

Decentralised Energy Systems webinar series: An Overview of the CHP Market

1st episode – 26 October 2023

Welcome session

ETN Webinar - “An overview of the CHP market”

Webinar content & speakers

- **Overview of Cogeneration Around the World with a Special Focus on Europe** (Hans Korteweg – Managing Director, COGEN Europe & Executive Director, COGEN World Coalition)

- **Between Efficiency and Net Zero: The Changing Face of the UK CHP Market** (Oz Russell – Industrial Policy Officer, The Association for Decentralised Energy Systems)





COGEN
WORLD COALITION

COGEN World Coalition (CWC)

Global CHP Market Overview

Aims



To create and foster dialogue with relevant intergovernmental organizations including the United Nations (UN), International Energy Agency (IEA), World Trade Organization (WTO), World Bank, International Monetary Fund (IMF), etc.



To support initiatives in order to lobby policymakers and regulators; to exchange, discuss and develop positions on issues of common interest including energy efficiency, climate change, sustainable development, financing and more.



To connect companies, entrepreneurs, associations and professionals active in the field of energy efficiency; to exchange information and experiences related to cogeneration technology; to promote a wider use of cogeneration worldwide.



To support the establishment and development of national and continental associations / networks linked to cogeneration.

Members

National Associations



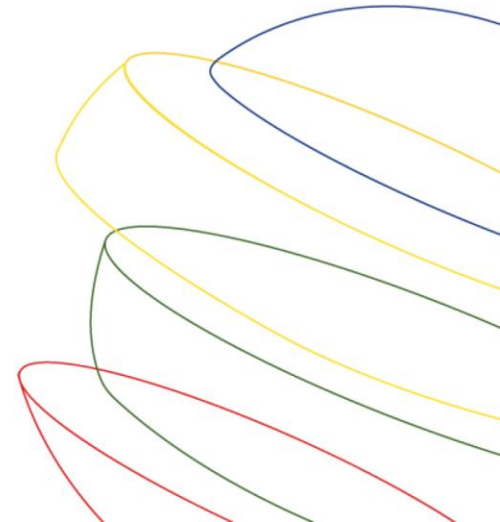
Corporate



CHP World Overview



www.cogenworld.org

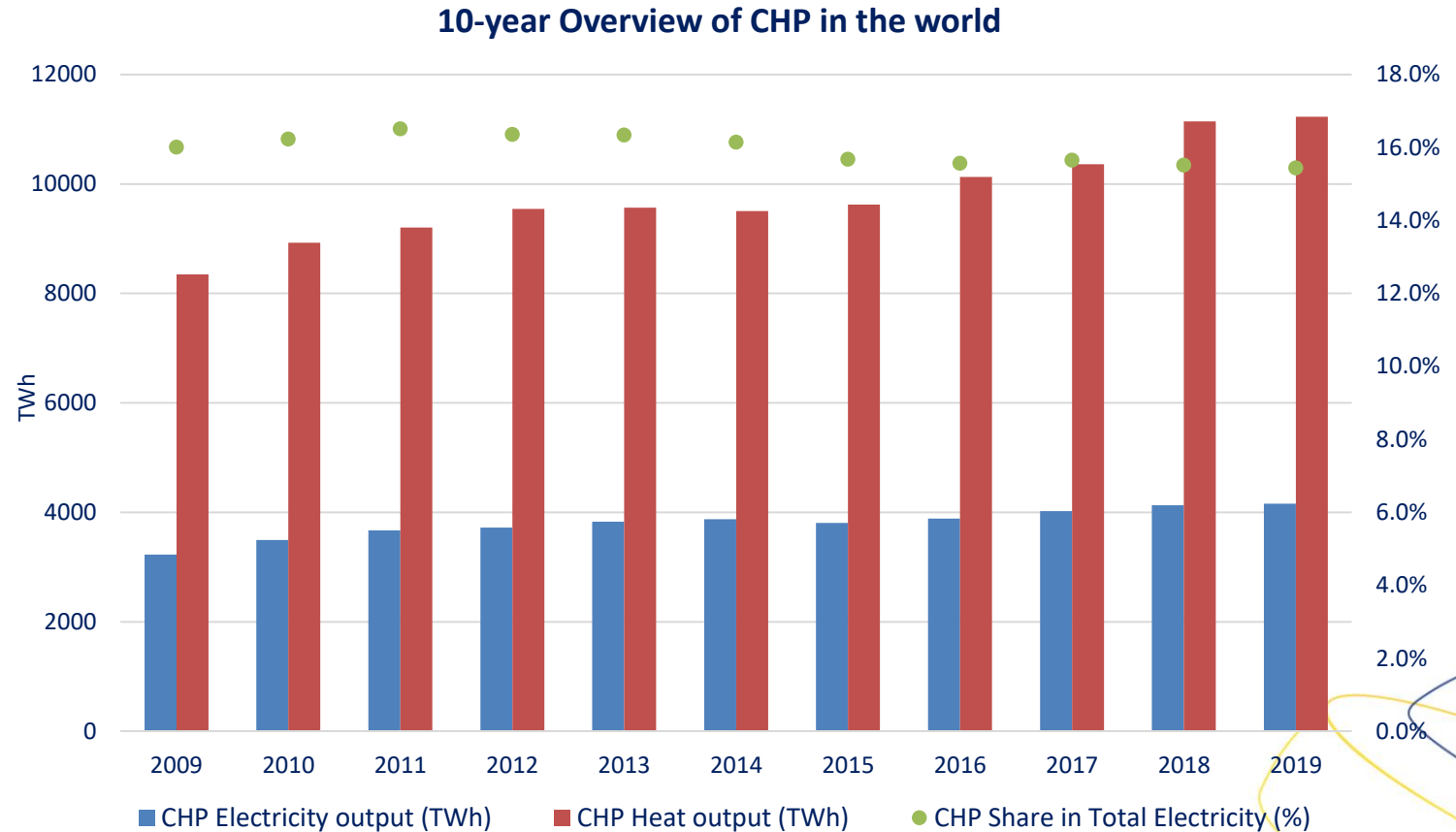


World

Electricity produced by CHP plants in 2019:

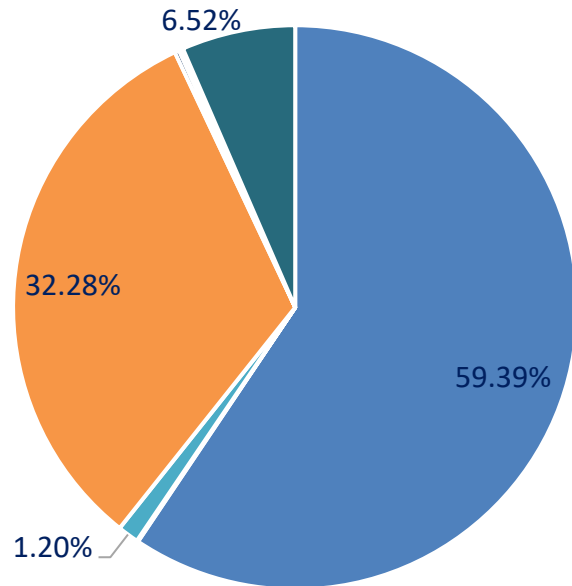
4,159 TWh

- Electricity generation values from IEA database include condensing parts which may lead to overestimated values.
- We can observe an **increase of the CHP electricity output of almost 1,000TWh between 2009 and 2019.**
- During the given period, **CHP Heat output went up from 8400TWh to 11200TWh.**
- On the contrary, **the share of CHP in the total electricity generation has slightly decreased.**



CHP Fuel Mix

CHP Fuel Mix in the World



■ Coal and Coal products ■ Oil products ■ Natural gas ■ Biofuels and waste

Proportion of the other fuels:

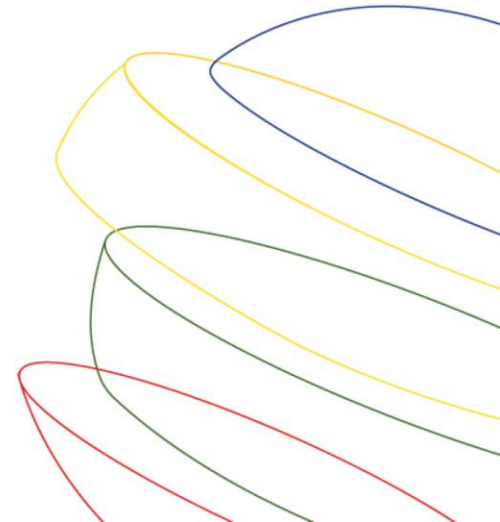
- Peat and peat products 0.08%
- Oil shale and oil sands 0.01%
- Nuclear 0.27%
- Geothermal 0.12%
- Solar/Wind/other 0.11%

Commentary:

- Fossil fuels continue to dominate with coal leading at 60%
- Biofuel is a growing share, now at ~6%
- 95% of the fuel mix share is held by 3 fuels: coal, natural gas and biofuels and waste.

Future trends:

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

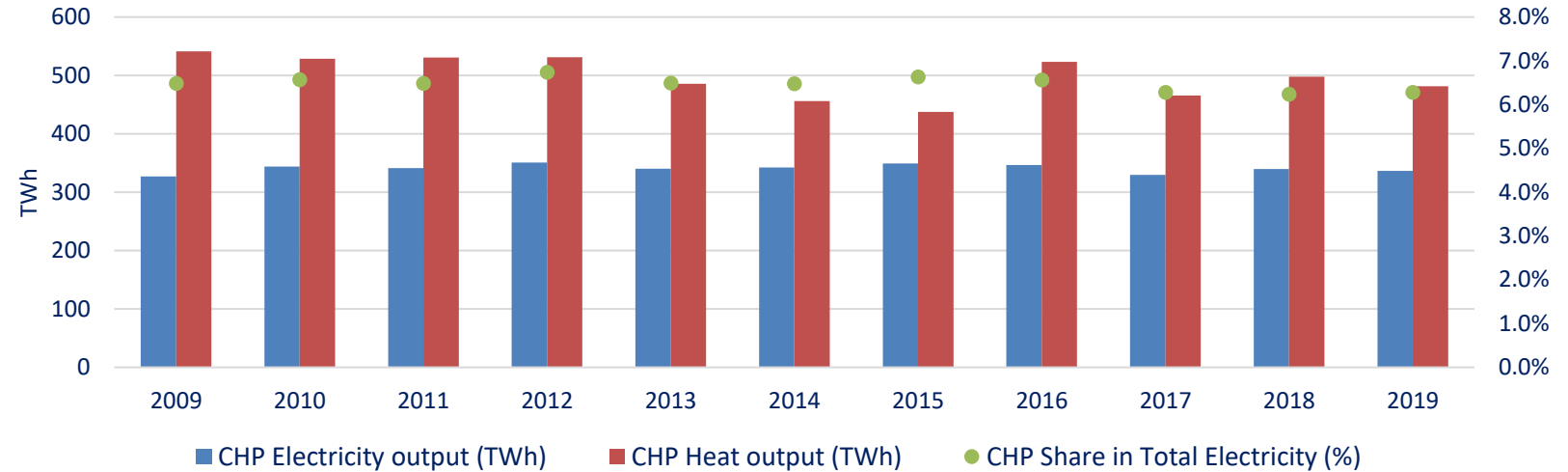


North America

10-year Overview of CHP in North America

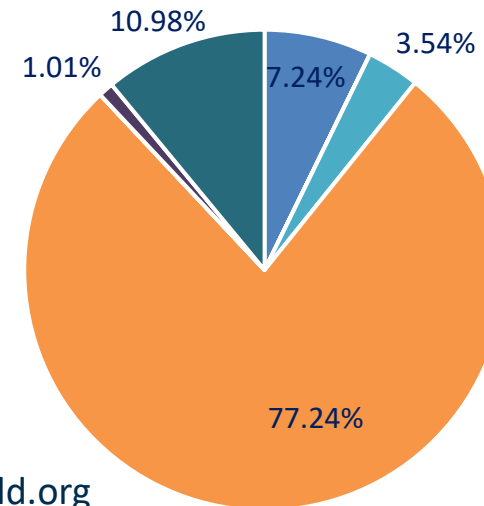
Electricity produced by CHP plants in 2019:

336TWh



- Little variation of the electricity output (**between 325 and 350TWh**).
- CHP's electricity share remains stagnant at **~6.5%** since 2008
- The main fuel used for CHP in North America is **natural gas**, followed by biofuels and waste, and coal. We can notice a small share of solar/wind/other in the CHP fuel mix.

