IDDRI

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

This Policy Brief has received financial support from ADEME (French Environment & Energy Management Agency) and the French government in the framework of the "Investissements d'avenir" programme managed by ANR (the French National Research Agency) under the reference ANR-10-LABX-01.

www.iddri.org

Institut du développement durable
et des relations internationales
27, rue Saint-Guillaume
75337 Paris cedex 07 France

SciencesPo

POLICY BRIEF

N°04/18 JULY 2018

Carbon neutrality: taking on the global challenge for ambitious climate action

Lola Vallejo, Aleksandar Rankovic, Michel Colombier, Sébastien Treyer, Judith Voss-Stemping (IDDRI)

The Paris Agreement, adopted in 2015, set the scene for discussions on carbon neutrality at the global and national levels in its Art. 4.1, which refers to the "balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases",[1] building on the Intergovernmental Panel on Climate Change (IPCC)'s 5th assessment report. The concept of carbon neutrality or net zero emissions[2] was already used before Paris by some countries and non-state actors, in relation to the offsetting of individual carbon intensive activities (e.g. plane travels). The terminology in Art. 4 of the Paris Agreement does mark, however, its first introduction into international agreements, and its first reference as a global objective.

Nearly two years into the Paris Agreement's entry into force, a small but growing number of countries have integrated the concept of carbon neutrality into their development strategies, with very different approaches. This diversity reflects in part the important methodological, technological and political challenges associated with defining climate neutrality and making it a reality,[3] especially as guidance for the bottom-up elaboration of the nationally determined contributions (NDCs).

These challenges do not lessen but only reinforce three imperatives (see key messages).

1. *"Parties aim to (…) reach global peaking of greenhouse gas emissions as soon as possible (…) and to undertake rapid reductions thereafter (…) so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century".*
2. Art. 4 technically implies "greenhouse gas neutrality", but expressions such as "carbon neutrality" or "net zero emissions" are more commonly used.
3. See Rankovic *et al.* (2018)

KEY MESSAGES

Countries interested in reaching carbon neutrality ought to :

- Urgently act to reach the existing potentials for greenhouse gas emissions' reduction across sectors, through a combination of technology and behaviour solutions aligned with countries' development objectives, in order to minimise the level of residual emissions after 2050 and specifically near to zero CO_2 net emissions in the energy and the industry sectors;
- Renew approaches to protect natural carbon sinks by targeting the sectoral drivers mostly linked to natural ecosystem degradation and destruction on land and sea (unsustainable agriculture and its expansion, deforestation, unsustainable fisheries, coastal planning, etc.) and foster changes in practices inside sectors to protect carbon sinks (e.g., soils in agriculture);
- Invest in R&D for carbon capture and storage technologies to deal with the residual emissions, as existing sinks and current innovation options are either not a permanent solution or not ready to operate.

1. CARBON NEUTRALITY AS A POLITICAL MARKER

The concept of neutrality raises an apparent paradox. On the one hand, this bold concept may not be the best suited to offer an effective guidance for country-level action. Its implications at the national level raise daunting methodological and political questions, such as: "For the planet to reach carbon neutrality, should all countries reach it too? To what extent can negative emission technologies contribute to this objective? How much additional efforts need to be considered in reducing gross anthropogenic emissions, and when should they occur?" On the other hand, a small but growing number of countries has already embraced carbon neutrality. Interestingly, regional, city-level or corporate actors who position themselves at the helm of climate action have also announced carbon neutrality objectives. Carbon neutrality is also the new horizon for a myriad of campaigns from non-governmental organisations, and for methodological tools built by research institutions and political coalitions.

Some critics attribute this growing success to its potential for interpretation: the variety of scope of emissions or reference year considered in the country and announcements mean very different levels of efforts in terms of emission reduction. In the existing national approaches towards carbon neutrality, the long-term targets often tend to be the mere linear projection of existing shorter-term targets. Some NGOs and experts point to the risk that neutrality could be used as an excuse to reduce mitigation ambition, by focusing on offsets rather than actual emission reductions. For now, this potential risk has not translated into most countries' plans.

On the contrary, the recent state and non-state approaches towards carbon neutrality seem to coincide with at least the willingness to reinforce climate ambition. Announcements are not so much made to impress an international audience but used domestically as a political marker. They allow national or local governments to launch new programmes and, more importantly, new reflexions, procedures and governance frameworks on climate action.

2. COMBINING SINKS, 'NETS', ABATEMENT & OFFSETS

Making carbon neutrality a reality at the global level means first reducing manmade emissions as much as possible, but also raises the question of using additional levers to compensate for residual emissions, and achieve net negative emissions later on. Neutrality specifically calls into question enhancing natural sinks, using negative emission technologies, and using offset mechanisms.

The Art. 4.1 of the Paris Agreement on achieving carbon neutrality encapsulates a complex assessment of the dynamics of emissions, consistent with the "well below 2°C" objective presented in the last IPCC assessment report, under the most ambitious sets of scenarios for decarbonisation (RCP 2.6).[4] The main features of this pack of scenarios are:

- CO_2 emissions are to decline dramatically and achieve net zero levels by 2060-2070, followed by significant negative levels afterwards;
- Non-CO_2 emissions are to decline steadily until they are almost halved by the end of the century.

