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INNOPATHS

Innovation pathways, strategies and policies for the Low-Carbon Transition in Europe

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D3.2 Report on online survey of key stakeholders

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1. Introduction

The INNOPATHS project is using an intensive process of stakeholder engagement and co-design in order to inform the development of technologically-detailed decarbonisation pathways for Europe to 2050. The first stage in this process is the implementation of a survey, targeting the INNOPATHS co-designers (a group of stakeholders recruited during the project proposal). This document sets out the background to the survey, discusses its development, and sets out the major results and findings.

1 About the survey: development and implementation

1.1 Design

The survey was designed to strike a balance between enabling co-designers to express broad beliefs and expectations through open-ended questions, while also ensuring that the survey prompted participants to provide specific information of direct relevance to the technologies and policies that can be modelled in INNOPATHS scenarios. The survey thus included a blend of open-ended questions, and those that scored technologies and policies against perceived importance. Participants were explicitly invited to consider both more techno-economic considerations that are relatively closely aligned to the modelling frameworks represented in the consortium, and broader issues: politics, culture, and behavioural dimensions of possible futures.

The survey was also designed to be flexible, recognising the diverse areas of expertise of our co-design group. Participants were invited to focus on those questions and areas of the survey in which they had most expertise, and were free to skip those areas in which they felt that they had little to contribute. Participants were also able to suggest additional technologies, policies and issues throughout the survey.

1.2 Development and testing

The project team developed a draft survey, and this was tested by colleagues within the teams' institutions. Feedback was gathered on a) clarity, phrasing and structure; and b) the appropriateness of the questions for generating useful content for INNOPATHS scenarios. Testing and feedback was carried out during November 2017. The survey was developed using an online survey tool (Opinio). Data protection assurance was provided by the UCL Data Protection Office.

1.3 Implementation

The survey was implemented during December 2017 and January 2018. In a first wave, INNOPATHS co-designers were invited to take part. Subsequent invitations were sent out to a further group of stakeholders on the basis of their expertise in relevant aspects of Europe's long-term energy options. The survey respondents were thus not expected

to be a statistically representative group, but rather they represent a range of relevant expert opinions and beliefs.

The team sent out ~50 invitations to complete the survey. We received 24 responses, including many that provided lengthy and detailed comments on future possibilities and options of relevance to European decarbonisation.

2 Results and discussion

2.1 Big picture trends and issues

The first section of the survey invited respondents to comment on the 'big picture' trends and developments that they believed might be particularly important in shaping Europe's decarbonisation pathway. Participants were given the opportunity to suggest the trends and developments they felt might be most important, and they were also asked to score four 'dimensions' (see Annex Question 2 for the wording). The results are presented in Figure 1. These scores show that participants thought that all four dimensions were important – though the greatest emphasis was put on the degree of 'co-operation vs. fragmentation; and the degree to which governments were willing to intervene in markets vs. taking a more laissez-faire policy approach.
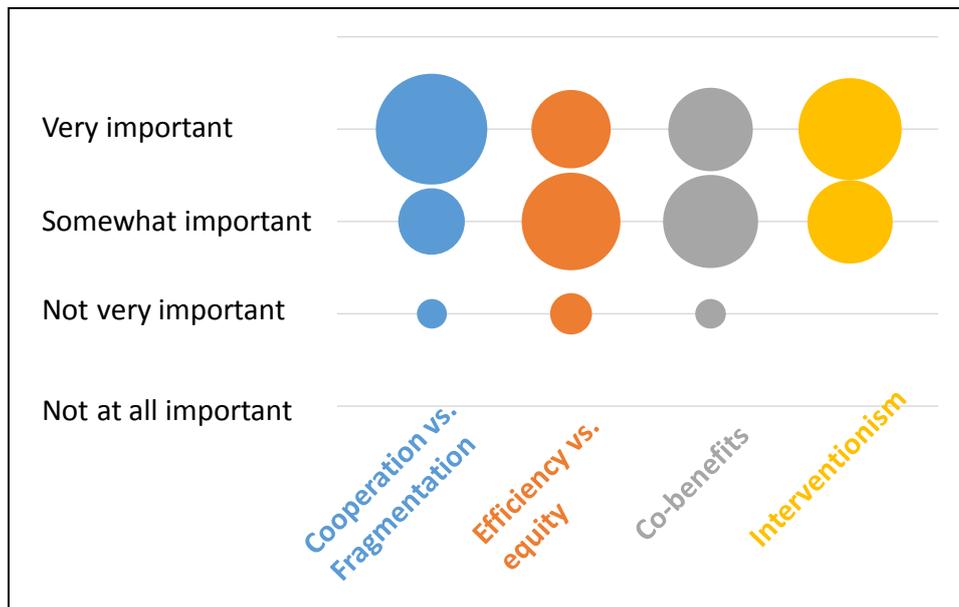

