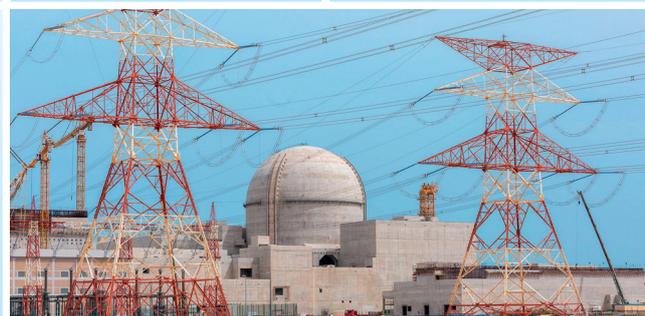


Nuclear Power

and Market Mechanisms

under the Paris Agreement



IAEA

60 Years

Atoms for Peace and Development

Nuclear Power and Market Mechanisms under the Paris Agreement

The Paris Agreement market mechanisms can enable the international exchange of greenhouse gas emission reductions, supporting deployment of low carbon nuclear power to limit the global temperature increase below 2°C. Ongoing negotiations can ensure that the mechanisms promote effective mitigation, investment and cooperation.

TOP-DOWN TO BOTTOM-UP: A NEW CLIMATE FRAMEWORK

The Paris Agreement (PA) entered into force in November 2016, one month after the ratification target of at least 55 countries covering at least 55% of global greenhouse gas (GHG) emissions was met. As of October 2017, more than 150 countries have ratified the PA (covering about 85% of global GHG emissions). The PA establishes ambitious climate change mitigation targets: to limit the global temperature increase to well below 2°C, with efforts to contain it to 1.5°C. It represents the culmination of over 20 years of international climate change policy development, following the UN Framework Convention on Climate Change (UNFCCC) adopted at the 1992 Rio Earth Summit and building on the 1997 Kyoto Protocol (KP) (see Box).

The Paris Agreement introduces a new approach and new flexible mechanisms to fight climate change

Unlike the KP, which includes negotiated top-down targets (for a limited group of countries) and centralized oversight (see Box), under the PA each country defines its abatement targets in a bottom-up fashion, expressed in Nationally Determined Contributions (NDCs). NDCs define countries' mitigation and adaptation targets, and the extent to which these targets are conditional on international support. Furthermore, countries commit themselves to re-evaluate their progress, every five years, in light of scientific assessments and global stocktakes, and submit progressively more ambitious plans. In this way, the PA provides a dynamic and enduring framework for climate policy with flexibility to respond to scientific, technological and economic developments, along with shifts in public priorities.

Crucially, the PA introduces two flexible 'market mechanisms' to facilitate achievement of the NDC goals: the Sustainable Development Mechanism (SDM)¹ and Cooperative Approaches (CAs). The mechanisms will enable the exchange of GHG emission reductions between countries, providing flexibility to achieve national targets cooperatively and to exploit market forces to determine where and how emissions can be reduced most efficiently. The rules governing these mechanisms are expected to be decided before 2019, and will be critical to how the mechanisms affect investments in low carbon technologies, including nuclear power.

Kyoto Protocol and the UN Framework Convention on Climate Change (UNFCCC)

The Paris Agreement (PA) followed years of climate policy negotiation by the countries that are Parties to the UNFCCC, who meet annually at 'Conference[s] of the Parties' (COPs) — the PA was agreed at COP21. The Kyoto Protocol (KP) adopted at COP3 was an important step towards the PA, being the first international agreement to reduce GHG emissions under the UNFCCC. The KP divides the world into Annex B (developed countries and economies in transition) and non-Annex B (mostly developing countries). Annex B countries were assigned legally binding emission reduction targets in two phases: initially for 2008-12 and later for 2020. The KP included strong central oversight and monitoring of GHG abatement, built on the UNFCCC reporting system, i.e. National Communications, Biennial Update Reports, and national inventories.

