CCC HIGHLIGHTS
FIRST COHORT OF MISSION LABEL CITIES

STRIVING TOWARDS SUSTAINABLE ENERGY SYSTEMS

SUMMARY

In October 2023, 10 cities were awarded the EU Mission Label, recognising their plans to achieve climate neutrality by 2030 as outlined in their respective Climate City Contracts (CCCs). This factsheet, as part of a series titled "CCC Highlights", which explores the lessons learnt from labelled cities, looks at six inspiring examples of how European cities plan to transform their energy systems to achieve climate neutrality.

- **Cluj-Napoca (Romania):** The city is working towards an energy paradigm shift by shifting its energy profile from gas-intensive to predominantly electric.
- **Klagenfurt (Austria):** Both direct emission reduction and compensation measures will be implemented to change the energy system and support Klagenfurt in its journey to climate neutrality.
- **Madrid (Spain):** The city has identified three strategic interventions and several fields of action to transform the energy system and move towards climate neutrality.
- **Mannheim (Germany):** The city has identified 81 measures, comprising over 200 activities in energy saving, energy systems, waste and circular economy, mobility and transport, green infrastructure and nature-based solutions, built environment, and others, to help achieve climate neutrality. Of the 81 measures, 34 have been identified as high-priority measures.
- **Sønderborg (Denmark):** The city aims to address its energy system in its entirety, including buildings, transport, industry, energy and waste emissions, and divides its energy system into 15 segments.
- **Stockholm (Sweden):** In the areas of energy systems, mobility, and transport, impact pathways and action portfolios are in place to reduce emissions by 80% compared to 1990 levels and to achieve climate neutrality.

First Cohort of Mission Label Cities:

- Cluj-Napoca (Romania)
- Klagenfurt (Austria)
- Madrid (Spain)
- Mannheim (Germany)
- Sønderborg (Denmark)
- Stockholm (Sweden)
- Valencia (Spain)
- Valladolid (Spain)
- Vitoria-Gasteiz (Spain)
- Zaragoza (Spain)

The Mission Label was received in October 2023.

Funded by the European Union

WHAT IS THE MISSION LABEL?

The Mission Label is the European Commission's recognition of cities' successful development of their Climate City Contracts (CCCs). These contracts outline the vision for climate neutrality and contain an action plan and investment strategy.

AN ENERGY PARADIGM SHIFT IN CLUJ-NAPOCA (ROMANIA): MOVING FROM NATURAL GAS TO ELECTRICAL ENERGY

Unwavering commitment and proper planning are key to achieving climate neutrality. Cluj-Napoca exemplifies this commitment, especially considering it has already outlined ambitious interventions to become a net-zero city by 2030.

One of the identified areas of intervention is related to the energy system. More specifically, Cluj-Napoca is seeking to accomplish an energy paradigm shift by changing its energy profile from gas-intensive to predominantly electrical energy.

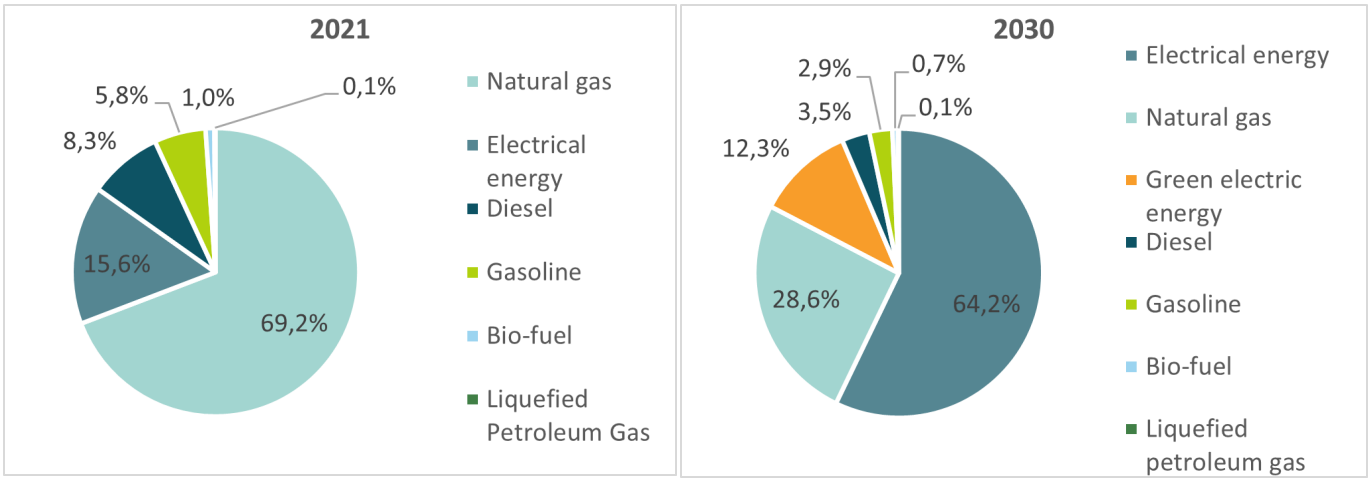

Figure 1. Comparison of Cluj-Napoca's energy profile in 2021 and what the energy profile is expected to look like in 2030[1]

As illustrated in Figure 1, Cluj-Napoca heavily relied on natural gas to meet its energy demand in 2021. Natural gas comprised a tremendous 69.2% of the energy profile, followed by electricity (15.6%), diesel (8.3%), gasoline (5.8%), biofuel (1%), and liquefied petroleum gas (0.1%).

