



Technology Executive Committee

17 September 2018

Seventeenth meeting

Bonn, Germany, 25–28 September 2018

Background paper on possible work by the TEC on the innovation of emerging climate technologies, including zero-emission and negative emission technologies

Cover note

I. Introduction

A. Background

1. In 2017, in the context of its rolling workplan,¹ the Technology Executive Committee (TEC) agreed to continue working on the innovation (including the research, development and demonstration) of climate technologies.² It noted that this work may relate to the innovation of emerging climate technologies, such as zero-emission and negative-emission technologies.

2. As per activity 3 of its workplan, TEC 16 requested its task force on innovation and RD&D to prepare a background paper on possible work by the TEC on the innovation of emerging climate technologies, including zero-emission and negative-emission technologies, for consideration at TEC 17.³

B. Scope of the note

3. The annex to this note contains the background paper referred to in paragraph 2 above.

C. Possible action by the Technology Executive Committee

4. The TEC will be invited to identify next steps in its work on the innovation of emerging climate technologies, in the context of its future workplan.

¹ See activity 3, deliverable 3.3: <https://bit.ly/2NJkT0t>.

² Agreed at its 15th meeting. See the meeting report of the 15th meeting, paragraph 45: <https://bit.ly/2ufzYPo>.

³ See the meeting report of the 16th meeting, paragraph 39: <https://bit.ly/2LcZFqi>.



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Background paper on possible work by the TEC on the innovation of emerging climate technologies, including zero-emission and negative emission technologies

Background paper

I. Introduction

A. Background

1. In recent years, emerging technologies have captured the attention of governments, private sector and the broader public alike. It has been said that we are undergoing a new technological revolution, with emerging technologies having the potential to impact profoundly on the way we live. What do these technologies mean for climate change? What are the key ‘emerging climate technologies’ and what are their environmental, economic and social impacts? How can policy-makers support the innovation of such technologies?

2. In 2017, in the context of its rolling workplan,¹ the Technology Executive Committee (TEC) agreed to continue working on the innovation (including the research, development and demonstration) of climate technologies.² It noted that this work may relate to the innovation of emerging climate technologies, such as zero-emission and negative-emission technologies. In March 2018, the committee requested its taskforce on innovation to prepare a background paper on possible TEC work on the innovation of emerging climate technologies, including zero-emission and negative-emission technologies, for consideration at TEC 17 (25-28 September 2018).³

B. Purpose of the paper

3. This background paper aims to provide an overview of possible work that the TEC may undertake on the innovation of emerging climate technologies. It is based on a brief literature review and an exploration of work in this field. It provides information on:

- (a) What emerging climate technologies are and why they are important;
- (b) Who the key actors are working on emerging climate technologies;
- (c) What work the TEC could undertake on the innovation of emerging climate technologies and when, and;
- (d) Possible next steps.

C. Emerging climate technologies

Definition

4. The literature review discovered two definitions that are used to describe emerging technologies. Rotolo, Hicks and Martin describe an emerging technology as:

¹ See activity 3, deliverable 3.3: <https://bit.ly/2NJKt0t>.

² Agreed at its 15th meeting. See the meeting report of the 15th meeting, paragraph 45: <https://bit.ly/2ufzYPo>.

³ See the meeting report of the 16th meeting, paragraph 39: <https://bit.ly/2LcZFqi>.

“[A] relatively fast growing and radically novel technology characterized by a certain degree of coherence persisting over time and with the potential to exert a considerable impact. (...) Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous”.⁴

5. Furthermore, the World Economic Forum defines emerging technologies as:⁵

(a) “Technologies which arise from new knowledge, or the innovative application of existing knowledge

(b) “Those that lead to the rapid development of new capabilities

(c) “Those that are projected to have significant systemic and long-lasting economic, social and political impacts

(d) “Those that create new opportunities for and challenges to addressing global issues

(e) “Technologies that have the potential to disrupt or create entire industries.”

6. While no definition was found for an ‘emerging climate technology’, from the above definitions it may be concluded that an emerging climate technology is any climate technology that can also be described by one (or both) of the above definitions. Note that in the literature often the words ‘emerging’, ‘breakthrough’, ‘innovative’, ‘disruptive’, ‘new’, ‘transformational’, ‘exponential’, ‘game-changing’, and ‘revolutionary’ were interchangeable.

