ZEP Advisory Council 54

14th March 2018

Agenda Item 5: Review of Network 2018 Work Programmes

5.a. Network Policy and Economics

Appended to this paper are the following pre-reads:

5.a.I. Network Policy Economics Update

5.a.II. February meeting minutes

5.a.III. Public Consultation Response on the Innovation Fund

5.b. Network Technology

Appended to this paper are the following pre-reads:

5.b.I Network Technology update

5.b.II. February meeting minutes

5.b.III. TWG CCU and Sink Factor Methodology - draft terms of reference

The AC are invited to approve the draft TOR

5.b.IV. ZEP and EERA CCS Missions for FP9

5.b.V. ZEP and EERA recommendations for sustainable hydrogen under FP9

European Zero Emission Technology and Innovation Platform

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14th March 2018

Agenda item 5.a.I Network Policy and Economics update

Co-chairs: Lamberto Eldering (Statoil), Angus Gillespie (Shell), Jonas Helseth (Bellona)

Network Policy and Economics met in Brussels on 5 February. There was a substantial discussion around the work programmes for the active Temporary Working Groups, the outcome of which is set out below.

Katrien Prins, DG ENER presented to the group on the Connecting Europe Facility, including co-funding requirements and expected budget. It was concluded that the ballpark figure projects could expect to successfully bid for was around €10-20m, given the funds available and the amount of successful projects. Katrien said it was highly unlikely a project would be rejected for a grant for a feasibility study as this is at the core of the CEF. Projects can also apply for up to 75% of cost for works; however CEF funding cannot be combined with funding from other EU sources for the same stage of a project. The Parliament is due to vote on the PCI list on 27 March. If it is approved, a CEF call should be launched soon after.

Luke Warren, ZEP Secretariat fed back on the meeting between Graeme Sweeney, himself and DG CLIMA on the mid- century strategy. It was agreed that the piece of work being undertaken by Network Technology with support from TWG ME5 on CCS in a below two degrees scenario could usefully feed into the mid- century strategy. A communication from the Commission on the Strategy is expected at the end of March, signalling the beginning for the official engagement process.

Temporary Working Group Policy and Funding

The group is currently being chaired by Theo Mitchell on behalf of Bellona. Mark Driessen, Port of Rotterdam is considering taking up the other co-chair position but may not be in a position to do so for a couple of months.

The main focus of the group currently is preparing ZEP's response to the Innovation Fund public consultation, which has a deadline of 10 April. The draft response is now appended to this update for AC approval.

Due to the restrictive word count in the consultation document itself, the group has proposed attaching several supporting documents including the previous paper on Market Makers and the Innovation Fund, and the ZEP Future Technologies report. It was noted that the response to the Innovation Fund should set out broader boundaries, as the finer details would be addressed in the consultation on the Draft Delegated Act.

Temporary Working Group Market Economics

- It was agreed previously that there was not a need for further modelling along the lines of an "ME6" report; however at the NPWE meeting it was proposed that the existing work could feed into several areas of importance.
- Filip Neele has requested that members of ME/NWPE put themselves forward to contribute to the TWG on a below 2 degrees scenario under Network Technology. It was suggested that this piece of work could usefully feed into the Commission's work on its Mid-Century Strategy. Charles Soothill has agreed to lead this piece of work alongside Karen Turner, University of Strathclyde, and contact members of the TWG to see who is in a position to support.
- Charles Soothill has also agreed that ME could do modelling work for North Rhine-Westphalia. However, as new modelling would need to be undertaken there would be a cost involved.

Temporary Working Group CCU & Energy Intensive Industries

- Rob van der Meer has agreed to lead a piece of work in Network Technology to address outstanding questions around Lifecycle Analysis for CCU products.

Temporary Working Group PCIs

- The revised Terms of Reference for the PCI group were approved at AC53. An initial call will be set up shortly. The group will focus on general support to the projects, including looking at the London Protocol, bilateral agreements between countries, and stakeholder outreach.
- It was agreed the group needs to include all PCI project developers, whether they are members of ZEP or not.

ZEP Network Policy and Economics
Minutes: NWPE meeting, 5h February 2018

Attendance

Ståle Aakenes, Gassnova
Rebecca Bell, SCCS
Thomas Berly, IEA
Nikki Brain, ZEP Secretariat
Eric de Connick, ArcelorMittal
Caterina de Matteis, IOGP
Lamberto Eldering, Statoil
Angus Gillespie, Shell
Chris Gittins, TAQA
Jonas Helseth, Bellona
Theo Mitchell, Enerfair Engagement
Katrien Prins, European Commission
John Scowcroft, GCCSI
Keith Whiriskey, Bellona

Via teleconference

Hazel Robertson, Pale Blue Dot
Martin Towns, BP

Items 1 & 2: Introduction and progress update

Lamberto Eldering (LE) welcomed everyone to the meeting and fed back on the activity of the Network since the August meeting. LE said that the AC had approved the Network's forward work programme and approved a revised Terms of Reference for the TWG PCIs.

TWG Market Economics 5

- While it had been agreed previously that there was not a need for further modelling along the lines of "ME6", the existing work could feed into several areas of importance.
- Filip Neele had requested that members of ME5/NWPE put themselves forward to contribute to the TWG on a below 2 degrees scenario which had been set up by Network Technology. FN envisioned the group would produce a report no longer than 5 pages as ZEP's response to IEA/IPCC work on CCS in a below two degrees scenario. Angus Gillespie (AG) asked whether this was a technical piece of work or whether the commercial aspects needed to be addressed including wider value of CCS. It was agreed the Network follow up with Filip to suggest amending the ToR to ensure commercial aspects were covered. It was agreed that Network members would review the ToR to see if they would be able to participate in the work. It was noted that this piece of work could usefully feed into the Commission's work on its Mid-Century Strategy.

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- Jonas Helseth (JH) said that North Rhine-Westphalia had asked whether ZEP could support on regional modelling for 2050 decarbonisation targets, and that the ZEP Chairman had also offered several member states this support.
- The TWG co-chair, Charles Soothill, was unable to attend and therefore had asked the Secretariat to arrange a call separately to discuss the forward work programme for the group.

TWG CCU & Energy Intensive Industries

- LE said that Rob van der Meer had agreed to lead a piece of work in Network Technology to address outstanding questions around Lifecycle Analysis for CCU products. The Terms of Reference were not yet agreed, but the Secretariat was to schedule a first call of the new group before the next Network Technology meeting. LE recommended that the group set a deadline for the piece of work.

TWG Policy and Finance

- LE said that the Innovation Fund public consultation would be the key piece of work the group would be focused on in the coming weeks. Given that the Fund would be of interest to all Network members it was agreed that draft responses would be shared with the whole Network. It was agreed there was value in ZEP members responding individually to the consultation in addition to the ZEP response.

TWG PCIs

- LE said that the revised Terms of Reference for the PCI group had been approved at AC53, and that an initial call would be set up after the NWPE meeting. LE said the group would focus on general support to the projects, including looking at the London Protocol, bilateral agreements between countries, and stakeholder outreach.
- It was agreed the group needed to include all PCI project developers.
- LE noted that there was pushback from Parliament on the PCI list due to the number of gas projects, and that the vote on the list may not be a “rubber stamp” exercise. If the Parliament were to reject the full list it would delay projects being able to apply for CEF funding.

Item 3: Feedback from AC53

- LE fed back on AC53 in December. The ZEP Chairman, Graeme Sweeney, had shared the outcome of his meeting with Deputy Director RTD Patrick Child, who had invited ZEP to input into the Mid-Century Strategy.
- The AC had included presentations from Summit Power, Ervia and BRGM. Angus Gillespie (AG) noted that organisations such as Summit Power and Pale Blue Dot were not closely involved in ZEP, and it would be good to bring them in.

Additional item 3 (a): feedback from SET-Plan meeting

- LE said the first meeting of the Implementation Working Group had taken place in the Hague on 30 January. 45 participants attended. Norway and the Netherlands would continue to lead the group, which would meet twice a year. LE said that a key consideration for the group was

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what action it could take if there were gaps in progress, as there was no way to enforce the Implementation Plan.

