Climate & Energy Policy Targets, Plans and Strategies

The Role of Monitoring and Evaluation Mechanisms

Final Report of a GJETC Working Group

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Executive Summary

Germany and Japan are pursuing ambitious energy and climate policies. Both countries have set themselves quantified targets for the medium-term time horizon, i.e. with a view to the year 2030. These targets relate primarily to the reduction of national greenhouse gas emissions, but also to other areas where energy and climate policy is geared to comprehensive target architectures. However, the structure of these target architectures and their direct links to international targets differ considerably in some cases.

The target architecture in Germany and its development for the time horizon 2030 is characterized by a comparatively high complexity, a relatively high dynamic and a high frequency of updates as well as linkages to both, European and international climate or energy commitments and an increasing legally binding nature. This concerns, e.g., with a view to the European Union Emissions Trading System (EU ETS), the European Effort Sharing Regulation (ESR), the EU targets on energy efficiency and renewable energies, combined with the EU Regulation on the Governance of the Energy Union and Climate Action, and the German Federal Climate Act (Bundes-Klimaschutzgesetz – KSG) which established legally binding sector targets for 2030 (EU ETS, ESR, KSG) and legally binding emission trajectories up to 2030 (ESR, KSG). On the other hand, Japan's target is linked to international climate regime while reflecting its complex energy challenges after the Fukushima Daiichi nuclear accident and its achievement is not legally binding based on domestic legislation. The reasons for these differences can be found in different traditions, different economic and technical core beliefs or perceptions in a few areas (nuclear, renewables, costs, etc.). Some but not all of them can be linked to the significant differences in terms of geography, infrastructure, political and cultural traditions between both countries.

Both countries still face significant gaps that need to be filled to be fully compliant to the targets by 2030. Against this background, comprehensive approaches of monitoring, evaluation and revision are increasingly important elements of climate and energy policies. The comparison of the wide range of experiences from ex-ante and ex-post evaluations and revision mechanisms in Germany, Japan and other countries underlines that advancing and streamlining the process, procedures and institutional arrangements of monitoring, evaluation and policy revision are needed. If continuing gaps between targets and implementation occur, strengthening of policies particularly in sectors that show implementation gaps will be appropriate, but a flexible adaptation of ambition levels of sectoral targets while respecting the overall national target might be justified. In this respect, the new and legally binding sector-specific enforcement and revision mechanisms created by the German Climate Protection Act as well as the EU's Governance Regulation will provide interesting experiences.

Ex-ante evaluation is becoming increasingly important, also with a view to long-term goals, e.g. for the year 2050. The nature of targets or goals for 2050 differs more between Germany (more binding and policy-guiding targets) and Japan (more indicative goals) than for the medium-term time horizon 2030. The approaches for dealing with technology and costs uncertainties are partly different but using long-term targets/goals at least for consistency checks for long-term decisions, e.g. for infrastructures and innovation efforts, will be of growing relevance. An interesting field of further research cooperation will be to analyze different approaches and methodologies for setting and

meeting long-term targets or goals under uncertainties (e.g. on global trends, technology developments) as well as with a view on investment security, innovation dynamics, avoiding lock-in effects, and reflecting path dependencies.

The approaches to derive medium- and long-term decisions differ, however, much less than expected. The long-term horizon (2050) is addressed in both countries primarily with techno-economic analysis on technical and economic feasibility, whereas the medium-term horizon (2030) is addressed more from the perspective of policy implementation and political feasibility.

With the increasing evidence from monitoring and evaluation processes and the improvement of ex-ante evaluation, it could be worth additional efforts to reach at least a better understanding on the factual basis of the different core beliefs in the energy transitions. The exchange of experiences on policy design, monitoring, evaluation, and revision cycles could be an interesting field of cooperation.

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1. Introduction

1.1. Background

Since 2016, Japanese and German experts have cooperated within the framework of the German-Japanese Energy Transition Council (GJETC) in order to carry out research on key issues of the energy transition in both countries and to search for joint solutions. To conduct government-independent research but at the same time to deliver government-relevant analysis and recommendations is the purpose of this particular format of international policy advice (see http://www.gjetc.org)

Against the backdrop of the upcoming global implementation of the Sustainable Development Goals (SDGs), the results of COP 21 (Paris) to COP 24 (Katowice), and various decisions by G7 and G20 summits, three process dynamics are in the forefront: "speeding up", „scaling up“ and „tightening up“, i.e. increasing the level of ambition. This applies in particular to the transformation processes of the energy system in order to promote climate protection and resource conservation.

As highly industrialized countries with significant carbon-intensive capital stocks on the one hand, but also as high-tech states on the other, Japan and Germany face similar challenges despite different geographic conditions, differing energy policy objectives (e.g. with regard to nuclear energy) and different political and cultural backgrounds. What can be a low-risk, long-term energy strategy that conserves resources and climate, promotes ecological modernization and international competitiveness, while guaranteeing a just and inclusive transition?

The aim of the GJETC initiative is to show that the national energy transition can succeed better if Germany and Japan learn from their strengths, but also try to make their weaknesses transparent in order to avoid them.

Like no other policy field, climate mitigation policies require a long-term policy style oriented to concrete official targets and further aspirational goals. The quantitative main objective is an ambitious reduction of greenhouse gas (GHG) emissions. The time horizon will be at least up to the year 2050. For highly developed industrialized countries such as Germany and Japan, aiming for leadership will require a fully decarbonised energy system. Such a climate mitigation and decarbonisation policy means an acceleration of the normal economic structural change induced by competition in globalized markets. Therefore, policy-makers must take a proactive responsibility to make the transformation process socially and economically compatible, while at the same time achieving the reduction targets that have been agreed.

In the face of manifold uncertainties of today and the future, modelling-based setting of targets/goals, policy roadmaps providing guidance to citizens and businesses, with a suitable and targeted mix of policies and measures to achieve the goals, but also comprehensive monitoring and evaluation processes are essential elements of an effective and efficient management of the necessary transformation processes.

Quantitative analysis of scenarios is the best research-based instrument to reduce uncertainty and to quantify the whole range of feasible energy futures. This holds true especially for decarbonized energy systems to support climate mitigation, which per se

are long-term target driven processes within the context of international regimes e.g. the Paris Agreement (2015) and follow-up procedures. Democratic and transparent choices of the preferred long-term pathways are needed in all countries, based as far as possible on a societal consensus. Scenario analysis helps to establish this consensus by providing information on feasible pathways and on targets/goals which could be achieved, and the associated environmental, economic, or social consequences of each pathway.

This causes new challenges for policy making in democracies: Politicians who decide on targets for 2050 and impacts on future generations will probably not profit or suffer from their decisions themselves. Thus, transparent information, proactive communication, participation of stakeholder groups to the extent possible, stepwise implementation processes, and permanent monitoring and evaluation are crucial for trust and consensus building, also on the need for readjustments of goals, targets, and measures.

Germany and Japan have both established medium- and long-term energy transition goals and use a broad range of numerical analysis to design and to evaluate strategies and policies which are sufficient to achieve their respective goals/targets. The rationale behind medium- and long-term targets/goals, the methodology of modelling exercises (e.g. techno-economic approaches, policy-based assessments), the role of scenarios for long-term policy making, consensus building for target-oriented policies and public support for ambitious climate mitigation strategies are in some respects comparable, in others quite different in Germany and Japan. The interlinkages between research (modelling communities), policy-making and public communication are especially crucial when it comes to the evaluation of strategies or policies and measures, especially if gaps between official targets and actual developments occur and the need for revision of strategies, policies and measures emerges.

Insofar, monitoring and evaluation mechanisms become more and more important when aiming to contribute as much as possible to long-term ambitious targets like decarbonisation and risk-minimisation and to narrow the gap between announced and actual national pathways towards the targets/goals. Reflecting changing circumstances (e.g. economic conditions, energy market conditions, technology cost, and emergence of new technologies) and respectively modifying – usually upgrading – goals and policies needs continuity as well as flexibility. It has to be reflected in quantitative analyses via both ex ante assessments as well as ex post evaluations. Monitoring and evaluation also help understanding the reasons for gaps between expected and actual pathways, their economic, technological or societal drivers and the likely impacts of policies adopted to achieve the targets/goals. This will also inform potential readjustments of policies to achieve the same or even more ambitious targets/goals in a more cost-effective and socially compatible way.

1.2. Linkages from policy to monitoring and evaluation

The analytical framework for the analysis presented in this paper is based on the concept of the policy cycle:

- The initial part of the policy cycle is problem identification and agenda setting. The problem identification is a result of societal developments and/or scientific

discovery processes. Agenda setting is undertaken by political players and/or stakeholders. They take positions in a way that dealing with the issue on a political level becomes necessary.

- Policy formulation and decision making is the process of formulating alternatives for political action and going through decision making processes, which are essentially selection processes between the existing alternatives. Policy formulation and decision making can be focused on targets, strategies (i.e. general fields or principles of activities, which can be specified largely independently of specific implementation mechanisms) and/or implementation mechanisms (political instruments and their combinations).
- Policy implementation is the process of application of the outcomes of the decision making process on the ground and their real-world outcomes.
- Policy monitoring and evaluation is the explicit or implicit process of assessing the expectations in the policy formulation and decision making process with the outcomes of the policy implementation process, and the reasons for meeting or not meeting expectations.
- Based on the outcomes of the policy evaluation process, either a process of policy revision will be initiated, starting usually with a new round of policy formulation and decision making, or the policy will be terminated (and would need a new process of agenda setting etc.).

Monitoring and evaluation of targets, strategies and implementation mechanisms play an important but also a differentiated role in such policy cycle:

- In the policy formulation and decision-making process as well as for the policy implementation process, the ex-ante evaluation of targets, strategies and/or implementation mechanisms usually plays a significant role. Such ex-ante evaluation can serve either to identify the most suitable or (politically) attractive decisions to be made and/or to build legitimation for policy decisions.
- Monitoring and ex-post evaluation processes need to play an important role in the policy evaluation and the policy revision process.

The purpose of this paper is to present evidence from existing and upcoming monitoring and evaluation processes in Germany and Japan for energy and climate policy. The main focus of the analysis is how energy and climate policy makes use of monitoring and evaluation for tracking achievement of targets/goals as well as for designing and improving policies and their outcomes, and what lessons can be drawn from the existing monitoring and evaluation approaches.

1.3. Research questions for the working group

The subject of this paper is the monitoring and evaluation of targets, strategies and implementation mechanisms in the framework of energy transition policies:

1. What is the structure or architecture of medium- and long-term targets and strategies (chapter 2)?

2. What monitoring and evaluation approaches are or will be used and what are the key issues to be considered (chapter 2)?

3. Which recommendations can be drawn from the experiences with monitoring and evaluation approaches in the framework of energy and climate policies (chapter 4)?

The progress on achieving energy and climate policy targets or implementation of strategies will be addressed on an indicative basis (chapter 3) but is a side issue for the analysis presented in this paper.

2. The Status of monitoring and evaluation mechanisms

2.1. Germany

2.1.1. Germany's energy and climate targets

Energy transition as a target-driven and programme-based approach of energy and climate energy has a long tradition in Germany (Table 2-1). Since the first Climate Policy Programme was approved in June 1990 (at the time for Western German), eleven energy and climate policy programmes have been issued by the German Federal government, most of them building more or less explicitly on the previous versions. All programmes include the formulation, confirmation or update of targets as well as comprehensive packages of policies and measures. Most of the programmes and their updates or revisions are based on comprehensive analytical exercises which can be characterized as ex-post as well as ex-ante evaluation approaches. However, the Integrated Energy and Climate Programme of 2007 was the first programme, which included an explicit monitoring obligation that went beyond the more ad-hoc approaches of the previous programmes.

Similar to Japan's energy policy (cf. chapter 2.2.1), there are some basic perspectives or objectives behind Germany's energy and climate targets. For climate policy, these are based on the need to meet the commitments that the EU and Germany made in the UNFCCC, the Kyoto Protocol, and the Paris Agreement. The three overarching objectives of energy policy are (1) environmental sustainability, (2) economic competitiveness and social balance, and (3) security of energy supply. In addition, nuclear safety and – for most of the last 20 years – phasing out nuclear power are key objectives of energy policy. All energy and climate programmes and their respective targets aim to achieve an adequate balance between these overarching objectives.

On average Germany approved new energy and climate programmes with a frequency of approximately three years. In climate policy term the ambition levels increased over time but changes in energy policy played also a significant role.

From the First to the Fourth Climate Programme (1990-1997) the time horizon for target setting, strategies as well as policies and measures was 2005. In the Fifth Climate Programme (2000) this time horizon was shifted to the Kyoto Period (2008-2012). That means that the foresight horizon of programmes was between 7 and fifteen years. This situation changed fundamentally in 2010 with the Energy Concept, which also addressed long-term horizons (2030, 2040 and 2050).

The switch to explicit long-term targets (2050) in 2010 was connected to the decision to extend the lifetime of nuclear power stations. The target set that was formulated in this context was, however, not changed after the decision on nuclear lifetime was reversed following the Fukushima nuclear disaster in 2011 to the original phase-out trajectory that had been negotiated in 2000 and implemented legally in 2002.

Climate and energy policy programmes from 2014 onwards were driven by the increasingly foreseeable failure to meet the national targets on greenhouse gas emission reductions for 2020 and the need for policies and measures that would enable a robust achievement of the much more demanding energy and climate policy targets for 2030 and beyond. With a view to this new driving force, the role of monitoring and evaluation

activities in different dimensions became more and more prominent. This relates to ex-ante evaluations of future targets, strategies and also policies and measures on the one hand but also to ex-post monitoring end evaluation efforts on the other.

Table 2-1: History of climate and energy programmes in Germany

Year	Climate/Energy Policy Programme	Key targets (all programmes also contain policies & measures)
1990 (June)	First Climate Policy Programme (West Germany)	CO_2 emission reduction of 25% by 2005 (compared to 1987)
1990 (November)	First Climate Policy Programme (incl. East Germany)	CO_2 emission reduction of 25% by 2005 (compared to 1987) and more in East Germany
1992	Second Climate Policy Programme	CO_2 emission reduction of 25-30% by 2005 (compared to 1987)
1994	Third Climate Policy Programme	CO_2 emission reduction of 25-30% by 2005 (compared to 1987)
1997	Fourth Climate Policy Programme	CO_2 emission reduction of 25% by 2005 (compared to 1990)
2000	National (Fifth) Climate Policy Programme	CO_2 emission reduction of 25% by 2005 (compared to 1990), GHG-6 emission reduction of 21% by 2008/2012 (compared to 1990
2007	Integrated Energy and Climate Programme	GHG-6 emission reduction of 30% (unconditional) or 40% (conditional) by 2020 (compared to 1990)
2010	Energy Concept	GHG-6 emission reduction of 40% by 2020 (unconditional), 55% (2030), 70% (2040), 80-95% (2050, compared to 1990), nuclear lifetime extension, energy efficiency & RES targets
2011	Energy Concept and Nuclear Phase-out	GHG-6 emission reduction of 40% by 2020, 55% (2030), 70% (2040), 80-95% (2050), all unconditional and compared to 1990, nuclear phase-out by 2022
2014	Climate Policy Action Plan 2020	Gap closure for GHG-6 emission reduction of 40% by 2020 (compared to 1990)
2016	Climate Action Plan 2050	Approval of 2020, 2030, 2040 and 2050 targets, sectoral targets for 2030
2019 (legal obligation)	First Integrated National Energy and Climate Plan	Overarching and sectoral targets, policies and measures for all dimensions of the Energy Union
2019	Climate Programme 2030	Climate neutrality by 2050 as the new paradigm, Climate Act with legally binding (annual) sectoral targets up to 2030, broad range of policies of measures
Memo items: 1. Germany's National Climate Change Programmes are embedded in European Union Climate Policy Programmes/Packages (2000, 2005, 2008, 2011, 2014, 2017/2018) 2. All German and EU programmes were based/accompanied on/by extensive modelling exercises (modelling cycles of typically 2 years)		

Source: Compilation by Felix Chr. Matthes

This also applies for the increasing interlinkages between German and EU energy and climate policies. The integration via the EU ETS is complemented by more and more demanding EU-wide ambitions for emission reductions in the non-ETS sectors as well

as for the use of renewable energy sources and the improvement of energy efficiency. The European framework adds, however, an additional dimension to the target structure for German energy and climate strategy. With respect to non-ETS emission reduction targets as well as the use of renewable energy sources, not only targets for 2030 apply but also for the trajectory towards these targets needs to be accounted for because also these trajectories will be monitored for Germany in the EU framework of targets and are subject for consideration in the EU compliance mechanisms related to the legally binding EU targets. With a view on this situation it should be pointed out that the German national target set as well as the monitoring and evaluation framework was made legally binding by the new German Federal Climate Act (Bundes-Klimaschutzgesetz – KSG) of December 2019, which makes the national sectoral targets legally binding also in the national framework and establishes policy enforcement mechanisms.

The recent target framework for German energy and climate policy originates essentially from the Energy Concept 2010 (Table 2-2). It was nevertheless extended and adjusted in several steps in 2011 (nuclear phase-out), 2016 (sector targets for greenhouse gas emission reductions), 2018 (coalition treaty with target for 65% power generation from renewables and downplay of the 40% emission reduction target for 2020) and (2019 (proposal of the so-called Coal Commission on phase-out of coal-fired power generation). Most of these new or updated targets were subject of ex-ante evaluations but there are also cases of target setting where no specific ex-ante evaluation took place (e.g. for the 65% target for power generation from renewables by 2030 in 2018).

Table 2-2: The evolving target set of German energy and climate policy, 2010-2019

Target year	Targets as of …													
	2019	2016	2016	2016	2016	2016	2010	2018	2010	2010	2010	2010	2011	2019
	Greenhouse gas emissions						Renewable energies		Energy efficiency				Nuclear energy (capacity)	Power from coal (capacity)*
	Total	Energy sector	Buildings	Transport	Industry	Agriculture	Gross final energy	Power generation	Primary energy	Space heating	Final energy transport	Electricity consumption		
2011													-41%	
2015													-47%	
2017													-54%	
2019													-60%	
2020	~~-40%~~						18%	35%	-20%	-20%	-10%	-10%		
2021													-80%	
2022													-100%	-30%
2025								~~40 to 45%~~						-37%
2030	-55%	-61 to -62%	-66 to -67%	-40 to -42%	-49 to -51%	-31 to -34%	30%	65%						-60%
2035								~~55 to 60%~~						(-100%)
2038														-100%
2040	-70%						45%	~~65%~~						
2050	climate neutrality						60%	80%	-50%	-80%	-40%	-25%		
Base year	1990	1990	1990	1990	1990	1990	-	-	2008	2008	2005	2008	(2010)	2017

Note: * according to the recommendations of the Coal Commission

Source: Compilation by Felix Chr. Matthes

As a result the most recent set of targets for German climate an energy targets covers the following range:

- greenhouse gas emission reduction targets for the economy in total (2030, 2040 and 2050) as well as for five key sectors (2030), whereas the national sectoral targets only approximately fit into the EU targets structure of ETS and non-ETS emissions;
- share of renewables in gross final energy consumption 2020, 2030, 2040 and 2050), which fits also in the related EU targets;
- energy efficiency targets for primary energy[1], space heating, final energy in transport and electricity consumption, which fit approximately into the EU target structures (targets for 2020, not specified by 2030);
- stepwise phase-out of nuclear energy production (with remaining steps for 2021 and 2022);
- stepwise phase-out of coal-fired power generation (2022, 2030 and 2038/35).

The implementation policies are based on a broad range of policy mechanisms, which include:

- the EU ETS and the redistribution mechanisms for the revenues from auctioning (Climate and Energy Fund);
- the national Fuel Emissions Trading System (nETS, created in 2019 and starting from 2021) and the redistribution mechanisms for the revenues from auctioning (Climate and Energy Fund and reduction of the Renewable Energy Act surcharge)
- the Renewable Energy Act (Erneuerbare-Energien-Gesetz – EEG) and other incentive programmes;
- the Combined Heat and Power Act (Kraft-Wärme-Kopplungsgesetz – KWKG), the Energy Saving Ordinance (Energieeinsparverordnung – EnEV) and other measures under the National Action Plan on Energy Efficiency (Nationaler Aktionsplan Energieeffizienz – NAPE)
- the Energy Industry Act (Energiewirtschaftsgesetz – EnWG) and several legislative acts on network infrastructures;
- the Atomic Energy Act (Atomgesetz – AtG)
- multiple incentive programmes;
- the Coal Phase-out Act (Kohleverstromungsbeendigungsgesetz – KVBG), which unfortunately foresees only the partial implementation of the more com-

[1] It must be pointed out that the primary energy evaluation of renewable energies like hydro, wind and solar (transformation rates of 100%) creates in energy statistics terms very significant reductions in primary energy supply which do not represent real energy efficiency gains (2020, 2030, 2040 and 2050).

prehensive and more ambitious recommendations by the German Commission on Growth, Structural Change and Employment;

The challenging situation that Germany would have most likely missed its greenhouse gas emission reduction target by 2020 in absence of the Covid-19 crisis will increase the need and the political pressure for a more stringent policy mix but also a more consistent and sufficient framework of monitoring, ex-ante and ex-post evaluation of the German policy mix.

