NET ZERO 2050

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Methodology

To better understand the role, and need, for innovation in the decarbonisation of the European economy, and to offer timely insights to policymakers designing future research and innovation funding programmes, this report combines a literature review, which focuses on existing funding for climate related innovation, with the results of an online survey of over 100 experts and institutions from four communities: Climate experts reviewing net-zero emissions scenarios for 2050, Energy experts developing energy sector decarbonisation scenarios for 2050, Experts from an ECF deep decarbonisation pathways network and Members of a 2050 platform considering the strategy for long-term EU greenhouse gas emissions reductions.

Europe's long-term decarbonisation challenge can be sub-divided into five segments: Power, Transport, Buildings, Industry and AFOLU (Agriculture, Forest, Land-Use & diet). The expert survey was designed to identify where innovation can best accelerate the low carbon transition in these five sectors. Aligning with the net-zero 2050 modelling architecture (described further in the section below), each segment was further sub-divided into its principal "component parts". In total the survey asked for expert opinions on 58 individual components of the five sector decarbonisation challenge and specifically about how the European Commission's investments in research and innovation in its next budget cycle (2021-27) could accelerate long-term, economy-wide decarbonisation.

This report builds its perspectives and framework to elicit expert opinion on the role for innovation in the long-term decarbonisation of the EU economy on two expert communities contributing to two specific projects modelling a net-zero economy in Europe by 2050 and developing 2050 energy sector decarbonisation scenarios. These two projects whose technical work and participant networks formed the base for this report are briefly described below:

European Net-Zero Emissions Climate Modelling Project

Under Article 4 of the Paris Agreement, all parties are required to put forward a long-term strategy setting out the action they will take across the economy to contribute to the global goals of limiting global average temperature increase to well below 2°C above pre-industrial levels, aiming at 1.5°C. This is likely to mean global emissions falling to net zero by mid-century, with developed countries arriving at this level earlier than the global average – an objective to which 19 countries, including 12 EU Member States have already committed. At the European Council meeting in March 2018, EU Heads of State and Government invited the European Commission to prepare a draft of the EU's collective mid-century strategy by Q1 2019.

The Governance Regulation (part of the EU Clean Energy Package) formalizes the requirement for the Commission to include in its long-term emissions strategy options at least one scenario which would reach net zero emissions within the EU by 2050, and to go into negative emissions thereafter. It also requires the Commission to assess implications of these pathways on global carbon budget and equity. Furthermore, the Environment Ministers of 14 Member States (members of the Green Growth Group) released a statement on 25th June calling on the Commission to include several pathways towards carbon neutrality, including a 1.5 degrees scenario, and at least one pathway towards net zero by 2050 followed by negative emissions.

While the long-term strategy options paper, expected in November, will only be a first approach by the European Commission, it will form the basis of the eventual mid-century strategy that Heads of State will approve in late 2019 / 2020 and submit to the UNFCCC. This in turn will set a 'North Star' for the whole next raft of EU policy-making, covering policy areas from climate governance to energy, to industry and agriculture, at least insofar as they relate to GHG emissions.

As part of ECF's work to establish a vision and evidence base transition to Pariscompatible emissions levels in the EU, in autumn 2017 it commissioned the consultancy Climact to build an economy-wide 2050 Roadmap Tool, that can be used to develop and test possible pathways to net zero emissions by mid-century. The tool incorporates an analytical base of deep dives on particular sectors including power, transport and buildings (Energy 2050), industrial transformation (IT50), agriculture (Agriculture 2050) and on topics including governance for net zero emissions.

The 2050 Roadmap Tool is a calculator which models, at aggregated EU level, the various GHG emitting sectors: transport, power, buildings, industry, AFOLU, and key interactions between them, out to 2050. It is based on the Carbon Transparency Initiative (CTI) model and defines over 50 levers representing key drivers of emissions (e.g. EV uptake, meat consumption etc.). Levers can be set anywhere between level 1 (current practice and policies) to level 4 (best practice and transformational options) for each decarbonisation strategy. By setting different combinations of levers, modellers can create scenarios whose emissions' impact and cost implications are calculated.

