Economics of nuclear cogeneration: an EU/US comparison

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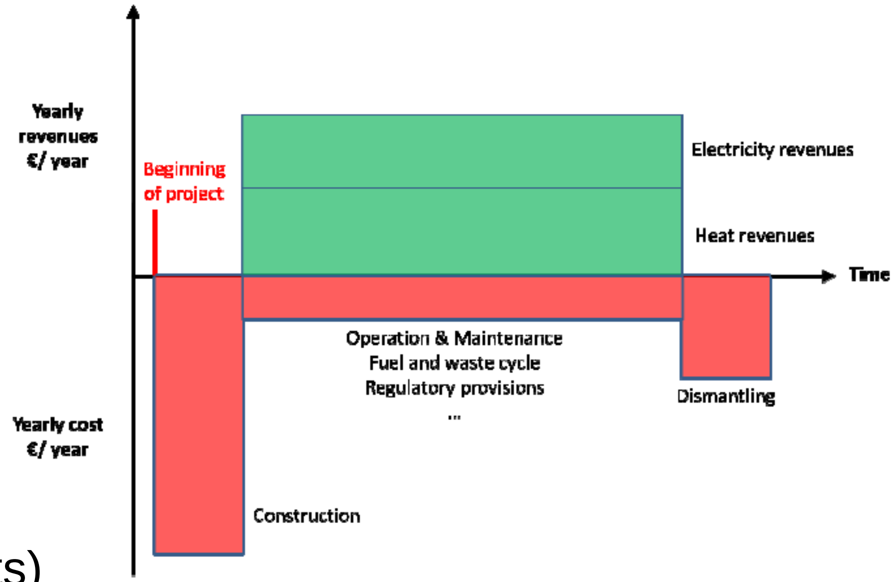
Evaluating a nuclear cogeneration project

- Usual in nuclear projects:
  - High initial investment
  - Long payback time
  - High cost of delay (interests)
  - Uncertain future revenues

- Emerging trends:
  - Small is beautiful…
  - Ensure/increase revenues (or benefits)
    - Feed-in tariffs (e.g. UK)
    - Cogeneration
    - (energy storage ?)

- Pending or under discussion
  - Who pays the first unit ?
  - What if… accident ?



$$NPV = -C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + ... + \frac{C_T}{(1+r)^T}$$

$$-C_0 = Initial\ Investment$$
$$C = Cash\ Flow$$
$$r = Discount\ Rate$$
$$T = Time$$