2.1.2. Energy-related monitoring mechanisms in Germany

The relatively broad range of programmatic documents on short-, medium- and long-term energy and climate change and the relatively high frequency of updating lead to a certain diversity of monitoring and evaluation processes:

1. There are explicit monitoring and evaluation processes on a strictly regular basis and on different levels

    a. The most comprehensive monitoring process in terms of topics and structured feedback is related to the Energy Concept 2010 and the related targets for Germany`s energy system up to the middle of the century. The monitoring process “Energy of the Future" tracks the implementation of the Energy Concept and package of measures, plus their targets, with a view to a secure, economic and sustainable energy supply. The Federal government under coordination of the Federal Ministry of Economic Affairs and Energy submits a comprehensive monitoring report on an annual basis[2] based partly on information of other evaluation processes. In addition to this, the Federal government publishes a progress report on the energy transition every three years.[3] The governmental reports are subject to a review by the independent scientific expert commission (see section 2.1.3).[4] This process will have to be aligned with the mandatory integrated national energy and climate progress reports under the new governance provision for the EU’s Energy Union from 2023 onwards (see section 2.1.6).

    b. The annual Climate Report[5] is a monitoring report under the Climate Action Plan 2020 coordinated by the Federal Ministry for Environment, Nature Conservation and Nuclear Safety and contains all relevant information which is available from the annual greenhouse gas inventory

[2] https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/sechster-monitoring-bericht-zur-energiewende.pdf?__blob=publicationFile&v=37

[3] https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/fortschrittsbericht-monitoring-energiewende.pdf?__blob=publicationFile&v=26

[4] https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/MonitoringEnergiederZukunft/Stellungnahme_6Monitoringbericht.pdf;jsessionid=6D4A780D7F3BA4E7DA3FE7C1822A5650?__blob=publicationFile&v=2

[5] https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzbericht_2018_bf.pdf

reports and the biennial projection reports on greenhouse gas emissions and policies and measures. According to recent announcements these Climate Reports will be continued also for the period beyond 2020. This monitoring report by government is not subject to an independent review by scientist or stakeholders. The climate monitoring report is partly based on the biennial Projection Report, which is the only ex-ante evaluation not only of targets and strategies but also of implementation mechanisms (see section 2.1.7).

c. The annual monitoring report on the energy sector by the Federal Network Agency and the Federal Cartel Office[6] assesses all aspects of the energy market, including market power, security of supply, energy prices etc. This monitoring report by government agencies is not subject to an independent review by scientists or stakeholders.

d. Under the UNFCCC Germany is like all parties obliged to present (besides the annual National Inventory Report) a National Report every 4 years and the Biennial Report with a two years frequency

2. There are monitoring and evaluation processes on a less or non-regular basis and on different levels

a. On the basis of the Climate Action Programme 2050 the Federal government commissioned a comprehensive ex-ante evaluation of the climate targets for 2030. This impact assessment[7] covers greenhouse gas emission trends, costs at different levels, security of supply, ancillary benefits etc. and is an ex-ante evaluation which is very close to the indicators of the monitoring process on the Energy Concept (see chapter 2.1.3). The process of developing the Climate Action Programme 2050 included also a structured stakeholder process from June 2015 to February 2017 which included a broad range of specific recommendations for policies and measures.[8]

b. Each update of energy and climate programmes was based on specific monitoring and (ex-ante) evaluation exercises. The depth and coverage of these exercises differed significantly over time.

c. Many specific policies and measures are subject to more or less comprehensive and/or tailor-made monitoring and evaluation processes. Examples are here the extensive evaluation reports on the Renewable Energy Act (Erneuerbare-Energien-Gesetz – EEG), the Combined Heat and Power Act (Kraft-Wärme-Kopplungsgesetz – KWKG), the National and International Climate Initiative (Nationale Klimaschutz-Initiative – NKI, Internationale Klimaschutz-Initiative – IKI), the Energy

[6] https://www.bundesnetzagentur.de/SharedDocs/Mediathek/Berichte/2019/Monitoringbericht_Energie2019.pdf?__blob=publicationFile&v=5

[7] https://www.oeko.de/fileadmin/oekodoc/Folgenabschaetzung-Klimaschutzplan-2050-Endbericht.pdf

[8] Prognos (2017): Evaluierung der Stakeholder-Beteiligung an der Erstellung des Klimaschutzplans 2050 (https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/ksp2050_evaluierung_stakeholderbeteiligung_bf.pdf)

Saving Ordinance (Energieeinsparverordnung – EnEV), the Energy Efficiency Funds and the KfW financial incentive programmes for energy efficiency, as well as the monitoring and review process proposed by the German Commission on Growth, Structural Change and Employment, also known as Coal Commission (see section 2.1.4).

In addition to the monitoring and evaluation exercises by the Federal government additional monitoring and evaluation efforts are taken at the German States level as well as from the private sector:

1. Some German States carry out own monitoring and evaluation activities, either with regard to policies and measures run by the States or to generally track progress on energy transition in the States. The state of North-Rhine Westphalia also carried out participatory stakeholder dialoques including a) the indentification of priority areas of action for climate change mitigation and adaptation, b) the selection of measures within the prioritized areas of action, and c) the impact assessment of specific measures in terms of social acceptance, employment, benefit-costs analysis, and economic and social viability.[9]

2. There are some monitoring activities from the private sector for different monitoring and evaluation mechanisms

    - The most prominent monitoring exercise here is the Energy Transition Index (Energiewende-Index – EWI) which is published on a biannual basis by McKinsey and tracks a set of illustrative energy and climate indicators.

    - In terms of ex-ante evaluation of targets and strategies a wide variety of stakeholders, the German industry[10], the German Energy Agency[11], the German science academies[12] and environmental NGOs[13], published their (ex-ante) analysis of targets and strategies.

The broad range of monitoring exercises and their overlaps can be attributed to very different reasons:

- The historical development of programmes and their institutional ownership play a significant role;

[9] Schepelmann, P (2018): Governance of Low-Carbon Energy System Transitions. A Case Study from North-Rhine Westphalia, Germany (https://www.adb.org/sites/default/files/publication/433861/governance-brief-32-low-carbon-energy-system.pdf).

[10] http://s3.amazonaws.com/document.issuu.com/180118132114-efe9264c3e456f322798fa434eadeb8f/original.file?AWSAccessKeyId=AKIATDDRE5J7Q7L6DZF6&Expires=1578512948&Signature=fJ%2BV3OeMokEgzKMw9CnyZG3MmSM%3D

[11] https://www.dena.de/fileadmin/dena/Dokumente/Pdf/9261_dena-Leitstudie_Integrierte_Energiewende_lang.pdf

[12] https://energiesysteme-zukunft.de/fileadmin/user_upload/Publikationen/PDFs/ESYS_Analyse_Sektorkopplung.pdf

[13] https://mobil.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/WWF_Blueprint_Germany.pdf

- The focus (targets and strategies, strategies and implementation mechanisms) creates some overlap;
- Some obligations in the EU framework do not fit completely in the national patterns of targets, strategies and implementation mechanism;
- There is a tradition of tracking governmental activities by non-governmental complements which also expanded to monitoring and evaluation activities.

This overview indicates that the system of monitoring and evaluation has multi-level characteristics on the one hand. The different monitoring and evaluation processes build upon each other to a large extent and use a broad range of sources:

- official energy statistics and emission inventories
- energy market transparency data on generation, infrastructures and (wholesale) prices;
- specific surveys and polls etc.

On the other hand, the structure of monitoring and evaluation processes is partly a result of historical processes and different responsibilities, which explain some of the overlaps between the different monitoring processes.

Last but not least, the scope of different monitoring and evaluation processes has broadened over time. In the very beginning, technical and feasibility issues and security of supply were the main focus, over time economic efficiency and distributional issues started to play a more significant role, and most recently the scope broadened to issues like network upgrades and adjustments, biomass and land availability, sector integration, cross-border integration etc. As for the content of the programmes, forms of participation have expanded in the development and revision of the programmes. Expert communities, the general public and parliament are playing an increasing role in these processes.

With a view of the great diversity of monitoring processes in Germany, the discussions in the following sections do not claim to be exhaustive and are limited to those processes that might offer specific insights and could be of specific interest for the German-Japanese exchange of experiences.

2.1.3. The energy transition monitoring process in Germany

The monitoring process "Energy of the Future" was launched on 19th of October 2011 to track the energy transition on a continuous basis and to take stock concerning the achievements and shortcomings of the transition process.

The Federal Ministry of Economic Affairs and Energy (BMWi) conducts the coordination of the process with support by the Federal Network Agency (BNetzA). Supporting ministries are most importantly the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry of Transport and Digital Infrastructure (BMVI). The monitoring is accompanied by an independent commission of scientific experts. The commission consists of Prof. Dr. Andreas Löschel (chair), Prof. Dr. Veronika Grimm, Prof. Dr. Barbara Lenz and Prof. Dr. Frithjof Staiß. At the

heart of the process are the monitoring report of the Federal Government, the progress report of the Federal Government and the statement of the expert commission.

Monitoring report and progress report

The Federal government publishes an annual monitoring report and a progress report every three years. The annual monitoring report is incorporated into the progress report, which allows the annual reporting to take place at its usual time.

The annual monitoring report of the Federal Government condenses the statistical information on energy into a number of selected indicators. This information provides a fact-based overview over the current status of progress with regard to implementation of the policies. Each year, the report provides information about the progress achieved in the preceding year. The Federal Government also uses the report to meet its information requirements under the Energy Industry Act (EnWG) and the Renewable Energy Sources Act (EEG). The progress report is more forward looking than the monitoring report and allows for deeper analysis. It also looks at what additional policies might need to be taken.

The governmental reports are prepared by the BMWi with inputs of BMU, BMVI and other ministries, where the BMWi has been appointed the lead ministry for the monitoring process. The main source of data is the official energy statistics. Further data and statistics are supplied by the BNetzA, the Federal Environment Agency, the Federal Motor Transport Authority, the German Institute for Economic Research, Statistik der Kohlenwirtschaft (an organization tasked with providing the Government with statistics from the coal industry), the Working Group on Renewable Energy Statistics, and the Working Group on Energy Balances. The data are publicly accessible in electronic form on the websites of the BMWi and the BNetzA.

Statement of the expert commission

The independent expert commission is appointed by the Federal Government to accompany the monitoring process scientifically. It supports the government in developing the monitoring concept and suitable indicators. The commission prepares an independent statement on each governmental report. The statement is critical but constructive and analyses current targets, developments and policies.

Annual preparation cycle:

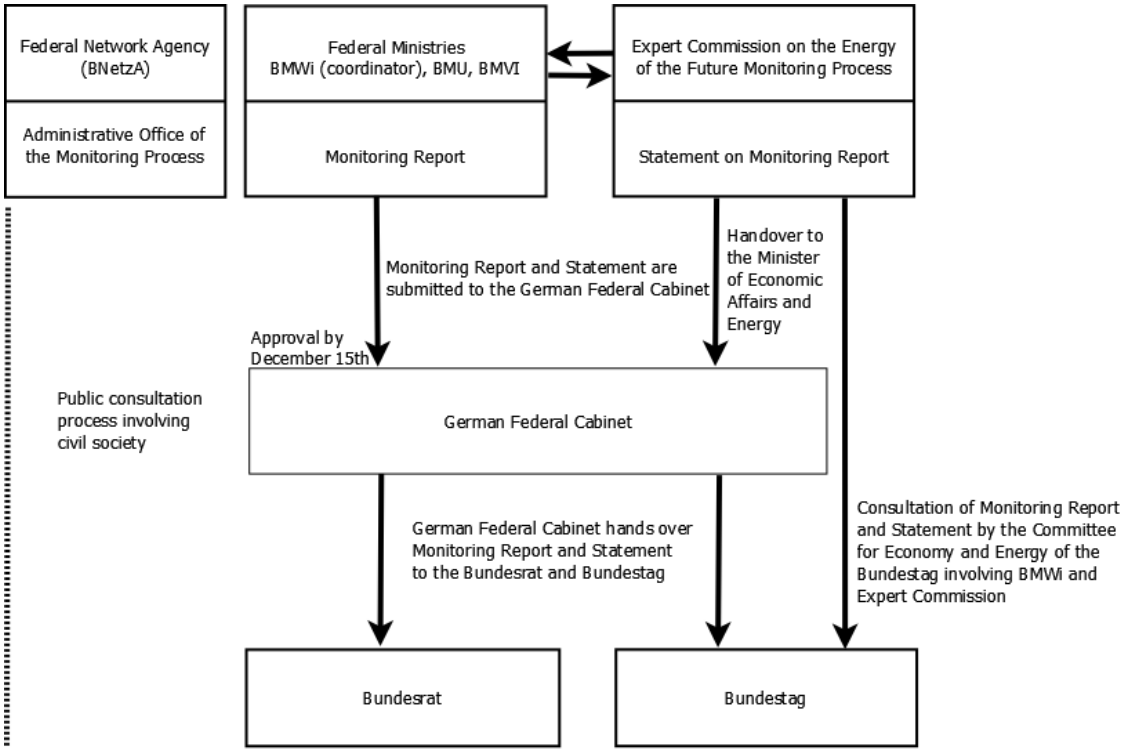
There are several meetings in the annual preparation cycle of the report and the statement. The BNetzA, the BMWi, the BMU, the BMVI and the expert commission participate in those meetings. The report and the statement are published on the website of the BMWi and handed over to the Minister of Economic Affairs and Energy. The monitoring report for each year must be approved by the Federal Cabinet until 15th of De-

cember. Report and expert statement are then submitted to the Bundestag[14] and the Bundesrat. The BMWi and the chairman of the expert commission are invited on a yearly basis by the Committee for Economy and Energy of the Bundestag to discuss the status of the energy transition.

Overview of publications:

The first two monitoring reports of the Federal Government were published in December 2012 and March 2014. In December 2014, the 3rd monitoring report of the Federal Government was published as a first progress report. Afterwards the 4th and 5th governmental reports were published in November 2015 and December 2016. Due to delays in government formation after Federal elections, the Government published a regular report with delay in June 2018, instead of a second progress report. The second progress report was published in June 2019.

Figure 2-1: The German Monitoring Cycle



Source: own illustration

The corresponding statements of the expert commission accompanied the reports of the Government. Delays from the annual monitoring cycle are mainly due to federal elections in Germany.

[14] The Bundestag is the chamber of elected representatives and the main legislative body in Germany, while the Bundesrat is the chamber of the Federal States and has rights of co-decision, if legislation or implementation, which is subject to the States, is affected by federal legislation.

2.1.4. The monitoring and evaluation process proposed by the German Commission on Growth, Structural Change and Employment

In June 2018, the German Federal Government set up a commission for designing a phase-out plan for coal-fired power generation in Germany that is consistent to the short-, medium and long-term climate targets. The mandate of the Commission on Growth, Structural Change and Employment (unofficially called the Coal Commission) was

1. to develop proposals to support coal mining regions, employees and companies in the transition process, i.e.
   a. to create an accountable perspective for the affected regions
   b. to draft a policy mix that integrates economic development, structural change, social sustainability, social cohesion, climate protection as well as a perspective for sustainable energy regions
   c. to draft an investment programme
2. to develop a proposal for a coal phase-out plan, i.e.
   a. to draft policies and measures for achieving the greenhouse gas emissions reduction targets for the energy industries by 2030 (61…62% below 1990 levels)
   b. to draft a plan for stepwise reduction and termination of coal-fired power generation including an end-date and the necessary accompanying measures
   c. to draft policies and measures for closing the gap to the 40% emissions reduction target (by 2020) as far as possible (as a contribution of the coal-fired power generation)

In January 2019 the final report of the commission was approved.[15] Apart from the specific proposals according to the mandate, it also covers a comprehensive monitoring, evaluation and revision process:

1. In 2023, 2026 and 2029 comprehensive progress reports shall be presented from the Federal government to the German Federal Parliament and the German Federal Council.
2. The Federal government shall appoint an independent expert group that checks and assesses the progress reports. It should consist of experts for structural development and regional policy, labor market, energy sector, industry, and climate policy.

[15] https://www.bmwi.de/Redaktion/EN/Publikationen/commission-on-growth-structural-change-and-employment.pdf?__blob=publicationFile&v=3

3. The progress reports shall be based on a set of criteria and indicators that reflect the following sectors

    - structural change, value creation and employment
    - climate policy
    - energy market and electricity prices for industry, businesses and residential consumers
    - security of supply
    - grids, storage, sector integration and innovation
    - operations of open cast mines and mining-aftercare

Although the Commission on Growth, Structural Change and Employment addresses only a certain, but nevertheless extremely important, policy area and only a subset of the comprehensive energy and climate policy targets in Germany, the proposed monitoring, evaluation and review process is piloting a new quality of assessments, especially with regard to regional aspects of the energy transition. This will be of special relevance not only for the energy sector and the coal regions but also for other sectors (transport/automotive industries, basic materials industry, agriculture) and their regional centres, which will be significantly affected by the upcoming transformational modernization driven by climate policies.

2.1.5. Germany's monitoring process as part of the existing EU monitoring mechanism

Energy and climate policy in Germany are embedded in the energy and climate policy of the European Union. The related legal framework goes, however, beyond the ex-post monitoring and reporting of certain progress indicators (e.g. on greenhouse gas emissions, share of renewables in gross final consumption).

All Member States of the European Union are obliged to present so-called projection reports on a biennial basis. These projection reports need to include

- model-based projections for greenhouse gas emissions, energy consumption etc. that consider all adopted policies and measures (with measures projection);
- model based projections without policies and measures where available and with additional measures where available;
- the outcomes on greenhouse gas emissions need to be presented in the formats which apply under the UNFCCC monitoring and reporting obligations and also differentiate between emissions that are regulated by the European Union Emissions Trading System (EU ETS) and emissions that are not regulated by the EU ETS; the projections need also to be accompanied by a set of indicators;
- policies and measures shall be analysed in a way that their impact can be assessed on a numerical basis (e.g. in emission abatement terms), the European Commission provides a comprehensive data roster for these assessments;

- a sensitivity analysis of the results shall be presented.

Germany presented these comprehensive projection reports in 2015 and 2017 and is in the process of drafting the projection report 2019.

The different projection reports for Germany were relevant essentially in two dimensions:

- Germany fulfilled its existing obligations under the Monitoring Mechanism Regulation[16], all outcomes were included in an European database and are published on a regular basis in the Trends and Projections Report of the European Environment Agency.
- The only regular ex-ante evaluation of policies and measures in a great detail was the trigger point for significant revisions in German energy and climate policy (e.g. the Climate Action Plan 2020).

The reporting obligations under Monitoring Mechanisms regulations apply also to the ex-ante monitoring on greenhouse gas emissions (regular greenhouse gas inventories for X-2 years and approximated greenhouse gas inventories for X-1 years), national adaptation plans, financial and technology support provided to developing countries, use of auctioning revenues and project credits).

Related to the EU's 2020 targets, Germany is also subject to mandatory monitoring and reporting to the European Union with regard to the use of renewable energy sources. On the basis of Article 22 of Directive 2009/28/EC[17] each EU member state need to submit a comprehensive report on progress in the promotion and use of energy from renewable sources on an biennial basis, starting in 2011. The 4th progress report was presented in 2017 (reference years 2015 and 2016) the 5th is to be submitted by end-2019. The progress reports need to build upon a common template and are aggregated by the European Commission.

Mandatory monitoring and reporting obligations exist also with regard to energy efficiency. Based on article 24(1) in conjunction with Part 1 of Annex XIV to Directive 2012/27/EU[18], Germany needs to submit a National Energy Efficiency Action Plan on an annual basis, starting in 2013 and containing data and information for the Year X-2. The most recent document on Germany from 2018 covers the years 2015 and 2016. These documents also need to reflect a common framework issued by the EU[19] and are aggregated by the European Commission.

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[16] Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC, http://data.europa.eu/eli/reg/2013/525/2018-12-24

[17] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, http://data.europa.eu/eli/dir/2009/28/2015-10-05

[18] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, http://data.europa.eu/eli/dir/2012/27/2019-06-12

[19] Commission implementing decision establishing a template for National Energy Efficiency Action Plans under Directive 2012/27/EU of the European Parliament and the Council {C(2013) 2882 final}, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:141:0048:0053:EN:PDF, Commis-

Different to the projection reports on greenhouse gas emissions and the ex-ante evaluation of policies and measures mentioned above, the progress reports on the use of renewable energy sources and on energy efficiency in the EU framework never played a significant role for the renewable or energy efficiency policies and politics in Germany, given the recent ambition levels of German and EU policies.

2.1.6. The emerging EU energy & climate governance mechanisms

The increasing climate and energy policy ambition for the EU and Germany will require more and more stringent efforts in both, the EU and the national framework. Against this background, the EU has approved legislation for more stringent and more comprehensive efforts by 2030 and later years, which go beyond the traditional targets on greenhouse gas emission reductions, the use of renewable energy sources and energy efficiency.

