The "European Green Deal": Research is key to achieve the goals

A contribution by the Helmholtz Association

1. Research as the basis

The European Commission's Green Deal sets out ambitious goals in order to tackle grand challenges related to climate and environment. Choosing the right path towards these goals is a challenge in itself. Decisions on major societal transformation processes require integrating the latest research results: In many cases, we still lack a thorough understanding of e.g. global climate processes or the interactions of chemicals and various other substances in the atmosphere. Whereas improved batteries and Power-to-X technologies could reduce the CO_2 footprint of our current energy system, their metal resources and environmental footprint are raising questions. Thus, much research and development remains necessary until we can use reliable new technologies in our daily life. In order to improve the societal acceptance of innovation on an industrial scale, social science instruments should also be used, such as "living labs" in Germany. Excellent research can not only support the Green Deal transformation with the knowledge of today, but should also play a crucial role by continuously generating the knowledge of tomorrow and beyond – best achieved in European collaborative projects.

Long-term R&I agendas starting from basic research set the ground for new breakthrough developments. **Fundamental collaborative research** contributes strongly, e.g. by enabling the development of new technological solutions for a sustainable supply of materials and processes. Research infrastructures are another important key. **Large analytical research infrastructures**, data infrastructures and others help achieving the goals of the Green Deal, as they enable deeper insights into material structures, interactions, and functions, e.g. by:

- Supporting the development of advanced materials for low power electronics and for energy efficiency under the Green IT paradigm.
- Making possible R&I for a rational design of batteries based on a detailed molecular understanding of the chemistry and structure of **battery materials** that allow for denser energy storage.
- Supporting development of components for **green hydrogen generation and infrastructure** e.g. by research on catalytic or electrochemical processes. Research results can additionally play a key role in the development and implementation of specific legislative options.

Furthermore, in order to monitor environmental parameters, distributed research infrastructures are of critical importance.

2. Adaptation and Mitigation: How research can contribute

Research is the prerequisite for implementing many of the actions named in the Green Deal, in particular the research on future materials for both better energy systems and greener IT and the research on climate and biodiversity protection. Integrated solutions relating to the actions named under 1-4 and 6-7 are likely to produce strong impact:

2.1. Promising research approaches to facilitate Green Deal Actions[1]

Blue: Focus on Adaptation – *Green: Focus on Mitigation*

1 Climate Ambition	Action	
Priority should be: Accelerate both climate change mitigation and adaptation to climate change by improving actionable knowledge on the climate-earth system, by **improving regional to global predictions and projections, by comparing, analysing and evaluating the impact of mitigation and adaptation measures** and by proposing and	→	New EU Strategy on Adaptation to Climate Change

[1] See Actions named in the „Roadmap - Key actions" in the Annex to the Communication on the European Green Deal COM(2019) 640 final