A number of leading organisations and experts were consulted during the building of the tool, and were involved in developing the pathways and outputs including: Agora Energiewende, Climate Strategy, Fraunhofer Institute for Systems and Innovation Research ISI, Friends of the Earth (FoE) UK, Grantham Research Institute - London School of Economics, Iberdrola, Institute for European Environmental Policy (IEEP), Institute for Sustainable Development and International Relations (IDDRI), Stefan Scheuer, Third Generation Environmentalism (E3G), UK Department for Business, Energy and Industrial Strategy (BEIS), and the World Wide Fund for Nature (WWF) European Policy Office. Other organisations consulted include Agora Verkehrswende, Aviation Environment Federation (AEF), Buildings Performance Institute Europe (BPIE), Ecofys, EuroACE, the European Consumer Organisation (BEUC), the European Federation for Transport & Environment (T&E), Fern, Fraunhofer ISI, International Federation of Organic Agriculture Movements – EU (IFOAM-EU), International Institute for Systems Analysis (IIASA), Öko-Institut, Imperial College London (ICL), Open Exp, Stefan Scheuer, and Vrije Universiteit Brussel (VUB) – Institute for European Studies (IES).

As well as making the underlying Roadmap 2050 model available on an open source basis, Climact and the ECF have published a set of example net-zero emissions scenarios to serve as a resource for policy-makers and experts to test possibilities, make comparisons and develop better systems understanding. The accompanying report describing these net-zero emissions pathways was published in September 2018 with the intention to support the Commission's preparation of the options for the EU's mid-century strategy. The report has key conclusions:

- Reaching net-zero greenhouse gas emissions by 2050 is feasible, but requires strong action across all sectors, widening the range of low carbon options used.
- Net-zero greenhouse gas emissions in 2050 requires an increase in 2030 ambition to set Europe on the right trajectory.
- Net-zero pathways can cost less than business-as-usual and build a more attractive, resilient society.

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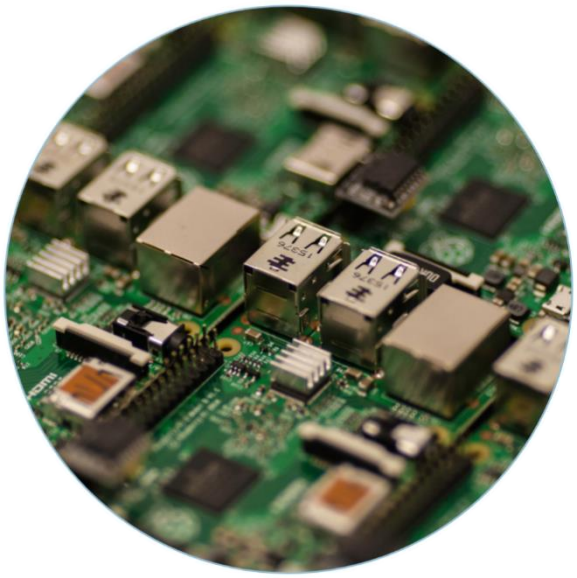
European Net-Zero Emissions Climate Modelling Project

The progress made in the last decade on improvements to energy efficiency and increasing the share of renewable electricity generation gives rise to a key question: What configurations of zero-carbon energy systems exist that affordably maintain security of supply for Europe? The answer requires consideration of several factors: the role of electrification of loads versus alternative decarbonisation vectors; the tighter sector coupling with mobility, heating and some industrial processes; and maintaining security of supply of electricity while moving away from our heavy dependence on fossil thermal plant.

To answer these key questions, ECF has contracted Cambridge Econometrics and Element Energy to develop decarbonisation options for the whole energy system, and to explore the following:



- the cross sectoral and systemic implications of decarbonisation across heat, power and transport sectors;
- the key role and extent green electricity can decarbonise heat, transport and industrial processes, including its combined impact on electricity supply and infrastructure;
- the positive impact of demand side measures, including: smart consumers/ consumption in managing daily variation in demand after supply of variable renewables; and the impact of energy efficiency in buildings on the viability of the green electrification pathways;
- the extent to which energy supply and demand could be matched more effectively by other green energy vectors in meeting seasonal energy demands for heat and in balancing the power system;
- the macro-economic impact on the European economy of different pathways.

