Joint Statement on the Energy Transition in France and Germany

by the Four Academies

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Executive Summary

A source of welfare, health, social and economic development, energy is essential to human life. Meeting world energy demand, restraining energy consumption in developed countries, and reducing global emissions of greenhouse gases (GHG) raises fundamental challenges for the future of our planet. Because the problem is so pervasive and because of the approaching 21st UN Climate Change Conference, COP 21, the four National Academies of science and technology in France and Germany decided to enhance their mutual cooperation and to organize two workshops on the "energy transition".

This initiative is intended to provide a framework for sharing knowledge, anticipating future challenges, identifying areas for closer cooperation between our countries and generating advice for decision makers and society in general. The workshops defined **priority areas for further collaboration**. These include energy efficiency, grid infrastructure and smart grids, mobility, nuclear energy (fission): safety and waste management, fusion, renewable energies, energy storage as well as social and economic aspects of the energy transition.

In view of the complex challenges, compounded by the political debate, and the different conditions and starting points for the energy transition in the two countries, the four academies also identified the following common lines of action.

1. Creating a sustainable energy system. The overriding aim of energy and climate policy in this century will be to create a sustainable system of energy supply, i.e. one in which GHG emissions are substantially reduced world-wide, while at the same time ensuring security of supply. This will require a long-term perspective, as well as a suitable balance between environmental goals, social expectations, and economic objectives.

2. Promoting collaborative policies. The academies welcome the stated intention of both governments to support effective energy and climate policies on a European level through the medium of a European Energy Union. This will make energy more sustainable, affordable and secure, and produce policies that are compatible with those implemented in other parts of the world. In this spirit, the academies particularly encourage the effort of both governments to reach an ambitious international climate agreement during COP 21 in Paris at the end of 2015.

3. Asserting the central role of science, technology and industrial development. Achieving an efficient energy transition resulting in a substantial net reduction of GHG emissions raises complex issues that are usually underestimated. They will require solutions that are fundamentally based on science, technology and industrial know-how. The academies thus support strong funding programmes for energy R&D, in particular for long-term basic research in cross-cutting topics. Such programmes should focus on novel approaches and, if designed properly, would also help to improve the international competitiveness of European industry.

4. Raising public awareness of energy policies. To promote a systemic and shared understanding of the energy system, it is important to understand public expectations and enhance public awareness of energy issues and constraints. Ultimately, a European energy vision should evolve on which the European citizens can agree.

5. Enhancing French-German scientific, technological and industrial cooperation. Both France and Germany need innovation and breakthroughs in the energy field. They are fortunately endowed with a high degree of competence in the appropriate areas, but would both benefit from more intense scientific and industrial cooperation.

Finally, the academies suggest the **establishment of an academy-led French-German consultative research committee** which could discuss both research issues of mutual interest and priorities in connection with the energy transition. It could also provide a means for assessing developments in our two countries.

Presidents' Preface

In an effort to enhance bilateral cooperation and in view of the approaching 21st United Nations Climate Change Conference, COP 21 to the UNFCCC, the four National Academies of science and technology in France and Germany invited distinguished researchers and experts to two workshops on the energy transition in both countries. The latter is defined here as a long-term transformation to an energy system with much lower greenhouse gas (GHG) emissions and is known in Germany as the "Energiewende" (energy turnaround) and in France as "La transition énergétique".

The motivation for the joint initiative of the four Academies is threefold:

Sharing knowledge

The two countries can learn from each other and benefit from sharing their experiences. The German energy transition aims at achieving a comprehensive transformation of the energy system, including a substantial decrease in overall energy consumption and the wide-scale introduction of renewable energy (RE). The recent law for "green" growth in France is intended to organise the transition to a lower GHG emission energy system. The evolution of the two systems offers rich opportunities for joint studies and fact-finding actions. The successes and difficulties as well as the impact on neighbouring countries need to be carefully assessed. A coordinated effort on a broader international level, for which the present exercise could serve as a model, would be desirable.

Anticipating the challenges ahead as well as advising both decision makers and society in general

In order to meet the challenges ahead, the support of a well-informed public is necessary. Experts are expected to provide all major players, including of course politicians and government, with reliable information, thus offering a basis for policy making. Drawing on the expertise of their members and of associated experts, the Academies likewise attempt to raise general awareness of energy issues and their implications and to foster a deeper understanding of energy-related matters in society at large.

