



Greening of the industrial symbiosis

Thomas Budde Christensen
Roskilde University

From strategies to activities - Bioenergy Promotion
International Conference • Latvia • Riga • 18 October 2013

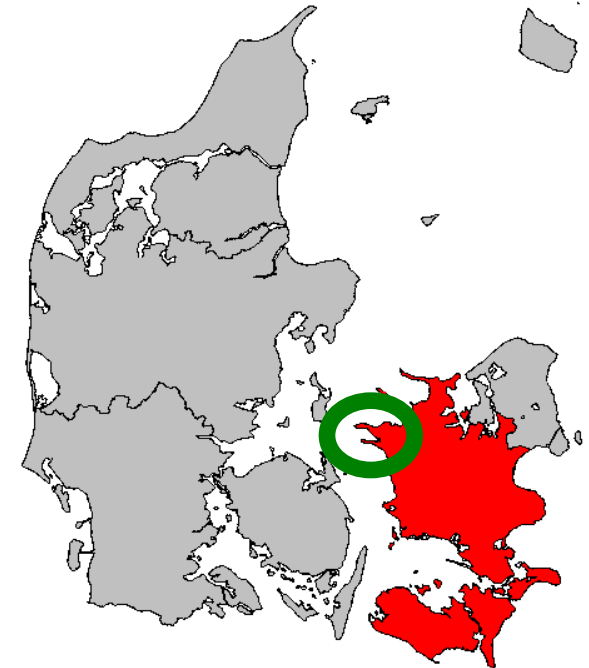


The Kalundborg Industrial Symbiosis

- By-product exchange between 9 companies and the municipality



- Exchange of energy, heat, water, by-products and waste
- 30 different symbiosis projects

