

## **Gasification of urban biomass residues**

– Possibilities in Hamburg/Germany–

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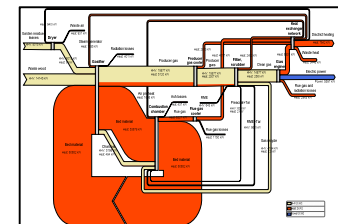
### Project Partners



**STADTREINIGUNG HAMBURG**



- **Background**
- **Biomass residues for gasification**
- **Gasification tests**
- **Process analysis and results**
- **Summary and outlook**



# Background

- Increasing interest in utilisation of biogenic residues for energy production



Feasibility study:

**Gasification of urban biomass residues in Hamburg**

# Biomass residues for gasification

## Waste Wood (WW)



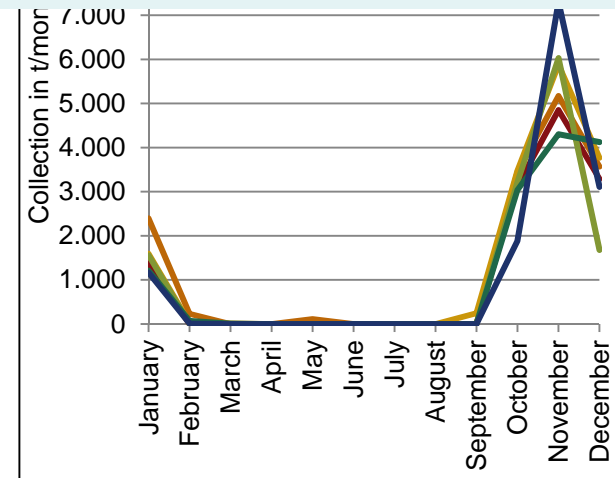
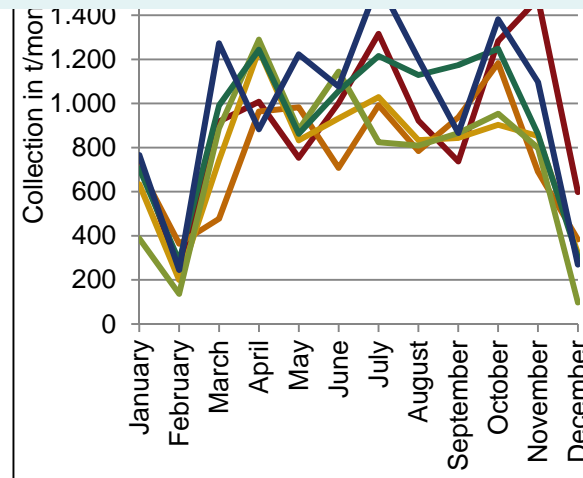
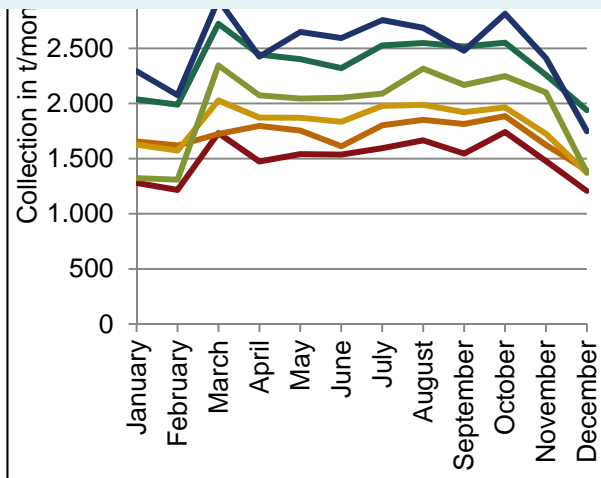
## Garden residues (GR)



## Leaves (L)

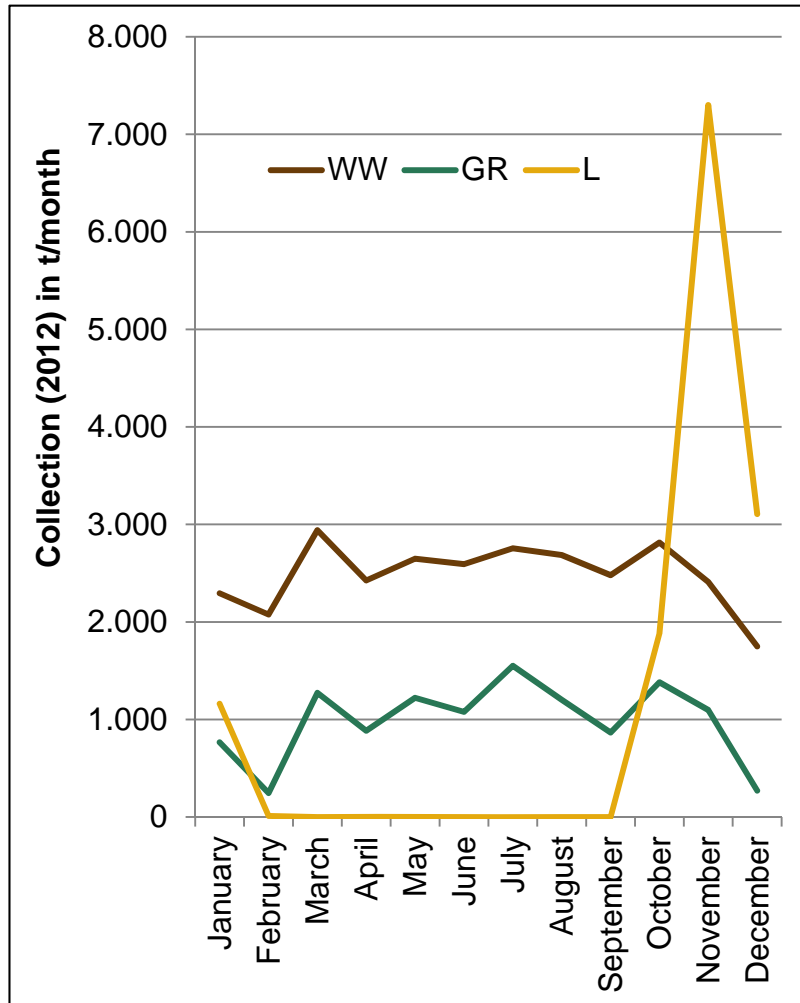


**All together about 40.000 t/a of biogenic residues available, but with very different characteristics in fuel properties and availability**





# Biomass residues for gasification



Analysis of different options:

**WW-GR-L:** waste wood, garden residues and leaves together

**WW:** only waste wood

**GR-L:** only garden residues and leaves

Estimated fuel production costs		
WW-GR-L	WW	GR-L
41 €/t	43 €/t	62 €/t

# Gasification tests

- Fuel samples for gasification tests



Waste wood

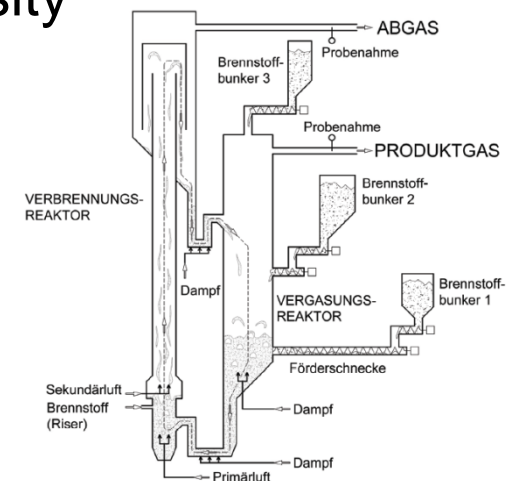


Garden residues

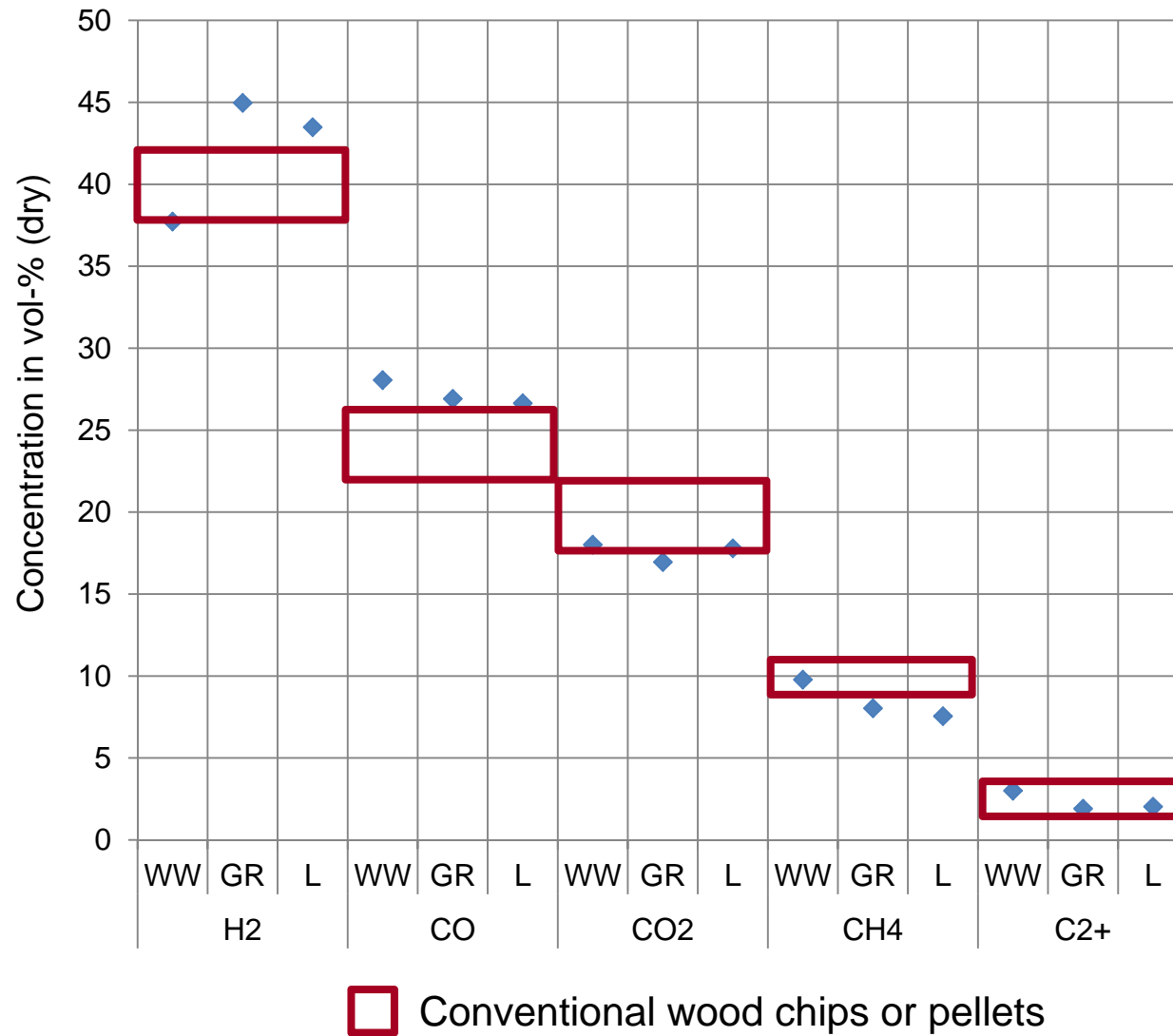


Leaves

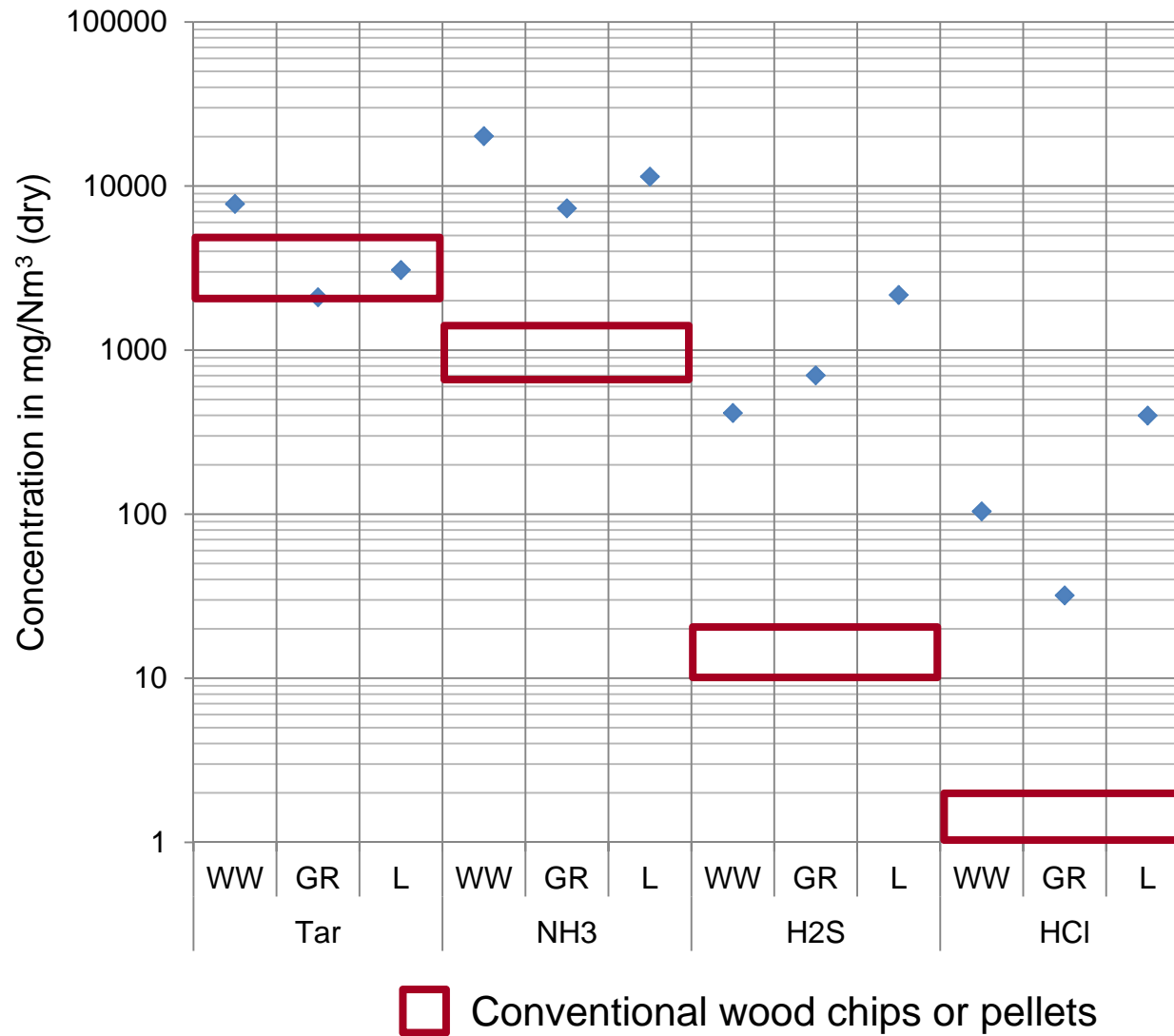
- Samples were gasified in a 100 kW steam blown dual fluidised bed pilot plant at Vienna University of Technology.
- Gasification behaviour was found to be very similar to conventional wood pellets



