INOGATE

PROGRAMME FUNDED BY THE EU

Roadmap on the Development of District Heating in Azerbaijan until 2020

INOGATE Technical Secretariat & Integrated Programme

Klaus Fafner

BUILDING PARTNERSHIPS FOR ENERGY SECURITY

The fundamental idea of District Energy

District energy =
district heating and district cooling

The main idea of using District Heating is to organize the heat production in a way that is more efficient than individual production, and to exploit surplus heat.

District energy is a *precondition* for cost effective use of renewable energy in large scale.

The fundamental idea of District Energy

District energy =
district heating and district cooling

District energy is the infrastructure needed to distribute hot water from heat production plants or cooling from cooling plants.

- Large investments
- Long technical lifetimes
- It requires planning!

The fundamental idea of District Energy

District energy =
district heating and district cooling

District heating in cold, densely populated areas.

District cooling in most cities.

Profitability depends on:

- Heating and cooling density
- Environmental requirements
- National energy policy, climate commitment, security of supply

Primary Resource Factor (PRF)

Fuel	Primary Resource Factor
Lignite Coal	1.30
Hard Coal	1.20
Oil	1.10
Natural Gas	1.10
Excess heat e.g. from industrial proc.	0.05
Renewables (e.g. Wood)	0.10
Waste as Fuel, Landfill Gas	0.00
Free Cooling	0.00
Electrical Power, European Average	2.5

