The STANDING GROUP ON LONG-TERM CO-OPERATION &
The COMMITTEE ON ENERGY RESEARCH AND TECHNOLOGY

Hosts a joint workshop on

“Energy Technology and Policy Post COP 21”

14 June, 2016
Background note for SLT-CERT Joint Workshop

Background

In a follow up to the Governing Board request at December 2010 meeting to identify IEA priorities, the Standing Group on Long-Term Co-operation (SLT) and Committee on Energy Research and Technology (CERT) held a series of discussions to seek solutions for increased collaboration between the SLT and the CERT. Hosting workshops to tackle issues cutting across the energy technology and policy landscape was seen as a good opportunity to discuss best areas for collaboration and to look at mechanisms on how the two committees could best work together.

On 4 June 2013, the SLT and the CERT held their first joint workshop and delegates confirmed its usefulness to enhance collaboration. A request was made to the Secretariat to organise a joint workshop every year, with a focus on analysis relevant to both committees. It was suggested that the focus of the yearly Energy Technology Perspectives (ETP), which deals with issues crossing the Technology/Policy/Markets aspects, would be a good focal point for how SLT and CERT can guide Secretariat analysis. On 3 June 2014, the SLT and the CERT held a second joint workshop on “The Role of Energy Technology and Innovation in Combating Climate Change”, a topic that was fully aligned with the thematic focus of the ETP 2015 report. On 9 June 2015, a third joint workshop on “Mobilising Climate Action towards COP21: The role of Energy Technology Innovation and Urban Energy Systems for Long-Term Energy Sustainability” was held to provide input for the IEA activities ahead of the COP 21. The workshop was considered by participants a useful platform to jointly address energy policy and technology aspects related to the international climate change negotiations that culminated in the Paris Agreement delivered under the UNFCCC.

At the CERT meeting held on 16 February 2016 and the SLT meeting held on 22 March 2016 it was agreed that the joint SLT/CERT workshop to be held on 14 June 2016 topic should focus on IEA role in energy technology and policy analysis post COP 21.

Workshop Objectives

The main objective of the 2016 workshop will be to provide an opportunity for SLT and CERT delegates to jointly examine the role that the IEA should play in the post COP 21 world. The primary focus will be on the role of the IEA in supporting the implementation of the energy sector associated issues of the Paris Agreement. It will examine IEA’s current work as well as shape its future analytical outputs. The first session will examine opportunities for the IEA in a post-COP21 world with respect to tracking energy sector transformation and clean energy technology innovation and deployment. The second session will primarily focus on assessment of the ambition for the energy sector to limit the temperature rise ‘well below 2°C’ above pre-industrial levels and subsequent IEA work in developing energy sector analysis on options.
STANDING GROUP ON LONG-TERM CO-OPERATION (SLT)
COMMITTEE ON ENERGY RESEARCH AND TECHNOLOGY (CERT)

Joint Workshop on

“Energy Technology and Policy Post COP 21”

DRAFT AGENDA

14:00-14:10 Welcoming remarks
SLT Chair: Mary B. Warlick, CERT Chair: Alicia Mignone

14:10-14:50 Panel 1: Setting the Scene: Implementation of Paris Agreement
Paul Watkinson, Ministry of Ecology, Sustainable Development and Energy (MEDDE), Head of the Climate Negotiation Team of France
Teresa Ribera, The Institute for Sustainable Development and International Relations (IDDRI), Director
IEA Speaker: Kamel Ben Naceur, Director, STO

14:50-15:30 Discussion: Opportunities for the IEA role in a post-COP21 world

15:30-16:00 Coffee

16:00-16:40 Panel 2: Delivering ‘well below 2°C’ temperature goal
Jean-Charles Hourcade, Directeur de Recherche CNRS Centre International de Recherche sur l’Environnement et le Développement (CIRED)
Virginie Marchal, OECD, Environment Directorate, Policy Analyst
IEA Speaker: Kamel Ben Naceur, Director, STO

16:40-17:30 Discussion: ‘Well below 2°C’ ambition and IEA analytical input

17:30-17:45 Workshop conclusion

17:45-18:00 Closing: how to enhance SLT/CERT co-operation to effectively drive post-COP 21 analytical work
SLT Chair: Mary B. Warlick, CERT Chair: Alicia Mignone
Panellists’ biographies

