Successful on-site Trigeneration

- The German Experience -

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Workshop on Trigeneration Technology - Promotion of Energy Efficiency in Indian Building Sector

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BEA – Facts and Figures (1)

Foundation

- **in 1992 as Public-Private Partnership**

Shareholders

- **Federal State of Berlin**
- **Vattenfall Europe**
- **GASAG**
- **KfW Banking Group**

Disposes of

2.5 million € of capital stock

Annual Turn-Over

approx. 6.5 million €
370 K€ Company earnings (EBIT)

Know-how

50 members of staff

Energy Services

- **Contracting**
- **Consulting**
- **International Know-How Transfer**

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BEA – Facts and Figures (2)

Energy Services

- **Consulting:**

  Advice on all aspects of efficient energy use for customers from industry and commerce as well as the housing, service and public sector

- **Contracting:**

  Planning, financing, construction, and operation of CHP and heat stations, of special supply components such as emergency power, cooling energy (Trigeneration) and compressed air, solar energy as well as lighting systems

- **International Know-how Transfer:**

  Transfer of successful models of efficient use of energy and of the deployment of renewable energy to developing markets

Generation Data

- at about 100 sites in the region of Berlin
- 63 CHP-units (incl. 5 micro-CHP), annual electricity generation ca. 15,000 MWh
- direct electricity supply for around 3.500 households in Berlin
- CO_2 savings of more than 6,000 t/a

German Energy Policy - Energy Efficiency

Energy policy targets of Federal Government

- **Security of supply**
- **Economic viability**
- **Environmental and climate compatibility**

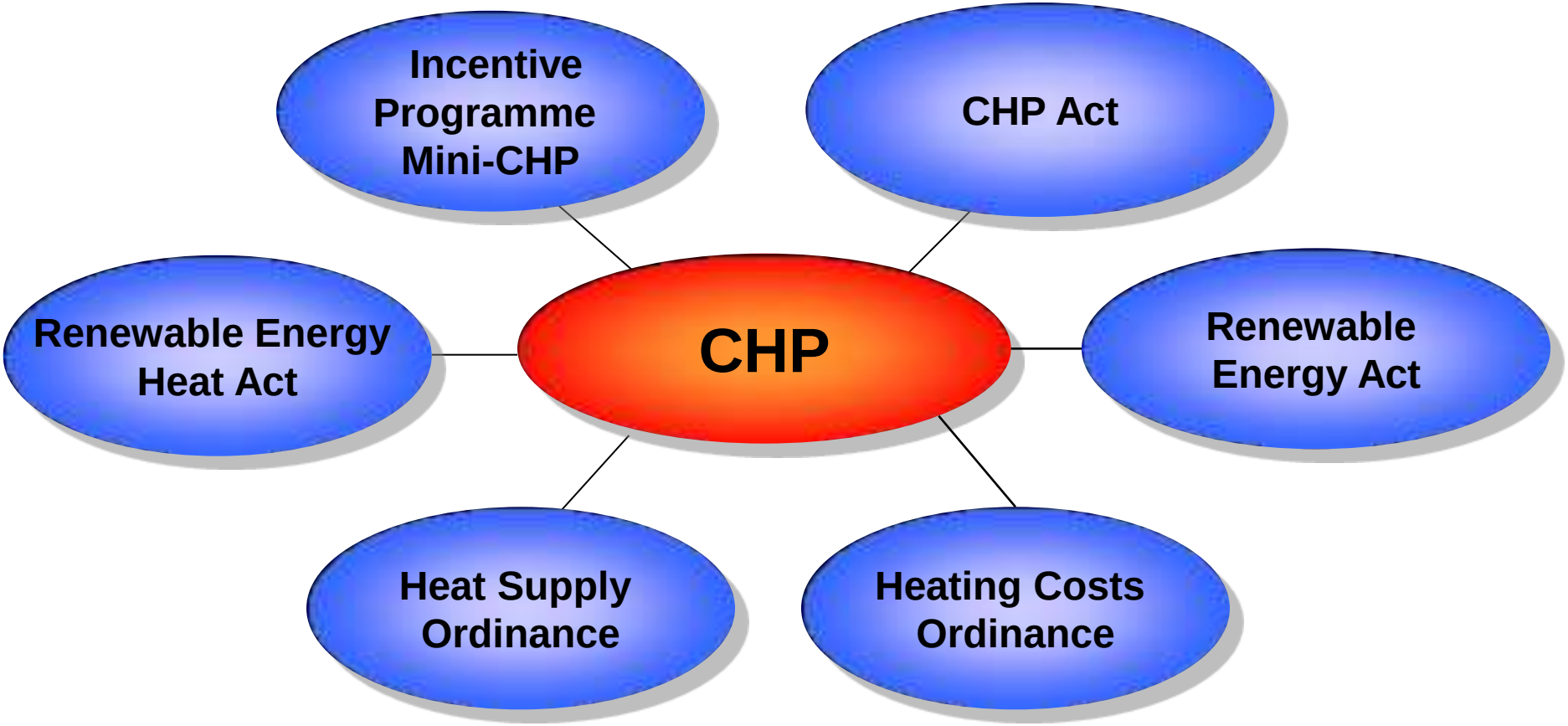
Policy targets until 2020

- **Reducing CO_2 emissions by 40%**
- Increasing RES' share of electricity production to 25-30%
- **Doubling CHP's share of power generation to 25%**
- Increasing RES' share of heat production to 14%

