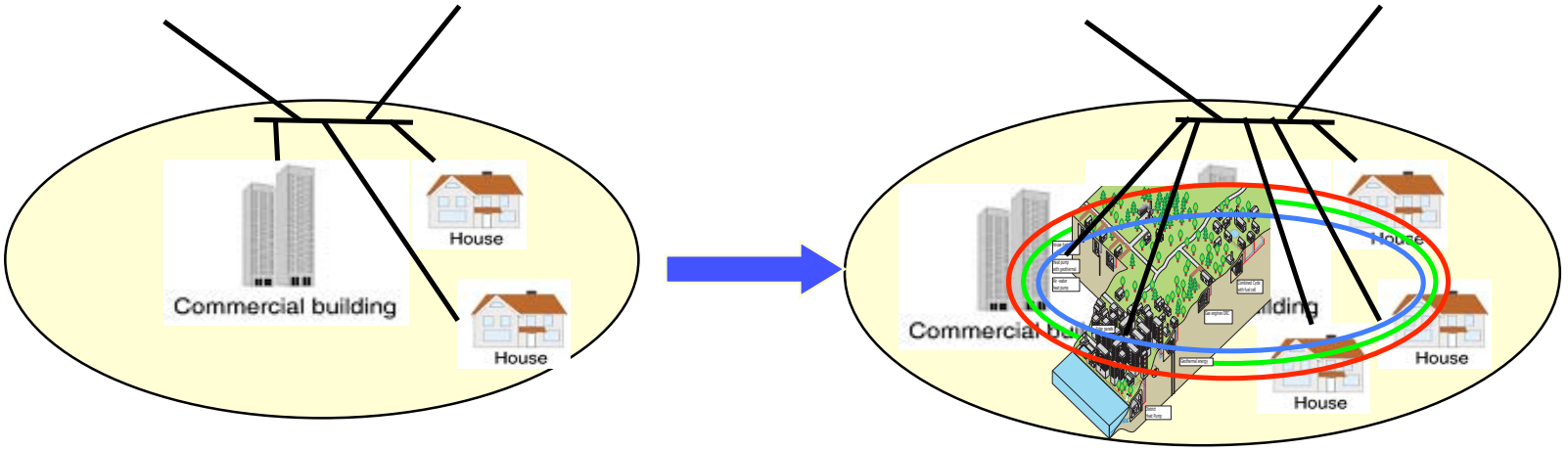


Services : Heating + electricity + cooling + transport
Ressources : Fossil fuels , biomass, renewables, waste
Network : Electricity,Gas, Heat, Water, Information
Technologies :
- Heat pumps
- CHP
- Combined cycles
- Storage

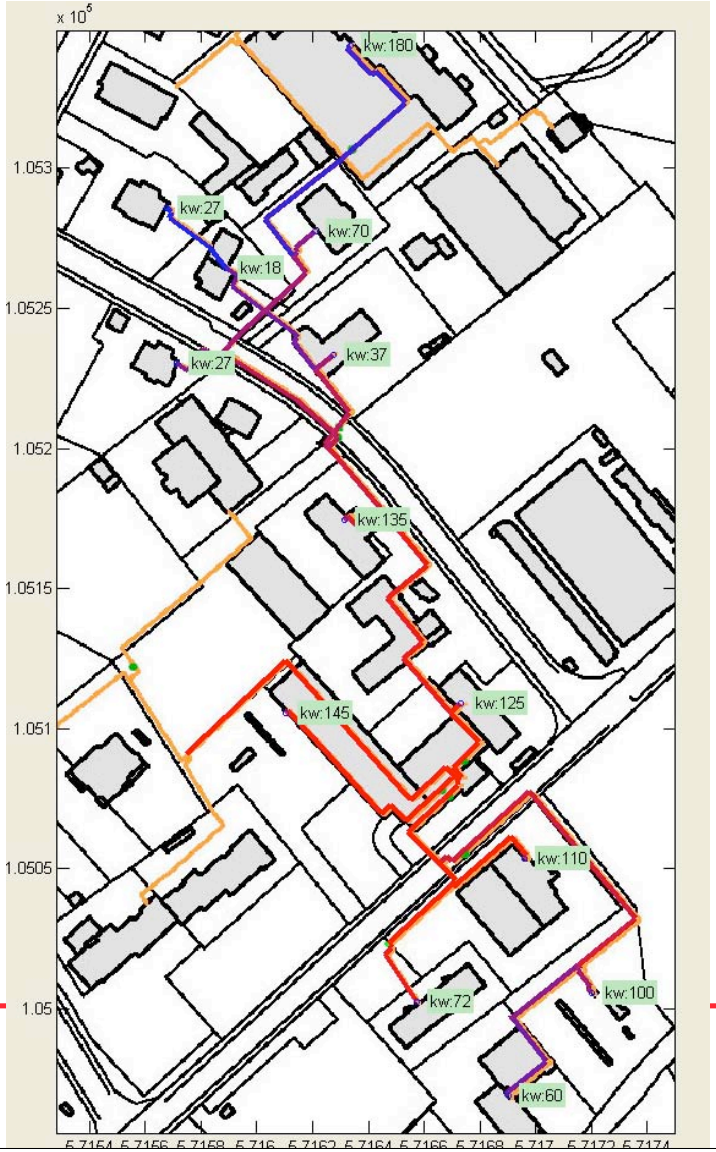
System engineering : ESCO
- Network management
- Maintenance
- Sharing ressources/equipment
- Market opportunites
- Investments