NUCLEAR POWER AND CLIMATE CHANGE MITIGATION

Countries are free to specify any technology, including nuclear power, to reduce emissions in future NDCs. Nuclear power already provides nearly one third of low carbon electricity globally, and has avoided over 60 billion tonnes of GHG emissions since 1970 (i.e. equivalent to the total combined energy related carbon dioxide (CO₂) emissions of 2013 and 2014). On a life cycle basis, which considers all the processes in the generation of electricity (from cradle-to-grave), GHG emissions per unit of nuclear power are comparable to those from renewable technologies (see Figure 1). As such, nuclear power is seen as playing an important role in realising stringent (1.5 and 2°C) targets.²

Nuclear power can provide cost effective, low carbon electricity for ambitious mitigation goals

A nuclear power plant can also provide affordable electricity compared to other technologies (see Figure 2), although there remain challenges in financing the upfront construction costs. In this context, the mechanisms in the PA may support cooperation between countries, along with the use of market forces to properly value the economic cost of GHG emissions, to direct abatement investment towards lower cost low carbon options (such as nuclear power), reducing the overall economic burden of realising the ambitious goals of the PA.

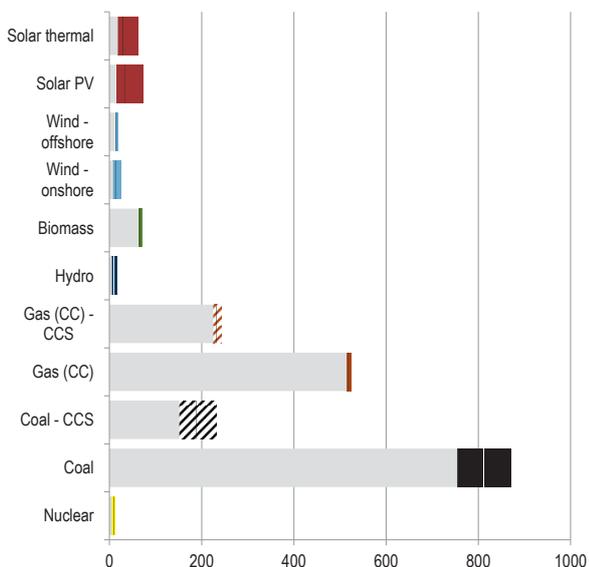


Figure 1. Life cycle GHG emissions (in g CO₂-equivalent/kW-h) of electricity technologies, 2010.^{3, 4} Coloured ranges show regional low, average, and high estimates.

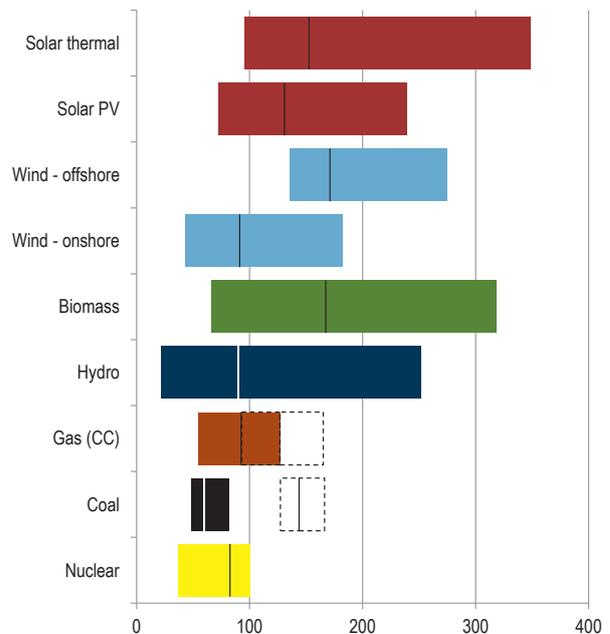


Figure 2. Levelized costs of electricity generation (US \$₂₀₁₃/MW-h), 7% discount rate.^{4, 5} Bars indicate low, median and high estimates. Transparent dashed bars show estimates with \$100/tonne CO₂ price.

EXPERIENCE WITH THE KYOTO MARKET MECHANISMS

The Kyoto Protocol pioneered the use of flexible market mechanisms in international climate change mitigation, as a means to facilitate compliance, reduce costs, mobilize investment and promote cooperation. The flexible market mechanisms under the KP comprise the [Clean Development Mechanism \(CDM\)](#), [Joint Implementation \(JI\)](#) and [International Emissions Trading \(IET\)](#). These three mechanisms supported the emergence of a market in units of emission reductions (defined in tonnes of carbon dioxide-equivalent, CO₂e) that can be used to offset domestic emissions, while supporting cost-effective abatement and mobilizing finance.

CDM in Practice: Qingdao Huawei Project

The Qingdao Huawei windfarm partnered a German wind turbine producer and a Chinese state corporation.⁶ By displacing coal-fired power, the 16 MW project generated about 200,000 CERs over 10 years (worth US \$1 million at US \$5/tonne CO₂e). The extra revenue from CERs helped secure finance and reduce operating risks.