Item 4: Country updates

- NB provided an overview of the work programmes that had come out of the UK's Clean Growth Strategy. These include a Cost Challenge Task Force which will report to Government in June, after which the Government would publish a deployment pathway. NB said that separately the government was undertaking a review of investment mechanisms for CCUS in power, industry and for transport and storage. The UK government had also committed to further international collaboration and funding for innovation.
- Rebecca Bell (RB) said that Scotland had a new energy strategy, but that much of the levers needed to progress CCS sat with the UK government.
- LE said that Norway had a new minority government with a new set of ministers. Instead of an automatic flow between phase 1 and 2 of the full chain project the government had decided to add a decision gate, meaning the three capture projects had stopped work while they wait on a white paper, due in April, and the Budget decision in May. Stale Aaknes said government was clear it wanted to progress the project but was struggling to see how. LE said that Statoil, Shell and Total were continuing work on appraisal of storage.
- LE said there was a lot of activity in the Netherlands, including a "HVision" project looking at hydrogen in the industrial sector; a feasibility study on providing infrastructure in the Port of Rotterdam; and a collaboration of organisations looking at commissioning and reuse.

Item 5: PCIs and the Connecting Europe Facility

- Katrien Prins (KP), Policy Officer at DG ENER presented on the four PCIs for CO2 transport, and the Connecting Europe Facility (see presentation slides). KP said that so far 74 PCIs had gained access to a total of €1.6bn under the CEF underpinning €48bn CAPEX.
- KP said there would be around €800m available in 2018, contained in one or more calls.
- KP said the CEF covers work on infrastructure projects that is not commercially viable, including grants for feasibility work, financial instruments, and cost of works. The eligible costs are 75% for studies and 50% for works. Projects can only apply for funds to cover the cost of activities set out in their PCI applications; however they can bid for funds multiple times to fund the different stages of work.
- KP said that the time between applying and receiving funds could be around 9-10 months.
- Chris Gittins (CG) asked whether it was possible to combine funds from the CEF with other sources of funding. KP said it would not be possible to combine with other sources of funding if those sources made the project commercially viable. KP agreed to send the Secretariat further information on the guidelines around combining funding.
- KP said the Parliament would vote on the list of PCIs on 27 March.

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Item 6: Mid- Century Strategy

- Luke Warren (LW), ZEP Secretariat, fed back from a meeting between himself, Graeme Sweeney and Tom Van Ireland, Head of Unit D1 at DG CLIMA, which heads up the Commission's work on its 2050 decarbonisation strategy.
- LW said that the previous from 2013 had a target of 80% reductions to 2030, and had included industry roadmaps. The new Strategy would reflect the Paris Agreement ambition and therefore look at net-zero emissions to 2050. The Commission's areas of focus included the role of Negative Emissions Technologies including Direct Air Capture and BECCS.
- LW said it was clear that some within the Commission were concerned about the lack of progress on CCS and therefore how much NETs could be relied on to meet decarbonisation targets. Theo Mitchell (TM) said that this was also a contentious issue for those working on the IPCC report on 1.5 degrees.
- TM said the Commission would put out a communication on the Strategy towards the end of March which would signal the start of the formal engagement process.
- LW said ZEP had offered to host a workshop with experts to work through some of these areas with Commission representatives.
- LE said the ZEP work on below two degrees scenario should ideally be done in time to feed into this process.

Item 7: ZEP response to the Innovation Fund consultation

TM led a session on ZEP's input into the public consultation on the Innovation Fund.

It was agreed that once the draft was complete it needed to be tested with stakeholders who would apply to the Fund, including those outside ZEP membership.

It was noted that the response to the Innovation Fund should set out broader boundaries, as the finer details would be addressed in the consultation on the Draft Delegated Act.

TM said a draft response would be shared with the whole Network, after which there would be one or two phone calls organised before the final draft was submitted for approval by the AC in March.

Item 8: AOB and next meeting

Claude Heller (CH) asked what progress had been made since the workshop held with the Commission on clean hydrogen. NB said that the Secretariat had been working to agree a date with hydrogen Europe and the details of the follow up meeting should be shared shortly.

It was agreed that given a lot of work would be undertaken by the TWGs in the coming months, the Network would meet next after the summer break.

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Actions

Action		Owner	Completed
2	Secretariat to arrange call with Charles Soothill to progress below 2 degrees scenario work.	Secretariat	Yes
5	KP agreed to send the Secretariat further information on the guidelines around combining funding.	Secretariat	Yes
7	Share revised draft of Innovation Fund consultation	Secretariat	Yes

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Public Consultation on the Establishment of the Innovation Fund

The EU emissions trading system (ETS) after 2020 foresees the establishment of the Innovation Fund to accelerate the commercialisation of low-carbon technologies. 400 million allowances will be reserved from 2021 onwards for this purpose. In addition, a further 50 million of unallocated allowances from 2013-2020 will be added, together with, as early as 2019; any possible un-used or remaining funds from the NER 300 Programme. Further 50 million allowances could be added to the fund post 2025, if these are not used for free allocation to industry.

The Fund will support innovation in low-carbon technologies, processes and products in industrial sectors listed in Annex I of the EU ETS Directive. The Fund should stimulate the construction and operation of projects that aim at the environmentally safe capture, use of CO2 (CCU) and its geological storage (CCS), as well as innovative renewable energy and energy storage technologies in the territory of the European Union. Technologies receiving support should not be commercially available yet, but shall be sufficiently mature to be ready for demonstration at pre-commercial scale.

Furthermore, the ETS Directive sets a number of key features of the Innovation Fund:

1. Up to 60% of the relevant costs of projects may be supported,
2. Project selection will be done based on objective and transparent criteria, including, among others, the potential for emission reductions, potential for wide application or significant lowering of transitioning costs towards a low-carbon economy in the concerned sectors,
3. Technologies to be supported are not yet commercially available, but represent breakthrough solutions or are sufficiently mature to be ready for demonstration at pre-commercial scale,
4. Up to 40% of the Innovation Fund's support for eligible projects (that is up to 24% of projects' relevant costs) may be pre-financed (may not depend on achieved reduction of greenhouse gas (GHG) emissions) provided that pre-determined project milestones are met,
5. Projects in all Member States, including small-scale projects, are eligible to apply.

During the first half of 2017, the European Commission hosted a series of stakeholder consultations with representatives from energy-intensive industries, the energy and finance sectors. The resulting summary report points to over 80 potential technologies, including cross-cutting innovations, such as CCUS, green hydrogen or energy storage.

This public consultation will gather the views of the wider public on additional, more detailed, design elements of the Innovation Fund, as an input to the Impact Assessment accompanying the Commission's proposal for a delegated act.

The questionnaire is divided into 6 sections. Section 1 relates to the identification of the respondent and is obligatory for all respondents. The following multiple choice questions in Sections 2-5 relate to key elements identified in the Inception Impact Assessment for the Establishment of the Innovation Fund. An open question at the end of each Section allows complementing any of the previous answers. Section 6 allows providing additional comments and uploading supporting documents.

A short summary of the key design elements and the related problems identified is provided at the beginning of each section.

NB: Questions 1-10 are registration questions

Eligibility criteria

The Innovation Fund will support deployment of innovative renewable energy technologies and industrial break-through innovation in low-carbon technologies and processes in the European Union. The energy intensive industries to be covered are those in the Annex 1 to the ETS Directive, concretely: ferrous metals, non-ferrous metals, cement and lime, glass and ceramics, chemicals, oil refining, pulp and paper, including potential application of environmentally safe CCU technologies in these industries, that would substantially contribute to climate change mitigation. The renewable energy sectors to be covered comprise innovative production from: wind, ocean, geothermal, biomass and solar sources. In addition, energy storage and CCS are also eligible.

The Innovation fund will be designed to help innovative projects to cross the "valley of death" and reach commercial viability. Eligible projects should contribute substantially to climate change mitigation through a significant reduction of GHG emissions.

11. Which are the five most important highly innovative technologies in your view that will be key to decarbonise the industry and power sectors in the EU and therefore need to be demonstrated over the coming decade? (1000 characters max):

- Developing CO2 transport and storage infrastructure in strategic hubs and clusters
- CO2 capture on both power and industrial plants (chemicals, steel, cement, etc.)
- Full-chain CCS projects in the power sector (with individual parts of the chain eligible for funding)
- Low- carbon hydrogen , not limited to electrolysis, but also through Steam Methane Reforming and ATR fitted with CCS
- Bioenergy with CCS to enable negative emissions

***Please specify for your own sector (as indicated in the introduction above). Cross-sector technologies can also be included, if relevant* (200 characters max):**

12. To apply to the Innovation Fund funding, should eligible technologies be defined?

- ○ a) Yes: Based on a pre-defined detailed list of eligible technologies per sector (as described in the introduction above), with a possibility of regular update (e.g. every 5 years);
- ○ b) No: Eligible technologies should not be pre-defined allowing for competition between projects and across sectors
- ◉ c) Other

13. To ensure that the Innovation Fund would support innovative but realistic projects (i.e. those that would effectively materialize and reach market maturity), should its eligibility criteria set deadlines for reaching specified milestones?

