Sino-German Urbanisation Partnership

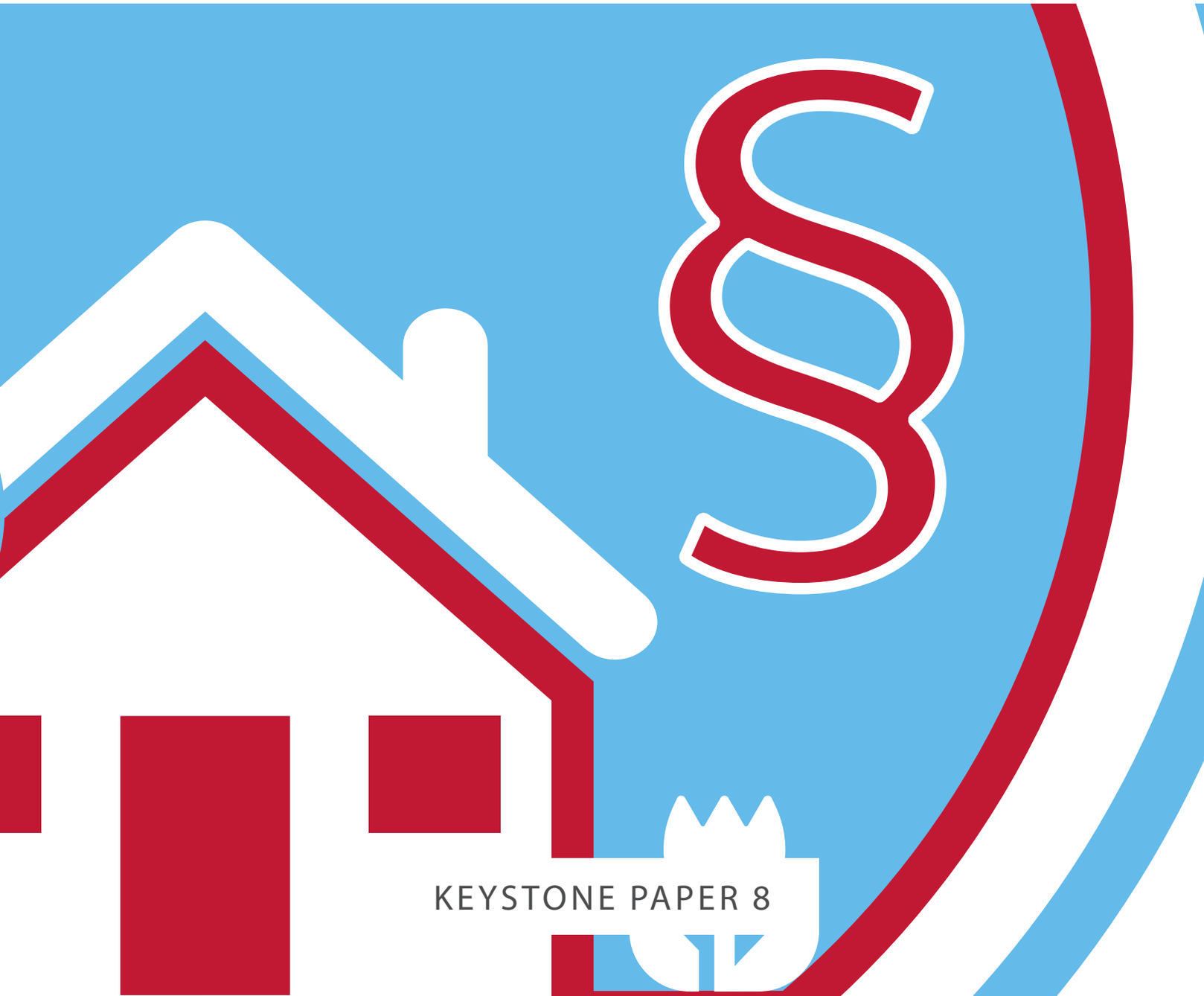
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Im Auftrag des:

Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit

ENERGY-LAW IN GERMANY

AT EUROPEAN, FEDERAL, AND MUNICIPAL LEVEL AND ITS IMPACTS ON LOW-CARBON URBAN DEVELOPMENT



KEYSTONE PAPER 8

Sino-German Urbanisation Partnership

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

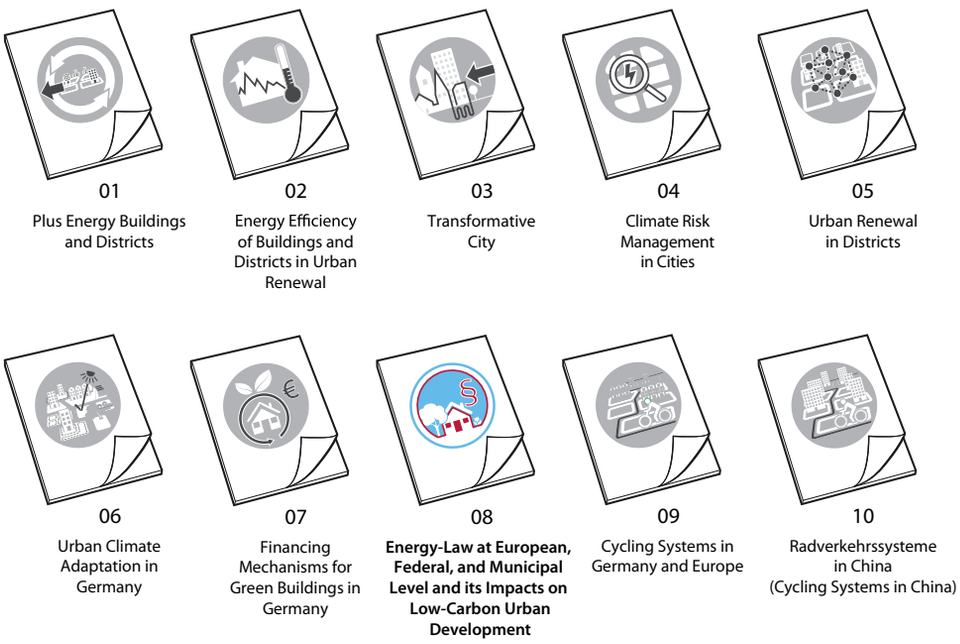
of the Federal Republic of Germany

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

This document is part of ten keystone papers looking at current emerging topics in the building and city sector, focusing on energy efficiency and resilience. The keystone papers were developed within the framework of the Sino-German Urbanisation Partnership as a basis for the forthcoming working period and cover following topics:



CONTENT

ILLUSTRATIONS

TABLES

INFORMATION BOXES

ABBREVIATIONS

BauGB	German Building Code (Baugesetzbuch)
BauNVO	Building Use Ordinance (Baunutzungsverordnung)
BEG	Promotion for Efficient Buildings (Bundesförderung für Effiziente Gebäude)
BEI	Baseline Emission Inventory
BGB	German Civil Code (Bürgerliches Gesetzbuch)
BImSchG	Federal Immission Control Act (Bundes-Immissionsschutzgesetz)
Bplan	Legally binding land-use plan (Bebauungsplan)
CHP	Combined heat and power
CO_2	Carbon dioxide
EC	European Community
ECI	European critical infrastructure
ECSC	European Coal and Steel Community
EEC	European Economic Community
EED	Energy Efficiency Directive - EU
EEG	Renewable Energy Act (Erneuerbare-Energien-Gesetz)
EffSTRA	Energy Efficiency Strategy (Energie-Effizienz-Strategie)
EWärmeG	Renewable Energy Heating Act (Erneuerbare-Energien-Wärmegesetz BadenWürttemberg)
EEWärmeG	Renewable Energy Heating Act (Erneuerbare-Energien-Wärmegesetz)
EnEG	Energy Savings Act (Energieeinsparungsgesetz)
EnEV	Energy Savings Ordinance (Energieeinsparungsverordnung)
ENP	Energy Use Plan (Energienutzungsplan)
EP	European Parliament
EPBD	Energy Performance of Buildings Directive - EU
ETS	EU Emissions Trading System
EU	European Union
EURATOM	European Atomic Energy Community
FES	Programme to Promote Energy Savings (Förderprogramm Energieeinsparung München)
FNP	Preparatory Land-Use Plan (Flächennutzungsplan)
GEG	Building Energy Act (Gebäude-Energie-Gesetz)
GHG	Greenhouse Gas(es)
GG	German Basic Law (Grundgesetz)
GO	Local Code (Gemeindeordnung)
INSEK	Integrated City Development Concept (Integriertes Stadtentwicklungskonzept)
KfW	Kreditanstalt für Wiederaufbau
kWh	Kilowatt Hours

KWKG	Cogeneration Act (Kraft-Wärme-Kopplungsgesetz)
kWp	Kilowatt Peak
LBO	State building regulation (Landesbauordnung)
NAPE/NEEAP	National Energy Efficiency Action Plan (Nationaler Aktionsplan Energieeffizienz)
NDC	Nationally Determined Contributions
NECP	National Energy and Climate Plan (Nationaler Energie- und Klimaplan)
NUA	New Urban Agenda
PV	Photovoltaic System
RED	Renewable Energy Directive - EU
ROG	Federal Spatial Planning Act (Raumordnungsgesetz)
SDG	Sustainable Development Goals
SECAP	Sustainable Energy Climate Action Plan
SWM	Munich City Utilities (Stadtwerke München GmbH)
TFEU	Treaty on the Functioning of the European Union

1. INTRODUCTION

BACKGROUND

The year 2020 was warmer in Europe than any other since records began, according to the European Copernicus Climate Change Service in London. In Europe, the year was on average 1.6 degrees Celsius warmer than the 30-year reference period 1981 to 2010, and 0.4 degrees warmer than the previous European record year of 2019[1].

Moreover, the economic damage caused by natural disasters increased last year[2] from which cities and their citizens suffer increasingly. This requires immediate action more than ever[3]. Nearly 70 percent of the world's population will live in cities by 2050. The United Nations estimated that the global urban population will increase to 68% by 2050 with around 90% of the increase taking place in developing regions[4]. In Germany, 77% of the population lives in urban areas, and China is in the midst of the largest wave of urbanization – with 770 million people currently living in cities, up from 190 million in 1980.[5]

Already, almost two-thirds of the world's energy is consumed in urban areas. Hence, the city of the future must be sustainable and low carbon, contributing to the worldwide efforts to fight climate change - on the level of buildings, neighbourhoods, city quarters and the overall city level. The way our cities develop has a huge influence on their energy consumption. Improving the efficiency of buildings, particularly their use of energy, is one of the fastest and most cost-effective ways of reducing carbon emissions and improving local economic development, air quality, and public health[6].

In December 2015, 195 countries agreed for the first time to a generalized, legally binding, and global climate action plan: the Paris Agreement. To counteract dangerous climate change, this agreement included a global action plan which aimed to limit global warming to well below 2°C by the year 2100. End of April 2021, the European Commission announced its will and commitment to reduce CO_2 emissions until 2030 by at least 55%, becoming climate neutral by 2050[7].

Germany's goal of achieving climate neutrality for the country's building stock by 2050, and thus reducing emissions of greenhouse gases (GHG) by 80-95 % is part of Germans so called Energy Transition ("Energiewende"). Remarkably, in April 2021 the Federal Constitutional Court of Germany in its verdict on the 2019 Federal Climate Change Act, criticised the concrete path to mitigate climate change until 2030 in this law as to short-sighted. It is now up to the new to be elected government (elections will take place in September 2021) to fulfil the requirements of the court and to define concreter measures to reach climate neutrality in 2050 safeguarding future generations[8].

Many German cities have shown their particular commitment to reducing greenhouse gas (GHG) emissions by setting themselves ambitious reduction targets, some have even declared a so-called "climate emergency" as overarching goal for their decisions. All cities have a responsibility in fulfilling their countries' Nationally Determined Contributions (NDCs) to achieving the climate change targets that "their" states have committed to by signing the Paris Agreement. They are at the forefront of urgently needed global action on climate change to reduce and therefore mitigate the global greenhouse gas emissions, while also reducing the vulnerabilities of people and assets by adapting to the impacts of a changing climate. Cities lead climate action by framing strategies and programmes, integrating such actions into ongoing urban development.

PURPOSE OF THIS PUBLICATION

The purpose of this publication can best be described by the following questions:

1. How do overarching commitments, laws and especially energy regulations on the European and national level in Germany influence city development? A city development, that is energy-saving, energy-efficient and covers the remaining demand by renewable energies.
2. What additional instrument do cities have to mitigate climate change in the field of energy and city development that complement energy regulations?
3. And how are different spatial levels affected and empowered by those regulations and instruments, the building, the neighbourhood or city quarter and the city level as a whole?

METHODOLOGY

This study elaborates the answers to the above questions from the viewpoint of a city and the three spatial levels: building, city quarter, and city.
First, an introductory chapter outlines the relationship between urban planning and energy in general (chapter 2), which is followed by an explanatory chapter, describing how law of the European Union in general and energy regulations in specific are transferred and implemented into national law (chapter 3).
The concrete implementations at the building, the district and the city level are described in chapter 4. Here, for each of the three spatial levels, it will be explained how

- energy regulations,
- formal planning instruments (according to German urban planning law), and the so-called
- informal planning[9]

influence (sustainable) urban development, each using a concrete

1 https://www.tagesschau.de/ausland/waermstes-jahr-europa-101.html; accessed 1.5. 2021
2 https://www.tagesschau.de/ausland/waermstes-jahr-europa-101.html; accessed 1.5. 2021
3 https://www.tagesschau.de/ausland/un-klima-guterres-101.html; accessed 1.5. 2021
4 https://population.un.org/wup/; accessed 1.5. 2021
5 Local Climate Action – Harmonising Ecology and Economy, GIZ, 2020, p5
6 Accelerating Building Efficiency, WRI, 2016, p12
7 https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en; accessed 1.5. 2021
8 https://www.badische-zeitung.de/klimaschutz-ungenuegend--201602821.html; accessed 30.4.2021
9 Informal planning tools are e.g., Sustainable Energy Climate Action Plans and Integrated City Development Concepts; see chapter 3.3

example from a German City. Aspects of financing are included as they play an important role in the implementation of energy-efficient measures[10]. Eventually, chapters 5 and 6 serve as background information on energy regulations at both European and national level. This chapter contains information on overall objectives, strategies, laws and energy regulations relevant to this paper and is followed by a summarising conclusion (chapter 7).

NOTE

Urban development is a complex process with many facets. This study focuses on the influence of energy law, formal and informal planning on energy aspects of urban development and thus on climate change mitigation. Adaptation to the consequences of climate change is not the subject of this study.

10 More information on Green Finance: Green Finance. Financing instruments for energy-efficient and climate-friendly buildings - Focus: Germany, GIZ, 2021

2. SUSTAINABLE CITY DEVELOPMENT WITH A FOCUS ON ENERGY

2.1. SUSTAINABLE APPROACHES TO CITIES AND ENERGY

The responsible use of energy plays an important role for sustainable city development and it´s planning processes to mitigate climate change. The three pillars for a responsible use of energy are:

1. energy saving,
2. energy efficiency and
3. renewable energies.

Moreover, a compact form ("city of short distances"), mixed use and decentralised centres that are connected by public transport, characterise a sustainable city, while contributing to further reducing the energy consumption. Already in 2015 nineteen non-profit organizations, jointly recommend ten key principles of low-carbon urbanization for Chinese cities. These principles fall into three categories: Low-Carbon Urban Form, Resource Efficiency, and Inclusive Urban Governance[11].

The figure below summarises the ten principles, of which principle 6 and 7 are directly related to energy, whereas principles 1-3 (mobility) and 7,8 (waste and wastewater) indirectly contribute to the reduction of use of energy.

Low carbon urban form	Resource efficiency	Inclusive Urban Governance
Principle 1: Prioritize land use efficiency in both new town development and urban renewal through compact, efficient, mixed use and functionally balanced urban design. **Principle 2:** Develop non-motorized transport as a major component of public transportation, integrating walking, biking and public transit into one transport system. **Principle 3:** Reduce private vehicle use through improved urban layout, efficient public transport networks, and transport demand management. **Principle 4:** Create and maintain more quality public spaces for the general public that are easily accessible, functional, and environmentally friendly.	**Principle 5:** Pay equal attention to process management and technology upgrading, when striving for energy and resource efficiency in the industrial and commercial sectors; pursue industrial symbiosis and the "circular economy." **Principle 6:** Keep in mind the energy and environmental performance of building operations when promoting building energy efficiency and green buildings. **Principle 7:** View municipal waste as a resource by improving waste recycling and implementing waste minimization mechanisms.	**Principle 8:** Expand the scope of reclaimed water use and select low impact nature-based methods to restore and improve urban ecological water cycles. **Principle 9:** Transition from "city management" to "city governance" with emphasis on fostering low-carbon communities through information transparency, public participation, and multi-stakeholder governance. **Principle 10:** Establish clear socioenvironmental thresholds and assessment mechanisms for urban infrastructure investments and financing to support green and low-carbon development.

Table 1: Ten key principles of low carbon urbanization[12]

To deliver successful climate mitigation policies, incorporating the above principles, a multi-disciplinary approach on the local level is crucial.

Moreover, it is necessary to link and harmonise (European or national) energy regulations, urban planning based on (national) building codes, and particular local building standards, energy plans and sustainable energy climate action plans (see chapter xx) to achieve sustainable and low carbon communities towards the 2030 and 2050 targets. Besides, financial resourcing and funding from the national level should support and foster the implementation of higher quality or innovative projects.

Mitigation of greenhouse gas (GHG) emissions comes together with the process of adaptation, the approach to reduce already existing damages or prepare for future challenges of climate change. Both should lead sustainable development planning. Adaptation is not in the focus of this paper. However, the figure below shows how interconnected both aspects are on the local level.

11 Ten key principles of low carbon urbanization; China Urban Sustainability Coalition; 2015
12 ibid, 2015, p5

Mitigation		Adaptation
• City of short distances (com-pact, mixed use, decentralised centres) • Public transport improvement, alternative mobility etc. • Energy efficient, low-carbon or zero-carbon buildings • Increasing use of renewable energies • Energy efficiency • Energetic use of wastewater treatment (sewage) • Landfill gas utilisation	• National building code requirements • Integration of mitigation/adaptation into infrastructural decisions • Improving thermal insulation of buildings • Rainwater drainage and greening of facades • Greening infrastructure and greening of roofs (plus integrating PV) • Natural shading and high reflective materials to reduce heating/cooling demand	• Optimisation of buildings (against flooding etc.) • Optimisation of rainwater drainage (e.g., sponge city ap-proach) • Urban water areas, rainwater usage, recycling of wastewater • Additional shading to reduce heat island effects (parks, trees) • Emergency plan • Risk insurance

Fig. 1: Climate mitigation and adaptation – Similarities, Differences and Overlaps[13]

2.2. THE CITY AS ENERGY SYSTEM

If we look at energy in the city from a holistic point of view, we might also speak of a city as an "energy system". However, this system is not a closed one. Cities usually obtain a large part of the energy they need from outside of their administrative boundaries, the region and beyond. Hence, the three main strategies for transitioning to a low-carbon city must be:

1. to reduce urban energy consumption levels and
2. to shift from fossil fuels to cleaner energy sources, while
3. increasing the production of renewable energy in the city itself or surrounding region.

Changes within the system, e.g., the refurbishment of the existing building stock (based on EU and national regulation), has implications on the supply side of the system. The reduced consumption of heat influences the degree of capacity utilisation in district heating networks. In other words, the system is dynamic and always in development and energy supply and consumption can no longer be seen independently form other urban systems like transport and e-mobility.

Figure 2 shows an urban energy system. For example, the City of Frankfurt has adopted a target to become carbon neutral by 2050. Hence, Frankfurt – with the support of funding from the National Climate Initiative - has developed the "Masterplan 100 % Climate Protection" – a vision of how the city can halve today's final energy consumption by the year 2050 and meet the remaining demand entirely from regenerative energies[14]. As it is assumed that the city will not be able to produce all needed renewable energy on its own area, partly regional wind-energy shall close the gap.

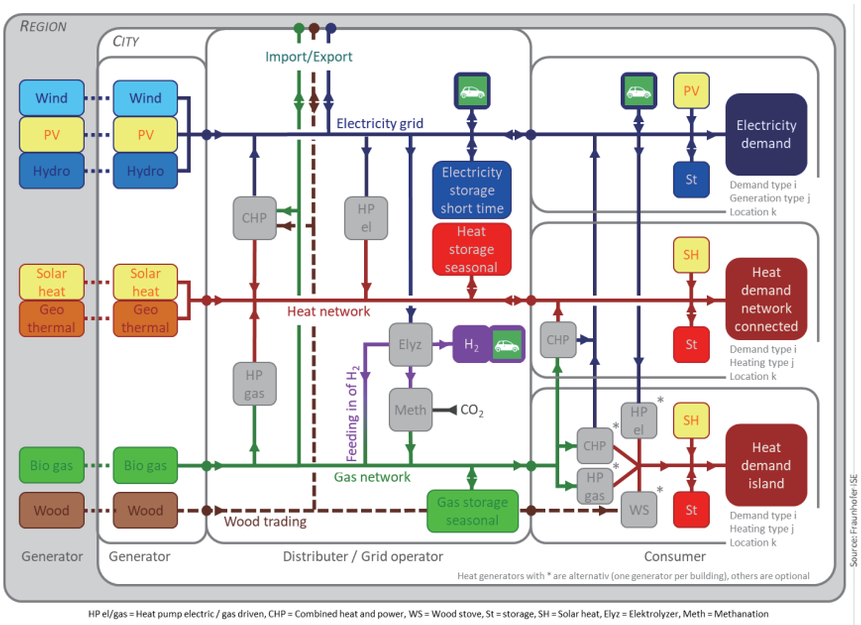


Fig. 2: City as Energy System based on 100% renewables– Case study Frankfurt[15]

13 Source: Anpassung an die Folgen des Klimawandels in der Stadtplanung und Stadtentwicklung - Der GERICS-Stadtbaukasten, Climate Service Center Germany, 2017; additions by author
14 Masterplan 100" Climate Protection – General Conception, Energiereferat, City of Frankfurt
15 Source: Fraunhofer ISE, Freiburg, Germany

Understanding, coordinating, and managing the city as an energy system is one important future task for local governments in cooperation with all relevant stakeholders, especially energy utilities, construction industry and homeowners. Planning procedures that take these complex interrelations into account are the so-called energy use plans (Energienutzungsplan - see chapter 4.4.4.4).

2.3. SYSTEM BREAKDOWN

However, and for a better understanding, we need to divide the city into different "sub-systems" or levels to better understand the influence of energy regulations, and different planning tools.

Three spatial levels
Hence, and as outlined in the introduction, the city can be divided at least into three spatial levels: building level – neighbourhood/city quarter level - overall city level (see chapter 4). Moreover, a city is strongly related to the surrounding region when it comes to future, decentralised energy systems.

Three technical levels
Furthermore, energy regulations have effects in the areas of energy saving, energy efficiency and renewable energies. Figure 3 summarises the three spatial and technical levels.

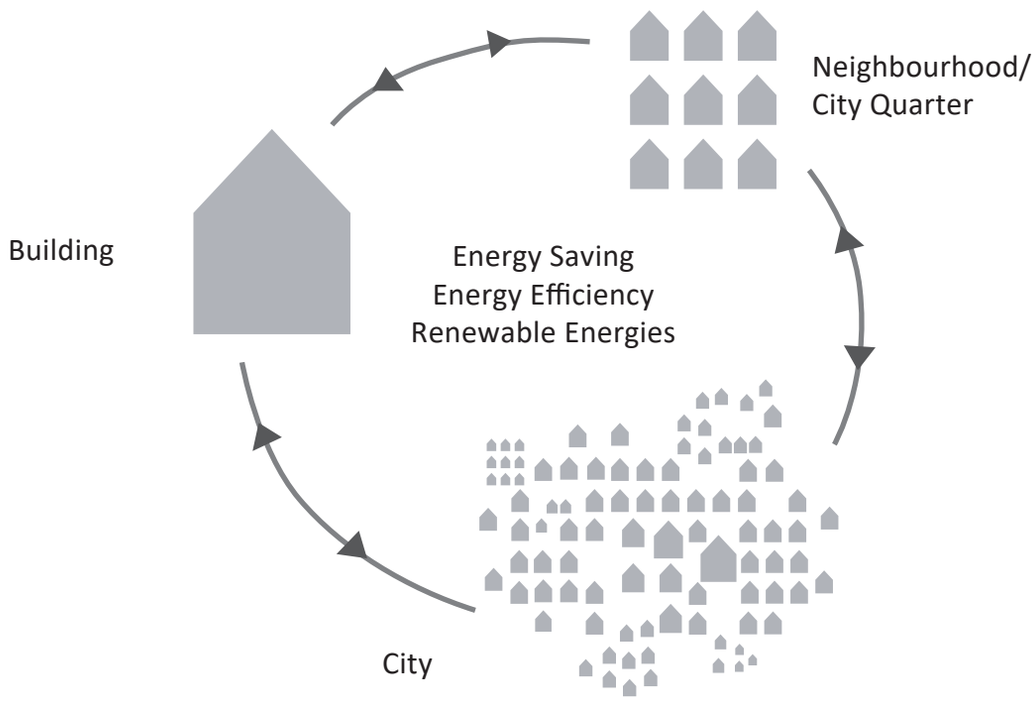


Fig. 3: Three city levels and three technical levels approach[16]

Although important, and concerning everyone in his/her daily life, is consumer behaviour or so-called energy sufficiency. Energy sufficiency aims at drastically reducing energy demand in quantity and quality[17]. However, user behaviour is not part of this documentation.

Three influencing aspects on the spatial and technical levels
The above levels are influenced by three specific aspects, which are in the focus of this publication:

1. Energy legislation and regulation on EU and German national level
2. Formal planning: Urban Development Law (Federal Building Code) and
3. Informal planning: Local governments own strategies, plans and measures.

The impact of energy legislation, formal and informal planning on energy consumption on the three spatial levels, will be outlined in more detail in chapter 4. Before that, the next chapter explains, how European Energy legislation is implemented on the national level and how it influences the local, city level.

16 Source: Handlungsleitfaden zur Energetischen Stadterneuerung, BMVBS (ed.), Berlin 2011
17 https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2015/1-foundations-of-future-energy-policy/energy-sufficiency-policy-an-evolution-of-energy-efficiency-policy-or-radically-new-approaches/; accessed 1.5. 2021

3. EUROPEAN ENERGY REGULATION, NATIONAL FRAMEWORK, AND LOCAL ACTION

This chapter introduces how the objectives, programs, and laws of the European Union (detailed information on EU laws etc. see chapter 5) are to be implemented by the EU member states and how they implement these into their own law (Level 1: Energy regulation). Furthermore, national planning law and its influence on urban development is explained (Level 2: Formal Planning). Finally, cities in Germany have the possibility to initiate their own planning and related activities (referred to as informal planning) through the right to local self-government according to § 29 of the German Basic Law (GG) (Level 3: Informal Planning).

3.1. RESPONSIBILITIES AND IMPLEMENTATION OF REGULATION BY MEMBER STATES

Article 191 of the Treaty on the Functioning of the European Union (TFEU) makes combating climate change an explicit objective of EU environmental policy. The Treaty of Lisbon, which amends the TFEU, lays down the responsibilities of the EU vis à vis member states, and breaks this down into three levels: exclusive competence, shared competence and supporting competence. In the case of energy policy, shared competence is stipulated under TFEU Article 2 (2): 'the Union and the Member States may legislate and adopt legally binding acts in that area'.[18] Member states may, however, only exercise their competence to the extent that the Union has not exercised its competence or to the extent that the Union has decided to cease exercising its competence. In order to enforce the competences, under Article 288 TFEU the EU may adopt regulations, directives and decisions (of a binding nature), as well as recommendations and opinions (which have no binding force)[19]. Table 2 sums up the substantive distinctions between the different legislative acts.