# Gasification tests: Results



# Gasification tests: Results





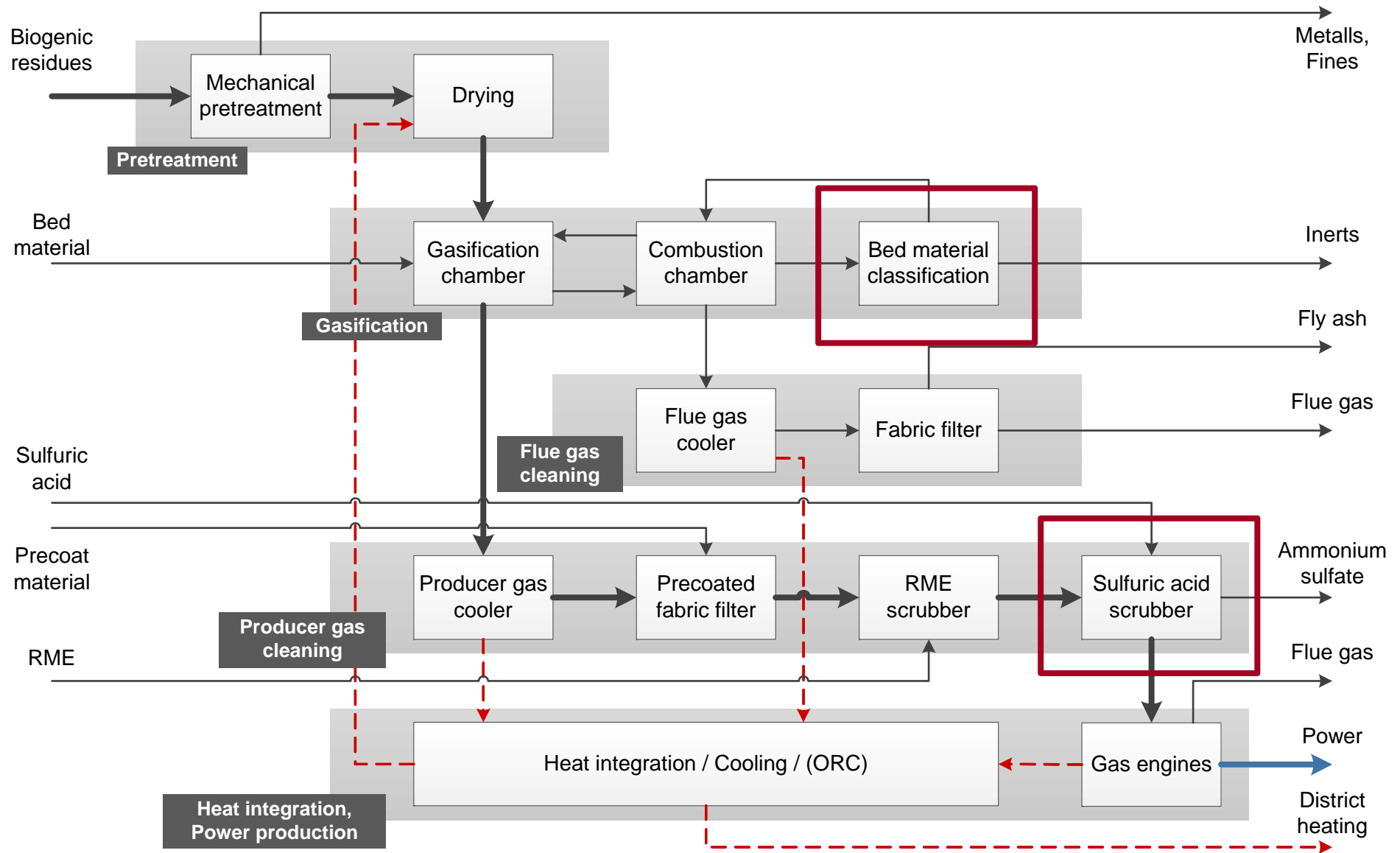
# Process concepts



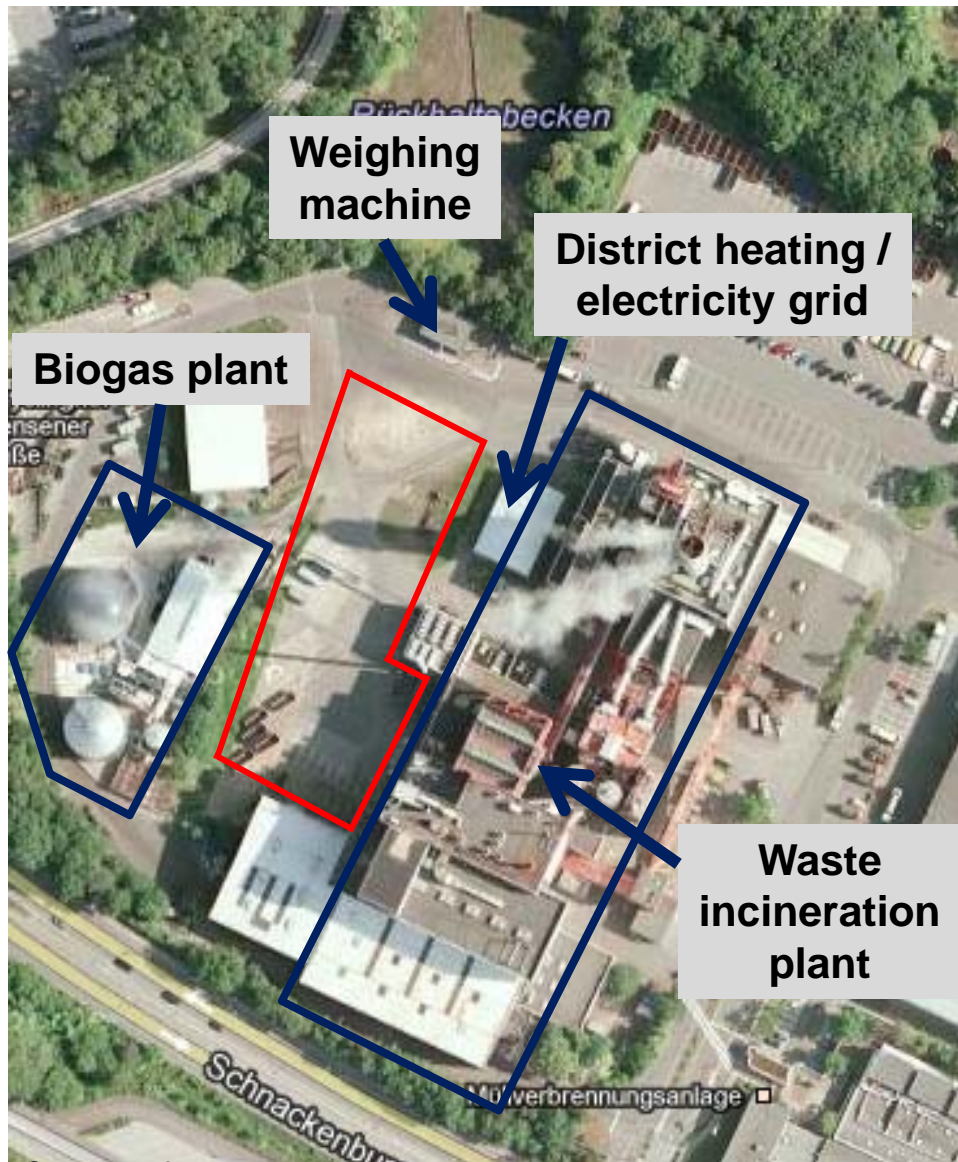
- Sulfuric acid scrubber for removal of ammonia to reduce NO<sub>x</sub> Emissions
- Bed material is taken from the combustion chamber and classified to remove inert material (Sand) from the process
- An organic-rankine-cycle (ORC) is considered to evaluate the possibility of electricity generation instead of district heating

	WW-GR-L		WW	GR-L
Description	Basic	Basic + ORC	-	-
- Waste wood	X	X	X	
- Garden residues	X	X		X
- Leaves	X	X		X
Pre-treatment	Mechanical, drying		Mechanical	Mechanical, drying
Gasification	Allothermal dual fluidised bed gasification, Classification, recovery of bed material			
Gas cleaning	Preacoated fabric filter, RME scrubber, Sulfuric acid scrubber			
Electricity generation	Gas engines	Gas engines, ORC	Gas engines	
Fuel input in MW	20,1		12,9	7,1
Main product / by-product	Electricity, district heating	Electricity	Electricity, district heating	