- ◉ Yes
- ○ No

14. The revised ETS Directive agreement stipulates that small-scale projects can also be supported. To better define the scale of small-scale projects eligible for support of the Innovation Fund, should eligibility criteria set a minimum size for small-scale projects?

- (●) a)Yes
- ( ) b) No

5. If you wish, please provide additional comment(s) in more detail, focusing on elements related to eligibility criteria not mentioned in the answers above (500 characters max):

ZEP strongly advises against the sub-categorization of CCS technologies as under the NER300 these proved unduly restrictive. ZEP supports broader "technology corridors" being treated separately to ensure the fund delivers a range of projects. For CCS and CCU, for example, eligibility could aligned with the R&I activities set out in the SET- Plan Implementation Plan. Crucially the Fund should be able to support the development of part-chain and CO2 transport and storage infrastructure projects.

Type of support

The ETS Directive states that the Innovation Fund can provide support of up to 60% of the relevant costs of selected projects, out of which up to 40% may be pre-financed, provided that pre-determined milestones are attained. The majority of the Innovation Fund support (at least 60%) should be provided on the basis of verified (achieved) reduction of greenhouse gas (GHG) emissions, once projects are operational.

The Directive leaves room for modulation of maximum support rate (up to 60% of relevant costs) according to the project's technology risks, providing various forms of financial support such as grants, loans or equity, but also for covering specific type of costs (such as project development assistance along with the capital expenditure). This section therefore aims at collecting your views on the type of support the Innovation Fund should offer.

16. Should the maximum funding rate (i.e. up to 60% of relevant costs covered by the Innovation Fund as stipulated above) be:

- ( ) a) Variable depending on the stage of technology development (and related technology risks)
- ( ) b) Variable, based on a different approach, please specify
- (●) c) The same for all eligible projects

17. Which form(s) of support should the Innovation Fund provide?

17.1 Which form of support do you consider most appropriate in relation to the stage of development? Please rank from 1-5 (5 being most appropriate).

	Pilot production and demonstration (TRL* 6-7)	***Initial market introduction (TRL 8)***	***Market expansion (TRL9)***
Investment subsidies (grants)	**5**	**5**	**4**

Risk guarantees	**4**	**4**	**5**
Loans	**3**	**3**	**3**
Equity	**2**	**2**	**2**
Other (specify)		Capitalisation of CCS Market Makers; Storage Sinking Fund (financial security)	

17.2 Should eligible projects have a possibility to combine the above forms of support during the projects' lifecycle? Please specify and provide more detailed explanation for your answer above (500 characters max.)

Yes. Grants are the most bankable form of funding to a CCS project, and therefore will be the most effective form of funding for reducing financing costs and costs to society. That said, ZEP would welcome a separate pot of funding for loans/ financial guarantees for successful bidders to support project financing.

Loans would only be helpful to developing the first CCS projects if there was a sufficient mechanism for rewarding CO_2 abated that would enable repayment.

17.3 Should the Innovation Fund also provide specific project development assistance? If so, please rank the relevance, according to your assessment, of pre-feasibility studies, cost-benefit analyses and related work-streams, human capacity building and others (4 being most important):

- [x] *Technical pre-feasibility studies*
- [x] *Financial analysis and plans*
- [x] *Capacity building*
- [ ] *Others*

18. Up to 40% of the Innovation Fund support may be pre-financed, provided that pre-determined milestones are attained. In your view, how should such milestones be defined?

- ○ a) According to the investment process (i.e. project launch, financial close, commissioning, operation);
- ○ b) Linked to specific construction phases (i.e. first procurement for plant parts signed, physical construction finalised, operation);
- ◉ c) Other

19. What are in your view the most important lessons learned from the monetisation of NER300 allowances / key aspects to be considered when deciding about the modalities, in particular the timing, of monetising the allowances available for the Innovation Fund? (1000 characters max):

ZEP believes there should be as much flexibility as possible in the number of allocation rounds and allowance auctions, in order to maximize the auction revenues and therefore the total funding available. Article 2.2 of the NER 300 Decision prescribed that 200million allowances had to be auctioned in the first round and 100 million allowances in the second,

which meant the European Investment Bank (EIB) had to auction 200 million when the EUA price was very low. The total revenue from monetisation would likely have been higher if the EIB had had flexibility to switch that round (e.g. 100 million then 200 million) – or even decide for itself what to auction when.

20. If you wish, please provide additional comment(s) in more detail focusing on elements related to the type of support criteria not mentioned in the answers above (1000 characters max):

Ref.q.18, ZEP supports up to 40% of funding being made available independent of verified avoidance of CO2 emissions. This should not only allow pre-financing of projects but also support the development of infrastructure & part-chain CCS projects (where verified avoidance may take place at a later date). As development timelines for low carbon technologies vary, milestones should be agreed on a project-by-project basis.

Ref. q.17 in its report on a Business Case for CO2 Storage, ZEP outlines the phases of CO2 storage projects. Whilst the initial capital investment in CO2 storage appraisal is a significant barrier to private sector investment in CCS, the financial security requirements stemming from the CCS Directive & the unquantifiable nature of potential CO2 liabilities also pose significant challenges. A Storage Sinking Fund whereby a shared pot of funding was built up over time and used as a form of financial security could therefore be another form of support the IF could provide.

Application and Selection procedure

According to the ETS Directive on the selection procedure, "Projects shall be selected on the basis of objective and transparent criteria." In addition, projects should deliver material GHG emissions reductions, well below the ETS benchmarks (where applicable), and have potential for wide application and lowering the costs of transitioning towards a low carbon economy for the sectors covered.

21. How should the application process be organized?

- ○ a) on a first-come, first-served basis
- ◉ b) through regular calls, at pre-defined dates
- ○ c) other

22. How many stages should the application process have?

- ○ a) a single-stage application process, requiring applicants to submit the full project documentation by a given deadline
- ◉ b) two-stage process consisting of expression of interest (based on a less than 10 page concept note) followed by the screening of pre-selected applications (based on complete project proposals)
- ○ c) Other

23. What should be the optimal mix of project selection criteria, taking into account the key requirements set by the ETS directive? Please rank in the order of importance (0 being least important).

	Ranking (0 - 6)	***Comments (if none put N/A)***
Innovativeness	**2**	Innovation should not refer just to technological innovation but also to commercial innovation, e.g. new business models. The Innovation Fund aims to scale up technologies that have developed beyond the innovation stage therefore technological innovation should not be the main focus. Early stage technologies and small pilots are best addressed under H2020/FP9.
Decarbonisation potential / contribution to emission reductions	**6**	Projects should be able to demonstrate long term value to EU decarbonisation, beyond MtCO2 avoided. For example, CCS is currently the only method to deal with process emissions from the cement sector, making it highly valuable. Projects should be compatible either with Member State 2050 decarbonisation roadmaps, or with longer-term EU objectives, including the Mid Century Strategy and a goal of net zero emissions by 2050.
Expected performance (i.e. Cost per unit of performance)	**1**	Projects should not be assessed on the cost of avoided emissions alone. Instead, a more-rounded approach to project assessment should be taken in line with the revised ETS Directive, which requires projects to “have the potential for widespread application or for significantly lowering the costs of transitioning towards a low-carbon economy”. A more flexible system should recognise the clean output of industrial processes. Rather than CCS as an “add-on” cost to existing processes, CCS can be combined with innovative new industrial processes to allow for deep decarbonisation- for example combining HIsarna technology with CCS, and potentially with biomass or clean hydrogen, to replace the traditional ironmaking process. For industrial processes, the €/CO2 abated is less relevant than the overall system cost or eventually the value of a low carbon product to the economy. Furthermore, CO2 avoided through more efficient processes should be rewarded on a similar basis to CO2 permanently abated through CO2 utilisation or storage. Regarding utilisation, there is only rationale for using ETS revenues to fund innovation CO2 reduction technologies that result in the permanent abatement of CO2.
Project viability/ bankability/ robustness of the business model	**3**	Setting normal business investment criteria to first of a kind projects is not useful. The fund should reward innovative business models that will allow for significant cost reduction over time. For example funding a CCS “market maker” through the Innovation Fund would enable significant emissions reduction over time and provide infrastructure for hard to decarbonise sectors (see paper attached to this response).
Cross-sector spill-overs / cooperation	**4**	Horizonally applicable technologies which aid decarbonisation in multiple sectors should be valued. An example would be large scale production of hydrogen through SMR/ATR with CCS. Low carbon hydrogen can be used in multiple sectors including as a replacement for methane for industrial use, heating, transport and power. Furthermore, using low cost hydrogen production to create a market would enable hydrogen derived from electrolysis with renewable energy to enter this market over time as costs come down. This

