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EMISSIONS REDUCTION THROUGH BIOMASS AND GAS CO-FIRING - THE BAGIT PROJECT

Presented by Arwel Griffiths

Content of presentation

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- General project concept
- Technical processes for co-firing of biomass and natural gas
  - gasified biomass
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- Environmental and operational performance of the co-firing technologies
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  - Corrosion impacts
- Cost of generation of co-firing systems
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- Conclusions
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BAGIT Project targets

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The project focus was on:

- The use of biomass and natural gas in the supplementary firing stages of the heat recovery steam generation sections of mid-sized gas turbine-based systems, for CHP systems.
- The joint utilisation of natural gas and biomass in standard boiler/steam turbine systems but with extensions for NOx reduction.

Overall the project concept was:

- to improve acceptance of renewable energy systems in European countries
- to overcome barriers to biomass use by utilising established gas technology
- to improve biomass fuel quality and consistency through processing of the biomass and use in hybrid systems

Project activities

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The work comprised the following tasks:

- Laboratory studies of the co-utilisation of biomass and natural gas
- Development of a pyrolysis oil/natural gas burner
- Development of a gasified biomass/natural gas burner with emphasis on applications to supplementary firing systems.
- Investigation of advanced controls and system integration
- Technical, environmental and social assessment of the technology options.

(Here, Supplementary firing is defined as additional fuel input into gas turbine exhaust to raise the temperature of the flue gas to raise steam.)

