Techno-Economic Feasibility of Biomass Fueled District Heating Systems in Belgium

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Presentation overview

Concept of the research project

Research questions

Belgium – Flanders

(Non-)Financial barriers to district heating in Flanders

Current district heating networks in Flanders

Reasons for renewed interest in district heating

Techno-economic feasibility and case-studies

Future research

Concept of this research project

Decentralized biomass technologies for district heating

- Identification
- Technological and economic assessment

- Initial focus on Flanders, with extension to Belgium, but with possible biomass import from abroad
- Attention to logistic chain of feedstock and heat (networks)
- Financial balance, energetic and technological assessment
- Development of an assessment methodology

Research questions

What are the bottlenecks to the implementation of district heating in Belgium?

- Financial/economic barriers?
- Non-financial barriers?

Are biomass fueled district heating systems techno-economically feasible in Belgium: case-study based assessment?

Can biomass fueled district heating networks contribute to the achievement of Belgium's 2020/2030 environmental and renewable energy share targets?

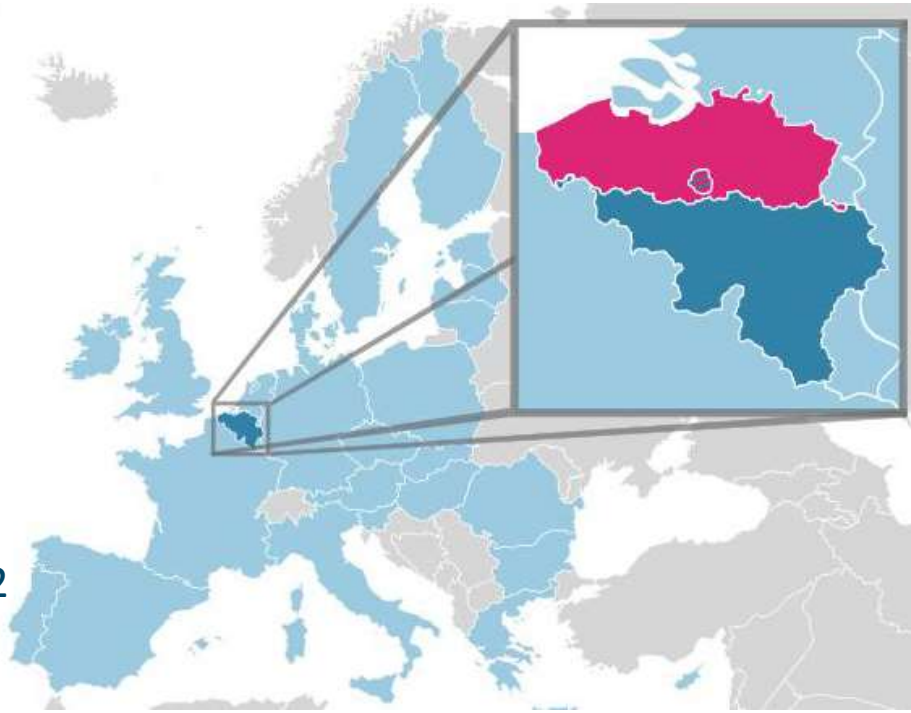
Belgium - Flanders

Small country:

- Belgium: 30 528 km^2
- Flanders: 13 522 km^2

High population density:

- Belgium: 342 inhabitants/km^2 (~ Massachusetts)
- Flanders: 452 inhabitants/km^2 (~ New Jersey)



Non-financial barriers to district heating in Flanders

No legal framework for district heating networks

- Proposal for a resolution concerning the development of district heating grids was only submitted in July 2013
- No regulator for district heat supply
  - Important for correct pricing and other regulatory initiatives such as technical characteristics etc.
  - Potential role for Flemish Regulator of the Electricity and Gas market?
- No system operators
  - Existing system operators have shown interest in the recent developments
- Development of a ‘Heat Map’ to match demand and supply is pending
- Involvement of local governments to improve the potential of district heating networks is required

Financial barriers to district heating in Flanders

Low support for the development of district heating networks as compared to green electricity and combined heat and power

- First call for support for 'green heat': announced end of 2013 (budget: € 6 712 000) and assigned as investment support
  - Call system – 2 times per year
  - Only installations > 1MW

Historic lag in infrastructure. Flanders invested in an extensive natural gas distribution network, but not in district heating networks