Regulation	• General application • Binding in its entirety • Directly applicable in all member states
Directive	• Binding, as to the result to be achieved, upon each member state to which it is addressed. • Leaves to the national authorities the choice of form and methods
Decision	• Binding in its entirety • A decision which specifies those to whom it is addressed is binding only on them

Table 2: Types of European legislative acts

To enable the EU to become active in the relevant areas, the ordinary legislative procedure that leads to the elaboration and adoption of regulations, directives and decisions is important. Hence, the European Parliament is directly involved in most legislative acts and can prevent or modify these planned regulations, directives, and decisions with a majority vote. It is important to note that no legislation can be adopted in the European Union without consulting the European Parliament, and that a large percentage of legislative acts cannot be adopted without the approval of the Parliament[20]

In the case of a directive, such as the Energy Efficiency Directive (EED) (see chapter 5.2.2.4), for instance, a goal and a timeframe for implementation are thus determined, within which member states are required to transpose the directive into national law. It is up to member states what method they choose to do so.[21] The Commission is responsible for making sure that all EU countries properly apply EU law. The Commission will take steps if an EU country, if it does not fully incorporate a directive or not apply it correctly. The uniform application of EU law throughout all Member States is essential for the success of the EU.

3.2. FORMAL PLANNING IN GERMANY[22]

3.2.1. Concurrent legislation – The regulatory principle in the Federal Republic of Germany

In Germany, legislative powers are basically vested in the federal states (Länder), provided the German Basic Law (GG) or constitution does not confer legislative power on the national (federal) government (Article 70 GG).

A distinction is also made between exclusive and concurrent legislative powers (Article 70 (2) German Basic Law). The matters that call for uniform regulation at federal level are of national interest and thus fall under the exclusive legislative authority of the federal government (Article 71 in conjunction with Article 73 GG).

Concurrent legislation means that under the provisions of Article 72 of the German Basic Law, the federal legislator might either regulate a matter itself or leave it up to the states (Länder). In case the legislator does not exercise this option, the states are responsible for the matter. Areas such as regional planning (Article 74 (1) 31 GG) are covered by concurrent legislation.

18 TFEU Article 2 (2) - https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12012E/TXT; accessed 30.4. 2021
19 TFEU Article 288 - https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12012E/TXT; accessed 30.4.2021
20 European Commission. 'Areas of EU action', policy fields, information and services, https://ec.europa.eu/info/about-european-commission/what-european-commission-does/law/areas-eu-action_en; accessed 3.5. 2021
21 'Primäres und sekundäres Gemeinschaftsrecht.' Gesetzgebung, 2019, http://www.eu-info.de/europa/eu-richtlinien-verordnungen/; accessed 30.4.2021.
22 Instruments and procedures in the regulatory area of public building and planning law

Länder-specific regulations would be counterproductive in this context (foreign affairs, customs, defence, etc.). Under the provisions of Article 74 (1) 11 German Basic Law, the energy sector is also subject to concurrent legislative authority whereby the federal government retains the right to legislate in this sector 'if and to the extent that the establishment of equivalent living conditions throughout the federal territory or the maintenance of legal or economic unity renders federal regulation necessary in the national interest' (Article 72 (2) GG)[23].

3.2.2. Spatial planning

Spatial planning in Germany takes place at different planning levels and in different planning areas, which interact with each other. The Federal Spatial Planning Act (ROG) regulates the tasks, guiding principles, principles and binding effects of spatial planning. In addition, the ROG includes general provisions on spatial plans and regulations for spatial planning in the Länder and at federal level.

In addition to spatial planning law, urban planning law also falls under the responsibility of the federal government. The tasks, principles and procedures of sustainable urban planning and development are regulated in the German Building Code (Baugesetzbuch - BauGB), which also specifies the instruments available to the municipalities.

The Länder draw up spatial development plans for the entire territory of the Land (Land-wide spatial development plan) and for sub-regions (regional planning) based on the spatial development legislation and their own land planning laws. In regional spatial development plans (regional plans), the principles and objectives of the Land-wide spatial development plans are concretised for sub-regions of the respective Land territory.

The central instrument of the urban planning law is urban land-use planning. It commisions local governments to prepare and guide the structural and other use of land in accordance with the German Building Code.

According to the BauGB, urban land-use plans (preparatory land-use plan and legally binding land-use plan – see below) should contribute to ensuring a humane environment, protecting and developing the natural foundations of life, and promoting climate protection and climate adaptation in the construction and other use of land. Urban development is to take place primarily through measures of internal development.

The following figure shows the cascade of land-use planning according to the Federal Building Code, including the building and user behaviour, which is not explicitly part of the code.

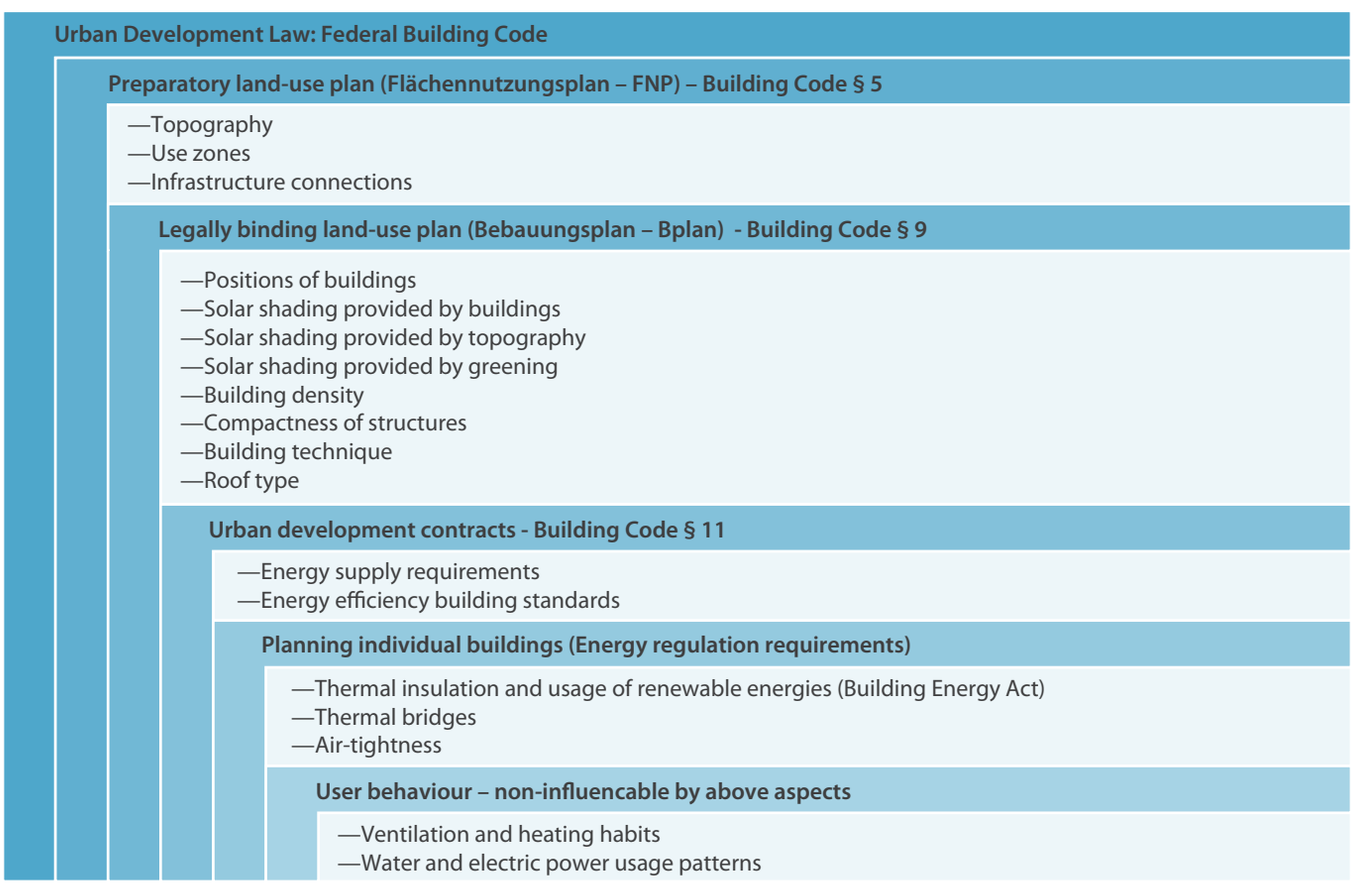


Fig. 4: Regulatory and decision-making cascade[24]

23 https://www.bundesregierung.de/breg-en/chancellor/basic-law-470510; accessed 30.4. 2021
24 Source: Information provided by the Federal Chamber of German Architects, BAK

The concern of climate-friendly urban development was significantly strengthened by the new wording of Article 1 (5) 2 BauGB (so-called climate protection clause) during the 2011 amendment to the BauGB by the Act to Promote Climate Protection in Development in Cities and Municipalities. It also clarifies the two dimensions of municipal climate protection that need consideration. According to this, the requirements of climate protection are to be considered both by measures that mitigate climate change and by those that serve to adapt to climate change.

Municipalities are obliged to promote climate protection and climate adaptation (Article 1 (5) 2 BauGB) and must check for each development plan whether the following energy-related concerns have been sufficiently considered, including:

- Reduction of land use and avoidance of traffic flows,
- Promotion of a climate-friendly urban and settlement structure ("compact city")
- Reduction of new construction and thus avoidance of emissions from raw material extraction, processing, transport, from construction processes, as well as avoidance of process-specific emissions (e.g., cement production),
- Adaptation to topographical conditions,
- Promotion of building- and energy-saving measures, e.g., orientation and form of buildings, thermal insulation, shading, as well as the selection of building products with favourable life cycle assessments (both in public tenders and in design statutes),
- Use of renewable energies (including passive use of solar energy) and combined heat and power generation[25].

In the meantime, it is no longer just about new residential areas, but increasingly about the conversion and resource-conserving modernisation of existing settlement areas into climate-neutral residential areas. Climate-friendly land use favours internal development over external development. Before designating new land for construction, internal development options should be examined.

Building planning is broken down into two phases:

- a preparatory phase, during which a land-use concept is produced for the entire area of the municipality in the form of what is termed the preparatory land-use plan (Flächennutzungsplan), and
- the phase during which the type and scope of permissible forms of use is laid down, and the plots on which construction is permissible are designated, the - legally binding - land-use plan (Bebauungsplan) (Article 1 (2) BauGB).

Preparatory Land-Use Plan (FNP)
At the first stage of urban land-use planning, the land-use plan serves (§ 5 BauGB) serves the purpose of large-scale planning. the preparation of which the provisions of the spatial planning are to be taken into account. § 5 Abs. 2 BauGB (BC) offers quite some opportunities to guide the city development in a direction to mitigate climate change, e.g., resource-conserving urban framework or areas suitable for district heating (because of their density). The content of the preparatory land use plan (PLUP) is self-binding for the local government[26].

Legally binding Land-Use Plan (Bplan)
The second stage of urban land use planning provides for the adoption of a binding land-use plan, which is to be developed from the land-use plan and contains specific provisions. Corresponding climate-protecting provisions of a development plan, however, encroach on land ownership and therefore require a legal basis, which is provided in § 9 (1) BauGB. The description of concrete designations for climate mitigation action in the land-use plan are outlined in chapter 4.3.3.

3.3. INFORMAL PLANNING PNSTRUMENTS

Article 28 (2) guarantees “the right to regulate all local affairs on their own responsibility, within the limits prescribed by the laws. Within the limits of their functions designated by a law, associations of municipalities shall also have the right of self-government according to the laws.”[27]

The constitutional guarantee of local self-government is an expression of the bottom-up state structure of the Federal Republic of Germany. It enables the municipalities to regulate their local affairs on their own responsibility. The Länder and the Federal Republic may not interfere in the fulfilment of tasks. The tasks of the municipalities include, in particular, those of local "services of general interest" for their citizens.

The so-called "informal" planning instruments – not to be confused with the informal sector of economy - plays an increasingly important role at the local level.

In addition to the legal planning instruments (see above), informal instruments are central components of successful municipal planning to strengthen climate mitigation in their own sovereignty. Examples are integrated city development strategies or concepts, sustainable energy and climate action plans, spatial energy plans and energy concepts.

Informal planning instruments express a particular local policy decision, here towards climate mitigation action. Those instruments normally include processes of involvement of those affected by the planning process. Integrated urban development turns cross-cutting project work from the exception into the rule. However, this permanent cross-cutting form of cooperation requires active steering and coordination[28] (see chapter 4.4.4).

Worldwide, local governments have a wide range of policies and activities to promote low carbon development and an economical and considerate use of energy. These activities and policies, generally performed at the same time and by different branches of a local government, can be grouped in the following main categories.

The following table offers a (non-exhaustive) overview of instruments, policies and tools for municipalities in the field of energy.

25 Klimaschutz in der räumlichen Planung; UBA; 2012 p37
26 Ibid., p38
27 https://www.bundesregierung.de/breg-en/chancellor/basic-law-470510; accessed 30.4. 2021
28 The City of Ludwigsburg already in 2008 and to face the coordinating challenges established a unit for sus-tainability (Referat für Nachhaltigkeit); https://www.ludwigsburg.de/-/verwaltungswegweiser/oe6008291; accessed 1.5. 2021

The municipality as regulator	• Promoting, introducing, and controlling of national energy regulations in land-use planning and building permits • Obligating investors to implement city building energy standards • Obligate investors to connect to district heating and cooling in defined areas using urban or purchase contracts • Prohibiting the use of single combustion units and polluting energy carriers in vulnerable zones, as valleys and natural depressions with limited air exchange rates
The municipality as planner	• Elaborating SECAPs or Integrated City Concepts, incorporating low carbon aspects and targets in different areas (energy consumption and supply, mobility etc.) • Specifying of overarching concepts by city quarter energy concepts or data-based energy use plans for the whole city • Developing of new city areas regarding climate relevant planning designations (Bplan)
The municipality as consumer	• Improving street lighting, being one of the most cost-effective examples for energy and cost saving in a short period of time • Energy saving and efficiency in public buildings through no-and low-cost measures, e.g. optimisation of heating systems • Purchasing of certified green electricity, increasing the share of electricity consumption from renewable sources in the city. • Switching the municipality´s car fleet to e-mobility
The municipality as provider	• Using municipal transport companies, local energy suppliers and housing associations as opportunities for climate-friendly transport, district heating, renewable energy generation, and energy efficient residential buildings. • Using local government land/property/buildings for district energy installations or connections that offer opportunities for private actors to connect
The municipality and promotor and advisor	• Awareness-raising and educational campaigning, awarding or community events, websites, target group-oriented publications, and information centres for personal contact and consultations • Providing advisory services and trainings for citizens and technical experts to foster climate mitigation • Establishing subsidy programs for refurbishment of the building stock or renewable energies, e.g., solar thermal installations in addition to national programs – mostly to facilitate the national funding options • Offering tax credits and exemptions within tax systems for new buildings meeting higher energy standards • Lobbying of higher levels of government for supporting policies and funding commitments, including grants and taxation policies
The municipality as facilitator, networker and coordinator	• Connecting different local players as municipalities are "neutral" institutions • Creating dedicated city unit or coordination mechanism to facilitate the development of bankable projects through capacity-building, trainings, project structuring, multi-stakeholder engagement • Managing formal and informal networks • Involving local stakeholders in processes and concept developments • Initiating or facilitating cooperation amongst actors like energy or heating companies and building owning societies and companies for joint projects • Moderating public-private-partnerships e.g., to process organic waste for co-generation based district heating or cooling • Initiating cooperation with industrial areas and parks to make use of e.g., waste heat
The municipality as role model and investor	• Committing to construct public buildings in the highest standards, showing the will to reach climate targets Green public procurement • Providing public buildings should be connected to or build a nucleus for district heating/cooling networks. • Showing commitment by providing city halls with solar roofs or facades, • Installing PV on schools and kindergartens for electricity production by • Investing into renewable energies within or beyond city boarders, e.g., photovoltaic or wind parks • Developing new district energy schemes involving the use of public buildings such as schools, hospitals, leisure centres and municipal as nucleus for further enlargement • Establishing of demonstration projects in the field of energy storage, district networks (see Best Practice below) or co-generation together with local research institutions • Piloting and testing emerging (often hybrid) technologies, such as low-grade waste-heat recovery from sewage • Investing in district energy for government buildings and schools as well as public transport and new forms of e-mobility

Table 3: Roles of municipalities in the fields of energy and city planning[29]

29 Compilation of author's experience and different publications, e.g. UNEP 2018, GIZ 2020

4. THREE SPATIAL LEVELS AND THE INFLUENCE OF ENERGY REGULATION, FORMAL AND INFORMAL PLANNING

4.1. INTRODUCTION

As explained above, the influences of the energy law framework, formal, and informal planning will be set into relation to three spatial levels (building, neigbourhood, and city – see figure 3). Therefore, the following chapters are structured as laid out below:

- Brief introduction to the respective spatial level and its relevance for sustainable urban development,
- Effects of the three levels of influence on the respective spatial level.
- Differentiation into the three technical levels (energy saving, energy efficiency, renewable energies), where possible.
- Good Practice Example for each spatial level

Spatial Level	Energy Regulation	National Planning Level	Informal Planning	Further Aspects
Building	• EU directives on ener-gy efficiency, renewa-bles etc. • Net Zero Emission Buildings (NZEB) • Building Energy Act (GEG) • Building permission (new), renovation pro-ject • National funding	• Federal Building Code, article 9 (1) ff • Urban Develop-ment Contracts, ar-ticle 11 (1)	• Local Building Standards • Role model (Public buildings) • Local financing schemes	• Research on pilot buildings • Passive houses • Innovative building stand-ards

Table 4: Building level and influencing aspects - Overview

4.2. BUILDING LEVEL

4.2.1. Background on buildings

The total final energy consumption of the global buildings sector was responsible for 35% of total global energy-related CO_2 emissions in 2019. With the inclusion of emissions from the buildings construction industry, this share increases to 38% of total global energy related CO_2 emissions.[30] This underlines the importance to reduce energy demand in the built environment. A decline in 2020 is due to the Covid-19 pandemic and expected to raise again after.

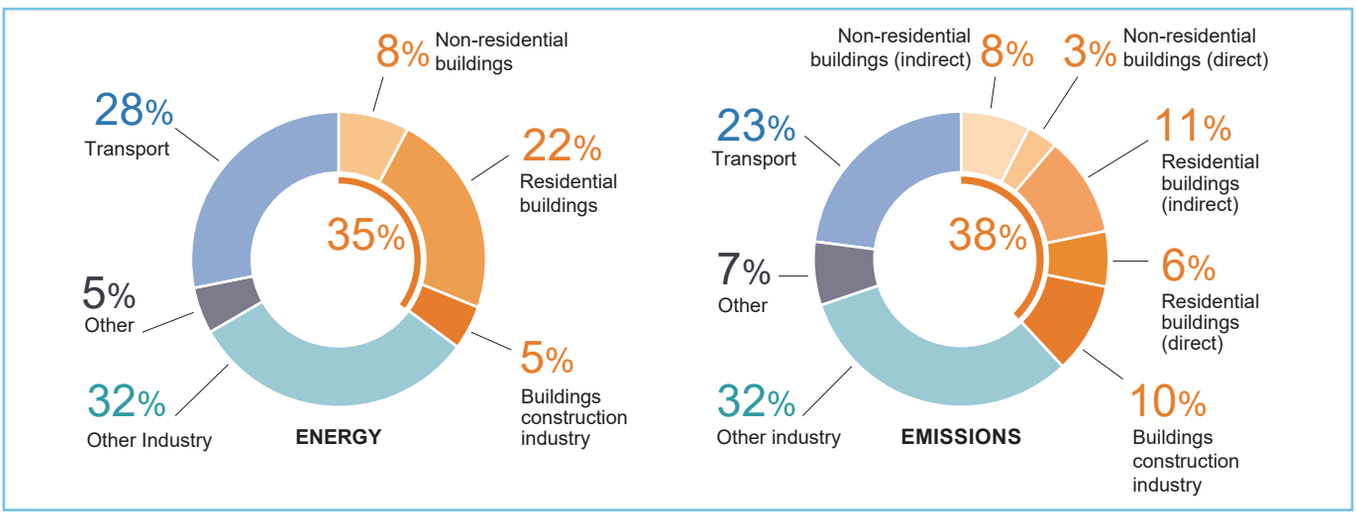


Fig. 5: Global share of buildings and construction final energy emissions 2019[31]

Hence, increasing efficiency in the building sector is one of the most important fields of action for a sustainable city development, with the highest potential for savings in the reduction of space heating[32] and cooling. To be on track to achieving a net-zero carbon building stock by 2050, the IEA estimates that direct building CO_2 emissions would need to decrease by 50% and indirect building sector emissions decline through a reduction of 60% in power generation emissions by 2030.[33]

30 2020 Global status report for buildings and construction, UNEP, 2020, p 4
31 ibid., p4
32 CO_2 Gebäudereport 2007, BMVBS, p4; https://www.co2online.de/fileadmin/co2/research/Gebaeudereport_2007.pdf; accessed 5.5. 2021
33 UNEP, p5

4.2.2. Energy legislation framework for new and existing buildings

4.2.2.1. European legislation

The revised Directive on Energy Efficiency sets an energy efficiency target of 32.5% for the EU by 2030 based on 2007 modelling for 2030. It contains a clause for upward revision by 2023. In addition, the revised Directive on Energy Performance in Buildings (EPBD, 2010/31/EU) was adopted in May 2018 as part of the Clean energy package for all Europeans[34]. This directive includes measures to accelerate the rate of building renovation and a move towards more energy-efficient systems. It aims to improve the energy performance of new buildings using intelligent energy management systems.

The Directive states that, from January 2019 for public buildings and from January 2021 for others, all new build construction should reach the target Nearly Zero-Energy Building (NZEB) as defined at the national level[35]. "Nearly zero-energy buildings (NZEB) have very high energy performance. The low amount of energy that these buildings require comes mostly from renewable sources"[36], produced on-site or nearby.

Based on the cost-optimality principle expressed in the EPBD recast directive (EU 2010/31), a NZEB should be "a building using national cost optimal energy use of 0 kWh/(m^2 a) in primary energy"[37]. Those buildings will have a huge impact on the future energy demand of cities, when implemented in the foreseen quality.

4.2.2.2. National level legislation

In order to accelerate the energy transition in the building sector, both energy efficiency and the use of renewable energies are to be advanced. In 2019, additional measures were adopted with the German Climate Action Program 2030 (see chapter 6.1.6) to achieve the ambitious energy and climate targets in the building sector. The basis for this is a mix of different instruments. These include increased financial support combined with information and advice, the pricing of CO_2 and regulatory law as well as targeted energy research.

The German government also adopted the Energy Efficiency Strategy 2050 (EffSTRA) on 18 December 2019. The EffSTRA sets a medium-term energy efficiency target in 2030 of minus 30 percent primary energy consumption compared to the base year 2008. All energy efficiency measures will also be brought together in a new National Action Plan on Energy Efficiency (NAPE 2.0), which also includes the building sector.

Building Energy Act (Gebäudeenergiegesetz - GEG)

Another important part of the German strategy to improve energy efficiency is the new Building Energy Act (GEG), which came into force on 1 November 2020. The GEG creates a new, uniform, coordinated set of regulations for the energy requirements for new buildings, for existing buildings and for the use of renewable energies to supply heating and cooling to buildings. This also implements the European requirements for the energy performance of buildings and integrates them into the unified law.

It is the responsibility of the federal States to monitor compliance with the requirements of the GEG, according to the saying "Trust is good, control is better". The federal government is demanding a report on the implementation practice on a random basis by early 2024 at the latest. Failure to comply can result in fines of up to 50,000 € for the investor.

Information box 1: Buildings and research

In view of its importance for the energy transition, the building sector makes up a special priority of research pro-motion in energy efficiency. A comparison of the development curves of statutory minimum requirements and research activities in buildings shows that research findings have been successfully adopted in building practices. Moreover, cities that introduced higher standards – in cooperation with research and innovative architects – paved the way for higher national standards in Germany. The national regulation followed the local standards as they proved ecologically and economically viable. However, the national standards do not require the technical feasible, but national funding tries to promote and support investors to implement the technical possible.

34 Commision welcomes Council adaption of new EPBD; https://digital-strategy.ec.europa.eu/en/news/commission-welcomes-council-adoption-new-energy-performance-buildings-directive; accessed 5.5. 2021

35 As cities all over Europe are located in different climate zones, the NZEB standard can be approached flexibly by the different member states, meeting the energetic requirements of these zones.

36 https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/nearly-zero-energy-buildings_en; accessed 30.4. 2021

37 https://www.buildup.eu/en/news/overview-zero-energy-buildings-does-definition-influence-their-design-and-implementation; accessed 30.4. 2021

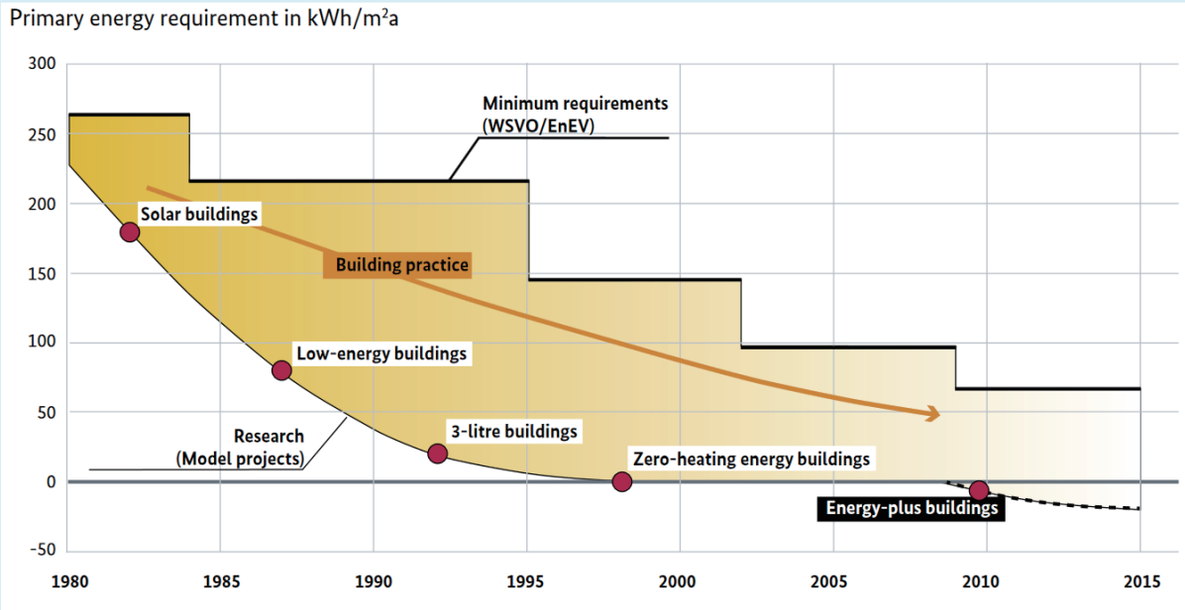


Fig. 6: Learning curve for energy efficient construction[38]

Financial support for higher energy-efficient standards
It is important in this context to highlight, that the NZEB standard, as defined in the GEG, is not the end of the line if it comes to energy-efficient buildings. In this context the new "Federal Promotion for Efficient Buildings (Bundesförderung für Effiziente Gebäude - BEG)", which bundles the existing building promotion programs in a new, addressee-friendly system from 2021 onwards is one step towards higher building standards for new and existing buildings. Those who exceeded the requirements of the Energy Saving Ordinance have so far benefited from attractive funding from KfW Bank[39]. While the bank supports efficient new construction projects with cheap loans, there are loans or grants for renovations of the building stock.

