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GLOBAL COGENERATION MARKET OVERVIEW

2nd Edition (December 2023)

Introduction

- The present work is a summary of the analysis of world CHP data.
- The aim of the analysis is to follow the trends in global CHP market and also to see how each regional market evolves over time both in terms of heat and power generation and fuel use.
- This exercise was first done in 2022.
- Two main sources of data have been used:
  - **IEA** 2022 statistics for the period 1990-2020 (we have analysed 2010-2020 period)
  - **Eurostat** 2023 which includes 2021 data.
- IEA data covers CHP heat and electricity generation by main activity producers and autoproducers as well as split by fuel source.
- Eurostat data are more detailed and give also split by technology type, number of CHP units, efficiency levels etc.
- The main problem we faced during the analysis is data incompleteness for some regional markets, namely South America and Africa (ex: no data on CHP heat output)
- The other point to mention is the difference between IEA and Eurostat data for the same countries and periods (Eurostat numbers are systematically lower thank IEA numbers - different methodologies in reporting) – effectively what is a CHP plant and when does it operate in CHP mode.

CHP World Overview

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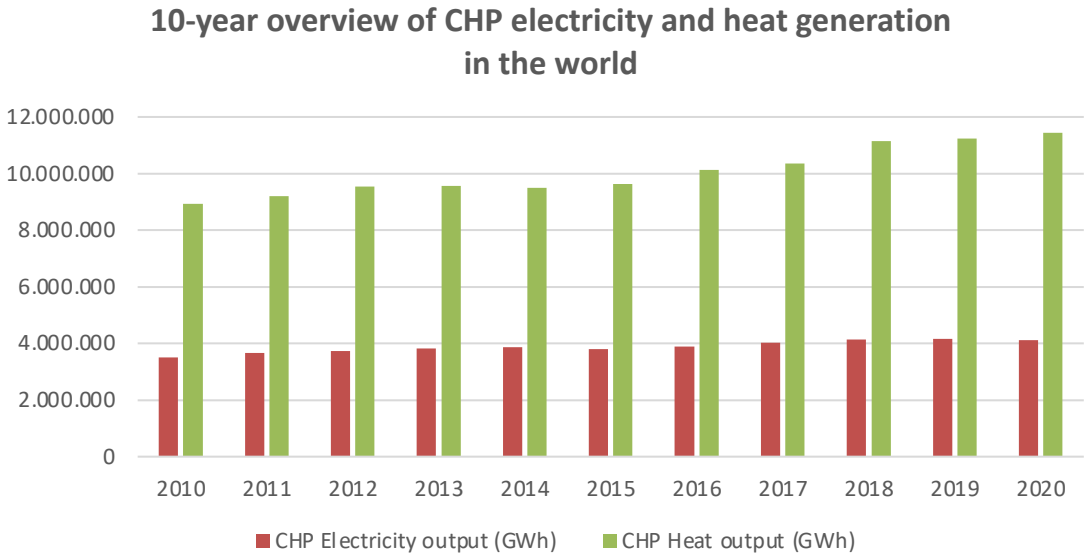
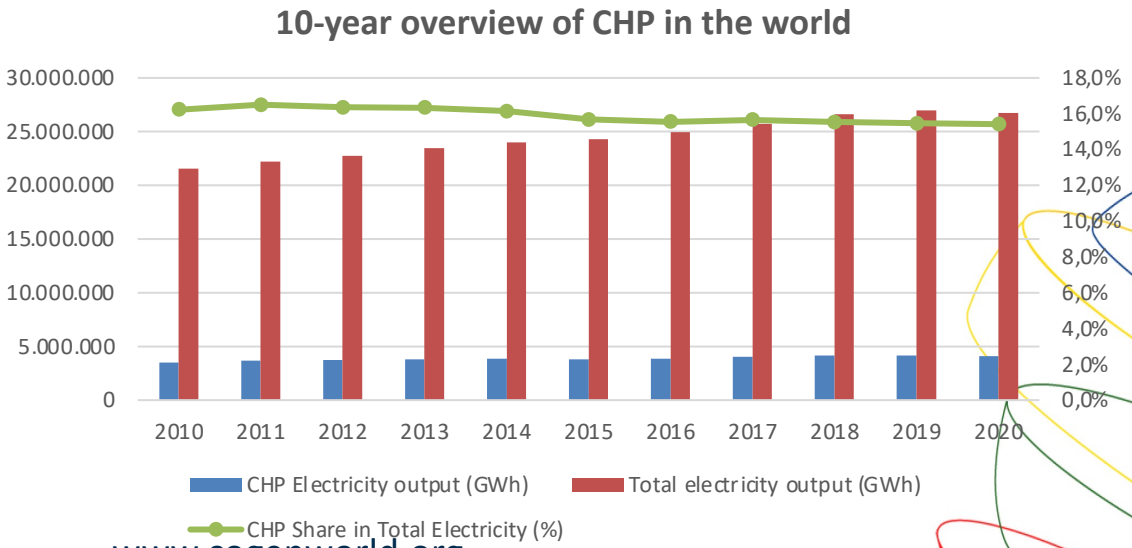
World

Electricity produced by CHP plants in 2020:

4,119TWh

- Electricity generation data from IEA database include condensing parts which may lead to overestimated values.
- CHP share in total electricity generation has been mostly stable over the last 10 years at **c. 15%,** with a slight downward trend (-1%).
- Between 2010 and 2020, annual CHP heat and power output increased on average by 3% and 2% respectively. In 2020, electricity generation decreased by 1%, which can be explained by Covid-19 pandemic.





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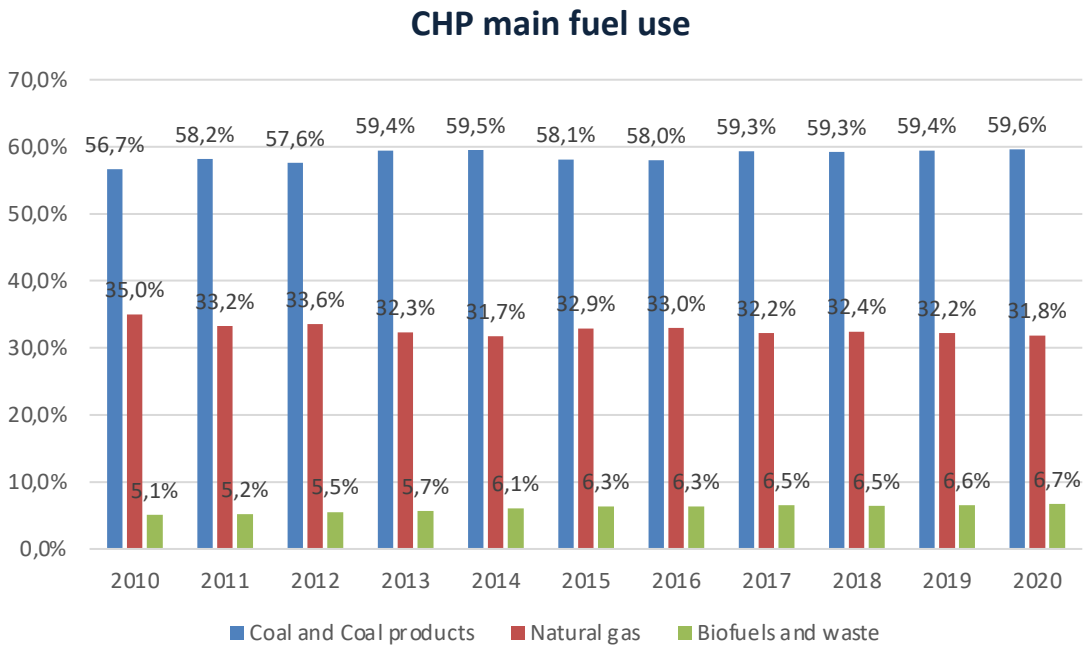
CHP Fuel Mix



