

Combined Heat and Power in the German Industry

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Power demand in the German industry

Electricity taken from the grid	223.000 GWh
Total domestic power production in the industry	49.000 GW
of which CHP	30.000 GWh
Heat demand in the industry	600.000 GWh

Energy policy's targets in Germany

	Climate	Renewable energies		CHP	Energy efficiency	
	Decrease CO2 1990	% electricity	Total	% electricity production	Electricity consumption's decrease	Primary energy consumption
2020	40 %	35 %	18 %	25 %	10 %	25 %
2030	55 %	50 %	30 %	-	-	-
2040	70 %	65 %	45 %	-	-	-
2050	80 – 95 %	80 %	60 %	-	25 %	50 %

Quelle: Prognos

CHP 2009 - 2015

electrical power	2009	2010	2011	2012	2013	2014	2015 ^{*)}
	MW _{el}	MW _{el}	MW _{el}	MW _{el}	MW _{el}	MW _{el}	MW _{el}
bis 50 kW	56	40	52	53	61	77	29
> 50 <= 500 kW	46	55	64	69	95	152	32
> 500 kW <= 1 MW	12	14	25	41	30	73	17
> 1 <= 2 MW	64	67	88	86	130	135	29
> 2 <= 10 MW	97	61	103	93	201	121	15
> 10 <= 50 MW	132	113	70	149	263	222	27
> 50 <= 100 MW	0	442	0	98	320	62	0
> 100 MW	140	0	184	106	191	779	236
Summe	547	792	586	695	1291	1621	385

*) 2015 noch vorläufig

Quelle: BAFA, Stand Nov. 2015

Amount of the supplementary tariff and duration of the payment § 7 und § 13

Einspeisung ins Netz d. allg. Versorgung	
< 50 kW	8 Cent/kWh
> 50 und <100 kW	6 Cent/kWh
> 100 und < 250 kW	5 Cent/kWh
> 250 und < 2 MW	4,4 Cent/kWh
> 2 MW	3,1 Cent/kWh

Ersatz Stein- oder Braunkohle + 0,6 ct/kWh

bestehende KWK-Anlagen mit gasförm. BS	
alle Leistungszonen	1,5 Cent/kWh

16.000 Vollbenutzungsstunden, mindestens 4.0000 Vbh/a Verminderung

§ 6 Supply CHP-Anlagen

Entitled to payment of a surcharge for electricity from cogeneration , which is not fed into a general supply grid , exists only in CHP plants ,

which have an electrical output of up to 100 kilowatts ,

the CHP electricity to final consumers in a customer facility or a GVN provide , as far as the full EEG surcharge is paid for that stream ,

which are used in current cost-intensive companies *) and their cogeneration of these companies is even consumed

or The operators of a company is to be associated with an industry according to Appendix 4 of the Renewable Energies Act , once a regulation according to § 33 paragraph 1 number 4 was adopted .

Dauerbetriebnahme bis zum 31.12.2022 erforderlich

Supply § 7 i.V. mit § 6 Abs. 4 Nr. 1-4

Dauerinbetriebnahme bis zum 31.12 2022

	nicht ins Netz der allg. Versorgung eingespeister Strom			
	Nr. 1 bis 100 kW	Nr. 2 bei EEG-Umlage	Nr. 3 BesAR	Nr. 4 Anh.4 EEG
< 50 kW	4 Cent/kWh	4,0 Cent/kWh	5,41 Cent/kWh	?
> 50 und <100 kW	3 Cent/kWh	3,0 Cent/kWh	-	?
> 100 und < 250 kW	0	2,0 Cent/kWh	4,0 Cent/kWh	?
> 250 und < 2 MW	0	1,5 Cent/kWh	2,4 Cent/kWh	?
> 2 MW	0	1,0 Cent/kWh	1,8 Cent/kWh	?

EEG-Umlage für KWK-Neuanlagen

2016: 35 %	2,16 ct/kWh
2017: 40%	2.47 ct/kWh

Duration of contract payments under § 8 for new - or modernized and upgraded devices

Dauer der Zuschlagzahlungen Vbh	
neue Anlagen bis 50 kW	60.000
neue Anlagen ab 50 kW	30.000

Dauer der Zuschlagzahlungen Vbh	
modernisierte Anlagen, 25% Kosten	15.000
modernisierte Anlagen, >50%	30.000
nachgeüstete Anlagen, 10% Kosten	10.000
nachgeüstete Anlagen, 25-50%	15.000
nachgeüstete Anlagen, >50%	30.000

„Energiewende“ in Germany: increasing the share of CHP electricity generation to 25 % until 2020

In 2020 should be around 140 TWh => increase target: 48 % (7 years)

Net electricity generation and total CHP electricity generation in Germany since 2007

Development of the CHP-electricity generation in TWh							
	2007	2008	2009	2010	2011	2012	2013
Net electricity generation	599	599	558	584	570	565	568
CHP net electricity generation	82,5	86,1	85,3	92,9	90,8	93,1	94,2
of which general supply	51,9	53,8	53,4	53,3	50,9	51,1	49,7
Of which industrial CHP	25,8	25,7	26,6	29,8	28,4	28,3	29,7
of which biomass CHP	2,4	3,9	5,3	6,5	7,6	9,2	9,9
Share of CHP in %	13,8%	14,4%	15,3%	15,9%	15,9%	16,5%	16,6%