The reliance on natural gas is expected to change by 2030 as the city shifts towards electrical energy. According to its estimates, Cluj-Napoca expects that electrical energy will source 64.2% of the required energy, while natural gas (28.6%) takes second place and green electric energy (12.3%) third. Regarding the latter, green electric energy refers to electric energy that is produced from renewable sources within the city boundaries, while electric energy means general grid energy. Diesel (3.5%), gasoline (2.9%), biofuel (0.7%), and liquefied petroleum gas (0.1%) will continue to constitute much smaller energy sources.

[1] For more information see the Climate City Contract designed by the City of Cluj-Napoca and available on the knowledge repository of the Mission Portal: https://netzerocities.app/resource-4061

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Furthermore, total energy consumption is expected to increase by 7% in 2030 compared to 2021, while total carbon dioxide emissions are expected to decrease by 80%.

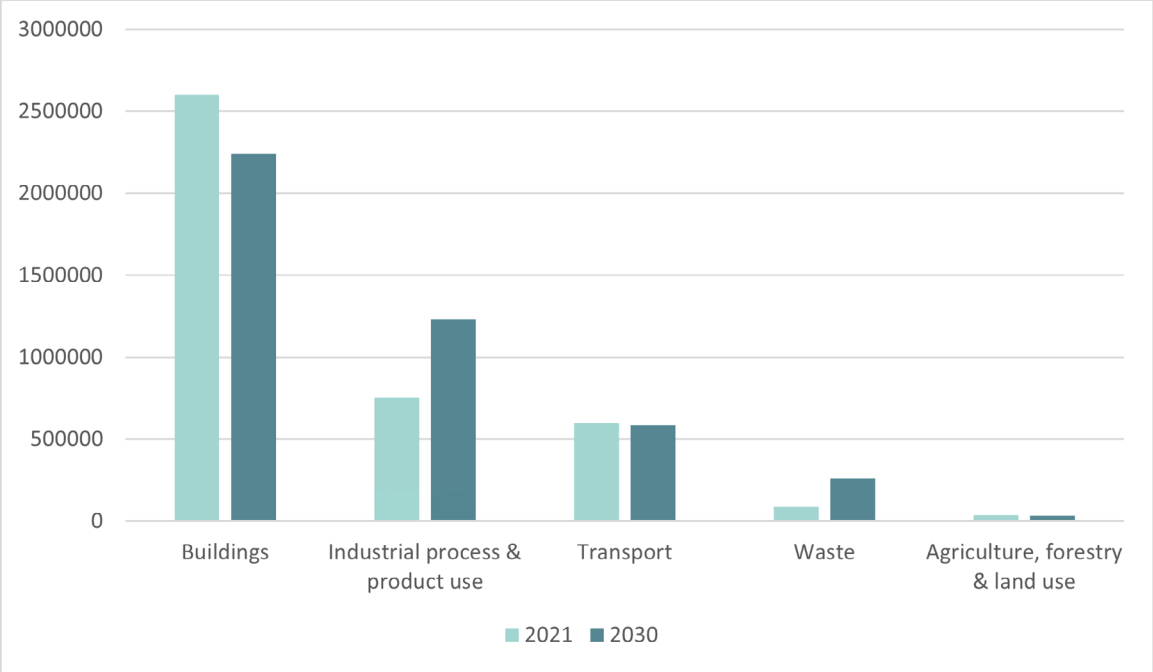

Figure 2. Energy consumption in 2021 by sector

A large majority of the energy needs come from the building sector. As illustrated in Figure 2, the order of the sectors, from those representing the most significant energy need to those with the lowest, is expected to stay the same when comparing 2021 to 2030. Although energy needs are expected to decrease by 2030, the building sector will continue to consume the most energy. Industrial process and product use will continue to occupy second place, the transport sector third place, waste fourth, and agriculture, forestry, and land use fifth place. In the case of both industrial processes and product use, as well as waste, the energy demand is expected to increase by 2030 compared to 2021 numbers.

KLAGENFURT (AUSTRIA)TACKLES CLIMATE NEUTRALITY USING BOTH DIRECT EMISSION REDUCTION MEASURES AND COMPENSATION MEASURES

To achieve climate neutrality by 2030, Klagenfurt is prepared to take necessary actions in energy systems, mobility and transport, built environment and housing, and nature-based and other innovative solutions.

Most of the actions can be categorised as complex actions due to their focus on creating new infrastructure. Nonetheless, in most cases, these actions also involve soft actions, such as awareness-raising and activities to encourage behavioural changes.

The different climate actions combine two kinds of measures: direct greenhouse gas (GHG) emission reduction measures and GHG compensation measures.