Commentary:

- 98% of the fuel mix is made of 3 fuels: **coal, natural gas and biofuels & waste.**
- Coal continues to lead at c. **60%**, and its share is still relatively stable (slight increase since 2018).
- Natural gas share is also stable around **32%.**
- Biofuel share is around **6%** and grows slowly.

Future trends:

- Gradual phaseout of coal, however very slow
- Electrification of industry
- Hydrogen CHP technology gradually gaining ground → acceptance is rising, but economics not yet.

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EUROPE

Data completeness: Complete
Data sources:

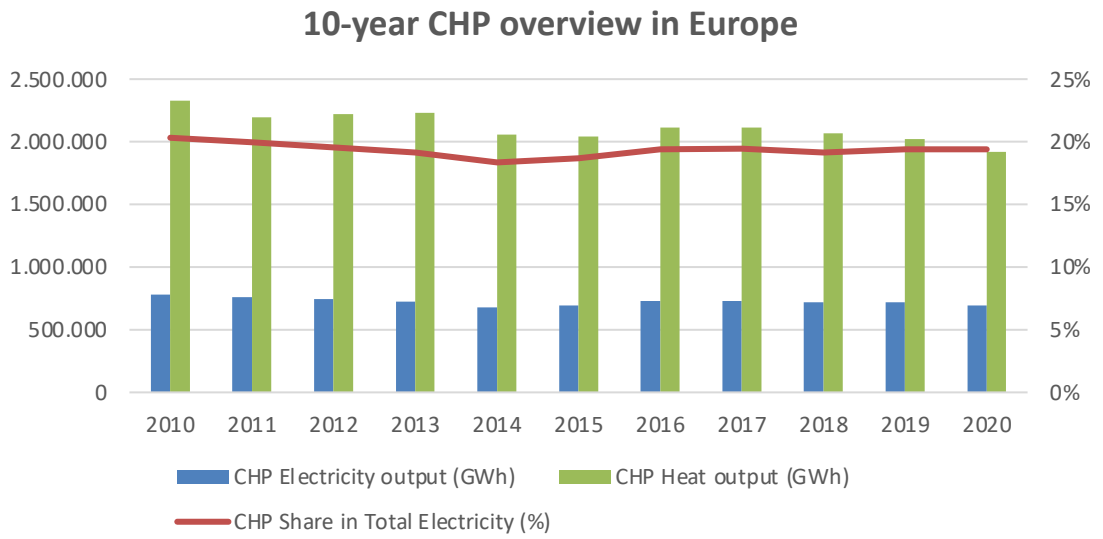
- *IEA 2022 (data until 2020) for all European countries (slide 6)*
- *Eurostat 2023 (data until 2021) for EU 27 (slides 7; 8 & 9)*

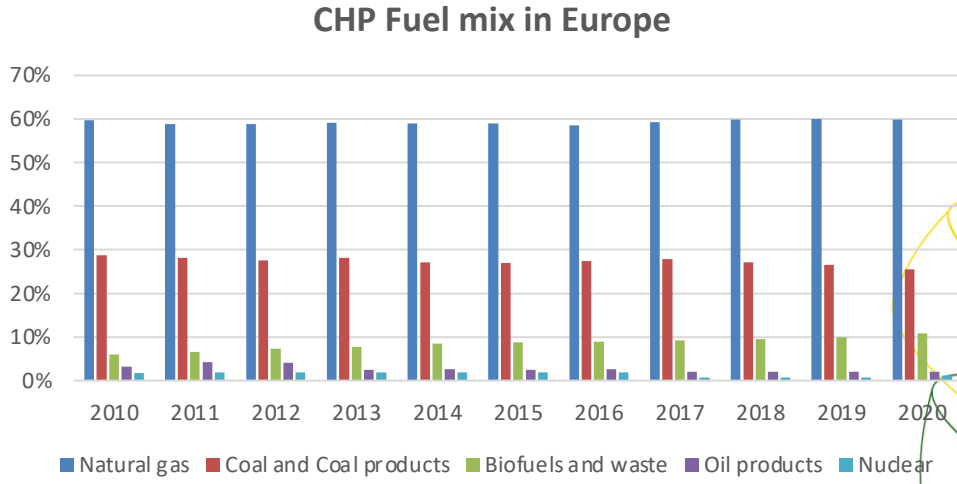
Europe

Electricity produced by CHP plants in 2020:

693TWh

- CHP share in total electricity generation is overall stable at around 19%.
- However, electricity from CHP is declining, as well as heat generation.
- The main fuels are **natural gas and coal**, followed by biofuels and waste. Natural gas has a stable share of 60%; coal is declining at a very slow rate (-3% in 10 years); biofuels and waste have a modest growth trend (+5% in 10 years).





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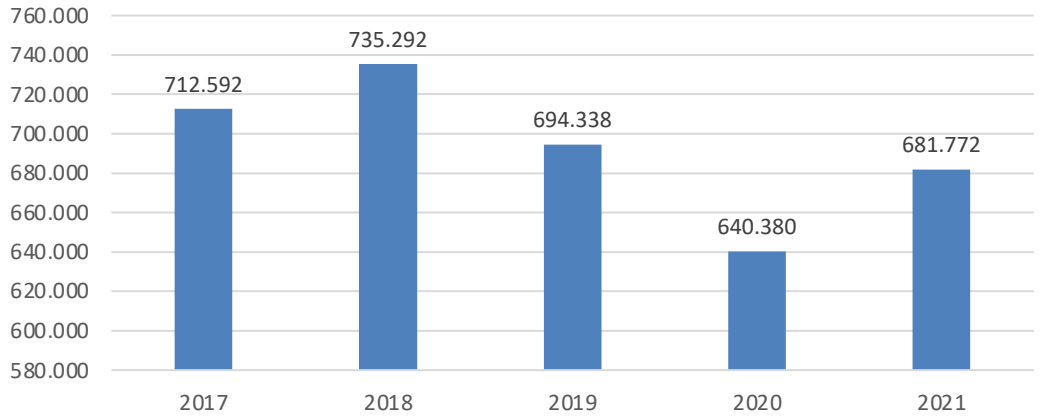
EU 27

Electricity produced by CHP plants in 2021:

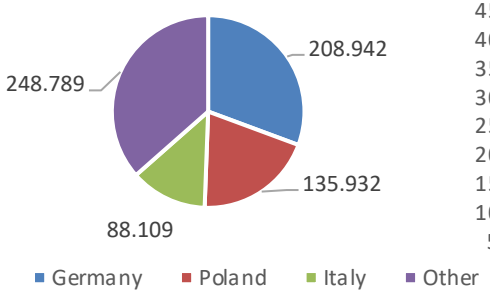
682TWh

- Gross electricity production in CHP plants is declining. The decrease was much more pronounced in 2020 due to COVID-19 pandemic. Generation went up in 2021, however it is still lower than in 2019.
- Germany is the biggest CHP market, representing c. 31% of total CHP electricity production in EU, followed by Poland (20%) and Italy (13%). Together they represent 64% of total CHP market.
- CHP in EU faces challenges related to fossil fuel use & CO2 emission limits and uncertainties due to unpredictable gas prices.

