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Modelling district heating infrastructure in global optimisation models

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4th Generation District Heating
Technologies and Systems

Overview

TIMES Global models

Modelling District heating and CHP

Options for modelling infrastructure

Using aggregated parameters

Archive of results from studies over many years

Genesis of EFDA-TIMES and TIAM

MARKAL/TIMES Global models

- Initial proposal by Amit Kanudia & Richard Loulou to ETSAP at ETSAP meeting in 1998
- SAGE at USDOE-EIA: 2000-2003 and on: Global, myopic MARKAL
- IEA-ETP project: 2001-2003 and on: global MARKAL with focus on technology, environmental issues
- EFDA: 2004 and on: First global TIMES model: focus on technology, environment, very long term (2100)
- ETSAP's TIAM: 2004-2006: elaborated from previous modelling experience. Focus on technology, energy trade, link with macroeconomy (GEM-E3), global environmental issues (GHG, climate module), very long term (2100)

From presentation by Richard Loulou, ETSAP workshop, Stuttgart, November 2006

Issues of archived model results

	EUROfusion	TIAM	China	SE4All	Grids
Model	EFDA-TIMES	ETSAP-TIAM	ETSAP-TIAM	ETSAP-TIAM	TIMES
Start year	2000/2005	2000/2005	2005	2005	2000/2005
Horizon	2100	2050/2100	2050	2030	2050/2100
Technology focus	Fusion, CSP, Wind, Biomass	Conversion technologies	Conversion technologies	Demand efficiency	DH grid, CHP, CCS
Climate	Max CO2	Max CO2, CO2 tax			Max CO2
Policies	Supply	Low carbon	Low carbon	Sustainable	
Tools	Scenarios	Scenarios			Archive
Reported	2005-2016	2008-2015	2015	2016	Ongoing

Modelling infrastructure – two options

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Geographical details

- National or local models

Aggregate technologies and parameters

- Electricity Pan European model: 2-3 levels with costs and efficiencies per PJ or MW
- District heating Pan European model: costs and efficiencies per PJ or MW
- Global models (TIAM and EFDA-TIMES): neglected

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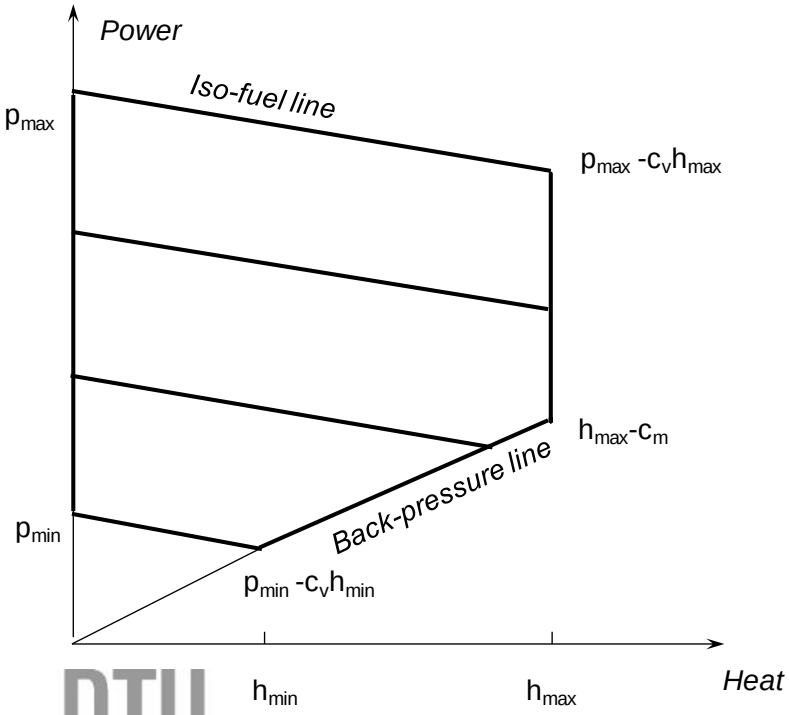
CHP as a virtual heat pump