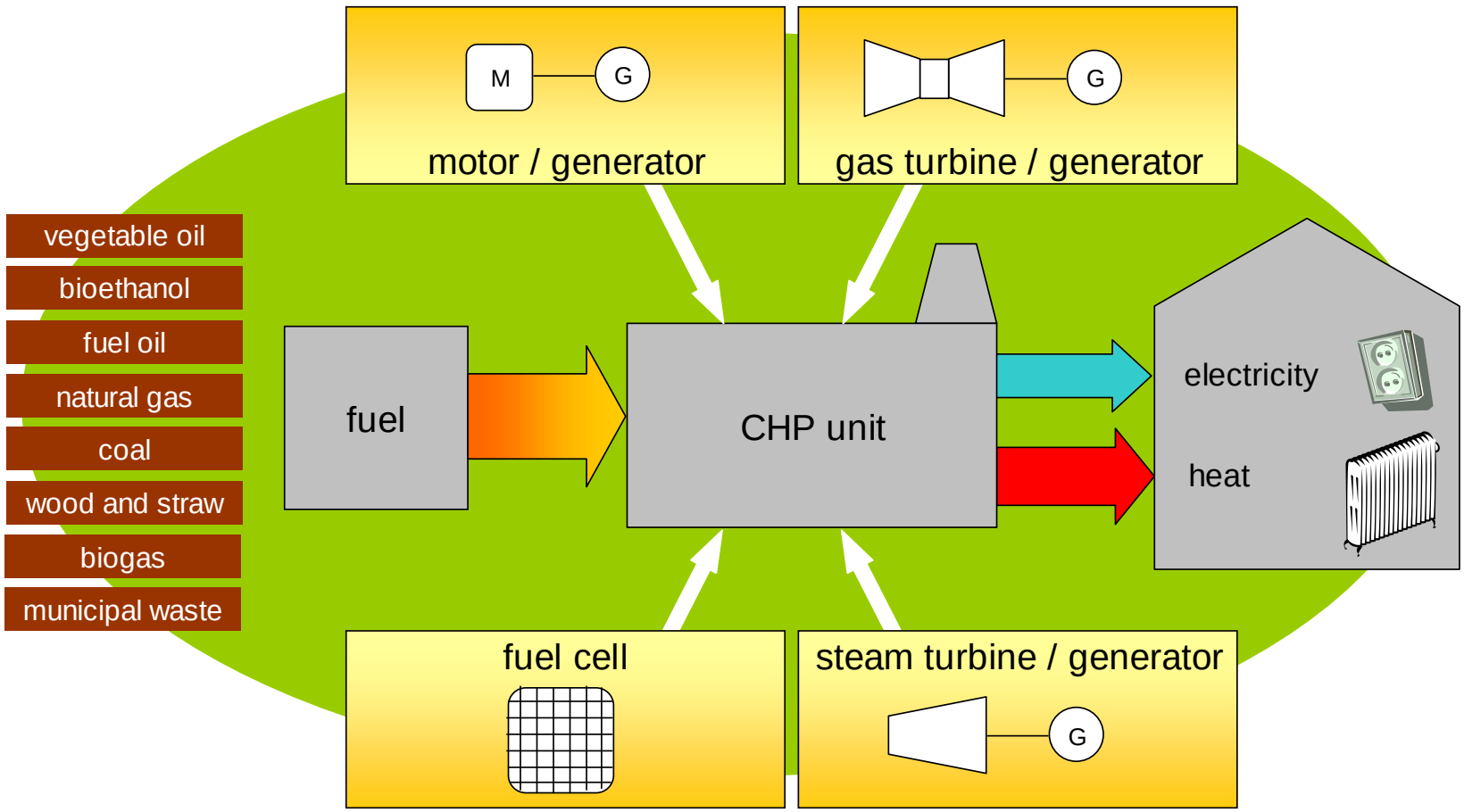
German Energy Policy - CHP

- **Increasing CHP's share of power production to 25% until 2020**
  - Currently 16% share of power production
  - Support the expansion of district heating and cooling networks as well as the use of heat storage units
- **Current areas of application:**
  - District heating
  - Industrial process heat
  - Heat supply to residential buildings, hospitals, etc.
- Increased potential through the production of heat and cold

German Energy Policy - Legal and Funding Framework for CHP

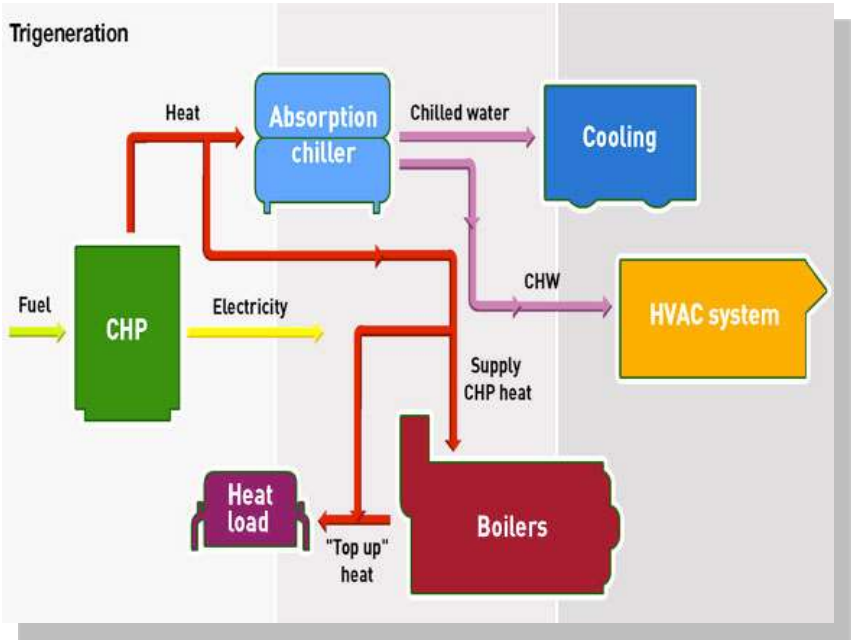


Cogeneration / Trigeneration - Basic Principles (Cogeneration)



Cogeneration / Trigeneration - Basic Principles (CHP Cooling)