- High upfront investments are required, with long payback periods

The heating costs should always be lower than the (individual) fossil fuel based heating costs to convince potential consumers

- No level playing field

Current district heating networks in Flanders

Very limited number of district heating networks in Flanders:

- Mirom Roeselare (greenhouses, dwellings & schools) - 7.5 km
  - Waste incineration plant (14 MW)
- IVAGO (Hospital of Ghent) – 1.5 km
  - Waste incineration plant (12 MW)
- IVBO (Prison of Bruges) – 11 km
  - Waste incineration plant (24 MW)
- SPE Luminus (dwellings in Ghent) – 8.2 km
  - Combined heat and power unit on gas (15.6 MW)

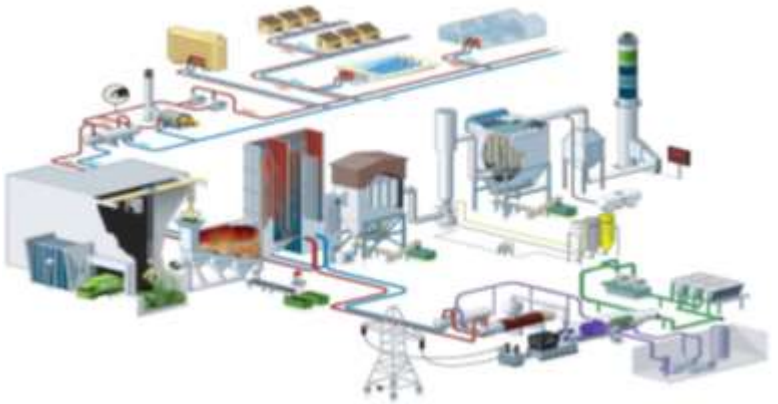


Photo credits: MIROM

→ Belgium lags behind on most EU countries, notably the Scandinavian countries!!!

Reasons for renewed interest in district heating

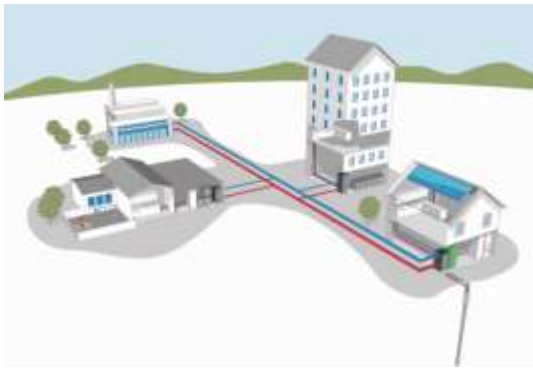
Belgium still far away from achieving the EU's 2020 climate and renewable energy objectives

- Every EU country has to evaluate the potential of efficient district heating systems by December 2015

District heating networks are required to allow the use of residual heat (power plants, waste incineration plants, etc.)

Green heat is a 'sleeping giant'

- Large unused and relatively inexpensive potential (high population density)
- 55% of the gross final energy consumption is dedicated to heating & cooling



