COGEN Europe

Decarbonising the Building Sector with Hydrogen Cogeneration

COGEN EUROPE
The European Association for the Promotion of Cogeneration

Our Vision

Resilient, decentralised and carbon neutral European energy system with cogeneration as its backbone

2050

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COGEN EUROPE 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

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MEMBERS

National Associations

Corporate Members

Achieving Carbon Neutrality by 2050

Cogeneration or Combined Heat and Power (CHP) is a key enabler to achieve carbon neutrality in Europe by 2050.

Prioritising cogeneration for thermally generated heat and power in all sectors will maximise energy efficiency and the integration of the European energy system at the lowest cost.

The cogeneration sector is committed to the creation of a resilient, decentralised and carbon neutral European energy system by 2050 with cogeneration as its backbone.

Opportunities for CHP in the energy transition

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Heating & Cooling is "hard to decarbonise"

Buildings & districts

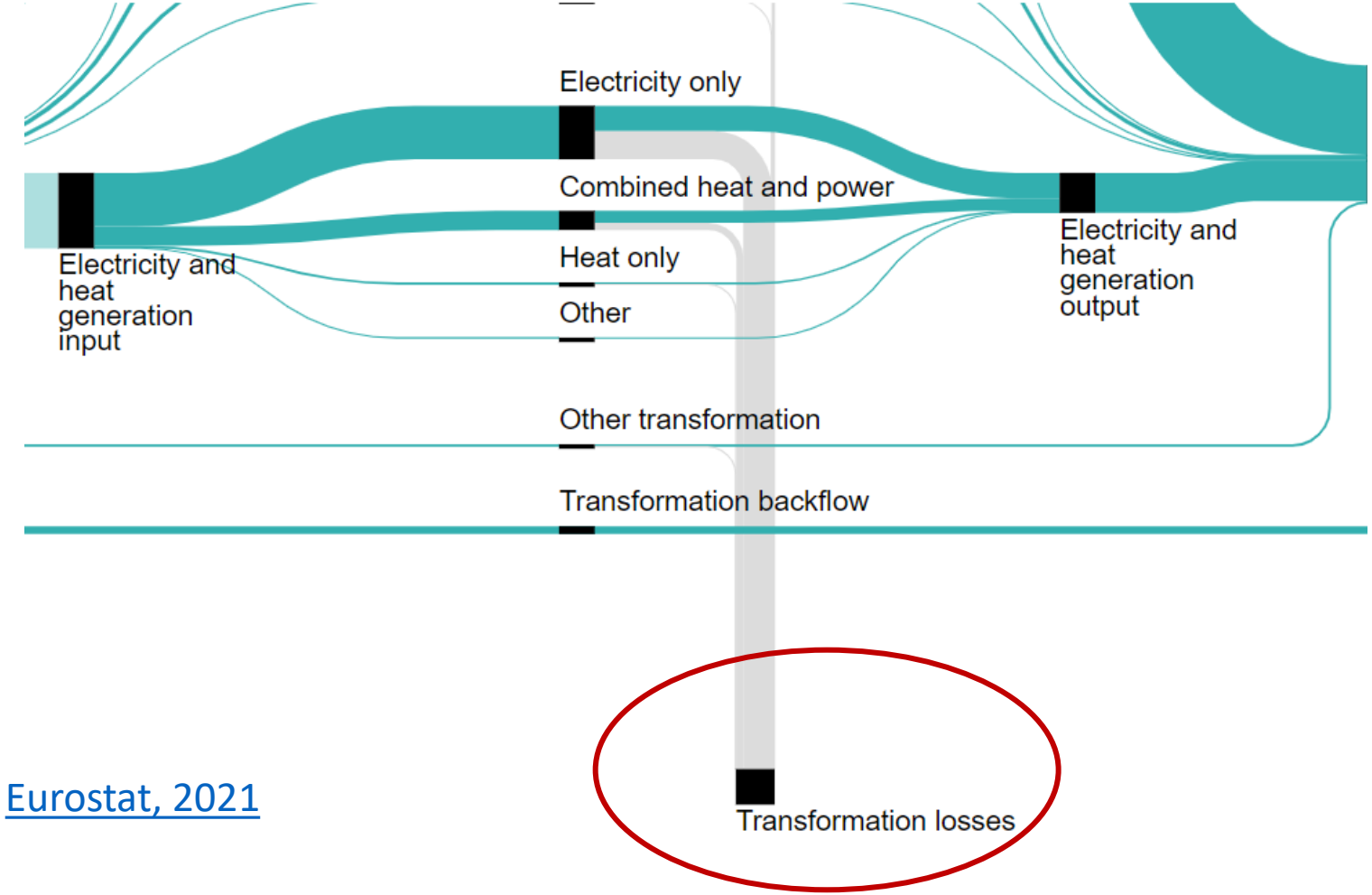
- **40%** of energy consumption & **36%** of GHG emissions.
- **80%** of buildings demand comes from heating and hot water
  - **High seasonal differences** between summer & winter
- **75%** is based on inefficient and oil boilers
- Only up to **45%** of heat could be electrified.

