COGEN EUROPE

Towards an efficient, integrated and cost-effective net-zero energy system in 2050

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Artelys
OPTIMIZATION SOLUTIONS

STUDY ON THE ROLE OF COGENERATION

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.

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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.**

Solution of Choice

Our 26 Partners

Cogeneration enjoys widespread industry support across EU and beyond: **Technology manufacturers, utilities, industrial players, energy service companies and national associations.**

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

Systems Focus

Two Scenarios

1.5 TECH*

Energy system derived from EC LTS 1.5TECH scenario

Integrated Energy Systems (IES)

Higher shares of green gases, incl P2X & H2, reflecting an increased focus on system integration

Economic Optimisation of Thermal Heat & Power (Optimised CHP)

More CHP installed compared to EC LTS 1.5 TECH, resulting in a more efficient use of energy and reduced energy system costs

CHP brings higher system benefits by efficiently replacing a large share of less-efficient non-CHP thermal generation in the energy mix

CHP DEPLOYMENY POTENTIAL LOW → HIGH

Artelys' understanding and modelling of EC Long-Term Strategy 1.5 TECH scenario that combines all technologies and relies heavily on biomass and CCS, referred to as 1.5 TECH in this study for simplicity.

SCENARIOS ASSESSMENT

CHP DEPLOYMENT
- CHP production per sector and energy source
- CHP technology mix

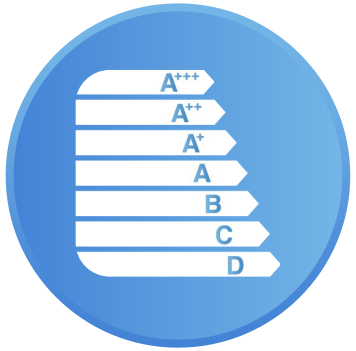
ENERGY SYSTEM INDICATORS
- Electricity generation mix
- Primary energy consumption
- CO2 emissions cuts

FINANCIAL INDICATORS
- System investment costs
  System operation costs

CHP's Multiple Benefits in 2050

€4-8 Bn

↓ cost for energy system



150–220 TWh

↑ energy savings across energy system

~20%

↓ 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.

Focus on Heat: CHP Key for all Sectors

ALL SECTORS IN THE EU

TOTAL HEAT

THERMAL HEAT

Buildings

- Micro-CHP empowering householders
- In a mix with electric & district heating
- Key technologies: fuel cells & engines

26%

52%

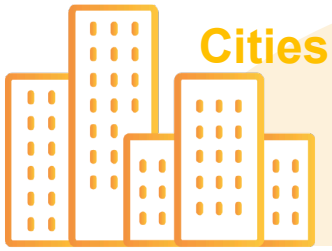
Industry & SMEs

- 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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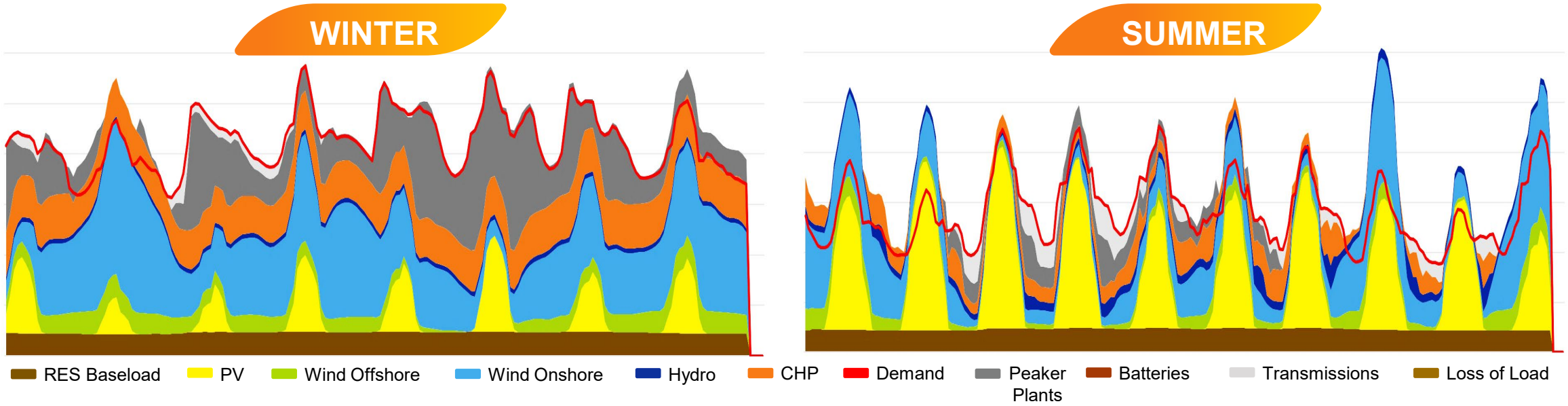
Focus on Power:

CHP Critical for Highly Renewable & Electrified System

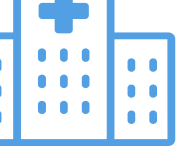
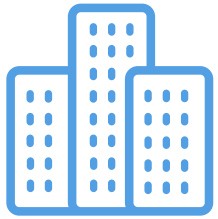
- CHP can flexibly and cost-effectively operate according to the electricity system needs.
- CHP does not compete but complements variable renewable generation to meet seasonal peak demand due to high shares of electrified heat.
- CHP is a flexible solution alongside batteries, hydro storage and demand-side management to meet electricity system needs.
- CHP short-term flexibility will vary by applications (heat or power driven).



CHP runs as base load during low wind and sun periods, covering high shared of remaining peak demand.

CHP stops producing when variable renewable generation is sufficient to cover demand.

Cost Savings for CHP Users

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
					
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)

*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.

CHP: Beneficial to Consumers in All Sectors

CHP enables the **most energy-efficient** & **cost-effective** pathways to decarbonisation in a **consumer-empowering** way.

220 TWH
OF PRIMARY ENERGY SAVINGS

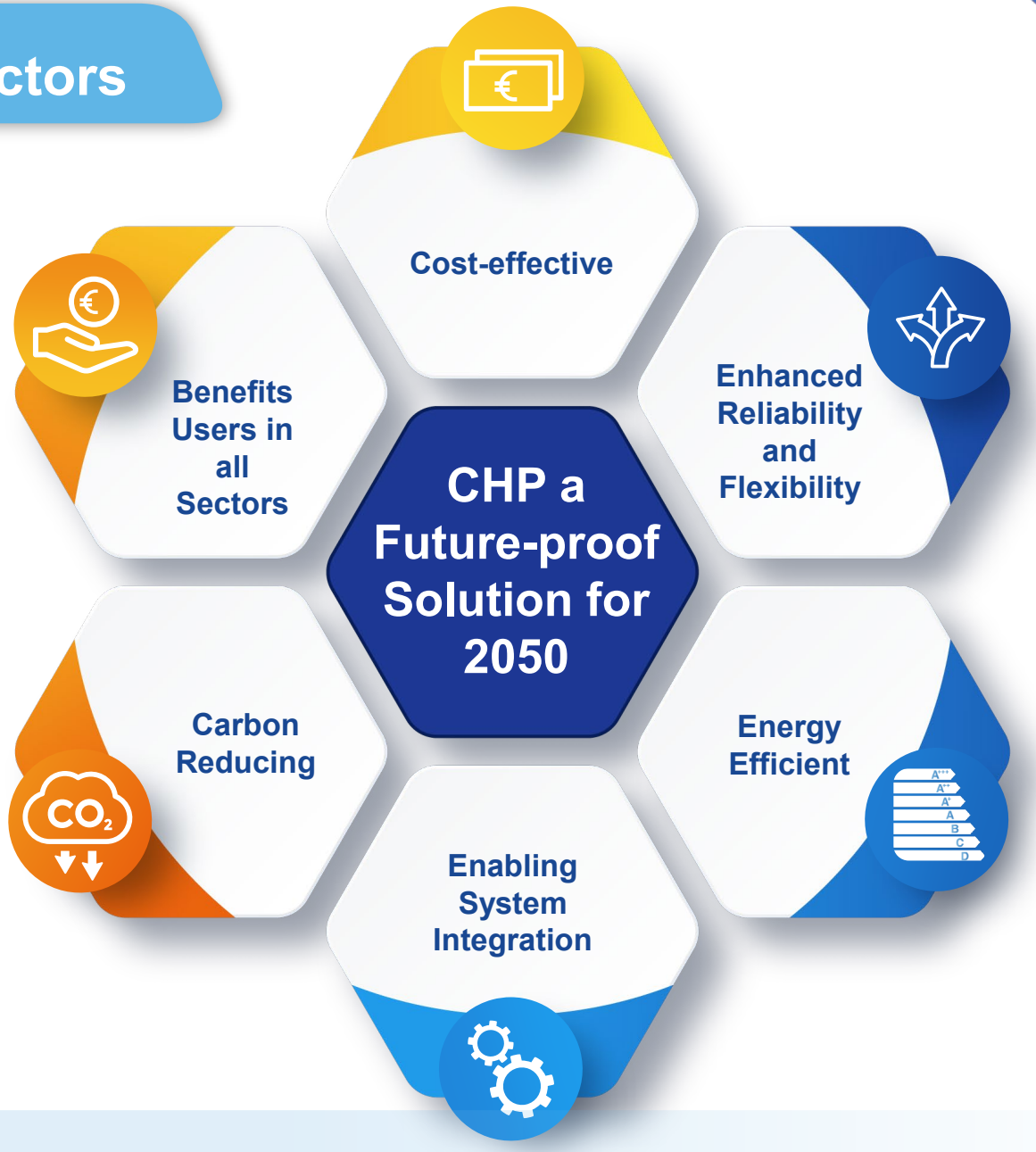
OR **2.5 x annual electricity consumption of Belgium***