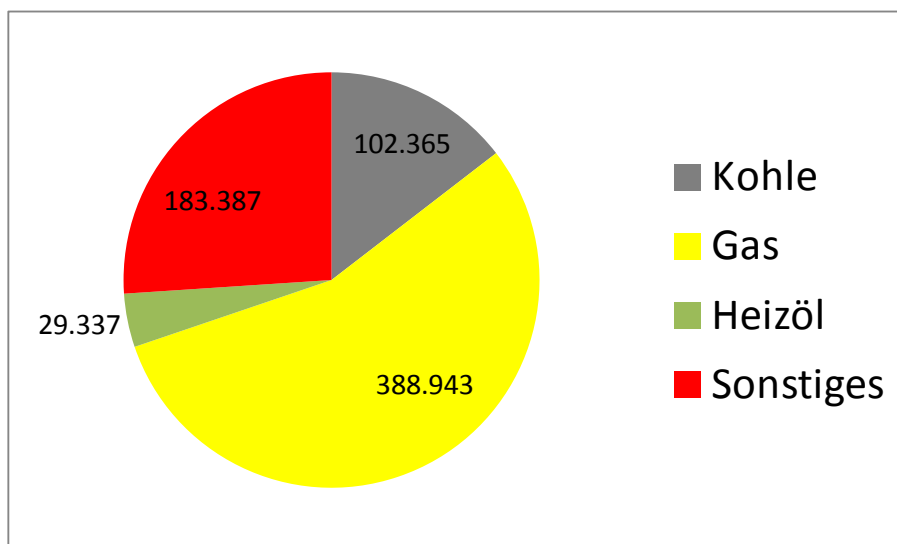
Quelle: Prognos 2014

Increase in 6 years 14%

Adapting CHP for more flexibility– increasing use of gas

CHP plants adapt to the increasing demand for flexible electricity generation from thermal power plants – gas turbines are frontrunners

Use of fuel in industrial power plants in 2012 [TJ]



Development of the CHP fuel usage – Gas and RES are increasing, coal and oil decrease

[MWh/a]	2007	2012
Kohle	71.500	64.913
Gas	269.220	293.833
Heizöl	25.573	19.967
Sonstige	117.737	127.387

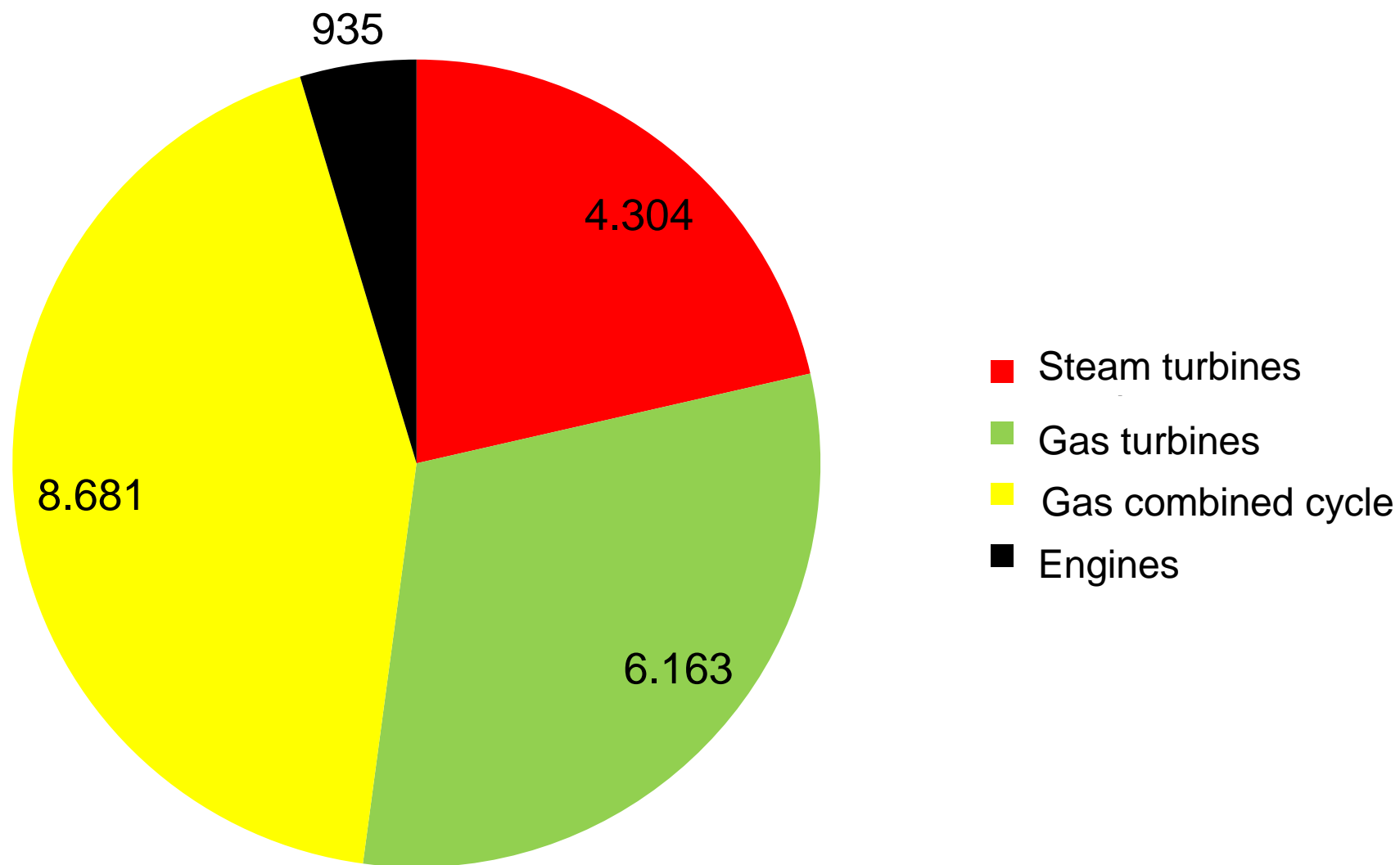
Quelle: VIK, Statistik der Energiewirtschaft 2014