Industry

- **70%** of industry's total energy demand is represented by H&C
- Large amounts of **high temperature heat** needed in chemical, pulp & paper, food& drink, ceramics, greenhouses, alumina refineries across the EU
- **Electrification not cost-effective** in most cases

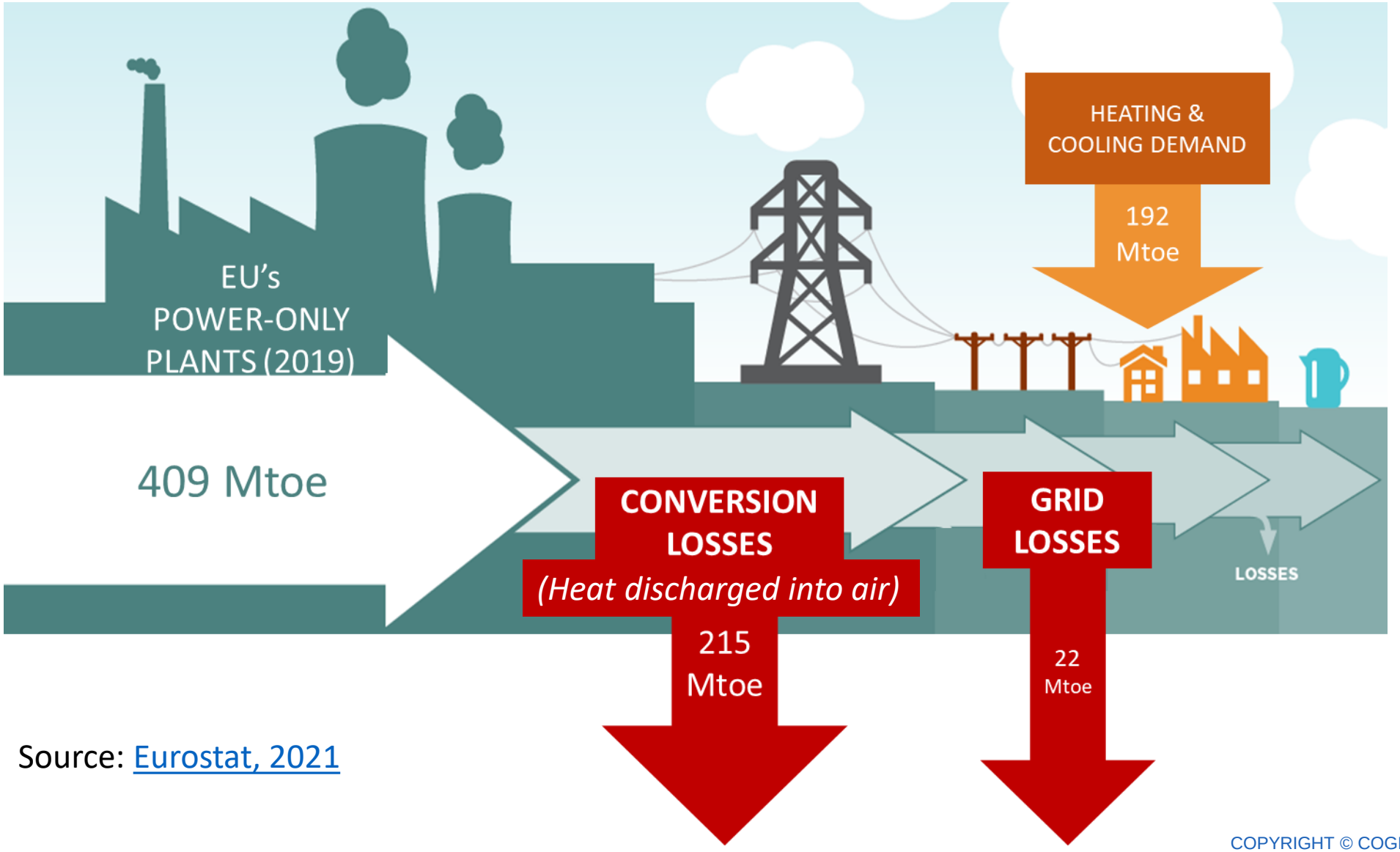
CHP is a key solution to deliver efficient H&C across a range of increasingly RES fuels

LOSSES IN ENERGY PRODUCTION (2019)