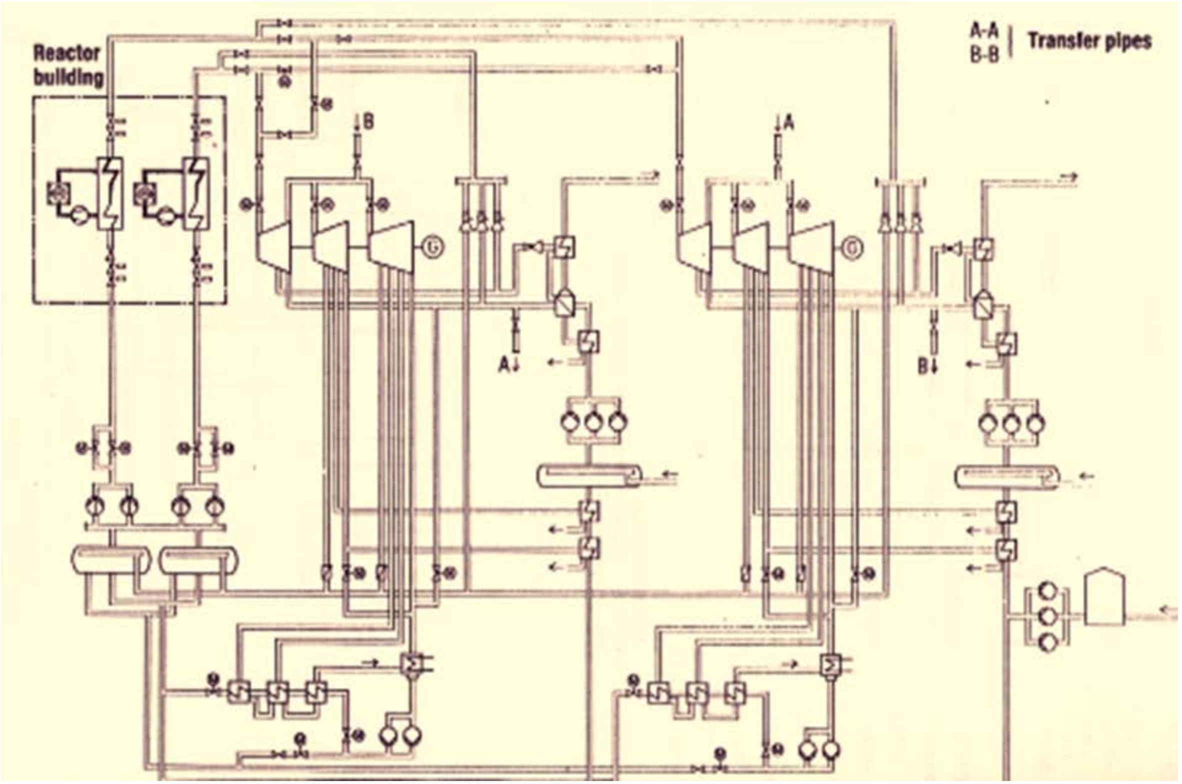
e·on

Case study based: Chemical plant in Germany

Data AREVA (provided in the frame of the NC2I project). The investment cost assessment and economic analysis of an HTR-MODULE 250 has been made on the basis of the analyses of an HTR-MODULE 200 in the 1990ies.

The HTR-MODULE 250 is a two-modular plant for cogeneration of power and process steam for chemical complexes.

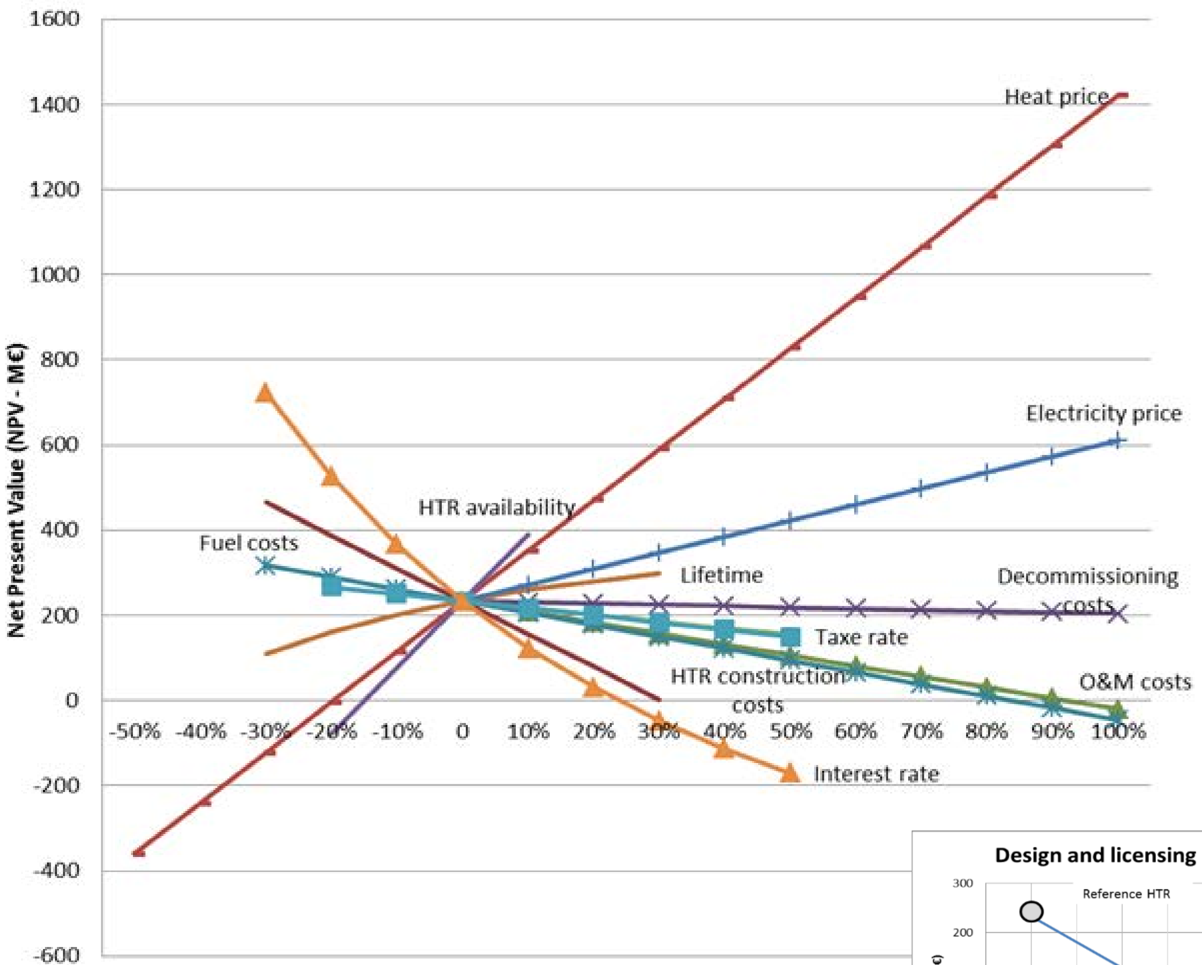
- Legal and economic conditions of Germany
- Plant is integrated in the site of the chemical complex
- due to the special requirements the plant is equipped with two diverse process steam lines in parallel and two turbine sets (in case of a shutdown of one module always 50% of the steam is ensured)
- On-site manufacturing of the large components (pressure vessels) is required
- Data : 500MWth (2x250)
  - 387.63 MWth(net) steam
  - 98.25MWel(net)
- Process steam :
  - 19 bar, 250°C, 42.9 kg/s
  - 3.5 bar, 139°C,104.3 kg/s