CHP Fuel Mix in North America



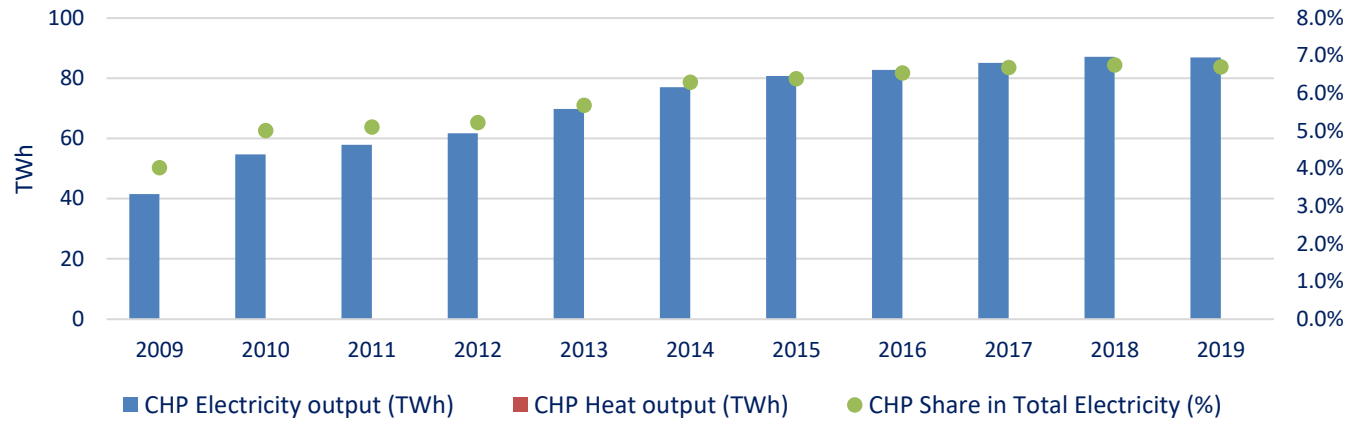
- Coal and Coal products
- Oil products
- Natural gas
- Solar/wind/other

South America

Electricity produced by CHP plants in 2019:

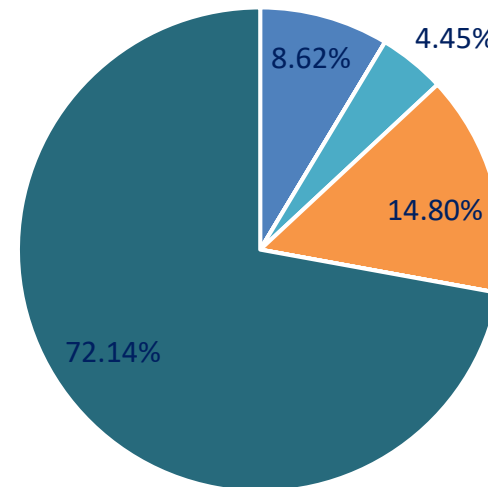


10-year Overview of CHP in South America



- In ten years, the CHP electricity output of South America doubled from 40TWh to 87TWh.
- During the same time, the share of CHP electricity gained 3%. In 2019 it was 6.7%.
- **Biofuels and waste** category clearly dominates the CHP fuel market in South America. It is followed by natural gas and coal.
- According to IEA data, South America experienced the largest growth rate in the world in term of CHP electricity output during the given period (2009-2019).

CHP Fuel Mix in South America



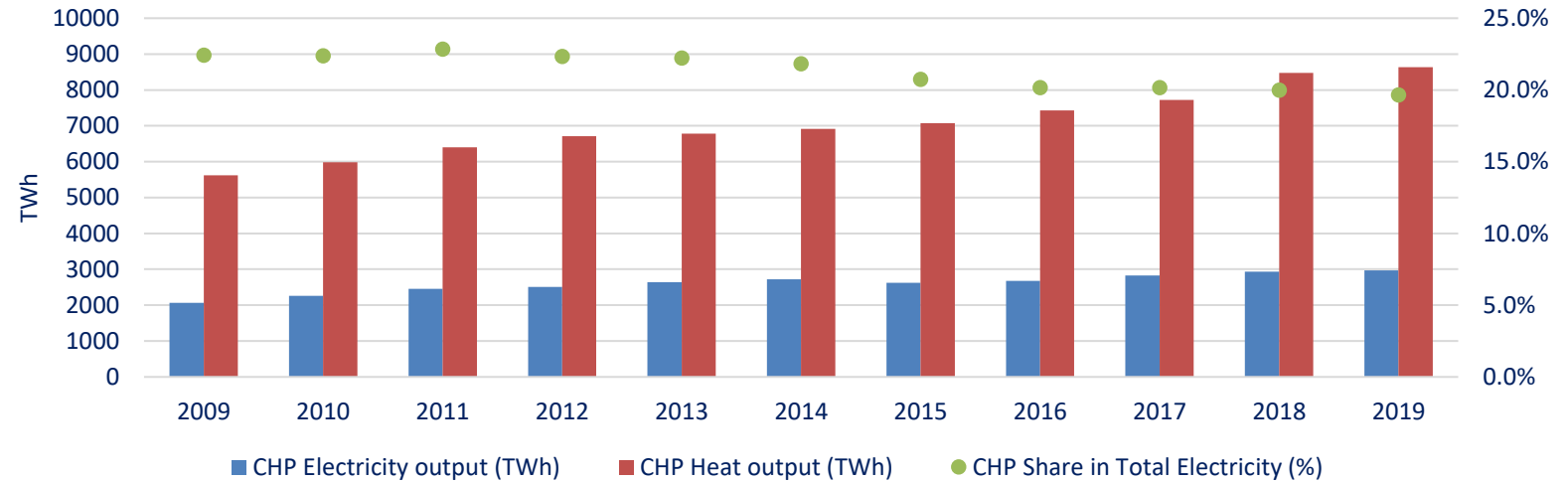
- Coal and Coal products
- Oil products
- Natural gas
- Biofuels and waste

Asia

Electricity produced by CHP plants in 2019:

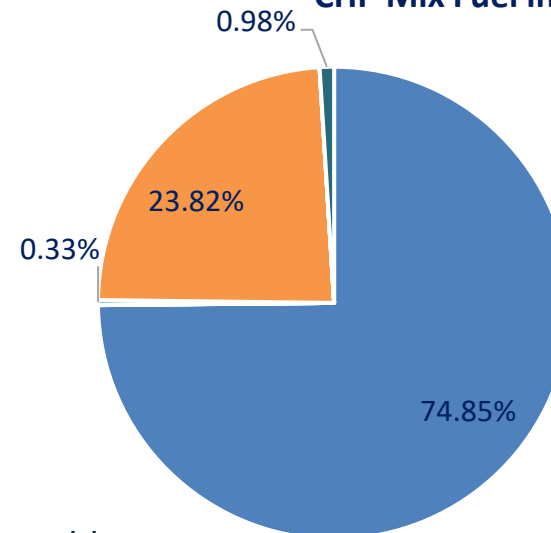


10-year Overview of CHP in Asia



- Increase of the electricity output from **2,000 TWh** to **almost 3,000TWh**.
- Despite an increase in output, CHP's share of electricity has decreased steadily since 2013 **from 22% to 19%**.
- Asian electricity markets are prioritising other technologies for development.
- Asia's main fuel remains **coal**, 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.

CHP Mix Fuel in Asia



- Coal and Coal products
- Oil products
- Natural gas
- Solar/wind/other
- Biofuels and waste

China

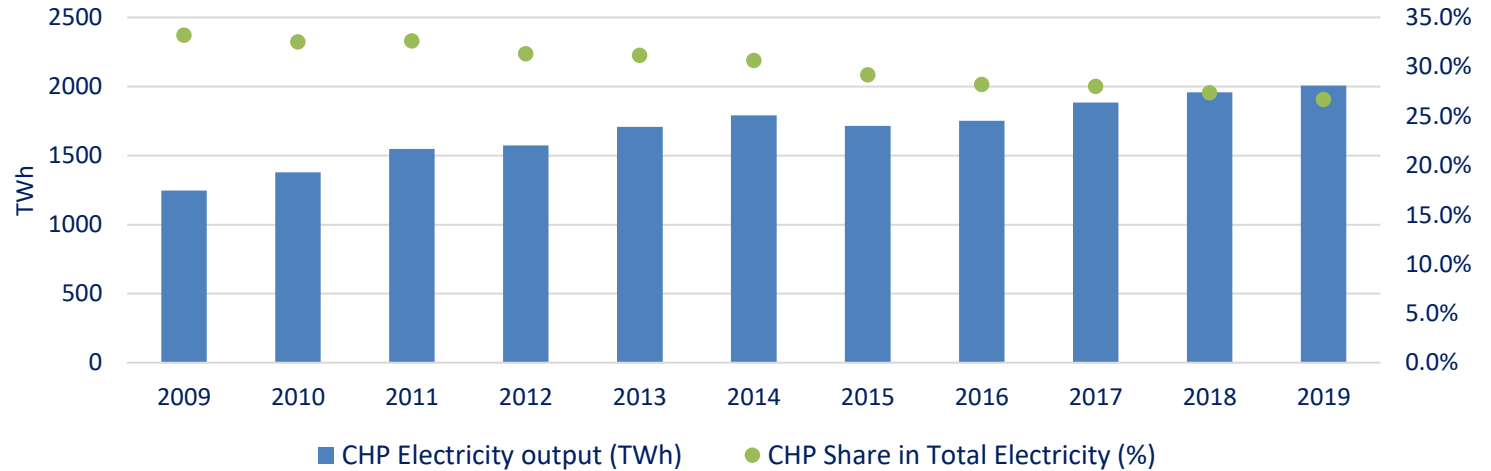
Electricity produced by CHP plants
in 2019:



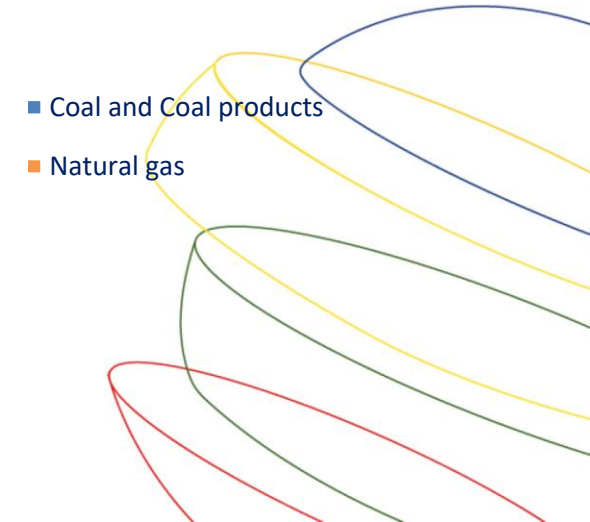
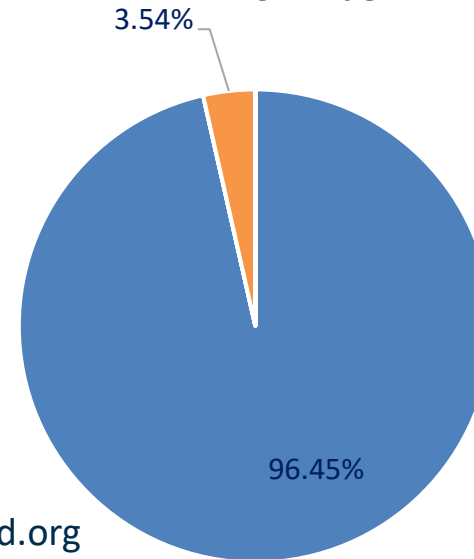
China represents **68%** of all CHP electricity produced in Asia.