- trigeneration units can produce cooling energy for air conditioning or industrial purposes
- “thermal compressor” powered by heat – absorption chillers provide energy for cooling systems with far less electricity
- main advantage: best way to use waste heat
- up to over 50% less of primary energy needed compared to compression refrigerating production
- But higher investment costs compared to compression chiller units



source: cesenergy, 2010

economical use depends on concrete business conditions

Cogeneration / Trigeneration - Potential Users

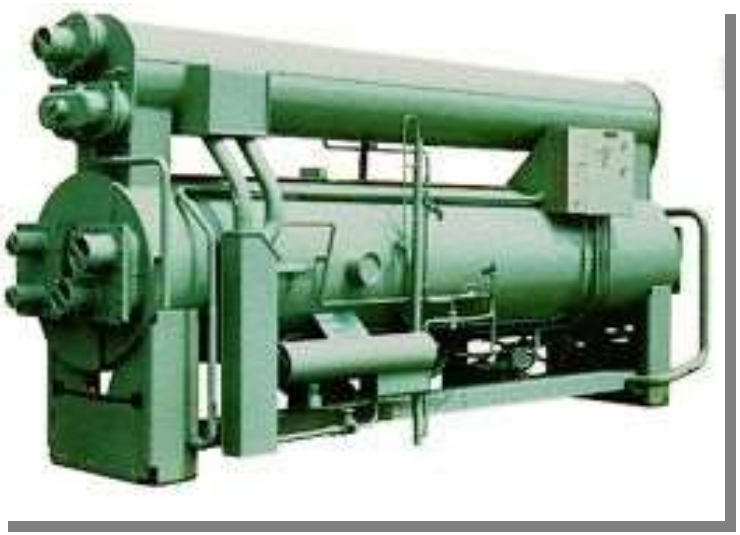
- hospitals and health facilities
- hotels, cinemas and hospitality venues
- industrial facilities
- agricultural / food industry
- government offices
- multi-dwelling residential
- educational facilities
- commercial
- public utilities

Cogeneration - Customized Energy Supply for Each Individual Consumer

	Senertec D	Honda Japan	MicroGen UK	Fuel Cell D. CH	2G D	CHP Diesel	CHP Otto
							
	established	established	field tests	field tests	marketable	established	established
	5.5 kW_{el}	1 kW_{el}	1 – 2 kW_{el}	since 2000	25 – 48 kW_{el}	1 kWel - 5 MWel	5 kWel - 20 MW kWel
electrical capacity			**< 15 kW_{el}**		**15 kW_{el} … 50 kW_{el}**	**50 kW_{el} … 2 MW_{el}**	
Price			**3000 – 9000 €/kW_{el}**		**2000 – 3000 €/kW_{el}**	**500 – 2000 €/kW_{el}**	
			Micro		**Mini**	**Small**	
field of application			one/two-family-house, commercial sector		apartment buildings, commercial sector, hotels, nursing homes	industrial sector, commercial sector, hotels, nursing homes,	

Trigeneration - Technical Options for Absorption Chillers

- Capacity: 15 … 5,000 kW cold
- Temperatures: Cold water: 5 … 20 °C
  Cooling water: 21 … 30 °C
  Heating medium: > 75 °C
- Size: 2.0 x 1.0 x 0.75m (35 kW)
  9.2 x 2.5 x 4.3 m (5,000 kW)
- Price: 200 – 1500 €/$kW_{cooling}$