US / EU comparison – Main inputs for the model

	EU	US
Configuration	2 x 250 MWth	4 x 625 MWth
Overnight costs (rate:1,07 $/€ !)	1862 €/kWt	2200 $/kWt
O&M costs	6,23 €/MW.t	4,9 $/MWt.h
Lifetime	40 years	60 years
Reference gas price	35 €/MWh + 10 €/t CO_2	6-8 $/MMBtu (20-27 $/MWh)
Design development costs	Excluded	4 scenarios
Technical basis	Near-term applications (750°C outlet temperature, SG, plug-in market)	

Sensitivity analysis for most influent parameters



Reference case:

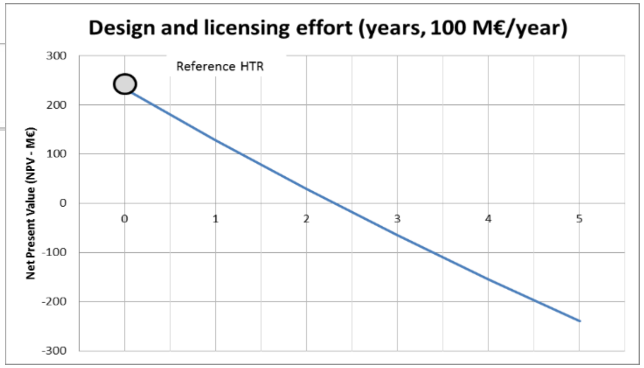
- NPV: + 233 M€
- IRR: 9,9 %
- Positive NPV after 24 years

If electricity production:

- LCOE = 81,6 €/Mwe.h

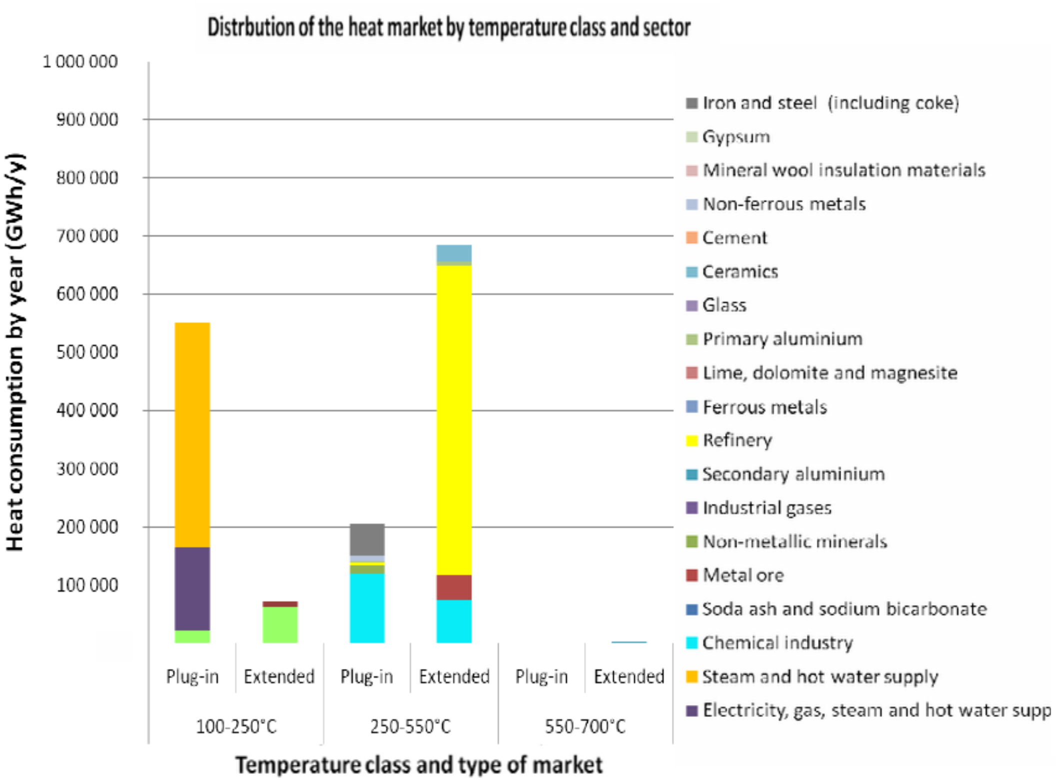
External factors:

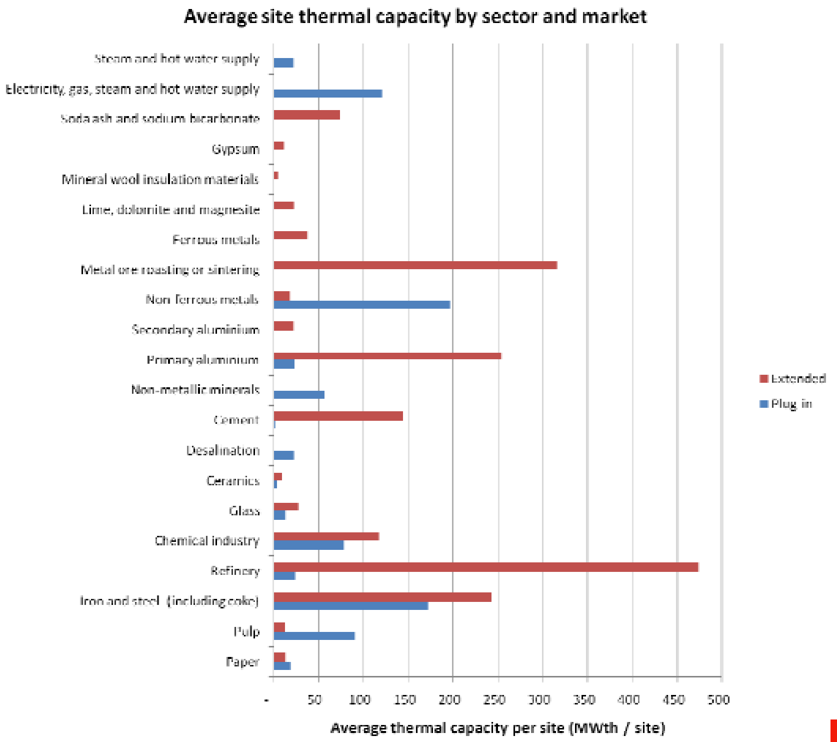
- High influence of heat price (with high impact of CO_2 prices)
- Influence of electricity prices
- Moderate influence of lifetime



Heat market overview

- Minimize design and project risks (at least for the 1st project(s))
  - Limitation of “technology gaps” : Outlet Temp. 750°C (Steam 550°C)
  - Limitation of customer‘s risks: Plug-in market targeted