The **CDM** is the most successful KP mechanism (see Table 1 comparison). It enables developed ('Annex B') countries to create certified emission reduction credits (CERs) for abatement activities in developing ('non-Annex B') countries, which benefit from financial support and technology transfer (see Box). CDM relies on robust monitoring, reporting and verification, although it can complicate projects.

JI is similar to the CDM, but applies to countries with binding GHG targets (i.e. Annex B). JI originally lacked strong centralized oversight, opening the door to conflicts of interest between ensuring strict environmental integrity and maximizing the quantity of JI credits generated in countries hosting the projects.⁷

IET allows countries to trade emission credits: those falling short of their mitigation targets can buy emission reductions from another country. IET faced questions over environmental integrity and corruption and was only employed by a few countries. In parallel, the European Union (EU) launched the EU Emission Trading Scheme (EU ETS) in 2005, initially covering electricity and industry, which allows some use of CDM/JI credits.

Nuclear power was restricted under the CDM and JI mechanisms of the Kyoto Protocol

The role of nuclear power under JI and CDM was first discussed at COP6. Some countries saw nuclear power as an important low carbon alternative to fossil fuels, while others were concerned about the risk of accidents, waste management and proliferation. It was ultimately decided (COP7, 2001) that countries 'refrain from using emission reductions units generated from nuclear facilities to meet their commitments'.⁹ Nonetheless, nuclear power remains supported

	CDM	JI	IET
Applicable countries	Annex B to non-Annex B	Annex B to Annex B	Annex B (only used by Japan, Spain, Russia, Ukraine)
Number/type of projects^a	8439 71% renewables 15% methane abatement	761 40% methane abatement 18% renewables	N/A
Credits issued	1.85 billion tonnes CO ₂ e	863 million tonnes CO ₂ e	N/A
Concerns raised	Slow, complicated, expensive, env. integrity	Lack of oversight, env. integrity	Environmental integrity, corruption

Table 1. Experience with flexible market mechanisms under the Kyoto Protocol

indirectly under emissions trading schemes (IET and EU ETS), since it provides low carbon electricity, easing the burden of meeting emissions targets.

Uncertainty led to the fragmentation of carbon markets under the Kyoto mechanisms

At COP15 in Copenhagen in 2009 the international community failed to agree on the climate policy regime that would follow the first KP period (ending in 2012), creating considerable uncertainty in carbon markets, which had grown rapidly from 2005 (see Figure 3). While eventually a second commitment period of the KP (2012–2020) was agreed in Doha (2012), only the EU and a few small countries agreed to mitigation targets. As a result, prices for JI and CDM credits

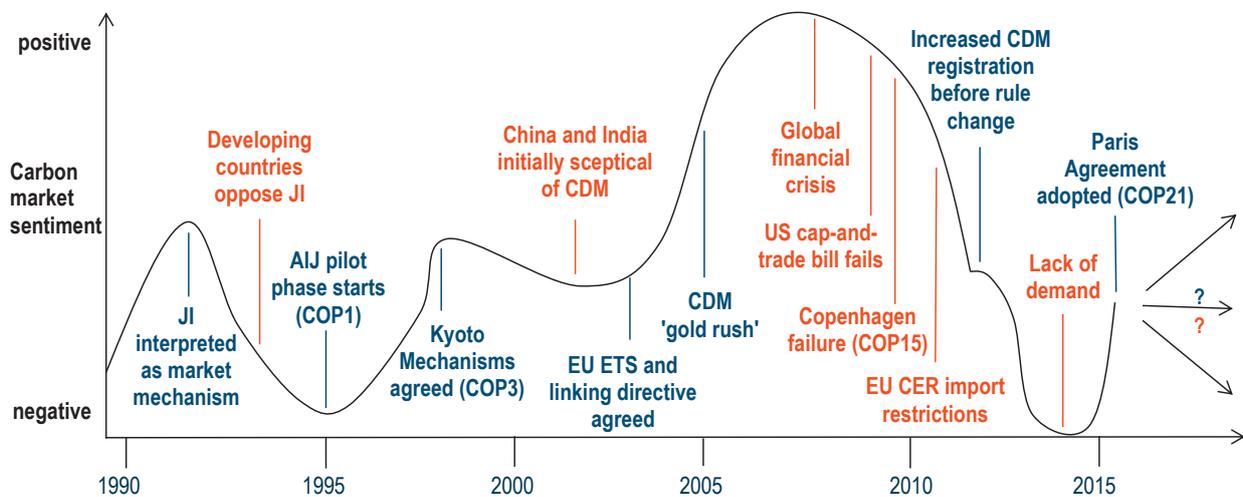


Figure 3. Positive and negative developments affecting carbon market mechanisms over time.¹⁰ AIJ refers to Activities Implemented Jointly, launched at COP1.