**Teresa Ribera** is director of The Institute for Sustainable Development and International Relations (IDDRI). Before her appointment as director, in July 2014, she was Senior Advisor on International Climate Policy at IDDRI. Teresa Ribera was Secretary of State for Climate Change in Spain’s Government between 2008 and 2011, responsible for environment and climate policies as well as the national meteorological agency. Between September 2012 and June 2013 she has been working in the renewable energy industry. She held different technical positions in the ministries of Public Works, Transportation and Environment (1996-2004) and was Director-General for climate (2004-2008). Teresa Ribera graduated in Law, holds the diploma in constitutional law and political science of the Centro de Estudios Constitucionales (Spain) and belongs to the Cuerpo Superior de Administradores Civiles del Estado.

**Paul Watkinson** is head of the Climate Negotiation Team of France. He has been a climate negotiator for France since 2000 and head of the French delegation to the UN Framework Convention on Climate Change since 2007. He was also one of the EU spokesmen between 2009 and 2013. He attended 17 of the 21 annual COPs (conference of the parties) that have taken place so far. Paul Watkinson studied at Trinity College at Cambridge as well as Ecole nationale d’administration in Strasbourg.

**Jean-Charles Hourcade** is Director of research at the Centre National de la Recherche Scientifique (CNRS) and director of the CIRED (Centre international de recherches sur l'environnement et le développement), a laboratory belonging both to CNRS and to EHESS (Ecole des hautes études en sciences sociales, Paris). Since 1990, he played a key role in french social science research coordination for backing up the awareness and negotiating capacities of official and governmental agencies in charge the climate change. He is a convening lead author of chapters for the Second (1996) and the Third Assessment Report of the IPCC. Jean-Charles Hourcade obtained Doctorat d'Etat en Sciences Economiques from Université de Paris VIII 1977, Doctorat en Sciences Sociales from Université de Paris I and Diplôme de l'Ecole des Hautes Etudes Commerciales (HEC).

**Virginie Marchal** is a policy advisor at the Environment directorate of the OECD since 2010. Her research areas include green finance and investment and low-carbon infrastructure (renewable energy, sustainable mobility, climate-smart agriculture and green cities). She co-authored the report *Aligning Policies for a Low-carbon Economy*, a joint report with the International Energy Agency the International Transport Forum and the Nuclear Energy Agency commissioned for the 2015 OECD Ministerial Council Meeting. Prior to joining the OECD, Virginie hold several positions in the oil and gas industry for BP Biofuels in London, Total Gas Argentina and Total France. She also collaborated with IDDRI and the European Climate Foundation during her studies. Virginie holds a management degree from Ecole des Hautes Etudes Commerciales (HEC, Paris) and a Master of Public Affairs from Sciences-Po Paris (Sustainable Development).
Background information on sessions

Session 1: Implementation of Paris agreement and the role of the IEA

The Paris Agreement: Background

As a part of the climate change agreement negotiated at the COP 21 in Paris, countries agreed upon an ambition to limit the global average temperature rise to well below 2°C and pursuing efforts to limit the temperature increase to 1.5°C. The collective goal of the Paris Agreement further aims to reach the global peaking of greenhouse gas emissions as soon as possible. The Agreement sends a strong signal to governments, businesses and investors, and lays the groundwork to deliver energy sector transformation by accelerating investments in cleaner technologies and energy efficiency. However, its success will ultimately depend on the ambition of national actions.

The agreement is designed around bottom up contributions towards GHG emissions mitigation submitted by countries, the NDCs. By the end of March 2016, 161 pledges had been submitted, covering 188 countries and more than 95% of energy-related GHG emissions. NDC targets will be updated on a five-year basis. They will also be supported by a single methodological framework to account for GHG emissions and track progress of NDCs for all countries with built-in flexibility for Parties' different circumstances.

To assess progress towards achievement of the long term temperature goals and GHG emissions targets of the Paris Agreement, a facilitative dialogue among Parties will be convened in 2018 to take stock of the collective efforts. The first formal global stocktake of progress in achieving NDCs will take place in 2023 and every five years thereafter. The five-year cycle for taking stock of progress and revising NDCs is intended to create an opportunity for countries to raise mitigation ambition further as they gain experience and as technology costs reduce. In the agreement, countries are also encouraged to develop and communicate national long-term, low-carbon development strategies to link their short-term national actions with the collective goal of the Paris Agreement to peak global emissions as soon as possible and undertake rapid reductions thereafter.

