Technological Innovation for the Paris Agreement

Implementing nationally determined contributions, national adaptation plans and mid-century strategies
Why this TEC Brief?

In 2015, countries adopted the Paris Agreement and the 2030 Agenda for Sustainable Development, setting out a vision of a low-carbon, climate-resilient and sustainable future for all. The goals of these groundbreaking instruments need to be urgently pursued. 2016 was the hottest year on record, with the average global temperature now almost 1 °C above pre-industrial levels. Climate change effects of growing intensity are being observed with rising frequency in all corners of the world, threatening prospects for sustainable development. Under the Paris Agreement, countries have developed nationally determined contributions (NDCs), national adaptation plans and mid-century strategies. Now, countries and the international community are focused on implementing them.

Technological innovation is a critical accelerator and enhancer of the efforts to implement national climate actions and achieve the above-mentioned global objectives. The Paris Agreement explicitly refers to innovation in its Article 10, paragraph 5. In the 2030 Agenda for Sustainable Development, technological innovation is referred to in connection with various sustainable development goals, particularly goals 7 (affordable clean energy), 8 (decent work and economic growth), 9 (industry, innovation and infrastructure) and 17 (partnerships for the goals).

The UNFCCC Technology Executive Committee has prepared this policy brief in recognition of the important role that technological innovation plays in achieving a low-emission, climate-resilient and prosperous future. It outlines the key elements of successful technological innovation and sheds light on the power of technological innovation to accelerate and scale up national climate action.
To achieve the goals of the Paris Agreement, there is a pressing need to accelerate and strengthen technological innovation so that it can deliver environmentally and socially sound, cost-effective and better-performing climate technologies on a larger and more widespread scale. But there is no ‘one size fits all’ approach. Different innovation approaches are needed.

To enhance the implementation of nationally determined contributions, national adaptation plans and mid-century strategies, the Technology Executive Committee recommends that the Conference of the Parties (COP) encourage Parties:

(a) To prioritize resources (human, institutional and financial) for such innovation efforts, in accordance with their needs, priorities, and capacities;
(b) To enhance public and private partnerships in the research, development and demonstration of climate technologies by increasing expenditure for it and providing a clear policy signal of a long-term commitment to act on climate change;
(c) To strengthen national systems of innovation and enabling environments, including through market creation and expansion, and capacity-building;
(d) To enhance existing and build new collaborative initiatives for climate technology innovation, including for sharing expertise, good practices and lessons learned;
(e) To create an inclusive innovation process that involves all key stakeholders, facilitating the incorporation of diverse and relevant expertise, knowledge and views and generating awareness of the benefits and impacts.
(f) To acknowledge and protect indigenous and local knowledge and technologies and incorporate them in their national innovation systems;
The Technology Executive Committee further recommends that the COP encourage:

(a) The Technology Executive Committee, the Climate Technology Centre and Network, the Global Environment Facility, the Green Climate Fund and other stakeholders to collaborate in identifying effective policies, instruments and collaboration forms that support Parties, particularly developing country Parties, and other partners in their innovation efforts.

(b) The Green Climate Fund to include information in its annual report to the COP on projects it has approved that support the innovation in and/or scaling-up of climate technologies, with the aim of informing the further work of the Technology Mechanism on climate technology innovation.

(c) The Global Environment Facility to continue including information in its annual report to the COP on projects it has approved that support the innovation in and/or scaling-up of climate technologies, with the aim of informing the further work of the Technology Mechanism on climate technology innovation.
Technological change has been inseparable from economic and social development since ancient times. Its more recent and more systematic iteration – technological innovation – broadly comprises the research, development, demonstration, deployment, and diffusion of a technology. It is through these stages that a technology (i.e. a technique, skill, method or process) evolves from an idea to widespread use. Innovation happens everywhere, in the formal and the informal economy, in private and public institutions and in households and communities (Charmes et al., 2016).