# Process overview



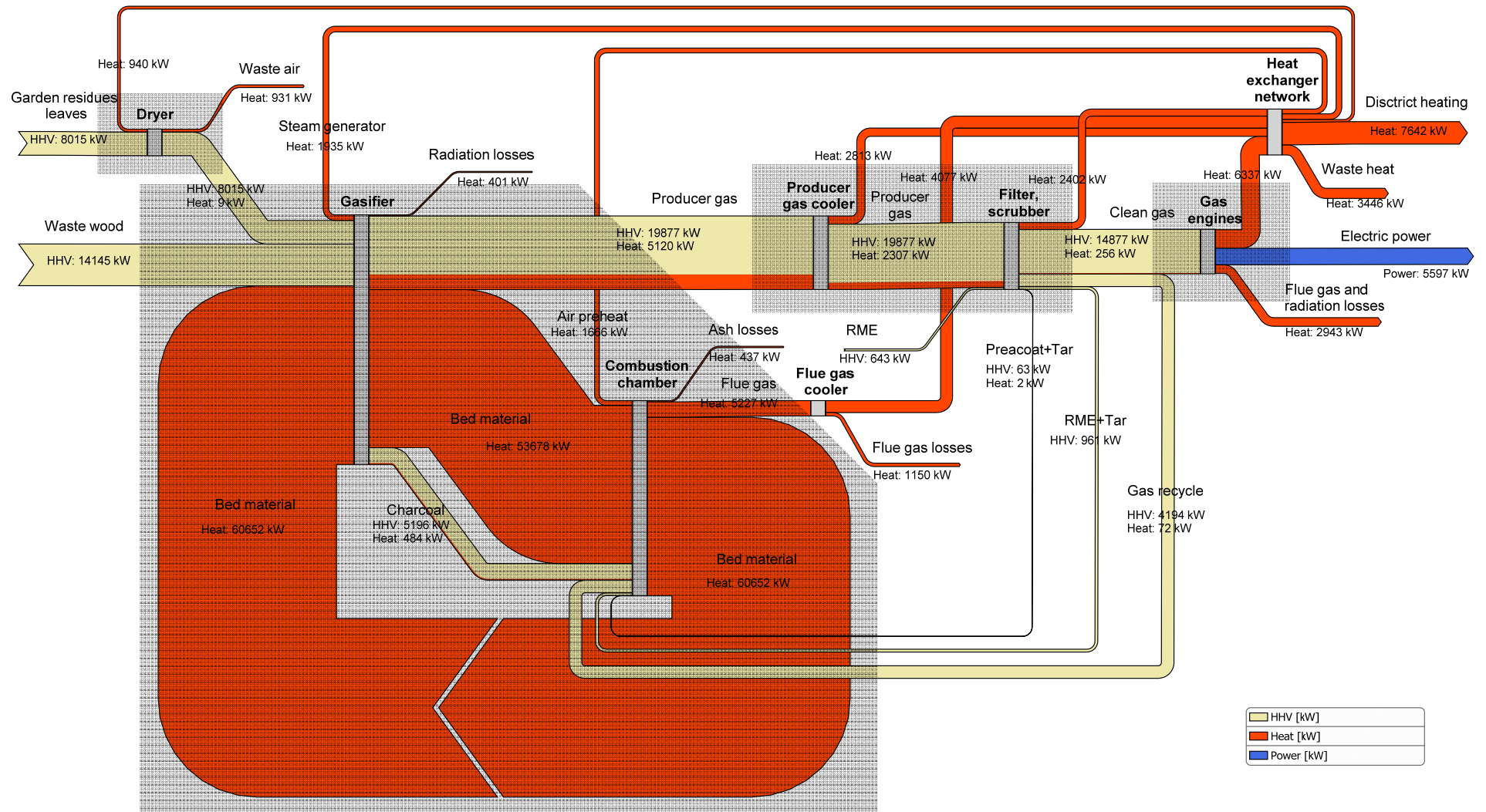
# Possible site in Hamburg



Source: google maps

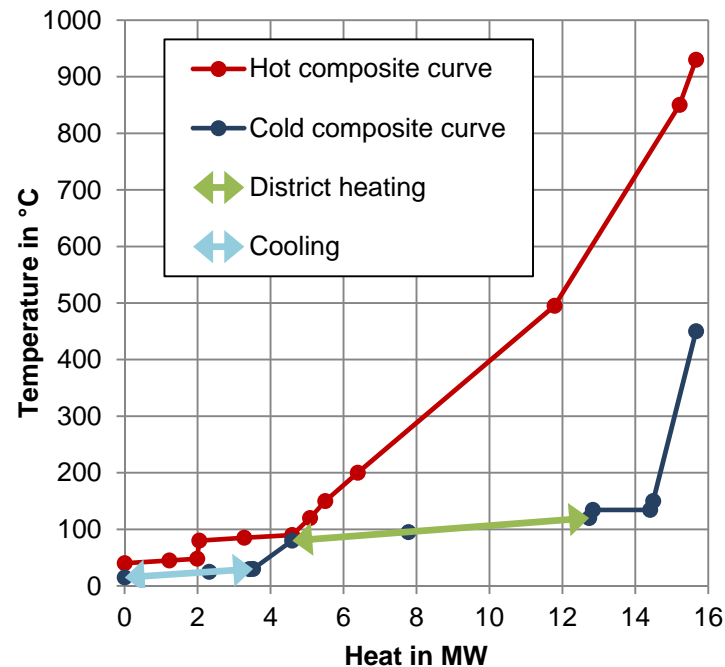
- Possible site at waste incineration plant in Hamburg-Stellingen
- Existing waste treatment location with related infrastructure (Biogas plant, Weighing machine, service facilities)
- Connection to the district heating system with high base load
- Direct connection to the highway