In the Franco-German context these aims have become even more important because of the recent joint declaration of the two countries at the ministerial level (31st March 2015) to further intensify their cooperation in the areas of climate and energy policy at the European, regional and bilateral levels. The two countries have declared their intention of making the "decarbonisation" of the economy (a progressive reduction of fossil fuel consumption), the realisation of the Energy Union and co-operation in the electricity market major priorities.

Identifying areas for closer scientific and technological cooperation

Both France and Germany have excellent scientific and technological research capacities in the energy field. The transformation process will strongly benefit from innovative solutions in R&D carried out jointly by the public and private sectors. It will involve various European industry sectors and could enable those sectors to strengthen their competitive position – provided that a consistent and stringent strategy is followed. Cooperation between the two countries in fields of common expertise and the use of complementary strengths could significantly accelerate innovative solutions. Cross-cutting subjects such as functional materials for energy applications, energy storage, modelling of energy systems, non-fossil-fuel resources or socio-economic aspects of the energy transition are examples of areas likely to benefit from closer scientific collaboration.

Although following different strategies in some areas, in particular for electricity generation, France and Germany can learn from each other's experiences and benefit from a close cooperation. By working closely together, they can set an important example in Europe and facilitate both the energy transition in other European countries and in Europe as a whole. A successful transition towards a sustainable energy system in Europe might also yield valuable experience for other countries and regions world-wide.

I. Introduction and Background

Energy is essential to human activities; it is a source of welfare, of health and of social and economic development. Meeting world energy demand, restraining energy consumption in developed countries, and reducing global emissions of greenhouse gases (GHG) raise fundamental challenges for the future of our planet. Internationally, the initial situation differs widely in the various countries due to their different historical background and economic situation, and particularly with regard to the resources and industrial assets at their disposal.

For the French energy system, nuclear power is crucial, presently providing 75 % of its electrical energy and accounting for more than one third of its total primary energy consumption. France developed nuclear power mainly to improve its security of supply after progressively phasing out coal-based electricity generation and utilising almost all its hydro-electrical potential. This has produced further positive effects, such as (i) a net reduction of fossil fuel imports, (ii) per capita CO_2 emissions amongst the lowest in Europe (with only 46 Mt CO_2/year emitted for a total yearly production of 540 TWh of electricity), and (iii) high grid stability due to the intrinsic inertia provided by the number of large power plants. At the same time, France is aiming to reduce the contribution of nuclear energy to electricity supply from 75 % to 50 % and to progressively increase the share of renewable energies (RE) as long as the latter really promote the reduction of GHG emissions.

Germany, on the other hand, has decided to phase out nuclear power and aims to increase the share of RE in its total electricity consumption to 80-100 % and to its total final energy consumption to 60 % by 2050. Indeed, the share of RE in electricity production has grown faster than expected, and was more than 25 % in 2014. However, the process so far has not always been smooth: CO_2 emissions have partly risen again in recent years due to the increasing contribution of cheap coal-fired plants for electricity generation (they are at a level of 334 Mt CO_2/year for a total production of 631 TWh of electrical energy per year); the “German Renewable Energy Act” has created high costs; and excess electrical energy has sometimes put a high load on the electricity grids also in neighbouring countries. Nevertheless, public support for the “Energiewende” remains high and Germany expects that these problems will be resolved in the future, in particular via an improved integration of the “Energiewende” into a comprehensive European energy system.

Several countries in Europe are currently transforming their energy systems, albeit following different paths. It is therefore time to rethink the energy strategy for Europe, taking recent experience into account. On this basis, a paradigm shift towards a comprehensive systemic approach should be the aim. However, there can be no master plan for the transformation – neither on a national, nor on a global scale – because the energy transition implies the continuous transformation of a complex system with its inherent dynamics. It must take into account the local resources, economic factors and industrial assets, all within the context of a sustainable future.