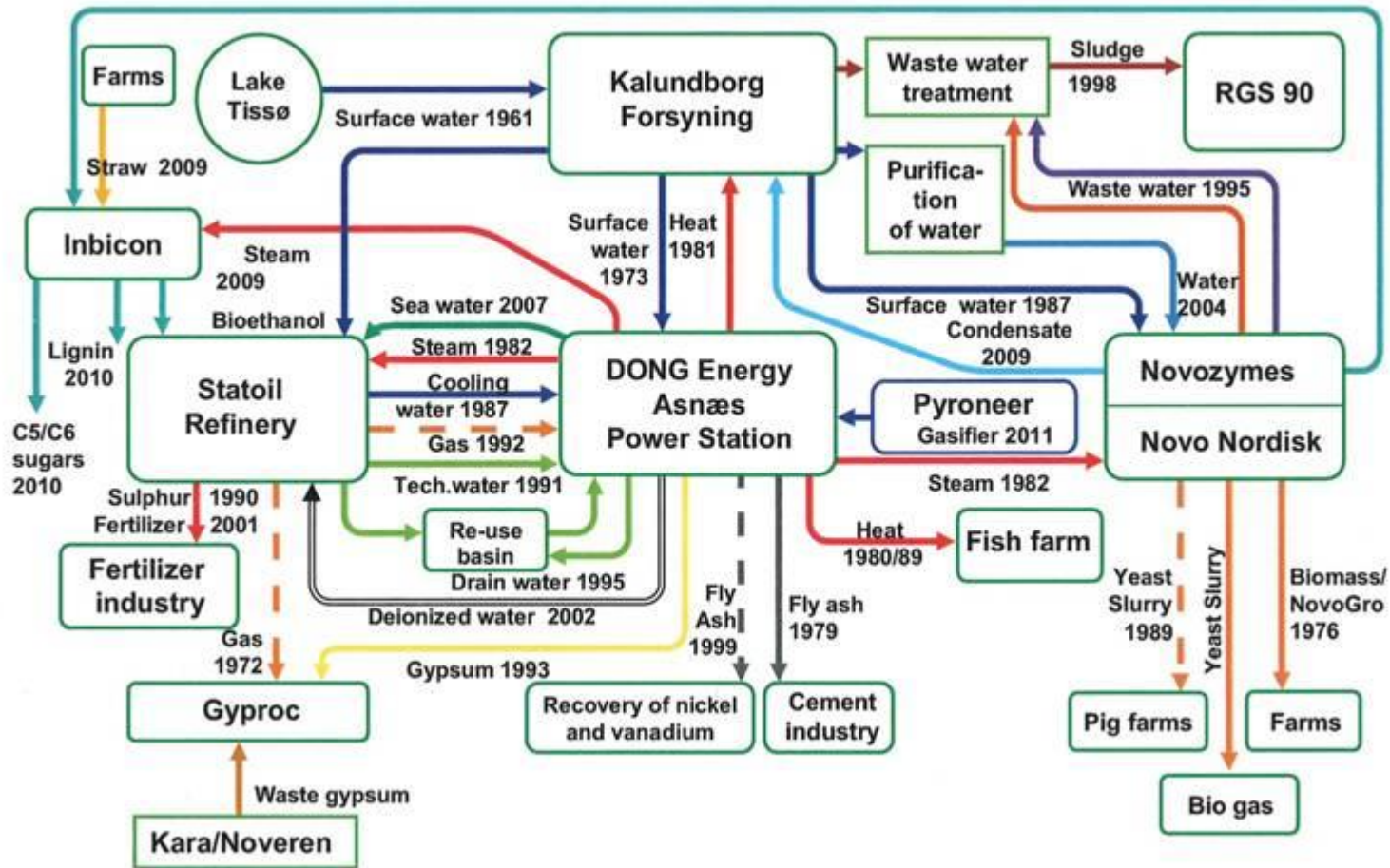


Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)





Kalundborg Industrial Symbiosis



Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

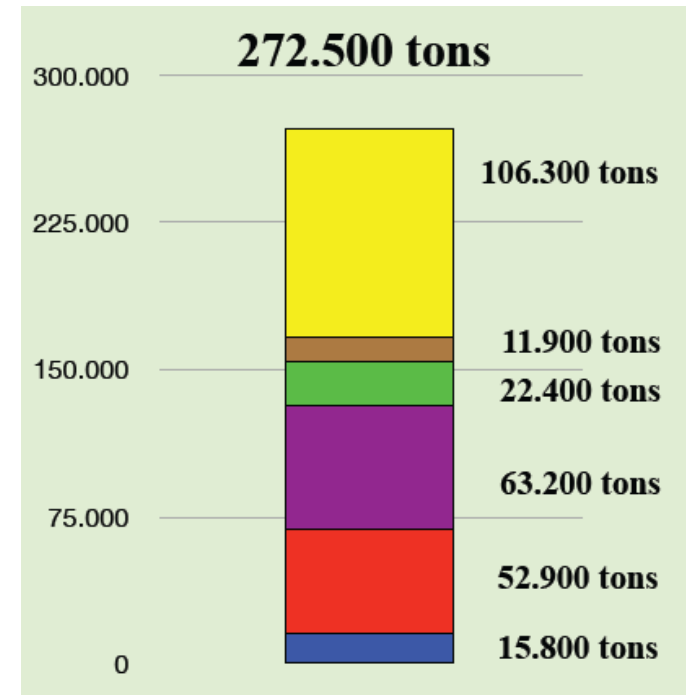




Economic effects

Direct effects in total: 410 million DKK

- **Waste Savings**
 - Estimated savings: 155 million DKK
 - Assumption: Normal cost 500 DKK per metric tons (range: 200 to 15,000 DKK per ton)
- **Greenhouse gas reduction:**
 - Estimated savings: 16 million DKK
 - Assumption: Current market price of 8 € per ton or 60 DKK per ton (price in 2008 of 30 € or 225 DKK per ton, or about 61 million DKK)
- **Energy savings:**
 - Estimated savings: 239 million DKK
 - Assumption: Current market price of energy (primarily heat) of 0.30 DKK / kWh



- [1] Steam to industry
- [2] District heating industry
- [3] Fuel substitution
- [4] District heating city
- [5] Input savings
- [6] Resource substitution



Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)