From July 2021, the KfW funding will be integrated into the new federal funding. The new funding is intended to help reduce the primary energy requirements of buildings by around 80 percent by 2050 compared to 2008 through a combination of energy saving and the use of renewable energies[40].
It also applies that the houses comply with a so-called KfW efficiency house standard. This is the case when the actual primary energy requirement is better than that specified in the GEG. The conditions of the subsidy are more favourable, the less energy a house is required after construction or renovation.

There are three KfW energy standards for new building projects: KfW Efficiency Houses 55, 40 and 40 plus. The number stands for the energy requirement as a percentage compared to the minimum requirements in the Building Energy Act. The lower the number, the more energy-efficient the building is and the more funding the client receives. An “efficiency house 55” has a 45 percentage point lower primary energy requirement than the GEG prescribes. For example, the maximum funding for a new separate “accommodation unit” will mount up to 24,000 euros if it meets the so-called “Energy Efficiency House Standard 40. For a refurbished existing building it mounts up to max. 54,000 Euro.[41]

4.2.2.3. Urban Development Law – Federal Building Code (BauGB)
In the development of (new) building areas, the legally binding land-use plan (Bebauungsplan) forms the basis for the implementation of corresponding measures that influence the energy performance of buildings. Especially section 9 of the Federal Building Code offers to municipalities options to integrate climate mitigation (and adaptation) aspects into their land-use planning. In principle, provisions in the development plan may only be made for urban development reasons, however, local government strategies for climate mitigation (see chapter XX) can provide the respective arguments.

Designations – Options to actively influence energy related factors
The table below lists main steering options that enable local authorities to actively influence energy-related factors for an energy efficient construction. Moreover, the land-use plan can include information and references to national or local building standards and funding instruments.

38 Source: Making more out of Energy - National Action Plan on Energy Efficiency; BMWi; 2014
39 See: Green Deal Study = Title?
40 https://www.kfw.de/inlandsfoerderung/Bundesf%C3%B6rderung-f%C3%BCr-effiziente-Geb%C3%A4ude/; accessed 30.4. 2021
41 https://www.kfw.de/inlandsfoerderung/Bundesf%C3%B6rderung-f%C3%BCr-effiziente-Geb%C3%A4ude/?query=*%3A*&page=1&rows=10&sortBy=relevance&sortOrder=desc&facet.filter.language=de&dymFailover=true&groups=1; accessed 30.4. 2021

Table: Energy Efficient Construction - Desgnation options in Federal Building Code

Article	Text	Influence on Energy Efficiency of Construction
Article 9 (1) 1	*[...] the type and extent of building use*	Option to optimise compactness and hence, reduces energy consumption of a building
Article 9 (1) 2	*[...] the construction method, the areas of the site that can be built over and those that cannot be built over, and the position of the structures*	Option to optimise orientation of buildings and avoiding of shading effects, increasing passive solar gains and allow fulfilment of GEG
Article 9 (1) 3	*[...]minimum dimensions for the size, width and depth of building plots and, for reasons of economical and careful use of land, also maximum dimensions for residential building plots.;*	Reducing of shading effects of buildings
Article 9 (1) 10	*[...] the areas to be kept free from development and their use*	???
Article 9 (1) 12	*[...] Services areas, including areas for plant and facilities for the decentralised and centralised generation, distribution and storage of electric power, heat or cooling from renewable energies or combined heat and power (CHP).*	Gives municipalities the opportunity to designate appropriate services areas for energy production, although there is no stipulation as to the type of use. This refers in particular to plants, facilities covered by the GEG and the Combined Heat and Power Act *(Kraft-Wärme-Kopplungsgesetz).These arre, for instance, '[...] power stations generating district heating, cogeneration heat and power stations including associated plant such as transformer stations, distributor stations, [...] ground-based photovoltaic plants, [...] wells and other water production plants [...].'*
Article 9 (1) 13	*[...] the location and course of overground or underground public infrastructure installations and transmission routes.*	Contractual agreements should be reached where areas are affected that are neither the property of the municipality nor of the energy supply utility(e.g., district heating pipes).
Article 9 (1) 21:	*[...] spaces to be encumbered with walking and driving rights and rights of passage in favour of the general public, an agency charged with the provision of public infrastructure or a limited group of persons;*	This designation is only possible for urban development reasons and not for private reasons. The favoured use thus rendered possible, must be substantively secured, either in the form of building encumbrances where this is provided for in the relevant state building regulations (LBO), or by limited personal easements. As a result, the 'planning designation [...]must be so precise that it is possibly to directly deduce the necessary substance of any such right.'
Article 9 (1) 23 a+b:	*areas in which [...] specific building and other technical measures must be taken when erecting buildings or certain other building plants for the generation, use or storage of electric power, heat or cooling from renewable energy or combined heat and power.*	a)provides options to require provisions for the use of renewable energies, e.g., structural analysis of roofs, that can be combined with the prohibition of combustion of specific energy sources (e.g.oil)

Table 5: Energy Efficient Construction – Designation Options of the Federal Building Code

Urban Development Contracts

In addition, urban development law offers the possibility of pursuing climate protection and climate adaptation goals by means of so-called urban development contracts. They represent a special form of public law contracts. Urban development contracts are concluded between the local government, prepared by the planning authority, and investors in the area of a legally binding land-use plan. This instrument can be introduced if the real estate does not belong to the municipal government[42]. In § 11 (1) nos. 4 and 5 of the Federal Building Code (BauGB) climate mitigation is addressed as one example of possible content of urban development contracts.

On the one hand, the instrument allows to fix binding agreements related to construction and use of plants and facilities for the decentralised and centralised generation, distribution, use or storage of electricity, heating or cooling from renewable energies or combined heat and power generation. On the other hand, requirements for the energy quality of buildings pursued with the urban development plans and measures should not put unacceptable (financial) burden on the contract partners.[43] Several German cities uses this form of contract to introduce building standards, that are higher than required by the national regulation complemented with an advisory service for investors (see below).

4.2.2.4. Informal planning on the local level

Local building standards for new construction

National Building Standards (based on EU regulation) are obligatory for each new construction. However, based on the self-government opportunities, local administrations can set higher building standards for public buildings (role model!), private and office buildings. These standards can be bindingly agreed in the above-mentioned urban development contracts or purchase contracts, if the real estate belongs to the municipality or was purchased by the municipality in advance for this purpose. To support investors and builders the standards are often aligned to the existing supporting programs of the national government or additional local advisory and support programs.

42 If the real estate belongs to the local government or was purchased by the local government in advance as part of an active real estate policy, requirements for energy efficiency construction can be integrated in pur-chase contracts.

43 Maic Verbücheln und Susanne Dähner (ed.). Klimaschutz in der Stadt- und Regionalplanung, 2016, p58

Information box 2: Key factors affecting energy consumption in buildings[44]

- Geometry (compactness) and orientation of the building
- Performance of the building envelope (thermal insulation, building tightness, surface)
- Ability to benefit from natural lighting
- Ability to benefit from heat gains in the winter and limit them in the summer (appropriate summer comfort strategy for cold areas)
- Solar shading and orientation of the glazed surfaces…) – especially in hot areas
- Efficiency of the technical installations, like heat boilers, air conditioners and lighting
- On-site energy production and renewable energy sources (RES), such as photovoltaic (PV) and thermal collectors
- Quality of the regulation and maintenance of the technical installations (are the technical installations managed and maintained in such a way as to maximise their efficiency and minimise their overall usage?)
- Building automation and control systems, able to continuous monitoring, analysing and adjusting the energy usage (smart meters)
- Behaviour (how we use the buildings and its equipment in our day-to-day life)

Local supporting mechanisms for the existing building stock
As already outlined, the energetic improvement of the building stock is a bigger challenge if it comes to convincing owners for action. The reasons are manifold: higher costs because of complexity, multiple ownership of multi-storey buildings, age of owners etc. However, this field needs to be "farmed" either.

In addition to the national regulations to include energy-efficiency measures in the general retrofitting process, municipalities have introduced own financial and advisory support programs. These programs are part of the sustainable strategies of cites to reach local adopted climate targets. Freiburg´s funding program "Do not do anything by halves" supports homeowners since 2002 in three main areas:

- Building envelope (= Energy Saving)
- Heating and cooling (= Energy Efficiency) and
- Electricity generation (Renewable Energies).[45]

The local funding – being complementary to the national fund - sums up to 545,000 Euro in 2021 and 2022.[46] Moreover, cities can act as role models, constructing new public buildings in, and refurbishing existing public buildings towards high energy standards, thus showing their commitment and willingness to lead the process of local low carbon development[47].

4.2.2.5. Further aspects – Plus-Energy-Houses
Information box 2 already highlighted the impact of research and engaged actors in the field of sustainable buildings contributing to the development towards more efficient and economical buildings for the future.

The "Solar Settlement" in Freiburg (Solar-Siedlung) by architect Rolf Disch is part of a larger urban redevelopment area in the Vauban district, a former barracks ground of the French army. Over a period of approximately ten years 60 "Energy-Surplus-Houses®" and a 125 m service block, called "Sonnenschiff" (Sunship), have been built along the main road. All roofs are covered with standard large area Photovoltaic (PV) modules which are smartly integrated in a plane above the south facing roofs of the different buildings. The total system size is 445 kWp".[48] Concluding, the Solar Settlement, as of its energy-efficient buildings and the pv-covered roofs produce more energy than is consumed. The yearly energy balance is positive; thus, each building is called "Plus-Energy".

4.2.2.6. Case Study: Heidelberg Bahnstadt – Building standard for a new district

Background

Heidelberg, located in south-western Germany with around 120.000 inhabitants is a growing city. Hence, the need for a new district to meet the needs for more apartments was obvious. When the German Railway abandoned the former freight area, the city took the window of opportunity to plan a new district which is near to the city-centre – the old town is only two kilometers away -. A development agency was founded and controlled (?) by the city especially to purchase the whole area, so the city was in a position to determine and develop the area according to an area-based development concept and, of course it´s ambitious climate goals. The mixed-use area, which is residential, commercial and scientific provides space for nearly 7000 inhabitants and 6000 work places.

44 Source: Kona A., Bertoli, P. et al (ed.). How to develop a Sustainable Energy and Climate Action Plan? 2018, p122; complimented
45 https://www.freiburg.de/pb/,Lde/232441.html; accessed 30.4.2021
46 Freiburg city budget plan 2021/2020; https://www.freiburg.de/pb/1042836.html; accessed 30.4.2021
47 https://energiemanagement.stadt-frankfurt.de/; accessed 1.5. 2021
48 http://pvupscale.org/IMG/pdf/Schlierberg.pdf; accessed 30.4. 2021

What?

In the new "Bahnstadt" district, the buildings on a total of 116 hectares have a particularly high efficiency standard (passive house standard). The buildings only consume a quarter of the heating energy required by law. Energy is supplied by a renewable district heating network. Through the combination of efficiency and supply, the district becomes a zero-emission settlement based on passive house standard.
PH Concept

How?

Several factors played a role in the successful implementation of the so-called passive-house standard:
Political will. A first step was a political decision for an ambitious efficiency standard in the new designated city district. This was the logical consequence of Heidelberg´s Integrated Energy and Climate Concept, first adopted already in 1992, followed by several updates (last update 2014).
Conception. A technically sound energy for the area was an essential basis for success. In addition to technical implementation options, this also includes soft measures for accompanying the project.
Planning basis: This concept was followed by the development of binding planning and contractual specifications with the project executing agencies within the framework of urban development contracts.
Public relations. Permanent accompanying public relations work (events, flyers, guided tours) created a positive image for interested clients, inhabitants, craftsmen and planners.
Funding: Financial incentives provided by the city created a further increase in the attractiveness of the new building standard.
Information. An energy consultation of the building owners and planners before and during the construction phase by the municipal environmental office as well as the local energy agency guaranteed well-informed involved actors.
Quality management. Differentiated quality management for all construction phases reduced typical implementation errors. Energy requirements were requested and checked at an early stage during the building application process. In addition, the implementation of the structural and technical measures during the construction phase is checked at the construction site. Success is measured by monitoring the consumption data.
Most importantly and early in the process, local government´s responsible unit informed the city council and especially the planning department about the benefits of the building standards for the climate-mitigation targets, the image of the City and the energy and cost saving opportunities when well-planned and making use of national funding by the investors.

Results

An independent institute monitored the heat consumption of the residential buildings in the first construction phase. It was found that the heat consumption in practice matches with the objectives of the passive house standard. The average consumption of heating energy in the houses is around 15 kilowatt hours per year and square metre of living space. This corresponds to an energy saving of over 80% compared to existing buildings in Germany. The first residents also expressed themselves positively in a survey. Three out of four residents are satisfied with life in a passive house.
In terms of energy efficiency, Bahnstadt's households are also equipped with intelligent electricity meters, so-called smart meters, which continuously provide information about energy consumption and the associated costs. The success factors are displayed in the graphic below.

Fig. 7: Heidelberg Bahnstadt: Passive-House-Neighbourhood
Source: City of Heidelberg; photo: Christian Buck
Link: www.heidelberg-bahnstadt.de

4.3. CITY QUARTER LEVEL

Spatial Level	Energy Regulation	National Planning Level	Informal Planning	Further Aspects
Neighbourhood/ City Quarter	• See: Building level regulations • National funding for city quarter level	• Federal Building Code: • Article 9 (1) 23 • Urban development contracts • Urban renewal	• Energy concepts for city quarters • Mixed area energy concept • Checklists for urban planners	• Living labs • Innovative low-temperature-solu tions

Table 6: City Quarter level and influencing aspects - Overview

4.3.1. Background on city quarter level

After a long time of energy experts focussing mainly on buildings, meanwhile neighbourhood solutions have become increasingly important in recent years. The following diagram shows the three different spatial levels. The neighbourhood level (in the figure below named district scacle) is "connecting" building and city level.

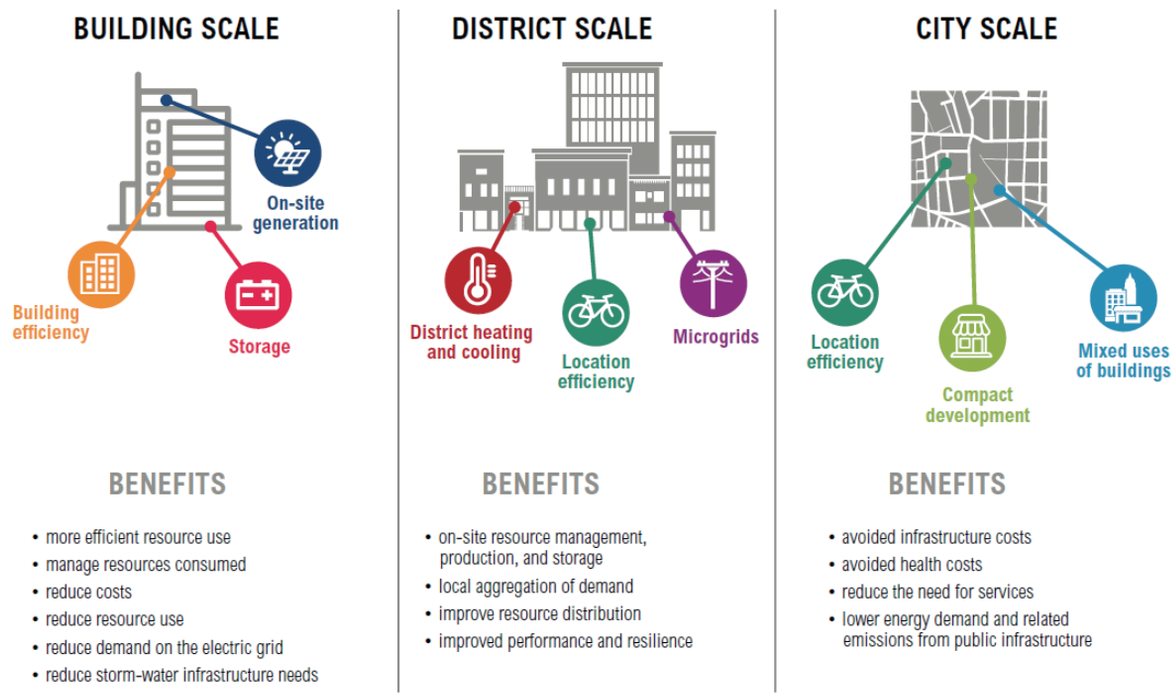


Fig. 8: Elements and Impacts of Efficient and High-Performance Buildings Across City Scales[49]

While for a long time the building as such was the target of energy efficiency, today neighbourhood solutions in combination with building solutions in a systemic approach are much more common. This is also confirmed by the EU's Horizon 2020 programme. There, innovative solutions at the city quarter level were promoted within the framework of lighthouse projects in European lighthouse cities. Essential aspects were:

- Integrated innovative solutions for positive energy blocks or districts (city quarters)
- Interaction and integration between the buildings, the users, and the larger energy system
- Implications of increased electro-mobility, its impact on the energy system and its integration in planning.

As for individual buildings, when developing new neighbourhoods, the three technical goals apply consequently, best in the below "hierarchy":

1. Energy Saving: Best possible reduction of the heating/cooling needs of buildings:
   a. Compact construction
   b. Technical provisions to prevent loss of heat (thermal insulation),
   c. Optimum passive use of solar radiation (positioning of building structures)
   d. Avoiding solar shading

49 Source: Accelerating Building Efficiency: Eight Actions for Urban Leaders WRI, 2016, p7

2. Energy Efficient provision of heat/cooling
   a. Heat grids (local/district heating from combined heat and power (CHP) units or other sources of heat energy)

3. Renewable Energies supply remaining energy needs in a way that is largely CO_2-free
   a. solar thermal power, geothermal power, etc.

The same applies, of course, for existing, especially older quarters, although the challenges to integrate those measures is more complex and partially more cost intensive. However, "there is an enormous potential for energy savings in this area, on the one hand because of the high share of total federal energy consumption, and on the other hand because of the age of the existing building and heating infrastructure, which therefore often does not even begin to meet the state of the art. Due to the same age of buildings within individual streets and neighbourhoods, the building typology and energy balance of the buildings are similar in many cases, so that a neighbourhood-based approach to the refurbishment and heat supply of the buildings is appropriate for achieving energy efficiency gains".[50]

4.3.2. Energy Legislation Framework and city quarters
The regulatory requirements for buildings described in chapter 4.2 also have an impact on the neighbourhood – naturally, new construction and increasing refurbishment of existing buildings reduce the overall energy demand in these areas.

Among other things, this has an impact on the energy supply, especially on central supply options for local or district heating. In the future, solutions for optimising existing or designing new, centralised supply variants will be necessary. Low-temperature heat in combination with renewable energies is a possible solution to operate such networks economically and ecologically (see chapter 4.3.4.2).

Funding energy-efficient neighbourhood refurbishment
Due to the legally lower leverage, the stimulation of energy modernisation measures in existing buildings is of particular importance. In view of rising energy prices and thus higher energy costs, this can also enable the provision of socially acceptable housing in the long term. Especially in city quarters that are characterised by owner-occupied homes or small landlord structures, low-threshold financial incentives are a key lever to win private owners for the implementation of energy-efficient refurbishment measures. An increased tax write-off for refurbishment measures can be such an incentive. By designating a redevelopment area in accordance with the Building Code (BauGB), municipalities can make this tax write-off accessible to homeowners[51].

National funding is available under the KfW 432 grant programme[52] of the Kreditanstalt für Wiederaufbau[53] - short KfW - to cover the costs of preparing an integrated city quarter energy concept, consisting of a grant that covers 75% of the eligible costs to prepare the energy concepts and for the services of the refurbishment managers.

A combination with other subsidies is possible. Hence, the remaining costs for the local government are very low. Furthermore, the KfW supports the improvement of energy infrastructure in a parallel programme with attractive credits, helping to implement the results of the concept in short time.

4.3.3. Federal Building Code (BauGB)
Some of the contents of the BauGB (see chapter 4.2.2.3) also have explicit effects on energy performance at the city quarter level in both new and existing buildings. This concerns both levels of urban land use planning, the land use plan (FNP) and the binding urban land use plan (Bebauungsplan).

4.3.3.1. Prepartory land-use plan (FNP) and legally binding land-use plan (Bebauungsplan)

The FNP (§5 BauGB), as the first level of urban land use planning, is used for large-scale planning. The associated catalogue (§5 BauGB paragraph 2) provides the municipality with various representations that can promote climate protection and thus energy-efficient urban development.
Following the 2011 amendment to the BauGB, section 5 (2) no. 2 BauGB now explicitly stipulates that the provision of the municipal area with facilities, installations and other measures that counteract climate change or serve to adapt to climate change can be depicted in the land-use plan and includes the following designations of the building code:

Article	Topic	Impact
§ 5 (2) No. 1 BauGB	Determining the location of planned building areas in terms of solar energy	Reduction of energy consumption through passive solar gains
§ 5 (2) Nr. 1 BauGB No. 1 in combination with No. 3	Determination of traffic-avoiding settlement development	Reduction of energy consumption in traffic
§ 5 (2) No. 2 b	Site planning for facilities with significant land use	Energy generation from renewable energies

Table 7: Designations to improve energy-efficiency in the preparatory land-use plan

50 http://quartierslabor.de/wp-content/uploads/2017/01/EEQ_Hoff.pdf; accessed 30.4. 2021
51 https://www.energetische-stadtsanierung.info/energetische-stadtsanierung/programmekfw/; accessed 30.4. 2021
52 https://www.kfw.de/KfW-Group/Newsroom/Latest-News/Pressemitteilungen-Details_361280.html; accessed 30.4.2021
53 The "Kreditanstalt for Wiederaufbau" (KfW) is one of the world's leading promotional banks. KfW has been committed to improving economic, social and environmental living conditions in Germany and across the globe on behalf of the Federal Republic of Germany and the federal states since 1948; see: www.kfw.de

In the second stage of urban land use planning, urban density has an influence on the energy situation in a neighbourhood. It is fundamentally true that the resource-conscious use of settlement area has a key position for the implementation of the goals of sustainable urban development (small plots, compact building forms). This is already justified in the framework set by the federal legislator, namely, to use land sparingly and carefully (BauGB § 1, para. 6)[54]. In addition, the more densely built-up a building area is, the higher the probability of implementing a central energy supply[55].

Checklists help!
Sustainable urban development is a complex process. When preparing land-use plans, the most diverse requirements and demands on an area must be evaluated and weighed against each other at an early stage. This applies to climatic and energy effects, too. On one hand, care must be taken to ensure appropriate distances between buildings so that passive solar gains are possible at all levels, on the other hand, the available land needs to be developed in the most space-saving way.
Checklists that also include the energy-relevant aspects help the municipal planner, ensuring that essential factors are taken into account as early as possible. A very basic checklist for urban planning competitions[56] is shown in table 8. More complex checklists for development plan procedures have been developed by the City of Potsdam[57] and the City of Essen[58].

Topics	Yes	No	Improve-ments
Geometry of the building (compactness of the building) • Depth / length / height • Roof shape • Structure			
Orientation of the building • Alignment of the main façade (passive solar energy use)			
Shading by building • Distance between the main facade and the shading edge • Graduation of the building from south to north			
Shading by planting • Distance between the plants and the main facade			
Integration of utilities • Pipeline network • Gradual heating/cooling infrastructure development possible • Location heat production / storage units • Flexibility of supply for future innovations			
Use of Renewable Energies • Orientation of the building body and roof pitch (active solar energy use) • Substitution of energy sources using carbon neutral energies			
"Experimental Living" • Participation in support programs; research projects			

Table 8: Checklist energy for an urban planning competition

4.3.3.2. Urban Energy Renewal – Energy efficiency in existing quarters
Urban energy renewal comprises the strategic orientation and coordination of measures to save energy, increase efficiency and use renewable energies. It is an interdisciplinary task that involves actors and system contexts at the levels of buildings, city quarters and the city as a whole[59].
In the context of the potentials and the increasing focus on existing buildings and quarters, the supplementary provisions of the BauGB, the urban redevelopment measures (§§ 136 ff. BauGB) and urban redevelopment (§§ 171a ff. BauGB) are becoming increasingly important.

It is already legally confirmed that redevelopment measures under § 136 BauGB also permit area-related energy measures such as combined heat and power plants, photovoltaics for an area or district heating. The regulations on urban redevelopment also provide legal foundations that are also relevant for climate mitigation action.[60]

54 https://www.bbsr.bund.de/BBSR/DE/themen/_alt/Stadtentwicklung/StadtentwicklungDeutschland/NachhaltigeStadtentwicklung/Projekte/Archiv/StrategienIndikatoren/05_Handlungsfeld_Boden.html; accessed 30.4.2021
55 Note: Density is not just good per se. A too dense development can have negative consequences not only for the energy aspects (shading, lack of ventilation), but also in the area of greening and not least in social terms. Therefore, it must be decided individually in each case how densely an area should and can be developed.
56 Klimaschutz und Stadtplanung Augsburg; Stadt Augsburg; 2007 p 21
57 Energieeffizienz in der Bauleitplanung – Arbeitshilfe zum B-Planverfahren; Stadt Potsdam; 2010
58 Leitfaden für eine energetisch optimierte Stadtplanung; Stadt Essen; 2009
59 BMVBS, 2011, p14
60 Umweltbundesamt, 2012, p41

4.3.4. Informal Planning – Energy Supply Concepts

In addition to a low-carbon individual supply of buildings using heat pumps, forms of geothermal energy or solar thermal energy)[61], there is the possibility of grid-connected heat supply systems in areas with a correspondingly high settlement density. This applies to both existing and new buildings.

In combination with cogeneration (simultaneous generation of electricity and heat), particularly energy-efficient generation with low losses can be achieved here. In this context, the so-called heat density, the heat demand per settlement area, can again be influenced by urban planning regulations:

- Type and type of development (from single-family house to multi-family house, the probability of a grid-connected supply increases).
- Building density (number and size of buildings and floor space)

4.3.4.1. City quarter energy concepts

Energy district concepts show energy saving potentials as well as basics and measures for a strategic target formulation. In this way, individual renovation concepts and roadmaps can be developed for each quarter. Furthermore, they help to develop financing models and implementation strategies for different building types.

Since the efficiency and thus the economic viability depends not only on the energy consumption of the buildings but also, among other things, on the distance to the heat source (length and losses through pipes), an energy concept should be developed for the area in question in advance of implementation, which compares the different supply variants in ecological and economic terms.

The energy concept examines the expected heat demand in the area, compares different variants of heat generation (centralised-decentralised) regarding their energy consumption and the associated CO_2 emissions and air pollutants. The costs of the examined variants should be examined in relation to the total annual costs (investment, energy costs and maintenance) to be able to make a comprehensible decision[62]. Those concepts should also be integrated into city-wide strategies in order to generate further synergies with e.g., existing heat supply variants in neighbouring areas. It is therefore recommended to pre-check surrounding areas before.

4.3.4.2. Practical Implementation Experience

The implementation of a heating grid in a city quarter depends on the prevailing conditions in each individual case. Today, the increasing efficiency of buildings might not provide the minimum heat requirements to run the system in an economical way. District heating is only economical if it serves lots of users in the long term as upfront investments are higher than individual solutions.

Advantages offered by local heating grids come to bear in more densely built-up areas with multi-storey flats or where new buildings are erected on vacant plots between existing buildings that are already connected to infrastructure, than in rural settings with detached homes. Figure 8 shows the length of pipes in district heating, which is one important environmental (heat losses) and economic (higher costs) factor.

In practice, a heating level of 1.5 MWh/metre pipeline (of the heating grid) is needed for heat generation and distribution through a heating grid to be economical.[63]
Against the background of the current historically low interest rates, the operation of municipal heat supply plants/grids open up new investment opportunities both for cooperative models and for (institutional) investors, who have not hitherto considered this form of investment.

Fig 9: Comparison of two heating grids one in a built-up area and one in a rural setting (EnBW).

61 ibid, p59
62 A pure comparison of the investment costs would be misleading, as these can be higher, especially with sus-tainable solutions, but can be more than compensated in the long run by lower consumption and maintenance.
63 This figure certainly would be the subject of debate among technical experts; However, the lower the figure is (and some energy agencies/advisory units base their calculations on a level of 0.5 MWh/metre pipeline), the greater the risk that heat generating plants cannot be operated economically, either because too little heating energy is needed or because the heating required must be transported over longer distances through the grid.