II. Priority Areas for a Closer French-German Collaboration

The energy transition requires enormous efforts and time as well as careful, dynamic control. There is a need for innovation in the energy domain. Fortunately, in this context, both France and Germany are endowed with a high degree of competence in research and technology. Closer scientific, technological and industrial cooperation could be beneficial to both countries and could generate the missing solutions and breakthroughs needed to solve urgent issues and simultaneously create employment. The following paragraphs describe some major focal points that the panel members from the four academies have identified as highly promising for a closer French-German collaboration at the scientific, technical, environmental, societal and economic levels. Although at present the electricity sector receives the most attention in the energy transition, the panel members point out that innovative solutions for efficient heating and mobility are needed as well (nearly one third of the energy is consumed for mobility, while 45 to 50 % satisfies demand for heating and cooling). Moreover, they emphasize the importance of energy R&D and in particular of long-term basic research that will support the transformation of the energy system in the next few decades.

1. Energy efficiency

Both France and Germany aim at increasing energy efficiency in all sectors and at meeting the ambitious goals declared by the European Union. This is a promising area for exchange of information and for cooperation. Substantial improvements in energy efficiency are a necessary precondition for reducing greenhouse gas emissions and achieving a sustainable energy system. Reducing energy demand by increasing energy efficiency is of particular interest in the context of the attempts to mitigate our reliance on fossil fuels, even if they remain abundant and relatively inexpensive.

In the building sector in particular, there is much potential in both countries for increasing energy performance. A systematic improvement of efficiency is feasible, if the ensuing economic challenges are addressed. It might therefore require a concerted political effort.

With regard to heating, the current situation in France and Germany is comparable, since the two countries show similar levels of energy consumption and efficiency and have a high percentage of older, less efficient buildings. Bilateral collaboration and research could also aim at developing new energy-efficient urban planning concepts. Further sectors to be taken into account are efficiency in energy intensive industrial processes and in rapidly growing information technologies.

2. Grid infrastructure and smart grids

The electricity grid is a matter of great interest in both countries, in particular with respect to possible improvements and further technological developments. Its flexibility and stability are vital not only for France and Germany, but also for Europe as a whole. It is of paramount importance to analyse the feed-in of increasing amounts of intermittent renewable energy and its implications for the stability and resilience of the grid. The preservation of stability of the electrical grid clearly constitutes a central issue, as does the question of use and storage of excess electricity. These are challenges which both countries face, although to different degrees. Deployment and exploitation of novel solutions might allow higher flexibility in the energy system. These include smart grids, demand-side management in both the private and the industrial sectors (like the “Ecowatt” system in French Brittany and Provence), peak shaving methods, or efficient power conversion systems (like power-to-X, where X can be hot water, heat, gas, fuel, or chemicals…). These fields would benefit from scientific and technical cooperation between the two countries. Although the discussion often centres on the electricity grid, the focus should be extended to include other energy grids, such as those for gas, heat or even hydrogen.

3. Mobility

For the next few decades, oil and gas will continue to cover a major part of the energy required for aviation and for the automotive transport of people and goods, particularly over long distances. However, research can bolster the development of more efficient conventional vehicles. Similarly, more efficient solutions for aircraft and automotive vehicles are needed, including hybrid electric or battery-powered electric vehicles and potentially fuel-cell powered vehicles. Future generations of battery systems beyond present lithium-ion batteries promise higher energy densities as well as much lower costs and hence should be the subject of joint R&D efforts. More efficient propulsion technologies, downsized thermal engines, energy recuperation systems and supercapacitor power storage are also important topics.

Bilateral research and industrial projects should also cover socio-technical aspects, including the public expectation and social perception of mobility, as well as the possible involvement of citizens in the introduction of new technologies and concepts.

4. Nuclear energy (fission): safety and waste management

Energy from nuclear fission will probably continue to remain the backbone of the French electricity production system, whereas it is being phased out in Germany. However, both countries need to deal with nuclear safety issues, the decommissioning of nuclear power plants and the management and disposal of nuclear waste. The knowledge to be acquired is important for both countries, but is also of global significance, thus making the establishment of long-term joint projects a logical next step. Cooperation between the two countries may also be possible in the field of partitioning and transmutation of nuclear waste, *e.g.* using accelerator-driven technologies. Only France is involved in the design of ASTRID, a prototype for developing Generation IV Fast Neutron Reactor Technologies.