Figure 1. Bubble chart showing responses to questions about possible big picture trends, and their importance for European decarbonisation. The size of bubbles is proportional to the number of responses.

In text responses, participants also highlighted a number of key themes. In particular, those that were most prominent included:

- Populist nationalism and resulting governance fragmentation: "a war on European soil is something to be considered in an extreme scenario"
- Digitisation and automation. It was noted that these enable system optimisation and efficiency, and might facilitate the emergence of new entrants and business models. It was also noted that there are countervailing forces that might reduce the potential impact of these trends: notably concerns about privacy and security
- Political leadership, public attitudes and ambition (such as whether the GHG target is 80% or 95% reduction). This was seen as potentially influenced by increasing climate impacts and mediated by shifting norms
- Techno-economic tipping points (RES vs. Fossil; EVs vs. ICEs), and the related idea of a tipping point around financing, with risk assessments of fossil fuel assets a core issue.

2.2 Innovation dynamics

In discussing innovation dynamics, participants were asked to consider whether INNOPATHS should focus more on rates of technology diffusion; on cost reductions; or on the emergence of new technologies. The results are shown in Figure 2, and show a tendency to see diffusion rates as the single most important dimension, with the emergence of new technologies being seen by many participants as less important. The comments made by participants echo this view, with several participants suggesting that the key technologies are broadly known, and the issues are how fast they can be deployed. This view was typically justified with reference to the power or transport sectors, and sits somewhat at odds with the substantial technological unknowns revealed in industry roadmaps[1], or in agricultural or aviation decarbonisation scenarios.

Participants also urged the project not to overlook the importance of business model and other non-technological innovation.
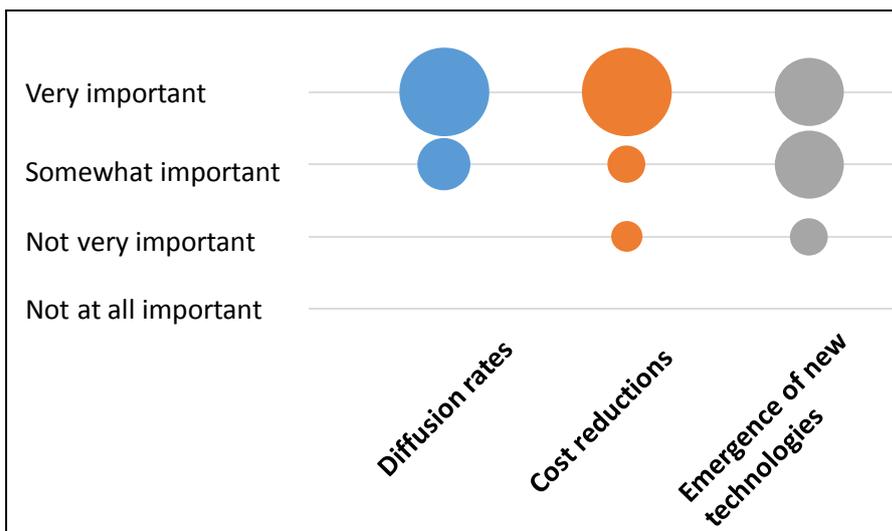

Figure 2. Bubble chart showing responses to the survey question on innovation dynamics