evaluating solutions for short-to-medium and long-term systemic impact in close interaction with stakeholders. Science can also contribute with improved quantitative forecasts of weather, atmospheric composition and seasonal extremes by expanding the practical limits of predictability based on advanced modelling, data assimilation, and observational capabilities. Systemic solutions should be envisaged, including a reflective master plan with intermediate goals, monitoring and strict responses if goals are missed. Complex simulations including economical and societal responses are needed to improve impact on political action.		
2 Clean, affordable and secure energy	**Action**	
Hydrogen and synthetic fuels can be produced from zero-carbon power sources, such as renewable energy. Research is essential to help improving performance and reducing cost along the supply chain. Development and demonstration of innovative technologies are needed to enable the future large-scale deployment of **novel photovoltaic solutions**, e.g. for building integrated PV. Further, renewable fuel generations can be combined to environmental restoration by e.g. large algal aquaculture locally binding excess nutrients and providing biomass for biogas production or pellet heating.	→	Strategy for smart sector integration
3 Industrial strategy for a clean and circular economy	**Action**	
The implementation of Industry 4.0 is associated with digitalization. The rapidly increasing requirements call for disruptive developments that can overcome the inherent limitations of the technologies available today. These need to be combined with an understanding of new green business opportunities and markets as well as societal values. New approaches in information technologies, including artificial intelligence, neuromorphic systems and quantum technologies, will be drivers for the digital transformation achieving usability, performance, energy efficiency, as well as the security and privacy needed for a clean and circular economy.	→	EU Industrial strategy
Materials are fundamental to technological progress and sustainable development. The growing demands for more efficient and environmentally friendly materials and sustainable biological products at lower costs **call for interdisciplinary efforts in material sciences.** This comprises the integration of systems and products of **inorganic and organic/biological origin, 3D manufacturing of functional devices,** making use of computational/virtual design and **simulation.** In particular, virtual and data-driven development of materials, together with a standardized data management concept, will enable inverse development of materials for future markets under explicit consideration of sustainability (lifecycle analysis).	→	Stimulate lead markets for climate neutral/circular products
In a world that is increasingly electrified, batteries will become one of the key technological components of a low-carbon economy. Research on "**beyond Li Batteries**" is needed: The current generation of Li-ion batteries still has significant potential for optimization, and new emerging technologies are appearing on the horizon (solid-state, Li-air etc.).	→	Legislation on batteries / Strategic Action Plan on Batteries
4 Sustainable and smart mobility	**Action**	
Autonomous and network supported driving assisted by a digitalised traffic infrastructure will increase safety, traffic flow, comfort in road traffic and as a result reduce CO2 emissions. Therefore, this topic is of high relevance for society and should be integrated into a mission. The share of climate impact resulting from air transport will increase. Therefore, there is an urgent need to work on **zero emission air transport** that will form the future basis for the worldwide economy. This calls for the implementation of the Clean Aviation partnership currently under preparation for Horizon Europe.	→	… boost the production/ supply of sustainable alternative fuels

Alternative sustainable fuels for aviation, surface transport and power plants will create a circular process by reusing CO_2 and water vapour from atmosphere and avoid additional CO_2 emissions from fossil fuels. Combustion processes can be optimized by using specifically designed sustainable fuels. In order to perform the cutting-edge research in these areas the planned Horizon Europe partnerships for **Clean Hydrogen** and **Batteries** will be vital.	→	...Alternative Fuels Infra. Directive / Trans European Network – Transport Reg.
6 Preserving and protecting biodiversity		**Action**
Preservation and protection require a thorough understanding of **the interactions between mitigation and adaptation efforts and biodiversity**. The main common target is to explore, derive, and design solutions for sustainable use of marine and terrestrial ecosystems under the conditions of global climate change. This target requires synthesizing data, processes and their multiple interactions, models, and forecasts as well as the theory of biodiversity change and the consequences for ecosystem functions and services. This area has strong links to food security, health and climate protection, as well as to European cultural values.	→	EU Biodiversity Strategy for 2030
7 Towards a zero-pollution ambition for a toxin-free environment		**Action**
The effects of changing environmental conditions – such as climate and pollution from various sources – on human health, including our respiratory and cardiovascular systems, must be better understood. To this end, we need to intensify research and restructure it to follow an **eco-exposome approach.** The approach should cover substances and other stressors in the environment and both their mutual interactions and their impact on human health. Considering the role of respiratory health in societal resilience against pandemics, the urgency to understand relevant interactions with climate and pollution is evident.	→	Chemicals strategy for sustainability Zero pollution action plan for water, air and soil

2.2. Best practise: Materials research – the way to improve batteries and catalysis

New methods are conceived for accelerated and integrated development of materials at the Helmholtz centres. This work is based on the joint use of research infrastructures and on the close collaboration of scientists in the different research fields. A successful example of past activities is the quick development of an initially fundamental research program relating to electrochemical energy storage focusing on key technologies and its subsequent transfer to technologies used in energy research. This approach is complemented by outstanding developments in photovoltaics and catalysis research.

Brief portrait of the Helmholtz Association

Helmholtz contributes to solving major challenges facing society, science, and the economy through top-level scientific achievements in six Research Fields: Energy, Earth and Environment, Health, Key Technologies, Matter, and Aeronautics, Space, and Transport. With more than 40,000 employees at 19 Research Centers and an annual budget of around 4.8 billion euros, Helmholtz is the largest scientific organization in Germany. Its work is rooted in the tradition of the great natural scientist Hermann von Helmholtz (1821–1894)

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