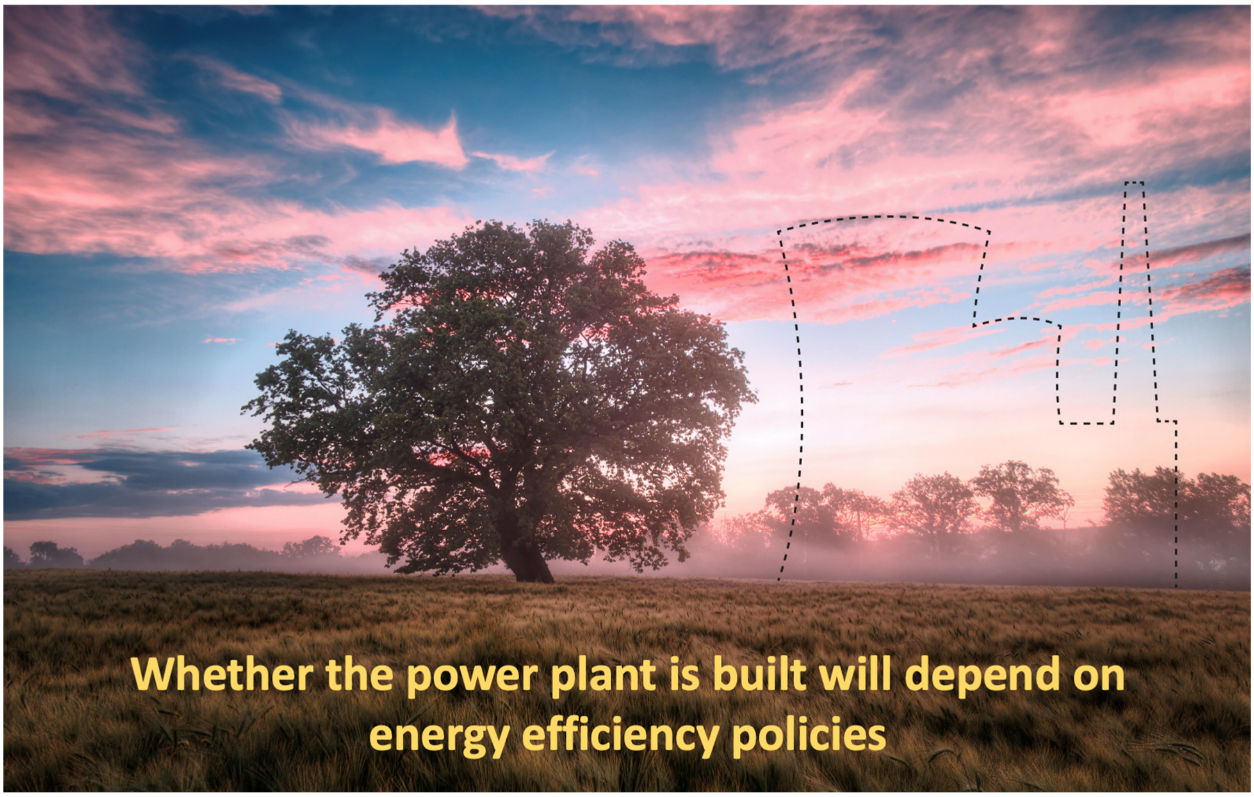
German Japanese Energy Transition Council



The more effective governance of energy efficiency policies

Imprint

Publisher:

Wuppertal Institute for Climate, Environment and Energy
Döppersberg 19
42103 Wuppertal
Germany

www.wupperinst.org

The Institute of Energy Economics Japan
Inui Bldg. Kachidoki,10th,11th Floor
13-1, Kachidoki 1-chome, Chuo-ku,
Tokyo 104-0054
Japan

https://eneken.ieej.or.jp/en/

Authors

Akinari Takeda, Ichiro Kutani (Institute of Energy Economics Japan)
Frank Labunski, Oliver Wagner, Henriette Reinhardt (Wuppertal Institute)
Peter Hennicke (Hennicke.Consult)

Please cite the publication as follows:

Labunski, F. et. al (2024): The more effective governance of energy efficiency policies. Wuppertal, Tokyo: Wuppertal Institute and Institute of Energy Economics, Japan.

Contact:

GJETC Secretariat
gjetc@wupperinst.org
Phone: +49 202 2492-345
Fax: +49 202 2492-10

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

METI Ministry of Economy, Trade and Industry

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List of Abbreviations

ACEEE	American Council for Energy-Efficient Economy
BAFA	Federal Office for Economic Affairs and Export Control
BEHG	National carbon pricing scheme
BEA	Berliner Energieagentur
BMWK	Economic Affairs and Climate Action
COP	Conference of the Parties
DENA	German Energy Agency
DENEFF	Business Initiative for Energy Efficiency
ECCJ	Energy Conservation Center, Japan
EED	Energy Efficiency Directive
EEW	Federal Promotion of Energy and Resource Efficiency in the Economy
EEEF	European Energy Efficiency Fund
EnEfG	Energy Efficiency Act (Energieeffizienzgesetz)
EffSTRA	Energy Efficiency Strategy
EU	European Union
ESCos	Energy Service Companies
ETS	Emission Trading Scheme
GDP	Gross domestic product
GWh	Gigawatt hours
IEA	International Energy Agency
JTF	Just Transition Fund
kL	Kilo Liter
KTF	Climate and Transformation Fund
KWh	Kilowatt hour
LEEN	Learning Energy Efficiency Networks
LCP	Least-cost-planning
MWh	Megawatt hour
Mtoe	Million tonnes of oil equivalent
NAPE	National Action Plan Energy Efficiency
NECP	National Energy and Climate Plan
NRW	North Rhine-Westphalia
PAM	policies and measures
PJ	Petajoule
R&D	Research and Development
SME	small and medium sized enterprises
StromStG	Electricity Tax Act
TWh	Terawatt hours

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Executive Summary

To reach the energy efficiency targets of Japan and Germany on the way to net zero, a more effective governance of energy efficiency policies is crucial. Japan's Sixth Strategic Energy Plan, formulated in 2021, targets a reduction of 62 million kL (673TWh) in final energy consumption by 2030 (compared to the 2013 base year). Germany aims to reduce the final energy consumption by 26.5% until 2030 (which is 677 TWh/yr compared to the 2008 base year) and to achieve a target amount of final energy consumption of 1,867 TWh. This study elaborates the governance and sectoral policy packages (taking the industry sector as an example) to increase energy efficiency in Japan and in Germany. The overarching governance framework, consisting of 1. Targets and concepts, 2. Infrastructure and funding for sectoral energy efficiency policies, and 3. Eliminating distortions especially in energy and carbon prices, will be analysed. Additionally specific energy efficiency policies, which support the governance framework, are being examined.

The analysis shows that plans for more ambitious energy efficiency target-setting are present in both countries. However, more needs to be done to achieve them. Hence, innovative initiatives for a more effective energy efficiency governance in Japan and Germany will need to be developed. For an effective energy efficiency governance, five central recommendations have been elaborated in this study:

1. Both countries should establish a roadmap how they could contribute most to the COP28 goal of increasing the annual rate of energy efficiency up to 4% by 2030.
2. Further research on energy saving potentials, benefits and costs should be conducted. In particular comprehensive bottom-up studies on the potentials, benefits and costs of energy savings, covering both cross-cutting technologies for application in all sectors and key process innovations especially in energy intensive sectors are essential.
3. For the case of Germany, the concept of a Federal Energy Efficiency Agency within a polycentric institutional setting – including existing regional energy agencies – is discussed. By concentrating the steering and coordination responsibility in a strong Federal Energy Efficiency Agency, which is legally responsible for the target achievement, an effective implementation of specific policies and measures can close the existing gaps.
4. In particular in Germany, the energy efficiency monitoring needs to be improved. For Japan, the establishment of key indicators that can accurately represent the policy target will be helpful to enhance the effectiveness of energy efficiency monitoring.
5. The establishment and further development of a strong and highly professional lobby (like the German DENEFF) for energy efficiency technologies and policies at the demand side is advisable to create a fair level playing field in relation to the strong energy supply interests on the markets for energy services.

Regarding the exemplary focus on the energy efficiency policies for the industry sector, the policy package of regulation, financial incentives, information and advice, local planning, capacity building and networking, and finally research and development and promotion of best available technologies is discussed in general and for both countries in this study. Based on the analysis, four industry-specific policy recommendations have been developed.

1. In Germany, 399 energy and resource efficiency networks with 3,251 companies (often SMEs) exist. While in Japan a knowledge transfer from industry organizations to SMEs exists, a publicly supported establishment and organisation of efficiency networks is advisable. The expansion/establishment of efficiency networks is beneficial for the exchange of information on energy efficiency and for overcoming barriers within the industry sector.
2. Strengthen the policy link between energy and resource efficiency, e.g., through establishing a network of regional agencies which can conduct audits and offer incentives for an integrated approach to invest in reducing energy and material costs.
3. To address the initial investment barrier, energy performance contracting has been identified as a useful tool. Some successful implementation in Germany is currently the case but should be extended in both countries.
4. Enhanced utilization of waste heat of industries or of data processing centers for supplying, e.g., district heating systems and industrial clusters is recommended as well.

1 Introduction

At COP 28 in Dubai in 2023, a global agreement was reached to triple the renewable energy capacity globally and to double the global average annual rate of energy efficiency improvements by 2030. Regarding carbon neutrality, it was once again recognized that it is impossible to achieve it through the introduction of renewable energy on the supply side alone and that it is essential to increase energy efficiency to reduce energy demand. To date, constant efforts to increase energy efficiency have been made in Germany and Japan. In developing countries, energy demand is projected to continue to increase due to population and economic growth, and both Germany and Japan, as countries based on technology and industry, are expected to serve as models for advanced energy efficiency. By "leap frogging" (Goldemberg, 1998) to advanced efficiency technologies the increase of energy demand in developing countries can be reduced drastically.

The ACEEE (American Council for Energy-Efficient Economy) publishes an international energy efficiency scorecard every two years that compares and evaluates the energy efficiency performance and policies of the top 25 energy-consuming countries. These top 25 countries account for 82% of global energy consumption. There are four categories of evaluation: national initiatives, architecture, industry, and transportation. Germany is ranked third and Japan is ranked seventh overall on the 2022 scorecard. In terms of national initiatives, Germany ranked first for its high goal-setting and financing programs, and Japan ranked third for its strong energy efficiency policies and R&D investments. In the industry sector, Japan ranked first for its regulatory measures and voluntary actions, and Germany ranked third for its goal-setting with industry and energy management systems. Thus, by international comparison both countries have implemented remarkable initiatives to raise energy efficiency. Nevertheless, due to market failures, there are still a lot of potentials and innovations for further improvement of energy efficiency, which can be harvested by overcoming existing barriers.

Following the guidelines of the International Energy Agency (IEA), Germany has focused its new efficiency initiatives on the 'energy efficiency first' principle. For example, a new and more comprehensive Energy Efficiency Act (Energieeffizienzgesetz – EnEfG) was enacted (see below). Germany, as a member of the European Union, is required to comply with the revised Energy Efficiency Directive (EED) adopted by the European Union in 2023, which also refers to 'energy efficiency first' as a fundamental principle of EU Energy policy, including binding efficiency targets, but can also take advantage of the European Green Deal investments. In Japan, where due to island status resources are scarce, long-standing policies have been implemented under energy efficiency laws since the oil crisis in the 1970s. The possibility of additional reductions is said to be lower than in other countries because energy consumption has been kept low through systems such as periodic reporting and the appointment of professional engineers.

Although Germany and Japan have different geographical conditions and climates, they share the common characteristic that their economies are based on a strong industry. Increasing energy efficiency in this key sector is thus important and several policies have already been implemented. However, both Germany and Japan can make further efforts to improve energy efficiency and are able to contribute beyond their domestic efforts to the target of doubling the speed of energy efficiency worldwide, as they have advanced GreenTech technologies that could also support other countries.

For further improvement of the policies already established, it is necessary to go back to the fundamental principles of least-cost energy services and organize the energy market, policies, and governance concepts, starting with an analysis of the existing structures. The different approaches and the exchange of experiences between the two countries could generate many new discoveries. Since energy efficiency is a matter of what consumers and investors as well as their supply chains have to decide, it is necessary to carry out more analyses considering consumers and investors as well as intermediary market actors perceptions and behavioral principles and practices. Building on this foundation, more consistent and effective energy efficiency policies can be designed, and the functions and structures of an effective governance of funding, implementing, and monitoring the policies can be created.

This paper first examines more effective ways of governance of energy efficiency policies in Germany and Japan. Specifically, the elements and structures necessary for effective governance are discussed and organized. It then analyzes existing policies and governance structures in both Japan and Germany (Chapter 2). The second focus is on the industrial sector as an example. Concerning the energy efficiency policies for this sector, the policy packages of the two countries and their effective interactions are reviewed (Chapter 3). After that, this study makes recommendations on policies and policy packages for more effective overall energy efficiency governance and policies for the industry sector in both countries (Chapter 4). The study concludes that implementing these recommendations can contribute to further improve energy efficiency policies towards carbon neutrality.

2 Concepts of 'effective governance' and analysis of existing governance structures

This chapter delves into the fundamental concepts of "effective governance" and conducts a comprehensive analysis of existing policies and structures for effective governance regarding energy efficiency in Japan and Germany. Therefore, chapter 2.1 discusses the overarching concept of "effective governance" in general and within the domain of energy efficiency. This is followed by an analysis of existing policies and governance structures in Japan (chapter 2.2) and in Germany and the European Union (chapter 2.3). Lastly, chapter 2.4 showcases further policies, that might lead to increased energy efficiency.

2.1 Discussion of concepts of 'effective governance'

2.1.1 Basic terminology

The objective of this paper is to analyze the more effective governance of energy efficiency policies. To commence this study, first the relevant terminologies are defined, commencing with the foundational concept of 'energy efficiency', given its pivotal role in the subsequent analysis.

Efficiency is generally referred to as 'the ratio of benefits to expenses', therefore energy efficiency quantifies the relationship between obtained benefits and energy consumed.[1] The less energy is used for the same benefit gained, the more energy efficient is that process. Comparing a reference case with an energy-saving device, the difference in energy consumption is called the energy savings potential (Irrek et al., 2008).

Governance broadly refers to the system of rules and coordination of the state, a municipality, an administration, or another organisation. Various differentiations of governance exist, with one notable example being 'good governance', characterized by key principles encompassing responsibility, accountability, participation and responsiveness (OHCHR, 2023). Due to the lack of a uniform definition, 'effective governance' will be defined in this paper as governance that ensures the achievement of intended targets, especially on the national level. Governance is thereby the overall framework directing the decision-making and implementation processes of a public entity which includes specific policies and measures (PAMs). PAMs are the concrete guidelines and instruments (e.g., standards, regulations, market-based instruments, information) implemented under the governance process. Based on the general definition of effective governance, 'effective governance of energy efficiency' will be defined as governance that ensures the achievement of decided targets for energy efficiency in time. This will be especially important if binding national targets for energy efficiency (e.g., concerning the rate p.a. or an absolute reduction of energy consumption) have been decided for specific target years.

2.1.2 Elements of governance

This chapter aims to answer the question, which elements of governance need to be implemented to ensure target achievement. Therefore, in the following, five governance elements are described.

[1] Additionally, the concept of energy services will be elaborated in chapter 2.1.6

In combination, these elements may lead to effective governance, ensuring that concrete policies and (sectoral) measures can be designed and implemented. They consist of 1) target setting, 2) assigning responsibility for implementation, 3) funding, 4) monitoring of target achievement, and 5) policy evaluation. Firstly, based on the principle of “governance through goals”, the definition of a clear target is the first step towards effective governance. In particular long-term targets serve as explicit signals to stakeholders or third-party entities, providing clear indications of the political orientation or trajectory being pursued. This can potentially foster partnerships and collaboration by attracting actors who share aligned interests and goals (Kanie, 2021). Additionally, a clearly defined target is beneficial for communication purposes and can thereby increase social acceptance.

Secondly, the roles, authorisation and responsibilities of each party involved must be explicitly and comprehensively defined. This entails a precise specification of the functions, powers and duties assigned to individuals or entities within the governance structure, ensuring a clear understanding of their respective mandates and obligations and fostering effective decision-making. One way of communicating the respective responsibilities can be a governance charter (OAG, 2023). An advantageous approach can involve the establishment of an institution singularly focused on a complex cross-cutting supreme objective, such as the enhancement of energy efficiency in all sectors. By concentrating on a unified goal, these institutions can streamline efforts, concentrate resources, and foster specialized expertise toward achieving substantial advancements in achieving the overall target. Additionally, these specified institutions (e.g., a mandated Federal Energy Efficiency Agency) should be accountable for moderating, coordinating, monitoring, and, if so mandated, incentivizing the realisation of the overall objective. As the implementation of an overall energy efficiency target will probably affect millions of households, small and medium-sized enterprises (SME) and industries directly or indirectly, these actors should be addressed by target-group-specific PAMs and should participate in the target-setting process and a transparent dialog on effective PAMs as early as possible.

Thirdly, adequate funding is essential for effective governance. The funding should be based on good financial governance and be transparent concerning the distributional effects (BMZ, 2015).

Fourthly, target monitoring is essential to ensure effective governance. Monitoring within governance serves multiple essential functions, encompassing explanation, accounting, auditing, and compliance. The explanatory function of monitoring provides insights into implementation outcomes. Accounting within the monitoring process is crucial for capturing diverse changes resulting from the implementation of governance/policies, spanning social, economic, and environmental domains. The auditing function of monitoring assesses whether resources and services designated for beneficiaries or specific target groups have effectively reached their intended recipients. Compliance monitoring ensures alignment with predetermined standards and procedures (Liciper et al., 2012). Furthermore, data-driven target monitoring provides feedback regarding the current trajectory toward target achievement, identifies areas of improvement and can lead to identifying issues early (Glass & Newig, 2019).

Lastly, and similarly, policy evaluation is indispensable based on the previously described evaluation functions, aiding in understanding variations or reasons behind intended and observed results. While policy *monitoring* involves systematically gathering data using predetermined indicators to allow stakeholders to assess the progress of a policy and determine if it is proceeding as planned towards achieving its stated objectives, policy *evaluations* go beyond monitoring and further involve assessing the impact and effectiveness of a policy (Lamhauge et al., 2012).

2.1.3 Barriers and the need for policy packages

As shown, PAMs are an essential and integrated part of effective governance. In particular, the differentiation of cross-sectoral instruments (e.g., carbon pricing) and sector-specific process-oriented instruments (e.g., audits or financial support) is advisable. In combination, they can address specific and broader issues to implement energy efficiency. Most energy efficiency experts agree that PAMs consist always of packages designed and combined to overcome specific barriers to market deployment or the use of energy efficiency technologies, management solutions, or practices for processes or appliances. Therefore, the questions arise, why in particular an energy efficiency strategy requires cross-cutting governance, and why existing PAMs are often not sufficient to close observed implementation gaps. To answer this question, the barriers constricting an energy-efficient economy have to be considered. Against the background of a market economy, a fundamental question has to be answered: Even cost-effective and highly profitable energy savings potentials, demonstrated by bottom-up energy efficiency analysis, are not automatically realized in practice. What are the reasons for this apparent market failure and how to remove existing barriers to speed up the implementation process? A barrier to energy efficiency is defined as “a mechanism that inhibits a decision or behaviour that appears to be both energy-efficient and economically efficient” (Sorrell et al., 2006). Bagaini et al. (2020) categorise barriers to energy efficiency into economic, institutional and behavioural barriers (see Table 1).

Table 1: Energy efficiency barriers categorization

Tope of Barrier	Description
Economic	Lack of financial incentives, lack/difficult access to finance, high risk for investors, uncertainty of investments and gains, pay back gap, short amortisation expectations in industry (e.g., 3 years), investor-user dilemma
Institutional	Lack of or complex legislative procedures and regulatory provisions, non-integrated and conflicting policies and targets, limitations of existing infrastructure (transport side), missing market transparency of the variety of efficiency equipment
Behavioural	Social group interactions, inertia, lack of a ‘culture of saving’, lack of awareness on savings potential, lack of access to trusted information and knowledge, lack of expertise (skills & training) and highly qualified specialists, habits and relevant behavioural aspects, undervaluing energy efficiency, mistrust/negative perception of new technologies.

Source: (Bagaini et al., 2020); (Jochem et al., 2010)

According to Palm (2010), the barriers to energy efficiency are multi-faceted and the categorization can differ respectively. Examples include (Schleich et al., 2016) and (Cattaneo, 2019), which categorize internal and external barriers to energy efficiency. Hereby, the internal barriers address individual preference and behavior, while the external barriers predominate and are based on institutional settings. Independent of the categorization, the vast number of barriers need to be addressed for all actors in the value chain of providing energy-efficient solutions. In particular- the cross-sectoral barriers to energy efficiency coupled with a lack of market transparency can lead to market failure. Most of these complex issues and barriers cannot be addressed alone e.g., by cross-cutting energy or carbon taxes or other energy price-based instruments. Therefore, an energy efficiency governance and sophisticated PAM packages are indispensable to overcome barriers concerning concrete technologies, sectors and target groups.

Considering the ambitious goal of carbon neutrality and "keeping the 1.5-degree target within reach" (COP 26 in Glasgow), the trends of the annual energy efficiency increase are by far not sufficient. As net-zero scenarios demonstrate, the reduction of absolute energy consumption is indispensable; this holds for the global level (Cozzi, Laura et al., 2023), for the European Union (European Commission, 2019), for Germany and Japan (Obane et al., 2022). In all of these studies, it is demonstrated that the technical energy savings potentials exist for absolute decoupling of GDP and energy consumption and, in principle, to double the annual rate of energy efficiency increase e.g., to 4% p.a. on a global level (Cozzi et al., 2023).

2.1.4 Policies and institutions related to energy efficiency governance

Figure 1 presents the categories (functions) and types of policies, measures, and institutions that we consider most relevant for providing the framework or structure for energy efficiency governance. They are the overarching framework for implementing the sector-specific policy packages with their six main elements, which are shown at the bottom of the figure and will be discussed for the example of the industry sector in chapter 3.

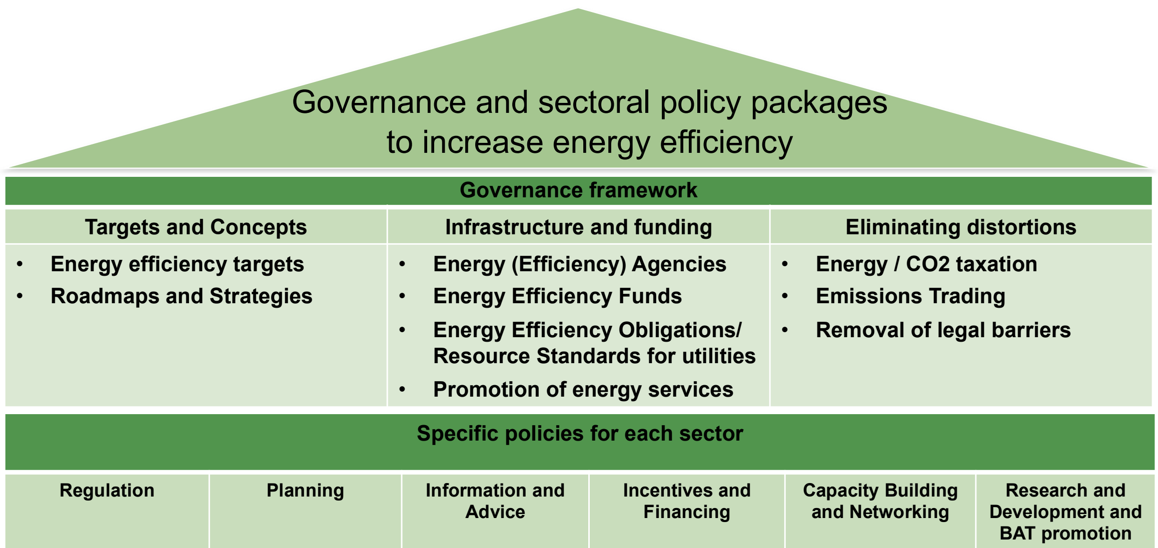

Figure 1: The governance framework for energy efficiency

Source: (Schäfer-Sparenberg, Carolin et al., 2017)

As discussed in chapter 2.1.2 and shown in Figure 1, the instrument category of "targets and concepts" is a governance instrument to communicate and establish the self-commitment of the government towards energy efficiency targets. Policy roadmaps and strategies demonstrate to market actors what they can expect and build their business strategies upon, in terms of support and energy efficiency criteria.

The "infrastructure and funding" acknowledges the importance of well-equipped energy agencies to support policy implementation and aims to provide clear responsibilities while ensuring adequate funding for the sectoral policies. Energy efficiency funds may just be chapters of the public budget that allow carrying over unused funds to following years, or they can be a combination of such budget chapters with functions of an energy efficiency agency and some freedom for implementing innovative energy efficiency programs and measures, as for example in Denmark or Vermont. An alternative to government agencies and funding can be energy efficiency obligations or resource standards for electric and gas utilities. These get the task to achieve a certain amount of savings through implementing energy efficiency programs that are providing financial incentives, targeted advice and other supports to their consumers, or work with supply-side actors. Since all utilities have the same obligations, they can fund the programs through energy prices or grid fees. The extra price component will usually be a fraction of a Eurocent or Yen. Finally, some energy efficiency improvements can also be implemented on a commercial basis by energy service companies. Supporting this business, e.g., through loan guarantees or services of bundling projects, is also a policy instrument under this governance function.

Lastly, the instrument category of "eliminating distortions" aims at improving the cost-effectiveness of energy efficiency actions through internalizing the external costs of energy consumption and supply, by either energy or CO_2 taxation, or emissions trading schemes. In addition, there may be legal barriers preventing energy efficiency improvements, and such barriers should be removed.

2.1.5 What to do about the rebound effects?

To establish a successful energy efficiency governance and foster energy efficiency up to absolutely reducing the overall energy consumption, it is imperative to consider rebound effects. This includes direct, indirect and macroeconomic rebound effects (Albicker et al., 2023). Rebound effects are often linked to increased taking of comfort and can reduce the achievement of energy savings through energy efficiency measures by up to 25% (Nadel, 2012; Gillingham et al., 2013). However, rebound effects should not be confused with growth effects: the main antagonist of energy efficiency in controlling energy consumption is the GDP growth and the growth in consumption of goods, transport, building floor area, and other energy services that it enables through growing average disposable income. This is driven by many other factors like innovation, exploitation of natural resources, and only a little by energy efficiency, which is called the macroeconomic rebound effect and is included in the up to 25% mentioned above. Therefore, the fact that there are some rebound effects does not lead to the conclusion that these are a justification against ambitious energy efficiency measures, but rather an effect that has to be anticipated and addressed by effective energy efficiency governance and specific PAMs to cushion rebound effects as much as possible (Hennicke, 2013).

2.1.6 Energy services and the 'economy of avoiding energy supply'

Moreover, when examining energy efficiency, the scope of consideration should extend the market concept beyond energy consumption at the demand side and producing energy at the supply side. Instead, it ought to broaden the perspective to encompass the concept of 'energy services'. Energy services are functional outputs for which mostly physical conversion devices (e.g., electrical motors, lamps, heating boilers and the building fabric, pumps, cooling devices, and communication equipment) transform energy into the services that are needed. The energy supplied by the equipment in this transformation process is known as useful energy (heat, light, motion), whereas final energy such as electricity and gas are the inputs to the equipment. The demand for 'services' such as e.g., lighting, hot water or transportation of people/goods is provided by energy carriers, and conversion devices on a suitable infrastructure (Jochem, 2018). However, the transformation of final energy into energy services can lead to complex optimization processes, depending on the addressed energy service, on the target group, on the technologies needed and on the cost relations between end-use energy and efficiency equipment. Consequently, a wide range of actors can be involved, ranging from self-sufficient home owners (e.g., independent insulation of private homes) to energy contracting companies/Energy Service Companies (ESCos) (European Commission, 2015), investing at the site of their clients. Complex optimization means that on different micro, meso or macro levels (e.g., buildings, cars, production processes, regions or even countries), the least-cost intersection point of supplying or avoiding energy for a certain amount of energy services has to be found. Figure 2 symbolizes this intersection point. This perspective you might call an ´economy of avoiding energy supply'.

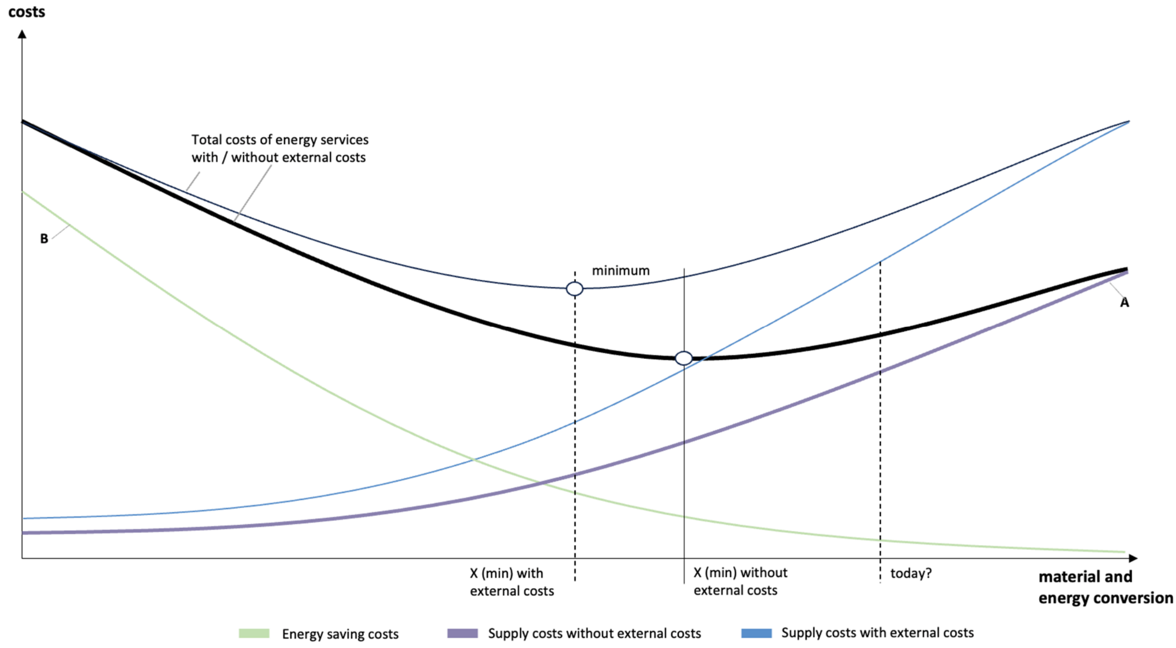

Figure 2: Economy of energy avoidance

Source: (Hennicke, 1999)

Graph A in Figure 2 represents the increasing costs if the level of service (e.g., a comfortable temperature level in a building) is reached due to the increased amount and costs of heating energy. Graph B shows the cost of saving energy and rising energy retrofit costs the more energy efficiency investments, e.g., insulation or efficient windows have been applied. The addition of both graphs (the black line) leads to the total costs. The minimum of the graph of the total costs is the cost-effective optimum. Furthermore, Figure 2 shows that the optimum will shift to less energy demand if external costs are considered at the supply side of energy (Hennicke, 1999).

2.2 Existing policies and governance structures in Japan

This section first provides an overview of Japan's energy efficiency policy and then summarizes its governance structure.

Policies and changes by sector

In Japan, a law on energy conservation was enacted in 1979 after the oil crisis. After experiencing two oil crises, Japanese people developed an awareness that the efficient use of energy was necessary to sustain Japan's rapid growth. Based on the Basic Act on Energy Policy enacted in 2002, the "Strategic Energy Plan" has been established approximately every 3 years, in which the objectives and goals for energy conservation are described. The latest target indicated in the 6th Strategic Energy Plan is to reduce final energy consumption by around 18% from business-as-usual by 2030. Based on the objectives, ministries and agencies promote energy conservation policies.

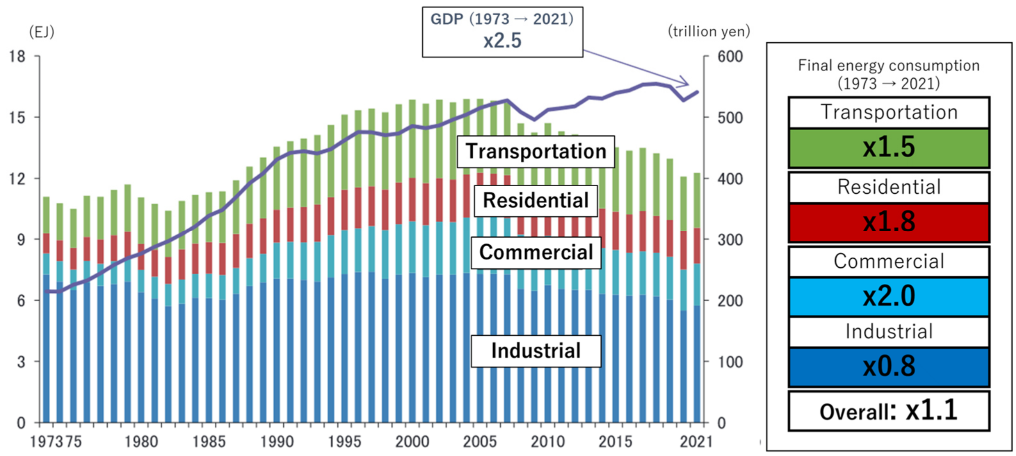

Figure 3: Final energy consumption and real GDP trends in Japan

Source: (Japan's Energy White Paper 2023)

In the 1970s, nearly 70% of final energy consumption was for industrial use, and direct regulations on consumption were imposed on large-scale factories and buildings. The industrial sectors that are heavily regulated by direct regulations have reduced their consumption over the past 40 years, and since 2008, their consumption has decreased by 20%. As energy consumption for household, commercial, and transportation use has increased due to increased floor space and logistics, direct regulations have changed their features. The law on energy conservation has been amended several times to expand its scope and developed a new legislation for the building sector in 2016.

Direct and indirect regulations

The breakdown of final energy consumption in 2020 was 45% in the industrial sector, 38% in commercial, and 17% in transportation. The direct regulations set a threshold of 1,500 kiloliters of crude oil equivalent, to designate businesses subject to the regulation imposing reporting requirements and reduction efforts. For transportation, thresholds are determined based on the amount of cargo transported and the number of vehicles operated by the company. These direct regulations cover 50% of total final energy consumption. This includes 79% of industry, 61% of commercial, and 9% of transportation.

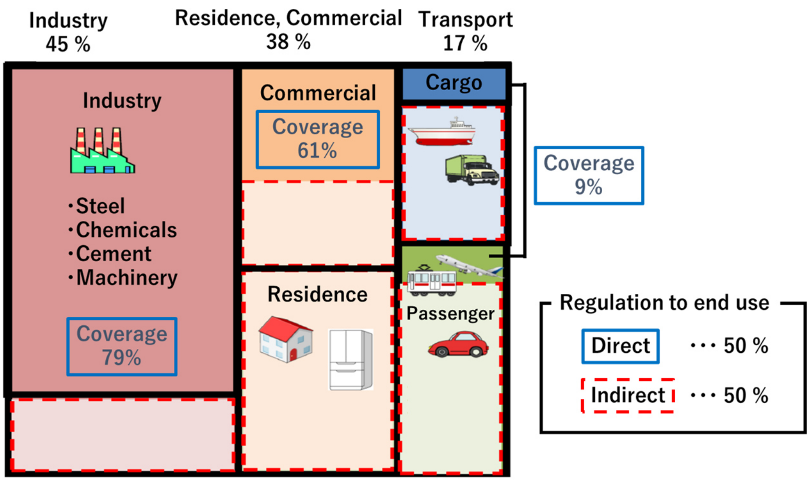

Figure 4: Energy consumption in Japan

Source: (Energy Efficiency Subcommittee, 2023)

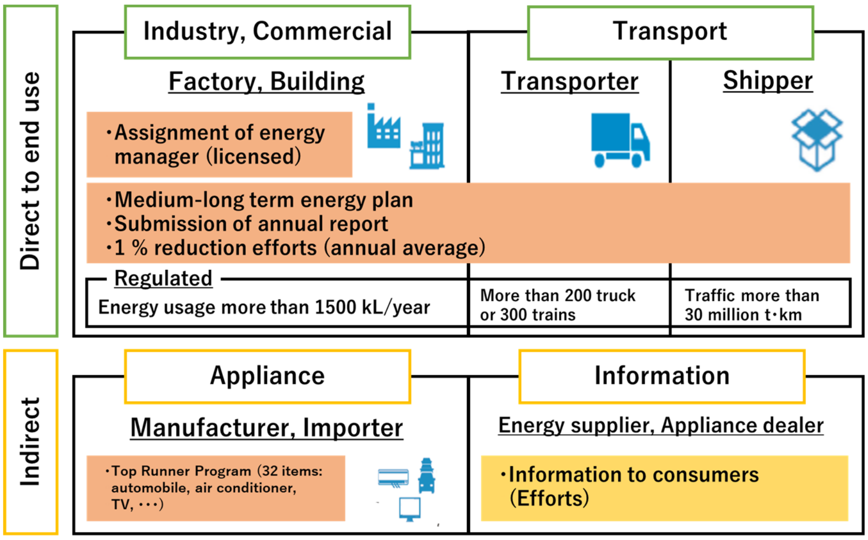

Figure 5: Energy efficiency regulations in Japan

Source: (Energy Efficiency Subcommittee, 2023)

Direct regulations

Under the direct regulations, the following obligations are imposed: 1) Appointment of a qualified energy manager, 2) Submission of medium- to long-term energy efficiency plans, 3) Periodic reports on energy usage, and 4) Efforts to reduce energy consumption by 1% annually. Businesses are ranked into three levels according to their achievement each year, and the top ranks are published for praise. The lower ranks receive guidance by the authority and require the development of an improvement plan. If the measures are deemed insufficient, improvement orders will be issued and the company's name will be published as a punishment.

Large-scale companies or premises are often highly managed because they have knowledgeable professional engineers who plan and improve equipment. However, the regulations have been revised, for example, making the company owner the energy management and supervision officer. This person is to be directly responsible for his/her investment decisions.

Revisions of direct regulations

In 2008, to expand the scope of the regulations, houses and buildings with large floor areas were included, and the threshold floor area was calculated by company, rather than by each factory owned by the company. As a result of this change, companies with several small-scale factories were also brought under the regulations.

In 2016, the Benchmark System was introduced to enable consumers to manage their goals in a way that makes sense to them, by ranking their energy efficiency efforts reflecting changes in the production of goods or services, rather than simple changes in energy consumption from the previous year. The benchmark system covers 70% of industry and business sectors. Furthermore, the Building Energy Conservation Act was enacted in 2016 for the building sector alone, and the energy conservation standards were optimized.

In 2018, the system was changed so that energy conservation can be jointly reported when waste heat is mutually accommodated by different companies in industrial parks, etc., promoting the effective use of CHP and waste heat. In transportation, in addition to regulations on carriers, regulations on shippers ordering transportation have been added, promoting efficient transportation of goods.

In 2022, the Building Energy Conservation Act was revised to make it mandatory for buildings including residential housing, to comply with energy-saving standards.

In 2023, the Energy Conservation Act was revised to increase the use of non-fossil energy and to level the load of electricity.

Effectiveness and challenges of direct regulations

Direct regulations have been tightened by gradual expansion of the scope, mandatory regulations, and strengthening of standards. A system in which a business with expertise and knowledge can make its own efforts, together with a system in which a business can recognize its position based on benchmarks within the same industry sector, has functioned well in encouraging their business operators to take action.

For professional engineers with pride of being qualified experts, there is a system to encourage them to make voluntary efforts through support programs such as building lateral networks and providing presentation opportunities. Businesses with professional engineers, who are subject to direct regulations, have capability to collect information and utilize subsidies by themselves, as well as having a system to work on their own.

The general setup of the **governance** for these direct regulations is as follows. Groups for each industry are organized, and ministries and agencies have a jurisdictional organization for each industry. Regulators interact with industry groups that they are responsible for, and they regulate and support the industry. The same applies to energy conservation policies. New measures are being considered through holding dialogue with the industry.

However, consumers who are not directly regulated, i.e., small- and medium-sized consumers, have few professional engineers, and lack the knowledge, human, and financial resources to take energy conservation actions by themselves. Therefore, it has become a challenge to encourage small and medium-sized businesses. The indirect regulations are important policies for this target group too.

Indirect regulations

Energy efficiency policies for housing and SMEs, i.e. outside the scope of direct regulations, include the top-runner program for appliances. Since energy consumption is carried out in consumption equipment, this is a program to improve the energy efficiency of the consumption equipment itself distributed in the market. Energy consumption standards (top-runner standards) are established for each equipment, and manufacturers and importers are required to achieve the standards by the target year. Manufacturers are required that the weighted average energy efficiency of shipped products exceed the standard. This program aims to increase the overall efficiency of equipment in the market.

22 items out of 29 types of energy-consuming appliances under the top runner program are subject to the labeling system. This system stipulates that retailers of appliances should endeavor to provide consumers with information, by labeling products to indicate their energy conservation performance and economic efficiency. By also showing economic efficiency, it allows consumers to choose highly efficient equipment by deepening their awareness when purchasing.

In Japan, where there are many domestic manufacturers, measures are implemented to improve the average efficiency of energy-consuming equipment on the market. Although some consumers may prefer a less efficient product with a lower initial cost, these indirect regulations are expected to improve the overall efficiency of products on the market.

Buildings

The construction and housing sector would be suitable for indirect regulation as building owners tend not to have sufficient knowledge or direct means to improve energy efficiency. However, due to fact that the building constructor has expertise in energy efficiency and the government can directly regulate them, the regulation for new buildings is actually in an intermediate position between direct and indirect.

In Japan, the largest part of the population is living in warm and humid climatic zones. Therefore, historically, ventilation and solar shading were emphasized in buildings. Therefore, and since buildings were not airtight and well-insulated, spot heating or cooling was the norm. Besides, the life of houses is shorter than in Europe because mainly wooden buildings are used and the rapid change of lifestyle has taken place. However, energy conservation standards are gradually being strengthened, and comfort, health promotion, and energy efficiency are improving.

The Building Energy Conservation Act was put into effect in 2016, making it mandatory for buildings of medium size and above to conform to the standards. The revision in 2022 has strengthened to make compliance with the energy conservation standards mandatory for all buildings. Because building permits are required by law, making compliance with energy conservation standards a requirement for building permits is strongly enforceable. Moreover, in terms of knowledge transfer to the building owner and as a part of indirect regulation, an architect with expert knowledge is obliged to explain the improvement of energy conservation performance to the owner. While new construction and large-scale renovation are subject to energy conservation standards, measures for existing buildings are limited to indirect regulations. Further information on buildings energy efficiency policy in Japan (and Germany) can be found in Nawothnig et al. (2023).

	Old		2022 Amendment	
	Non-Residential	Residential	Non-Residential	Residential
Large (≧ 2000 m^2)	Mandatory 2017.4 ~	Report	Mandatory 2017.4 ~	Mandatory 2025.6 ~
Medium	Mandatory 2021.4 ~	Report	Mandatory 2021.4 ~	Mandatory 2025.6 ~
Small (< 300 m^2)	Advisory notice	Advisory notice	Mandatory 2025.6 ~	Mandatory 2025.6 ~

Figure 6: Amendment building Energy Conservation Act

Source: (Energy Efficiency Subcommittee, 2023)

Governance structure

Based on the discussion above, the energy efficiency governance structure in Japan can be summarized as follow.

In terms of targets and concepts, medium- and long-term targets are set in the Strategic Energy Plan, which is reviewed by the Government approximately every three years. Policies to achieve these targets are set out in the Energy Conservation Act and the Building Energy Conservation Act, which interweave direct and indirect measures, including obligations on businesses and households to improve end-use efficiency.

In terms of infrastructure and funding, the role of ministries and industry associations can be noted. Ministries enforce and fund policy and monitor the market through regular reports from companies and others. This supervision process also takes into account the achievements of policy and makes the necessary amendments to legislation to achieve its targets. Furthermore, as energy saving practices are carried out by businesses, the government is usually in close dialogue with industry associations to make the policies feasible as well as ambitious.

In terms of financial support, the Sustainable Open Innovation Initiative’s website offers a one-stop shop service for various subsidy measures provided by the central government. In addition, the government agency New Energy and Industrial Technology Development Organization, NEDO, plays a role in supporting the development of advanced technologies.

In terms of eliminating distortions, the aforementioned financial support may fall into this category. In addition, a trial of emissions trading started in 2023 and the GX surcharge is scheduled to be introduced in 2028, which is expected to lower the barriers of the energy transition, including energy efficiency improvement. In addition, the dialogue with industry associations during the policy development process is a valuable opportunity for the government to identify issues in the existing regulations and to create a better environment for businesses to engage in energy efficiency.

2.3 Existing governance, policies and structures in Germany/EU

Energy efficiency targets, roadmaps, agencies, and funds, as well as energy taxation and emissions trading play a pivotal role in implementing energy efficiency governance and ultimately foster an energy transition to net zero at least costs. This chapter aims to showcase which governance policies and structures are implemented 1) In Germany and 2) the European Union (EU).

2.3.1 Energy efficiency governance structures and policies in Germany

Targets and roadmaps

The German Federal Government announced the goal of transforming the German economy into the most energy-efficient economy globally (Bundesministerium für Wirtschaft und Energie, 2019). Embracing the principle of 'efficiency first', the German Government in its official publications underscores the prioritization of "energy that does not have to be generated", as the cleanest and most cost-effective approach in its energy transition (BMWK, 2016). As energy efficiency is a fundamental principle of Germany's energy and climate policies, it can hardly be completely detached and examined in isolation and often interacts with related policies e.g., the rapid market deployment of renewable energies.[2]

Several policy frameworks have been implemented to pursue the energy efficiency first principle. One is the 'Climate Protection Programme 2030' which states that energy efficiency is a substantial element in reaching more ambitious climate targets. Additionally, the 'Energy Efficiency Strategy 2045' (EffSTRA) entails concrete energy efficiency targets, PAMs and a roadmap for an improved cross-sectoral energy efficiency strategy. This includes firstly, the 'National Action Plan Energy Efficiency' (NAPE 2.0) which incorporates a catalogue of measures for the achievement of efficiency targets in the medium term. The measures focus on the energy demand site and aim to reduce energy consumption. Secondly, based on NAPE 2.0 the 'Roadmap Energy Efficiency 2045', a cross-sector dialogue process, is implemented. In collaboration with economic and industrial stakeholders' solutions, approaches and concepts towards target achievement and a pathway from 2030 to 2045 are elaborated (Bundesministerium für Wirtschaft und Energie, 2019).

Both, the Climate Protection Program 2030 and the Energy Efficiency Strategy 2045 were published in 2019. Based on the Energy Efficiency Directive (EED) of the EU, a new 'Energy Efficiency Act' has been approved up to 2030 which updates the energy efficiency law in Germany. The Energy Efficiency Act (Energieeffizienzgesetz – EnEfG) concretises and enforces more ambitious energy efficiency targets. Based on §4, the final energy consumption in Germany must be reduced by at least 26.5% by 2030 (with 2008 as the base year) leading to an absolute final energy consumption of 1,867 TWh. Similarly, the primary energy consumption needs to be reduced by at least 39.3% by 2030. In absolute terms, the primary energy consumption shall not surpass 2,253TWh by 2030. These targets are based on a formula for sharing the new EU-wide energy efficiency targets according to the EED among the Member States. By 2045, the final energy consumption has to be reduced by 45%, compared to 2008. Furthermore, a multitude of energy efficiency measures and sub-targets are included in the Energy Efficiency Act. The most pronounced is the lowering of the annual final energy consumption by 45 TWh each year as a result of energy efficiency policies, starting from 2024 until 2030 (§5). Additionally, public bodies with a total annual final energy

[2] As renewables are statistically counted with 100% efficiency when counting primary energy consumption in all sectors (especially in the power sector) with an increasing substitution of fossil or nuclear energy by renewables future primary energy consumption is reduced by this statistical effect more than final energy.

consumption of 1 gigawatt hour or more are obliged to achieve annual savings in final energy consumption of 2%/year until 2045 (§6).

Infrastructure and funding

As discussed in the previous chapter, dedicated organizations and ministries are an essential component of energy efficiency governance and the development and implementation of PAMs. They entail a wide range of tasks regarding energy efficiency. In Germany, the Federal Ministry of Economic Affairs and Climate Action (BMWK) is responsible for shaping the national energy policy, which includes energy efficiency strategies. It develops legislation and initiatives to increase cross-sectoral energy efficiency. One key organisation promoting energy efficiency is the German Energy Agency (dena). The scope of tasks ranges from developing strategies to providing expertise, consulting and to initiate energy efficiency projects. Additionally, numerous federal and regional energy agencies focus on promoting energy efficiency in the respective state and at the local level. They support businesses, municipalities and households in implementing energy efficiency practices. The KfW is a government-owned development bank that offers financial support and incentives, especially for energy-efficient building projects, both new build and renovations. In particular, the KfW is responsible for financing technical building measures, including efficient heating technologies. The Federal Office for Economic Affairs and Export Control (BAFA) also administers energy efficiency programs and incentives. It provides support for energy efficiency technologies in industry, SMEs and households.

Most of the financial incentive programs are funded by the Climate and Transformation Fund (KTF). However, this is not an energy efficiency fund with its own organizational structure and the mandate to develop and implement programs and other measures, but merely a part of the federal budget with the possibility to transfer unused funds from one year to another. It is fed from the revenues of the EU ETS for the energy and industry sectors as well as from the German national carbon pricing scheme (BEHG) for buildings, transport and SMEs.

Germany does not have an energy efficiency obligation scheme or energy efficiency resource standards for energy companies.

The promotion of the market for energy services is also important for increasing energy efficiency. The German government offers loan guarantees for energy performance contracting projects as well as information and advice to potential customers of energy service companies. While the BMWK remains in a superordinate role, the dena is responsible for consulting. Similarly, local agencies like e.g., the Berliner Energieagentur (BEA) provide information and advice. The BEA also bundles projects and organizes calls for contracting tenders for retrofitting public buildings ("Berliner Energiesparpartnerschaften") on behalf of the local districts of Berlin. On average, about 26% of energy savings are achieved.

The German energy service market can be divided into three segments energy consulting, energy contracting and energy management. By emphasizing all three segments energy efficiency can be increased. The total annual revenue of approximately 11-13 billion € indicates the importance of this market to achieve ambitious energy efficiency target. The energy contracting market shows an approximate average annual growth rate of 8%. Furthermore, the consulting market is growing rapidly with approximately 37% annually (Rau et al., 2023). The total market volume of energy services in Germany can be seen in Table 2.

Table 2: Market volume at the energy services market in Germany

	2015	2016	2017	2018	2019	2020	2021
Energy consulting in mio. €	470-520	790-850	370-402	360-403	416	654	893
Energy contracting in bn. €	7.2-8.4	7.7	7.2-8.6	6.7-9.7	7.4-9	8.8-10.9	9.5-10.6
Energy management in mio. €	-	107	110	99	88	96	76
Total energy services market in bn €	**7.9-9.1**	**8.9-9**	**8-9.5**	**7.2-10.2**	**7.9-9.5**	**9.6-11.7**	**11.4-12.5**

All numbers are approximations

Source: (Rau et al., 2023)

Eliminating distortions

The elimination or reduction of distortions is essential to increase energy efficiency. Relevant in this context are the tax rates of mineral oil and electricity. According to §2 of the Mineral Oil Tax Act, for 1.000 liters of petrol a tax rate of 669,8 to 721 € (depending on the Sulphur content) is required. The tax rate for electricity remains at 20.5€/MWh according to § 3 Electricity Tax Act (StromStG).

Additionally, the European Union Emission Trading Scheme (ETS) is a key EU policy for reducing greenhouse gas emissions that is directly valid in Germany too. The ETS-1 regulates stationary installations, such as power plants and boilers above 20 MW of heat output, aviation air and marine transport. With the ETS-2, the building sector and road transportation was added and will be implemented from 2027. It will then replace the German CO_2 price, which was introduced in 2021 and currently stands at 45 €/ton.

2.3.2 Energy efficiency governance structures and policies in the European Union

As Germany is one the 27 member states of the European Union, a complete analysis of the energy efficiency policies can only be made, if the context of the energy efficiency policies on the European level is examined. The most prominent energy efficiency policy at the EU level is the Energy Efficiency Directive (EED), which was first adopted in 2012 and updated in 2018 and 2023. The EED aims to set EU energy efficiency targets as well as rules and obligations which are in line with target achievement (European Commission, 2023a). The European Union's energy efficiency target (Art. 4 of the EED) entails a mandatory reduction of at least 11.7% in primary and final energy consumption by the year 2030, compared to results for 2030 of the reference scenario dating from

2020. This target is binding for all member states and should result in a primary energy consumption of 992.5 million tonnes of oil equivalent (Mtoe) and a final energy consumption of 763 Mtoe in 2030. Starting from 2024 to 2030, new savings for each calendar year at an average annual energy saving rate of 1.49% (final energy consumption reduction: 2024-2025 1.3%; 2026-2027 1.5%; 2028-2030 1.9%) must be realised and proven as a result of concrete policies. Furthermore, the public sector has an increased annual energy consumption reduction target of 1.9% (European Commission, 2023b). A further key point of the EED is the emphasis on alleviating energy poverty. EU countries are required to raise awareness and inform on energy efficiency. Moreover, energy audits are mandatory for all companies, if they surpass a certain threshold[3] of energy consumption. This includes also SMEs. Energy management systems are only mandatory for large industries with a high energy demand. In municipalities with a population above 45,000 local heating and cooling plans have to be prompted (European Commission, 2023a).

A further framework related to energy efficiency is the 'National Energy and Climate Plan` (NECP), in which the member states concretise their national energy and climate policies. Energy efficiency is -besides decarbonisation, energy security, internal energy market and research, innovation and competitiveness- one of the five addressed dimensions. The NECP is formulated for a timeframe of 10 years (2021-2030) (European Commission, 2019b).

Funding for energy efficiency is directly or indirectly co-financed by investments under the 'European Green Deal'. One additional, specific funding program is the 'European Energy Efficiency Fund' (EEEF) with a current volume of 265 mn € (BMWK, 2024a). This is small compared to the multi-billion Euro structural development funds or the Covid-19 recovery program. These require the use of a part of the fund for mitigation of climate change, including energy efficiency.

There is no strong central energy (efficiency) agency at the EU level, just staff in DG Energy of the European Commission and contracts to consultants. In addition, there are funding agencies for the research and development programs, e.g. CINEA.

Regarding the elimination of distortions, the EU-ETS I and II have already been mentioned in chapter 2.3.1. A part of the revenues will be used at the EU level for the Social Climate Fund. There is also an energy taxation directive with small minimum tax rates.

Figure 7 shows further policy packages to increase energy efficiency within the governance framework of the EU.

[3] Based on (80) EED the specific European standards on energy audits are currently under development. However international standards, such as EN ISO 50001 (Energy Management Systems, EN 16247-1 (Energy Audits) and EN ISO 14000 (Environmental Management Systems) should be considered.

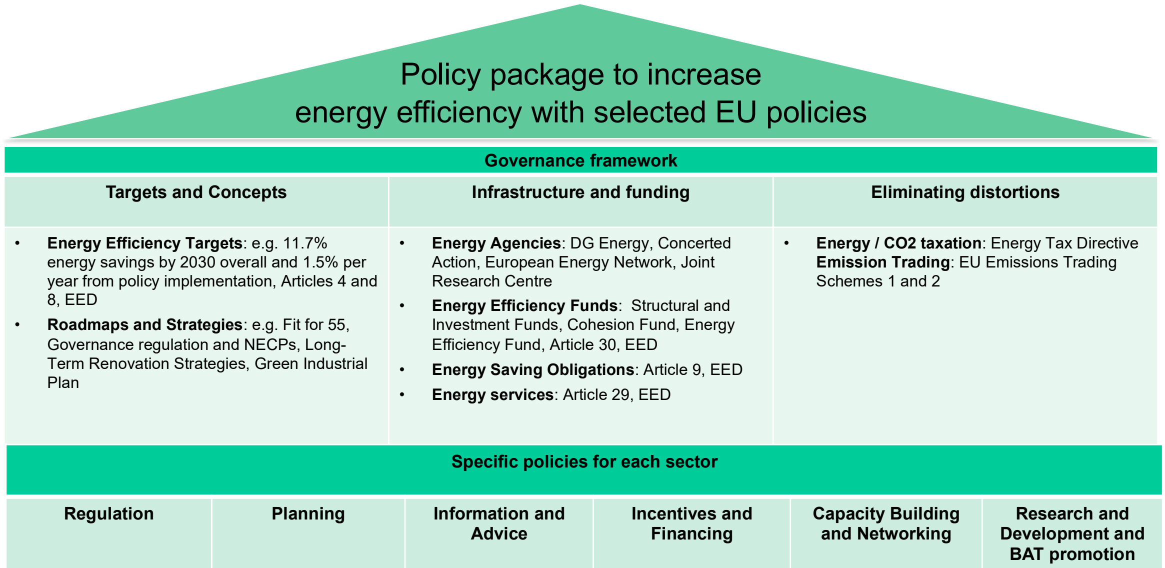

Figure 7: Policy package to increase energy efficiency with selected EU policies

Source: (Schäfer-Sparenberg et al., 2017); updated for the 2023 recast of the energy efficiency directive (EED; 2023/1791)

2.4 Analysis of existing policies and governance structures in comparison to concepts of 'effective governance'

This section discusses, how the energy efficiency governance could be further strengthened.

Targets and roadmaps

Germany and the EU have ambitious energy efficiency targets for 2030, thus no gap in target-setting is present (see chapters 2.3.1 & 2.3.2). However, more needs to be done to achieve them.

As shown in the previous chapters, multiple policies are in place. Nevertheless, due to the gap between energy efficiency targets and current implementation pathways, further policies need to be implemented. As the data in Table 3 indicates, a gap between the ambitious German energy efficiency targets and the actual implementation arises.

Table 3: Energy consumption and energy productivity in Germany

	Unit	1990	2008	2019	2020	2021	Change for 2021 in comparison to 2008	Change for 2021 in comparison to 2020
Primary energy consumption	PJ	14,905	14,380	12,805	11,895	12,413	-13.7%	4.4%
Final energy consumption	PJ	9,472	9,159	8,973	8,400	8,667	-5.4%	3.2%

Net electricity consumption	TWh	455	524	500	481	496	-5.4%	3.1%
Primary energy productivity	€ BIP/GJ	142	197	245	252	259	31.3%	2.5%
Final energy productivity	€ BIP/GJ	223	309	359	360	369	19.3%	2.5%
et electricity productivity	€ BIP/MWh	4,639	5,403	6,484	6,484	6,456	19.5%	-0.4%

Source: (Umweltbundesamt, 2023b)

This implementation gap is particularly pronounced in light of the final agreement of the COP28, which states the goals of tripling renewable energy capacity and doubling energy efficiency improvements by 2030 (United Nations, 2023). These goals are in line with recommendations of the International Energy Agency (IEA), that the global annual rate of energy efficiency has to be doubled from 2% annually reaching over 4% annually until the year 2030 (IEA, 2023).

In the following, policies are being discussed that might be helpful to address ambitious energy efficiency targets in Japan, Germany and the EU and which are currently not applied sufficiently.

Strengthening the energy efficiency though a polycentric governance structure

The current institutional setting in Germany consists of a multitude of different ministries and institutions that have scattered responsibilities and no clear mandate for planning, monitoring, financing, supporting and reporting to reach the ambitious energy efficiency targets. The inefficiencies resulting from these fragmentations can be addressed by a consistent polycentric governance. Possible options are the strengthening of the existing agencies or the consolidation of the existing agencies into one energy efficiency agency. The most relevant institutions for this approach are the dena, BfEE and the KfW. They could either be extended or combined within a 'Federal Energy Efficiency Agency' with a respective efficiency fund.

Energy Efficiency Funding

The KTF contains currently lots of funding, particularly for energy efficiency in buildings (€16.6 bn). However, in addition to this emphasis on the building sector, funds for industry and the transport sector could be increased. Moreover, these funds need to be maintained at these levels to reach 2030 targets. Current challenges are the 'debt brake' and the ruling of the Federal Constitutional Court. A proposal to overcome these challenges could be a multiannual €100bn climate fund created by 2/3 majority in the German parliament, the Bundestag. A recent example was the provision of €100bn for the defense fund in 2022.

The 'energy efficiency first' principle and corresponding strategies

Energy efficiency is mostly discussed regarding the customers on the demand side of the energy market. However, this isolated view only on the demand side might cause an uphill battle for ambitious energy efficiency policies, if the supply side, e.g., powerful and unregulated energy suppliers, tries to maximize energy sales even in the many cases where investing in energy savings technologies would be more beneficial for the customer. From the perspective of an economy of energy avoidance (see Figure 1), this would lead to a suboptimal, not cost-effective intersection point investing too much in the supply instead of the avoidance of energy.

In unregulated markets, energy suppliers normally have a monetary incentive for selling energy, if they are not obliged (e.g., by a specific incentive regulation for energy savings) to offer energy savings programs to their customers as well. Least-cost-planning (LCP) is one approach that aims to address this issue by conceptualizing, encouraging and supporting energy-saving measures on the side of the customers by energy supply companies. According to the rationale of an economy of energy avoidance, LCP includes the systematic integration of savings opportunities and promotes energy savings and demand-side-management. If more cost-effective than supplying energy by "MEGAWatts", investing in energy savings technologies ("NEGAWAtts") should be considered as preferable options to satisfy the need for a certain amount of energy services (Fichter, Wolf, 2018).

Today, the term used for this concept is 'energy efficiency first'. The EU's EED (Art. 3 in the 2023 recast) has obliged the Member States to use this principle in all policy, planning and major investment processes, not only in the energy sector. Germany has until 11 October 2025 to implement this Article in national law, most likely in an amendment of the EnEfG.

Energy Performance Contracting

Energy performance contracting (or Third Party Financing) is an effective instrument to increase energy efficiency e.g., in the industry and building sector; in the building sector, it is currently applied only on a small scale in Germany. As an energy service it entails the benefit for the contracting recipient (company) that the planning, financing, installation, and - during the contracting period - operation costs of the installed energy efficiency technology remain with the contractor. Furthermore, the energy savings guaranteed by the contractor leads to planning stability from the point of view of the contracting recipient. In exchange, the contractor receives a part of the energy cost savings to refinance its investments. The outsourcing of energy efficiency measures/technologies can offer risk-adverse clients advantages by freeing capital and human resources (KEA, 2024)(Competence Centre Contracting, 2024). Figure 8 illustrates the financial effects of investment, amortisation and reduced energy costs due to an energy contracting arrangement.

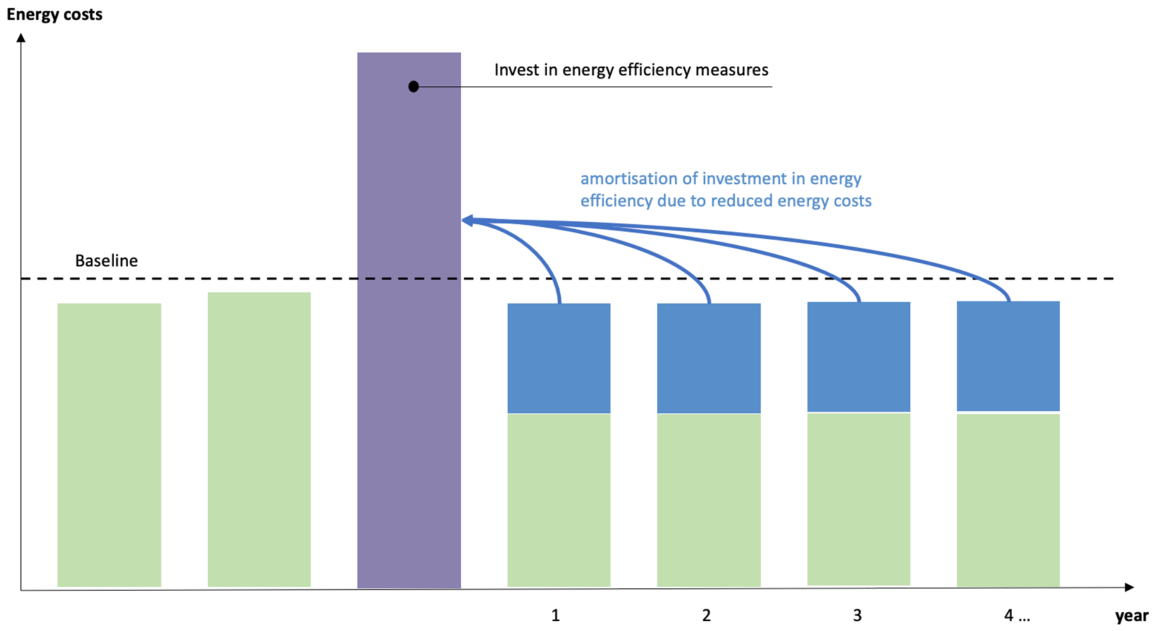

Figure 8: Energy contracting

Source: (Competence centre Contracting, 2024)

3 Policies & Measures to foster energy efficiency in the industry sector

This chapter delves into the basic concept of an 'effective policy package' and analyzes energy efficiency policy packages for the industrial sector in Japan and Germany. Chapter 3.1 summarizes and highlights the concept of an 'effective policy package'. It next analyzes existing policy packages and interactions in Japan (Chapter 3.2), Germany (Chapter 3.3), and Europe (Chapter 3.4). Chapter 3.5 provides an analysis of effective policy packages compared to the concepts.

3.1 Elements of an effective policy package

3.1.1 Factors of energy efficiency decisions, barriers and the need for policy packages

Following on from the governance analysis in Chapter 2, this study analyzes the elements and concepts necessary for a package of supplementary policies to make policy implementation effective. First, energy efficiency in industry is achieved by corporate energy consumers or sometimes building owners, and decisions are made within the consumer's or owner's organization. To this end, how energy efficiency decisions are made and the factors that give them is examined. Next, the elements required for policy packages are analyzed.

Improving energy efficiency often involves actions such as capital expenditures. Consumers/owners decide whether to improve energy efficiency considering their energy costs, financial conditions, and various regulations, or spend their money on other areas, such as production equipment.

Such decisions are based on necessity and investment effect (economic efficiency). The investment effect is particularly important in industries where international competition is fierce. There is no problem as long as the investment is cost-effective and there are no obstacles. There is a cause and transparency as a country, and whether to accept it or not is the first thing. There is also a strong pressure such as the penalty for not accepting. There are no regulations that prevent consumers from using energy, but there are social consequences (they are publicized, their social reputation is lowered and their sales are affected, there are inspections and penalties). And it is whether energy efficiency improvement is acceptable compared with the economic burden, inconvenience, etc. It is important to remember that industry decisions include location.

Table 4: Factors influencing corporate energy consumer decision making

	Description
1. Acceptance	Commitment, Comparison (between countries, industries, same industry) Assessment - fairness
2. Pressure	Penalties, publicity, from trade associations, inspection, monitoring / Subsidies, Social awareness, comparison, synchronization
3. Information	Technology, Finance /Who gives information?

4. Understanding	Understanding of Technology, Finance
5. Actor	Qualified personnel, Expert engineer, External support (energy efficiency diagnosis)

Let us look at consumer decisions from a behavioral economics perspective. There is a "status quo bias" in which a person’s overlooked opportunity to enjoy benefits is not as painful as the actual, directly perceived loss. Decision-making is biased toward maintaining the status quo because the degree of loss is considered more important than the gain. Thus, more information provision and impetus are needed to guide consumers.

In addition, it is said that the behavior of others around has a great influence, especially in Japan, where peer pressure plays a strong role. In Japan, what others are doing is the most compelling impetus for action. This action called "Nudge" has attracted attention as a method to induce energy conservation behavior through comparison by showing the energy consumption of the same attribute for promoting behavior change. Since it is executed after seeing others’ actions, time is required.

Energy efficiency investment decisions also require information about what to do, consideration of what is best, and the actors who implement it.

In the case of large operators, they have actors who can gather information and review them. However, SMEs and households need external support and guidance structures because they do not have actors.

Policy package requirements

As the situation of consumers varies according to industry, size, corporation or individual, locality, income, etc., one method is less effective, and multiple types of measures are tailored to the target. Large-scale business sites that use a large amount of energy have a large effect on energy efficiency and often have many professional engineers and a large investment capacity. Therefore, if a goal is indicated, they will be able to proceed by themselves. However, the amount of investment for improving energy efficiency is large, and significant efficiency increases will require time and financial assistance.

It is difficult for SMEs and households to secure human resources, such as those with expertise, so support is needed to supplement their information, technical knowledge, and driving forces.

There are various obstacles to energy efficiency implementation. Even if several conditions are met, a single obstacle may stop the process. Some of the obstacles are caused by the private sector, but others on the administrative side, as well as the length of time to complete may be long. It is necessary to remove every one of them. To do this, the instruments in the policy packages need to work together seamlessly, not just individually. It also requires adjustment of policies to modify according to changing situation while implementing.

Elimination of obstacles

Various obstacles arise in energy efficiency improvement due to the different circumstances of individual consumers. The obstacles described in chapter 2.1 can be reclassified from the consumer's point of view as follows:

Preparation stage: Lack of knowledge and information; SMEs have few professional engineers, lacking knowledge. Even large companies often have no knowledge except for the specialized sections. Lack of understanding about information; as mentioned above, it is impossible to make a plan because technical information cannot be properly understood without a professional engineer. Planning effort; if there are no professional engineers, there is no effort to do energy efficiency planning as a job. Actual challenges; energy efficiency equipment tends to be enlarged and added, needs space, and has other challenges.

Decision stage: Awareness of decision-makers; do not prioritize energy efficiency as an investment decision. Differences in motivation among organizations and stakeholders; energy departments may prioritize energy efficiency, but this may not be the case with other departments involved in making decisions. Incomprehension of lost opportunity; not understanding the long-term benefits of hiring, miss opportunities. Status quo bias; consumers prefer to maintain the status quo because they tend to focus on losses rather than gains. Risk assessment of investments; place more importance on actual investment than uncertain profits. Added environmental investment; In addition to energy efficiency, investment targets such as the SDGs are expanding.

Execution stage: Absence of actors; SMEs do not have professional engineers, so there are no actors to implement the project. Lack of impetus; if there is no specialized department, the work becomes a duty outside of regular work, lacking a driving force. Legal restrictions, administrative procedures; additional or modern facilities face legal and administrative hurdles.

Economic matters: Own funds and access to funds; budget challenges because the investment is a prominent expense, not an ongoing expenditure. SMEs often need loans because they do not have investment capacity. Risk of uncertainty; future effects are subject to fluctuating factors such as energy prices, becoming a risk to upfront investment. Long-term payback; It takes a long time to recover the investment of equipment, and other investments take priority.

To address these various obstacles, it is necessary to design a detailed policy package in line with the reality of consumers. In particular, the presence of professional engineers who think internally from a corporate perspective is significant.

3.1.2 The general policy package for energy efficiency in industry

Figure 9 presents an overview of the general policy package for energy efficiency in industry.

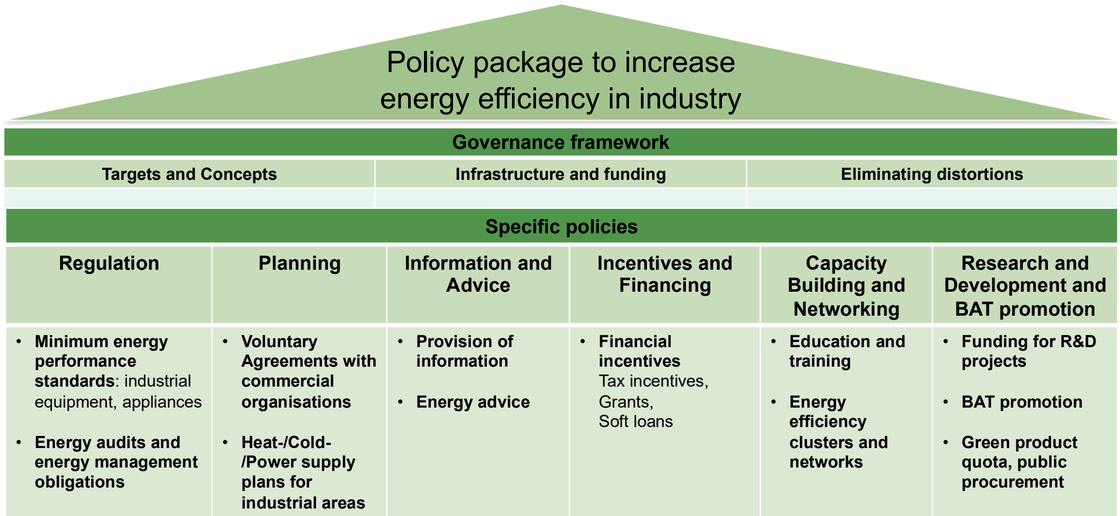

Figure 9: The general policy package for energy efficiency in industry

Source: (Schäfer-Sparenberg et al., 2017)

Figure 9 shows six broad categories of energy efficiency instruments, each with several types of instruments, that can be found in the literature.

Regulation can include minimum energy performance requirements or standards for industrial buildings, equipment, and even typical plants. In addition, regulation can have the objective to facilitate the search for potentials, and the development and implementation of energy efficiency projects, by mandating energy management or regular energy audits, setting up implementation plans or even requiring implementation of cost-effective projects, and finally reporting to the authorities about what has been implemented and achieved.

In connection to good oversight by the authorities, **voluntary agreements** may be an effective alternative to some of these regulations.

Such regulation or voluntary agreements will usually be more effective if combined with information and concrete advice on specific energy efficiency solutions, as well as with **financial incentives**. The latter could take several forms, such as tax incentives (tax rebates or accelerated depreciation), direct grants, or soft loans.

Other categories of instruments can support this core policy package of regulation, information and financial incentives or the 'sticks, carrots, and tambourines'. These categories include **planning**, e.g., heat, cold, and power supply plans for industrial areas, which aim to develop information and projects on energy exchange between companies in the area; **capacity building and networking**, which serve to secure the availability of qualified experts and, through the networks, the exchange between peers on 'what has worked' to stimulate replication, and finally **research and development** on innovation in energy efficiency solutions and special instruments to **promote** these innovations, such as award competitions, green product quota, or public procurement.

3.2 Interaction as a package with existing policies in Japan

In Japan, the importance of energy efficiency has long been recognized since the two oil crises in the 1970s. Japan's energy self-sufficiency rate is very low due to its lack of energy resources, and its energy costs are relatively high due to its dependence on imports. Because of the high positive correlation between energy efficiency and economic incentives, it was acceptable to consumers.

3.2.1 Direct regulations in combination with energy advice for SMEs and financial incentives

In Japan, regardless of industry subsector, businesses that consume energy above a certain threshold are subject to "direct regulations," which require (1) annual reports of energy consumption, (2) submission of medium- and long-term plans, (3) appointment of a qualified energy manager, and (4) obligation to make efforts to reduce energy consumption by 1% annually. Larger-scale businesses are often highly managed because they have knowledgeable professional engineers who plan and improve equipment. Since Japan has a lot of energy-intensive manufacturing industry, the subject of direct regulation is as high as 79% of total energy consumption in the industrial sector. Therefore, direct regulation consisting of four packages described below has been functioned well to improve energy efficiency in the sector.

As such, Japan’s policy package for energy efficiency in larger industry companies focuses on a set of interlinked regulations. However, this is combined with an information element – the benchmarking – and financial incentives in the form of investment subsidies. For SMEs, there is also an offer of independent energy advice. The following paragraphs provide some detail on these instruments.

Annual report of energy consumption

Annual reporting of energy use is the responsibility of the energy manager and is therefore highly accurate. For this purpose, measurements and records are made, and internal governance can be exercised to compare with the previous year. Factories, etc. are classified into three ranks of S/A/B according to the degree of achievement of reduction targets. S-rank operators, which have a high degree of achievement, are announced as excellent businesses. Inadequate B-rank operators are alerted, subject to detailed reporting, on-site inspection or target facility inspection, and required to submit improvement plans, which may result in fines, publication and orders. In the 2021 data, S-rank operators accounted for 53%, which was the majority, and B-rank operators accounted for 19%. Large factories have professional engineers with the capacity and effort to handle these pressures.

Correction of unfairness (Benchmark system)

Set a benchmark target for energy consumption per output in the same industry to the top 10-20%. A company is given the rank of S, if its benchmark achievement is high, and that accounts for more than 50% of their business. This system clarifies the goals that each industry should achieve. This also eliminates a sense of unfairness in evaluation due to an increase or decrease in production. The system extends beyond industry to commerce (convenience stores, hotels, offices, etc.), covering 70% of the industrial and commercial sectors.

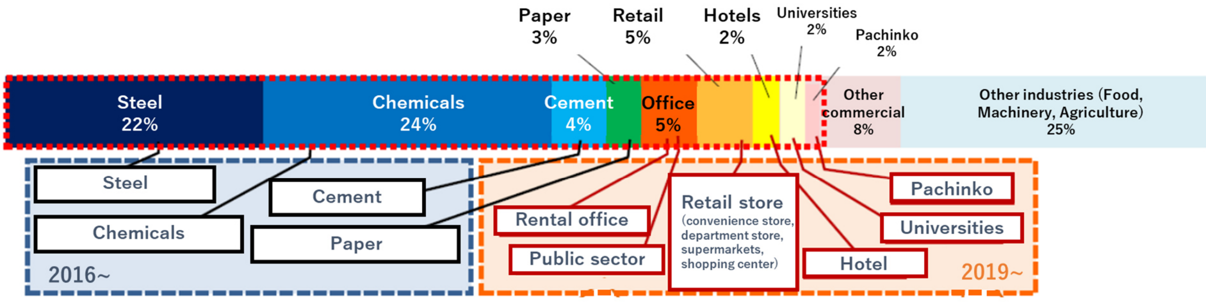

Figure 10: Benchmark system

Source: (Energy Efficiency Subcommittee, 2023)

Enlargement of the scope

Previously, when a company had multiple factories, although each of them was small, it was not subject to direct regulations. The regulations have changed, and if the combined total consumption of multiple plants is equal to or greater than the specified consumption, the company can be subject to direct regulations. Accordingly, the scope is also expanded as mentioned above, and the scope to be regulated has expanded in the benchmark system as well.

Sharing waste heat

The energy efficiency of one factory is sufficiently achieved. In order to further improve energy efficiency, a system was added to share waste heat among factories of different companies so that the overall energy reduction can be evaluated. This has facilitated the use of waste heat from others, such as cogeneration waste heat, and thermal accommodation in industrial complexes.

Notification of medium- to long-term plans

Large-scale factories are obliged to submit a "medium- to long-term plan" (3-5 years) for achieving the target every year. Examples of plant equipment to be invested are provided in the format. If a factory has earned an S-rank for two consecutive years, a period of exemption from submission is given. Energy equipment is subject to renewal timing and can be systematically renewed for investment over the elapsed years. Because of the long-term and continuous policy, companies can establish the system and create a reduction plan.

Energy efficiency award

As an activity of the advisory body in the government, there is an annual award program for factories and offices with high levels of energy efficiency measures. From the installation of new technologies to the improvement of operations, the technology related to energy efficiency is evaluated, and the awards are given on a regional, national and divisional basis. The award program not only enables companies to appeal to society and customers but also has the effect of raising the status of professional engineers within the company and motivating them. In addition, there is the effect that other factories can refer to the practice of good methods and promote the initiative in implementing the latest technologies. There are also competitions for household appliances, which are listed in the Top Runner section.

Appointment of professional engineers

Factories, etc. that use a large amount of energy must appoint 1-4 professional engineers (energy managers) according to the rank of energy consumption. Although the energy manager is a national certification and its exam level is high, 3,000 people pass the exam every year. The license is often acquired by people who are in charge of planning and managing equipment at factories, etc., which helps to maintain a high level of technology within companies. These companies have personnel responsible for energy efficiency planning, execution and operation, and are able to maintain a high level of energy management.

(Energy management and supervision officer) Even if an energy manager formulates an energy efficiency plan, it will not be adopted without the recognition of the decision-makers. Therefore, the head of the division with settlement authority is appointed as an energy management and supervision officer, who takes managerial responsibility for energy efficiency. In doing so, it promotes organizational understanding in companies and encourages them to consider energy efficiency as a company.

Energy efficiency optimization diagnostic service

The Energy Conservation Center, Japan (ECCJ) under the jurisdiction of the Ministry of Economy, Trade and Industry carries out the energy efficiency optimization diagnosis. In recent years, the demand has been high due to energy price hikes, making the number of requests grow. This diagnostic practice is added to the point scoring for the adoption of subsidies, and the diagnosis has been induced. Similarly, the Sustainable Open Innovation Initiative has established a system for SMEs to receive energy efficiency support from regional experts.

Subsidy

Energy efficiency subsidies have been implemented in the past. Subsidies are available for updating production equipment at factories to improve energy efficiency, and introducing high-efficiency equipment. In addition, the subsidies for conversion of equipment toward electrification and decarbonization were newly established in 2023. The subsidy ratio is set high for SMEs and is a major driver of energy efficiency. It has been increased from 2023 to 700 billion yen in 3 years.

3.2.2 Indirect regulations on product energy performance and information

In the area of appliances, Japan uses a combination of product regulation (the Top-Runner Program) and information through the energy label combined with regulation for retailers to provide energy efficiency information. This also covers some types of equipment that is used in industry.

Improving efficiency through the Top-Runner Program for consumer equipment

Since energy consumption in houses and SMEs is carried out in consumer equipment, energy efficiency standards (top runner standards) are set for each equipment, and manufacturers and importers are required to achieve the standards by the target year. The target equipment includes 32 items of energy-consuming equipment including private cars and building materials. Manufacturers are required that the weighted average energy consumption efficiency of shipped products exceed the standard, to increase the overall efficiency of market equipment.

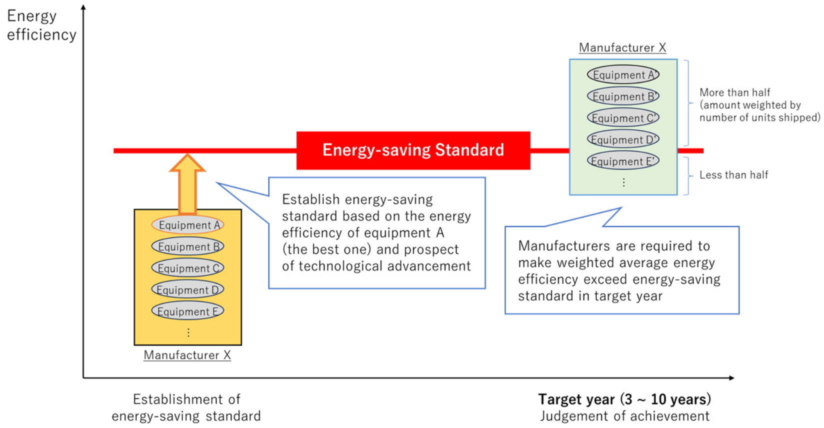

Figure 11: Top-Runner program

Source: (Energy Efficiency Subcommittee, 2023)

Retailer labeling system for energy equipment

22 out of 29 energy-consuming devices are subject to the energy-saving labeling system. This system stipulates that retailers of home appliances should endeavor to provide consumers with information, by labeling on products to indicate their energy conservation performance and economic efficiency. By showing economic efficiency, it allows consumers to choose highly efficient equipment by deepening their awareness when choosing.

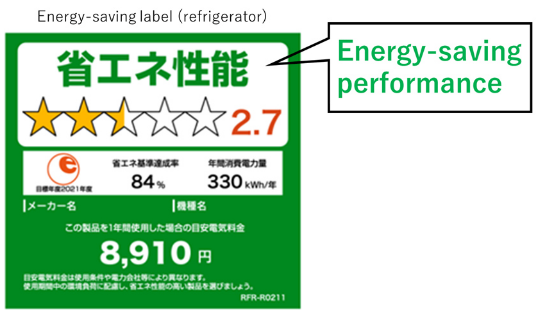

Figure 12: Labeling system for energy equipment

Source: (Energy Efficiency Subcommittee, 2023)

Provision of information for consumers

Appliance retailers and energy retailers are obliged to make efforts to provide energy efficiency information to consumers. Energy retail businesses are evaluated on the level of information and service provision, which are published as a communication ranking (optional, not mandatory). In Japan, direct regulations are functioning well, and it is necessary to deal with SMEs that are outside the scope of direct regulations.

3.3 Existing policies and their interplay as a package in the EU

In addition to national targets, the European framework conditions are also of great importance to Germany for the transformation process. Many national policy initiatives can only be understood in the context of European requirements.

The European Commission wants to respond to the pressing geopolitical and climate policy challenges with a series of political initiatives and intends to drive forward the green and digital transformation of European industry. In addition to the revised EU industrial strategy, with its special focus on small and medium-sized enterprises (SMEs), the Green Industrial Plan in particular aims to accelerate the transition to climate neutrality. The intended switch to climate-friendly energy sources can be achieved all the more quickly and cost-effectively the better the existing energy-saving potential can be tapped. This is because the lower the energy demand, the fewer additional renewable energy plants need to be built. Four elements are of central importance for the Green Industrial Plan (Bundesamt für Wirtschaft und Ausfuhrkontrolle, 2023)

1. planning certainty and simpler regulations
2. faster access to funding
3. expansion of competencies
4. open and fair trade

While open and fair trade is primarily aimed at energy trade, the other three elements are also relevant for energy efficiency in the industrial sector. This is because regulation, financing and capacity building are important for climate-friendly industrial policy as a whole and are also of great importance for the focus on energy savings. However, other elements are also needed to tap into the potential for energy savings. SMEs in particular, but also industrial companies that supply large industrial sectors, often lack the knowledge of how energy can be saved. Many industrial companies are not aware of technical innovations and their cost-effectiveness. Therefore, information and advice elements are a further aspect. Finally, the area of research and development plays a central role. This is because numerous innovations in technical developments, but also communication tools for increasing acceptance, calculating economic efficiency and many other aspects, can be significantly improved and tested in pilot projects through appropriate research funding.

Figure 13 provides an overview of the EU directives that have a strong influence on German energy efficiency policy for the industry sector. As the graph shows, there are legal provisions, mostly directed to the Member States, for implementing most types of policy instruments discussed in chapter 3.1 as part of the policy package for energy efficiency in industry, and covering all six categories of instruments.

For example, energy audits are mandatory for all companies, if they surpass a certain threshold[4] of energy consumption. This includes also SMEs. Energy management systems are only mandatory for large industries with a high energy demand. In municipalities with a population above 45,000 local heating and cooling plans have to be prompted (European Comission, 2023a).

[4] Based on (80) EED the specific European standards on energy audits are currently under development. However international standards, such as EN ISO 50001 (Energy Management Systems, EN 16247-1 (Energy Audits) and EN ISO 14000 (Environmental Management Systems) should be considered.

Policy package to increase
energy efficiency in industry with selected EU policies

Governance framework		
Targets and Concepts	Infrastructure and funding	Eliminating distortions

Specific policies					
Regulation	**Planning**	**Information and Advice**	**Incentives and Financing**	**Capacity Building and Networking**	**Research and Development and BAT promotion**
• **Minimum energy performance standards**: Industrial Emissions Directive; Ecodesign Directive • **Energy audits and energy management**: Article 11, EED	• **Voluntary Agreements with commercial organisations**: under Article 10, EED • **Heat-/Cold-/Power supply plans for commercial areas**: Art 25 (6) EED for municipalities > 45,000 inhabitants	• **Provision of information**: *no EU policies implemented* • **Energy advice:** Articles 10 and 22, EED	• **Financial incentives**: under Article 10, EED	• **Education and training**: under Article 10, EED • **Energy efficiency clusters and networks**: *no EU policies implemented*	• **Funding for R&D projects:** Horizon Europe • **BAT promotion**: *no EU policies implemented*

Figure 13: Policy package to increase energy efficiency in industry with selected EU policies

Source: Schäfer-Sparenberg et al., 2017; updated for the 2023 recast of the energy efficiency directive (EED; 2023/1791)

In addition to the energy efficiency policies, there are also other overarching policy initiatives.

With regard to the necessary financing for the transformation of industry, the EU wants to remove existing barriers and provide financial incentives at the same time. To this end, the European Commission wants to ensure a level playing field in the internal market and at the same time make it easier for member states to grant the necessary subsidies for a climate-friendly transformation of the industry. Specifically, the European Commission has created opportunities for state aid in order to transform the industry in a future-proof manner with a view to the Green Deal (European Commission. Directorate General for Communication., 2021). In addition, EU funds for innovation, production and the introduction of clean technologies are to become more readily available. To reduce the industry’s dependency and clarify investment needs, the Commission is also examining the establishment of a European Sovereignty Fund.

With regard to the expansion of skills, the European Commission is pursuing a strategy at the European level to build up skills for new technologies and attract skilled workers from other countries. For example, academies for a CO_2-neutral industry are to be developed to offer further training and retraining programs.

Open and fair trade is to be strengthened through global cooperation and the role of trade in the green transition. To this end, the Commission is further expanding EU free trade agreements and other forms of partnership cooperation in the interests of the green transition. At the same time, however, the internal market is to be protected against unfair trading practices.

3.4 Existing policies and their interplay as a package in Germany

3.4.1 Energy consumption and energy saving potentials in German industry

Energy consumption in Germany has only fallen slightly since the beginning of the 1990s. Although energy is being used more and more efficiently and energy-saving potential has been tapped in many cases, economic growth and increases in consumption of goods and services are preventing a more significant reduction in absolute final energy consumption. This becomes clear when you consider the development of energy productivity. This reflects the ratio of gross domestic product to energy consumption. It is often used as a measure of efficiency in the use of energy resources. German energy productivity has risen significantly since 2008. In addition to energy efficiency, this was also due to a change in the economic structure. The following chart illustrates this development.

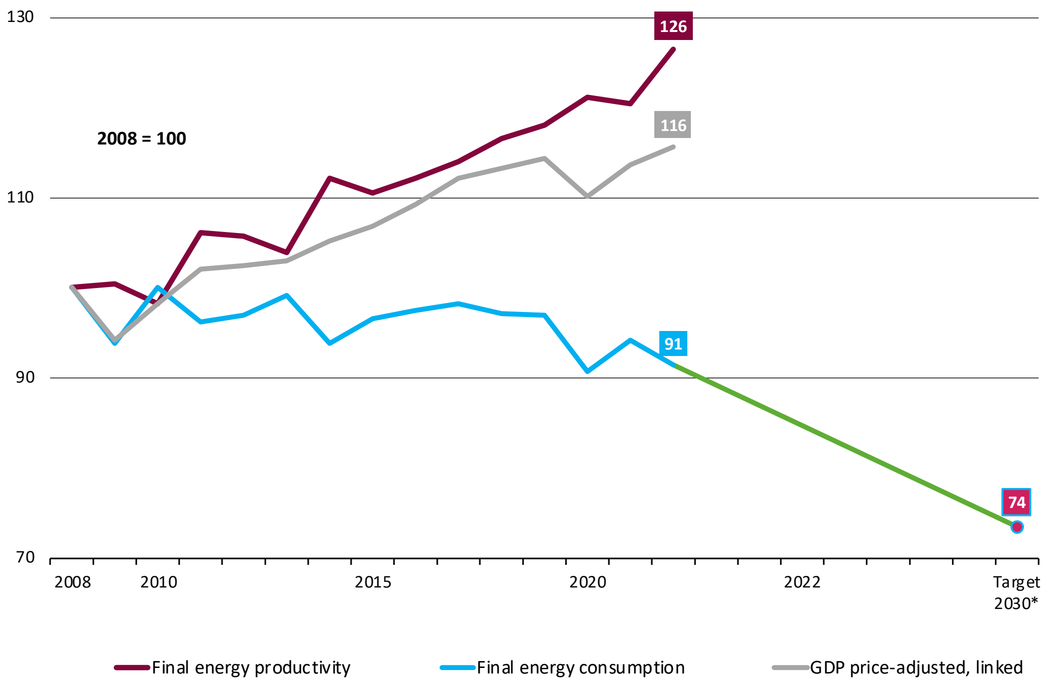

Figure 14: Final energy productivity in Germany - Gross domestic product (GDP) in relation to final energy consumption

Source: German Environment Agency on the basis of final energy consumption: Working Group on Energy Balances, Energy Balances (as of 11/2023); Gross domestic product: German Federal Statistical Office, Genesis, Table 81000-0001 (as of 09/2023).

This general trend also applies to final energy consumption in industry. Apart from years with economic downturns (2009, 2020 and 2022), this has remained almost constant over the last three decades. Progress in energy efficiency has been offset by economic growth (Figure 15).

Around two-thirds of final energy consumption in industry is required for process heat. Mechanical energy, for example for operating electric motors or machines, accounts for around a quarter of consumption, while space heating only accounts for a small proportion (UBA, 2023a).

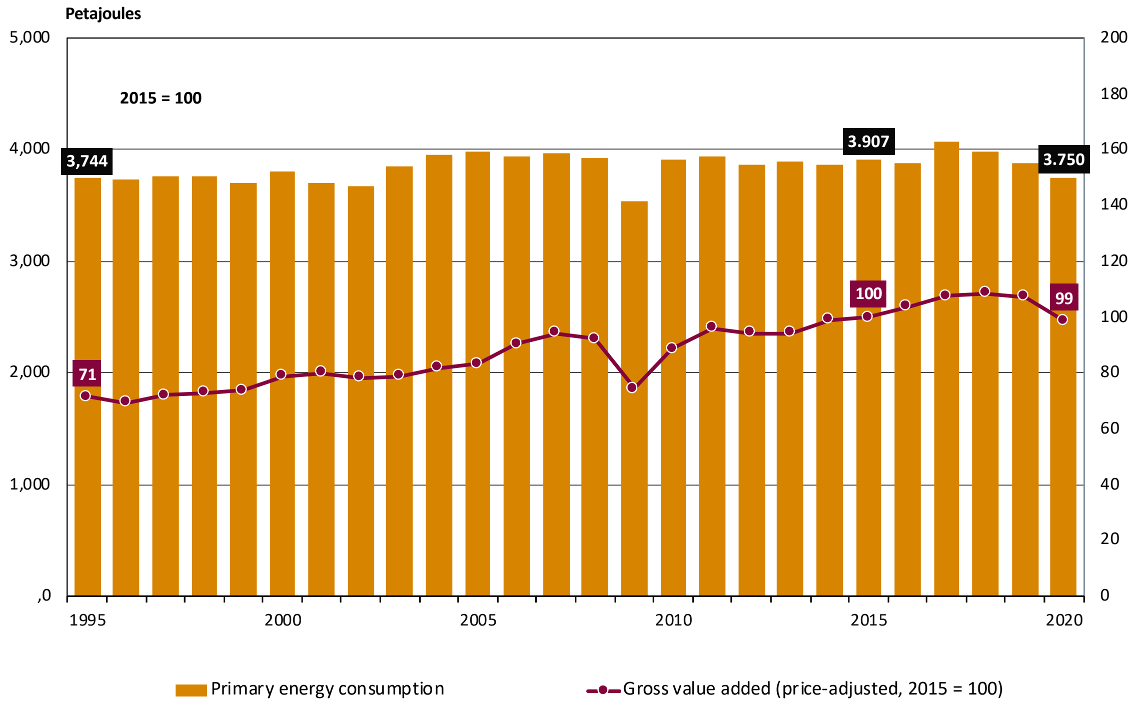

Figure 15: Primary energy consumption in the German manufacturing industry

Source for energy consumption: Federal Statistical Office of Germany 2022, UGR. Energiegesamtrechnung. Berichtszeitraum 2000-2020. Tabellenblatt 3.4 (in German only); Federal Statistical Office of Germany (m. y.): Tabellen zu den UGR, Umweltnutzung und Wirtschaft, Teil 2, Energie (in German only); Source gross value added: Federal Statistical Office of Germany 2023, Inlandsproduktberechnung - Lange Reihen ab 1970, Fachserie 18, Reihe 1.5 - Tabelle 2.2 (in German only).

Figure 15 shows that the primary energy consumption of the German industry ('manufacturing') in 2020 has hardly changed compared to 1995: It was around 3,744 petajoules (PJ) in 1995 and 3,750 PJ in 2020. After a longer phase of fairly constant values, 2017 saw the highest value in the time series at 4,067 petajoules (PJ). Since then, energy consumption in the German industry has been falling continuously. In contrast, gross value added in the industry rose by around 38% (taking price trends into account). This means that industry is using energy much more efficiently today than in the past. The development also makes it clear that the successes to date in reducing CO_2 emissions in the industry are largely due to the expansion of renewable energies. The relative decoupling of gross value added and *final* energy consumption in Industry is caused by energy efficiency, structural change and the increased use of renewable energy.

In its energy concept, the German government has set itself targets for primary energy consumption: By 2020, this should have fallen by 20 % compared to 2008 and it should fall by 50 % by 2050 (BMWi, BMU, 2010). According to the Federal Environment Agency, the target for 2050 cannot be achieved unless the industry also reduces its energy consumption in absolute terms (Umweltbundesamt, 2023b). The importance of energy efficiency in the industrial sector is therefore high, and existing and - due to innovations - additional potentials must be consistently tapped in order to achieve the targets. Additionally, combining energy efficiency with material efficiency and strategies of a Circular Economy can contribute to an absolute reduction of energy use.

In industry, new processes must therefore be established in basic industries, especially in energy-intensive sectors like steel, metals, aluminum, chemistry, cement, glass, pulp, paper, etc., in order to achieve the climate targets. The fact that around 50% of industrial plants in the German primary materials industry are due for reinvestment over the next ten years will have a supporting effect (Prognos, Öko-Institut, Wuppertal-Institut, 2021).

There is currently a lot of talk about hydrogen strategies in the steel industry, but simply converting the energy source can only unlock part of the potential for climate protection. New processes based primarily on hydrogen and biomass (Prognos, Öko-Institut, Wuppertal-Institut, 2021) undoubtedly have great potential for climate protection. However, efficiency measures can also contribute and can be implemented more quickly. According to a study by ABB, steel production is still an energy-intensive process with considerable losses. The majority of the energy used in iron and steel production is accounted for by blast furnaces, which consume around 81% of the energy. However, there is still considerable potential for savings in the remainder. This primarily relates to the savings potential in electricity applications. Due to the very high proportion of blast furnaces, these potential savings have often been overlooked to date. Although motors only account for around 7% of total energy consumption in the steel industry, it is estimated that up to 70% of this can be saved. This potential is found in rolling mills, blowers, fans, pumps, compressors, conveyors and other transportation applications such as overhead cranes. A study by the US Department of Energy came to the conclusion that up to 70% of the energy used for motor systems in the iron and steel industry can be lost due to inefficient systems (ABB, 2022, p. 6). Although there are no current consumption figures regarding the savings potential in motor applications for Germany, a dissertation from 2017 shows that the technical energy savings potential in the production of iron and steel in Germany amounts to 19% of the energy requirement from 2013, which means that around 8% can be tapped economically (Brunke & Ulf, 2017, p. 122).

In 2022, German industry emitted around 164 million tons of CO_2 equivalents. Industry therefore accounts for over 20 percent of national greenhouse gas emissions (UBA, 2023). This emissions volume alone makes it clear that industry is a very important sector for the national climate protection strategy. Within the industrial sector, energy-intensive industry plays a dominant role, accounting for around two-thirds of emissions. The steel and cement industries in particular produce large quantities of CO_2, which is due to process-related procedures and high process temperatures. Decarbonization in these industries is therefore particularly challenging.

However, given the global climate protection targets, there is no alternative. Highly industrialized and wealthy countries such as Japan and Germany must demonstrate as frontrunners that decarbonizing also hard to abate industries is technically feasible and in the long run economically viable. They can then be a role model for other countries if the necessary transformation of industry is successful, jobs are preserved and innovations enable a competitive advantage. Against this backdrop, the development and further development of policy packages that contribute to increasing energy efficiency in industry is of great importance.

In Germany and the EU, there is a broad funding framework to stimulate the necessary transformation of industry. Some of the funding is well interlinked in the multi-level political system. In general, a distinction can be made between cross-sectoral funding for certain technical innovations (such as energy-efficient motors and pumps, which are used in many manufacturing processes) and funding for sector-specific processes (such as switching energy sources and new production processes in steel production). Finally, a distinction can also be made between energy-saving incentives that contribute to electricity savings, those that encourage savings in heating or cooling and those that promote a change of energy source (often to electricity). The following is a rough overview of the current funding framework.

Given the importance of industry in terms of the jobs it creates and the prosperity it generates, there is a political interest in stable and business-friendly framework conditions. In 2022, the energy-intensive industry accounted for around 140 billion euros in gross value added (and around 14% of employees in the industry), while the non-energy-intensive industry accounted for around 700 billion euros (BMWK, 2023b).

While the non-energy-intensive industries were remarkably resilient during the crises of the recent past, the production in energy-intensive sectors fell noticeably in the wake of the turmoil in the energy markets as a result of the Russian war of aggression against Ukraine and has not yet recovered fully.

From the perspective of German industrial policy, competitive energy prices are therefore of great importance for companies. As the prices for practically all energy sources have risen massively as a result of the Russian war of aggression against Ukraine, political measures had to be implemented accordingly to preserve industrial jobs and the associated prosperity.

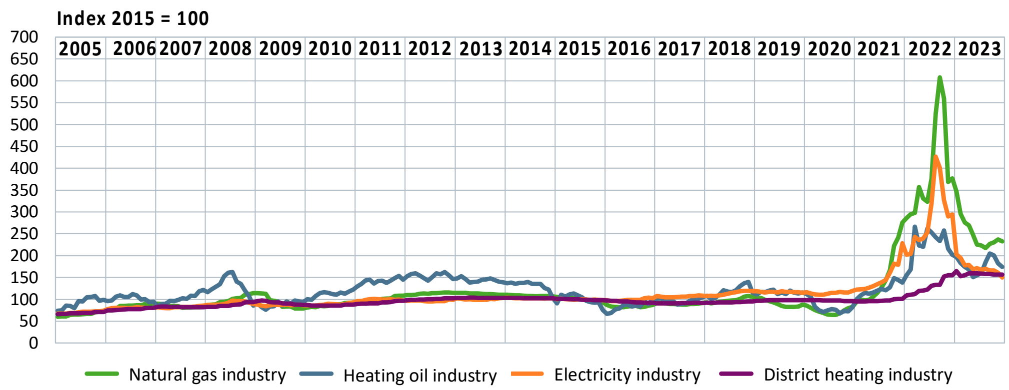

Figure 16: Development of various energy prices for industry

Source: Destatis (FS 17, R 2), illustration based on the BDEW electricity price analysis of February 2024, https://www.bdew.de/media/documents/240223_BDEW-Strompreisanalyse_Februar_KORR_23.02.2024.pdf

Several measures were taken to make the domestic industry less dependent on such crises in the long term. A central pillar of the associated strategy, next to energy efficiency improvements, is the rapid expansion of renewable energies and the necessary infrastructure. In the view of the German government, this is of utmost importance for the future of the industrial location, as only with renewable energies can electricity prices fall again in the long term and sustainably (BMWK, 2023b). The very ambitious German expansion targets of renewable energies are therefore aimed at achieving a competitive price level.

Against the background described above, many measures have already been taken and it is to be expected that a large number of further initiatives will be taken at the national level to increase energy and resource efficiency in industry.

3.4.2 Regulation

The EED (Energy Efficiency Directive) also has a considerable influence on national legislation. The Energy Efficiency Act (EnEfG) and the Energy Services Act (EDL-G) specify that all companies with an average total annual energy consumption of more than 7.5 GWh per year must introduce and operate an energy or environmental management system within 20 months of the law coming into force (November 18, 2023). In addition, all companies with an average total energy consumption of more than 2.5 GW per year that operate an energy or environmental management system or have completed an energy audit will be obliged to draw up implementation plans for cost-effective final energy saving measures. These plans must be published by independent experts and verified by independent experts. Prospectively, waste heat from production processes shall be avoided. The information about industrial waste heat potential shall be compiled in a new platform and be publicly accessible (BMWK, 2023a).

3.4.3 Planning

With regard to planning measures, the law on heat planning and the decarbonization of heating networks (Heat Planning Act) came into force in Germany at the beginning of the year (2024). According to this law, heating plans must be in place in large cities (with more than 100,000 inhabitants) by June 30,2026 and in smaller municipalities with fewer than 100,000 inhabitants by June 30, 2028. Very small municipalities (with fewer than 10,000 inhabitants) can undertake a simplified heat planning procedure but are not exempt from the obligation. The Heat Planning Act sets certain targets for the generation of heat in heating networks: From March 1, 2025, new heating networks must be supplied with heat from renewable energy sources, unavoidable waste heat or a combination of these to account for at least 65 percent of annual net heat generation.

This opens up an opportunity to tap into the high waste heat potential of the industry (Kawamura, Taro et al., 2023). A recent study as part of a Horizon project has shown that 29 petajoules of waste heat from industrial sites in Germany could be used for space heating (https://seenergies.eu/). This would create an opportunity to enable the efficient and low-CO_2 heat supply of buildings through the use of industrial waste heat in district heating systems. Energy-intensive industrial sites in the chemical, iron and steel, cement, glass, paper and refinery sectors produce a lot of surplus heat, particularly from flue gases, but this is rarely used at present. In the future, the heating plans will show how this potential can be made visible on a decentralized basis and provide an incentive to use this heat in heating networks.

In the broadest sense, planning measures also include voluntary agreements between industry and the state. In the federal state of Baden-Württemberg, for example, there are special climate protection agreements aimed at reducing greenhouse gas emissions and energy consumption in companies and becoming climate-neutral in the process. The following applies: avoidance of emissions before reduction before compensation. By signing the climate protection agreement, the climate alliance partners - the Ministry of the Environment on behalf of the state of Baden-Württemberg and the company - declare that they will support each other in achieving the political and corporate climate protection goals and work together cooperatively. In the climate protection agreement, the companies set out their corporate goals for the next ten years and substantiated them with a 5-year interim target and corresponding measures. The company targets and measures are discussed in a content-related coordination process with the Ministry for the Environment, Climate Protection and the Energy Sector of the federal state of Baden-Württemberg. After a successful vote, the country and the company management sign the climate protection agreement by mutual consent and thus join the Climate Alliance. Voluntary commitments by industry can affect not only the manufacturing process but also the goods produced.

In industry, voluntary commitments can also be considered as an alternative to ecodesign implementation measures within the meaning of Art. 17 of the Ecodesign Directive. This is possible if the political objectives can be achieved faster or more cost-effectively with a voluntary commitment than with any implementing regulations.

3.4.4 Information and advice

There are currently 38 energy and climate protection agencies in the federal states and some municipalities and regions organized in the Federal Association of Energy and Climate Protection Agencies in Germany (see: https://energieagenturen.de). There is also the German Energy Agency (dena). One of the most important goals of these agencies is to inform about best practices and BAT to ensure that energy is used as efficiently as possible. According to the energy agencies themselves, their experience shows that energy costs in companies, commercial buildings and public properties can often be reduced by 30 percent or more. According to the association's website, around half of this can be achieved through non-investment measures such as energy controlling, system optimization, training and raising user awareness. The task of the energy agencies is to identify this existing potential and support companies in tapping into this potential as economically as possible and using existing funding programs. To this end, numerous regional and sector-specific information campaigns and events are held.

3.4.5 Financial incentives

The Federal Office of Economics and Export Control is already supporting the German economy in its transformation process in a variety of ways through the Federal Promotion of Energy and Resource Efficiency in the Economy (EEW) (Bundesamt für Wirtschaft und Ausfuhrkontrolle, 2023). Key elements of this are presented below. For example, EEW provides for grants and special loans. Of great importance in this context is the promotion of technologies that facilitate the transition to a resource-efficient and energy-saving industry. Investments to replace or purchase new systems or units for industrial and commercial use are supported with up to 200,000 euros and a funding rate of up to 50 percent. These are above all the following cross-cutting technologies

- Electric motors and drives
- Pumps for industrial and commercial applications
- Fans
- Compressed air systems and their higher-level controls
- Systems for waste heat recovery or heat recovery from wastewater
- Insulation of industrial systems and system components
- Frequency converters

Very good funding conditions also exist for the purchase of software and hardware in connection with the establishment or application of an energy or environmental management system at companies. The maximum funding amounts to 15 million euros per investment project with a funding rate of up to 50% of the investment costs.

In particular, the purchase, installation and commissioning of

- software solutions to support an energy management system or environmental management system (energy management software)
- sensors and analog-to-digital converters for recording energy flows and other variables relevant to energy consumption for the purpose of integration into the energy or environmental management system
- control and regulation technology for influencing systems and processes, provided that the primary purpose of their use is to reduce energy consumption

Eligible investment costs include in particular

- Purchase of a license to use an energy management software or software solution
- Purchase, installation and commissioning of
    - Sensors for integration into an energy or environmental management system or alternative system
    - Analog-digital converters
    - Actuators for the efficient control/regulation of energy flows
    - Data loggers and gateways for transferring sensor data to the software solution, the use of which should lead to a quantifiable reduction in energy consumption
- Instruction or training of personnel by third parties in the use of the subsidized software solution

If the energy management software is a cloud service, the full external costs of use.

There is great potential to improve the energy and resource-related optimization of systems and processes through various technical innovations that reduce the consumption of fossil energy and save CO_2-intensive resources in companies. In order to address this in particular, there is also a technology-open funding scheme that aims to bring promising inventions to market maturity.

This area primarily supports investment measures aimed at saving energy and resources by modernizing processes and procedures. Specifically, investments in energy-efficient systems and machines and the replacement of individual components as well as energy and resource-oriented optimization of process management are financially supported. This also includes the use or development and provision of waste heat from industrial processes. Funding is also available for feeding waste heat into heating networks. The construction of district heating pipelines is also covered by this funding. Innovative technical solutions can also be funded in order to exploit previously unused waste heat potential using innovative technology such as Organic Rankine Cycle (ORC) technology to generate electricity.

Investments to increase the energy and/or resource efficiency of systems for heat supply, cooling and ventilation are also eligible for funding, provided that these systems are clearly and predominantly used for processes for manufacturing, processing or refining products. This funding program explicitly addresses the increase in competitiveness, as it also promotes the avoidance of energy and/or resource losses in the production process. This applies, for example, to the production of thermal insulation/heat insulation for systems and distribution lines as well as measures to avoid production waste.

A change of energy source that contributes to the use of a renewable energy source instead of a fossil fuel, supporting the energy-efficient electrification of processes in industry, is also supported.

In addition, there is financial support for expenses for the creation of a savings concept and the implementation support of the subsidized investment measure by external energy consultants.

Up to 15 million euros per investment project with a funding rate of up to 50 percent of the eligible investment costs can be applied for. The maximum funding is limited to an amount of 500 euros (900 euros for medium-sized companies and 1200 euros for small and micro companies) per ton of CO_2 saved annually (funding efficiency).

The incentives and financing options mentioned here are closely linked to regulatory and informational measures. For example, it is a prerequisite for funding that a savings concept has been drawn up by an energy consultant. The creation of such concepts can also be subsidized and high demands are placed on the quality of energy consultants, which must be documented by certificates.

3.4.6 Capacity building and networking

A particularly successful network for promoting capacity building in Germany and Austria especially for small and medium enterprises (SMEs) is the so-called ÖKOPROFIT®. It is not geared towards individual companies but aims to create a local network for environmental protection. After the first year of taking part in the program, many companies join a club in which they are informed in workshops about new developments in environmental law and relevant organizational and technical innovations, such as energy-saving innovations.

Important components of the concept are joint workshops for the participating companies, in which the content is conveyed, and on-site consultations by Ökoprofit consultants. After approximately one year of the project, the companies are audited and awarded for their achievements by the municipality. Many companies complete their environmental management system after participating in the basic program.

In Germany, over 4,000 companies have taken part in Ökoprofit projects to date. In the federal state of North Rhine-Westphalia (NRW) alone, which is home to many industrial companies, around 3,000 companies have taken part in this project. In NRW, the savings successes were balanced, according to which 40,400 tons of waste, 3.1 million m^3 of water or wastewater, 545 million kWh of electricity, 186,000 t of CO_2 and around €50,000,000 in operating costs are saved each year. The investment for these savings measures amounts to € 141,000,000 and the payback period is about three years.

Another important energy efficiency network also for small and medium enterprises (SMEs) is the LEEN network: Ten to 15 companies work together in Learning Energy Efficiency Networks (LEEN networks) to learn from each other by sharing experiences and thus reduce energy consumption in a time and cost-effective manner. This also reduces energy-related greenhouse gas emissions. The Federal Ministry for the Environment has expanded the "LEEN100" project, which has been running since August 2014 as part of the National Climate Initiative, to "LEEN100plus" and facilitates participation in new energy efficiency networks. Participants were initially subsidized with up to 4,000 euros per company, in particular for the energy audit or implementation advice (see: https://www.energie-effizienz-netzwerke.de/een-de/index.php).

LEEN network companies aim to reduce their energy costs much faster than the industry average. Many years of experience have shown that companies participating in LEEN networks can reduce their emissions by an average of 1,000 tons of CO_2 per company after four years and reduce their energy costs by an average of ten percent after four years. This means that they increase their energy efficiency twice as fast as the industry average - and thus also their competitiveness. The main starting points for the joint work in the network are efficiency improvements in cross-sectional technologies (e.g. generation and distribution of compressed air, heating and cooling as well as electrical drives, lighting, waste heat recovery) and organizational measures (Energieeffizienz Netzwerke, 2024).

In December 2014, the German government and 22 industry associations and organizations agreed on the introduction of energy efficiency networks and thus launched the Energy Efficiency Networks initiative. Due to the successful work of the networks, it was agreed in September 2020 to continue the initiative until the end of 2025 with an additional focus on climate protection, resource efficiency and sustainability. Since January 2021, the alliance has therefore been continued as the Energy Efficiency and Climate Protection Networks Initiative. The aim of the initiative is to establish 300 to 350 new networks by the end of 2025 and save nine to eleven terawatt hours of final energy or five to six million tons of greenhouse gas emissions. Since the initiative was launched in 2014, more than 330 networks with more than 3,100 companies and locations have been established (as of March 2022) (BMWK, 2022)

3.4.7 Research & development and best available technologies (BAT):

The Federal Ministry of Education and Research (BMBF) supports research and development projects on innovative basic energy technologies that can make a significant contribution to the success of the energy transition. The Federal Ministry for Economic Affairs and Climate Protection also supports innovations for the energy transition in its energy research program. As a strategic element of energy policy, the program is aligned with the energy transition. Funding is provided for projects that contribute to reducing energy consumption and increasing renewable energies. In particular, the goal of reducing primary energy consumption by half by 2050 compared to 2008 is very ambitious. Funding is available for technical and social innovations, which may also include financing and projects to increase acceptance.

The federal states also have special funding programs in this area. EU funds, for example, are also used here. The European Regional Development Fund (ERDF) and the Just Transition Fund (JTF), for example, support projects in the areas of innovation, sustainability and the promotion of SMEs. ERDF funding can cover an entire federal state. JTF funding, on the other hand, is limited to areas that are particularly affected by the coal phase-out.

Figure 17 summarizes the policy instruments in Germany's policy package for energy efficiency in industry.

Governance and policy package
to increase energy efficiency in industry sector

Governance framework

Targets and Concepts	Infrastructure and funding	Eliminating distortions
• Energy efficiency targets • Roadmaps and Strategies	• Energy (Efficiency) Agencies • Energy Efficiency Funds • Energy Efficiency Obligations/ Resource Standards for utilities • Promotion of energy services	• Energy / CO_2 taxation • Emissions Trading • Removal of legal barriers

Specific policies

Regulation	Planning	Information and Advice	Incentives and Financing	Capacity Building and Networking	Research and Development and BAT promotion
• Minimum energy performance standards: industrial equipment, appliances • Energy audits and energy management obligations	• Voluntary Agreements with commercial organisations • use of industrial waste heat -> Heat-/Cold-/Power supply plans	• Provision of information • Energy advice	• Financial incentives Tax incentives, Grants, Soft loans • National funding programs, in particular the Climate and Transformation Fund	• Education and training • Energy efficiency clusters and networks	• EU-Funding for R&D projects (Horizon 2020, Life, EFRE, …) • Green product quota, public procurement

Figure 17: Governance and policy package to increase energy efficiency in industry sector

Source: (Schäfer-Sparenberg et al., 2017)

3.5 Analysis of existing policies and their interactions compared with the concept of effective policy packages

The policies on energy efficiency in industry of the two countries show that the policy packages are implemented according to the characteristics and circumstances of each country.

In Japan, energy efficiency was legislated immediately after the oil crisis. Public awareness of energy efficiency was developed and the situation was easily accepted. Owing to the rapid progress of renewable energy policy in recent years, the current focus is on renewable energy, and it will be necessary to educate people about energy efficiency again. Greater energy efficiency will require a commitment from the government and a budget that can be guided. The policy package of direct regulations for the industry and commercial sectors is also working. Periodic reporting, commitment to efforts, and the preparation of medium- and long-term plans can clarify the energy efficiency actions of the company. Companies are structured to make systematic reduction efforts under moderate pressure. In addition, changes have been made to correct the sense of unfairness and expand the possibility of efforts, such as expanding the flexibility of the calculation method based on the benchmark system, expanding the scope of regulation, and accommodating waste heat. A feature in the Japanese system is the appointment of internal professional engineers. It is a structure in which internal professional engineers obtain information, examine with knowledge, and act as actors to eliminate obstacles. There is also a support system for licensing and training for professional engineers and sharing technical information. However, this structure is established in large-scale industries, but not in SMEs. This segment requires support from the surroundings, such as the energy advice offered by the Energy Conservation Center, Japan as well as private consultants, and investment subsidies.

In Germany, energy efficiency is a fundamental principle of energy and climate policy and therefore cannot be completely separated and independent from these overarching policy fields. Around 50% of the industry's core factories will be reinvested over the next decade, with support encouraging the establishment of new processes. Energy efficiency is a fundamental principle of climate policy not only in Germany but also in the EU, and this makes sense. Germany and the EU have financing frameworks for specific innovations and sector-specific processes to promote industrial transformation, incentives to save electricity, change energy sources and consumer incentives. It also requires and promotes the introduction of energy and environmental management systems in companies, and supports financing not only for software but also for hardware. This will help improve the control of energy use and will also include training for company personnel. Germany is implementing new policies, where subsidies and regulatory requirements complement each other.

As chapter 3.4 has discussed and Figure 17 summarizes, Germany's energy efficiency policy package for industry combines regulation on energy management systems or energy audits, as well as the EU's ecodesign requirements for energy-related equipment, with strong financial incentive programs and supporting instruments, such as voluntary energy efficiency networks, voluntary agreements, and now also the municipal heat planning, which may become very effective in better utilization of waste heat in the future.

Federal funding for energy and resource efficiency in the economy (EEW) also supports the decoupling and feeding of industrial and commercial waste heat into heating networks with an investment grant or a loan with a repayment subsidy (BMWK, 2024b). Funding is provided not only for the heating network infrastructure and the supply of heat, but also for the demand side. In addition to efficiency improvements such as thermal insulation, the federal subsidy for efficient buildings also supports the connection of a building to an existing heating network. Smaller heating networks ("building networks") are also subsidized if they are fed with a minimum proportion of renewable energy (BMWK, 2024).

On the other hand, there is the law on heat planning and the decarbonization of heating networks (Heat Planning Law), which requires the creation of a regional / local heating plan depending on the size of the municipality. According to a research project, this policy is expected to generate 29 PJ of waste heat utilization. Meanwhile, efforts are also underway to build voluntary alliances between industry and states to voluntarily work together on climate action. This law works together with the Building Energy Act to implement the so-called 65 percent renewable energy target. It initiates the switch to climate-friendly heating systems and reduces the use of fossil fuels. According to this law, new heating systems may only be installed in future if they generate at least 65% of the heat provided using renewable energies. Alternatively, the building can also be connected to a heating network.

Both countries have their own approaches, and effective elements can be seen depending on each country's characteristics and circumstances. The package of activities differs depending on the culture of the country, such as Japan's system to train specialized engineers in-house, and Germany's framework for companies to voluntarily form networks together to tackle energy efficiency. In order to further improve energy efficiency, it will be necessary to share mutual success points and take effective measures. This can help Japan and Germany to develop a coherent mix of policy measures.

4 Policy recommendations

4.1 Policy recommendations for energy efficiency governance

This chapter discusses a few policy recommendations that are beneficial to reach ambitious energy efficiency target achievement, building on existing experiences in both countries where relevant.

1. **Efficiency roadmap up to 2030 and extended Energy Efficiency Laws**
Both countries should establish a roadmap how they could contribute most to the COP28 goals of increasing the annual rate of energy efficiency up to 4%, while taking the tripling of renewable energy capacities up to 2030 into account. The roadmap should be based on an extended Energy Efficiency Law establishing ambitious and binding efficiency targets up to 2045 (Germany) and 2050 (Japan) and an effective energy efficiency governance.

2. **Study on saving potentials, benefits and costs**

We recommend that both countries conduct comprehensive bottom-up studies on the potentials, benefits and costs of energy savings, covering both cross-cutting technologies for application in all sectors (e.g., motors, pumps, fans, heating/ cooling, communication infrastructure, appliances) and key processes in energy intensive sectors. Multiple impacts, e.g., for productivity, jobs, resources, health etc. should be assessed as well.

3. **Federal Energy Efficiency Agency within a polycentric institutional setting:**
In Germany (and in Japan) energy efficiency is a major pillar for the energy transition. Nevertheless, a multitude of different ministries and institutions have scattered responsibilities, relatively low budgets and scarce human resources (comparable to the supply side) and no clear mandate for planning, financing, implementing, supporting, monitoring, and reporting in order to reach the ambitious energy efficiency targets. This fragmentation of responsibilities can lead to inefficiency in the implementation process, inefficient use of financial and human resources, communication conflicts and low transparency for enterprises and households. Therefore, concentrating the steering and coordination responsibility in a strong federal Energy Efficiency Agency, which is legally responsible for the target achievement, can foster an effective implementation and helps to close existing gaps. In Germany, this needs to be embedded in the context of a polycentric governance with existing local and regional energy agencies and newly established local/regional One-Stop Shops for guiding the retrofit of the building stock. It should be assessed how the mandate and the institutional setting, with regards to energy efficiency policy analysis and implementation, of existing federal institutions like the DENA, the BfEE and the KfW could be extended or combined within a 'Federal Energy Efficiency Agency' with a respective energy efficiency fund. It is advisable to also integrate resource efficiency and related circular economy strategies into this governance structure.

4. **Monitoring:**
The German federal government has to report to the German parliament the status of energy efficiency at the beginning of a legislative period in order to suggest adjustments if the targets are

not meet. This means that only every four years recommendations for adjustments in energy efficiency polices can be made. Due to the impact and importance of energy efficiency, a more frequent monitoring is essential to ensure the overall target achievement. A yearly or biyearly monitoring should therefore be decided. In Japan, the Ministry has to report the energy white paper, i.e. record of energy status and policy in last year, to the parliament every year. The Council on Energy Efficiency also reviews the situation every year. In this sense, there is a system to monitor the energy efficiency status annually. However, Japan could further improve the monitoring by establishing key indicators that can well represent the policy target.

5. **Establish a strong Efficiency Lobby**

In Germany, the German Business Initiative for Energy Efficiency (DENEFF) was founded in 2010 and developed to a ‘strong voice’ for energy efficiency today with more than 220 member companies. Such or comparable organizations, lobbying with high competence and strong industrial support, have proven to be very important for a ‘balance of interests’ between the supply and the demand side of the energy markets. In Germany the lobbying, the influence and the impacts on industries of DENEFF should be strengthened close to the governments, but staying politically independent. In Japan a comparable institution should be established, and learning from the experiences and the cooperation with DENEFF might be helpful.

4.2 Energy efficiency policy recommendations for the industry sector

This chapter aims to discuss policy recommendations that are beneficial for achieving ambitious energy efficiency targets, building on existing experiences in both countries where relevant. This list is by far not exhaustive but offers a few easy-to-implement improvements to the policy package.

1. **Establishment of efficiency networks for each sector**

In Germany, there exists an energy efficiency and climate protection network initiative by BMWK and BMUV, and 21 associations and organizations in industry. It currently includes 399 networks, with 3,251 companies/locations. We consider this networking to be a suitable instrument for exchanging experiences on energy saving option and welcome the expansion of this network activity. In Japan, various industry organizations are active, and the transfer of knowledge and technology from large companies to small and medium-sized enterprises can be expected. It may be useful for sharing information with SMEs, but a solid coordinator is required. For SMEs, the provision of information from energy retail companies is likely to be effective.

2. **Strengthen the policy link between energy and resource efficiency**

Energy efficiency policies and resource efficiency strategies for local circular economies create many synergies. In Germany, the Energy Efficiency Initiative Network is collaborating intensively with the ECO-Profit Network, which started in Austria and has successfully expanded to Germany. The goal is not only to increase energy efficiency, renewable energy and energy cost reduction, but also to combine all these energy-related activities with resource conservation (water, waste reduction, etc.). It may also be effective in Japan.

3. Energy performance contracting to address the initial investment barrier and depreciation premium for energy efficiency

Equipment for energy efficiency requires initial investment, which may be an obstacle. This initial investment barrier can be overcome with energy services, such as energy performance contracting, provided by ESCOs. Policy can support this through loan guarantees and subsidized independent coaching of companies through the contracting process, which already exist in Germany but could be extended. In addition, the payback period for the initial investment is long and may not meet the company's investment standards. Therefore, tax assistance in the first few years after purchase can be provided by allowing accelerated depreciation.

4. Utilization of industrial waste heat for heating supply

Industrial waste heat is rarely used, so it would be effective to perform sector coupling and use it for regional heating networks. This is very effective in Germany, where there is a high demand for heating, and it is recommended that it be planned through a regional coordinator. The financial risks associated with tapping industrial waste heat for use in heating networks should be reduced by means of default guarantees or insurance.

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