- Increase of the electricity output **from 1,100TWh to 2,000TWh**.
- Small decrease of the CHP electricity share in the total electricity generation (**from 33% to 27%**).
- China does not seem to develop its CHP capacity at the same rate as its electricity demand. This suggests that China prioritises other technologies.
- **Coal** largely dominates the CHP fuel market in China. Natural gas has only a share of less than 4%.

10-year Overview of CHP in China



CHP Fuel Mix in China

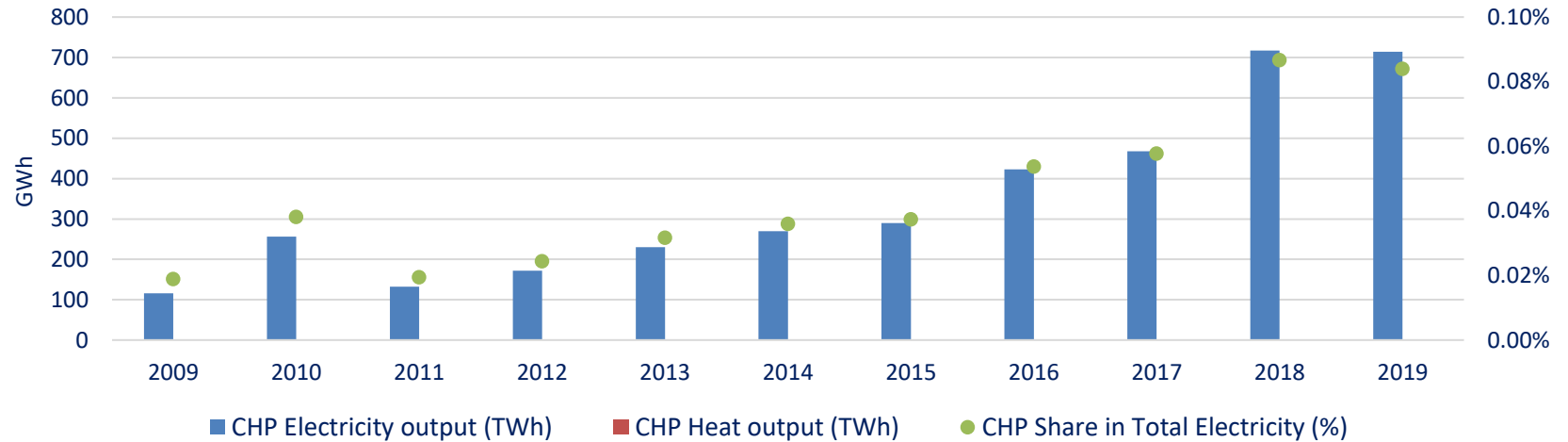


Africa

Electricity produced by CHP plants in 2019

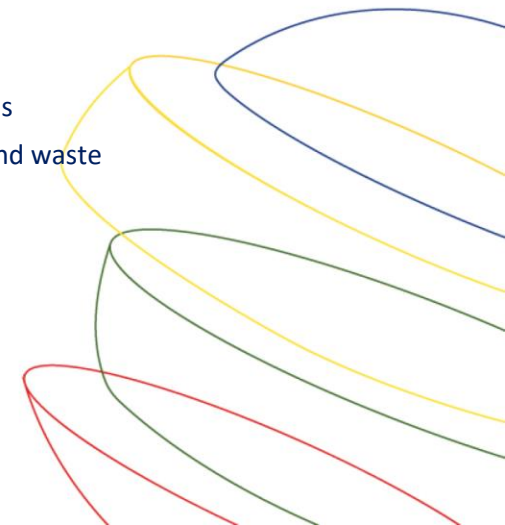
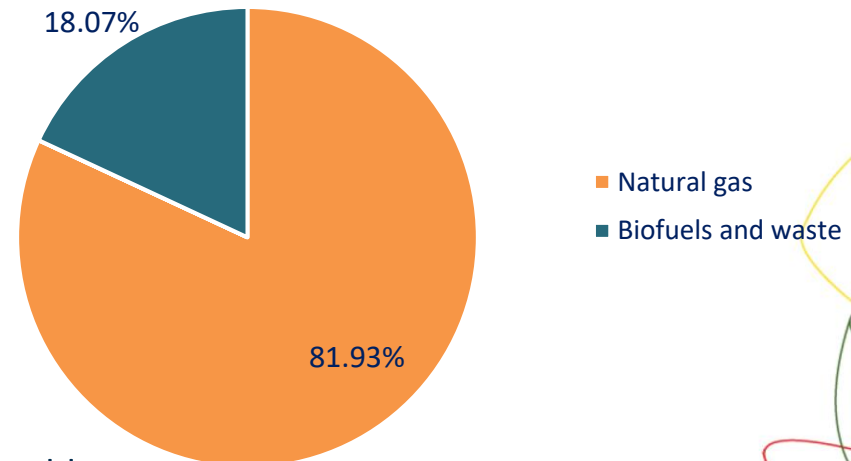


10-year Overview of CHP in Africa



- Increase of the CHP electricity output from **110GWh to 714GWh**.
- The share of CHP electricity output in the African electricity generation is insignificant. In 2019 it was **c.0.08%**.
- According to the Energy balance table of Africa (IEA), CHP is powered with **biofuels and waste and natural gas**.
- No complete data from the IEA to do analysis by African countries.

CHP Fuel Mix in Africa



Current and Future Trends of the CHP Market

	Geography	Technology	Fuel	Size	End-Users
Current Situation	<p>Asia Pacific accounted for a 55.7% share of the CHP market in 2020.</p> <p>Europe and North America have also a developed CHP market.</p>	<p>Gas and steam turbines are the two main technologies on the market.</p>	<p>Natural gas and coal are currently the most used fuels in the world.</p>	<p>Large capacity plants dominate the market because of the important use of CHP in the industrial sector.</p>	<p>Industries such as chemicals or pulp and paper are currently the main end-users of cogeneration.</p> <p>Commercial and residential facilities (hospitals, universities, district heating) in lesser measure.</p>
Forecast	<p>Growth in India and China due to the industrial expansion and technological innovations.</p> <p>A growth in South America, particularly in Brazil, is expected to continue.</p>	<p>Fuel cells are expected to be increasingly used in the next years, as it is a technology with clean by-products (water and heat).</p> <p>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.</p>	<p>A transition from coal-based generation to cleaner powered generation is assumed. Gas should still have an important part to play because of its relatively low greenhouse emissions compared to other fuels. However, some part of the world such as the EU are establishing greenhouse emissions regulations which could be a barrier for new CHP running on fossil fuels.</p> <p>Consequently, it is expected to observe an increase of the use of renewable resources like solar, geothermal or biofuels.</p> <p>Hydrogen should experience a rapid growth linked to the fuel cell emergence in the CHP sector.</p>	<p>High demand for up to 10MW capacity from residential and commercial end-users.</p> <p>Use of Micro-CHP to replace domestic boilers.</p>	<p>Increase in the commercial and residential CHP installations: CHP as a key technology for city and district level utilities. Power or Heat produced by utilities can be used on-site, distributed to the local facilities or transmitted to the grid/district heating.</p>





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COGEN Europe National Snapshot Survey 2022



COGEN
EUROPE The European Association
for the Promotion of Cogeneration

Members

National Associations



Corporate Members



Mission

- **Cross-sectoral voice of the cogeneration industry in Europe.**
- **Work with EU Institutions and stakeholders to shape better policies by:**



**BUILDING A
ROBUST EVIDENCE-
BASE
DEMONSTRATING
THE BENEFITS OF
COGENERATION**



**USING THE
EXPERTISE OF
OUR
MEMBERSHIP**



**ESTABLISHING
STRONG
COALITIONS
AND
PARTNERSHIPS**

Our Vision

The cogeneration sector is committed to creating a resilient, decentralised, carbon neutral European energy system by 2050, with cogeneration as its backbone:

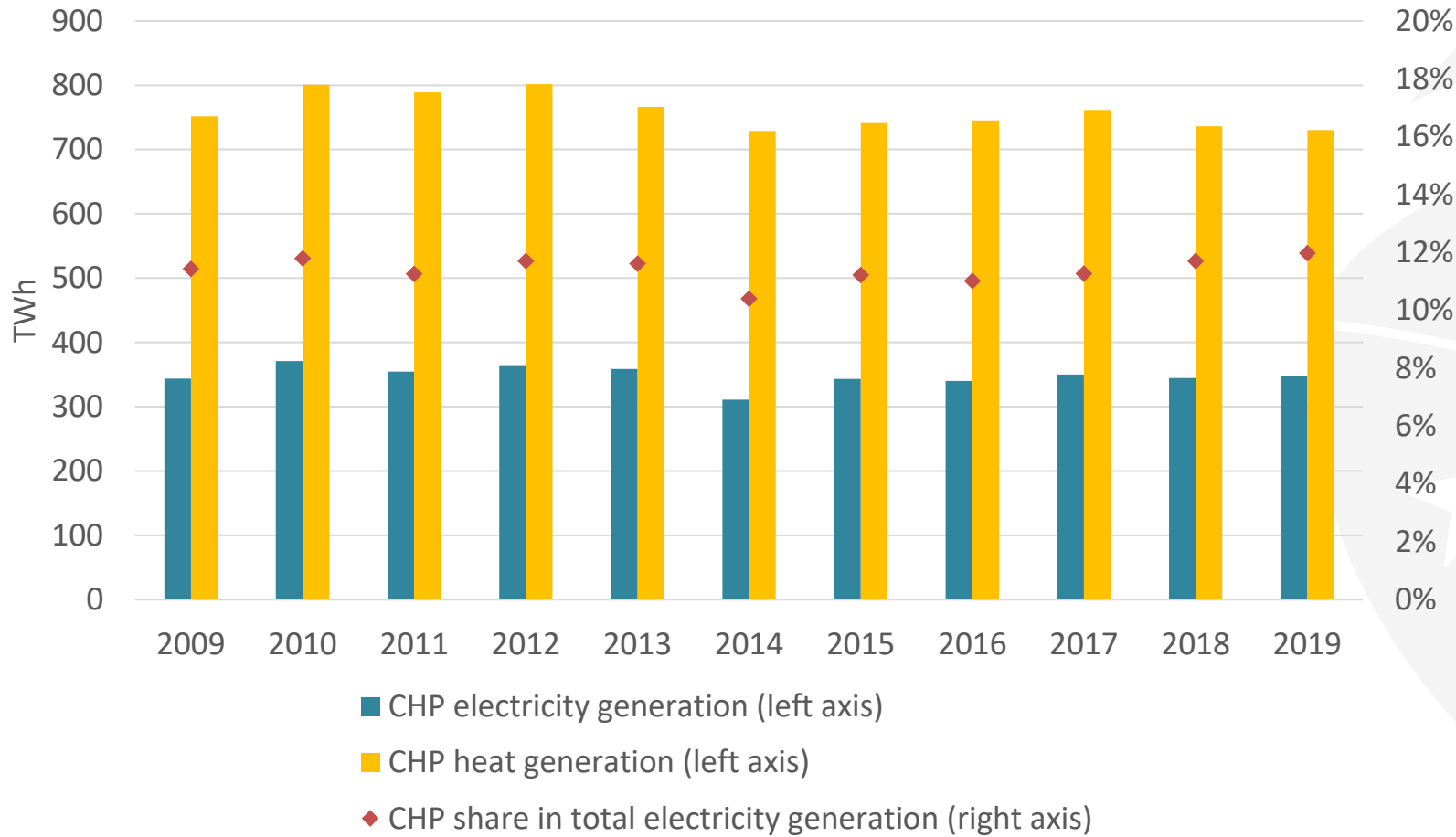
empowering European citizens and industry to generate their own efficient, reliable and affordable clean heat and power locally