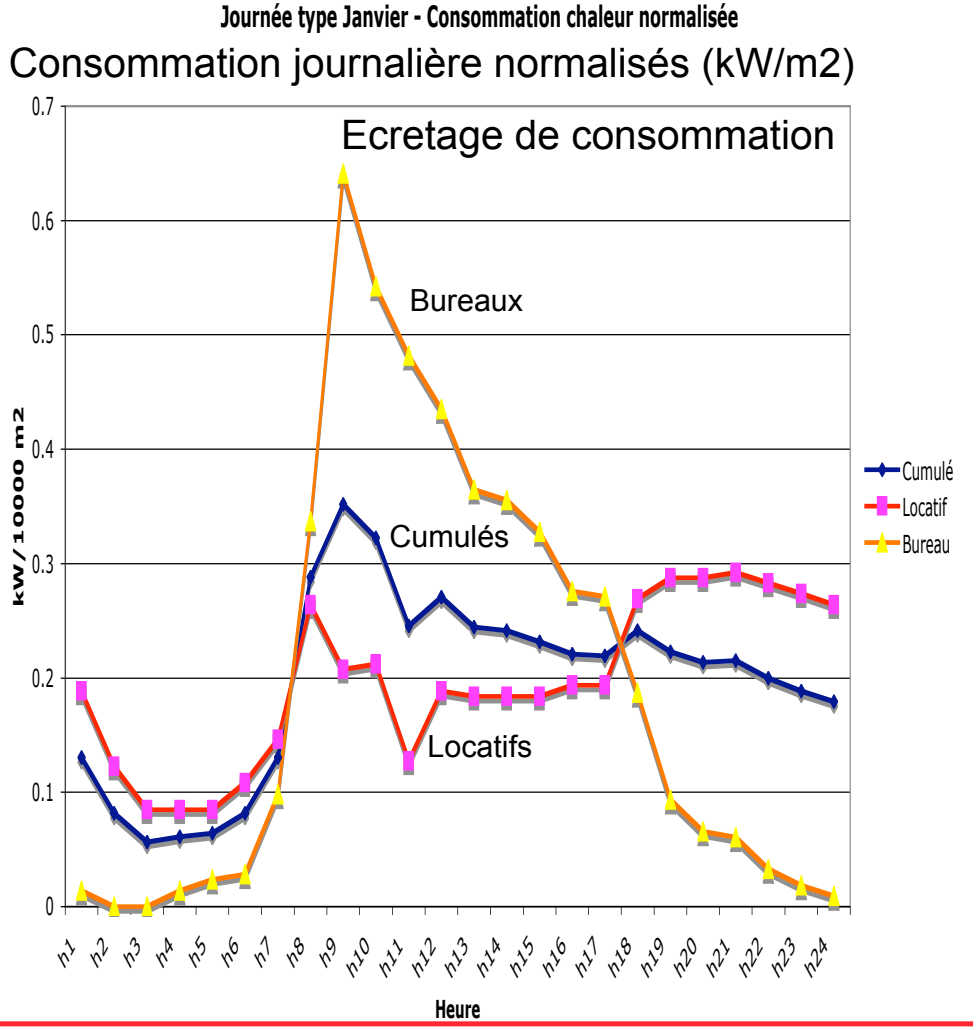
From centralised electricity to decentralised integrated energy systems