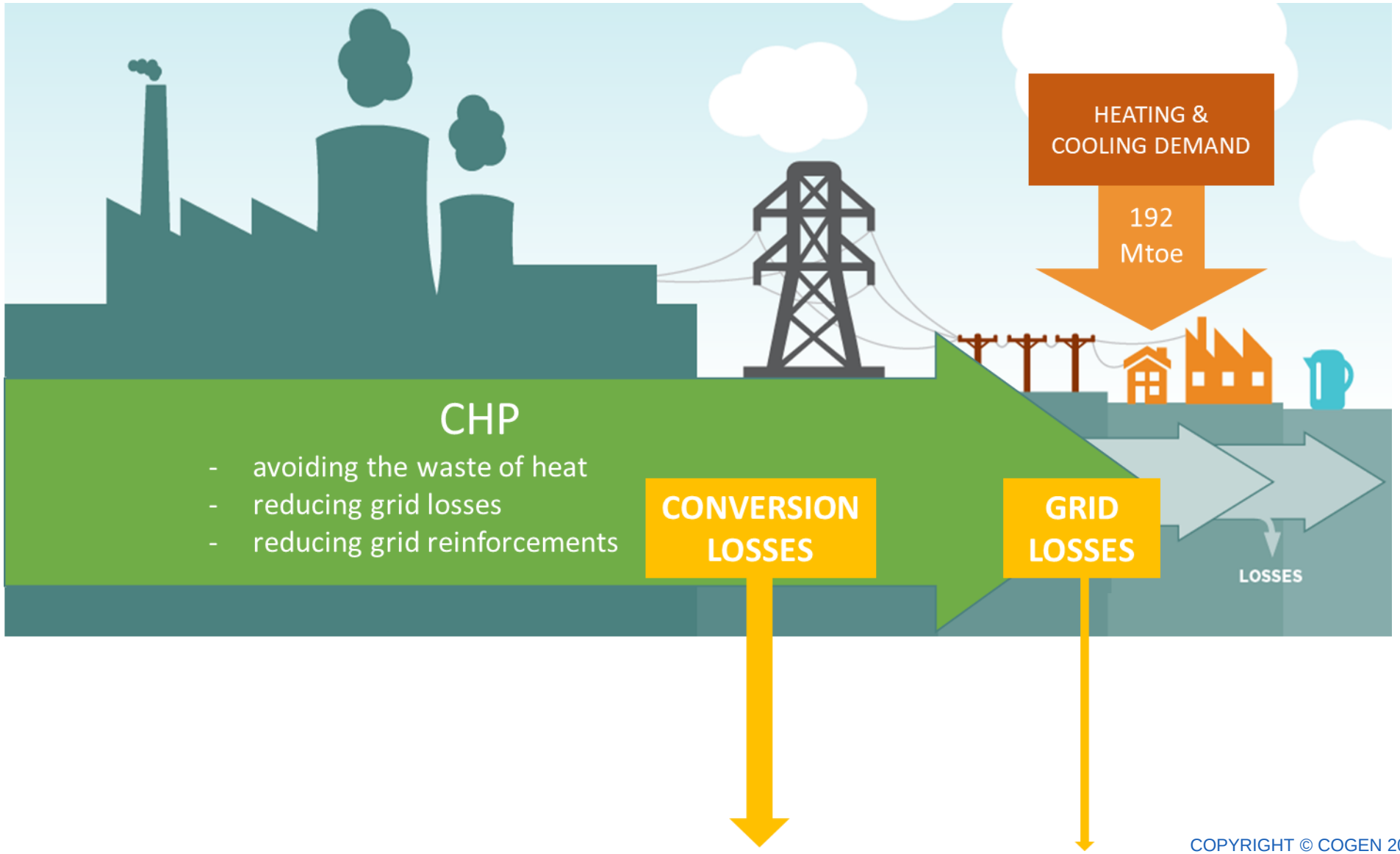
Source: Eurostat, 2021

EFFICIENCY OPPORTUNITES IN POWER SECTOR



Source: Eurostat, 2021

ROLE OF CHP IN SYSTEM EFFICIENCY

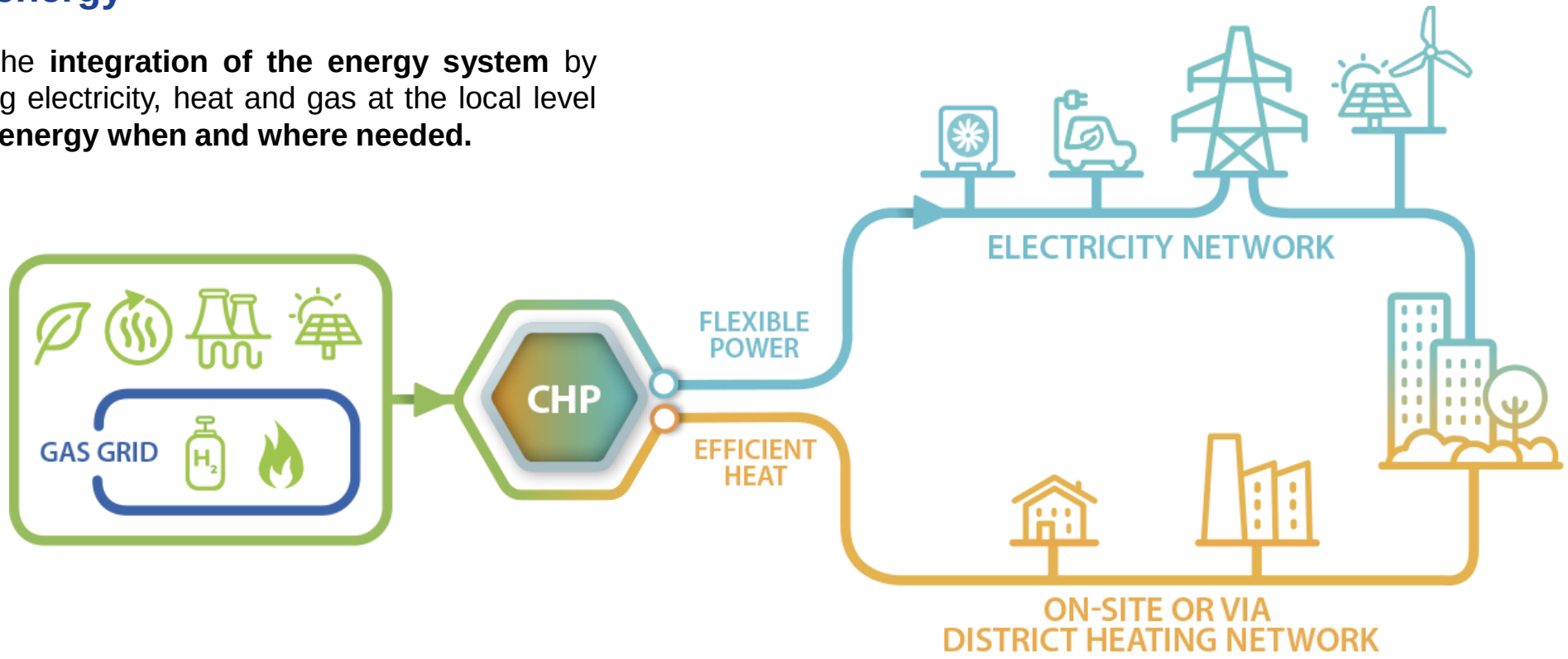


System Focus

Cogeneration:

backbone of local and integrated energy

CHP enables the **integration of the energy system** by efficiently linking electricity, heat and gas at the local level and **providing energy when and where needed.**



