All for less carbon

The development and implementation of low-carbon and carbon-free technologies will be essential to limit the global temperature rise well below 2 °C from pre-industrial levels.

The world is finally taking concerted action against global warming. Known as the Paris agreement[1] — which was adopted on 12 December 2015 by 195 countries in the twenty-first Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC) — the text accommodates the different priorities of developed and developing nations[2], and sets the goal of limiting the rise in the global average temperature to well below 2 °C (or, more ambitiously, close to 1.5 °C, as the 2 °C limit may not be enough to prevent irreversible interference in the climate[3]) by 2100. The Paris agreement is a clear and much-needed step forward when compared to the Copenhagen climate change conference in 2009[3], where the members of the UNFCCC failed to concur on the practical steps — in terms of policies, finance and technological development — to cut global greenhouse gas (GHG) emissions.

The success of COP21 can be partly attributed to the intended nationally determined contributions (INDCs) — documents, which the Parties were asked to submit ahead of COP21, that included quantification and implementation time frames of planned cuts in GHG emissions[4]. The INDCs have provided concrete ground for discussion at the Paris talks, where it was agreed that progress on the implementation of these voluntary contributions be periodically verified, and that the planned emission cuts be reviewed every five years. In fact, significant revisions will be required, because at present the INDCs will result in an aggregate amount of GHG emissions in 2030 that is way above the limit of 40 gigatonnes set to keep the rise in temperature below 2 °C. In this respect, key support will come from the definition of a clear roadmap for a global energy transition based on renewable energy sources[5].

Essential elements for this transition are low-carbon technologies for the generation and storage of electrical energy and for the production and transportation of other commodities, as Dolf Gielen and colleagues from the International Renewable Energy Agency (IRENA) explain on page 117 of this issue. Several technologies for energy production from solar, wind, biomass and other sources are already available, yet some are inefficient or rely on materials that are in short supply. Large-scale adoption will depend on whether materials scientists and engineers will find alternative technological solutions that are better-performing and economically viable. Similar progress is sought after in the realization of affordable and high-performing energy-storage technologies, needed to balance demand and supply in the energy grid and to boost the commercialization of electric vehicles. The development of new technologies such as batteries based on Li–air, Li–S, Al–air, Na–ion, Mg and Ca as well as redox-flow systems, in combination with sustainable materials is currently being pursued, together with an increasing interest in recycling processes. As discussed in a Commentary by Jean-Marie Tarascon and colleagues on page 121, a better understanding of the fundamental processes taking place in the redox chemistry of oxides will be beneficial for the design of more efficient energy-storage systems and energy-related materials such as electrocatalysts for water-splitting devices.

Of course, adequate financial resources will be needed to support the necessary innovation. Two initiatives announced during the Paris talks aim at allocating additional public and private funding to accelerate innovation in carbon-free energy technologies, and to drive the most promising ideas to the marketplace[6,7]. According to Keith Barnham and collaborators (page 115), national financial plans that incentivize the installation of clean-energy power plants — whose emissions do not exceed the limit of 50 g CO_2 per kWh — would also be key to reduce carbon emissions from electricity generation. By projecting the latest years' trends in cumulative installed photovoltaic, wind power and biogas capacity, they argue that these technologies, which all have carbon emissions below this limit, could make an all-renewable electricity supply feasible by 2020 in Germany and by 2022 in the UK. Countries should follow the German lead and determine their own all-renewable mix from indigenous resources. Also, another international program — the Lighthouses initiative developed by IRENA in collaboration with 51 partners[8] — is already exploring the structural, financial and policy changes required to substantially increase the shares of renewable energy in the power sector of small island developing states. The outcome of such virtuous examples of close collaboration between social scientists, climate and energy experts, and policymakers should help to identify the most effective routes to an all-renewable energy transition on a global scale. Actions aimed at their implementation will reveal which countries are most prepared to walk the reduced-carbon path. ❐

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The President of COP21, Laurent Fabius, announces the adoption of the Paris agreement.

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