Consequently, the EU also approved a legally binding governance of the Energy Union and Climate Action[20] that also includes more ambitious provisions on policy planning and monitoring:

1. The EU Member States need to submit Integrated National Energy and Climate Plans every ten years, starting in 2019 (with a fist draft in 2018). These plans shall specify the objectives, targets and contributions with regard to the different dimensions of the Energy Union
    - decarbonisation (medium- and long-term)
    - renewable energies
    - energy efficiency (medium- and long-term)
    - energy security
    - internal energy markets (electricity interconnectivity, energy transmission infrastructure, market integration, energy poverty)
    - research, innovation and competitiveness (medium- and long-term)
2. The EU Member States need to submit updates to their Integrated National Energy and Climate Plans once during the ten years period, starting in 2024 (with a first draft in 2023).

sion staff working document on Guidance for National Energy Efficiency Action Plans {SWD(2013) 180 final}, https://ec.europa.eu/energy/sites/ener/files/documents/20131106_swd_guidance_neeaps.pdf

[20] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council, http://data.europa.eu/eli/reg/2018/1999/oj

3. The European Commission will assess these plans and provide feedback to the Member States (e.g. on necessary revisions to meet the targets).

A new quality of the governance system is achieved due to the much broader coverage of assessment criteria as well as the change of commitment structures. The latter do not longer focus solely on target values for certain target years but trajectories (for greenhouse gas emissions not regulated by the EU ETS as well as for the use of renewable energy sources).

A comprehensive system of monitoring will be set up for the governance of the Energy Union and Climate Action with the following reporting obligations on the monitoring results:

- integrated national energy and climate progress reports on a biennial basis, starting in 2023;
- integrated reporting on greenhouse gas policies and measures and on projections on a biennial basis, starting in 2021 (continuing the existing system described above);
- integrated reporting on national adaptation actions, financial and technology support provided to developing countries and auctioning revenues on a biennial basis, starting in 2021;
- integrated reporting on renewable energy on a biennial basis, starting in 2023 (as part of the integrated national energy and climate progress reports);
- integrated reporting on energy efficiency on a biennial basis, starting in 2023 (as part of the integrated national energy and climate progress reports);
- integrated reporting on energy security on a biennial basis, starting in 2023 (as part of the integrated national energy and climate progress reports);
- integrated reporting on the internal energy market on a biannual basis, starting in 2023 (as part of the integrated national energy and climate progress reports);
- integrated reporting on energy poverty on a biennial basis, starting in 2023 (as part of the integrated national energy and climate progress reports);
- integrated reporting on research, innovation and competitiveness on a biennial basis, starting in 2023 (as part of the integrated national energy and climate progress reports).

The framework for the monitoring and reporting obligations described above is laid down in legislation, the legislative documents will be followed by implementation guidelines.

2.1.7. The new policy evaluation and revision mechanism of the German Federal Climate Act

The German Federal Parliament approved the German Federal Climate Act on 12th December 2019[21] as part of the Climate Programme 2030. The essential elements of the act are the following provisions:

- The purpose of the act is to meet the German and European emission reduction targets, the goal of the Paris Agreement and to fulfill Germany's long-term commitment to reach climate neutrality by 2050;
- The act makes the emissions reduction target for 2030 of 55%, compared to 1990, legally binding. Climate targets can be adjusted and made more ambitious, an adjustment to less ambitious targets is not possible;
- The act establishes legally binding sectoral greenhouse gas emission targets for the energy industries (2020 and 2030), industry, buildings, transport, agriculture, waste managements and others (on an annual basis for 2020 to 2030);
- Any deviation of emissions from the annual emission targets will from 2021 onwards will lead to an equivalent offset for the target in the subsequent year;
- An independent Expert Council will be set up, which shall assess the annual sectoral emissions data and advise the government on changes or advancements of climate programmes or emission reduction targets;
- At the latest three months after the Expert Council stated an overrun for a sectoral emission target, the responsible ministry of the Federal government is obliged to present an immediate action programme to ensure compliance for the subsequent years (enforcement and self-commitment mechanisms);
- Public authorities are obliged to take into account the national and sectoral emission reduction targets in all their activities and investment decisions (this does not apply for public authorities of the German States and the municipalities, which cannot be ruled by Federal legislation).

In addition to this, the Federal government decided that the Climate Cabinet (Chancellor, ministers for the Environment, Finance, Economic Affairs & Energy, Building, Transport, Agriculture, Head of the Chancellery) shall continue its work and assess the implementation of the Climate Programme 2030.

The Federal Climate Act of 2019 constitutes a new legal quality for Germany's greenhouse gas emission reduction targets, the monitoring and evaluation as well the policy revision and advancement procedures. It implements legal obligations from EU legislation but goes also significantly beyond the EU minimum requirements.

The expectation of the Federal Government concerning the 'new legal quality' has been formulated by the Ministry of Environment in the following statement: "In the event

[21] https://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&start=//*[@attr_id=%27bgbl119s0010.pdf%27]#__bgbl__%2F%2F*%5B%40attr_id%3D%27bgbl119s2513.pdf%27%5D__1576571177290

that an area deviates from the reduction path, the law requires the responsible ministries to take immediate action." The Federal Climate Act thus ensures that the overarching climate target for 2030 (55 percent less greenhouse gas emissions compared to 1990) is reliably achieved. In this respect, the enforcement and self-commitment mechanism provided for in the German Federal Climate Act appears to be a unique innovation in monitoring and policy review procedures in Germany. However, it remains to be seen how these procedures will be implemented in practice, e.g. with regard to the transformation of long-lasting infrastructures and overcoming path dependencies.

2.2. Japan

2.2.1. Japan's energy policy and climate target/goal

Japan's climate target/goal and energy mix underpinning them derive from several key perspectives.

1) Perspectives behind Japan's energy policy

3E+S

First and foremost, 3E+S is the guiding principle of all the aspects of Japan's energy policy. In formulating energy policies and setting related targets, Government of Japan (GOJ) always simultaneously aims at the following on the premise of "**S**afety."

- stable supply ("**E**nergy Security")
- low cost energy supply by enhancing its efficiency ("**E**conomic Efficiency")
- maximum efforts to pursue environment suitability ("**E**nvironment").

This is crucial for Japan, the energy supply-demand structure of which is inherently vulnerable without indigenous fossil resources and international grid/pipeline connection with other countries and is in a process of overcoming challenges since the Great East Japan Earthquake and the TEPCO's Fukushima Daiichi nuclear accident. Under this principle of 3E+S, GOJ is advancing energy policy and the responses based on it with the aim of realization of the 2030 energy mix (see Figure 2-2 below).

Global perspective

Due to Japan's vulnerable energy supply-demand structure, changes in the surrounding global energy circumstances directly affect Japan. Japan's energy policies and energy mix always seek to reflect the global developments (e.g., inter-technology competition for decarbonization, geopolitical risks that may be increased by technology changes, intensified competition between nations and firms), taking into account multiple geopolitical and geo-economical uncertainties.

Economic growth perspective

Achieving stable supply of energy and reducing the environmental load while realizing low cost energy supply by enhancing economic efficiency is a precondition for keeping existing business operations in Japan and attaining further economic growth. The "Japan Revitalization Strategy (Cabinet decision on June 2013)" strongly calls for promoting the establishment of an energy supply-demand structure, in which constraints on electric power and energy are overcome and cost is reduced at the same time, by carrying out reforms of the energy sector in order to make Japan a conducive place for business activities through enhancement of the country's competitiveness as a business location.

In addition, the reform of the energy supply-demand structure will encourage new business entry in various ways and may lead to the arrival of companies, which supply energy more comprehensively and effectively and create a new market integrated with non-energy markets.

Furthermore, such reform structuring will provide an opportunity for Japan's energy industry to strengthen its competitiveness and boost its presence in the global market. It is expected to contribute to improving the trade balance through exports by energy-related companies of energy-related equipment and services with high value added.

In addition, effectively utilizing the energy resources present in the regions to build an independent and distributed energy system leads to the economic revitalization of the regions and their greater resilience including disaster management, etc.

Therefore, the contribution to economic growth is considered as one of the most important viewpoints when developing energy policies. When doing so, the viewpoints of utilization of the outstanding energy technologies possessed by Japanese companies, the creation of domestic and overseas markets, and expansion of overseas contributions using those technologies are also fully taken into account.

Multilayered and diversified flexible energy supply-demand structure

For Japan to create an environment where social and economic activities are conducted in a stable manner despite the limited availability of energy resources, it is necessary to establish an energy supply-demand structure, which makes it possible to secure a stable supply-demand balance continuously. To that end, it is necessary to ensure stability and efficiency so as to enable flexible responses to changes in energy supply volumes and prices in normal times. At the same time, it is also necessary to make it possible to use other energy sources as backups in a smooth and appropriate manner if supply of a specific energy source is disrupted in times of crisis.

Japan's energy policy aims at creating such a "multilayered and diversified flexible energy supply-demand structure" through:

- Multi-layered supply structure with a combination of energy sources, where the strength of individual energy sources could be maximized to appropriately offset each other's weakness
- Resilient energy supply structure, which could function not only on normal

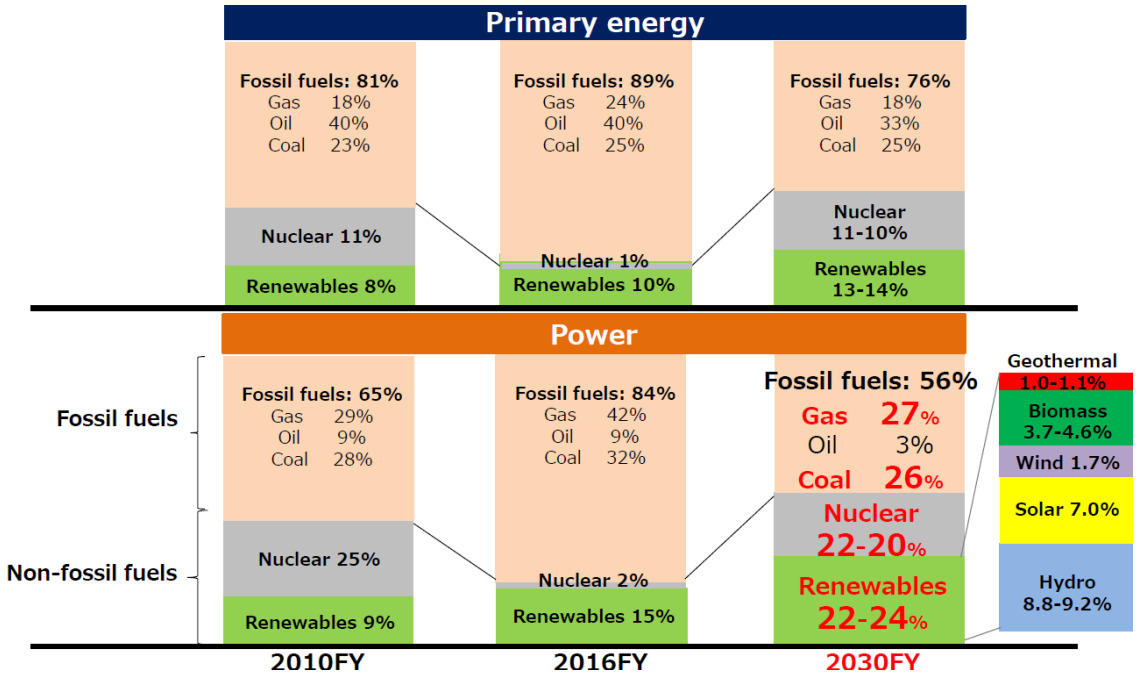
times but also in times of crisis

- Participation of diverse entities in the energy supply system through energy structural reforms and development of mid-to-long-term business environment
- Creation of an energy supply-demand structure led by the demand side through providing various options for end users
- Improving self-sufficiency by developing and introducing indigenous energies (renewable energy, nuclear energy and methane hydrate) as well as raising independent development ratio (the proportion of import volume and domestic production volume accounted for by the volume of trades and domestic production volume pertaining to the interests of Japanese companies) in oil, gas and coal with a view to minimize the impact of changes in overseas circumstances
- Contribution to global warming countermeasures for reducing domestic and overseas greenhouse gas emissions through transfer of efficient and environmentally friendly technologies to developing countries as well as developing new and innovative technologies.

2) 2030 climate target

In 2015**,** Japan submitted the Intended Nationally Determined Contribution (INDC), which is supposed to be the Nationally Determined Contribution (NDC) under the Paris Agreement to the UNFCCC Secretariat. Japan's INDC aims at 26.0% reduction of GHG compared to the FY 2013 (25.4% reduction compared to the FY2005 level) by FY2030.

Figure 2-2: Japan's energy mix underpinning GHG target



Source: Japan's Strategic Energy Plan, ANRE, 12 April 2018

This target is underpinned by a specific energy mix, which was developed in 2015 aiming at simultaneous achievement of three requirements, namely, a) restoring energy self-sufficiency to more than 25%, b) reducing electricity cost from the current level and c) presenting a GHG target comparable with those of the US and the EU (see Figure 2-2). This energy mix was reconfirmed in the 5th Strategic Energy Plan (SEP) adopted by the cabinet in July 2018[22].

It should be emphasized that the 2030 energy mix is a "forecast" taking into account existing infrastructure, technologies, and human resources and is presented with sufficient probability with a view to providing certainties to the investment behaviors in the private sector. What matters is the implementation of policies underpinning the energy mix. Specific figures (e.g. 17% energy saving from the reference case, 22-24% share of RE and 20-22% share of nuclear) are indicative ones resulting from policy implementation. Therefore, it is not appropriate to characterize these figures as "targets".

Energy efficiency, renewable and nuclear, all of which are to play a crucial role in reducing energy-related CO2 emissions, are positioned in the Strategic Energy Plan. Some detail is provided in the following.

[22] http://www.meti.go.jp/english/press/2018/0703_002.html

Energy efficiency

Due to the combined efforts of the public and private sectors, Japan's energy consumption efficiency has improved 40% since the oil crises in the 1970s and is at the highest level in the world. The Act on the Rational Use of Energy (The Energy Saving Act), which was established in 1979 in response to the oil crises, obligates business operators that use a lot of energy in industry, operation and transportation to report the state of their energy efficiency measures and improvement of energy consumption efficiency every year to the government. Moreover, it builds a framework that encourages such business operators to take measures for energy saving. In the commercial and residential sectors, the act encourages manufacturers of equipment, etc. to improve their energy consumption efficiency using Top-Runner programs for energy consuming equipment. Realization of a more rational energy supply-demand structure and the reduction of emissions of greenhouse gases will be advanced by implementing these measures based on the Energy Saving Act and effective support measures for each sector in an integrated manner.

Also, in 2013 the Energy Saving Act was amended, and from April 2014 GOJ started taking measures that take into account in the evaluation of energy saving the efforts contributing to the equalization of electricity demand on the demand side to deal with peak demand of electricity, and it is estimated that equalization of electricity demand is making progress through the efforts of the business operators.

Furthermore, with the advance of technological innovations such as next-generation power electronics devices, which is anticipated to make power consumption even more efficient, more efficient energy use and the applications of energy sources will continue expanding. Besides, due to structural reforms such as the electricity system reform, a diverse set of options regarding the usage of energy, including the management of the demand amount as well as the supply amount, will become available for consumers as a result of the entry of various entities into the energy market.

In a market that offers a variety of options, consumers can make their choices freely, based on their own rational judgment. Through this process, changes in the supply structure and the energy source mix will occur.

It is necessary to reinforce measures to accelerate the creation of such a new energy supply-demand structure. As a result of the efforts to date, the measures by individual business operators using energy have made substantial progress. Furthermore, the energy consumption performance has improved due to the pursuit of optimal design for each individual piece of equipment. Going forward, for further energy saving, in addition to the measures to date, it is necessary to utilize AI and the IoT, big data, etc. to promote measures for new energy saving that can be realized through mutual collaboration among multiple business operators and types of equipment.

Renewable energy

While renewable energy has various challenges in terms of stable supply and cost at this moment, it is a promising, multi-characteristic and important energy source which can contribute to energy security as it can be domestically produced free of greenhouse gas emissions, is low-carbon, and is utilized with a focus on reducing the envi-

ronmental load over the long term.

GOJ has been accelerating the introduction of renewable energy as far as possible since 2013 and will continue actively promoting it. Therefore, GOJ steadily proceeds with the enhancement of power grids, rationalization of regulation, research and development for cost reduction, etc. GOJ utilizes the policy coordination of the Ministerial Council on Renewable Energy, Hydrogen and Related Issues to continue promoting cooperation among related ministries and advance the implementation of further measures. In this way, GOJ is advancing on early measures for laying the foundation for steady conversion of renewable energy into a major power source, as well as for realization of the power source composition ratios in the 2030 energy mix.

Besides, it is necessary to proceed with technology development in a way to keep a good balance between economic efficiency and other factors while taking into consideration the different characteristics of various energy sources, with a view to creating new energy-related industries and jobs, including creation of new technologies such as the world's most advanced floating offshore wind power systems and large-scale storage batteries.

Nuclear

Nuclear power's energy output per amount of fuel is overwhelmingly large and it can continue producing power for several years only with domestic fuel stockpile. Nuclear power is an important base-load power source as a low carbon and quasi-domestic energy source, contributing to the stability of the energy supply-demand structure in the long term, on the major premise of ensuring of its safety, because of the perspectives; 1) superiority in stability of energy supply and efficiency, 2) low and stable operational cost, and 3) free from GHG emissions during operation.

On the premise that safety takes precedence over everything else and that every possible effort is made to resolve the people's concerns, judgment as to whether nuclear power plants meet the new regulatory requirements will be left to the Nuclear Regulation Authority (NRA) and in case that the NRA confirms the conformity of nuclear power plants with the new regulatory requirements, which are of the most stringent level in the world, GOJ will follow NRA's judgment and will proceed with the restart of the nuclear power plants. In that case, GOJ will make best efforts to obtain the understanding and cooperation of the host municipalities and other relevant parties. Dependency on nuclear power generation will be lowered to the extent possible by energy saving and introducing renewable energy as well as improving the efficiency of thermal power generation, etc. Under this policy, GOJ will steadily advance the necessary responses with the aim of realizing the power source composition ratio in the energy mix for 2030 formulated by carefully examining the volume of electricity to be secured by nuclear power generation, taking Japan's energy constraints into consideration, from the viewpoint of stable energy supply, cost reduction, global warming countermeasures and maintaining the technologies and human resources necessary to secure safety.

GOJ takes thorough measures to minimize the risk of the accidents considering the experience of and lessons of the TEPCO's Fukushima Daiichi nuclear accident. In addition to that, in case the accident occurs, GOJ copes with its responsibility based on the related legislation. In addition, accumulation of spent fuels resulting from the gen-

eration of nuclear energy is a global problem to be solved. As a responsibility of the current generation, it is essential to steadily make efforts to deal with the problems of spent fuels while making use of an international human network in order to avoid passing the problem on to future generations.

Moreover, Japan will take necessary measures and promote relating R&D to ensure nuclear non-proliferation and strengthen nuclear security in light of international developments, including the holding of the Nuclear Security Summit and the adoption of the revised Convention on the Physical Protection of Nuclear Material

Innovative Energy Strategy

In July 2015, Japan formulated the Long-term Energy Supply and Demand Outlook (energy mix) and set ambitious targets, including a) thorough energy efficiency and conservation (improving energy efficiency by 35%, an equivalent level to the post-oil crisis period) and b) maximum introduction of renewable energy (doubling the current figure).

To meet these targets, it is essential for Japan to develop comprehensive policy measures, not leaving the matter solely to the markets. Aiming to integrally improve the related systems, METI has formulated the Innovative Energy Strategy. Through this strategy, it will endeavor to facilitate investment in the energy fields and greatly improve energy efficiency, thereby simultaneously achieving a strong economy and a reduction of carbon dioxide emissions.

In addition, the implementation of the strategy is expected to bring about economic effects, in FY2030, of 28 trillion yen in the field of energy-related investments, such as energy efficiency and conservation and renewable energy, including 1 trillion yen in the field of hydrogen-related investment. The key points of the strategy are as follows.