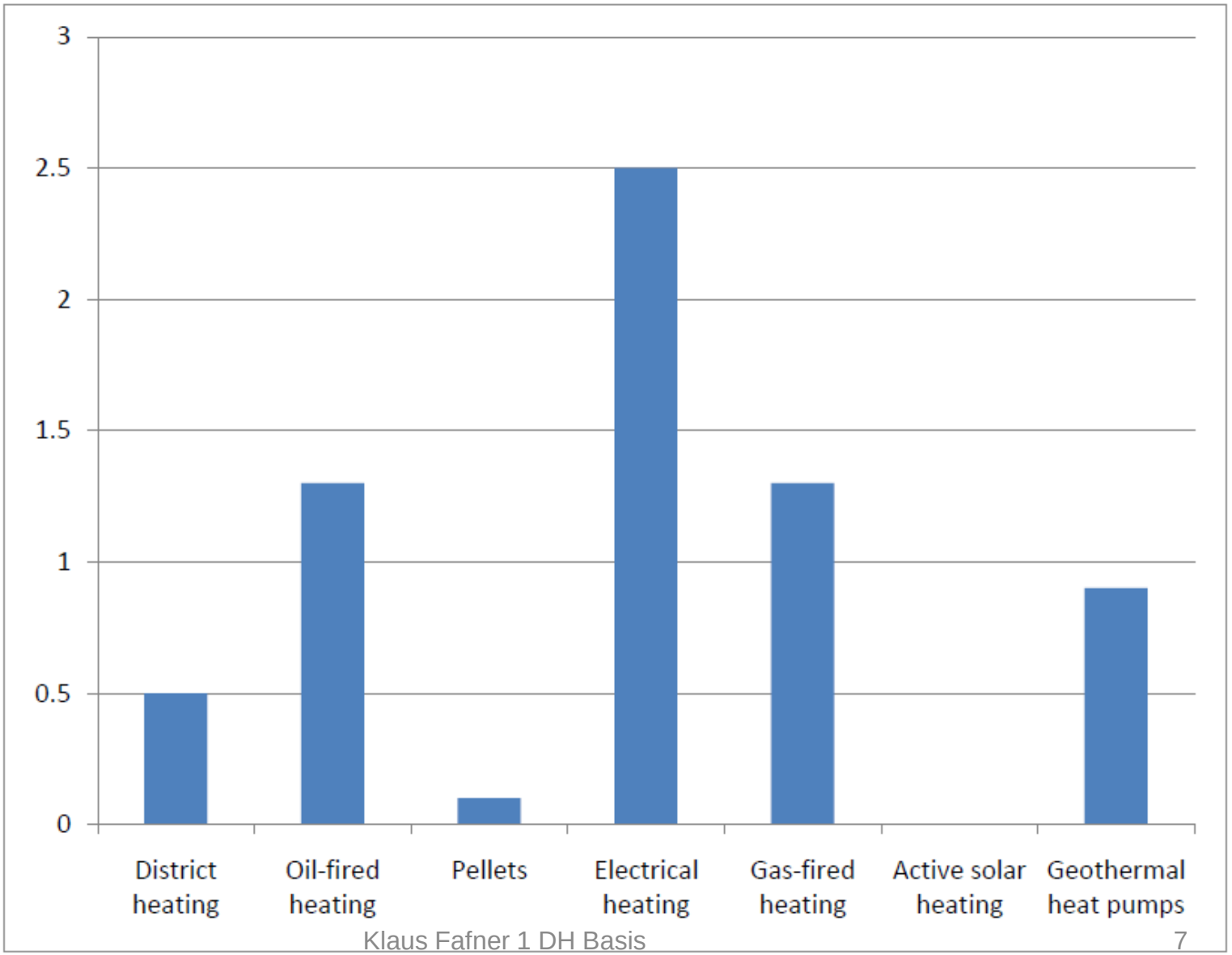
PRF for Heat Supply Systems
Calculation

PR Calculation		H_i	E_i	F_i	f_i	f_E	$P_{h,i}$	
District Heating System		Heat GWh	Electricity GWh	Energy GWh	PRF fuels	PRF power	PR calc	PRF System
WtE Plant	Waste	10	2	15	0	2,5	-5	
CHP 1	Hard coal	50	45	105	1,2	2,5	14	
CHP 2	Gas	35	20	60	1,1	2,5	16	
HOB	Gas	5		6	1,1		7	
Sum production	H	100	67				31	
Heat losses		-15						
		C					P_H	fH
Result		85					31	0,37

