Briefing series

Sectoral implementation of nationally determined contributions (NDCs)

May 2017

ENERGY SUPPLY

This publication forms part of a series of NDC sectoral overviews, which provide information about current sectoral contributions to global greenhouse gas emissions and prospects for implementing NDCs in these sectors.

Each briefing paper presents concrete options for integrating sectoral measures in future NDCs, as well as more general cross-sectoral recommendations for moving forward with emissions-reductions measures.

Written primarily from the perspective of climate change experts, with input and suggestions from sector colleagues, the briefing series' intended target audience is twofold: first sectoral experts, who are facing the challenge of implementing the NDCs and related climate policies in their respective sectors; and second climate change experts, highlighting the relevance of the sector for NDC implementation.

This briefing paper presents the situation and prospects for implementation of NDCs in the power sector. It thereby mainly focuses on the electricity supply side of the sector. Energy efficiency is covered in a separate briefing paper.

The power sector and climate change

Implications of the Paris Agreement targets for the energy supply sector

Accounting for approximately 32% of global greenhouse gas (GHG) emissions in 2013, the electricity and heat supply sector is the largest contributor to global GHG emissions among all sub-sectors (Bruckner et al. 2014). Figure 1 shows that worldwide GHG emissions from power generation under current policies are projected to grow from 13.5 $GtCO_2e$ to about 16.3 $GtCO_2e$ by 2030 (IEA 2016c). The expected absolute growth in GHG emissions is attributed to an increase in emissions by about 3.5 $GtCO_2e$ in non-OECD countries by 2030, whereas emissions from power generation in OECD countries are projected to slightly decrease by 0.6 $GtCO_2e$ by 2030. The projected emissions growth in non-OECD countries is driven mainly by continuous, strong economic growth, an increase in energy demand despite some success in decoupling emissions from growth, and the expansion of reliable electricity provision. The 450 scenario, which is also displayed in Figure 1, indicates that emissions from the power sub-sector must drop considerably if the 450ppm concentration threshold is not to be exceeded.