		provides opportunity for shared knowledge development and increased cross-industry cooperation.Spillover in terms of job creation/ retention and wider economic benefits should also be considered.
Scalability/ potential for widespread application	**5**	The Innovation Fund should prioritise projects that will enable widespread application- for example the development of enabling CO2 storage infrastructure that can enable deep decarbonisation of industrial regions and that can be built out over time to provide access to storage for Member States without their own options for CO2 storage. Enabling a business model for the first CCS networks will enable cycles of deployment, innovation and cost reduction to take place, enabling the widespread application of CO2 capture technology.
Other (please specify)		

24. Should there be a mechanism to ensure a balanced portfolio of projects?

- ○ a) yes, with regard to sectors
- ○ b) yes, with regard to technologies
- ○ c) yes, with regard to sectors and technologies
- ◉ d) No

25. If you wish, please provide additional comment(s) in more detail focusing on elements related to the selection procedure not mentioned in the answers above (500 characters max):

With regards to q.21 there should be frequent calls for applications to the Innovation Fund, unlike the two calls under NER 300.

Regarding q.24, ZEP believes that having a rigid mechanism for ensuring a balanced portfolio of projects may reduce the impact of the Fund. It is more beneficial to have fewer projects with high impact that contribute significantly to long-term decarbonisation in Europe, than many smaller projects to fill a quota.

Relation to the Other Funding Instruments

26. In your view, how should the Innovation Fund complement other funding mechanisms at the EU and national level? Such mechanisms are the for example EU Framework programme for research and innovation (Horizon 2020), European Structural and Investment Funds (e.g. ERDF) or Research fund for coal and steel). **Please specify (1000 characters max):**

ZEP strongly believes that funding under the Innovation fund should be combinable with other EU and Member State funding programmes. Large investments needed for CCS could be supplemented, in particular, by funding under the Modernisation Fund and/or Connecting Europe Facility if and when appropriate, but access to these additional sources of funding

should not result in a further limitation on the amount of funding a project is eligible to receive under the Innovation Fund.

27. In your view, could the Innovation Fund avoid overlaps with other funding instruments and if so, how this should be done? (1000 characters max):

Horizon 2020 is the mechanism to deal with pilot and proof of concept projects; the Innovation Fund must focus on scalable technologies with significant climate impact.

28. In your view, how unnecessary administrative burden for applicants could be avoided? Please specify.

29. If you wish, please provide additional comment(s) in more detail focusing on elements related to financing synergies not mentioned in the answers above (1000 characters max):

Final comments

30. If you wish to add further information, comments or suggestions - within the scope of this questionnaire - please feel free to do so here (1000 characters max.):

In addition, you could also upload a document proving further information, comments or suggestions.

The proposition is to upload the following documents:

- *ZEP "Funding Market Makers through the ETS Innovation Fund" paper*
- *ZEP "Funding Modalities" paper*
- *ZEP Future Technologies report*

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14th March 2018

Agenda Item 5.b.I: Network Technology update

NWT co-chairs: Filip Neele (TNO), Arthur Heberle (Mitsubishi Hitachi Power Systems)

The Network Technology met on Thursday 22nd February in Brussels. The minutes from this meeting are appended as pre-read 5.b.II.

The next NWT meeting will take place in October 2018 in Brussels (date to be confirmed).

The NWT co-chairs, TWG chair/s and Secretariat will also hold a teleconference meeting on 27th June to discuss the progress of the overall work programme.

TWG Collaboration across the CCS chain

TWG Co-chairs: Ward Goldthorpe (Sustainable Decisions)/Hallvard Høydalsvik (Gassnova)

Terms of reference for the TWG were approved at the AC53 meeting in December. An initial teleconference took place on 15th February, with TWG members invited to submit a list of priorities for the report across the 2 work streams. These are to:

1. Understand and estimate the likelihood and impact of a range of events specific to CO_2 storage operations, using analogues and extrapolations from North Sea industry experience to create expert best estimates.

2. Provide industry and expert support to the 2 ERA-NET ACT projects: ELEGANCY and ALIGN-CCUS.

The timeline to deliver the report is linked to the ELEGANCY and ALIGN projects, with initial results expected early in the summer. The objective is to have a preliminary draft of the work ready to be presented at the AC57 meeting in December.

A follow up teleconference is currently being arranged to discuss next steps. At the February NWT meeting it was agreed there should also be a meeting of the TWG to discuss early results ahead of the AC55 meeting in June (date and location to be confirmed).

TWG Role of CCS in a below 2 ˚C scenario

TWG Chair: Charles Soothill (ZEP Vice-Chair), Karen Turner (University of Strathclyde)

Draft terms of reference were approved at the AC53 meeting in December. The objective of the TWG is to produce a ~5 page briefing note, outlining the role of CCS in deeper and earlier decarbonisation scenarios and the development requirements of CCS to contribute to these pathways, providing a ZEP position on the level of CCS ambition in the IEA ETP report.

The paper will also be shared with the Commission as input to the Mid-Century Strategy, which is currently being developed and focuses on reaching net-zero emissions by 2050. It is understood that a Commission position will be published shortly before the summer break.

Charles Soothill and Karen Turner will jointly chair the TWG and have sought expressions of interest for membership from those involved in developing the Market Economics 5 report, as well as the NWT and NWPE.

An initial teleconference is currently being arranged on Friday 9th of March at 10am (GTM), which will discuss in detail the scope of the paper, and the timeline and next steps for the TWG.

TWG CCU and Sink Factor Methodology

TWG Chair: Rob van der Meer (Heidelberg Cement)

The objective of the TWG is to build on the work of the ZEP CCU report published last year, providing clarification and refining the sink factor analysis introduced. The paper will include categorisation of different CCU pathways, as well as CCS and EOR.

An initial teleconference is currently being arranged (date to be confirmed) to discuss the scope of the paper and next steps. Two other CCU projects are currently underway; one lead by the consultants Rambol of behalf of the Commission, and the second by CO_2 Value Europe and the TWG are seeking further information on these projects and how they may link to the draft terms of reference, appended as pre-read 6.b.II.

The AC are invited to approve the draft terms of reference for the TWG, which are appended are pre-read 6.b.II.

TWG Mission Innovation

Co-chairs: Filip Neele (TNO), Nils Røkke (Sintef)

A final report is expected to be published in March, which will set out the Mission Innovation 'Priority Research Directions' (PDRs) for CCS and CCU. The list of draft PDRs, which were developed at the workshop in Houston in September, has been incorporated in the ZEP and EERA joint submissions to the Commission for FP9, outlined further below.

Input to FP9

ZEP and EERA have jointly produced 2 draft CCS Missions as input to the development of Framework Programme 9 (FP9), the successor funding programme to H2020. These are appended as pre-read 5.b.IV

The draft Missions have shared with the Commission, in response to a request from Patrick Child (Deputy Director General, DG RTD), made at a meeting with Graeme Sweeney and Jonas Helseth in October last year.

In response to a separate request from Mark van Stiphout (Deputy Head of Unit, DG ENER) ZEP and EERA have also provided the Commission with joint recommendations on future support for sustainable hydrogen under FP9 This paper is appended as pre-read 6.b.IV.