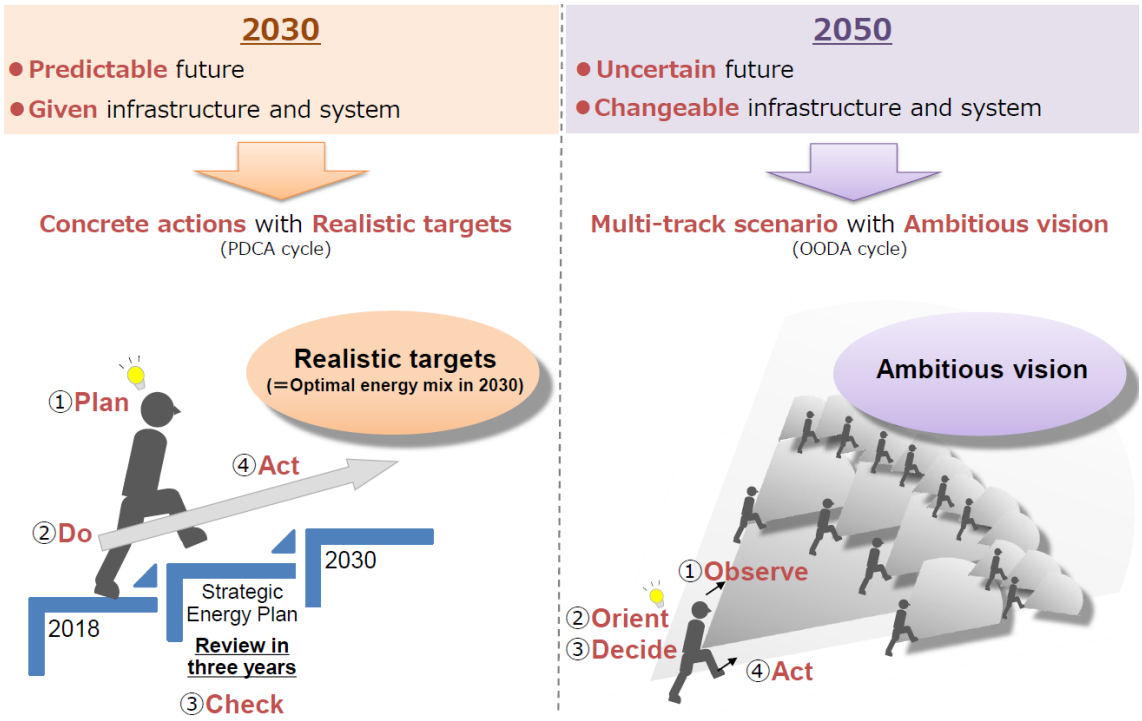
- Thorough energy efficiency and conservation
  - Expanding the scope of targets of the Energy Efficiency Benchmark Program to all industries
  - Enhancing the introduction of energy efficiency and conservation efforts into the fields of Small and Medium-sized Enterprises (SMEs), house and transportation
- Expanding the introduction of renewable energy, ensuring compatibility between maximum introduction and expansion, and inhabitation of public burden
- Establishing new energy systems
  - Simultaneously encouraging new entrants to the field of electricity and reducing carbon dioxide emissions
  - Starting up an integrated energy system of renewable energy and energy efficiency and conservation
  - Establishing an energy system of local production for local consumption

3) 2050 long-term goal (vision)

With regard to the long-term goal, the Plan for Global Warming Countermeasures (2016) states that Japan aims at 80% GHG emissions reduction by 2050. It should be noted that mid-term target in 2030 and long-term vision in 2050 are different in nature. Since 2030 target is underpinned by the energy mix in the relatively predictable future assuming given infrastructure and system, its secure achievement is to be pursued by concrete and, if needed, strengthened measures on each energy source.

On the other hand, 2050 goal is regarded as "ambitious vision" since long-term projection with high level of probability is difficult due to multiple uncertainties in such factors as technological innovation, international/domestic political and economic situation and so forth. Therefore, unlike 2030 target, 2050 vision is to be pursued based on multi-track scenarios with priorities decided based on the latest information (see Figure 2-3) instead of establishing a specific energy mix in 2050.

Figure 2-3: 2030 target and 2050 vision



Source: Structure of the 5th Strategic Energy Plan, ANRE, 12 April 2018

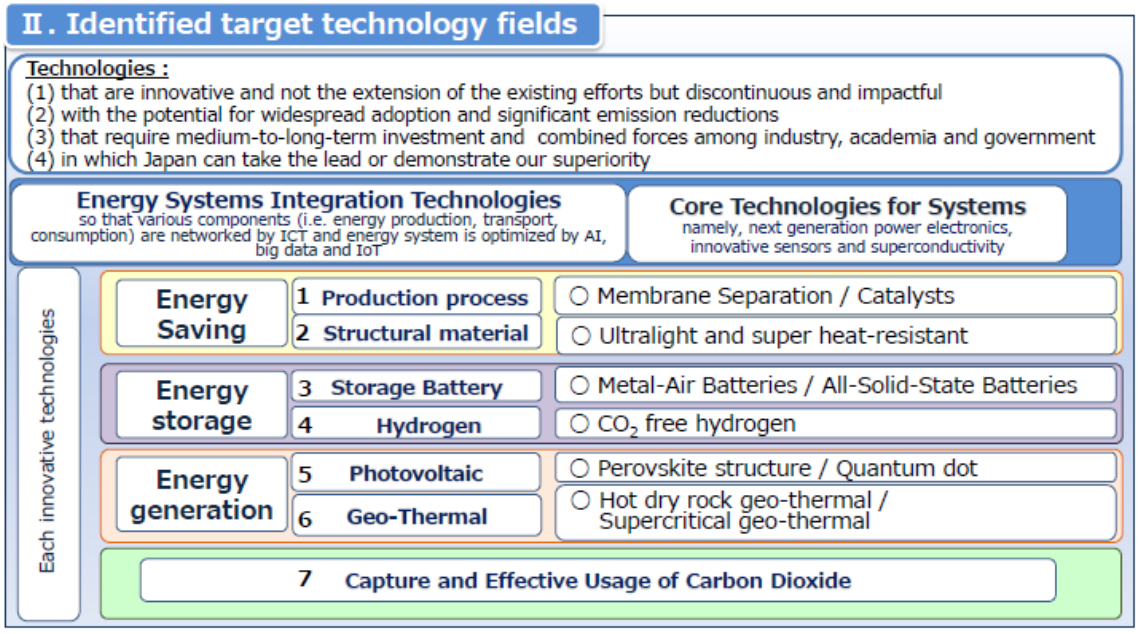
4) Policies for long-term decarbonization

The Plan for Global Warming Countermeasures (2016) states that "Japan will lead the international community under the Paris Agreement so that major greenhouse gas (GHG)-emitting countries will undertake the reduction of their emissions under a fair and effective international framework in which all major countries participate and will aim at the long-term goal of reducing greenhouse gas emissions by 80% by 2050 while reconciling global warming countermeasures and economic growth. Such a large-scale emissions reduction is difficult to do by merely continuing existing efforts. Therefore, it

is decided that Japan will pursue to the maximum solutions through innovation including the development and adoption of innovative technology that makes thoroughgoing reduction of emissions possible, encourage domestic investment, strengthen international competitiveness, and aim at large-scale emissions reduction through long-term, strategic initiatives and contribute to worldwide reduction."

Therefore, introduction of revolutionary energy technologies through long-term R&D and institutional reforms for enabling it plays the central role in the efforts towards 2050 goal. GOJ formulated the Roadmap for Energy-Related Technology Development in December 2014 as the strategy for consistently carrying out such various technology development projects based on the "Innovation Plan for Environmental Energy Technology (decided in September 2013 by the Council for Science and Technology Policy)" and other plans. In April 2016, the Ministry of Economy, Trade and Industry formulated the "Innovative Energy Strategy," which aims to achieve the 2030 energy mix by establishing the relevant institutional framework for energy conservation, renewable energy, etc. together. In the same month, the GOJ formulated the "Energy/Environment Innovation Strategy" based on the understanding that creating innovation that achieves thoroughgoing reduction is essential in addition to continuing current efforts to reduce greenhouse gases (see Figure 2-4).

Figure 2-4: Energy and environment innovation strategy



Source: Cabinet Office

5) Long Term Strategy under the Paris Agreement

On 11 June 2019, Japan has adopted the Long-Term Strategy under the Paris Agreement[23] based on the Article 4-19 of the Paris Agreement. It is intended to share Japan's concept and actions with the world, to contribute to the achievement of the long-term goals of the Paris Agreement including efforts to limit the temperature increase to 1.5℃ and to lead international discussions.

As its long-term vision, the Strategy proclaims a "decarbonized society" as the ultimate goal and aims at accomplishing it as early as possible in the second half of this century, while taking measures towards the reduction of GHGs emissions by 80% by 2050.

Its basic concepts towards the long-term vision is to realize "a virtuous cycle of environment and growth" towards the vision with business-led disruptive innovation, to swiftly implement actions from now on and to contribute to the world. Key elements underscoring the Strategy are: achievement of SDGs; "Co-innovation"; Society 5.0; "Circulating and Ecological Economy"; and "leading country in solving problems"

5-1) Sectoral Vision of the Long-Term Strategy

Energy Sector

As for the energy sector, the Strategy envisages the pursuit of various energy options for energy transition and decarbonization, including energy efficiency, renewable energy, battery, hydrogen, nuclear, and CCS&CCU (carbon capture and storage, carbon capture and utilization). To this end, renewable energy is intended to be economically viable and a major decarbonized power source, through drastic cost reduction and overcoming power grid constraints. In the field of thermal power, CO2 emissions are to be reduced in line with the long-term goals of the Paris Agreement through lowering the dependence on thermal power as much as possible, promoting CCS&CCU and Carbon Recycling and establishing the first commercial-scale CCS technology by 2023. Japan is aiming at realizing a "hydrogen society" ahead of the rest of the world by bringing down the procurement and supply costs of hydrogen, including the environmental value, to levels that compare favorably with those of conventional energy sources. To that end, pursuant to the Basic Hydrogen Strategy[24], the Government will accelerate an expansion of demand for hydrogen in mobility in the immediate future.

Industrial Sector

As for the industrial sector, the Strategy aims at establishing new manufacturing processes to achieve decarbonized manufacturing through disruptive innovation. To this end, use of CO2-free hydrogen (e.g. "zero-carbon steel"), feedstock change (e.g. CCU including artificial photosynthesis, carbon recycling and biomass), drastic energy efficiency, development and introduction of low-GWP (global warming potential)/non-

[23] https://unfccc.int/sites/default/files/resource/The%20Long-term%20Strategy%20under%20the%20Paris%20Agreement.pdf

[24] https://www.meti.go.jp/english/press/2017/pdf/1226_003b.pdf

fluorocarbon refrigerant technology and decarbonization in corporate management will be promoted.

Transport Sector

As for the transport sector, the Strategy aims at "Well-to-Wheel Zero Emission" by achieving the highest level of environmental performance of Japanese vehicles supplied worldwide by 2050. To this end, international policy coordination on electrified vehicles, including automotive environmental performance assessment on "Well-to-Wheel" basis is to be enhanced as well as promoting open innovation for the electrified vehicle technology and road/transport systems using big data and IoT.

Community and Life

In the field of community and life, the Strategy envisages "Circulating and Ecological Economy" aiming at the achievement of SDGs through local decarbonization and integrated environmental/economic/social improvement in the region and the achievement of carbon-neutral, resilient and comfortable communities and life by 2050 and enabling communities and corporations to achieve carbon neutrality even before 2050. To this end, technology development and dissemination to achieve net Zero Energy Buildings, which is equivalent to stock average of housing and office buildings, shift of lifestyles and carbon neutral community building through urban city building, farming/forestry/fishing villages building, and development of distributed energy systems will be promoted.

5-2) Cross-sectoral Measures for Achieving a Virtuous Cycle of Environment and Growth

With a view to achieving a "virtuous cycle of environment and growth", the Strategy presents three major pillars, namely, innovation, green finance and business-led international application and international cooperation.

Innovation

Innovation is the centerpiece of the Strategy for drastic reduction of GHG emissions. The Government of Japan will formulate a Progressive Environment Innovation Strategy and make efforts in the medium term to facilitate disruptive innovation at the level of cost which enables it to be adopted in the society. The Innovation Strategy has been formulated during 2019 and will be disseminated to the world. The purpose of the strategy includes

- Making business case for technologies contributing to the global mitigation;
- Setting clear targets (e.g. cost);
- Ensuring financial flow from both public and private sectors;

- Indicating long-term commitment of sizable investment;
- Seeking out and creating potential technology seeds in Japan and abroad;
- Identifying challenges to be overcome;
- Providing flexible support for ambitious challenges for innovative themes overcoming excessive risk-aversion;
- Setting up institutional promotion and comprehensive support for business.

With a view to discovering and creating technical seeds in- and outside Japan, technical review of cost and GHG emissions reduction based on objective LCA (life cycle assessment) will be provided as well as accelerating public R&D with ambitious targets. In addition, Japan will host an international conference (RD20 for clean energy technologies) inviting leaders in science and technology from G20 to drive disruptive innovations in the clean energy technology field and enhancing alliances among R&D institutes with facilitation of international joint R&D activities.

Support leading to actual business will be enhanced. For example, GOJ will provide knowledge-based support (e.g. NEDO Pitch) to selected companies. Furthermore, the search for superior environmental and energy technologies and human resources will be "visualized" to market for incentivizing investment.

Targets and key technologies are identified in key innovation areas, namely, energy efficiency and conversion, CCUS and negative emission, hydrogen, renewable energy and nuclear. For example, the Strategy aims at providing CCU and carbon recycled products with costs equivalent to existing products. It also aims at reducing manufacturing cost of CO_2 free hydrogen by 90% for realizing cost parity to conventional fuels.

Promotion of Green Finance

In realizing a low carbon society envisaged in the Paris Agreement through technological, economic and social innovation, the role of finance is crucial through mobilizing investment for corporations addressing climate change issues and innovation. To this end, "visualization" of such corporate efforts is to be strengthened.

By utilizing the TCFD (Task Force on Climate related Financial Disclosure), the strength of contributions of companies are to be visualized, thereby financial flow capturing opportunities from climate change are developed. The industry sector is encouraged to enhance information disclosure through such measures as TCFD Guidance/ Scenario Analysis Guide. With a view to facilitating assessment of disclosed information by financial sectors, a guidance on green investment will be formulated for financial institutions. As a venue for dialogue between industry and financial sector, the TCFD Consortium is created. Japan held a TCFD Summit in autumn of 2019, to discuss and share the above initiatives with the world.

Various initiatives will be promoted to expand ESG finance aiming to brand the Japanese capital market. They include the issuance of green bonds, and promoting ESG finance in direct finance. ESG dialogue platform will be developed for enhancing assessment of environmental information and corporate value.

Business-led International Application and International Cooperation

While aiming at a large-scale reduction of emissions of its own, Japan will expand co-operative partnership with other countries for promoting international dissemination of goods and products with high environmental performance, thereby contributing to global reduction of emissions.

To this end, the Government will facilitate business-led international application through creating markets, human resource development, and institutional development. In doing so, "co-innovation" with partner countries will be sought by adapting Japanese decarbonizing technology suitable to the partner country and supporting necessary economic and social system changes. This includes public-private workshops to share best practices on: global comparison and assessment of energy efficiency, introducing energy efficiency labels and building systems such as international standardization. Decarbonization and energy transition in ASEAN will be particular priority in the above endeavor. The Government will also make efforts towards data compilation for the "visualization" of energy consumption efficiency by industry, country and region, as well as working towards international standards on the assessment on the energy consumption by the steel sector, the energy efficiency capacities of building materials and general estimates on GHG emissions.

With a view to addressing energy access and decarbonization, Japan will take leadership in the international collaboration for decarbonizing fossil fuels such as CCS, CCU and carbon recycling. The Government will also present all available options including renewable and hydrogen to help reduce CO_2 emissions according to the needs of the partner country. The Government will promote the development and investment of energy infrastructure abroad in order to contribute to the global reduction of CO_2 emissions consistent with the long-term goals stipulated in the Paris Agreement.

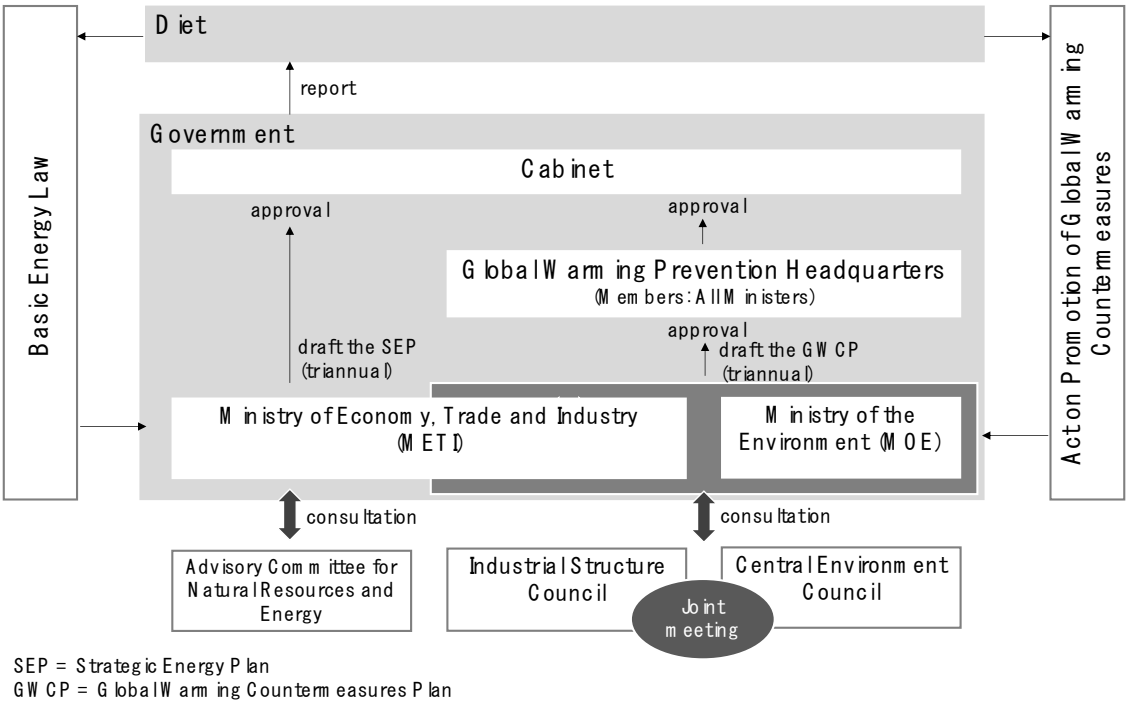
The public finance will be used as leverage for mobilizing private investment. By raising awareness of institutional investors on environmental finance including green bonds, the Government will facilitate investment and lending on climate change measures in Japan and overseas.

2.2.2. Monitoring Process in Japan

2030 target

The Basic Act on Energy Policy stipulates that the Strategic Energy Plan is to be reviewed at least once in three years. Therefore, the progress towards achieving the energy mix and GHG target is monitored and assessed throughout this review process.

Figure 2-5: Review process of the strategic energy plan



Source: Author

Review process of mid-term target under the Paris Agreement

Japan submitted its Intended Nationally Determined Contribution (INDC) in 2015[25].

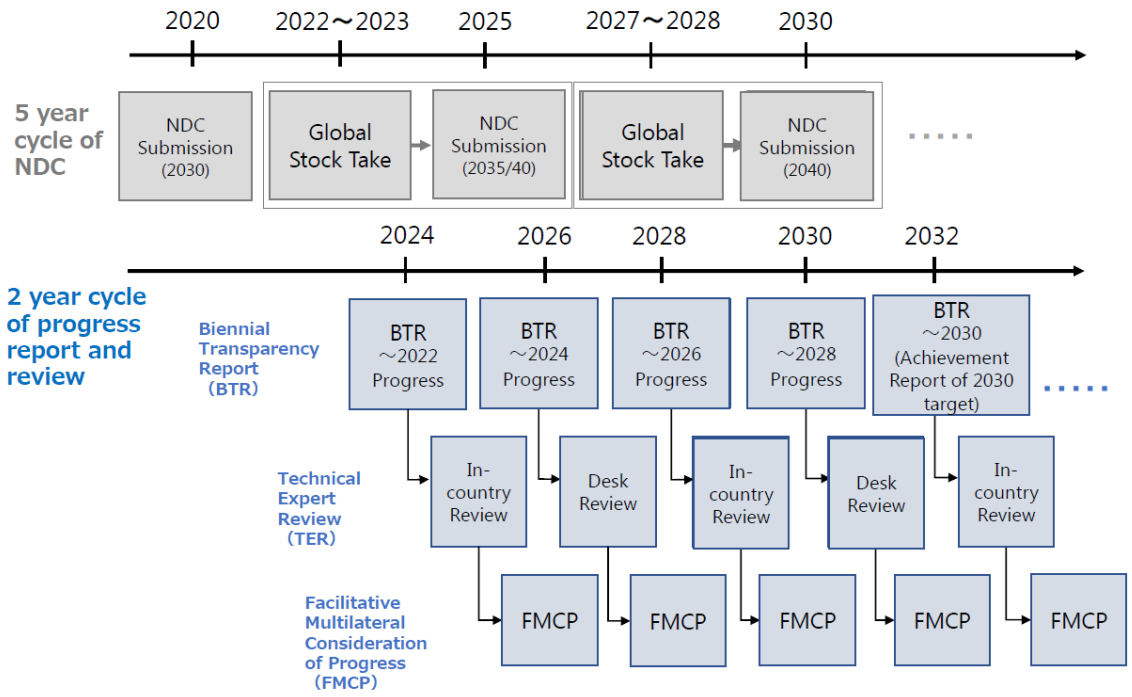
Under the paragraph 24 of the "Adoption of the Paris Agreement" (FCCC/CP/2015/L.9/Rev.1)[26], Parties, whose intended Nationally Determined Contribution (NDC) contains a time frame up to 2030, are requested to communicate or update by 2020 their NDC and to do so every five years thereafter pursuant to Article 4, paragraph 9, of the Paris Agreement. Given the progress towards the envisioned energy mix is only half way and the Strategic Energy Plan has confirmed its adherence to the mix, Japan is most likely to submit the same target as the INDC in 2020.

Based on the Article 13 of the Paris Agreement and the modalities, procedures and guidelines for the transparency framework adopted in the COP24, Japan, as a Party of the Paris Agreement, is required to submit biennial progress report (BPR) and then undergo technical expert review (TER) and facilitative multilateral consideration of progress (FMCP) (see Figure 2-6). First BTR is to be submitted in 2022. Monitoring progress towards energy mix is also integrated in this reporting process. In the course of biennial reporting process, Japan will monitor the progress towards its 2030 energy mix underpinning its 2030 GHG target.