- **Integrated energy systems**
  - District heat
  - Gas network
  - Micro-electrical networks
  - Retrofit
  - Other networks
    - information - H2 - chemicals - transport
- Perspectives
  - Certified electricity
  - Renewables
  - Market : CO_2 (Kyoto) - Electricity

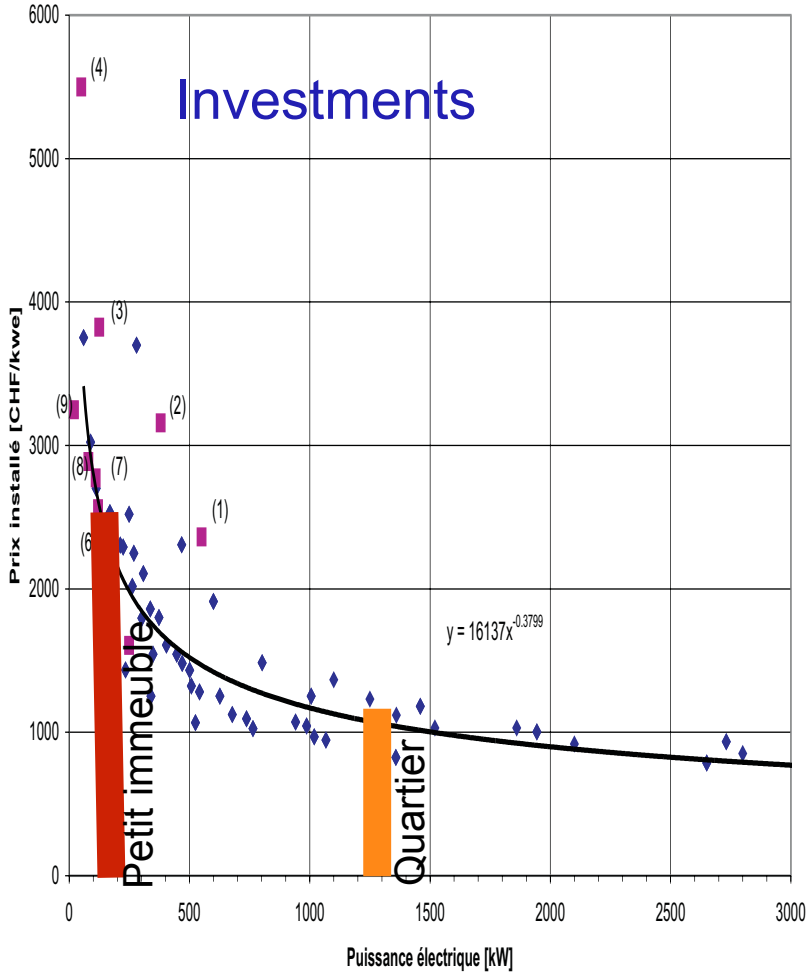


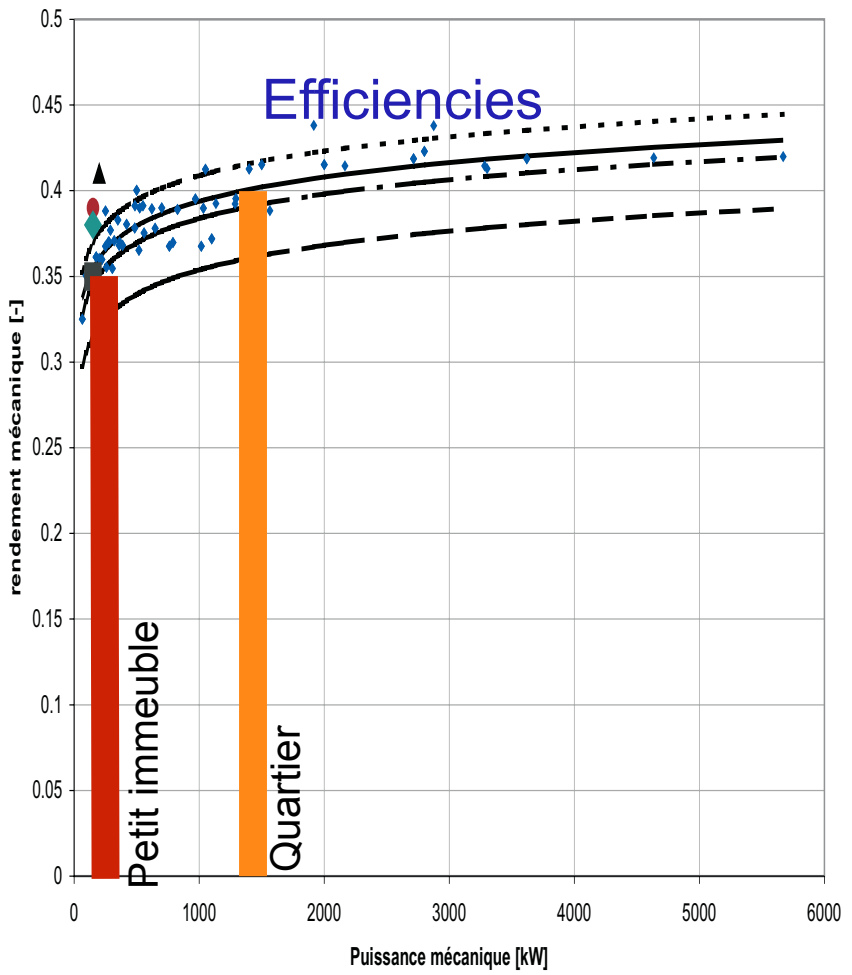
District heating systems : peack shaving