Published by:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

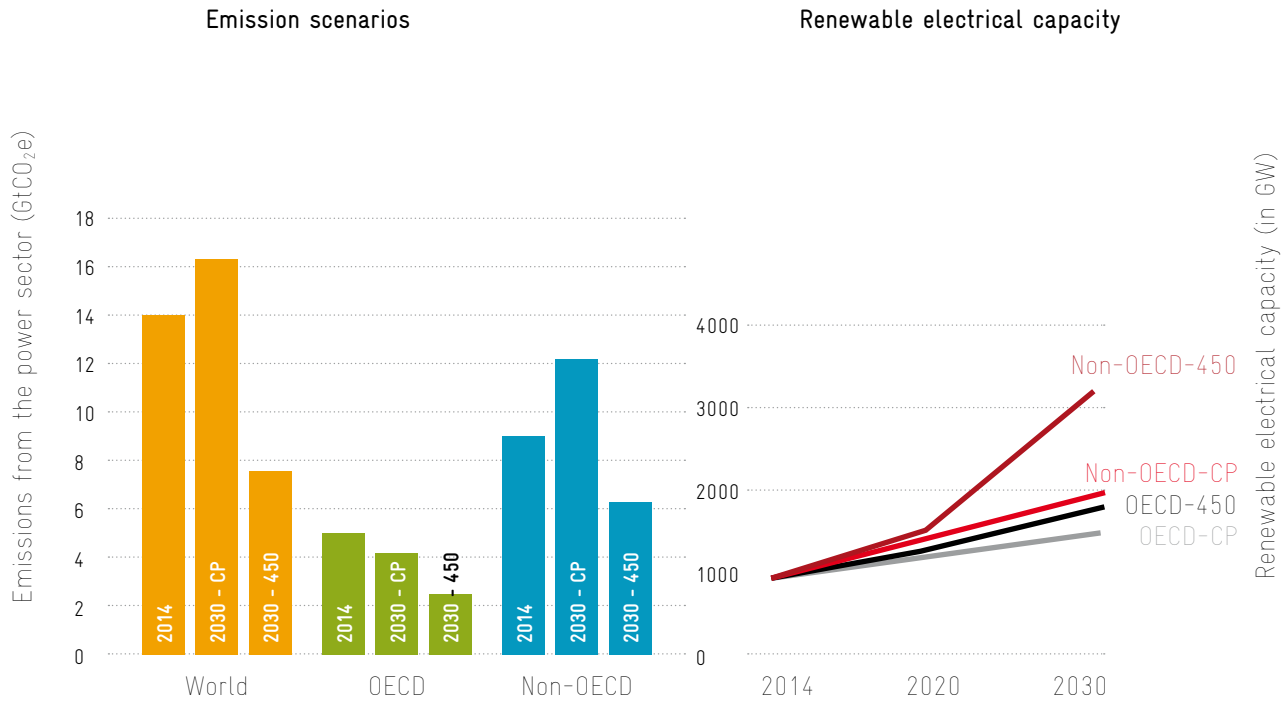

FIGURE 1: Emission scenarios for the power sector in OECD and Non-OECD countries (left side). Projected growth in renewable energy capacity for OECD and non-OECD scenarios (right side). Author's own elaboration, based on Current Policies Scenario (CP) and the 450 Scenario (450) of IEA's World Energy Outlook 2016 (IEA 2016c).

Looking beyond 2030, and considering the Paris Agreement's long-term objective „to hold global temperature increase to well below 2°C and to pursue efforts to limit the temperature increase to 1.5°C" it is evident that GHG emissions from power sector must be further reduced. The median outcome of 1.5°C scenarios calls for a trajectory of CO_2 emissions from electricity generation of around 7 $GtCO_2e$ in 2020, 4 $GtCO_2e$ in 2030 and zero emissions in 2050 (Rogelj et al. 2015).[1] The 2°C scenario also requires complete decarbonisation of the power sector by 2050, albeit with higher emissions in the medium-term and then steeper reductions towards 2050. Table 1 provides an overview of selected implications of the Paris Agreement targets for the power sector. Renewable energy generation plays a central role in attaining the targets. In order to follow the 1.5°C trajectory, current growth rates of renewable energy or other zero and low-carbon technologies have to be sustained (Climate Action Tracker 2016).[2] In addition, no new coal-fired power plants should be built as of today and emissions from existing coal-fired power plants need to be reduced by at least 30% by 2025 (Climate Action Tracker 2016).

The power sector gains even more importance for a timely increase in zero-carbon technologies when taking into account its relevance for electrification trends in other sectors, e.g. the shift to electric vehicles in the transport sector or the expected growth of heat pumps and appliances in the buildings sector. Studies suggest that a five-fold increase in demand for electricity until 2050 is conceivable in the context of these electrification trends (Riahi 2014).

A significant gap exists between the required trajectory of global power generation and the commitments set forth in the Nationally Determined Contributions (NDCs). If the goals of the Paris Agreement are to be achieved, the NDCs' collective level of ambition and national climate policies for the power sector must be improved.

1 Rogelj et al. (2015) uses emission scenarios from MESSAGE.
2 Greenpeace shows the requirement for a continuation of exponential growth rates to achieve 100% share of renewables in electricity supply by 2050 with a total of 23,600 GW installed generation capacity (Greenpeace 2015; IRENA 2016); while the IEA projects a more linear increase to achieve 100% share of renewables in electricity supply by 2050 (IEA 2015; IRENA 2016).