5. Nuclear fusion

Nuclear fusion is potentially a long-term, sustainable and safe option for base-load electricity generation. Research in this area takes place in both countries and there are several joint projects. France has taken a leading position in research for fusion by hosting the international fusion project ITER. The support of Germany with its very strong fusion research programme was crucial for the approval of the ITER project. The two countries should continue their long cooperation in fusion by working together for the success of this endeavour. Panel members from the four academies are of the opinion that research in this field should continue at the present level and that the ITER project should be brought to a successful conclusion. However, they note that, before 2050, fusion is unlikely to make a contribution to electricity supply.

6. Renewable Energies

For both countries, raising the share of RE is regarded as an essential means for reducing GHG emissions. Recent experience shows, however, that the increasing feed-in of intermittent renewable electricity into the power grid generates technical and economic challenges. To compensate for the absence of electricity when there is no wind or sun, flexibility options need to be introduced into the energy system. This requires in particular the design and deployment of solutions for large-scale long-term and short-term energy storage and, as mentioned in Section III 2 above, new concepts for demand-side management and grid stabilisation. It is also important to ensure that renewable energies remain economically viable for consumers and do not destabilise the economic system. Both countries could benefit from mutual experience in the field of RE and focus their expertise on new, innovative solutions.

Energy from biomass stored in solid (wood), liquid (biofuel) or gaseous (biogas) form has some potential in replacing fossil fuels. There are very different routes of biomass utilisation presently pursued in both

countries. First generation biomass, *e.g.* bioethanol or biodiesel from cultivated energy plants like maize, has recently become subject to a critical assessment due to conflicts with a sustainable agricultural system and affordable food production. Indeed, new legislation in France, for example, requires that biofuels must not be produced from edible plants to avoid competition with human food sources. Crop fertilizers are also unwanted because they can contribute strongly to GHG emissions. However, second and third generation biomass from waste material like cull, straw, or organic waste could provide a significant amount of sustainable biomass-based energy sources after conversion to tailored solids, liquids or gases. Research on the development of concepts, methods and processes to efficiently produce such biomass-based products is pursued in both countries, but should receive more attention and increased funding.

7. Social and economic aspects of the energy transition

Expertise in social and economic sciences is required on the one hand to identify and assess social and economic consequences of choices in energy policy, to assure social compatibility of the transformation steps, to accompany large projects or changes (*e.g.* by participation), and to study the various aspects of involvement of citizens (*e.g.* as 'prosumers'). On the other hand, it is essential to foster public understanding of the objectives of the energy transition as well as its technical possibilities and constraints. In particular it is necessary (1) to analyse, recognise and account for social expectations and compatibility problems when making choices in energy policy; (2) to identify major socio-economic, technological, environmental and industrial consequences of these choices, namely with respect to cost, competitiveness, employment, and involvement of all stakeholders, and (3) to improve our understanding of the interconnections between technological development, organisational governance and human behaviour, within the entire energy system.

III. Conclusions

Considering the complex technical challenges, the political discussions and the different starting points for the transformation of the energy system in the two countries, the four academies come to the following conclusions. They are expected to be important for all stakeholders, but are particularly relevant for policy makers.

1. Creating a sustainable energy system

The overriding aim of energy and climate policy in this century must be to create a sustainable system of energy supply, i.e. one in which greenhouse gas emissions are substantially reduced. To move in this direction in a reliable way, policy makers will have to find trajectories that will balance environmental goals, social expectations and economic objectives while ensuring security of supply. On a practical level, energy policies demand a long-term perspective and planning, focusing on multidimensional sustainability issues. This in turn requires the identification of best-practices, taking into account past experience and relying on a comprehensive analysis, as well as emphasising regional cooperation and integration.

The academies consider the decision of the European Council of October 2014 to set a binding EU target of an at least 40% (with respect to 1990) domestic reduction in greenhouse gas emissions by 2030 as an important step. The academies observe that the corresponding effort will only be of real value if the goal of GHG reductions is shared on a global level, leads to similar binding targets and becomes part of a world-wide agreement. Moreover, they recognise that a functioning system for emissions trading can be an effective instrument in this context, as confirmed by many experts in both countries. The academies thus explicitly support the revision of the EU Emissions Trading System (EU ETS) and refer to a recent Euro-CASE Policy Position Paper “Reform Options for the European Emissions Trading System (EU ETS)” for alternative approaches. They note that increasing the number of countries willing to participate in carbon pricing would increase the credibility of the system and that this should be given the highest priority. Furthermore, they suggest that there should be coherence between the EU ETS and the strategies for RE subsidies in all EU member states.