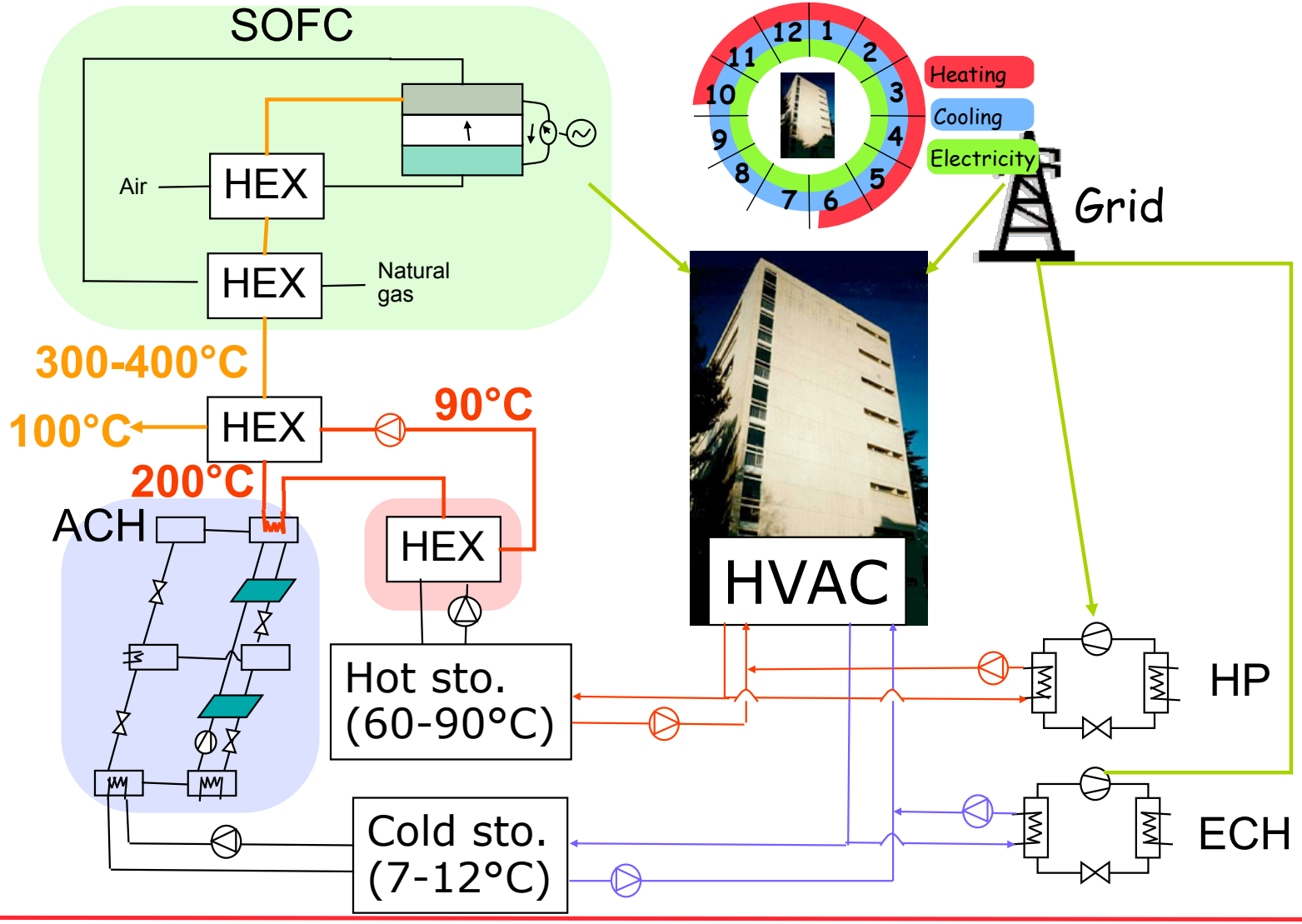


District heating : scale effect





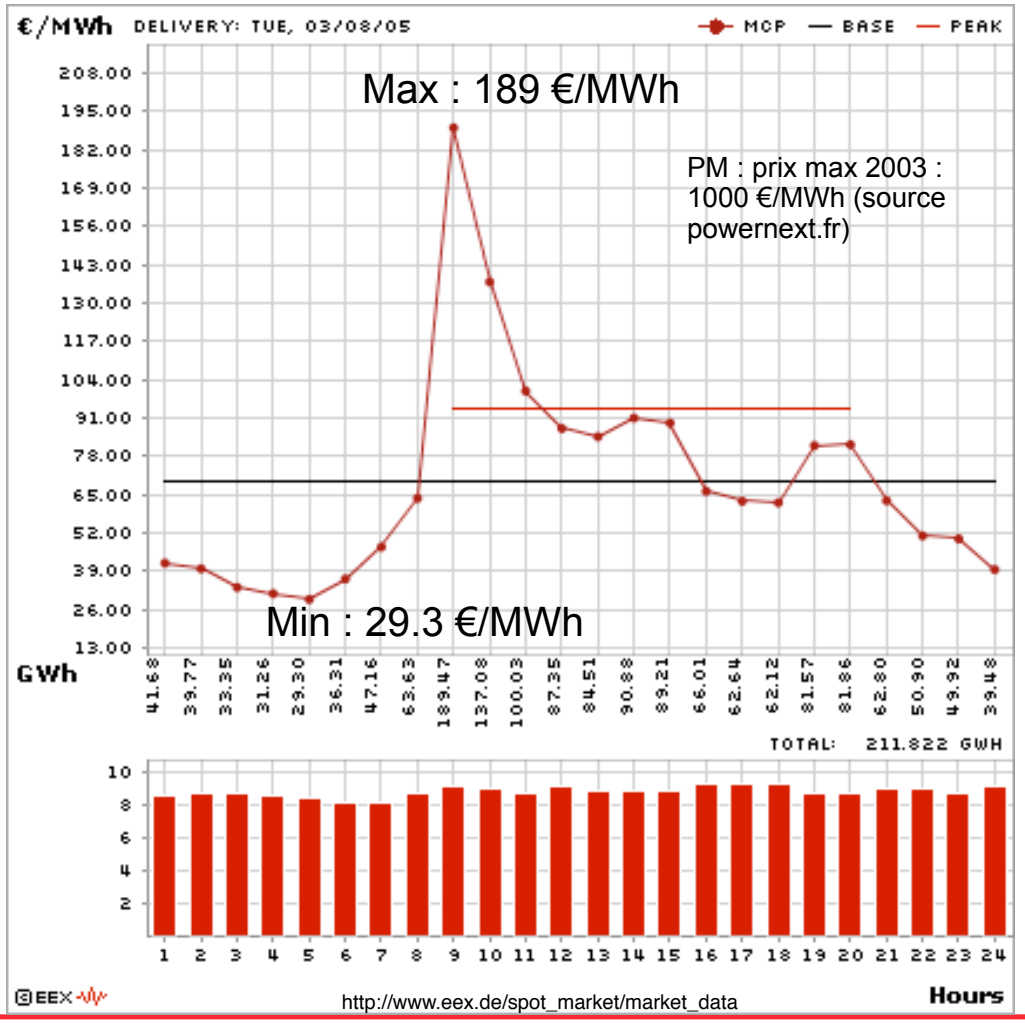
Trigeneration system in a building