Baltic Sea Region
Programme 2007-2013

RUC Roskilde Universitet
Roskilde University



The anchor tenant: Asnæs Power station

Energy symbiosis in Kalundborg 2010

Coal: 5.718.000 MWh



El: 1.883.000 MWh

Losses & own consumption:
3.132.000 MWh

Heat/Steam: 703.000 MWh

Steam:
380.000 MWh

Statoil A/S Raf-
finaderiet
Novo Nordisk
Novozymes

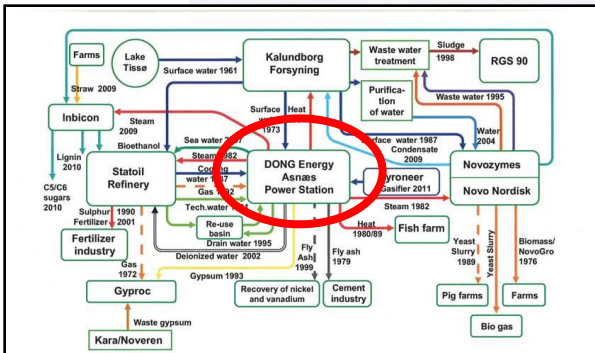
District heat:
41.000 MWh

Novo Nordisk
Novozymes
Kara/Noveren

District heat:
282.000 MWh

Kalundborg
Varmeforsyning

If straw: 1.4 mio tons



Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)





Kalundborg demo-region: Biomass resources, use and potentials

- Municipalities
 - Holbæk - 27.093 inhabitants
 - Kalundborg - 48.294 inhabitants
 - Odsherred - 32.452 inhabitants
- Biomass resources used:
 - Biogas: 20.700 MWh
 - Straw: 57.700 MWh
 - Wood: 61.000 MWh
- Biomass potentials:
 - Biogas: 380.000 MWh
 - Straw: 671.900 MWh
 - Wood: 98.900 MWh



Kalundborg demo-område:
Biomasseressourcer i Holbæk, Kalundborg og Odsherred
Opdateret maj 2013



Part-financed by
the European Union (European Regional
Development Fund and European
Neighbourhood and Partnership
Instrument)



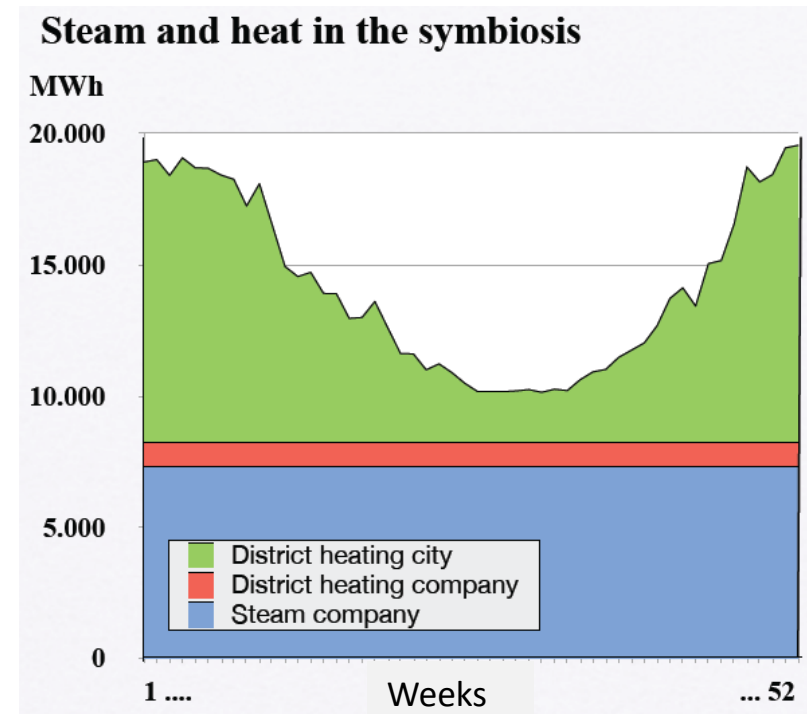

Baltic Sea Region
Programme 2007-2013

RUC **Roskilde Universitet**
Roskilde University



Goal and principles: Biomass in the symbiosis

1. Demand-side planning
2. Dimensioning after the demand for heat and steam
3. Planning for highest energy efficiency
4. Flexibility through the technology choices