5.5 MT
OF REMAINING CO_2 EMISSIONS AVOIDED

OR **Annual CO_2 emissions of 3 million petrol cars**

8.2 BN €
SAVED YEARLY

OR **9.5 x of LIFE Climate Action funding**

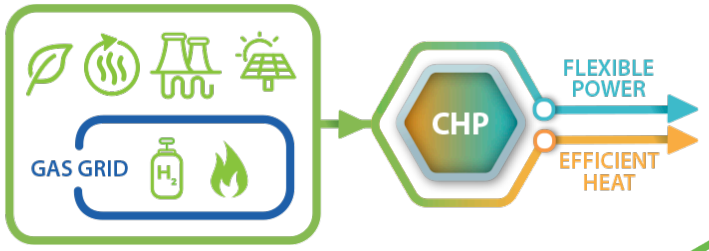


** IEA 2019*

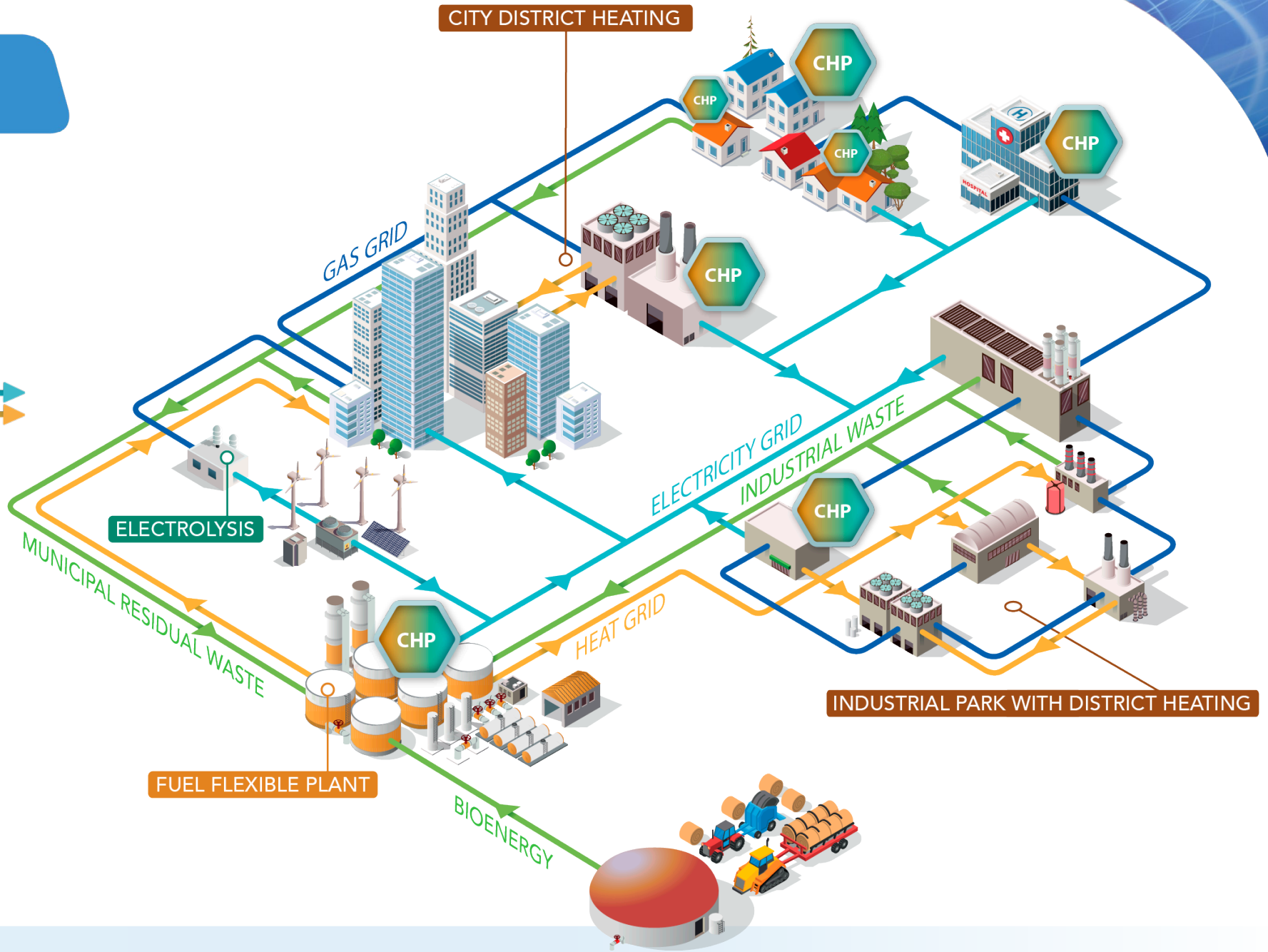
System Focus

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.**