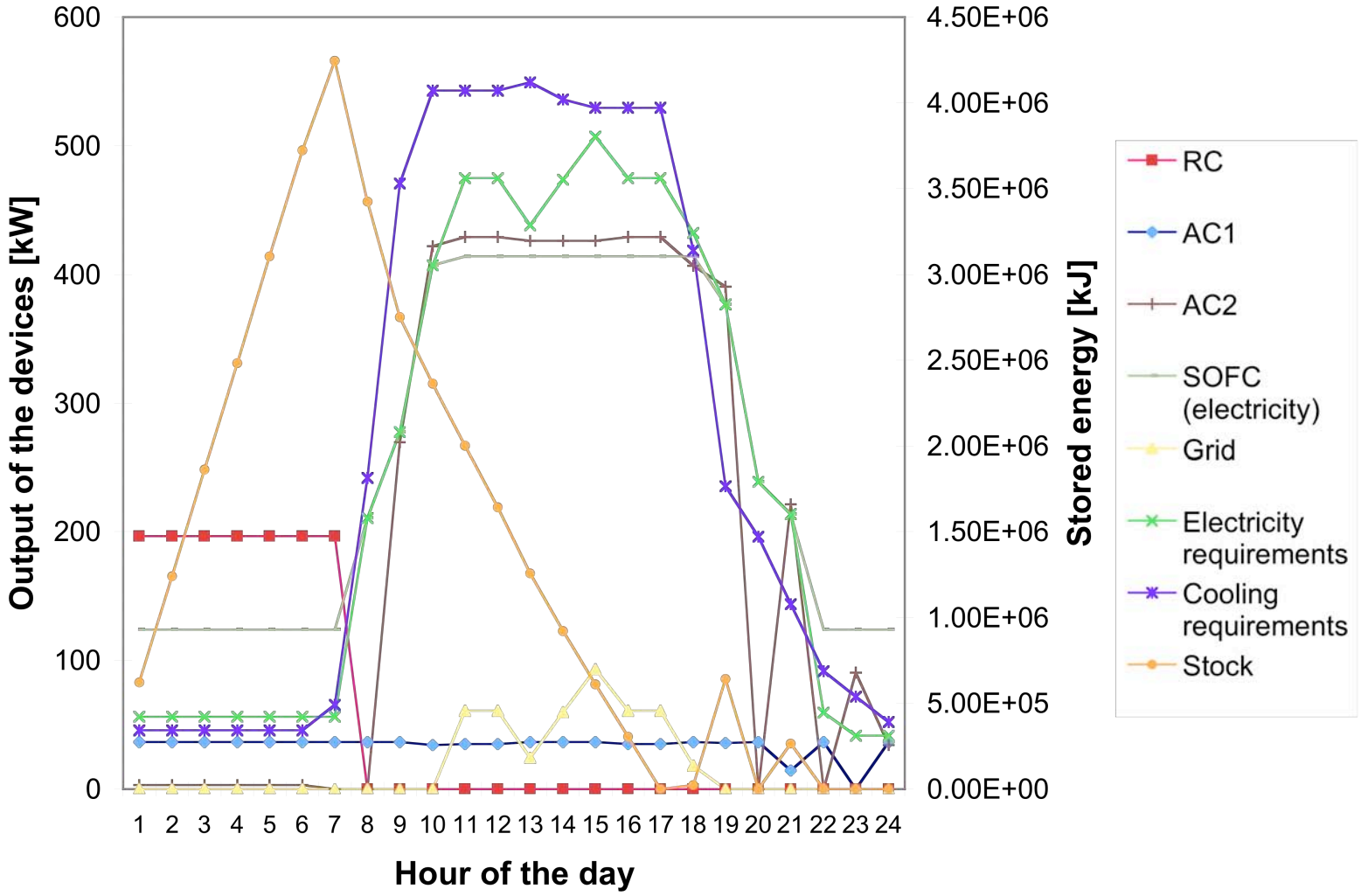
Alliance for Global sustainability project : in collaboration with UT and MIT

Market opportunity ? (EEX) : 08/03/2005

- **Optimal management**
  - Storage
  - Forecating
  - Automation
  - Information network & remote control