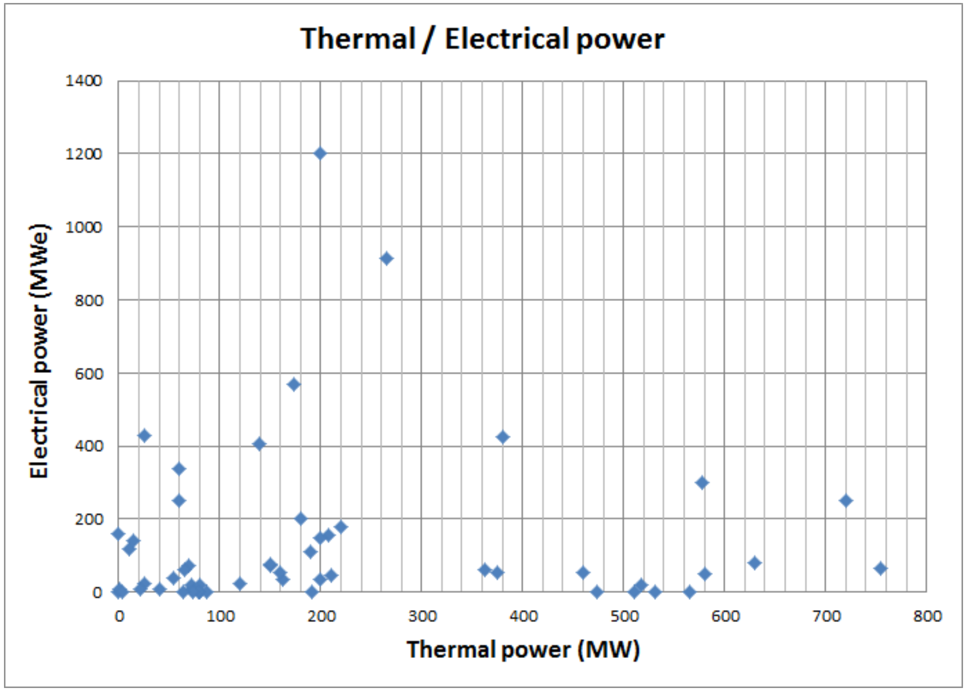




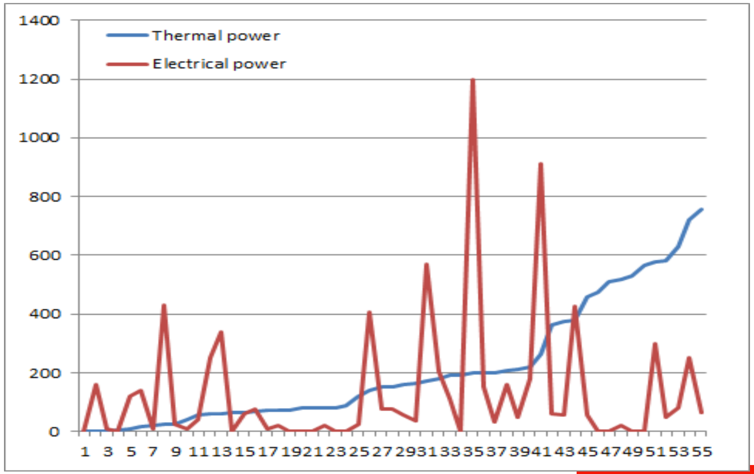
* Reminder: 2x250 MW = 4000 GWh/y

Results of the site mapping (NC2I - Task 4.2)

- Minimize design and project risks (at least for the demonstrator)
  - Limitation of “technology gaps” : Outlet Temp. 750°C (Steam 550°C)
  - Limitation of customer‘s risks: Plug-in market targeted
- 132 chemical complex investigated, data provided for 57 sites.



- 20 chemical sites > 150 MW (PlugIn)
- 1 site > 2000 MW.th
- 1 site > 2000 MWe



Preliminary conclusions and challenges

- An HTR design, supplying energy to a chemical complex is profitable in the reference case calculated with penalising assumptions (especially for CO2 prices and Electricity prices).
- A case with electricity-only production would hardly compete with current alternative electricity sources (Hydro, Coal, large nuclear).
- Design development (or adaptation) costs challenge the viability of a project. Standardization within Europe (especially for regulations and licensing) is an absolute priority.
- To maximize revenues for smaller chemical complex, a broader range of services (e.g. integrated energy supply: Heat and electricity, district heating, grid stabilization..) is to be investigated.

Thank you for your attention…