"Neutrality" is not defined *ex ante* by scientists as an equilibrium, but reflects that, adding CO_2 and non-CO_2 emissions measured in tCO_2 equivalent, the resulting emission pathways reach net zero global emissions around 2080 and negative levels afterwards. A closer look reveals that IPCC RCP 2.6 scenarios assume that such a dramatic decrease in global net emissions could be achieved through unprecedented efforts to develop net negative emissions options.

Enhancing natural sinks

Forests, soils and coastal ecosystems (such as saltmarshes or mangroves) are natural sinks for greenhouse gases. While the degradation of these ecosystems by human activities (farming, deforestation) could lead to releasing large quantities of greenhouse gases, their enhancement could improve their potential as sinks. Reaching carbon neutrality at the global scale necessarily means good stewardship of these ecosystems by the public and private actors who manage them. However, in the literature, the potential for additional sequestration seems quite uncertain, and is estimated between 1.83 and 14 $GtCO_2$/year over a period of some decades, after which these sinks might have to be considered saturated. Similarly, the potential for sequestration in soils is estimated between 2.6 and 11.4 $GtCO_2$/year.

In practice, enhancing natural sinks over the long run will require tackling the political drivers of the degradation or destruction of these ecosystems at every level. Encouraging more sustainable farming practices and ensuring the conservation of forests and grasslands would most effectively address the twin threats of deforestation and soil degradation, enabling better carbon storage overall. Protecting and restoring coastline ecosystems depends on proactive ecological measures, but

4. Representative Concentration Pathways (RCPs) model possible climate futures, and are named after the radiative forcing values in the year 2100 relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5 W/m^2).

also on ensuring that infrastructure development, agriculture, aquaculture and deep-sea fishing better take into consideration these impacts.

Policies to incentivise the protection or restoration of these ecosystems at the international level have proven moderately effective, and side effects on food security, biodiversity or other environmental issues need to be fully evaluated. These challenges are further compounded by the ecological uncertainties, both on the permanence of these carbon stocks, the complex links between nitrogen and carbon cycles, the risks of non-permanence due to reversal in land use or changes in practices, and regarding the exact impact of climate change on carbon sequestration potential.

Investing in negative emission technologies

Negative emission technologies (NETs) are still at the research or demonstration stage at best, and their massive deployment raises technical, economic and ecological issues. A large deployment of both bioenergy carbon capture and storage (BECCS) and ocean fertilisation is likely to have large and irreversible impacts on biodiversity, as well as potential reverse effects on climate change. Large deployment of BECCS would also require considerable amounts of land, water and nutrients, and compete with land allocated to food production and forests and other ecosystems, with potential very critical impacts on food security. On balance, direct air capture with carbon sequestration (DACCS) seems to be the NET presenting the least risk for now: it puts the least pressure on land use and can be located to accommodate its high requirements for geological storage and water. But the technology is still in its infancy.

In spite of these serious causes for concern, the RCP 2.6 makes an unbridled use of BECCS,[5] which would mean allocating at least 20-35% of existing farmland surface to growing biomass for BECCS.[6] The important use of BECCS as a sort of 'silver bullet' is one of the limitations of current global models, and need to be interpreted carefully. It should not be considered as "technology prescriptive", but reveals that, in complement to the efforts envisaged on natural sinks, NETs at large will be required after 2050 to compensate for the current overshoot of global emissions.

5. In IPCC's 5th Assessment Report, 344 out of 400 scenarios with a 50% probability of limiting global warming to 2°C assumed a large-scale deployment of BECCS (Anderson, 2015).
6. Smith *et al.* (2016) calculated that 1-1.7 Gha of land would need to be dedicated to BECCS, out of 9 Gha currently used by agriculture (1.5 Gha), cattle (3.5 Gha) and forests (4 Gha) to reach the lower limit of RCP 2.6.

Reducing gross GHGs emissions: challenges for the energy and food systems

The IPCC scenarios compatible with the Paris Agreement's objective mobilize important amounts of negative emissions, close to their estimated technical potential. But at the same time, these scenarios do not slacken efforts in terms of emission reductions. Achieving a 50% reduction on methane and N_2O emissions implies that most technical options would be implemented at their high range potential to cut emissions attached to waste management, agriculture, cattle farming, etc. In addition, these scenarios assume that the global average meat consumption would rise but still level off below current European levels. In parallel, energy-related emissions (building, industry, services, transport, and energy production) are supposed to dramatically decrease before 2050 and the overall energy system would be almost fully decarbonized at the global level in the following decades.

Assuming that NETs would be available at reasonable cost after 2050, scientists have explored the possibility to postpone mitigation action and compensate the emission overshoot with additional removals by NETs in the second half of the century. Their conclusion are that such scenarios would not only be extremely costly but very unlikely, raising a number of technical, industrial, and ecological issues. Conversely, we need to acknowledge that the assumptions made under the 2.6 IPCC scenarios on natural sinks enhancement and NETs deployment are quite optimistic regarding both the availability of the technology and our implementation capacity.

Overall, deep decabonization scenarios, leading to less than two tons of CO_2 emissions per capita in the energy sector, and to at least 30 to 40% reduction of emissions on CH_4 and N_2O by 2050, remain the reference for mitigation action. The order in which various greenhouse gas emissions and sinks are addressed matters, as different atmospheric compositions have different implications in terms of warming. At the national level, policymakers should capture these specificities by developing distinct strategies for reducing three categories of emissions: i) domestic emissions, ii) international transport emissions, iii) consumption-based emissions. In each of those, each greenhouse gas should be accounted separately, rather than converted into tonnes of CO_2 equivalent.

At the same time (and not alternatively), natural sinks need to be enhanced, and R&D efforts reinforced to develop acceptable NETs by mid-century.

'Domestic neutrality' and international offsets

A carbon neutral world is not necessarily a world where each country, city or business reaches net zero emissions in isolation. Art. 6 of the Paris Agreement recognises the different endowments and capacities for reducing emissions or increasing greenhouse gas environmental sinks, and allows Parties to 'collaborate' on climate mitigation. The mechanism to operationalise the exchange of 'Internationally Transferable Mitigation Outcomes' (ITMOs) while avoiding double counting is still uncertain.

The Deep Decarbonization Pathway scenarios (2015) have shown that, to achieve extremely low-carbon energy and industry systems in a few decades, early low-carbon investments are needed to avoid stranded assets and social costs. In addition, by 2050, there will be little room for offsetting practices within the world energy system. During this transition period, countries aiming for carbon neutrality would have to demonstrate that they are "on track" to very low levels of energy-related emissions by 2050 (and to 30 to 40% cuts on other gases) before considering compensation as a complementary tool, for instance to support investment in developing countries. Countries departing from this rule would jeopardize our common capacity to reach deep decarbonization in the energy system by mid-century, and thus our capacity to deliver the Paris objective.

For instance in the case of agriculture, as crop and cattle farming related emissions are reduced overall, some countries will still prove better endowed and more competitive for a given food production (meat, rice, corn, etc.). In that case, international trade will result in higher associated emissions in some (exporting) countries and lower emissions in other (importing) countries. The same is true for both natural and artificial carbon sinks, and there is no reason why neutrality in that context should be achieved at national level: carbon compensation will then ensure the global balance between emissions and removals, wherever they may occur.

3. CARBON NEUTRALITY, A COMMON LANGUAGE ACROSS SCALES

To date, setting quantitative emission reduction objectives at various geographical levels (states, regions, cities) has not led the various actors involved to develop coordinated visions with a common time horizon. But carbon neutrality implies defining a vision at a time horizon both far enough to allow ambition, and close enough to allow its translation in operational measures, bearing in mind the lifetime of current decisions. In this vision, each actor should *define its place in a carbon-neutral world*, depending on its respective constraints, endowments, potentials, and not only (or necessarily) aim for neutrality at their own activities' level.

By offering a common language for ambitious climate action, the concept of carbon neutrality can support the opening of a discussion across geographic and institutional scales on respective visions. Ultimately, such a process can foster the alignment of expectations from a wide range of actors, from the public and private sector, state and local authorities, policy-makers and civil society.

Mitigation implies not only deploying low-carbon technologies, but also considering the impacts of changing our societies' lifestyles and consumption patterns. To date, conservative behavioural and economic assumptions have formed the basis for global modelling of ambitious decarbonization (Waisman *et al.*, 2018). But meeting the climate challenge most likely calls for profound societal transformations, and reflecting on those is a key complement to building long-term pathways to decarbonization. The notion of carbon neutrality has the potential to start discussions on possible transformations regarding economic models and consumption patterns, and to firm up the domestic case for protecting and enhancing carbon sinks.

REFERENCES

Anderson, K. (2015). Duality in climate science. *Nature Geoscience* 8, 898–900.

Deep Decarbonization Pathways Project (2015). Pathways to deep decarbonization 2015 report, SDSN - IDDRI.

EASAC (2018). Negative emission technologies: What role in meeting Paris Agreement targets? EASAC policy report 35 - February 2018. 45 pp.

Rankovic, A. *et al.* (2018). La neutralité carbone, défis d'une ambition planétaire. Clarifications conceptuelles, panorama des initiatives et recommandations pour les stratégies nationales. IDDRI, *Studies*, forthcoming.

Smith, P., Davis, S. J., Creutzig, F., Fuss, S., Minx, J., Gabrielle, B., Yongsung, C. (2016). Biophysical and economic limits to negative CO2 emissions. *Nature Climate Change*, 6(1), 42–50. http://doi.org/10.1038/nclimate2870

Waisman, H. *et al.* (2018). Constructing national 2050 pathways to meet the goals of the Paris Agreement. Submitted.