Natural gas/biofuel hybrid technology – the concept

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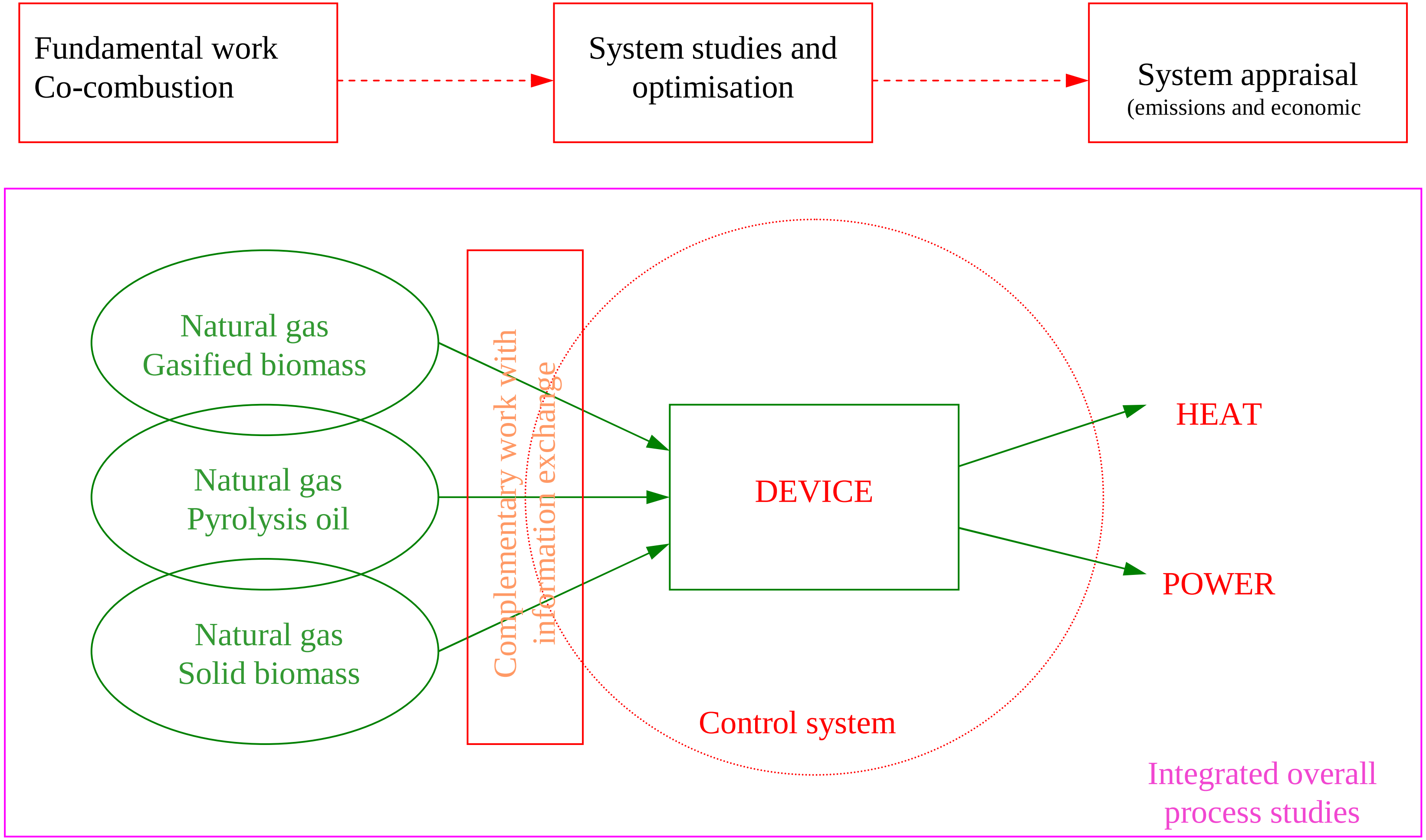
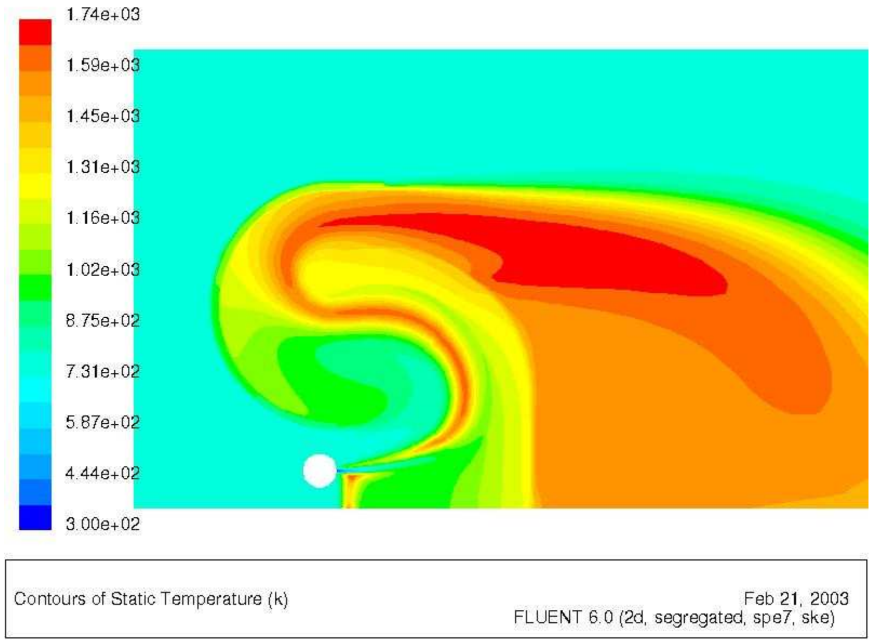