The IEA’s 4 “E”s

The four main areas of IEA focus are energy security; economic development; environmental sustainability; and engagement worldwide. Careful balance needs to be achieved when delivering upon all the key areas of focus. Energy sector plays a very important role in delivering upon the long term GHG emissions targets of the Paris Agreement. Energy production and use accounts for two-thirds of global greenhouse-gas emissions. However, energy sector must cut emissions, while powering economic growth, boosting energy security & increasing energy access. All areas of IEA focus must therefore be taken into account in the Post COP 21 IEA analyses. Moreover this needs to happen in broad partnership with partner countries, especially major economies, to find solutions to shared energy and environmental concerns.

Clean Energy Technology Innovation and Collaboration

Accelerated deployment of cost-competitive, low-carbon technologies and development of innovative technologies is critical to achieve emissions reduction in line with a 2°C goal. The launches of Mission Innovation and the Breakthrough Energy Coalition to accelerate technology innovation on the margins of the COP 21 can both provide an impetus for clean energy technology development. However, according to IEA analysis, the overall rate of development and deployment of clean energy technologies currently falls short of the 2°C goal (IEA, 2015). The NDCs are expected to drive demand for clean technology, and their implementation ought to work towards closing the technology gap to meet the 2°C goal.
IEA can deepen its support for technology innovation through its existing and new initiatives. IEA currently provides a thorough technological analysis through its annual Energy Technology Perspectives publication. Linked to this analysis, IEA Energy Technology Roadmaps have for over five years helped set the milestones needed to achieve the transition to a low-carbon energy system, and are now being evolved into living initiatives that can carry forward the high level recommendations and turn them into tangible actions. Additionally, IEA already has a long track record in helping to build a supportive enabling environment for collaboration in technology innovation. The IEA Technology Collaboration Programmes (TCPs) have both fed into and taken advantage of the multitude of tools developed by the IEA. They provide information on how technology innovation can contribute to achieving policy and business objectives, and to track progress on these goals.

Supporting UNFCCC processes

IEA actively contributes towards the UNFCCC negotiations process and regular meetings by providing technical input on specific issues and organising technical side-events. IEA co-chairs the Climate Change Expert Group (CCXG) with the Environment Directorate of the OECD. CCXG provides analysis of technical issues in the international climate change negotiations and convenes meetings of technical experts from developed and developing countries to promote informal dialogue on selected issues. IEA is also currently supporting the French and future Moroccan Presidency during the upcoming year in the lead-up to COP22 in Marrakesh. Furthermore, the IEA is preparing a publication on Energy, Climate Change, and Environment 2016, which will include discussions on selected energy sector implications of the Paris Agreement, such as tracking progress of the energy elements of NDCs or enhancing energy sector resilience.

UNFCCC Transparency framework and the IEA work on energy sector tracking

The Paris Agreement established a transparency framework, referring to sharing of information to mitigation, adaptation, finance, technology and capacity building. The detailed procedures and guidelines for the framework are yet to be developed. IEA however already possesses a considerable expertise in tracking energy sector metrics. IEA could thus firstly provide technical input into the UNFCCC’s implementation of the Paris Agreement, including development of methodologies to track energy NDCs and processes to scale up pre-2020 ambition. Secondly, IEA currently monitors CO2 from the energy sector through its yearly “CO2 Emissions from Fuel Combustion” publication. IEA can consider expanding its statistical capacity to monitor the drivers of transformation of the energy sector, complementing the monitoring of GHG emissions carried out through UNFCCC greenhouse gas inventories (for example by looking at whether investment patterns are shifting rapidly enough to low-carbon). Enhancement of the IEA tracking capacity can enable a critical input to the five-yearly reviews of progress under the Paris Agreement, as it could provide a clearer picture of where emissions are headed (due to factors such as locked-in infrastructure) not just where they are today. Finally, IEA could also play a role in the expanded capacity building efforts under the UNFCCC, including training for statistics, modeling, and clean energy policy.