Part-financed by
the European Union (European Regional
Development Fund and European
Neighbourhood and Partnership
Instrument)

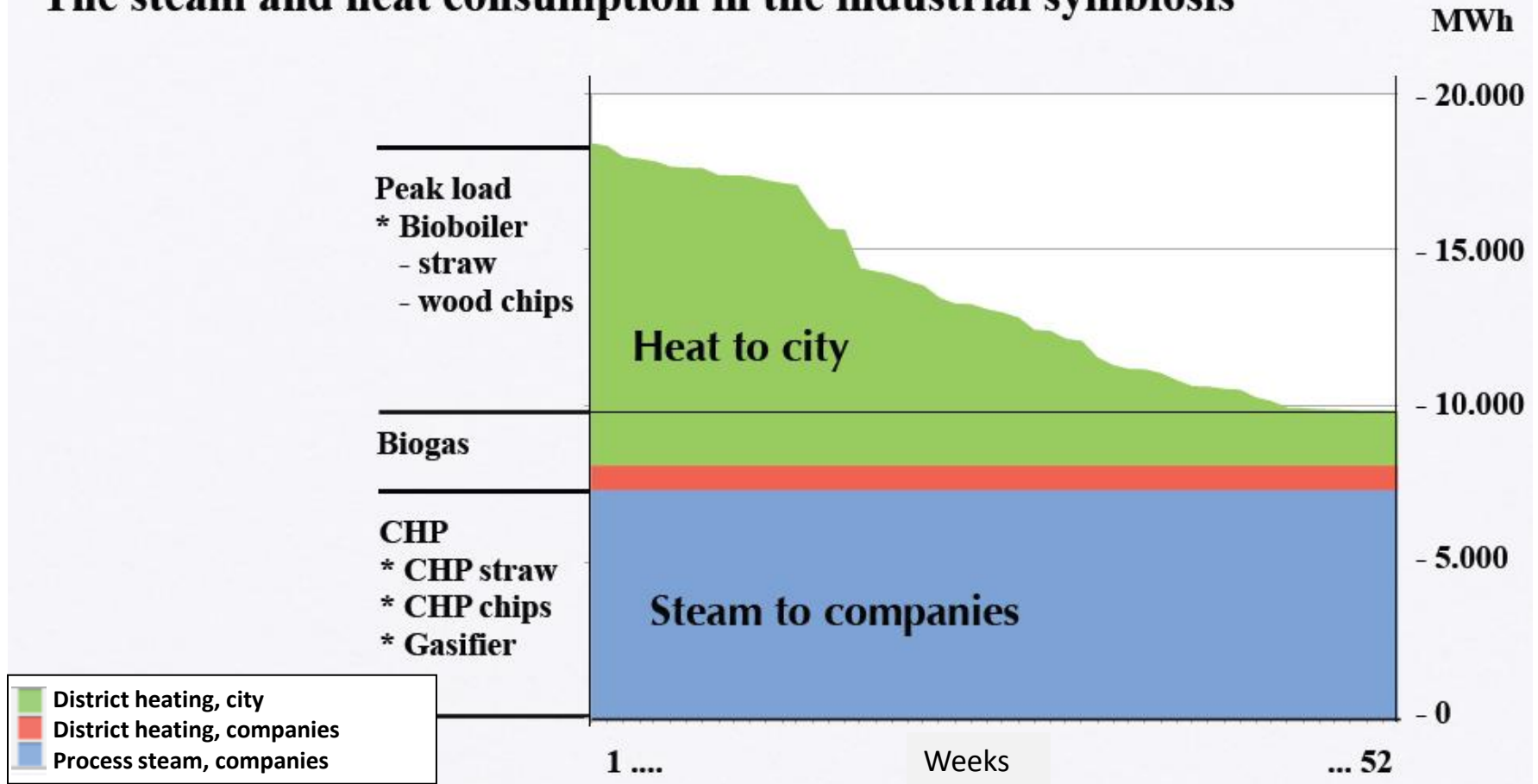




Renewable energy in demo-region