TABLE 1: Selected implications of the Paris Agreement targets for the power sector

INDICATOR / SUBSECTOR	SELECTED IMPLICATIONS OF PARIS AGREEMENT FOR REQUIRED PATHWAYS
Emissions (electricity generation)	**2°C**: Full decarbonisation of power sector by 2050 with slightly less steep trajectory, compared to 1.5°C scenarios (Rogelj et al. 2015). **1.5°C**: Full decarbonisation of power sector by 2050 with milestones of 7 $GtCO_2e$ in 2020 and 4 $GtCO_2e$ in 2030 (Rogelj et al. 2015).
Emissions (entire energy-related emissions)	**2°C**: Full decarbonisation of the entire energy sector by 2060 to 2075 (UNEP 2016). **1.5°C**: Full decarbonisation of the entire energy sector by 2045 to 2055 (UNEP 2016).
Renewable energy deployment	**2°C**: Growth of solar and wind generation need to continue for another five to ten years at similar levels to those seen over the last decade, and then gradually relax to around 4–5% per year from 2025 until 2050 (IIASA 2015; Climate Action Tracker 2016). **1.5°C**: Share of electricity generated by renewables and other zero and low- carbon sources will need to reach around 50% by 2020 and 70% by 2030, and approach 100% by 2050 (Rogelj et al. 2015; Climate Action Tracker 2016).
Coal phase out	**"well below 2°C"**: Phase-out of inefficient, unabated coal-fired plant technologies and coal-fired plant fleets not retrofitted with CCS technology or biomass conversion before 2040 (OECD; IEA 2016). **1.5°C**: No new coal-fired power plants should be built and emissions from existing coal-fired power plants need to be reduced by at least 30% by 2025 (Climate Action Tracker 2016).

Approaches and opportunities for mitigation in the power sector

Mitigation options with regard to power generation consist mainly of low-carbon technologies, including renewable energy, carbon capture and storage (CCS) and nuclear. The two latter technologies, however, come with considerable risks[3] and other disadvantages. In the mid-term, natural gas might serve as a bridging technology, even though the large-scale application of gas technologies requires the costly set-up of needed infrastructure, which may lead to stranded investments. To achieve the full decarbonisation of the power sector by mid-century, existing fossil-fuel technologies generally need to be phased out. Energy efficiency is also vital to mitigation efforts, including efficiency in the process of electricity generation, transmission, distribution and consumption. Energy efficiency is addressed in a separate briefing in this series.

Of all available technologies, renewable energy is the most promising and continues to surpass expectations (Cronin et al. 2015). Since 2011, renewables have outpaced fossil fuels for net investment in power capacity additions each year (REN21 2016). Technology costs have been falling — a trend which is set to continue. In several global regions, renewable energy technologies have reached grid parity and are economically viable without subsidies. Projections suggest that by 2030 solar will become the least-cost production technology in most countries (BNEF 2016).

Many countries – both developed and developing – have established renewable energy targets, as well as aligned financial support schemes. By 2015, 90 developing countries had set renewable energy targets and 64 developing countries had put support schemes in place to achieve those targets (One Gigaton Coalition 2016). In addition, the 48 developing countries that make up the Climate Vulnerable Forum (CVF)[4] announced their intention of achieving 100% renewable energy capacity between 2030 and 2050.

3 Due to the high risks of nuclear energy technologies, the German development cooperation completely excludes nuclear energy as a potential low carbon or bridging technology.

As intermittent renewable energy resources (especially solar and wind) become more prevalent, energy systems must become more flexible and technologically relevant to accommodate them. Adaptations might include the modernization and extension of grid infrastructure, including energy storage, smart grid solutions and off-grid electrification, which can address changing demand- and supply-side needs.

While the pathway to decarbonisation is promising and possible, there remains a risk of long-term lock-in to unsustainable power supplies if coal-based power continues to expand. While investments in renewables are currently twice as high as in fossil fuel technologies, electricity consumption from coal-fired power plants is projected to remain constant (BNEF 2016). Further divestment is therefore needed to move the sector away from coal and to avoid the risk of sunk costs. While this may also be true to a lesser extent for the expansion of gas-based power capacity, gas-based technologies might represent viable bridging technologies if embedded in decarbonisation strategies. The phase out of fossil fuel subsidies, which amounted to almost USD 500 billion globally in 2014 (IEA 2016c), remains crucial. While several countries have already committed to a fossil fuel subsidy reform (REN21 2016), more ambitious efforts aimed at completely phasing out such subsidies are necessary.