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Types of measures	Activity	GHG reduction	Total
Direct GHG emission reduction	Replacement of natural gas by green synthetic gas	30,000 tGHG	50,000 tGHG
	Expansion of district heating system. (Removed/substituted energy, volume, or fuel type = gas, oil, wood, coal (proportion is unknown))	15,000 tGHG	
	Implementation of district cooling for selected larger companies and/ or establishments in the city centre Implementation of district cooling for selected larger companies and/or establishments in the city centre	5,000 tGHG	

Table 1. Activities, grouped by type, that Klagenfurt plans to carry out to address the energy systems and their expected GHG reduction[2]

[2] For more information see the Climate City Contract designed by the City of Klagenfurt and available on the knowledge repository of the Mission Portal: https://netzerocities.app/resource-4062

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Types of measures	Activity	GHG reduction	Total
GHG compensation measures	Photovoltaic projects on municipality buildings	30,000 tGHG	64,500 tGHG
	Photovoltaic projects in the central area of Carinthia	30,000 tGHG	
	Energy storage	4,500 tGHG	

Table 1. Activities, grouped by type, that Klagenfurt plans to carry out to address the energy systems and their expected GHG reduction

Table 1 illustrates the energy systems-related actions that Klagenfurt plans to take. Some actions, such as district cooling, are entirely new to the city, while others, such as the district heating system, represent extensions of existing approaches.

Three identified activities are considered measures to directly reduce GHG emissions, while the other three are GHG compensation measures. The total emission reduction resulting from the former is expected to be 50,000 tGHG, with much of this reduction stemming from the replacement of natural gas with green synthetic gas. Regarding the second set of activities, namely those linked with compensation, it is expected that they will lead to the compensation of approximately 64,500 tGHG. The total amount of GHG emissions reduced and compensation in the energy systems sector is expected to, thus, total 114,500 tGHG.

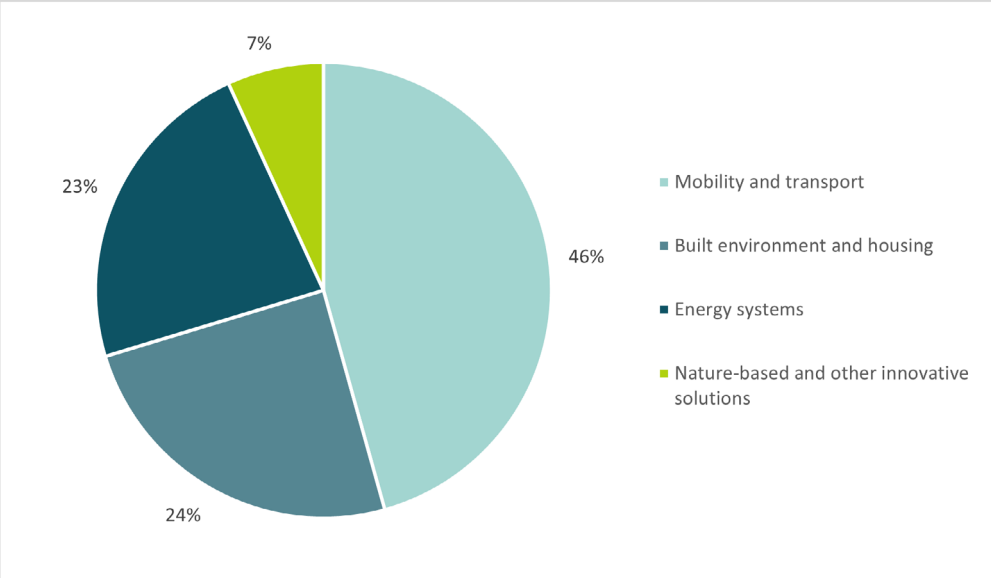

Figure 3 Share of direct emission reduction projects according to sector

The city of Klagenfurt plans to implement several key projects that directly reduce GHG emissions. Of these projects, the largest number deals with the mobility and transport sector (46%). The built environment and housing sector (24%) represent the second highest amount, followed by energy systems (23%) and nature-based and other innovation solutions (7%). As a result of these projects, Klagenfurt expects to see a reduction of CO2 emissions by 219,000 tons.