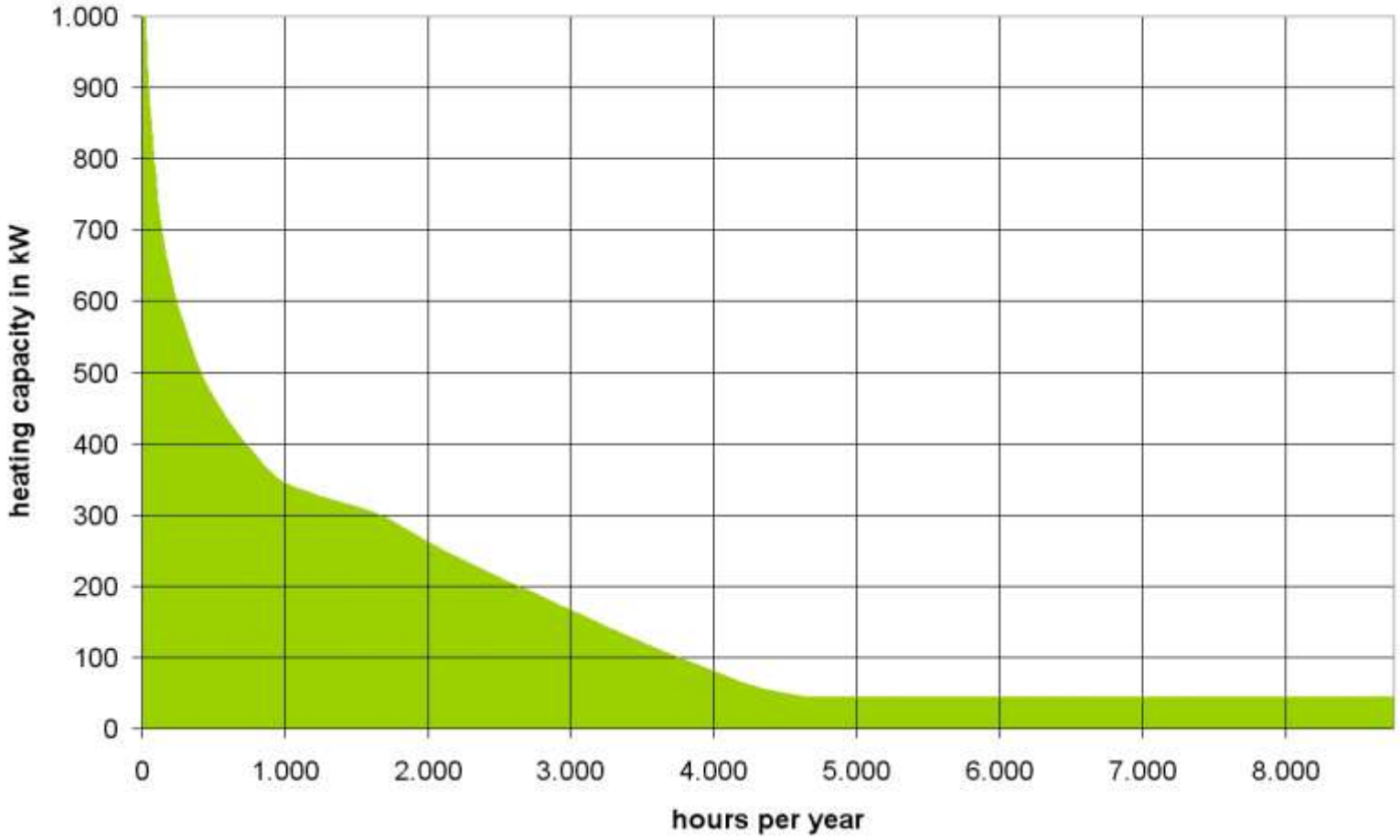


Source: YORK Deutschland GmbH

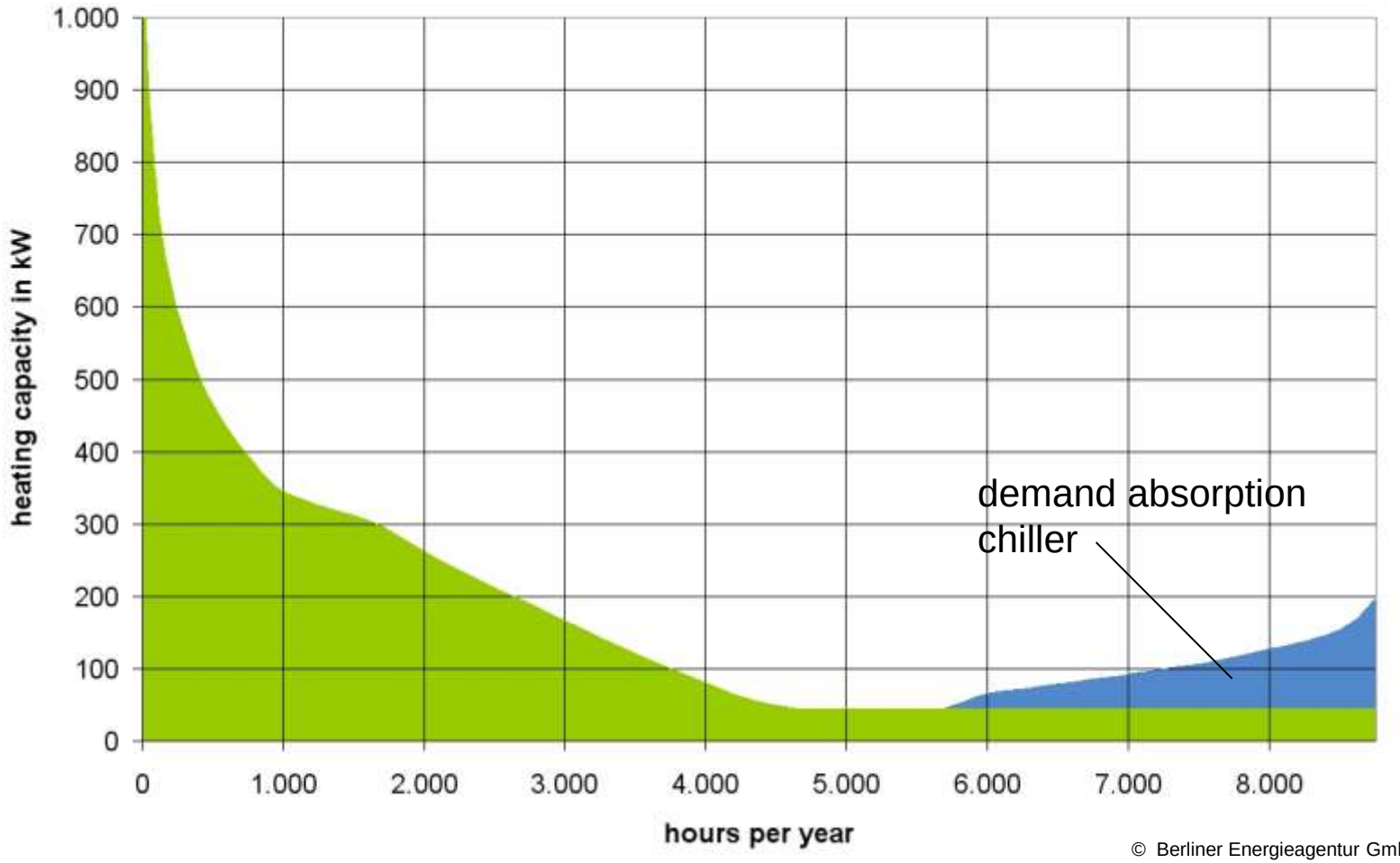
Trigeneration - Key facts

- Proportion heating capacity vs. Cooling capacity – approx. 1.3:1
- Important: Absorption chillers require more space than a compression chiller (more components, larger cooling tower, connection to heating, airconditioning system and electricity grid)
- Waste heat with a temperature from 70 to 100°C for heating applications available.
- Absorption chillers may provide capacities for air conditioning as well as for process cooling. Temperature levels below 0°C may be achieved.