bringing together heat, electricity and gas networks, allowing the efficient integration of substantial amounts of renewable energy and providing energy when and where needed

enabling an integrated energy system and a cost-effective transition towards a sustainable future

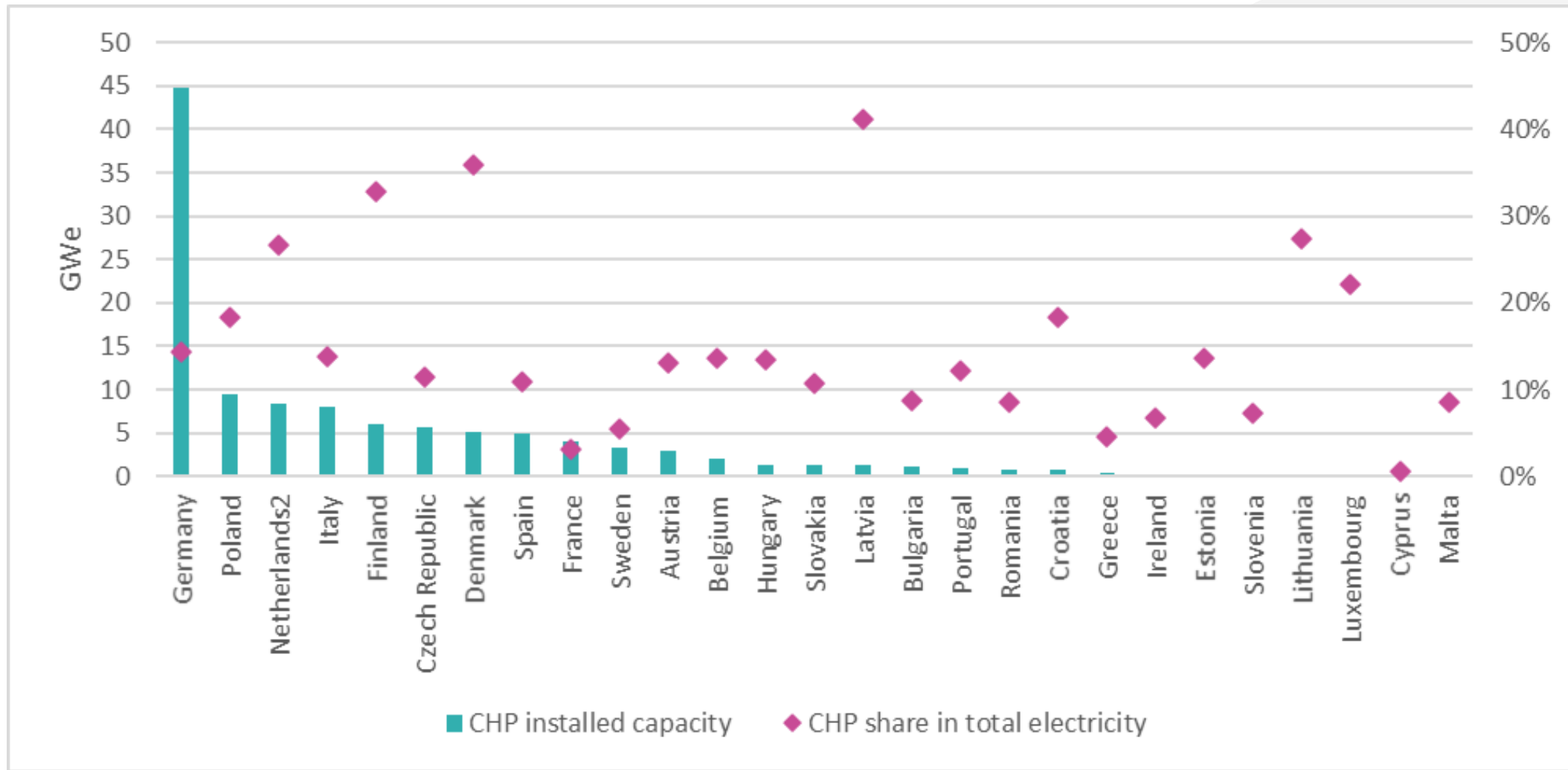
Overview of CHP in Europe

CHP in EU27 Overview

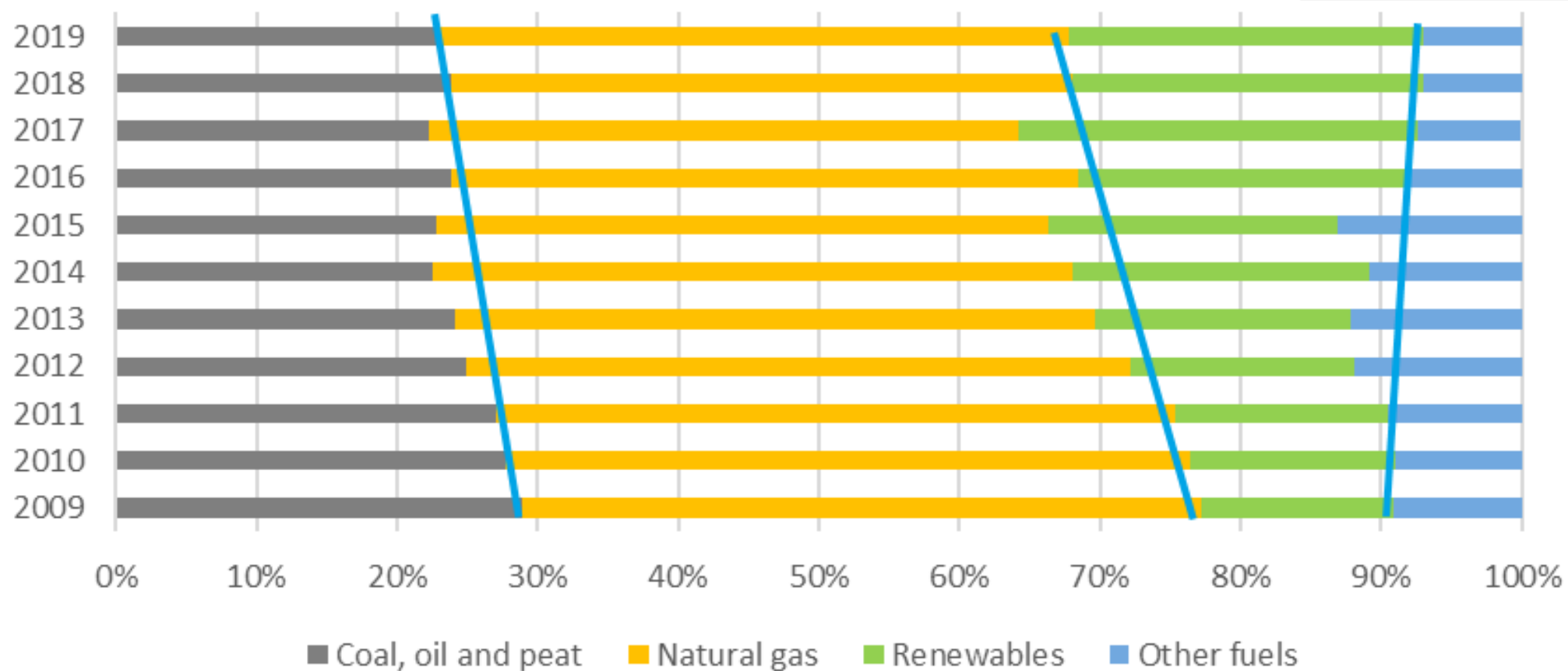


- 113 GWe of high efficiency CHP installed in 2019
- CHP generates 12% of total electricity and 16% of the heat in EU27
- CHP across the EU reduces up to 150 Mt of CO₂
- ~30 Mtoe of primary energy savings today (equivalent to the emissions of ~90 million cars)
- 15 bcm of direct natural gas savings (10% of Russian gas imports in 2021)

CHP by country in 2019

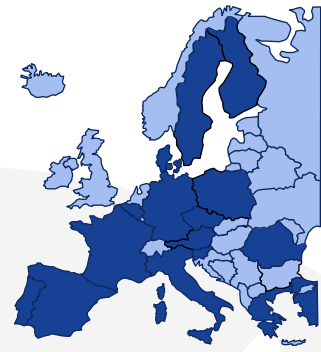


CHP Fuel Mix in the EU (2009-2019)



- Stable share of natural gas use in CHP
- Increase of RES, reaching close to 25% in 2019 (from 13% in 2009)
- Steady decline in solid fossil fuels and oil use in CHP

Expert contributions from **16** CHP national experts...