Multiple urban development projects are in the pipeline, e.g. in Antwerp

Techno-economic feasibility assessment

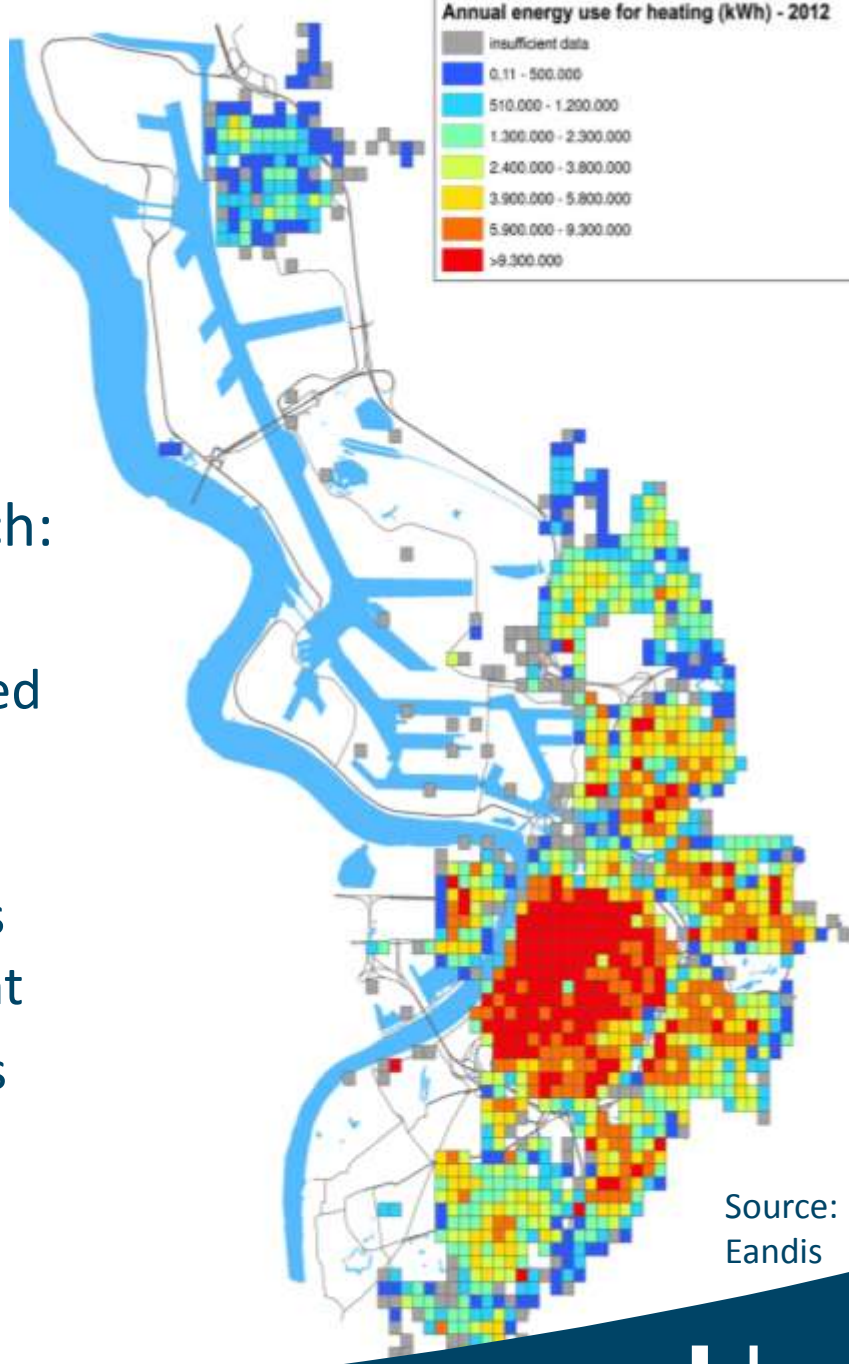
We distinguish three scenarios

- New residential areas
  - Lower infrastructure costs, cost sharing with other utilities
  - Possibility to make grid connection mandatory

- Existing residential areas
  - High infrastructure and connection costs
  - No level playing field
  - Feasibility highly dependant on number of connected consumers

- High energy density areas, e.g. college campus, block of apartments, etc.
  - Lower infrastructure costs, smaller distances with high demand
  - Mostly one owner: easier negotiations

Case-studies



Initial focus of our on-going research:

Antwerp

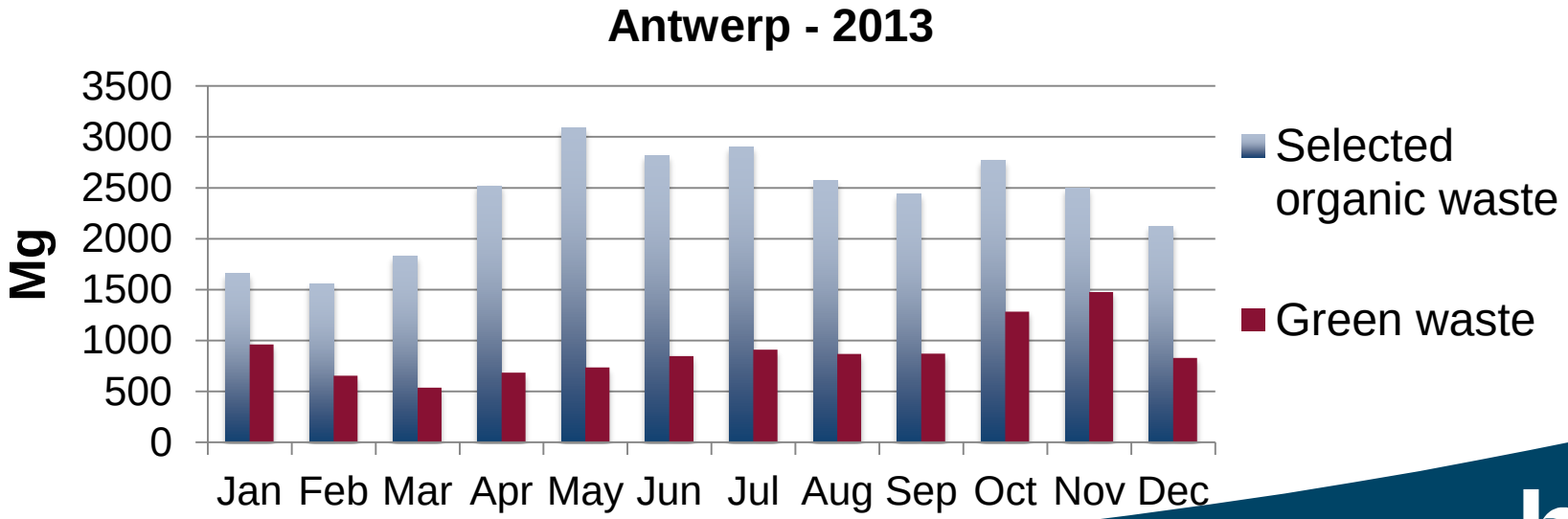
- Large potential for all three considered scenarios
- Much interest and cooperation from local authorities (several local studies pending): European Mayor Convenant
- Large quantities of (residual) biomass

Source: Eandis

Biomass resources in Antwerp

Focus on residual biomass and green waste

- Large quantities of prunings are available at the municipal recycle parks, possibly complemented with resources from the Agency of Nature and Forest
- Green waste is selectively collected in most municipalities in Flanders, including Antwerp
- Most of these biomass resources are currently available at negative costs, up to € 56 Mg^{-1} for prunings and € 86 Mg^{-1} for green waste (excl. transportation)



Biomass conversion technologies considered

Biomass combustion with flue gas condensation

- Proven technology
- Multiple off-the-shelf configurations available
- Condensation contributes up to 20% of total output, ideal for ‘wet’ biomass

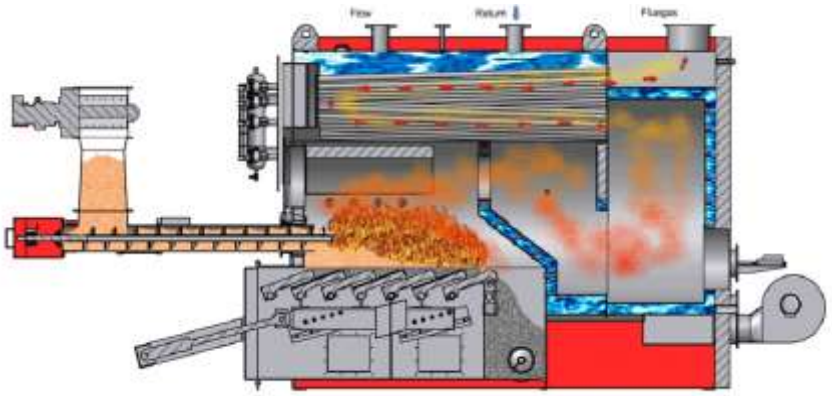


Photo credits: Weiss A/S

Anaerobic digestion (DRANCO)

- Specifically designed for organic waste
- Proven technology, high biogas production
- Capacities up to 60 000 Mg y^{-1}

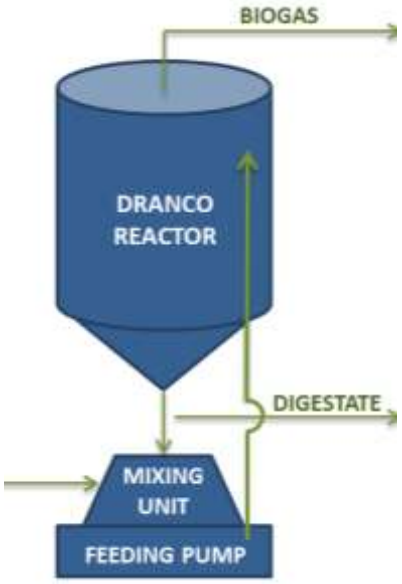


Photo credits: OWS nv

Existing residential areas

Large potential in the city centre

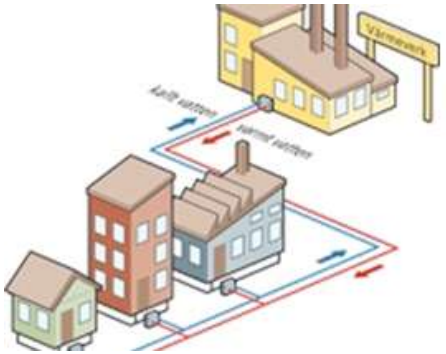
of Antwerp

- High population density, high energy demand: > 13 MWh y^{-1} km^{-1}
- Lower transportation costs for non-local biomass resources (Scheldt)