Suggested points for discussion

- Given the IEA expertise in the decarbonisation of the energy sector, how can IEA best contribute towards the UNFCCC processes and COP meetings on implementation of Paris Agreement?
- Do delegates have any guidance in terms of ensuring that the IEA’s focus areas are in balance?
- What can be the role of the IEA energy technology innovation work in facilitating the developments needed for the decarbonisation of the energy sector in line with the ‘well below 2°C’ targets?
- How can IEA energy technology innovation capacity be more effectively translated to national and international policy measures?
• What areas of clean energy investment should the IEA focus on to develop and disseminate best practice?
• There is a variety of new clean energy technology market areas. What should the IEA be focusing on to ensure value added?
• What role should IEA play in tracking energy sector metrics relevant for the UNFCCC transparency framework?
• How can IEA statistical outputs best contribute towards the tracking progress under the UNFCCC five yearly reviews?

Session 2: IEA analytical input to support the delivery of a below 2°C future

Delivering upon the ambition to limit the global average temperature rise to ‘well below 2°C’ would require significant energy system transformations through accelerated technology deployment and behavioural change, driven by stronger policies. The IPCC has been invited by the Paris Agreement to provide a special report in 2018 on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways (paragraph 21 of the Paris Agreement). IEA analysis has a potential to contribute to the IPCC report and UNFCCC stocktaking dialogue in 2018.

The IEA is considering how its energy system analysis could benefit from and contribute towards enhancement of the knowledge base to achieve ‘well below 2°C’ goalpost. The CERT and the SLT will be instrumental in guiding the secretariat on the level of ambition that the energy sector should seek to achieve. New scenarios would require new analysis as well an expansion of the modelling tools used to develop IEA long-term scenarios. The aim would be to gain understanding of the technology shifts, the needed non-technology levers as well as the pace needed to effect such structural changes. However, to pursue well below 2°C scenarios, the IEA would also have to consider how to identify new emissions pathways (including their probabilities) and the associated carbon budget’s range consistent with a ‘well below 2°C’ scenario1.

IEA analysis of moving beyond 2°C

Up to date, there have been a limited number of studies with scenarios consistent with a ‘well below 2°C’ temperature limit, and no study specifically assesses energy-system characteristics of ‘well below 2°C’. The IEA can support filling this gap by expanding its analysis of what would ‘well below 2°C’ mean for the energy system. IEA long-term modelling scenarios could improve the understanding of the mix and timing of technologies and policies needed to achieve emissions pathways that are considered as consistent with the long-term Paris Agreement goal.

The analytical scenarios will require a set of ambitious low-carbon strategies across both the supply and end-use side. The long-term goal of net zero emissions of GHGs in the second half of this century will require considerable technological innovation to enhance low-carbon technology development and deployment. The section below highlights some of the areas, which will need to be considered.

(1) Emissions reduction and the pace of the energy-system transformation analysis

Significant additional emissions reductions and at much higher pace will need to be analysed to achieve ‘well below 2°C’. Peak and significant decline in CO2e emissions during the twenty-first century will be required in all ‘well below 2°C’ scenarios. The distinction between 2°C and ‘well

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1 For further detail on IPCC Representative Concentration Pathways that are used to calculate carbon budget see Annex 1.
2 IPCC assigns a considerable uncertainty level to its predictions, which thus means that a level of emissions reduction in line with IPCC will only deliver outputs that are at best equivalent to IPCC uncertainty rate.
below 2°C’ scenarios will be in the timing and the pace of cumulative emission reduction. Limiting the end-of-century warming to ‘well below 2°C’ relative to pre-industrial levels would leave a much tighter budget for the energy sector in comparison to the 2°C (as discussed above). As a reference, available model scenarios used by the IPCC for its latest assessment additionally show that 1.5°C-consistent scenarios reach global carbon neutrality between 2045 and 2065, which is one to two decades earlier than scenarios that are consistent only with 2°C (IIASA, 2015).

(2) Analysing contribution of different sectors of the energy system

Analysis of ‘well below 2°C’ scenarios would require expanded modelling capacity on both supply and end-use models. Under the current IEA model scenarios, much of the supply-side mitigation potential is exhausted by 2050 already with the 2°C temperature limit (IEA, 2015). In order to push the temperature limit to ‘well below 2°C’, there is a need for an enhanced focus on potential emission reduction on the end-use side. Revision on the end use side could however have to go beyond technological solutions and consider behavioural change and policy induced alternatives, which indicates a need to overcome barriers towards realizing the full mitigation potential in demand-side sectors.