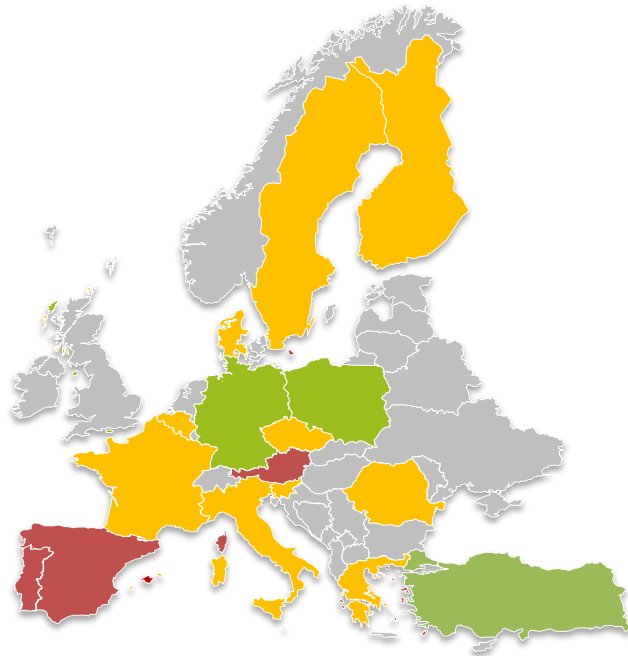
Cogeneration Snapshot Survey 2022

...representing **90%** of installed capacity **in EU27 & Turkey**

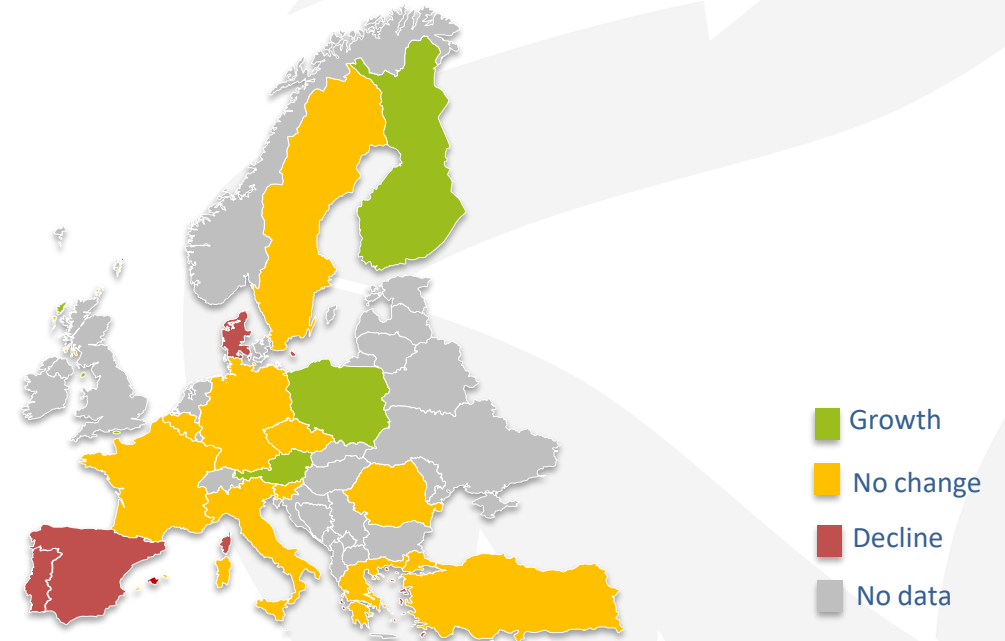
...capturing the **European CHP industry sentiment**

CHP Market Developments in Europe (2020-2021)

CHP Installed Capacity



CHP Electricity Production



- CHP installed capacity growth in ~50% of markets & generation stable in 62% of markets
- Growth segments included natural gas & RES CHP, across industry & commercials sectors

* Percentages on all slides represent the aggregated answers weighted by the installed capacity in each country.

National Policy Frameworks

High level support for CHP in National Plans

CHP assessed in National Plans on Energy & Climate (76%), Heating & Cooling (67%), System Adequacy (65%), Renovation Strategies (55%) & Hydrogen (67%)



Unfavourable policy framework in 60% of markets

Most common support:
Auctions, CAPEX support & Tax incentives

Capacity payments are emerging &
flexibility tariffs

Other support: FiT, FiP, green
certificates



Level of support insufficient & unpredictable

Not always correlated with fluctuating
spark spreads

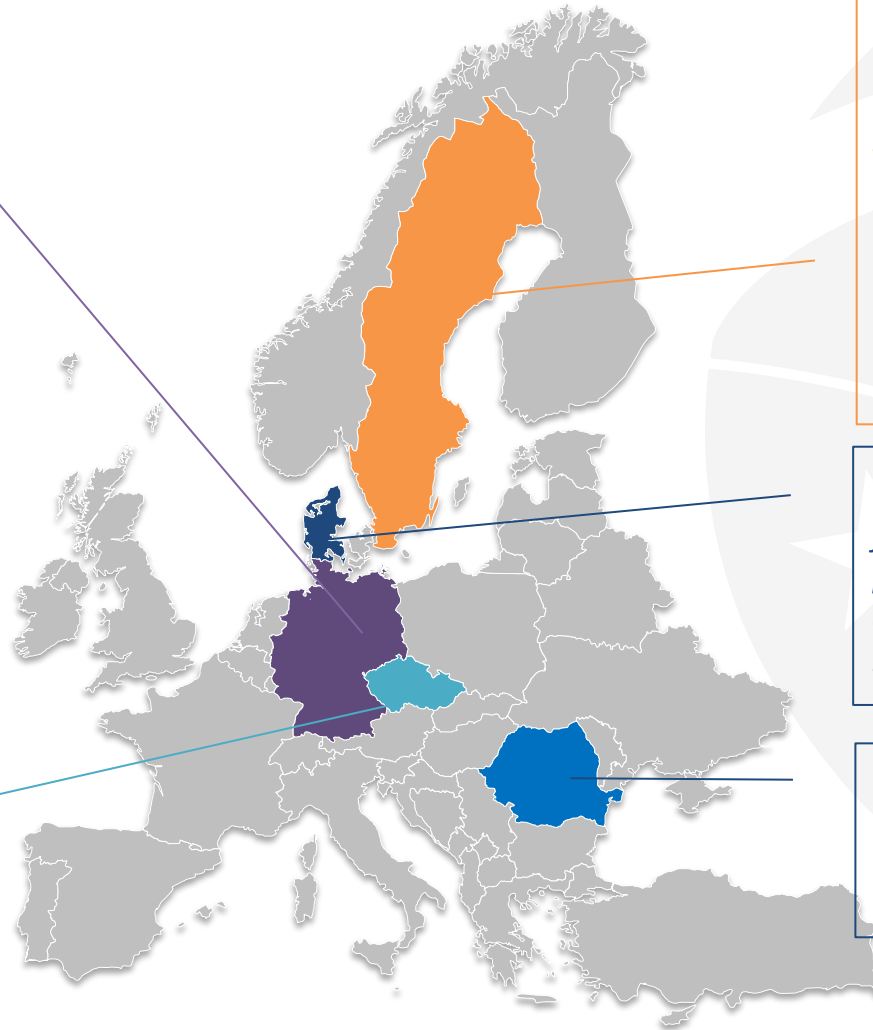
Complexity of regulation &
administrative burden

Support schemes not adapted to CHP
particularities

Relevant quotes from the H&C on CHP

*“The **smart use of large heating pumps, electric boilers and cogeneration units (with heat storage)** will especially help with integrating renewable electricity production [...], reducing pressure on the grid in times of high residual load as well as reducing grid shortages and the need for grid extensions.”*

“The remaining heat supply from current coal-fired thermal energy systems, which will not be provided through heat production in cogeneration plants, will be provided by small heat-only plants and small decentralised cogeneration sources.”

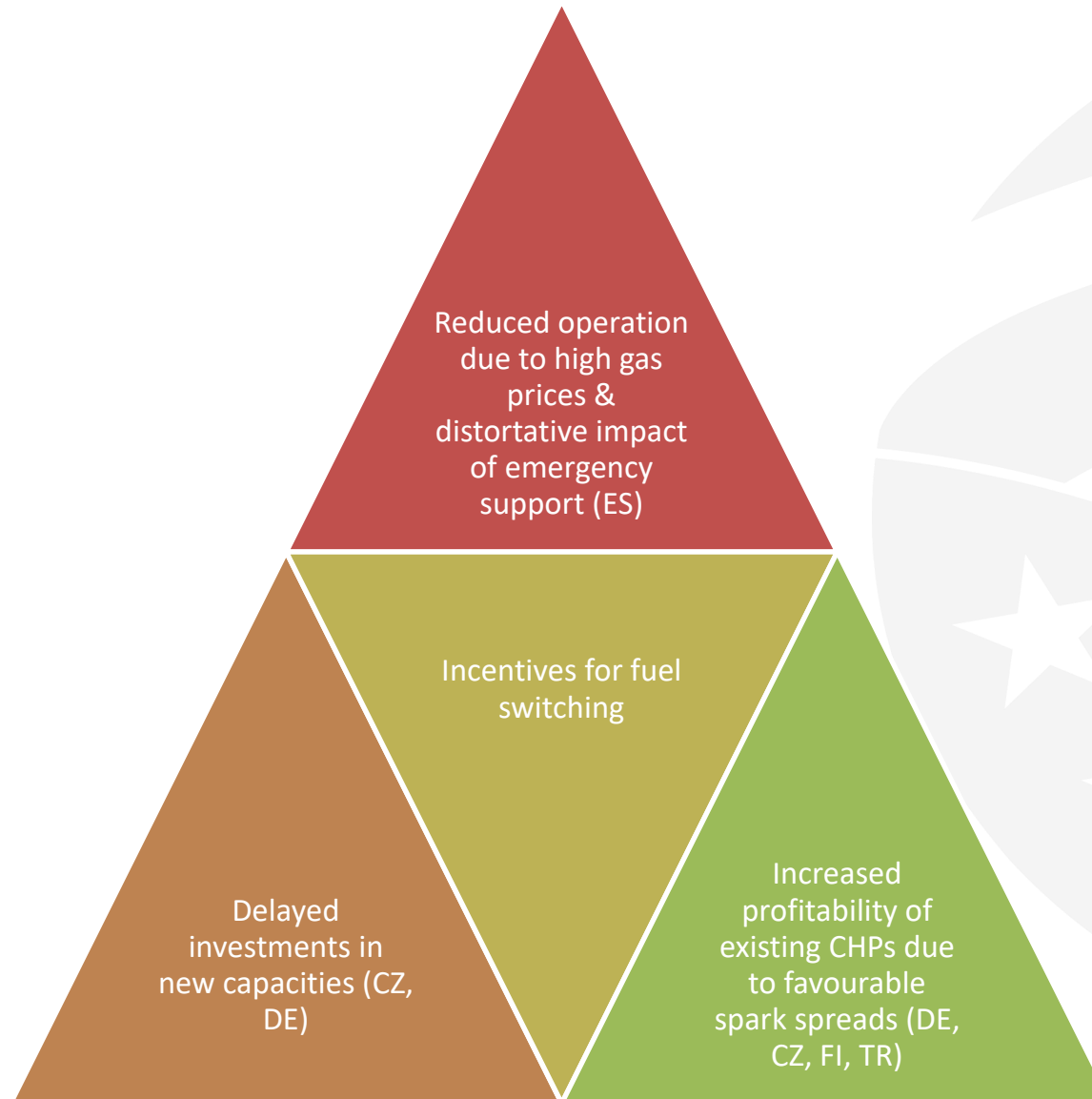


*“Although the profitability of new cogeneration will be relatively weak over the next few years, it should be borne in mind that **once the demand for controllable electricity increases significantly in the future, it may be partly too late to count on cogeneration...**For us it is about **safeguarding cogeneration due to benefits in the form of system support services and contributions to a robust energy system with a secure energy supply.**”*

*“Surplus heat and waste cogeneration remain fairly constant throughout the analysis period...**cogeneration based on renewable energy provides the largest amount of district heat generation**”*

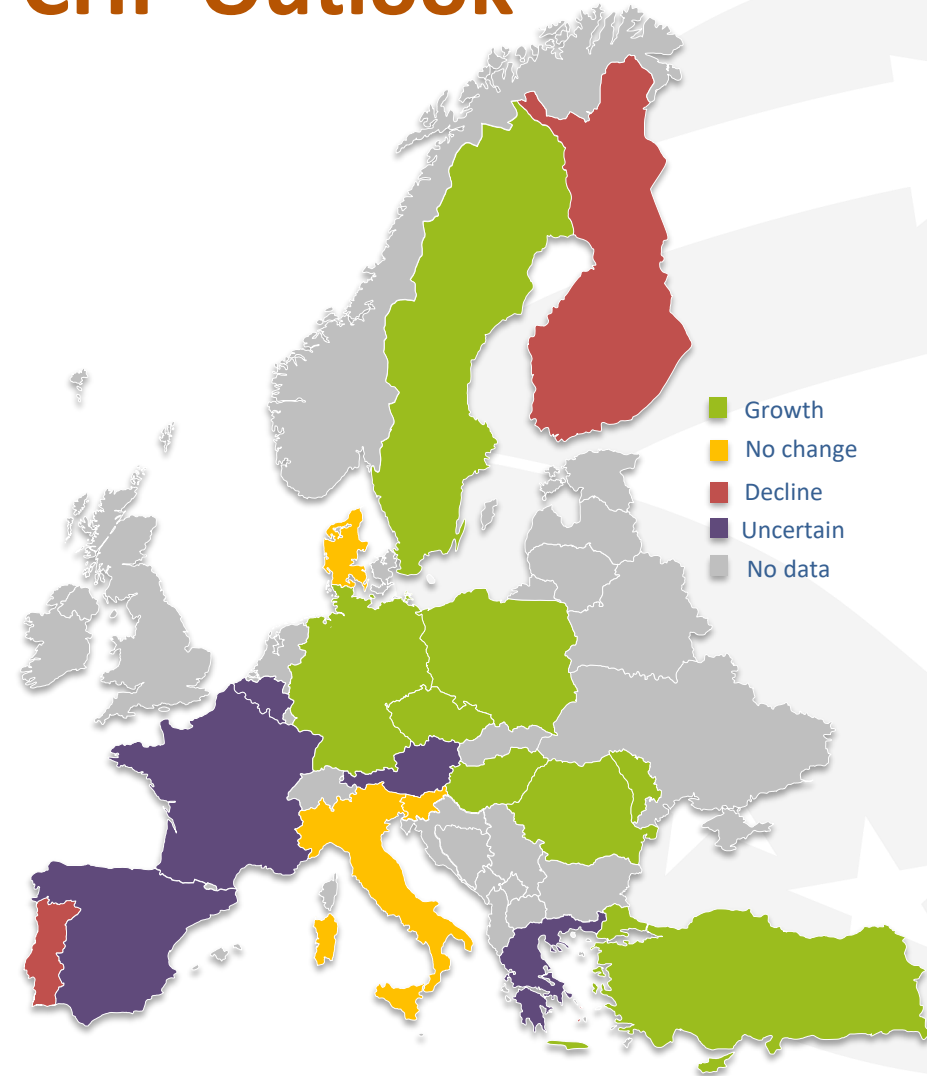
*“Promotion of **future proof cogeneration** by ensuring hydrogen-readiness, including H2 blending and flexibility to accept different blends of H2”*

Impact of Energy Price Crisis on CHP Sector

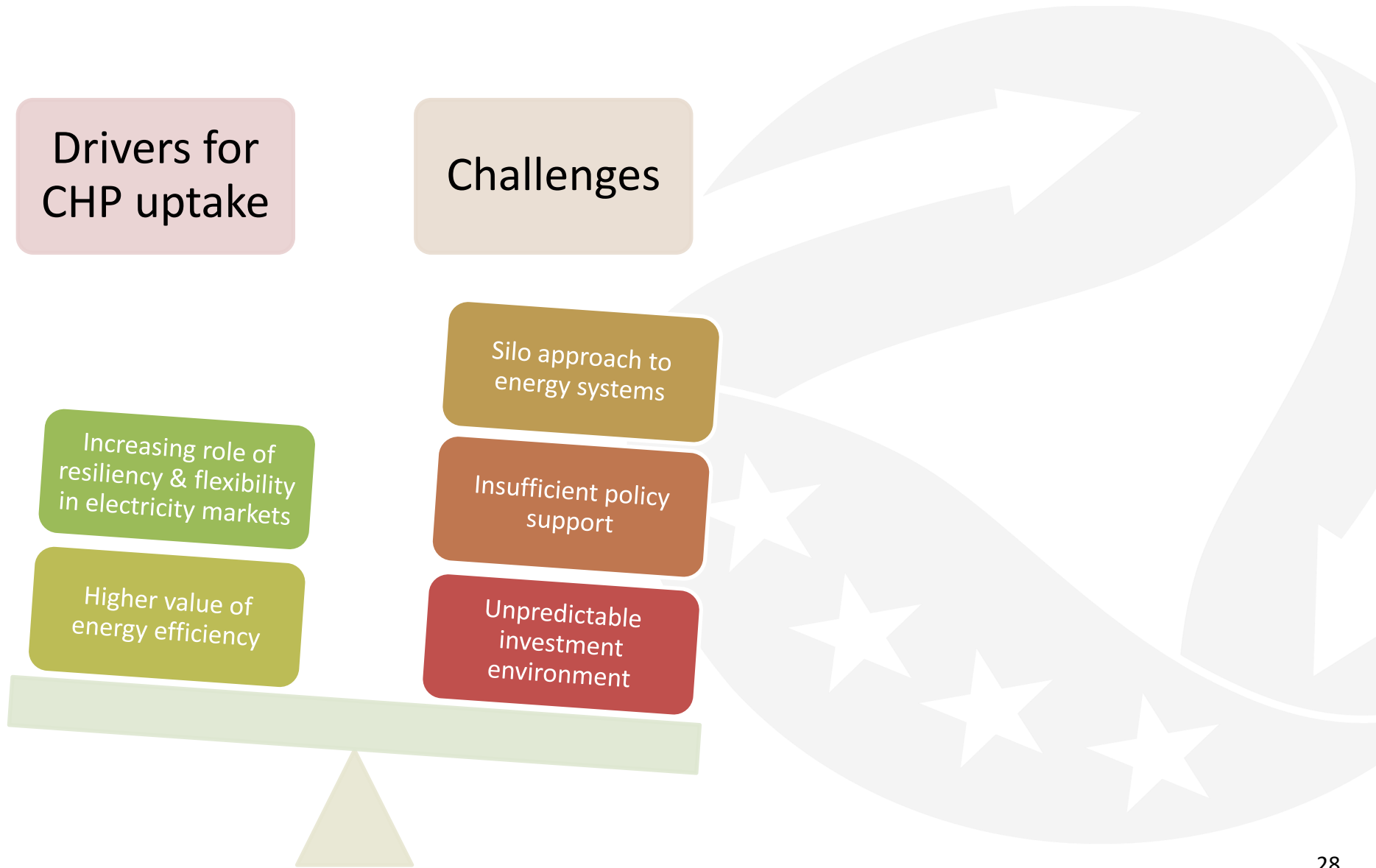


5-year CHP Outlook

Growth expected in **60% of the CHP markets** in Europe, in the next 5 years.



2022 Snapshot Survey Takeaways



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The Association for
Decentralised Energy



ade

Bringing Energy
Together

Combined Heat & Power
District Heating & Cooling
Demand Side Services

The UK CHP Market: From Efficiency to Net Zero



Introduction

- ⦿ Industrial Policy Officer at the Association for Decentralised Energy- covering everything industrial decarbonisation, technology neutral, strong representation of dispersed sites
- ⦿ Traditionally heavily CHP focussed. Founded in 1967, known as District Heating Association, then Combined Heat and Power Association, since 2015 ADE
- ⦿ Still the leading trade group for CHP, represent a range of CHP engine manufacturers and end users – Clarke Energy, British Sugar, Exxon, Tata Chemicals, VPI, Centrax etc.

Timeline of UK CHP



- ⦿ Late 19th and early 20th century, a few entrepreneurs in urban areas, no wider market
- ⦿ Post WW2, CHP and district heating actively considered, but still limited
- ⦿ Post 1973 oil crisis, CHP considered more strongly, attempts to set up a wider market
- ⦿ 1980s through 2000s, targets set for CHP, wider market emerges, focus on industrial
- ⦿ Present, district heating zoning, changes to incentives, Net Zero technology

Bringing Energy
Together

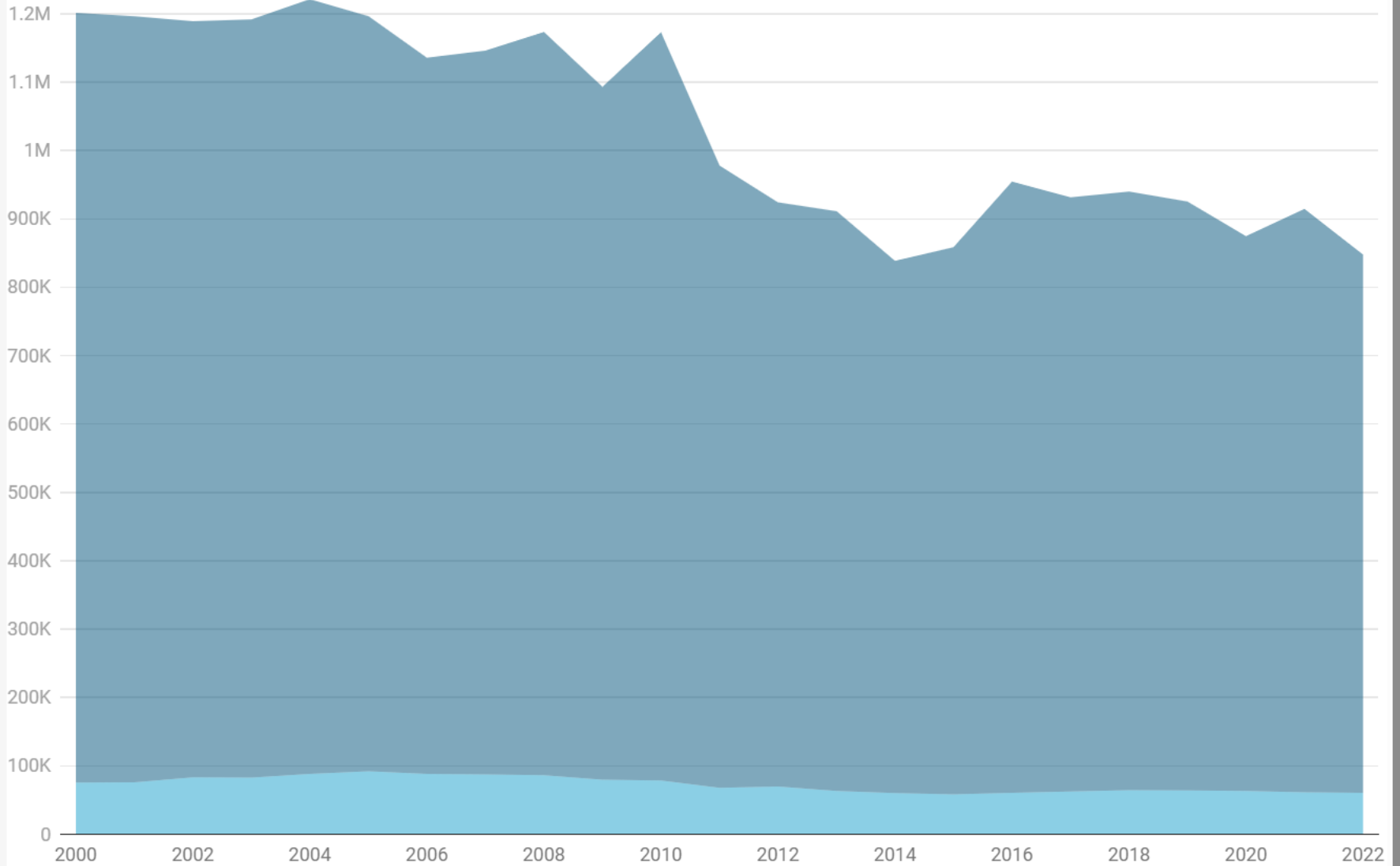


Why did UK CHP develop differently to the rest of Europe?