European Zero Emission Technology and Innovation Platform

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ZEP Network Technology

Minutes: Network Technology meeting 22nd February 2018

Attendance

Nikki	Brain	ZEP Secretariat
Karl	Buttiens	ArcelorMittal
Niels Peter	Christensen	Gassnova
Isabelle	Czernichowski	BRGM
Arthur	Heberle	Mitsubishi Hitachi Power Systems (NWT Co-Chair)
Harriet	Howe	ZEP Secretariat
Vassilios	Kougionas	European Commission
Marko	Maver	Bellona
Mona	Mølnvik	Sintef
Filip	Neele	TNO (NWT Co-Chair)
Gunhild	Reigstad	Sintef
Owain	Tucker	Shell
Peter	van Os	TNO
Keith	Whiriskey	Bellona
Peter	Zweigel	Statoil

Dialling in:

Charles	Soothill	ZEP Vice-Chair
Chris	Gittins	TAQA
Karen	Turner	University of Strathclyde
Romain	Viguier	SCCS

Item 1: Introduction and issues update

Filip Neele (FN) and Arthur Heberle (AH) introduced the meeting and provided a short update on Network Technology activities since the last meeting in October 2017. The meeting agenda was adopted. There was an invitation for national CCS updates, these included:

The UK - Nikki Brain (NB) presented slides updating on UK CCS activities since the Government's Clean Growth Strategy was published in October. NB noted that the Government is now focused on broader applications for CCS, beyond power. It was asked whether the Cork CCS project, being developed by Ervia, was considering options to import CO_2 from South Wales. NB responded that this is not currently part of the project's business model.

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The Netherlands - FN updated on Dutch CCS activities, including plans for the CO_2 backbone pipeline at the Port of Rotterdam, where first injection is expected to start in 2021/22. FN agreed to give more details on the official status of the project at the next NWT meeting.

Norway- Niels Peter Christensen (NPC) provided an update on Norwegian CCS activities. Work on transport and storage activities is continuing as before; however, the Government has put a hold on FEED studies. This will continue until a budget review in May/June, which could lead to a delay of the project timeline. Mona Mølnvik (MM) provided information on a feasibility study to capture CO_2 from the Lysekil refinery in Sweden (link to the press release).

France - Isabelle Czernichowski (IC) informed the meeting that France is currently revising their CCS Roadmap, which will now more broadly cover CCUS. France is also preparing a low carbon national strategy, which will set a target of zero emissions by 2050 and involve significant deployment of CCS. IC also updated that France will be joining the 2nd call for ERA-NET ACT.

Harriet Howe (HH) provided an update on the SET-Plan Implementation Working Group 9 (IWG), including the outcomes of the meeting which took place on 30th January in The Hague. Subgroups will now be established to carry out actions under each of the R&I Activities and hold regular teleconference meetings. The next IWG9 meeting will be taking place on the 20th September in The Hague. OT asked if there would be an opportunity to consider infrastructure equipment innovation as part of this process. Vassilios Kougionas (VK) responded that it would be up to members of the IWG9 and subgroups to determine the scope, but that these kinds of innovation issues are well aligned with SET-Plan objectives.

HH updated on the ZEP and EERA joint input on draft CCS 'Missions' under FP9, which had been shared with the Commission. VK added that the Commission are expected to provide more information on the overall proposals in June.

HH noted that there was little to update on Mission Innovation since the previous NWT meeting, with the report expected to be published in March. VK added that Saudi Arabia had expressed interest in collaborating with the Commission and that this could be linked to Mission Innovation and the ERA NET call.

Item 2: ELEGANCY Project – Gunhild Reigstad (Sintef)

Gunhild Reigstad (GR) presented slides on the ELEGANCY project, which aims to develop CCS and H_2 in 5 European countries (UK, Netherlands, Norway, Switzerland, and Germany).

GR stated that it was encouraging that the project would now be supported by industrial stakeholders through the TWG Collaboration across the CCS chain.

A question was asked on if/how the project was engaging with the electrolysis-derived H_2 community. GR answered that Sintef were having discussions with stakeholders representing both production pathways and that the interplay would benefit both groups. MM added that due to issues around scale there was no competition between the 2 groups.

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Item 3: ALIGN Project – Peter van Os (TNO)

Peter van Os (PvO) presented slides on the ALIGN CCUS project, which will provide a blueprint to decarbonise industrial clusters, complimentary to ELEGANCY.

The project is wide-ranging, with over 100 deliverables across 6 work packages (capture, transport, storage, re-use, industrial clusters, society).

The project will also look at liability issues associated with taking over old wells. There was a discussion on the importance of public communication on CO_2 storage, which falls under Work Package 6 of the project.

Item 4: TWG Role of CCS in below 2 degree scenarios

Charles Soothill (CS) and Karen Turner (KT) will jointly chair the new TWG, with terms of reference approved at the AC53 meeting in December. The TWG will produce a short (~5 page) briefing note, incorporating economic modelling work by KT and the University of Strathclyde.

It was agreed that the TWG should also consider the benefits of early decarbonisation in terms of cumulative emissions, as well as cross-border issues arising through inconsistent policies and the ETS.

HH agreed to collate expressions of interest from NWT members to participate in the work.

KT presented slides on economic modelling work, which will feed into the TWG paper. There was a discussion around the employment multiplier metric presented, with KT noting that the UK oil and gas sector has the highest indirect employment of the sectors analysed, and that this helped communicate the value of CCS to the UK Treasury. A question was asked on whether this type of modelling could be completed for other European countries. KT responded that all Member States have a legal requirement to record the input/output data needed to calculate the employment multipliers, but that access to these figures would be needed.

It was agreed that the TWG should look to develop links with OGCI.

KT and Graeme Sweeney have provided the Dutch Government with a 1 page briefing on this work, which can be shared with the NWT. FN took an action to follow up with the Port of Rotterdam, as it was agreed they could be a valuable partner in the TWG's work.

Item 5: TWG Collaboration across the CCS chain

FN presented slides giving an overview of the new TWG Collaboration across the CCS chain, with the terms of reference approved at the AC53 meeting in December. The TWG had an initial teleconference the previous week, with a set of priorities for the TWG identified.

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There was a discussion on uncapped well liability and issues around extended monitoring requirements and the associated ongoing costs following storage. FN agreed to add this issue to the list of priorities.

The TWG will work alongside the ELEGANCY and ALIGN projects, in addition to the Detect and Acorn projects. Société Generalé have been contacted in order for the TWG to understand how insurance premiums are calculated. Iit was agreed that the TWG should also reach out to IAS.

The timeline for the work follows the ELEGANCY and ALIGN projects, with initial results expected early in the summer. The objective is to have a preliminary draft of the work ready to be presented at the AC57 meeting in December. It was agreed that the report should include a summary, which could communicate key messages around storage risk to the general public. This could tie in with the work packages 5 and 6 of the ALIGN project and could involve devising a joint communications strategy.

HH agreed to collate expressions of interest from NWT members to participate in the work.

It was agreed that the TWG should arrange a meeting, with Schiphol in the Netherlands the suggested location. The Secretariat agreed to coordinate this.

Item 6: TWG CCU and Sink Factor Methodology

AH presented slides on the background to the new TWG CCU and Sink Factor Methodology, with the work based on the ZEP CCU report published in 2017.

The planned output will involve a 2 page clarification on the sink factor methodology. It is outside the scope of the TWG to examine LCA methodologies or specific CCU cases. The TWG will also look into linking with the work on LCA currently being undertaken by CO_2 Value Europe.

It was agreed that an initial teleconference with the chair Rob van der Meer was needed to initiate the work and discuss the terms of reference before they are submitted to the AC for approval.

Item 7: NWT next steps

The next NWT meeting will be planned for October.

It was agreed that TWG chair/s will be invited to join a teleconference with the NWT co-chairs and Secretariat on the 27th June.

Actions

Action		Owner
4	FN to contact the Port of Rotterdam Authority to inform them of the TWG Role of CCS in below 2 degrees scenarios work.	FN
5	Secretariat to arrange a TWG collaboration across the CCS chain meeting in	Sec

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	Schipol.	
6	Secretariat to arrange an initial teleconference meeting for the TWG CCU and sink factor	Sec
7	Secretariat to invite TWG chair/s to join the June NWT update teleconference	Sec

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TWG CCU and Sink Factor Methodology draft TOR

Chair: Rob van der Meer (Heidelberg Cement)

The ZEP report: *Climate solutions for EU industry: interaction between electrification, CO_2 use and CO_2 storage*, published in September 2017, introduced the Indicative Sink Factor (ISF) as a way of assessing the extent to which different CCU and CCS processes can contribute towards climate change. The report stated that CO_2 mitigation depends on the lifecycle of the product and if or when the captured CO_2 is released into atmosphere. The report concludes that treating all forms of CCU as de facto CO_2 abatement could have serious detrimental impacts on efforts to reduce emissions, and that each application of CCU must be comprehensively assessed on its ability to contribute to long-term emissions mitigation. The TWG will bring together published research and work currently being undertaken by DG CLIMA. A key factor in developing the Indicative Sink Factor will be the assessment and definition of the boundary conditions used in LCA. This will provide the fundamental basis from which different CCS and CCU processes may be compared.