rapidly collapsed (from over US \$20 to about US \$0.5/tonne) to the point where new projects were no longer financially attractive. The EU also limited eligibility under the EU ETS (i.e. the main source of demand for emission reduction credits), allowing only credits generated in least developed countries and excluding credits from certain projects.

These developments led to fragmentation in the carbon market, as countries implemented independent domestic carbon pricing initiatives and bilateral mitigation schemes, with a stronger focus on domestic priorities, such as Japan's bilateral Joint Crediting Mechanism (JCM) (see Figure 4). Given Japan's traditional use of nuclear power, JCM support may be possible, although no nuclear projects have been implemented.¹¹

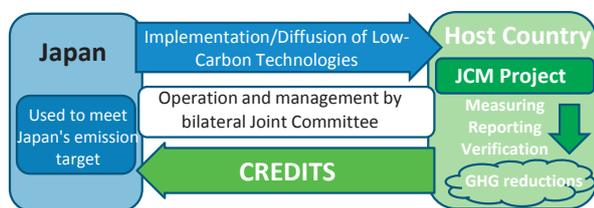


Figure 4. Japan's bilateral Joint Crediting Mechanism (JCM): a possible template for Cooperative Approaches under the PA. Note: JCM activities are hosted in 17 countries and include energy efficiency and renewable supply projects.¹¹

NEW MECHANISMS UNDER THE PARIS AGREEMENT

The adoption of the Paris Agreement (PA) in 2015 created renewed interest in market mechanisms, and is seen as having the potential to stabilize and reinvigorate the carbon markets. The PA includes two voluntary market mechanisms: **Cooperative Approaches** (CAs) and the **Sustainable Development Mechanism** (SDM) (defined in Articles 6.2 and 6.4, respectively of the PA) that can be used by Parties (countries) to fulfil their NDCs. So far, around 90 NDCs (over 50%) indicate an interest in accessing international carbon markets.¹² The PA mechanisms are yet to be fully defined, although it is clear that both will incorporate strong environmental integrity and transparency principles, addressing some of the shortcomings of the Kyoto mechanisms.

Cooperative Approaches could support bilateral initiatives and potentially emissions trading

The likely operation of CAs has been interpreted in different ways. Many observers see CAs as a tool for countries to transfer emission reduction credits

(referred to as **Internationally Transferred Mitigation Outcomes** (ITMOs) under the PA, likely measured in tonnes of CO₂e) under specific bilateral project or programme based agreements. This interpretation shares similarities with both JI and the JCM (see Figure 4), and indeed Japan is seeking to ensure the latter is recognized as an eligible cooperative approach under the PA and UNFCCC,¹¹ potentially opening the door to a wider range of bilateral mitigation activities under the PA. An alternative interpretation is that CAs could be used to transfer ITMOs in the context of linking sector or economy wide carbon trading schemes, without project specific creation of emission reductions. In either case, the text of the PA leaves open the eligibility of specific activities or technologies, including nuclear power projects and programmes, within CAs.

The Sustainable Development Mechanism is expected to adopt many features of CDM

As opposed to CAs, the SDM is a centrally governed mechanism (see Figure 5, which also compares other mechanisms) under the collective supervision of the Parties to the Paris Agreement. The SDM is also more clearly defined, with key features adopted from successful elements of the CDM:¹³ a central governing body and oversight (including monitoring, reporting and verification), public and private participation, and eligibility of emission reduction units to achieve NDC targets. However, unlike the CDM in which abatement activities are limited to non-Annex B countries, all