2. Promoting collaborative policies

The academies acknowledge the joint declaration of the French and German governments, issued by the Franco-German council of ministers on March 31st 2015. The academies welcome the stated intention of both governments to support effective energy and climate policy on a European level through the medium of a European Energy Union. Along these lines, EU-wide collaborative programmes focusing on novel scientific and technological approaches to energy generation and use should be promoted. Furthermore, the setting of priorities, the agreement on development programmes and the allocation of resources should constitute integral parts of any future European energy policy. EU-wide policies consistent with the long-term goals of the energy transition should be endorsed, aiming at compatibility with policies implemented in other parts of the world. Furthermore, EU countries should have complementary strategies, aiming at maximum compatibility, modularity and interconnectivity with neighbouring countries. In short, the Energy Union should make energy more sustainable, more affordable and more secure.

Overcoming national barriers of both technological and political nature could pave the way to future agreements on an international level. In this spirit, the academies particularly encourage the effort of both governments to reach an ambitious international climate agreement during the COP 21 in Paris at the end of 2015.

3. Asserting the central role of science, technology and industrial development

How to achieve an efficient energy transition resulting in a net reduction of GHG emissions is a complex question. It requires answers not only on an economic and geopolitical level but, more fundamentally, also with regard to scientific, technological, and societal issues. These involve many constraints and challenges that have still to be overcome. The need to reduce carbon emissions puts pressure on policy makers to act. Such action, in turn, requires a mobilisation of science and technology and a supporting involvement of industry and citizens at all levels, in order to select and develop appropriate solutions. When mapping out energy transition policies, it is vital to consider scientific, technological and socio-economic issues and assess not only the state of the art, but also possible future progress and potential breakthroughs. This requires sufficient support of research, development and innovation so that these insights and breakthroughs manifest themselves more frequently. It also requires a close cooperation between technical and social sciences to ensure the social and economic compatibility of technological development.

The academies thus support strong funding programmes for energy R&D, in particular for long-term basic research in cross cutting topics, such as energy efficiency, storage or energy-related materials. These activities will serve to support the transformation of the energy system in the next few decades and help to improve the international competitiveness of European industry.

4. Raising public awareness of energy policies

Energy has become a topic of discussion in the media and the public at large. Such societal trends correspond to an increased level of awareness but, on the other hand, the understanding of basic facts and constraints often remains limited or is biased by interest- or ideology-driven opinions. However, the public at large is now conscious of the fact that the period immediately ahead will be crucial in terms of decision-making on energy matters, and that such decisions must be underpinned by scientific, technological and economic deliberations. Therefore, taking into account the diversity of expectations, the objectives as well as the technical possibilities and constraints of energy policies should be discussed more extensively with the general public, in order to raise awareness and promote a systemic and shared understanding of energy questions. Furthermore, policies should be scrutinised with regard to their multidimensional, international consequences. Ultimately, a European energy vision should evolve, on which European citizens can agree.

5. Promoting French-German scientific, technological and industrial cooperation

As outlined in the previous chapter of this statement, both countries would benefit from intensified cooperation in the energy sector. The recent ministerial declaration as well as the present statement emphasizes that cross-border projects could yield valuable experience for both countries and foster systemic cross-border integration. There is a need for innovation in energy-related domains and both France and Germany are endowed with a high degree of competence in these fields. Furthermore, closer scientific, technological and industrial cooperation could generate otherwise unrealised synergies.

Finally, the academies suggest the **establishment of an academy-led French-German consultative research committee** which could discuss research areas of mutual interest and research priorities in connection with the energy transformation. It could be a medium for reporting on developments in each country (for example, the recommendations of the German ESYS project). Its deliberations would also be of interest to policy makers.

List of all participants of the two workshops “Round Table on Energy Transition”

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