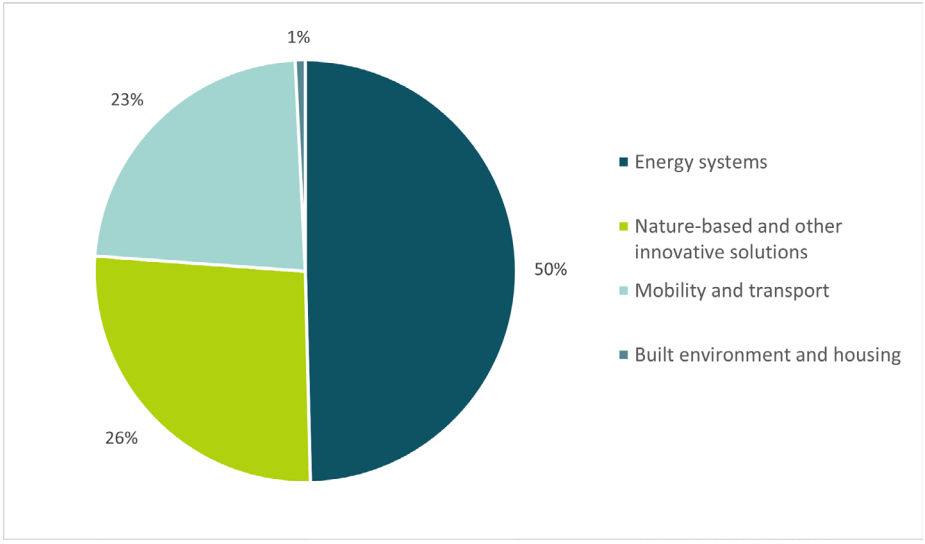

Figure 4 Share of GHG compensation projects according to sector

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Klagenfurt has also identified several GHG compensation projects to implement over the next few years to help the city achieve its vision. Of these projects, 50% tackle the energy systems sector. The second highest share of the projects is related to nature-based and other innovative solutions (26%), followed by mobility and transport in third place and built environment and housing in fourth place. A total of 130,000 tons of GHG emissions are projected to be compensated due to these actions.

SETTING OUT TO TRANSFORM THE ENERGY SYSTEM AND ACHIEVE CLIMATE NEUTRALITY IN MADRID (SPAIN) THROUGH STRATEGIC INTERVENTIONS AND AMBITIOUS FIELDS OF ACTIONS

The City of Madrid has outlined three priority strategic interventions to achieve climate neutrality:

- **New climate-neutral city developments**. The development of the Madrid Nuevo Norte area is already underway and is being guided by the vision to make it the largest urban development with an electrified energy model (zero emissions) in Europe.
- **Transformation of university campuses and schools** into climate-neutral environments and the creation of a new culture for the future.
- **Transformation and regeneration of the city** with facilities, public space, and other public facilities acting as nodes of neutrality in which the administration's activities connect with urban actors on the territory through, for example, energy communities, participatory design of environments, and shared modes of mobility.

In addition to the strategic interventions and considering the city's vision, Madrid has outlined several activities it plans to carry out, including in energy systems.

Fields of action	Define innovative energy use and storage systems as demonstration projects.
	Establish new energy rehabilitation models involving citizens and the private sector in their definition.
	Creation of systems/models for consultation and management support for citizens.
	Promoting the renovation of individual and collective systems in buildings (lighting, electrical appliances, etc.).
	Promotion of electrified heating systems (heat pump).
	Development of a pilot project on the study of new energy models to extend the distributed energy generation network in the city.

Fields of action	Demand from citizens' groups, start-ups, SMEs, and large companies for the promotion of renewable energy (co-) production initiatives.
	New business model tested in pilot project for renewable energy production through a local energy community.

Table 2. Fields of action identified and planned by Madrid and which relate to the energy systems sector[3]

The different activities will have an impact not only GHG emissions, but also on energy consumption and the energy sources to meet the need.