- ⊙ Similar geography, and economy to Northern European counterparts, access to the same technology, but the market remained much narrower
- ⊙ The role of government – fell between departments, hostility from public utilities, but the 1980s emphasis on market solutions meant little room for CHP planning, weakness of local government compared to other countries
- ⊙ Post 1973 oil crisis, CHP considered more strongly, attempts to set up a wider market
- ⊙ 1980s through 2000s, targets set for CHP, wider market emerges, focus on industrial
- ⊙ Present: district heating zoning, changes to incentives, Net Zero technology, Energy from Waste

Total Gas Demand vs CHP Gas Demand

CHP gas demand (GWh) Total UK gas demand (GWh)



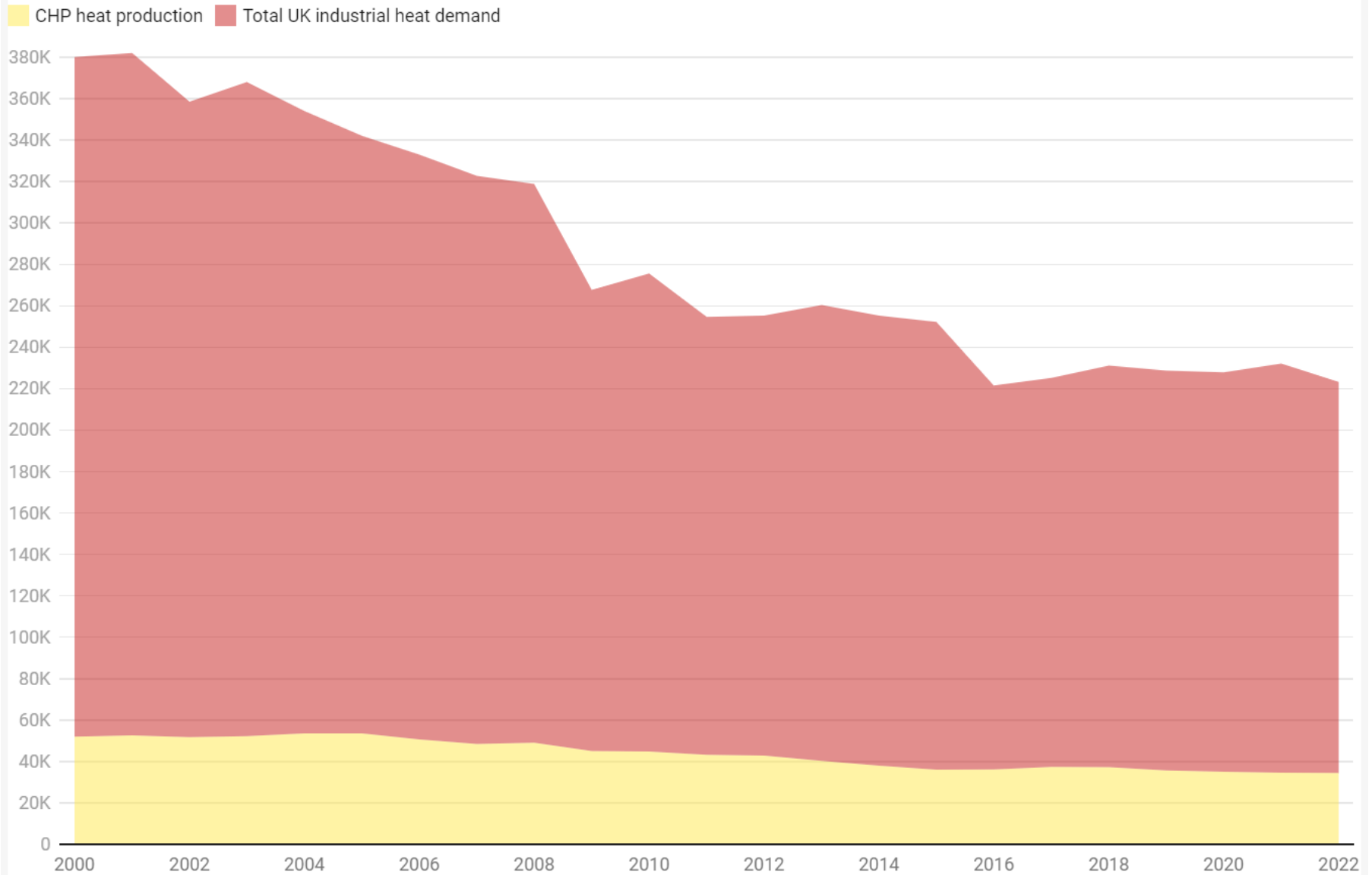
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CHP Industrial Heat production vs UK Industrial Heat Demand (MWe)

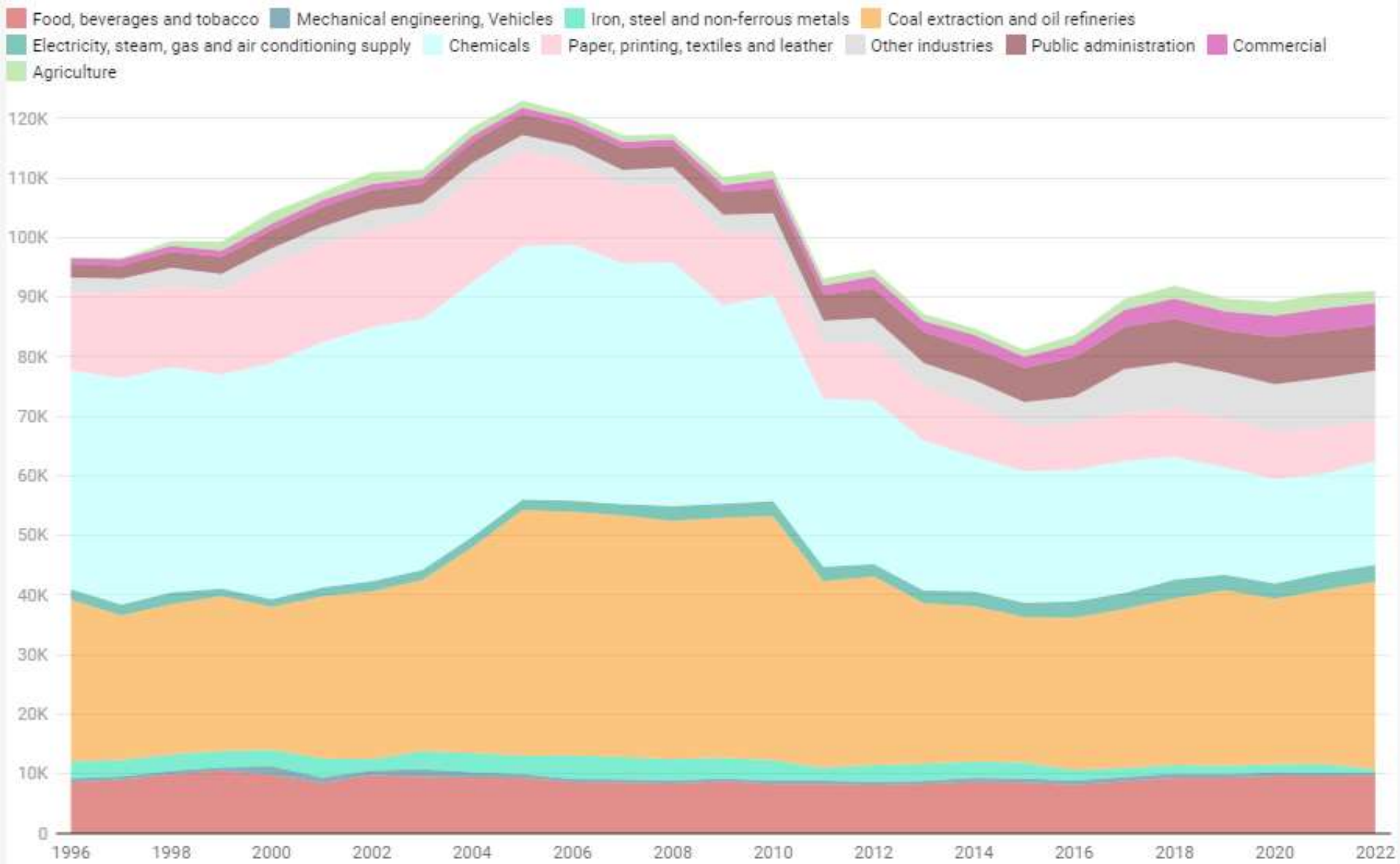


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CHP by Sector, UK, 1996-2022



Source: UK Digest of Energy Statistics

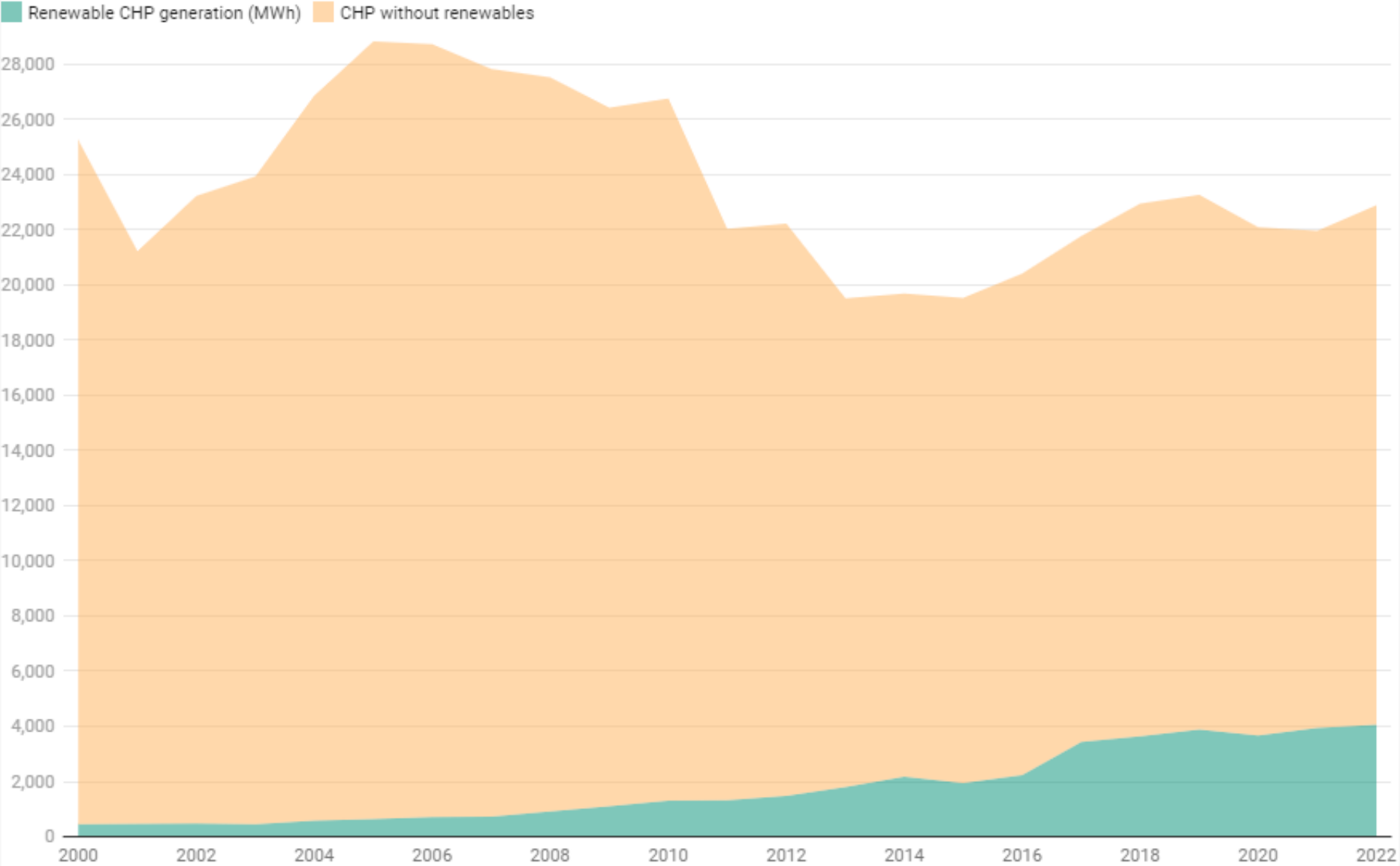
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UK CHP, Renewable vs Non-renewable fuel sources