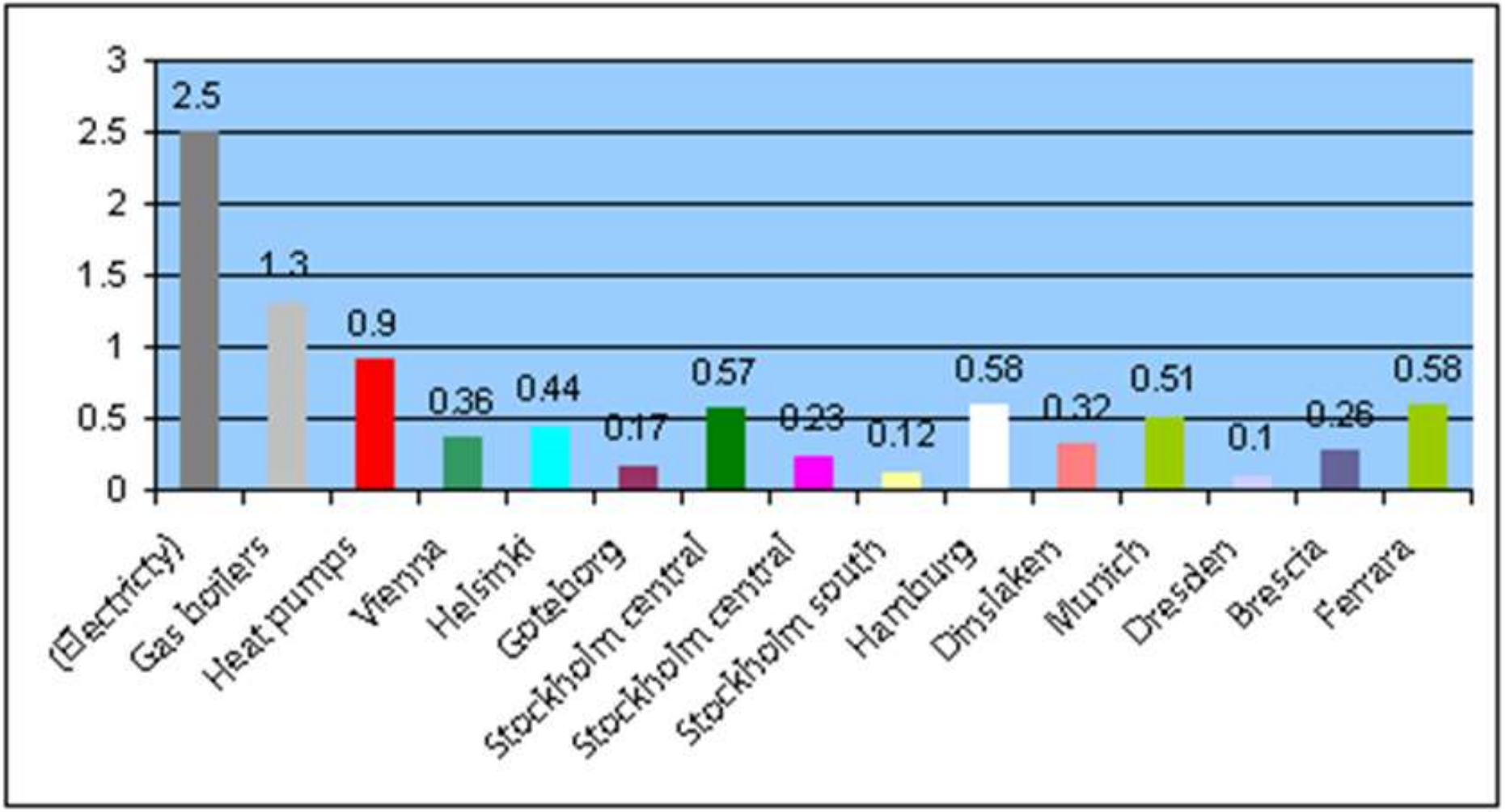
$$P_{h,i} = f_i \times F_i - f_E \times E_i$$