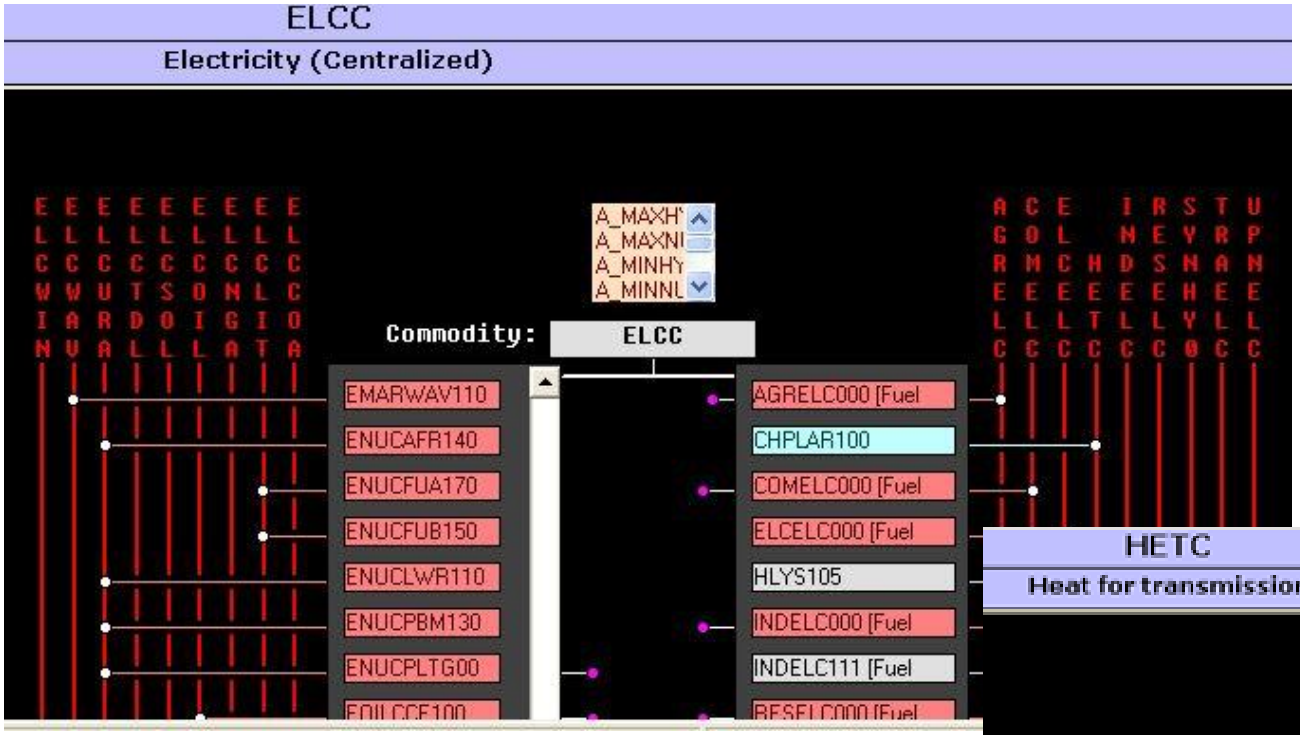
Production of electricity and heat in extraction-condensing units

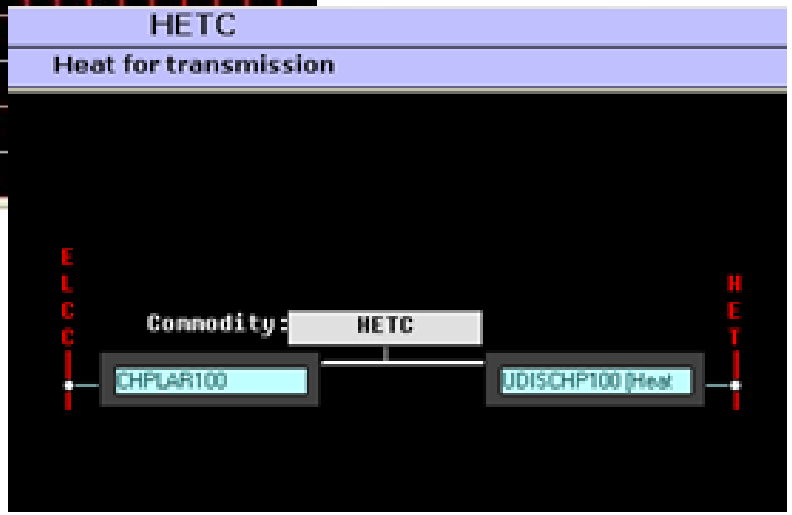


Technology	Power-loss-ratio	Effi-ciency factor
Electricity driven heat pump	n.a	3
Nuclear CHP	0.25	4
Coal/gas CHP; Fission Gen. IV and Fusion.	0.15	7
Low-temperature DH	n.a.	10
Conservative average for heat transmission	n.a.	5
CCS with heat recovery	n.a.	n.a.