Bottlenecks

- Uncertain infrastructure costs, ranging between € 750-1500 per running meter in built environments
- High connection costs, up to € 6000 per dwelling
- Uncertain demand due to uncertain number of connections (no legal obligation to connect)

New residential areas



Opportunities

- Lower infrastructure (€ 350-600 m^{-1}) and connection costs, up to € 2500 per dwelling
- Possibility to connect all buildings in the considered area
- Conversion plant can be centralized to decrease pipeline network

Bottlenecks

- Phased connection of new consumers
- Low energy and passive houses, lower heat demand

Feasibility of district heating in residential areas

Base case assumptions:

- 4 MW_{th} biomass combustion plant met flue gas condensation
- Biomass source: woody chips (approx. 50% moisture content)

Preliminary results

- Existing residential sections not feasible without additional (government) support
- New residential sections are profitable at a stable low costs for biomass
- Higher investment and maintenance costs for biomass as compared to gas fired conversion plants

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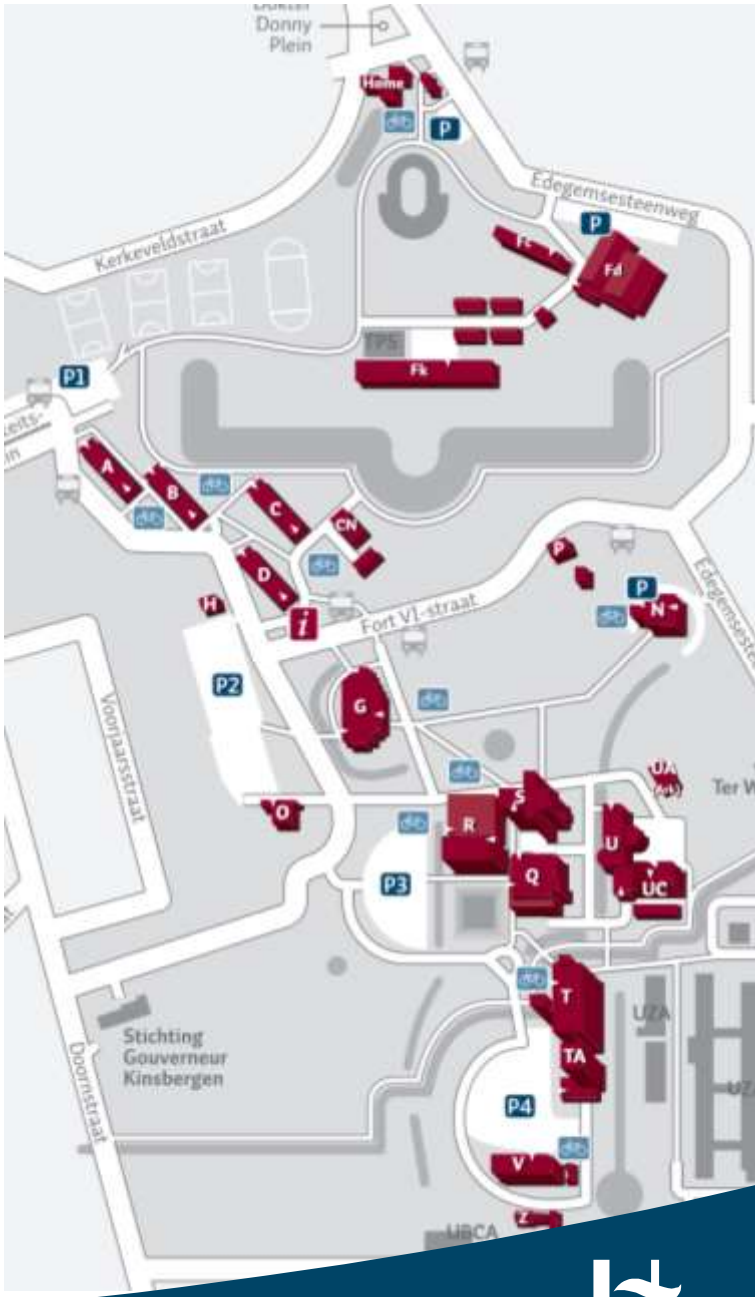
15 university buildings at Campus Drie Eiken ('Three Oaks')