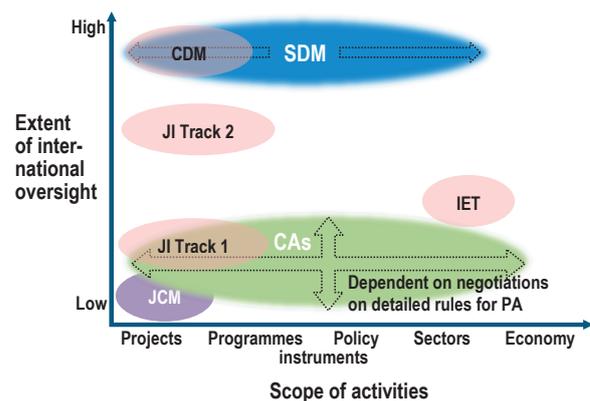


Figure 5. Comparison of market mechanisms under the PA and KP, and the JCM by level of oversight and scope of activities covered by the mechanisms.¹⁰ Notes: a) to overcome the lack of independent oversight under JI Track 1, a Supervisory Committee (JISC) was established to approve and oversee later projects under JI Track 2; b) for CAs and SDM, the applicable scope of activities remains unclear, particularly whether eligibility will be restricted to projects/programmes, or cover broader policies and sector-wide initiatives.

countries will be eligible under the SDM. The SDM is also expected to differ from the CDM in other ways, particularly in explicitly ensuring that projects are consistent with broader aspects of sustainable development, such as ecosystem protection and poverty reduction. The scope of the SDM may also be broader, potentially ranging from projects up to sector wide initiatives. Despite these differences, the adoption of many CDM features in the SDM leaves open the question as to how nuclear power projects will be treated.

OPEN QUESTIONS FOR THE PARIS MECHANISMS

International progress to define the rules of the new PA mechanisms before they enter into force has been slow, with the original timetable aiming for late 2018 pushed back until 2019. Several key issues affecting the general operation of the mechanisms, including the treatment of nuclear power, remain open.

Key issues include transparent accounting, the transition of existing projects, and directing incentives towards additional abatement

One prominent issue is the avoidance of double counting. This issue takes on additional relevance under the new approach of the PA, in which all Parties have mitigation targets, and where the new mechanisms will potentially cover broad sectoral initiatives. Ensuring environmental integrity and transparency will be crucial:

while some text in the PA reinforces this requirement for both CAs and the SDM, agreement will be needed on the final operational rules, such as on adjustments to GHG inventories to account for exchanges of emission reduction units (ITMOs) (Figure 6).

Furthermore, given that the SDM is expected to adopt the existing CDM infrastructure, a transition of ongoing CDM activities into the SDM will potentially be considered. While this approach would ensure existing CDM projects continue to be supported, it may be necessary to impose some limitations (e.g. on type of activities, contribution to sustainable development) to regulate the process.

Another key topic to be clarified is the extent to which market mechanisms can be used to achieve 'unconditional' and 'conditional' targets defined in many NDCs. The latter refers to targets that a country will adopt only with international support (financial, technical or capacity building). Since the mechanisms represent a conduit for international support, theoretically only activities that reduce emissions beyond 'unconditional' targets will be eligible to generate ITMOs. A consistent approach would also imply that ITMOs can only be used to meet 'conditional' targets.¹⁵ Nevertheless, other interpretations may be adopted in final negotiations.

Open questions on the market mechanisms will also affect the role of nuclear power in mitigation

For nuclear power, CAs appear to be a promising source of support. While yet to be defined, CAs may provide