Acknowledgement: William Orchard, 11th IAEE European Conference, Vilnius, September 2010.

Aggregate technologies for large-scale CHP and heat transmission/distribution I





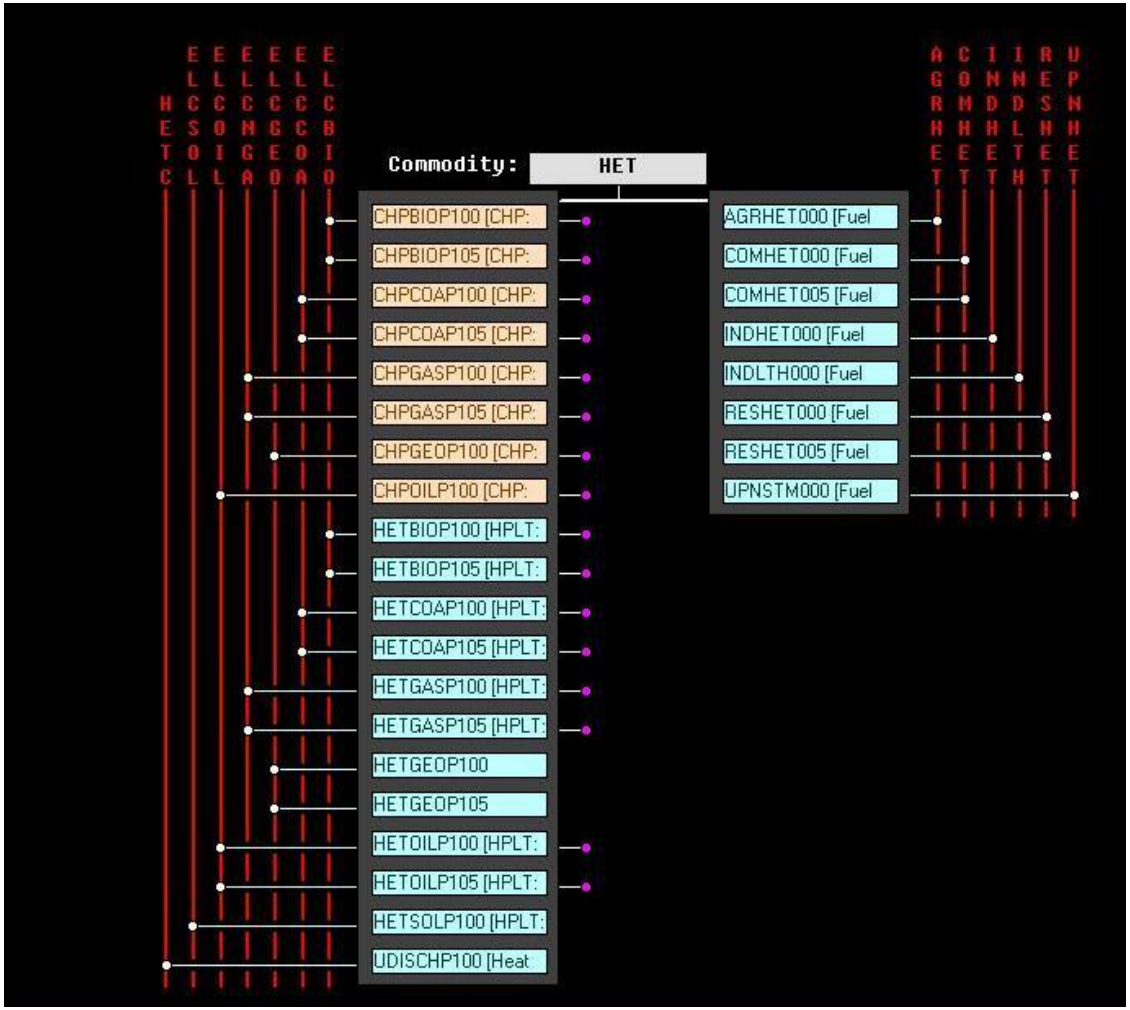
New Processes
Large CHP/"virtual heat pump"
Heat transmission
New commodity
HETC

Aggregate technologies for large-scale CHP and heat transmission/distribution II

HETC (new) Heat supply from large CHP to urban grids. Regional constraints depending on climate and heat market in Base scenario.