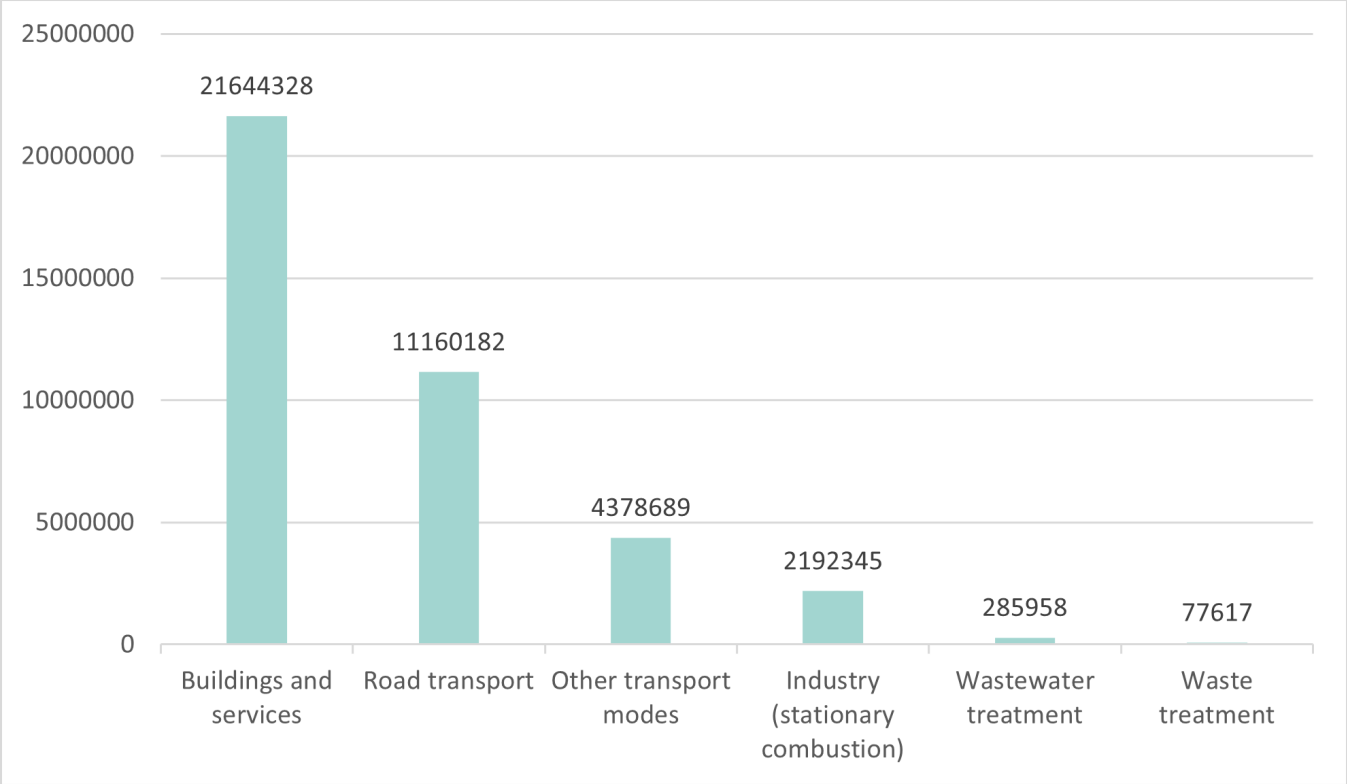

Figure 5 Text Final energy use by sector of origin --> GHG inventory 2019 (2019 is base year)

Figure 5 provides a breakdown of energy consumption in 2019 according to the different sectors. By far, the buildings and services sectors are responsible for the highest energy consumption. Road transport takes second place when it comes to the most energy consumed, followed by other transport modes, industry, wastewater treatment, and waste treatment.

[3] For more information see the Climate City Contract designed by the City of Madrid and available on the knowledge repository of the Mission Portal: https://netzerocities.app/resource-4063

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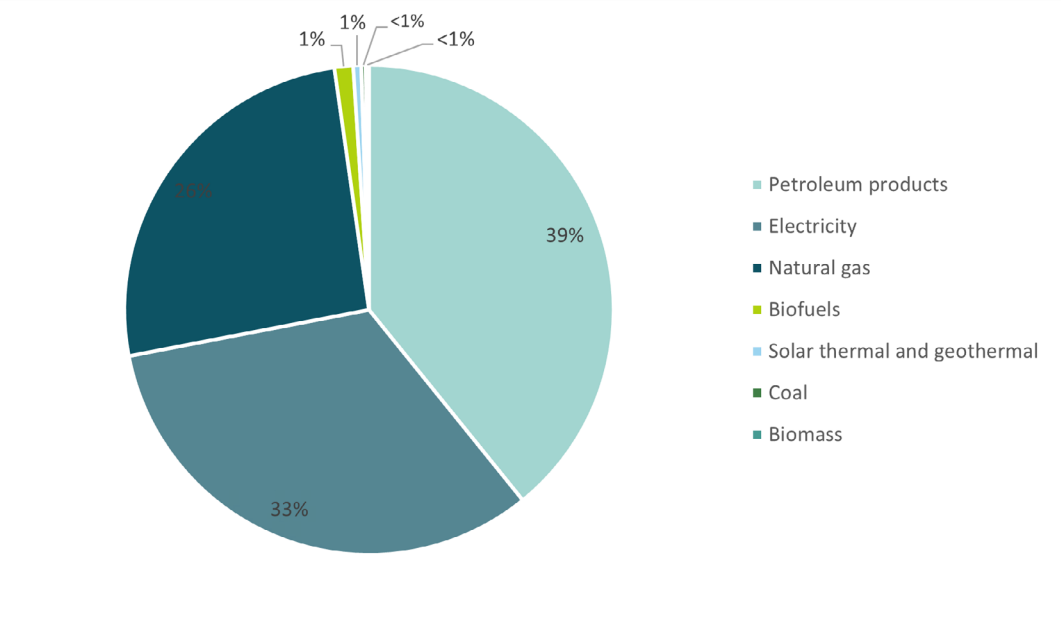


Figure 6 Final energy use by sector of origin --> GHG inventory 2019 (2019 is the base year)

To better understand the impact of some of the activities foreseen to be implemented by Madrid, it is helpful to understand the different sources that meet the city's energy demand. In 2019, petroleum represented a large source of energy, comprising 39%. Electricity (33%) came in as a close second, followed by natural gas (26%). Biofuels (1%), solar thermal and geothermal (1%), coal (<1%), and biomass (<1%) constituted insignificant energy sources.

MANNHEIM (GERMANY) IDENTIFIES TOP MEASURES, INCLUDING THOSE LINKED TO ENERGY SYSTEMS, TO RECEIVE PRIORITY IMPLEMENTATION

The city of Mannheim has emphasised that a successful path towards climate neutrality requires ambitious activities by the city and its entire society, including local companies, interest groups, and citizens, and suitable framework conditions at the state, federal, and European levels.

As a result, Mannheim has drawn up a list of 81 measures, comprising a total of over 200 activities in the fields of energy saving, energy systems, waste and circular economy, mobility and transport, green infrastructure and nature-based solutions, built environment, and others. Of this long list, the city has further identified 34 as high-priority measures, meaning they will receive priority implementation due to the central role they play for Mannheim when it comes to reaching climate neutrality.