# Results: Energy flow diagramm

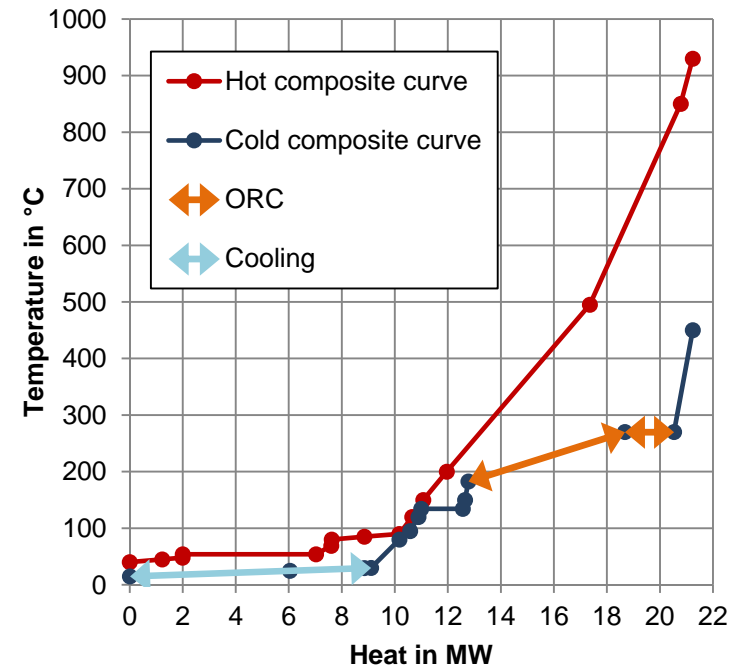


# Results: Heat integration

### Without ORC

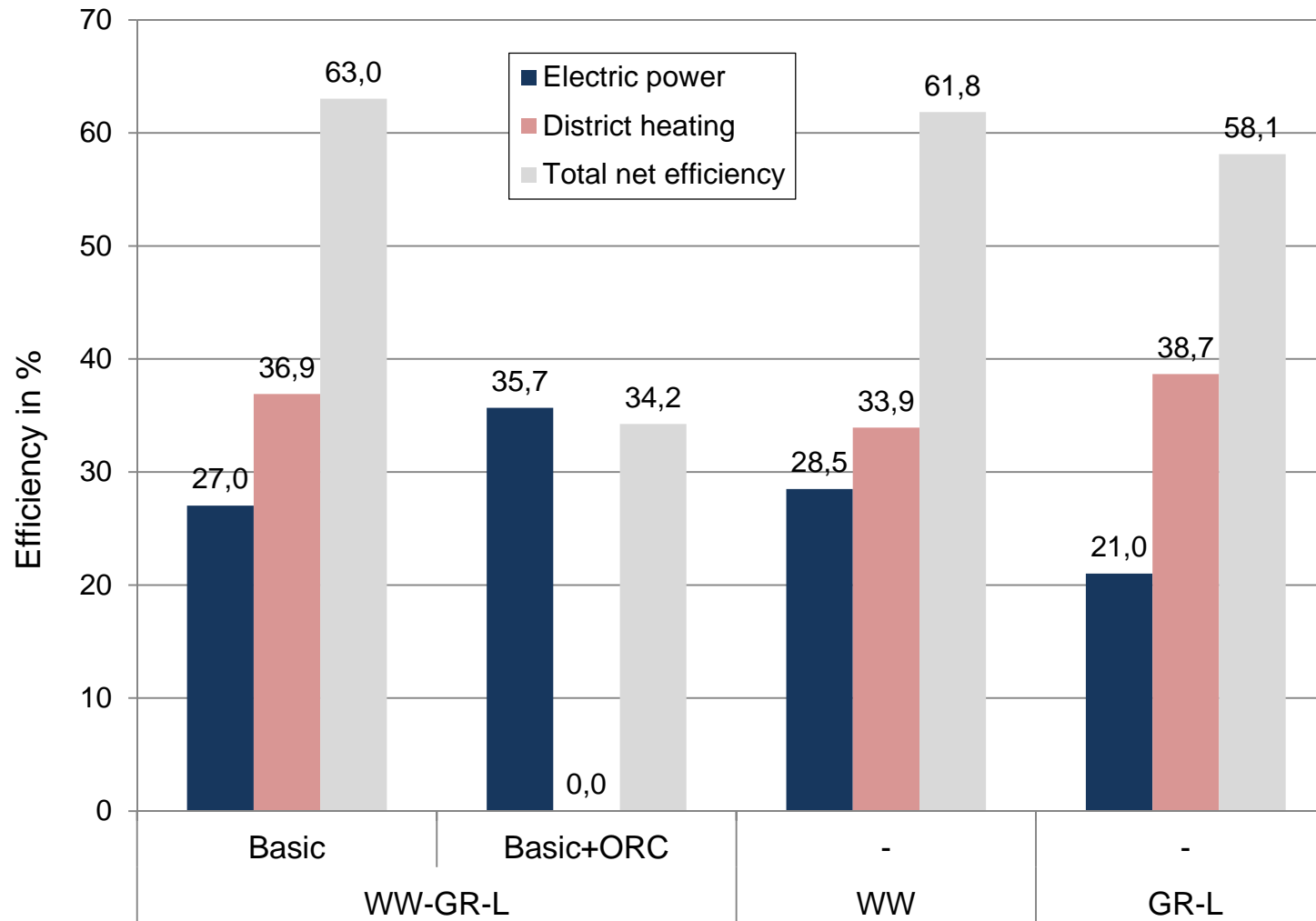


### With ORC



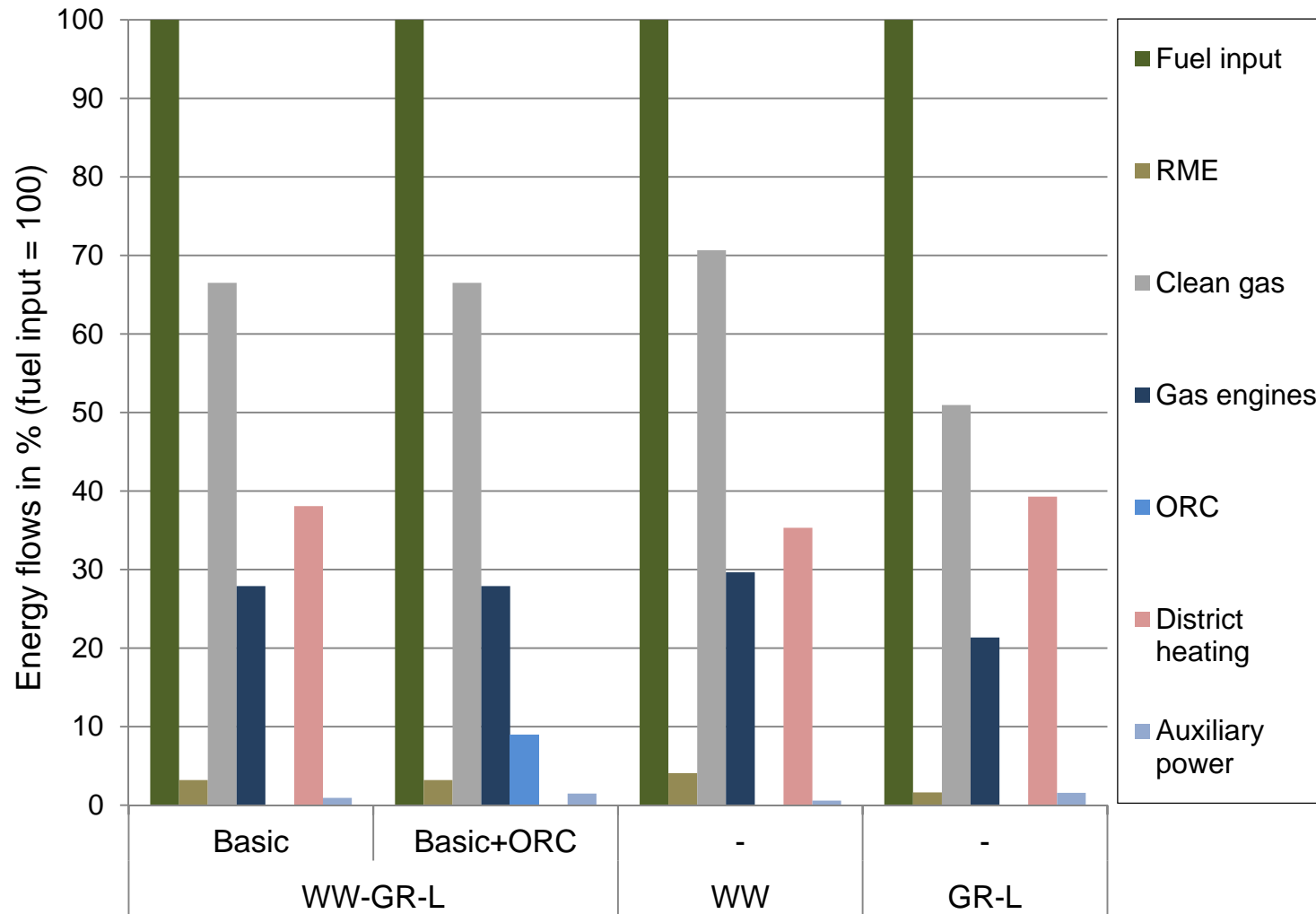
- Better utilisation of the high temperature with ORC but significantly higher cooling demand and increased process complexity
- ORC may be operated in backpressure mode for CHP