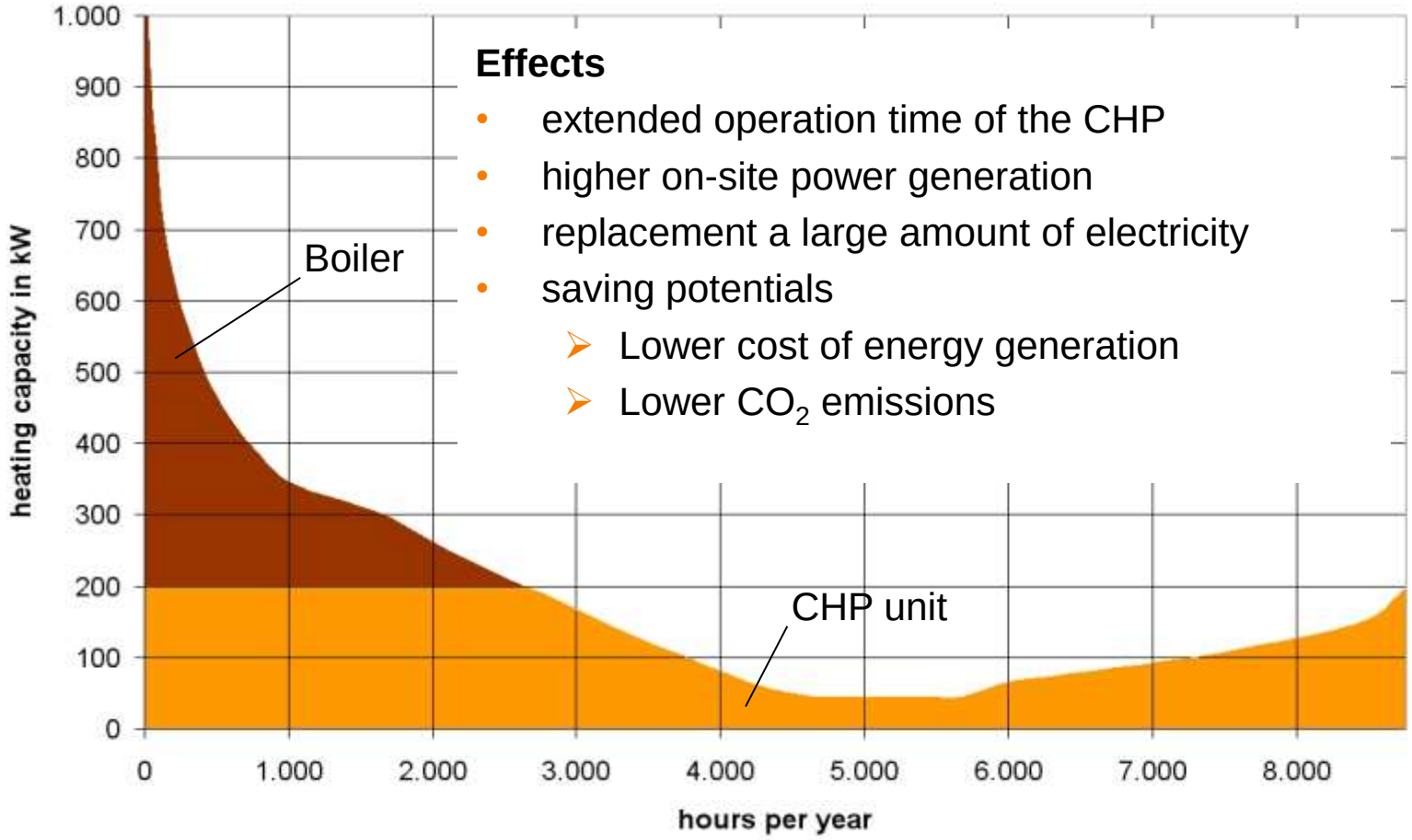
Trigeneration - Demand for space heating and hot water



Trigeneration - Demand for space heating, hot water and cooling



Trigeneration - Covering of the Heating Demand



Effects

- extended operation time of the CHP
- higher on-site power generation
- replacement a large amount of electricity
- saving potentials
  - Lower cost of energy generation
  - Lower CO_2 emissions

Trigeneration - Case study: Potsdamer Platz

- 3 absorption chillers in combination with the local DH-system
- District cooling system: 7.5 km main length
- Total cooling capacity: 36.6 MW, ca 46,000 MWh/a
- Absorption chillers: 7.5 MW, ca. 9,400 MWh/a cooling production
- DH-heat: 11.25 MW, ca. 12,500 MWh/a
- CO_2 saving potential: up to 3.000 t/a

Trigeneration - Case study: Munich Airport, Germany

- 2 natural gas operated CHP units
- 7.44 MW electricity
- 8.7 MW heat
- Absorption chiller unit: 5.3 MW
- Supply buildings and hangars, 5 MWe of emergency power can be made available within 15 seconds
- Commissioning: 2003

Source: MWM GmbH

Trigeneration - Case study: Technology Center Nordenham

- CHP-unit, boiler, absorption chiller and water chiller
- 5,5 kW_{el} electricity
- 812 kW_{th} heat
- 655 kW_{th} cold
- Air conditioning to meet specific temperature requirements for Carbon-fiber-reinforced polymer processing

Source: EWE GmbH

Overcome challenges to implementation - Information

CHP Pilot City Berlin

Starting position: Berlin – CHP hot spot

- 42 % of power consumption (No 1 in Germany)
- 1,500 km district heating grid (No 1 in Western Europe)

Need for action: Knowledge and interest

- Sensitize all relevant stakeholders
- Initiate interest in innovative CHP energy solutions

Approach: broad information campaign

- Place CHP as enabler for climate protection
- Trigger eagerness for knowledge
- Established in Summer 2008

KWK MODELLSTADT BERLIN energie effizient nutzen

Overcome challenges to implementation - Information (2)

Overcome challenges to implementation – Information (3)

Overcome challenges to implementation - Energy Services

Barriers:

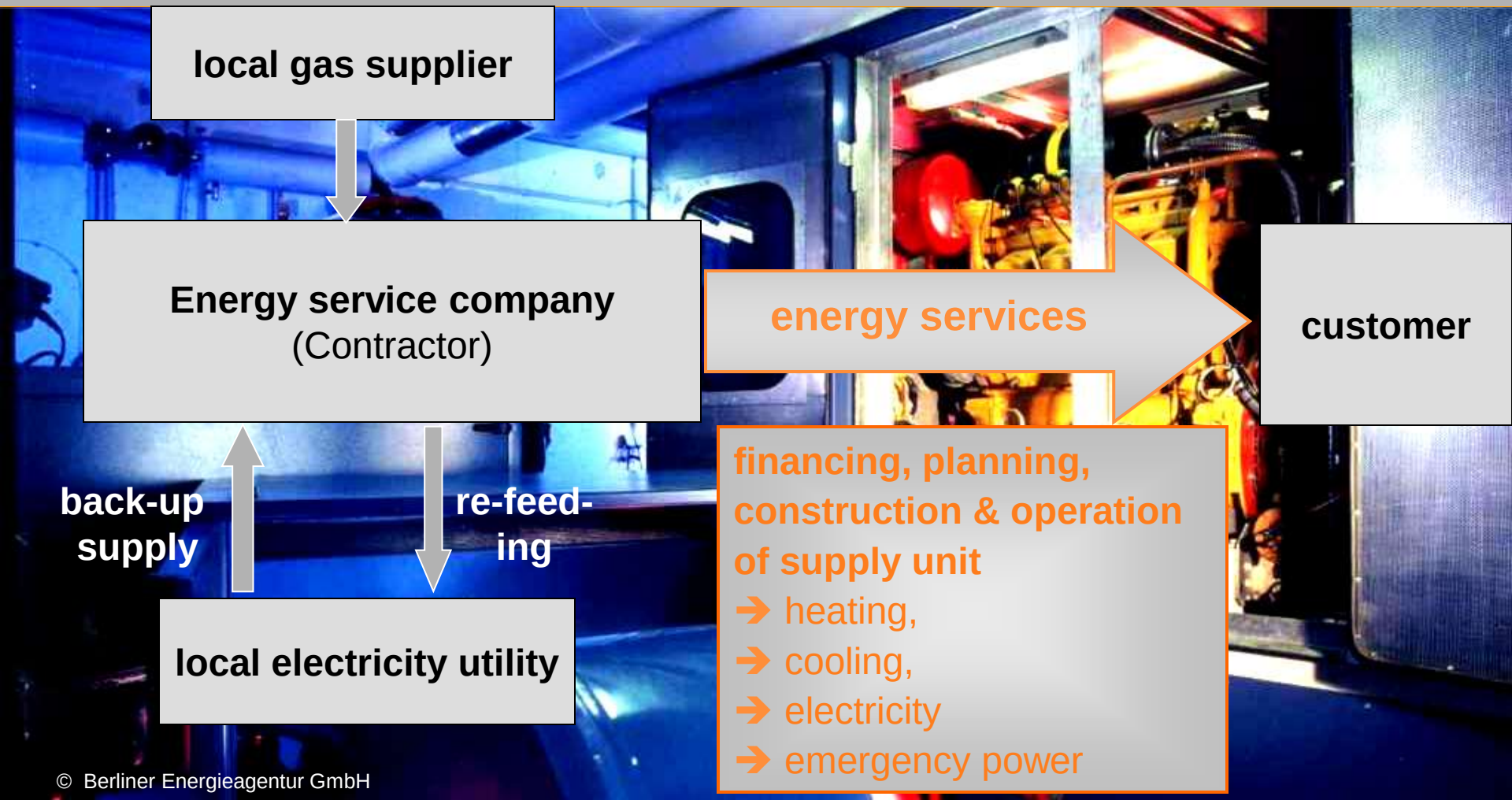
- Lack of capacities
- Lack of information
- Lack of motivation (energy not core business)
- High investment costs

Solution: Energy Services

Energy Services – Some typical models

	Energy Supply Contracting (ESC)	Energy Performance Contracting (EPC)	Energy Operation Contracting (EOC)
Client	energy consumer	user of existing units/equipment	user & owner of existing units/equipment
Target	energy supply	realisation of energy saving potentials	economically optimized operation
Services by ESCO	Planning, construction, operation, maintenance, financing	partly renewal (financing incl.) operation & maintenance	operation
re-financing	energy sales	energy savings	operation fee
Risks borne by ESCO	risks of construction, operation, maintenance, finance and purchase	risks of actual energy savings, of O & M	risks of maintenance and replacement investment
economic advantages for client:	avoided investment, purchase/bulk buying advantages, re-allocation of risks	energy savings guaranteed by contract	technical optimization and professional experience of ESCO

Energy Services – General Project Scheme



local gas supplier

Energy service company
(Contractor)

energy services

customer

back-up supply

re-feed-ing

local electricity utility

financing, planning, construction & operation of supply unit
- ➔ heating,
- ➔ cooling,
- ➔ electricity
- ➔ emergency power

Best Practice – Service complex „Königstadt-Terrassen“ (1)

Energy services for trigeneration

- Service and commercial complex, 25 retail units, 25,300 m²
- 2 natural gas boilers running at low temperature: 1,900 kW
- 2 natural gas operated CHP units each 120 kW_{el}, 214 kW_{th}
- Absorption chiller unit: 350 kW
- Emergency current: 220 kVA
- Start of supply: 1996

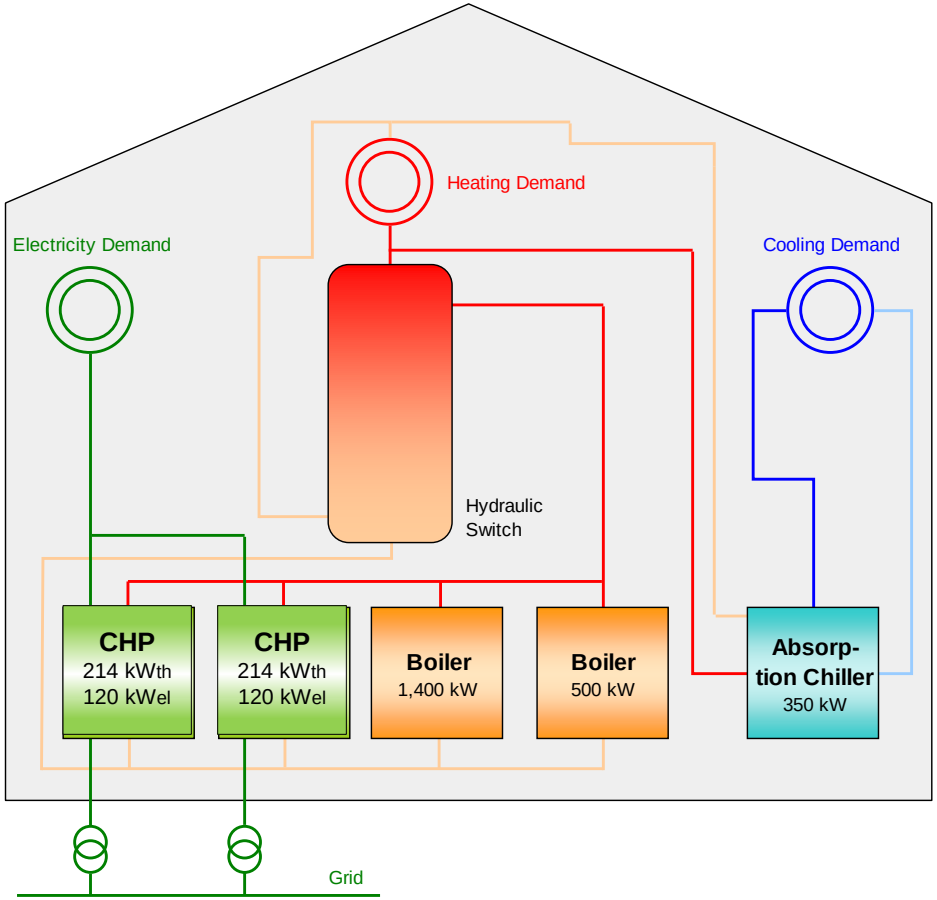
Königstadt-Terrassen Schönhauser Allee, Berlin-Prenzlauer Berg