Developing countries face several unique challenges to decarbonising their power sectors. Currently, about 1.2 billion people have no or only very limited access to electricity supply (IEA 2016c). Off-grid solutions to supply remote areas, and a shift towards modern cooking energy services are needed. Furthermore, de-risking the investment environment in many developing countries will be necessary to attract adequate finance and capital for renewable energy projects (UNDP 2013).

Solar energy can both reduce GHG emissions and contribute to economic development like in Morocco, where the production of photovoltaic cells creates hightech industrial jobs.

Mitigation measures to decarbonise the energy supply share commonalities with the objectives of several SDGs, particularly SDG 7 (Sustainable Energy Access) and SDG 9 (Infrastructure, Industrialization, and Innovation), however, care must be taken to ensure that win-win outcomes can be achieved for both mitigation and development. While some of the proposed mitigation actions for the power sector are fairly well aligned with the SDGs, for example, providing universal access to electricity is best served by low-carbon distributed technologies, the risk of potential trade-offs between expanded energy consumption and climate objectives remains. Whether SDG 9 can be fully aligned with mitigation objectives, will be contingent on the replacement of existing infrastructure with low-carbon alternatives.

Electricity sector in NDCs

Figure 2 provides an overview of the inclusion of the power-supply sector in the mitigation and adaptation components of Parties' NDCs. Overall, the power supply sector was one of the most commonly included sectors in the mitigation contributions of NDCs, appearing explicitly in almost all NDCs (World Bank 2016, own analysis). However, only 22% of all Parties' NDCs specify investment needs for intended mitigation efforts.

About 70% of all NDCs mention the need to expand or strengthen renewables in their country's energy mix (Stephan et al. 2016; REN21 2016, own analysis). Roughly 46% of all NDCs set quantified targets for the share of renewables in the energy or electricity mix (Stephan et al. 2016; REN21 2016, own analysis) and a number of countries specify plans in their NDCs to decarbonise their power generation by aiming for 100% renewables.[5]

4 For further information on CVF see http://www.thecvf.org/.

5 Cabo Verde (by 2025), Cook Islands (by 2020), Costa Rica (by 2030), Fiji (by 2030), Papua New Guinea (by 2030), Samoa (by 2017), Tuvalu (by 2025), and Vanuatu (by 2030) aim for the full decarbonisation of their power generation, while Ecuador and Uruguay state in their (I)NDCs that they are aiming to achieve a share of 90% respectively 95% in their electricity mix by 2017 (Stephan et al. 2016). Iceland already generates almost 100% of its electricity from renewables.