$$fH = \frac{P_H}{C}$$

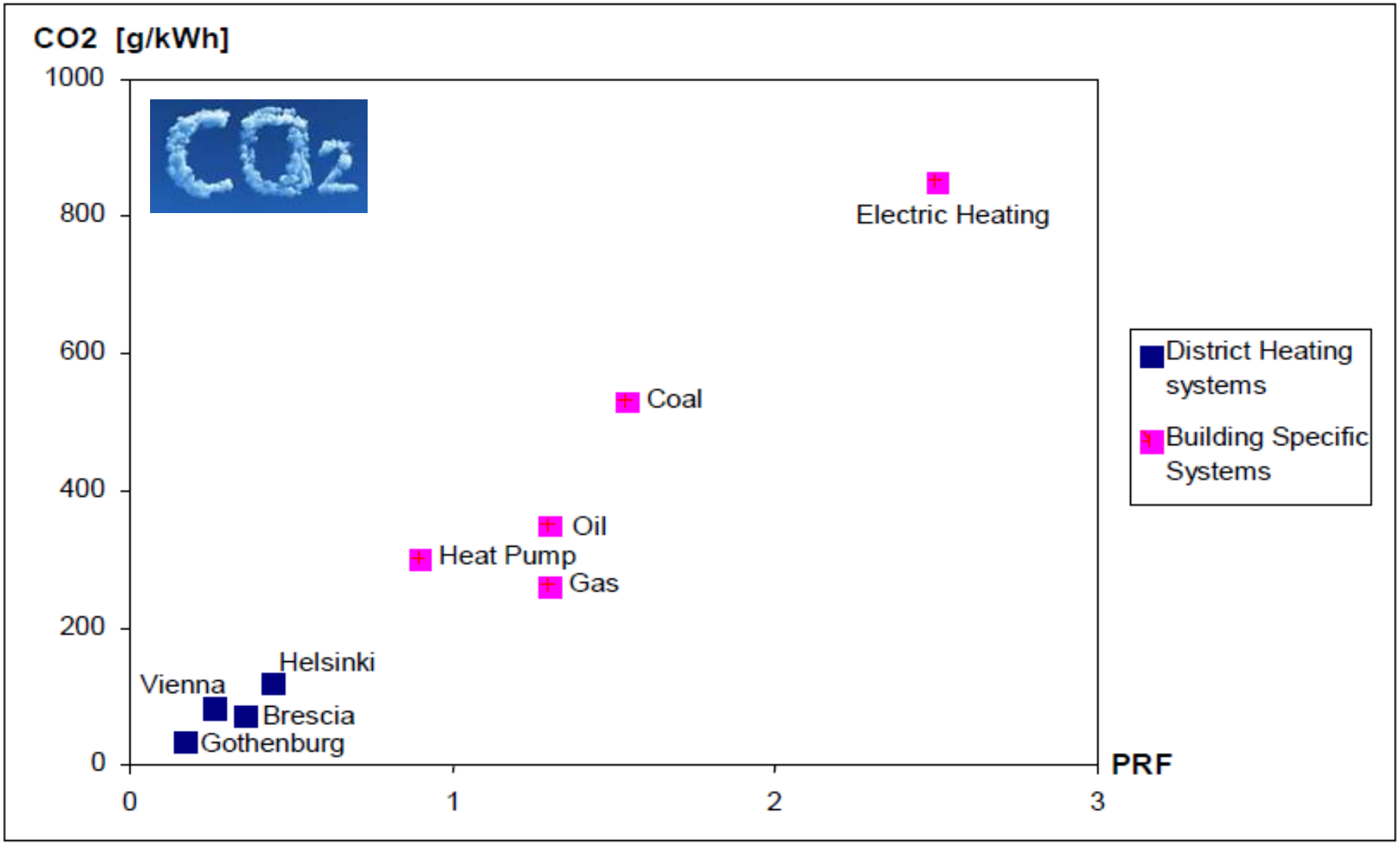
PRF for Heat Supply Systems



PRF for Heat Supply Systems



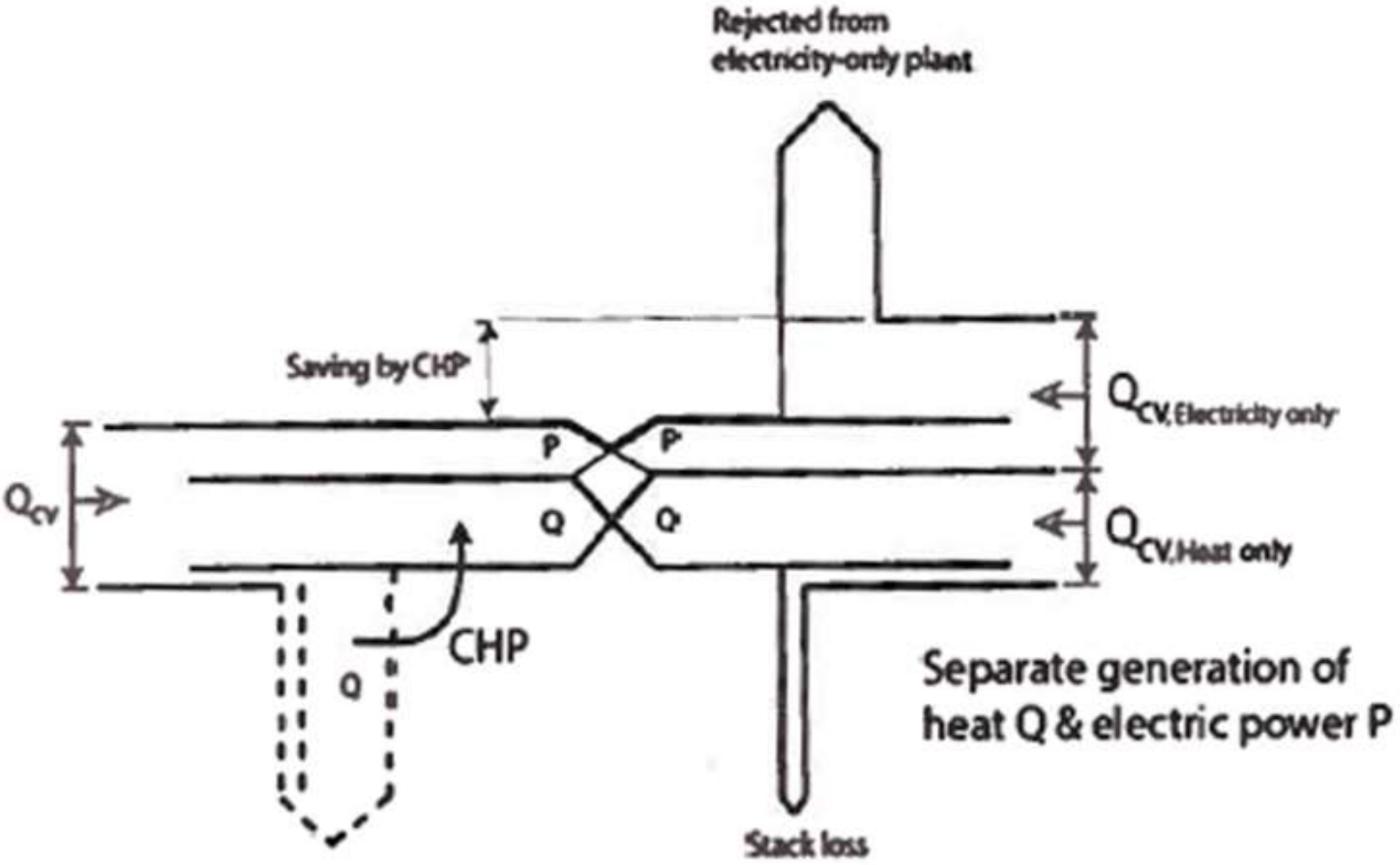
PRF and CO2


CO2 [g/kWh]
1000
800
600
400
200
0
0
1
2
3
PRF
Electric Heating