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[1] See, e.g. the 'technological breakthroughs' required in the CEMBUREAU or …? Glass? Roadmaps.
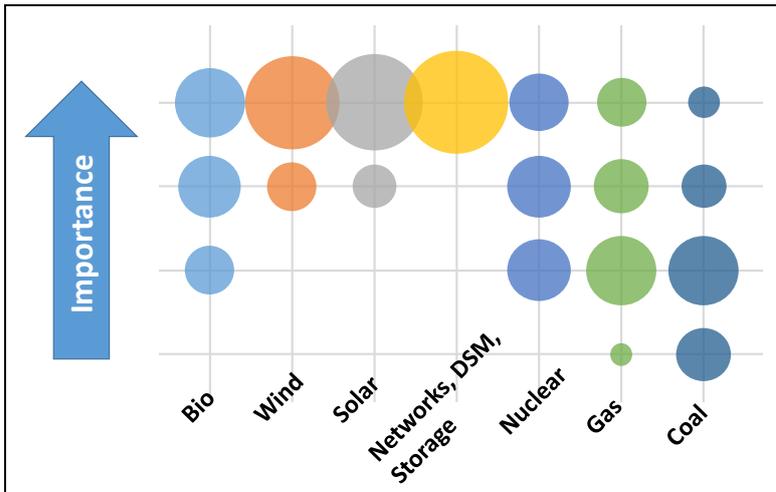
2.3 Power sector

Figure 3. Responses on priority technologies in the power sector

As shown in Figure 3, respondents expressed a unanimous view that networks, DSM and storage are very important for INNOPATHS scenarios to explore, and all participants viewed wind and solar as either 'very' or 'somewhat' important. Much more ambivalent views were expressed about bioenergy and nuclear: indeed, in the comments justifying these scores, several participants expressed strong reservations about the sustainability of bioenergy, while others expressed precisely the opposite view (and indeed expressed the fear that unwarranted sustainability concerns would prevent the use of bioenergy unnecessarily). There was clearly much less interest in exploring the roles of coal and gas – and the text comments suggested some scepticism about the potential for CCS to play a major role by 2050 in Europe. This are interesting responses from the co-designers, particularly in view of the central roles played by both nuclear, CCS and bioenergy in many existing decarbonisation scenarios for Europe.

2.4 Transport

The technology-specific responses on passenger mobility (shown in Figure 4) emphasise co-designers' interest in EVs and PHEVs as key technologies for exploration in the INNOPATHS scenarios. There is much greater variation in the interest for alternative low-carbon transport fuels (hydrogen and bioenergy). The strong degree of interest in various mode-shifting measures – including rail, walking and cycling – is also notable.
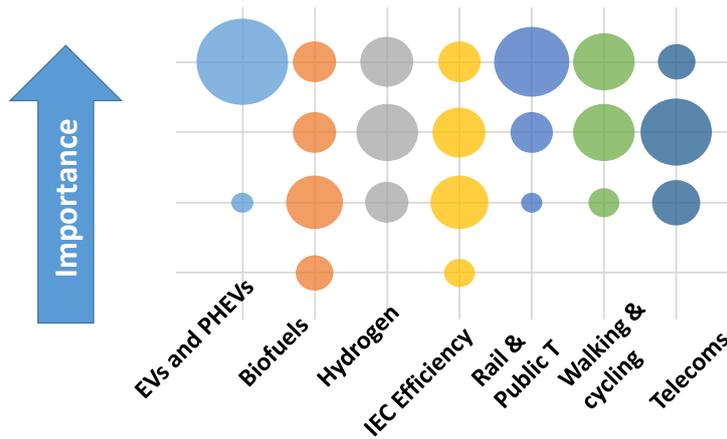
Figure 4. Responses on priority technologies for passenger mobility

For freight transport, there is a less clear pattern of preferences among co-designers about the priorities for INNOPATHS scenarios. The scepticism from some co-designers about the potential for bioenergy to play a significant role in this sector is again worth noting, and it reflects a wider controversy about the long-term sustainability and GHG-balance of bioenergy.
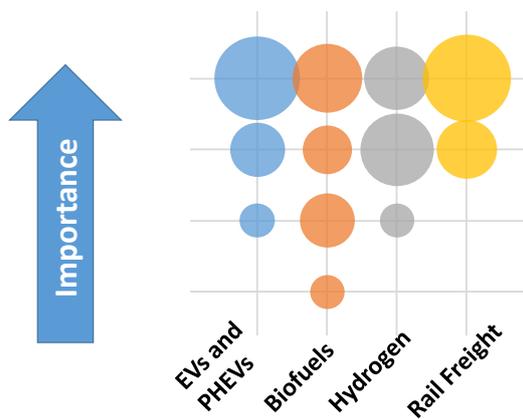
Figure 5. Responses on priority technologies for freight transport