Notably, innovation is a complex process. It involves the interaction of many actors, with multiple feedback loops across the different stages. These loops may be due to trial and error, as actors experiment with a technology to identify how it may solve the problem on hand. During the innovation process a technology may also need to be modified to suit local conditions. Furthermore, based on user feedback, it may be redesigned to have better performance, more features or new functions.
Harnessing technological innovation is a prerequisite for countries to smoothly implement their NDCs, national adaptation plans and mid-century strategies. These are central elements of the Paris Agreement. NDCs set out targets, policies and measures that governments aim to implement in response to climate change and as a contribution to global climate action. Key to the contributions is the concept of national determination, meaning that the plans are based on national context, needs and preferences. Another important element is the Paris Agreement’s mid-century strategies. The Conference of the Parties invited countries to communicate their mid-century, long-term low greenhouse gas emission development strategies by 2020. Many developing countries also develop national adaptation plans to identify medium- and long-term adaptation needs and the strategies for addressing them.

A review of the 190 NDCs submitted prior to the twenty-first session of the Conference of the Parties found that nearly 140 developing countries highlighted the importance of climate technologies. Furthermore, almost 50 percent of all developing countries specifically referred to the importance of technological innovation or research and development for achieving their climate objectives.
It will be extremely difficult, if not impossible, to fully implement NDCs, national adaptation plans and mid-century strategies without technological innovation. It is only through innovation that countries can develop, modify, and deploy technologies that can reduce greenhouse gas emissions and build resilience to the adverse effects of climate change. But not all countries will innovate the same way; they will do so in accordance with their needs, priorities and capacities.

The different time frames of NDCs, national adaptation plans and mid-century strategies suggest the need for different but complementary approaches that balance short- and long-term imperatives. NDCs, which generally refer to shorter-term targets (to 2030), require a focus on the later stages of technological innovation. Attention will need to be placed on deploying and diffusing technologies so as to respond to immediate mitigation and adaptation needs. Tailoring technologies to local circumstances and usage requirements will also be a focus. For many countries, these shorter-term efforts will be undertaken with other pressing concerns in mind, such as reducing poverty, providing access to clean drinking water or improving health.

The priorities for technological innovation may be different for implementing mid-century strategies, which have a longer-term horizon (to 2050 and beyond). Here, countries may focus on researching and developing a new generation of technologies that can enable deep or full decarbonization, jump-start low-carbon development, facilitate resilience against climate change, or respond to societal needs that are not yet fully conceptualized. These goals will also interweave with long-term sustainable development aspirations objectives such as achieving energy access for all, eliminating poverty, developing a skilled workforce and enhancing competitiveness. Similarly, national adaptation plans generally have medium to long-term perspectives. Viewing the short- and long-term together, our challenge, then, is to harness technological innovation to achieve short-term goals without compromising progress towards long-term objectives.

**Fiji’s vision on innovation**

Fiji, the president of the twenty-third session of the UNFCCC Conference of the Parties, highlights the importance of innovation in the following part of its vision for the conference:

“To harness innovation, enterprise and investment to fast track the development and deployment of climate solutions that will build future economies with net zero greenhouse gas emissions, in an effort to limit the rise of global temperatures to 1.5 degrees Celsius above pre-industrial levels.”

Find out more: https://cop23.com.fj/fijis-vision-cop23/
As the world ramps up its response to climate challenge, it is deploying climate technologies on an unprecedented scale. For instance, in 2016 the world added more renewable power capacity (161 gigawatts) than capacity from all net fossil fuels combined, with most new renewable energy capacity being installed in developing countries (REN21, 2017). Moreover, the costs of such technologies are falling, making them competitive with fossil fuel options in many countries (World Economic Forum, 2017; Bloomberg, 2017).

While these are promising developments, much more needs to be done. Economic growth may no longer be closely tied to emission increases in many countries and the global carbon intensity has decreased, but global greenhouse gas emissions continue to rise. Science clearly indicates that the window for achieving the Paris Agreement objectives is rapidly closing. Low-emission technology is not being developed or deployed at the necessary speed or scale to achieve the Paris Agreement objectives (IEA, 2017). And progress varies among countries. To respond to these urgent climate challenges, there is a pressing need to significantly accelerate and strengthen climate technology innovation, to deliver cheaper and better-performing technologies on a larger and more widespread scale than ever seen before. Countries are aware of this and new initiatives are emerging. For instance, through the Mission Innovation initiative, 22 countries and the European Union have committed to accelerate clean energy innovation in the longer term, and have agreed to seek to double their public clean energy research and development investment over the next five years. Other actors are responding as well. Through the Breakthrough Energy Coalition, private sector actors have committed to accelerating private and public sector investment in new energy technologies. But more needs to be done, especially in other mitigation sectors and in adaptation. Furthermore, countries facing other critical development challenges may struggle to find resources needed to adequately respond to climate change.