Coal
Oil
Heat Pump
Gas
Helsinki
Vienna
Brescia
Gothenburg
District Heating systems
Building Specific Systems

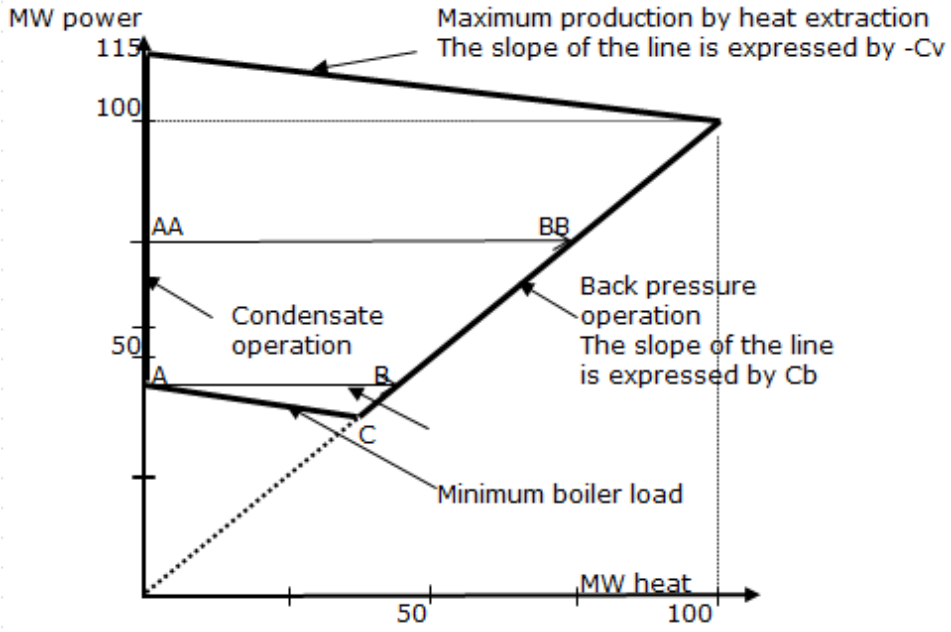
Efficiency in Production and Distribution depends on the whole heat supply system.