2.5 Buildings, heating and cooling

Respondent views on priority technologies for this sector are shown in Figure 6. These show strongest interest in electrification of heating, and efficiency measures in the built environment.
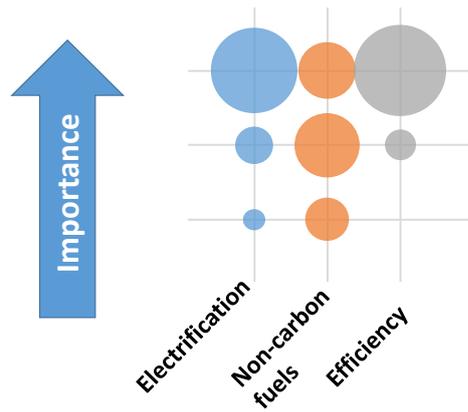
Figure 6. Responses on priority technologies for buildings, heating and cooling

2.6 Industry

Several respondents noted that they lacked significant expertise in industrial energy and emissions, and declined to complete this section. Of those that did complete the section, there is a surprising degree of ambivalence about the role of CCS, which is often seen as a core technology option for achieving deep decarbonisation in industry, particularly for those sectors with substantial process emissions (such as cement).
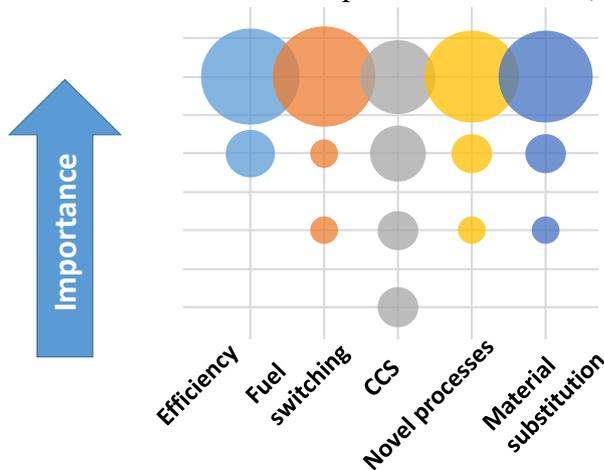
Figure 7. Responses on priority technologies for industry

2.7 Agriculture

As with industry, a number of respondents declined to complete this section, citing limited expertise. Of those that did respond, all the suggested options were considered to be important, but the emphasis on the abatement of non-CO2 gases and on crop yields – both of which require long-term investments in R&D – is an interesting. This observation perhaps sits at odds with the broader picture expressed by participants that most of the technologies required for achieving European are known, and that speed of diffusion rather than emergence of new technologies is the key issue.
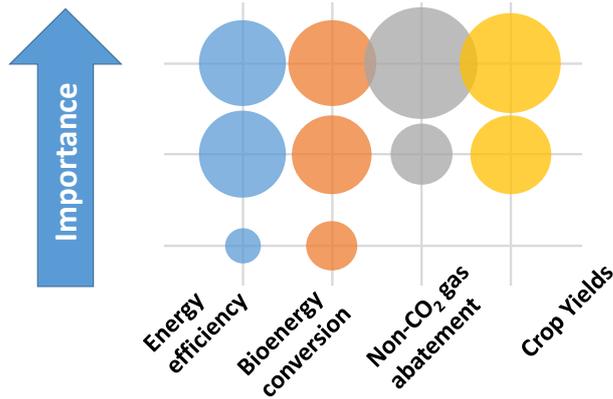
Figure 8. Responses on priority technologies for agriculture and bioenergy

2.8 Policy

In addition to asking participants for their perceptions of the technologies that should be the focus of INNOPATHS scenarios, the survey asked respondents about the most relevant policy instruments within each sector.