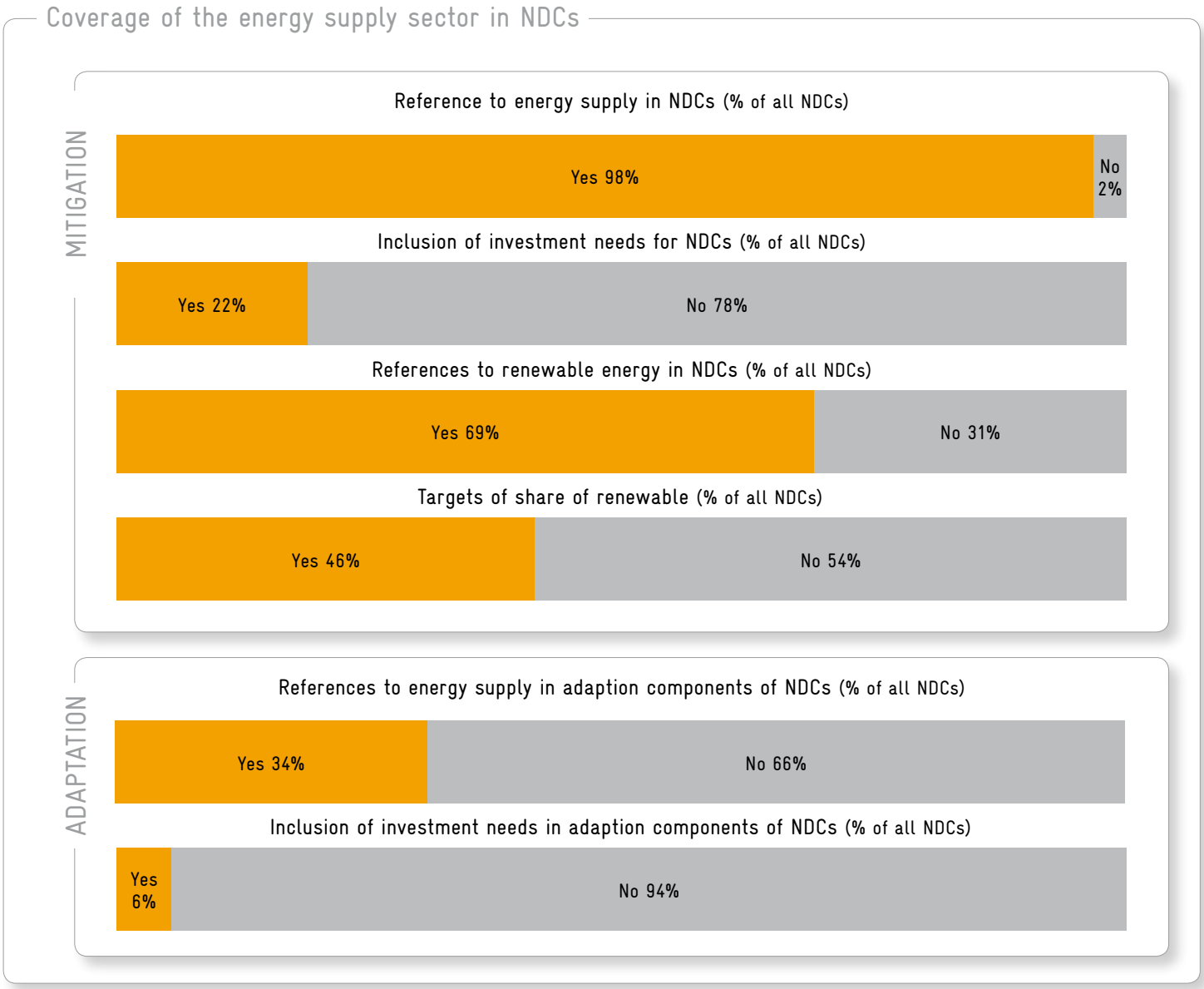

FIGURE 2: Overview of energy sector coverage in NDCs. Authors' own elaboration, based on World Bank (2016), Stephan et al. (2016), REN21 (2016).

The NDCs do not always reflect previous actions and target-setting in the power sector. As of 2015, 173 countries had already set renewable energy targets at the national or sub-national level, although this information is not always reflected in the NDCs.

Even though the power sector is highly relevant for adaptation efforts — including aspects such as climate-resilient energy infrastructure, energy storage, and off-grid electrification — the power sector is less commonly included in adaptation plans within NDCs. Only around 34% of all countries explicitly address the energy supply sector in the adaptation components of their NDCs, and only 6% of all countries specify investment needs for adaptation contributions (Figure 2: own analysis; World Bank 2016).

Moving ahead with implementation and raising ambition

Actions can be taken within the power sector in the immediate- to short-term to support the implementation of the the NDC targets and actions, and for raising ambition. International cooperation is key, specifically in two areas: First, G20's intention to rationalize and stepwise phase-out fossil fuel subsidies should be reflected in actions taken by other multilateral bodies like the multilateral development banks. Therefore, the G20 could closely cooperate with the MDBs to reduce and eventually eliminating lending and policy support for fossil fuel investments, aiming e.g. at not supporting investments in fossil fuel exploration.