- Currently: all individually heated
- Total installed capacity: 10 MW
- High energy requirement per running metre
  - Gas consumption (2013): 12.7 GWh
- Barriers:
  - New buildings required for the conversion facility and the storage of biomass
  - Much resistance after failed district heating project in the 1980s
  - No level playing field (infrastructure, heat exchangers, etc.)



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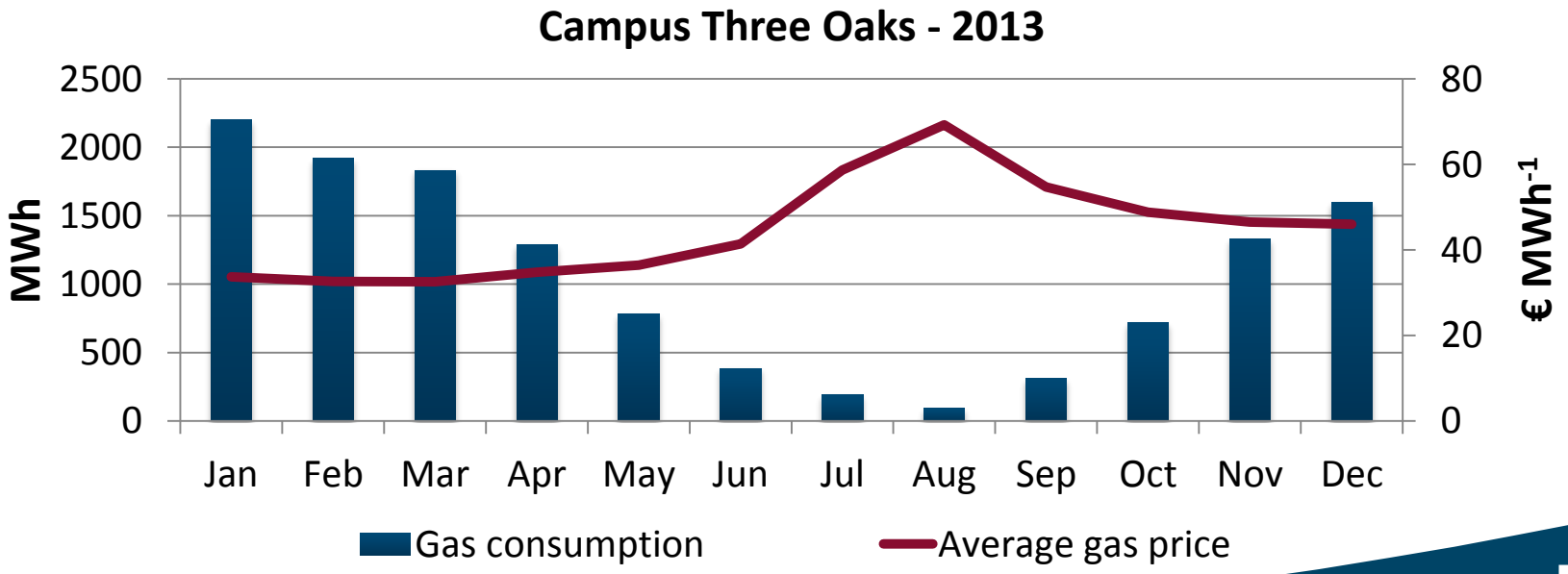
Low gas prices – thanks to the high demand – complicate the business case for biomass fueled district heating

- Weighted average gas price of € 38 MWh^{-1} in 2013
- Biomass fueled district heat prices oscillate between € 42 and 65 MWh^{-1}
- Conflicts with ‘not more than usual principle’



Future research

In-depth techno-economic assessment the introduced cases

Inclusion of (recent) financial incentives (subsidies, tax exemptions, etc.)

Investigation of additional biomass resources and other heat sources, e.g. residual (industrial) heat

Optimization of the connected loads to decrease the simultaneity factor

Life cycle assessment to quantify the environmental benefits

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