The challenge for municipalities and energy utilities in specific lies in the way promote district heating in the future, as the system is "resource flexible", providing the opportunity to switch form fossil fuels (gas) to renewables (biogas or biomass). A mixture or pull (use of regulation) and push (funding, incentives, information) is needed to keep or make district heating a part of energy systems in cities in the future.

Information box 3: Role of energy utilities

Importance of Energy Utilities

Energy utilities are, of course, involved in many ways in the development of climate change mitigation strategies and action. In particular, their involvement is crucial in the establishment of energy concepts and energy use plans (see next chapter) - at a very early stage of planning processes.

In the preparatory land-use plan for the strategic outline of district heating and in the legally binding land-use plan when concrete energy solutions are to be defined, local energy utilities play an important role for future energy-efficient solutions.

Moreover, and to improve the operating grade of existing heat networks, energy supply utilities have to be engaged in urban renewal planning. As for all stakeholders in this process, regular communication and exchange between the responsible planning units of the local government and the energy utility is a prerequisite. Successful cooperation and co-creation of projects depends on such exchange on political and administrative levels.

Municipality owned local energy utilities, although market actors, can also act as role model in the fields of energy-efficiency and extension of renewable energies (see chapter 4.4.6).

Energy utility as driver in local climate mitigation

In May 2020, the regional energy supply company "badenova", more specifically its branch for district heating announced a model project called "Heat supply 4.0" for a larger city district in Freiburg. The heart of the project is the construction of a new energy centre on the premises of the regional dairy using industrial waste heat from its production. It will use low-temperature waste heat from the wastewater and refrigeration processes, which would otherwise remain unused. With the quantities available, up to 60 per cent of the calculated demand of the surrounding area, mostly housing areas with multistorey buildings can be covered. The heat will be fed into the existing heating grid, fuelled by co-generation including solar thermal.

As the output from the dairy is higher than the demand of this network, the plan is to stepwise link neighbouring networks and use the existing co-generation units flexibly. As so-called "short-runners" and in the sense of sector coupling they help to compensate fluctuations in renewable electricity production.

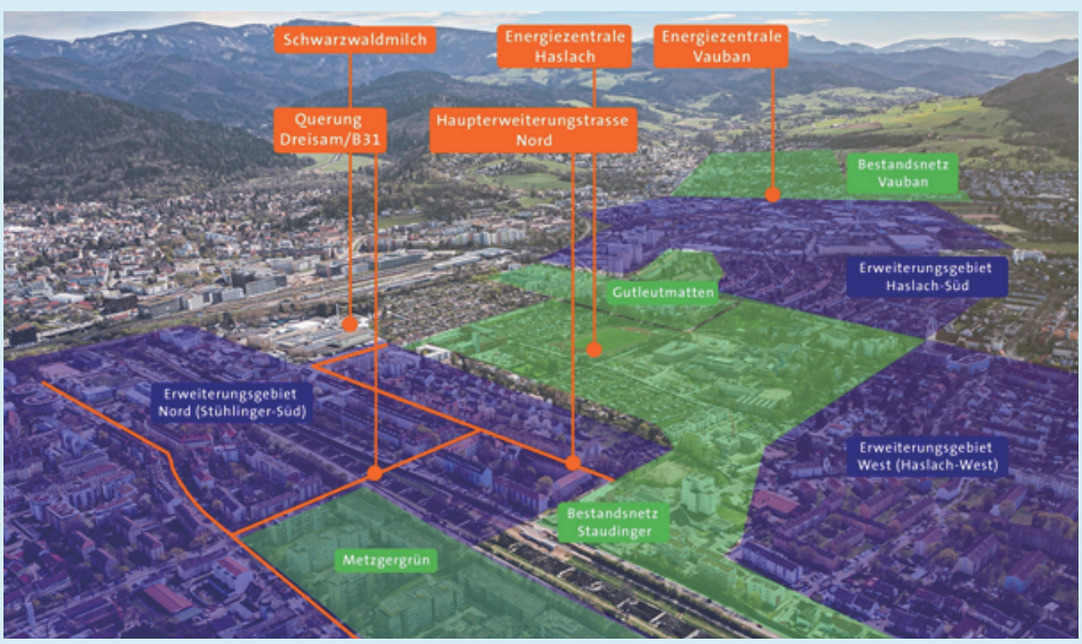


Fig. 10: Freiburg Heating network perspectives [64]

The project is part of the City´s overall climate mitigation strategy. It involves several stakeholders: energy utility, dairy (Schwarzwald Milch), the City of Freiburg environmental agency and several building associations. Moreover, those pilots need financial support at the start. The model project, involving a total of 36 million euros in investment, is funded by the Federal Ministry of Economics (BMWI).

64 Source: https://www.badenovawaermeplus.de/waermeversorgung/waermeverbund-freiburg-sued/; accessed 5.5. 2021

4.3.5. Further aspects – Living labs

In 2018, the Federal Cabinet adopted the 7th Energy Research Programme: "Innovations for the Energy Transition". It contains the guidelines for energy research funding in the coming years including a budget of €7 billion for projects. The funding focuses on a holistic and systematic approach towards a transformation of the energy system. Funding is made available for cross-sectoral approaches in the fields of reduction of consumption, energy efficiency, sector coupling and digitalisation. One specific format addresses the quarter level. In so-called 'living labs', the energy system of the future can already be tested today. The results and experience will serve as blueprints for the actual practical implementation to provide fresh impetus to the energy transition[65], e.g., transforming heating systems in former coal regions to low temperature levels[66].

4.3.6. Case Study: City of Freiburg - Integrating energy in urban planning processes

Background
Based on the city council decisions in the early 1990s the City of Freiburg developed two new pilot districts for up to 20.000 inhabitants, piloting reduced energy demand of all buildings and connecting them to district heating based on co-generation. Unfortunately, the local administration did not apply these standards regularly in new developments; no mandatory procedure to integrate energy aspects in the urban planning processes existed.
What?
In 2004, with an amendment of the German building code, land use plans could and should integrate measures to mitigate climate change. The city mayor (in accordance with the city council) commissioned the local administration to not only assess the impact of this amendment but to suggest how the intention of the new code could be translated in urban planning procedures in the City. For this purpose, a task force - including urban planning, real estate, and energy department – was put together to define a procedure that integrates energy aspects in the future process of urban planning.
How?
The outcome of several negation rounds, involving energy experts and the local energy agency, has been called the "instruments for climate-mitigation in land-use-planning" and are based on three pillars: 1. Within the framework of the development plan, passive-solar aspects must be considered already at the design stage and provision must be made for solar installations. 2. The "Freiburg building standards" are to be implemented when selling municipal land as well as in all new development plans, for residential and office buildings. 3. In the context of energy concepts, variants of the energy supply (inter alia decentralized - central) are examined. In addition to CO_2 emissions and air pollutants, the economic aspects are to be considered (total annual costs: investment, energy, and operating costs). The most ecological variant is to be implemented if it is not 10% more expensive than the respectively defined basic variant. The task force suggested furthermore, to integrate these basic aspects early on in urban planning processes and to fix the results of the procedure in the context of purchase contracts or urban contracts with investors or property owners. The mayor and the city council adopted the proposal unanimously as an integrated part of Freiburg´s "urban planning policy principles", a catalogue of to be considered requirements for all new construction areas.
Results
Since then, the members of the task force meet regularly to discuss each (!) new district plan and development concerning the integration of energy aspects in early planning stages, including urban competitions, and based on energy concepts. The newly planned city district "Dietenbach" for approximately 15,000 inhabitants is the latest example and aiming for climate neutrality[67]. New district developments will only pass the city council if they contain statement and suggestions for climate-mitigation action. The procedure has been successfully integrated without timewise extending the planning process.

65 7th Energy Research Programme. Innovations for the Energy Transition, BMWi, 2018
66 https://projektinfos.energiewendebauen.de/en/project/low-temperature-replaces-coal-infrastructure/; accessed 1.5. 2021
67 https://www.freiburg.de/pb/1329444.html; accessed 1.5. 2021

4.4. CITY LEVEL

Spatial Level	Energy Regulation	National Planning Level	Informal Planning	Further Aspects
City	• See Building level regulations • National and state funding for city level networks	• Involvement in regional plans • Preparatory land-use plan (FNP)	• City strategies • Integrated City Development Con-cept (INSEK) • Sustainable Energy Climate Action Plan (SECAP) • Energy use plan	• City wide ener-gy strategies in-volving energy utilities • Regional coop-eration, con-cepts

Table 9: City level and influencing aspects - Overview

4.4.1. Cities at the forefront of climate change
Cities are focal points of energy consumption. Hence, their current and future size, forms, and buildings have a significant bearing on their future carbon footprint. Energy regulations, land-use and other urban planning decisions affect buildings both before and after their construction is proposed and implemented. Policies already in place determine many aspects of building design. Urban planning acts as a constraint on private development, and may be intended to improve health, safety, or other desired characteristics of a city or city quarter. Combining urban planning with energy and resource planning provides a unique opportunity to accelerate efficiency in the built urban environment[68].

To support sustainable action on this level, city leaders and city councils need to adopt holistic strategies, plans and climate targets that build the basis for mitigation and adaptation action through city´s administration and stakeholders. As all aspects of sustainable development, ecological, economical, and social aspects are interrelated, it needs strong commitment and structures to steer and coordinate the process and implementation on the different levels. Energy, again, plays an important role towards low carbon cities.

4.4.2. Energy Legislation and the city level
As mentioned in the previous chapters, EU and national regulations on energy influence buildings and city quarters. They also influence, of course, the energy consumption of a whole city. They are an essential pillar on which sustainable urban development with a focus on energy can be built upon. As described for the building level (see chapter 4.2), energy legislation alone, will not suffice to reach carbon neutral cities by 2050, as its impact mostly refers to the building sector.

4.4.3. Federal Building Code
The preparatory land use plan is the legal planning instrument for a city-wide partition of land use and thus also suitable for the implementation of climate protection goals (see chapter 3.2.2). In conjunction with informal planning instruments as further described below, the land-use plan may integrate requirements from concepts as the sustainable climate energy action plan (SECAP), like marking potentially suitable (and dense) areas for an enlargement of existing district or new quarter heating supply solutions. In process of establishment of a legally binding land-use plan (Bebauungsplan), such preliminary attributions can then be further developed and fixed.

4.4.4. Informal Planning
4.4.4.1. Integrated concepts as instruments
Local governments can influence the efficiency of new and existing buildings, neighbourhoods and the whole city area in different ways (see table 3, chapter 3.3). They can deploy a variety of policy options, ranging from setting targets, leading by example, implementing codes and performance systems or by development of strategic plans and concepts to steer the implementation of measures towards low-carbon cities. [69]
Integrated or integral planning concepts are defined as informal (planning) instruments. They are not an additional formal planning level but – based on the sovereignty of local governments – additional tools to foster climate mitigation on the overall city level. Strategic planning frequently used in municipal planning practice includes integrated city development concepts (Integriertes Stadtentwicklungskonzept - INSEK), sustainable energy climate action plans (SECAP)[70], energy use plans (ENP) or energy concepts for new neighbourhoods.

These concepts offer the opportunity, while considering current regulative developments and framework conditions, not only to show comprehensive and perspective overarching objectives for the future development of a municipality, or a district. They already prepare or elaborate concrete measures. To avoid "disappearing in the drawers", every integrated concept should lay down mechanisms and structures to control the achievement of goals and reporting requirements[71].

4.4.4.2. Integrated Urban Development Concepts (INSEK and INSEKe)
Integrated urban development concepts (INSEKs) create concrete, area-related, long-term effective solutions for a multitude of challenges and fields of action such as urban, economic and environmental development. Integrated development planning

68 World Resources Institute, 2016, p5
69 Ibid, p4
70 In Germany the term SECAP, defined by the EU in the framework of the Covenant of Mayors, is referred to as Integrated Energy and Climate Concept (Integriertes Klimaschutzkonzept – IKK) with a similar scope
71 Verbücheln M., Dähner S. (eds.), 2016, p21

coordinates between spatial levels and between sectoral planning and/or policies.

The energy-optimized integrated urban development concept (INSEK^{e}) integrates energy-related aspects in each of the concept´s sectors, what means that each subconcept as e.g., mobility needs to incorporate energy-related effects and providing solutions for mitigation (e.g., in the field of mobility improving public transport etc.). It is also called a sector-specific instrument of energetic urban renewal[72]. The energetic consideration of the energy concept is linked in the INSEK^{e} with urban planning, urban planning, architectural, social, or cultural as well as other technical and infrastructural issues[73].

Central components are an energy concept and a program of measures to improve and optimize the energy balance in a city. The concept combines studies on the energy-saving potential of buildings and facilities in households, trade, and industry as well as transport with the potential for the use of combined heat and power or renewable energies. From this, it derives strategic considerations for an optimal energy supply. Obviously, it is closely connected to the SECAP (see below) and both instruments influence each other with a "request" for intense coordination within the local government´s responsible departments. Integrated urban development concepts must be regularly reviewed and updated. This offers the opportunity to incorporate new legal developments, results of energetic planning for future urban development[74].

Fig 11: INSEK^{e}-energy-optimised integrated city development concept[75]

4.4.4.3. Sustainable Energy Climate Action Plan

From a legal point of view, also sustainable energy climate actions plans[76] are (voluntary) informal specialist concepts, too, which, when linked to land-use planning or urban development contracts, can also become more binding in relation to the use of energy and space in new developments. Individual specialist topics are conceptually developed in sub-concepts, and climate protection management ensures implementation and consolidation.

72 Orientierungen für kommunale Planung und Steuerung; DIfU; 2014, p27
73 BMVBS; 2011 p13
74 ibid, p18
75 ibid, p21
76 SECAPs initially did not include measures for adaptation, called Sustainable Energy Action Plans (SEAPs)

Different from the INSEK a SECAP´s view focuses basically on the city-wide energy and climate situation. SECAPs combine technical and scientific aspects with a definite political planning basis in the form of a catalogue of measures in different fields of action, including city planning. Thus, a SECAP is the starting point for a structured approach to local climate action. Several steps are crucial in the development of a SECAP. It is important to know the current situation in detail elaborating a baseline emission inventory (BEI). In a next step is to examine what could be done in the future (analysis of potentials) and what the local climate goals should be (target setting). Based upon these steps, necessary measures can be elaborated and prioritised (action plan)[77]. As for an INSEK, regular monitoring is crucial for the regular adjustments process.

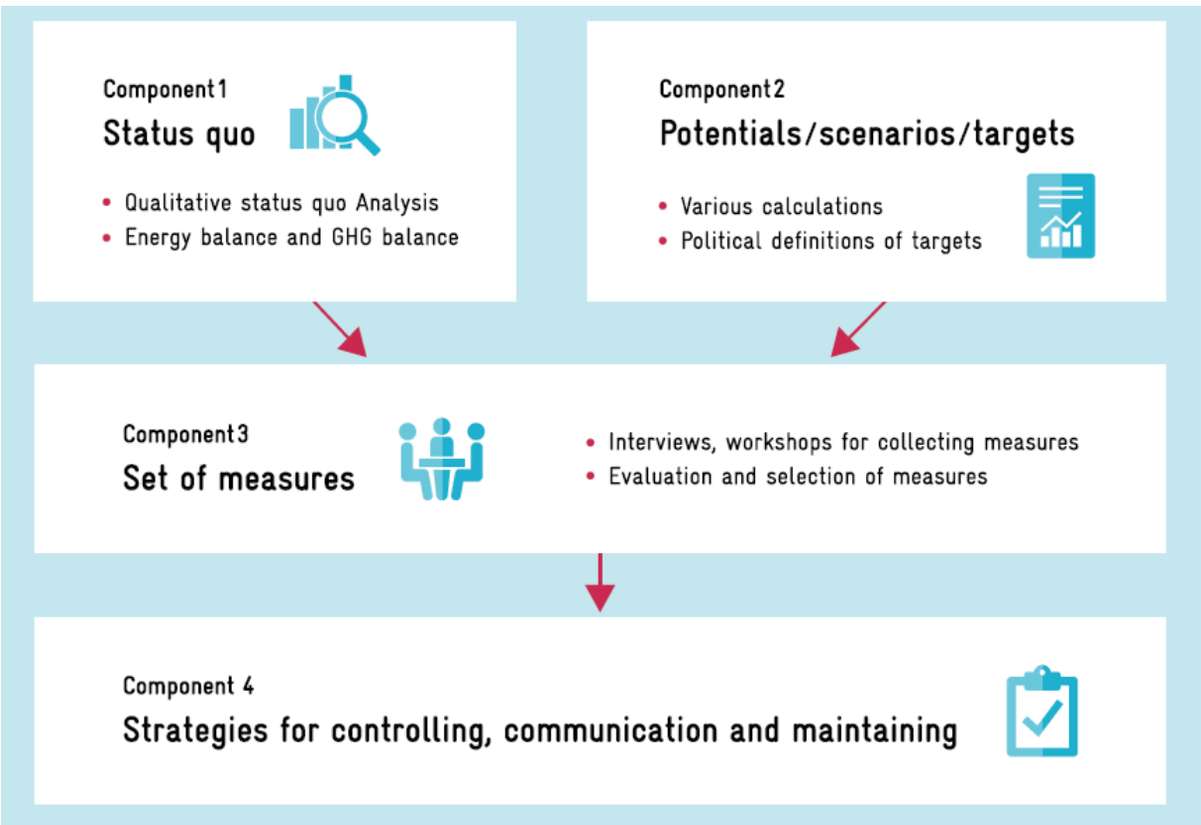


Fig 12: Process of SECAP development[78]

SECAPs have proven to be an important instrument in climate action for a number of reasons:

- They represent a long-term strategy of climate action and energy transition based on a holistic and scientific analysis of all sectors
- Definite measures show the necessary steps for the first few years
- They are a source for making political decisions and policies
- They ensure a stable policy framework and investment environment
- They define the role and possibilities of municipalities in a national energy transition process

Developing a SECAP means that a municipality enrols for the long-term process of climate action and energy transition.[79]

Funding opportunities for SECAPs
In the framework of the German National Climate Initiative (Nationale Klimaschutz Initiative - NKI), local governments are entitled to apply for funding to elaborate and implement SECAPs. In order to receive funding, a SECAP must be developed in the above described stepwise approach. Above all, the process of development must involve relevant stakeholders, and contain a citizens' public relations concept.

4.4.4.4. Energy Use Plan (Energienutzungsplan - ENP)
The Energy Use Plan (ENP) is a link between the tasks of urban development and climate protection. It is often also referred to as Municipal Energy Plan (MEP) or Spatial Energy Plan (SEP). In the Federal Republic of Germany, the State of Bavaria plays a pioneering role, where several energy utilisation plans have already been implemented. In the neighbouring State Baden-Württemberg, such plans will be mandatory for municipalities from 2023 onwards. The ENP can be incorporated into urban development planning as a sub-plan (sectoral plan) of the SECAP or also into the land use plan, as in the case of the city of Esslingen[80].

77 GIZ; 2020, p2
78 ibid, p3
79 ibid, p7
80 http://www.esslingen-und-co.de/,Lde/start/43+Projekte+_+mehr/Energienutzungsplan.html; accessed 30.4. 2021

The ENP adds an essential component to the climate protection concept: The concrete spatial and ideally also temporal allocation of energy consumption and existing sources or developable potentials of renewable energies. By integrating the criteria from climate protection into urban development and through the possible spatial reference of entire city districts to individual blocks of houses, the ENP has a high strategic value for achieving the self-imposed urban climate protection goals.

With the ENP, cities will have a fine-grained instrument at their disposal that can be integrated into different planning levels:

- At the level of target development, the ENP can serve as a basis, for example in the framework of the development of the land use plan up to the urban land use planning.
- In the strategic area of urban planning, the ENP provides an energy planning basis that can be integrated into urban planning analyses and concept developments, for example in the context of new developments or urban expansion.
- Local actors, for example the municipal utilities, have a high-quality basis in the ENP for further expansion planning, e.g., district heating or renewable energies[81].

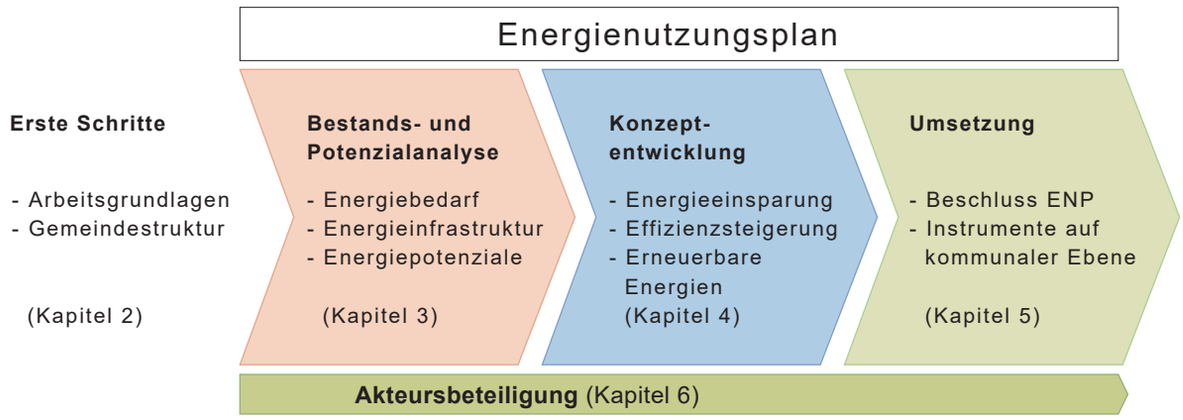


Fig 13: Phases in drawing up the Energy Use Plan.[82]

4.4.5. Further Aspects – City and the Region

A City is not an island. Cities are connected, interlinked, and interrelated with the surrounding region (s) in many ways. Both cities and regions are in a continuous process of change. The energy transition is one of the factors that forces cities and regions to adapt and manage change in the field of energy. Simply put, the city is the energy consumer, the region, especially in the area of renewable energies, acts as provider. Both, city, and region need to play their role when it comes to more decentralised energy systems, tightly connecting both, requiring constant communication and coordination for regional low carbon development.

Example: The regional climate protection concept for the economic region of Augsburg is a joint project of the city of Augsburg, the district of Augsburg and the district of Aichach-Friedberg. It lays the foundations for bundling competences at regional level and organising climate protection activities in a joint initiative of the three administrative units[83]. The aim of developing the regional concept was to elaborate and create synergies and to increase the regional added value for the entire economic area focussing on energy and low carbon development.

The integrated approach, involving more than 600 regional and external experts, ensured that all relevant fields of action to mitigate climate change were considered. Furthermore, the regional approach offers the opportunity to realise large scale project due to their impact, cost-effectiveness, their innovation potential, and transferability to many municipalities within the region.

The measures are oriented towards the sub-goals of reducing energy demand, increasing energy efficiency, substituting fossil fuels with renewable energy sources, and switching to a climate-friendly way of doing business and living. These include, e.g.,

- Development of an energy utilisation plan for the Augsburg conurbation area
- Model development concept and implementation support for a rural community
- Optimal utilisation of the legal possibilities of urban planning law in development plans
- Decentralised energy supply (wind, solar energy, biomass, and geothermal energy) where possible with citizen participation and regional value creation
- "Virtual power plant" (interconnection of decentralised plants for continuous supply with renewable energies)
- Mobility (management in enterprises, model concepts for rural sub-regions, regional bicycle strategy)[84]

81 Verbücheln M., Dähner S, (eds.), p62ff
82 Leitfaden Energienutzungsplan: https://www.ar.tum.de/fileadmin/w00bfl/klima/Publikationen/Berichte/Leitfaden_Energienutzungsplan.pdf; p5, accessed 4.5.2021
83 Regionales Klimaschutzkonzept, Wirtschaftsraum Augsburg, 2011, p8; https://www.landkreis-augsburg.de/fileadmin/user_upload/Klimaschutz/Regionales_Klimaschutzkonzept_Langfassung.pdf, accessed 5.5. 2021
84 ibid, p173ff

Example: The City of Frankfurt and the surrounding Frankfurt Region cooperate towards a decentralised, regional energy supply. One of the main motives is to gain beneficial effects on regional value creation. It gives the opportunity to keep small and medium-sized enterprises in the region, to create jobs, to strengthen purchasing power and to increase tax revenues. The "100 % Climate Protection Master Plan" of Frankfurt envisages replacing the import of energy raw materials and final energy with regional energy sources, technologies and services.

Like other large cities, Frankfurt faces the special challenge of limited space and high energy demand. A supply of renewable energy exclusively from municipal land is hardly feasible and therefore a regional cooperation aims at an increase of regional supply to minimise dependency from fossil fuels[85].

4.4.6. Case Study – Munich´s Integrated Approach on Climate Action

The example of the city of Munich will be used to show how the instruments for action described so far (energy regulations, formal and informal planning) interrelate on a city-wide level and how the different spatial levels (building, city quarter, and city) can be addressed and integrated. This is only possible if the city has formulated a goal for climate protection and this goal is supported by all relevant actors, from politics and administration to industry and citizens.

This has been the case in Munich for many years. In 2017, the state capital renewed the resolution on climate mitigation. Munich aims at climate neutrality by 2050. Due to global developments, in 2019 the city of Munich brought forward its climate neutrality target for the entire city area from 2050 to 2035[86]. A corresponding package of measures for 2019 to 2021 was already set in motion end of 2018.

Perspektive München (Prospects for Munich) Integrated Urban Development Concept (INSEK)

The city of Munich is in a steady progress towards the goal of becoming a viable and climate-friendly city. One of the guiding concepts is its integrated urban development concept, Perspektive München (Prospects for Munich). The concept covers a whole series of areas of action that are networked, while being mutually dependent and influencing one another.

The development concept - the leitmotiv “A city in balance” - contains 60 leading projects that are currently being implemented in 10 areas of action. The urban development concept was first adopted by the City of Munich in 1998 and is regularly brought into line with changing circumstances and requirements, by prioritising individual thematic areas.

For this concept to continue to fulfil its function as a target system for the city of Munich, it must be further developed and adapted to changing conditions. In the process, the Sustainable Development Goals of the United Nations and other overarching target systems will be integrated into the strategic guidelines. The results of the further development in the period 2019-2021 with intensive citizen participation are to be presented to the municipal council by mid-2021[87].

Fig 14: Poster Perspective München; Source City of Munich[88]

85 Verbücheln M., Dähner S. (eds.), 35f
86 https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Gesundheit-und-Umwelt/Klimaschutz_und_Energie/Klimaschutzstrategie.html; accessed 2.5. 2021
87 https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Stadtplanung-und-Bauordnung/Stadtentwicklung/Perspektive-Muenchen/Fortschreibung.html; accessed 2.5. 2021
88 Source: www.muenchen.de/.../PM_Poster_web.pdf; accessed 4.5. 2021

Most of these thematic areas are directly or indirectly linked to energy supply and infrastructure and to develop the city compact, urban and green.

Integrated Energy and Climate Concept (IECC)
Moreover, the city of Munich – by decision of the city council in September 2017 and to support the international targets defined in Paris in 2015 - wants to reduce GHG Emissions to 3 tons per capita in 2030. Furthermore, the target is to become almost climate neutral by the year 2035. This means that, only 0.3 tons of carbon dioxide might be released into the atmosphere in 2035 per capita and per year.
In the framework of the revision of Munich´s IECC[89] and to reach the above-mentioned targets in the near and far future, energy supply, especially for heating and cooling needs to be carbon free as soon as possible[90].

