Advice Note

adopted by vote

by the National Academy of Technologies of France (NATF)

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TECHNOLOGY AND CLIMATE CHANGE

SEVERAL SOLUTIONS TO MITIGATE THE EFFECTS AND TO ADAPT

Ever since the National Academy of Technologies of France (NATF) was established [2000], it has dealt with the relationships – in its academic reports, advice notes and recommendations - between technology and the economic, social and environmental impacts due to the deployment of human activities.

The COP21 conference is an important milestone is the framing of a global policy in the area of climate change, but certainly will not spell the end of a process that will continue for numerous years to come. The NATF studies and debates are based on the Intergovernmental Panel on Climate Change (IPCC) Reports, inasmuch as there is no evidence that they are not reliable. The content of greenhouse gases (GHGs) in the Earth's atmosphere increases continuously; the CO_2 concentration has risen from 285 ppm at the beginning of the industrial era to 400 ppm currently and is still increasing, rapidly. NATF recognizes the manmade origins of this growth and subsequent effects, at the local, regional, national, continental, oceanic and planetary scales.

The present Advice Note aims at announcing **the principal contents of a forthcoming Academic Report** that will result from in-depth investigations carried out by NATF Fellows; it will be finalized taking into account the roadmap decided at COP 21. The effects of climate change are already beginning to be observed and will be increasingly numerous and visible over the coming decades. The 'warming' aspect has begun and the most optimistic scenarios forecast a minimum 2°C rise in temperature by year 2100, provided we reduce drastically, as of today, our CO_2 emissions. Global warming will be accompanied by rising sea levels. Consequently, practically all human activities will be adversely affected: agriculture and forestry, industries, the building, energy, urbanism, coastline activities, health, access to drinking water, transportation, the bio-economy. The above aspects will be addressed in the NATF Academic Report announced above.

The Academy, however, refused to adopt two contrary attitudes that lead to inaction: 1° that of the 'climate sceptics' who believe that human activities have not contributed at all to global warming and claim that any efforts to reduce emissions will be useless, and 2° that of the predicators of a forthcoming apocalypse for whom nothing will save the Earth from a final catastrophe. Two main roads should be used simultaneously as guidelines for action: on one hand, the monitoring, control and reduction of GHG emissions; and, on the other, more research commitments and implementation of solutions to mitigate - as best as we can - the negative consequences and to make the most of several positive consequences.

The investigations, findings and recommendations of NATF are coherent with the objectives decided by Europe before COP21, *viz.,* **a 40% reduction of GHG emissions by 2030**, compared with year 1990 values. They also take into account the geographic scales and a wide spectrum of human activities involved. They are framed in terms of realities*, i.e.,* claiming that technology has - and must now play - a role in a strong interaction with the other dimensions such as policy-making, regulations, the economy or social factors. Under certain circumstances, technology will play a modest role. For example, to help coastal planning that integrates a rising sea-level, a map showing possible sea rise effects should be made available by the State authorities (similar to the regulations to cope with possible seismic events (earthquakes)). This roadmap no doubt constitutes a priority.

Technology must play an important role.

First and foremost, the Internet and social networks already allow actors in the field to exchange their experience and their implementations. They also play an increasingly consequent role in training, both in first level education, and – more importantly – in continuous education schemes. Public authorities, beyond initial training as given in French high schools [lycées], apprenticeship training centres (CFAs) or at secondary schools, must encourage their use.

In most cases, the required technologies already exist and all that is needed is to have them implemented, knowing full well that they will continue to progress and expand; for example, the technologies for increasing urban densities or optimum use of transportation systems, in particular via use of ICTs and the Internet. As of now, we see new, zero-emission, buildings with measured energy performance levels that comply with the theoretical forecasts. Technical solutions exist that enable building renovation and rehabilitation but the financial outlay required constitutes the main stumbling block, hence the importance of research and innovation that should be integrated to a financial engineering approach. In reverse, massive storage of CO_2 in underground repositories is also a solution for a distant future that will call for extensive research programme and demonstrators to assure not only profitability but also higher safety standards. Likewise, there are the so-called climatic geo-engineering techniques which, in the main, are still in their conceptual phase, some not assessing the problem on the right scale, while others present a risk of triggering uncontrolled negative feedback in the existing climatic system.

Public authorities should not rely on technological silver bullets. Solutions to mitigate effects and to adapt will always arise through multiple combinations that need intelligence and perseverance to succeed. To this end, comparisons should be drawn with what is taking place elsewhere round the world – such as developments of international collaborative programmes - since the problems we are facing are often similar in essence. Naturally, these solutions will need to be adapted to local circumstances, including the situation prevailing in France. To unshackle the forces of creativity and innovation, NATF recommends to limit regulations to the key points and to be as flexible as possible. In parallel, it is essential that measurements be made in order to ascertain facts and act accordingly; there are already a certain number of metrology tools as well as protocols to analyse data and to carry out modelling computations, but they all need improving and new methods and tools should also be developed.

As far as energy questions are concerned, the top priority must be given to controlling consumption. Technologies exist for buildings. Concerning transportation, energy savings will

stem more from a better efficiency level of the various systems employed, rather focusing in each individual vehicle which must also transport (with an exception made for railroad guided transport systems) - in some form or another –the energy source they need to provide propulsion power. Of course, all-electric or hybrid solutions are already being introduced in the market-place; their commercial distribution and technical performance improvements should be encouraged, while bearing in mind, at the same time, that new corresponding infrastructures will also be needed. Evolution of citizen behaviour, in this respect, still represents (and shall continue to do so) a major challenge.

As far as economic incentives are concerned, the carbon exchange market represents a tool that should be supported but the current carbon price level is far too low to prove efficient. The regulatory measures to be enforced here are vital inasmuch as it is important to decrease the exploitation of fossil energies which will remain abundant for some decades to come, or even centuries if we limit the scope to coal resources. As far as economics is concerned, NATF recommends that more research programmes be made in externalities to optimize energy source policy choices. If the analysis is restricted to short term, current costs, the result often includes assessment errors. NATF proposes a series of paths that are worth exploring, in collaboration with other institutions and organizations. In more general terms, for each measure taken, it is necessary to reason in wide-ranging assessment reports, in costs and advantages, at the various relevant scales in time and geography.

On a global scale, electric power today still represents a minority energy carrier; it is often produced by burning fossil fuels, or via nuclear power reactors and, increasing now, via renewable energy sources. Widespread use of electric power will continue to grow and therefore production will need to be increasingly carbon-free. NATF recommends that France should target a future mix of renewable energies (RE) and nuclear power, underlining the fact that REs are naturally intermittent and that electric storage is still a topic that calls for extensive innovation of highly varied and partial solutions to date, many of which can only apply to local distribution configurations.

Of course, it is absurd to try to forecast the future using only existing technologies. The latter will certainly be improved and new and useful combinations will be discovered; **technological breakthroughs are vital** in many areas, such as for example in the area of electricity storage, or in agriculture or water, water-tables and field management issues will need to be adapted to the changes induced by global warming. During the COP21, the States present will therefore need to commit more means to R&D, to innovation and to experimenting the various solutions proposed. It will also lie with these States to encourage open bottom-up tools, as simple and as flexible as possible to as to facilitate collaborative programmes between the stake holders in the field and their countries.