Overview of CHP today

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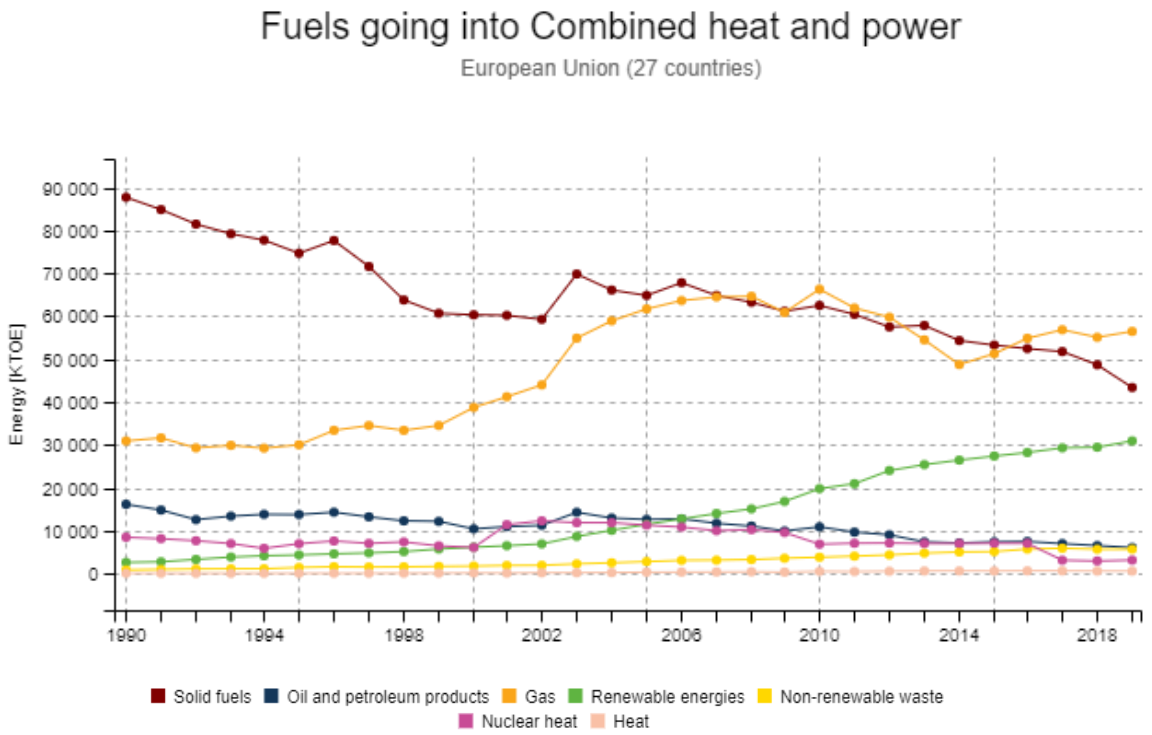
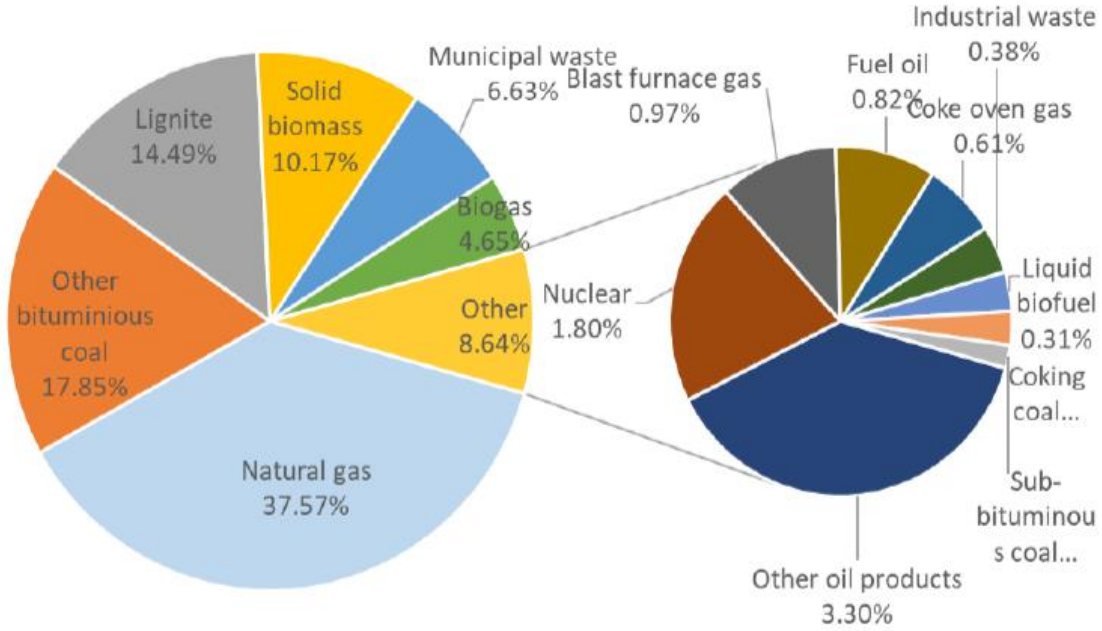
OVERVIEW OF CHP TODAY