Objective:

The TWG will produce a report with comparison of selected LCA concepts in order to better understand and range indication of the Indicative Sink Factor for some of the CCU and CCS processes. However, the report will not entail the development of a full LCA concept.

Approach:

- Refinement of the sink factor analysis presented in the ZEP CCU report, linking sink factor with LCA
- Categorisation of different CCU pathways, as well as CCS and EOR
- Analysis of existing test cases for the different CCU pathways, and an assessment of the sink factor and CO_2 emissions avoided compared to conventional processes with consideration of proper boundaries
- Collate information from stakeholders and research organisations to use as the basis for report consisting of a table with boundaries and outcomes of LCA concepts to CCUS processes.

Membership:

- Network Technology members and members of the Network Policy and Economics TWG Market Economics
- Energy intensive industries and organisations who can contribute to ‘test cases’ to illustrate the sink factor methodology presented, including Arcelor Mittal and Mitsubishi Hitachi Power Systems
- Member States and regional stakeholders
- Liaise with academics and European Commission

Carbon Capture and Storage (CCS) as an integrated part of our low-carbon energy future	
Mission Statement	**CCS for enabling the energy transition for all**
	The Mission: CCS is mandatory to achieve the Paris Agreement target to keep the global temperature rise this century well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 °C. This CCS Mission will enable the increasing deployment of renewables into an energy system which will be reliant of fossil fuels for back-up power in the medium term [1], but which must become as low-carbon as possible and increasingly dynamic and flexible. CCS enables greater renewable development (PV and wind) by reducing system integration costs. CCS provides important opportunities for expanding generation of electricity and/or H_2 needed to decarbonise transport, heating and cooling, and energy storage. IPCC states that to achieve less than 1.5 °C warming, carbon-negative solutions, such as bio-CCS, will be needed[2], especially during the near-term transition to low- carbon energy systems. CCS technologies will be important both in Europe and in many emerging economies around the world. The implementation of CCS technologies in the framework of a coupled CCS-renewables energy system will be crucial both in Europe and in many emerging economies around the world to achieve the "low-to-free carbon society" target as quickly as possible and at lowest costs. ***Goal/Vision:*** This Mission will create fully low-carbon societies by providing CO_2-free energy, though flexible, dynamic energy systems that makes effective use of synergies between renewable energy and CCS. This Mission will create fully low-carbon biomass based power generation. This will support faster uptake of renewable energy services, including heating, in both domestic and industrial settings. It will make Europe the global innovation lead in CCS technologies to support emerging renewables-based energy systems. ***Expected impact & targets:*** • Deliver flexible, dynamic energy systems that make effective use of synergies between renewable energy and CCS on fossil-based power generation and bio-CSS. • Reduce the capital investments needed for electricity generation by utilising CCS, since increases in electricity for transport and heat pumps will lead to an increase in needed generation capacity of 1800GW by 2050[3]. • Provide clean energy for delivering heating and cooling in domestic and industrial uses.

[1] ZEP, 2017. CCS and Europe's Contribution to the Paris Agreement. Modelling least-cost CO_2 reduction pathways.

[2] IPCC, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

[3] ZEP, 2017. CCS and Europe's Contribution to the Paris Agreement. Modelling least-cost CO_2 reduction pathways.

	Enable electrification and/or hydrogen-based land transport (road and rail) through the supply of low-carbon H_2 and electricity. • Enable the reduction of atmospheric CO_2 emissions, including historical emissions in a time-frame on track with the Paris Agreement. • Facilitating flexibility in transition to a permanent low-carbon energy system. • Enable a continued use of existing gas infrastructure in households and industry by delivering H_2 generated from natural gas with CCS. Gas infrastructure, both in heating and as a chemical feedstock switched to use with H2 will enable efficient utilization of H_2 generated by excess renewable power via electrolysis, thereby replacing H_2 from fossil resources by renewably generated H_2 step by step. • Ensure that bio-CCS is developed as rapidly as possible to deliver its potential for managing global climate change by removing CO_2 from the atmosphere. • In addition to required implementation in Europe, the Mission will enable export of innovation and knowledge to global markets, especially those emerging economies that are most likely to be dependent on CCS to achieve low-carbon economic growth (inter alia India, China, Mexico, southern African states). ***Underlying overall challenge:*** The future energy system will need to be flexible, with different solutions in different settings and in different regions. The IPCC states that the cost for society of decarbonising without CCS is three times more than with CCS. Delaying CCS deployment to 2035 would cost power and industry sectors an extra €200 billion to reach the EU's 2050 target, with the value of CCS for the EU exceeding €1 trillion between now and 2050 and more than €50 billion per year thereafter[4]. In addition, time is quickly running out to make the necessary reductions in emissions required for limiting the temperature increase to 2 °C, and CCS is able to get Europe on track to achieve the stipulated climate goals. Therefore energy from renewables will need to be increased in combination with other integrated low-carbon energy solutions. Increasingly flexible, fossil-based energy, alongside energy storage, will be needed during the transition to a low-carbon society. For example, natural gas will continue to provide most of the H_2 where cities adopt H_2-based transport due to the high costs of producing H_2 by electrolysis. Where cities are promoting low-pollution road transport, electric vehicles are also being encouraged. The production of H_2 and/or increased electricity demand will need to be partially met by fossil fuels and biomass in Europe for the foreseeable future. Flexible CCS (including Bio-CCS) will be necessary to support increased penetration of renewables, where renewables will, by themselves, not be sufficient. ***KPI's*** • Job creation and innovation • Export of CCS technology internationally • Keeping energy-intensive industries in Europe promoting the implementation of coupled CCS-renewables • Decarbonising energy and increasing security • Reducing costs though CCS to meet the Paris Agreement • Assessment of bankable CO_2 storage sites • Increased free-flow of energy across countries and within regions by creating integrated H_2 and CCS transport and storage infrastructures • Security of supply through diversifying different sectors of the energy system

[4] CCS and Europe's Contribution to the Paris Agreement: Modelling least-cost CO_2 reduction pathways (ZEP 2017).

	• Increased clean H_2 production with successful integration into pilot transport infrastructure and/or delivery of energy services in buildings • CCS deployed at commercial scale on gas-fired power-plants and other large CO_2 emitting plants in Europe • Achieving SET Plan Implementation Plan Action 9 • Projects of Common Interest for CCS proceed successfully through pre-FEED, with FEED design studies initiated • New CO_2 capture pilots for emerging technologies including bio-CCS • New CO_2 storage pilots
Typology	***Nature of the Mission challenge, and description of its eco-system:*** This Mission will build upon the existing collaborations amongst the members of the working group that has efficiently developed the SET Plan Implementation Plan for Action 9. This Mission requires integrated actions across the three pillars of H2020 - excellence science, industrial leadership and societal challenges: *Societal:* Policy and financial enablers. CCS in strategic infrastructure *Technical:* Demonstrating the requirements for and characteristics of flexible operation of CCS systems when integrated within realistic energy systems *Innovation:* Exploiting technological and innovation requirements for CCS in full chain systems to maximise synergies within European energy systems (wind, solar, gas, geothermal, nuclear or hydro), and with current and future energy storage systems (e.g. Compressed air storage, batteries, pumped storage) *Scientific:* A wide range of challenges exist across several disciplines including sciences and engineering. For example, low carbon H_2 production from methane reforming for heating and transport and geological storage of CO_2 in novel applications (working fluid for geothermal, unconventional hydrocarbons). *Systemic:* Quantifying the impacts (cost reductions, security of supply, power merit orders etc) in the total energy system of integrated CCS in flexible generation
Key Activities	***High level breakdown of the mission identifying used scientific & research disciplines, technologies and innovation level:*** The following activities reflect those agreed in the SET Plan Implementation Plan Action 9: • PCI design studies to support SET Plan CCS IP Target 4 (R&I Activity 3) to develop at least one PCI in the North Sea. Expand to other regions (e.g. Baltic, SE Europe) in support of Target 10 for MS to review the feasibility of CCS in their regions. • H_2+CCS deployment for urban transport and domestic and industrial heating (R&I Activity 1 and 2). • Storage de-risking – strategic targets for advanced testing via pilot injections where scalability is identified (SET Plan CCS IP Target 5 for an updated storage inventory (R&I Activity 3) and Target 7 for a minimum of 3 new storage pilots (R&I Activity 5)). This would support the SET Plan's Flagship Activity: Storage Appraisal • Development of new technologies for CO2 capture (SET Plan CCS IP Target 6 (R&I Activity 6)) for supporting export to other countries deploying CCS, including sustainable bio-CCS (especially those with strong potential for bio-