Action field – Sustainable Energy and Climate Action Plan	Field of action	TOP measures
Energy production	Power generation	PV offensive

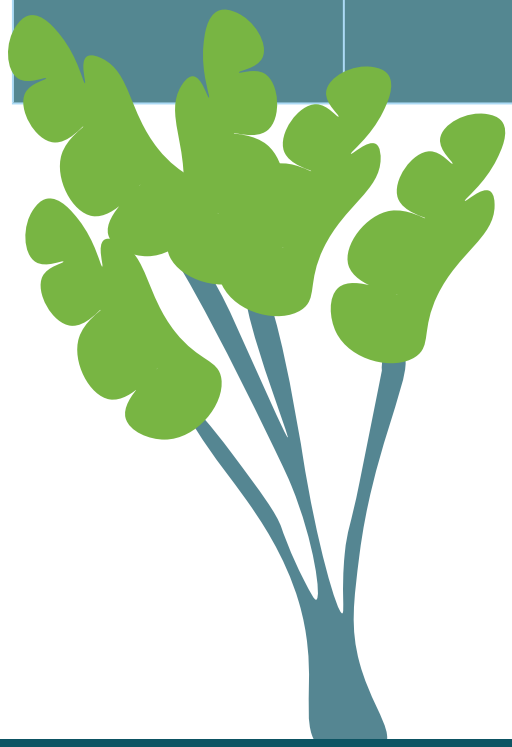
Action field – Sustainable Energy and Climate Action Plan	Field of action	TOP measures
Energy production	Smart grids	Development and expansion of intelligent energy control and smart grids
Energy production	Decarbonisation of the heat supply	District and local heating
		Geothermal energy
		Promotion for the conversion of the heat supply
Energy production	Hydrogen	Hydrogen strategy
Energy production	Concrete and overarching measures	Energy self-sufficient sewage treatment plant
Industry	Energy measures in the company	Use and expansion of renewable energy

Table 3. High-priority measures selected by Mannheim in connection to energy systems, along with their corresponding field of action[4]

[4] For more information see the Climate City Contract designed by the City of Mannheim and available on the knowledge repository of the Mission Portal: https://netzerocities.app/resource-4069

Mannheim's Climate Action Plan includes a list of crucial interventions for reaching climate neutrality by 2030 and their descriptions. Some of these interventions, specifically those related to stationary and renewable energy, are listed in Table 4 below.

Area of intervention	Intervention	Description
Stationary energy	Municipal refurbishment road map	Energy retrofits, green district heating, renewable energy expansion saving by 17kg CO2/ m2/a. CO2 reduction by 80% within 20 years
		All buildings powered by PV electricity by 2027
		Green roofs and facades
	Smart Quarter Spinelli	Lighthouse project on conversion area with energy self-sufficient heating concept – groundwater energy, heat pumps, PV electricity on all roofs and facades
	Local renovation wave	3,000 flats refurbished by 2030, with 1,000 of these connected to district net by 2025. Expected impact of 40% heat reduction and 55% CO2 reduction.



Area of intervention	Intervention	Description
Renewable energy	Solar initiative Mannheim	sMArt City company 20 MWp PV for all municipal buildings, including schools); support of private homeowners with solar bonus for PC; cost-free solar checks
	Street lighting	Energy-efficient and insect-friendly. 14,600 poles replaced in 2028 (LED-quote 40%); 1,000t CO2 reduction per year; counteracting light pollution
	Renewable heat transition	Geothermal energy from Rhine Valley (150-200 GWh); River heat pump into operation in 2023 (20MWth, heat generation 80 GWh)
	Decarbonisation district heating	100% climate neutral by 2030 through mix of thermal waste treatment, renewable sources such as biomass, biomethane, river heat, geothermal energy, sewage sludge incineration and industrial waste heat

Table 4. List of interventions connected to stationary energy and renewable energy and their descriptions.

SØNDERBORG (DENMARK) SETS AMBITIOUS TARGET TO TRANSITION TO A CARBON-NEUTRAL ENERGY SYSTEM BY 2029

The city of Sønderborg's climate neutrality journey started in 2007 when it was decided that Sønderborg would aim to transition its energy system to carbon neutrality by 2029. Since then, the CO2 emissions within its energy system have continued downward, as depicted in Figure 7. According to 2021 data, CO2 emissions have reduced by 55.4%, corresponding to a reduction of 388,235 tonnes of CO2, since 2007. The city hopes to further reduce the remaining 312,809 tonnes of CO2 emissions to zero by 2029.

Sønderborg delivered a robust overall strategy and action plan to move towards this vision by developing the Masterplan2029. With this plan, Sønderborg aims to confront the city's energy system, including buildings, transport, industry, energy, and emissions from waste.