The findings here suggest that co-designers believe that the most important policy types differ across sectors: i.e. there is no single form of policy instrument that fits all sectors. In summary:

- Pricing instruments (carbon pricing, and vehicle/fuel taxation) were seen as leading policy instruments for the power sector, industry and for road transport. But such instruments were seen as having secondary relevance in agriculture, and in the decarbonisation of buildings, heating and cooling.

- Regulatory standards were seen as very important in all sectors, and especially so in buildings. Text comments discussing this issue highlighted the perceived inertia in people's behaviour with regard to investments in energy efficiency in buildings.

- R&D and innovation support were generally seen as less important than other instruments, but received relatively high scores in agriculture, industry and the power sector. But such policies were not seen as having a particularly strong role for passenger mobility. One possible explanation is a sense that the automotive sector is relatively more R&D-intensive than many other areas of energy, and that policy support for innovation in this sector is less important.

- Technology-specific subsidies were not seen as the most important form of policy instrument in any of the sectors. Given the substantial roles of feed-in tariffs in re-shaping Europe's power system in recent years, this is perhaps a surprising result. It seems that respondents see such subsidies as a second-class or supporting policy across all sectors, with either regulatory instruments or prices setting the direction, and technology-specific subsidies playing a supportive role.

Participants also suggested that the team explore a number of other policy issues. The question of energy and power *market design* was raised repeatedly, with participants raising the concern that current market designs shield consumers from dynamic power pricing, and thus dilute incentives and opportunities for demand-side response. Other respondents expressed the need for power market design to respond to the shift towards high penetration of zero-marginal-cost power generation technologies.

It was also suggested that INNOPATHS consider which policy agents are of greatest relevance: member states, the EU, or individual cities or regional governments.

Strategic investments in large scale infrastructure were also seen as being qualitatively different from technology-specific subsidies, and represent a distinct kind of policy action. Such strategic investments may, it was argued, be necessary for the deployment an EU-wide supergrid, CCS infrastructure, or hydrogen.

Finally, it was suggested that policy instruments might be too narrow a framing, and that scenarios should deal with broader strategic approaches and policy directions.

3   Conclusions and next steps

3.1   Conclusions

The INNOPATHS scenarios survey provides valuable insight into the issues and trends that stakeholders believe to be important in shaping the decarbonisation pathways that Europe might pursue.

Analysis of the responses suggests that many of the co-designers that participated in the survey share a loosely defined vision of a European decarbonisation pathway, which is characterised in terms of:

- specific energy technologies (in particular, accelerated diffusion of wind, solar and electric vehicles, coupled with flexible integration of these into "smart" grids);
- the enabling power of pervasive digitisation (which is seen as facilitating integration of renewables; and also facilitating efficiency gains elsewhere, particularly in the built environment);
- a policy and political environment in which political will to take action co-evolves with a public that largely supports such action, and in which trends towards populist nationalism and mutual hostility between regions and states fails to develop further.

This future was by no means seen as inevitable, and indeed participants suggested a number of potential delays or roadblocks—such as cyber security or privacy concerns; grid constraints slowing adoption of EVs; or persistent inertia in adoption of energy efficiency measures.

Participants displayed much greater ambivalence about the prospects for three technology groups that have often been seen as having critical importance for decarbonisation in the past: bioenergy, nuclear and CCS.

It is worth noting that the sample of respondents (24) is small, and that the opinions expressed by them are not necessarily representative of the beliefs of a wider set of European energy system stakeholders. While the survey clearly provides some important and useful insights into some of the issues that some stakeholders believe to be important, it would be a mistake to interpret the trends discussed above as representing a consensus view of European energy futures.

3.2 Next steps

As set out in the INNOPATHS description of work, the survey is followed by a stakeholder workshop (which took place in Florence on the 6th February 2018), and a process of developing narrative scenarios. The workshop, and the subsequent process of co-design and scenario development, will be reported in subsequent INNOPATHS deliverables.

4 Annex: blank survey example

Respondent 1934583

Single response:	Innopaths Scenarios
Respondent id:	1934583
Start date:	11/21/17 3:14 PM
Completed date:	-
Response language:	English [en]

1. I consent to participate in the survey. I understand that I can revoke my consent and withdraw from the survey at any time.

   1. Yes

<div align="right">11/21/17 3:14:09 PM GMT</div>

2.

Decarbonisation governance and politics: which dimensions should Innopaths scenarios explore?