Considering the urgency we have, a key question is how we can stimulate technological innovation to achieve a low-carbon economy and climate resilience. Transformational change may be needed to move away from incremental improvements of technologies linked to a fossil-fuel dependency (OECD, 2017). While incremental improvements may deliver important short-term benefits, transformational change will be needed to achieve carbon neutrality in the second half of the twenty-first century. And breaking this dependency will open up opportunities for new sustainable paths to develop and flourish. We have come a long way, but the journey is just beginning.

**Uruguay: generating almost all electricity through renewables**

In 2015, Uruguay generated more than 90 per cent of its electricity from renewable energy sources. Through its 2030 energy policy framework (La Política Energética 2005–2030), the country has implemented policies and financial incentives to encourage the development of the wind turbine industry.

One of the key challenges with enhancing technological innovation is that there is no ‘one size fits all’ approach. This is due to several reasons. Firstly, no two countries are alike. Countries have different political, economic, social, cultural and environmental conditions. They also differ in national priorities, needs, capabilities, renewable energy resources and stages of development. This means that each country will have unique innovation needs and will have to develop its own approach to stimulating innovation efforts. Secondly, countries themselves are not homogeneous. There can be as much diversity within a country as that observed between them. Thirdly, each stage of the technological innovation process may require a different mix of actors, institutions, networks and financing models. Fourthly, the innovation approaches required for different sectors can vary, as can the approaches required for different technologies within a sector. The technological innovation processes for climate change mitigation and adaptation may also be different! In sum, *different innovation approaches will be needed to address different problems in different contexts.*

This complexity makes it difficult for a country to immediately identify how to improve its innovation performance. Unfortunately, there is no simple answer. But this does not mean that we can shy away from the challenge. In fact, although there is no ‘one size fits all’ approach, there are key principles that can guide effective technological innovation as per elements 4–9 below.

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**Innovation: how diverse are countries?**

The Global Innovation Index analyses the innovation performance of 121 countries using 81 indicators. The indicators cover a broad vision of innovation, including political environment, education, infrastructure, and business sophistication. Such indicators highlight the diverse elements that relate to innovation. The index is produced annually by Cornell University, INSEAD and the World Intellectual Property Organization.

Find out more: https://www.globalinnovationindex.org/
Irrespective of a country’s challenges and circumstances, successful innovation interventions depend on a sound national system of innovation. A national system of innovation is defined as the combination of actors, institutions (both organizations and policies/laws) and networks that interplay to undertake and drive the innovation process in a national setting. A sound national system of innovation provides the conditions for innovation to flourish without attempting to pick winners. As the Technology Executive Committee highlighted in a 2015 policy brief, building a strong system of innovation requires the strengthening of each of these three elements (TEC, 2015). There is a need to develop a strong education system (developing human capacity), institutions (developing organizations that design, implement and monitor effective policies, regulations and standards, thus creating a strong enabling environment), and networks (facilitating collaboration and interaction among the different actors). In addition, there is a need for strong political leadership that can incentivize and help to coordinate the technological innovation process and guide the national system of innovation towards priority areas (in our context, those related to a low-carbon economy and climate resilience).

While these steps may be clear, the reality is that many countries face coordination, resource and capacity challenges to building strong innovation systems. Short-term priorities can make it difficult to keep measures in place that are crucial for developing the system but take many years to yield results. A country may therefore wish to focus its limited resources on a particular climate and development challenge. The following elements highlight ways to achieve this.
How do we create new and improved climate technologies, or modify them to local conditions? The earlier stages of the innovation process, namely research, development and demonstration (RD&D), are also known as the ‘technology push’ stages. The government plays a key role in encouraging public and private actors to focus their RD&D efforts on climate technologies and on making these viable. This can be especially important where RD&D may be more often undertaken by public actors, (e.g. in developing countries), and where a market might not exist (e.g. large climate infrastructure projects or some adaptation technologies), is not as well developed or is informal. To facilitate an effective climate technology push, governments can undertake a mission-oriented approach (Mazzucato, 2015). This involves strategically combining financing and a policy and regulatory framework to encourage actors to focus on a portfolio of options directed towards a specific climate aim (Stern et al., 2007).