CHP is particularly strong, where additionally there is both electricity and heat demand

Installed electrical power by type of plant in MW

Gross bottleneck capacity				
	Steam turbines	Gas turbines	Combustion engines	Other plants
2012	6.151	2773	362	73
2011	8.970	2621	358	128
2010	9.041	2.626	340	183
2009	8.801	2.691	328	139
2008	8.640	2.112	323	149
2007	8.434	2.033	327	150
2006	8.478	1.894	356	154

CHP electricity generation in GWh in 2012



CHP electricity generation in GWh/a by sector in 2012

	GWh
Mining	64
Food and feed animal industry	2454
Textiles	25
Wooden ware, cork goods and wickerwork goods	1.210
Paper and cardboard	5,147
Coking plants, oil refining	3.342
Chemical industry	13.770
Glass, ceramics	63
Metal production and processing	617

CHP electricity generation

Branchen	Stromerzeugung mittels KWK [Anteil an gesamter Stromerzeugung mit KWK, %]						Stromerzeugung in TWh
	Dampfturbinen		Gasturbinen			Verbrennungsmotoren	
	Gegendruckmaschinen	Entnahmekondensationsmaschinen	ohne Abhitze-kessel	mit Abhitze-kesel	mit nach-geschalteter Dampfturbine		
Ernährung und Tabak	20%	***	***	16%	***	45%	2,5
Fahrzeugbau u. sonstige Fahrzeugbau	***	***		***	***	18%	0,4
Gewinnung von Steinen und Erden. sonst. Bergbau						3%	0,3
Glas, Keramik u. Verarbeitung v. Steine u.			***		***	0%	0,1
Grundstoffchemie u. Sonstige Chemie	40%	11%	***	61%		18%	14,0
Gummi- und Kunststoffwaren	***	***		3%		***	0,2
Maschinenbau	***	***				8%	0,1
Metallbearbeitung				***		***	0,0
Metallerzeugung		15%		***		***	0,6
NE-Metalle. -gießereien	***	***		***		0%	0,0
Papiergewerbe	38%	44%		20%	100%	5%	5,4
Sonstige Wirtschaftszweige	2%	29%	***	***		2%	1,3
Industrie gesamt - durch Geheimhaltung unvollständig	5,9	3,09	-	5,17	0,53	0,84	24,9

Development of fuel usage in CHP plants in MWh/a

	2007	2008	2009	2010	2011	2012
Coal	71.500	73.980	63.847	77.170	75.007	64.913
Gas	269.220	278.777	309.992	310.111	299.776	293.833
Oil	25.573	26.896	22.730	23.974	19.862	19.967
Others	117.737	107.228	121.483	122.018	116.887	127.387

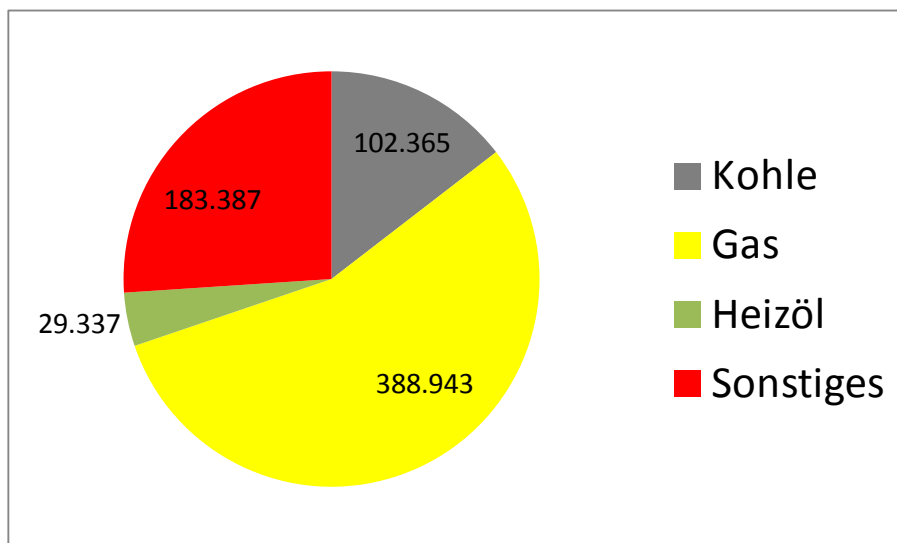
Energy related CO2 emissions from industrial power plant

Sector	Mio t CO2/a
Oil refining	1,72
Steel	7,04
Pit&querry	1,00
Paper	1,18
Chemical	20,34
Car	3,93
Food	3,79
Others	11,25
Sum	50,26
CHP Share	30,0