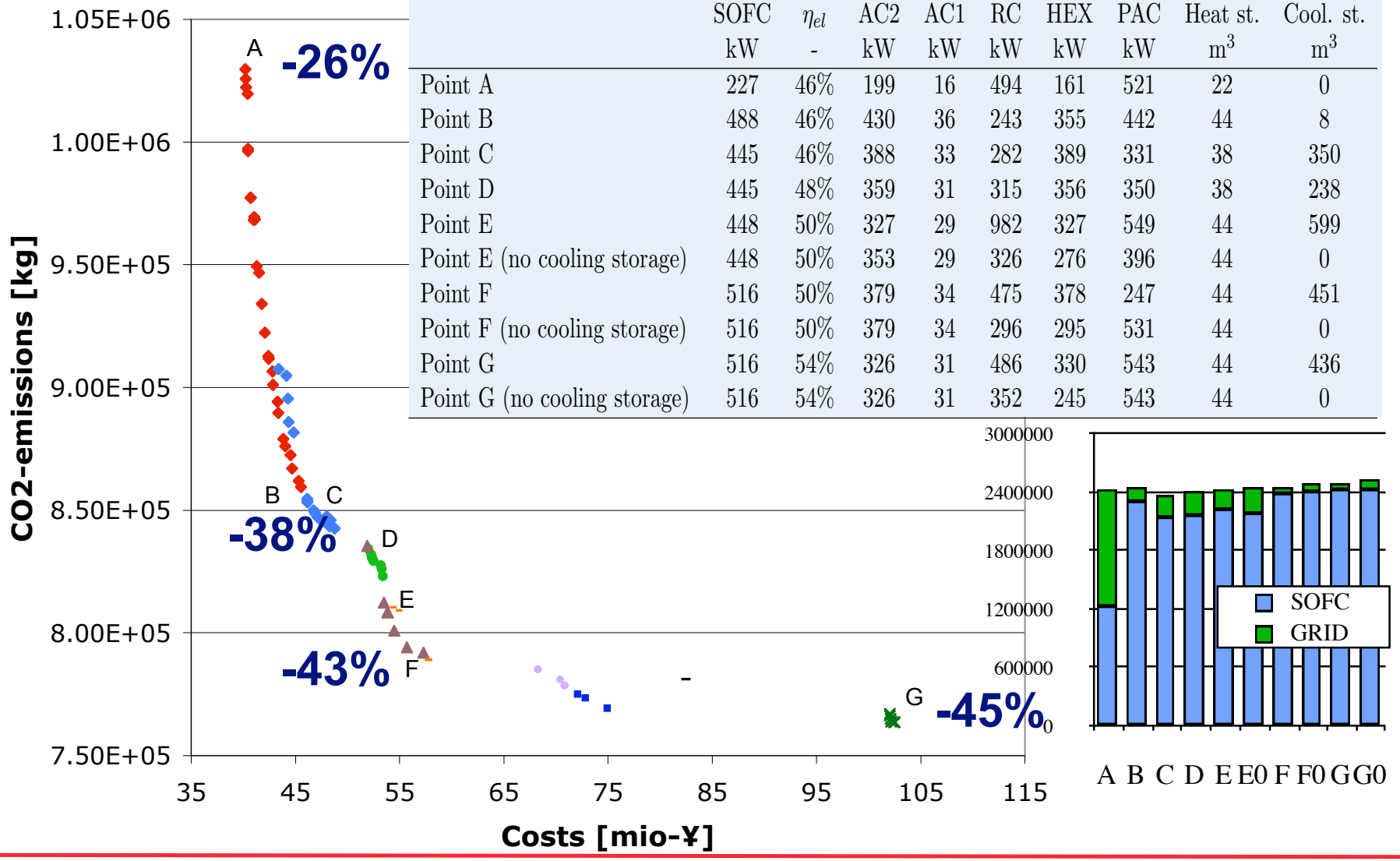


Optimal daily operation



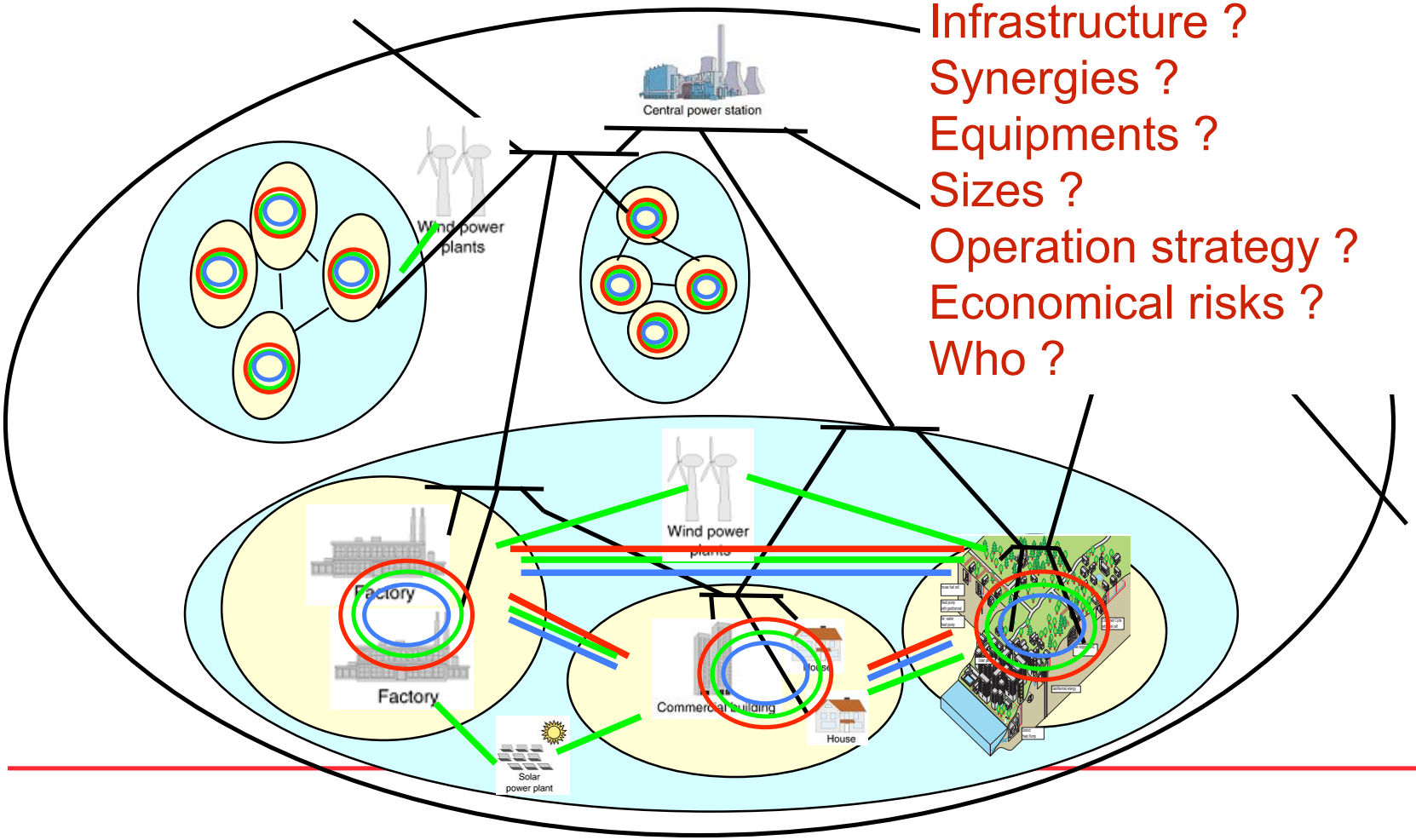
Pareto curve for the system

	SOFC kW	η_{el} -	AC2 kW	AC1 kW	RC kW	HEX kW	PAC kW	Heat st. m^3	Cool. st. m^3
Point A	227	46%	199	16	494	161	521	22	0
Point B	488	46%	430	36	243	355	442	44	8
Point C	445	46%	388	33	282	389	331	38	350
Point D	445	48%	359	31	315	356	350	38	238
Point E	448	50%	327	29	982	327	549	44	599
Point E (no cooling storage)	448	50%	353	29	326	276	396	44	0
Point F	516	50%	379	34	475	378	247	44	451
Point F (no cooling storage)	516	50%	379	34	296	295	531	44	0
Point G	516	54%	326	31	486	330	543	44	436
Point G (no cooling storage)	516	54%	326	31	352	245	543	44	0



From centralised electricity to decentralised integrated energy systems

- **The system design and operation challenge**



Infrastructure ?
Synergies ?
Equipments ?
Sizes ?
Operation strategy ?
Economical risks ?
Who ?

Decentralised production of energy services

- **Multi-disciplinary projects**
  - Design methodology
    - **Energy conversion + storage**
    - **Networks**
  - Integrating new technology developments
    - **R&D EPFL**
    - **Renewable energy**
  - Planification
    - **Infrastructures**
    - **safety of supply**
  - Optimal management
    - **Energy Service Companies (ESCO)**