[25] https://www.mofa.go.jp/mofaj/files/000090898.pdf

[26] https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

Figure 2-6: Process on mitigation (NDC, progress report, review and consideration of progress)



Source: Takahiro Ueno

2050 Goal

It should be noted that the Long-Term Low GHG Emissions Development Strategy is not subject to periodic reporting and multilateral review as opposed to the NDC. Therefore, it is not appropriate to define the long-term goal or vision in 2050 as “international commitment”.

While pursuing the “ambitious multiple-track scenarios” towards 2050, a “scientific review mechanism” is to be established with a view to secure proper energy and technology choice simultaneously achieving 3E+S (energy security, economic efficiency, environmental protection and safety) amid multiple uncertainties. This mechanism is to grasp the latest technological trends and global political/economic situation, to determine and revise technology development goals and the priority of each technology option under transparent procedures. The mechanism is to go through the following multi-layered verification process.

a) Collect and analyze information using human networks in Japan and abroad

b) Conduct the comparative verification of technology under a unitary yardstick

c) Assess the various risks of each technology qualitatively and quantitatively

d) Verify the relative competitiveness of domestic industries related to each technology

e) Establish development goals for each option based on the objective, multifaceted, and technical analysis of the above, determine the priority among the options, and determine the focus of policy resources accordingly.

In pursuing the 2050 scenario, the GOJ will take “cost-risk verification between decarbonization energy systems”, switching from traditional “cost verification by power source”. This will make crosscutting understanding of the technological maturity of multiple energy systems such as electricity/non-electricity, and heat and transportation possible. In addition, by making it the verification of system cost, it will become possible to compare the actual overall cost.

The possible decarbonization of electricity systems includes, for example, renewable energy-electricity storage systems, which place renewable energy at the center and complement it with storage batteries, hydrogen or other electricity storage systems; hydrogen-gas synthetization systems, which convert cheap energy sources such as overseas renewable energy or lignite subjected to CCS into hydrogen gas or synthetic gas (methane); and existing decarbonization technology such as hydropower, geothermal power, and nuclear power. Other possible approaches include the enhancement of energy conservation through distributed energy systems consolidated with digital technology; electrification, hydrogenation, and traffic volume control through automatic driving and other means for the decarbonization of the transportation system; and electrification, hydrogenation, and switch to synthetic gas for the decarbonization of the thermal system.

Since all of the above options are still in the development stage and each option has its own risks, it is crucial to conduct continuous technical verification under the above scientific review mechanism. Open and transparent review in itself should have the effect of accelerating the competition between the options. In addition, this decarbonization energy system approach also has the effect of encouraging more dynamic energy transitions. If decarbonization energy system technologies such as electricity storage, hydrogen, and digitalization become viable for practical use cost-wise, the decarbonization of a wide variety of electricity sources will become possible beyond existing borders such as base-, middle-, and peak-load electricity sources, while such technologies will become available for use in the decarbonization of heat and the transportation system at low cost. In addition, making decarbonization technology smaller will enhance the potential for distributed energy systems, in which the electricity, thermal, and transportation systems are completed within compact areas.

Review of Long-Term Strategy and its Implementation

Taking into account future situational changes, the Government will carry out analyses based on the best available scientific knowledge (e.g., constraints on land, climate, resources and social systems, adverse economic effects and growth opportunities caused by climate change). Furthermore, the Government will widely disseminate the information and promote collaboration and dialogue with the stakeholders including younger generations.

Reflecting on the vision established in this strategy and taking into account the Plan for Global Warming Countermeasures and the Strategic Energy Plan, the Government will

flexibly revisit the policy measures in this Strategy about every 6 years and review this Strategy where necessary.

2.3. Good practices from other countries

2.3.1. Preliminary remarks

Good practices for energy transition monitoring can be found on a national and international level. On the national level, the monitoring frameworks of France and the UK can be compared to the German monitoring framework. On the international level, monitoring generates substantial added value by increasing transparency and determining the transferability of best practice policies.

2.3.2. Comparing different national monitoring approaches: Germany, France and the United Kingdom

Germany, France and the UK not only have very different ideas about how to transform their economies towards climate neutrality, they also come to different conclusions about where they have their monitoring process accompanied by science.

Targets and their legal mandate

In contrast to Germany, both France and the UK have "carbon budgets" that guide their actions. In France, an emission reduction by a factor of 4 compared to 1990 was set for 2050. The UK targets a reduction of 80 %. At this point, it should be mentioned that the German commission of experts suggested emission budgets in its 5th statement as an alternative approach to achieving the climate targets. The focus is then on the total amount of greenhouse gas emissions released into the atmosphere over time, which is the correct measure for climate related impacts. In other words, even if Germany achieves its 2050 target, it still matters that the 2020 target will be missed. Concrete sector contributions or targets do not have to be defined in advance, which increases flexibility and could be beneficial with a view on cost efficiency.

However, only the English model is so consistent that it dispenses sector targets. The French model on the other hand, defines a large number of sectoral targets, similar to the German energy concept. The English model strictly thinks in terms of the climate target, so that sectoral paths are derived from the emission budgets, which are intended to achieve the 2050 target at the lowest possible cost. It can be assumed that significant cost efficiency potentials can be raised in this way. To this end, the Committee on Climate Change uses modelled sectoral CO_2 abatement costs. On the basis of the sectoral paths, concrete policy recommendations are derived. First a transformation of the electricity sector is prioritized (one decade), then in the building sector (one decade) and finally in transport (one decade). With the imminent phasing out of coal and the further expansion of renewables in electricity generation, Germany is (partly) proceeding in a similar way in the short term, even if it was not planned to do so from the outset.

While the German energy concept was set in a cabinet resolution of the Federal Government, the energy transition in France and Great Britain have legal precedence (Law for Energy Transition and Green Growth 2015 / Climate Change Act 2008). A departure from the climate protection targets would require a formal change in the law. With the German climate protection law from end of 2019 also the German GHG emission targets are also enshrined into law. It is not the case for other areas of the energy concept like e.g. efficiency or renewable goals.

Scientific support

In Germany, France and the UK, independent experts accompany the monitoring process. The different orientations in the transition processes are reflected in the indicator work of the commissions. While the expert commission in Germany monitors the progress of the energy system transformation with the help of its energy transition traffic light and an accompanying indicator set (as mentioned in chapter 4.1.), the British experts use a set of indicators for each sector. The French experts write their reports on a case-by-case basis and several times during the year, whenever they are asked for their detailed expertise. Reporting in Germany and the UK, on the other hand, follows an annual cycle with large summary reports.

However, the expert commissions not only differ in where they accompany the monitoring process, they also differ in their legal mandate. The expert commissions in France, Great Britain and Germany (i.e. the newly introduced independent Expert Council) are enshrined by law, their mandate differs. The German Expert Council on Climate will assess emissions data and give advice on *climate* programmes and their adjustments, the Expert Commission on the monitoring process of the *energy* transition, installed by a cabinet resolution, provides a scientific opinion on the annual Monitoring Reports of the government. In France and Great Britain, the mandate is much stronger than in Germany.

2.3.3. Opportunities for international monitoring

International monitoring creates the necessary transparency to identify which countries are actually leading the global energy transition and which are lagging behind - and thus could be named ("name and shame”). It increases the incentives for countries to make similar efforts regarding their national energy transition. At the same time, it should not be forgotten that German trading partners - depending on the metrics used - sometimes perform better than Germany when it comes to implementing the energy transition. According to the international energy system transformation index, Germany ranks 16th out of 114 surveyed countries (World Economic Forum, 2018). It therefore seems reasonable for Germany to observe the energy policy of foreign countries systematically and, where appropriate, to adopt successful elements. In fact, the advantages of such a process are increasingly emphasized by third parties on national and international level:

At the national level, the Federal Association of German Industry (Bundesverband der Deutschen Industrie e.V. - BDI) recommended that politics focus their monitoring more strongly than before on international issues. Monitoring "should be supplemented by

global framework conditions for climate protection [...]" and that "such extended monitoring [...] must also cover social and international developments". A further reason for the Federal Association to support aligned ambitions, is to maintain the competitiveness of German industry, in the sense of a level playing field.

In their Hamburg Action Plan, the G20 (2017) have adopted clear policies for the implementation of the Paris Climate Agreement and for the initiation of a global energy transition in line with the objectives of the 2030 Agenda for Sustainable Development. In the Action Plan it is underlined that science and an international monitoring process provide "significant support" for the global energy transition.

One of the most important international monitoring tasks arises from the Paris Climate Agreement, which aims to develop a robust method for comparing national efforts, which will enable review and evaluation of climate protection ambitions, as well as an assessment of efficiency potentials and possible transfer payments between countries.

The following tasks, independent of national similarities and differences, are necessary for an international scientifically based monitoring and evaluation process (see Löschel et al., 2018):

1. *Inform – gather and harmonize:* Build a comprehensive, validated international database, which accounts for differences in data availability and accessibility and which can be used both to monitor and evaluate G20 countries' energy transition progress as well as to improve methodologies for future policy assessment. The database should take into account technical, economic, environmental and social data.
2. *Monitor – design indicators and track progress:* Identify harmonized methodologies and develop indicators to provide policy makers with a neutral benchmark that is tailored to national circumstances in a way that checks national progress against national ambition based on the specific voluntary goals of the individual country.
3. *Evaluate – analyze implementation and impact:* Undertake a stock-take of relevant policy in (but not limited to) G20 countries, analyze the status of the implementation of policies and business models and their impact using ex-ante and ex-post evaluation methods (covered in chapter 4.1.).
4. *Exchange – share experiences and knowledge:* Assess the individual national success factors of impactful policies in order to determine their transferability to other countries and create a toolkit for policy makers consisting of leading-practice policy options.

1. Inform – data gathering and harmonization:

Similar to the efforts undertaken to harmonize the data on climate change and corresponding mitigation efforts, relevant data for the assessment of energy transition processes needs to be collected and standardized from a systemic perspective. Such an evaluation needs to take the varying levels of technological change and innovation and the different rates of economic development in each country into account. For policymakers, the potential impacts of a policy are of great interest, since they greatly bear upon the negotiation processes preceding an implementation. In many cases, policies and according business models have already been implemented elsewhere and can be

replicated in a different context. This requires a standardized assessment of the (environmental, social, technical, and economic) framework conditions. The harmonization of international data and indicators could hence create substantial added value, because it would allow for a better assessment of potential impacts under different circumstances.

Energy transformation processes towards a secure, affordable and sustainable energy supply pose substantial challenges to data and its harmonization that need to be overcome. In order to assess, for instance, sectoral transitions, technological changes or potentially heterogeneous developments of small and large companies in different sectors, disaggregated energy data is required. A standardized methodical basis for the calculation of energy prices and costs is a prerequisite for understanding different companies' competitive situation. Detailed disaggregated and internationally harmonized data on energy prices and consumption patterns of households and individuals is necessary for a thorough assessment of the social dimension of energy transitions and of according distributional effects, including the risks of energy poverty and policy options to alleviate it. Similar challenges regarding a solid data base arise in numerous other fields of the energy transition. Structuring the data process and assuring that the data is made public would spur new research and analyses.

The global importance of a reliable database has been recognized at the highest level. It is underlined by the creation of two important groups: The Independent Expert Advisory Group on the Data Revolution for Sustainable Development, appointed by former UN Secretary-General Ban Ki-moon on 29th of August 2014, and the High-level Group for Partnership, Coordination and Capacity-Building for statistics for the 2030 Agenda for Sustainable Development, convened on 6th of March 2015 by the United Nations Statistical Commission.

2. Monitor – design indicators and track progress:

Internationally comparable indicators (in addition to energy use and supply indicators also social, environmental, technical, economic, and concerning the security of the energy supply) could be identified and defined, each based upon and calculated according to the same methodology across countries. The harmonization would allow for the transfer of identified policy impacts in order to create practical knowledge for policymakers. With regard to the complexity of energy systems, it is necessary to identify or develop a detailed set of indicators enabling a balanced assessment of the transformation processes. In particular, future-orientated indicators can help to identify risks and thus improve the resilience of systems in transition. Harmonized indicators should be simple and easy to interpret and monitor. They should address all aspects of the energy sector, including renewable energy, energy efficiency, energy infrastructure, supply security, energy research and innovation, affordability of energy and the competitiveness of companies. The set of indicators could thus provide a fact-based overview of the status of the implementation of the energy transition.

The development of comparable indicators requires systematic preparation and in-depth discussions, which will also have important consequences for the development of a comprehensive, validated international database. A careful calibration of indicators – harmonized, while nevertheless taking different national circumstances into account – offers several advantages: It would substantially improve the reliability of the interpreta-

tions of national developments, provide data for the scientific evaluation of policy impacts and extend the evidence base of policy-makers without restricting their political choices.

Based upon a harmonized methodology, the monitoring process could provide policy-makers with a neutral benchmark tailored to individual national circumstances. By comparing national progress with the respective national ambitions (based on the targets the countries have chosen to set themselves), the search for leading practice policies could be facilitated. Furthermore, each country could be provided with an independent assessment of its progress, which would highlight areas for improvement and identify its most successful policies. Following the example of the UNFCCC Measurement, Reporting and Verification (MRV) process, this should be non-intrusive, non-punitive and respectful of national sovereignty. There is a broad consensus – reflecting the spirit of the Paris Climate Agreement – that the plurality of efforts calls for a change in mindset.

3. Evaluate – analyse implementations and impact:

In addition to the identification, harmonization and monitoring of common indicators, analyzing the implementation of policies and their impact would provide added value to the ongoing discussion on energy transitions. It would compile a foundation of reliable scientific evidence to inform the policy preparations, business models and implementation processes. There is a clear need for a platform for in-depth debates on evaluation methods and scientific energy policy analyses. A global stock-take of policy approaches could identify effective practices as well as areas worthy of improvement. The diversity of ongoing transformation processes offers a wide scope and countless opportunities for the exchange of experiences, information and good practices. At the same time, the different framework conditions impact energy transition processes differently. But the proposed monitoring and evaluation process would not interfere with political processes outside its scope.

Sharing and understanding the different modelling approaches and key assumptions regarding ex-ante evaluations of impacts with quantitative simulation models of energy systems can contribute to a better understanding of the details crucial for designing a consistent benchmark. The ex-post impact evaluation of policies would be conducted on a case-by-case basis. A careful assessment of both the structural details of the policy as well as the specific conditions under which it is applied (e.g. technical, economic, infrastructural, legal, institutional, social, political), would ensure that the evidence is discussed in the appropriate context. In particular, it would be possible to identify leading practice policy options with measurable impacts and provide political decision-makers with easily accessible information.

Furthermore, it would be possible to specifically assess knowledge transfer processes between academia and the political communities. A standardized meta-format for results would constitute a valuable improvement both for researchers and policy experts as it would facilitate the transfer of knowledge into the political decision-making processes. Policy-makers, on the other hand, might draw upon these experiences to improve the functionality and reliability of impact assessments, ultimately contributing to improved decision-making. Further, the possibility of regionally differentiated approaches in policy design should be considered. This could, for instance, imply intro-

ducing a policy with a delay between different regions, which could dramatically improve the assessment of its impacts, because the regions where implementation is delayed will serve as a control group for the evaluation. However, the delayed implementation will also mean that the benefits for the energy transition and climate change mitigation will be delayed in these regions.

In addition, new standards for the description, evaluation and identification of potential causal impacts of policies as well as for quantitative simulation models used in impact assessments would create substantial added value. We should endeavor to develop a harmonized framework for impact evaluation adjustable to different contexts, thus increasing the accessibility and replicability of empirical analyses. In the context of the EU's energy efficiency targets and legislation, such efforts have already been made over the last 15 years to compare member states' targets and achievements.

4. Exchange – share experiences and knowledge:

The goal would be to provide policy-makers in different countries with the best tools and information, fully acknowledging that policies as well as performance benchmarks have to be tailored to national circumstances. The identification and exchange of best practices would be based on the evaluation of a variety of policies in different countries, a comparison of the identified impacts, and a thorough analysis of the transferability of a policy. Particular care would need to be taken regarding the external validity of results obtained under very special circumstances. There should be no one-size-fits-all solutions, rather guidelines on how to adjust policies to different circumstances, pointing out those factors that should receive particular attention. In order to provide practical insights for policy-makers, special consideration need to be given to the context under which a policy was implemented, in order to derive success factors and preconditions for a successful adoption and implementation elsewhere.

Such a process could work complementary to the MRV process already established by the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP). The evaluation of actions taken at the national, regional and international levels in the field of energy systems transformation would be facilitated. Furthermore, a toolkit of leading practice policy options and appropriate metrics and indicators to facilitate the consistent monitoring and evaluation of progress at the international level could be recommended. This would especially include instruments resulting from the synergy of science and technology that have the power to foster innovation processes of global momentum. The exchange of scientific methods for data collection, impact evaluation and modelling would generate added value since it would lead to the adoption of common standards. At the same time, it would present the participating countries with continuous opportunities to broaden their knowledge and understanding. Finally, the discussion on energy and climate justice would benefit from the thorough analysis of national circumstances as well as from any shared information, mutual communication and collaboration structures.

3. Are Germany and Japan on track towards or lagging behind their targets?

3.1. Identifying gaps between announced and actual pathways

3.1.1. Germany

The progress in the achievement of the targets is mixed. Germany is on track in the areas of nuclear energy and renewable energy. The majority of nuclear power plants has already been shut down, and the German and European 2020 targets for the share of renewables in Germany have already been met (German target) or will most likely be met (European target). However, Germany is lagging behind in the areas of greenhouse gas emissions, energy consumption and energy efficiency, and grid extension.

Greenhouse gas emissions

Relative to 1990, the greenhouse gas emissions have been lowered by 30.6% until 2018. The development of GHG emissions is still off course, Germany would have been very likely in a situation to miss its 2020 target on greenhouse gas emissions if the Covid-19 crisis had not occurred. Even the partial gap closure due to substantial emission reductions of 3 percentage points in 2018 and approx. 6 percentage points in 2019 (according to initial estimates) would not have been sufficient to robustly meet the 2020 target in a non-crisis environment for 2020.

The fact that progress is lagging behind the target is due to multiple reasons. Energy consumption did not decrease as it was supposed to, since (1) economic growth rates since 2010 were higher than expected and (2) the increases in energy efficiency are too small. Additionally, for a long time low CO_2 prices in the EU ETS have had substantial implications for the German energy transition, because they provide limited incentives for regulated industries to switch to low-carbon inputs (fuel switch) and to invest in low-carbon technologies. Higher CO_2 prices in the EU ETS start to play an important role in guiding the decarbonisation in electricity generation. Climate action measures in the transport and building sectors must still be aligned with the EU objectives for non-ETS sectors, using a multiple set of policies and measures including carbon pricing.

Nuclear energy

During the past, Germany stuck to its plan of phasing out nuclear energy. 10 nuclear power plants have been shut between 2011 and 2019. 6 plants are remaining. 3 plants will be decommissioned in 2021 and another 3 will be shut down in 2022.

Renewable energy

The share of renewables in transport reached 5.6% in 2018. The share of renewables in heat consumption is likely to reach the 14% target in 2020, since it already rose to 13.9% in 2018. The share of renewables in gross electricity consumption reached 43% in 2019 leading to an overachievement of the 35% target by 2020. Overall, the share of renewables in gross final energy consumption reached 16.5% in 2018, which is on

track for reaching the target of 18% by 2020, mainly driven by the growth in renewable electricity generation.

Energy consumption and energy efficiency

Primary energy consumption remains high in Germany. The reduction of 5.5% in 2017, relative to 2008, is not on track to achieve the targeted reduction of 20% in 2020. Gross electricity consumption remains high as well. Relative to 2008, gross electricity consumption decreased by 3.2% until 2017. The plan, however, was a reduction by 10% until 2020.

Both the low reduction of primary energy consumption and the low reduction of gross electricity consumption are at least partially due to low improvements of final energy productivity. In fact, the temperature adjusted annual rate of final energy productivity improvements was only 1.0% between 2008 and 2017, significantly below the targeted increase of 2.1% per year.

Until 2016, the heat consumption of buildings was reduced by 7.0%, whereas it should be reduced by 20% until 2020. It seems most likely that this target will be missed.

Gross final energy consumption for transport increased by 7.1% between 2005 and 2017. This is due to an increase in overall distance travelled in cargo and passenger transport, which outweighs the achieved energy efficiency improvements. It is unlikely that the trend will reverse, resulting in a large gap with respect to the reduction target of 10% by 2020.

Security of Supply

It is fair to say that there is currently no general shortage of capacity in Germany. But electricity supply has shifted to the north of Germany, which bears the risk of regional imbalances between generation and consumption. Those imbalances can be intensified by the lagging extension of the German grid. There is a large discrepancy of around 2,400 kilometres between planned and actual figures in transmission grid expansion (EnLAG and BBPIG projects). Of the 3,450 kilometres that needed to be extended, only 1,050 kilometres have been completed in fact. Although the grid operators have tripled their annual investments since 2011, it is unlikely that the grid extension returns to its planned path.