Key steps for moving towards sector-driven implementation and ambition raising

Many of the key steps for moving ahead with NDC implementation and ambition raising are relevant for all sectors. They are summarised in this box. Further details on the individual steps can be found in the overview briefing paper of this briefing series.

Establishment of institutional bodies for oversight of implementation and monitoring of progress: Alignment of institutions based on optimisation of existing mandates, to include broader levels of governance in strategy making including finance and planning ministries, and devolvement of responsibilities to line ministries and agencies with most sector influence. Approaches developed should be resilient to government staff turnover.

Development and dissemination of knowledge on climate requirements and benefits: Enhancing understanding on the implications of the Paris Agreement for the sector, and the social and economic benefits of climate change mitigation and adaptation measures.

Plans for achievement of sector targets, and review of potential for increasing ambition in specific sub-sectors: Stock-take and integration of subnational, national and non-state action, translation to subsector targets, determination of long-term full decarbonisation targets for the sector, and collation of this information into a target-based roadmap. Potential for ambition raising can be analysed based on regional best practice policies and consideration of targets for sub-sectors not covered in climate strategy.

Planning and implementation of instruments to leverage investments: Evaluation of investment requirements and the role of private and public finance for leveraging those investments. Analysis of persisting barriers and development of concepts for projects/programmes that can address those barriers through unilateral action or international support (e.g. NAMAs).

Revision of NDC: Update content of NDC for greater transparency, clarity and in line with aligned national strategy and identified ambition raising potential.

Introduction of policy packages and programmes to kick-start action: Introduction of new policies and strengthening of existing policies, in accordance with sector planning process, and development and submission of proposals for internationally supported programmes (e.g. NAMAs).

Second, enhancing development cooperation will be important to support developing country Parties for the effective implementation (Article 3 of the Paris Agreement). Support for frontrunner initiatives such as the Africa Renewable Energy Initiative (AREI) will help to keep up momentum.

Specific considerations for the energy supply sector are presented in the following.

» ***Introduce immediate- and short-term policy packages, including renewable energy support schemes, for the implementation of NDC targets.*** The policy packages should be geared towards developing markets for low-carbon technologies and renewable energy. The packages should also move parties towards an energy transition, which will entail planning for flexibility and supply security of the power system with reduced shares of high carbon technologies, using 'bridging solutions' technologies, and planning for modernization/extension of the grid infrastructure.

» ***Review periodically the ambition-raising potential of NDCs.*** A recurring review process, aligned with the periodic revision of the NDCs, should identify how the country-specific level of ambition set forth in the NDCs can be increased. The reviews would take into account the knowledge accumulated from NDC implementation, innovations and updated global circumstances.

The agricultural college at the Muni Seva Ashram in India cooks for its 500 students using steam produced by ten solar cookers.

» ***Enhance consistency between power system capacity planning and the level of ambition in NDCs.*** National capacity development planning oftentimes remains inconsistent with NDC targets, as many processes, analyses and tools utilised for the set-up of the NDC differ from those used for planning in the power supply sector. Policymakers should merge these processes in order to establish a common decision-making, support and planning facility.

» ***Establish long-term decarbonisation options that show that decarbonisation is possible.*** In view of the need to attain zero emissions in the power sector, countries should explore their technical-economic options for a holistic energy transition on the basis of known and expected technological development. This should include milestones for the fossil fuel peak and phase-out, which will lead to a full decarbonisation. By identifying feasible options, policymakers send signals that the transition is possible. Options should also leave open the possibility for the inclusion of new or improved technologies and innovations as they become available. The potential for technological advancements and expanding the number of options to achieve zero emission targets should be an integral part of NDCs.

» ***Integrate planning with sectors that undergo fundamental electrification transformation.*** Electrification trends that are transforming certain sectors, such as the shift to electric vehicles in the transport sector requires integrated planning. Cross-sectoral coordination and alignment of sectoral strategies would help ensure that the implementation of such transformational trends happens in a sustainable and well-planned manner.