It has recently been noted that current RD&D investment falls well short of the levels required to meet the long-term goals of the Paris Agreement (IEA, 2016). In a recently published working paper titled *Enhancing Financing for the Research, Development and Demonstration of Climate Technologies*, the Technology Executive Committee noted that governments can accelerate efforts to meet climate challenges by increasing public expenditure for climate technology RD&D. To stimulate private RD&D spending, governments can provide a clear policy signal of a long-term commitment to reduce greenhouse gases and build resilience to climate change. They can furthermore strengthen enabling environments that accelerate private investment (TEC, 2017a).

Another important element of a successful technology push is in governments clearly understanding national climate and development needs and priorities. Such a need-driven approach may help to ensure that investments in national technological innovation are aligned with national priorities and effective in the context of broader economic and social development (Kholsa et al., 2017). UNFCCC technology needs assessments and technology action plans can help in this regard (see element 10).

**Cutting edge energy technology innovation**

The United States of America’s Advanced Research Projects Agency-Energy advances high-potential, high-impact energy technologies that are not mature enough for private-sector investment. It focuses on transformational energy projects that can be meaningfully advanced with a small investment over a defined period.

Find out more:
https://arpa-e.energy.gov/
A problem governments frequently face is facilitating the transformation of a viable technology into a product that is used at a scale large enough to contribute to national climate objectives. Creating sufficient market demand (pull) for the technology is a key issue. Here the focus is on the later stages of the technological innovation process – deployment and diffusion. In many countries such activities are undertaken by the private sector (Stern et al., 2007), but the government also plays a key role in fostering private sector involvement by facilitating market creation and even expansion. It may achieve this by designing and implementing policies, regulations and standards that create enabling environments and favourable market conditions for climate technologies (e.g. through feed-in tariffs or auctions) and removing disincentives such as high-carbon subsidies (OECD, 2017). It should also avoid market incentives that lock in high-emission technologies or infrastructure that is ill-prepared for adapting to the changing climate. As well as incentives, governments can also stimulate a long-term market pull through instruments that seek to capture the negative externality of greenhouse gas emissions, for instance by putting a price on carbon (OECD, 2017).

There are ways other than market creation to support ‘demand pull’, especially in weak markets or for technologies that are not well suited to a market. Public programmes that increase awareness about the value of technologies can lead to informed selection and increased demand. The government can also create programmes that support entrepreneurs and small and medium-sized enterprises with bringing their prototypes to market (such as innovation incubators). In addition, innovative financing and business models involving a combination of public, private and non-for-profit sector actors can also help (see also element 7). Finally, the government can try to stimulate demand through global trade in climate technology goods and services, while also considering how to harmonize this with its chosen development pathway.

**Kenya Climate Innovation Center**

The Kenya Climate Innovation Center provides holistic, country-driven support to accelerate the development, deployment and transfer of locally relevant climate technologies. It provides incubation, capacity-building services and financing to Kenyan entrepreneurs and new ventures developing innovative solutions in energy, water and agribusiness in order to address climate change challenges.

Find out more:
https://www.kenyacic.org
We can only fully leverage the potential of climate technologies if we also innovate in other areas such as financing, social innovation (including new cooperative forms and business models), information-sharing and policy mechanisms. Fortunately, replicable examples of such innovation abound (see the next box for one). On finance, venture capital and angel investors are growing alternative sources of funding for bringing climate technology prototypes to market. Green bonds are also beginning to provide significant financing for technological innovation, especially for large scale diffusion of mature technologies. Examples of social innovation include innovative pay-as-you-go models that are revolutionizing the use of pico-solar photovoltaic technologies in the developing world, especially in Africa and India. And new policy mechanisms such as feed-in tariffs or auctions are innovative ways to build markets and create demand. Finally, potentially revolutionary technologies, such as nanotechnology, and blockchains, the internet of things and other information communication technologies have the potential to greatly improve lives. For example, they may allow knowledge and ideas to reach remote locations and marginalized people (OECD, 2012).