Further indicators of supply security are congestion management measures and the System Average Interruption Duration Index (SAIDI) for gas and electricity. The congestion management measures the feed-in reductions in conventional and renewable generation capacity required to eliminate grid congestion. Congestion management increased from less than 5,000 GWh in 2012 to 15,700 GWh in 2017. The SAIDI gas considers all blackouts of gas and calculates their average duration. The SAIDI electricity considers all blackouts of electricity supply of more than 3 minutes and calculates their average duration. The SAIDI gas stayed constant at about 1.0 minute, while the SAIDI electricity decreased during the past years and reached 15.1 minutes in 2018.

Affordability

Two different groups need to be considered when thinking about affordability: consumers and industry.

An appropriate measure of affordability for consumers is their spending on energy. It is split into consumer spending for transport, heat, and electricity. Consumer spending on transport and consumer spending on heat are mainly determined by the international price development of oil and gas. Likewise, they have fallen in recent years. In 2017, consumer spending for transport and heat accounted for 2.1% and 3.0%, respectively, of nominal GDP. For consumer spending on electricity, the market-driven elements (generation and distribution) decreased, while the government-driven elements (electricity tax, EEG levy, KWK levy, grid-charges and sales tax) increased sharply. During the past 15 years, consumer spending on electricity almost doubled, leading to a general discussion about affordability. However, relative to nominal GDP, it remains mostly constant over the past 15 years. In 2017 the indicator is at 2.1%. In total, consumer spending on energy amounts to 7.4% of nominal GDP in 2017.

For industry, the expert commission proposes to use real unit energy costs to measure the burden of energy on firms. Real unit energy costs are the cost of energy per unit of gross added value in real terms. For Germany, the industrial sector is of major importance, since its share in gross added value is about twice as large as in other European countries – 22% in fact. The real unit energy costs of the industrial sector were 7.9% in 1995 and raised to a peak of 11.9% in 2008. Afterwards they decreased slightly. Throughout the entire timeframe, they were below the average real unit energy costs of the industrial sector in the EU.

Acceptance

To measure acceptance, the expert commission uses three indicators, which they base on representative surveys. The indicators are the general consent on the objectives of the energy transition, the consent on the implementation of energy transition and the consent based on personal experience. The general consent on the objectives of the Energiewende is very high, especially for the extension of renewable energy and the increase in energy efficiency with more than 80%. In contrast, consent on the implementation is low. 51% think the energy transition is unfair and 75% think the energy transition is expensive. The consent based on personal experience was rated as problematic by the expert commission.

With a view to the remaining gap regarding the 2020 target and the legally binding nature of the 2030 targets, the German government initiated a comprehensive process to identify robust measures to close the gap for the 2020 target as soon as possible and to ensure that the 2030 target will be met:

- The different sector ministries were asked to present action plans to ensure compliance to the sector targets of the Climate Action Plan 2050;
- These proposals were assessed by the Ministry of Environment, Nature Protection and Nuclear safety with regard to their emission abatement effects;

- The results of these assessments are subject of consultations between the ministries and their consultants to identify differences with regard to the assessment of the proposed measures;
- When necessary, a third consultant was involved to enable a robust ex ante assessment of the proposed measures;
- The Climate Cabinet approved the comprehensive plan of policies and measures on 9th October 2019.

In addition to this, the German Federal Climate Act was approved by the German Federal Parliament on 12th December 2019. It makes sector targets, key policies and enforcing mechanisms (which shall apply in case of any indication for non-compliance) legally binding.

This new quality of assessment, monitoring and review is partly based on the experiences with non-compliance to the not legally binding national targets but more prominently triggered by the legally binding emission reduction targets for the sectors that are covered by the Effort Sharing Regulation of the European Union[27] (i.e. those not covered by the EU ETS, excluding LULUCF).

3.1.2. Japan

In the course of the deliberation of the 5th Strategic Energy Plan (SEP), thorough review of the progress to date was conducted. As presented below and in Figure 3-1-2-1, while Japan is on track to the energy mix as of 2016FY, it is still only halfway. With this in mind the 5th SEP emphasizes actions need to be further strengthened for its accomplishment.

Energy saving

Final energy consumption in FY2013 was about 360 million kl crude oil equivalent (334 million tons of oil equivalent: Mtoe), and due to thorough energy saving measures a reduction of about 50 million kl (47 Mtoe) compared to before the measures is expected in FY2030. This is equivalent to a reduction of about 2.8 million kl (2.6 Mtoe) per year. The reduced amount as of FY2016 is about 8.8 million kl (8.1 Mtoe), and the current situation is that it is being reduced at the pace of about 2.2 million kl (2.0 Mtoe) per year. Note that the breakdown of the final energy consumption as of FY2016 (about 340 million kl (314 Mtoe)) is about 90 million kl (83 Mtoe) for electric power, about 80 million kl (74 Mtoe) for transportation, and about 180 million kl (166 Mtoe) for heat.

[27] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013.

Zero-emission power source ratio

The zero-emission ratio (share of power generation from nuclear energy and renewable energy sources in total power production) in FY2013 was about 12%, including renewable energy of 11% and nuclear power of 1%, and this is expected to reach about 44% in FY2030 through the promotion of the introduction of renewable energy and the restarting of nuclear power plants that are recognized by the Nuclear Regulation Authority to conform with regulatory requirements which are at the most stringent level in the world. This is equivalent to a rise of about two percentage points per year. In FY2016 it reached about 16% so the current situation is that it is rising roughly two percentage points per year.

CO_2 emissions from fuel combustion

CO_2 emissions from fuel combustion in FY2013 were 1.24 billion tons, and they are expected to be about 930 million tons in FY2030. This is equivalent to a reduction of about 20 million tons per year. In FY2016 they were about 1.13 billion tons, so the current situation is that they are reducing at the pace of about 40 million tons per year.

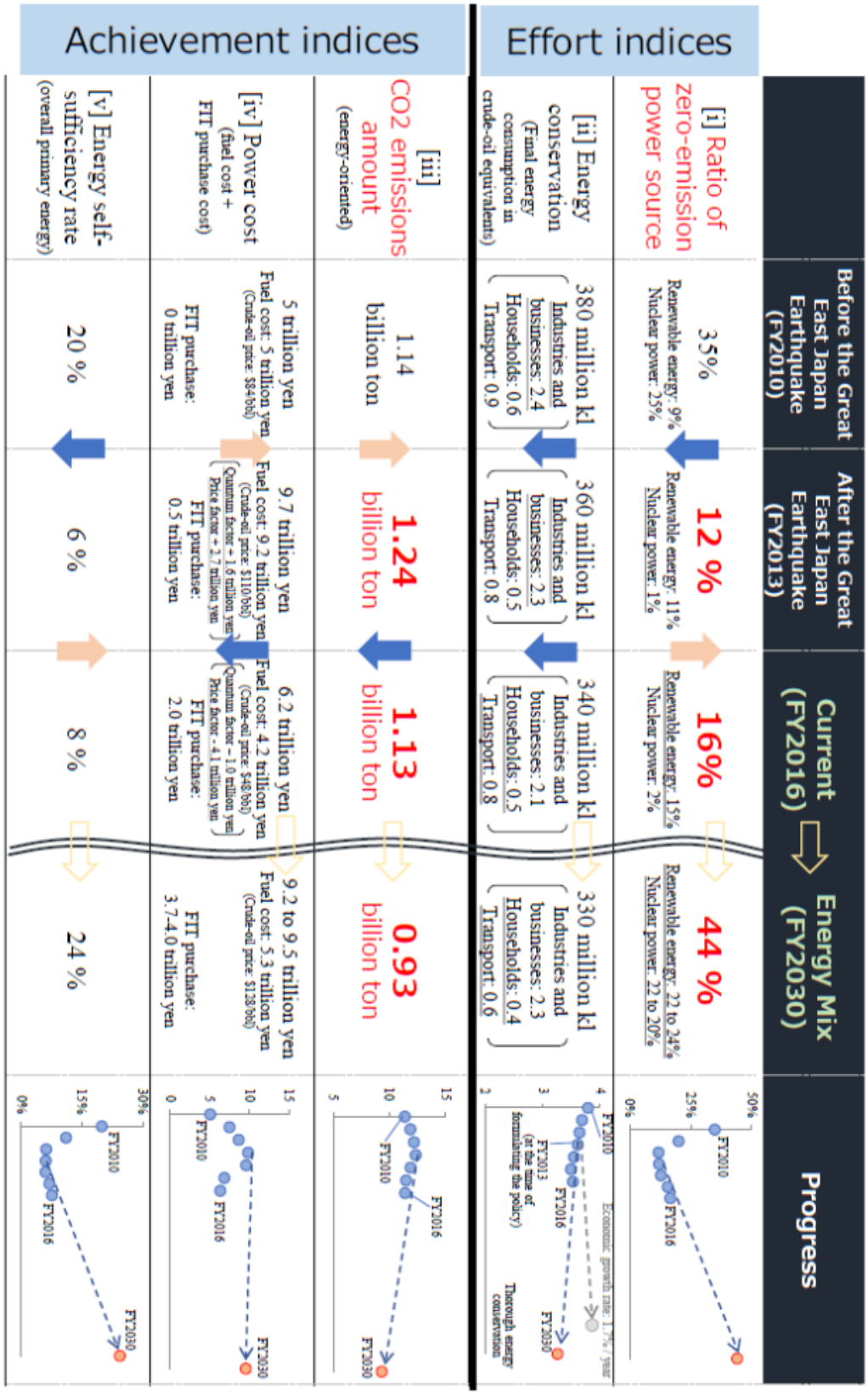
Electricity costs

In FY2013 electricity costs, the sum of the fuel costs of electric power and the purchase costs of the feed-in tariff (FIT) system, etc., were 9.7 trillion yen, and they are expected to be lowered to 9.2-9.5 trillion yen in FY2030. The current situation is that there is an increase in purchase costs due to the FIT system while on the other hand fossil fuel prices are falling, and in FY2016 electricity costs were 6.2 trillion yen overall.

Energy self-sufficiency

Energy self-sufficiency in FY2013 had fallen greatly after the Great East Japan Earthquake to 6% but it is expected to reach 24% in FY2030 through the promotion of the introduction of renewable energy and the restarting of nuclear power plants that are recognized by the Nuclear Regulation Authority to conform with regulatory requirements which are at the most stringent level in the world. This is equivalent to a rise of about one percentage point per year. In FY2016 it was about 8%.

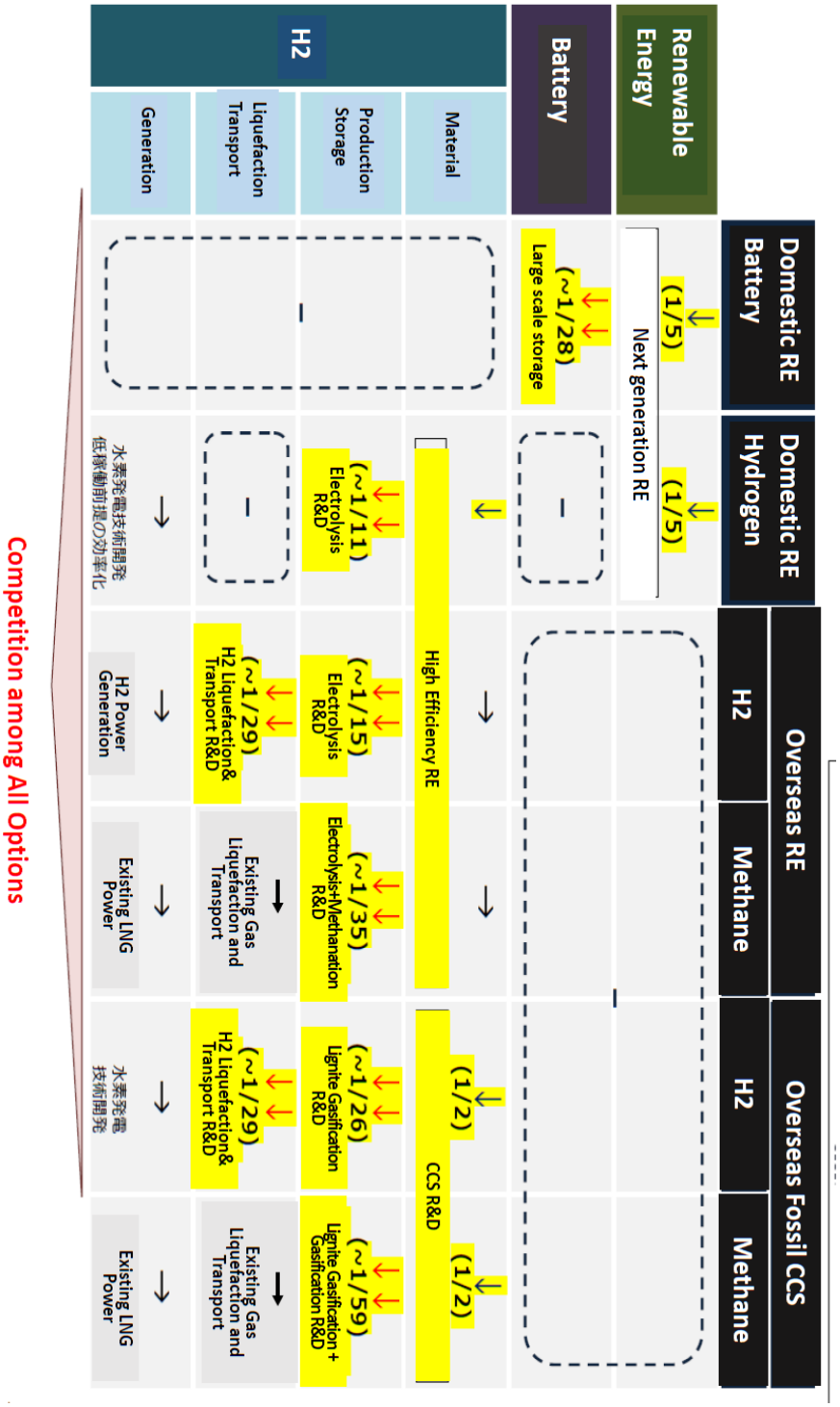
Figure 3-1: Progress towards envisioned energy mix



Source: Prepared by ANRE based on the data in the Comprehensive Energy Statistics, etc.

Source: Structure of the 5th Strategic Energy Plan, ANRE, 12 April 2018

Figure 3-2: Technology Cost Gap



Source: The Roundtable for Studying Energy Situations ANRE, 10 April 2018

This type of progress review above is not conducted for the 2050 Goal due to the different nature between 2030 target and 2050 goal. While 2030 target is underpinned by a particular energy mix, 2050 goal is to be pursued based on multi-track scenarios with priorities based on the latest information instead of establishing a specific energy mix in 2050. Moreover, as presented in the Long-Term Strategy, Japan focuses not only on

domestic GHG emissions reduction but also "beyond-the-border" GHG emissions reduction enabled by a) international contribution through dissemination of Japan's efficient and environmentally friendly technologies to developing countries, b) global value chain-based reductions by industries and companies and c) development of innovative technologies. Under that situation, a "gap analysis" of GHG emissions based on a linear back-casting approach starting from 80% goal does not make sense.

Since a "virtuous cycle of environment and growth" envisaged in the Long-Term Strategy could only be achieved with business-led disruptive innovation and availability of zero-emission energy system technologies with competitive cost, a "gap analysis" should be focused on technologies (e.g., performance and cost) rather than GHG emissions. That is why the Long-Term Strategy has decided to formulate a Progressive Environment Innovation Strategy, setting clear targets such as the cost as a signal from the Government. For example, the Long-Term Strategy already includes such cost target to lower manufacturing cost of CO_2-free hydrogen by 90%. METI's indicative calculation shows that there is a huge cost gap for making zero-emissions energy systems reach cost parity with conventional systems (Figure 3-2). Achievement of the Long-Term Goal under virtuous cycle of environment and growth highly depends on how to quickly narrow the huge cost gap. A scientific review mechanism, to be established based on the 5th Strategic Energy Plan, will be utilized for tracking progress.

3.2. Reflection on barriers and reasons for the implementation gaps

3.2.1. Germany

Greenhouse gas emissions stagnated for approximately a decade in Germany. This is mostly a result of stagnating or only slightly decreasing greenhouse gas emissions from the power sector, which is the largest source of greenhouse gas emissions in Germany. Emissions from industry also remained almost constant, and increasing emissions from the transport sector compensated emission reductions in other sectors. In 2017 and 2018, however, significant changes occurred especially for the power sector. As a result of increasing CO_2 prices, changing fuel price patterns between coal and natural gas, the increase of power generation from renewables, and a buy-out policy for 2.7 GW of lignite-fired power generation, the greenhouse gas emission decreased significantly in 2017, 2018 and according to preliminary data also for 2019.

The gap in complying with the national emission reduction targets for 2020 is essentially a result of asymmetric political strategies[28] regarding four key avenues to decarbonization:

1. Paving the way for the clean options

   The focus of German energy and climate policy was on power generation from renewable energy sources. The efforts on improving energy efficiency (especially in the building sector) and new vehicle technologies lagged behind the

[28] Matthes, FC: Energy transition in Germany: a case study on a policy-driven structural change of the energy system. Evolut Inst Econ Rev (2017) 14: 141. https://doi.org/10.1007/s40844-016-0066-x

needs. In addition to this, a key pillar of climate policy in the transport sector failed due to an ineffective implementation of EU vehicle standards (and some fraud from the car manufacturers).

2. Designing the exit game for the high-carbon assets

   The need to push high carbon assets out of the market has been the crucial blind spot of German energy and climate policy. Only after an active coal phase-out policy[29] was developed and carbon pricing by the EU ETS became effective in 2018 this gap was actively addressed. For other sectors this strategy is still to be strengthened. The lack of ambitious efforts on carbon pricing is a key determinant of this strategic gap.

3. Triggering the necessary infrastructure adjustments with sufficient lead times

   The roll-out of electricity network infrastructures lags significantly behind the plans and creates additional costs for redispatch and other adjustment measures in the electricity system. The discussion on greening the heat network and the future of gas infrastructure (from decommissioning to introducing hydrogen-ready investment strategies) is still in an early phase.

4. Making innovation work in time

   The experiences with energy transition in Germany show that a vast range of innovative solutions have been developed or are in the pipeline. This has made a significant part of the progress in the energy transformation possible. A more systematic approach to create a level playing-field (carbon pricing, taxation, market ramp-up policies) is still lacking in many areas.

With a view to these four strategies an asymmetric approach in German energy and climate policy can be observed:

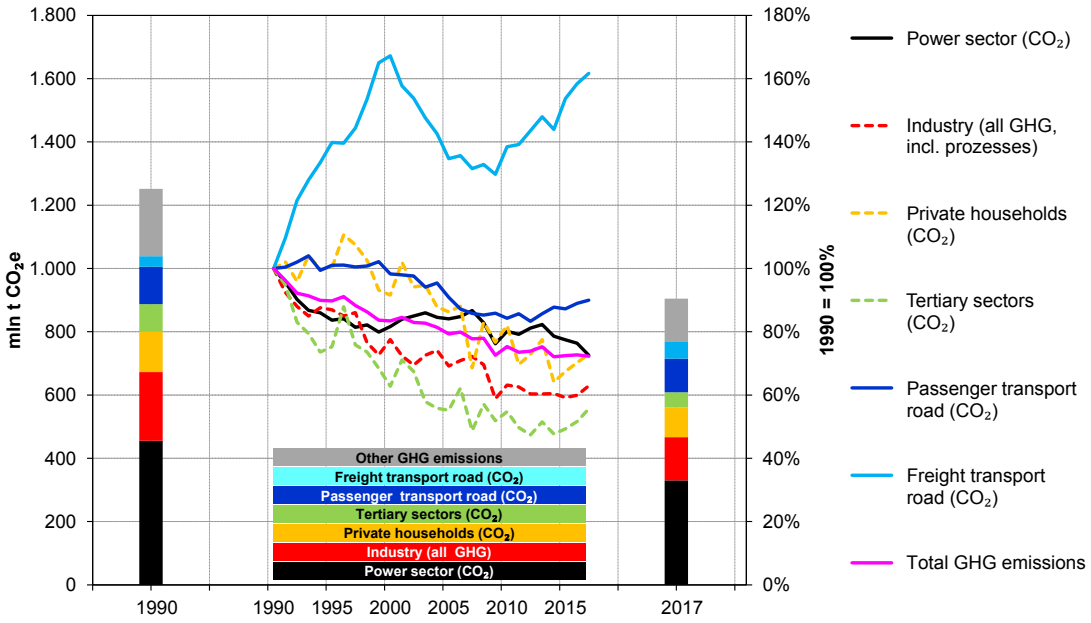
- There was a clear focus on the first and the fourth strategy, while the second and the third strategies were not addressed sufficiently with robust policies and measures.
- Within the different strategies the most significant efforts were made on the ramp-up of power generation from renewable energy sources. This is certainly a crucial area for the energy transformation but not a sufficient approach, unless complemented by comparable efforts on energy efficiency and other measures to address the broad range of emission reduction levers.

The most recent developments in German energy and climate policy do, however, signal that these strategic asymmetries have been clearly identified as areas for additional action. A crucial motivation for this strategic reorientation is certainly the fact that the 2030 targets are now of legally binding nature and key decisions need to be made to

[29] It should be pointed out that the increased power generation from renewables did not substitute the power generation from German coal-fired plants which continued operations and high-carbon electricity was increasingly exported to the interconnected electricity markets in Central Europe. Modelling shows that without these electricity exports the emission reduction in the national boundaries would have been approx. 5 percentage points stronger and the gap to comply with the national emission reduction target of 40% by 2020 would have been at least partly closed.

bring the emission reduction pathways on track towards the new EU target of climate neutrality by 2050.