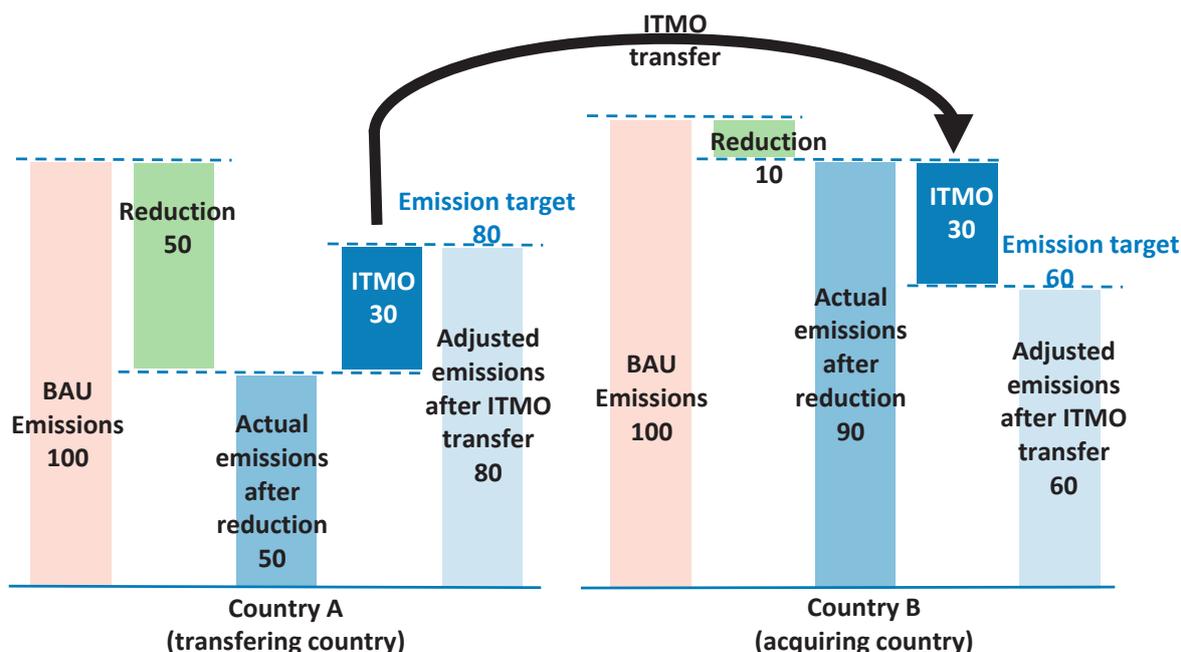


Figure 6. Illustration of the transfer of Internationally Transferred Mitigation Outcomes (ITMOs) under the Cooperative Approaches and adjustments of national GHG inventories.¹⁴

substantial flexibility for Parties to develop tailor-made bilateral agreements: if no technology limitation applies to CAs, Parties with and without nuclear power could agree to transfer emission reduction units (ITMOs); this could potentially cover bilateral project based activities (e.g. lifetime extension of existing nuclear plants, and new nuclear power projects based on current technology or, over the longer term, innovative designs) up to sectoral initiatives such as emissions trading. CAs may be of particular interest for countries considering nuclear power as an addition to their energy mix in the medium term, including as a mechanism to support technology transfer and financing (see Box on page 6). A key consideration will be ensuring that bilateral CAs adopt stringent environmental, accounting and transparency standards.

Evolution of the rules and procedures of the SDM is also relevant for nuclear energy. While the SDM may ultimately adopt many of the CDM features, it remains open whether all technologies will be eligible (e.g. large hydro projects). Countries may also decide that the SDM should prioritize technologies with superior performance across sustainability criteria (in the nuclear field these relate to advanced nuclear technologies, such as accident tolerant fuels, high temperature reactors, small modular reactors).

In addition to explicit application of CAs or SDM, both Paris mechanisms can contribute to establishing a clear price for GHG emissions across national economies, directing investors away from carbon intensive sources of energy, such as coal and gas, towards low carbon options, such as nuclear power and renewables.

Cooperative Approaches and emergent carbon pricing regimes under the PA may be the main avenues of support for nuclear power

MARKET MECHANISMS AND NUCLEAR POWER IN NDCs

The PA has generated renewed interest in market mechanisms, which are seen as cost effective tools for achieving mitigation targets and contributing to sustainable development. Many countries (around 90) anticipate the use of market mechanisms to achieve their mitigation targets.¹² In addition, several countries intend to use nuclear energy as part of their contribution to global mitigation. Market mechanisms could support the utilization of nuclear power to deliver low carbon energy (and potentially transfer surplus emission reduction outcomes to other countries). The approaches in NDCs are briefly described for China, India and Japan.

Paris Mechanisms and Financing Climate Change Mitigation

An integrated climate financing strategy is critical for mobilizing the required resources for a low carbon world. Domestic public budgets and international sources of climate finance may not be sufficient to cover the investment necessary to meet NDC targets (estimated to be well over US \$100 billion annually for mitigation).¹⁶ Additional sources will be needed for a successful financing strategy. For nuclear power, eligibility under the mechanism of the Paris Agreement could unlock additional sources to complement public budgets and private finance. These international sources could also be used to build capacity and establish a consistent investment environment for nuclear power (e.g. in terms of regulations, risk management, training), beyond purely financing infrastructure construction. Further, market mechanisms could provide a stream of additional revenues that could become significant for low carbon energy sources. On the other hand, restrictions on the eligibility of low carbon nuclear energy will channel climate to a more limited set of technologies that may not be sufficient to realise ambitious climate goals.