Gas-absorption chiller (Carrier, LiBr, single-lift)

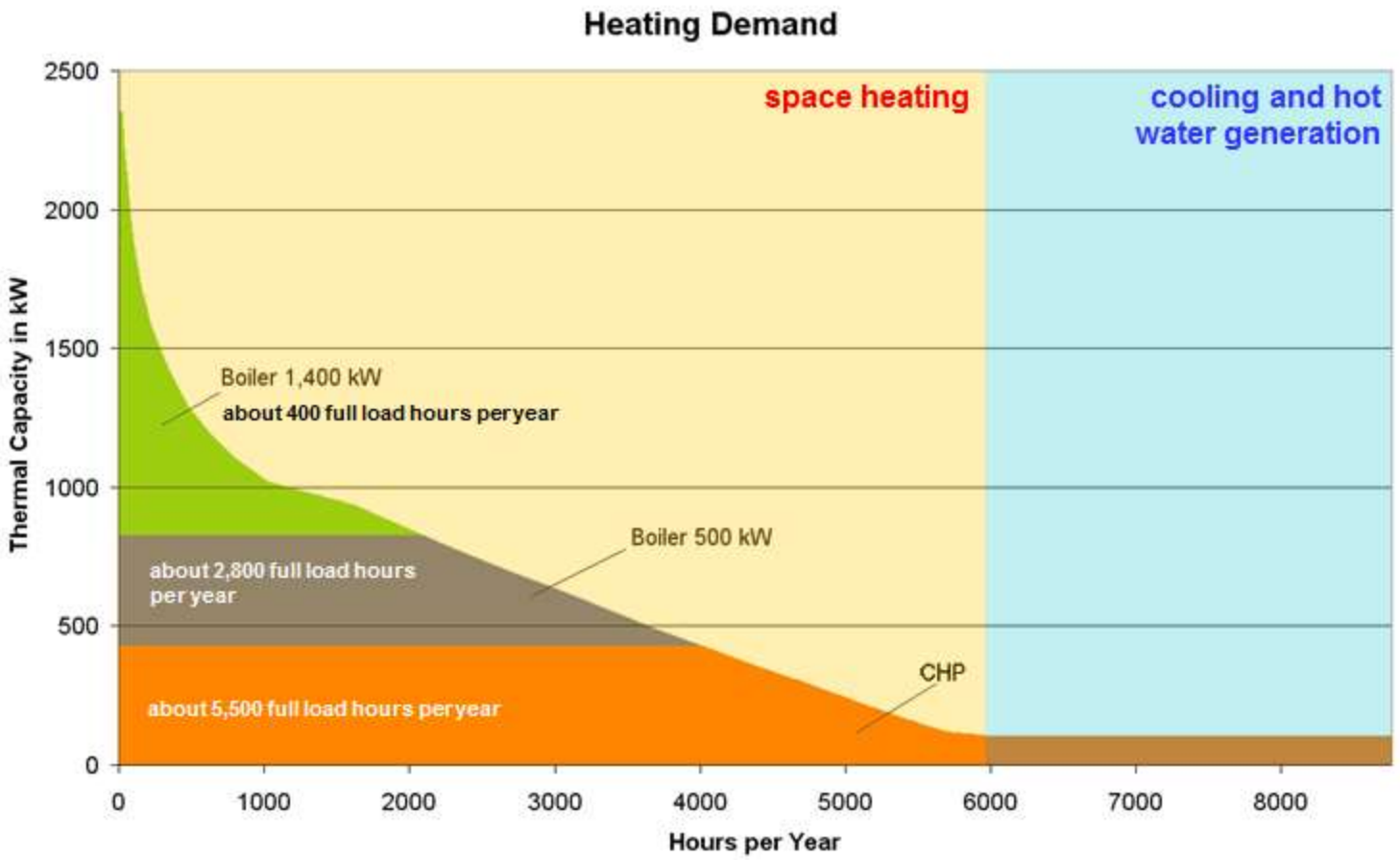
Best Practice – Service complex „Königstadt-Terrassen“ (2)

Total energy supply scheme

- base heat load covered by CHP (428 kW_{th}),
- peak heat load covered by boiler (total 2,328 kW_{th})
- summer heat demand (hot water, absorption chiller) covered by CHP
- CHP-electricity used on-site
- surplus CHP-electricity supplied to the grid



Best Practice – Service complex „Königstadt-Terrassen“ (3)



Best Practice – Service complex „Königstadt-Terrassen“ (4)