The study examines the feasibility of zero carbon energy systems for the EU by 2050 on the basis of a number of different scenarios that explore a wide range of technological options for supply, demand, flexibility and smartness that can be applied to meet this goal. Archetypes were generated and applied across Europe which represented diverse climatic conditions (reflecting renewable energy supply as well as heating demand) and the availability of gas infrastructure (as an alternative means of decarbonizing heating). The model used balances energy for each hour of the year, responding to varying renewable supply and energy demands. To achieve this balance, the model uses a portfolio of flexibility options – demand side response, thermal storage, grid-connected batteries, controlled EV charging & V2G, and interconnectors. Where required, longer timescale/seasonal deficits of energy are balanced using hydrogen as a storage medium.

Each scenario is designed to provide security of energy supply throughout the year – a key challenge with high renewable energy scenarios. Scenarios were compared in terms of: System costs; and macro-economics. They were also compared against a BAU/Current Policies baseline to 2050. A core assumption is that electrification is a primary vector for decarbonisation of demand loads. Smart consumption and energy efficiency within these sectors are included in the scope. The analysis also includes the role that some industrial and commercial processes can play in providing demand response. Scenarios explore the use of other green energy vectors (such as biogas and

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hydrogen) and e-fuels to support the system where electrification would be costly. Each scenario is being evaluated not only from an energy systems and climate perspective, but also from a socio-economic perspective to deliver insights into the impact on the economy and employment. For example: while the energy system model might indicate a lower overall cost if energy is imported from outside Europe, this would have an adverse impact at the macroeconomic level.

The project model's integrated treatment of the economy, the energy system and the environment enables it to capture bidirectional linkages and feedbacks between these components. Its high level of disaggregation enables relatively detailed analysis of sectoral effects and it delivers outputs in terms of changes to household budgets, the energy trade balance, consumption, GDP, employment, CO2, NOx and particulates. The report will be published in late 2018.

Expert Innovation Survey Structure

Matching the architecture of the net-zero 2050 models, the expert survey was designed to elicit the answers to five questions and the relative prioritisation and scores for each of the 58 sector component decarbonisation strategies. These five questions were:

1. How critical, in your view, is innovation in this component to deliver a net-zero economy in 2050?
2. Where in this component's supply chain is innovation most relevant? (I.e. Is it Technology, Product/ Service, Business Model or Social/ Cultural Innovation?)
3. Could innovation investment in this component generate an EU competitive advantage? (either building on an existing one or acting in a space where the lead is yet to be established, globally)
4. Can you pick the funding instrument that would be most effective (or needed) in funding innovation for this component area?
5. Would you increase or decrease FP9 funding for innovation to this component? (Relative to its spending in Horizon 2020 - whose summary allocations were provided, see chart 7 in Section 2 of this report).

Experts were offered the opportunity to elaborate on any of their answers to any of the questions by sector and to identify or describe a potential "EU Mission" or mission orientations which should guide EU-level innovation budgets and priorities in that sector. Experts were informed that mission-oriented innovation should be "ambitious, exploratory and ground-breaking in nature, often cross-disciplinary, targeting a concrete problem/challenge, with a large impact and a well-defined timeframe". Moreover, that missions "have a clearly defined (societal or technological) goal with preferably qualified and/or quantified targets and progress monitored along predefined milestones. Directionality and intentionality of these initiatives is what differentiate them from other types of initiatives, such as systemic or challenge-oriented policies."

Net zero GHG emissions can be confused with net-zero carbon emissions, but when accurately used, means all greenhouse gas emissions decline to zero, as opposed to just carbon dioxide. This is the same concept as net zero carbon emissions but conveys a net zero emissions target for CO2 and all non-CO2 gases.