	CCS e.g. inter alia India, China, Mexico) • Energy system modelling for national and regional energy systems to support Target 10 (R&I Activity 8). • Support for whole-chain CCS project in Power Sector (R&I Activity 1) via ERANet
Key Actors /Stakeholders	• Direct policy and political engagement with planning authorities, regional and national and European politicians (and their influencers and opinion makers), not just with those with responsibility for CCS but also rest of energy sector. • Investors and insurers • Oil and gas companies • Bioenergy producers • Electricity distributors, H_2 producers, electricity generators • Regional development agencies and political leaders (city mayors, planning • authorities and transport policymakers) • Domestic and industrial heat associations • Industrial factories (steel, cement plants etc.) • EERA CCS and the research community • ECCSEL ERIC • Zero Emissions Platform (ETIP) • NGOs • Social scientists • Energy systems modellers and policy makers • Business developers • DG Energy • Members of SET Plan Action 9 Working Group on CCS
Supported Policy Goals	***Identification of supported political goals and their related policy agenda such as:*** This Mission will support the goals of the Energy Union and implementation of the SET Plan Action No.9 CCS and CCU Implementation Plan, which was accepted by the EC and supporting Member States in October 2017. It will support unlocking of infrastructure funds such as the Innovation Fund and other funding programmes under the Multiannual Financial Framework, by enabling further close collaboration between industry and commercial organisations , governments (regional and national), the EC and the research community. Specifically it supports achievement of Targets 1, 4, 5 and 10. This Mission address three SDGs: *SDG 7:* Ensure access to affordable, reliable, sustainable and modern energy for all *SDG 9:* Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation *SDG13:* Take urgent action to combat climate change and its impacts However, it specifically addresses SDG7 by addressing Target 7.A: By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology. It also addresses EU Policies, such as A Roadmap for moving to a competitive low carbon economy in 2050, the new Reference Scenario of the EU. It also supports the SET-Plan Declaration of Intent on Action No 9 on CCS (EC, 2016).

	National Plans for decarbonisation and CCS in Netherlands (new CCS Plans), Norway (creation of state "transtor co" and full-chain demonstration) and the UK (Clean Growth Strategy). This Mission specifically addresses Innovation Challenge number 3 under the Mission Innovation – Accelerating the Clean Energy Revolution. Challenge 3 aims "to enable near-zero CO2 emissions from power plants and carbon intensive industries".
Duration	***Estimated duration with potentially first level of intermediate milestones:*** Estimated duration is 7 years to achieve targets set by 2030, assuming a 2020 start and enabling 3 years for commissioning and construction in 2027-2030: *Years 1-2:* PCI Design studies; Energy-system modelling; European Storage Inventory; Storage de-risking; Capture technologies; national feasibility studies; Apply for infrastructure funds; Collaborations with Mission Innovation countries *Years 3-5:* Extend PCI and CCS feasibility studies to other European regions; new regional development; export to Mission innovation Countries; Set-up national transtor companies *Years 6-7:* CCS Pilot operations; export to Mission innovation Countries
Budget	***Estimated order of magnitude of budget requirements, possibly already highlighting the various funding sources/instruments:*** See SET Plan Action 9 Implementation Plan for CCS and CCU – timelines to 2030 are developed there, including funding sources.

Enabling low-carbon growth through Carbon Capture and Storage (CCS) in industry	
Mission Statement	**Creating carbon-free European industries by 2030**.
	The Mission: This Mission will develop CCS technologies needed to provide CO_2-neutral industrial products. To remain competitive, manufacturing industries must provide sustainable products on the global market. Increasing energy efficiency and the share of primary energy from renewable sources will reduce carbon dioxide emissions. In addition, for many processes, such as steel and cement, CO_2 is an unavoidable by-product of the manufacturing process as well as being emitted in energy-intensive industries - CCS is needed to reduce these emissions. CCS is mandatory to achieve the well-below 2 °C target of the Paris Agreement. This ~Mission will develop optimum pathways that deploy appropriate options (energy efficiency, fuel switching, process integration, carbon capture, etc.) to reach fully carbon-neutral manufacturing. ***Goal/Vision:*** This Mission will sustain existing industry and create new economies to increase employment in our industrial regions by enabling carbon-free European manufacturing hubs and clusters to strengthen European competitiveness. Expected impact & targets: IEA's roadmap[1] to achieve a 2 °C target indicates that globally 2000 Mt CO_2 per year will need to be stored by 2030, increasing to 7000 Mt CO_2 in 2050, with 45% of these emissions being captured from industrial processes. In 2010, direct emissions form industry accounted for 25% of total EU CO_2 emissions, which this Mission will seek to reduce to make those industries carbon-neutral. Emissions reductions of between 60-80% can be achieved in cement and iron and steel for example2. This Mission will support the safeguarding of existing jobs in Europe's energy-intensive industries, which employ approximately 1.3 million people.[2] Modelling by ZEP has also shown that deploying a CCS industry in Europe could also create 330000 new jobs in fuel supply, CCS equipment manufacture, plant operation and CO_2 storage facility operation.[3] ***Underlying overall challenge:*** Europe must develop low-carbon industries in which CCS is a key solution. CCS allows industries (inter alia steel, chemical, fertiliser, plastics, glass, and cement) to provide economic growth in the carbon-constrained economy. Whilst reductions from energy efficiency will still be needed, the biggest challenge is reducing remaining emissions requiring fuel switching, process reform and process integration. This will require major investments and major interruptions in production and the R&D and industry communities will need to cooperate to meet this challenge to develop new solutions, underpinned by robust science, to overcome the technical, financial, and commercial and socio-political obstacles to enable low-carbon industries through CCS

[1] IEA, 2013. Technology Roadmap: Carbon Capture and Storage

[2] ZEP, 2013. Recommendations for transitional measures to drive deployment in Europe. Belgium

[3] ZEP, 2013. CO2 Capture and Storage (CCS): Recommendations for transitional measures to drive deployment in Europe. 2013, 78 pages.

	deployment. ***KPI's:*** • Job creation and innovation • Export of CCS technology internationally • Keeping energy-intensive industries in Europe • Decarbonising industry • Pre-FEED for industrial clusters with CCS • Completed feasibility studies on industrial CCS in SET Plan countries • Engaged regional development groups • Achieving SET Plan Implementation Plan Action 9 • CO_2 Storage inventory for all Europe • Projects of Common Interest for CCS proceed successfully through pre- • FEED, with FEED design studies initiated • New CO_2 capture pilots for in key industrial areas that demonstrate deep • decarbonisation • New CO_2 storage pilots that de-risk future storage locations and provide foundations for future roll-out.
Typology	***Nature of the Mission challenge, and description of its eco-system:*** This Mission will build upon the existing collaborations amongst the members of the working group that has efficiently developed the SET Plan Implementation Plan for Action 9. This Mission requires integrated actions across the three pillars of H2020 - excellence science, industrial leadership and societal challenges: • Technical demonstration of technologies at scale and in fully integrated systems with embedded capabilities for innovation to increase efficiencies • Scientific research for next generation capture technologies and to quantify and reduce long-term liabilities for storage • Appropriate organisational and commercial structures, potentially through one or more market makers, are needed to enable a fair balance between project risk and societal benefit, requiring more fundamental engagement with investors (public and private) and policy makers, • Politicians (at national and regional levels), communities and project proponents must come together to jointly develop projects embedded within regions • Decarbonisation via CCS must be deployed within global markets, both seizing opportunities for innovation and also mitigating impacts on manufacturing flexibility and competitiveness. It will require strong links to strategic planning of new infrastructure, including integration with new heat and power networks.
Key Activities	***High level breakdown of the mission identifying used scientific & research disciplines, technologies and innovation level:*** The following activities reflect those agreed in the SET Plan Implementation Plan Action 9 and will support the Implementation Plan No 6. on Energy Efficiency: • Create low-carbon growth engines across Europe by enabling communities to develop the physical, financial and political environments to support CCS deployment at clusters of major industrial and other sources. Multi-tiered societal engagement (communities as hosts, trade associations, political groups, governments, European Parliaments…) will be needed to achieve this Flagship activity. Supports SET Plan IP Target 3 (R&I Activity 2)