With regard to the pace of action, ‘well below 2°C’ consistent scenarios would require a near-term decarbonization of energy supply that is more rapid than in 2°C scenarios. Unabated fossil-based electricity generation would have to be phased out earlier and low carbon energy technologies will have to be introduced at a faster pace. This decarbonisation could be achieved through early reductions in the electricity sector, but additional solutions, such as enhanced energy efficiency, will be required during coming decades for demand-side sectors.

(3) The importance of sinks and negative emissions technology analysis

For a below 2°C scenario, the IPCC estimates the need to capture over 20 GtCO₂ per annum in total by the mid-century, while the ETP 2016 estimates just under 6 GtCO2 of capture in 2050 (IPCC, 2014; IEA, 2016). A range of new technologies and acceleration of deployment of existing technologies will be required to achieve ‘well below 2°C’. An important element in analysing an ambition below 2°C will be to refine the role of carbon sinks and negative emission technologies, which into a great extent goes well beyond the scope of the energy sector analysis. With respect to the energy sector, technologies related to the BECCS could be the main focus of the analysis of the possibility of enhanced negative emissions.

Suggested points for discussion

- How ambitious should IEA be in terms of its analysis of the role of the energy sector in meeting ‘well below 2°C’ objectives?
- What role should the IEA play within the energy sector community in terms of ‘well below 2°C’ ambition?
- What do the delegates recommend as areas of specific joint SLT-CERT analytical focus in terms of ‘well below 2°C’ ambition?
- What changes in terms of the energy sector shifting from 2°C to ‘well below 2°C’ do the delegates foresee or are currently underway?
- What information do the delegates have in terms of transforming their national energy sectors on a pathway to deliver ‘well below 2°C’?
- Did national governments collect information on achieving ‘well below 2°C’ ahead of COP 21?
Annex 1: Below 2°C Representative Concentration Pathways

The IPCC developed Representative Concentration Pathways (RCPs) to evaluate a variety of factors influencing global temperature change and to provide projections of possible climate outcomes. RCPs are not definitive scenarios, but sets of time-dependent forcing projections that could potentially be realized with more than one underlying socioeconomic scenario (IPCC, 2013). To develop its Representative Concentration Pathways (RCPs), IPCC evaluates radiative forcing (RF) to determine GHG emissions concentrations (See Figure 1). The primary products of the RCPs are concentrations but they also provide GHG emissions pathways.

**Figure 1. Development of IPCC Climate Projections**

![Diagram of IPCC Climate Projections](Source: IPCC, 2013)

Analysing projections from a large number of different scenarios with similar RF and emissions characteristics, IPCC presented results for four summary scenarios in its fifth Assessment Report: RCP 2.6, RCP4.5, RCP6.0 and RCP8.5. Under the RCP2.6 pathway global warming stays below 2°C throughout the 21st century, but it exceeds 2°C under all the other pathways (See Figure 2).

**Figure 2. Climate Projections within IPCC Representative Concentration Pathways**

![Graph of Climate Projections](Source: IPCC, 2013)

3 Radiative forcing is used to assess and compare the anthropogenic and natural drivers of climate change. IPCC adopted the definition of Radiative Forcing according to Ramaswamy et al. (2001) as ‘the change in net (down minus up) irradiance (solar plus longwave; in W m–2) at the tropopause after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values’.
Annex 2: Carbon budget to achieve ‘well below 2°C’

To limit warming caused by CO₂ emissions to a given temperature target, cumulative CO₂ emissions from all anthropogenic sources need to be limited to a certain carbon budget⁴. Actively removing CO₂ from the atmosphere, for example through enhanced re-forestation or by the combined use of biomass energy and carbon capture and storage, would further accelerate the decrease in forcing (IPCC, 2013). The IPCC AR5 provides an overview of available ‘well below 2°C’ climate model scenarios, linking likelihood⁵ of reaching a specific temperature limit with a range of emission concentrations (IPCC, 2013). The likelihood of reaching a goal of 2°C or below, which could be considered as consistent with the long term Paris Agreement goal, can be associated with scenarios that reach concentrations of up to 500 ppm CO₂eq by 2100⁶ (IPCC, 2014). To reach a likelihood of at least 66% of below 2°C outcome, concentrations below 450 ppm CO₂eq by 2100 (in the range of 430 to 480 ppm) are required (IPCC, 2014). At this concentration range, reaching 1.5°C is however more unlikely than likely. There is only a limited number of individual model studies that have explored levels below 430 ppm CO₂eq, making their representative analysis and enhanced likelihood of reaching 1.5°C target difficult (IPCC, 2014).