Adapting CHP for more flexibility – increasing use of gas

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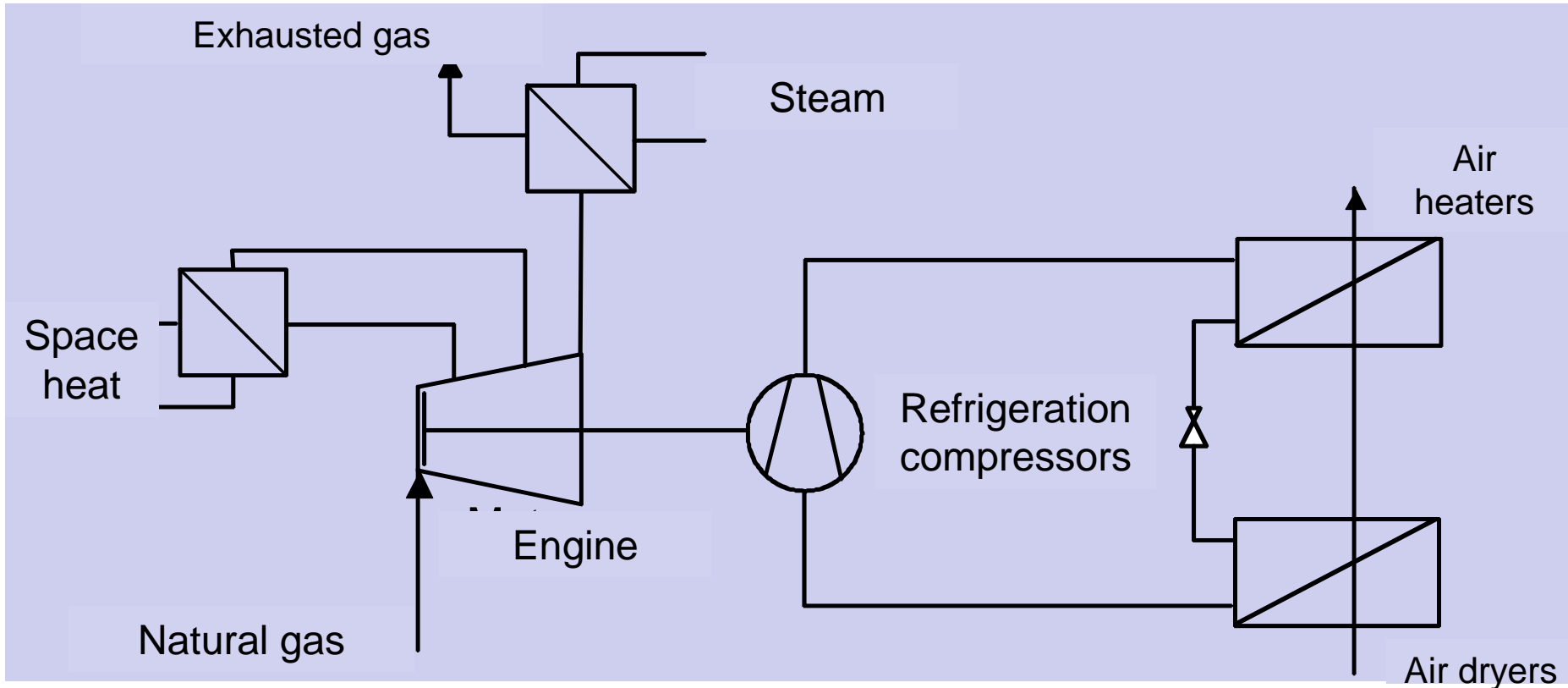
Quelle: VIK, Statistik der Energiewirtschaft 2014

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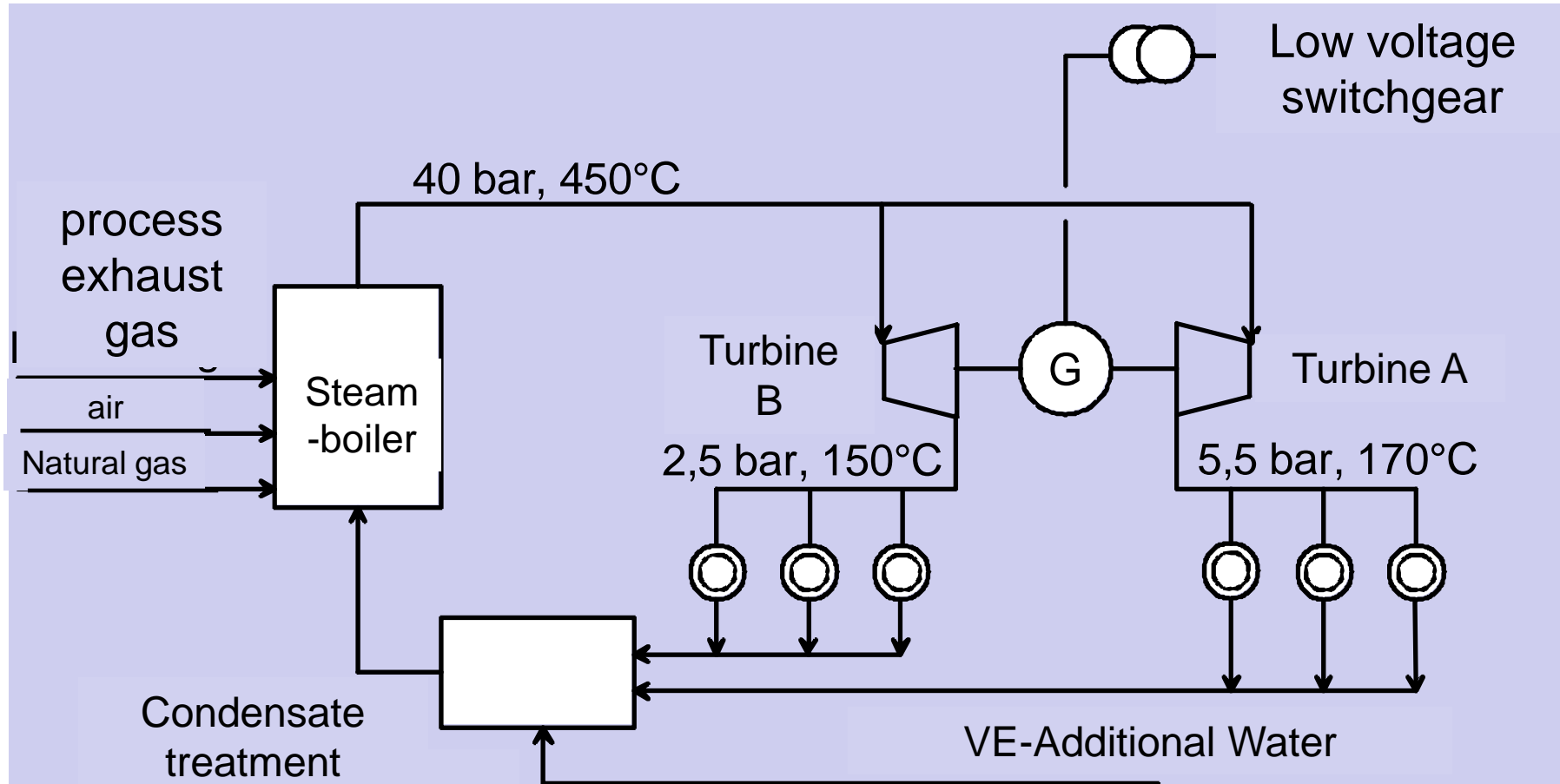
Combined power and heat supply- cogeneration technology