Municipal Energy Plan
'Reducing the energy and resource consumption of a city must not only be done on a small scale. An urban area is an interconnected system, almost like an organism. It is not enough to insulate a few individual buildings and install more efficient heating systems here and there.'[91]

With the ENP[92] the city is providing a document for the development and restructuring of the energy supply infrastructure. It

- Contains information about the current and future energy needs of the City of Munich on existing data bases,
- Identifies potentials for the use of renewable energy with the help of relevant urban planning instruments, such as solar potential maps and heating needs maps for buildings, and
- Presents a concrete strategy for the implementation.

Moreover, the City wants to leverage the reduction of energy use two ways:

1. Consumer side: Energy saving and efficiency measures (advanced building standards for new construction, accompanied by funding and advisory; motivate consumer behaviour through information campaigns), and by the
2. Supply side: Improving the energy supply (introducing new technologies, improve existing generation, inclusion of renewable energies)

Sustainable energy supply thus consists of three specific areas of action, which are not only closely interconnected, but which influence one another: energy savings achieved by setting political priorities (consumer side), enhancing energy efficiency, and developing the use of renewable energy (supply side). The interconnections and interdependencies between these areas of action are illustrated in the below.

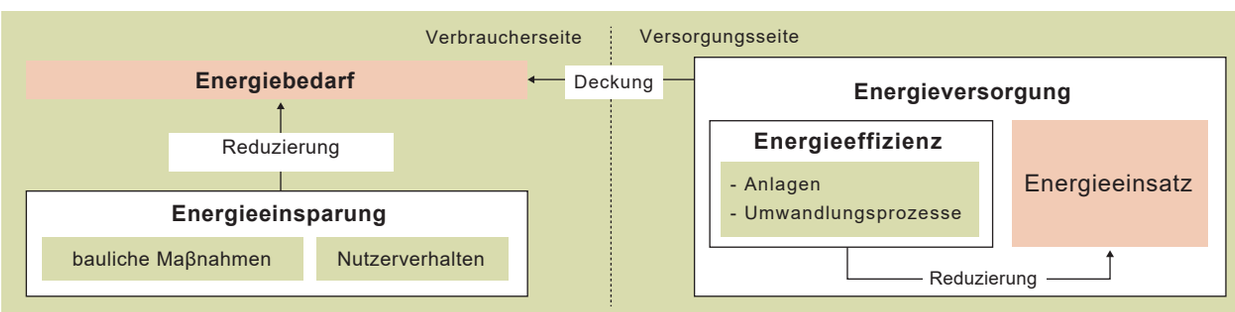


Fig 15: Main areas of action of an Energy Use Plan[93]

Building Level Standards
Munich anticipates that heating energy consumption in buildings can still be reduced by more than 50% through restoration projects to enhance energy efficiency in conjunction with modernisation measures that were already planned. This can be achieved by appropriate thermal insulation for roofs and external walls, as well as the installation of new windows and new heating systems.[94]

The City of Munich drew up a Catalogue of environmental criteria already in 1995[95]. It sums up concrete requirements for sustainable building and refers to the national laws and ordinances in force. These criteria have since been regularly updated. The regulations apply to commercial and industrial buildings and to residential buildings erected on land owned by the City. When City-owned land is sold, the Municipal Affairs Division ensures that the list of environmental criteria is incorporated into the sales contract under private law. It is then

89 The Munich IECC is more or less synonymous with a SECAP as defined by EU
90 https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Gesundheit-und-Umwelt/Klimaschutz_und_Energie/Klimaschutzstrategie.html; accessed 2.5. 2021
91 Eisenack, Marco, et al. München: Zukunft mit Perspektive - Strategien, Leitlinien, Projekte. Magazin zur Fortschreibung der Perspektive München, June 2015. p24
92
93 Figure based on Technical University of Munich. Leitfaden Energienutzungsplan. 2011, p 122; https://www.ar.tum.de/fileadmin/w00bfl/klima/Publikationen/Berichte/Leitfaden_Energienutzungsplan.pdf; p 6; accessed 4.5.2021
94 Landeshauptstadt München. Gebäudestandards und Energiekonzepte. https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Gesundheit-und-Umwelt/Klimaschutz_und_Energie/Energiestandards.html, accessed 5.5. 2021
95 https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Stadtplanung-und-Bauordnung/Stadtentwicklung/Nachhaltig/Leitlinie-Oekologie.html; accessed 2.5. 2021

the responsibility of the Division for Urban Planning and Building Regulations to inspect and ensure compliance with the criteria.[96]

The list of criteria aims to encourage a more economical use of energy and other resources, and also cut costs, reduce pollution and create healthier and more attractive living and housing conditions. In this spirit, the list contains particularly relevant stipulations in the following areas:

- **Building materials**
  According to the list of criteria, only building materials 'that can be produced and processed or installed using little (primary) energy and with low emissions of hazardous substances'[97] and that have environmentally sound and re-usable features may be used. In this framework, recommendations are made for certain materials, while specific building materials are listed as being unacceptable.
- **Thermal insulation**
  In the field of thermal insulation, the regulations laid out in the GEG for residential and non-residential buildings apply. In the case of residential buildings, specific mention is made of transmission heat loss (Ht'), which must be at least 15% below the value calculated for reference buildings. For non-residential buildings, the median thermal transmission coefficient (U) of external parts of the building must be at least 10% lower than the equivalent reference value. In addition to the national passive building standard, the City of Munich has introduced the 'low heat energy' standard, which is eligible for subsidies from the Division for Health and the Environment under Munich's Programme to Promote Energy Savings (FES).

Fuels

To protect the urban air from harmful pollution, the list contains specific bans on the combustion of solid and liquid fuels for heating or hot water. Exceptions are permitted in the case of heating systems that comply with the technological standards laid out in the first Ordinance to implement the Federal Immission Control Act (1st BImSchV) and the 13th Ordinance relating to Large-scale Heating Systems and Gas Turbine Plants (13th BImSchV), the 17th Ordinance relating to the Incineration and Co-incineration of Solid Waste (17th BImSchV) and the specific provisions of the Fuel Ordinance of the State Capital of Munich (BStV).

Munich's policy is to subsidise the construction of passive buildings, 'low-energy building construction as part of publicly assisted housing construction, and thermal insulation measures for the existing building stock'.[98] In addition, the energy-related requirements for both new buildings and the restoration of city-owned buildings and housing companies are significantly higher than those laid out in previous national regulations. The existing list of criteria is currently being reviewed and updated to bring it into line with the GEG 2021.

Consumer side incentives mechanisms - Programme to Promote Energy Savings (FES)

Besides existing national and state incentive mechanisms, the City of Munich has used financial mechanisms since the late 1980s to encourage private investment. The FES is open to owners of buildings (individuals, communities of owners, etc.), as well as plant operators who wish to implement measures either to save energy or to enhance the overall energy performance of buildings. Munich provides 14.7 million euros a year in this framework.[99]

The programme covers both the construction of new buildings and the modernisation of the existing building stock, where it focuses on restoration work on the building envelope and on energy measures relating to building systems technology (e.g., installation of efficient hot water storage facilities). More specifically, support is available for concrete measures to enhance thermal insulation, encourage the use of renewable resources in building construction and the use of renewable energy such as installing photovoltaic plants to harness solar energy (see next table).

96 Ökologischer Kriterienkatalog, 2017; https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Stadtplanung-und-Bauordnung/Wohnungsbau/oekokatalog_vorwort.html; accessed 4.5.2021

97 Ökologischer Kriterienkatalog der Landeshauptstadt München. 2017, https://www.muenchen.de/rathaus/dam/jcr:606d0934-14be-4c6c-b388-a21dfa1d2e63/Oekologischer_Kriterienkatalog-2017.pdf; p2; accessed 4.5.2021

98 Landeshauptstadt München. Gebäudestandards und Energiekonzepte. https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Gesundheit-und-Umwelt/Klimaschutz_und_Energie/Energiestandards.html; accessed 4.5. 2021

99 Hazebrouck, Benoit, and Wolfgang Qual. Münchner Förderprogramm Energieeinsparung (FES) für energieeffiziente gebäude: Maßnahmen - Anforderungen - Erfolg. Munich, p 8

Munich's Program to Promote Energy Savings (FES)
Conditions of the City of Munich for assistance to be granted

Individual measure	Assistance
Insulation of external walls (U < 0.2)	€40.00 / m² living area; max. €4,000 / housing unit
Window (U < 0.95)	€36.00 / m² / living area for plastic frame windows (without lead/cadmium) €46.00 / m² /living area for wooden frame windows
Hydraulic balancing of heating system	€1.00 / m² / living area; minimum of €300 per unit
Insulation of roof and ceilings (U < 0.20 / 0.25)	€10.00 € / m² living area; minimum of €1,000 per building (U < 0.22) €15.00 / m² living area; minimum of €1,000 per building (U < 0.20)
Insulation of basement roof (U = 0.27)	€5.00 € / m² living area; minimum of €1,000

Table 10: Overview of the terms and conditions of the Programme to Promote Energy Savings[100]

The financial assistance provided by the City of Munich through its FES programme since it was launched in 1989 has been highly successful, as shown in figure 14. As the financial assistance has increased, large quantities of CO_2 emissions have been prevented.

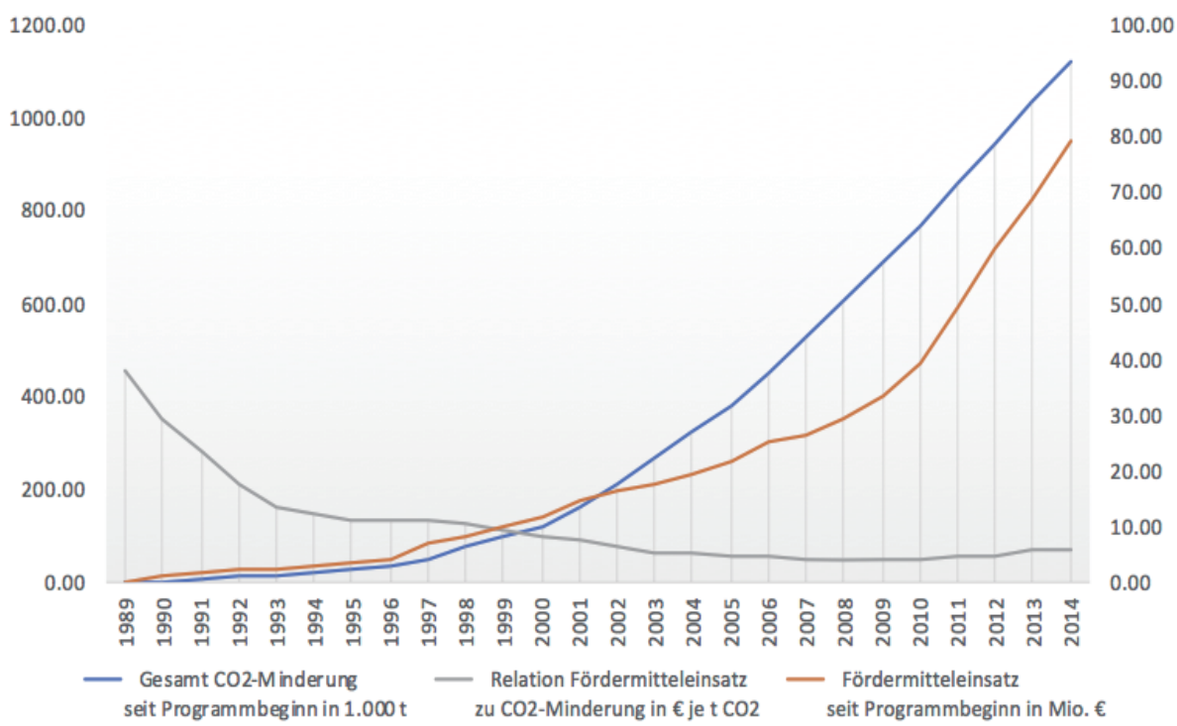


Fig 16: Program to promote energy savings - Financial assistance granted/reduction in CO_2 [101]

Energy supply with renewable energies
Along with Stadtwerke München (SWM), Munich´s energy utility, the City of Munich aims to achieve ambitious climate and environmental objectives. Its Ausbauoffensive Erneuerbare Energien[102] (campaign to promote the development of renewable energy) plays a major part in realising the energy transition and hence generating electricity and heating from renewable energy. In view of its ambitious goals, including the aim of achieving climate neutrality by 2050 and reducing per capita greenhouse gas emissions to 0.3 tonnes, the City of Munich has invested

100 Figure based on Kompetenzzentrum Energieeinsparung. 'Münchner Förderprogramm Energieeinsparung (FES).' https://energiezentrum-muenchen.de/Foerderkonditionen/Zuschuesse-und-Kredite; accessed 2.5. 2021
101 Source: Kompetenzzentrum Energieeinsparung, City of Munich
102 https://www.muenchen.de/leben/swm/muenchens-klimazukunft.html; accessed 2.5. 2021

heavily in developing renewable energy.

To be more precise, SWM has drawn up three concrete targets: [103]

- By 2025 developing the generation of green power to cover all of Munich's energy needs.
  The City expects to be able to meet 70% of the population's energy needs from its own energy production by the end of 2021 (5.1 billion kW/h). SWM currently operates 32 photovoltaic plants, 14 hydro-power plants, one woodchip heating plant, one biogas plant, five geothermal plants (two generating only heating power) and one wind power plant (see Figure XX) in Munich and outside Munich´s city boarders.
- By 2040 Munich's heating needs are to be met largely from deep geothermal energy and thus in a CO_2-neutral way. Munich's 800 km long district heating network, one of the longest systems in Europe, guarantees secure supplies, largely from energy-efficient combined heat and power plants. With a view to the energy transition, SWM is also striving to shift gradually to renewable heating and is investing in the development of geothermal plants, so that fossil fuels can be completely replaced with green power as of 2040[104].
- Munich's climate-friendly supply of cooling energy (eco-cooling) can save a total of about 70% of electricity by making efficient use of the ambient geological conditions. The increasing use of air-conditioning and cooling systems mean that the need for eco-cooling has also risen. With a view to the climate targets of the City of Munich, and the high growth and success potential offered by district cooling, SWM has invested over €30 million to date in developing these systems.

Energy Strategy Freiham (EU Smart City Project – Smarter Together)

Background
The City of Munich – by decision of the city council in September 2017 and to support the international targets defined in Paris in 2015 - wants to reduce GHG Emissions to 3 tons per capita in 2030. Furthermore, the target is to become almost climate neutral by the year 2050. This means that, only 0.3 tons of carbon dioxide might be released into the atmosphere in 2050 per capita and per year. Munich can rely on a large natural treasure: geothermal energy resources, in form of a huge hot water deposit in 2000-3000 m depth that can be used to generate environmentally friendly heat energy.
What?
In the framework of the revision of Munich´s IECC and to reach the above-mentioned targets in the near and far future, energy supply, especially for heating and cooling needs to be carbon free as soon as possible. Therefore, the city-owned local energy supply company (Munich Public Service Company – SWM), developed a strategy to decarbonise the district heating system until 2040.
How?
Although geothermal energy extraction is GHG friendly, it can only be exploited in accordance with a dense network, not challenged by other decentralised or net based energy supply technologies. The City of Munich provides additional subsidies for those who newly connect to the system. Since 2016 the new city district of Freiham and nearby neighbourhoods are supplied by geothermal energy. Three further installations are planned until 2025, one already in 2020, providing GHG friendly heating energy for more than 80.000 inhabitants and cooling demand of Munich´s superstore for food and flowers, using the infrastructure of an existing power station and replacing the use of fossil fuels. The project is integrated into the Smart Together Lighthouse Area, a project funded by the EU. Along with numerous other project partners such as the Fraunhofer Society, Siemens and SWM, some €20 million was invested in the project area, including an EU grant worth €6.81 million. The project has also received financial support totalling some €300,000 from the Federal Ministry for Transport, Building and Urban Affairs. With a view to realising the intended district approach, smart energy grids have been established and a smart energy management system put in place in the form of virtual power stations that integrate decentralised electricity generation. In the area, the City of Munich is also promoting local power generation by providing monetary subsidies targeting the public and private installation of photovoltaic plants. If one half of the roofs in Freiham were fitted out with photovoltaic elements, it would be sufficient to meet two thirds of the local electricity consumption.[105] The energy needed by local infrastructure and mobility structures will be further reduced by introducing new alternative concepts such as extending car-sharing platforms and further developing public transport.[106]

103 Stadtwerke München. 'Ausbauoffensive Erneuerbare Energien.' Energiewende, 2019, https://www.swm.de/privatkunden/unternehmen/energie/ausbauoffensive-erneuerbare-energien.html. accessed 2.5. 2021
104 Munich has ideal geological conditions for harnessing geothermal energy, Stadtwerke München. „SWM Fernwärme-Vision.", 2019, https://www.swm.de/energiewende; accessed 2.5. 2021
105 Division for Urban Planning and Building Regulations. Project. 'Energiegerechte Stadtentwicklung in München Freiham/Neuaubing', 2014, p4; https://www.muenchen.de/rathaus/Freiham/download.html; accessed 5.5. 2021
106 ee concept GmbH, Darmstadt. Sustainable Freiham: Objectives, Plans, Steps of Urban Planning. 2017, p14

Results

The project was able to show that energetic building refurbishments with connections to renewable heat and power generation are an important pillar on the way to climate neutrality in 2035.[107] Based on this and other positive pilot projects, Munich is continuously expanding the use of geothermal energy.
The prerequisite and common goal is to create and maintain acceptance - both within the administration and in the entire urban society. Although the city is already experienced in the field of renewable heat generation, risks need to be minimised in the future, by exploring additional sources of energy, for example waste heat, anerobic waste digestion or solar thermal appliances.

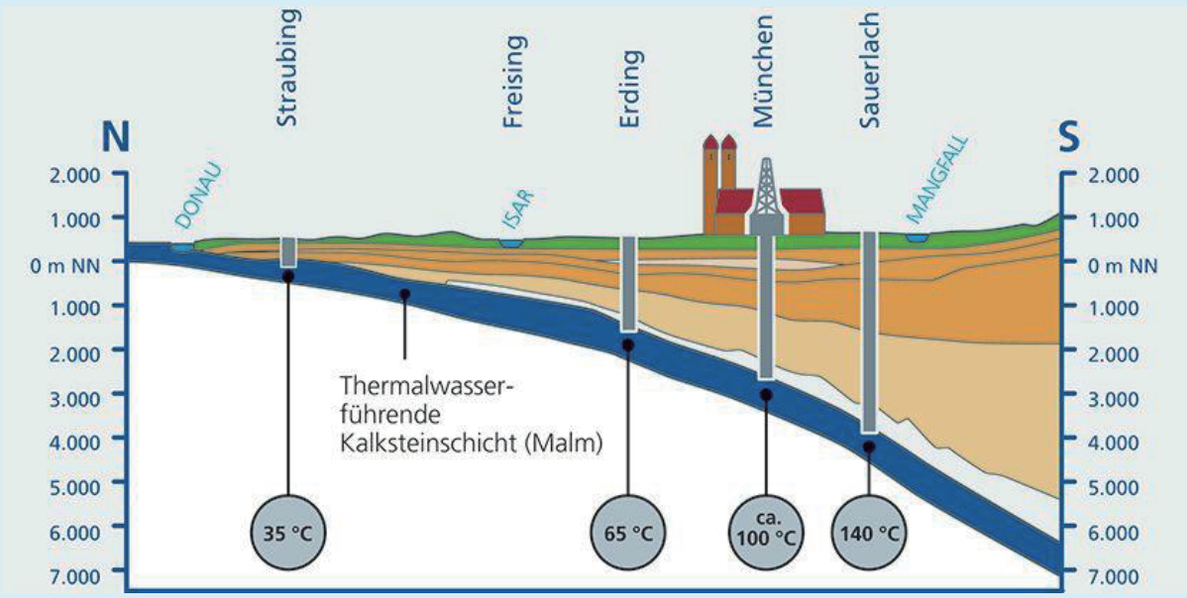


Fig 17: Geological conditions for the use of geothermal energy in and around Munich[108]

Links:
https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Arbeit-und-Wirtschaft/Europa/Smart-Cities.html;
https://smarter-together.eu/cities/munich#/

107 Smarter TogetherMunichActivities and Achievements2016–2021; http://www.wirtschaft-muenchen.de/publikationen/pdfs/Smarter_Together_Muenchen_2021_Web-en.pdf; accessed 27.4.2021
108 Source: Stadtwerke München: Gestalter der Wärmewende, SWM, 2018, p4

5. ENERGY REGULATIONS ON EU LEVEL – BACKGROUND INFORMATION

In the previous chapters the role of energy regulations, formal and informal planning was explained based on three special levels of the local level. This chapter describes the background of these regulations, based on the climate and energy targets, programs, major strategic concepts, law, regulations and directives of the European Union.

The national energy policy, as it builds upon the EU´s requirements and directives will be outlined subsequently. However, underlying international agreements and commitments as well as intrinsic motivation with a strong influence on the European climate and energy policy will act as a starting point.

5.1. COMMITMENTS AND MOTIVES

Under the Kyoto Protocol, the European Union undertook to achieve binding reduction targets for the first time, pledging to reduce emissions of relevant greenhouse gases during the first commitment period (2008 - 2012) by a total of at least 5%[109] of the 1990 levels[110]. these vary from country to country. the EU, as it then was, committed to achieve an 8% reduction in emissions (compared to the base year 1990) by 2012.

More than ten years later, in December 2015, over 195 countries met in Paris to negotiate the follow-on agreement to the Kyoto Protocol. The result was the Paris Agreement on climate change, which aims to keep the increase in global average temperature to well below 2°C in comparison to the pre-industrial level, while endeavouring to limit global warming to no more than 1.5°C.

All parties to the Paris Agreement on climate change are called on to present packages of measures by 2020 for the period up to 2050. In addition, global CO_2 emissions must be reduced to zero by about 2070, which will scarcely be possible unless we end the use of coal, gas and oil to generate energy. This agreement, which is binding under international law, demands that the EU accept its responsibility as the third-largest emitter of CO_2 and that it leads the fight against climate change with the help of a comprehensive energy and climate strategy.

5.1.1. Sustainable Development Goals (SDG) and New Urban Agenda (NUA)

In September 2015, the UN adopted the 2030 Agenda for Sustainable Development, and its 17 Sustainable Development Goals (SDGs) that formulate a sustainable development agenda for developing and developed countries with 169 targets and 231 indicators, which aim to be achieved by 2030. Two goals, SDG 11, and SDG 13, specifically focus on the topics of climate change and urban development. SDG 11 focuses on making 'cities and human Settlements inclusive, safe, resilient and sustainable'. SDG 13 highlights the need to 'take urgent action to combat climate change and its impacts', further defined in the Paris Agreement.

The most recent international agreement is the New Urban Agenda (NUA), which was adopted in October 2016. Integrated urban development contributes to energy and post-fossil transformation. The increased use of renewable energies and the corresponding restructuring of energy supply systems, the promotion of efficient energy and resource use, including energy-efficient buildings and lighting systems, sustainable supply and disposal systems and the development and expansion of sustainable transport systems are central fields of action for cities and municipalities.

5.1.2. Urban Agenda for Europe

The 'Pact of Amsterdam' describes the main features of the Urban Agenda for the EU. The Urban Agenda for the EU will contribute to the implementation of the UN 2030 Agenda for Sustainable Development, notably Goal 11 'Make cities inclusive, safe, resilient and sustainable' and the global 'New Urban Agenda' as part of the Habitat III process. The Urban Agenda for the EU will rely on the principle of an integrated approach to sustainable urban development as the guiding principle.

One of the priority topics is the energy transition: The objectives are to have a long-term structural change in energy systems i.e., shift to renewable energy and energy efficiency. The focus will be on improving energy efficiency (also in buildings), fostering innovative approaches for energy supply (e.g., local systems) and increasing the local production of renewable energy (Pact of Amsterdam)[111].

5.1.3. The New Leipzig Charter 2020

Most recently, the new Leipzig Charta[112], was adopted by the EU-Ministers being responsible for urban matters. Building upon the Leipzig Charter (as it was the place of adaptation) in 2007, the New Leipzig Charter with its set of strategic principles of good urban governance provides a framework guiding post-2020 urban policy coordination in Europe. This framework reaffirms the objectives and achievements of the Pact of Amsterdam, thus linking the Urban Agenda for the EU's working method to the New Leipzig Charter's strategic principles.

As one of three dimensions of the European City[113], the Charta defines "the green city". The transformative power of cities contributes to combatting global warming and to high environmental quality for air, water, soil, and land use. The development of high-quality urban environments for all includes adequate access to green and recreational spaces. Climate-neutral energy supply, renewable resources, the implementation of energy efficiency measures, as well as climate-resilient and carbon-neutral buildings will contribute to significantly reducing greenhouse gas emissions and helping Euro¬pean cities adapt to the impacts of climate change. Some European frontrunner cities can already provide a blueprint for a net-zero carbon city today. The transformation requires investments in innovative and efficient technologies as well as fundamental changes to production and consumption, allowing for the establishment of a circular economy which redefines and ensures a sustainable use of resources, while significantly reducing waste and carbon emissions.

109 In view of the individual targets set for parties to the agreement in Annex B, an average reduction of 5.2% in greenhouse gas emissions was the set target.
110 See Article 3 (1) of the Kyoto Protocol to the United Nations Framework Convention on Climate Change. 1997; https://unfccc.int/resource/docs/convkp/kpeng.pdf; accessed 1.5. 2021
111 https://ec.europa.eu/futurium/en/system/files/ged/pact-of-amsterdam_en.pdf; accessed 2.5. 2021
112 The new Leipzig Charta – The transformative power of cities for the common good. BMI. 2020
113 Just City and Productive City represent the two other dimensions of the Leipzig Agenda

5.1.4. Further (intrinsic) motives

Other motives are also in play, which underline the need for a well-founded climate and energy agenda. The first focus is ensuring secure energy supplies, which can be enhanced and expanded by developing an energy system. This corresponds nicely to the goal of guaranteeing affordable energy for all consumers in the EU. The EU also aims to reduce energy imports to retain its independence. Most EU imports oil followed by gas, where it is particularly dependent on Russia[114]. In addition, the EU aims to become a global leader in the field of renewable energy and intends to take up this position within the framework of an ambitious climate and energy. This development also opens new opportunities for economic growth and employment strategy.

5.2. EUROPEAN REGULATIONS IN THE FIELD OF ENERGY

5.2.1. Brief historical background of EU

The European Union was originally created to prevent any more wars between the nations of Europe. However, in 1950 the European Coal and Steel Community (ECSC) was founded, marking the first step towards the economic and political unification of the nations of Europe with a view to ensuring lasting peace, incorporating the topic of energy. Over the subsequent decades Europe-wide regulations also apply in the energy sector and in the fields of environmental protection and climate action.

With the Treaty of Maastricht in 1992 (Treaty on European Union), the cooperation was expanded into new policy fields and consultation on consumer protection, environmental matters, health systems and development cooperation were introduced.

The Treaty of Lisbon (2009), which amends the Treaty on the Functioning of the European Union (TFEU), lays down the responsibilities of the EU vis à vis member states, and breaks this down into three levels: exclusive competence, shared competence and supporting competence. In the case of energy policy, shared competence is stipulated under TFEU Article 2 (2): 'the Union and the Member States may legislate and adopt legally binding acts in that area'.[115] Member states may, however, only exercise their competence to the extent that the Union has not exercised its competence or to the extent that the Union has decided to cease exercising its competence.

To enforce the competences, under Article 288 TFEU the EU may adopt regulations, directives and decisions (of a binding nature), as well as recommendations and opinions (which have no binding force).[116] Table 10 sums up the substantive distinctions between the different legislative acts.