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Decarbonising CHP Case Studies: Tata Chemicals and VPI Immingham



During the 2020s

New gas CHP

- ⦿ Fundamentals in a positive spark spread and short payback periods will continue supporting the market
- ⦿ Decarbonisation targets, regulation and restrictions on finance will reduce viability of gas CHP in public sector and heat networks markets
- ⦿ In some cases, industrials may need to replace assets before zero carbon options are available

Existing gas CHP

- ⦿ Those with gas CHP engines and turbines will continue to maintain their assets
- ⦿ Only exception is whether planning standards bring forward replacement of CHPs in existing heat networks

Zero carbon CHP

- ⦿ Hydrogen clusters will see some fuel-switching of turbine CHP in these areas
- ⦿ Biomass and waste-led EfW will be encouraged to increase heat offtake through CHP

What future role can CHP play in the UK?

During the 2030s and beyond

Role in providing high-grade heat

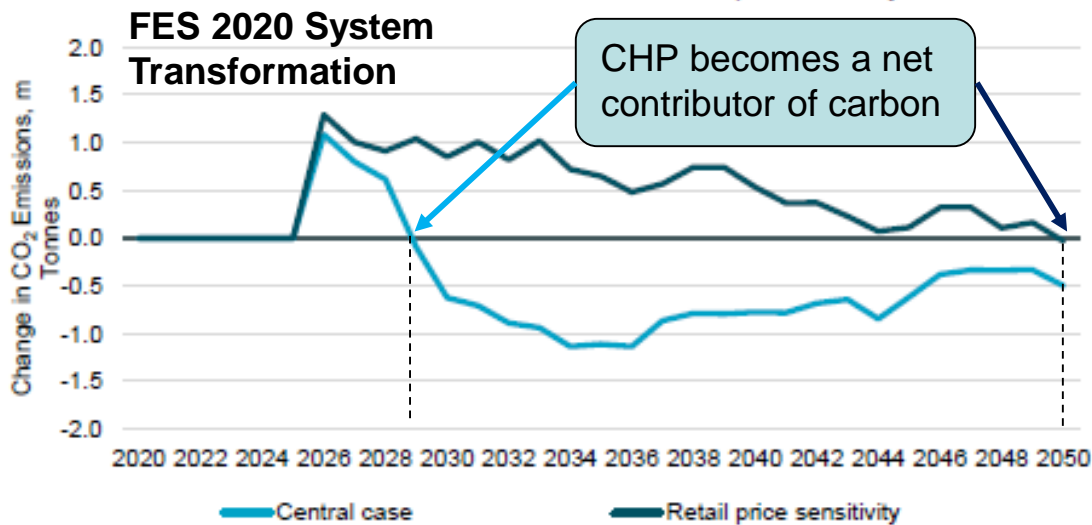
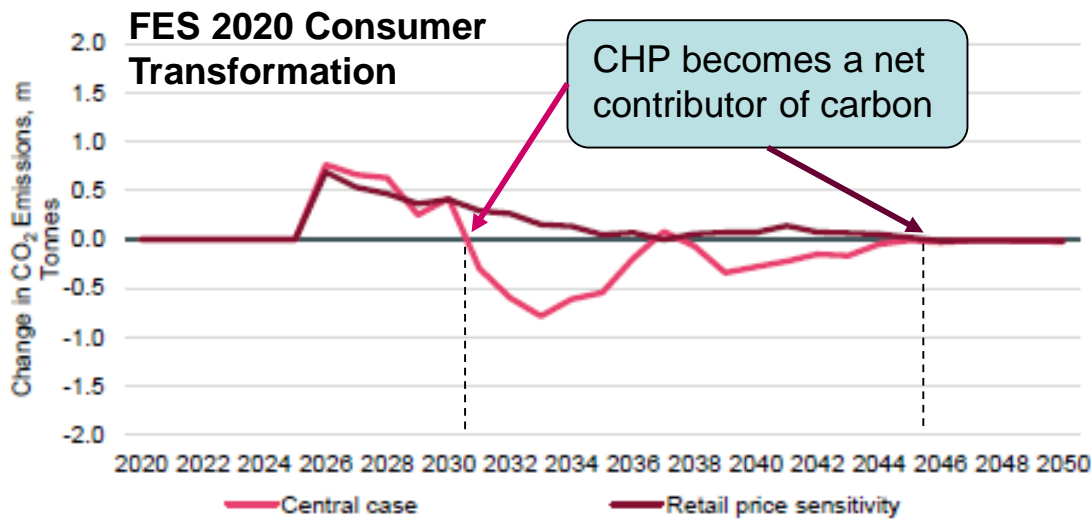
- High-grade steam using decarbonised fuels is going to be more expensive than it is today – supporting efficiency

Role in providing low-grade heat

- Heat network sector (and DESNZ) are focused on EfW as a strategic source of heat which may promote CHP
- Trajectory for smaller commercial and public sectors unclear – Will depend upon wider, national access to decarbonised fuels or otherwise, limited to areas of H2 production

Role in the electricity system

- CHP will need to shift to a more extreme peaking role, providing flexible, firm power when needed
- Future of private wire unclear and currently subject to reform



Legend

Central case: System costs are charged as today
 Retail price sensitivity: On-site CHP is exposed to the wholesale price.

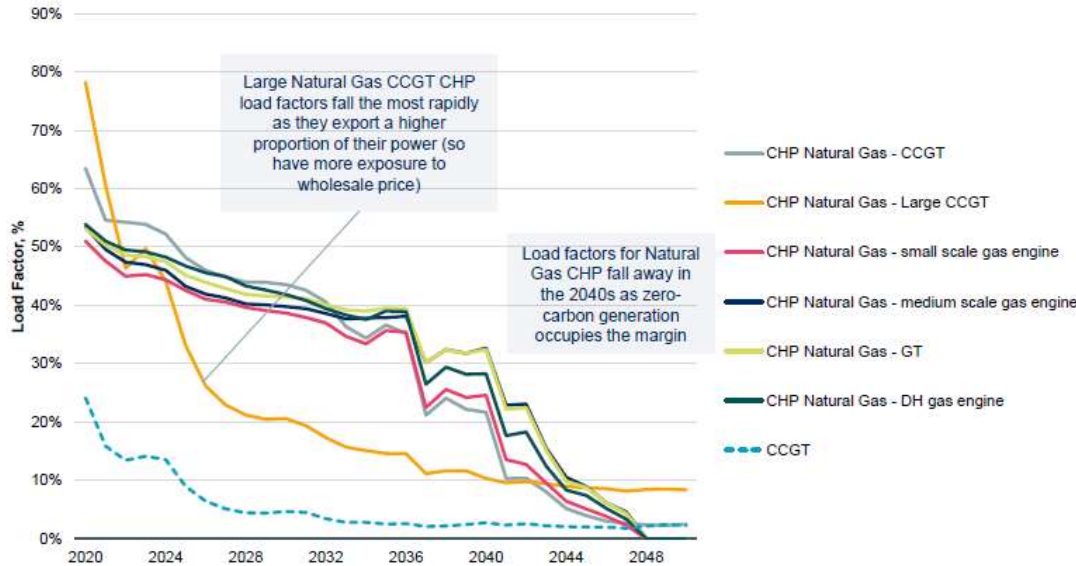
Key messages:

1. CHP saves carbon until the early 2030s, regardless of the path to net zero
2. Policy costs and network charges (system costs) on electricity imports limit CHP flexibility leading to the CHP fleet contributing to carbon emissions after the early 2030s

Conclusion:

1. CHP should continue to be supported in the short-term.
2. Significant risk that policy support and/or on-site CHP's ability to avoid system costs will be removed in the short- to medium-term.

Load Factors, %

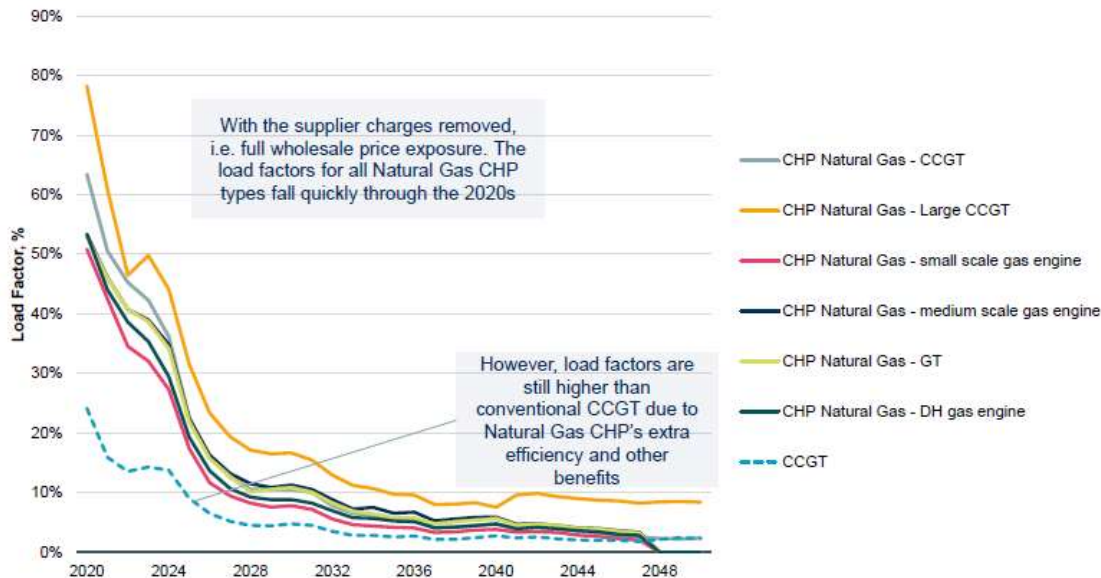


Key messages:

[Regardless of net zero pathway]

1. If CHP is not exposed to wholesale prices, it maintains higher load factors for longer but becomes a net contributor to carbon sooner
2. If CHP is exposed to wholesale prices, its load factors drop more quickly but it continues to save carbon to at least the late 2040s

Load Factors, %



Conclusion:

1. To continue to save carbon, CHP must be operated more flexibly, with lower load factors, and forego savings from avoided system costs
2. Alternative/new revenues will be needed to secure existing and new CHP in future

The Association for
Decentralised Energy



ade

Bringing Energy
Together

Combined Heat & Power
District Heating & Cooling
Demand Side Services

Thank you

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