	• New research facilities. To be delivered via ESFRI's ECCSEL Research Infrastructure (R&I Activities 5 & 6). • Fundamental research is needed to maximise safe storage potential (SET Plan IP Target 7 on storage pilots) and provide innovative solutions for capture technologies in a range of industrial sectors (SET Plan IP Target 6 – 3 capture pilots). • Financial, commercial and policy innovation is needed to address challenges in supply-chain development and especially to address challenges of sharing long-term liabilities between governments and developers.
Key Actors /Stakeholders	Identification of direct actors involved in executing the mission as well as global stakeholder context (EU institutions, NGO's, communities, …) • Industry • Investors and insurers • Regional development agencies and political leaders (city mayors and planning • authorities) • EERA CCS and the research community • ECCSEL ERIC • Zero Emissions Platform (ETIP) • New market makers to coordinate development of the transport and storage networks. • NGOs • Social scientists • Business developers • DG Energy • Members of SET Plan Action 9 Working Group on CCS
Supported Policy Goals	***Identification of supported political goals and their related policy agenda such as:*** This Mission will support implementation of the SET Plan Action No.9 CCS and CCU Implementation Plan, which was accepted by the EC and supporting Member States in October 2017. This Mission address three SDGs: *SDG 7:* Ensure access to affordable, reliable, sustainable and modern energy for all *SDG 9:* Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation *SDG13:* Take urgent action to combat climate change and its impacts However it specifically addresses SDG9 by addressing Target 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities. It also addresses EU Policies, such as A Roadmap for moving to a competitive low carbon economy in 2050,[4] and the new Reference Scenario of the EU The Mission will enable development of the four selected Projects of Common

[4] https://ec.europa.eu/energy/en/consultations/consultation-list-proposed-projects-common-interest-cross-border-carbon-dioxide

	Interest for CO_2 transport and storage.
Duration	***Estimated duration with potentially first level of intermediate milestones:*** This is highly ambitious and will take at least a decade to deliver. Lighthouse global lead cities and regions would focus on the most advanced regions such as Rotterdam, Norway, Teesside, Grangemouth (1-4 years). 2nd phase would be emerging industrial zones in regions such as Ruhr, southern Ireland, and Baltic (5-6 years). 3rd phase will be other regions in Czech Republic, Italy, Spain, Greece, and Poland (6-10 years). Estimated duration is 7 years to achieve targets set by 2030, assuming a 2020 start and enabling 3 years for commissioning and construction in 2027-2030: *Years 1-4:* Flagship industrial clusters development *Years 5-6:* Extend PCI and CCS feasibility studies to other European regions; Capture pilot construction; Storage Pilot Construction; new regional development *Years 6-7:* CCS Pilot operations;
Budget	***Estimated order of magnitude of budget requirements, possibly already highlighting the various funding sources/instruments:*** See SET Plan Action 9 Implementation Plan for CCS and CCU – timelines to 2030 are developed there, including funding sources.

ZEP and EERA Recommendations for Sustainable Hydrogen under Framework Programme 9

Hydrogen has a key role to play in the global energy transition, providing options for cross-sector decarbonisation, and at a European level supporting all 5 pillars of the Energy Union. Recently, the transition to hydrogen economies has gained prominence through global initiatives, such as the Hydrogen Council, established during the 2017 World Economic Forum in Davos[1], with the goal to promote hydrogen's role in achieving climate goals and energy security. Also last year, Japan announced ambitious plans to deliver a hydrogen economy by 2050 by cutting current hydrogen fuel costs by 80%, to achieve cost-competitiveness with fossil fuels.[2] Japan aims to have 40,000 fuel cell vehicles in operation by 2020, increasing to 800,000 by 2030. Similarly the state of California aims to have over 20,000 fuel cell vehicles on the road and 5 operating power to gas projects in place by 2025.[3]

FP9 presents an opportunity for the Commission to set out a coherent approach to sustainable hydrogen, recognising its enabling role in establishing early markets for a European hydrogen economy. ZEP and EERA make the following recommendations:

1: Integrate support for sustainable hydrogen technologies across multiple sectors:

A European hydrogen economy will return maximum economic benefit where the technology can be applied to multiple sectors. Under the current H2020 Work Programme sustainable hydrogen is included only as an industrial application, not recognising the additional opportunities for decarbonising the power, heat and transport sectors.

There is also an opportunity to expand the remit of public-private partnership initiatives, such as the Hydrogen Fuel Cell Joint Undertaking, beyond the current focus on applications for electrolysis-derived hydrogen in the transport sector, to incorporate broader support for sustainable hydrogen research and innovation initiatives.

2: Maximise the synergies between sustainable hydrogen production pathways:

The ZEP report: *Commercial Scale Feasibility of Clean Hydrogen*[4], concluded that natural gas reformed hydrogen with CCS (produced through Steam Methane Reforming (SMR) or Auto Thermal Reforming (ATR) of natural gas) can currently be produced at less than half the cost of electrolysis-derived hydrogen, which is not expected to become cost-competitive until 2045. At the same time, natural gas reformed hydrogen can enable the production of the large hydrogen volumes needed to establish early markets, an issue discussed at the ZEP hydrogen workshop in November. An example of the achievable production volumes is the Magnum hydrogen project in

[1] http://hydrogencouncil.com/
[2] Japanese Agency for Natural Resources and Energy, Basic Hydrogen Strategy (2017)
[3] https://www.californiahydrogen.org/
[4] ZEP Commercial Scale Feasibility of Clean Hydrogen (2017)

the Netherlands; where Statoil is evaluating options to convert the gas plant into a 1300 MW hydrogen-powered plant, able to deliver backup power constantly over 24 hours.

The European CertiHy scheme[5] has established an EU-wide guarantee of origin for 'low-carbon hydrogen', where the emissions intensity of production is lower than that of the standard route of SMR without CCS. It is recommended that FP9 maximise these synergies by supporting technologies under both production routes.

The Implementation Plan[6] for CCS and CCU under the SET-Plan Action 9 includes sustainable hydrogen under the Research and Innovation Activities 1 (Delivery of a whole chain CCS project in the power sector) and 2 (Delivery of regional CCS and CCU clusters, including feasibility for a European hydrogen infrastructure). Horizon 2020 is an important source of funding, and therefore to maintain momentum beyond the period to 2020 a future FP9 programme must be consistent with the targets and recommendations set out in the Implementation Plan. FP9 also represents an opportunity to engage across the SET-Plan Action areas, in particular with Implementation Plans for Action 5 (cross-cutting technology for heating and cooling), Action 6 (Energy Efficiency in Industry) and Action 8 (Renewable Fuels and Bioenergy), to ensure recommendations for hydrogen and the supporting infrastructure are fully aligned.

3: Support sustainable hydrogen initiatives across the full TRL range to accelerate commercial-scale deployment as well as drive innovation and cost-reduction:

The Mission Innovation Carbon Capture Challenge programme, where ZEP and EERA have worked closely with the European Commission, has identified sustainable hydrogen as a 'Priority Research Direction'. However, with Mission Innovation currently focusing on lower TRL levels it is important that FP9 supports the transition to higher TRLs.

Europe's position as a leader in the transition towards a low-carbon hydrogen economy will only be realised through coherent and consistent regulation and financial support mechanisms. Flexible support for sustainable hydrogen under FP9 will be vital, where this can be integrated across a range of sectors, and able to be used in combination with other sources of EU funding, such as the ETS Innovation Fund and Connecting Europe Facility, in addition to national and industry funding.

[5] http://www.fch.europa.eu/news/certifhy-project-establishing-first-eu-wide-guarantee-origin-green-hydrogen
[6] SET-PLAN TWG9 CCS and CCU Implementation Plan (2017)