GJETC
German Japanese Energy Transition Council

REPORT 2018

INTENSIFIED GERMAN-JAPANESE COOPERATION IN ENERGY RESEARCH

Key Results and Policy Recommendations

Wuppertal Institut

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Organization

Funding

Support

This report is based on the work of the German-Japanese Energy Transition Council (GJETC). The work of the GJETC was financed by the German Federal Environmental Foundation (DBU), the Stiftung Mercator Foundation, the German Federal Foreign Office, the Japanese Ministry of Economy, Trade and Industry (METI), Elektrizitätswerke Schönau eG as well as WS Wärmeprozesstechnik GmbH. Furthermore it was supported by the German Federal Ministry for Economic Affairs and Energy (BMWi), the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), the Japanese-German Center Berlin (JDZB), the German Chamber of Commerce and Industry in Japan (AHK), and Medienbüro am Reichstag (MaR) (media partner). Responsibility for the contents of this publication lies with the authors.

Please cite the report as follows
Wuppertal Institut; Institute of Energy Economics, Japan (2018): GJETC Report 2018. Intensified German-Japanese Cooperation in Energy Research: Key Results and Policy Recommendations. Wuppertal/Tokyo.

Project term
May 2016–April 2018

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German Japanese Energy Transition Council

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INTENSIFIED GERMAN-JAPANESE COOPERATION IN ENERGY RESEARCH

Key Results and Policy Recommendations

PREFACE

In September 2015, the world community decided on the Sustainable Development Goals (SDGs) and, in December 2015, the Paris Agreement on Climate Change was unanimously accepted at COP 21. If implemented with high ambitions and the cooperation of the frontrunners, these visionary world roadmaps could be a turning point in global climate and resource protection policies. As UN General-Secretary Ban Ki-Moon put it: „2015 is not just another year, it is a chance to change the course of history". But the course of history cannot be changed to the benefit of mankind without the trustful international cooperation of all countries. Time is our scarcest resource. Mutual learning from good practice and how to avoid mistakes and lock-in effects are crucial for speeding up, scaling up, and tightening up the ambition out of our common target: Living well within the limits of the planet.

For the purpose of climate and resource protection and in order to improve competitiveness and energy security, the sustainable transformation of the energy sector is of utmost importance. Although there are many differences in framework conditions and energy policies, Germany and Japan are facing common challenges: How to establish a long-term risk-minimizing energy strategy based on public consensus and sound research, which protects the climate and natural resources and at the same time drives ecological modernization, energy security, and international economic competitiveness. As high-tech, prosperous and innovative countries, the cooperation between Japan and Germany can create a role model to foster the global energy transition. The research-based and independent work of the GJETC can contribute to and support the many bilateral Japanese-German activities and dialogues at government and industry level.

Every country has to decide on its own future energy mix. Some countries, such as Japan for example, may use nuclear energy, while other countries such as Germany may phase it out. But two similar basic strategies lead to deep decarbonization: Energy efficiency and the decarbonization of energy supply, particularly electricity, including sector

integration with increasing electrification. Both our countries, Japan and Germany, are faced with challenges and many uncertainties to achieve a long-term energy transition and a sustainable future energy mix. But as leading industrialized countries, we have a special responsibility to take the lead in implementing the Paris Agreement and to contribute as much as possible to a global deep decarbonization pathway.

For technology leaders such as Germany and Japan, a pathway to a decarbonized and risk-minimizing energy system will probably create more societal benefits than costs, if the external costs of the risky use of fuels are avoided, even though the perception and monetarizing of "risks" may differ by country. Energy efficiency, zero-carbon technologies such as renewables, cleaner use of fossil fuels, sustainable mobility, resource efficiency, and energy related green IT are examples of global lead markets of the future, where Japan and Germany can and should play an outstanding role as key players.

As independent researchers, we should not restrict our analysis of the energy transition to current policies and goals, but open the horizon to new social and technological innovations in both countries using evidence-based scenarios and system analysis. We have learned from the past that scientific knowledge of energy technology opportunities, potentials, benefits and costs, and energy policy options have changed tremendously – far more than the conventional wisdom of politics foresaw. A transparent dialogue between all relevant stakeholders (academia, civil society/NGOs, industry, politics) is the precondition for consensus building and the ambitious implementation of the energy transition.

Prof. Dr. Peter Hennicke,
Prof. Masakazu Toyoda,
Co-Chairs of the GJETC

April 2018

INTRODUCTION

1

The German-Japanese Energy Transition Council (GJETC) is a non-governmental initiative by individuals from research institutions, energy policy think tanks, and practitioners in Germany and Japan, which has been established for two years and is in its first phase. It works independently of interference from politics and businesses. The main activities of the Council and the supporting secretariats are to identify and analyze current and future issues regarding policy frameworks, markets, infrastructure, and technological developments in the energy transition and hold council meetings to exchange ideas and propose better policies and strategies. The GJETC has six Full Members from academia, three Associated Members with special expertise and one Co-Chair from each country.

From May 2016 to March 2018, the GJETC debated and published a broad range of materials:

- An 800-page study program
- In-depth information based on three stakeholder dialogues in Tokyo and Berlin
- Eight input papers to facilitate research-based dialogue
- Press releases and publications in the media

These outputs and the recommendations of the GJETC are summarized in this "GJETC Report 2018" including seven appendices. This material is also published on the website www.gjetc.org. In addition to the GJETC Report 2018, the Council has noted the publication of the seven appendices (cf. www.gjetc.org).

Structure of the Council

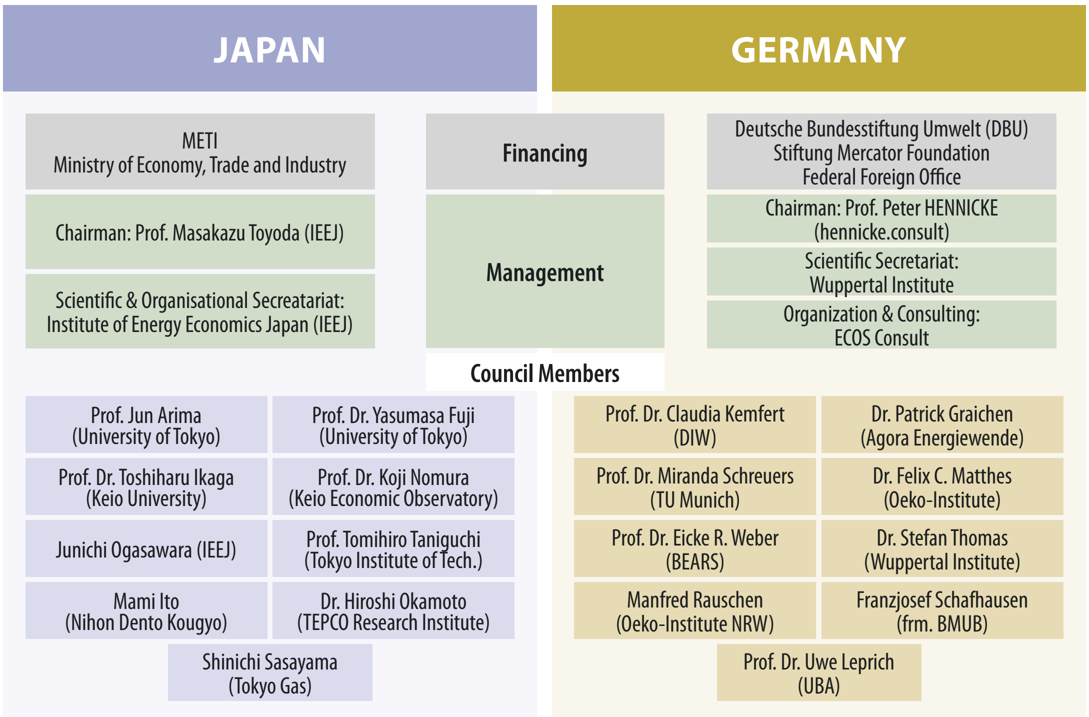
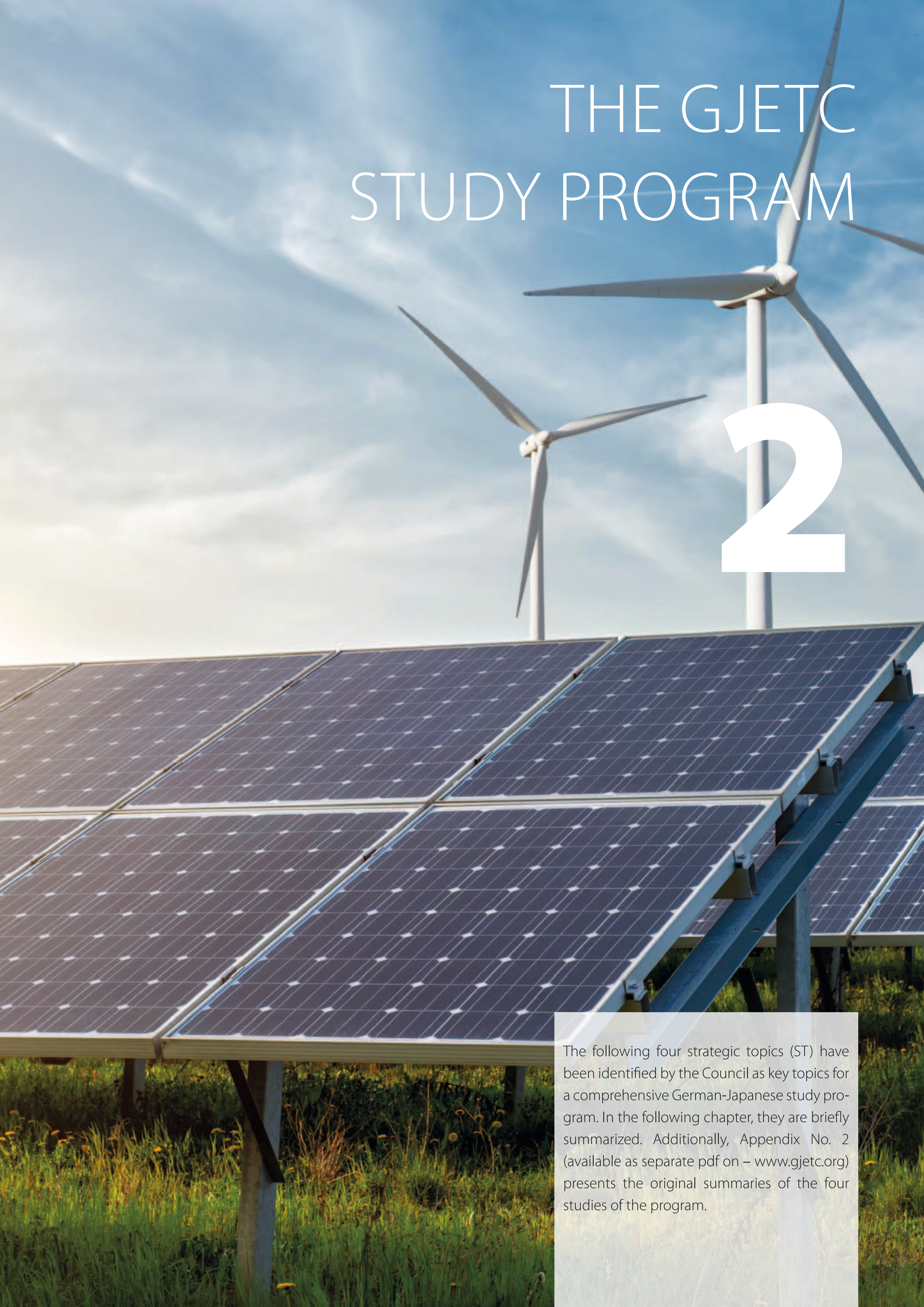


Figure 1: The structure and members of the GJETC



2 THE GJETC STUDY PROGRAM

The following four strategic topics (ST) have been identified by the Council as key topics for a comprehensive German-Japanese study program. In the following chapter, they are briefly summarized. Additionally, Appendix No. 2 (available as separate pdf on – www.gjetc.org) presents the original summaries of the four studies of the program.

ST1 “ENERGY TRANSITION AS A CENTRAL BUILDING BLOCK OF A FUTURE INDUSTRIAL POLICY – COMPARISON AND ANALYSIS OF LONG-TERM ENERGY TRANSITION SCENARIOS”

STUDY 1

The objective of the study was to identify (1) the official national energy transition targets, (2) the range of existing research-based, long-term scenarios, including scenarios that go beyond official national targets, and (3) the reasons behind the differentiation of scenarios.

KEY FINDINGS

(1) Long-term energy policies in both countries are based on selected scenarios from a range of projected energy futures.

(2) In Japan, there is an ongoing debate on the long-term (2050) CO_2 reduction goal and ways and means for achieving it. Germany has decided on a CO_2 reduction target range of 80–95 % for 2050.

(3) One key difference is the expectations regarding future system costs and potentials of wind and photovoltaic (PV) energy: Germany expects high shares in energy supply due to low costs and high potentials, while up to now Japan has expected higher costs and lower shares.

In Japan, there is an ongoing debate as to the future role of renewable energies. Up to now, Japan has decided on an electricity generation mix with a 20 %–22 % share of nuclear energy by 2030; Germany has decided to phase out all nuclear by 2022.

(4) Japan’s island nature restricts grid connection to neighboring countries as an available flexibility mechanism in the electricity system. The country therefore sees different challenges potentially arising from very high shares of variable wind and PV generation.

ST1
STUDY 1

	GERMANY ZS	GERMANY KS 80	GERMANY KS 95	JAPAN METI (2012) multiple models and scenarios	JAPAN IEEJ (2015) multiple scenarios	JAPAN RITE (2015) multiple scenarios
Energy demand reductions						
Final energy demand reductions through energy efficiency	Strong reductions	Strong reductions	Very strong reductions	Reductions	Reductions	Reductions
Final energy demand reductions through behavioural changes	Not considered	Not considered	Moderately considered	Moderately considered	Moderately considered	Moderately considered
Changing the use of energy sources						
Increased use of domestic renewable energy sources	Strong use	Strong use	Strong use	Moderate use	Moderate use	Moderate use
Phasing out the use of nuclear power	Complete phase-out	Complete phase-out	Complete phase-out	Yes (in some scenarios)	Yes (in some scenarios)	Yes (in some scenarios)
Continuing the use of nuclear power	No	No	No	Yes	Yes	Yes
Substitution of fossil fuels through electricity	Strong substitution	Very strong substitution	Very strong substitution	Moderate substitution	Moderate substitution	Moderate substitution
Use of renewable energy based H2 or synthetic fuels as final energy carriers	No use (until 2030)	No use (until 2030)	No use (until 2030)	No use	No use	No use
Importing low-carbon or carbon-free energy sources/carriers						
Net imports of electricity	No net imports	No net imports	Moderate net imports	No trade	No trade	No trade
Net imports of bioenergy	No imports (until 2030)	No imports	No imports	No imports	No imports	No imports
Net imports of H2 or synthetic fuels	No imports	No imports	No imports (until 2030)	No imports	No imports	No imports
Using CCS						
Use of CCS technology to reduce industrial GHG emissions	Not used	Not used	Starting to be used in 2030	Not used	Not used	Not used
Use of CCS technology to reduce power sector GHG emissions	Not used	Not used	Not used	Not used	Not used	Yes

Table 1:
Overview of the level of reliance on key energy transition strategies in selected scenarios for Japan and Germany until the year 2030 (Source: WI/IEEJ/DIW Econ 2017)

ST2 "STRATEGIC FRAMEWORK AND SOCIO-CULTURAL ASPECTS OF THE ENERGY TRANSITION"

STUDY 2

The objective of the study was (1) to identify the targets, strategies, and strategic framework conditions in Germany and Japan for a successful energy transition. (2) It also analyzed the respective socio-cultural preconditions in both countries and the approaches to changes of lifestyle and actors' behavior in the fields of consumption, habitation, mobility, products, production, and services. (3) The perception of the energy transition by the general public and geographical differences between Germany and Japan were examined.

KEY FINDINGS

(1) In both countries, energy policy is based on the principles of economic efficiency, energy security, and environmental sustainability ("Three E").

(2) The citizens of both countries view the energy transition favorably.

(3) An intensified bilateral policy research dialogue between the two countries has been identified as crucial, complemented by a national multi-stakeholder dialogue with businesses, civil society, and the research community.

Figure 2: Social shifts underlying the „anti-nuclear-movement" narrative (Source: IZES/Arepo Consult/IGES/Nagoya University/NIES 2017)

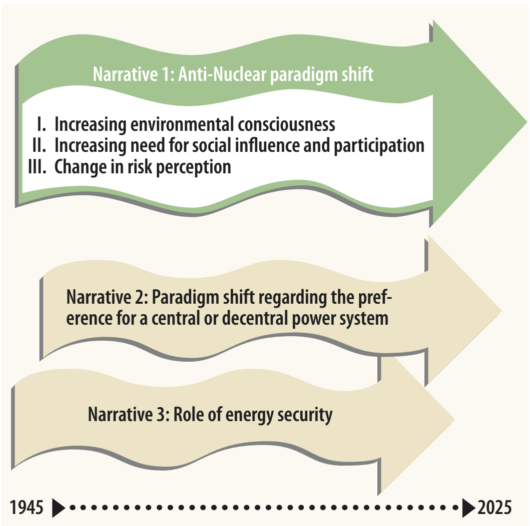
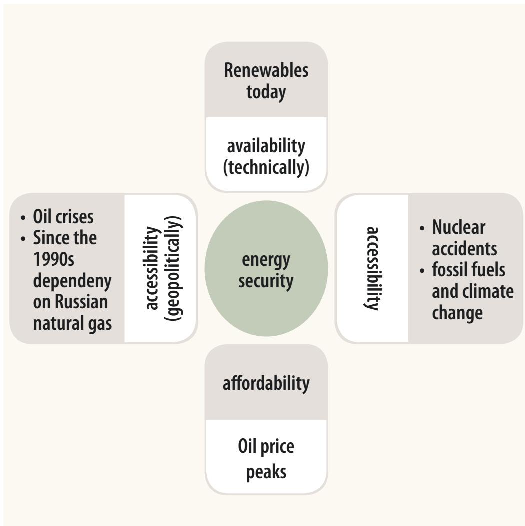


Figure 3: Energy security (Source: IZES/Arepo Consult/IGES/Nagoya University/NIES 2017)



"NEW ALLOCATION OF THE ROLES AND BUSINESS SEGMENTS OF ESTABLISHED AND NEW PARTICIPANTS IN THE ENERGY SECTOR BOTH CURRENTLY AND IN A FUTURE ELECTRICITY MARKET DESIGN"

ST3

STUDY 3

The objective of the study was to analyze (1) the national framework conditions in both countries, especially for the electricity market design influencing the role of established and new participants in the energy sector, (2) the technical and economic challenges for new electricity market arrangements and designs, and (3) the conditions regarding a decentralized energy market for Japan and Germany, so there is a fair playing field for new actors to develop robust business models.

KEY FINDINGS

(1) While Germany has gained more in-depth experience of the restructuring of electricity markets over a longer period of time, triggered by the liberalization of the EU's electricity system, both countries face similar challenges for the electricity market design of the near future.

(2) These challenges concern a robust economic basis for the electricity system, which addresses (1) the coordination of a more decentralized system with significant shares of variable wind and PV generation and significant needs for flexibility options, (2) the payback of investments in a system that is characterized by very low short-term marginal costs, (3) the need for integration of the power, heat, and transport sectors, and (4) the need for an appropriate regulatory framework to trigger the necessary grid adjustments.

Views on the future role of conventional power generation, particularly coal and nuclear, diverge.

(3) New business and consumer concepts, such as prosumers, municipal utilities, and energy co-operatives, provide opportunities.

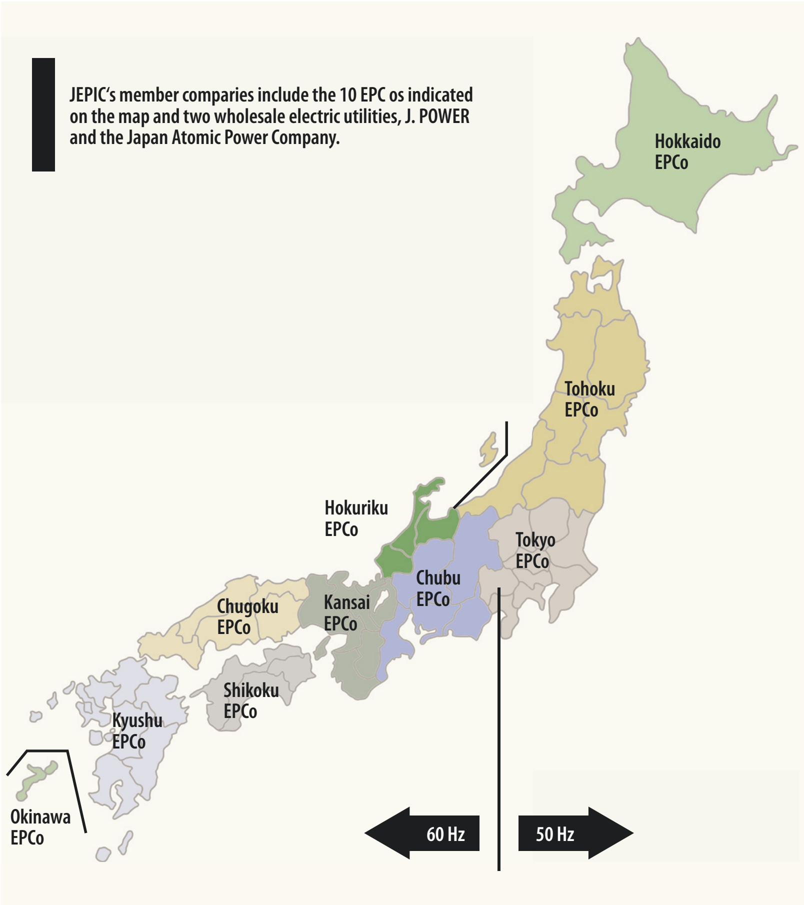


Figure 4:
Ten electric utilities and their areas in Japan (Source: IZES/JEPIC 2017)

ST3

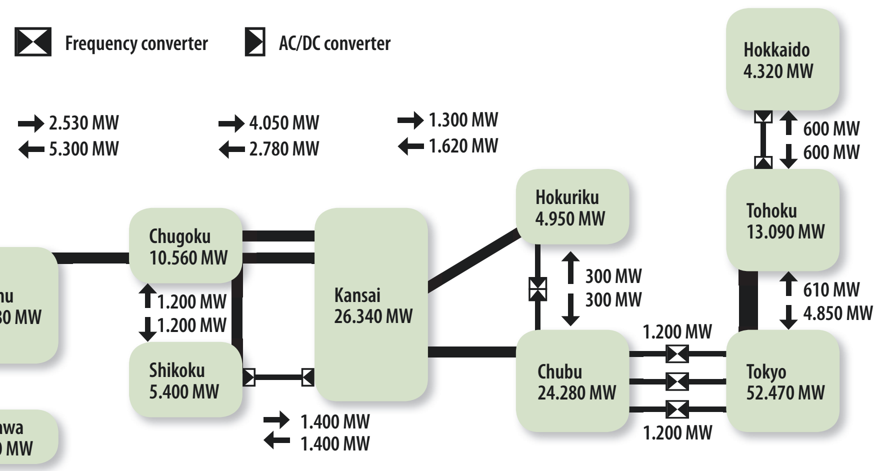


Figure 5: Transfer Capacity and Maximum Electricity Demand Forecast in Japan (Source: IZES/JEPIC 2017)

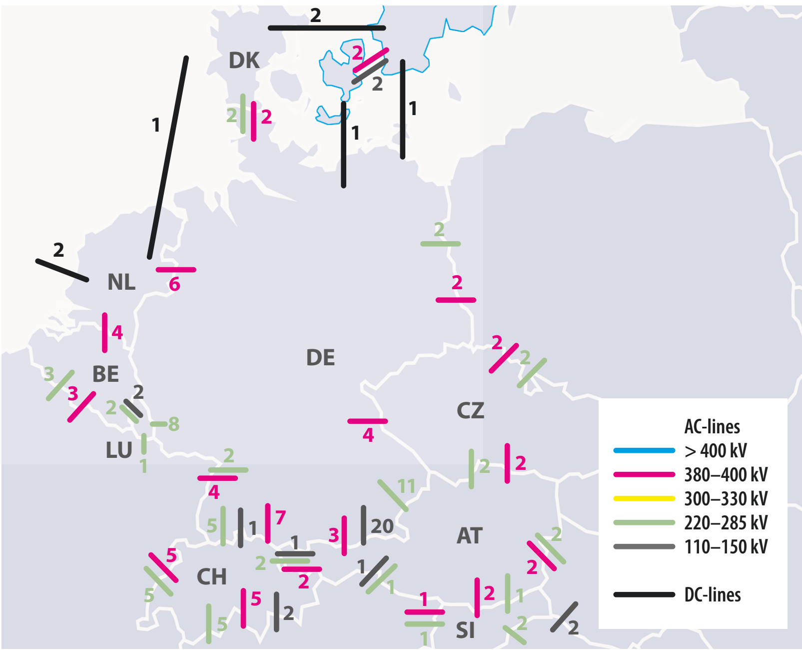


Figure 6: Cross-border transmission lines (as of end 2016) in Germany (Source: IZES/JEPIC 2017)

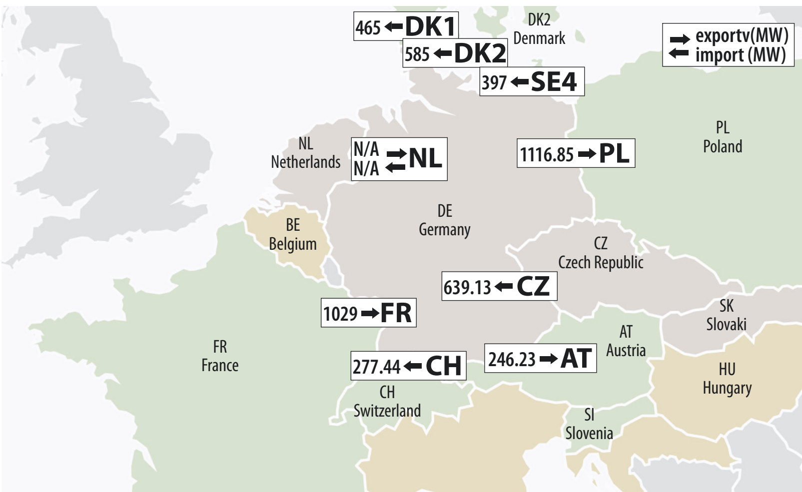


Figure 7: German cross-border flows with neighboring countries (Source: IZES/JEPIC 2017)

"ENERGY END-USE EFFICIENCY POTENTIALS AND POLICIES AND THE DEVELOPMENT OF ENERGY SERVICE MARKETS"

ST4

STUDY 4

The objective of the study was to identify (1) cost-effective energy end-use efficiency potentials in buildings, appliances, industry, and transport, and the main barriers preventing them from becoming reality and (2) the potential for demand response in the different sectors, and the effects of ICT, Internet of Things, and Big Data on the potentials for energy efficiency and demand response. (3) The respective policy packages were analyzed to support energy end-use efficiency and demand response in the buildings, heating/cooling, industry, transport, and electricity usage sectors in Japan and Germany and good practice experiences. (4) The current state of providers of Energy Performance Contracting and Energy Supply Contracting and the market were analyzed, as well as how to push the development of energy service markets and remove barriers. (5) Finally, the study examined energy efficiency-induced rebound effects, the Setsuden initiative (realized in Japan after the Fukushima Daiichi NPP accident), the role of energy *sufficiency*[1], and expected energy savings from behavioral approaches.

KEY FINDINGS

(1) Both countries are already world-leaders in energy productivity, also due to their existing policies.

(2) Both countries have ambitious energy efficiency targets for the future, based on the large potentials that still exist. Both have to strengthen their packages of energy efficiency policies to overcome barriers, including those hindering demand response.

(3) While Germany could learn from Japan on energy efficiency in the transport sector, Japan could learn from Germany on energy-efficient buildings.

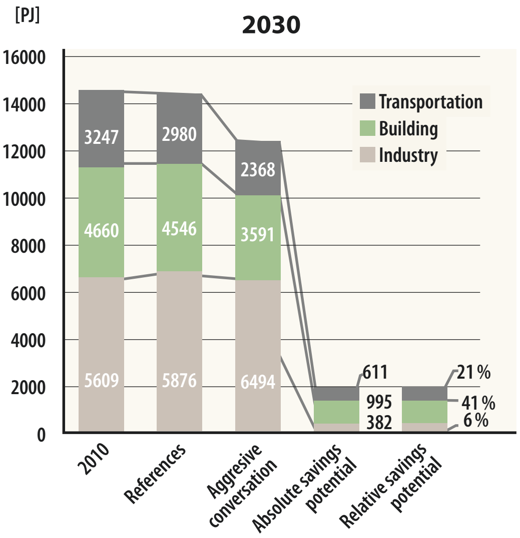
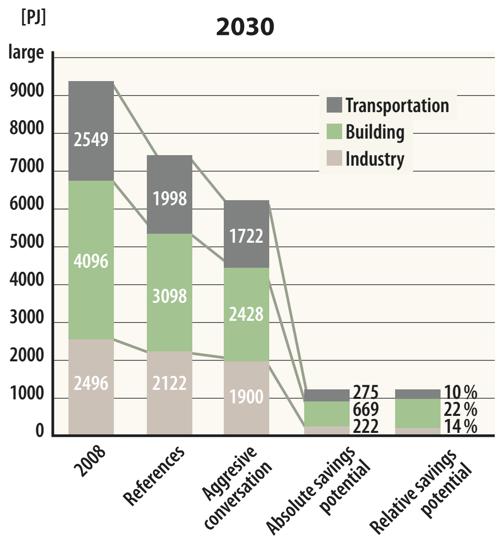


Figure 8: Energy efficiency potentials per sector in Japan, based on a comparison of policy scenarios: Potential = difference between Reference 2030 and Aggressive Conservation 2030 (Source: ecofys/IAE 2017)

1 Satisfaction with fewer or other energy-using services/products that already adequately meet basic human needs, with the aim of reducing the absolute amount of energy demand.

ST4
STUDY 4

Figure 9:
Energy efficiency potentials per sector in Germany, based on a comparison of policy scenarios: Potential = difference between Reference 2030 and Aggressive Conservation 2030 (Source: ecofys/IAE 2017)



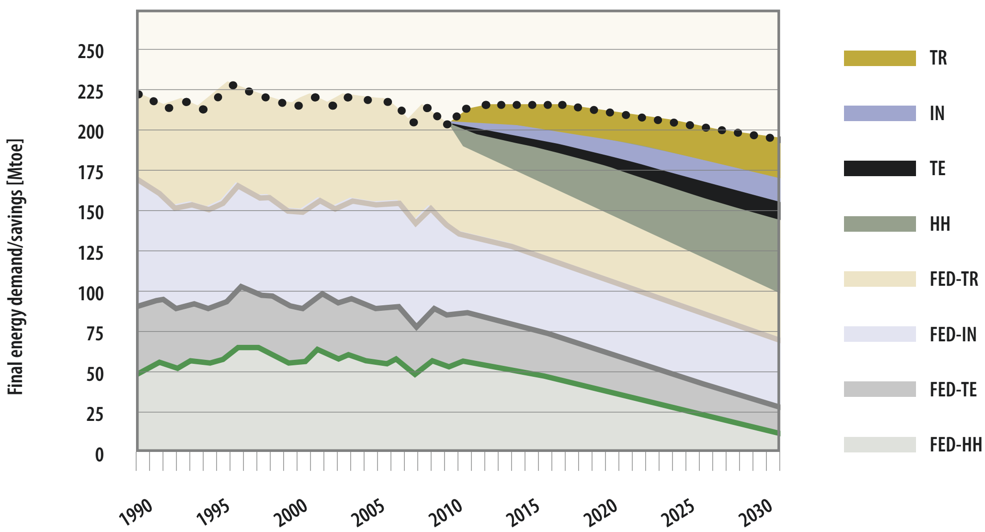


Figure 10:
Technical energy-saving potentials in Germany by sector demonstrate the possibility of cutting energy demand by half (no similar analysis is available to us for Japan, but we suggest it would be important with regard to future development). TR: transport sector, IN: industry sector, TE: tertiary sector, HH: household sector, FED: final energy demand (Source: Fraunhofer ISI 2017)

RECOMMENDATIONS BY THE GJETC

3

Based on the study program, stakeholder dialogues, joint outreach events, and input papers, the GJETC has established good common ground for further bilateral exchange of knowledge and experience on the energy transition in both countries. Such a shared and detailed knowledge basis was not available before. The relationship of trust between the German and Japanese sides and the outstanding expertise of the Council Members and the secretariats are the basis for the ongoing search for common solutions to problems, as well as for the exchange of critical analyses on different evaluations.

The ultimate goal of the Council's work was to discuss and decide on recommendations for all stakeholders. In Chapter 3, we have divided the GJETC recommendations into key recommendations for both countries and specific recommendations derived from more detailed results of the ST 1–ST 4 studies, which are organized according to thematic fields.

3.1 KEY RECOMMENDATIONS

THE COUNCIL WISHES TO HIGHLIGHT THE FOLLOWING KEY RECOMMENDATIONS ON STRATEGIC ISSUES FOR BOTH COUNTRIES:

(1) JOINT EFFORTS TO DECARBONIZE THE ENERGY SYSTEMS

Both Germany and Japan are Parties to the UN Paris Agreement on Climate Change, which aims to limit global temperature rise in this century to well below 2 degrees Celsius above pre-industrial levels. This implies that industrial nations need to take the lead by substantially reducing GHG emissions by 2050 and continuously pursuing carbon neutrality. Starting to achieve reduction goals early on, namely in the coming years, will be of particular importance. Hence, in the coming decades and beyond, both Japan and Germany will have to substantially transform their energy systems.

Based on their long-standing friendship and basis as technologically-oriented industrial nations, Germany and Japan should work together on the 'man-to-the-moon-challenge' of a carbon-neutral energy system. However, the specifications for mid-century reduction targets have differed between the two countries to date. More in-depth exchange on these differences is needed.

Like almost every other country in the world, Germany and Japan ratified the Paris Agreement on Climate Change in 2016. It requires nations to take national action to limit climate change. Both Japan and Germany have agreed to similar targets: Germany has set a domestic target of reducing greenhouse emissions by 80% to 95% below 1990 levels by 2050. Japan is aiming to reduce greenhouse gas emissions by 80% subject to certain conditions[2]. Since residual emissions will largely come from industrial and agricultural sectors, these long-term targets imply that Japan and Germany will need to extensively decarbonize their energy sectors within the next 30 years. This is a huge challenge for both countries as they are industrial nations dependent on reliable and cheap energy. But it can also be a driver for innovation and cooperation as both Germany and Japan have a long-standing tradition of engineering excellence that can now be used to establish sustainable energy systems. Hence, Germany and Japan should join forces and skills to implement the challenge of carbon-neutral energy systems as role models for all industrialized countries. This should also take into account the other sectors and emitting sources.

(2) THOROUGH ANALYSIS AND PERIODICAL REVIEW

Both Germany and Japan should conduct a thorough analysis of domestic resource availability (potentials), technological capabilities, economics including cost-benefit-comparisons, and implications for energy security in defining their long-term targets/goals[3] and energy transformation strategies, taking into account climate science and international energy markets.

Given that there are many uncertainties with regard to the above factors, policy makers should exercise resilience and flexibility through the periodical review of long-term pathways reflecting the best available information and encouraging innovation. Although the choice of energy mix and implementation strategies may differ by country, experiences in each country can be mutually complementary.

2 The "Plan for Global Warming Countermeasures" of the Japanese government decided in May 2016 states: "Based on the Paris Agreement, under a fair and effective international framework applicable to all major Parties, Japan leads the international community, so that major emitters undertake emission reduction in accordance with their capacities, and aims to reduce greenhouse gas emissions by 80% by 2050 as its long-term goal, while pursuing the global warming countermeasures and the economic growth at the same time."

3 While Germany has adopted firm targets for both 2030 and 2050, Japan differentiates between firm targets for 2030 and, to date, more aspirational goals for 2050. Therefore, we use both words, i.e. targets/goals, throughout the text when referring to targets and goals.

The ultimate goals shared by Germany and Japan are to pursue a sustainable energy system that satisfies their objectives with regard to security of supply, economics, and environment, while at the same time ensuring social acceptance.

The energy transition will be a long journey. Therefore, it needs to be politically, economically and environmentally sustainable. Potential growth opportunities should be fully exploited through active learning and innovation.

An important role for policy makers is to formulate and indicate ambitious but feasible long-term targets/goals and pathways to their people and industries, informed by a thorough cost/benefit analysis, while also facing various uncertainties in regard to climate science (e.g. climate sensitivity and damage, mitigation, and adaptation cost), future fossil fuel prices, reduction of RES-E generation and integration cost, and the domestic/international economic situation.

In light of the broadly based dynamic innovation in technology and society led by a new generation of IT, AI, networking, and Industry 4.0, the entire energy sector should proactively introduce and apply these technologies and practices in forms such as Smart Grid, Internet of Things (IoT), blockchain, housing, and mobility, in order to support decarbonization and improve security.

Policy makers should also take into account not distorting security of supply during the transitional period and maximizing economic and social benefits while minimizing detrimental side effects for society.

Furthermore, such targets/goals and pathways should be monitored and, when necessary, reviewed, reflecting the most recent information on the above-mentioned uncertain factors. Sticking to inflexible targets/goals and pathways without due regard to political/economic feasibility could result in the disabling of long-term sustainable action.

The Council recognizes the dramatic, ongoing reduction in costs for renewable energies worldwide, which could reduce the cost of transforming the energy system. Policy makers need to ensure that this happens fast enough in order to achieve the important climate goals in a cost-effective manner.

The choice of energy and implementation strategy may differ by country because of resource endowment as well as available and applicable technologies.

Although, Germany and Japan have different strategies, there are numerous areas where they can learn from each other.

(3) RENEWABLE ENERGIES AND SYSTEM INTEGRATION

A robust market and regulatory framework should be established, which allows for the large-scale expansion of renewable energies for electricity generation (RES-E) in the context of a nation's appropriate energy mix, and reflects the specifics of variable and low-marginal cost renewables. These specifics will create significant barriers for the different types of RES-E, even if they are highly competitive in terms of levelized costs of energy (LCOE). The remuneration mechanisms should be designed in a way that supports (1) cost reduction in the generation and supply of variable RES-E, total system and integration costs, and (2) the roll-out of the non-technical infrastructure (planning, designing, permitting, financing) for the different types of RES-E, especially in the early phases of deployment. Institutional, legal, and administrative aspects should be taken into account.

To ensure security of supply, a balanced build-up of flexibility options is needed, such as transmission network expansion to balance PV and wind feed-in, demand-side management and smart distribution grids, energy-efficient power to heat (e.g. using heat pumps), cogeneration of electricity, heating and cooling, energy storage, and, in the long run, potential technologies for the carbon-neutral production of hydrogen or synthetic fuels.

In Germany, it was crucial to establish priority access to the grid for RES-E and to include the specific connection costs in the general grid fee for rapid RES-E development. A corresponding upgrade of transmission and distribution grids has to be secured, so that competitive supply of RES-E to final customers is ensured. The increasing sectoral interconnection between the electricity, heating, and transport sectors (e.g. through e-mobility, smart grids, tri-generation/district heating/cooling), triggered by technical, ecological, and economic factors, should be promoted through targeted research and development as well as through pilot and demonstration projects.

The efficiency of supporting policy for the market introduction of RES-E should be considered, including cost-efficiency and the cost-benefit balance of the feed-in tariff system as well as the integration cost, and the fair distribution of incremental costs across demand sectors.

Policy makers need to continuously evaluate and innovate the support policy as well as the relevant regulatory framework to reflect the changing reality and transition targets.

(4) ENERGY EFFICIENCY GOVERNANCE

The governance of energy policy, especially with regard to reaping cost-effective energy savings, and the energy efficiency policies themselves should be further developed in

both countries in order to close the implementation gap in both countries and achieve ambitious absolute energy savings targets (the 'Efficiency First' principle).

Studies by the IEA and a large number of national studies in Germany and Japan show, especially with regard to energy saving policy, that there are still significant shortcomings with regard to adequate policy packages and programs for overcoming the many barriers and actually realizing the vast economic opportunities and co-benefits of increasing energy efficiency and saving.

Against this background, the GJETC recommends that both countries enhance the process and control responsibilities for the realization of their energy saving targets/goals through energy efficiency and energy sufficiency policies. Corresponding institutional innovations at the national and decentralized level should be identified.

For example, if applicable, a country might consider to establish a strong National Energy Efficiency Agency and Energy Savings Fund that is integrated into the institutional setting and policy-making process, with a clear mandate for such policy and process responsibility to achieve energy saving targets. Whether and how this implementing agency might effectively and efficiently provide added value in the highly complex development, implementation, and evaluation of energy efficiency and saving policy packages should be examined.

The GJETC also identified good opportunities for mutual policy learning between Germany and Japan with regard to energy efficiency and saving policy.

(5) RESTRUCTURING THE ELECTRICITY AND GAS SECTOR

The restructuring process for the electricity (and gas) sector should be continued to achieve structural changes that provide major benefits for the energy transition as early as possible: enabling free customer choices, opening up the market for more and more diverse participants, making networks neutral parts of the system, creating a robust economic framework for coordination and investments in a much more diverse system, triggering more technical innovations, achieving more transparency for all market and system participants.

The market entrance for new competitors on the one hand and an appropriate market design, which triggers price signals for the coordination of the system and enables the necessary investments, on the other are crucial elements of a successful restructuring process. This can be only be ensured through non-discriminatory network access for producers and consumers. Furthermore, transparent network regulation by an independent regulatory authority is necessary, as along with a high degree of unbundling of network owners and operators from the other parts of the value chain in the electricity market in order to allow the network operators to act as neutral market facilitators. Smart design of the different market segments, such as the wholesale market with a power exchange at the center, different balancing markets and competitive arrangements for metering and billing, as well as smartly designed market segments, or other mechanisms that remunerate sufficient investments in low-carbon, variable, and low-marginal cost generation, require response and storage facilities.

A high level of transparency in the different market elements and regulatory procedures (e.g. network planning) is a crucial precondition for a well-functioning restructured market that builds a robust basis for the transformation towards a low- or zero-carbon electricity system.

It is important to avoid a situation where there is a shortage of investment.

(6) INTEGRATION ENERGY AND RESOURCE EFFICIENCY POLICIES

The integration of energy and resource efficiency policies should be vigorously pursued in both countries.

Some existing studies show that by increasing material efficiency and implementing key mechanisms of a circular economy (e.g., "Three R": Reduce, Reuse, Recycle), enormous co-benefits can be achieved simultaneously through increasing energy efficiency and energy savings. Thus, the energy policies of both countries should be more closely linked to resource (efficiency) policy in order to systematically exploit synergies and co-benefits. To a certain extent, the energy transition is just a component, driver, and test field for a more comprehensive resource transformation process ("Ressourcenwende"), which aims to absolutely decouple increasing quality of life from the consumption of nature.

(7) EFFICIENCY AND SUFFICIENCY

An ambitious efficiency strategy should be combined with an energy sufficiency policy to make energy consumption reduction targets easier to achieve.

Specific gains in efficiency may partly be countered through growth, comfort, or rebound effects, such as an increase in living space per capita, an increase in the average power of cars and of transport in general, numbers of electrical devices, or the size of appliances (such as TV screens).

It is expected that a combination of instruments including mandatory energy efficiency or consumption standards, energy/CO_2 pricing, and revenue-neutral combined incentive/disincentive systems (such as 'feebates' as discussed in the USA or 'bonus-malus' in France) will provide a significant cushioning effect in both countries for such effects, in particular concerning vehicles, buildings, and appliances.

(8) ENERGETIC RENOVATION OF BUILDINGS

The necessary state funding to incentivize investments, as well as for consultancy, education, and training should be ensured for "deep renovation" of the building stock as well as to increase the annual renovation rate. In addition, renovation roadmaps and timetables for "low to plus energy houses" are necessary, for non-residential buildings too.

Long-term scenarios show that full decarbonization is not possible without a forced energy-saving refurbishment of the building stock (residential and non-residential buildings). However, this requires considerable government start-up funding in order to shorten the sometimes long payback periods for building owners and provide incentives for an ambitious standard of energetic renovation („deep renovation") of residential and non-residential buildings. Because of this financing requirement and the complexity of implementation, this „heat/cold transition" of buildings has not been sufficiently addressed in either country so far. In order to keep decarbonization on track, a "Public buildings renovation investment program" could also generate macroeconomic net benefits through new business fields and jobs.

(9) CENTRALIZED AND DECENTRALIZED ENERGY SYSTEMS

National energy policy should promote the co-existence of centralized and decentralized energy systems, taking into consideration the characteristics of each. In the decentralized energy system, innovative energy transition efforts in regions/municipalities, citizens' finance models (e.g. energy cooperatives), and civic participation should be encouraged. The experiences of numerous municipal utilities („Stadtwerke") and the growing decentralized sector in Germany provide examples of these.

The importance of decentralized actors to the implementation of the energy transition is increasing with regard to locally based renewable energies and the promotion of resilience, regional added value, social services, citizen financing, and public acceptance. Renewable energy and technologies/measures to increase energy efficiency not only generate additional regional profits, income, and tax revenues, but also a general „citizen value" in a broader sense, which can contribute to the attractiveness and revitalization of rural areas. The development and integration of a decentralized energy system into a modernized, centralized system, e.g. by creating the necessary new technological basis, with the corresponding regulatory framework is crucial for the energy transition in both countries.

(10) ROBUST AND ACCOUNTABLE TARGETS/GOALS, STRATEGIES, AND THE CORRESPONDING POLICY MIX

Each country should increase efforts to create a set of targets/goals, strategies, and implementation mechanisms in order to enable a robust policy mix that is effective, efficient, predictable, and accountable for the general public as well as businesses and investors.

The energy transition is a long-term energy and climate policy project. It needs to reflect the availability, costs, public acceptance, and infrastructure requirements of the different options and needs for action.

With regard to the extensive inertia in the system (lifetime and substitution cycles of capital, stocks, lead times for roll-out of infrastructure and innovation) and the need for a timely transformation, setting up short-, medium-, and long-term targets/goals is crucial to ensure that the necessary measures are consistent, to avoid significant lock-in effects, and to create the basis for international coordination.

Based on these targets, a set of strategies should be developed that describe key lines of activity and create accountability for the public and the market participants, e.g. (a) paving the way for clean and more sustainable energy options, (b) designing the process to reduce dependence on non-sustainable energy forms, (c) triggering the necessary infrastructure adjustments with sufficient lead times, (d) making innovation work in time, (e) explicit/implicit carbon pricing, and (f) activating as many market participants and stakeholders as possible).

The strategic combination of implementation mechanisms (policy mix) can and will be flexible over time, reflecting not only changing political and economic environments but also the sequences of phases within the energy transformation. Building the policy mix on a set of strategies can also prevent implementation policy blind spots.

(11) CONTINUOUS EVALUATION AND INVOLVEMENT OF ALL STAKEHOLD ERS

The successful implementation of the energy transition and climate protection policy requires continuous evaluation of conformity with the targets/goals, the widest possible involvement of all stakeholders, as well as transparent accountability and proactive commu-

nication with citizens. Both countries need to harness these driving forces for the energy transition more effectively.

A comprehensive energy transition towards creating a sustainable energy system in terms of decarbonization, environment, energy security, public acceptance, and economics is arguably the most ambitious reform project by the world community and many countries for the future. This long-term vision of the future can only be successfully implemented as a joint project by all stakeholders and in compliance with the respective national framework conditions. In terms of time frame as well as cost and benefit distribution, an energy transition is a kind of intergenerational contract: Today's generation finances and manages, with considerable effort, a transformation process that reduces and in part completely avoids the risks and costs of a non-sustainable energy system for future generations. Thus, long-term, reliable policy-making is crucial for the success of the energy transition. This includes making every possible effort to achieve the stated climate targets/goals for the years ahead in both countries.

(12) DISSEMINATING LOW-CARBON TECHNOLOGIES TO OTHER COUNTRIES

Both Germany and Japan should seek to maximize their technological contribution to GHG emissions reduction by supporting and disseminating efficient, sustainable[4], and low-carbon technologies to other countries, offering these technologies to global supply chains and developing innovative technologies enabling long-term GHG emissions reduction.

These endeavors regarding the energy transition are motivated by the climate change challenge. Since climate change is a global problem, it must be solved on a global scale. While setting ambitious national targets/goals and implementing domestic strategies, developed countries should take a broader perspective, allowing their technologies to contribute to reducing GHG emissions beyond their borders.

Both having strong technological bases, Germany and Japan could make an enormous contribution to the GHG emissions reduction through the diffusion of clean and efficient technologies to developing countries, backed by financial/technical support where necessary, the delivery of clean and efficient goods/services to the global supply chain and the development of innovative technologies, thus drastically changing the global mitigation pathway. Both countries should consider how they can maximize these contributions both individually and jointly.

(13) JOINT SCENARIO MODELING

A continuous working group on joint German-Japanese scenario modeling should be established.

Scenario-based policy-making is crucial for long-term target setting, process management, and evaluation of the energy transition, especially in respect to the uncertainties of future developments. Thus, well-informed long-term decisions based on predictive tools depend on excellence, best practice and accepted methodologies as well as validated models and data sets. It is in the interest of both countries to develop long-term energy scenarios applying a common methodology based on comparable energy system analysis, including macroeconomic analysis of both Germany and Japan. This joint effort is also expected to provide a better understanding in both countries as to which strategic, technological, or social innovations offer the better transformation pathways.

The Council found that there are differences in the modeling results and in how modeling outcomes are perceived and interpreted in Japan and Germany. Against this background, the Council recognizes the need for continued dialogue on the differences in data, methodologies, modeling concepts, and economic concepts.

(14) BILATERAL AGREEMENT ON AN EDUCATIONAL EXCHANGE PROGRAM

A bilateral agreement, budget, and marketing concept for a German-Japanese support program for the exchange of students, joint master's and doctoral theses, and in general

4 German experts do not include nuclear energy into the definition of "sustainable technologies".

for vocational training and school education are strongly advised. This could be modeled on the European Union's Erasmus Programme. With regard to an ambitious Japanese-German exchange program, attractive financial support for acquiring language skills and for accommodation abroad would be essential.

The Erasmus Programme is the world's largest funding program for overseas stays at universities. Since 2003, it has been extended beyond Europe through the Erasmus Mundus add-on program, which funded around 1 million scholarships in its first 15 years. The total budget of the program is about 450 million euros a year, provided from the EU budget. According to a survey, participants in Erasmus programs are about twice as likely to enter into life relationships with foreign partners (27 %) than students who do not spend time abroad at a university (13 %). Furthermore, the unemployment rate for Erasmus students is 23 percent lower five years after graduation.

(15) CONTINUOUS DIALOGUE

The Council recommends intensified and continuous dialogue, including that of the GJETC, on technologies, social innovations, and policies to speed up sustainable energy transformation in both countries.

Undoubtedly, technological and societal processes of decarbonization and risk minimization in both countries and worldwide could be accelerated in the future on the basis of disruptive technologies and new comprehensive experience, as well as the transfer of lessons learned. The current implementation processes in Germany and Japan can also be significantly supported through cooperation and the exchange of knowledge. For this purpose, the GJETC has created a format that allows science-based policy advice to be provided close to politics, but independent of any political mandate. This continuous format implies a wealth of synergy effects with long-lasting, successful German-Japanese dialogues at the level of government and business.

Past experience shows that differentiated insights and a better understanding of the respective traditions, problem situations, framework conditions, and intercultural exchange require time and continuity. After two years of intensive work, a good foundation has been created in this regard in order to take the joint work of the GJETC to a new, advanced level in a second phase.

3.2 SPECIFIC RECOMMENDATIONS BASED ON THE STUDY PROGRAM

IN ADDITION TO THE KEY RECOMMENDATIONS IN CHAPTER 3.1, THE COUNCIL STRONGLY SUPPORTS THE FOLLOWING SPECIFIC RECOMMENDATIONS DERIVED IN DETAIL FROM THE RESPECTIVE STUDIES.

With the four joint research reports from German-Japanese consortia, interested stakeholders now have a wealth of information totaling around 800 pages at hand. For the first time, a thorough analysis has been performed of four major areas relevant to the energy transition, with comparable information for both countries and section containing comparisons and mutual critical review.

Against this background, the following joint conclusions and recommendations have been derived for policy and business as well as for civil society and NGOs. In addition to this, further research needs have been identified (Chapter 4.) The full sets of study-specific recommendations are included in each of the four study reports, which are available for download at www.gjetc.org.

Of the four studies, ST1 and ST2 analyzed overarching questions pertaining to the energy transition, while ST3 and ST4 focused on sectoral studies. Due to their topics and analysis, the four studies partially overlap in terms of their recommendations. Therefore, it was decided to present a thematic synthesis of the **recommendations** in the following, which were developed by the responsible institutes and summarized and adopted by the GJETC.

The first overarching theme of the recommendations is the ambitious energy transition and climate change mitigation targets of both countries – can they be met, and how? How can the economic impacts of meeting the targets be optimized? The second overarching theme concerns the role of politics vs. other actors, and how to improve the dialogue between all actors. The two main **sectoral topics** are (1) energy (end use) efficiency and savings and (2) energy supply and markets. For both of these, the GJETC received and adopted recommendations on policy, business opportunities, and mutual learning.

3.2.1 MEETING ENERGY TRANSITION TARGETS/ GOALS

The analysis of the selected energy scenarios for both Japan and Germany showed that considerable deviations from current energy system developments are needed in both countries in order to reach the countries' respective 2030 energy transition targets, especially when looking at the targets in the longer time frame up to 2050. Managing the process of "deviations" and driving the energy transition forward according to ambitious targets is a historically unprecedented and challenging task for both countries.

THE FOLLOWING POLICIES ARE RECOMMENDED FOR MANAGING THESE "DEVIATIONS" FROM BUSINESS AS USUAL IN GERMANY AND JAPAN:

(1) Implement the energy transition in a well-balanced way, i.e. along pathways that do not distort any element of the three '3Es' (i.e. the three basic objectives of energy policy in both countries:

Maintaining and if possible improving energy security, economy, and the environment). Base long-term energy pathways (at least until 2050) on the latest global and country-specific information regarding technological and economic trends (e.g. costs), including renewables, energy efficiency, and system integration. Japan needs to establish a long-term energy plan[5].

(2) A clear indication of targets and policy roadmaps from the government is an indispensable element in order to guide industry and the general public to make the right long-term decisions.

(3) Ambitious further promotion of energy (end use) efficiency and savings is needed in every end use sector.

(4) Foster the increase in lower carbon energies and reduce the use of fossil fuels. Choose low-carbon options with respect to the specific circumstances of each country, including availability, (technical and social) acceptability, and the specific economics of various resources.

(5) Adopt a higher price on CO_2, considering the possible side effects and taking into account the specific national circumstances. Careful consideration is required in order to protect consumers, in particular low-income households, and not to harm the industrial basis through non-competitive prices.

(6) Increase knowledge sharing between Germany and Japan to accelerate the energy transition in both countries:

- Target/goal setting for climate change mitigation and risk minimization: Germany needs a plan for the phasing out of coal (lignite), which is embedded in its decarbonization concept. Japan needs to establish a long-term plan to include, for example, guidelines on the future role of nuclear energy.
- Lock-in effects and stranded investments should be avoided in both countries.
- A consistent strategy and policy mixes should be developed and implemented.
- Development, cost reduction, and system integration of solar PV and on/offshore wind need to be advanced.
- Energy efficiency policies should be strengthened to harness the potential.
- Automotive technology and climate-friendly transport systems should be developed and implemented.
- Decarbonization of emission-intensive industries is needed.
- Development of joint databases of market-ready, emerging, and long-term innovative technologies will be crucial to inform modeling and policy-making.
- Public dialogue and participation processes need to build consensus.
- Experiences, strategies, and programs should be exchanged with regard to sectors and/or regions that will face major challenges during the transformation process, especially if these changes are, for whatever reason, disruptive.

(7) Public dissemination, continuing evaluation of transitional targets/goals, and increased transparency are needed. The GJETC expects the responsibility and willingness of all stakeholders to do everything possible to reach the officially declared targets/goals.

5 Germany already has both long-term energy transition and climate change targets for 2050, and a climate change action plan for 2050.

3.2.2 IMPROVING PARTICIPATION AND DIALOGUES ON THE ENERGY TRANSITION

The GJETC believes that the involvement of civil society and relevant stakeholders is crucial to the energy transition. Many important opportunities will be at local level, making changes in personal and professional behavior necessary. Stakeholders, including the general public, that are well informed, have a good understanding and are willing to cooperate in regard to policy are a crucial element of achieving national consensus and acceptance of energy transition targets/goals. In such a multi-stakeholder discussion, concerns about energy security and affordability, safety and environmental impacts can be voiced, and potential solutions can be discussed.

GJETC RECOMMENDS THE FOLLOWING POLICIES IN GERMANY AND JAPAN

(1) Better cooperation between different ministries involved in the energy transition in order to create consensus or achieve compromises on how to advance the energy transition.

(2) Strengthen stakeholders' involvement in policy-making, policy dissemination, investment decision processes, and financing of low-carbon technologies, including decentralized options to revitalize rural areas. Involving and engaging stakeholders will encourage their autonomous efforts and support for targeted policies.

(3) Provide industry with greater confidence and concrete prospects regarding their business environment in order for them to develop or change their business model/activity in line with the national energy transition.

(4) Multiple approaches to improving the public's acceptance of policy and energy investment.

- Government leadership in both policies and regulatory issues.
- Share the benefits of energy investment with local communities and people, e. g. through local ownership models.
- Provide learning opportunity for policy and energy investment.

- Independent and scientific public education.
- Public involvement from the planning stage of an energy investment project.

(5) Establish an international dialogue between policy makers and businesses from both countries to improve the understanding of why and how the energy transition can work more smoothly for the benefit of both countries.

(6) Government, ministries or other active stakeholders: Initiate approaches for the public through dialogues, particularly on the strategic energy plans and targets/goals of the country, but also on more concrete energy transition aspects. Such dialogues will also make the energy transition part of public discourse and the mindset of the people.

(7) Create a diverse and independent research community and ensure research funding as a precondition for informed decision-making and a cornerstone of democratic policy-making by choosing the right path based on scientific evidence. This creates transparency, generates trust and awareness among the general public ("social learning"), and enhances the room to maneuver for all stakeholders.

(8) Integrate the energy issue into the educational system and vocational training as a basis for societal transformation and future innovations. The energy issue should therefore be integrated at different levels and into various fields of education:

- Curricula for various disciplines at university and in professional education and training as well as for various school subjects (politics, physics, etc.).
- Encourage practical experience.
- Offer further training for teachers and educators on energy transition issues and the relevance of unsustainable consumption.
- Foster personal experiences in kindergarten through games and other active elements.
- Adapt training courses to new competences needed on the job market, including technical knowledge and skills for the implementation of participatory planning processes.
- Decide on a joint bilateral exchange program for students and pupils between Japan and Germany (cf. Chapter 3.1, key recommendation 14).

3.2.3 ENERGY (END USE) EFFICIENCY AND SAVINGS

Both countries, Germany and Japan, are already among those with the highest energy productivity in the world. The fact that energy efficiency policies have been in place in both countries for many years has contributed to this. Nevertheless, both countries still have high unrealized and economically promising energy efficiency potentials, which justify ambitious energy efficiency targets for the future. Advanced energy efficiency policies will be an important driver for business opportunities. For example, digitization can provide an opportunity for new consulting tools to save energy in equipment by enabling cost-effective consulting services. Big data and a market for energy savings could bring further business opportunities.

GJETC RECOMMENDS THE FOLLOWING POLICIES IN ORDER TO ACHIEVE AMBITIOUS ENERGY (END USE) EFFICIENCY TARGETS IN GERMANY AND JAPAN

(1) Operationalize the principle of "Energy efficiency first" (as proposed, for example, by the IEA and the European Union); decide on ambitious targets, continuously assess, develop, and strengthen energy efficiency policies.

In general, more balanced and comprehensive policy packages that use regulatory, financial, informational, and all other instrument types can be expected to be effective in overcoming the multiple barriers to energy efficiency, as can more energy-sufficient lifestyles.

(2) Potential policy improvements can be found in the following fields.

- Industry: Support harnessing the remaining energy efficiency and waste heat utilization potential, including with payback times greater than three years.
- Transport: Pursue urban planning efforts that focus on reducing transport needs and fostering public and non-motorized transport options.
- Building: Increase implementation of energy-saving measures particularly in the existing buildings stock as well as in new buildings to reduce final energy consumption.
- Pursue not only energy efficiency but also energy conservation in the sense of energy sufficiency.
- Ensure that sector coupling between the power, heat, and transport sectors is pursued in an energy-efficient way.
- Integrate energy efficiency and energy sufficiency with demand management, sector coupling between the power, heat, and transport sectors, and other flexibility options.
- Harness the potential of digitization for new energy efficiency services, demand management, and sector coupling.

(3) Create energy efficiency and conservation policies to drive new business opportunities. Big Data collected through digitization and a market for energy savings can bring further business opportunities, such as automation, demand response, and more effective consultation services, for example.

- Establish a market system to exchange energy savings (sometimes called a "NegaWatt-Market"). The system can be combined with an energy trading system to ensure the flexibility of such ancillary power supply services.
- Third-party aggregators and utilities could recruit customers for demand response programs in order to relieve the grid during periods of high energy demand, which would facilitate the development of demand response automation.

(4) Germany could, for example, learn from Japan's experience of using energy efficiency benchmarks in the industrial and commercial sectors, the Japanese Top-Runner approach, and Japan's transport system and policies.

(5) Japan could, for example, learn from Germany in regard to taking a long-term view of the energy transition, energy efficiency targets and policies and policies to advance energy efficiency in buildings.

3.2.4 ENERGY SUPPLY AND ELECTRICITY MARKET DESIGN

Both countries need to provide a reliable policy framework and a level playing field for the diversification of energy supply technologies, and for potential current and new investors to achieve medium- to long-term energy transition targets. As a part of this framework, both countries need to create an electricity (and gas) market design that translates the energy transition targets and objectives into new framework for energy markets, by setting incentives that would advance the transformation of the energy systems.

While Germany has greater and more extensive experience in the liberalization of electricity markets, both countries face similar challenges in terms of the electricity market design of the near future. Germany has reached the point where variable renewable energies are gaining more and more system relevance. Though Japan is still in the process of integrating large amounts of variable renewable energies, it should anticipate these further stages in the current process of market liberalization. When modifying the system, it could accommodate both – energy transition and liberalization – at once.

GJETC RECOMMENDS THE FOLLOWING POLICIES FOR TRANSFORMING THE ELECTRICITY MARKET IN PARTICULAR

(1) Governments should allow for a broad variety of market participants by ensuring strict neutrality of the network operators through unbundling and transparent network regulation, as well as by creating new markets with low barriers to entry, especially for newcomers (e.g. balancing markets). Investors in new generation units should bear investment risks inherent to competitive markets. Provide as much transparency as possible with regard to market shares, prices, forecasts, and assets in the electricity sector.

(2) Both countries need to make full use of their renewable energy source endowments, while reducing the use of fossil fuel, as this would be beneficial in terms of reducing the import dependency and carbon intensity of the economy. As a whole range of low-cost technologies are available on the global market (incl. wind, PV, and geothermal), both countries should aim at a balanced distribution of technologies, as this reduces integration costs. Energy markets should be designed to provide appropriate long-term indications and confidence for market players, particularly for those involved in capital-intensive investment, and to guide the change in energy supply structures according to the targets/goals of the energy transition.

(3) Sufficient incentives for the various flexibility options should be created to integrate variable renewable energies, typically wind and solar PV, through electricity market design and instruments. This is appropriate, although it is still a question of at what stage in the transition, at what time, and of what appropriate technologies are needed for both countries to increase the system's flexibility capability. No general recommendation is possible at the moment but there is a need for further research. These flexibility options include, for example, reinforcing the power grid, strengthening and implementing demand-side management, utilizing and developing pumped hydro storage, research and development, and market deployment of new storage technologies. How to create sufficient incentives for the various flexibility options while minimizing incremental costs is still an unsolved question for both countries.

(4) Germany can further increase its domestic North – South transportation grids together with its European interconnections. Japan needs to increase East-West interconnections as well as the interconnections between the former monopoly areas. Thus the grid integration options in Japan can be optimized despite it being an island country.

(5) Encourage new business and consumer concepts, such as prosumers, municipal utilities, and energy cooperatives, which provide multiple opportunities. The electricity market design and instruments should facilitate these decentralized options.

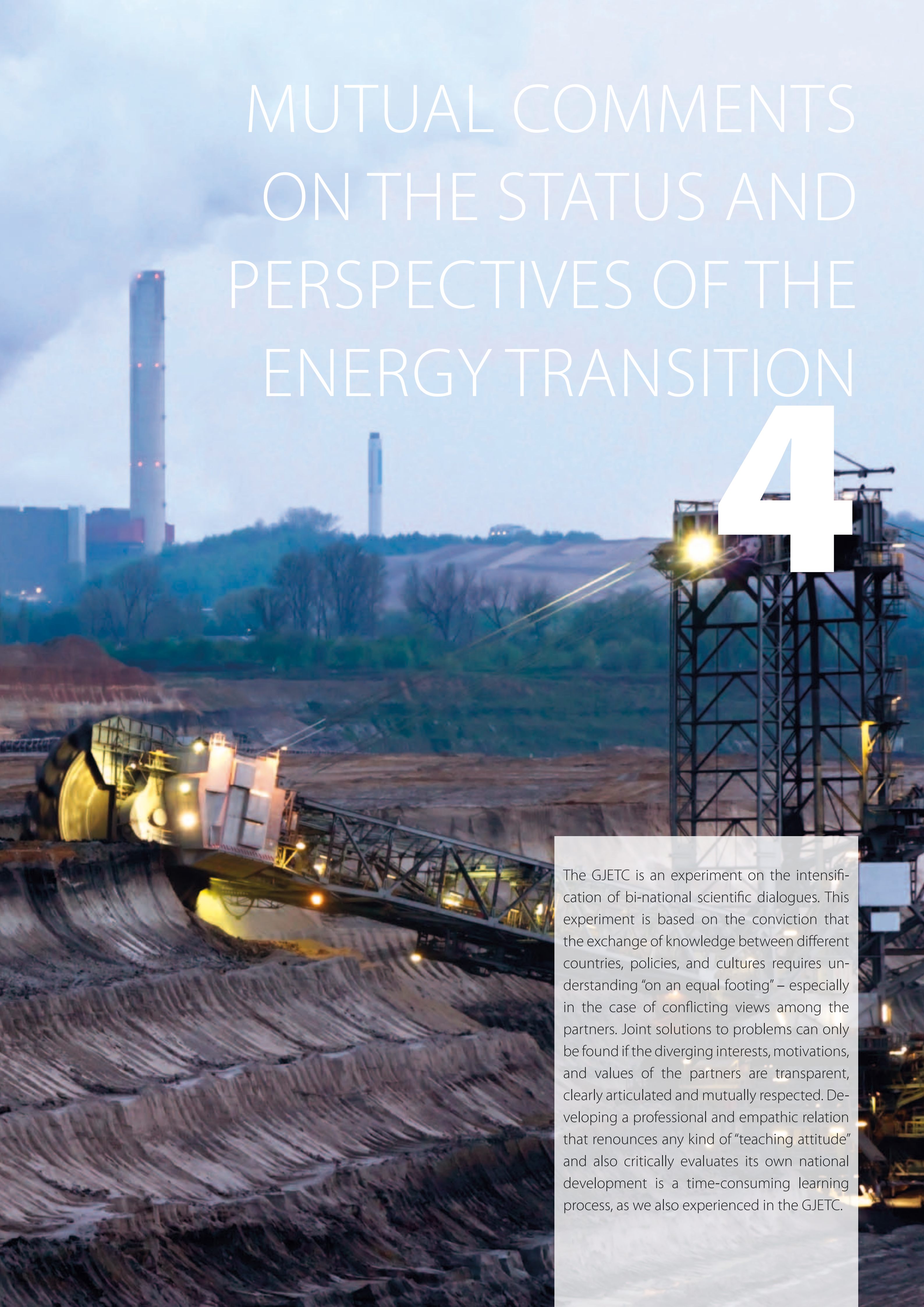
(6) Both countries need to set the framework for (more) sector coupling, i.e. for the integration for electricity, heat (and cold), and mobility. As a prerequisite, electricity grids need to be enhanced with new functionalities (smart grids) to enable coordination between the sectors – technically, in terms of market incentives as well as in terms of the corresponding regulatory framework.

(7) Business opportunities are manifold. Offshore wind power plants (with innovative floating technology to be build at deep-water sites) and long-distance, high voltage direct current (HVDC) technology, which are needed to exploit the full wind power potentials, are just two examples.

(8) There are mutual learning opportunities between Germany and Japan in the following fields:

- Examining each other's concepts for and experience with policy frameworks and market design for the energy markets overall, and in particular for renewable energies and flexibility options.

- Learning from pilot programs for flexible electricity structures. Here, Germany could look at the virtual power plant demonstration projects that are currently underway in Japan, and vice versa.



MUTUAL COMMENTS ON THE STATUS AND PERSPECTIVES OF THE ENERGY TRANSITION

4

The GJETC is an experiment on the intensification of bi-national scientific dialogues. This experiment is based on the conviction that the exchange of knowledge between different countries, policies, and cultures requires understanding "on an equal footing" – especially in the case of conflicting views among the partners. Joint solutions to problems can only be found if the diverging interests, motivations, and values of the partners are transparent, clearly articulated and mutually respected. Developing a professional and empathic relation that renounces any kind of "teaching attitude" and also critically evaluates its own national development is a time-consuming learning process, as we also experienced in the GJETC.

The following Chapters 4.1. and 4.2. on lessons learned and "mutual scientific critique" and "self-criticism" try to contribute to this process. In terms of format and content, this is undoubtedly an experiment and a novelty for German-Japanese energy and environmental dialogues.

To this extent, the mutual commentary principle, as used by the research institutes conducting the study program, is applied in this chapter to the discourse within the Council and between German and Japanese Council members. An attempt is made to compare the respective views of the German and Japanese Council members regarding fundamental questions, as pointedly as possible. This means that the Japanese and German sides each summarize their respective critical views of the energy transition in the partner country as well as in their own country.

This exercise is not an attempt to present a complete picture of the status and perspectives of the energy transition in both countries, and it is not about details. It focuses on the discussion of key strategic issues that GJETC experts from both countries perceive as relevant, both for their own country and for the partner country.

This format deliberately deviates from the principle of consensus in order to transparently explain the different positions and assessments of the energy transition to a broader public in both countries. At the same time, it should stimulate public discourses on the targets/goals and means of the energy transition.

4.1 COMMENTS BY THE JAPANESE COUNCIL MEMBERS

4.1.1 THE STATUS AND PERSPECTIVES OF THE ENERGY TRANSITION IN JAPAN

The Energy Mix 2030, which was determined in light of 3E (energy security, environment, and economic efficiency) in 2015, has three pillars, namely, a 22 % to 24 % share of renewables electricity, a 20 % to 22 % share of nuclear power, and the substantial improvement of energy efficiency.

The Japanese Council members are of the opinion that this energy mix is a well-crafted one, simultaneously aiming at 1) restoring the energy self-sufficiency to the pre-earthquake level, 2) staving off the further increase in electricity cost from the level in 2013 and 3) realizing the GHG emissions reduction target, which is comparable with other developed countries, such as the EU and the US. It is obvious that restarting nuclear is to play the central role for achieving the above three requirements, given that the increase of the FIT surcharge from 2013 to 2030 is to be absolved by the reduction of fossil fuel import bills as a result of a nuclear restart.

In defining the above energy mix, there was an argument that Japan should follow the German

example, phasing out nuclear on the ground that another nuclear accident could put Japan's energy supply and economy at risk. However, such argument neglects the fact that nuclear safety standards have been substantially strengthened with the establishment of an independent regulatory authority of Japan, to minimize the risk of a future nuclear accident to the tolerable level, and, if any accident happens, to contain its miasma. Judging from various scenario analyses[6], the phase-out of nuclear and its replacement with solely renewable energy and energy efficiency was regarded extremely costly and not economically viable. The Japanese Council members also endorse such view.

Advocates of renewable energy, of which views are cited in the German Council members' statement on the energy situation in Japan in 4.2.2, often argue that renewable energy is getting more and more competitive vis-à-vis conventional power sources, emphasizing that Japan should give a far higher share to renewable energy in its energy mix. However, we are rather skeptical about this argument, which sounds fashionable, but unfortunately groundless. We are fully aware, that there are scenarios, as exemplified in 4.2.2, which present rather optimistic cost estimates of the energy transition. However, we do not regard them as theoretically and empirically robust ones, that could withstand the critical review of experts and therefore, while acknowledging the need of a continuous look at the future trends, we do not regard them as an appropriate basis for actual policy making.

Generation costs of various renewable energy sources reflect country and local specific conditions. Even though PV cost has become far cheaper than conventional power in some other countries, it is not automatically relevant to Japan, which is a typical example of an island economy without interconnectivities with neighboring economies. If renewable energy has become that competitive, it is not rational to continue such huge indirect subsidies under FIT. In fact, the cost of renewable energy in Japan is still 1.5–2 times higher than in most European countries. Most recent auctioning of PV did not dramatically change this situation.

It is not appropriate to solely focus on panel costs or wind turbine costs. To evaluate total power generation costs, we need to take into account relatively high construction costs due to customers' requests for better-quality service, including procedures against earthquakes and typhoons, land costs as well as growing system integration costs in accordance with the growing share of intermittent renewable energy sources without interconnectivities. The government is currently considering "connect and manage", ensuring a grid management that is as efficient as possible in integrating renewable energy sources. However, its impact on cost reductions remains to be seen.

Of course, the Japanese Council members hope that renewable energy will gradually become more competitive, while taking into account the unique high costs in construction, land use and system integration. If such a situation emerges without counting on subsidy, the raison d'être of

6 See 5.1.7 http://www.gjetc.org/wp-content/uploads/2017/12/GJETC_ST1_Energy-transition-as-a-central-building-block-of-a-future-industrial-policy.pdf.

nuclear could be reduced significantly. However, cost data shows that renewable energy in Japan has not yet come to that stage and cannot substitute the role of nuclear, at least, in the near future. Furthermore, we are rather surprised to hear that GHG emissions have stayed almost flat in spite of the substantial increase in renewable energy, possibly due to the steady decline in nuclear energy in recent years in Germany. That is why the Japanese Council members consider that Japan needs both nuclear AND renewables. From our perspective, nuclear and renewables are both essential tools for achieving multiple energy and climate policy objectives. Promoting renewable energy and making the best efforts for their cost reduction, while retaining nuclear in our energy mix, is not mutually exclusive. We do not regard the promotion or the phase-out of particular types of energy as an objective itself and do not consider the abandonment of nuclear energy as an "economic chance". On the contrary, the agenda setting that is often advocated by some groups, stating "nuclear OR Renewable" or "nuclear VS renewable", is not only irrelevant, but rather harmful for the Japanese energy sector and economy.

Achieving the above energy mix is a challenge. Among them, the Japanese Council members consider that renewables are highly likely to achieve their expected share. By contrast, restoring the share of nuclear power to its goal does not appear to be easy due to political, judicial and economic uncertainties, but could still be possible with better communication among people. Improving energy efficiency as expected is also quite challenging, but not impossible.

It is fair to ask what would happen, if the nuclear share of 20–22 % cannot be achieved. While we do not believe that it is necessary to revise the energy mix at this point in time, the progress needs to be regularly monitored and, if necessary, the energy mix may need to be revised at some stage, taking into account factors such as the progress of a nuclear restart, the present situation and future prospects of fossil fuel and renewable energy costs (both total generation cost and integration cost) as well as the overall domestic/international economic situation. If such revisions are deemed necessary, the Japanese Council members do not regard the 26 % as a fixed target that has to be achieved under whatever the underlying energy situation would be. The 26 % target was devised in a bottom-up manner, based on an energy mix satisfying the above three requirements. Likewise, a new energy mix should be devised taking into account various factors at that time and a new GHG target should be set accordingly.

If the renewable energy costs have dramatically declined by that time, we may be able to maintain the 26% or aim at a higher target, even though the nuclear restart is lagging behind. On the other hand, if the higher targets for renewable and energy efficiency for compensating the slow progress of the nuclear restart in achieving 26% would result in higher electricity costs, such course of action would require extreme caution not ruling out downward revision of the 26% target, given the already higher electricity cost faced by Japanese industries. The patience of households should be carefully considered as well. According to an opinion survey, over 90% of respondents' willingness to pay is within 500 yen per month. The current FIT surcharge, even though we have not yet achieved the 2030 target, has already exceeded 670 yen per month in 2016.

The Japanese Council members certainly acknowledge the big business opportunities of renewable and energy efficiency technologies on the global market going towards decarbonization. Since many Japanese companies are operating globally, they will be highly astute in capturing them. However, from our perspective, such pursuit does not need to be underpinned by an unduly ambitious target setting on renewable and energy efficiency, not taking into account its economic feasibility or the abandonment of nuclear power as an objective in itself. Such dogmatic approach could rather harm the Japanese industry and economy.

The energy costs are one of the important factors affecting international competitiveness and Japanese industries that are already facing higher electricity costs. German experts point out "while the electricity price for the Japanese industry is higher than for the German industry, the energy consumption added per value was higher in Japan". However, the higher industrial energy intensity in Japan reflects the higher share of the energy intensive industry. After adjusted taking into account the industrial structure, the Japanese industrial energy intensity is at the same level as the German one[7]. More fundamentally, Japan faces harsh competition in the APEC region (e.g. US, China, Korea), accounting for 71% of Japan's import and 77% of Japan's export. Competitors

in this region are enjoying far lower electricity prices. If higher energy costs harm the macroeconomic performance, it would discourage private enterprises to spend on innovative and high-risk technologies. Overall, Japanese Council members consider that an argument advocating ambitious target setting as a driver for boosting new technologies, industries and jobs is overly simplistic. Since the introduction of the FIT in Japan, the bulk of installed PV cells have been imported from China. Chinese PV industries did not flourish due to domestic target settings, but because of lucrative subsidized oversea markets, like in Germany and Japan.

While Japan is aiming at reducing GHG emissions by 80% by 2050 as a long-term goal, it is in many ways different in nature from the 2030 target.

The figure "80%" originates from developed countries' proposal in the UN climate negotiation in 2009 to reduce global GHG emissions by 50% until 2050, whereby developed countries take a lead by reducing their emissions by 80%. In other words, the 50% reduction of global GHG emissions until 2050 and the 80% reduction in developed countries formed a package. However, developing countries have never accepted this proposal. While developed countries proposed a 40–70% reduction of global GHG emissions by 2050, together with the temperature target of 1.5–2.0 degrees at the time of COP21, it did not fly. As long as the

7 http://www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf

global GHG emissions reduction goal is not agreed upon, the above package deal should be regarded invalid. In this regard, Japanese Council members tend to see the 80% goal with certain caveat.

Furthermore, while the proposed global GHG emissions reduction goal of 50% or 40–70% derives from a specific level of climate sensitivity (3.0 degrees), there are ranges of views about climate sensitivity from 1.5 to 4.5 degrees without any consensus. With a difference of only 0.5 degrees, the shape of global GHG emissions for achieving the 2.0 degrees target largely changes[8], which makes the rationale of "50% globally and 80% for developed countries" further questionable.

It should also be highlighted that the 80% reduction goal is not unconditional, but premised to three preconditions written in the "Global Warming Prevention Plan" as highlighted below, which are actually not fulfilled with the US intending to withdrawal from the Paris Agreement;

"Based on the Paris Agreement, **under a fair and effective international framework applicable to all major Parties**, Japan leads international community so that **major emitters undertake emission reduction in accordance with their capacities**, and, aims to reduce greenhouse gas emissions by 80% by 2050 as its long-term goal, while **pursuing the global warming countermeasures and the economic growth at the same time**. Such a deep cutin emissions is difficult to achieve through the extension of existing measures so far. Therefore, Japan pursues solution through innovation such as development and deployment of innovative technologies which enables drastic emission reductions, and, while promoting domestic investment, enhancing the international competitiveness, and asking citizens for their opinion, aims to achieve a deep cut in emissions through long-term, strategic actions, and contributes to global GHG emission reductions."

As underlined above, the 80% reduction goal cannot be achieved by the extension of existing measures and technologies and should be differentiated from the formulated 2030 target, accumulating robust policies and technologies. Therefore, it should be regarded as direction or vision, rather than a hard target. In addition, climate change is characterized with multiple uncertainties (e.g. climate science, future industry, technology, society and the international situation). That is why Japanese Council members do not consider it appropriate to apply inflexible back-casting approaches, starting from the 80% goal.

8 http://www.rite.or.jp/system/latestanalysis/pdf/E-Climatesensitivity_2degrees_INDCs.pdf.

More fundamentally, given that climate change is a global problem, an approach just focusing on the production level of GHG emissions reduction in each country is not necessarily relevant. If country A unilaterally raises energy costs for the sake of deep decarbonization, its energy intensive industries will be put in a disadvantageous position vis-à-vis their competitors of country B, not implementing similar actions. If the industries of country A have a higher efficiency performance than those in country B, but lose their share in the international market, this could simply cause carbon leakage and would be counterproductive to global mitigation.

Therefore, as suggested in the long-term Climate Change Policy Platform[9], the Japanese Council members consider that Japan should rather seek "three arrows" game changers as countermeasures against global warming: (1) international contribution through dissemination of Japan's efficient and environmentally friendly technologies to developing countries, (2) global value chain-based reductions by industries and companies through technologies such as Green IT and high-performance steel with a view to reducing GHG emissions at utilization stage, and (3) development of innovative technologies. This "beyond the border" approach would enable simultaneous achievement of Japanese economic growth and global mitigation.

For long-term GHG emissions reductions, within and beyond border, Japanese Council members put more emphasis on ensuring as broad options as possible and on a conducive environment for innovation, rather than target setting based on a linear back-casting approach. From our perspective, only economically feasible and affordable mitigation options make ambitious targets achievable, not vice versa.

Taking into account the above, the following summarizes the perspectives of the Japanese Council members, regarding the "Energy Mix 2030" and the 2050 pathway.

- To accelerate the reduction of energy consumption, transportation and residential sectors are required to play a key role. In the industry sector, the costs to reduce energy use tend to be higher than in other countries, as Japan's higher energy productivities have been realized under long-lasting higher energy prices. As a result, energy consumption in the industry sector is even estimated to increase, as long as productions do not move to foreign countries (this may result in an increase in global net GHG emissions).

- With a view to avoiding further undue burdening of the FIT surcharge, policies are needed to drive down the generation cost of RES-E, which is still 1.5–2 times higher than in the European market. The priority is to develop an exit strategy from FIT, as well as revising it as a more market-oriented scheme.

- The growing system integration cost should also be included in the assessment of the cost-effectiveness of RES-E support policies. This is crucial in order to keep the electricity cost within reasonable limits.

- The nuclear restart is the centerpiece of the Energy Mix 2030. The government should take a more proactive approach to explaining the crucial role of nuclear energy in light of the aforementioned 3Es.

9 http://www.meti.go.jp/english/press/2017/pdf/0414_001a.pdf

- With a view to providing a sound sense of direction and predictability to private investors, the government should formulate long-term energy policy scenarios up to 2050, while maintaining sufficient flexibilities and resilience in responding to scientific, economic, and technological uncertainties as well as the international situation.

- In doing so, the government should take a holistic approach not only seeking domestic mitigation potentials, but also maximizing Japanese technologies' contribution beyond the border.

- The government should redouble its efforts in the area of long-term R&D, particularly with regard to developing zero-carbon and negative carbon energy technologies (e.g. next generation nuclear, nuclear fusion, space photovoltaic, hydrogen production and usage, CCUS), as well as providing an enabling environment to incentivize the private sector to tackle long-term innovation.

- If the government is seriously aiming at a 80% reduction to 2050, it should consider the replacement of the existing nuclear reactors by new, more advanced ones as an arrow in the quiver.

- Whether we stick with the nuclear option or not, finding a solution to the issue of the final disposal of spent fuel and radioactive waste is crucial.

4.1.2 THE STATUS AND PERSPECTIVES OF THE ENERGY TRANSITION IN GERMANY

Since the Fukushima nuclear accident, the Energiewende has been widely publicized by some people in Japan. They advocate that Japan should follow the German example by phasing out of nuclear, promoting RES-E, and improving energy efficiency to the greatest extent possible. Japanese Council members regard the Energiewende as a laudable initiative based on a sovereign decision by the German people. Nevertheless, they do not find the above argument appropriate, under the belief that policies should be designed based on sufficient evidence and perspectives on technological, economic, and social feasibilities for achieving its targets considering the differences in resources and circumstances. There are stark differences between Germany and Japan, at least in terms of 1) geographical conditions, 2) natural conditions, 3) the role of municipalities, 4) economic circumstances, and 5) the difference in approach.

First and foremost, the transmission connectivity of Germany with at least nine adjacent countries is in stark contrast to the insularity of Japan, which has no interconnection. Exploiting the existing balancing capability is normally the cheapest option for absorbing the variability of renewables. It is true that Germany is a net exporter to neighboring countries, but looking in depth, Germany has been exporting surplus wind power in the North to the grids of its neighboring countries, while importing power in the South. If its Eastern neighbors had employed the same policies as Germany, promoting intermittent RES-E in their own countries, the above arrangement would not have been possible. This intrinsic advantage enjoyed by Germany should not be downplayed. By contrast, Japan's insular geographical setting does not allow such cherry picking. Even if Germany seldom exercises this option as claimed, tightrope walking with a safety net is totally different from tightrope walking without one. This is the reason why Japan takes a more vigilant approach, keeping all energy options open and maintaining enough margins for any unexpected event.

While Germany will also need to take grid stability options into account at home, in accordance with increased penetration of intermittent RES-E in its neighbors, Japan has been obliged to address grid stabilization without international exchange from the outset. Unlike interconnection among largely homogenous EU member states sharing common political values, the relationships between Japan and its neighboring countries are more complex. Japanese Council members do not envisage grid connection in any meaningful extent in the North

East Asian region, at least for the time being, due to economic and geopolitical reasons.

The *second* difference is the natural conditions, which RES-E need to enjoy. A limited share of flat areas of land is one example. Japan is a mountainous country and the share of inhabitable lands is 34 %, while that of Germany is 70 %. On the other hand, Japan's population is 1.5 times higher than that of Germany. This would make it more challenging to find suitable lands for mega solar or wind mills to enable competitive costs in Japan. In order to generate the same amount of power [kWh] from 1GW of nuclear, a 90-times larger space is necessary for mega solar and 360-times larger for wind power. Although Japan has wind potential, it tends to be concentrated in remote areas, which would require long and costly transmission line connections. Due to deep water, offshore wind in Japan would require costlier floating technologies. In addition, Japan's typhoon-prone meteorological circumstances and earthquake-prone geological circumstances make the construction cost of wind power and mega solar costlier in light of construction safety standards.

Thirdly, the role of municipalities is markedly different. In Germany, which is a federal republic, electricity companies owned by municipalities have survived as Stadtwerke, together with a sense of local's ownership. While market power has shifted from Stadtwerke to big utilities e.g. E.on and RWE, in the course of the electricity market reform, the tradition of municipal utilities has provided a good basis for positive acceptance of decentralized RES-E electricity generation as a mean of partly winning back local sovereignty from the central.

In Japan, which is a classic case of centralist government, municipalities have not played such roles, due to the different governmental system and the historical development of utility industries. Given the increased role of distributed RES-E plants and their inherent local nature, Japan could learn some lessons from the German experience of Stadtwerke. Having said that, the Japanese Council members would register that some caveats on "fallacy of composition" in that bottom-up, municipality-led RES-E introduction may not result in an optimum energy mix in aggregate. This is particularly true for Japan, since its grid system is thin, long, and isolated, not allowing import/export options with neighboring countries, which is completely different from the European system.

The *fourth* is the difference in economic circumstances. While German Council members seem to have an optimistic view about the economic implications of the energy transition, Japanese Council members tend to be more cautious. While the power generation cost of RES-E is rapidly declining and becoming increasingly competitive vis-à-vis conventional thermal power on

the world market, this is only one side of the story. Policy makers must also consider how to contain the growing system integration costs in accordance with a higher share of RES-E. It could also be argued that investment in energy efficiency and RES-E is by definition positive for the macro economy in model simulations without considering the crowding-out effect. While this is true in the short term, if it results in higher energy prices, it could have an adverse impact on industrial competitiveness, disposable income, and employment in the mid- to long-term. Some Japanese Council members consider such a difference in regard to economic consequences to partly stem from the Euro currency, which gives German industries an advantage. The IMF assessed the real effective exchange rate for Germany as being undervalued by 10–20% in 2015. In the same year, the share of net export in GDP reached 7.6% in Germany, which is two times greater than Japan's unsustainable peak recorded in 1986. In addition, the difference in trading partners between Germany (EU region accounts for 70% of import/export) and Japan (APEC region accounts for 70% of import/export) should be taken into account in designing an appropriate policy. Such differences could partly explain why Japanese industries are more sensitive to the impact of the energy transition on their international competitiveness than those in Germany.

Last but not least, the Japanese Council members have found the difference in approach to the energy transition process/scenario particularly interesting. Germany's ambitious targets stem from a back-casting approach from an 80% reduction target in 2050. By contrast, Japan regards the long-term goal (2050) as a direction or vision, which is different in nature from the mid-term target (2030) underpinned by the energy mix developed based on a bottom-up approach. Japanese Council members consider that the 80% reduction goal by 2050 cannot be achieved by a simple extension of existing policies and technologies, and that the possibility of realization depends entirely on future innovations. In addition, due to the many uncertainties relating to climate science, the future industrial, technological, and social situation, and the international situation, they think it inappropriate to apply a back-casting approach with an inflexible process management. In fact, this back-casting approach is too luxurious for Japan to take. Unlike Germany, Japan cannot import zero-carbon electricity from neighboring countries, even if it cannot achieve its target.

Another notable difference is that Japan tends to put a particular emphasis on mitigating CO_2 emissions through technology transfer and on innovation, having an impact beyond the national border. Germany seems to primarily focus on domestic production-based CO_2 emissions. While it is not a question of which is better or worse, these differences in addressing long-term mitigation should be duly recognized when comparing German and Japanese targets.

Japanese Council members have some reservation as to whether the Energiewende will be as successful as it is often claimed. Germany has undoubtedly marked a great success in expanding the share of RES-E, together with cost reductions. On the other hand, the expansion of the domestic grid for sending wind power from the northern region to the southern industrial center is lagging behind due to local opposition. Germany has not succeeded in reducing CO_2 emissions as expected despite massive the expansion of RES-E since 2000. This is due to the nuclear phase-out and the slow reduction of coal/lignite power generation, coupled with the low level of the EU-ETS price. Phasing out of coal-fired plants is a politically contentious issue, which is one of the reasons for the abortive coalition talks between the CDU/CSU, the FDP and the Green party. Reportedly, Germany has given up its 2020 target for GHG emissions reductions. The Japanese Council members sense that Germany has given greater priority to the nuclear phase-out than the reduction of CO_2 emissions.

Japanese Council members are not fully convinced by the cost-effectiveness of the Energiewende. Soaring FIT surcharges have made the German household electricity price among the highest in the world. While energy intensive industries exposed to international competition are exempted from FIT surcharges, an additional burden is placed on SMEs and households. The German Chamber of Commerce (DIHK) has pointedly criticized the heavy burden of the FIT surcharges. Dusseldorf Institute of Competitive Economics (DICE)[10] estimates that the total cost of the Energiewende could reach € 520 billion by 2025, of which € 408 billion comes from EEG related subsidies, and that the cumulated (2010–2025) additional cost burden for an average family of four people could surpass € 25,000, which is almost par with average saving. The German Federal Court of Auditors also criticizes the government for failing to provide of a clear overview of the costs of the Energiewende in its report in January 2017. While Japan should have carefully leant lessons from European experiences, including those in Germany, Spain and UK in designing its own FIT system, it introduced a far more generous system, which is causing a soaring FIT surcharge burden. While German household consumers are more receptive to the power rate increase, Japanese consumers are less willing to shoulder the burden for industries. That is why industries need to assume a heavier share of the burden of the energy transition than their German counterparts.

All in all, Japanese Council members find the exchange of views, experience, and expertise between Germany and Japan immensely valuable. However, this does not mean that the German experience and approach should be replicated in Japan, or vice versa. Since their respective energy and climate policies should reflect their specific national circumstances, their cooperation should be focused on areas of common interests.

About three hundred years ago, Berkley asked "Whether the imitating those neighbors in our fashions, to whom we bear no likeness in our circumstances, be not one cause of distress to this nation?" (George Berkley, The Querist, 1735).

10 DICE Consult GmbH (2016): Kosten der Energiewende. Untersuchung der Energiewendekosten im Bereich der Stromerzeugung in den Jahren 2000 bis 2025 in Deutschland. Available at: http://www.insm.de/insm/Themen/Soziale-Marktwirtschaft/Gesamtkosten-Energiewende.html.

4.2 COMMENTS BY THE GERMAN COUNCIL MEMBERS[11]

THE MUTUAL COMMENTS IN THIS CHAPTER HIGHLIGHT THE TOPICS ON WHICH THERE ARE COMMON BUT ALSO DIFFERENT VIEWS BETWEEN THE JAPANESE AND GERMAN COUNCIL MEMBERS: IMPROVING ENERGY EFFICIENCY, INCREASING THE SHARE OF RENEWABLE ENERGIES, RESTRUCTURING, AND FULLY OPENING ENERGY MARKETS, AS WELL AS PROMOTING BENEFICIAL LOCAL RENEWABLE ENERGY SUPPLY AND CITIZEN PARTICIPATION ARE ELEMENTS OF A SUSTAINABLE ENERGY TRANSITION THAT BOTH GERMAN AND JAPANESE COUNCIL MEMBERS SUPPORT (CF. ALSO CHAPTER 3).

However, the long-term visions of feasible energy systems would still appear to differ substantially: All German Council members conclude from increasing scientific evidence that a full or nearly full decarbonization (i.e., 80 to 100%) of the energy system will be feasible based on energy efficiency and renewable energy supply, including the integration of the power, heat, and transport sectors, with all kinds of storage and flexibility options and with possible long-term technologies for the carbon-neutral production of H2 and/or synfuels, or CCS/CCU for some industrial processes. As confirmed by the recent study by BCG[12] for the German Federation of Industries (BDI), at least 80% of carbon reduction up to 2050 is, under feasible conditions, likely to be cheaper from a macroeconomic perspective and to enable "better growth" than conventional energy systems. Avoiding high external costs and generating numerous co-benefits of decarbonization and risk minimization must also be added. This will require substantial investment but it will also spur innovation and technology leadership.

In contrast to this, the Japanese Council members are apparently not convinced that decarbonization by 80% or more is feasible or affordable in Japan without nuclear energy, and that in the long run nuclear fusion or space photovoltaics may even be needed. Particularly for the situation in Japan, the current and expected higher costs of variable renewable energies and their system integration, Japan's island nature, and the need to protect industry and consumers from increasing energy prices are mentioned as major challenges in that respect. They see Japan as locked in an 'Energy quadlemma', as presented in the GJETC input paper by Jun Arima: Decarbonization and security of supply (low energy imports) could either be achieved at high costs and energy prices (renewables) or high risk (nuclear); so there seems to be no currently feasible solution for achieving all '3E+S' goals simultaneously.

In this chapter, the German members present collected evidence that both countries have a real chance of achieving the '3E+S' goals together, i.e. decarbonization and security of supply in an affordable new energy system, without the need for nuclear energy.

4.2.1 THE STATUS AND PERSPECTIVES OF THE ENERGY TRANSITION IN GERMANY

BROAD CONSENSUS ON TARGETS, MULTIPLE BENEFITS, AND IMPLEMENTATION OPTIONS

The German targets and strategies are not simply based on a "back-casting approach with inflex-

11 Chapter 4.2 was partly written and expanded after the statement of the Japanese experts in Chapter 4.1 was delivered. This timeline explains the larger scope. Due to the tight timeframe for completing the report, it was unfortunately not possible for the Japanese experts to review Chapter 4.1 again. However, it is planned to continue this dialogical format in the second phase of the GJETC.

12 Boston Consulting Group and Prognos (2018): Klimapfade für Deutschland; available at http://image-src.bcg.com/Images/Klimapfade-fuer-Deutschland_tcm108-181947.pdf (English: https://www.bcg.com/de-de/publications/2018/climate-paths-for-germany-english.aspx).

ible process management". Numerous and very detailed studies of the technologies, potentials, costs and benefits, and the policies necessary to achieve the energy transition and the overarching climate protection target of reducing GHG emissions by 80 to 95 % by 2050 have created a consensus among the majority of scientists, policy makers, and the public that:

(1) this climate change target can be met through a transformed energy and transport system based on energy efficiency and renewable energies without nuclear energy, possibly with some CCUS for industrial processes (cf. Table 1 on ST 1 above), and that

(2) the total system costs will probably become lower than those of the reference scenario before 2050 (possibly before 2040). In the case of 80 % decarbonization, under certain conditions this is also a finding of the Boston Consulting Group and Prognos (2018) study for the BDI, based on a bottom-up process involving 200 experts and 70 companies. Insofar, it is much more comprehensive and robust in its results than the DICE study cited in Chapter 4.1, which only estimates total 'costs' of the Energiewende, which are in fact investments that yield many benefits, and omits these direct benefits as well as all other macroeconomic and environmental benefits. As a shortcoming, both studies fail to include avoided external costs of climate change and possible nuclear accidents. The multiple co-benefits of climate change mitigation strategies are not included either (cf. https://combi-project.eu/).

Therefore, in Germany, the combination of energy efficiency and renewable energies is expected to **enable and, at the same time, meet all 3E+S basic energy and climate policy objectives** – energy security (as they are predominantly domestic sources), economic efficiency, and environmental protection – while avoiding the risks of nuclear energy. Although it is not clear in every detail today how, for example, the electricity system stability will be maintained a few decades from now with close to 100 % variable renewable energies, the current analysis shows that in principle there are ample opportunities. Recent experiences in the northern part of Germany, which currently has the highest share of variable power, have improved confidence that system stability can be achieved with a much higher share of variable renewables than today. The question for further RD&D in Germany is, therefore, not whether system stability is feasible but mainly what is the most cost-effective technology mix for generation and grid integration, storage, and flexibility in order to maintain system stability in the future, and what policy framework is needed to support the emergence of this mix.

This broad expert consensus on strategic targets, their multiple benefits, and feasible implementation options has allowed the government to adopt ambitious targets for GHG emissions, energy efficiency, and renewable energies for 2020, 2050, and the interim period.

ACHIEVEMENTS OF THE CURRENT ENERGY TRANSITION AND CRITICAL REMARKS

Regarding achievements to date, due to the German feed-in law, the EEG, the rapid market deployment of PV and wind has contributed to a tremendous global learning effect, cost degression, and an unexpectedly rapid increase in the share of green electricity. The stepwise and strategic nuclear phase-out is on its way; the new German government's target to achieve a 65 % share for RES-E by 2030 is a good step in the right direction. To this extent, the German "electricity transition" is perceived by most experts as a success and is also supported by a stable majority of the German population.

But despite these strong efforts, the level and success of the energy transition varies by sector. Even stronger, reliable policies and new governance structures are needed to harness the potentials and steer the transition processes. The German Council members are convinced that the energy transition can still achieve its targets for 2030 and 2050 but it urgently needs to meet the following **challenges**:

- The exigent need for a proactive, medium-term, and socially accepted coal exit strategy, overcoming the delays and meeting the needs for proactive and strategic actions concerning an environmentally and socially benign phase-out of coal.

- Widening the scope from the one-sided focus on the electricity system transition.

- The need for decisive action in transforming the transport sector towards decarbonized sustainable mobility.

- Overcoming the implementation deficits regarding the cost-effective energy saving targets in all sectors, and raising the level of ambition as well as strengthening the governance structure in implementing the principle of "Energy Efficiency First" e. g. regarding deep renovation of buildings or cross-cutting technologies in SMEs and industry.

- Better communication, coordination, and management in the implementation of the energy transition.

- The re-acceleration of the expansion of RES-E generation following recent delays.

- Triggering the necessary infrastructure adjustments with sufficient lead times e. g. electricity networks as well as heat and gas networks, and infrastructure for flexibility and sector integration

- Finding alternative solutions to the far-reaching privilege enjoyed by too many industrial en terprises regarding the exemptions from the EEG levy at the expense of households and SMEs and from energy taxes.
- Development of long-term strategies and technology innovations enabling the energy intensive industries to transform, diversify, and decarbonize in time.
- The failure not to increase energy, fuel, or CO_2 taxation and ETS certificate prices even during the recent phase of lower oil and gas market prices; carbon pricing mechanisms in particular are inconsistent and inappropriate; a carbon floor price for EU ETS and more harmonized approaches to taxation, levies, duties, and surcharges should be established.
- Development of a coherent and effective market support system for investments in flexibility options.
- Answering the open questions regarding an appropriate attribution of innovation needs to the different phases of the energy transition.
- Changing the hesitant attitude to supporting decentralized actors and decentralized network infrastructures (smart grids).
- Providing better support for public participation and citizen-funded investment.

These bullet points are neither exhaustive nor systematically prioritized, but should serve as a signal of trust that a fruitful German – Japanese cooperation should always imply a critical research dialogue between independent scientists.

4.2.2 THE STATUS AND PERSPECTIVES OF THE ENERGY TRANSITION IN JAPAN

In Japan, there have been strong policy efforts too, e.g. for energy efficiency and promoting renewable energies (especially PV). But the debate is still ongoing in Japan as to what is the best energy and technology mix to reconcile the 3E+S objectives. Japan also struggles with the decision regarding the level at which to set long-term (2050) CO_2 reduction, energy efficiency, and renewables goals, and whether to revise the 2030 energy mix targets.

Therefore, the following comments focus on the achievability of targets and on the strategies needed.

ENERGY-POOR OR ENERGY-RICH?

With the background of the German Energiewende experience, the following basic question seems crucial for a fully decarbonizing und risk-minimizing energy transition in Japan: Is Japan an "energy-poor" or an "energy-rich country"? The Japanese Co-Chair, Masakazu Toyoda, has provided comprehensive argumentation for Japan being an "energy-poor country" (Toyoda 2017)[13]: Due to its insularity and precarious national resources of fossil fuels and affordable renewable energy, a long-term, complete decarbonization may only be possible if nuclear energy risks are permanently accepted as a "necessary evil", even if CCS, CCU, and international carbon offsets are considered as further decarbonization options.

Based on this assessment, the target set for a rising, but ultimately limited share of renewable energy of about 22 % in the official Japanese energy mix of 2030, is understandable.

13 (Toyoda, Masakazu (2017): The challenge of energy-poor Japan. In: Energy Market Authority of Singapore (2017): Singapore International Energy Week 2017: Rethinking Energy; Navigating Change. 10 Global Insights. pp. 42–47).

But what if another severe nuclear accident at any of the aging nuclear power plants in Japan and around the world put Japan's energy supply at risk of a sudden shut-down of all nuclear power plants again due to public pressure, as was experienced in Germany? This could result in a dangerous blow to the Japanese economy and to societal coherence.

And does abandoning nuclear power not imply economic opportunities too? After the irreversible political decision on a finite date for nuclear phase-out in Germany, a strong signal and robust framework conditions for fostering innovation and investing in low-risk, low-carbon technologies were offered to all stakeholders, especially to German industry. Opinions have changed tremendously: While in the 1990s, the German energy industry, a large section of the political sphere, and the public held true that, as an 'axiom' of energy policy, renewable energies could only play an "additive role" together with coal and nuclear (Berlo/Wagner 2015)[14]. Today, German industry supports the Energiewende[15] under the condition that a favorable and fair level playing field is guaranteed to protect international competitiveness, and the renewable energy share of gross electricity consumption was at c. 36 % in 2017, with a rising tendency.

At the same time, the stability of the German electricity supply, as measured by the SAIDI index[16], actually increased, because the grid had to be considerably strengthened to accommodate such a large fraction of variable power.

Numerous scenarios have demonstrated that even a 100 % renewable energy sector is still technically feasible for Germany, though the uncertainties increase in relation to the costs of exceeding 80 %. According to all long-term scenarios for the decarbonization of Germany and Europe by 2050/2060, no need for new nuclear, fusion, or space solar power has been identified. In addition, they lack market readiness, and their risks, costs, and system integration are highly uncertain.

DOMESTIC POTENTIAL OF RENEWABLE ENERGY SOURCES – IS JAPAN "ENERGY-RICH"?

If Japan exploited its extensive technical potential for PV, wind, geothermal energy, and biomass, could it not instead be evaluated as an "energy-rich country" (Thomas Kåberger 2015)? "Energy-rich" in the sense that, by simultaneously harnessing existing considerable energy savings potentials (e. g. in buildings), the security of supply and economic competitiveness could be guaranteed. Furthermore, a final abandonment of nuclear energy and fossil fuels, and ambitious long-term CO_2 reduction targets similar to Germany (80–95 % in 2050) could still be achieved. Scenarios by Kainuma, M. et al (2015[17]) or Kuramochi, T. et al (2015[18]) show that, in principle, such a risk-minimizing long-term strategy is also possible in Japan.

Thus, we encourage Japan to perform a critical analysis of potentials for PV and wind energy (e. g. in Hokkaido and Tohoku) as a precondition for determining future energy mixes and not – as would seem to be the case – as a consequence of politically decided targets for 2030. Though (floating) offshore wind would probably be a more expensive option for Japan than in Europe, it could create an interesting competitive edge for Japanese technology in regard to comparable deep ocean conditions in other regions.

"The larger space necessary for mega solar" sites may indeed be a problem of public acceptance and land use in densely populated countries. This is exactly the reason why, in Germany, most solar PV is installed on roofs (private, commercial, and farm buildings) to save scarce land space. By the end of 2017, these were app. 1.6 million rooftop PV systems[19] with a nominal power of 43 GW. Many German cities developed and published a solar cadaster of roofs suitable for solar PV. A new, emerging option that might be especially interesting for Japan is agro-photovoltaics, i. e. harvesting solar energy from agricultural areas that can afford a 30 % reduction in solar irradiance due to the partial shading of solar modules over the fields.

14 Berlo, Wagner (2015): Strukturkonservierende Regime-Elemente der Stromwirtschaft als Hemmnis einer kommunal getragenen Energiewende Eine Akteursanalyse aus der Multi-Level-Perspektive der Transitionsforschung. In: Momentum quaterly. Zeitschrift für sozialen Fortschritt. Vol. 4, No.4.

15 See for example Boston Consulting Group and Prognos (2018): Klimapfade für Deutschland; available at http://image-src.bcg.com/Images/Klimapfade-fuer-Deutschland_tcm108-181947.pdf (English: https://www.bcg.com/de-de/publications/2018/climate-paths-for-germany-english.aspx).

16 Cf. https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Versorgungsunterbrechungen/Auswertung_Strom/Versorgungsunterbrech_Strom_node.html.

17 Kainuma, M. et al. (2015). Pathways to deep decarbonization in Japan, SDSN - IDDRI. Available at: http://deepdecarbonization.org/wp-content/uploads/2015/09/DDPP_JPN.pdf.

18 Kuramochi et al (2015): Comparative assessment of GHG mitigation scenarios for Japan in 2030. IGES Working Paper, May 2015. Available at: http://www.wri.org/sites/default/files/uploads/IGES-OCN_2030scenarios_Final3.pdf.

19 Fraunhofer ISE: Aktuelle Fakten zur Photovoltaik in Deutschland (version 21.02.2018) Available at: https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/aktuelle-fakten-zur-photovoltaik-in-deutschland.pdf.

COSTS OF RENEWABLE ENERGIES AND PRIORITY FEED-IN

Regarding renewable energies, driving down generation and system integration costs certainly is key. If successful, this change, together with energy efficiency, **could solve Japan's 'Energy quadlemma'**. Several input papers by the German GJETC members (available at www.gjetc.org) provide further evidence that this may be a realistic future development. They concern the relatively low 'Integration costs of variable renewable power sources' (PV/Wind; Graichen et al. 2018), the opportunities of sector coupling (currently mostly through co- and tri-generation, Leprich et al. 2017), the promising potentials and cost-effectiveness of energy efficiency (notably for buildings and cross-cutting technologies; Thomas/Hennicke 2017) and the high and non-competitive costs of new nuclear power plants in Europe (Kemfert et al. 2018).

When aiming to reduce the costs of renewable energies, the feed-in-tariff (FIT) scheme may not be the problem, but rather the solution for some time, as it provides investor security and helps to drive down costs. However, this requires combining the FIT with the right to priority feed-in and grid connection at no cost to the generator, as is the law in Germany. Grid owners are obliged to take up variable electricity and to distribute the incremental costs to all non-privileged customers[20]. This also opened the market to a broad variety of suppliers of renewable electricity, reduced the market power of the traditional dominant power companies using coal or nuclear, and fostered innovation and cost degression of PV and wind power. This scheme worked successfully, so that as a next step auctions became possible. What remains to be done is to find an improved allocation of the costs, and finally to establish a fully competitive, level playing field.

The situation in Japan seems to be quite different. After the introduction of the feed-in law in Japan in 2012 with very attractive remuneration for PV, the certified power capacity increased very rapidly to 144 TWh/yr (September 2016). However, due to long-term contracts ("planned transmission"), lacking grid extensions, and the prevailing dispatch order, "nuclear has priority over solar and wind power generation"[21]. The ten regional electric power companies can set caps for the generation capacities of solar and wind power. This blocks dynamics for modernizing and cost degressions in the electricity sector. A strategic decision would appear to be necessary: unlocking innovations and investments for the national energy transition and global lead markets in energy efficiency and renewables.

20 About 2000 energy intensive companies will be exempted from the EEG surcharge (6,8 cts/kWh) in 2018. The total amount of the exemptions adds up to about 6.5 billion Euros, which are distributed to all other customers.

21 T. Wakiyama/A.Kuriyama, Assessment of renewable energy expansion potential and its implication on reforming Japan`s electricity system, Energy Policy, 115 (2018) 302-316.

THE ROLE OF DECENTRALIZED ENERGY SUPPLY

Today, more than 1,000 municipally-owned utilities exist in Germany. But we also recognize a high level of interest in Japan in developing new, decentralized, and municipally-owned energy companies[22]. These are rooted in their city and region and are thus highly motivated and provide good conditions to advance decentralized energy efficiency and renewable energy investments. Favorable framework conditions would certainly increase the number of municipal utilities.

ENERGY PRICES

We also recognize that high energy prices can increase problems of competitiveness for energy intensive industries. Therefore, in Germany, many companies are exempted from the cost sharing mechanism of the EEG (cf. Chapter 4.2.1). In addition, it is not the prices but rather the energy costs per unit of production that matter, so energy efficiency can counterbalance high costs. The study program found that, even though energy prices for Japanese industry may be higher than for German industry, the energy consumption per unit of value added was also higher in Japan. Although we need to better understand this, it may indicate that the energy efficiency potential is still high in Japan's industry sectors too. The electricity prices for German households are indeed much higher than in Japan. Nevertheless, due to lower average use of electricity (Germany: 3,362 kWh/yr; Japan: 5,373 kWh/yr; 2015), the electricity bills are comparable in both countries.

ECONOMIC OPPORTUNITIES

We acknowledge differences in economic conditions between Japan and Germany (GDP growth, investment rate (though this has declined and is low in Germany too), the Euro zone, underemployment, and public debt). However, in our opinion, these differences are neither a reason to postpone ambitious decarbonization targets nor to not phase out nuclear if possible and supported by the public. The opposite seems to be true: The energy transition is a paramount future investment program for ecological modernization, creating new business fields, additional employment, opportunities for the revitalization of the countryside, more resilience against disaster, and higher competitiveness on global "core markets" (see GreenTech made in Germany[23]).

The main difference "in economic conditions" does not appear to be any of those mentioned above, but rather the strikingly different Japanese and German perception of the global economic opportunities of climate and resource protection (e.g. technologies, processes, products). These opportunities for Germany are well documented in the new BCG study[24] analyzing and explaining in detail why German Industry supports the Energiewende, at least under specific conditions: An **"80 percent GHG reduction"** is technically feasible and macro-economically viable in the considered scenarios. A key argument is increased competitiveness: "Successful efforts to tackle climate change would trigger extensive modernization activities in all sectors of the German economy and could furthermore open opportunities to German exporters in growing 'clean technology' markets. Studies suggest that the global market volume of key climate technologies will grow to € 1 trillion to € 2 trillion per year by 2030. German companies can solidify their technological posi-

22 ICLEI 2017 in Nagano http://www.iclei.org/details/article/local-renewables-conference-2017.html ; Foundation of the Japanese Stadtwerke Network (JSWNW) in September 2017 http://www.jswnw.jp/.

23 BMUB/Roland Berger (2014): GreenTech made in Germany 4.0. Umwelttechnologie-Atlas für Deutschland. Available at: http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/greentech_atlas_4_0_bf.pdf.

24 Boston Consulting Group & Prognos (2018): Climate Paths for Germany; cf. previous footnote.

tion in these global growth markets" (Boston Consulting Group and Prognos 2018).

Why should the same opportunities not exist for Japan's exporting industries and their competitiveness on global markets for climate technologies? Evaluating numerous global and national long-term scenarios for climate change mitigation, it is quite evident that energy efficiency and renewable energies can be expected to take the lion's share of promising markets for global climate technologies. By contrast, even with an extremely optimistic perspective, the global market for nuclear energy technologies, including the most advanced ones, is marginal in comparison to the lead markets for efficiency and renewables[25].

ENERGY MIX 2030 – IS IT REALISTIC?

The Japanese members seem to reaffirm that there is seemingly no alternative to the 'Energy Mix 2030'. But the German Council members do have some questions:

- Referring to the current status of restarted nuclear power plants, it seems highly uncertain whether and how a nuclear share of 22 % can be reached by 2030. "Explaining the crucial role of nuclear" might not be convincing enough for the public. How many new nuclear power plants and/or extensions of lifetime will be needed to achieve a 22 % nuclear share? What about public acceptance, monetized risks, higher construction costs, and additional nuclear waste? Is there a "Plan B" if the 22 % share proves to be unrealistic? If additional coal power plants are taken into consideration, what about lock-in effects and not achieving a decarbonized energy sector in the long term?

- "Finding solutions to the issue of final disposal of spent fuel and radioactive waste" is also a key question for both countries. But do the solutions not differ enormously depending on whether "we are to stay with the nuclear option or not"? The quantity of fuel and waste and the costs of final disposal will depend on the total amount of electricity generated from nuclear energy. In Germany, it was only possible to gain more public acceptance of the search of a final disposal site after the government made a final decision on the specific year of nuclear phase-out (2022).

THE ROLE OF BACK-CASTING APPROACHES

Japan, too, would benefit from a well-performed back-casting exercise. The critical statement in Chapter 4.1 against back-casting approaches confuses modeling outcomes (feasibility of decarbonization in Germany vs. the islands of Japan) with the method. Regarding the method, it should be clarified that 1), according to the Paris Agreement, without a back-casting approach the feasibility and economic implications of long-term ambitious CO_2 reduction targets of any country can hardly be calculated. 2), scenario-based policy consultancy in Germany (mostly based on back-casting approaches) takes continuous monitoring and steering flexibility as self-evident. "Responding to scientific, economic, and technological uncertainties as well as the international situation" is an inherent part of regularly updated back-casting approaches. 3), fixing targets for 2030 without modeling the further future up to 2050 poses a high risks of lock-in to technologies that will inhibit cost-effective decarbonization later.

INSPIRATION FROM OTHER COUNTRIES

In addition, **learning from the technical and social innovations of other countries** should be activated. The German GJETC experts point to some selected country experiences, which nobody would have thought possible 20 years ago. Due to the worldwide dramatic cost reduction in power generation (PV/ wind) and storage technologies, and greater adherence to the "Efficiency First" (IEA) principle, drawing on a new diversity of experiences from other countries will increasingly become possible.

25 BMUB/Roland Berger (2014), cf. previous footnote.

- **Denmark** intends to reach 100 percent renewable electricity by 2035, and to be completely free of fossil fuels by 2050. The share of renewable electricity rose to more than 50% in 2016, enabled also by the Danish energy companies (electricity, gas, district heat) saving their customers more than 2% of energy each year un der their Energy Efficiency Obligation Scheme.

- **Taiwan** decided on a nuclear phase-out program until 2025 and ambitious targets for PV and wind power that will be strongly expanded to substitute nuclear power (PV capacity rising from 1.3 GW in 2016 to 20 GW by 2025, and wind power capacity from 755 MW to 4.2 GW). The country is as much concerned with the business and export prospects of green industry as with reducing carbon emissions.

- The **UK** has committed to a program that will phase out coal from all electricity generation by 2025, **Canada** will do so by 2030. Both countries are urging others to put a stop to coal-powered energy generation.

- **China** is responsible for over 40% of global renewable capacity growth (2016), which is largely driven by concerns about air pollution and capacity targets up to 2020. With 112 GW online, China has already surpassed its 2020 solar PV target, and the IEA expects China to reach a cumulative installed wind capacity of about 264 GW by 2020. In addition, the country announced plans to cancel more than 100 coal plants under development, which would have generated about 120 GW of electricity capacity. China is also the world market leader in hydropower, bioenergy for electricity and heat, and electric vehicles.

These and other national energy transitions around the world provide increasing evidence that fully decarbonized and low-risk energy systems may be achievable in all countries, including not only Germany but also Japan, by around the middle of this century. Of course, national circumstances need to be taken into account, and the specific paths and resulting energy mixes will differ.

Regarding national circumstances, we fully recognize “stark differences” (Chapter 4.1) between Japan and Germany with regard to geographical (Island status) and natural conditions; but all other conditions can be influenced and changed in principle by policy makers, based on public support. Under favorable conditions, even cooperation with neighboring countries to build a ‘super grid[26]’ would not appear to be out of the question in the long term. The same holds true for a core decision to establish a full-fledged high-voltage transportation grid – a problem that Germany is also working to solve – and to adapt the frequency between East and West Japan. In addition, Japan (and Germany) may be able to produce synthetic hydrogen or fuels from PV or wind power that exceed demand, or to import these from diversified sources of certified carbon-neutral production at affordable costs in the long run. Although energy is a strategic good, so both energy security and national economy considerations provide a rationale to reduce energy import dependency, why a nation should seek full autarchy in energy supply seems questionable. In a world economy based on free trade, there will be room to trade carbon-neutral fuels and electricity, if this is cost-efficient and supply can be expected to be secure.

In light of this dialogue, but also of what are still debatable arguments and possible misunderstandings, the German Council members believe that continuing the exchange with their Japanese colleagues in the GJETC will be of great value. We have now gained a much better mutual understanding of the background, opportunities, and challenges of a sustainable energy transition in both countries. This can be used to learn from each other, and also for the joint analysis and development of solutions relevant to both countries and beyond.

26 Asia International Grid Connection Study Group ; Interim Report April 2017. Available at: https://www.renewable-ei.org/en/activities/reports/img/20170419/ASGInterimReport_170419_Web_en.pdf.

FURTHER RESEARCH NEEDS

5

Both the joint recommendations in Chapter 3 and the mutual critical comment on development in the respective partner country, as well as the self-critical view of their own country's energy transition in Chapter 4, revealed large and promising fields for further research and joint cooperation. It would undoubtedly be in the common interest of both countries to extend the cooperation and to close the knowledge gaps.

An important task of the GJETC and the four strategic studies was to analyze these gaps in depth. The GJETC offers its recommendations for further research, categorized under the same four topics as in Chapter 3. The detailed recommendations can be found in **Appendix 7** (available as a separate pdf on www.gjetc.org). In this Chapter 5, these recommendations are only summarized under headlines and bullet points.

5.1 HOW TO SET AND MEET ENERGY TRANSITION TARGETS/ GOALS AND STRATEGIES?

IN GENERAL, THE GLOBAL AND GEOSTRATEGIC CONTEXT OF DOMESTIC ENERGY TRANSITION STRATEGIES IN GERMANY AND JAPAN SHOULD BE ANALYZED IN MORE DETAIL, BECAUSE THIS INTERNATIONAL CONTEXT HAS BEEN MOSTLY EXCLUDED FROM NATIONAL ENERGY SCENARIOS.

A concept of "transformation" is introduced below to emphasize social and structural characters of the necessary energy transition.

(1) Scenario development and modeling: Best available knowledge on worldwide predictive tools is a crucial prerequisite of research-based long-term policy-making. Future uncertainties cannot be avoided, but can be anticipated to a certain degree within a range of possible alternative strategies. Thus further research is recommended in the field of scenario development.

(2) Long-term energy system transformation: More and extended research is needed to answer open questions in regard to the techno-economic and socio-cultural drivers and effects of the long-term energy transitions, for example, how to justify and meet targets, how to quantify cost developments, and how the energy system transformation is embedded into future industrial and ecological policies and structural change.

(3) Macroeconomic implications of a long-term energy system transformation: There is little analysis available[27] for either Germany or Japan on macroeconomic impacts, and the data are often difficult to compare. A detailed and transparent analysis of macroeconomic implications and of the induced economic structural and sectoral change should be conducted.

(4) The benefits of cooperation and "beyond the border" GHG emissions reduction: There is little analysis as to how the export of low-carbon technologies/products can be incentivized and how foreign trade contributes to domestic and global GHG emissions reduction, to sustainable development, and "better growth" in the partner countries. Quantitative analysis of some key technologies (i.e., energy-efficient production processes, high efficiency thermal technologies, RE technologies) should be conducted.

(5) Long-term innovation: The ultimate solution to the global climate problem lies in the development and dissemination of innovative energy and environmental technologies and social practices. Both possessing enormous technology bases, Germany and Japan are expected to play a vital role as frontrunners for climate mitigation. They should cooperate on the conceptualization of long-term innovation strategies, policies, and measures for implementing them, and identify areas for technology partnership. It is crucial to ensure and maintain the competitiveness of Germany and Japan in key technologies. Long-term technological as well as social and institutional innovations are crucial for the transformation of the energy system.

(6) Implications for long-term strategies and foundations of a robust policy mix: The scenario modeling should pay more attention to the inertia of the energy transformation as well as to the implications of the different phases of the transformation process.

(7) Monitoring: Energy and climate policies in the 21st century have a strong quantitative dimension and far-reaching implications. Thus, comprehensive and accountable monitoring processes are crucial elements for evaluating and improving targets/goals, progress towards these targets/goals, related strategies, and the policy mix, as well as assessing implications. The approaches and methodologies for such comprehensive monitoring and evaluation processes need a better scientific foundation, e.g. with respect to assumptions regarding scenario analysis, the involvement of policy makers, and the participation of stakeholders.

27 Just recently published: BDI-Handlungsempfehlungen zur Studie „Klimapfade für Deutschland".

5.2 IMPROVING PARTICIPATION AND DIALOGUE FOR THE ENERGY TRANSITION

THE ENERGY TRANSITION PROCESSES BRING UP NEW FORMS OF GOVERNANCE, FORCED ECONOMIC STRUCTURAL CHANGE, THE REPLACEMENT OF "BROWN" INDUSTRIES BY "GREEN" INDUSTRIES, CHANGES IN BUSINESS FIELDS AND JOBS, OR MEASURES WITH UNEQUAL DISTRIBUTIONAL EFFECTS ON REGIONS AND CITIZENS.

A shared vision of the direction and implications of change and an understanding of concrete steps is a crucial condition for a societal transition and corresponding behavioral change.

(1) Overall visions of Germany and Japan for the future energy system: The overall societal visions ("narratives") of the energy transition in both countries need to be better understood.

(2) Identification of and dealing with socio-economic, sectoral, and regional implications of difficult choices in the course of energy transformation: Energy transformation driven by policy and/or technology innovations will inevitably have various socio-economic sectoral and regional implications (e.g. jobs) in the parts of the energy and transport system that could face fundamental structural changes. Different countries might face these challenges with different intensities and at different times. However, this deserves in-depth analysis of the experiences in these areas and the kinds of processes that would be necessary for societies to cope with the associated difficult choices in advance.

(3) Intensified societal dialogues on the energy transition including all relevant stakeholder groups: There is consensus that stakeholder dialogues should clarify societal issues regarding future visions and alternative concepts. But research is needed on proven, effective concrete concepts and the possible impacts of such dialogues.

(4) Socio-cultural preconditions: Many further concrete socio-cultural preconditions for implementing an energy transition have not been analyzed in depth, e.g. aging and shrinking populations, regional depopulation, migration or strategies to increase acceptance of huge onshore wind and large PV expansions in both countries.

(5) Comparative study of the governance structures and approaches as they pertain to the energy transformations of Japan and Germany and to consider cross-societal learning potential: This would include an examination of both innovative examples and problem areas.

5.3 ENERGY (END USE) EFFICIENCY AND SAVINGS

FOR ENERGY EFFICIENCY AND ENERGY-SAVING POLICIES, POTENTIALS, BARRIERS, COSTS, MULTIPLE BENEFITS, POLICIES, DAILY ROUTINES AND PRACTICES, THERE ARE MANY OPEN RESEARCH ISSUES AND QUESTIONS THAT HAVE TO BE ANALYZED IN MORE DEPTH. THEY ALSO PROVIDE AMPLE OPPORTUNITY FOR MUTUAL LEARNING BETWEEN JAPAN AND GERMANY.

(1) The "Efficiency first" principle: The principle needs to be clarified with regard to potentials, barriers, business opportunities, costs, and multiple benefits. In particular, what further development and implementation of technologies and policies/policy packages will be needed to make this priority happen should be analyzed.

(2) Energy efficiency potentials: Further research is needed on energy efficiency potentials and cost-effectiveness in all sectors in order to allow for a more detailed comparison and implementation strategy in both countries. This analysis should identify and quantify the multiple benefits of energy efficiency. An examination of the German Nearly-Zero- or Plus-Energy Standard and Japanese Zero-Energy houses or buildings should be conducted to understand differences, maximize savings at minimal costs, and inform development of policies.

(3) Energy efficiency policy packages: Comparative research on different energy efficiency instruments and measures should be conducted, focusing primarily on standards for appliances, buildings, vehicles, and processes, as well as on strategic packages for target group-specific policies. This research should help to understand differences in design, results, costs, benefits, and how to minimize rebound effects.

(4) Mobility and transport: Decarbonization of the mobility sector also includes research on the integration of sector coupling, as well as energy efficiency and sufficiency potentials and policies. In addition, research is needed to better understand what Germany could learn from Japan in regard to energy efficiency and the respective transport system policies.

(5) Energy savings and sufficiency: There is no comparable knowledge as yet on how energy-sufficient practices may contribute to both countries' energy transition targets, and which enabling conditions can be used to promote changes in practices.

(6) Energy service markets: A better understanding of the differences in energy service markets is needed in order to learn how to increase new and existing business models.

(7) Energy policy and energy prices: The impact of energy policies on energy prices in both countries needs to be better understood. This comprises analysis of CO_2 or energy taxes as well as possible counterproductive subsidies.

5.4 ENERGY SUPPLY AND ELECTRICITY MARKET DESIGN

MANY RESEARCH NEEDS AND QUESTIONS HAVE BEEN IDENTIFIED REGARDING THE DESIGN OF THE ELECTRICITY MARKET IN PARTICULAR, INCLUDING THE FOLLOWING:

(1) Integration of variable renewable electricity (wind, PV): The technological and economic drivers of the expected further cost degression of renewable electricity (wind, PV) and its system integration with a rapidly growing share (sector coupling, flexibility options, integration costs) require research.

(2) Instrument design for financing renewable energies: Both countries should examine the current scheme to distribute and refinance the FIT surcharge. The increase in surcharges is often due to old installations or exemptions for large industrial consumers.

(3) Combined heat/cold and power production (co-/tri-generation): A comparative analysis of potentials, fuels, costs, and energy needs for systems (including storage) of combined heat/cold and power production for individual facilities or district heating/cooling networks as a strategic component of the energy transition should be conducted.

(4) Incentives for the various flexibility options: The incentives and implications of different market designs, for example such as an energy-only-market and various forms of capacity mechanisms, should be assessed and comparatively analyzed in the German and Japanese settings.

(5) Business models and perspectives: The business perspectives for traditional and new electricity suppliers, energy service companies, and other actors, and possible side effects of the energy transition (e.g. stranded assets) have not been sufficiently analyzed and published up to now, although they are a strategic factor for the success or failure of the energy transition.

(6) Developing markets for energy services to foster competition and promote technological and social innovations between suppliers e. g. energy service companies (ESCOS) and users of efficient technologies.

(7) Working on a target model for a future market design and the interim transitional steps toward such a market design: In the long run, creating a sustainable economic basis for the future energy system cannot be based on an increasing number of mechanisms that are increasingly difficult to harmonize and hold consistent. Joint efforts to compare the different concepts of such a target model in very different jurisdictions, political cultures and progress in the transformation process could add significant value to the emerging debates on the future market design, even beyond the two countries.

(8) Economic barriers to sector coupling/distribution of taxes and levies: Analysis is needed on a potential new distribution of taxes and levies that accommodates various goals, such as increasing flexibility and meeting emission reduction needs, including through energy end-use efficiency, and distributional issues.

(9) Understanding the challenges and probable costs of the nuclear fuel cycle: The comparison of long-term management, disposal, and decommissioning costs of the nuclear fuel cycle, for example between the results of the German final disposal site commissions, and current Japanese policy and practice would be highly relevant, especially for the cost comparison with alternatives on a level playing field.

CONCLUDING REMARKS

6

The GJETC intends to present evidence-based knowledge to decision-makers in politics, business, science, and civil society on existing needs and realistic solutions for sustainable development and the energy transition at local, regional, national, and international level. Social and technological innovations are key. Positive experiences and case studies should be identified and disseminated, negative side effects of action or inaction and policy failures should be avoided as much as possible.

In regard to climate change and other risks associated with unsustainable energy systems, there is a sense of urgency. We are running out of time to keep the temperature increase "well below 2 degrees Celsius above pre-industrial levels", if the implementation processes based on the Paris Agreement (2015) are not accelerated and tightened up. This also implies that the global governance of climate policies needs more effective and additional elements of cooperation and knowledge management. "New diplomacy on energy through leading global efforts against climate change" (Ministry of Foreign Affairs of Japan, 2017, http://www.mofa.go.jp/files/000335212.pdf) is needed. This will also support the achievement of the other energy policy objectives – energy security, cost-effectiveness, and risk minimization.

Against this background, the European Union's DG Clima recently called for "shifting EU focus towards a stronger role of bilateral partnerships, including with major economies. Alliances of frontrunners can generate good examples, which on the other hand can encourage worldwide processes of decarbonization and risk minimization."

Within this context, the Japanese and the German members of the GJETC are convinced that the format and the work of the GJETC can play an important supporting role and can generate added value and synergies from established strands of cooperation.

Comparing the format and working method of the GJETC with the variety of successful dialogues, conferences, and workshops between Germany and Japan, the GJETC offers the following unique features which could, however, be further developed in the future:

- The learning process in terms of format, knowledge generation, and energy policy discussions without a political mandate is **scientifically independent** and may be perceived by the public as a necessary complement to official data and analysis.

- Enabling dialogical and (self-)critical procedures by the Council members even with regard to **controversial topics** goes beyond the scope of conventional diplomatic consensus and s upports transparency, intercultural dialogues, and mutual understanding.

- **The continuity and depth of research** of the work (e. g. comprehensive study program, strategic input papers) combines evidence-based knowledge with the ad-hoc information from special events of both the policy and business dialogues.

- The dissemination of material and scientifically founded recommendations supports politics, businesses, and NGOs with data and analysis for **better informed decision-making.**

- This may concern both learning from good practice in the other country and **joint development and deployment of social and technological innovations** that will be needed for a sustainable energy transition and to mitigate climate change.

- Via the German-Japanese research consortia of the study program, the development and deepening of **personal networks** within the research community can be strengthened, including relevant stakeholders who answered the GJETC questionnaires and attended the discussions at the meetings.

Therefore, important lessons have been learned that serve as a profound basis and starting point for a possible second project phase in order to conduct deeper analysis, especially on technologies and innovations and their embeddedness in societal transformation. In spite of different lines of thought, for example concerning the future role of certain technologies and the rationale of policy-making, we, the German and Japanese GJETC Council Members have gained important common knowledge through the exchange over the past two years. This work has been valuable and we deeply wish to continue this fruitful, worthwhile work in the future. And last not least, we would very much appreciate if the GJETC were to encourage comparable bilateral cooperation in other parts of the world.

APPENDIX

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LIST OF APPENDICES

Please see: www.gjetc.org

(1)	Set-up and procedures of the study program
(2)	Executive summaries of ST 1-4
(3)	Table: Basic empirical data on Japan and Germany
(4)	Questionnaire for stakeholder dialogues I-III
(5)	List of companies represented at the stakeholder dialogues
(6)	List of GJETC input papers
(7)	Detailed recommendations for further research

LIST OF ABBREVIATIONS

AHK	German Chambers of Commerce (Deutsche Außenhandelskammern)
AI	Artificial Intelligence
APEC	Asia-Pacific Economic Cooperation
App.	Approximately
BCG	Boston Consulting Group
BDI	Federation of German Industries (Bundesverband der deutschen Industrie e.V.)
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit)
BMWi	Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie)
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilization
CCUS	Carbon Capture, Utilization, and Storage
CDU	Christian Democratic Union of Germany (Christlich Demokratische Union Deutschlands)
CSU	Christian Social Union in Bavaria (Christlich-Soziale Union in Bayern e. V.)
DBU	German Federal Environmental Foundation (Deutsche Bundesstiftung Umwelt)
DG Clima	Directorate-General for Climate Action
DIHK	German Chamber of Commerce (Deutsche Industrie- und Handelskammer)
DICE	Düsseldorf Institute for Competition Economics
EEG	German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz)
e. g.	exempli gratia
EU	European Union
EU-ETS	European Union Emission Trading Scheme
ESCO	Energy Service Company
FDP	Free Democratic Party (Freie Demokratische Partei)
FIT	Feed-in Tariff

GDP	Gross Domestic Product
GHG	Greenhouse gas
GJETC	German-Japanese Energy Transition Council
GW	Gigawatt
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics, Japan
i.e.	id est
IMF	International Monetary Fund
IoT	Internet of Things
IT	Information Technology
JDZB	Japanese-German Center Berlin (Japanisch-Deutsches Zentrum Berlin)
kWh	kilowatt-hour
LCOE	Levelized Cost of Electricity
MaR	Medienbüro am Reichstag
METI	Ministry of Economy, Trade and Industry, Japan
MW	megawatt
NGO	Non-Governmental Organization
PV	Photovoltaics
R&D	Research & Development
RD&D	Research, Development & Demonstration
RE	Renewable Energy
RES-E	Electricity from Renewable Energy Sources
SAIDI	System Average Interruption Duration Index
SDGs	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
ST	Study Topic
Three E	The principles of economic efficiency, energy security and environmental sustainability
Three E+S	A nation's energy policy, emphasizing energy security, economic efficiency, and environmental protection without compromising safety
Three R	Key mechanisms of a circular economy include Reduce, Reuse, Recycle
TWh	Terawatt-hour
yr	year

LIST OF FIGURES AND TABLES

IMPRINT

Publishers
Wuppertal Institute for Climate,
Environment, Energy gGmbH
Döppersberg 19, 42103 Wuppertal,
Germany
www.wupperinst.org

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Ecos Consult.
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April 2018

Picture credits
Thinkstock, FOTOLIA/Visions-AD, Michael Niemann

Design concept
Ilona Mottog, Dortmund, www.bg-medienwerkstatt.de

Print
color-offset-wälter GmbH & Co. KG, Dortmund
www.color-offset-waelter.de.

Expression of thanks
Our special thanks goes to all of the institutions and organizations that supported and endorsed us, and in person to H.E. Ambassador Takeshi Yagi, Dr. Kotaro Kawamata and Mr. Nobuo Kiriyama of the Japanese Embassy in Germany, H.E. Ambassador Dr. Hans Carl von Werthern of the German Embassy in Japan as well as Dr. Friederike Bosse and Dr. Wolfgang Brenn from the Japanese-German Center Berlin for their great hospitality, and to Michael Müller, Klaus Mindrup, Bene Müller, Harald Neitzel, Sylvia Kotting-Uhl, Prof. Jörg Raupach-Sumiya, Sebastian Sladek, Aileen Smith, Christoph Freiherr von Speßhardt, Dr. Joachim G. Wünning, Joachim Wille, Olivier Feix, and Dr. Iris Wieczorek.

We would also like to express our special thanks to the German-Japanese research consortia for conducting the analyses of the GJETC study program, and to the representatives of the industries, the decentralized energy sector, the energy efficiency sector, and the members of parliament who participated in the GJETC stakeholder dialogues and made important contributions to the GJETC discussions (see Appendices: www.gjetc.org).