Most countries plan to use market mechanisms to deliver low carbon energy

India has a well-defined NDC, which mentions the importance of nuclear power in the national energy mix, including the six reactors (3.9 GW(e) capacity) currently under construction. The NDC highlights India's experiments with domestic market mechanisms together with fiscal instruments and regulatory interventions to mobilize climate finance.¹⁷ As one of the world's fast-growing large economies, India will play a significant role in determining the success of international market mechanisms under the PA and their role as effective tools for supporting mitigation activities.

China also foresees the development of nuclear energy in a safe and efficient manner as an important contributor to domestic mitigation. Regarding market mechanisms, China is focusing on the promotion of a Carbon Emission Trading System (ETS),¹⁸ in line with activities since 2013 to develop a national emission trading scheme by 2017. China's ETS allows the use of credits from CDM activities that meet certain requirements, and a similar approach may apply to the SDM. The country is also developing cooperation with other Parties with trading schemes, such as the Republic of Korea and the EU. Linking domestic emissions trading schemes, as well as other carbon pricing initiatives, could potentially be recognized under CAs.

Japan expects to continue using nuclear power to meet its NDC targets. The NDC also anticipates the use of market mechanisms such as the JCM to source ITMOs to offset domestic emissions (expected to generate 50–100 million tonnes of CO₂ by 2030).¹⁹ Japan has already implemented the JCM in 17 countries.²⁰ The JCM is an example of a potential application of CAs to help meet national targets by generating emission reduction outcomes from bilateral agreements (also potentially stemming from low carbon nuclear power, which is not excluded in the JCM).

CONCLUDING ON MECHANISMS, NUCLEAR AND THE 2°C TARGET

The market mechanisms in the PA can help to ensure that the low cost abatement potential of nuclear power is best utilized to achieve the Agreement’s ambitious 2°C target, provided that the main barriers faced by nuclear energy are addressed, particularly regarding safety and waste management. Table 2 summarizes the potential options for support to nuclear energy under the existing Kyoto Protocol mechanisms and those emerging under the PA. The framework accompanying the PA market mechanisms could also facilitate the emergence of a consistent international regime to manage and support investments in nuclear power (i.e. stable regulations, know-how and knowledge exchange between Parties, support to enhance environmental safety measures drawn from the expertise of the IAEA and others). Creating such an environment requires sustained political support and general acceptance at the international level.

PA market mechanisms may provide an opportunity to develop a consistent global framework for nuclear investment

In addition to supplying low carbon electricity to support the ambitious climate target, nuclear power can also provide access to stable and reliable power for households, businesses, and public services, such as hospitals, schools, water/sanitation facilities, thereby contributing to the UN Sustainable Development Goals, such as poverty alleviation, health and education, and economic development (IAEA 2016c). Compared to other energy technologies, nuclear power has low land and material requirements and imposes a relatively small burden on ecosystems and health from a life cycle perspective (IAEA 2017). Accordingly, with the right design of the SDM and CAs under the Paris Agreement, nuclear power can play an appropriate role in both climate change mitigation and sustainable development. The flexibility of the PA mechanisms can also ensure that the legitimate choice of some countries to forgo low cost nuclear power does not necessarily impose the burden of higher abatement costs on the global community. In other words, if designed accordingly, the mechanisms can ensure there are incentives for countries willing to achieve additional abatement with nuclear power (i.e. beyond domestic targets), reducing the need for countries without nuclear power to deploy more costly abatement options, and fostering international cooperation.

Mechanism	International agreement	Support for nuclear power?	Potential scope for support	Comments
Clean Development Mechanism (CDM)	Kyoto Protocol	No	N/A	
Joint Implementation (JI)			N/A	
International Emissions Trading (IET)		Neutral	Supported indirectly as a low carbon technology	Similar support applicable under the EU Emissions Trading Scheme
Voluntary market	N/A	Limited interest from buyers	N/A	Non-controversial activities with high sustainable development contributions (e.g. reforestation, energy access) are the preferred options for voluntary buyers
Cooperative Approaches (CAs)	Paris Agreement	Final rules and procedures yet to be agreed	Support could include: <ul style="list-style-type: none"> • capacity building/training, security enhancements, technology transfer • direct infrastructure construction and plant operation • indirect support through emissions trading/carbon pricing 	Mixed acceptance of nuclear energy among Parties. Seen by some as important contributor to NDC targets and generating carbon credits (bilaterally and via ETS)
Sustainable Development Mechanism (SDM)				As a multilateral, centrally governed mechanism, a consensus approach on eligible technologies is expected in SDM (similar to CDM)