Please give us your view about how important it is that our scenarios consider and reflect these dimensions.

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Dimension 1: Degree of co-operation (i.e. fragmentation vs. cooperation across member states)	-	-	-	-	-
Dimension 2: Trade-off between efficiency and equity (i.e. least-cost decarbonisation vs. equity across regions, member states and social groups)	-	-	-	-	-
Dimension 3: Degree of emphasis on co-benefits (i.e. Emissions reductions are the absolute priority vs. emphasis on co-benefits)	-	-	-	-	-
Dimension 4. Degree of state intervention to direct the transition (i.e. States willing to make choices and co-ordinate infrastructure and technological transitions, vs. market-oriented approaches in which states set the framework)	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

3.

Innovation dynamics: Which dimensions of innovation processes are most important for Innopaths to focus on?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Rate of diffusion of technology	-	-	-	-	-
Rate of cost reductions and performance improvements in existing or near-commercial technology	-	-	-	-	-
Emergence of new technologies (currently unforeseen or very far from commercialisation)	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

4.

Big picture trends and developments

A review of recent scenario exercises has revealed a range of emerging trends and issues that various actors think are relevant for the development of Europe's future, from the impact of automation on employment and transport, to the rise of populism. What broad trends – social, cultural, economic, technological, political – do you think may have a decisive influence on European decarbonisation?

5.

Whole systems interactions and priorities: What are the key issues to be considered in terms of infrastructure and the integration of electricity, transport and heating technologies? Which sectors are priorities for early action?

6.

What do you hope for? In a few sentences or bullet-points, describe an optimistic storyline for the deep decarbonisation of Europe's power sector.

This could include behavioural, technological, political, cultural or other elements.

7. What do you fear? Describe the things that you most fear would prevent the achievement of your optimistic outcome.

These could be technological, political, or something else.

8. Which technologies are most important for Innopaths to explore in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Bioenergy	-	-	-	-	-

Wind	-	-	-	-	-
Solar	-	-	-	-	-
Storage, networks and demand-side response	-	-	-	-	-
Nuclear	-	-	-	-	-
Gas	-	-	-	-	-
Coal	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

9.

What policy instruments for the power sector deserve most attention in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Carbon prices and the ETS	-	-	-	-	-
Technology-specific subsidies	-	-	-	-	-
Market and system integration across borders	-	-	-	-	-
Regulatory standards (e.g. emissions performance standards)	-	-	-	-	-
R&D and innovation support	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

10.

What do you hope for? In a few sentences or bullet-points, describe an optimistic storyline for the deep decarbonisation of energy in buildings – including both demand and options for the supply of heat.

This could include behavioural, technological, political, cultural or other elements.

11. What do you fear? Describe the things that you most fear would prevent the achievement of your optimistic outcome.

These could be technological, political, or something else.

12. Which technologies are most important for Innopaths to explore in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Electrification of heat (including heat pumps)	-	-	-	-	-

Other low-carbon heating fuels (biomass, biogas, hydrogen)	-	-	-	-	-
Energy efficiency in buildings: insulation, lighting & appliances	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

13.

What policy instruments for the decarbonisation of buildings, heating and cooling deserve most attention in our scenarios?

Please tell us which you think are most important to explore

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Carbon prices and the ETS	-	-	-	-	-
Technology-specific subsidies and/or deployment programmes (e.g. in low-carbon heat, or in energy efficiency measures)	-	-	-	-	-
Regulatory standards (e.g. building regulations; also eco-design rules for energy efficiency of products)	-	-	-	-	-
R&D and innovation support	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

14.

What do you hope for? In a few sentences or bullet-points, describe an optimistic storyline for the deep decarbonisation of transport and mobility.

This could include behavioural, technological, political, cultural or other elements.

15. What do you fear? Describe the things that you most fear would prevent the achievement of your optimistic outcome.

These could be technological, political, or something else.