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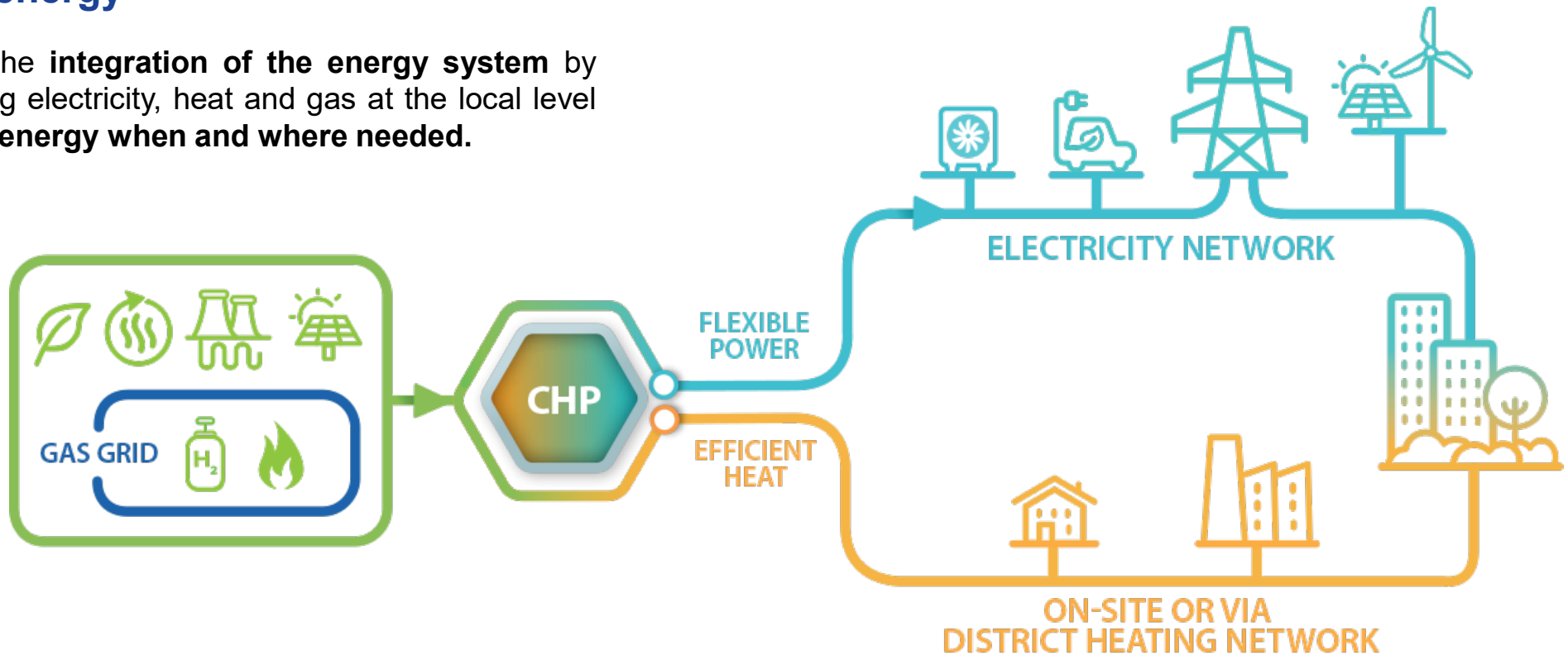
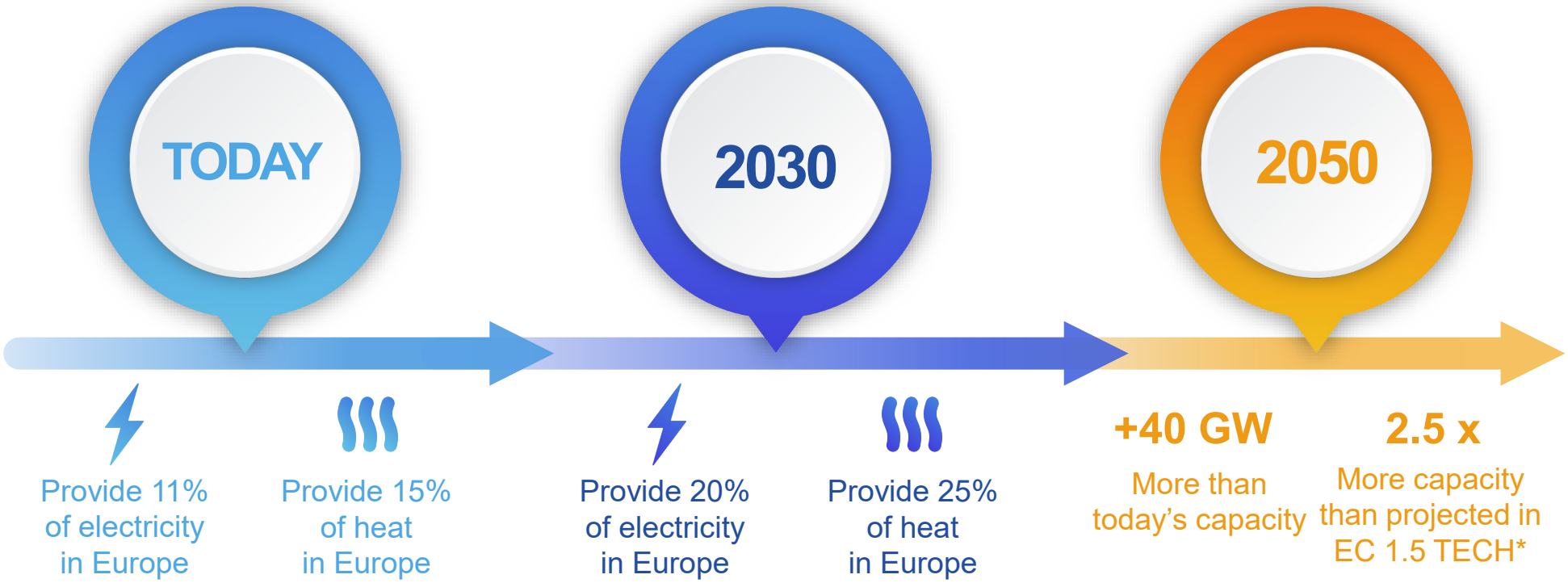