- **Gas turbines**
- **Steam turbines**
- **Combined cycle (combined gas and steam turbines)**
- **Combustion engines (Otto or Diesel)**
- **Fuel cells**

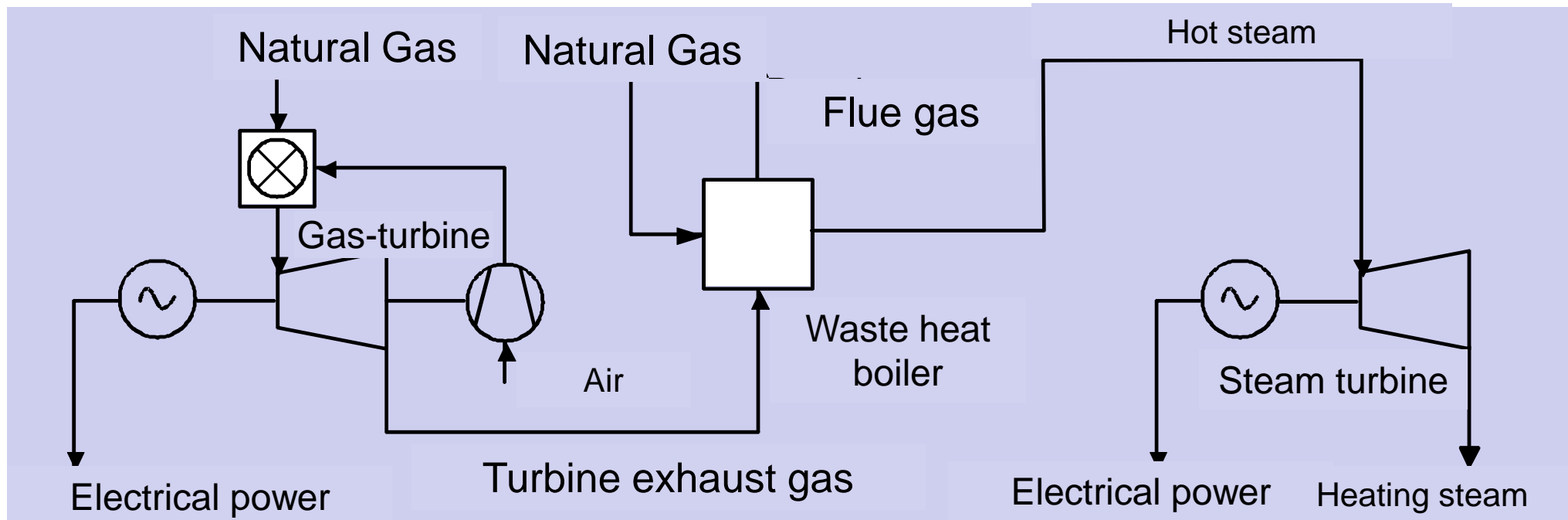
Engine plant for cooling, steam and space heating supply



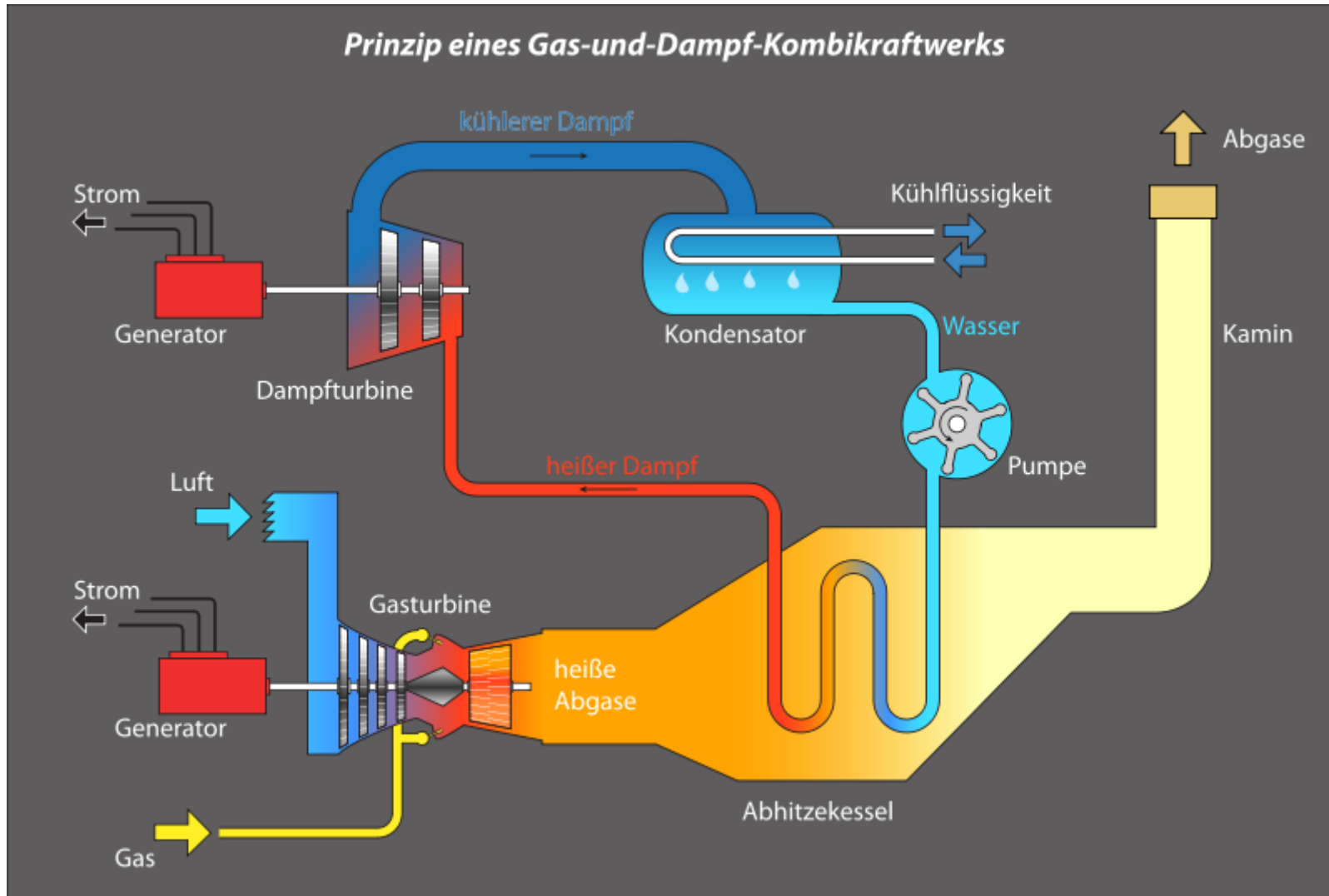
Steam turbine plant with combined gas- and exhaust gas firing



Combined cycle power plant with additionally fired waste heat boiler

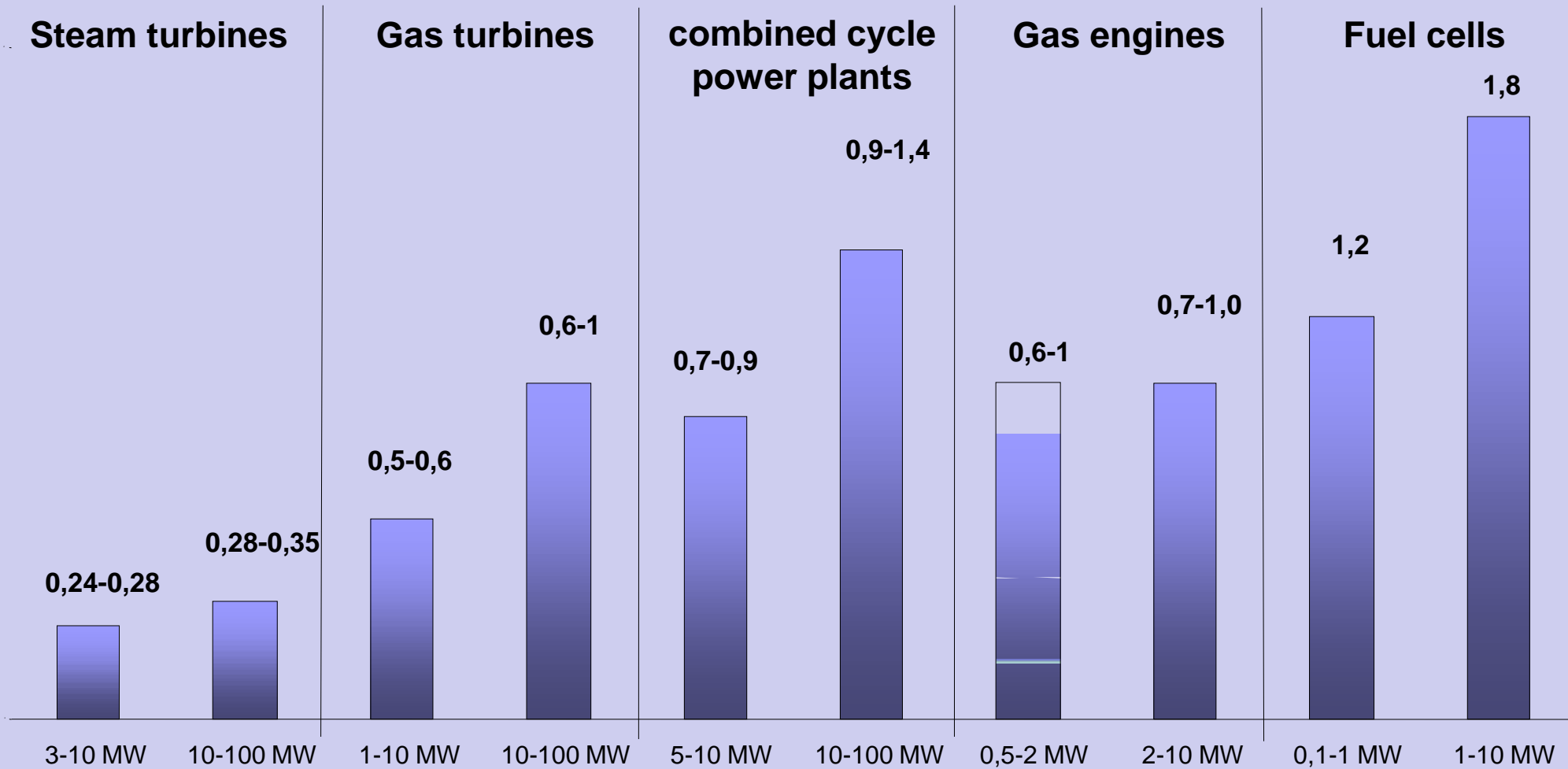


Example Plants

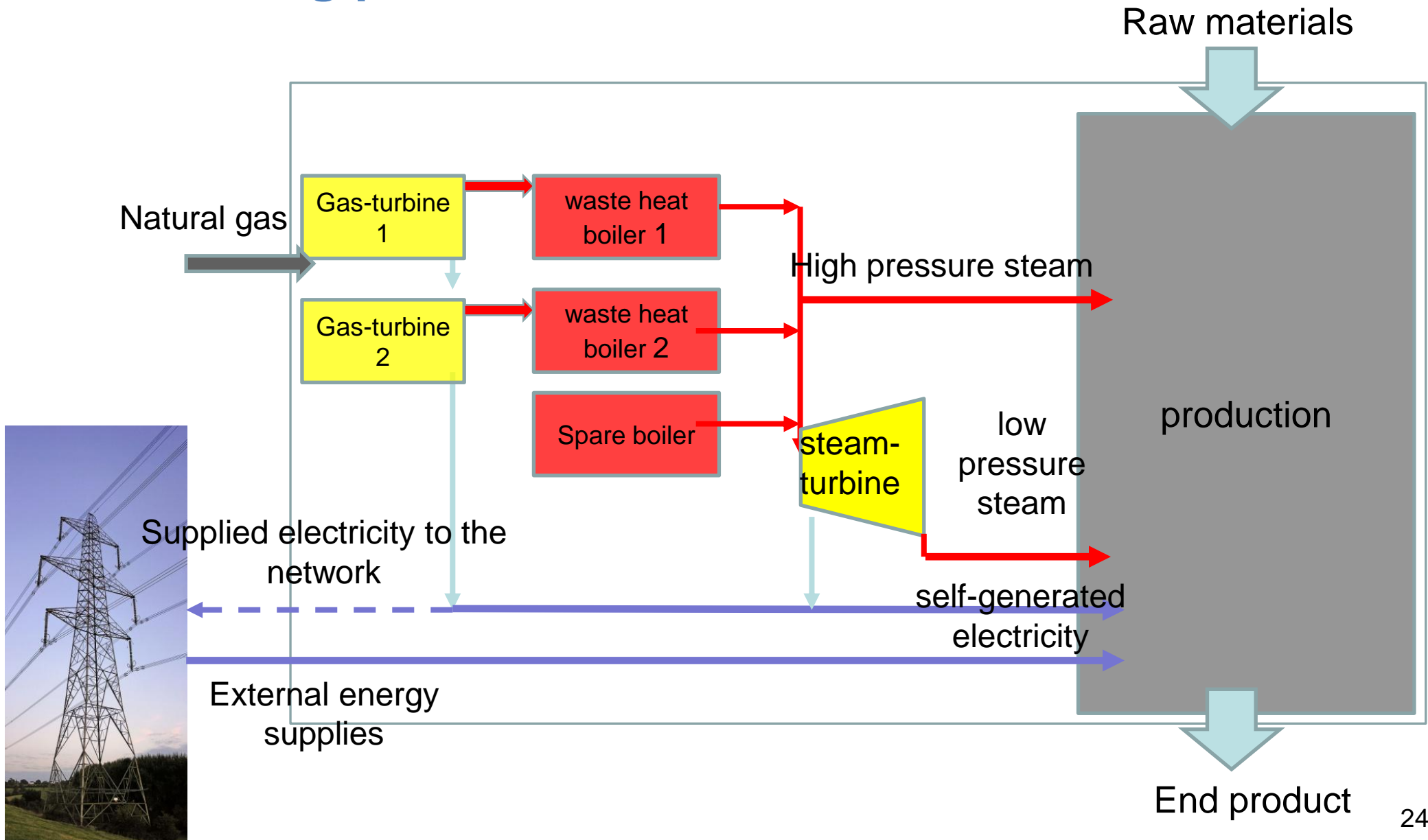


Power to heat ratio of typical CHP processes

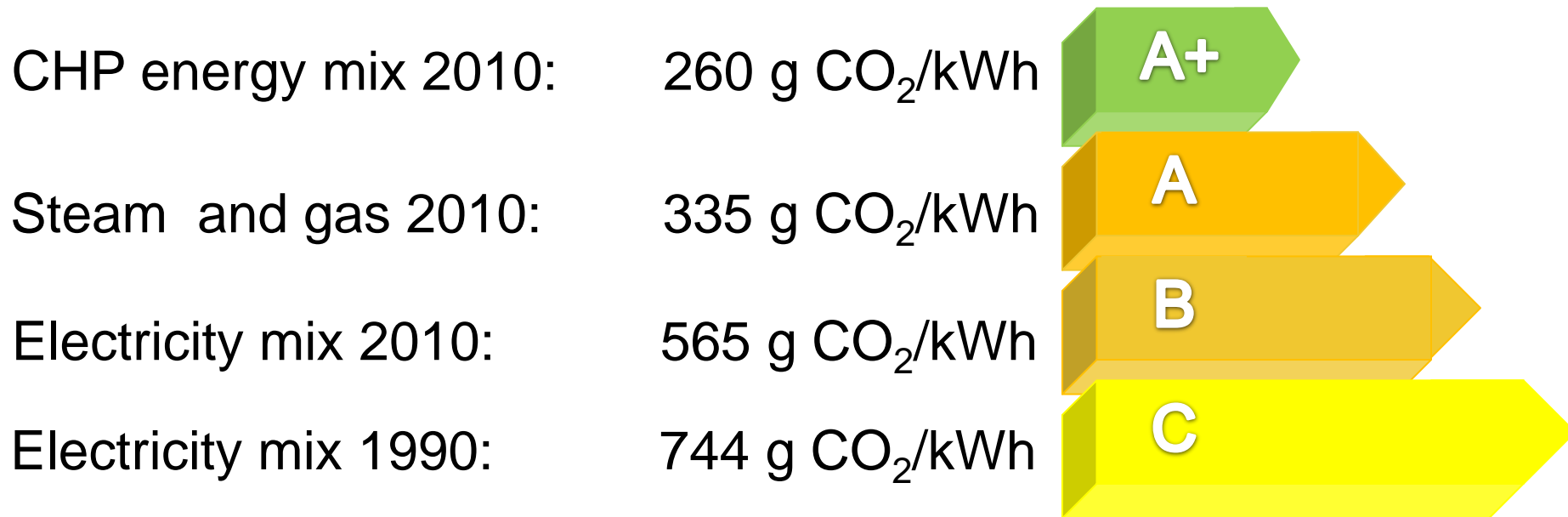
Power to heat ratio of typical CHP processes



Linkage between energy production and manufacturing process

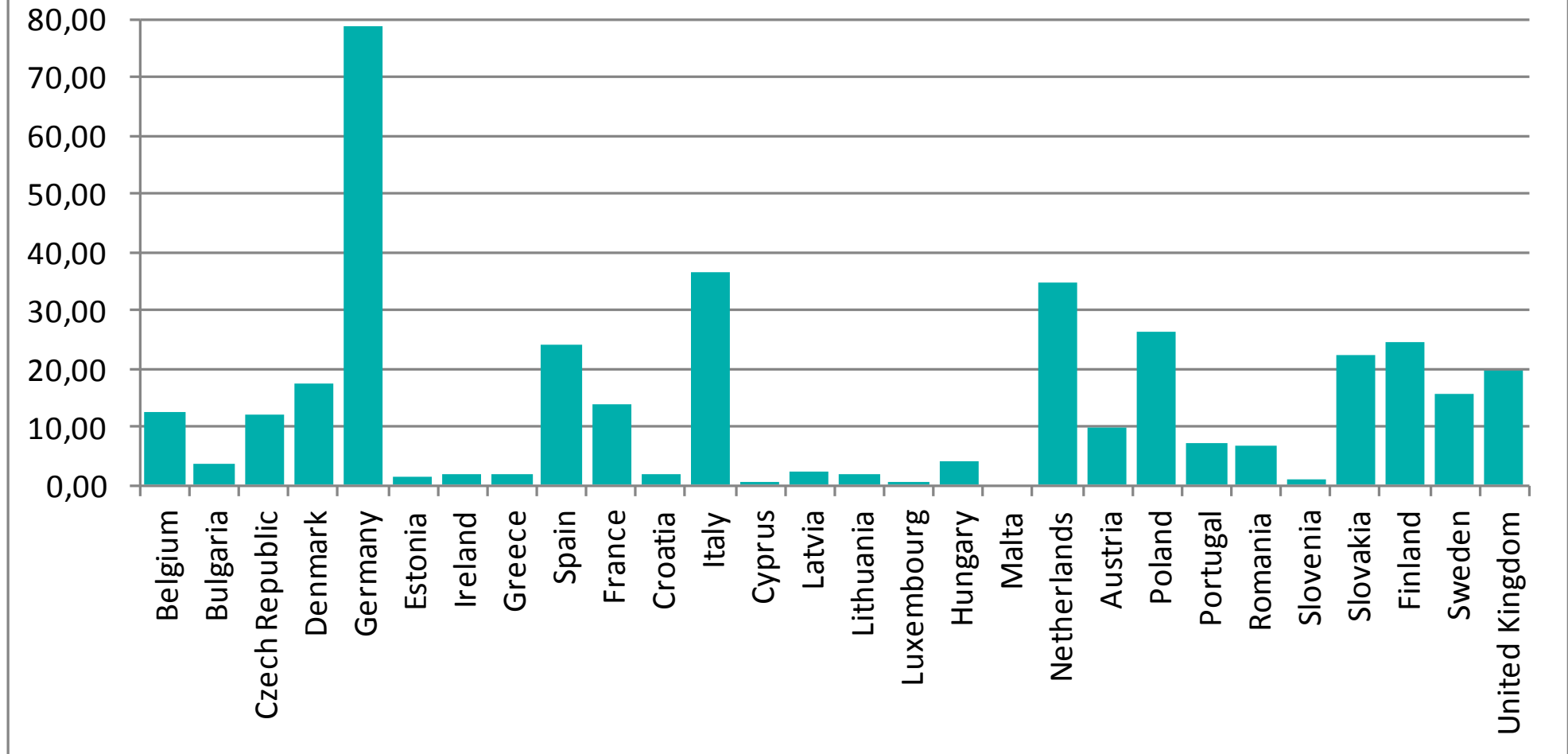


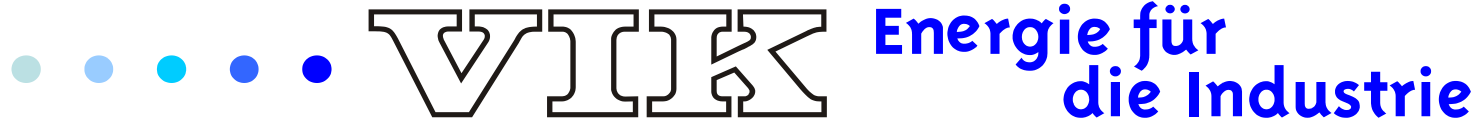
CO₂ savings through CHP



CHP in Germany with all fuels (from coal to biomass), heat emissions calculated by reference system of the Ökoinstitut for CHP monitoring

CHP electricity generation, TWh





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