16. Which passenger mobility technologies are most important for Innopaths to explore in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Plug-in electric vehicles: battery and plug-in hybrids	-	-	-	-	-
Biofuels in road transport	-	-	-	-	-
Hydrogen vehicles	-	-	-	-	-
Efficiency in internal combustion	-	-	-	-	-
Rail and public transport	-	-	-	-	-
Mode-shifting to walking & cycling	-	-	-	-	-
Displacement of travel demand via telecommunications	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

17. Which land freight technologies are most important for Innopaths to explore in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Plug-in electric vehicles: battery and plug-in hybrids	-	-	-	-	-
Biofuels in road transport	-	-	-	-	-
Hydrogen vehicles	-	-	-	-	-
Rail freight	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

18. Which other transport technologies are most important for Innopaths to explore in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Aviation innovations and fuels	-	-	-	-	-
Shipping innovations and fuels	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

19.
What policy instruments for transport and mobility deserve most attention in our scenarios?

Please tell us which you think are most important to explore

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Taxes and subsidies on vehicles and fuels	-	-	-	-	-
Other financial incentives: congestion charges, road charging, differential parking costs, etc.	-	-	-	-	-
Public subsidy for infrastructure development (e.g. electric vehicle charging; hydrogen infrastructure)	-	-	-	-	-
Policies promoting rail (passenger & freight) and public transport	-	-	-	-	-
Regulatory standards on vehicle emissions	-	-	-	-	-
Land-use and transport planning	-	-	-	-	-
R&D and innovation support	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

20.

What do you hope for? In a few sentences or bullet-points, describe an optimistic deep decarbonisation storyline for agriculture, land and the production of bioenergy.

This could include behavioural, technological, political, cultural or other elements.

21. What do you fear? Describe the things that you most fear would prevent the achievement of your optimistic outcome.

These could be technological, political, or something else.

22. Which technologies are most important for Innopaths to explore in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Energy efficiency and fuel switching options in agricultural vehicles and machinery	-	-	-	-	-
Bioenergy conversion technologies (e.g. lignocellulosic biofuels; advanced gasification and pyrolysis, etc.)	-	-	-	-	-
Emissions abatement options for non-CO2 gases from agriculture	-	-	-	-	-
Crop yields – including consideration of the impacts of climate change	-	-	-	-	-
-	-	-	-	-	-

-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

23.

What other factors affecting this sector should be the focus of scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Dietary habits and food waste	-	-	-	-	-
Demand for land for purposes other than agriculture and forestry	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

24.

What policy instruments for agriculture, land use and bioenergy deserve most attention in our scenarios?

Please tell us which you think are most important to explore

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Carbon prices and the ETS	-	-	-	-	-
Technology-specific subsidies and deployment support	-	-	-	-	-
Regulations on agricultural practices	-	-	-	-	-
R&D and innovation support for new bioenergy feedstocks	-	-	-	-	-
R&D and innovation support for abatement of agricultural emissions (e.g. non-CO2 gases)	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

25.

What do you hope for? In a few sentences or bullet-points, describe an optimistic storyline for the deep decarbonisation of industrial production in Europe.

This could include behavioural, technological, political, cultural or other elements.

26. What do you fear? Describe the things that you most fear would prevent the achievement of your optimistic outcome.

These could be technological, political, or something else.

27.

What technologies and systems are most important for Innopaths to explore in our scenarios?

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Energy efficiency potential in industrial processes	-	-	-	-	-
Fuel switching: bioenergy, hydrogen and electrification	-	-	-	-	-
Carbon capture and storage in industry	-	-	-	-	-
Potential of novel industrial processes: e.g. raw material substitution in cement, direct iron reduction using hydrogen	-	-	-	-	-
Shifts in demand through material substitution (e.g. use of wood instead of steel & concrete in new buildings), re-use, repair and circular economy	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

28.

What policy instruments for the decarbonisation of industry deserve most attention in our scenarios?

Please tell us which you think are most important to explore

	Not at all important	Not very important	Somewhat important	Very important	No opinion/prefer not to say
Carbon prices and the ETS	-	-	-	-	-
Technology-specific subsidies	-	-	-	-	-
Technology-based standards	-	-	-	-	-
Resource-efficiency policies fostering repair, reuse, remanufacturing	-	-	-	-	-
R&D and innovation support	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

29. Type of organisation

-

30. Sectors in which you have greatest experience

-

31.
Please use the space below to provide us with any further reflections or suggestions for shaping the Innopaths scenarios. Are we missing key dimensions or developments?