» ***Enhance the dialogue for policy and sectoral readiness for technological innovation.*** Energy storage, smart grids, and future renewable energy production will require enhanced stakeholder dialogue amongst generators, local system operators, and electricity suppliers to optimize planning and enhance the regulatory environment that can spur necessary technological innovation.

In the medium- and long-term, taken together, these steps will help modify the priorities, perceptions and even the planning instruments of the power sector and energy policy. Such steps are needed to align the power sector with the Paris Agreement.

FURTHER READING

Further details on the topics discussed in this briefing paper may be found in the following sources, amongst others:

Emission scenarios for the energy supply sector

- IEA, 2016 → World Energy Outlook 2016 (current policy and 450ppm scenarios for energy use and emissions from power generation up to 2040).
- IEA, 2016 → Energy Technology Perspectives 2016 6°C, 4°C and 2°C scenarios (6DS, 4DS, and 2DS) for energy use and emissions from power generation up to 2050).
- IRENA, 2016 → Roadmap for a Renewable Energy Future 2016 (scenario on renewable energy penetration and energy-related emissions until 2050).

Long term implications of 2°C and 1.5°C for the energy supply sector

- UNEP, 2016 → Emissions Gap Report 2016 (indication of timeline for full decarbonisation from energy and non-energy sectors).
- Climate Action Tracker, 2016 → 10 most important steps to limit warming to 1.5°C (requirements and feasibility of options for 1.5°C compatibility in light of the decarbonisation of the electricity supply sector and the phase out of coal-based electricity generation).
- → AR5 Scenario Database, Long-term scenarios reviewed in the Fifth Assessment Report (AR5) of Working Group III of the Intergovernmental Panel on Climate Change (IPCC).
- Rogelj et al., 2015 → Energy system transformations for limiting end-of-century warming to below 1.5°C (analysis and sectoral breakdown of integrated energy–economy–environment scenarios that keep warming to below 1.5°C by 2100).

Integration of energy supply sector in NDCs

- World Future Council, 2016 → What Place for Renewables in the INDCs? (overview of the coverage of renewables in the INDCs).
- World Bank, 2016 → NDC Platform (data explorer on coverage of energy sector in NDCs and sector-specific targets, focus on developing countries).