Table 2. Support to nuclear energy under different market mechanisms

For more on the role of nuclear power in climate change mitigation, please see:

<https://www.iaea.org/topics/nuclear-power-and-climate-change>



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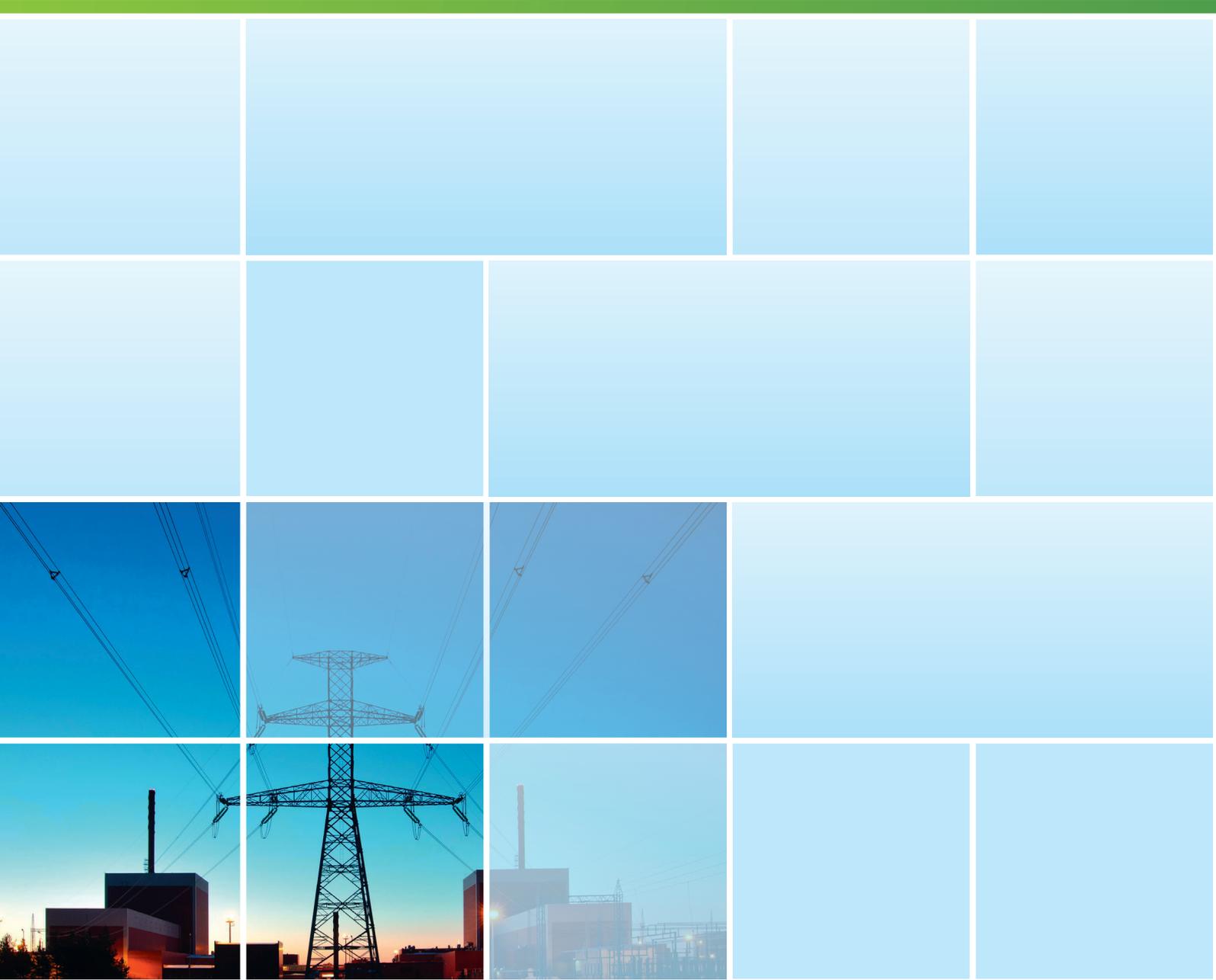
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Acknowledgement

The IAEA wishes to thank Axel Michaelowa and Perspectives Climate Group GmbH for their contributions in the preparation of this brochure.



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November 2017