Examples of emerging climate technologies

7. The broadness of the above definitions provides significant space for subjective consideration of what and what might not be considered an emerging climate technology. The TEC provides some guidance on this, by noting that its work in this area should include a consideration of zero-emission and negative-emission technologies (which are mitigation technologies which may have significant adaptation co-benefits):

(a) **Zero-emission technologies** = technologies that emit zero (or negligible) emissions when in operation.⁶ Emerging technologies in this field may include most renewable energy technologies. Zero-emission technologies might also include ‘soft’ technologies that facilitate the provision of goods or services in non-emitting ways.

(b) **Negative-emission technologies** = technologies that remove greenhouse gas emissions from the atmosphere.⁷ The TEC will undertake further work to identify what technologies may be considered negative emission technologies, including by considering the work of the IPCC in this area.

8. In addition to these technologies, there are many other emerging technologies, sometimes called general purpose technologies, that are not necessarily developed specifically for climate purposes but may impact climate change mitigation or adaptation. These include: next generation batteries; precision and cellular agriculture and hydroponics;⁸ artificial intelligence; blockchain; 3D printing; the internet of things; nanotechnologies; and big data. In undertaking its work on emerging climate technologies, the TEC shall consider both adaptation and mitigation technologies. In this context, further work needs to be undertaken to identify emerging technologies in the adaptation space, and the potential role of the aforementioned general purpose technologies in supporting countries to build resilience and adapt to climate change.

⁴ <https://arxiv.org/pdf/1503.00673.pdf>

⁵ <http://reports.weforum.org/global-agenda-council-2012/councils/emerging-technologies/>

⁶ If emissions during the fabrication of the technology were included the concept of a zero-emission technology would be impossible, at least at this point in time.

⁷ <https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/Negative-Emissions-Technologies---Grantham-BP-8.pdf>

⁸ http://www3.weforum.org/docs/WEF_Top_10_Emerging_Technologies_report_2017.pdf. See also the European Academies Science Advisory Council policy report 34: “Negative emission technologies: What role in meeting Paris Agreement targets?”

Why focus on emerging climate technologies?

9. Many of the TEC's documents and publications have highlighted the importance of enhancing climate technology innovation for supporting Parties to achieve the aims of the Paris Agreement and address climate change.⁹ In this context, enhancing the innovation of emerging climate technologies, and emerging technologies more broadly, has significant potential to speed up and scale up the global response to climate change. Although one needs to be cautious not to fall into technological optimism,¹⁰ it may be noted that emerging technologies have the potential to greatly facilitate the transformation to a low-carbon and climate resilient world as articulated in the Paris Agreement. In the best case, the innovation of emerging climate technologies may support developing countries to undertake technology leap-frogging, moving directly to the wide-scale use of innovative low-emission technologies that deliver social benefits without having a negative impact on the environment. However, further work needs to be undertaken to understand just what impact such technologies would have on the economy (e.g. the productivity paradox),¹¹ the environment (e.g. positive, negative or no impact), and society (e.g. ethical and moral impact, and existing societal inequalities). Considering the broad impact that emerging technologies are projected to have on the way we live, and their potential contribution to the global response on climate change, it is relevant and timely that the TEC considers the innovation of such technologies.

D. Key actors

10. Most of the world's global players are considering the role and potential impact of emerging technologies, including emerging climate technologies. Such actors, and their potential roles, include:

(a) United Nations organizations, which may provide a space for multilateral consideration of the potential benefits and impacts of such technologies;

(b) Intergovernmental and international organizations, which may identify policies and actions that governments may implement to harness the potential benefits and mitigate the potential negative impacts.

(c) Private sector, which may research, develop and commercialize emerging climate technologies;

(d) Academia, which may develop a detailed understanding of the potential benefits and impacts of such technologies;

(e) Governments, which may implement policies to harness such technologies and mitigate their potential negative impacts;

(f) NGOs, which may raise awareness on the potential benefits and negative impacts of such technologies, and advocate for policy change in this context.

E. Possible work of the Technology Executive Committee

11. As noted above, many actors are analyzing the potential role of these technologies. However, due to the rapid innovation of these technologies, policymakers around the world are often struggling to stay abreast of new developments.¹² Consequently, policy development can be slower than the innovation of these technologies. This means that emerging technologies are sometimes in use or even become outdated before regulation catches up.¹³ In addition, policy-makers and other stakeholders often lack access to

⁹ See for example, <http://unfccc.int/tclear/tec/brief10.html>.

¹⁰ <https://repository.law.umich.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1927&context=articles>

¹¹ Brynjolfsson, Erik (1993). "The productivity paradox of information technology". *Communications of the ACM*.

https://www.researchgate.net/publication/220423773_The_Productivity_Paradox_of_Information_Technology.