HET (current) All heat – from rooftop solar panels to institutional distribution network and small district heating grids.

Next step: Adding intermediate heat network(s),



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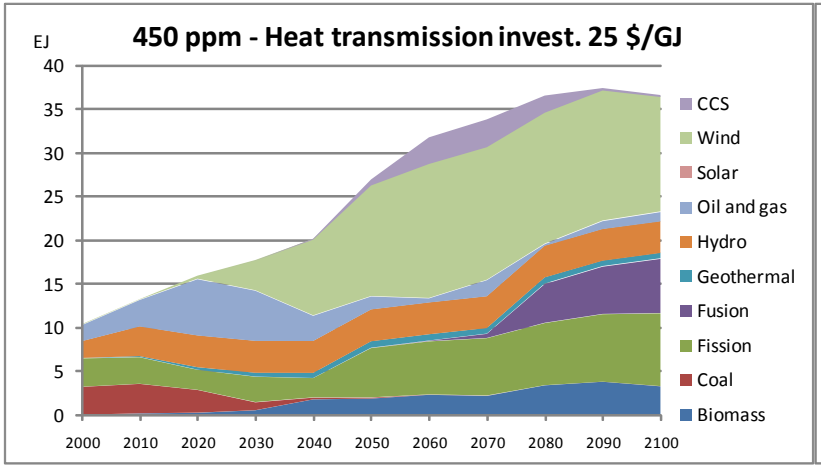
Modelling the infrastructure development for heat recovery from CCS and fusion

- The most critical parameter for CCS is the loss of thermal efficiency during carbon capture.
- CCS can be a driver for the development and expansion of large-scale district heating systems, which are currently widespread in Europe, Korea and China, and with large potentials in North America.
- If fusion will replace CCS in the second half of the century, the same infrastructure for heat distribution can be used.
- This may support the penetration of both technologies.
- EFDA-TIMES and TIAM consider trade among regions, but not the infrastructure development within each region in the optimisation.
- This issue must be modelled using very aggregated technologies and parameters

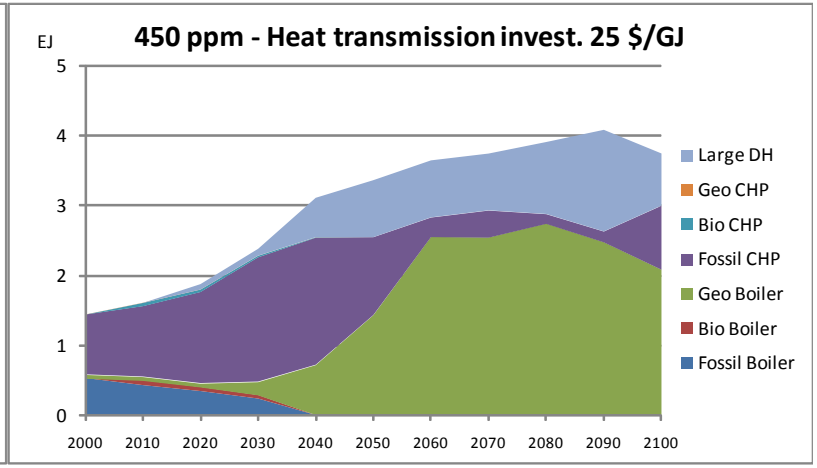
Europe – Adding large-scale heat transmission infrastructure

- In the current model, the heat transmission infrastructure has little impact on the mix of electricity supply.
- On the other hand the added infrastructure option will take a significant share of the heat market.
- Further modification of the model will be needed to analyse the contributions of technologies that benefit from this technology: Fossil CHP, possibly with, urban waste incineration, fusion with CHP, large heat pumps.

Electricity supply



Heat supply



Conclusions

- So far, district heating infrastructure has been neglected in most studies using global TIMES models.
- This gives a bias against several important technologies for CO2 reduacton, e.g. large-scale CHP, Waste-to-energy, Carbon Capture and storage (CCS), deep geothermal energy.
- District heating infrastructure has a prominent role in recent model studies of regional or local energy systems, e.g. Nordic Energy Technology perspectives and TIMES-DK. These studies are all very detailed.
- More aggregate parameters must be used for global models (divided into large regions). These parameters should be verified using the results of detailed studies.
- Archived results of the global models offer a source for studying the impact of a modified model structure . Using aggregated parameters for efficiencies and costs.

Some references

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