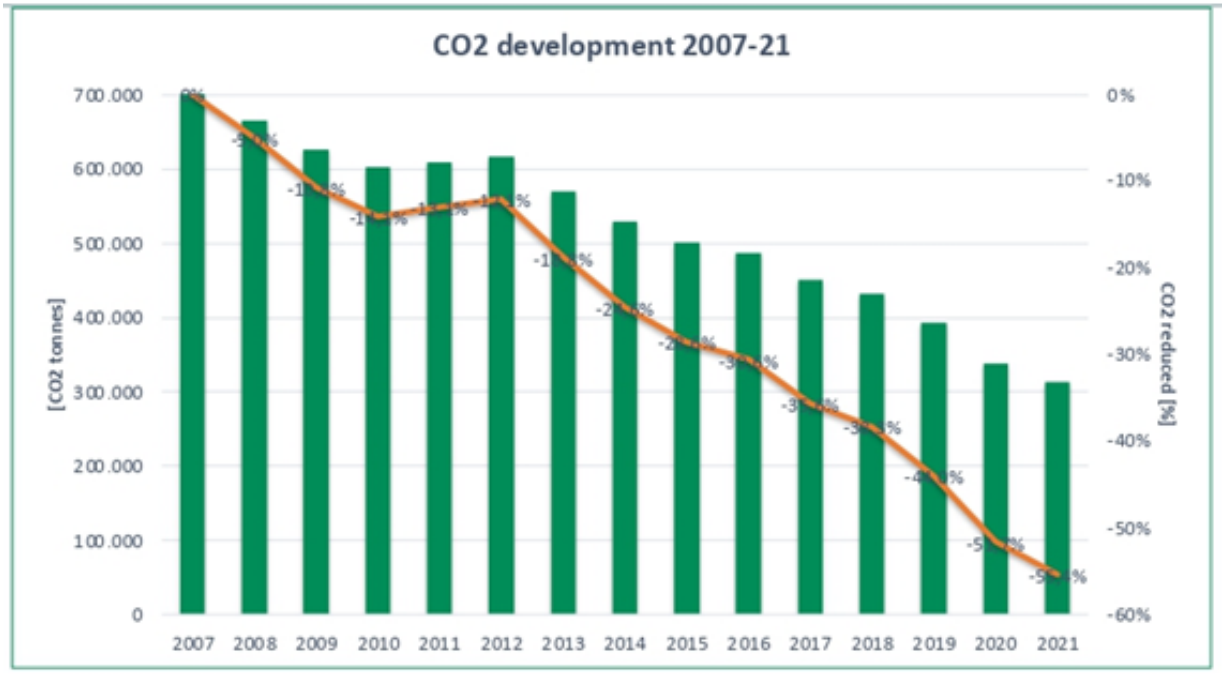


Figure 7 Reduction of CO2 emissions in Sønderborg from 2007 to 2021[5]

The Masterplan2029 breaks down Sønderborg's energy system into 15 segments called hotspots, covering buildings, transport, industry, and transport sectors, to help bring the city to CO2 neutrality.

Sector	Hotspot	KTon CO2 – 2020 (baseline)	KTon Co2 - 2029	Total CO2 reduction
Building	Rented homes	6	0	28kt CO2
	Owner-occupied homes	18	0	
	Public buildings	4	0	

[5] For more information see the Climate City Contract designed by the City of Sønderborg and available on the knowledge repository of the Mission Portal: https://netzerocities.app/resource-4064

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Sector	Hotspot	KTon CO2 – 2020 (baseline)	KTon Co2 - 2029	Total CO2 reduction
Transport	Passenger transport PassengPassenger transport	92	75	27kt CO2
	Goods and heavy transport	27	20	
	Agricultural machinery	14	11	
Business	Big companies	19	0	56kt CO2
	Brick manufacturers	37	6	
	SMEs	6	0	
Energy	District heating (incl. electricity production)	40	0	129kt CO2
	Electricity import	89	0	
Enabler	Biogas and methanisation (export)	-7	-60	-123kt CO2
	PtX	0	-70	
	Wind turbine park	N/A	N/A	

Sector	Hotspot	KTon CO2 – 2020 (baseline)	KTon Co2 - 2029	Total CO2 reduction
Enabler	Wastewater treatment plant	N/A	N/A	-123kt CO2
	Sector coupling	N/A	N/A	

Table 5. Text Sønderborg's energy system is divided into 15 segments

Table 5 provides an overview of the hotspots, along with their respective 2020 (baseline) CO2 emission levels and CO2 reduction goals for 2029.

Most hotspots are grouped according to the relevant sector, namely building (three), transport (three), business (three), and energy (two). The remaining five hotspots are characterised as enablers due to their ability to further decarbonise and carbon offset the energy system. Within this group, the sector integration hotspot deals with integrating energy end-use and supply sectors by improving Sonderborg's energy system's efficiency, flexibility, and reliability.

The energy sector is expected to see the most significant CO2 reduction, with a total reduction of 129 tonnes through district heating and the import of electricity. Following the energy sector, the enabler hotspots (-123 tonnes), business sector (56), building sector (28), and transport sector (27) will also see considerable CO2 reductions.

IMPACT PATHWAYS AND ACTION PORTFOLIOS WITHIN ENERGY SYSTEMS ARE UNDERWAY IN STOCKHOLM (SWEDEN)

In 2022, Stockholm formally adopted the goal of becoming climate-neutral and even climate-positive by 2030. The city will focus on emission reduction measures and bio-energy carbon capture and storage to meet this goal. Impact pathways and action portfolios are already underway in Stockholm, specifically within energy systems, mobility and transport, and the city is simultaneously also looking at achieving negative emissions.

Achieving climate neutrality by 2030 in Stockholm would signify an 80% reduction in emissions compared to 1990 levels. Figure 8 below illustrates the percentage share of GHG emissions divided by the different sectors. Road traffic contributes the largest share of emissions (40%), followed by heating (28%), and electricity use (16%). Work machines (7%), methane emissions (5%), port, waterway and sea transport (4%), and oil for heating (4%) also contribute to emissions, but to a far smaller degree.