¹² Friedman, Thomas. 2016. *Thank you for being late*. Farrar, Straus and Giroux.

¹³ Ibid.

knowledge on the positive and negative impact of these technologies. In many cases, such knowledge is evolving as technology developers, governments and other key actors continue to test and design these technologies. All of these challenges are amplified in developing countries, where policy-makers often face even greater challenges in staying up-to-date, building capacity and juggling conflicting demands. There is thus a need for a trusted source of information on the potential role of these technologies in supporting the global response to climate change, and on policies that could support the innovation (and social consideration and acceptance) of such technologies. In this context, the TEC could complement existing efforts by bringing together existing information produced by key actors to shed light on the potential role of emerging climate technologies in facilitating the global transformation to a low-emission and climate resilient world. The TEC provide insights on potential positive and negative impacts of technologies, noting these are specific to country and context, on achieving the aims of the Paris Agreement and identify policies that can support their innovation. This work could be undertaken drawing on inputs from (or also working in collaboration with) key actors in this space, including those identified in section 3 above.

12. TEC work on the innovation of emerging climate technologies could thus include:

(a) Identifying key emerging technologies in the climate space, their application, including in least developed countries and small island developing states,¹⁴ and their potential economic, environmental (particularly on the climate) and social impact;

(b) Identifying key policy challenges and solutions related to the innovation of these at the different stages of the technology cycle, including by drawing on successful business stories of emerging climate technologies and success factors including government support, regulatory reform, and innovative financing. Identify also ways to monitor and evaluate the impact of such technologies (for instance, on the impact of carbon capture underground);

(c) Developing a TEC brief and recommendations on how policy-makers can support the innovation of potentially important emerging climate technologies;

(d) Disseminating the TEC brief and the recommendations to key stakeholders.

| # | Activity | Deadline |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 1 | Develop a technical paper on the innovation of emerging climate technologies which covers, inter alia: ¹⁵ <ol style="list-style-type: none"> i. Key emerging technologies in, or relevant to, the climate space, their application, including in least developed countries and small island developing states, and their potential economic, environmental and social impact ii. Key policy challenges related to the innovation of these for the different stages of the technology cycle, noting that many challenges are often dependent on specific local, national or regional circumstances. Ways to monitor and evaluate the impact of such technologies iii. Ways for policy-makers to effectively support the innovation of emerging climate technologies | First half of 2019 |
| 2 | Hold an event on the innovation of emerging climate technologies (format, location and timing to be decided by the TEC). This event focuses on the three elements of the technical paper listed above | 2019 |
| 3 | Develop a TEC Brief and recommendations to COP 25 | 2019 |
| 4 | Disseminate the TEC Brief and recommendations to key stakeholders | 2019 and beyond |

F. Possible next steps

The TEC is invited to consider the possible activities that it could undertake on the innovation of emerging climate technologies, as listed in section 4 above. In this context, it is invited to agree on a way forward as part of the activities of its future rolling workplan (for the period 2019 and beyond, as to be decided).

¹⁴ In this context, further work will need to be undertaken to develop an understanding of the potential ‘transferability’ of emerging climate technologies from countries that develop such technologies to other countries. It is likely that the countries with the highest technological capabilities are those which develop such technologies.

¹⁵ An initial list of possible elements of the technical paper are listed in the annex.

Annex – Possible elements of the technical paper on the innovation of emerging climate technologies

(Elements listed below are not necessarily in chronological order.)

1. Technologies applicable to the climate change response
 1. Core technologies enabling digital transformation
 2. Nanotechnologies

 - (1) Scope of climate technology targeting in the paper
 1. Target technology should cover both mitigation and adaptation.
 2. Climate technology with high tech including big data, internet of things, artificial intelligence, blockchain, nanotech and so forth should be applicable and manageable in the local conditions of least developed countries and small island developing states.
 3. Technology to utilize carbon captured by negative emission technology should be developed in parallel.

 - (2) Technology assessment
 1. Some mechanism to assess negative environmental and social impacts of emerging climate technology needs to be structured.
 2. Existing technology assessment system to evaluate social and environmental impacts, if available, should cover emerging climate technology.

 - (3) Market creation
 1. Co-benefit or multi-benefit of each emerging climate technology needs to be clarified.
 2. Pricing of cost of carbon is critical incentive to scale up zero emission or negative emission technology.
 3. Analysis of both GHG emission and climate impacts in supply chain in various industry or business sector would help to identify new markets for emerging climate technology.
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