The selection of the desired concentrations range has important implication for the development of emissions pathways consistent with specific temperature goals and subsequent IEA scenarios. There are large differences in emissions pathways depending on the extent of how far ‘below 2°C’ would the intended analysis strive to go. In order to achieve 66% likelihood of staying below 2°C, a carbon budget of 1000Gt was available in 2011 (IPCC, 2014)⁷. Achieving net anthropogenic warming below 1.5°C with 66% likelihood however implies that in 2011 a carbon budget of only 400Gt⁸ was available (IPCC, 2014). Additionally, the envisaged total remaining carbon budget has to be divided within all sectors of the economy. While the energy sector will play an important role in the ‘well below 2°C’ world, other sectors will be equally important, and so an emissions pathway specific for the energy sector is therefore needed.

Exploring the IPCC cumulative carbon emission ranges for likely below 2°C consistent scenarios shows that total emissions are some 550–1300 GtCO₂ during the period of 2011–2050, but only 630–1180 GtCO₂ during 2011–2100 (IPCC, 2014)⁹. Examining a limited number of studies with emissions levels reaching 1.5°C up to date implies net removal of CO2e emissions from the atmosphere of over 500 GtCO₂ during the second half of the 21st century (IIASA 2015). Furthermore, to move below 2°C,

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⁴ The total amount of anthropogenic CO₂ released in the atmosphere (often termed cumulative carbon emissions) is a good indicator of the atmospheric CO₂ concentration and hence of the global warming response to CO₂. The change in CO₂ concentration is the main cause of difference in the total RF among the IPCC scenarios (IPCC, 2013). Aerosols have a large negative contribution to the total forcing (about −40 to −50% in 2010), but this contribution decreases (in both absolute and relative terms) in the future for all the RCPs scenarios (IPCC, 2013).

⁵ IPCC Likelihood Scale linking term with likelihood of outcome: Virtually certain - 99-100% probability; Very likely 90-100% probability; Likely 66-100% probability; About as likely as not 33 to 66% probability; Unlikely 0-33% probability; Very unlikely 0-10% probability; Exceptionally unlikely 0-1% probability.

⁶ Scenarios that reach 530 to 650 ppm CO₂eq concentrations by 2100 are more unlikely than likely to keep temperature change below 2°C. While scenarios reaching concentration levels of 500 ppm CO₂eq by 2100 are more likely than not to deliver 2°C (depending on overshoot). Scenarios reaching long-term concentrations of about 450 ppm CO₂eq in 2100 are likely to limit temperature change to less than 2°C. Finally, mitigation scenarios in which temperature increase is more likely than not to be less than 1.5°C relative to pre-industrial levels by 2100 are characterized by concentrations in 2100 of below 430 ppm CO₂eq. (IPCC AR5)

⁷ 2011 is the latest year for which official IPCC carbon budget estimates are available. Some analysts estimate that total cumulative CO₂ emitted from 2011 to 2014 was 157Gt, which would result in a carbon budget of 843Gt in 2015 (Global Carbon Project, 2015)

⁸ This would result in an estimated carbon budget of 243Gt in 2015 (Global Carbon Project, 2015)

⁹ Furthermore, exploring the IPCC cumulative carbon emission ranges for 1.5 °C-consistent scenarios shows that total emissions are some 680–800 GtCO₂ during the period of 2011–2050, but only 90–310 GtCO₂ during 2011–2100 (IIASA, 2015).
net zero carbon emissions globally (that is, carbon neutrality) have to be achieved by mid-century (between 2045 and 2065, or about 10–20 years earlier than for 2°C scenarios (IIASA 2015). This translates into a need to accelerate the phase-out of GHG emissions. Technologies that can generate negative emissions, such as bioenergy carbon capture and storage (BECCS), as well as CCS technology applications to capture process and fugitive emissions or land-use sinks may equally have an important role to play.

Given the limited carbon budget outlined above, considerations over the scale and pace of energy sector decarbonisation will be important in any scenario going below 2°C. Other sectors will however play an equally important role as non-energy sector emissions reduction and sinks will very likely be crucial to deliver the needed scale of decarbonisation and negative emissions.

References


Ramaswamy et al. (2001) Radiative forcing of climate change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.