**Off-Grid Electric innovative business model for Africa**

Off-Grid Electric provides solar home systems to homes and businesses in rural Africa through an innovative financial product. It developed a modular pay-as-you-go solar photovoltaic product that is being used in Côte d’Ivoire, Rwanda and the United Republic of Tanzania.

Find out more: http://offgrid-electric.com
For maximum impact, technological innovation must be inclusive and equitable. An inclusive process ensures that diverse relevant expertise, knowledge and views are incorporated. Such a process ensures that all key stakeholders are involved in the design, development, demonstration, deployment and diffusion of the technology. An equitable process will ensure that those engaging in innovation activities are treated fairly and justly. Participants in an inclusive and equitable process are more likely to support the technology’s introduction and resulting interruption of existing behavioural patterns. Such a process is also more likely to lead to equitable innovation outcomes. Participants may include governments, the public, civil society, the private sector, academia and local communities. An inclusive process may also facilitate the incorporation of indigenous knowledge. A technology resulting from such a process is likely to perform more effectively and be better suited to local settings and traditional practices. An inclusive process will also ensure that participants develop awareness of the technology’s potential benefits, impacts and uses. Inclusive innovation can moreover facilitate grassroots entrepreneurship and help to integrate marginalized groups into circuits of economic activity (OECD, 2012).

An inclusive innovation process can also build human capacity better by supporting the continuous development of the local workforce and the development of the endogenous skills required to drive a national low-emission and climate-resilient transformation. Through this, countries will develop the learning capacities that allows countries to catch up technologically and developmentally (OECD, 2012). The Technology Executive Committee recognizes the importance of endogenous capacities for successful technological innovation. It will continue to work on this and related issues in 2018 and beyond, as mandated by the Conference of the Parties.

Europe’s Climate Knowledge and Innovation Community

The Climate Knowledge and Innovation Community is Europe’s largest public–private innovation partnership focused on climate change. It consists of companies, academic institutions and public sector entities. Its mission is to bring together, inspire and empower a dynamic community to build a zero-carbon economy and climate-resilient society.

Find out more:
http://www.climate-kic.org
In an interconnected world within which we live, it is impossible to think of the innovation process as a purely national activity. Global value chains, information and communication technology and a global workforce highlight advanced interconnectivity and modalities that the innovation process can draw upon in undertaking technological innovation. Collaboration across national, institutional or other frontiers allows participating partners (public, private, academic, non-governmental organizations, etc.) to share expertise, experience, good practices and lessons learned, and to draw on one another’s strengths. Failure to collaborate may lead to duplication, inefficient resource allocation or ineffectual innovation outcomes.

The Paris Agreement acknowledges the importance of collaboration on innovation in its Article 10, paragraph 5. Notably, international collaboration on technological innovation in the energy and agriculture sectors has existed for some time. For over forty years, for example, the International Energy Agency Technology Collaboration Programmes and the Consultative Group on International Agricultural Research (CGIAR) have been responding to technology challenges in these areas. Another example is the Clean Energy Ministerial, a partnership that promotes policies and programs that advance the transition to a global clean energy economy. However, participation in these initiatives is often limited to major economies (TEC, 2017a), although CGIAR is an example of an international effort focusing on developing country needs. Furthermore, the extent of international collaboration on innovation in adaptation sectors, such as water and infrastructure, and in other mitigation sectors, such as industry or transport is mostly unknown (TEC, 2017a). Collaboration is also taking place regionally and bilaterally. An instance of the former is the European Union Horizon 2020 programme, which provides opportunities for developing country participation, and of the latter the agreements between the United States of America and India.

Moving forward, these initiatives need to be enhanced and new ones, in other sectors, started. The participation of a higher number of countries may enhance their relevance, reach and impact – facilitating large-scale deployment of low-emission and climate-resilient technologies – and therefore their contribution to achieving the Paris Agreement and sustainable development goals. South–south cooperation can complement these efforts, helping countries to build capacity and transfer knowledge on innovating in similar contexts (TEC, 2017b).
The United Nations Framework Convention on Climate Change and its bodies can help to coordinate innovation efforts and make them more coherent. The Technology Mechanism, which aims to enhance the development and transfer of climate technologies, can play a key role. The mechanism’s Technology Executive Committee can identify (as in this brief) how countries may be able to strengthen their climate technological innovation interventions nationally, regionally and internationally. As noted in its current workplan, the committee will continue its work on innovation and research, development and demonstration of climate technologies. Its aforementioned working paper and its 2017 special event on innovation identified questions that could benefit from further examination. These include how countries can implement the technologies referred to in their NDCs and national adaptation plans by 2030 to address the urgent need for climate action. An answer could be to identify new collaborative arrangements for technology research, development and demonstration, including public–private partnerships (TEC, 2017a).