Regulation	• General application • Binding in its entirety • Directly applicable in all member states
Directive	• Binding, as to the result to be achieved, upon each member state to which it is addressed • Leaves to the national authorities the choice of form and methods • Countries must adopt measures to incorporate them into national law
Decision	• Binding in its entirety • A decision which specifies those to whom it is addressed is binding only on them

Table 11: Regulations, Directives and Decisions in EU – Binding aspects

To enable the EU to become active in the relevant areas, the ordinary legislative procedure that leads to the elaboration and adoption of regulations, directives and decisions is important. The European Parliament is directly involved in most legislative acts and can prevent or modify these planned regulations, directives, and decisions with a majority vote. The proposal of the Commission for a legislative act is first debated in the European Parliament under ordinary legislative procedure. After the European Parliament issues an opinion which either approves the proposal or proposes changes, the Council of the European Union (also known as the Council of Ministers) must approve the proposal in that form. If it does so, the legislative act has been adopted and becomes new secondary community law.

It is important to note that no legislation can be adopted in the European Union without consulting the European Parliament, and that a large percentage of legislative acts cannot be adopted without the approval of the Parliament.[117] In the case of a directive, such as the Energy Efficiency Directive, for instance, a goal and a timeframe for implementation are thus determined, within which member states are required to transpose the directive into national law. It is up to member states what method they choose to do so.[118]

5.2.2. EU – Climate and Energy Framework and EU Targets

5.2.2.1. Climate and Energy Framework 2030

With a view on the increasing challenges to stabilise the world´s

114 Eurostat. https://ec.europa.eu/eurostat/statistics-ex-plained/index.php?title=Energy_production_and_imports#The_EU_and_its_Member_States_are_all_net_importers_of_energy; accessed 4.5.2021

115 TFEU Article 2 (2); https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12012E/TXT; accessed 2.5. 2021

116 European Commission. European Citizens' Initiative, FAQ, Getting an answer, question 5; https://europa.eu/citizens-initiative/faq_en; accessed 2.5. 2021

117 European Commission.'Areas of EU action', policy fields, information and services, https://ec.europa.eu/info/about-european-commission/what-european-commission-does/law/areas-eu-action_en; accessed 2.5.2021.

118 'Primäres und sekundäres Gemeinschaftsrecht.' Gesetzgebung, 2019, http://www.eu-info.de/europa/eu-richtlinien-verordnungen/. accessed 2.5. 2021.

climate and rising energy dependence on non-EU member states, the EU has set itself the goal of introducing reforms to achieve a modern, competitive, climate-neutral economy by 2050. European energy supplies are to be modified such that a transition to a climate-neutral economy is possible. To continue to ensure secure energy supplies and the smooth functioning of the EU energy market, the EU's energy policy is to support the development and interconnection of energy networks, energy efficiency, renewable energy, and a reliable energy supply. It deals with different energy sources from fossil fuels to renewables (solar, wind, biomass, geothermal, hydro/tidal power).[119]

The 2030 climate and energy framework has been adopted by the European Council in October 2014. The targets for renewables and energy efficiency were revised upwards in 2018. It will enable the EU to move towards a climate-neutral economy and implement its commitments under the Paris Agreement. The framework helps drive progress towards a low-carbon economy and build an energy system that

- Ensures affordable energy for all consumers,
- Increases the security of the EU's energy supplies,
- Reduces our dependence on energy imports,
- Creates new opportunities for growth and jobs and
- Brings environmental and health benefits – e.g. through reduced air pollution.[120]

5.2.2.2. Clean Energy for All Europeans Package

The EU has updated and extensively amended its energy and climate policy framework for the period 2021-2030 in a reform package entitled 'Clean energy for all Europeans'[121]. It forms the basis for the implementation of the Energy Union and the European climate and energy targets up to 2030.

The main targets are as follows:

- **Reduce GHG emissions by a minimum of 40% (of the 1990 levels)**
  The target his is to be achieved jointly by the sectors covered by the ETS and by those not covered by the scheme. The sectors covered by the ETS must reduce GHG emissions by 43% by 2030, while the other sectors not covered are to reduce emissions by 30%.
- **Increase in the percentage of energy generated from renewables to at least 32%**
  The original target was raised from 27% to 32% and relates to the percentage of power generated from renewables in the EU (final energy consumption). (see chapter 5.2.2.4, Renewable Energy Directive). It contains an upward revision clause by 2023.
- **Enhance energy efficiency by at least 32.5%**
  On the basis of the amended Directive on Energy Efficiency (see chapter 5.2.2.4) the European Council raised the figure from 27% to 32.5% to be achieved by 2030, relative to a business-as-usual scenario. It too includes an upward revision clause in 2023.

5.2.2.3. Governance Framework - National Energy Climate Plans

Moreover, the package includes a new governance framework (2018/1999 Governance Regulation) for the Energy Union[122]. In a departure from the previous nationally binding targets for member states, it is now up to member states to specify their contributions to EU targets in so-called National Energy and Climate Plans (NECP). The new framework is based on 'long-term strategies, integrated national energy and climate plans covering ten-year periods starting from 2021 to 2030, corresponding integrated national energy and climate progress reports by the Member States and integrated monitoring arrangements by the Commission.'[23] In the monitoring process necessary recommendations to member states for additional measures in order to ensure that the measures of the NECPs make a sufficient contribution to achieving the targets of the Energy Union.

National long-term strategies are to be drawn up by each member state every ten years; the strategies are to cover a period of at least 30 years. In particular, the plans are to lay out how member states intend to achieve the necessary reductions in GHG emissions. They should also provide information on the percentage of power to be generated from renewables by 2030 and the energy savings to be achieved over the same period, considering the existing legal regulations and concepts of the Union[124].
The new governance structure aims increase action in all five dimensions (securing energy supplies, internal energy market, energy efficiency, decarbonisation and research, innovation, and competitiveness).

119 Eur-Lex. „Energy.", https://eur-lex.europa.eu/summary/chapter/energy.html?root_default=SUM_1_CODED%3D18; accessed 2.5. 2021
120 https://www.buildup.eu/en/explore/links/2030-climate-energy-framework; accessed 2.5. 2021
121 https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en; accessed 2.5. 2021
122 https://ec.europa.eu/energy/topics/energy-strategy/energy-union_en; accessed 2.5. 2021
123 Regulation 2018/1999/EU
124 Based on the new principles, the governance process involves consultations with citizens and stakeholders

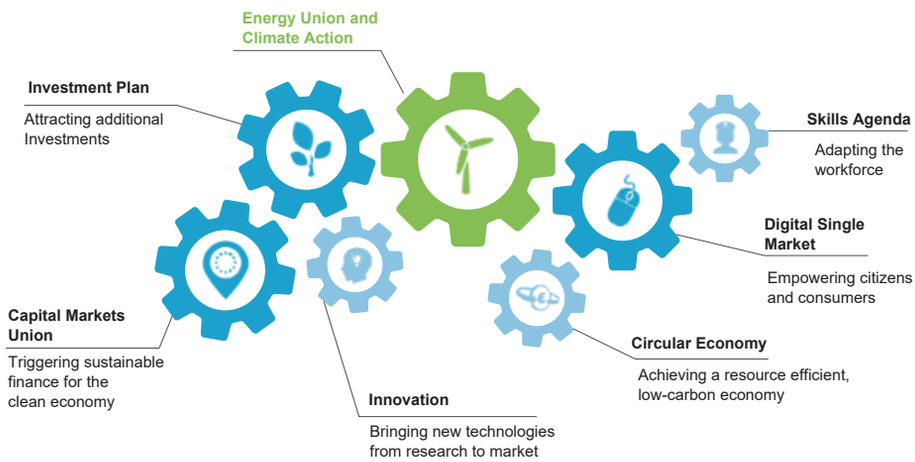


Fig 18: Modernising of the economy - Role of the Energy Union and Climate Action[125]

5.2.2.4. EU- Directives and Regulations

The 2030 climate and energy framework lists measures and instruments that are designed to help achieve the new targets. The initiative Clean Energy for all Europeans put in place a concrete legal basis in the form of regulations and directives binding on member states.[126]
The package itself consists of four Directives and four Regulations[127]. In the following, the directives that especially have an impact on energy and city development will be described in more detail:

Energy Performance of Buildings Directive 2018/844 (EPBD)
Buildings are responsible for approximately 40% of energy consumption and 36% of CO_2 emissions in the EU, making them the single largest energy consumer in Europe. The EPBD is the most important legislation, when it comes to harnessing the efficiency potential use in both, the residential and non-residential sector and hence, for a sustainable city development.
By improving energy performance in buildings, the EU can more readily achieve its energy and climate goals. The Energy Performance of Buildings Directive (2018/844/EU) outlines specific measures for the building sector to tackle challenges, updating and amending many provisions from the previous Directive 2010/31/EU. Selected requirements for member states related to a sustainable city development:

- development of long-term strategies to decarbonise the building sector by 2050
- financing measures to support the energy efficiency of buildings
- all new buildings must meet a Nearly-Zero-Energy-Building (NZEB) standard from 2019 on for public buildings and 2021 for all buildings
- new buildings must be ready for the use of electric vehicle charging points (more than ten car parking spaces).

Energy Efficiency Directive 2018/2002 (EED)
Putting energy efficiency first is a key objective in the package, as energy savings are the easiest way of saving money for consumers and for reducing greenhouse gas emissions. The EU has therefore set binding targets of at least 32.5% energy efficiency by 2030, relative to a 'business as usual' scenario and compared to 1990 basis. Selected requirements for member states related to a sustainable city development:

- real savings of 0.8% a year were agreed for the first time.
- annual average energy savings of 1.5 per cent over the period from 2014 to 2020 through an energy savings obligation scheme (or alternative measures); mandatory real annual energy savings of 0.8 per cent per year based on final energy consumption ???
- three per cent of central government buildings to be renovated every year
- member states required to produce regular progress reports in the form of national energy-efficiency action plans (NECPs from 2020)

Renewable Energy Directive (RED) 2018/2001 EU
With a view to showing global leadership on renewables, the EU has set an ambitious, binding target of 32% for renewable energy sources in the EU's energy mix by 2030. In addition to common funding rules for electricity from renewables, the directive also addresses the heating and transport sectors, which account for two-thirds of energy consumption.

125 Source: Clean energy for all Europeans; European Commission; 2016
126 Ibid, p3
127 Overview on all four directives and regulations, see: https://www.bmwi.de/Redaktion/EN/Artikel/Energy/european-energy-policy.html ; accessed 20.4.2021)

Information box 4: EU Climate Energy Package - Short history

Agenda 20-20-20 - 2007
In 2007 the EU laid down comprehensive climate and energy targets, called the Agenda 20-20-20, that were to be achieved by 2020, focusing on three main objectives:

- Reducing greenhouse gas emissions by 20% (of the 1990 levels)
- Increasing the percentage of energy generated from renewables to 20%
- Improving energy efficiency by 20%.

To achieve these goals, the European emissions trading system[128] (ETS) plays a major part, since this system covers more than 45% of greenhouse gas emissions (e.g., power stations, industrial plants, air traffic). In 2020, the relevant branches are to produce 21% less emissions than in 2005.
The branches of the economy not covered by the ETS, such as housing construction, agriculture and waste management (which together account for 55% of total EU emissions) are covered by binding national emission reduction targets within the scope of the burden-sharing agreement.
The focus on reducing GHG emissions, promoting renewable energy and enhancing energy efficiency has become accepted and was revisited in follow-on policies and brought into line with changing conditions.
Roadmap for moving to a competitive low-carbon economy in 2050[129] - 2011
The roadmap reconfirmed the goals to reduce greenhouse gas emissions by 80 - 95% set in 2009.[130]. However, the roadmap states, that under the 2011 circumstances and policies the EU would only be able to reduce greenhouse gas emissions by 60%. The roadmap acted as basis for developing sector specific policy initiatives.
Climate and Energy Agenda 2030 – 2014
The agenda build upon the Agenda 20-20-20 and took the medium-term strategy forward until 2030, setting new goals for CO_2-Emission reduction by 40%, increase the share of renewables by 27% and improving Energy Efficiency by 27%.

5.2.2.5. EU Targets in a nutshell
The graphic below displays former and current EU targets in a nutshell. In 2023 all member states are required to update their national climate and energy plans to reflect the new targets set for 2030.

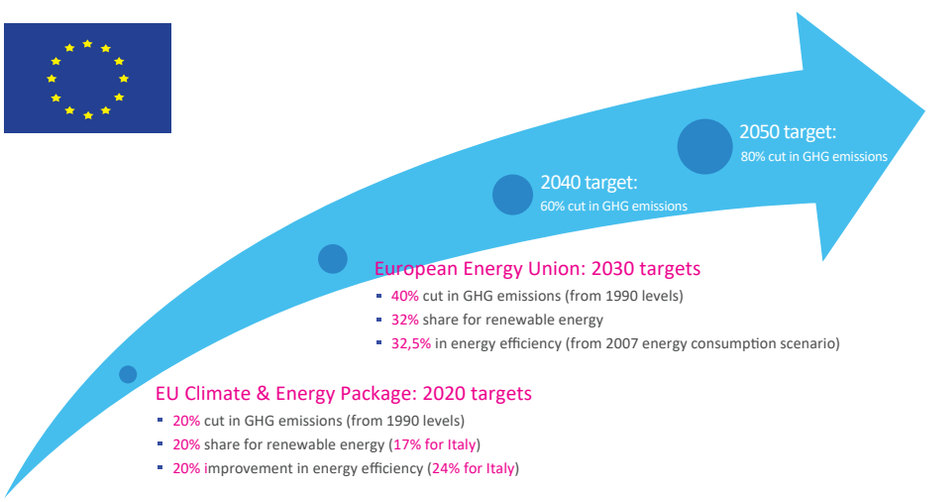


Fig 19: European Targets for climate and energy[131]

5.2.2.6. European Green Deal
Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, the European Union has adopted a new growth strategy that will transform the Union into a modern, resource-efficient and competitive economy, achieving no net emissions of greenhouse gases by 2050, a decoupled economic growth from use of resources.

128 More information about the ETS is available at: https://ec.europa.eu/clima/policies/ets_en; accessed 2.5. 2021
129 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0112:FIN:EN:PDF; accessed 2.5. 2021
130 European Commission. A Clean Planet for all A European strategic long-term vision for a prosperous, mod-ern, competitive and climate neutral economy. European Commission. 2018
131 Source: https://windenergysolutions.nl/blog/worldwide-wind-market-european-union/attachment/european-targets-for-climate-and-energy/; accessed 30.4. 2021

The European Green Deal[132] aims to make the EU's economy sustainable. It provides an action plan[133] to boost the efficient use of resources by moving to a clean, circular economy and restore biodiversity and cut pollution. Reaching climate neutrality in 2050 will require action by all sectors the economy, including

- investing in environmentally friendly technologies
- supporting industry to innovate
- rolling out cleaner, cheaper, and healthier forms of private and public transport
- decarbonising the energy sector
- ensuring buildings are more energy efficient and
- working with international partners to improve global environmental standards.

Some of the main plans of the European Green Deal are:

- to introduce a European Climate Act that will enshrine the EU's goal of achieving net-zero greenhouse gas emissions by 2050;
- to launch a 'Renovation Wave' in the building sector;
- to adapt relevant requirements and directives to the revised and more ambitious 2030 climate goal, e.g., the Renewable Energy Directive (RED) and the Energy Efficiency Directive (EED) and
- a Circular Economy Action Plan.

A new Sustainable Finance Strategy will replace the EU Action Plan on Financing Sustainable Growth. The EU will also provide financial support and technical assistance to help those that are most affected by the move towards the green economy. This is called the Just Transition Mechanism.[134]. It will help mobilise at least €100 billion over the period 2021-2027 in the most affected regions. Figure 18 provides an overview of the European Green Deal targets and actions.

Fig 20: The European Green Deal[135]

5.2.2.7. European Climate Law

The European Climate Law intends to transform political promises into a binding legal obligation. As one of the key elements of the European Green Deal, the European Climate Law enshrines the EU's commitment to reaching climate neutrality by 2050 and the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. It will write climate neutrality target for 2050 into law and propose the path to get there. In addition to the 2050 climate neutrality target, it will strengthen the European framework for climate action by introducing, e.g.:

- a process for setting a 2040 climate target, considering an indicative greenhouse gas budget for 2030-2050 to be published by the Commission,
- a commitment to negative emissions after 2050,
- the establishment of European Scientific Advisory Board on Climate Change, that will provide independent scientific advice,
- stronger provisions on adaptation to climate change,
- strong coherence across Union policies with the climate neutrality objective and
- a commitment to engage with sectors to prepare

132 https://ec.europa.eu/clima/policies/eu-climate-action_en; accessed 2.5. 2021
133 Compilation of all actions under the green deal: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1596443911913&uri=CELEX:52019DC0640#document2; approached: 20.4.2021
134 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/just-transition-mechanism_en, accessed 2.5. 2021
135 Source: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en; accessed 2.5. 2021

sector-specific roadmaps charting the path to climate neutrality in different areas of the economy.

The European Commission welcomed a provisional agreement between the co-legislators on 21.4. 2021. Once the provisional agreement is formally approved by Parliament and Council, the European Climate Law will be published in the Official Journal of the Union and will enter into force.
The individual measures will be translated into concrete legislative proposals together with the European Parliament and member state governments (Council of the European Union) and will then shape the future development of EU economic, energy and climate policy.[136]

In particular, climate laws[137] if designed with binding targets and transparent procedures allow for better control of the climate and energy policy, creating planning and investment security for companies. Furthermore, those laws assign the public sector a role model function towards a climate-neutral administration, public buildings and procurement.

Targets, Programs and Strategies as outlined in this chapter, steer the way towards low-carbon development. Regulations and Directives set a basic framework to fight and mitigate climate change in the EU, its nation states and on the local level. However, that might not be enough.

Framework climate laws can serve as a bridge between shorter term actions pledged and the long-term objective which all parties to the Paris Agreement are committed to delivering. The Paris Agreement has given a strong boost to the rationale for adopting long-term climate policy frameworks. "A law speaks louder than a thousand promises", as a dedicated law signals political commitment and can enhance reliability, thereby also facilitating planning and improving investment security[138]

The new climate target, a 55% percent reduction of green-house gas emissions until 2030 is without doubt a challenge for the EU and its member states. Within nine years, Germany[139] must reduce his greenhouse-gas emissions by additional 35% compared to today. Hence, all existing laws, regulations, financial supporting mechanisms, formal and informal planning tools must be put to the test and amended wherever necessary. The next chapter describes the German status quo in 2021.

136 https://www.consilium.europa.eu/de/policies/green-deal/; accessed 28.4. 2021
137 The same counts for national and state laws.
138 Climate Laws in Europe; Ecologic Institute, 2020, p12
139 Due to burden sharing in EU between member states, Germany´s target for 2030 is higher than 55% (= 65% compared to 1990 level).

6. GERMAN REGULATORY FRAMEWORK

This chapter outlines how energy related regulations are incorporated into German law and give more detailed information on the content of the German targets, programs and regulations. It presents the development of the policy framework and the main decisions on climate mitigation and energy efficiency on the national level in a chronological order.
As elaborated in chapter 3.1, Regulations and Directives must be implemented into national law. Furthermore, to meet the EU's energy and climate targets for 2030, EU countries need to establish a 10-year integrated national energy and climate plan (NECP) for the period from 2021 to 2030 (Regulation on the governance of the energy union and climate action (EU/2018/1999) [140].
Therefore, this chapter – as the chapter about the EU framework - provides additional background information to the practical implementation in chapter 4.

6.1. GERMAN POLICY FRAMEWORK – CLIMATE PROGRAMS AND TARGETS

6.1.1. Historical Background

The debate within German society about a more environmentally sound energy supply in the country was launched in the 1970s and 80s by the anti-nuclear power movement. Over the years it has been fuelled by external factors such as the 1973 and 1979/80 oil shock and the Chernobyl disaster in 1986.
In 2000, the German Government decided to terminate the use of nuclear power in the long term, which demanded a radical rethinking of the provision and use of renewable energy. Although the German Government had just announced in December 2010 'an end to the end' of the use of nuclear power and decided to authorise nuclear power plants to operate for an extended period, pushing the decommissioning deadline back from 2022 to 2034.

6.1.2. German Energy Transition (Energiewende)

The Fukushima disaster triggered a public debate about the role, risks and hazards involved in operating nuclear power plants and led to an extensive review of all German nuclear power plants. Moreover, German politicians decided on several legislative packages on the subject of energy and Germany's phase-out of nuclear energy. These far-reaching changes to the energy landscape are referred to as the German Energy Transition, literally "German Energy Turnaround" (Energiewende)[141]. With the insight that fossil fuels such as coal, gas and oil are not a viable long-term solution either, the German Government adopted a strategy to retire all existing coal-coal fired power plants by 2038. Most importantly, the costs must be limited and distributed fairly, as the energy transition can only be successful if all parts of society contribute, politics, citizens, companies and municipalities.

6.1.3. Energy Concept 2010 (2010)

Already in 2007 Germany set itself the target of reducing its greenhouse-gas emissions by 40%
When the German government adopted its Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply in late 2010, it ushered in the era of renewable energy.
he strategic concept lays out how energy consumption can be halved by 2050, while renewables are to account for the lion's share of the energy mix of the future. The master plan also aimed to secure jobs in the long term, guarantee affordable energy, maintain Germany's social welfare, and advance prosperity.[142]
To sum up, the energy concept builds on an integrated overall strategy based on two pillars: developing the use of renewables and enhancing energy efficiency. This is to be achieved, for instance, by expanding electricity grids, building new storage facilities, and realising specific efficiency measures in the building sector.
In the long term, the energy concept aims to achieve the German Government's climate targets as the following table demonstrates:

- 40% reduction in greenhouse gas emissions by 2020, 55% by 2030, 70% by 2040 and 80-95% by 2050
- Steady increase in the percentage of gross final energy consumption accounted for by renewables: 18% by 2020, 30% by 2030, 45% by 2040, 60% by 2050
- Steady increase in the percentage of electricity generated from renewables: 35% by 2020, 50% by 2030, 65% by 2040, 80% by 2050.

Climate and energy policy targets of the German Government's 2010 energy concept

	Status quo	Targets			
	2010	2020	2030	2040	2050
Changes (%): GHG emissions compared to 1990 Primary energy consumption compared to 2008 Electricity consumption compared to 2008	 - 23 - 1 - 2	 - 40 - 20 - 10	- 55	- 70	- 80 to -95 - 50 - 25
Final energy consumption in the traffic and transport sector compared to 2005	- 1	- 10			- 40
Percentages: Gross final energy consumption accounted for by renewables Gross electricity consumption accounted for by renewables	 11 17	 18 35	 30 50	 45 65	 60 80

Table 12: Climate- and energy-policy targets laid out in the energy concept[143]

140 https://ec.europa.eu/energy/topics/energy-strategy/national-energy-climate-plans_en; accessed 28.4.2021
141 https://www.cleanenergywire.org/germanys-energiewende-brief; accessed 2.5.2021
142 BMWi. Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung. 2010
143 Source: AGEB, AGEE, BMU, UBA

6.1.4. Climate Action Program 2020 (2014)

2014, German cabinet adopted the Climate Action Programme 2020. With its action programme the German government will ensure that it achieves the goal it set in 2007 of cutting greenhouse gas emissions by 40 percent by 2020 compared with 1990[144]. A series of key policies were incorporated into the program, as the National Energy Efficiency Action Plan.

National Energy Efficiency Action Plan (NEEAP) - 2014/2019
The German National Action Plan on Energy Efficiency (Nationaler Aktionsplan Energieeffizienz- NAPE) was commissioned under the EU Energy Efficiency Directive 2012/27/EU. It´s focus is to increase the energy efficiency especially in the building sector and views energy efficiency as a business model.[145] It lays out in detail the energy efficiency strategy of the German Government for the 18th legislative period (Oct. 2013-2017).

The plan endeavours to involve all relevant actors, from private households to public institutions, to raise awareness of the imperatives of energy efficiency and explain this complex issue, and to foster investment in energy-efficient projects with the help of many assistance programmes and incentives mechanisms. In this, it uses a mix of instruments with educational campaigns, concrete assistance measures and updated standards for new buildings.

NEEAP 2.0 focuses on the demand side of the energy system and expands the existing efficiency policy. The tax incentives for energy-efficient building renovation introduced at the beginning of 2020 create tangible incentives for greater energy efficiency in residential buildings. In addition, the existing building promotion programmes have been bundled, further developed and simplified with the BEG since January 2021.

6.1.5. Energy Efficiency Strategy for Buildings - 2015

The Federal Government's climate protection goals can only be achieved if environment-friendly and climate-friendly building, energy-efficient neighbourhood and urban development, housing and building issues go hand in hand. This is the purpose of the "Energy Efficiency Strategy for Buildings". The strategy sets out a possible corridor for achieving the goal of a 'nearly climate-neutral' building stock and is based on the goal of achieving a virtually climate-neutral building stock by 2050 in line with the Federal Government's energy concept. A sensible combination of energy efficiency and renewables can generally help to develop solutions which may even include a "virtually" climate-neutral building stock[146].

However, the background paper on which the Energy Efficiency Strategy for Buildings is based sets out a number of opportunities and risks. These include unexpectedly high volumes of renewable power generating capacity (high proportion of power-to-heat systems, e.g. heat pumps), renewable gas energy (unexpectedly rapid progress in the development of power-to-gas technology), biomass (high imports of biofuels), other currently unforeseeable technology options and low-cost insulation strategies (requiring solutions to technical obstacles).[147]

6.1.6. Climate Action Plan 2050 (Klimaschutzplan 2050) - 2016

In the light of the European targets and the outcomes of the 2015 Climate Change Conference in Paris, Germany defined an emissions reduction pathway with a final target of 80 to 95 percent lower greenhouse gas emissions compared to 1990 by 2050. Concrete measures to reach the targets were outlined in the Climate Action Plan.

144 https://www.bmu.de/en/topics/climate-energy/climate/national-climate-policy/climate-action-programme/
145 https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Aktionsprogramm_Klimaschutz/aktionsprogramm_klimaschutz_2020_hintergrund_en_bf.pdf; accessed 2.5.2021
146 https://www.bmwi.de/Redaktion/EN/Publikationen/energy-efficiency-strategy-buildings.pdf?__blob=publicationFile&v=6; accessed 4.5. 2021, p5
147 Hintergrundpapier zur Energieeffizienzstrategie Gebäude; Prognos, IWU, Ifeu; 2015, p64

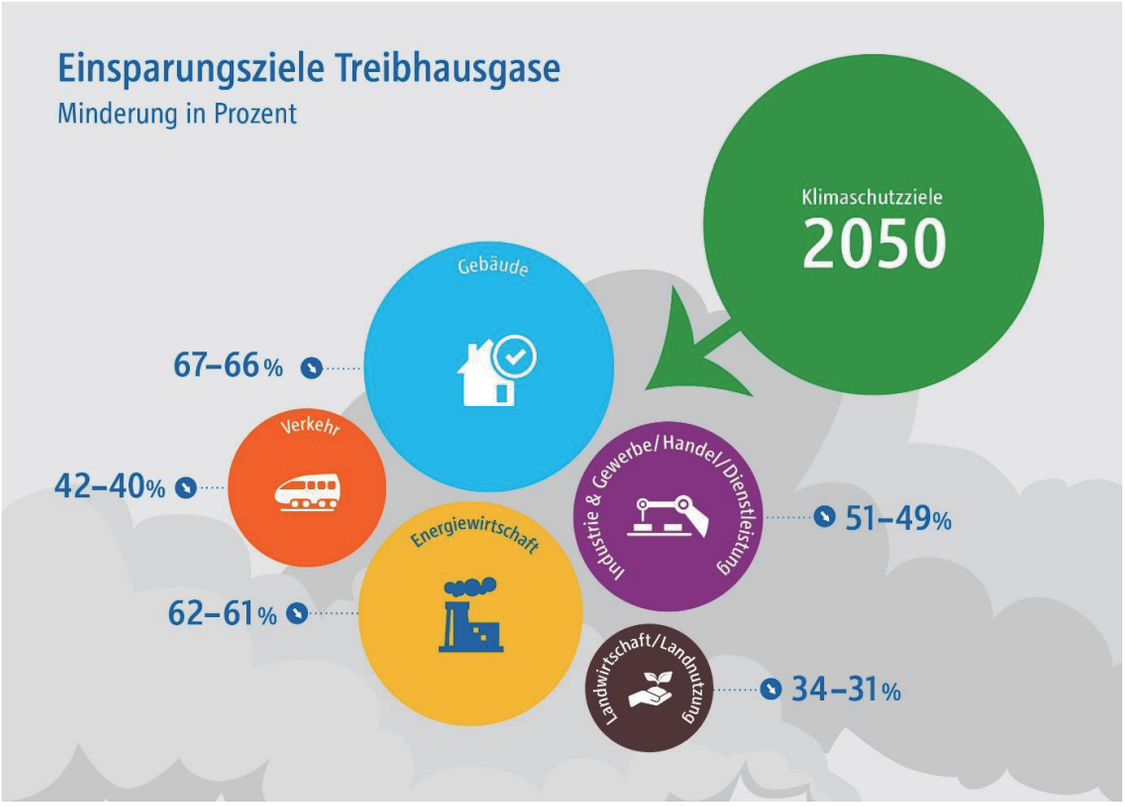


Fig 21: Targets of the Climate Action Plan 2050[148]

Key elements of the plan are[149]:

- A long-term target based on the guiding principle of extensive greenhouse gas neutrality in Germany by the middle of the century
    - The goal of a nearly climate-neutral building stock
    - Guiding principles und transformative pathways as a basis for all areas of action by 2050
    - Milestones and targets as a framework for all sectors up to 2030
    - Strategic measures for every area of action and the
    - Establishment of a learning process which enables the progressive raising of ambition envisaged in the Paris Agreement.