Designing of biomass energy system

The steam and heat consumption in the industrial symbiosis



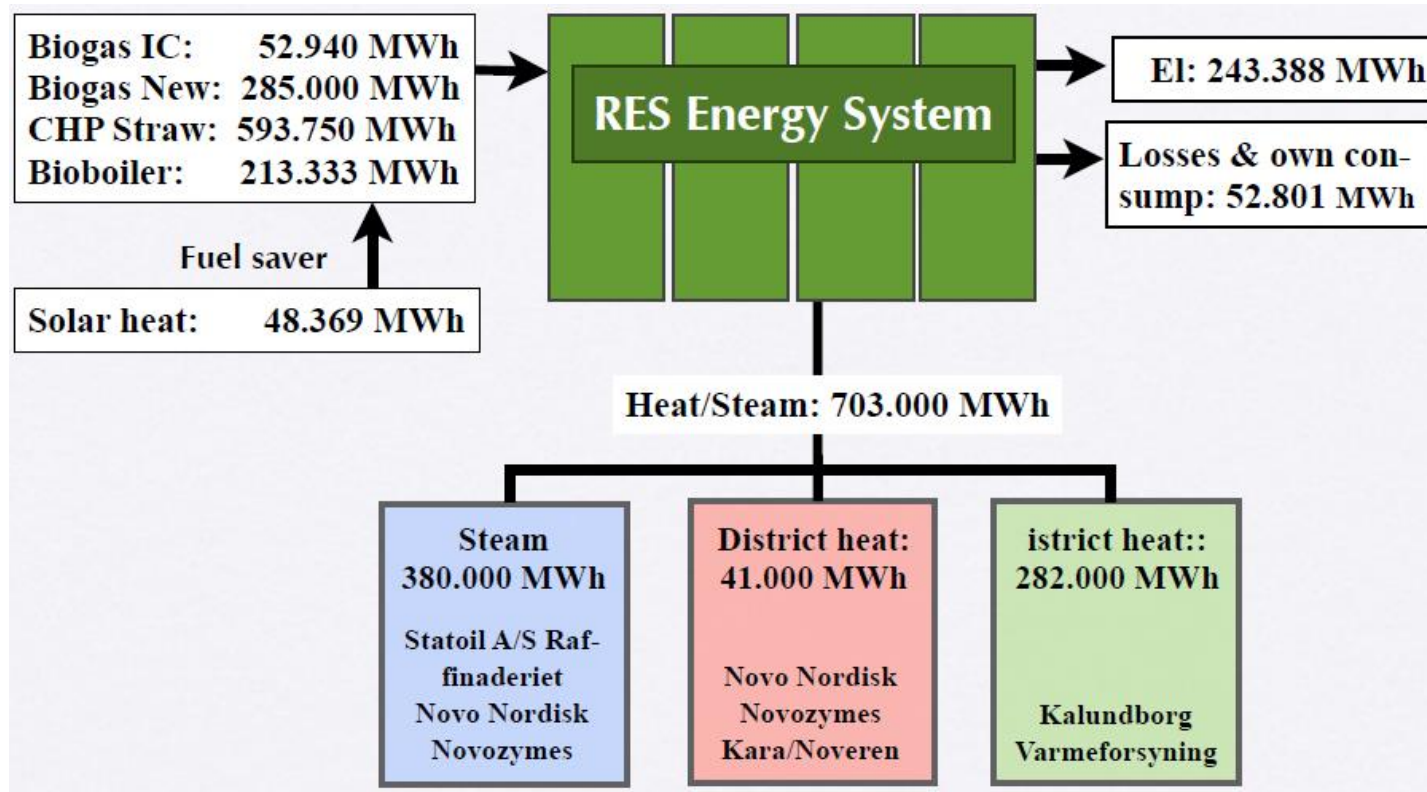
Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)