The Climate Technology Centre and Network will continue to play a key role in providing climate technology and policy assistance. To respond to developing country requests for technical assistance on technological innovation issues, it can draw on the expertise of over 300 network members. Indeed, recently it received requests related to developing national innovation centres. UNFCCC technology needs assessments can also play a role by helping developing countries to identify and prioritize their technological innovation needs and priorities. Outcomes of the assessment process, such as technology action plans, may facilitate strategic planning and implementation of innovation processes. Countries can also deploy low-carbon development strategies to guide their climate technology innovation.

The UNFCCC Financial Mechanism’s operating entities can also play an important role. For over 25 years, the Global Environment Facility has supported climate technology demonstration and deployment, including through its Poznan strategic programme on technology transfer. The Green Climate Fund is also providing funding for climate change projects, including technological innovation. The latter is currently exploring how it can support collaborative efforts at earlier stages of the technological innovation process. To facilitate the Technology Executive Committee’s further work on technological innovation, the Green Climate Fund could annually share information with the committee on projects it has approved that support the scaling-up of climate technology.

These bodies are collaborating on the effective delivery of support to countries. Furthermore, entities accredited to these bodies and the national focal points are sharing experience on channelling support. The wealth of technological and financial knowledge that these bodies hold creates huge potential for collaboration that can unlock transformational climate action. For instance these bodies could collaborate to identify policies and instruments that support efforts to enhance technological innovation (TEC, 2017a).

**Effective UNFCCC Collaboration on climate finance and technology for Tonga**

In 2017 it was announced that Tonga will receive readiness and preparatory support from the Green Climate Fund for climate technology assistance delivered by the Climate Technology Centre and Network (CTCN). Tonga requested CTCN assistance to develop a national energy efficiency plan that can assist it in meeting its nationally determined contribution.

Way forward

Technological innovation is a key part of the climate solution. Without scaling up and speeding up climate technology innovation, it will be difficult, if not impossible, for the world to achieve the Paris Agreement objectives and sustainable development goals. The climate plans under the Paris Agreement – NDCs, national adaptation plans and mid-century strategies – present us with challenges of different time horizons. NDCs are focused on short-term goals, to 2030, while mid-century strategies have a longer-term perspective, to 2050 and beyond. National adaptation plans also generally have medium to long-term perspectives. Stimulating innovation to address all three without compromising any, while also addressing urgent development concerns, presents significant challenges. But those challenges can and should be overcome.

How do we scale up and speed up technological innovation? There are no simple answers. But tailored efforts can have an immediate and significant impact and put countries on the path to low-carbon and climate-resilient development. Ongoing efforts throughout the world highlight that change is possible, and not necessarily at a high cost. The Technology Executive Committee has highlighted in this brief some of the key elements for scaling up and speeding up innovation efforts. These efforts can help to achieve the vision of a low-emission, climate-resilient and prosperous world.
Recent work of the Technology Executive Committee

Since its establishment in 2010, the Technology Executive Committee has done a significant amount of work on technological innovation. Notably, in 2015 it produced a policy brief and key messages for the Conference of the Parties on national systems of innovation. The same year, the Conference of the Parties requested the committee to undertake further work on the research, development and demonstration of climate technologies. Since then, the committee has worked to respond to this request and continued related work on technological innovation. In 2017 the committee produced a working paper on enhancing the financing of the research, development and demonstration of climate technologies. It also held a major event on technological innovation and climate change, bringing together more than 100 innovation experts from around the world. This policy brief is based on the working paper and the event.
References


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About the Technology Executive Committee

The Technology Executive Committee is the policy component of the Technology Mechanism, which was established by the Conference of the Parties in 2010 to facilitate the implementation of enhanced action on climate technology development and transfer. Along with the other component of the Technology Mechanism, the Climate Technology Centre and Network, the committee is mandated to facilitate the effective implementation of the Technology Mechanism.

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