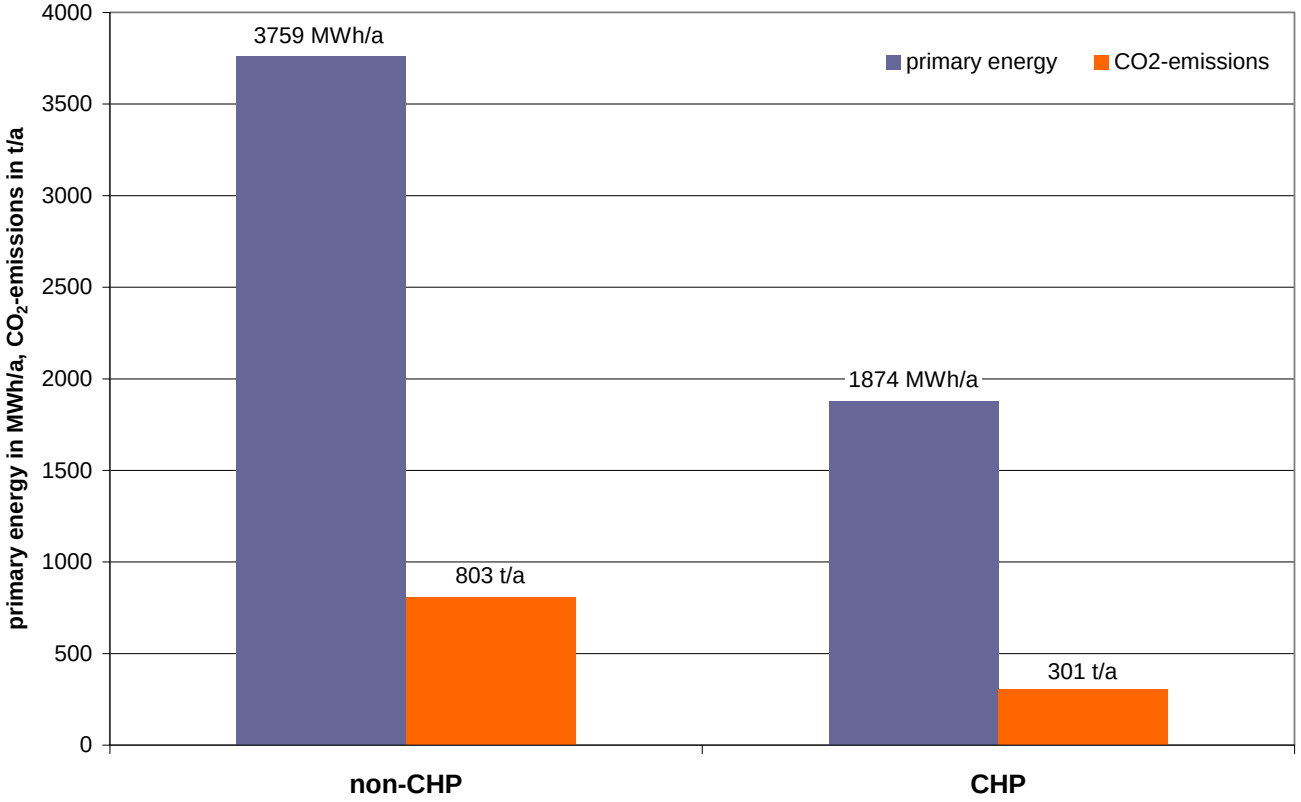
Energy and emission savings

total primary energy savings:

- 1,884 MWh/a
- 50.1%

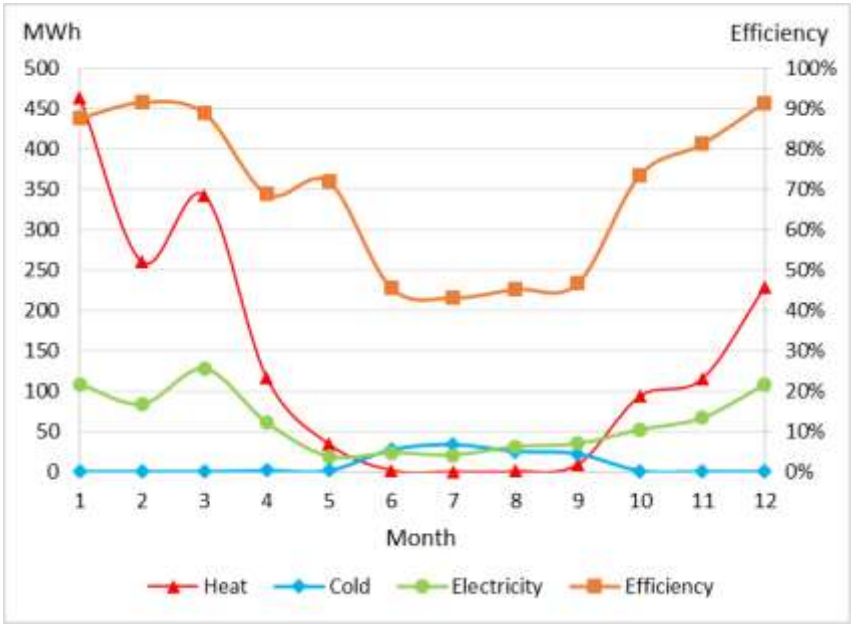
total CO_2 emission savings:

- 503 t/a
- 62.2%



Best Practice – Service complex „Königstadt-Terrassen“ (5)

Electricity, heat and cold generation per year



Monthly data for year 2006

- Yearly averages (1997 – 2012):
  - Sold heat (CHP+Boiler) 1520 MWh
  - Sold cold (CHP+Boiler) 100 MWh
  - Electricity generation (CHP) 690 MWh
  - Gas consumption (CHP+Boiler) 3000 MWh
  - Efficiency (CHP+Boiler) 75.4%
  - Operation time (CHP) 2870 h/year

Lessons learned

- Cost-effective cogeneration / trigeneration technology is available
- Wide range of potential users in industry, housing and service sector exists
  - **Regulation and information are key to success!**
- Need for exact sizing and reliable operation
  - **Energy services are key to success!**

Conclusions

- ✓ Trigeneration reduces costs and CO2 emissions
- ✓ Trigeneration can be effectively integrated in an Energy Services scheme
- ✓ Trigeneration can be a success factor in many areas of application if proper framework conditions and information are available

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Thank You for Your attention!

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