Climate Action Program 2030 (2019) – As Part of Climate Action Plan

In 2019, the Federal Government concluded that it was on track to achieving a reduction of only around 32 per cent in greenhouse gas emissions by 2020 compared with the 1990 baseline and would therefore not reach its 40 per cent target. (Bundesregierung, 2019).[150]

Towards the end of 2019, as part of the Climate Action Plan 2050, the Federal Government presented its Climate Action Programme 2030, which covers every sector of the economy. The measures set out in the action programme are being gradually implemented.

6.1.7. Federal Climate Change Act (2019)

A first step of the Climate Action Program 2030 was the adoption of the Federal Climate Change Act (Bundes-Klimaschutzgesetz - KSG) in December 2019. The Act enshrines into law the Climate Action Plan's energy-saving targets for each sector (e.g. buildings, the energy sector, industry and transport).

These targets are to be reviewed regularly. Each year, the targets of the previous year are to be reviewed. If the targets are exceeded, the respective ministries must present an immediate programme within 3 months to ensure that the targets are met.

The first data was collected in March 2021 by the Federal Environmental Agency. A council of climate experts will present an assessment of the data by April 2020. As first estimations suggest, the targets for 2020 might not be reached in the building sector. After that, the Federal Ministry of Transport, Building and Urban Affairs must present an emergency programme within 3 months with proposals on how the climate targets can be met in the next few years[151]. As mentioned in the introduction to the study, the climate change act needs to be improved (see chapter 1)[152].

148 Source: https://blog.enviam.de/klimaschutzplan/; accessed 2.5. 2021
149 Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Climate Action Plan 2050.
150 Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Klimaschutzber-icht 2018. However, the 2020 target may be achieved after all as a result of the coronavirus pandemic; https://www.dw.com/en/the-coronavirus-effect-germany-achieves-its-2020-climate-targets/a-56126506; ac-cessed 2.5. 2021
151 https://energie-m.de/info/ksg-sektorziele.html; accessed 2.5. 2021
152 https://www.dw.com/en/german-climate-law-is-partly-unconstitutional-top-court-rules/a-57369917; accessed 21.5.2021

6.1.8. National Energy and Climate Plan - NEPC (2019)

Areas covered by the NECPs are, amongst others, energy efficiency, renewable energies and greenhouse gas emission reductions. Member states must impose cost-effective minimum energy-efficiency standards for new buildings, for the complete renovation of existing buildings and for the exchange or retrofitting of building components (e.g. heating and air conditioning systems, roofs and walls).
The draft NECP built on already adopted national strategies, targets and measures. These include above all:

- the Energy Concept,
- the Climate Action Plan (KSP) 2050,
- the Energy Efficiency Strategy for Buildings (ESG), and
- the 7th Energy Research Programme.

These already adopted strategies and programmes with their goals and measures, the results from the consultation of national stakeholders and EU neighbouring states, as well as the results of new discussion and decision-making processes of the Federal Government, especially in the context of the implementation of the Climate Action Programme 2030, (these include, among others, the Energy Efficiency Strategy with the National Action Plan on Energy Efficiency NAPE 2.0 as well as the Coal Phase-out Act) have been incorporated to produce the final NECP[153].

6.1.9. Energy Efficiency Strategy 2050 – EffSTRA

Although, the key to greater energy efficiency can be seen in the building sector, improving energy efficiency is a universal issue. The potential in industry, companies, private households and in the public sector offers an additional field to reduce energy consumption, save costs and reduce the environmental impact. Some specific measures include:

- The transparent identification of the energy consumption of vehicles and products
- Considering energy efficiency as a criterion in public procurement
- Providing objective information and well-founded explanations and advice for consumers within the framework of the 'Energy Efficiency Initiative'
- Realising potentials for saving in industry through improved promotion programmes and tax incentives.

In late 2019, the German Federal Cabinet adopted the Energy Efficiency Strategy 2050 (EffSTRA). The strategy paves the way for additional energy-efficiency gains in Germany and sets out the Federal Government's first energy-efficiency target for 2030 – a 30 per cent reduction in primary energy consumption compared with 2008. It brings together a raft of proven efficiency measures[154] for the decade from 2021 to 2030 in the new National Action Plan on Energy Efficiency (NAPE 2.0).

The strategy also established a wide-ranging process of consultations with key stakeholders, the Roadmap to Energy Efficiency 2050. The purpose of this initiative is to analyse ways of halving the country's primary energy consumption by 2050 and to develop the actions and mechanisms needed to achieve this goal. The primary energy consumption is to be reduced by 30 percent (compared to 2008) by 2030. The process of the roadmap will end with the adoption of a programmatic strategy paper on energy efficiency until 2050 in 2022[155].

6.1.10. German Energy Targets - Overview

The second Energy Transition Report published in 2019 summarises the overall and sectoral climate targets of the Federal Republic of Germany on 2017 basis.

153 https://www.bmwi.de/Redaktion/DE/Textsammlungen/Energie/necp.html; accessed 2.5. 2021
154 Energieeffizienzstrategie 2050; BMWi; 2019, p37f
155 https://www.bmwi.de/Redaktion/DE/Dossier/Energieeffizienz/roadmap-energieeffizienz-2050.html; accessed 2.5. 2021

	2017	2020	2030	2040	2050
Greenhouse gas emissions					
Greenhouse gas emissions (compared with 1990)	-27.5%	at least -40%	at least -55%	at least -70%	largely greenhouse-gas-neutral -80% to -95%
Renewable energy					
Share of gross final energy consumption	15.9%	18%	30%	45%	60%
Share of gross electricity consumption	36%	at least 35%	at least 50%* Renewable Energy Sources Act 2017: 40-45% by 2025	at least 65% Renewable Energy Sources Act 2017: 55-60% by 2035	at least 80%
Share of heat consumption	13.4%	14%			
Efficiency and consumption					
Primary energy consumption (compared with 2008)	-5.5%	-20% →			-50%
Final energy productivity (2008-2050)	1.0% pro Jahr (2008-2017)	2.1% pro Jahr (2008 - 2050)			
Gross electricity consumption (compared with 2008)	-3.3%	-10% →			-25%
Primary energy consumption in buildings (compared with 2008)	-18.8%	→			-80%
Heat consumption in buildings (compared with 2008)	-6.9%	-20%			
Final energy consumption in the transport sector (compared with 2005)	6.5%	-10% →			-40%

Table 13: Quantitative targets of the energy transition and 2017 status quo[156]

6.1.11. Regulations related to EU Directives influencing city development

6.1.1.1. The new Buildings Energy Act (GEG) – 2020

The new Buildings Energy Act (Act on the Saving of Energy and the Use of Renewable Energies for Heating and Cooling in Buildings – Gebäudeenergiegesetz (GEG)) was adopted in November 2020.
It translates the EU Building Directive into German Law and the standard that the directive lays out for nearly zero-energy buildings[157] (NZEB) for new constructions. The GEG is part of the German government's climate protection plan to reduce greenhouse gas emissions in the building sector by 66 percent by 2030. It sets out requirements for the energy performance of buildings, the issuing and application of energy performance certificates, and the use of renewable energy in buildings.[158]

Moreover, it merges and replaces

- the former Energy Conservation Act (EnEG),
- the former Energy Conservation Ordinance (EnEV) and
- the former Renewable Energies Heat Act (EEWärmeG)

into a single law to form a simpler regulatory framework for lowest energy building standards and to eliminate overlaps of the existing regulations.

For example, this includes the requirements of the former EEWärmeG to 15 per cent energy from solar radiation or 30 per cent from gaseous biomass or 50 per cent of the total energy requirement for heating and/or air conditioning from liquid or solid biomass, geothermal and ambient heat. Renewable gas is not (yet) recognized as a source of energy for new buildings.

The GEG introduces a new alternative, which stipulates that the obligation to use renewables can be offset by meeting a minimum of 15% of the heating/cooling needs of the building using electricity produced on-site or nearby (e.g. by photovoltaic plants).

156 Source: The Energy of the Future – 2nd Progress report on the energy transition; BMWi; 2019, p16
157 The final energy demand of an NZEB must not exceed 45-60 kWh/m² and year (covered by renewables)
158 https://www.bmi.bund.de/EN/topics/building-housing/building/energy-efficient-construction-renovation/buildings-energy-act/buildings-energy-act-node.html; accessed 2.5. 2021

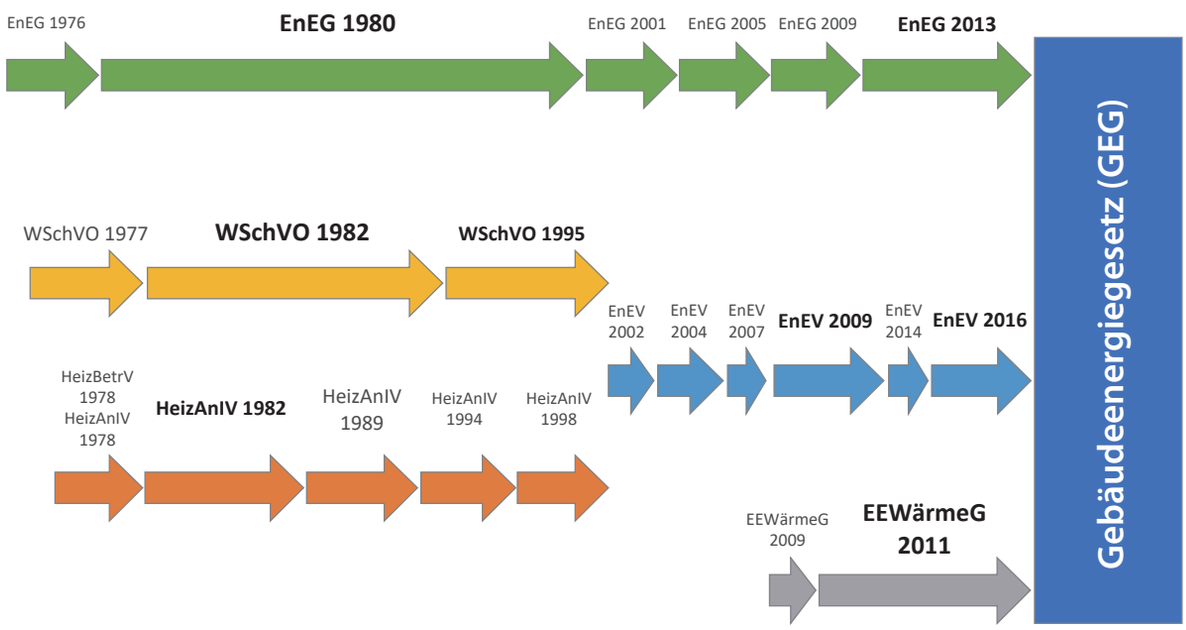


Fig 22: Development of regulations on building energy efficiency since the 70ies in Germany[159]

The amended EU Building Directive 2010/13 presupposes that building standards are tightened to bring them into line with nearly zero-energy building levels. The directive defines a nearly zero-energy building as a building that 'has a very high energy performance'.[160] The nearly zero or very low amount of energy required should 'be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby'.[161] Member states were obliged to ensure that as of 2019 all non-residential buildings belonging to public bodies and as of 2021 all new buildings comply with the nearly zero-energy building standard:

- In Germany and in line with the GEG, the final energy demand must not be more than 45-60 kWh/m² and year.
- Installations of new oil-fired and coal-fired boilers will be generally prohibited from 2026, and there will be stronger mechanisms in place to advise on energy matters. To further "fuel" the replacement of old boilers, there are corresponding replacement premiums.
- From 2020, anyone planning an energy-efficient renovation must have qualified energy advice. Here, too, up to 80 percent of the costs can be recovered through subsidies.
- The energy certificate will play a more important role in the future and its content will be expanded. New, for example, is information on the climate compatibility of the building (CO_2 emissions).

Information box 5: Importance of building stock in Germany

Germany's building stock consists of some 18 million residential and 1.7 million non-residential buildings (municipal, social and commercial in nature). Heating, hot water and lighting in publicly and privately owned buildings in Germany account for 40% of all energy consumed and nearly 30% of all CO_2 emissions nationwide; there is enormous potential for savings in this area.
The problem: 75% of all buildings were built before the 1978 ordinance on thermal insulation went into effect. In many cases they are unrenovated, which means their energy efficiency is extremely poor. This can lead to heating and energy costs amounting to almost as much as rent.
The current rate of restoration and modernisation must be roughly doubled.
The national government tries to gear up this process through legislation and complementary advisory and funding[162].

159 https://www.energie-experten.org/energie-sparen/energieberatung/gebaeudeenergiegesetz; accessed 2.5. 2021
160 Article 2 (2) Directive 2010/31/EU
161 Article 2 (2) Directive 2010/31/EU
162 https://www.bmi.bund.de/EN/topics/building-housing/building/energy-efficient-construction-renovation/making-cities-more-energy-efficient/making-cities-more-energy-efficient-node.html; accessed 28.4.2021

6.1.1.2. Federal funding for efficient buildings (BEG)

As mentioned in the above list, regulatory requirements in the former and the new legislation, are complemented with specific funding opportunities[163]. In accordance with the GEG the federal funding was renewed, too. The BEG bundles the existing investment funding programmes in the building sector into a single comprehensive and modernised funding offer and optimised in terms of content to increase the target group-friendliness and attractiveness of the funding.

Key points of the BEG include greater emphasis on renewable energies through e.g., special "Efficiency House EE" bonuses, extensive alignment of systemic support for residential and non-residential buildings (LOW), parallel loan and grant support across all sectors, greater emphasis on the use of renewable energies in the area of individual measures, introduction of a replacement premium for the replacement of oil heating systems, increased support for digitalisation measures to optimise operation and consumption, and increased support for the use of renewable energies in the area of energy efficiency[164]. Last not least the programme's budget will be increased.

However, still better energy standards are possible through efficient heating technology and/or structural measures that further reduce energy loss through the building envelope. The higher construction costs for this are subsidised by KfW Bank (Kreditanstalt für Wiederaufbau).

Germany's Cogeneration Act (Kraft-Wärme-Kopplungsgesetz, KWKG) promoted the construction and modernisation of CHP plants, the market introduction of fuel cells and the expansion of grids and storage facilities for energy generated in CHP plants since 2002. Hence it has influence on city district heating supporting sustainable city development. The declared goal of the law is to increase the share of energy generation (net electricity generation) from CHP in total electricity generation in Germany to 25% by 2020.

6.1.1.3. Renewable Energy Act (Erneuerbare Energien Gesetz – EEG) - 2000

Renewable energy has become an important pillar in Germany's energy supply as illustrated by the Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG). The Renewable Energy Act came first into effect in April 2000, when it replaced the 1991 Electricity Savings Act (Stromeinsparungsgesetz) and stipulated that the percentage of Germany's energy mix generated from renewables would be doubled over the next ten years.

The Renewable Energy Act (EEG) provides a framework for the development of renewable energy and ushers in the sustainable development of the energy supply, as well as fostering investment in renewable energy technology and thus increasing the percentage of electricity generated from renewables to at least 80% by 2050.[165] The original Act was based on three fundamental concepts:[166]

- Electricity generated from renewables takes precedence over conventionally generated electric power
  Pursuant to Article 11 (1) of the Act, grid operators were required to give precedence to electricity generated from renewables, which had to be accepted and transmitted immediately.
- Guaranteed minimum remuneration
  Since the costs of generating electricity from renewables could not at that time be covered by charging the market price alone, the Renewable Energy Act introduced an assistance mechanism that offered investors and operators additional incentives. The remuneration for feeding electricity into the national grid (green electricity feed-in payment) represented a minimum remuneration for the operators of plants generating electricity from hydro-power, landfill gas, firedamp or digestor gas, biomass, geothermal power, wind power and solar thermal energy, with fixed remuneration for a period of 20 years as of start-up of the plant (see Article 9 Renewable Energy Act).
- Renewable Energy Act levy
  The Renewable Energy Act levy represents the difference between the high price paid to buy in electricity generated from renewables and the low sales price within the system of remuneration for feeding power generated from renewables into the grid. This difference is shouldered by practically all electricity users by means of the Renewable Energy Act levy, pursuant to Article 60 ff. of the Renewable Energy Act. In this way both the benefits and the costs of promoting renewable energy are transferred to consumers, who demand the power in the first place.

163 https://www.mein-eigenheim.de/modernisierungsplanung/foerderung-energieberater.html; accessed 30.4.2021
164 https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzprogramm_2030_bf.pdf; accessed 30.4.2021
165 The Renewable Energy Act (Erneuerbare-Energien-Gesetz). 2019, https://www.erneuerbare-energien.de/EE/Redaktion/DE/Dossier/eeg.html?cms_docId=132292; accessed 2.5.2020.
166 Pritzsche, Kai Uwe, and Vivien Vacha. Energierecht: Einführung und Grundlagen. 1st ed., C.H. Beck, 2017. p. 58 - 61.

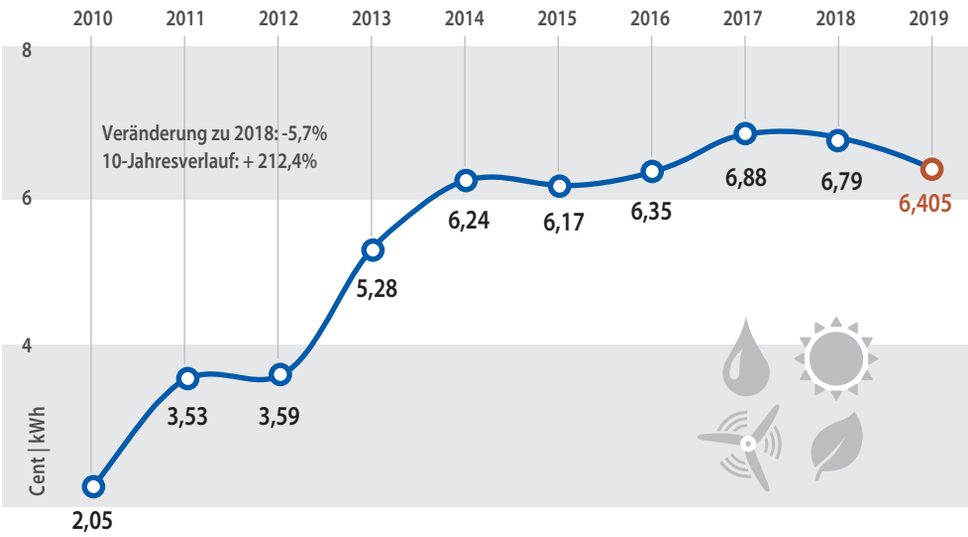


Fig 23: Development of the EEG levy 2010-2019[167]

According to the Federal Ministry for Economic Affairs and Energy (BMWi), the Renewable Energy Act levy was 6,5 cent/kWh in 2021, expected to drop to 6,0 cent/kWh in 2022, (see fig. 21), and bringing it to roughly the 2015.[168]

Figure 22 also clearly illustrates the fact that the introduction of the Renewable Energy Act measures has been successful. It shows the share of renewable electricity used for public power supply. In 2020 renewable energy accounted for the first time for more than 50% of net electricity generated in Germany – and the trend is still upwards.

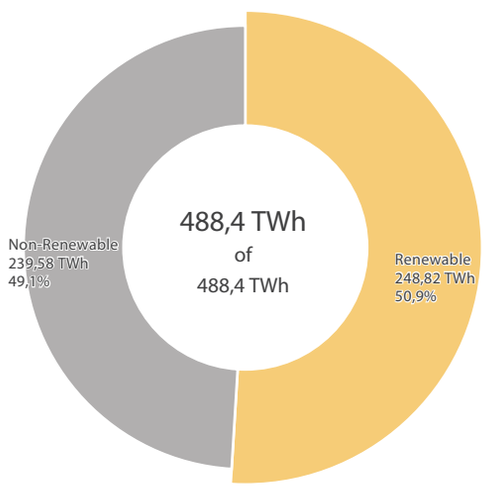


Fig 24: Renewable electricity share on public power supply 2002 - 2020[169]

A mandatory corridor for expanding the use of renewables was introduced when the EEG was revised in 2014. The amended Renewable Energy Act retained the fundamental remuneration structure of the original Act, but the green electricity feed-in payment was declared the exception; assisted direct marketing became the standard.

In 2017, the Act was again amended to specify that the price for electricity from renewable sources should be determined by tender rather than, as previously, by the government. It replaces

167 Source: https://strom-report.de
168 https://strom-report.de/eeg-umlage/; accessed 2.5.2021.
169 Source: https://energy-charts.info/charts/energy_pie/chart.htm?l=en&c=DE&year=2020&interval=year&source=public; created 2.5. 2021

the remuneration rates previously laid out in law by competitive bidding. This amendment also serves to directly implement the EU's Directive on Guidelines on State Aid for Environmental Protection and Energy[170], which provides for competitive bidding to determine remuneration for electricity generated from renewable energy.

Plans to further expand the use of renewable energy remain at the heart of Germany's energy transition policy. The goal here is to increase renewables as a proportion of total power consumption from the current level of around 32 per cent to 40-45 per cent in 2025 and – as set out in the coalition agreement – to 65 per cent in 2030.

On January 1, 2021 the amended Renewable Energies Act (EEG 2021) came into force. With the amendment to the EEG, the German government aims to further promote the expansion of renewable energies. For the first time, the goal of greenhouse gas neutrality for electricity supply before the year 2050 is enshrined in law. In order to maintain and further promote the acceptance of the expansion of renewable energies, the EEG amendment provides for a voluntary financial participation of municipalities in the revenues of wind farms. The Federal Ministry for Economic Affairs and Energy has already announced the next amendment. In the first quarter of 2021, a more far-reaching expansion path for renewable energies is to be defined that sufficiently takes into account the European climate target of 55% by 2030.

6.1.12. Immission control (Federal Immission Control Act, Ordinance (BImSchG, BImSchV)

The Federal Immission Control Act aims to protect people and the environment from harmful impacts, while also preventing environmental damage. In this framework, it refers in particular to 'integrated avoidance and mitigation of harmful impacts on the environment caused by emissions into the air, water and soil, including the waste management sector'.[171] The BImSchG regulates the rights and obligations of operators of plant and authorities in more detail.

The BImSchV stipulates the specific modernisation requirements for existing plants and lays out provisions on new heating systems in private households and small industry. With regard to the quality of life and human health, this regulation is designed to reduce odour nuisance and levels of fine particulate matter. Because of the ambitious goals of the German Government to achieve a CO_2-neutral building stock, restrictions are placed on the use of solid fuels such as wood or biomass for heating, as well as on the release of fine particulate matter that is harmful for human health, in order to limit the rise of air pollutants and in the long term reduce emissions of fine particulate matter.[172] Hence, the BImSchV has an impact on the future energy supply towards a low carbon and low polluted city as it excludes polluting substances or requires high technical solutions to mitigate emissions.

The 13th Ordinance on Large-scale Heating, Gas Turbine and Combustion Engine Plants (Verordnung über Großfeuerungs-, Gasturbinen- und Verbrennungsmotoranlagen) was adopted with a view to fully implementing the European Directive on Industrial Emissions 2010/75/EU also limiting emissions of particulate matter and NOx. It gives operators and authorities legal certainty and a basis for future planning when plants are licensed.[173] The aim is to protect the health of the general public in Germany by reducing emissions of particulate matter and NOx from large-scale heating plants.

The 17th Ordinance lays out regulations governing the incineration and co-incineration of waste and specifies requirements relating to 'the establishment, the nature and the operation of waste incineration and waste co-incineration plants'.[174] The Ordinance endeavours to regulate the emissions of organic and inorganic substances released during the incineration of waste by laying down limits.[175]

6.3. ENERGY REGULATIONS ON STATE LEVEL (LÄNDER)

The federal States (Länder) must also make an active contribution to climate protection in order to achieve the national goals. In Germany, several federal States have already set their own climate targets. Some Länder have anchored their reduction targets by means of their own climate laws.

At first glance, as climate mitigation falls under the so-called concurrent legislative competence, the Länder are only authorised to legislate as long as and insofar as the federal government does not take action (see chapter 3.2). However, the federal government, by a so-called opening clause, stipulated, that those state laws are not affected by the Federal Climate Act, allowing synergies of both acts to reach climate targets in a joint effort. The Länder have also the possibility to create conditions in the so-called state building regulation (Landesbauordnung - LBO) and the local code (Gemeindeordnung – GO) facilitating the implementation of climate measures and energy efficiency. They also set the frameworks for local activities.

170 Guidelines on State Aid for Environmental Protection and Energy 2014/C 200/01; https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN; accessed 5.5. 2021,

171 'Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge.' BImSchG: Bundes-Immissionsschutzgesetz, 18 July 2017, https://www.bmu.de/gesetz/gesetz-zum-schutz-vor-schaedlichen-umwelteinwirkungen-durch-luftverunreinigungen-geraeusche-erschuett/; accessed 3.5. 2021

172 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. 'Erste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes.' Verordnung über kleine und mittlere Feuerungsanlagen, 26 January 2010, https://www.bmu.de/gesetz/erste-verordnung-zur-durchfuehrung-des-bundes-immissionsschutzgesetzes/. accessed 3.5. 2021

173 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. '13. Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes.' Verordnung über Großfeuerungs-, Gasturbinen- und Verbrennungsmotoranlagen, December 2017, https://www.bmu.de/gesetz/13-verordnung-zur-durchfuehrung-des-bundes-immissionsschutzgesetzes/; accessed 3.5. 2021

174 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. '17. Verordnung Zur Durchführung des Bundes-Immissionsschutzgesetzes.' Verordnung über die Verbrennung und die Mitverbrennung von Abfällen, May 2013, https://www.bmu.de/gesetz/17-verordnung-zur-durchfuehrung-des-bundes-immissionsschutzgesetzes/; accessed 3.5. 2021

175 Laid out in Articles 8 and 9 of the 17th BImSchV

6.3.1. Climate Law of Baden-Württemberg

In October 2014, the state parliament of Baden-Württemberg passed the "Law for the Further Development of Climate Protection in Baden-Württemberg" as one of the first climate laws in Germany. Greenhouse gas emissions in the state are to be reduced by at least 42 percent by 2030 compared to 1990. By 2050, emissions are to be reduced by 90 percent compared to 1990.[176]

The Climate Protection Act contains among others, specifications that have an impact on sustainable urban development. These include the obligation to develop a municipal heat plan (energy use plan) and to install photovoltaic systems on newly built non-residential buildings from 2022 on.