References

BNEF, 2016. New Energy Outlook 2016: Long-term projections of the global energy sector (Executive Summary). Available at: http://www.bloomberg.com/company/new-energy-outlook/#form.
Bruckner, T. et al., 2014. Energy Systems O. Edenhofer et al., eds..
Cronin, C. et al., 2015. Faster and Cleaner - Decarbonisation in the power and transport sectors is surpassing predictions and offering hope for limiting warming to 2°C. Available at: https://newclimateinstitute.files.wordpress.com/2015/12/faster-cleaner-decarbonization-in-the-power-transport-sectors.pdf.
Greenpeace, 2015. Energy [R]Evolution. Available at: http://www.greenpeace.org/international/Global/international/publications/climate/2015/Energy-Revolution-2015-Full.pdf [accessed on 5 December 2016].
IEA, 2016a. Energy Statistics and Balances.
IEA, 2016b. Energy Technology Perspectives 2016. Towards Sustainable Urban Energy Systems.
IEA, 2016c. World Energy Oulook 2016.
IEA, 2015. World Energy Outlook 2015.
IIASA, 2015. IAMC AR5 Scenario Database. Available at: https://secure.iiasa.ac.at/web-apps/ene/AR5DB/dsd?Action=htmlpage&page=about [Accessed July 16, 2015].
IRENA, 2016. Roadmap for a Renewable Energy Future. Available at: http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_2016_edition_report.pdf.
NewClimate Institute, Climate Analytics, Ecofys, 2016. Climate Action Tracker. The ten most important short term steps to limit warming to 1.5°C,. Available at: http://climateactiontracker.org/assets/publications/publications/CAT_10_Steps_for_1o5.pdf [accessed on 17 November 2016].
OECD; IEA, 2016. Energy, climate change and environment. 2016 Insights. Available at: http://www.iea.org/publications/freepublications/publication/ECCE2016.pdf.
One Gigaton Coalition, 2016. Renewable energy and energy efficiency in developing countries: contributions to reducing global emissions.
REN21, 2016. Global Status Report Renewables 2016. Available at: http://www.ren21.net/wp-content/uploads/2016/06/GSR_2016_Full_Report_REN21.pdf.
Riahi, K., 2014. IPCC AR5 Database. In IPCC AR5.
Rogelj, J. et al., 2015. Energy system transformations for limiting end-of-century warming to below 1.5°C. Nature Climate Change, 5, pp.519–527. Available at: http://www.nature.com/nclimate/journal/v5/n6/full/nclimate2572.html.
Stephan, B., Schurig, S. & Leidreiter, A., 2016. What Place for Renewables in the INDCs?. Available at: http://www.worldfuturecouncil.org/inc/uploads/2016/03/WFC_2016_What_Place_for_Renewables_in_the_INDCs.pdf.
UNDP, 2013. Derisking renewable energy investment: A Framework to Support Policymakers in Selecting Public Instruments to Promote Renewable Energy Investment in Developing Countries. Available at: http://www.undp.org/content/dam/undp/library/Environment and Energy/Climate Strategies/UNDP Derisking Renewable Energy Investment - Full Report (April 2013).pdf.
UNEP, 2016. The Emissions Gap Report 2016. Available at: http://web.unep.org/emissionsgap/.
World Bank, 2016. NDC Platform. Available at: http://spappssecext.worldbank.org/sites/indc/Pages/INDCHome.aspx [Accessed November 4, 2016].

About the GIZ Climate Policy Support Programme

GIZ Climate Policy Support Programme aims at developing and mainstreaming innovative approaches to tackle the challenges of climate change in the context of German Development Cooperation. On behalf of the Federal Ministry for Economic Cooperation and Development (BMZ), it supports developing countries in their efforts to mitigate climate change and to adapt efficiently to its impacts. Through conceptual and practical activities, the Climate Policy Support Programme actively contributes to the implementation of the Paris Agreement and the UN Sustainable Development Goals.

Published by:
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 40
53113 Bonn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E climate@giz.de
I www.giz.de/climate

Programme:
Climate Policy Support Programme

Responsible/contact:
Axel Olearius
E axel.olearius@giz.de

Authors:
Briefing energy supply:
Frederic Hans, Markus Hagemann, Thomas Day,
Broader briefing series:
Frauke Röser, Thomas Day, Katharina Lütkehermöller,
Markus Hagemann, Frederic Hans, Maria Jose de Villafranca Casas,
Antoine Warembourg, Niklas Höhne, Marie Kurdziel

Acknowledgments:
The GIZ Climate Policy Support Programme expresses its gratitude to the following GIZ colleagues and other experts, who reviewed this briefing paper and provided valuable comments and suggestions: Michael Köberlein, Bhozil Kondev, Frank Seidel, Paul Suding

Editorial team:
Heiner von Lüpke, Inga Zachow, Tobias Hausotter, Charly Heberer,
Erik Kemmling (all GIZ Climate Policy Support Programme), Sallie Lacy

Design/layout etc.:
Jeanette Geppert, pixelundpunkt kommunikation, Frankfurt am Main

Fotonachweise/Quellen:
Page 1: © GIZ / Catharina Vale; Page 4: © GIZ / Carolin Weinkopf; Page 6: © GIZ / Michael Netzhammer

URL links:
Responsibility for the content of external websites linked in this publication always lies with their respective publishers. GIZ expressly dissociates itself from such content.

On behalf of
German Federal Ministry for Economic Cooperation and Development (BMZ)
Division 313 Climate Policy
Bonn

GIZ is responsible for the content of this publication.

Bonn, May 2017

On behalf of

Federal Ministry
for Economic Cooperation
and Development