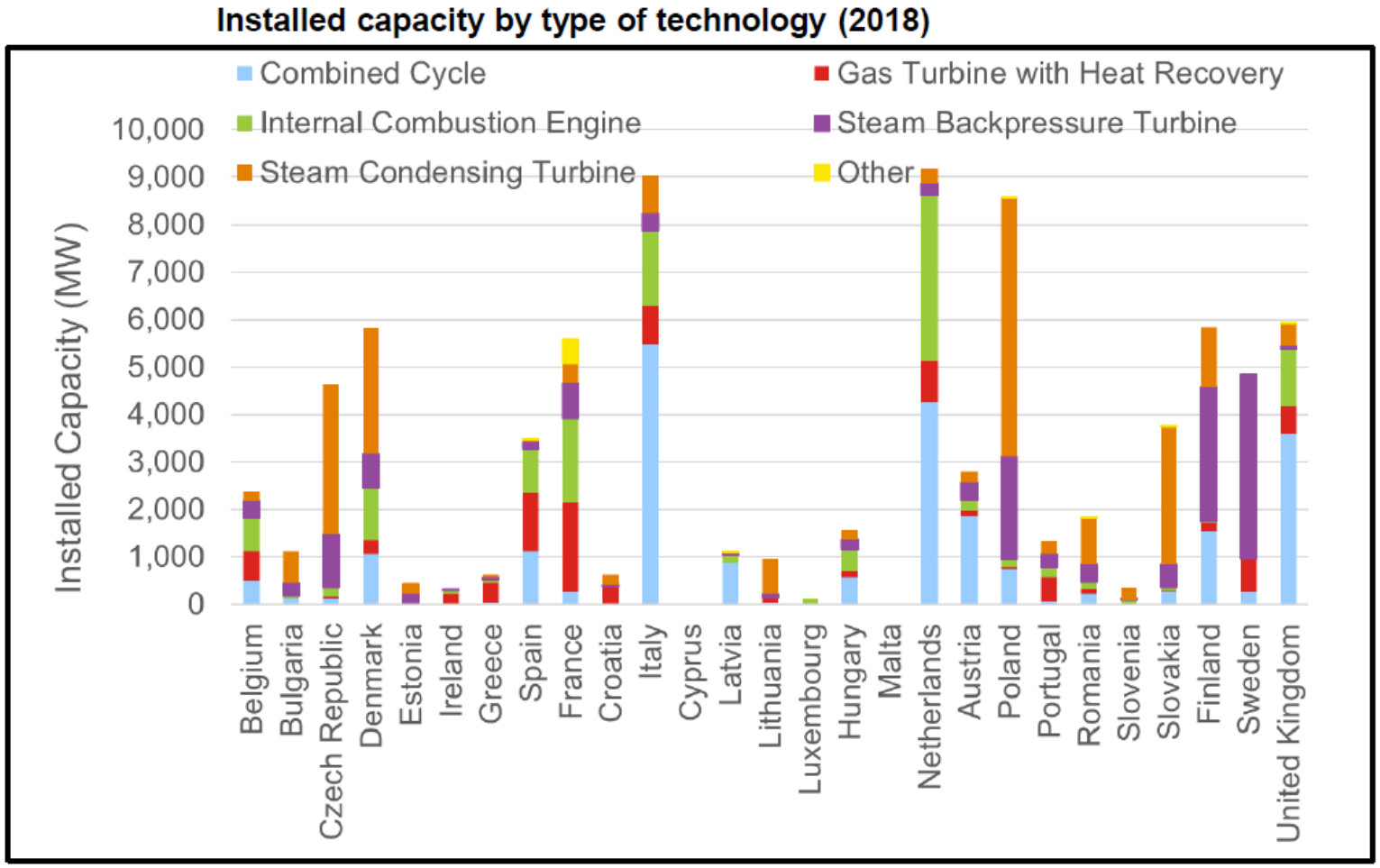
Source: Eurostat, 2021

CHP fuel mix in 2018 in EU28



Source: Ricardo AEA, 2021

OVERVIEW OF CHP BY TECHNOLOGY



Source: Ricardo AEA, 2021

Study: Role of CHP in 2050

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Introduction

BACKGROUND

Energy efficiency first and energy systems integration are key dimensions of carbon neutrality in 2050.

So far, EU policymaking and scenarios have not fully captured the benefits of efficiently combining heat and power as enabling solution to move to a net-zero integrated energy system.

Artelys
OPTIMIZATION SOLUTIONS

European-wide modelling of integrated gas, heat and power scenarios with Artelys Crystal Super Grid, capturing key aspects of the energy transition and in particular smart sector integration strategies.

STUDY OBJECTIVES

1. **Explore the potential of further integrating Europe's energy system in an efficient way to reach carbon-neutral economy at least cost.**
   - Assess the role of cogeneration building on the EC's Long-Term Decarbonisation Strategy (LTS).
2. **Provide recommendations to better reap the benefits of efficient and local system integration solutions in policy making & modelling.**

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The Study

OVERVIEW

The study proceeds in two steps:
first considering the point of view of a user, then the wider system

SYSTEM FOCUS

Explore CHP Benefits for the Energy System

Scenario-based assessment of 2050 European energy mix featuring:

- Benefits for the whole energy system; and
- Cost-optimised high efficiency CHP deployment across 1.5 TECH* & Integrated Energy Systems (IES) decarbonisation pathways.

Derived from the EC Long-Term Strategy 1.5 TECH scenario and additional assumptions, referred to as 1.5 TECH in this study for simplicity.

USER FOCUS

Identify Cost-competitive CHP Applications

Micro-economic assessment of heat generation solutions (with/without CHP) in different use-cases using various

- Heat demand profiles
- Technologies
- Energy sources
- Archetypal countries

CHP's Multiple Benefits in 2050

€4-8 Bn

cost cuts for energy system every year

150–220 TWh

↑ primary energy savings across energy system

3.8 – 5.5
Mt CO_2

↓ reduction in remaining CO_2 emissions

13-16%*
of total electricity

and **~30-36% of flexible thermally generated power** at times of low wind & sun and to cover peak demand

19-27%**
of total heat

and **52-100%*** of thermal heat** in buildings, industry & district heating

* excluding off-grid RES for P2X generation.
** excluding furnaces.
*** excluding furnaces; DHC for industry is 100% CHP.

Cost Savings for CHP Users

Family Home (hydrogen fuel cell)	Hospital	District Heating (DHC)	Industry (high-temperature)	Industry (medium-temperature)	Industry and City DHC (using residual and industrial waste and biomass)
up to 800 €* for 10 MWh	6 - 52k € for 8 GWh	0.4 - 3M € for 500 GWh	3 - 10M € for 684 GWh	1.5 - 7.1M € for 500 GWh	0.9 - 16 M €** for 700 GWh

*Based on retail power prices including taxes, levies and grid costs, self-consumed electricity and hydrogen retail price of 80-100 €/MWh. All other user cases assume cogenerated electricity is sold to market at wholesale electricity prices, excluding taxes.
**Based on biomass price of 40-60 €/MWh.

Focus on heat: CHP operations combine flexibility & efficiency

In 1.5TECH, the heat demand is electrified by between 34% and 70% depending on the sector.

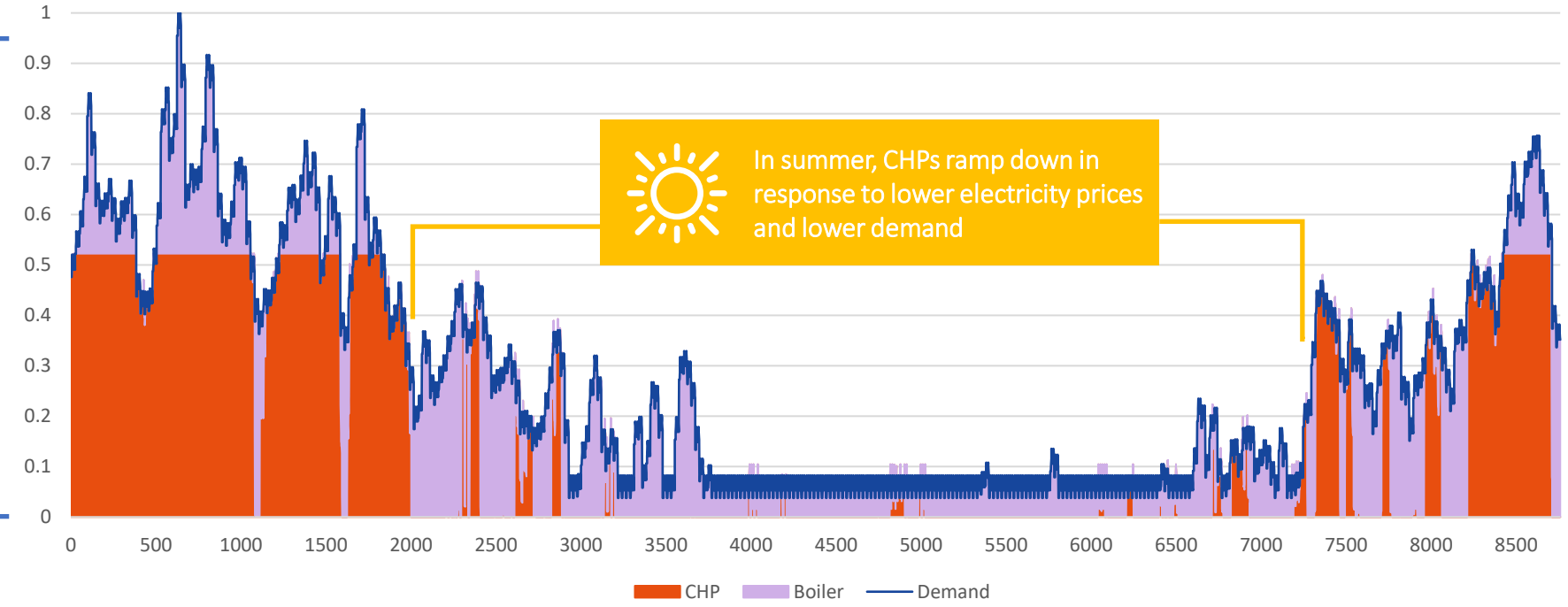
Optimised CHP can contribute by 50 to 100% to the supply of the the heat demand that cannot be electrified.

In **summer**, back-up boilers are used because electricity prices are low and fuel-based power generation is not often required (nuclear and RES generation are sufficient to cover the demand for most hours)

In **winter**, CHPs can operate at maximum load, complemented by boilers to cover peak demand

CHP hourly operation – example for a thermosensitive heat demand (district heat for buildings)

In winter, CHPs operate at maximum load ramping up to cover higher demand and capturing higher electricity prices

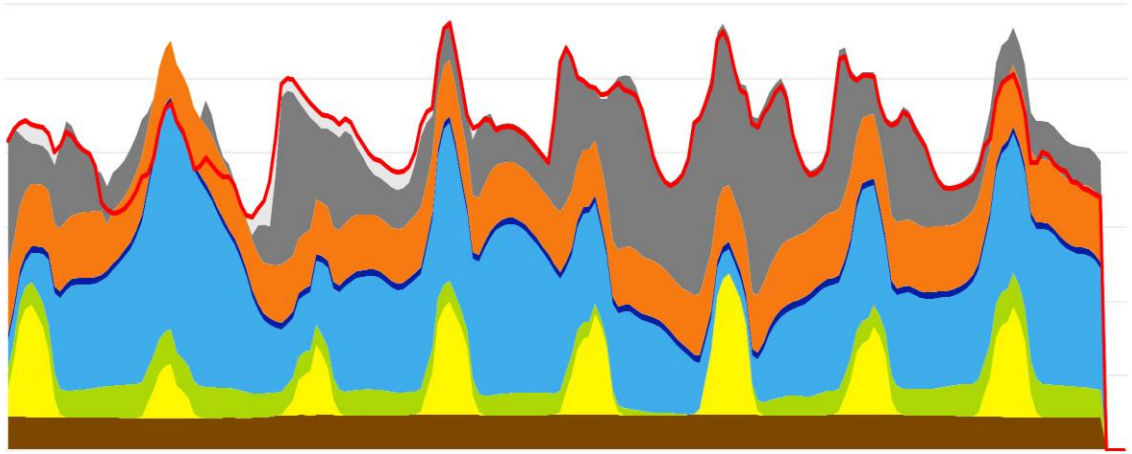


Focus on power: CHP flexibility benefits (1/2)

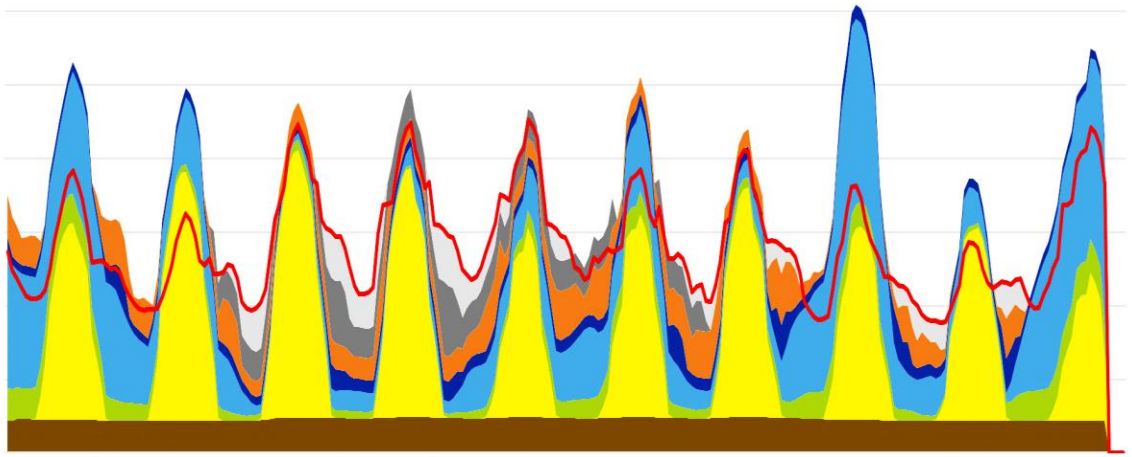
The dynamic operational management of CHPs is simulated with Artelys Crystal Super Grid. CHPs adopt a virtuous behaviour by only generating when it is cost-effective for the joint electricity and heat system.

In particular, CHPs, with a flexible price-driven operational mode, do not compete with, but **complements** variable renewable generation to meet seasonal peak demand due to high shares of electrified heat.

WINTER



SUMMER



RES baseload | PV | Wind offshore | Wind onshore | Hydro | CHP | Demand | Peakers | Batteries | Transmissions | Loss of load

CHPs (orange) run as base load during low wind and sun periods, covering a high share of the peak demand.

CHP stops producing when variable renewable generation is sufficient to cover demand, and covers evening peaks.

Focus on Heat: CHP Key for all Sectors

ALL SECTORS IN THE EU		TOTAL HEAT	THERMAL (NON-ELECTRIFIED) HEAT
Buildings 	• Micro-CHP empowering householders • In a mix with electric & district heating • Key technologies: fuel cells & engines	26%	52%
Industry & SMEs 	• CHP boosting competitiveness • Delivering medium and high temperature heat on-site or via DHC • Optimising waste heat recovery • Key technologies: engines, turbines & fuel cells	26%*	84%**
Cities 	• CHP supplying local and affordable heat • Complementing waste heat & heat pumps • Key technologies: engines & turbines	40%	91%

*excluding furnaces.
** excluding furnaces; DHC for industry is 100% CHP.

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EU Green Deal
Overview of proposals for 2030

NEW EU PROPOSALS FOR 2030

Energy Efficiency Directive Recast

17.0-17.4%
Current energy efficiency savings for primary and final energy consumption (in 2019)

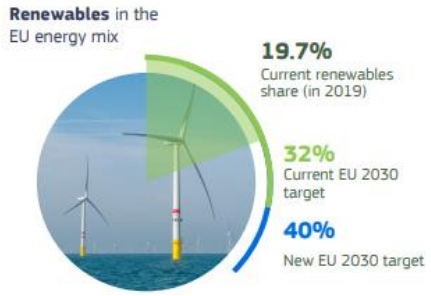
32.5%
Current EU 2030 non-binding target (relative to 2007 projections)

36-39%
New EU 2030 binding target for final and primary energy consumption

9% increase compared to the ambition pledged by Member States in 2020 within their National Energy and Climate Plans

- **Exclusion of "direct combustion of fossil fuels technologies"** from energy savings obligation
- Additional criteria for climate compliant high efficiency CHP: **fossil fuelled CHP must emit below 270 g CO2/kWh**
- **Efficient district heating redefined:** requirements for RES/waste heat shares as of 2035, but **no recognition of efficiency benefits from CHP**

Renewable Energy Directive Recast



Renewables in the EU energy mix

19.7%
Current renewables share (in 2019)

32%
Current EU 2030 target

40%
New EU 2030 target

- New definitions for renewable fuels, incl green hydrogen
- Sub-targets for RES in heating & cooling, DHC, buildings

EU ETS Revision

- Tighter rules for existing ETS applicable to industry and energy sector
- Separate EU wide emission trading system for buildings and transport fuels

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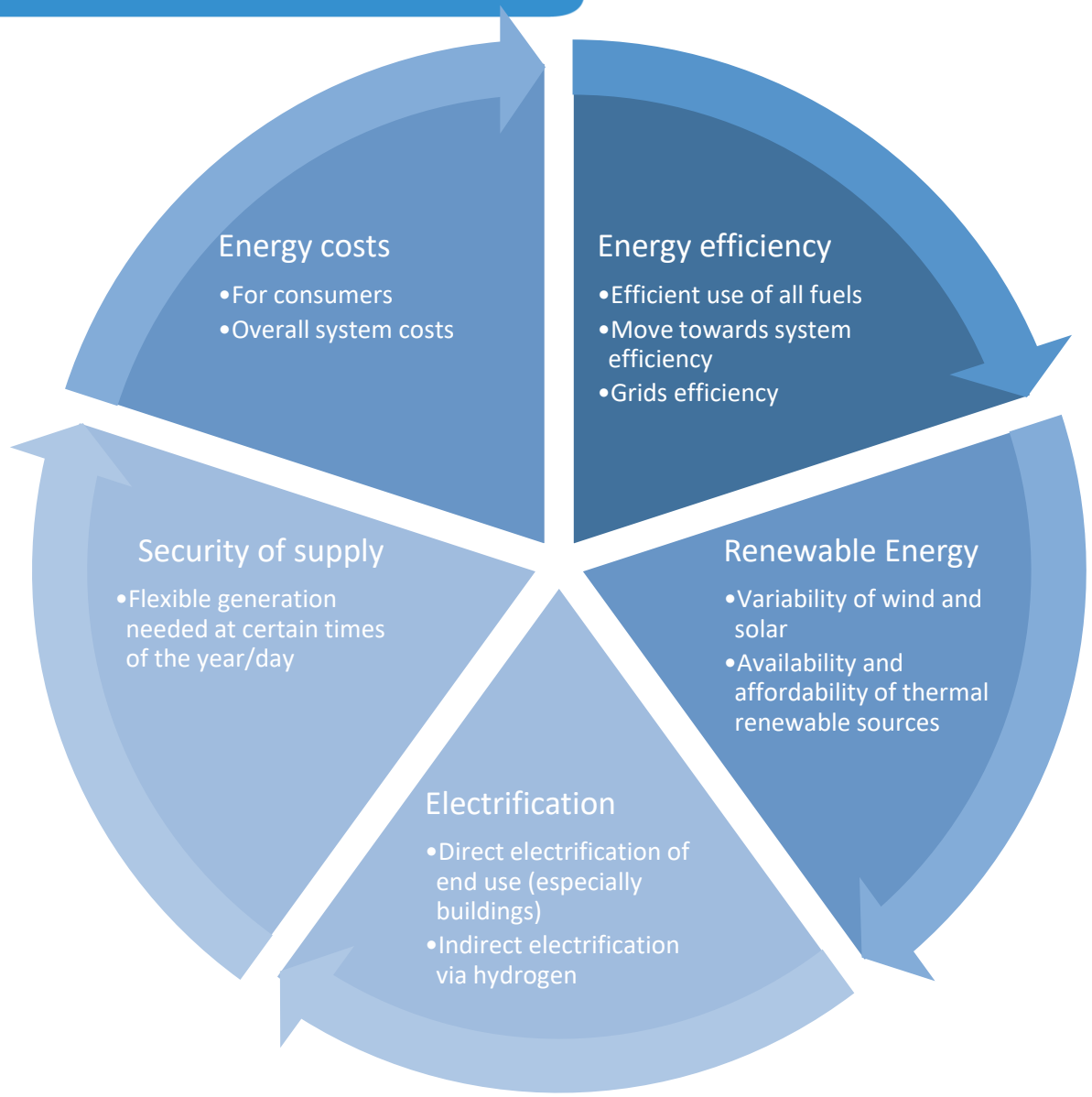
CHP ROLE IN THE ENERGY TRANSITION



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