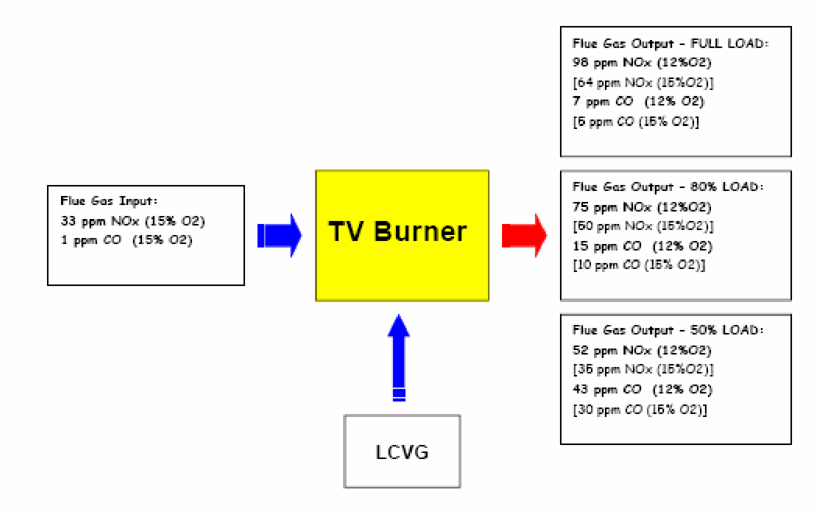
Gasified biomass – supplementary firing

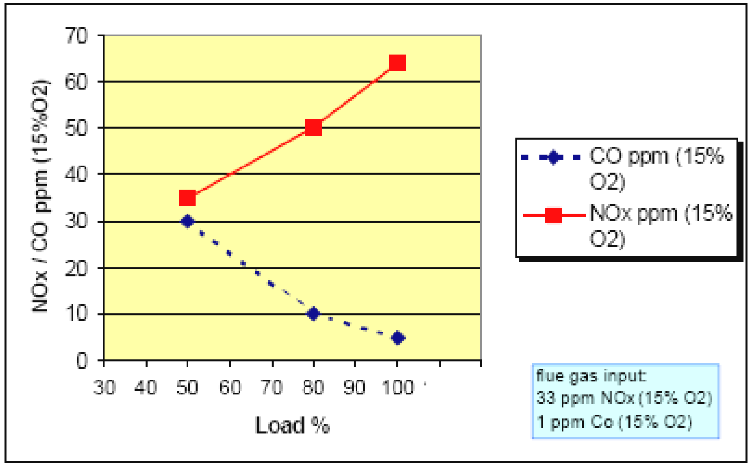
- **CFD Studies**
  - Used for design of the vortex combustor
  - Used in optimisation
  - Used for modelling studies and sensitivity analysis of design parameters



Flameless oxidation

Co-firing of natural gas and gasified biomass





- CO and NOx emission dependent on load
- Optimum design for burnout of fuel but NOx increases with load

Natural gas and bio-oil co-firing

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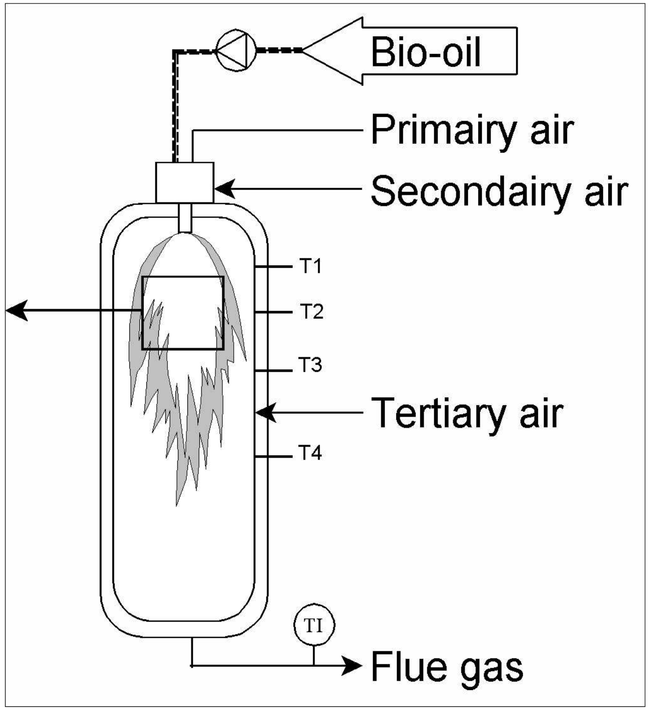
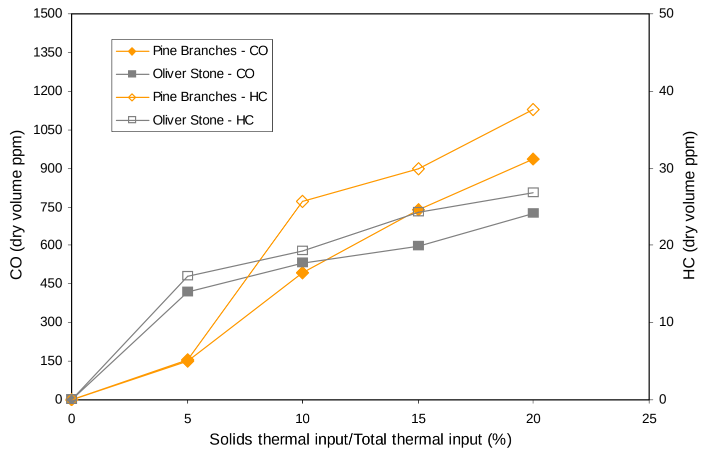
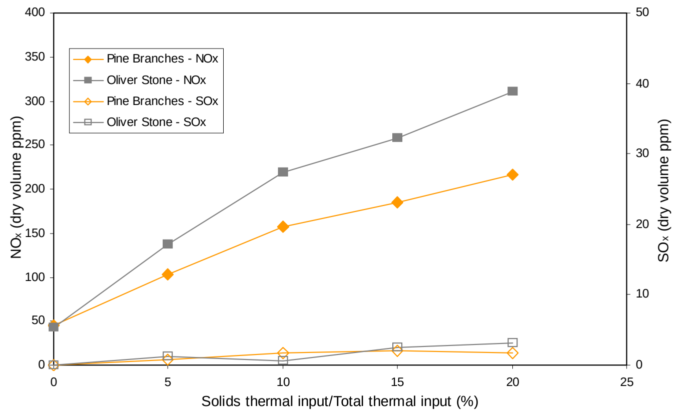
- Studies on flame stability and emissions
- Corrosion of steam tubes