Figure 3-3: Aggregate and sectoral greenhouse gas emission trends for Germany, 1990-2017



Source: RITE

3.2.2. Japan

2030 Target

As presented above, the progress is on track towards the 2030 target, but still only halfway. In fact, achieving the above energy mix is a challenge.

The steady reoperation of nuclear power plants is the prerequisite for achieving the 2030 target and simultaneously achieving GHG emissions reductions, energy security and cost reductions. The role of nuclear as an existing zero-emission technology is clearly acknowledged in the 5th Strategic Energy Plan and the Long-Term Strategy.

However, it is still highly uncertain whether a 20-22% share of nuclear could be achieved in 2030. In the opinion polls, there is still a strong “nuclearphobia”. Without a comprehensive perspective on energy security and climate change mitigation, the general public tends to consider that there is no need of nuclear so long as there is no blackout and no rapid upsurge of electricity tariffs. Since nuclear power is still politically controversial, discussion about replacement and new construction tends to be averted.

Regulatory environment is also far from ideal. Nuclear Regulatory Authority (NRA) tends to react excessively to “zero-risk” demand, which is scientifically and technically impossible. NRA tends to even avoid close communication with the power industry

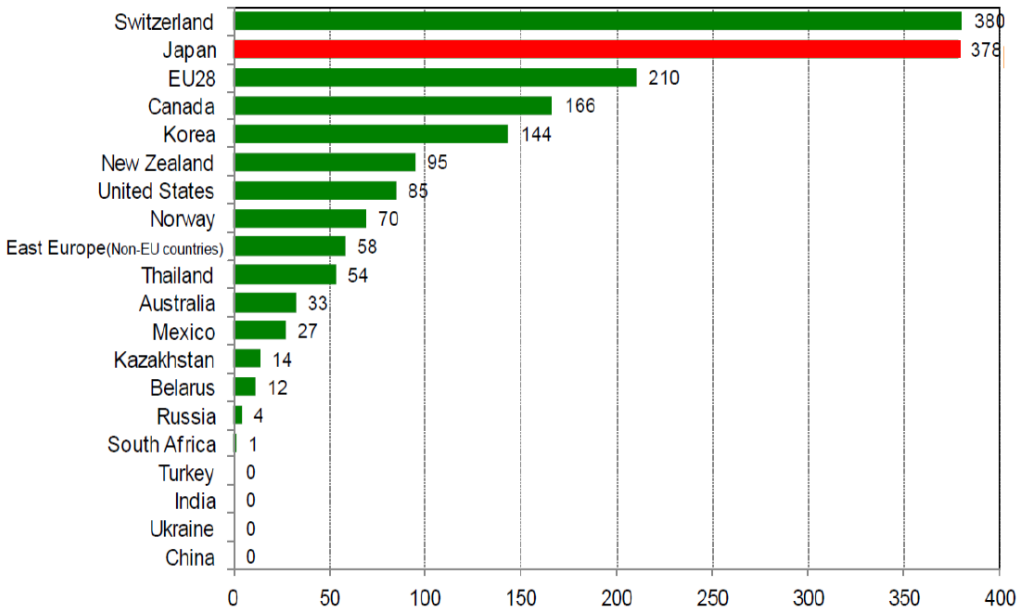
based on erroneous interpretation of “neutrality”. This may be seen as a deviation from a regulator’s original mission, namely, ensuring safe operation of nuclear power plants. In addition, due to insufficient staffing, there is still a long queue for safety checks, which is further delaying reoperation.

On-going electricity market liberalization is making the business environment for nuclear more unpredictable. Replacement of existing nuclear power plants and new construction would be extremely challenging due to high upfront cost, difficult financing environment and regulatory and political uncertainties. Such adverse environment is also affecting utilities’ decision-making on restarting existing nuclear power plants. Due to unduly lengthy regulatory process, increasingly costly investment for safety measures and limitation of lifetime at most to 60 years, some power utilities have decided to decommission some of their reactors.

Under such a situation, achieving the 26% GHG emission reduction target is highly subject to uncertainties depending on the prospect of nuclear restart.

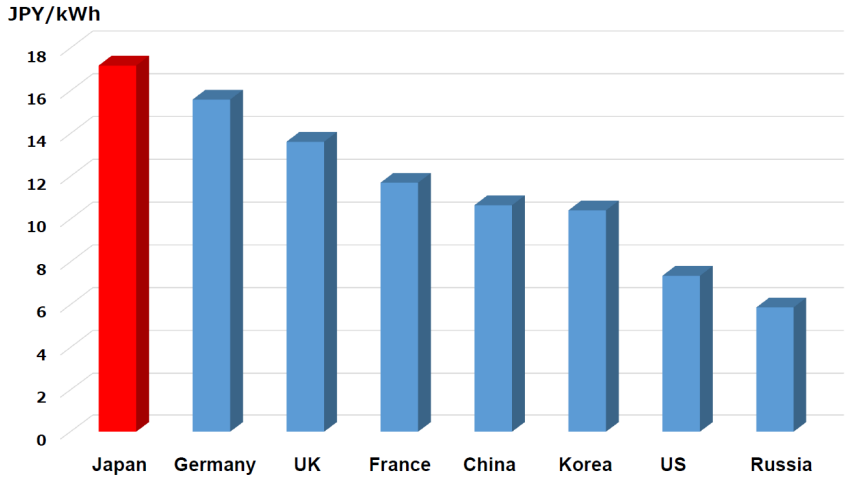
By contrast, renewables are highly likely to achieve their expected share of 22-24% of total power generation. There is an argument that renewable should have a far higher share in the energy mix while reducing the share of nuclear. While the power generation cost of renewable energy is globally declining, the generation cost of various renewable energy sources reflect country and local specific conditions. The cost of renewables in Japan is still 1.5-2.0 times higher than in most European countries. The most recent auctioning of PV has not dramatically changed the situation. Moreover, it is inappropriate to solely focus on panel costs or wind turbine costs. Such factors as high construction cost due to customers’ requests for better quality service, safety measures in response to earthquakes and typhoons, high land costs and growing integration costs in accordance with the growing share of intermittent renewables must be taken into account as well.

Figure 3-4: Comparison of marginal abatement costs of major countries, 2030



Source: RITE

Figure 3-5: Comparison of Industrial Electricity Prices, 2016



Source: Source: Japan Electric Power Information Centre

Substituting nuclear with renewables is not only irrelevant in addressing climate change and energy security, but also harmful to Japan's energy cost. Japan's Marginal Abatement Cost for achieving its NDC is among the highest (Figure 3-4). In addition, Japan's industrial electricity price is the highest, 1.5-2 times more expensive compared with its competitors in the APEC region such as the US, China and Korea (Figure 3-5).

2050 Goal

As discussed above, the gap analysis focusing on GHG emissions or the energy mix is not conducted for the 2050 Goal, since the 2050 Goal is to be pursued based on "multi-track" pathways instead of establishing a specific energy mix in 2050. The gap which matters here is not the GHG emissions gap but rather the likely huge cost gap between zero-carbon energy systems, which will enable deep GHG emissions reduction, and conventional systems.

The biggest challenge would be how to promote active innovative R&D investment in the private sector. For achieving substantial GHG emissions reduction towards 2050 and beyond, disruptive innovation would be indispensable not only in the public sector, but also in the private sector. Government needs to expedite the formulation of the Progressive Environment Innovation Strategy to send a clear signal to the private sector as well as "visualizing" active innovation-oriented companies and encouraging financial flow to them.

A healthy macro-economic environment and robust profit making is essential for private companies to become more active in long-term and high-risk innovations. Furthermore, deep GHG reduction requires electrification in various sectors including transport. In this context, an escalation of electricity price could eat up resources for high-risk innovation as well as discouraging electrification.

4. Recommendations

4.1. Germany

4.1.1. Diversity, consistency and focus of monitoring and evaluation processes

The experience from Germany shows that a relatively broad diversity of monitoring and evaluation processes developed over time by manifold reasons. This provided significant value in terms of data and information mining on the one hand and methodological progress on the other hand. At the same time significant overlaps emerged.

A clearer structure and possibly a certain hierarchy of monitoring and evaluation efforts could streamline the monitoring and evaluation processes. This is a specific challenge for the use of monitoring and ex-post evaluation results at the level of implementation mechanisms in the more top-level monitoring and ex-post evaluation process. More efforts on bottom-up aggregation could raise additional evidence for improving policies at the levels of strategies and targets. This applies in particular to overarching objectives and strategies for energy efficiency and energy saving. Due to the high complexity of technologies, actors, market barriers and bottom-up data gaps, the monitoring process of implementation gaps and the identification of an effective policy mix to overcome the barriers remains a challenge.

In addition to this, ex-ante evaluation of policy mechanisms needs stronger attention. The broad range and large diversity of ex-ante evaluation at the aggregated levels of targets and strategies provides a large body of value for the longer time horizons but in the medium term, a more careful ex-ante analysis of implementation mechanisms and their alternatives deserves more efforts. It has, however, to be pointed out, that the ex-ante evaluation of implementation mechanisms requires also more efforts on methodological issues. In general, the use of indicators that were developed in different monitoring processes should also be addressed in the full range of ex-ante evaluation exercises.

In addition to this, the interlinkages between the monitoring and evaluation efforts in Germany and the increasing obligations in the framework of the EU will require some significant adjustments of the existing procedures and approaches.

With the background of still large implementation gaps concerning energy efficiency and energy conservation improvements the institutional arrangements for monitoring and evaluation should be embedded into a governance of transformative energy efficiency policies. The high complexity of end use energy efficiency technologies and energy service markets especially raises the question how the process and steering responsibility to reach the decided energy conservation targets can be secured. Thus also from the monitoring perspective this papers confirms the recommendation of the GJETC 2018 report.[30] In this GJETC Report the following institutional innovation was recommended: “For example, if applicable, a country might consider to establish a strong National Energy Effciency Agency and Energy Savings Fund that is integrated

[30] http://www.gjetc.org/wp-content/uploads/2018/04/GJETC-Report-2018.pdf

into the institutional setting and policy-making process, with a clear mandate for such policy and process responsibility to achieve energy saving targets."

4.1.2. Institutional arrangements for monitoring and evaluation

The institutional arrangements of the Energiewende monitoring process in Germany are increasingly used as a blueprint for other monitoring or review processes. This means that the initial monitoring reports are produced by the government and are subject to a review process by independent experts. The monitoring report, the expert review and the response of the government to the expert review is then submitted to the parliament. This approach was adopted also in the German Federal Climate Act and should be used more widely at least for monitoring and evaluation processes, which focus on the aggregated trends.

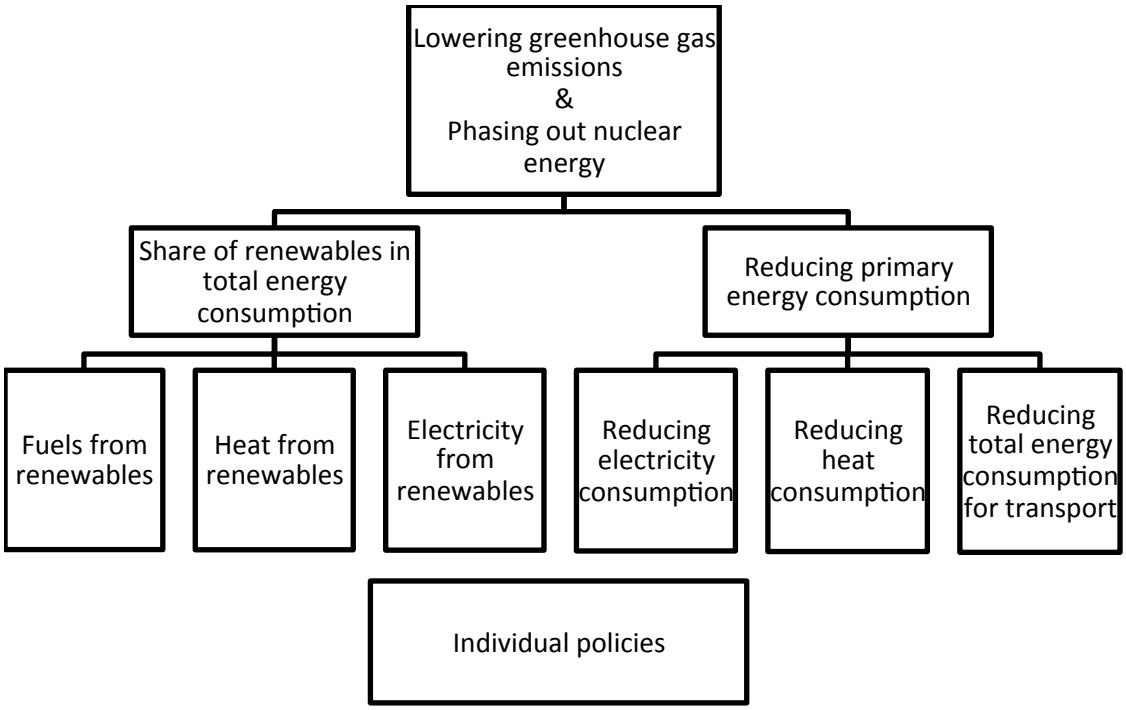
4.1.3. Target hierarchy

Initially, all energy transition targets were seen as equally important. But given a large number of targets, conflicts between targets were unavoidable. Prioritization was necessary. After a proposal of the expert commission, two superior targets were defined. That is, lowering greenhouse gas emissions by 80 to 95% until 2050, compared to 1990 (and now climate neutrality by 2050), and phasing out nuclear power until 2022. Given the superior targets, an entire target hierarchy was specified.

The superior targets are of course on top of the hierarchy (first stage). Directly below the superior targets (second stage), there are targets that highly contribute to their achievement, namely the share of renewables in total energy consumption and reducing primary energy consumption. Those two can be further decomposed (third stage). Fuels from renewables, heat from renewables and electricity from renewables contribute to the share of renewables in total energy consumption. Reducing electricity consumption, heat consumption and total energy consumption for transport contribute to reducing primary energy consumption. The foundation of the hierarchy are the individual policies taken to achieve the targets (fourth stage).

The non-superior targets (second and third stage) and the individual policies (fourth stage) can and should be flexibly adaptable, as long as the superior targets are not missed.

Figure 4-1: Target Hierarchy of the German Energy Transition



Source: own illustration based on (BMWi 2016)

The complex framework of targets of German energy and climate policy could, however, deserve some revisions:

- With a view to the statistical artefacts of the primary energy assessment of electricity from hydro, wind and solar energy, the specific target on primary energy demand seems increasingly questionable as a measure of energy efficiency improvements;
- With a view to the increasing role of electrification in many sectors, the question can be asked if a separate target for the decrease of total electricity consumption is still meaningful, or whether it should be split in a target for decreasing electricity consumption of 'classical' electricity uses and one for efficient electricity use in new uses that replace fossil fuels e.g. in transport, buildings, or industry; this latter target would likely increase over time;
- With a view to the major role of electric mobility in future it needs to be discussed if the final energy consumption of the transport sector is still a meaningful metric.

With a view to the political processes in Germany and the EU since 2010, when the first comprehensive target framework for Germany was set up, the sectoral greenhouse gas emission targets and the share of renewables in power generation and gross final energy consumption have been the most relevant ones. It should also be made transparent how the increased shares of renewable energy are linked to progress in reducing electricity and gross final energy consumption through energy efficiency measures.

4.1.4. Indicators

Core indicators

Up to now, the Federal Government included more than 70 different indicators in the monitoring process.[31] Those indicators are not only reported in the governmental reports. They are also summarized in a separate data document, where they are separated by categories. The large number of indicators offers a lot of information. But at the same time, it is too complex and incomprehensible to guide decisions.

The expert commission follows a different approach. It proposes to use core indicators, which highly compress information and present it in a comprehensible and understandable way. For a first illustration, the core indicators are allocated to 7 different categories, shown below. Of course, they cover the superior targets. Additionally, they are part of the energy transition "traffic light" proposed by the expert commission, which will be presented in chapter 4.1.5.

Table 4-1: Core Indicators of the German Commission of Experts

Category	Core indicator
Greenhouse gas emissions	Reduction in greenhouse gas emissions
Nuclear energy	Operational nuclear power plants
Renewable energy	Increase in the share of renewable energy in gross final energy consumption
Energy efficiency	Reduction of primary energy consumption[32]
Security of supply	Expansion of transmission grid
Affordability	End-user spending on electricity in terms of GDP
Acceptance	General approval of the goals of the energy transition

Source: own illustration

Qualitative indicators

The German Federal Government mainly uses quantitative indicators, which are easy to collect and gather. Qualitative indicators – indicators for which no explicit quantitative targets in the Energy Concept exist – are secondary in the governmental reports. That poses the risk of missing relevant dimensions of the energy transition, like security of

[31] See annex and the related data for the Sixth Monitoring Report "Energy of the Future" of the Federal Government for 2016 at https://www.bmwi.de/Redaktion/DE/Binaer/datenuebersicht-zum-sechsen-monitoring-bericht.xlsx?__blob=publicationFile&v=8

[32] Due to the cross-cutting and highly complex characteristics of national primary energy reduction strategies, more sector-specific indicators are needed; this applies in particular to the challenges of separating the effects of economic structural change, more efficient use of final energy and statistically induced effects from higher shares of renewable energy.

supply, affordability and acceptance. The expert commission therefore also takes into account qualitative indicators. In their statements, they proposed, inter alia, to monitor supply security, affordability (consumer spending on energy relative to nominal GDP, real unit energy costs), energy poverty, environmental pressure (land-use, resource-use), CO_2-prices (implicit, explicit), and acceptance.

4.1.5. Presentation design

To facilitate comparison between targets and status quo, the German commission of experts introduced the energy transition traffic light in the 5th statement. Given the current development path, the traffic light indicates whether it is likely to reach the upcoming 2020 (2022 for nuclear energy) targets.

For quantitative indicators, the expert commission uses the statistical concept of forecast intervals to determine whether the achievement of a given target is likely. If the target value for 2020 lies within the respective forecast interval, it is likely that the target will be achieved if the trend continues, at least from a statistical point of view. If the target is expected to be exceeded or missed, the values are correspondingly outside the interval. Recently implemented policies, which are not yet reflected in the data, are taken into account by expert assessments, if no quantitative effects have yet been identified. For qualitative indicators, expert judgement is used based on the development of relevant indicators to determine whether the achievement of a given target is likely.

If the achievement of a target is likely, the traffic light is green. If the achievement is unlikely, the traffic light is red. If the development path does not allow for clear predictions, the traffic light is yellow. The traffic light makes it possible to compare targets and status quo on a single page.

Figure 4-2: Energy Transition Traffic Light of the German Commission of Experts

Dimension	Indicator
Mitigating climate change	Reduction in greenhouse gas emissions (leading indicator or overarching target)
Phase-out of nuclear power	Operational nuclear power plants (leading indicator or overarching target)
Renewable energy	Increase in the share of renewable energy in gross final energy consumption (leading indicator)
	Increase in the share of renewable energy in gross electricity consumption
	Increase in the share of renewable energy in heat consumption
	Increase in the share of renewable energy in transport
Energy efficiency	Reduction of primary energy consumption (leading indicator)
	Final energy productivity
	Reduction in demand for heat in building sector
	Reduction in final energy consumption in transport
Security of supply	Expansion of transmission grids (leading indicator)
	Redispatch measures
	System Average Interruption Duration Index – SAIDI electricity and SAIDI gas
Affordability	End-user spending on electricity in terms of GDP (leading indicator)
	End-user spending on heating services
	End-user spending in road traffic
	Industrial electricity unit costs in the international comparison
	Residential electricity costs
Public acceptance	General approval of the goals of the energy transition (leading indicator)
	Approval of the implementation of the energy transition
	Approval on the basis of the personal impact
Target attainment: likely uncertain unlikely	

Source: BMWi (2018) Statement on the Sixth Monitoring Report of the Federal German Government

4.1.6. Policy evaluation

It is also highly important to evaluate the implementation and impacts of policies. Indicators cannot reflect the risks of inadequate effectiveness, unexpectedly high costs and positive or undesirable side effects of policies, or only with a very long delay. Only with the help of policy evaluation can risks be identified at an early stage. Minimum re-

quirements of policy evaluation are the objective of the policy, scope (total amount of subsidy, total tax loss, etc.), efficiency (e.g. energy saving costs in € per GJ), interaction with other policies, and other effects (e.g. job effects).

When evaluating policies, a distinction is made between the time of evaluation (ex-ante or ex-post) and the level on which the impact is measured (individual level or aggregated level). Ex-ante analyses focus on the evaluation of policies to be implemented. They can identify solution paths for the effective implementation of policies. They can also assess the consequences of policies before they are implemented and show whether policies are suitable for achieving given targets. For subsequent evaluations, they help to define benchmarks that serve as a reference point. Ex-post analyses focus on the evaluation of policies that are already implemented. They identify cause-and-effect relationships and aim at evaluating the effectiveness and efficiency of policies (impact evaluation or summative evaluation) as well as insights on potential improvement of policies (process evaluation or formative evaluation). Analyses at the individual level attempt to identify causal effects of policies. The core method is a counterfactual analysis, that poses the question of how (groups of) individuals would have fared if a certain policy had not been implemented. On an aggregated level, the use of time series analyses and descriptive statistical analyses can empirically support the evaluation of policies. However, there is no optimal method that can be applied in all areas. Rather, attention should be paid to a balanced portfolio of policy evaluation methods.

