The role of energy efficiency for the energy transition - a brief overview

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Disclaimer: The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official opinion or position of the German-Japanese Energy Transition Council GJETC.
Content

1. Introduction: The role of energy efficiency from a global perspective .......................... 1

2. The multiple economic and co-benefits of energy efficiency .......................................... 2
   2.1. "NEGAWatt" vs. "MEGAWatt" ......................................................................................... 3
   2.2. Co-benefits – sometimes more important than direct benefits ......................................... 5

3. The role of energy efficiency for the German Energiewende ............................................. 8

4. Strategic elements of effective energy efficiency policies .................................................. 11
   4.1. Barriers and market failures .............................................................................................. 11
   4.2. Overcoming barriers with ambitious, targeted packages of policy instruments .......... 12
   4.3 The need for a coordination agency in a polycentric energy efficiency governance ..... 14

5. Outlook on the cooperation between Germany and Japan ............................................... 16

Bibliography .......................................................................................................................... 19
1. Introduction: The role of energy efficiency from a global perspective

The energy transition in Germany as well as in Japan is embedded in two global megatrends, which are about to be strategic game changers: the new international focus on energy efficiency through the “Efficiency First” paradigm (e.g., International Energy Agency/Paris) and the spectacular decreasing trend in costs of electricity generation from wind and photovoltaic (PV) energy. The strategic combination of fostering energy efficiency and energy conservation as well as accelerating the market introduction of renewable electricity generation will increase the chances that the global energy transition will become both, technically and economically feasible. Based on global and national scenarios, one can demonstrate that by fostering energy efficiency, GDP growth can be – at least relatively – decoupled from primary energy consumption levels. In industrialized countries with a decreasing population, like Germany and Japan, an absolute decoupling is feasible and in fact already evidenced by recent downward energy consumption trends in many countries of the European Union (EU) (European Commission 2016b). It seems to be technically feasible to halve primary energy consumption up to 2050, while increasing GDP (FhG-ISI/BMU 2012). Successful national examples and international cooperation could act as launching pad for the global energy transition.

Against this background, this paper concentrates on potentials, targets, barriers and opportunities for restructuring the demand side of the energy transition. The “German Energiewende” will be taken as a reference case to demonstrate that the paradigm shift “Efficiency First”, in order to reach long-term decarbonisation and risk minimisation, has started. But many challenges concerning the ambitious and long-term implementation of energy conservation targets are still ahead.

Today, the International Energy Agency (IEA/Paris) seems to be the most influential international advocate of energy efficiency, seen as the “key to unlock the energy transition.” (Bryant, Tyler. IEA. 2017). All “450 scenarios” of the World Energy Outlook (WEO) of the IEA in recent years yield energy efficiency as the most powerful abatement measure for CO₂ emissions reductions. For example, the “450 scenario” published in the WEO in 2016 expects a contribution of around 35% by end-use and supply-side energy

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1 See for example the publications of the IEA, World Energy Outlook, of the recent years; Global Energy Assessment (GEA) (2012). DLR (2015).
2 See e.g. Deep Decarbonisation Pathways Project (DDPP) (2015).
efficiency in 2040 to reduce CO₂. To reach this goal, intensity gains of energy efficiency must increase to 2,5% p.a. up to 2040 compared to the historical average of about 1%. In contrast to this, IEA projections for 2035 show that about two-thirds of energy efficiency potentials in industry, transport, power generation and buildings will remain untapped unless policies change.

To sum up: Managing the tremendous step forward to “Efficiency First” raises huge challenges for all stakeholders and needs an innovative and disruptive new governance of energy efficiency policies. To put it into other words: Only with a veritable “efficiency revolution” and with new thinking on how to remove barriers to foster the implementation of energy efficiency and energy conservation, the two degree target will be within reach.

2. The multiple economic and co-benefits of energy efficiency

Energy efficiency is often called a “sleeping giant”, or in technical terms: most national energy systems, as well as the global energy system, are extremely inefficient energy transformation machines. Out of a primary energy supply of 100%, only about a third actually goes into the use of energy services. The rest gets lost on the way, from primary energy to final and to useful energy, and the respective energy services. “If the inefficient energy transformation machine replaces fossil or nuclear fuels with renewable energy, it is still – figuratively speaking – a bathtub that is filled without a stopper. Hence, the “first law” of the Energiewende should read: Avoid losses first and then cover the remaining energy demand as quickly and comprehensively as possible with renewable energy.” (Sonnenschein/ Hennicke, 2015) This is exactly what is meant by the principle of “Efficiency First”.

Tremendous technical potentials of energy efficiency in all sectors (electricity, heat/cold and transportation) are widely accepted and are well documented in the literature for many countries (e.g. for Germany). Nevertheless, the economics of energy efficiency, the co-benefits, the barriers and hence the need for policy to support energy efficiency, although it is cost-effective for society in principle, and possible counteracting dynamics (above all, economic growth, but also the rebound effect, lifestyle changes, new

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5 See Wuppertal Institute, Ecofys, BMWi.
applications and preferences) are intensively debated and partly (e.g. concerning the rebound effect) not well understood.

2.1. “NEGAWatt” vs.“MEGAWatt”

Let us begin by comparing the costs of the “NEGAWatt” (e.g. costs per kWh of energy saved by efficiency measures) with the costs of the “Megawatt” (e.g. the levelized costs of a range of new electricity or fuel supply) for the same amount of energy services. In this context, energy efficiency can be perceived as a resource, because efficiency generates energy and demand savings that can substitute e.g. electricity generation from coal, natural gas, nuclear power, wind power, and other supply-side resources for the same energy service (e.g. a certain physical value of lighting, ventilation, pumping, communication, transportation).

A typical result of evaluated costs of energy efficiency programs has been presented by the ACEEE⁸ for U.S. utilities. Fig.1. demonstrates the clear cost advantage of energy efficiency. It should be stressed that these calculations do not account for the external costs of electricity supply options, which, for fossil based electricity in Germany, amount to about 5 to 11 Eurocents/kWh (UBA, 2017) and need to be added to the direct costs incurred by the utility.

Figure 1: Costs of energy efficiency programs of US utilities compared with the cost of new power supply (ACEEE 2017)

A comparable relation between the specific costs of avoided energy and energy supply has been calculated by the Wuppertal Institute⁹ for Germany. This analysis compared the costs

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⁹ See latest version of the conservation cost curve in IZES et al. 2011 (n German only).
per kilowatt-hour of a range of energy efficiency technologies (e.g. efficient ventilation, cooling, compressed air, lighting, pumps, ICT and other appliances; thermal insulation of buildings and efficient heating systems; energy efficiency in industrial processes) of typically 2 to 6 Eurocents / kWh, with the levelized costs of the electricity or fuel supply, which are much higher. In total, already within the next ten years, about 120 TWh per year of final energy (electricity and fuels) could be saved in Germany with an economic benefit. Again, avoided external costs were not considered.

Even if policy costs are included, energy efficiency will on average be highly cost-effective. A study on an exemplary portfolio of programs that would enable Germany to reach its energy savings target for 2020 found that a policy investment of around 6 billion Euros per year, with financial incentives of ca. 5 bn Euros, would allow meeting the target while long-term financial savings to private investors in energy efficiency (citizens and companies) including incentives received from one year of programme implementation would be more than three times as high (39 billion Euros) as their incremental investment (12 billion Euros) (Wuppertal Institut 2013).

![Figure 2: The benefits and costs for investors of meeting German's energy efficiency target by 2020](Wuppertal Institut, 2013)

The above analytical comparison of “NEGAWatt” and “MEGAWatt” is based on the ideal of a level playing field, on which efficiency technologies and energy supply are interchangeable and, thus, freely compete with each other. A certain energy service can be supplied with low energy input at maximum efficiency and vice versa. For the economy and consumers alike it is important that energy services are provided at minimum cost (including external costs). This implies that for both sides, “NEGAWatt” and “MEGAWatt”, the same interest rates and the respective technical lifetimes are used in the calculation of costs of saving or supplying one kWh. In reality, however, many investors on the end-use
efficiency side implicitly or explicitly expect pay-back times between 1 and 5 years, while the energy supply industries accept power plants and networks as long-term investments, with pay-back times of up to 20 years or even more. This “pay-back gap” is one of the many barriers preventing energy efficiency from being fully realised (cf. chapter #4.1 below), although it has a high economic net benefit in principle.

Energy efficiency or “NEGAWatts” is also not a self-evident business field for energy suppliers (see below). Actual energy markets are fundamentally different from the level playing field required in most countries (exceptions include a growing number of U.S. States and Denmark, which have created such a level playing field in regulation of the energy supply industries). Nevertheless, it makes sense for policy-makers, regulators, and utilities to analyse the comparable microeconomic costs of the energy supply (“MEGAwatts”) and the energy savings through efficiency technologies (“NEGAwatts”) under the assumption that the existing barriers and market failures of real markets were removed (see below).

Efficiency programs can also reduce the need to install, upgrade or replace transmission and distribution equipment. All these benefits occur at the micro level. Regulators should encourage or oblige e.g. energy utilities to engage in Energy Efficiency and Demand Side Management, based on an Integrated Resource Planning (Least Cost Planning), helping their customers to reduce energy consumption by targeted programs as long as the „NEGAWatts“ are cheaper than the additional energy supply (“MEGAWatts”). There are ways to achieve this also in liberalised energy markets, not affecting the competition in energy generation and supply, and making this even more profitable for energy companies than selling energy (cf. eg. Pagliano et al. (1999), Wuppertal Institute et al. (2000).

2.2. Co-benefits – sometimes more important than direct benefits

Both from a societal and investor perspective, numerous additional benefits of energy efficiency can be calculated. The IEA has analysed the most prominent multiple co-benefits of energy efficiency (IEA, 2014).
For example, the IEA found that large-scale energy efficiency programmes can have the following impacts:

- An increase in GDP growth rates of + 0.25 to 1.1% per year
- Additional employment equivalent to 8 to 27 job years per EUR 1 million invested
- Health and well-being impacts may quadruple economic savings compared to energy cost savings alone
- Productivity improvements may be worth 2.5 times the energy cost savings alone.

Though quantification is sophisticated, it should be underlined that e.g. energy security, local air pollution, employment, health and well-being as well as poverty alleviation are of paramount importance for most countries, including Japan and Germany. Energy efficiency (policy) has often even net positive effects for public budgets.

### 2.3. Counteractive dynamics against energy efficiency and the role of energy sufficiency

While energy efficiency will in any instance decouple GDP growth at least in relative terms from primary energy consumption levels, energy consumption in absolute terms may still grow if GDP growth is higher than energy efficiency gains. In industrialized countries with a decreasing population, like Germany and Japan, an absolute decoupling, i.e., an absolute decrease in energy consumption levels, is feasible and in fact already evidenced by recent downward energy consumption trends in many countries of the European Union (EU) (European Commission 2016b).

Still, a general caveat concerning the power of energy efficiency has to be discussed briefly. In this context, presenting all counteracting dynamics like the rebound effect, lifestyle changes, new applications and preferences (which are linked to GDP and hence income growth) in detail, is not possible. The problem is that most global and national scenarios are not able to quantify these effects in detail. Thus, a certain over-optimism concerning the impact of energy efficiency measures may have developed in energy politics, encouraged by the “scenario community” and last but not least, by the WEO Scenarios of the IEA.
Concerning the rebound effect this will be shortly highlighted: First of all, it is important to differentiate between actual rebound effects (i.e., some of the co-benefits of energy efficiency, such as improved thermal comfort, may lead to a slight re-increase of energy consumption compared to what was expected before the energy efficiency action was taken) and a whole bundle of drivers of economic growth that is largely independent of efficiency improvements, including catching-up effects in consumption in the global south as well as comfort, luxury and lifestyle effects.

The methods for quantifying the **extent of direct, indirect and macroeconomic rebound effects** (cf. eg. Nadel 2012 for a definition) are subject to an ongoing scientific debate. The International Energy Agency (IEA) estimates indirect rebound effects, which occur when money saved on energy is spent on additional goods and services, to be of about 9% (IEA, 2012).

As a rule of thumb it can be assumed that in OECD countries about 20 to 25% of the energy savings expected from energy-efficiency improvements are “eaten up” by overall rebound effects (Thomas, 2012; Nadel 2012; Gillingham 2013).

Even though rebound effects are not as strong as frequently claimed, the fundamental principle still holds: “Do not waste any saved kilowatt hour!” Scenarios and policy strategies should take rebound effects into account when calculating the targeted energy savings. A foresighted energy policy package needs to include specific additional instruments that help to minimize rebounds.

As we discussed in chapter 3 below, Germany still is not fully on track to meet its energy efficiency targets. These would be achievable given the potential but barriers remain strong.

Therefore, if policy is not successful enough in achieving the energy efficiency potential, it should also address energy sufficiency. While energy efficiency only reduces the energy input for a given level of utility or services from energy but leaves that level unchanged, energy sufficiency is about changing that level in quantity or quality as well. Examples are the size of dwellings, offices, refrigerators, or TV sets, as well as the indoor temperature setpoints, or even switching lights off when leaving the room. While it will remain difficult to inadequate for policy to prescribe peoples’ demands and behaviours, policy can also support and enable energy-sufficient purchase and use of buildings and equipment, or

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transport. Policies should therefore address energy efficiency and sufficiency in an integrated manner, but also try to limit the increase e.g. in per capita building space (cf., e.g., Thomas et al. 2017).

General development, economic and demographic growth effects and affluence are the main systemic drivers of energy and resource consumption, which cannot be limited sufficiently without political intervention, i.e. a coupled efficiency and sufficiency policy to encourage and incentivize sustainable patterns of production and consumption.

A balanced amount of sustainable consumption and production and of political intervention in favour of sufficiency can only be found in a long-term democratic discourse respecting the concrete framework conditions in each country and – most of all - public acceptance.

But in any case: Energy efficiency remains crucial for reaching decarbonisation and risk minimisation in every country. Despite rebound effects, efficiency is still the quickest, largest and most economical option to mitigate climate change and to harvest tremendous economic benefits and societal co-benefits. An „efficiency revolution“ is not the driver of unsustainable economic growth, but a necessary condition for a truly green economy.

3. The role of energy efficiency for the German Energiewende

The German Government – then a conservative coalition of Christian Democrats (CDU) and Liberals (FDP) under Chancellor Angela Merkel - decided in 2010 on the mid- and long-term targets of the „Energiewende“. These „revolutionary targets“ (Angela Merkel) up to 2050 were based on a far-reaching consensus of the German scenario community. At the same time, the government announced to extend the operation of the nuclear power plants, against the massive opposition of the civil society and against the stringent arguments of a great share of energy experts. But after the Fukushima Daiichi desaster (spring 2011) the German Government under Angela Merkel turned around to phase out nuclear by end of 2022 without changing the targets of the „Energiewende“. This historical background is important to understand why the integration of energy efficiency and renewables is absolutely crucial for the German „Energiewende“, heading for decarbonisation and risk minimisation (nuclear phase out) at the same time.

Especially, it explains why the targets for energy efficiency increase and for an absolute reduction of primary energy consumption might be the most ambitious in the world (see below Tab 2). A simple rule-of-thumb calculation shows the important role of energy efficiency for the Energiewende: If Germany succeeds in reducing primary energy consumption by 50 % until 2050, it will only need to expand the absolute amount of energy
production from renewable energies by a factor of a little more than three compared to today (15% of the 100% of energy consumption today (BMWi 2016b) would be equivalent to 30% of the 50% remaining energy consumption in 2050). This would mean a complete decarbonisation of Germany's energy system, while saving a lot of money for further expansion of the renewables-based energy system.

The following graph from BMU/FhG-ISI 2012 shows that the technical potential exists in Germany to reach the targets: already in 2030 almost 50% savings are possible even in final energy demand. In addition, around 80% of this potential is cost-effective when doing a lifecycle cost calculation.

Is Germany on track to meet these targets?
Comparing the past increase (1.6% p.a.: 2008-2014) with the above target increase (2.1% p.a. up to 2050) of final energy productivity, the ambitious absolute reduction of primary energy (-50% up to 2050) might be still within reach, together with a real GDP growth rate of about 1% p.a.

Although the energy savings target for electricity (-25% in 2050) was not as ambitious as the overall 50%, because it already assumed an increased use of electricity in transport and buildings (heat pumps), its achievement is questionable because the demand for additional renewable electricity for decarbonizing the buildings and transportation sector may be higher than expected back in 2010. The 2020 target (-10%) still seems within reach, due to EU and German electricity efficiency policies.

However, in the short run (up to 2020), the decrease of primary energy consumption and particularly in the transport, and partly the buildings sector is not on track. Besides the missing strategic roadmap of gradually phasing out hard coal and lignite for power production, the implementation gap of fostering energy efficiency are the main causes why Germany might not reach its CO₂ emissions reduction goal (-40%) in 2020.

This is why the German Government comments, in its latest Green Paper on Energy Efficiency (BMWi, 2016), correctly by writing “energy saving in Germany: much achieved but still much to do”.

Therefore, harvesting all the indispensable benefits of energy efficiency discussed in chapter 2 for climate mitigation strategies, coming from energy efficiency, appears a much more challenging task than the rapid market introduction of renewables against the possible resistance of incumbents.

Three main challenges for adjusting energy and climate policies occur: Firstly, raising the awareness of all related stakeholders in order to recognize the benefits that energy efficiency has in principle. Secondly, explaining why, due to barriers and market failures, we have to talk about benefits „in principle“ and how – even for potentials that are highly profitable for society and investors if calculated on a level playing field (cf. chapter 2) – a huge implementation gap can be closed by an innovative governance structure and consistent policy packages. Thirdly, analyzing how to get the right balance between a new policy guided by the „Efficiency First“ principle and the forced market introduction of renewables.

What has to be done? This paper argues that the consequences of the paradigm shift to “Efficiency First“ and the need for a new “polycentric” governance structure of a stringent energy efficiency policy are still not well enough understood by many policy-makers and businesses, not only in Germany but in other countries as well. The next chapter expands on what will be needed to achieve the energy efficiency potentials that will provide net economic benefits in principle.
4. Strategic elements of effective energy efficiency policies

It is a deep-rooted legend still propagated by some energy policy-makers that efficiency improvements can be realized by the so called “free market” and “sovereign consumers” alone. But due to many barriers, the market for energy services requires regulation and interventions for it to function.

4.1. Barriers and market failures

Although many market actors have incentives to save energy or to offer energy-efficient technologies and services, the barriers to energy efficiency action are often stronger. If only one actor in the market chain for eg. appliances or buildings decides against the energy-efficient solution, it will not happen. Such barriers include:

- Lack of awareness on the existence of more energy-efficient solutions and their benefits: energy efficiency is often hidden in many items
- Lack of information and market transparency, leading to high search and transaction costs, compared to sometimes small individual gains
- Little consideration of life-cycle costs instead of purchase costs only
- Other priorities in consumption or production to spend/invest money on
- Expectation of short payback times (few years), equivalent to implicit internal rates of return of 10 to 30 % over the much longer life times of the energy-efficient technologies, fuelled e.g. by uncertainty or mistrust in the savings that can be made or the increase in value of an energy-efficient building, or the priority in investment in core businesses
- The principal-agent dilemma (e.g. split incentives between landlords and tenants in all rental buildings)
- Maybe unavailability of the energy-efficient technology from the “usual” supplier, risk aversion regarding new solutions on both supply and demand side
- Subsidies to energy supply will reduce cost-effectiveness, as will a lack of energy taxation, so that external costs are not sufficiently internalized

Therefore, energy efficiency policies must support all market actors in overcoming these barriers.

In addition, in many liberalised energy markets the perspective of suppliers does not coincide with the perspective of consumers. As long as utilities make more profit from the sales of energy they have little interest in increased efficiency on the demand side. Only if the framework conditions are adapted in a way that the supply of energy services results both in a cost depression for the consumer and in appropriate profits for the supplier, the...
market for energy efficiency and energy services can flourish.\textsuperscript{11} This type of incentive-regulation is practised in several countries, but not yet in Germany.

4.2. Overcoming barriers with ambitious, targeted packages of policy instruments

Due to the complexity of the market and the numerous actor-specific barriers (see Chapter #4.1), policy is needed to overcome the barriers and to harness the (cost-effective) potential of energy efficiency measures. For each sector, a consistent and synergetic package of policies needs to be in place to improve information and market transparency, to overcome financial barriers, and to make at least a minimum level of energy efficiency, which is cost-effective for most consumers, the standard. Professional training and certification of suppliers, instruments of local planning, or special instruments to foster innovation towards new or improved technologies with even higher levels of energy efficiency are also needed. Examples of sectoral policy packages discussed in literature for buildings and appliances (cf. Thomas et al. 2015), and for the industry sector along with how Germany’s energy efficiency policies implement these packages will be provided below.

In addition to the sectoral instruments, a set of overarching policies we call the governance framework serves to guide and enable implementation of the sector-specific policies (Thomas et al. 2015). These include strategic targets and concepts such as those presented in Figure 5, the infrastructure and funding for implementing the sectoral policies, and energy or GHG taxation, reform of eventual energy subsidies, and removal of legal barriers for energy efficiency.

The following figure presents the typical instruments of the governance framework, and how they are implemented or not in Germany. It should be noted that Energy Saving Obligation for energy companies are an alternative to the combination of government’s Energy Agencies and Energy Efficiency Funds.

\textsuperscript{11} There is a growing literature on possible incentive schemes to motivate (by incentive regulation) or demand (by binding targets) energy suppliers to offer energy efficiency programs to their customers.
The role of energy efficiency for the energy transition - a brief overview

Figure 5: Energy efficiency policy packages in Germany: the governance framework (own results)

Next, Figure 6 presents the prototypical energy efficiency policy package for buildings and appliances, and how it is implemented in Germany, including the EU’s ecodesign and labelling policies that directly apply in Germany.

Figure 6: Energy efficiency policy packages in Germany: buildings and appliances (own results).

Finally, figure 7 presents an overview of the policy package for the industry sector.

The role of energy efficiency for the energy transition - a brief overview
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The many policy instruments presented in these figures show that Germany’s achievements vs. its energy efficiency targets discussed in chapter 3 are already enabled by strengthened energy efficiency policies, also at EU level (Ecodesign minimim efficiency regulation and labelling for energy-relevant equipment), and further policies are currently being introduced under the National Action Plan Energy Efficiency (NAPE) of 2014. Still, neither the policy spending nor the impact has reached the levels estimated neccessary (cf., eg, Wuppertal Institut (2013). For example, there is an operational target to achieve energy-efficient renovation of 2 % of the building stock per year, but recent rates remain around 1 % only. And although staff preparing, implementing, and evaluating energy efficiency policies and programmes in the federal administration and agencies was increased significantly, there still is not a central coordinating institution with strong financial and staff resources (Wuppertal Institut 2013). Therefore, targets are still in reach but stronger efforts are needed. This is particularly the case for a new, energy-efficient and sustainable transport policy.

4.3 The need for a coordination agency in a polycentric energy efficiency governance

One main problem we identified is that in Germany there are neither an institutionalized steering responsibility nor sufficient capacities for coordination and bundeling of the overall energy efficiency packages to fullfil the official energy savings targets - quite opposite to designing and guiding the green power sector. When the development of renewable electricity is not on track in relation to official targets, intervention will follow soon, but to date nothing comparable happens on the demand side.

Figure 7: Energy efficiency policy packages in Germany: the industry sector. Source: own results (own results).
The human resources in the departments responsible for energy efficiency policy in the Ministry of Economic Affairs and Energy and its subsidiary institutions (BAFA/BfEE) still do not have the budget and the competencies for target-driven interventions. Their human power is much too weak compared to the huge amount of experts supervising the supply side of the energy market.

Thus, the paradigm shift to “Efficiency First” is not yet backed by a paradigm shift in efficiency policy governance needed to make it really happen.

The Energiewende on the demand side is an extremely challenging complex process that cannot be designed and implemented by the national government in Berlin alone. It creates great opportunities to strengthen the role of German states, regions and municipalities. In a multilevel political system the lower levels often have a catalyzing and pioneering function. In many areas of Germany they have already become the drivers of a highly dynamic development. The success of the “federal Energiewende” depends on a strong collaborative effort, which is characterized by “polycentric governance”.

Polycentric governance acknowledges the creative and constructive potential of NGOs, voluntary work initiatives and other non-market organizations. It supports their work as a necessary and conducive part of the overall Energiewende process. Polycentric governance still means that the federal government retains responsibility for the Energiewende process, including ambitious target-setting, suitable framework conditions, and the balancing of conflicting interests in regard to the energy policy (between industry, civil society, academia, between federal states and municipalities). The following picture visualizes the institutional setting of a proposal for a policentric governance in Germany. The main idea is to give an institutional innovation, the National Energy Efficiency Agency, as well as an Energy Savings Fund.
The role of energy efficiency for the energy transition - a brief overview

5. Outlook on the cooperation between Germany and Japan

Against this background of general considerations and the status and necessities of energy efficiency policies in Germany, it might be possible to raise some questions concerning energy efficiency policies in Japan as well. We are quite aware of the tremendous successes concerning the status of average energy efficiency in Japan and efficiency policies, e.g. the top runner program or Setsuden implemented after the Fukushima Daichii nuclear desaster. Therefore, this outlook does not at all intend to be a review of the energy efficiency policies in Japan or Germany. The only purpose is to raise questions for further discussion. In this context, we focus on seven strategic questions:

1. The comparison of scenarios for Japan and Germany\(^\text{14}\) highlighted apparent differences concerning the improvement of the final energy productivity and the

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\(^{12}\) Compare to: A proposal for a Federal Agency for Energy Efficiency and Energy Saving Funds (BAEff) by the Wuppertal Institute.


reduction targets for primary energy in 2030. For example, average annual improvements of energy productivity in the selected Japanese scenarios are quite lower than in German Scenarios, e.g. 1.7% - 1.9% compared to 2.4% - 3.0%. The primary energy consumption in the selected Japanese scenarios varies between a decrease of 7% between 2015 and 2030 and an increase of 10% during the same period. The selected German scenarios expect a massive decrease between 28% to 37% in those 15 years. What are the reasons for these apparent gaps concerning the impact of energy efficiency and the reduction of primary energy? Can it be explained by technical and socio-economic restrictions or is it caused by (assumptions on) policy decisions?

2. Which new, energy-efficient technologies have potential in both countries and beyond? E.g. Passive Houses, nearly or net zero buildings, trigeneration of heat, cold, and power, particularly with fuel cells for smaller buildings.

3. Combined heat/cold power generation (“trigeneration”) does not only raise supply-side energy efficiency but could play an increasing role as a flexibility option with an increased share of intermittent power (PV, Wind) and as a transition technology to a fully decarbonized energy system. Could it be interesting to develop a road map for further fostering the market introduction of co-/trigeneration in both Japan and Germany?

4. From our perspective, “Setsuden” seems to be one of the most successful national market campaigns for a short-run reduction of electricity demand and behaviour changes. Can this success be continuous and might it even get intensified in the future? Can it be transferred to Germany?

   More generally, which role can energy sufficiency play in reducing energy demand, and how can policy support and enable it in both countries?

5. In the past, the dominant role of utilities was to deliver a secure energy supply (electricity, gas) with affordable prices and acceptable profit margin to the customers. After the Fukushima desaster, the role of the 10 regional monopolies might change tremendously, by suppling none or less nuclear power and by being affected by the liberalisation of the electricity market. Is it possible and intended to change their business fields to also selling energy services (Energy Supply and Performance Contracting, DSM, Energy efficiency programs) by an incentive regulation like in the US or in other countries? The same question is also still unresolved in Germany.

   More specifically, in which sectors have Energy Service Companies and Energy Performance Contracting worked well in both countries, in which others not so well? What are the reasons for this, and what can be learned to make them more effective in both countries?

6. Are the prototypical policy packages outlined in chapter 5 applicable on both countries and beyond, albeit with adapted choices in case of policy alternatives and
with country-specific adaptations of the typical instruments? What can be mutually learnt for making energy efficiency (and sufficiency) policies more effective in both countries?

7. The complexity of restructuring the demand side of the energy market during the energy transition in Japan is comparable to that in Germany. This raises the question, whether especially the cooperation on a new (polycentric?) governance structure, according to the principle “Efficiency First”, could be intensified? For example, do both countries need a central coordinating institution (agency) for energy efficiency (and sufficiency) policies with strong financial and staff resources?
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The role of energy efficiency for the energy transition – a brief overview
The role of energy efficiency for the energy transition - a brief overview


The role of energy efficiency for the energy transition - a brief overview


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