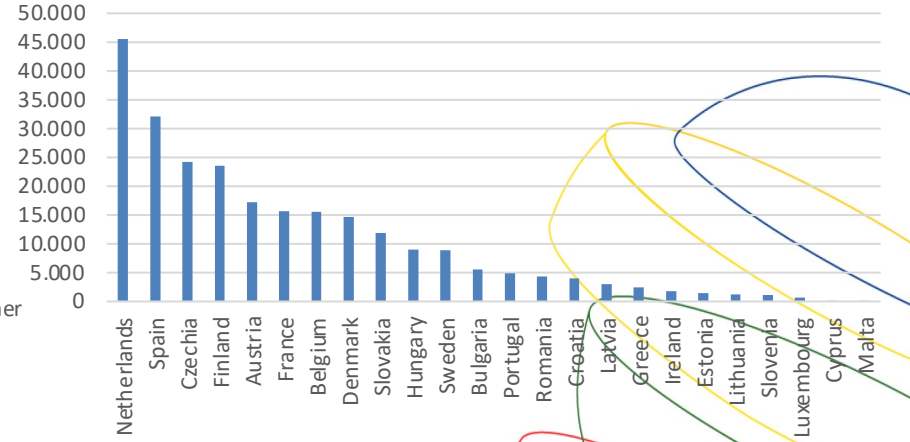
Gross Electricity Production by HE CHP Plants in EU 27 (GWh)



CHP Gross Electricity Production by CHP Plants (GWh) in 2021 - TOP 3 countries



CHP Gross Electricity Production by CHP Plants (GWh) in 2021 – Other EU countries



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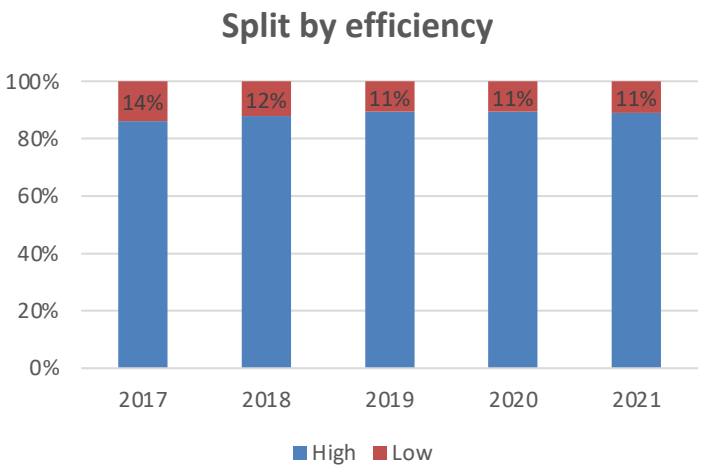
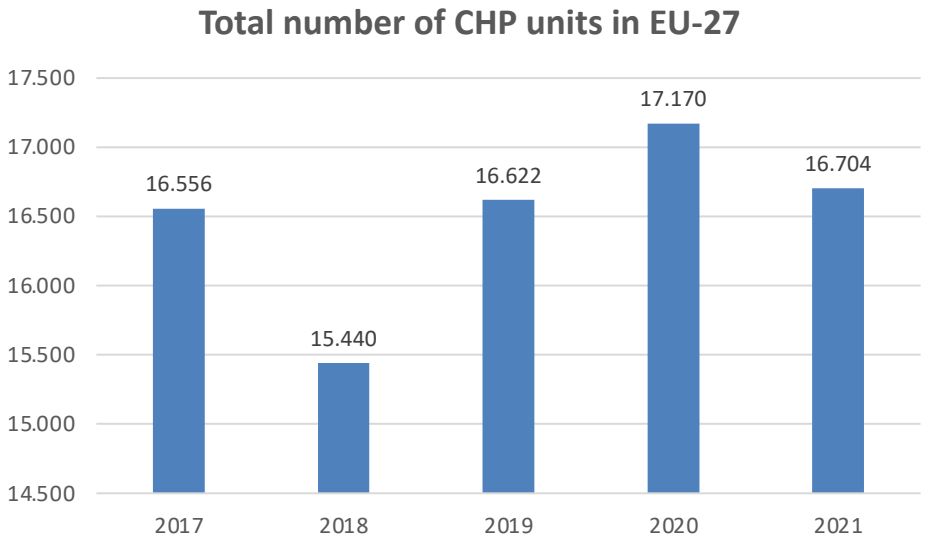
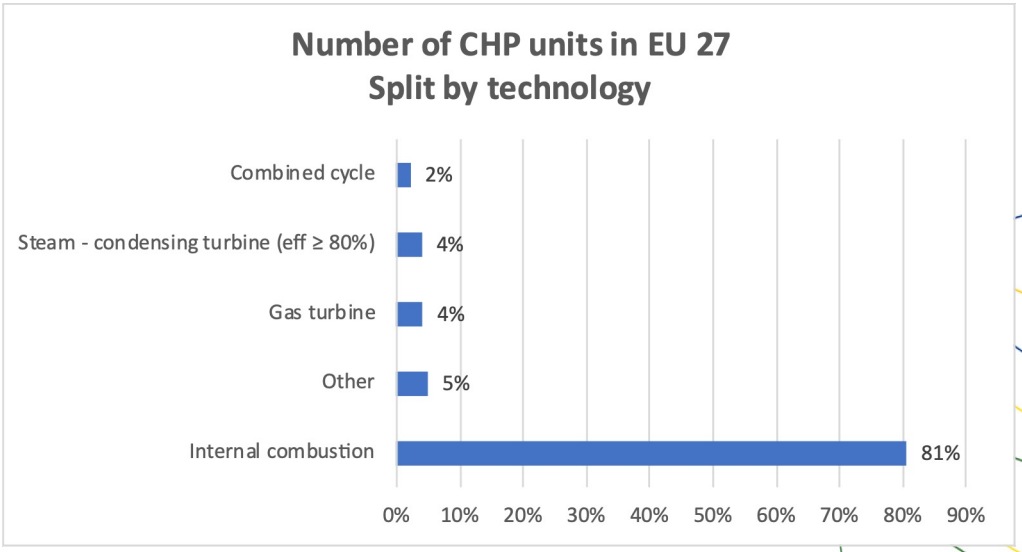
EU 27





- High efficiency CHP represents on average 88% of total CHP-generated electricity. This % has slightly increased over years (86% in 2017; 89% in 2021).
- In terms of technology, internal combustion engines dominate the market with 81% of total installed units.



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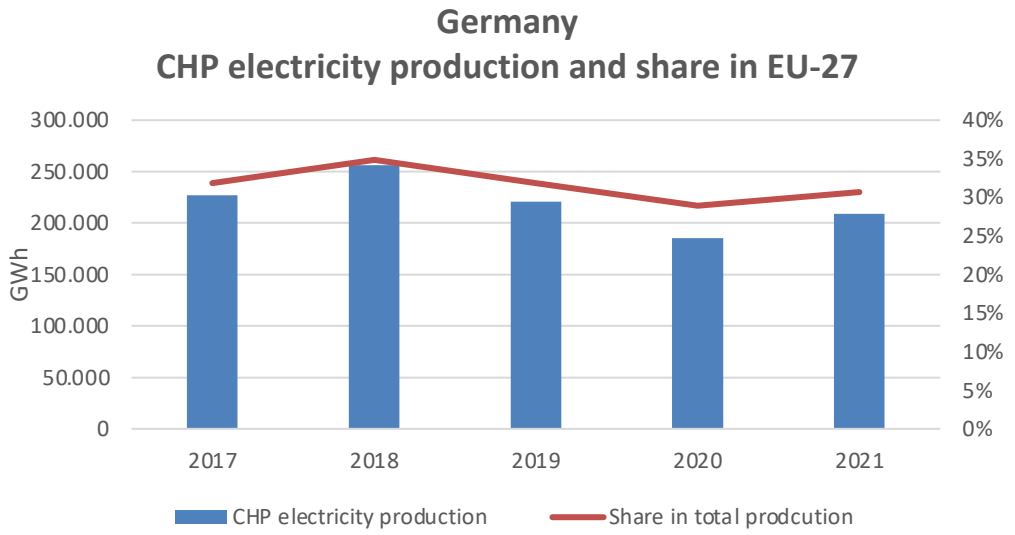
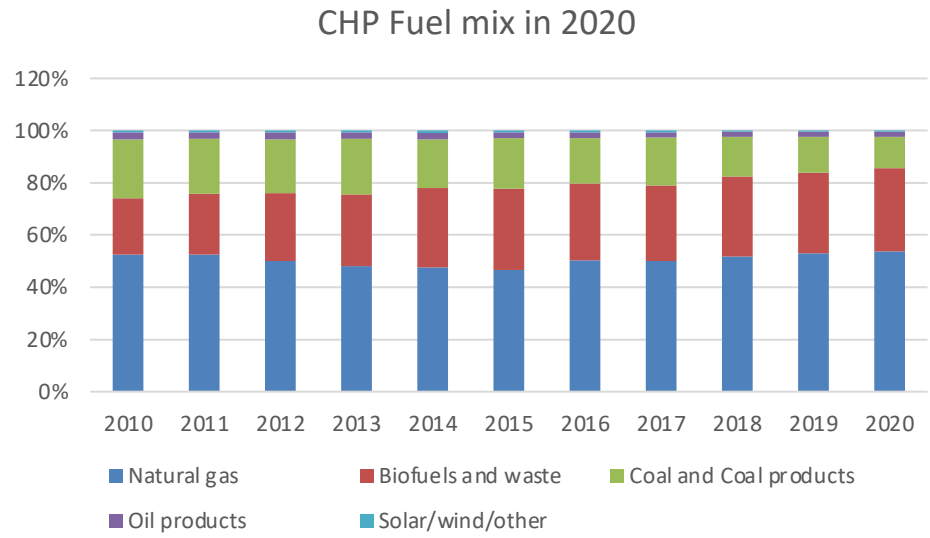
Germany

Electricity produced by CHP plants in 2021:

209GWh

- Germany is the biggest CHP market in EU with c. 31% of total CHP electricity production in EU-27. After some decline in 2019 and 2020, electricity production has slightly increased in 2021.
- In fuel mix natural gas is the main fuel with c.54% share, followed by biofuels and waste (22% in 2010; 32% in 2020). Coal is the 3rd fuel, and its share is decreasing continuously (22% in 2010; 12% in 2020).





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NORTH AMERICA

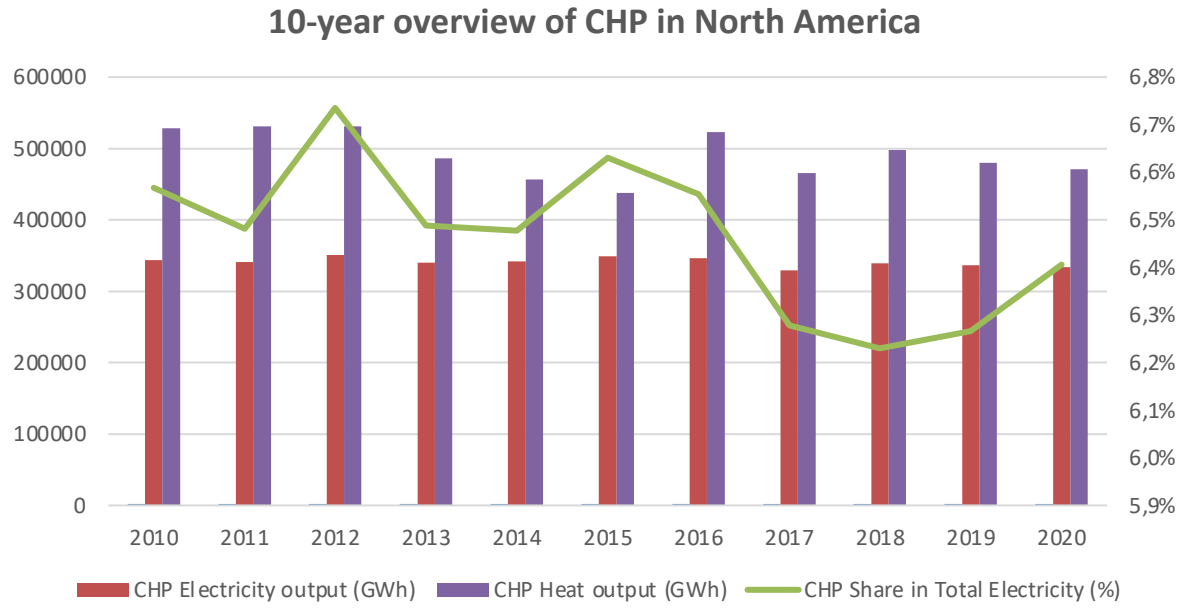
Data completeness: complete
Data sources: IEA 2022

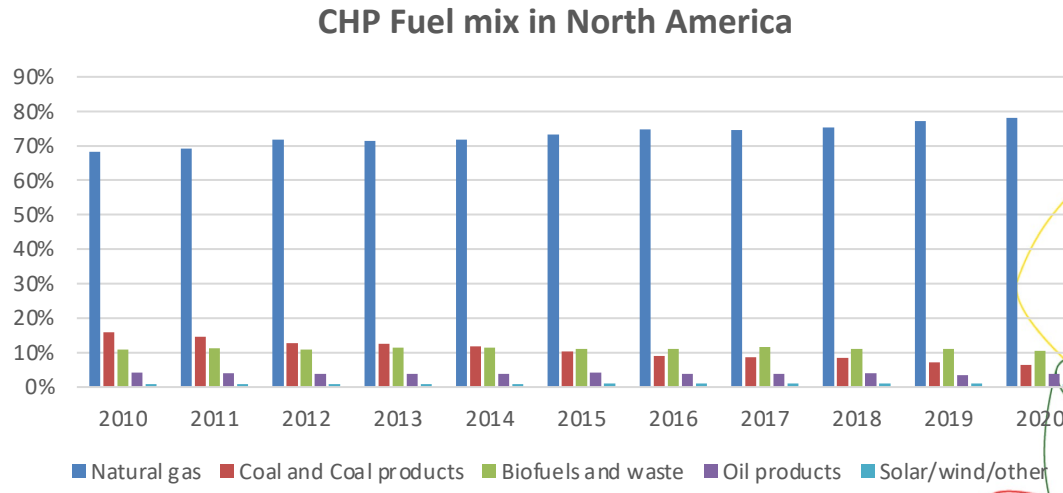
North America

Electricity produced by CHP plants in 2020:

333TWh

- CHP electricity output is relatively stable, with a slight decreasing trend since 2019.
- CHP electricity share is c.**6.5%** since 2010.
- The main fuel currently used for CHP in North America is **natural gas**, followed by **biofuels and waste**, **coal and oil**. There is also a small share of solar/wind. Coal is steadily decreasing (from 16% in 2010 to 7% in 2020); natural gas is increasing (from 68% in 2010 to 78% in 2020); biofuels and oil products are stable (11% and 4% respectively).





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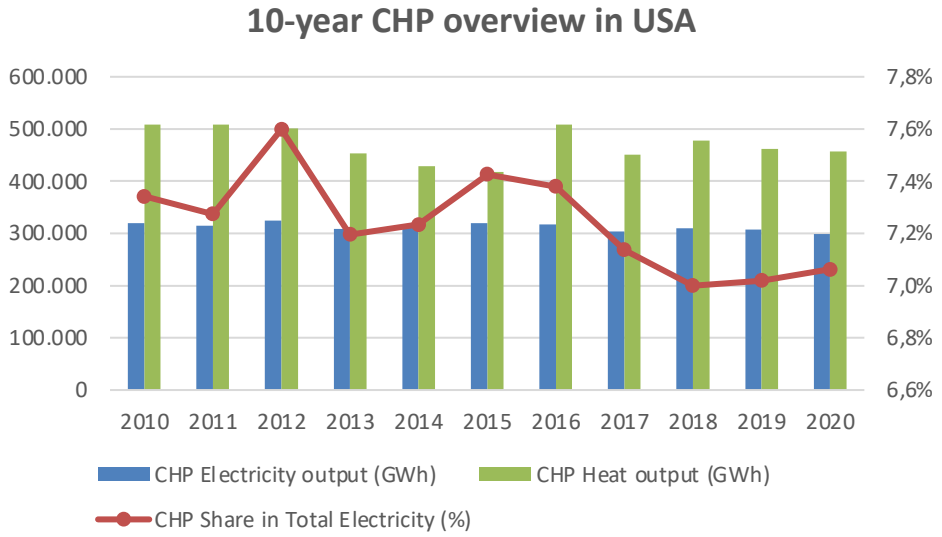
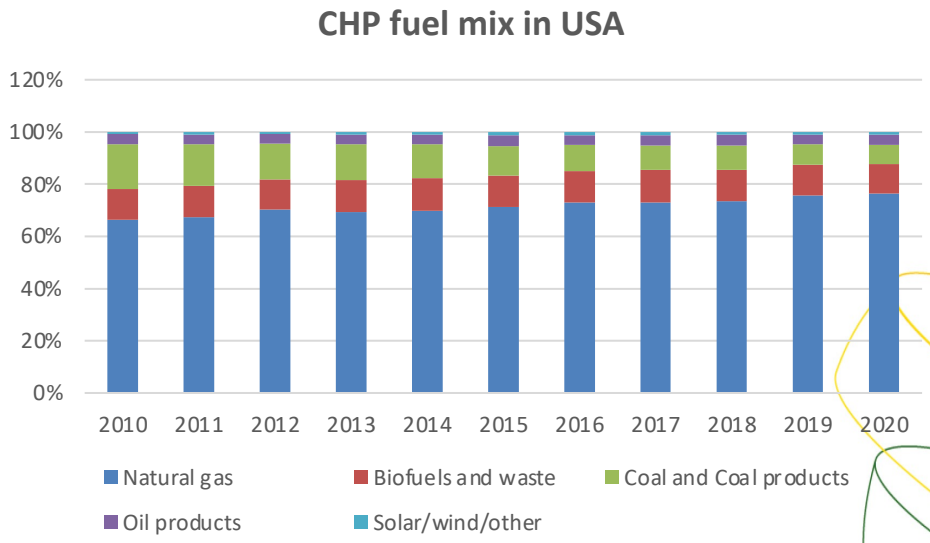
USA

Electricity produced by CHP plants in 2020:

299TWh

- USA is the biggest CHP market in Northern America with 90% of CHP electricity production in the region. CHP electricity has a downward trend in the USA.
- The impact of the Inflation Reduction Act may reverse this trend, but it is too early to see in the statistics.
- Fuel mix is dominated by natural gas (c.76% in 2020) which has been increasing since 2010. Biofuels and waste are in 2nd place, their share is stable(c.11%), while coal share is declining (17% in 2010; 7% in 2020).





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CENTRAL / SOUTH AMERICA

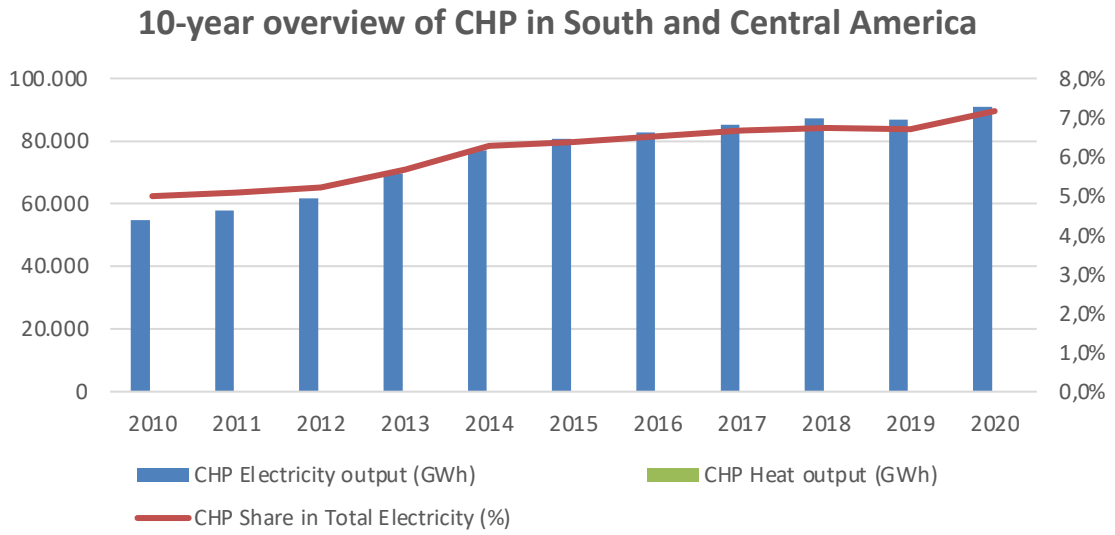
Data completeness: incomplete
Data sources: IEA (2022)

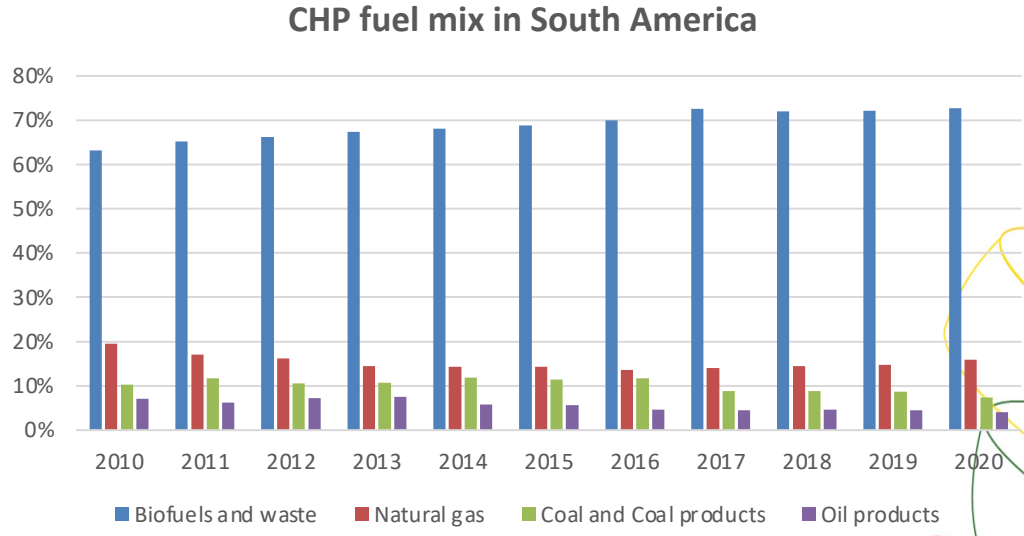
South America

Electricity produced by CHP plants in 2020:

91TWh

- CHP electricity generation has an increasing trend. Its current share in total electricity generation is c. 7% (up from 5% in 2010). Heat generation data are missing.
- **Biofuels and waste** clearly dominate the CHP fuel mix in South America (73% in 2020, up from 63% in 2010). It is followed by natural gas and coal (slowly declining).





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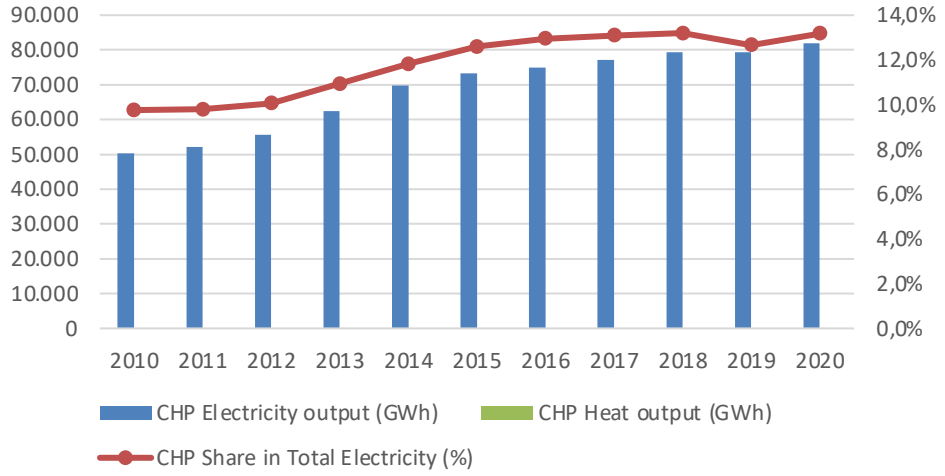
Brazil

Electricity produced by CHP plants in 2020:

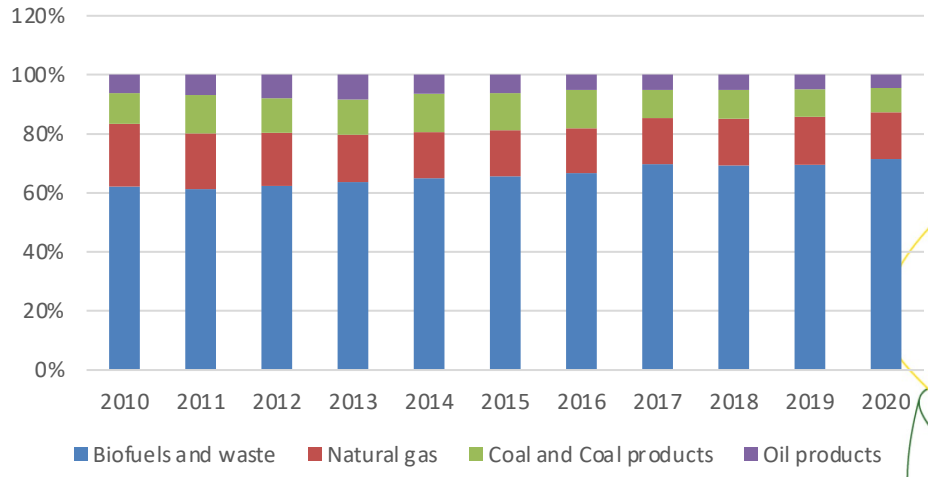
82TWh

- With c.90% share in total CHP electricity production in South America, Brazil is the largest CHP market in the region. CHP electricity generation has an increasing trend. Its current share in total electricity generation is c. 13% (up from 10% in 2010). Heat generation data are missing.
- **Biofuels and waste** are the main fuel with 72% (growing), followed by natural gas (relatively stable share – 16%), coal (c.8%, declining) and oil (c.5%, declining).

10-year CHP overview in Brazil



CHP fuel mix in Brazil



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ASIA

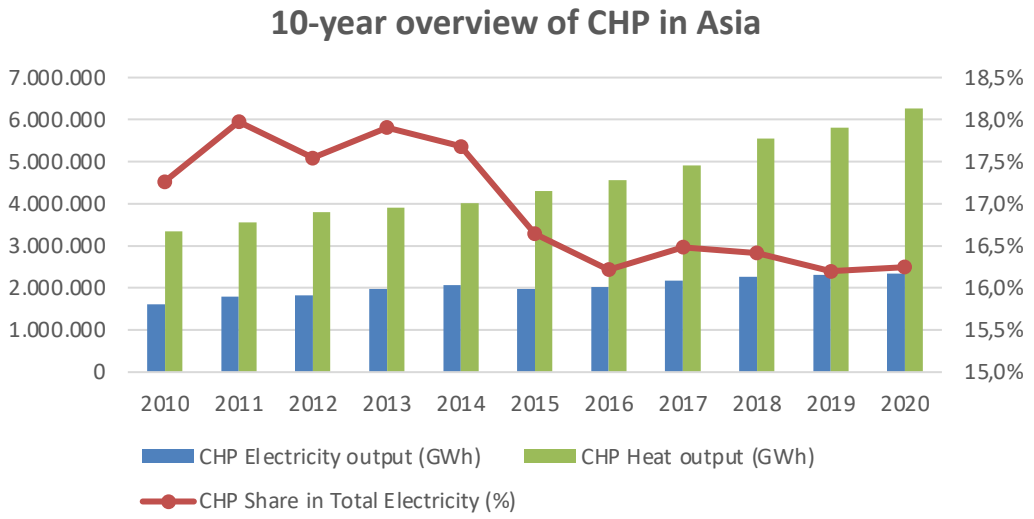
Includes Australia, New Zealand and Oceania
Data completeness: complete
Data sources: IEA (2022)

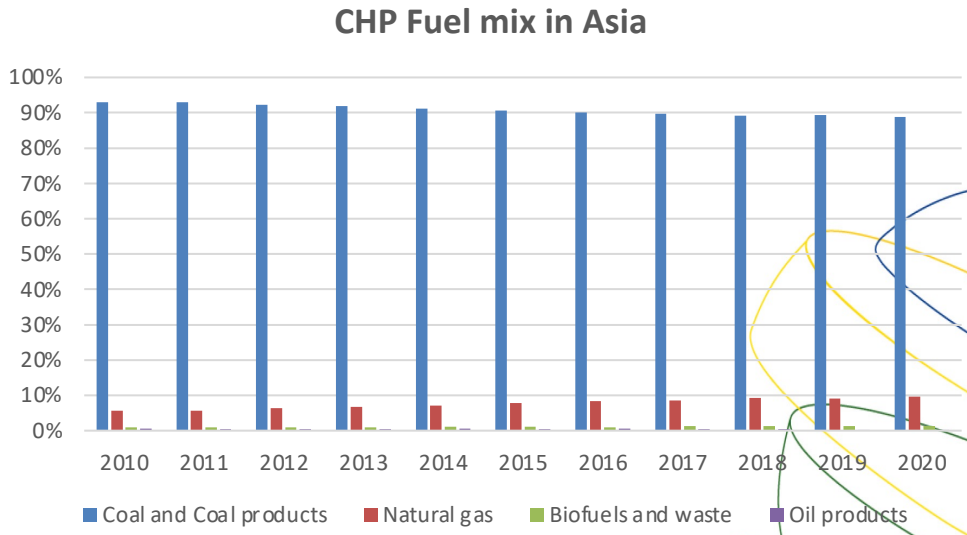
Asia

Electricity produced by CHP plants in 2020:

3,000TWh

- Electricity and heat output from CHP are constantly increasing. However, CHP share in total electricity generation has a downward trend and is currently c.16%**.**
- Asia's main fuel remains **coal (c.90%),** and this is due to China's very high consumption of coal to power CHP. The rest of the fuel used in Asia is almost exclusively natural gas and a tiny % of biofuels (1%).





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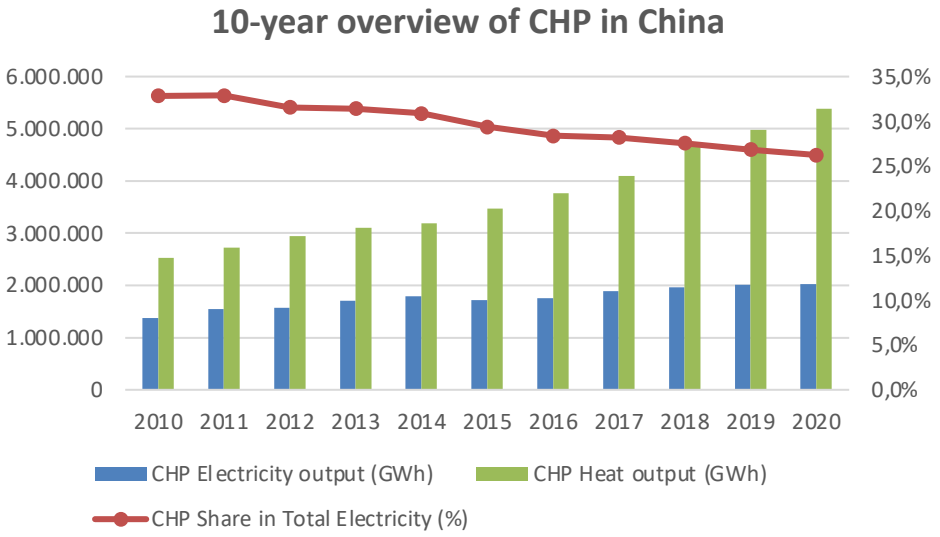
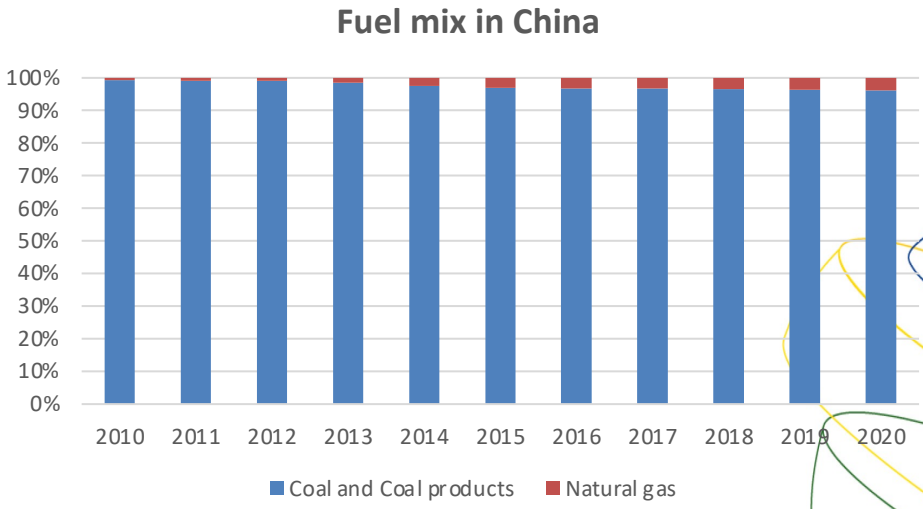
China

Electricity produced by CHP plants in 2020:

2,029TWh

- China is the largest CHP market in the world and represents c.87% of Asian CHP market. CHP constantly increasing. Despite the continuous increase of CHP electricity and heat, CHP electricity share in total electricity generation is decreasing which means that other technologies are prioritised over CHP.
- CHP in China almost entirely relies on **coal (c.96%),** its share has been slowly declining and gets replaced by natural gas (c.4%).





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AFRICA

Data completeness: incomplete
Data sources: IEA (2022)

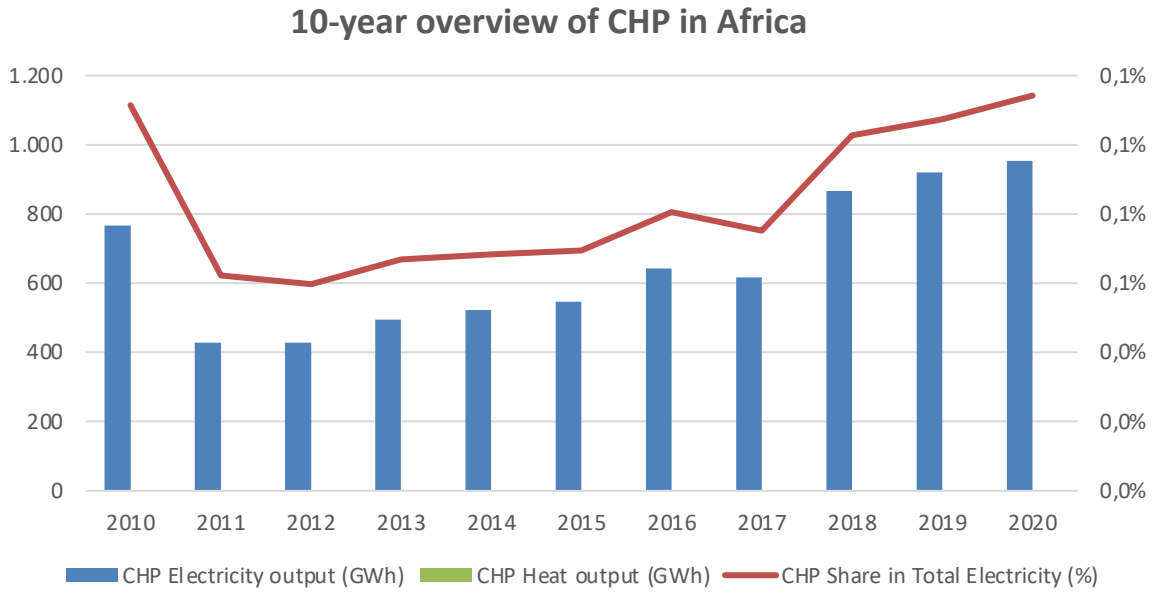
Africa

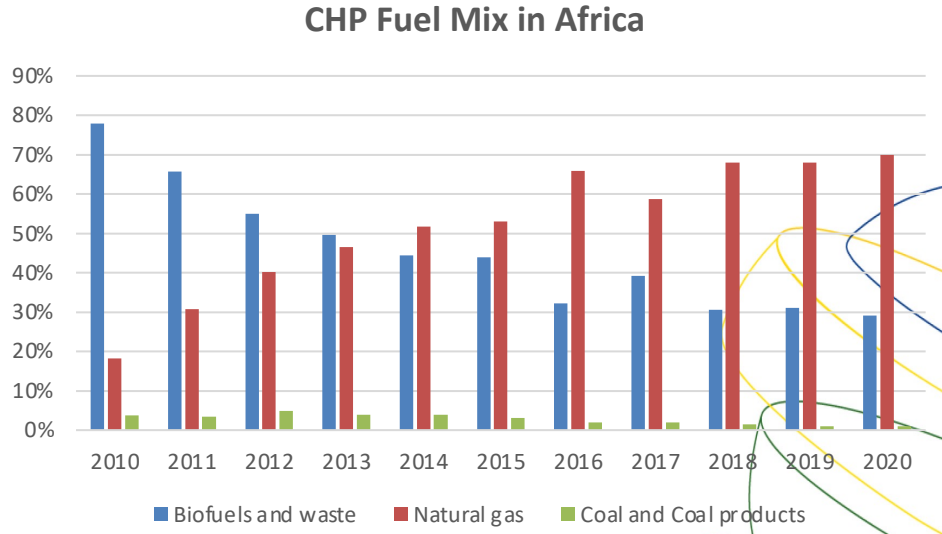
Electricity produced by CHP plants in 2019

953GWh

- Upward trend in CHP electricity output. No data on CHP heat output.
-
- The share of CHP electricity output in the total electricity generation is negligeable. Even if electricity output from CHP is increasing, its total share is below 1%.

- CHP is powered with **natural gas, biofuels and waste and very small amount of coal**. Natural gas is gradually replacing biofuels whose share went down from 78% in 2010 to 29% in 2020.





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Current and future trends of the CHP Market

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Current and future trends of CHP Market

	Geography	Technology	Fuel	Size	End-Users
Current situation	Asia Pacific is the largest and the fastest growing market in the world. Europe and North America have a developed, but stagnating CHP market.	Gas and steam turbines are the two main technologies on the market.	Coal and natural gas are currently the most used fuels in the world. Biofuels & waste are still marginal.	Large capacity units still dominate the market because of their extensive use in industrial sector (refineries, chemical plants etc…)	Industries such as refineries, chemicals, pulp and paper, food and beverages are currently the main end-users of cogeneration. Commercial and residential facilities (hospitals, universities, district heating) in lesser measure.
Forecast	Growth will come from Asia (India, China) due to industrial expansion Growth in South America expected to continue. Growth in US from IRA stimulus On the contrary, Europe will see CHP role diminish, at best stagnate, due to current oil/gas prices and tighter GHG emissions norms.	Fuel cells are expected to be increasingly used in the next years, as it is a technology with clean by-products (water and heat). Micro-CHP fuel cell have already emerged on the market. Larger CHP fuel cells begin to be installed in the US, Japan and South Korea.	Transition from coal-based generation to cleaner sources is assumed, but low. Gas should still have an important part to play because of its relatively low greenhouse emissions compared to coal and oil. However, due to current geopolitical situation, unstable and unpredictable oil and gas prices, the share of new CHP running on fossil gas will eventually drop. More stringent GHG emission standards will also penalise gas fired CHP, worsening the business case. While it is expected to observe an increase in use of renewable sources, this will be marginal and cannot fully replace coal and gas as CHP fuels. Hydrogen should experience a rapid growth linked to the fuel cell emergence in the CHP sector. However, in short and medium term the business case will not be strong.	High demand for smaller size units (up to 10MW) from residential and commercial end-users. Use of Micro-CHP to replace domestic boilers. Industrial demand drive larger units	Increase in the commercial and residential CHP installations: CHP as a key technology for city and district level utilities. Power and heat produced by utilities can be used on-site, distributed to the local facilities or transmitted to the grid/district heating.

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