Table 4-2 provides an overview of evaluation methods; in addition, analysis of poligy or program monitoring data, engineering estimates, and surveys of participants and non-participants (control groups) are common methods.

Table 4-2: Policy Evaluation

	ex-ante	**ex-post**
individual level (individuals, households, firms)	microsimulation, randomized field experiments	case studies, descriptive analyses and correlation analyses (microdata), quasi-experiments
aggregated level (sectors, macroeconomic)	simulation, numerical methods	descriptive analyses and correlation analyses (aggregated data), time series analyses

Source: BMWi (2014) Statement on the First Progress Report of the Federal German Government

4.2. Japan

NDC compatible with 3E+S

As a Party of the Paris Agreement, Japan is required to biennially report the progress towards its NDC, which inevitably entails monitoring progress towards the envisioned energy mix in 2030 underpinning Japan's NDC. This means Japan will have to conduct more frequent tracking of progress and review of the situation than envisaged under the Basic Act on Energy Policy stipulating once in three years' review.

Parties to the Paris Agreement are supposed to communicate or update their NDCs by 2020 and continue to do so every five years thereafter to enhance ambition. For 2020, Japan is most likely to submit the current NDC as it is. There could be an argument that Japan should raise its level of ambition even before 2020 inspired by the IPCC 1.5 Degree Special Report or international initiative such as High Ambition Coalition. However, it is not considered advisable for Japan to raise its ambition while it is still half way to the current target and nuclear power plants under operation will be obliged to stop their operation due to their delay in preparing anti-terrorist attack facilities. As discussed above, while Japan is likely to maintain the current NDC in 2020, Japan will need to revisit its GHG emissions reduction target and target year before 2025. In this process, it will naturally be examined whether the current 26% target in 2030 could be achieved before considering a new target and time table. It should be borne in mind that the 26% GHG emission reduction target and the underlining energy mix was formulated aiming at simultaneous achievement of 3E+S. It is fair to ask what would happen, for example, if a nuclear share of 20-22% cannot be achieved. Of course, it should be explored whether the 26% target is still achievable while maintaining the balance among 3E+S taking into account various factors (e.g., progress on energy efficiency, renewable energy production cost and system integration cost, fossil fuel prices). However, it is not pragmatic to stick to 26% by all means even though it would fail to achieve the balance between 3E+S. From Japan's perspective, climate change mitigation is one of the objectives, not the supreme one taking precedence to economic efficiency and energy security. As the 26% target was devised in a bottom-up manner based on an energy mix satisfying 3E+S, if a crucial element of the envisioned energy mix becomes difficult, a new optimal energy mix should be devised taking into account the above factors under the most recent situation and a new GHG target should be set accordingly.

Evaluation of policy impacts

Depending on the outcome of the monitoring process of the current NDC, additional policies and measures might be deemed necessary. In that case, the cost effectiveness of such policies and measures should be thoroughly evaluated from the viewpoint of 3E+S. For example, Japan's FIT was introduced without proper cost benefit analysis. On one hand, it made substantial contribution to expanded penetration of solar PV, but it also resulted in much larger economic cost than initially anticipated. There is a calculation that the CO_2 mitigation cost of the FIT was 30,000-50,000 JPY/t-CO_2 (very roughly 240-400 EUR/t CO_2). Since Japan's energy cost (industrial electricity price and industrial gas price) is among the highest in major countries, rigorous review of cost effectiveness of various policies and measures is crucial. For example, the renewable energy promotion policy will substantially reviewed (e.g., switch from Feed-In Tariff to

Feed-In Premium) for reducing the economic burden to Japanese economy. Again, it is not justifiable to introduce unduly expensive policies just for achieving the 26% target.

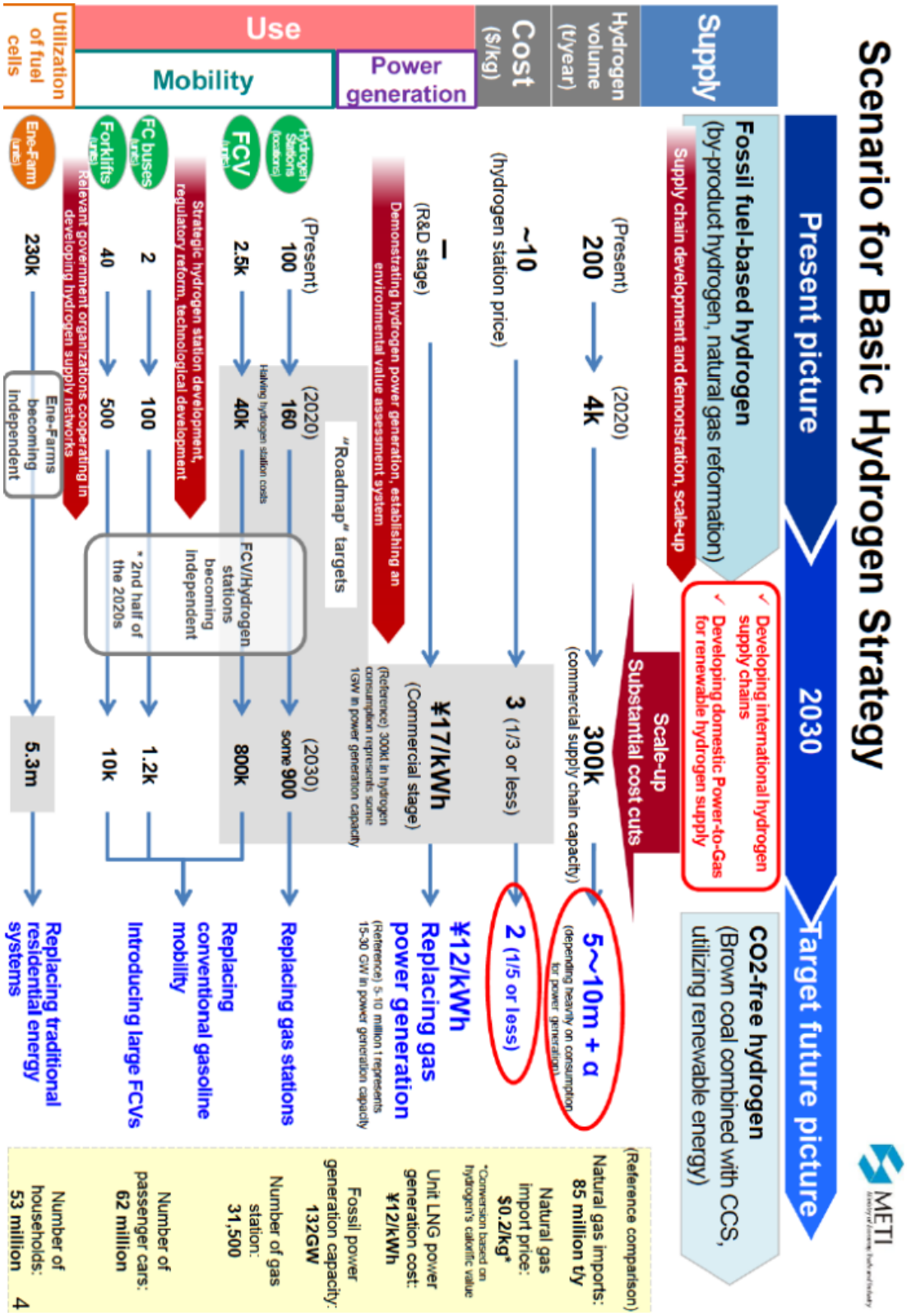
Scientific review focusing on innovation

In its endeavor to long-term decarbonization towards 2050 and beyond, Japan is placing innovation as the centerpiece. GOJ has already developed the energy and environment innovation strategy in 2016. But GOJ has not fully devised the roadmap for implementing it. In its Long-Term Strategy for the Paris Agreement (2019), GOJ has announced that it will formulate a Progressive Environment Innovation Strategy during 2019 with view to making business cases for technologies, which will make substantial contribution to global mitigation: setting clear targets (e.g. cost); maximizing financial flow from both public and private; and setting up institutional promotion and comprehensive support for the business (cf. chapter 2.2.1).

Since there are various sets of technologies for decarbonizing energy systems (e.g., RE+battery, hydrogen, CCS/CCUS, nuclear, Artificial Intelligence and Internet of Things), Japan will take a multiple-track approach in pursuing its long-term goal. Its "OODA" cycle, namely, observe, orient, decide and act, needs to be backed by "scientific review". However, the review process is still under development and has not yet been fleshed out. It is strongly expected that the forthcoming Progressive Environment Innovation Strategy could also spell out how such review mechanism works.

This review process should focus on examining the maturity of various technologies and effectiveness of policies to make it happen rather than setting arbitrary percentage figures for GHG emissions. Since deep decarbonization is possible only when technologies for achieving it become sufficiently cheap to be disseminated domestically and internationally, there should be technology targets (e.g., cost, performance, time scale). The Long-Term Strategy already presents some technology targets (e.g. reducing production cost of hydrogen to 1/10 by 2030), but a detailed roadmap for high priority technologies would need to be developed. As for hydrogen, Japan has developed Scenarios for Hydrogen Basic Strategy (see Figure 4-3). GOJ should develop such scenarios for other key zero-emissions technologies and they should be periodically reviewed based on "scientific review mechanism". This sort of "technology-based review" incorporating EBPM (evidence-based-policy-making) elements is considered much more effective in long-term mitigation endeavor compared with review based on mitigation target and timetable approach.

Figure 4-3: Scenarios of Basic Hydrogen Strategy

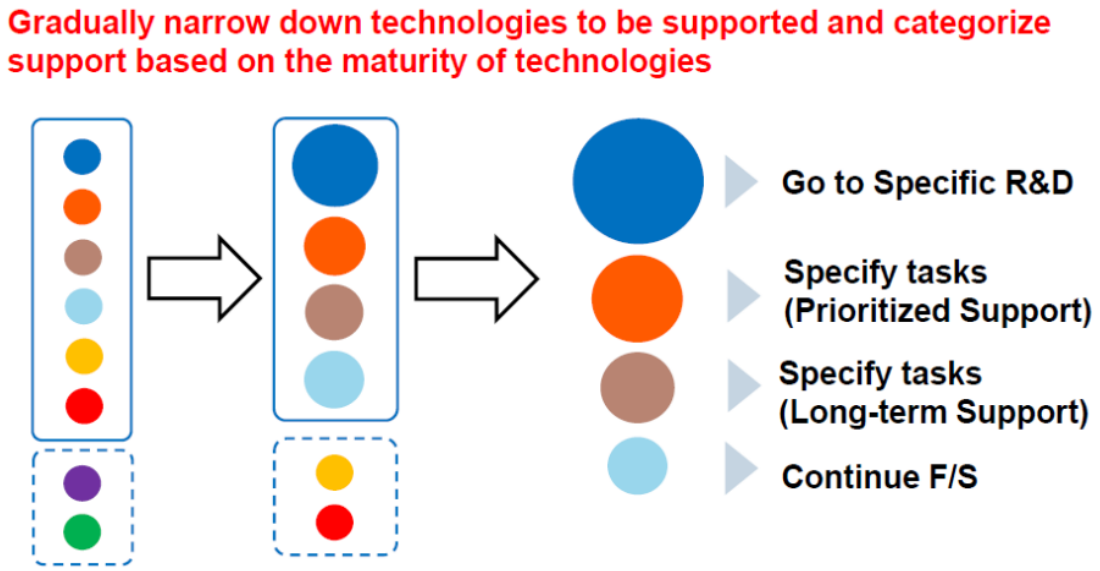


Source: METI

Gradual prioritization of technologies

Since there are many technological uncertainties and it will take time to develop innovative technologies, it could be more sensible to distribute the public R&D budget to a wide range of technology seeds. On the other hand, since the public R&D budget is finite, this sort of "across the board" support cannot be simply maintained. Therefore, for the sake of efficient use of the R&D budget, the R&D program should be gradually narrowed down incorporating the views of various stakeholders in each stage from basic research to commercialization. In this screening process, some technology seeds could receive more priority and go to a specific R&D stage. Some seeds could be assigned to work on specific tasks which could be short and medium term or long-term. Other seeds could better stay in a feasibility study (F/S) stage (see Figure 4-4).

Figure 4-4: Image of Narrowing Down Technologies to be Supported



Source: METI

In addition to specifying priorities based on the above process, the support scheme should also be differentiated. For example, in the initial development stage, a high support ratio (XX% of investment cost) could be applied for limited number of facilities. On the other hand, a lower support ratio (YY% of investment) could be applied, but for a larger number of facilities. In the US, e.g., nuclear technologies are being supported with various schemes in accordance with the development stage including ARPA-E (Advanced Research Project Agency-Energy), MEITNER (Modeling-Enhanced Innovations Trailblazing Nuclear Energy Reinvigoration), advanced reactor development program, and FOAK (first-of-a-kind) reactor demonstration project. Depending on the nature of technologies, and the situation of industry and academia, such schemes could also be envisaged in Japan drawing lessons from other countries' experience.

4.3. Lessons learned

The in-depth documentation of ex-ante assessments as well of the monitoring and evaluation efforts in Germany and Japan shows significant similarities and differences:

- The regulatory framework for greenhouse gas emission reduction targets and/or goals differs. The German approach is based on an almost three decades long tradition of national climate programmes and the energy transition decisions in 2000/2002 and 2010/11, but increasingly integrated in the governance framework of EU policies and the common NDC of the EU in the framework of the Paris Agreement. The national policy of Japan is much more directly linked to the UNFCCC framework.

- The German and EU policies are increasingly based on fixed medium- and long-term targets. These long-term targets have to be developed further. Even though, they are not (yet) made legally binding, they provide guidance for infrastructure decisions, innovation efforts and for investors and businesses and are at least partly integrated in policy mechanisms like the EU ETS. The differentiation between (policy-guiding) targets for 2030 and (more indicative) goals for 2050 in Japan seems to be much stricter.

- The approaches to derive medium- and long-term decisions, however, differ much less than expected. The long-term horizon (2050) is addressed with techno-economic analysis on technical and economic feasibility. The medium-term horizon (2030) is addressed more from the perspective of policy implementation and political feasibility. The exchange of experiences on these different approaches is a promising area of future cooperation.

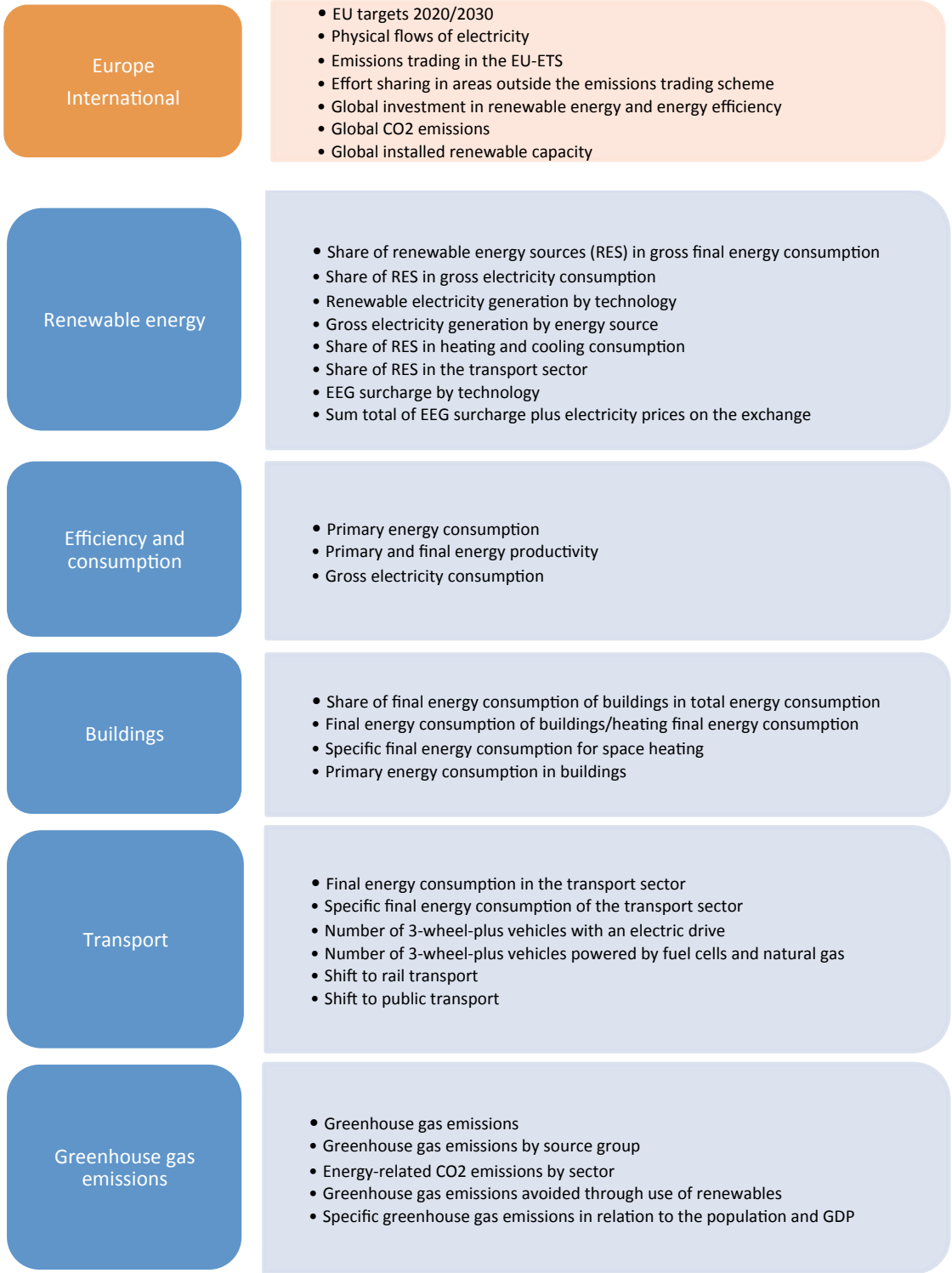
- Both countries have set ambitious climate policy targets, especially in the medium term. Both countries still face significant gaps that need to be filled to be fully compliant to these targets by 2030. For both countries, more comprehensive approaches of monitoring, evaluation and revision will be needed. The exchange of experiences on these policy revision cycles could be an interesting field of cooperation.

- There are many differences in the set-up and the framework of monitoring and evaluation processes. The content of these processes seems, however, to converge significantly. With the new quality of monitoring, evaluation and ex ante assessment of strategies or policies and measures, especially in the EU context, a more in-depth exchange on approaches and experiences could obviously add significant value to the energy and climate policies of both countries.

- Energy and climate policy in both countries are based on different economic and technical core beliefs or perceptions in a few areas (nuclear, renewables, costs etc.). Some but not all of them can be linked to the significant differences in terms of geography, infrastructure, political and cultural traditions etc. between both countries. With the increasing evidence from monitoring and evaluation processes and the improvement of ex ante evaluation, it could be worth additional efforts to reach at least a better understanding on the factual basis of the different core beliefs in the energy transitions.

Annex: Energy transition progress indicators of the German government

Indicators from the Sixth Monitoring Report “Energy of the Future” of the Federal Government for 2016



Security of supply Nuclear energy phase-out	• Installed capacity of power generation plants • Distribution of power plant capacity across the Länder • Combined heat and power including electricty generation • Conventional generation capacities: new plant construction and dismantling of plants • Capacity of pumped storage power stations • Nuclear phase-out roadmap • SAIDI power • Conventional power plants under construction
Affordability Competitiveness	• Final consumer spending on energy and as a share of GDP • Energy spending of private households • Electricity prices of private households • Energy costs for industry • Oil and gas prices • Prices of electricity on the exchange • Electricity prices of non-privileged industrial enterprises • Macroeconomic energy spending • Energy prices compared to other countries
Environmental compatibility	• Environmental monitoring of the energy transition using a suitable set of indicators (being developed)
Grid infrastructure	• Projects under the Power Grid Expansion Act and Federal Requirements Planning • Grid investments • Grid charges • Costs for ancillary services
Sector coupling Digitisation	• Number and electricity consumption of heat pumps • Number and electricity consumption of E-mobility • Remote controllability and remote readability of RES installations • Smart meters in private households • Smart meters in industry • Digitisation of the energy transition and the energy sector
Energy research Innovation	• Industry spending on R&D • Federal research spending in the Energy Research Programme • Project funding from EU funds • Patents • Market uptake of innovative technologies in energy consumption
Investment Growth Jobs	• Investment in renewable energy and energy efficiency • Investment in grids and electricity supply • Primary energy sources saved as a result of the use of renewable energy • Numbers employed in renewable energy sector • Employment in the energy sector

Source: Sixth Monitoring Report “Energy of the Future” of the Federal Government for 2016 with in-house data from the Federal Ministry for Economic Affairs and Energy, 3/2018