Our Call to Action

An **ambitious and predictable regulatory framework** must be set in place to fully reap the benefits of cogeneration for citizens, businesses and the energy system between now and 2050.

Prioristise cogeneration for all thermally generated heat and power, to avoid wasting valuable energy.



Policy Recommendations (1/2)

1. **Fully recognise CHP role in sectoral policy** for industry, buildings and district heating.

   - *Renovation Wave, Energy Labelling/Ecodesign, Industrial Strategy.*

2. **Better account for CHP displacing less efficient and more carbon intensive marginal generation** up to and in 2050.

   - *Energy Labelling/Ecodesign, Sustainable finance/Taxonomy, Building Codes, Primary Energy Factors (PEFs), 2050 whole Life-cycle Performance Roadmap, EU ETS, Effort Sharing Regulation, Energy Taxation Directive.*

3. **Foster CHP to deliver lowest cost heat and better valorise waste heat:**
   - Prioritise cogeneration as an efficient source of useful heat across a range of increasingly renewable and valuable energy sources, minimising the waste of heat; and
   - Recognise its further role in waste heat recovery on-site or via DHC and as a potential user of waste heat.

   - *Energy Efficiency Directive, Renewable Energy Directive, Energy Systems Integration.*

Policy Recommendations (2/2)

4

Reward CHP for its positive impact on system efficiency:

- Significantly reducing primary energy consumption for all thermal energy sources;
- Avoiding grid losses (reducing OPEX); and
- Reducing the need for network reinforcements (reducing CAPEX).

➢ *Electricity Market Design, Energy Efficiency Directive, TEN-E, EU/National Adequacy Assessments.*

5

Better consider the role of CHP to integrate heat, power and gas systems in a flexible and efficient way at local level

➢ *Energy System Integration, Hydrogen Strategy, National Energy & Climate Plans, National Comprehensive Assessments on Heating & Cooling.*

6

Foster a predictable policy framework towards carbon neutrality including:

- Adequate and stable support scheme design for CHP; and
- Decarbonisation roadmap considering the synergetic impact of both higher RES and higher efficiency of supply.

➢ *GBER & State Aid, Energy Efficiency Directive, Renewable Energy Directive.*

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