In addition to cutting emissions, the City of Stockholm will continuously aim to reduce residual CO2 emissions.

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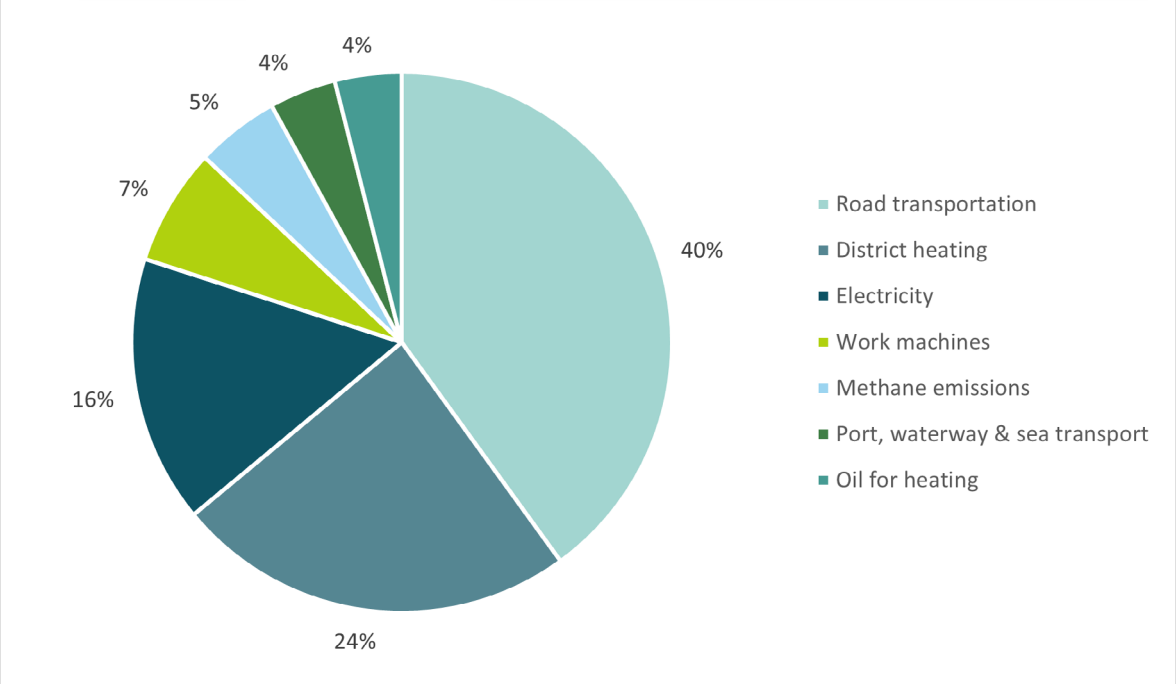

Figure 8 Share of emission according to different sectors [6]

To reach its GHG emission reduction targets, the city of Stockholm has identified several interventions it plans to take.

Intervention	Action	Description	Impact
Heating	Phase out fossil fuels in district heating	To a limited extent, fossil oil is used on very cold days and as a back-up. This will be replaced by bio-oil.	125,000t CO2 reduction per year
	Phase out oil burners in buildings	A limited number of houses still use oil-burners. The city aims to phase these out.	

[6] For more information, see the Climate City Contract designed by the City of Stockholm and available on the knowledge repository of the Mission Portal: https://netzerocities.app/resource-4060

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Intervention	Action	Description	Impact
Waste	Reduce the amount of fossil plastic in incineration (for district heating)	Includes actions along the value chain of plastics: Prevent plastic waste from occurring, increase sorting of fractions, Increase collection of plastic waste for recycling. Plastic waste is the main fossil contributor in Stockholm's district heating. Hence, the main focus is on reducing the amount of plastics in the combustion plants.	125,000t CO2 reduction per year
Electricity use	Reinforcements in the electricity grid	Investments are planned to double the capacity by strengthening the grid and using digitalization. Flexible market mechanisms are being tested.	65,000t CO2 reduction per year
	Phase out of fossil fuels in the Nordic electricity production	Increase renewable energy production in the Nordic Region, and phase out oil, natural gas and coal from electricity production.	

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Intervention	Action	Description	Impact
City gas	Phase out natural gas	When the bus fleet is electrified, the demand for gas will decrease. The production of biogas is expected to increase as sorting of bio-waste becomes mandatory. New applications for biogas will be investigated.	10,000t CO2 reduction per year
	Reduce leakage from the city gas distribution network	Investments in the network will be coordinated with other infrastructure investments to cut costs and effort.	
Negative emissions	Establish negative emissions using carbon capture and storage in connection to the KVV6 bio-CHP plant (BECCS)	Combining CO2 capture with heat recovery, the BECCS Stockholm-project will capture and permanently store large quantities of biogenic CO2.	800,000t CO2 reduction per year

Table 6. Energy system-related intervention planned by the city of Stockholm, along with their specific action, description, and impact

In table 6, the impact of heating and waste treatment is combined possibly because the district heating system in Stockholm covers 80% of the buildings, and incinerated waste is used as a source of energy in the City's CHP plants. This means that the impact pathways for the energy sector, waste, and buildings are highly intertwined.

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