- Co-combustion is possible without any technical problems
- NOx levels linearly dependent on the proportion of biomass and link to the nitrogen content of the fuel. Thermal NOx is less important

Solid biomass and natural gas co-firing





- Emissions increase with proportion of biomass in the overall fuel mix
- Burnout of the solid biomass needs to be optimised
- Very low sulphur content of these solid biomasses (pine branches and olive stones) results in low SOx emission

Comparison of NOx and CO_2 emission for a range of fuels

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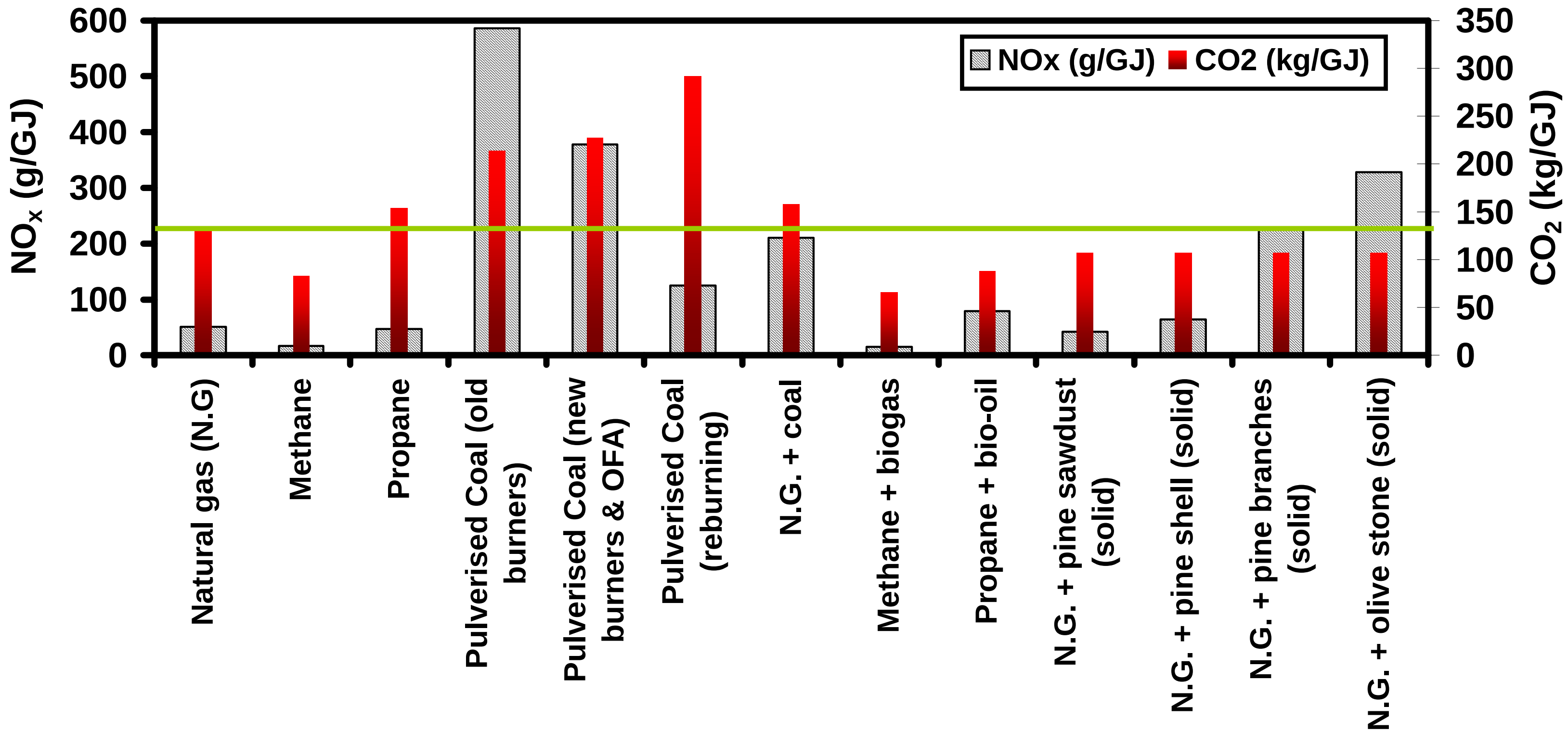
- Benefits in terms of CO_2 emission
- NOx emission varies with fuel type



CO_2 emission saving through co-firing

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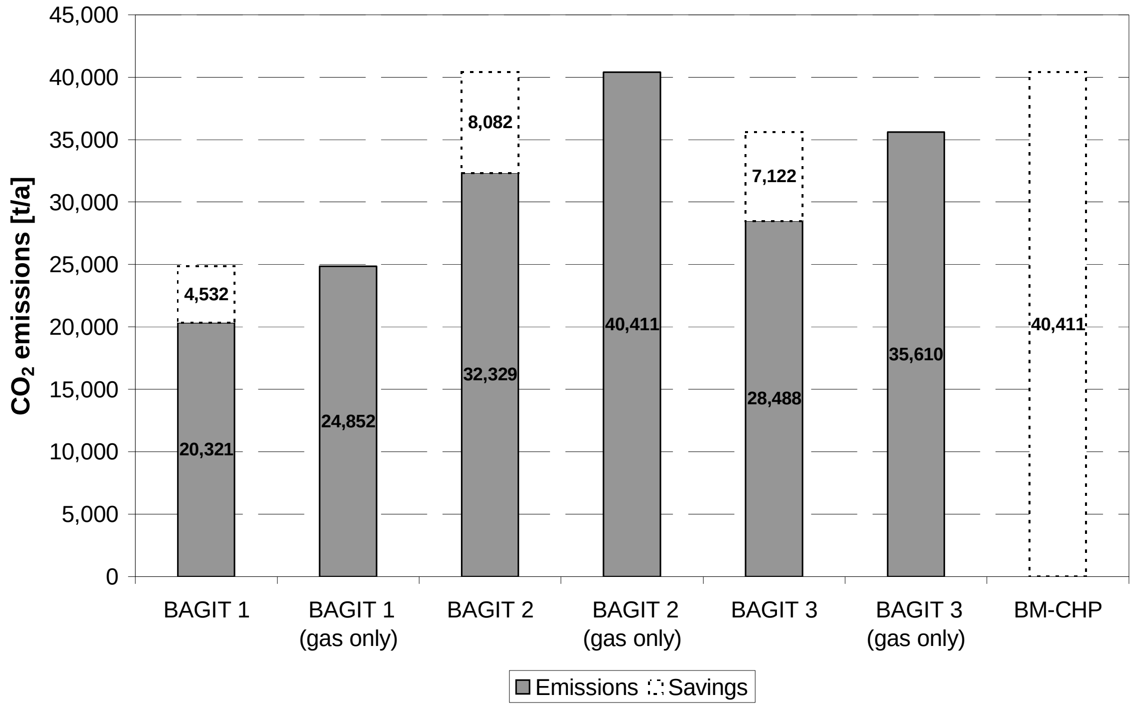
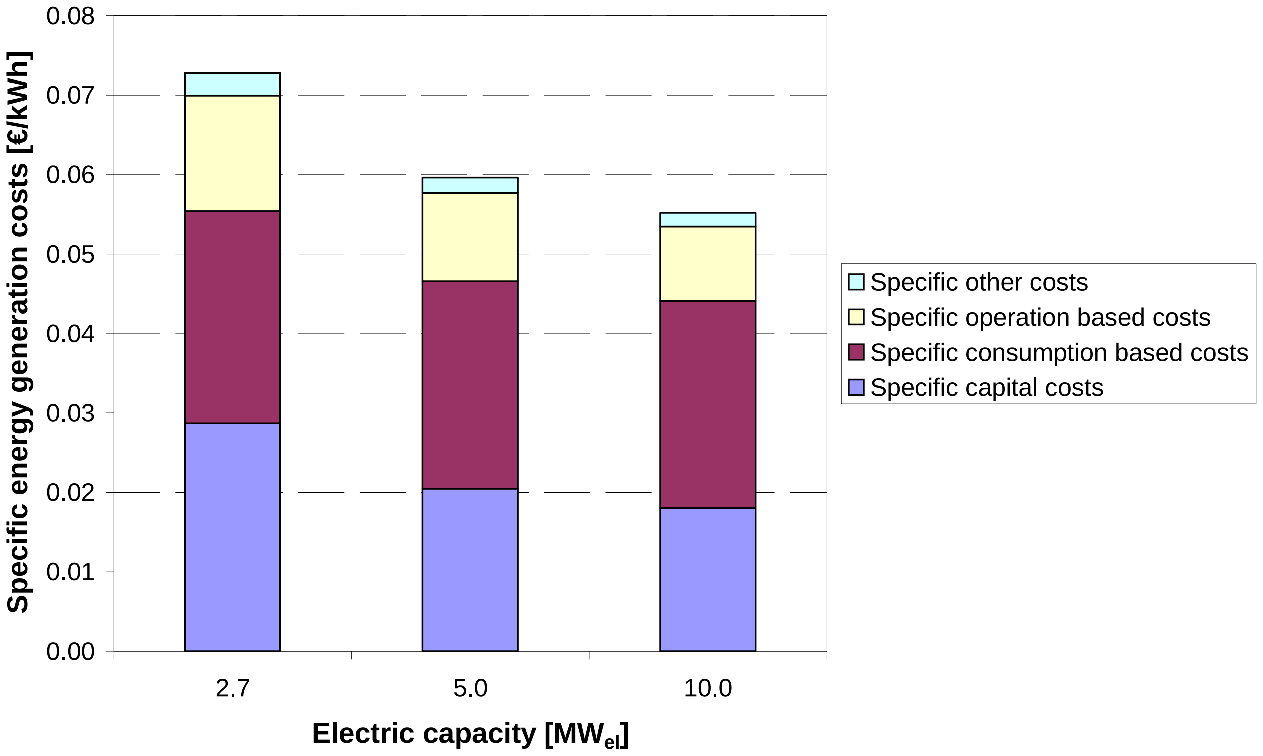
- Example of 5MWe plant compared to pure biomass CHP
- Three systems studied
  - -gasified biomass (BAGIT 1)
  - -Bio-oil (BAGIT 2)
  - -Solid biomass (BAGIT 3)



Costs of natural gas co-firing – impact of plant size

- Cost breakdown for natural gas/gasified biomass system (BAGIT 1)
- Capital cost sensitive to scale
- Operation cost (eg. manpower) decreases with plant size
- Consumption costs (eg. fuel cost) not very sensitive to plant size



Benefits of natural gas/biomass co-firing

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- Application to either new build or retro-fit applications and cover a range of sizes of plant, applicable for CHP systems and basic power/heat generation
    - 1 – 30 MW (total; gas provides >70% of the heat input)
- Good enabling technology for biomass systems
    - Provides a bridge between established gas technology and renewables
- Good for project developers
    - Based on reliable gas technology
    - Limits risk associated with biomass use
- Supports climate change objectives
    - Reduced CO_2 emission
    - Up to 25% of the output energy from biomass input (Renewables targets)
    - CHP systems for improved energy efficiency
- Benefits both the natural gas and biomass/biofuel industries

General conclusions

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- Co-combustion of natural gas and biomass can be undertaken successfully in a flexible manner
    - with a range of biomass types, solid, liquid and gaseous.
    - with a range of technologies
- Co-combustion of biomass with natural gas results in significant benefit in reducing fossil CO_2 emissions, compared to fossil fuel fired plant.

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