# Results: Efficiency

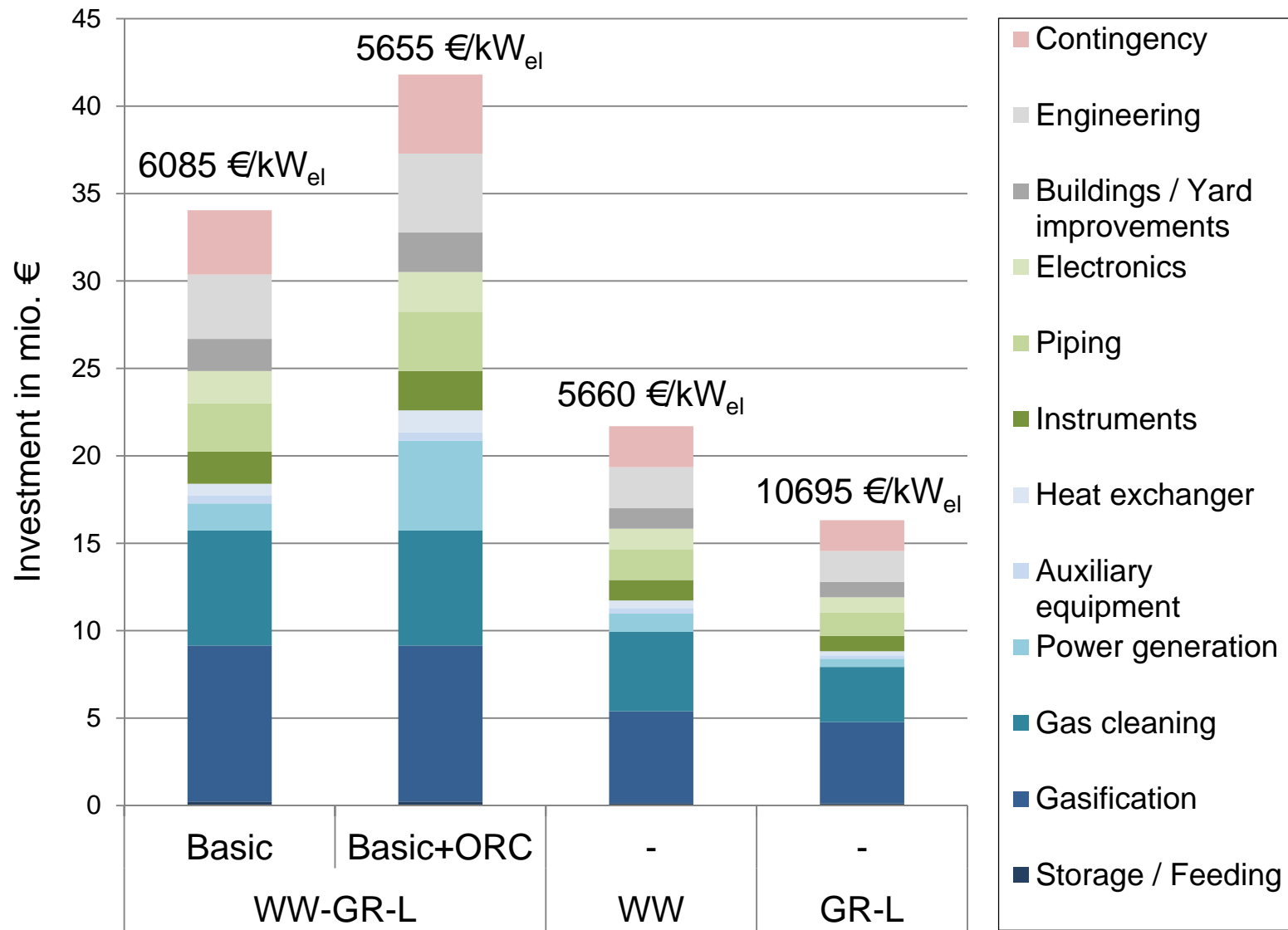




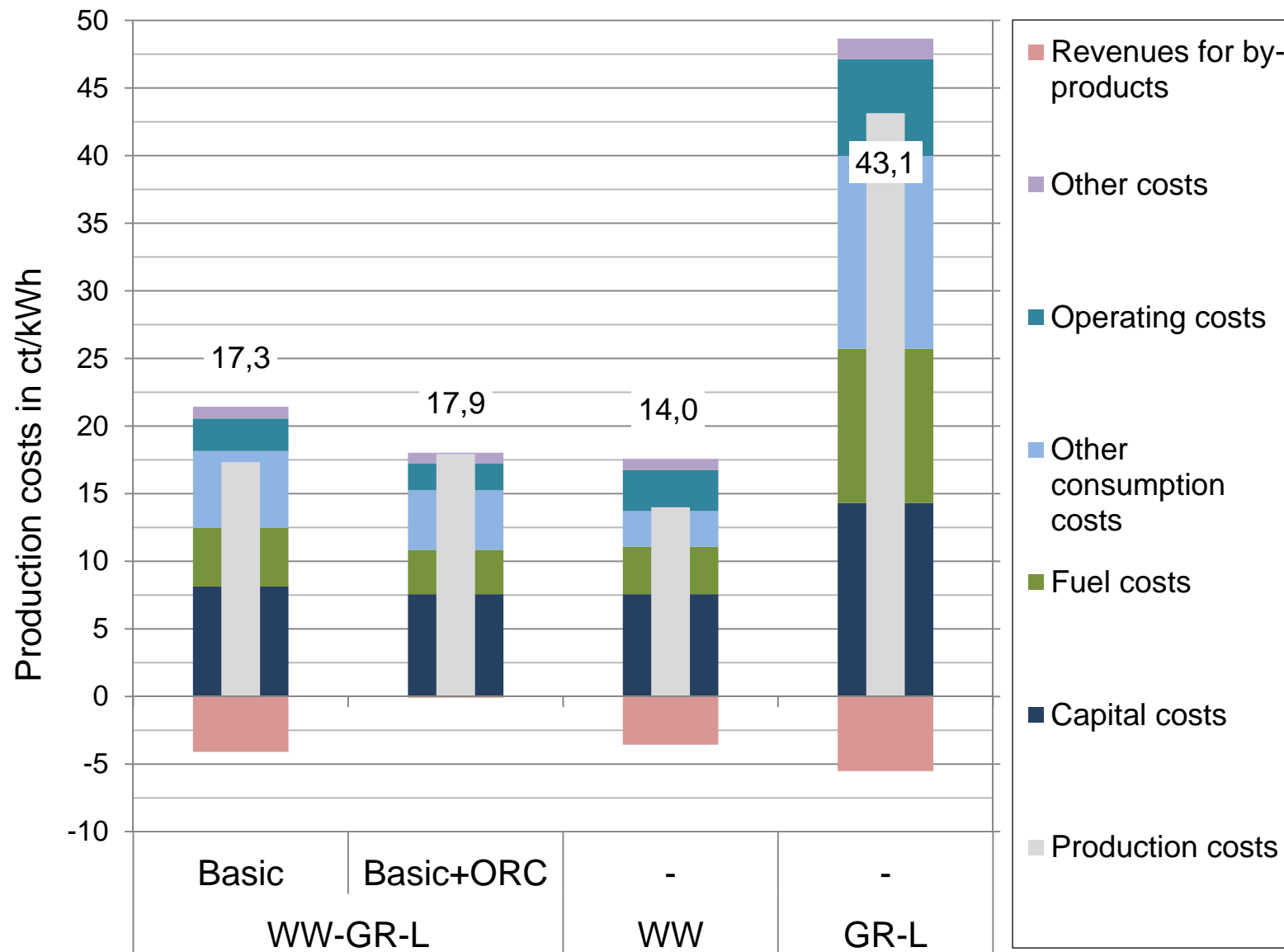
# Results: Specific energy flows



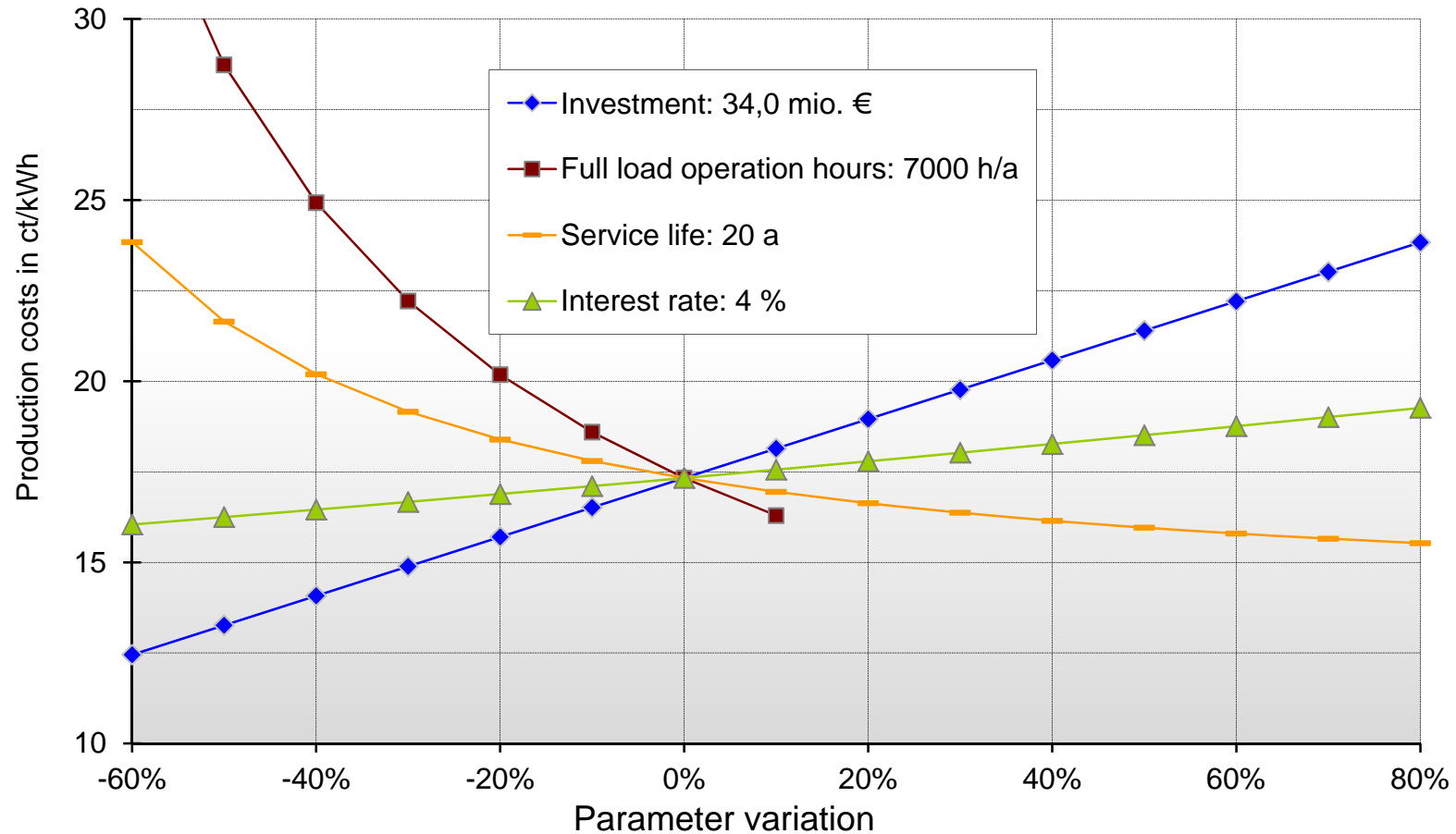
# Results: Investment costs



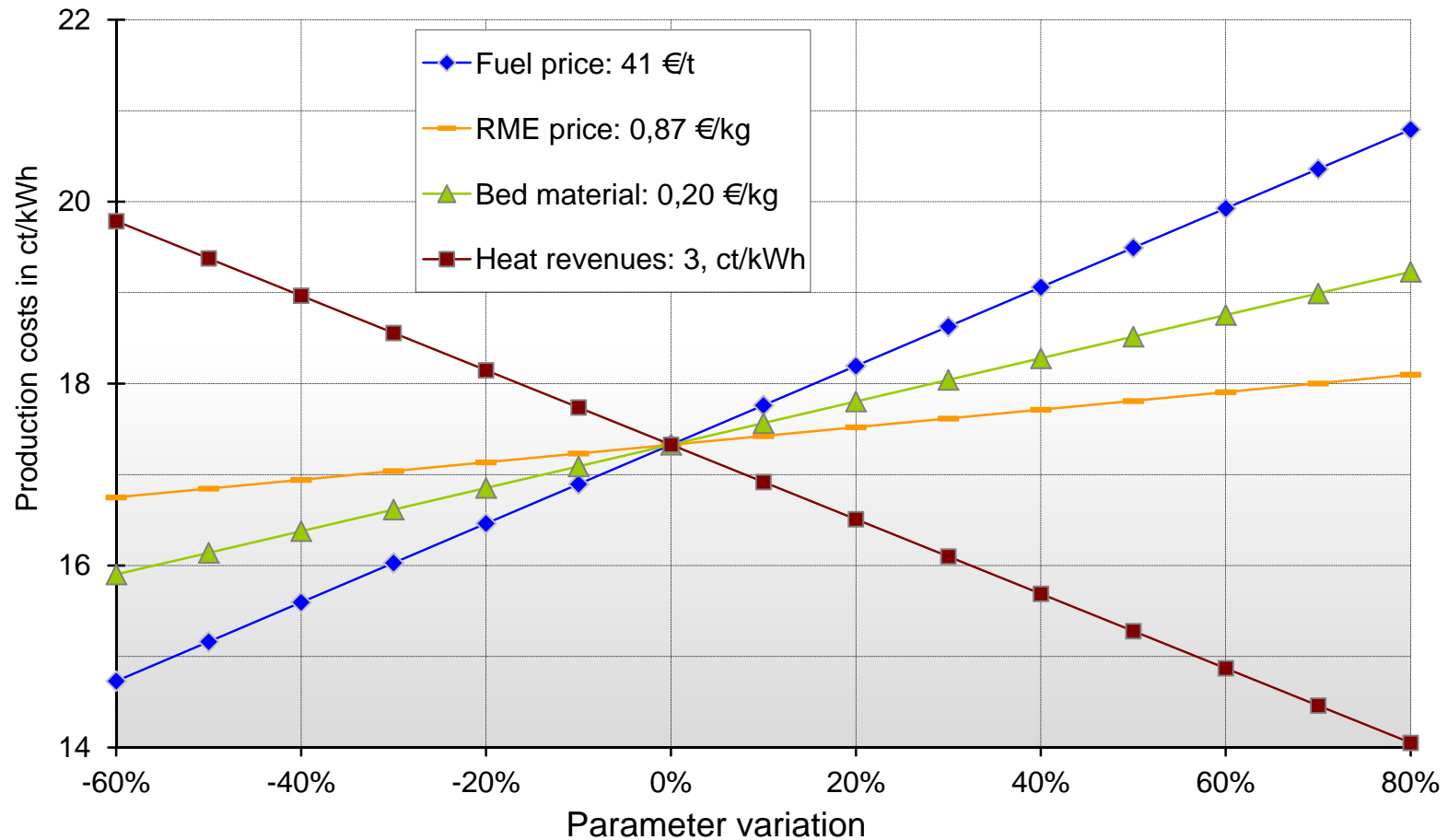
# Results: Production costs



# Results: Sensitivity analysis capital costs



# Results: Sensitivity analysis for WW-GR-L



- Up to 40 000 t/a of biogenic residues equal to approx. 20 MW fuel input are available for gasification in Hamburg
- Gasification tests indicate similar characteristics to wood chips or pellets, however fuel properties are still challenging, especially:
  - Large fractions of inert material have to be removed from the gasification process, recovery of bed material is necessary
  - Higher fractions of contaminants ( $\text{NH}_3$ ,  $\text{H}_2\text{S}$ ,  $\text{HCl}$ ) have to be treated, sulfuric acid scrubber for ammonia removal to reduce  $\text{NO}_x$  emissions
- Gasification of leaves and garden residues seems to be unfavourable from an economic point of view mainly caused by high pretreatment and operation costs as well as lower process efficiency
- The management of inert material (sand) has to be investigated further to get first hand data about the behaviour and fate of these materials in the process
- Evaluation of further options for example sand as bed material to reduce costs



## **Gasification of urban biomass residues**

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