RUC Roskilde Universitet
Roskilde University



The system design



Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

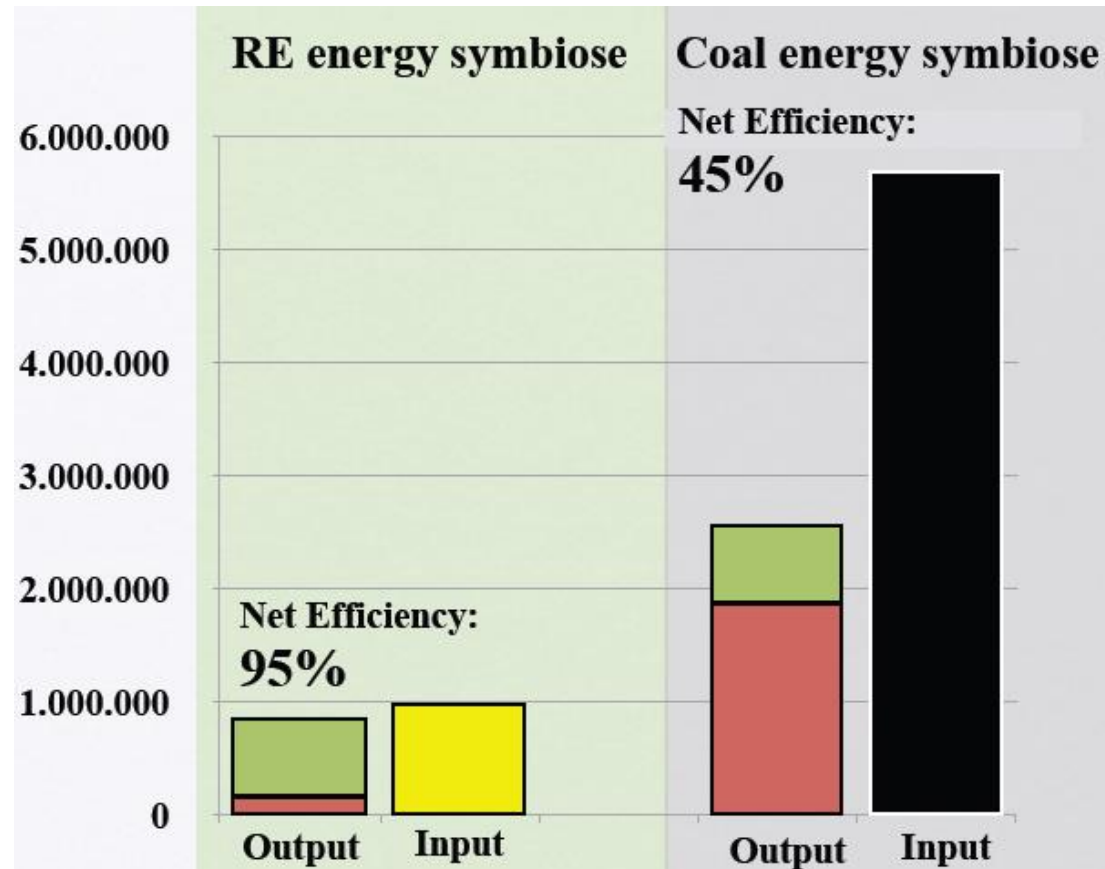
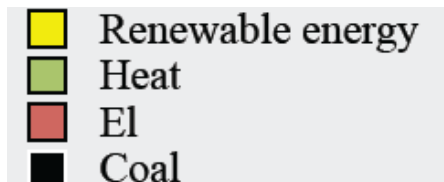




Greening of the industrial symbiosis

The new energy system

- Substitution of coal with renewable energy sources (biomass)
- Increased net efficiency
- Reduced electricity production (national policy on increased wind power)



Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)





Thank You!
Thomas Budde Christensen
tbc@ruc.dk



Part-financed by
the European Union (European Regional
Development Fund and European
Neighbourhood and Partnership
Instrument)



RUC Roskilde Universitet
Roskilde University