Heat supply system	Production	Production efficiency	Distribution efficiency	Gas consumption Gcal fuel per 1 Gcal heat	Emissions kg CO2 per 1 Gcal heat
Electric heating	Central steam turbine	38%	95%	2,77	651
District heating – old	Old gas boiler plant	75%	70%	1,90	447
Building level heating	Traditional gas boiler	80%	96%	1,30	306
District heating – new	New gas boiler plant	92%	90%	1,21	284
Flat level heating	Individual gas heater	96%	100%	1,04	245
District heating – new	50% surplus heat			0,60	142
District heating (120°C)	CHP - Gas turbine	200%	83%	0,60	142
District heating (90°C)	CHP - Gas turbine	300%	86%	0,39	91

Efficiency in Production
Combined Heat and Power



Heat Extraction from Power Plants



Extracted heat temperature oC	De-rating factor MWh el/MWh heat	Efficiency in power-only mode			
		30%	35%	40%	45%
		Fuel consumption for heat production. MWh fuel / MWh heat			
80	0,10	0,33	0,29	0,25	0,22
100	0,13	0,43	0,37	0,33	0,29
120	0,16	0,53	0,46	0,4	0,36
150	0,20	0,67	0,57	0,5	0,44

Environmental issues

	ENVIRONMENTAL ISSUES	Primary Energy Factor, PEF (Typical)
District Heating	+ low environmental impact due to heat recycling and use of renewables	**< 0.8 (European average)**
Electrical heating	- subject to the energy source used for the electricity production - low conversion efficiency	**2.5 (European average)**
Gas-fired heating	+ 1/4 less CO2-emissions compared to oil. + no sulphur emissions, small particle emissions	**1.3**
Active solar heating	+small environmental impact - needs complementary heating system	**0**
Geothermal heat pumps	+ energy efficient and environmentally friendly compared direct electrical heating system	**0.9**

Cost issues

	COSTS		
	Fuel costs	**Maintenance costs**	**Investment costs**
District Heating	+ no concern about fuel availability for the customer + steady pricing, public tariffs + predictable prices - local pricing differences	+ very low maintenance costs	+ moderate investment costs if the building is already using a centralized waterborne heating system as little equipment is necessary
Electrical heating	- prices hard to predict - local pricing differences + no fuel availability concern for the customer	+ no maintenance costs	+ very low investment costs
Gas-fired heating	+ no fuel storage space needed, connected directly to the gas grid + cost efficient heating alternative + almost all oil heating systems can be used with gas	- moderate maintenance costs	- large investment costs
Active solar heating	+ no fuel costs	- moderate / large maintenance costs	- large investment costs
Heat pumps	- preheating of the DHW with heat pump will save 25-50% of warm water costs - costs for adjusting the radiators to the system when retrofitting +longer lifespan than conventional heating systems	+ small/very small maintenance costs	- drilling costs depending on location - large investment costs

Maintenance issues

	MAINTENANCE
District Heating	+ no maintenance necessary for the customer
Electrical heating	+ no maintenance necessary
Gas-fired heating	- must be maintained regularly to ensure high efficiency and security - maintenance work can only be performed by accredited repair shops
Active solar heating	- requires regular supervision and maintenance
Heat pumps	+requires little maintenance as few mechanical components

Thank you for your attention!

Klaus Fafner
klf@ramboll.com