Information box 6: Municipal heat plan requirements

To achieve the national climate protection goals, it is important to save heating energy at the municipal level and to decarbonise heating consumption. Private households are of particular importance for the heat transition, as they account for almost half of the heating energy demand in Germany. In this context, municipalities have a decisive role to play: a large-scale use of renewable energies for heat supply requires many municipalities to switch to grid-connected heat supply. This requires strategic heat planning that illuminates the given options and derives measures for districts, neighbourhoods, and individual buildings.
A municipal heating plan or energy use plan forms the basis for achieving a climate-neutral building sector. The Climate Protection Act of the Land obliges all larger municipalities in Baden-Württemberg to draw up such a plan by the end of 2023, including corresponding implementation strategies.
To this end, the state has already developed a corresponding action guideline to help the municipalities master this task[177], and the state's owned energy agency (KEA) will advise the municipalities accordingly.

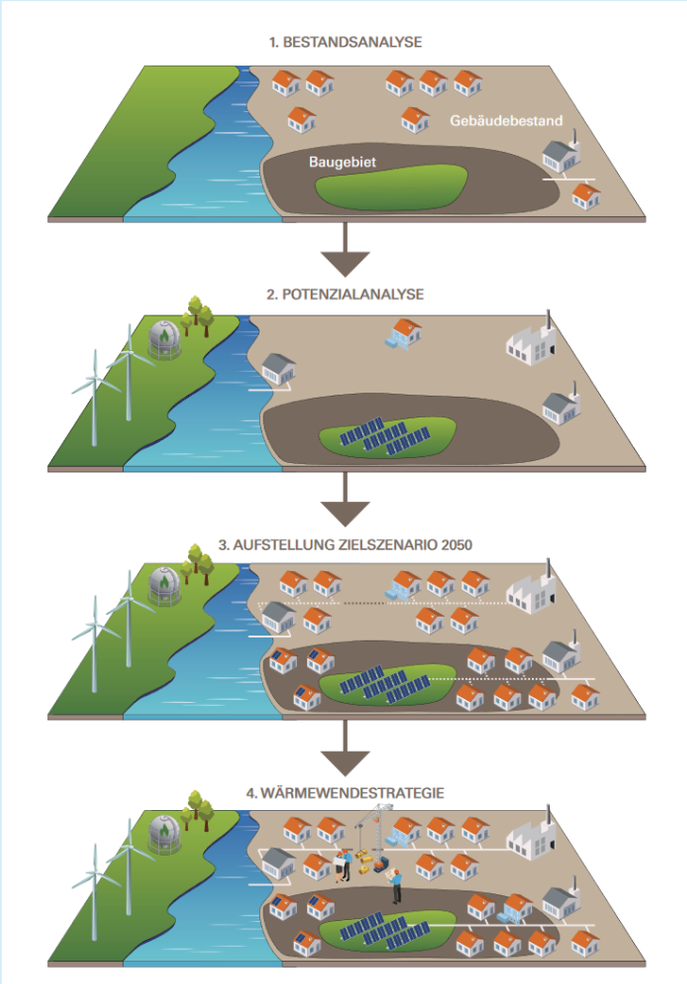


Fig 25: Steps towards an energy use plan[178]

176 https://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2020/12/20201217-bundestag-verabschiedet-eeg-novelle.html; accessed 1.5. 2020
177 Kommunale Wärmeplanung – Handlungsleitfaden, Min. Umwelt, Klima und Energiewirtschaft, 2020
178 ibid, p22

6.3.2. Renewable Heat Law Baden-Württemberg – EWärmeG (2007)

The EWärmeG (Erneuerbare Wärmegesetz) is a State law in Baden-Württemberg that applies to buildings constructed before 1 January 2009. As soon as a building changes the owner or is subject to major renovations, including a replacement of the heating system, the (new) owner must henceforth generate 15 % of its heat via renewable energies.

While the law was initially only designed for residential buildings, since 2015 it is also valid to non-residential buildings above a certain size. The Renewable Heat Act is particularly open to technology, as owners have a number of options for meeting the requirements (solar thermal, biogas, biomass, etc.; also, in conjunction with a renovation plan for long-term holistic building optimisation).[179]

The law was introduced in 2007, before the federal law of the same name, and was intended to document the country's pioneering role vis-à-vis national legislation. As with all legal requirements, the evaluation of the implementation has shown that the control can and must be improved to achieve the set goals for increasing the use of renewable energies in the heating sector.

6.3.3. State Building Codes (Landesbauordnung – LBO)

While the Building Code (see chapter 3.2.2) primarily regulates building land use planning in cities and municipalities (FNP, Bebauungsplan), the Land Building Regulations (LBO) deal with so-called building regulation law. In addition to procedural issues, the LBO regulates in particular the concrete structural-technical requirements for building projects. These structural-technical requirements, on the other hand, are much more specific than the development plan and relate to the construction method of the building itself[180]. To a certain extent, the state building regulations therefore also offer opportunities to integrate requirements in connection with climate protection or the efficient use of energy, or to facilitate such measures and thus also motivate homeowners.

This includes for example,

- Facilitating subsequent measures to save energy through thermal insulation in Berlin[181]
- Facilitating the installation of solar systems in certain cases in Schleswig-Holstein without a building permit procedure.[182]

In addition, the regulation of parking spaces for motor vehicles can influence behaviour, for example, if the properties are connected to local public transport, sufficient bicycle parking facilities are provided, or car-sharing services are available[183]. For urban development, this opens opportunities to make entire city quarters less traffic-intensive and to plan "neighbourhood" garages for cars as an example.

6.3.4. Local Codes (Gemeindeordnung - GO)

In Germany, the Local Code (GO) often also referred to as the Municipal Constitution - forms the legal basis according to which the municipalities regulate matters of the local community on their own responsibility and self-administration. The GO is a state law.

The GO as the LBO offers opportunities for climate protection and energy efficiency. In the local code of the state of Baden-Württemberg[184] (§ 1) the so-called "mandatory connection and use" obligation enables the municipality to oblige e.g., local and district heating connections and their use. However, an appropriate justification, such as air pollution control or general climate mitigation reasons, must be provided.

In practice, municipalities today introduce a connection and use obligation for district heating less and less frequently. This is because the introduction of a connection and use obligation not only leads to a connection and supply obligation but can also lead to a monopoly position with a corresponding critical examination of prices[185]. Therefore, solutions via agreements in urban development contracts or with the help of a price-worthy offer, great customer friendliness and a wide range of services are preferred nowadays.

179 https://www.erneuerbare-waerme-gesetz.de/ewaermeg; accessed 3.5. 2021
180 https://www.baustoffwissen.de/baustoffe/baustoffknowhow/baurecht/welchen-zweck-erfuellen-eigentlich-die-landesbauordnungen-lbo/; accessed 2.5. 2021
181 https://www.berlin.de/rbmskzl/aktuelles/pressemitteilungen/2010/pressemitteilung.52552.php accessed 2.5.2021
182 https://www.schleswig-holstein.de/DE/Landesregierung/IV/Presse/PI/2014/140128_im_aenderungLBO.html
183 https://www.hamburg.de/contentblob/3810612/3c5b1093e482f0ee77f1bb88fcf88f93/data/fa-1-2013.pdf; accessed 2.5. 2021
184 http://www.landesrecht-bw.de/jportal/portal/t/7p9/page/bsbawueprod.psml/screen/JWPDFScreen/filename/GemO_BW.pdf; ac-cessed 2.5. 2021
185 https://www.agfw.de/energiewirtschaft-recht-politik/recht/anschluss-und-benutzungszwang/; accessed 2.5. 2021

7. CONCLUSION AND OUTLOOK

This publication deals with the effects of energy regulations in the European Union and the Federal Republic of Germany on (sustainable) urban development. It becomes clear that these regulations, relate to commitments on the international level, the strategies, programmes and laws on EU and national level.

The regulations and directives of the EU on energy have their greatest impact at the building level. Beyond that, formal and informal instruments at the national, state, and municipal level offer opportunities to develop cities towards climate neutrality. An early integration of energy aspects into planning procedures is key and a basic prerequisite. Municipalities can set further course through higher building standards. However, these measures and implementation depend on the commitment, political will and capacities of local governments. Fortunately, EU and na-tional funding opportunities are available to support the necessary measures at all spatial and technical levels. A lot has already been done, as the examples in the document show.

The question is: Is it enough? Can all actors continue this way? Will the goals that have been set be achieved? Is the glass half full or half empty?

Moreover, recently the EU not only reaffirmed its will, but also tightened the targets (EU target to reduce greenhouse gases from 40% to 55% by 2050). The German government was even ordered (!) by the highest national court to improve the set targets (seen as not ambitious enough), to ensure the living conditions of future generations.

Environmental organisations criticise that the goals[186] set are not ambitious enough and that the targets developed from them are not sufficient[187]. This counts especially for the regulations on energy standards for buildings. The Zero Carbon Buildings 2050[188] report from 2020 criticised that the EU is by no means on the way to decarbonising the building sector.

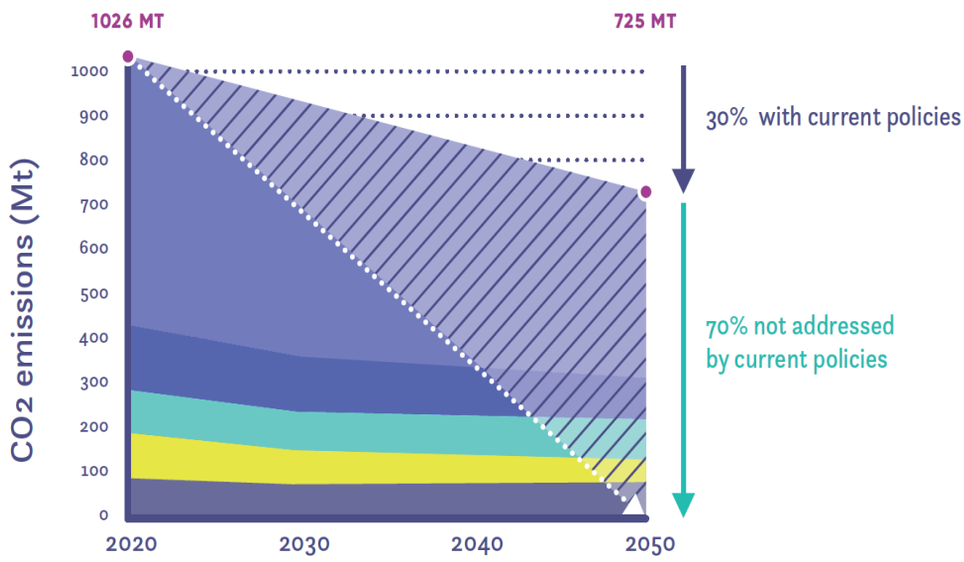


Fig 26: Baseline and annual CO_2 emissions of residential sector (direct, indirect, embedded)[189]

The institute calculated that, in a business-as-usual scenario, the legislation put in place by the EU by 2016 would not be enough to achieve decarbonisation. GHG emissions from the residential building sector will have decreased by only 30% by 2050.

However, the report acknowledges that it does not include the policies adopted under the Clean Energy Package as they are yet to be implemented. This applies for the Green Deal, too. Nevertheless, this statement should be taken seriously. This seems to be the case, as both the EU and Germany have introduced binding climate legislation with targets, target paths and review mechanisms. If targets are not met at the member state level, there is also the threat of penalties and further action. Not acting against climate change is thus not a trivial offence.

Of course, sustainable urban development has more facets than just energy. Municipalities act in many areas, from climate mitigation, climate adaptation, to the city of short distances. Cities depend on overarching framework conditions, set by the EU and member states., Many pioneering municipalities in climate mitigation in Germany struggle meanwhile to further reduce energy consumption and greenhouse gases at the municipal level[190]. High emission rates from transport are one reason, the other is that "low-hanging fruits" have been harvested already.

186 https://www.wwf.eu/?2302316/Fit-for-55-what-is-it-and-what-does-WWF-want; accessed 4.5. 2021
187 Euractiv: It´s time to put climate targets first; https://www.euractiv.com/section/climate-environment/opinion/its-time-to-put-climate-targets-first/; accessed 5.5. 2021
188 Zero Carbon Buildings 2050 – Summary Report. CE Delft. 2020, p9
189 CE Delft, p9
190 This includes the transport sector, showing increasing emissions ; see climate balance of the city of Freiburg – "Der Verkehr verhagelt Freiburg die CO_2-Bilanz " (Traffic spoils Freiburg's CO_2 balance), Badische Zeitung 26.4.2021, printed version

To support the German government, the independent think tank "Agora Energiewende" proposed in May 2021 "Six key points for a reform of the climate protection law". These include, among other things, a tightening of the climate targets, a concretisation of the targets for the individual sectors and thus clear guidelines for their actors, automatic consequences in case of missed targets within the framework of the annual monitoring, a strengthening of the role of the independent advisory council of experts, as well as an immediate programme with measures in all areas of climate protection.

The paper concludes: "The expansion of renewable energies must be unleashed, the coal phase-out must be brought forward, the electrification of transport must be accelerated, and environ-mental transport strengthened, the climate-neutral building stock must be developed, a green hydrogen economy must be established in industry, and agriculture must be put on a climate-friendly direction. The path is mapped out"[191].

Ultimately, each and every individual has the opportunity to review their behaviour, act accordingly and contribute to a sustainable city. Every contribution counts.

191 Sechs Eckpunkte für eine Reform des Klimaschutzgesetzes, Agora Energiewende, 2021, p18; https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_04_KNDE45/A-EW_212_Eckpunkte-Klimaschutzgesetz-2021_WEB_01.pdf; accessed 5.5.2021

BIBLIOGRAPHY

Bayrisches Statsministerium für Umwelt und Gesundheit. Leitfaden Energienutzungsplan. München. Februar 2011, https://www.ar.tum.de/fileadmin/w00bfl/klima/Publikationen/Berichte/Leitfaden_Energienutzungsplan.pdf

Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety). „13. Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes." Verordnung über Großfeuerungs-, Gasturbinen- und Verbrennungsmotoranlagen, Dezember 2017, https://www.bmu.de/gesetz/13-verordnung-zur-durchfuehrung-des-bundes-immissionsschutzgesetzes/.

Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety). Klimaschutzprogramm 2030 - Maßnahmen zur Erreichung der Klimaschutzziele 2030. Berlin. Oktober 2019, https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzprogramm_2030_bf.pdf

Bundesministerium für Wirtschaft und Technologie (BMWi) (Federal Ministry for Economic Affairs and Technology). Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung. Dezember 2010, https://www.bmwi.de/Redaktion/DE/Downloads/E/energiekonzept-2010.pdf?__blob=publicationFile&v=3.

Bundesministerium für Wirtschaft und Energie (BMWi) (Federal Ministry for Economic Affairs and Technology). Energieeffizienzstrategie 2050. Berlin. Dezember 2019, https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/energieeffiezienzstrategie-2050.pdf?__blob=publicationFile&v=12

Bundesminsterium für Wirtschaft und Energie. Zentrale Vorhaben Energiewende für die 18. Legislaturperiode. Berlin, https://www.bmwi.de/Redaktion/DE/Downloads/0-9/10-punkte-energie-agenda.pdf?__blob=publicationFile&v=3

Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS), (ed.). Handlungsleitfaden zur energetischen Stadterneuerung. Belin, 2011, https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/ministerien/bmvbs/sonderveroeffentlichungen/2011/DL_HandlungsleitfadenEE.pdf;jsessionid=F5CBF8B63F805F5960F0DD6FE7B7BA54.live21302?__blob=publicationFile&v=1

Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS). CO_2-Gebäudereport. Berlin. 2007, https://www.co2online.de/fileadmin/co2/research/Gebaeudereport_2007.pdf

CE Delft. Zero Carbon Buildings 2050. Summary Report. Delft. July 2020, https://europeanclimate.org/wp-content/uploads/2020/07/ecf--buildings-netzero-fullreport-v11-pages-lo.pdf

China Urban Sustainability Coalition. Ten principles of low carbon urbanization. Supporting China´s new type of urbanization. December 2015, https://icma.org/documents/ten-key-principles-low-carbon-urbanization

City of Munich. Sustainable Freiham: Objectives, Plans and Steps of Urban Planning. 2017, https://www.muenchen.de/rathaus/dam/jcr:f7c7dd39-c047-43e3-ac31-be4edb54080c/2017_Sustainable%20Freiham.pdf

City of Frankfurt. Masterplan 100% Climate Protection – Frankfurt am Main. General Con-cept-Summarised version. Frankfurt, https://frankfurt.de/-/media/frankfurtde/frankfurt-themen/klima-und-energie/pdf/energiereferat-79a/masterplan-climate-protection---summarised-version.ashx

Climate Service Center Germany, Anpassung an die Folgen des Klimawandels in der Stadtplanung und Stadtentwicklung. Der GERICS-Stadtbaukasten. October 2017, https://www.climate-service-center.de/products_and_publications/publications/detail/073854/index.php.de

Das Protokoll von Kyoto zum Rahmenübereinkommen der Vereinten Nationen über Klimaänderungen. 1997, https://unfccc.int/resource/docs/convkp/kpger.pdf

Deutsches Institut für Urbanistik (DIfU) (ed.). Orientierungen für die kommunale Planung. Ber-lin. 2016

Ecologic Institute. Climate Laws in Europe. Good practices in net-zero management. Berlin. February 2020, https://www.ecologic.eu/sites/default/files/publication/2020/climatelawsineurope_fullreport_0.pdf

Eisenack, Marco, et al. München: Zukunft mit Perspektive - Strategien, Leitlinien, Projekte. Magazin zur Fortschreibung der Perspektive München, June 2015.

Energieeffizienzstrategie Gebäude: Wege zu einem nahezu klimaneutralen Gebäudebestand. Bundesministerium für Wirtschaft und Energie (BMWi), 18 November 2015, https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/energieeffizienzstrategie-gebaeude.pdf?__blob=publicationFile&v=25/

Energie-Experten. EnEV 2016 Pflichten im Überblick. März 2016, https://www.energie-experten.org/energie-sparen/energieberatung/energieeinsparverordnung-enev/enev-2016.html.

"Erste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes." Verordnung über kleine und mittlere Feuerungsanlagen, 26 Jan. 2010, https://www.bmu.de/gesetz/erste-verordnung-zur-durchfuehrung-des-bundes-immissionsschutzgesetzes/

Eur-Lex. "Energy." Eur-Lex, https://eur-lex.europa.eu/summary/chapter/energy.html?root_default=SUM_1_CODED%3D18

European Commission. Clean Energy for all Europeans. Brussels. November 2016, https://eur-lex.europa.eu/resource.html?uri=cellar:fa6ea15b-b7b0-11e6-9e3c-01aa75ed71a1.0001.02/DOC_1&format=PDF

European Commission. A Clean Planet for all. A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. Brussels, November 2018, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0773&from=EN

eurostat. EU Imports of Energy Products - Recent Developments. eurostat, May 2019, pp. 1–13, https://ec.europa.eu/eurostat/statistics-explained/pdfscache/46126.pdf.

Federal Ministry for Economic Affairs and Energy (BMWi). Making more out of energy. Na-tional Action Plan on Energy Efficiency. Berlin. 2014, https://www.bmwi.de/Redaktion/EN/Publikationen/nape-national-action-plan-on-energy-efficiency.pdf?__blob=publicationFile&v=1

Federal Ministry for Economic Affairs and Energy (BMWi). 7th Energy Research Programme. Innovations for the Energy Transition. Berlin 2018,

https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/7th-energy-research-programme-of-the-federal-government.pdf?__blob=publicationFile&v=5
Federal Ministry for Economic Affairs and Energy (BMWi). Energy Efficiency Strategy for Buildings. Methods for achieving a virtually climate-neutral building stock. Berlin. November 2015,
https://www.bmwi.de/Redaktion/EN/Publikationen/energy-efficiency-strategy-buildings.pdf?__blob=publicationFile&v=6
Federal Ministry for Economic Affairs and Energy (BMWi). The Energy of the Future. Second progress report on the Energy Transition. Berlin. June 2020,
https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/the-energy-of-the-future.pdf?__blob=publicationFile&v=3
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Cli-mate Action Plan 2050. Principles and goals of the German government´s climate policy. Berlin. November 2016,
https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Klimaschutzbericht 2018. Berlin. November February 2020, https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf
Federal Ministry of the Interior, Building and Community. The new Leipzig Charter. The trans-formative power of cities for the common good. November 2020,
https://ec.europa.eu/regional_policy/sources/docgener/brochure/new_leipzig_charter/new_leipzig_charter_en.pdf
Gebäudestandards und Energiekonzepte.
https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Gesundheit-und-Umwelt/Klimaschutz_und_Energie/Energiestandards.html.
"Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge." BImSchG: Bundes-Immissionsschutzgesetz, 18 July 2017,
https://www.bmu.de/gesetz/gesetz-zum-schutz-vor-schaedlichen-umwelteinwirkungen-durch-luftverunreinigungen-geraeusche-erschuett/.
GIZ. Local Climate Action – Harmonising Ecology and Economy, Developing Sustainable En-ergy and Climate Action Plans (SECAPs). Beijing. March 2020
GIZ. Green Finance. Financing instruments for energy-efficient and climate-friendly buildings - Focus: Germany. 2021
Hazebrouck, Benoit, and Wolfgang Qual. Münchner Förderprogramm Energieeinsparung (FES) für energieeffiziente Gebäude: Maßnahmen - Anforderungen - Erfolg. Munich.
Kona A., Bertoli, P. et al (ed.). How to develop a Sustainable Energy and Climate Action Plan? European Union 2018,
http://com-east.eu/media/k2/attachments/Com_east_guidebook_2018.pdf
Kompetenzzentrum Energieeinsparung. "Münchner Förderprogramm Energieeinsparung (FES)." Förderkonditionen, May 2019,
https://energiezentrum-muenchen.de/Foerderkonditionen.
Landeshauptstadt München. Ökologischer Kriterienkatalog der Landeshauptstadt München. München 2017,
https://www.muenchen.de/rathaus/Stadtverwaltung/Referat-fuer-Stadtplanung-und-Bauordnung/Wohnungsbau/oekokatalog_vorwort.html
Landeshauptstadt München. Ökologischer Kriterienkatalog der Landeshauptstadt München. Referat für Stadtplanung und Bauordnung Stadtsanierung Referat für Stadtplanung und Bauordnung Stadtsanierung, 2017,
https://www.muenchen.de/rathaus/dam/jcr:606d0934-14be-4c6c-b388-a21dfa1d2e63/Oekologischer_Kriterienkatalog-2017.pdf.
Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg. Kommunale Wärmeplanung. Handlungsleitfaden. Stuttgart. Dezember 2020,
https://um.baden-wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/Dokumente/2_Presse_und_Service/Publikationen/Energie/Leitfaden-Kommunale-Waermeplanung-barrierefrei.pdf
München CoolCity. Münchner Förderprogramm Energieeinsparung (FES).
https://coolcity.de/muenchner-foerderprogramm-energieeinsparung/.
"Primäres und sekundäres Gemeinschaftsrecht." Gesetzgebung, 2019, http://www.eu-info.de/europa/eu-richtlinien-verordnungen/.
Pritzsche, Kai Uwe, and Vivien Vacha. Energierecht: Einführung und Grundlagen. 1st ed., C.H. Beck, 2017.
Prognos, IWU, Ifeu. Hintergrundpapier zur Energieeffizienzstrategie Gebäude. Berlin, Darmstadt, Heidelberg. Dezember 2015,
https://www.bmwi.de/Redaktion/DE/Downloads/E/energieeffizienzstrategie-hintergrundinformation-gebaeude.pdf?__blob=publicationFile&v=5
Stadt Augsburg. Klimaschutz und Stadtplanung Augsburg. Leitfaden zur Berücksichtigung von Klimaschutzbelangen in der städtebaulichen Planung und deren Umsetzung. Augsburg. 2007,
https://www.energieatlas.bayern.de/file/pdf/782/Leitfaden_Klimaschutzundstadtplanung_Augsburg.pdf
Stadt Essen. Leitfaden für eine energetisch optimierte Stadtplanung. Planungsgegebenheiten - Städtebaulicher Entwurf - Bebauungsplan - Vertragliche Regelungen. Essen. 2009.,
https://media.essen.de/media/wwwessende/aemter/61/dokumente_7/aktionen/klimaschutz/Leitfaden_fuer_energetisch_optimierte_Stadtplanung.pdf
Stadt Potsdam. Energieeffizienz in der Bauleitplanung. Arbeitshilfe zum B-Planverfahren. Potsdam. Februar 2010
Stadtwerke München. "Ausbauoffensive Erneuerbare Energien." Energiewende, 2019,
https://www.swm.de/privatkunden/unternehmen/energie/ausbauoffensive-erneuerbare-energien.html.
Stadtwerke München. Gestalter der Wärmewende. Fernwärme – 100 Prozent erneuerbar. München. 2018,
https://www.geothermie.de/fileadmin/user_upload/Aktuelles/Presse/Pressemappe/Muenchen_2018/Stadtwerke_Muenchen_-_Brosch

uere_Gestalter_der_Waermewende.pdf
Stadtwerke München. “SWM Fernwärme-Vision.” Energiewende, 2019,
https://www.swm.de/privatkunden/unternehmen/energie/vision-fernwarme.html
Stadtwerke München. “SWM Kampagnen.” Die Stadtwerke München, 2019,
https://www.swm.de/privatkunden/unternehmen/swm/kampagne.html#gallery-open.
Umweltbundesamt. Klimaschutz in der räumlichen Planung. Gestaltungsmöglichkeiten der Raumordnung und Bauleitplanung. Berlin. 2012, https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4369.pdf
UNEP. 2020 Global Status report for buildings and construction. Towards a zere-emissions, efficient and resilient buildings and construction sector. Nairobi. 2020, https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf
Verbücheln, M., Dähner, S. (ed.). Klimaschutz in der Stadt- und Regionalplanung. Erneuerbare Energien und Energieffizienz in der kommunalen Planungspraxis. Berlin. Februar 2016, https://repository.difu.de/jspui/handle/difu/218020
Wirtschaftsraum Augsburg. Regionales Klimaschutzkonzept. 2011.
https://www.landkreis-augsburg.de/fileadmin/user_upload/Klimaschutz/Regionales_Klimaschutzkonzept_Langfassung.pdf
World Resources Institute (WRI). Accelerating Building Efficiency – Eight Actions for Urban Leaders. 2016,
https://www.wrirosscities.org/sites/default/files/16_REP_Accelerating_Building_Efficiency.pdf

PUBLISHING DETAILS AND DISCLAIMER

Title

Energy-law framework at European, federal, and municipal level and the impacts on sustainable urban development; Maybe better: Energy-law framework, Building code and municipal instru-ments – impacts on sustainable urban development

Publishing details

The papers are published within the framework of the Sino-German Urbanisation Partnership. Under the International Climate Initiative (IKI), the project was commissioned by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and im-plemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in con-junction with the Ministry of Housing and Urban-Rural Development of the People's Republic of China.
As a federal enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Registered offices
Bonn and Eschborn
Sunflower Tower
Maizidian Str. 37, Chaoyang District
100125 China, Beijing
T +86 10 85275180, F +86 10 85275185
E giz-china@giz.de
I www.giz.de/china
www.sustainable-urbanisation.org/en

Edited by

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Marie Kaufmann
Klaus Hoppe Consulting
Sustainable Solutions for Cities

Steering and coordination

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

ENERGIERECHTLICHE RAHMENBEDINGUNGEN AUF EUROPÄISCHER, BUNDES- UND STADTEBENE UND DESSEN AUSWIRKUNGEN AUF DIE STADTENTWICKLUNG

Sino-German Urbanisation Partnership

Grundlagenpapiere für die Schwerpunktthemen der „Deutsch-Chinesischen Urbanisierungspartnerschaft“

Editor:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Klaus Hoppe Consulting
Sustainable Solutions for Cities

Im Auftrag des:

Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit