

# Accelerating CCS Technologies

## The ACT final report - the years 2016-2021 -

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## 1. This is ACT

ACT was established in 2016 with 10 partners from 9 European countries as a response to the H2020 call in 2015 on low carbon technologies. This consortium joined forces with the aims to accelerate and mature CCUS technologies by making funds available for R&D and innovation projects and a solid basis for knowledge sharing in an open mind approach.

ACT since it was kicked off in February 2016 has become a widely renown program within the transnational CCUS R&D initiatives in Europe and beyond, extending the consortium with funding agencies from Europe, India, Canada and USA. Since 2020 a total of 16 funding agencies are involved in ACT and took part in the third ACT call (ACT3).

The background for ACT is based on the fact that the level of carbon dioxide (CO<sub>2</sub>) released into the atmosphere has increased significantly since the industrial era, and it is well documented that burning fossil fuels emits CO<sub>2</sub> with serious and negative impact on the climate.

Carbon Capture, Utilisation and Storage (CCUS) is part of a portfolio of technologies to combat climate change. CCUS can help mitigate CO<sub>2</sub> emissions from electricity production and is a prerequisite for reducing CO<sub>2</sub> emissions from industry such as steel, cement, chemicals and petrochemical refining.

ACT has contributed to accelerating CCUS Technologies by making available funds for transnational research and innovation activities. CCUS has an important role in the transition to a low-carbon economy.

The CCUS technology involves capturing CO<sub>2</sub> from large CO<sub>2</sub> emission point sources, such as fossil fuelled power plants and large, energy intensive industrial plants, compressing it for transportation and then injecting it deep into a rock formation at a carefully selected and safe site, where it is permanently stored. In addition, CCUS projects which deal with innovative and cost reducing utilisation of CO<sub>2</sub> have also been in the scope for ACT.



Figure 1: Geological storage of CO<sub>2</sub>

The IPCC 1.5 degrees report makes it very clear that CCUS must be part of an affordable and socially acceptable energy transition. The thematic priority CCUS is essential to the climate-neutrality goal of Europe, which has been underlined in a number of policy documents issued by EC and others the recent years.

The ACT calls have asked for RD&I projects that can lead to deployment of CCUS. Project proposals with high industrial relevance and industrial involvement have been prioritised. Of major importance is also that the projects being funded should comply with the SET Plan implementation plan for CCUS and the Mission Innovation research priorities for CCUS.

Even if ACT formally ended as an EC initiative 30 September 2021, the follow-up, monitoring and close interaction with the running projects will continue. The ACT2-projects end in the autumn 2022/winter 2023 and the ACT3-projects will end in the autumn 2024/winter 2025.

We welcome your visit to the ACT webpage [ACT \(act-ccs.eu\)](https://act-ccs.eu) for updates on activities, events and projects results.

## 2. Executive summary

This report summarises the 5,5 years of ACT as a transnational funding scheme and knowledge sharing platform for CCUS projects and results.

ACT was established in 2015 with funding partners from 9 countries agreeing on collaboration, with a joint application to the call launched by Horizon Europe in December 2014 for "*Low carbon technologies*". The ACT-application was approved for funding in December 2015 and ACT was formally kicked off (starting date) as a five-year initiative on the 1 February 2016 with an end date 30 January 2021.

ACT has undertaken three successful calls (in 2016, 2018 and 2020), with a growing number of participating countries and funding organisations. The ACT partners have established themselves as a powerful multilateral funding scheme for research and innovation dedicated to CCUS. ACT is a fit-for-purpose, partner-driven, flexible and an easy-to-join funding scheme that serves our ambition: **to make CCUS a commercially viable climate mitigation technology.**

Results relevant to the industry and policy makers have been and are still being provided from the ACT projects. Most importantly is that the ACT-projects have provided results of significant value:

- Paved the way for large scale CCUS deployment, e.g., provided results of relevance to development of large scale CCUS projects like Longship, Porthos, Acorn/Sapling etc.
- Delivered results aligned with the European SET Plan CCU-CCS Implementation Working Group<sup>1</sup> and the Mission Innovation Priority Research Directions<sup>2</sup>.
- Each ACT project is more than the sum of national efforts. Large impact is achieved when expert groups from several countries join forces in international ACT projects.
- Collaboration between partners (in Europe and across the Atlantic) who without ACT would not have found each other (not at all or not that easily).
- Annual ACT knowledge sharing workshops since 2016, all ACT projects present and share knowledge and ideas.

**ACT has been a most successful ERANET, and the following points have surely contributed to that.**

- A meaningful budget means meaningful projects. Norway and Germany had the guts and the foresight to start high on committed funding. This resulted in a number of additional strong partners, that could fund high quality projects with impact for the CCUS deployment.
- Coordinator RCN has consistently led the work, supported by own funding. This inspired all partners to go similar and work on own resources. This approach also had the impact that there was no need for counting hours and reporting on this from the various WPs to the coordinator.
- A lean and flexible approach and a willingness to contribute from all partners have been a key for running this initiative efficiently and smoothly.
- The share of the unit costs (from EC) to the ACT-partners – and donations from these to RCN for coordination and management purposes made it possible for RCN to run the call secretariat and the evaluation processes at cost.
- ACT has been a true collaboration between partners. From the start on, partners were encouraged and expected to contribute actively to the success of ACT. For example, all initial

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<sup>1</sup> The CCU-CCS Implementation Working Group: [https://setis.ec.europa.eu/implementing-actions/ccu-ccs-implementation-working-group\\_en](https://setis.ec.europa.eu/implementing-actions/ccu-ccs-implementation-working-group_en)

<sup>2</sup> Mission Innovation Priority Research Directions: [Accelerating Breakthrough Innovation in Carbon Capture, Utilization, and Storage | Department of Energy](#)

- partners were work package leaders (except Switzerland who originally was assigned to WP5 Communication but had to withdraw from that just before the proposal to the EC was sent).
- Concerning Call topics, ACT has implemented Calls that are thematic wide. As a result, ACT has maximized synergies. The broad consistent scope also generated trust with the CCS and CCU researchers and industry.
  - ACT had great country representatives, who had meaningful positions in international collaboration on CCUS, in IEAGHG, Mission Innovation, CSLF and other important organisations.
  - ACT is now a truly international collaboration with partners from Canada (Alberta), USA and India in addition to the European partners
  - ACT has also recruited new European partners since the start in 2016.
  - ACT has succeeded in getting impactful projects funded in all ACT participating countries (though not all countries in all calls), and many of them have provided a considerable number of publications – not only for the scientific community but reached out to a broader community.
  - Some examples - highlights from some ACT1-projects:
    - [ELEGANCY](#) have established a roadmap for how to establish a European infrastructure for hydrogen transport and hydrogen production combined with CCUS.
    - [ALIGN-CCUS](#) established unique results with a long-term pilot run at RWE and a CCU demonstration. The project has created a blueprint of how large-scale CCUS projects can be built.
    - [ACORN](#) was established as a PCI (Project of Common Interest) under the Connecting Europe Facility after the ACT project. The project has closed knowledge gaps related to reuse of infrastructure for CCUS purposes.

### 3. ACT governing structure

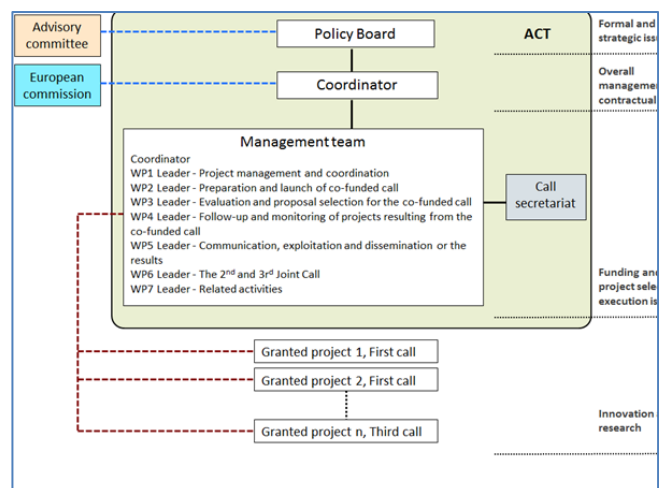
The ACT initiative has been built on a management consisting of the management team (the WP leads) and the ACT coordinator being responsible for the day-to-day operation of ACT.

A biweekly (sometimes weekly) meeting routine was established with the WP-leaders and the coordinator with the aim to keep all partners informed, dedicated to the tasks, and focused on our mutual goal. This approach has been resource-demanding, but at the end paid off very well because all partners have always had access to the same information and therefore sharing ideas and knowledge has been easier.

This way of operation has also built trust among the partners and created impact outside the group.

The ACT coordinator has been responsible for the continuous dialogue and interaction with the European Commission (EC) and the policy officer assigned to ACT there.

A policy board was established with representatives from all the funding agencies with the purpose for handling strategic and formal issues for ACT and taking decision for funding projects.



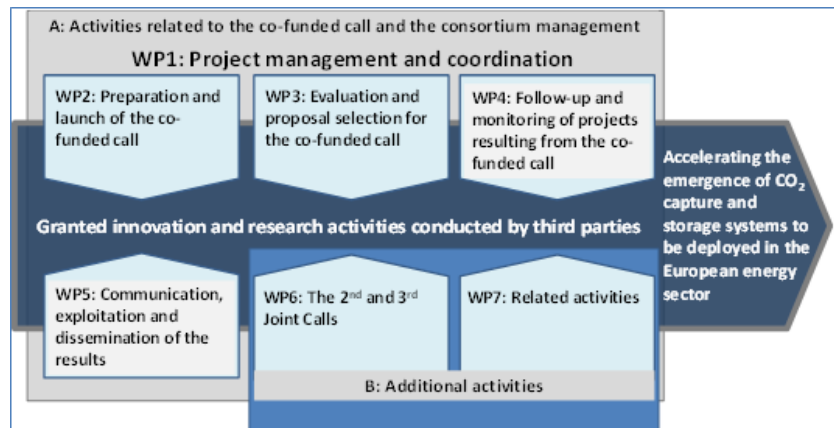
ACT also established a scientific advisory committee (SAC) with 5 representatives from CCUS-organisations and industry. This group has been consulted for inputs to the call text (especially ACT1 and ACT2 calls) and has been essential in the midterm review meetings with the ACT-funded projects.

The governing structure has in many ways worked nicely. However, several funding agencies have had the same person being a WP-lead also attending as the formal policy board member.

## 4. Work packages (WP)

In the ACT work program for the five-year operation a total of seven work packages were described in detail. The figure shows the WPs in a schematic manner and the title of the various WPs.

The work program had two main activities, A and B:



**Part A:** Activities related to the cofunded call and management of the consortium, WP1-WP5.

**WP1:** Project management and coordination, led by RCN, Norway

**WP2:** Preparation and launch of the Cofunded call (ACT1), led by PtJ, Germany

**WP3:** Evaluation and proposal selection for funding, led by BEIS (former DECC), UK

**WP4:** Monitoring of project resulting from the Cofunded call, led by RVO, The Netherlands

**WP5:** Communication, exploitation and dissemination of results, led by RCN until August 2018 when GSRT, Greece joined ACT and took over this WP.

**Part B:** Additional activities, consists of WP6 and WP7.

**WP6:** Additional calls (ACT2 and ACT3), led by PtJ, Germany

**WP7:** related activities (ACT knowledge sharing workshop, collaboration with other CCUS initiatives and indication with industry etc), led by UEFISCDI, Romania

In the following pages we present the work packages (WP), their goals and achievements for each of them respectively.

### WP1: Coordination and management

This WP is led by The Research council of Norway (RCN), who is the coordinator for the whole initiative of ACT. The expanding ACT Consortium and the active involvement of ACT partners in implementation of the various work packages show that the coordinator has been successful in establishing a truly international collaboration characterized by trust and good internal communication.

ACT has a small coordinating unit (2 people for the day-to-day management of the ACT process) – and it is fair to say that it has taken much more time to coordinate and manage this program than expected.

ACT was kicked off 23-25 February 2016 at a consortium meeting hosted by Mineco (later taken over by AEI) in Madrid. A site visit to the CCS-test plant at Hontomin/Cuiden and a joint workshop with the European research Infrastructure project ECCSEL<sup>3</sup> were also included as key elements of this meeting. This event really established a great and trustful collaboration between the ACT partners, which we successfully have built on further.

Even before that kick off in February 2016, RCN had the lead of establishing the consortium, processing the proposal together with the consortium partners and handling the dialogue with the EC related to the proposal and the grant agreement.

After the first call, it became clear that challenging and resource demanding processes evolved when different national requirements partly were in conflict with the CA, agreed time schedules, and had different approaches to important tasks. In such cases there was need for additional coordinating and consortium actions to solve the issues.

The substantial number of external referees needed for the evaluation in March 2017 also draw a huge part of the budget from the coordinator. The following years the ACT partners agreed to re-distribute parts of their unit costs to RCN, and it was also decided that new partners should pay an annual fee to RCN for the coordination tasks.

The WP1 lead has been responsible for the dialogue with the EC project officer for ACT (Vassilios Kougionas). This has worked very well, and the fruitful dialogue with the EC project officer was highly appreciated throughout the ACT period as well as his participation at the ACT knowledge sharing workshops since 2017.

The ACT coordinator, The Research Council of Norway (RCN), has also provided legal advice to other ACT partners as well as hosting the Electronical Submission System (ESS) for the first joint call.

On behalf of RCN, Dr. Ragnhild Rønneberg (special advisor) and Dr. Aage Stangeland (special advisor) have provided the day-to day operation of ACT, whereas Mr. Kristoffer Robin Haug was responsible for the ACT-web page the two first years until GSRI (Greece) entered ACT and kindly took over the WP5 Communication and the maintenance of the web since 2018. Ms. Hanne Lund Larsen guided ACT through the various legal parts and the Grant agreement and Ms. Marit Øien Kristoffersen has been responsible for the financial administration until 2019. Ms. Siri Kinge Ovstein and Ms. Sølvi R. Lindseth have been responsibility for registration of the ACT- proposals in the electronic submission system and have in addition designed ACT's formal document templates.

Since June 2016, the coordinator established biweekly telecon-meetings with the ACT consortium. The meetings evolved into virtual Teams meetings from 2020 and onwards. These meetings have been very helpful in passing important information across to the consortium and ensuring that all partners are updated on the status and progress of ACT calls, project monitoring, and reporting to EC. There have been weekly meetings in busy periods, especially in periods with evaluations of applications.

The whole consortium has benefited a great deal from these regular meetings; we have forged excellent working relationships where we have a significantly improved understanding of the “nuts and bolts” of different funding and award processes in the different counties - and moreover we have been able to

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<sup>3</sup> ECCSEL: <https://www.eccsel.org/>



keep track with issues and tasks of more pressing concern as timelines for calls, evaluation procedures, reports for EC, etc. Each telecon-meeting has been followed up with Minutes.

In order to keep all ACT funders engaged and directly involved in our meetings we established a routine where the chair (and responsible for the Minutes) of each meeting being on rotation.

The coordinator RCN has hosted the Call secretariat (for all three calls) and has been responsible for organizing the Policy Board meetings, establishing the Scientific Advisory Committee, and handling the daily routines that are necessary for running the consortium with all partners as effectively as possible.

Due to the pandemic in 2020, where many labs and activities were closed down, the ACT1-projects reported expected delays and they had no possibility to finish during summer/autumn 2020, as originally planned. The ACT board agreed to extend the ACT1 projects period until the end of 2020. Hence the final reports were received by ACT and the funding agencies February/March 2021.

In May 2020 the ACT Policy Board members also agreed to seek extension from the EC policy officer for the ACT-initiative. The date of ending ACT was set to 30.09.2021 with the final reports being made available to the EC-portal no later than 30.11.2021.

#### Deliverable from WP1:

D1.1: Consortium agreement (CA), submitted 25.04.2016

D1.2: Short annual progress report (from year 2016), 31.02.2017

D1.3: Report to EC (main results after 15 Months), 27.09.2017

D1.4: Final report – [this report](#), covering the full period 01.02.2016 to 30.09.2021

D1.5: Cumulative expenditures 2016, 30.11.2016

D1.6: Cumulative expenditures 2017, 31.01.2018

D1.7: Cumulative expenditures 2018, 08.01.2019

D1.8: Cumulative expenditures 2019, 02.01.2020

D1.9: Cumulative expenditures 2020, 16.12.2020

and in addition, the Financial report (Part B), covering the period from 01.02.2016 to 01.05.2017

#### Lessons learned from WP1 Coordination:

1. RCN has gained a lot of valuable experience throughout these 6 years of coordinating ACT.
2. The coordination and management have been very resource demanding and required more resources than expected.
3. Thanks to shared burdens of leading tasks and WPs among the ACT partners the management of ACT was handles effectively.
  - RCN is grateful to all WP-leads for their efforts in managing their tasks successfully carried out and reported.
4. ACT1 partners contributed financially to the coordination by allocating shares of their Unit Costs to the ACT coordinator (RCN). Together with the annual fees from the new ACT-partners, RCN was able to coordinate ACT at a reasonable budget.
  - RCN is very grateful for the financial contributions from the ACT1-funders and the new partners joining after 2017 for their financial contribution.
5. The lean management structure combined with flexibility and willingness by all partners to find good solutions has shown itself to be a very effective way of running ACT.
6. Starting out with a rather small consortium (10 partners from 9 countries) to a larger group (16 partners) enabled lessons learned to be implemented as we grew.
7. The way of operation has created trust among the partners, but also been a good basis for attracting new partners.



8. Managing and balancing the various needs, requests and wishes among the partners have sometimes been challenging, but in the end good solutions have been found.
9. The fact that several of the ACT partners have been active ACT-ambassadors, mobilized their own resources, and addressed the CCUS-community at national and international levels have enabled a successful story and a great development of ACT.
10. The close collaboration and open-minded dialogue established between the ACT-coordinator and the ACT-project officer(s) at EC have been valuable.
11. A great benefit is the routine with biweekly meetings and the sharing of chairing these meetings which have reduced the burden on the coordinator.
12. All in all, it has been a great pleasure having established and operated a success like ACT.

## WP2: The cofunded call

This WP was led by Projektträger Jülich (PtJ), Germany in close collaboration with all the other ACT partners. The main persons involved from PtJ were Hubert Höwener and Heiko Gerhauser.

PtJ and RCN together drafted the first call text and invited all the other ACT funders to contribute in framing the scope and the ambition of the call. All aspects related to the evaluation procedures were dealt with in WP3.

The first joint call (later named ACT1) was launched in June 2016 with a total of 41.2M€ available for funding projects that met all the appropriate evaluation criteria. In September ACT received a total of 38 pre-proposals with a total budget request of ~ 160 M€. After 1<sup>st</sup> stage evaluation, undertaken by the ACT consortium, 20 projects were invited to submit a full proposal by 16 January 2017. A total of 16 full proposals were received and distributed to external international experts for assessments. According to the rules set out by EC, the ACT consortium engaged an external observer to follow the evaluation process. He attended the evaluation panel meeting (with the 12 experts) which took place in London on the 22 and 23 March 2017. The experts agreed on a ranking list which was the basis for the decision of funding, where no break of the ranking was allowed. The observer's report is not public but was submitted to the EC when the ACT1-projects were decided to be funded.

ACT contracted with eight projects selected for funding and provided grants at total of ~37.8 M€. Funding decision for all these eight projects were only possible by highly acknowledged additional funds from The Netherlands (increased from 4 to 4,3 mill €), Norway (increased from 6 to 7 M€) and UK (where the exchange rate of 4 M GBP levelled to 5 M€, which was higher than originally calculated).

These projects from the first call (collectively named ACT1) started in August/September 2017 and all except one ran for 3 years. ACORN was completed according to plan after 1,5 years.

All ACT countries were successfully involved in one or more ACT1-projects.

An overview of the project funded (with cofund from EC) is shown in the table below.

Project	Activities	ACT, M €	Norway	Netherlands	UK	Germany	Romania	Switzerland	Spain	Turkey
ALIGN	Chain integration, clusters	14,5	x	<b>X</b>	x	X	X			
ELEGANCY	Chain integration, hydrogen	8,9	<b>X</b>	x	x	X		x		
PRE-ACT	CO2 storage, pressure handling	4,5	<b>X</b>	x	x	X				
ACORN	Full chain CCS / infrastructure	2,0	x	x	<b>X</b>					
DETECT	CO2 storage, risk assessment	2,0		<b>X</b>	X	X				
ECOBASE	CO2-EOR SouthEast Europe	1,2	<b>X</b>	x			x			x
GASTECH	Gas switching technology	1,7	<b>X</b>	x			x	x	x	x
3D-CAPS	3D printed sorbents	1,5	X	<b>X</b>			x			

All the ACT1-projects have submitted their final technical and final financial report to ACT and to the respective ACT-funding agencies. The final public reports can be found on the act-web [here](#)

At the end, based on the final accounts, the ACT1-projects received a total of approx. 33M€ (of which 22,1 M€ from the ACT1 funders and approx. 10.9 M€ as cofund from the EC).

#### Deliverable from WP2:

D2.1: Guidelines for the first call, submitted 02.05.2016

D2.2: Evaluation criteria for the first join Call, 04.05.2016

D2.3: Call text, the 1<sup>st</sup> Joint Call, June 2016 (sent to EC for approval 30 days before launch), 02.05.2016

D2.4: List of submitted proposals- Stage 1, 22.09.2016

D2.5: List of submitted proposals- Stage 2, 31.01.2017

#### Learnings from the WP2 Cofunded call:

- The process of writing the call went smoothly, all partners were engaged and underlined their preference of topics. Due to the national requirements, specific topics of national interest and budgetary constraints, this first call text became broad.
- The external Observer commented that the Call text should have been much more specific. However, this was not possible to achieve because different national priorities had to be respected.
- The main issue overall has been one of constricted timing and limited flexibility due to the conditions of the co-funding.

## WP3: Evaluation

This WP was led by BEIS (former DECC, UK) in close collaboration with the Research Council of Norway (RCN). Brian Allison and Amy Cutter were the key persons at BEIS. Hanna Lord substituted Amy Cutter in May 2018. Aage Stangeland and Ragnhild Rønneberg were the key persons from RCN.

A two-step evaluation process was established for the Co-Funded call (ACT1 in 2016). This has since been the policy for the two additional ACT calls (ACT2 in 2018 and ACT3 in 2020).

The proposals have been evaluated against the criteria (1) Excellence, (2) Impact, and (3) Quality and Efficiency of Implementation. Sub-criteria have been used within each of these main evaluation criteria to

help the referees in their assessments of the applications. The evaluation procedures have been detailed in the call text.

The pre-proposals were initially assessed by the individual ACT funding organizations and measured against their national conditions set out in the annexes in the Call Text. The funding organizations first scored each pre-proposal Red/Amber/Green to rate the projects in which they were involved. Some funding organizations only performed eligibility checks, while other funding organizations also evaluated the scientific quality of the pre-proposal. The next step was an ACT consortium meeting where all funding organizations discussed all pre-proposals and agreed on which whether the applicants could proceed to submit full proposal. This was decided based on national eligibility checks and evaluations as described in the call text.

The full proposals were assessed by external referees. Each proposal was assessed by three referees. All referees did individual assessments first and then the experts met to come to agreement on a common scoring of each application. The referees also had to agree on written statements for each criterion and each application. All this was summarized in an evaluation report. There was one evaluation report for each application and the reports were put forward to the ACT Policy Board who took final decisions on which projects to fund.

The budget for the first ACT was split into large and small projects. Large projects were defined as projects asking for more than 3 million euro in support from ACT. After the evaluation, two ranking lists were produced, one for small projects and one for large projects. The ranking lists were respected when the ACT Policy Board decided on funding. The top three large projects and the top five small projects were funded.

EC appointed an observer for the first ACT call. The observer did a very good job and his report on the evaluation procedure concluded that it had been a fair and professional process, although he had some suggestions for improvement that the ACT consortium paid attention to when setting up the next ACT call.

Evaluation of applications to the ACT2 and ACT3 calls were performed in a similar way as for ACT1. Two significant changes were introduced. The calls had only one ranking list, not two as in ACT1. Another important change was a slightly different procedure when the ACT Policy Board made its final decision on which project to fund. The procedure was now to stick as much as possible to the ranking list, but availability of money from the funding agencies was also paid attention to.

Top ranked projects were funded as long as funding was availability from all funding organizations. When the first funding organization ran out of money, the ACT Policy Board also looked further down the ranking list to see if additional projects could be funded. As a result, both ACT2 and ACT3 ended up with more projects being funded than would otherwise be possible if the ranking list had to be followed strictly.

#### Deliverable from WP3

D3.1: List of independent experts, submitted 02.05.2016

D3.2: List of successful projects – stage 1, 04.10.2016

D3.3: Applicant notifications – stage 1 evaluation, 04.10.2016  
D3.4: Transnational Project Selection Summary Report, 10.05.2017  
D3.5: Stage 2 Applicant Notification, 10.05.2017  
D3.6: Stage 2 Evaluation - Ranking Lists, 25.04.2017  
D3.7: Projects selected for funding, 31.08.2017  
D3.8: Independent Observer's report of the evaluation, 06.07.2017  
D3.9: Commitment letters for funding the projects, 17.10.2017  
D3.10: Evaluation – final report, 08.01.2018

Learnings from WP3 Evaluation:

1. A thoroughly assessments of the pre-proposals is essential in order not to end up with projects that might be deemed in-eligible when the full proposal I received and ranked. All ACT-funders have been better skilled in this sense after we had the learnings and experience from the ACT1-call and evaluation process.
2. The CCUS community is rather small, so finding external experts not having conflict of interest was challenging. However, we succeeded quite nicely and managed to carry out the evaluation and concluded with ranking lists in the ACT1 call which was strictly followed for choosing the projects to be funded.
3. According to the request from EC an external observer was following the evaluation of the ACT1-call proposals – from the pre-proposal throughout the conclusion by the expert panel. One of the points the observer identified was the lack of gender balance in the expert panel. This was a point the ACT coordinator took seriously and at the later evaluations (of ACT2 and ACT3-proposals) this was addressed and improved.

## **WP4: Monitoring**

This WP was led by RVO, Netherlands and the task carried out in close collaboration with the other funding agencies and partners.

The main persons involved at RVO were Gerdi Breembroek, Harry Schreurs, Li Hua and Peter Balemans.

WP4 Monitoring developed the monitoring guidelines intended for partners in ACT-granted projects, in particular the Project Coordinator and the Country Coordinators in the respective participating countries. The guidelines and procedures were agreed amongst the partners to the first joint Call of ACT, and since then only slightly modified.

Since the ACT joint calls are based on a mixed mode, with national contracts with national partners, the guiding principle of the monitoring was that national procedures for monitoring and payment would be in full force for all partners in ACT projects. On top of this, there was established a lean but frequent progress monitoring on the ACT-granted project level. Moreover, at this level, there were carried out mid-term reviews for large projects (> 3 M€ in funding) in ACT1, and for all projects in ACT2.

To complete the picture of monitoring, the ACT-granted projects are obliged to participate in the annual knowledge-sharing workshops. Finally, ACT also required a final report. Templates for monitoring on ACT-granted project level were part of the Guidelines for partners in ACT-granted projects.

Another crucial building block of the monitoring approach was to assign each project to the ACT partner in the Coordinating country of that particular project. This ACT partner would be first contact for ACT projects with questions or concerns. In this way, the burden of monitoring was naturally spread across the ACT countries, albeit a bit uneven.

## Project meetings

The ACT consortium has had a policy to attend all kick-off meetings and annual (or even more frequent) project meetings with at least one representative from the ACT-core group.

This has been highly appreciated by the projects teams and the close interaction has led to improved results, as constructive comments from the ACT team could be taken on board throughout the project period. .

## Quarterly reports

Based on traffic light system, the projects assigned a 'green' 'amber' or 'red' to the progress in their work packages every three months. The projects were challenged to come up with remedial actions for 'amber' or 'red' work packages.

At RVO, Li Hua was responsible for summarising the traffic light reports. The traffic light reports were on the agenda at weekly / biweekly ACT meetings every three months when the quarterly reports were received. With 12 ACT-2 projects and 8 ACT-1 projects running, in-depth discussion of the traffic light reports at ACT Telcons was no longer realistic. Starting summer 2020 for ACT-2, the ACT partner in the coordinating country proposed feedback to the traffic light report per mail, which was then reviewed by the other countries involved in funding that project and communicated to the project lead.

## Mid-term review meetings

Of the ACT1-projects the consortium agreed to only invite the large projects (receiving more than 3 million euro from ACT) to the mid-term review meeting. In due time in advance of the meetings, the ACT consortium had received the mid-term review report from each of the large projects.

The Scientific Advisory committee was invited to the mid-term review meeting. Two members of this committee joined us in Zeist, the Netherlands: Philip Ringrose (Equinor, NTNU) and Keith Burnard (IEAGHG). The aim of the meeting was to encourage the projects to do an even better job in the (then) remaining 14 months and deliver and disseminate their results in time. At this ACT1 mid-term review meeting, a morning or an afternoon was dedicated to one project. Both ACT officials and the Scientific Committee members could interact with the project lead and the work package leads. After the meeting, the ACT Consortium supplied written feedback, highlighting the main points.

Contrary to the ACT1-mid-term review request, for ACT2-projects all were invited to mid-term review. The reason for this was that the ACT Consortium had the experience that the Midterm Review had been very beneficial for both ACT Consortium and ACT projects. The Mid-term review was a face-to-face moment of communication on the work that had been done and the outlook of the second half of the projects. The investment in time really paid out.

For the ACT-2 projects, ACT engaged 5 external experts to review the reports and take active role at the mid-term review meetings. The expert's joint feedback (written report) was forwarded to the project leads who were requested to implement the feedback/recommendation in their next Quarterly reports. Due to Covid-19 restrictions, all ACT-2 Mid-term review meetings were organised as virtual meetings.

## Covid-19 situation and impact on projects progress

Both the ACT1 and the ACT2 projects were challenged by Covid-19. During lockdowns, labs were closed, workers had home teaching responsibilities, transport and delivery of goods was impacted and travel was impossible. This had a serious impact on many ACT projects.

The ACT team has remained in good contact with the projects. There was also a need to make joint decisions on extensions for the projects, so that their delivery would remain aligned. For ACT1, this resulted in an extension towards the end of 2020 for all projects that were impacted by Covid-19.

For ACT2, agreeing on a reasonable extension is still in progress. Covid was a bigger challenge for ACT2 projects than ACT1 projects. ACT1 projects had completed most of their lab activities at the breakout of the pandemic and were able to complete their projects with only minor delays. Many planned outreach activities had, unfortunately, to be converted to virtual events. Given the situation it worked very well with virtual dissemination events. ACT2 projects, on the other hand, had to postpone many lab activities. Most of the ACT2 project had to move their end date up to six months, and they are now well underway with their projects.

### Final reporting

The impact of the ACT-funded projects and their contribution to the state of the art is formed by the whole suite of publications, deliverables, videos, social media presence, webinars and other meetings organised by them. All this communication contributes to their lasting relevance for the CCUS community - and the accelerated mitigation of climate change.

The final report summarises the results and impacts of the funded projects. Approved final reports are available from the ACT website. The projects are also encouraged to keep their websites online for some years to come.

Those ACT Consortium members that are connected to the project as funding organisation review the final report and discuss its contents in a joint video meeting. The joint feedback to the project is prepared by the lead country and approved by the others. Also, the approval procedure includes a check on deliverables. All deliverables (public, restricted and confidential) have to be at the ACT Secretariat before the final OK, and the public deliverables have to be available on the website of the project. The quality check from the side of ACT has sometimes resulted in new sections in the approved final report version, and also to discipline in publishing all public deliverables on websites.

For ACT1, it is worth mentioning that many projects took the opportunity to present their results at the GHGT 15 (GreenHouse Gas Technology conference), the world leading conference on CCUS, organised March 2021 as a virtual meeting. This conference very well coincided with the finalisation of the ACT1 projects, and the projects presented many successful papers, see [ACT presentations at GHGT-15 — ACT \(act-ccs.eu\)](#). The top five downloads from the conference at the day of writing (23 November 2021) features three papers from ACT-funded projects, with about 300 downloads for each of them!

### Final events / conferences

Contrary to the initial plans in the monitoring guidelines, the ACT Consortium decided not to organise an ACT Conference to mark the finalisation of the ACT1 projects. The main reason for this was that the wealth of results for ACT1 was such, that a conference of all the ACT1 projects would not do justice to all of them. The projects were encouraged to organise their own final events. An additional motivation was the Covid-19 restriction on travel in the autumn of 2020. Large networking events were simply impossible. Series of webinars were much better adapted to the 'work-from-home' principle and this is the way the ACT1 projects made their final results known to the world.

The ACORN project was an exception in ACT1, because the ACORN project period finalised early 2019. This project staged a well-visited event in Westminster, London, on 23 January 2019. In the same year, the project was granted a PCI status. The 3D CAPS project did not organise a public final event, but presented their ideas and progress at many conferences – a full list can be found in the 3D CAPS final

report.

List of final webinars/events of ACT1 projects:

- 24 March – 27 May 2020: Pre-ACT Webinar Series (6 meetings)
- 18, 19, 22, 23 June 2020: ELEGANCY Webinar Series
- 28-29 October 2020: ALIGN-CCUS final online event
- 26 November 2020: Webinar ‘Accelerating CO2 storage’, co-organised by ALIGN-CCUS, ELEGANCY, Pre-ACT and DETECT.
- 26 November 2020: ECOBASE final Webinar
- 1 December 2020: DETECT final dissemination event
- 16 December 2020: GasTech final Webinar

Deliverable from WP4:

D4.1: Monitoring guidelines, submitted 25.11.2016

D4.2: Grant Agreements with ACT-funded projects, submitted 13.02.2017

D4.3: Annual progress report ACT Call 1 projects – 2017, submitted 30.03.2018

D4.4: Evaluation of project results, due 30.11.2021

Learnings from WP4 Monitoring:

- The monitoring approach has worked well to ensure delivery of the project objectives and valorisation of the results.
- Three-monthly traffic light reports have allowed us to keep a watch on progress and deviations.
- The lean and distributed philosophy with the ACT lead in the country with the funded project lead as the main person for interaction with the project worked well. There are always challenges, of course. Getting everybody aligned about project changes has been handled on a case-by-case basis, with only those international decisions that were strictly necessary
- Managing the increasing number of projects with the same team requires attention and potentially some rethinking in the long run.
- Close interaction with the projects has encouraged them to deliver their ambitious goals, and the project partners have acknowledged this close interaction.

## WP5: Communication

This WP was led by RCN until GSRI (Greece) joined ACT in 2018 and took over this WP/task.

The main persons involved in this WP have been Evi Afentaki and Anna Rosenberg from GSRI and Aage Stangeland and Ragnhild Rønneberg from RCN.

The objective of WP5 is to realise communication and dissemination of the ACT project itself and exploitation of results from the ACT funded projects. In this context the Knowledge sharing workshops are integral. Not only have such workshops been a platform for dissemination of results from the ACT funded projects, but they have also stimulated the cooperation between the EC, academics and industry; and also, a place for policy makers to assimilate the latest news about transnational CCUS progress in Europe.

Posters, brochures and leaflets have also been prepared, printed and distributed during the Knowledge Sharing Workshops to the broad public and experts who have attended, but also in other relevant events for CCUS organised all over the world, where ACT has been represented.



ACT has also been represented in various events and meetings, through webinars, presentations, interviews as well as attendance on CCUS discussions in Brussels and elsewhere, liaising closely with EU officers and members of the European Parliament, representatives, and policy makers in the CCUS and Energy field.

## Web

The ACT web site, <http://www.act-ccs.eu/>, has been kept continuously updated with news from ACT and ACT funded projects. Each project has a dedicated website and are all linked to the central ACT web page. The web site has been important for dissemination ACT results at various stages of the progress of the Network and in the life of each project as well as for keeping potential applicants updated with information about upcoming and Open calls.

In addition, through the ACT website, relevant events, publications, reports at regional, national and international level have been advertised, thus making it a point of reference for CCUS. The matchmaking section has been constantly updated with current ACT participants and interested stakeholders from all over the world, proving to be an efficient tool for partner search amongst experts, industry, academia and the research community dedicated and active in the CCUS field.

## Other outreach activities

The ACT-consortium, and mainly the ACT coordinator and the ACT WP-leads have been very active with information about ACT at various national and International meetings and conferences. ACT became only few months after kick-off in February 2016 a well-known tradename for transnational funding and knowledge sharing within the CCUS domain. Since then, it has maintained its brand name and has managed to enhance its impact and solidify its scope by broadening its partners' network and activities to include more European members and also members from around the globe, the US, Canada, and India.

ACT has organised and participated in numerous webinars, workshops, summer schools, seminars, conferences and graduate courses presenting their views and findings. In addition, ACT has participated in various Committees and Open consultations in national parliaments as well as the European Parliament to present and discuss strategies for contributing to combatting climate change. Finally, ACT projects have also prepared public science versions of their findings in video, poster, and flyers in order to be able to convey key messages efficiently and convincingly to broad audiences apart from specialised and focused reports, publications, posters etc.

## Final reports from ACT1-projects

The ACT1 projects were completed at the end of 2020, and the final reports are listed below

- Final report from ACORN [Download](#)
- Final report from ALIGN [Download](#)
- Final report from DETECT [Download](#)
- Final report from ECOBASE [Download](#)
- Final report from ELEGANCY [Download](#)
- Final report from GaSTech [Download](#)
- Final report from Pre-ACT [Download](#)
- Final report from 3d-CAPS [Download](#)

## Deliverables from WP5:

D5.1: ACT website, submitted 31.03.2016

D5.2: Database with projects results, submitted 31.01.2018

D5.3: Evaluation report on Communication, due 30.11.2021

D5.4: Communication plan, submitted 07.05.2016

D5.6: Plan for knowledge sharing workshops, submitted 20.07.2016

Learnings from WP5 Communication:

- A dynamic website, being constantly updated with feedback from projects has been key in maintaining a centralised and detailed platform and representation of ACT, accessible to everyone.
- A diversified strategy of communication of key results and future challenges has been successful with the employment of various means of dissemination, such as social media, the web, email lists, matchmaking section, written and audio-visual materials, attendance to events addressed to various audiences and in different countries
- Careful planning and good attendance of Knowledge Sharing Workshops as well as efficient post dissemination of the work presented in these successful events has been catalyst in the ACT progress and the excellent communication and collaborative spirit amongst partners, funders, experts and the broad public.

**WP6: Second and third calls**

This WP has been led by PtJ and developed in close collaboration with the rest of the consortium and new partners involved in the respective calls. The main persons involved from PtJ have been Heiko Gerhauer, Annette Weiß and Hannes Stadler.

**The second ACT call (ACT2)** was launched 4 June 2018.

The ACT Consortium received 47 pre-proposals and these were assessed by the ACT consortium funding partners (some also used external experts at this stage), and invited 27 to submit full proposal. We received 26 full proposals which were independently evaluated and ranked by external CCUS experts. Based on this evaluation, the ACT Consortium chose 12 projects for funding (following the ranking list).

The total budget for these projects is approx. 44M€ of which approx. 32M€ requested from the ACT funding organisations. Several of the project have good industry involvement and both cash and in-kind contributions from them.

Projects	Activities	ACT, M€	France	Germany	Greece	Netherlands	Norway	Romania	Spain	Switzerland	Turkey	UK	USA
AC2COM	Oxyfuel technology in Cement production	3,0	x	x	x		x			x			
ACTOM	Offshore Monitoring	1,5				x	x					x	x
ANICA	Carbonate Looping Process in cement industry	2,4		x	x							x	
DIGIMON	Digital Monitoring of CO2 storage projects	5,0		x	x	x	x	x				x	x
FUNMIN	CO2 mineralisation into anhydrous MgCO3	0,7	x						x			x	
LAUNCH	CO2 capture in various industries	5,1		x		x	x					x	x
MemCCSea	Membrane systems for CO2 capture and storage at sea	1,7		x	x		x						x
NEWEST-CCS	Negative Emissions in the Waste to Energy Sector	2,2		x		x	x					x	
PRISMA	Sorbent Materials for energy efficient carbon capture	2,1					x			x		x	x
REX-CO2	Reusing existing wells for CO2 storage	2,5	x			x	x	x				x	x
SENSE	CO2 storage sites - ground surface monitoring	2,7	x	x			x		x			x	x
SUCCEED	CO2 storage Coupled with geothermal Energy Deployment	2,5				x					x	x	

The third ACT call (ACT3) was launched in June 2020.

From the ACT3-call we received 91 pre-proposals and after the assessment of these projects by the consortium members a total of 37 applicants were invited to submit full proposals by mid-March 2021. The table below shows the 13 projects selected for funding, and they are being kicked off October/November 2021.

Project	Activities	Alberta	Denmark	France	Germany	Greece	India	Italy	Netherlands	Nordic	Norway	Romania	Switzerland	Turkey	UK	USA
ABSALT	Solid adsorption looping technology				x	x		x					x		X	
ACTION	CCS Networks	x		x					x			x			X	x
CEMENTTEGRITY	Well integrity and cementing								x		X				x	
CoCaCO2La	Converting CO <sub>2</sub> to Ethylene					x									X	x
CooCE	Convert CO <sub>2</sub> to biofuels and chemicals		x			x		x							x	
CREATE	Conversion of CO <sub>2</sub> from cement plant	X		x									x			
ENSURE	Microseismic monitoring	x		x							X				(x)	(x)
EverLoNG	Ship-based CO <sub>2</sub> capture				x				X		x				x	x
LOUISE	Chemical looping combustion (CLC)				X	x					x			x		
NEXTCCUS	Convert CO <sub>2</sub> to methanol			x		x		X				x			x	x
RETURN	CO <sub>2</sub> storage in depleted reservoirs	x			x				x		X				x	
SCOPE	CO <sub>2</sub> capture				x		x		x		X				x	x
SHARP	Storage risk reduction		x				x		x		X				x	

The total budget of the 13 projects is 46M€ of which ~30M€ is funded by the ACT Consortium partners, approx. 3M€ is private financing (the majority comes from industry partners) and the in-kind contribution to these projects is approx. 13 M€ in total.

A short summary of each project is available at the act-webpage [here](#)

#### Deliverables from WP6:

- D6.1: Memorandum of understanding (MoU) for ACT 2nd Call, submitted 29.06.2018
- D6.2: Call text, guidelines and evaluation criteria, ACT 2nd Call, 01.07.2018
- D6.3: List of submitted pre-proposals ACT 2nd call in June 2018, 29.10.2018
- D6.4: List of submitted proposals, stage 2 – ACT second call, 01.05.2019
- D6.5: List of external experts - ACT 2, 29.10.2018
- D6.6: List of Stage 1 Successful Projects ACT second call, 10.12.2018
- D6.7: Stage 1 Applicant Notifications, ACT second call, 10.12.2018
- D6.8: Transnational summary selection report, ACT2, 22.07.2019
- D6.9: Stage 2 Applicant Notifications, ACT2, 22.07.2019
- D6.10: Ranking list after 2nd stage evaluation in 2nd ACT call, 22.07.2019
- D6.11: : List of projects to be funded after the second call, ACT2, 22.07.2019
- D6.12: Report from the observer on the evaluation - ACT2, 22.07.2019
- D6.13: Letters of commitment for funding ACT2 projects, 24.09.2019
- D6.14: Evaluation report ACT2 projects, 22.07.2019
- D6.15: Annual progress report, after 2nd ACT call, 23.02.2020

Learnings from WP6:

- The two calls were very successful and overall the call text has been proven fit for purpose. There are differences between the countries in terms of what type of research is preferred, both in terms of the technical specifics, such as allowing air capture, and in terms of the technology readiness level. This was largely dealt with well through national annexes.
- Even so, there was some confusion among applications regarding the acceptability of projects with low aimed for technology readiness levels. This should be clearer in future calls.

## WP7: Related activities

The leader of WP7 is Partner 4, UEFISCDI (Romania) and support from all partners.

The main person from UEFISCDI has been Nicoleta Dumitrache.

This WP aimed at implementing cross-cutting, topical additional activities for transnational- and national research projects. These activities are a systemic approach to foster the development of CCS by providing to research program owners and managers relevant information on CCS research initiatives and networking, evaluating progress and results. This WP has provided input to other WPs with regard to strategic knowledge and information on projects.

The purpose of this WP was to provide a formal planning document for cooperation with relevant bodies and key decision makers both at national and European level: researchers, academics, industrials, policy makers and the general public in order to share knowledge and to foster the development of CCUS.

### Collaboration with CCUS initiatives outside ACT

ACT has been in close interaction with several European CCS RD&D activities and outside, in order to align with and strengthen the Europe's main research program owners and managers ties to related CCS activities. The result of this is that all ACT1-funders have continued to support ACT (in the second and third call and taken part in funding high quality projects even without the EC cofund).

Moreover, the ACT coordinator and several of the ACT funding partners have been active in collaboration and interaction with other **CCUS initiatives** both at national and at international levels. Many presentations have been given focusing on who we are, what we do and what we have achieved and results from projects. Hence, focus on research and innovation process, funding and knowledge sharing have been pointed out and results achieved shared with a broader audience.

Academic and other research institutions such as EERA JP CCS, CCS-Association, ZEP, Club-CO<sub>2</sub>, CO<sub>2</sub>GeoNet have been targeted stakeholders and discussion groups – some of them on a continuous and annual basis since 2016, some even more frequently visited. Likewise have ACT members presented ACT results and achievements to the SET Plan Implementation working group for Action 9 (CCUS) on a yearly basis.

In addition, workshop(s) together with **pilot projects and demonstration projects** with the intention to make ACT funded research relevant for pilot and demonstration activities have been carried out. An example here is the ACT knowledge sharing workshop at the power station RWE in Niederaußem, Germany in 2018 where a guided tour throughout the plant and more detailed information about their CCU work was presented.

Another example is the interaction with Mr. Hans Wassenaar from AVR (Netherlands) at the 4<sup>th</sup> ACT knowledge sharing workshop. AVR operates the world's largest installation for CO<sub>2</sub> capture at a waste incinerator.

ACT has also succeeded in reached out to **overseas CCUS initiatives/bodies** with the intention to strengthen R&D collaboration with key stakeholders outside Europe. The result of this is that US-Department of Energy (US-DOE) joined ACT in 2018, The Emission Reduction Alberta (ERA) joined in 2019 and The Department of Science and Technology (DST), India joined in 2020. US-DOE has taken part in both the second and third ACT calls, whereas ERA and DST have been in the third ACT call.

Through the collaboration with US-DOE and some of the ACT1-funding partners, the ACT group has stood up as a relevant and practical initiative for the Mission innovation.

In the first ACT call, the research priorities were linked to the SET Plan Implementation goals, whereas the Mission innovation Research priorities were included in addition to the SET Plan goals for Action 9 (CCUS) in the second and third ACT calls.

ACT has taken the initiative to arrange workshops where all ACT-partners and ACT funded projects were present together with other stakeholders such as EC representatives and industry. But also, the ACT funded projects have been encouraged to arrange workshops and meetings with the aim to present and align results with industry requirements for R&D to support their CCUS deployment. Knowledge sharing workshops

The ACT consortium has since its start had a strong believe and focus on sharing knowledge. Let projects meet each other and the ACT funders and other relevant stakeholders with the aim of an open and trustful manner share knowledge within the CCUS domain.

### Knowledge sharing workshops

Five Knowledge Sharing Workshops have been held under ACT.

The first took place 14 November 2016 in Lausanne (Switzerland) in conjunction with the IEAGHG-conference. The second was held 24<sup>th</sup> and 25<sup>th</sup> October 2017 in Bucharest (Romania). The third workshop took place on 13 November 2018 in Niederaußem (Germany) at the facilities of RWE (Rheinisch-Westfälisches Elektrizitätswerk power plant). The fourth workshop took place in Athens (Greece) on the 6<sup>th</sup> and 7<sup>th</sup> November 2019 and the fifth workshop was undertaken virtually (due to covid-19) on the 16<sup>th</sup> and 17<sup>th</sup> November 2020.

The sixth workshop was planned on 23 and 24<sup>th</sup> November in connection with the high-level CCUS conference in Rotterdam (Netherlands). This workshop is a collaboration between CATO, the Norwegian Embassy in The Hague, the Ministry of Economic Affairs and Climate Policy and ACT where we jointly organize a two-day CCUS conference in which the development, challenges, and opportunities for CCUS in Europe's fight against climate change will be discussed. However, due to the sharp increase in Covid-19 infection rates, this meeting has been postponed.

The ACT consortium has organised these events with the aim to ensure fruitful knowledge sharing and increase collaboration between all the ACT funded projects and other CCUS initiatives.

In terms of funding schemes/other initiatives, ACT worked towards improving procedures and re-acting to challenges; updating procedures according to improvements needed (catching up with the processes of USA or Canada, analysing learnings from one call to another). Changes were done from one call to the other in order to ease the submission/evaluation processes, taking into consideration the observations from the funding agencies, but also by dedicating time in a workshop to freely discuss next calls and how the applicants saw the process from the outside, and could take into consideration improvements suggested by the applicants.

The most important actors in ACT workshops were the funded projects: the collaboration between ACT and funded projects, the opportunity of ACT projects to learn more about other initiatives, but also the collaboration between one ACT funded project and other ACT funded projects. ACT tried to intensify sharing knowledge between projects and within the workshop dedicated time and organised sessions designed for asking questions and finding possible common directions.

The presence and involvement of ACT funders in monitoring and at the annual meetings of projects also contributed to the success of these workshops. Getting to know projects more in depth, constantly following the activities carried/to be carried, helped in designing the workshop and inviting the appropriate key speakers.

In the end, organising annual workshops helped intensifying collaboration between funding agencies and funded projects, helped promoting ACT activities with other relevant initiatives and learn/improve activities based on all findings.

The workshops have been hosted by the ACT funding partners in that country for the event, but with a good inputs and assistance from all ACT-partners.

From each ACT-knowledge sharing workshops a report/deliverable has been submitted via the EC portal and are publicly available at the ACT-website:

- 2016 Lausanne, Switzerland – report [here](#)
- 2017 Bucharest, Romania - report [here](#)
- 2018 Niederaußem, Germany - report [here](#)
- 2019 Athens, Greece - report [here](#)
- 2020 Virtual - report [here](#)
- 2021 Rotterdam, Netherlands (In-person/on-line) – draft program here. The event is postponed until spring 2022 due to the dramatically changed Covid situation in the Netherlands and other countries.

#### Deliverables from WP7:

D7.1: Plan for cooperation with relevant organisations, submitted 25.04.2016

D7.2: Evaluation report on cooperation with relevant organisations, due 30.11.2021

D7.3. Summary Report on the 1st Knowledge sharing workshop (in 2016), submitted 05.01.2017

D7.4: Summary Report 2nd Knowledge sharing workshop (in 2017), 31.01.2018

D7.5: Summary Report 3rd Knowledge sharing workshop (in 2018), 31.01.2019

D7.6: Summary Report 4th Knowledge sharing workshop (in 2019), 23.03.2020

D7.7: Summary Report 5th Knowledge sharing workshop (in 2020), 22.01.2021

#### Learnings from WP7:

After organising all these events, and attending many CCUS-meetings and conferences, our major learnings are:

- A solid understanding of the research and innovation space in Europe helps focus on application-driven research needs by an emerging commercial sector.
- The ACT-initiative has been a highly efficient catalyst for information about funding opportunities and to match industry needs with research & innovation capabilities and sharing results of mutual interest.



- Positioning of the funding mechanism has defined the level of collaborative/cooperative versus targeted solicitation of the research & innovation community.
- All funding schemes emphasize the value of a deep knowledge of the research and innovation space of CCS technologies.
- Contracts are multi-faceted and require time to formulate and execute. Reporting is «manifold» and commensurate with TRL’s.
- The provision of a platform (annual reviews) for dissemination is highly effective, also to engage stakeholders outside-of-Europe.
- ACT worked continuously towards knowing and sharing information both on funding schemes/other initiatives and results in terms of funded projects and calls.

Several projects have been eager to collaborate with other ACT-funded projects, examples below:

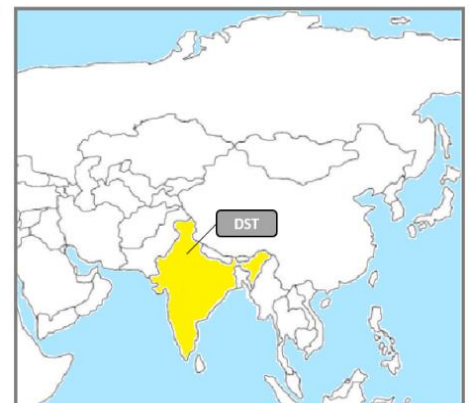
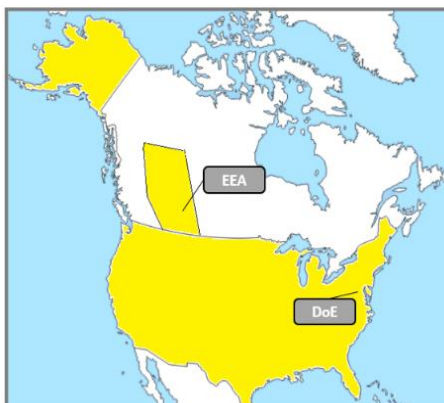
- ACT1 projects collaborated on an event in September 2019 with participants from the EC and other stakeholders on results from CO2-storage.
- ACT1 and ACT2 projects are in Autumn 2021 collaborating on planning a workshop on CO2-storage monitoring issues. The aim is to discuss findings in more details and in the larger context of CCS monitoring with relevant industry (e.g., Equinor, Shell, Total, others) deploying these methods, and other research projects.



A number of other events (conferences, meetings, workshops), locally and internationally during the implementation of the project) were important venues for the ACT consortium members to attend and meet possible target audiences.

## 5. Extension of the consortium

ACT is an international initiative based on the Horizon 2020 European Commission funding scheme. Nine European countries started this collaboration in 2015. The first Call for projects took place in 2016. Since then, ACT has expanded its collaboration within and beyond Europe, with USA and Canada/Alberta Region





and India included in the consortium.

Since December 2020, ACT has 16 countries/regions participating – these are:

Canada/Alberta region (ERA), Denmark (EUDP), France (ADEME), Germany (Jülich, FZJ/PtJ), Greece (GSRI), India (DST), Italy (MUIR), the Netherlands (RVO), Norway (RCN and Gassnova), the Nordic Region (NER), Romania (UEFISCDI), Spain (AEI), Switzerland (DETEC), Turkey (TUBITAK), UK (BEIS), and the USA (DoE). The Research Council of Norway (RCN) is coordinating ACT.

By the extension of the consortium, we have also managed to become a vital instrument for Mission Innovation targets for CCU/CCS research and development.

#### Learnings from extension of a consortium outside Europe:

- Expanding ACT beyond Europe has been a very positive experience.
- The new partners from USA, Canada, and India are highly competent and skilled and they have active CCUS R&D communities that link up with European R&D partners. Their contributions to the ACT2 and ACT3 calls have resulted in high quality ACT2 and ACT3 projects where the partners outside Europe contribute with state-of-the-art competence.
- A challenge has been for projects to establish consortium agreements (CA).
- In ACT1 all project based their CA on the DESCAs model which is a template based on European law and culture. The DESCAs model does not work well in projects with partners outside Europe. Many ACT2 and ACT3 project have had big challenges getting their CA signed by all partners, which in some cases has led to delay of kick off meetings and also a bit frustration.
- Several of the CCUS-scientific communities in Europe have asked the ACT coordinator and expressed clearly that they wish US will open up for other than only the National Labs for participating in ACT-projects with funds from DOE.

## 6. Socio-economic impact

Socio-economic issues were included in many of the ACT-1 projects and in several of the ACT2 projects as well. During the ACT-1 operation period, the researchers working on the socio-economic issues related to CCUS also formed a group to discuss their progress and how their results were communicated to the public and stakeholders in general.

The ALIGN-CCUS project had a significant work package on social acceptability of CCUS, with several deliverables looking into the details in various countries, please use [this link](#). ALIGN-CCUS also led the working group on social acceptance within ACT1.

The ACT2 project ACTOM has a goal to help regulators and operators to communicate to the effectiveness of proposed monitoring strategies to enable informed societal consensus in view of marine spatial planning, and the DIGIMON project is developing guidelines for the societal embeddedness level related to CCS monitoring, see news and publications [here](#).

## 7. Gender balance

The ACT group has paid attention to the gender balance and addressed this as a principal issue also in the calls for proposals. Even though the CCUS community is dominated by male candidates, several of the projects being funded by ACT have female project leaders (insert numbers 18 out of 33 projects). but

even so the projects consortia have a better gender balance – in the sense that several of the WP-leaders are female.

In the ACT management group, the coordinator and 4 of the 7 WPs-leaders are 4 females (of which one male was substituted by a female last year). Among the full ACT-consortium member list we have 24 females out of a total of 42 representatives from the funding agencies.

Of the **ACT-experts** we have seen an improvement in the share of female candidates. This is also because we paid seriously attention to this after the mid-term review of ACT and the ACT1-observer stating that we should do better on this issue.

- ACT1-experts: 1 female out of 12 external experts in the panel
  - ACT1- Mid-term review experts: 2 out of 4 experts
- ACT2-experts: 6 females out of 11 external experts
  - ACT2-mid-term review experts: 2 females out of 5 experts
- ACT3-experts: 11 females out of 23 experts

The **ACT-projects** organises themselves, and the ACT-funders have no direct influence on how this is being done and carried out in terms of gender balance. However, we actively encourage them to take the gender balance into consideration when establishing the consortium and distributing the WPs and tasks.

The Call text mentions that the gender balance is an evaluation criterion. Of the ACT1-projects one out of eight project leaders, of the ACT2-projects only 1 female out of 12 project leaders, and finally the ACT3-projects scores much better – here we have 7 females out of 13 projects leaders.

## 8. SET Plan Implementation plan, Action 9

In 2016, the European Commission, the SET-Plan countries and industry agreed on 10 of ambitious targets for Action 9, outlined in a Declaration of Interest ([DoI](#)). In 2017, the IWG9 elaborated the [Implementation Plan](#) of Action 9 that presents 8 Research and Innovation Activities to reach the DoI targets for 2020 and further actions to meet Key Performance Indicators for 2030.

The SET-Plan aims at accelerating the development and deployment of low-carbon technologies, through cooperation amongst EU countries, companies, research institutions, and the EU itself. One of these actions is dedicated to CCUS, the Action 9. **A recently updated version of the CCUS roadmap is here [Roadmap to 2030 \(ccus-setplan.eu\)](#).** This roadmap aims to identify and stress the actions that will be necessary for the large-scale development and deployment of CCS and CCU in the 2020s, build on the work done within the CCUS SET-Plan, and provide an overview of the status of the technologies today. The roadmap also includes a list of actions to be taken by European and national policymakers to underpin the European development of CCS and CCU.

The ACT consortium has funded several CCUS projects which are in line with the SET Plan Implementation plan targets - as shown in the table below.

SET Plan Targets (2030) (summarized)	ACT1 projects	ACT2 projects	ACT3 projects
Delivery of 15 commercial-scale CCS projects linked to industrial sources	ALIGN, ELEGANCY	LAUNCH	ABSALT, ENSURE, SCOPE

Delivery of 10 commercial-scale CCS project for clean flexible power and heat	ALIGN	LAUNCH	ABSALT, ENSURE, SCOPE
SET Plan countries have roadmaps for dedicated CO2 transport infrastructure for the EU Ten-Year Network Development Plan.	ALIGN, ELEGANCY	0	ACTION
10 additional EU Projects of Common Interest for CO2 transport infrastructure	ACORN, ECOBASE	0	0
Inventory of geological storage capacity	0	0	0
CO2 capture pilots for different industrial and climate-neutral applications, TRL 7-8 and TRL 5-6	GasTECH, 3D-Caps	LAUNCH, NEWEST-CCS, ANICA, EC2OCEM, PRISMA, MEMCCSEA	ABSALT, EverLoNG
6 New storage sites in preparation or operating by 2030, in different settings	Pre-ACT, DETECT, ECOBASE	SUCCEED, DIGIMON, ACTOM, REX-CO2, SENSE	RETURN, SHARP, CEMENTTEGRITY
Several CCU demonstration installations for fuels and chemicals based on CO2	ALIGN	FUNMIN	CoCaCO2La, CooCE, CREATE, LOUISE, NEXTCCUS
By 2030, first large-scale commercial CCU installations, supported by regulatory framework			CREATE, LOUISE
All European countries have identified the role of CCS/CCU in meeting climate neutrality by 2050	All	All	All

## 9. Mission innovation research targets

The two last ACT calls, have in addition to focusing on SET plan issues, also addressed the Mission Innovation research priorities. The CCUS Mission was initially led by the United States and Saudi Arabia, and the United Kingdom and Saudi Arabia took over the Chair role in 2019. The CCUS Mission had the following Participants: Australia, Canada, China, Denmark, European Commission, Finland, France, Germany, India, Indonesia, Italy, Japan, Mexico, Netherlands, Norway, Republic of Korea, Saudi Arabia, Sweden, United Arab Emirates, United Kingdom and United States.

The CCUS Mission released a report in May 2018 which outlined 30 priority research directions (PRDs) to guide future CCUS RD&D. ACT projects are in alignment with these PRDs as shown in the following table.

CCUS Mission PRDs	ACT 1 Projects	ACT 2 Projects	ACT 3 Projects
<b>Carbon Capture</b>			
Designing high-performance solvents for CO2 capture		LAUNCH	
Creating environmentally friendly solvent processes for CO2 capture		LAUNCH, NEWEST-CCUS	
Designing tailor-made sorbent materials	3D-CAPS	PRiSMa	ABSALT
Integrating sorbent materials and processes	3D-CAPS	PRiSMa	ABSALT
Understanding transport phenomena in membrane materials		MemCCSea	
Designing membrane system architectures		MemCCSea, NEWEST-CCUS	
Catapulting combustion into the future		NEWEST-CCUS, ANICA, AC2OCEM	LOUISE

Producing hydrogen from fossil fuels with CO2 capture			
<b>Utilization</b>			
Designing complex interfaces for enhanced hydrocarbon recovery with carbon storage			
Valorizing CO2 by breakthrough catalytic transformations into fuels and chemicals			
Creating new routes to carbon-based functional materials from CO2			
Designing and controlling molecular-scale interactions for electrochemical and photochemical conversion of CO2			CoCaCO2La, NEXTCCUS
Harnessing multiscale phenomena for high-performance electrochemical and photochemical transformation of CO2			CoCaCO2La, NEXTCCUS
Accelerating carbon mineralization by harnessing the complexity of solid-liquid interfaces		FUNMIN	
Tailoring materials properties to enable carbon storage in products			CREATE
Tailoring microbial and bioinspired approaches to CO2 conversion			
Hybridizing electrochemical and biological processes for CO2 conversion to fuels, chemicals, and nutrients			
<b>Storage</b>			
Advancing Multiphysics and multiscale fluid flow to achieve gigatonne/year capacity			
Understanding dynamic pressure limits for gigatonne-scale CO2 injection			
Optimizing injection of CO2 by control of the near-well environment			
Developing smart convergence monitoring to demonstrate containment and enable storage site closure		SENSE, ACTOM, DIGIMON	ENSURE
Realizing smart monitoring to assess anomalies and provide assurance		SENSE, ACTOM, DIGIMON	
Improving characterization of fault and fracture systems	DETECT		
Achieving next generation seismic risk forecasting		DIGIMON	
Locating, evaluating, and remediating existing and abandoned wells		REX-CO2	
Establishing, demonstrating, and forecasting well integrity			CEMENTTEGRITY
<b>Crosscutting</b>			
Integrating experiment, simulation, and machine learning across multiple length scales to guide materials discovery and process development		PRiSMa	
Coupling basic science and engineering for intensified carbon capture, purification, transport, utilization, and storage processes			SCOPE
Incorporating social aspects into decision-making			
Developing tools to integrate life cycle techno-economic, environmental, and social considerations to guide technology portfolio optimization			

In November 2021, Mission Innovation launched several new Missions, one of which is on carbon dioxide removal (CDR). In the future, this new mission may provide opportunities to leverage collaborative funding mechanisms such as ACT since several partners of the mission are also ACT consortium members.

## 10. Financial overview

The max. granted amount to ACT from EC was based on the following figures:

- Estimated project costs: 38.507.310,59 EUR
- Requested EC contribution: 11.889.929,23 EUR (30,88 % of total eligible national funds)
  - of which: 538.312,50 EUR (the total amount of Unit Costs)
- Payment from EC, February 2016: 640.715,63 EUR
- Payment from EC, December 2017: 8.997.416,39 (for the first payment to projects).

The remaining funds is expected to be transferred from EC to RCN when the final budget for the projects and ACT-eligible costs are reported and the balance calculated and approved by the EC. This is expected to be completed early 2022.

## 11. List of deliverables

The table below shows the full list of deliverables from ACT provided from February 2016 - November 2021. Many of the deliverables are Confidential (meaning they are only for members of the consortium and the Commission Services) whereas some of them, for obvious reasons, are public. The public ones have been updated at the ACT-webpage as soon as they were provided and submitted to the EC.

Deliverables to EC from ACT										
WP No	Del. Rel. No	Del No	Title	Description	Lead Beneficiary	Dissemination Level	Est. Del. Date (annex I)	Receipt Date	Approval Date	Status
WP1	D1.1	D1	Consortium agreement	At the outset of the	RCN	Confidential *)	29 Feb 2016	02 Apr 2016	14 Mar 2021	Approved
WP1	D1.2	D2	Short annual progress reports to the consortium	Short annual report	RCN	Confidential	31 Jan 2017	31 Jan 2017	14 Mar 2021	Approved
WP1	D1.3	D3	Reports to EC	Reports with a mor	RCN	Confidential	30 Apr 2017	21 Jun 2017	14 Mar 2021	Approved
WP1	D1.4	D4	Final report	A final report descr	RCN	Confidential	31 Jan 2021	30.11.2021		Pending
WP1	D1.5	D50	Information on Cumulative expenditure	Report on cumulat	RCN	Confidential	31 Jan 2017	31 Jan 2017	14 Mar 2021	Approved
WP1	D1.6	D52	Information on cum.exp. 2016	Information on cum	RCN	Confidential	31 Dec 2016	30 Nov 2016		Submitted
WP1	D1.7	D53	Information on cum.exp. 2017	Information on cum	RCN	Confidential	31 Dec 2017	08 Jan 2018		Submitted
WP1	D1.8	D54	Information on cum.exp. 2018	Information on cum	RCN	Confidential	31 Dec 2018	11 Jan 2019		Submitted
WP1	D1.9	D55	Information on cum.exp. 2019	Information on cum	RCN	Confidential	31 Dec 2019	02 Jan 2020		Submitted
WP1	D1.10	D56	Information on cum.exp. 2020	Information on cum	RCN	Confidential	31 Dec 2020	16 Dec 2020		Submitted
WP2	D2.1	D5	Guidelines for first joint call	The procedural det	Jülich	Public	30 Apr 2016	02 May 2016		Submitted
WP2	D2.2	D6	Evaluation criteria for first joint call	The selection of pr	Jülich	Public	30 Apr 2016	04 May 2016		Submitted
WP2	D2.3	D7	Call text for first joint call	Call text will be de	Jülich	Public	31 May 2016	02 Jun 2016		Submitted
WP2	D2.4	D8	List of submitted proposals to Stage 1	A list of submitte	Jülich	Confidential	30 Sep 2016	22 Sep 2016		Submitted
WP2	D2.5	D9	List of submitted proposals to Stage 2	A list of submitte	Jülich	Confidential	31 Jan 2017	31 Jan 2017	14 Mar 2021	Approved
WP3	D3.1	D10	List of Independent Experts - Stage 2 Evaluation	Stage 1 evaluation	BEIS	Confidential	30 Jun 2016	01 Jul 2016		Submitted
WP3	D3.2	D11	List of Stage 1 Evaluation - Successful Projects	Following partners	BEIS	Confidential	30 Sep 2016	04 Oct 2016		Submitted
WP3	D3.3	D12	Applicant notification - Stage 1	All applicants, whe	BEIS	Confidential	30 Sep 2016	04 Oct 2016		Submitted
WP3	D3.4	D13	Transnational Project Selection Summary Report	A short transnation	BEIS	Confidential	31 Mar 2017	10 May 2017		Submitted
WP3	D3.5	D14	Stage 2 Applicant Notification, including evaluation	Following the seco	BEIS	Confidential	31 Mar 2017	10 May 2017		Submitted
WP3	D3.6	D15	Ranking list - after Stage 2 evaluation	The WP3 lead will	BEIS	Confidential	31 Mar 2017	25 Apr 2017	07 Jun 2017	Approved
WP3	D3.7	D16	List of project to be funded	Using the ranking li	BEIS	Public	31 Jul 2017	31 Aug 2017		Submitted
WP3	D3.8	D17	Observers report on the evaluation	For transparency it	BEIS	Confidential	31 Jul 2017	06 Jul 2017		Submitted
WP3	D3.9	D18	Commitment letters for funding the Cofunded projects	The Call Secretaria	BEIS	Confidential	31 Jul 2017	18 Oct 2017		Submitted
WP3	D3.10	D19	Evaluation report - compulsory deliverable	FZI/PTJ will lead on	BEIS	Confidential	30 Sep 2017	08 Jan 2018		Submitted
WP4	D4.1	D20	Monitoring procedures	The monitoring pro	RVO	Confidential	30 Nov 2016	25 Nov 2016		Submitted
WP4	D4.2	D21	Template for Grant Agreement	The template for th	RVO	Confidential	31 Jan 2017	13 Feb 2017		Submitted
WP4	D4.3	D22	Annual progress reports	Annual reports from	RVO	Confidential	31 Jan 2018	23 Mar 2018		Submitted
WP4	D4.4	D23	Final evaluation report - project results	The final evaluation	RVO	Public	31 Jan 2021	30.11.2021		Pending
WP5	D5.1	D25	ACT Website	The ACT Website v	RCN	Public	30 Apr 2016	02 Apr 2016	14 Mar 2021	Approved
WP5	D5.2	D26	Database with ACT results on the web	The website will co	RCN	Public	31 Jan 2018	31 Jan 2018		Submitted
WP5	D5.3	D27	Evaluation report on results of communication and	It is of absolute ne	RCN	Public	31 Jan 2021	30.11.2021		Pending
WP5	D5.4	D24	Communication plan	Communication, dis	RCN	Public	30 Apr 2016	07 May 2016		Submitted
WP5	D5.5	D51	Plan for knowledge sharing workshops	In close dialogue w	RCN	Confidential	31 Jul 2016	20 Jul 2016		Submitted
WP6	D6.1	D28	MoU for additional calls	MoUs for the addit	Jülich	Confidential	31 Oct 2017	01 Jul 2018		Submitted
WP6	D6.2	D29	Call text, guidelines and evaluation criteria for ad	Call text and the gu	Jülich	Public	31 May 2018	05 Jul 2018		Submitted
WP6	D6.3	D30	List of submitted proposals, stage 1	A list of submitted	Jülich	Confidential	30 Sep 2018	29 Oct 2018		Submitted
WP6	D6.4	D31	List of submitted proposals, stage 2	A list of proposa	Jülich	Confidential	31 Jan 2019	03 May 2019		Submitted
WP6	D6.5	D32	List of Independent Experts for Stage 2 Evaluation	The lists of indepe	BEIS	Confidential	30 Jun 2018	29 Oct 2018		Submitted
WP6	D6.6	D33	List of Stage 1 Successful Projects	List of pre-proposa	BEIS	Confidential	30 Sep 2018	10 Dec 2018		Submitted
WP6	D6.7	D34	Stage 1 Applicant Notification	Stage 1 Applicant n	BEIS	Confidential	30 Sep 2018	10 Dec 2018		Submitted
WP6	D6.8	D35	Transnational Project Selection Summary Report	A summary report	BEIS	Confidential	28 Feb 2019	22 Jul 2019		Submitted
WP6	D6.9	D36	Stage 2 Applicant Notification	Invitation to applic	BEIS	Confidential	28 Feb 2019	22 Jul 2019		Submitted
WP6	D6.10	D37	Ranking list after 2nd stage evaluation	The ranking list of	BEIS	Confidential	28 Feb 2019	22 Jul 2019		Submitted
WP6	D6.11	D38	List of projects to be funded after the 2nd and 3rd	For the 2nd and 3r	BEIS	Public	31 Mar 2019	22 Jul 2019		Submitted
WP6	D6.12	D39	Report from observers on the evaluation	Observers report t	BEIS	Confidential	31 Mar 2019	22 Jul 2019		Submitted
WP6	D6.13	D40	Commitment letters for funding the projects	Projects to be fund	BEIS	Confidential	31 May 2019	25 Sep 2019		Submitted
WP6	D6.14	D41	Evaluation Report	Evaluation report f	BEIS	Confidential	31 May 2019	22 Jul 2019		Submitted
WP6	D6.15	D42	Annual progress reports after Call 2 and 3	Progress reports fr	RVO	Confidential	31 Jan 2020	24 Mar 2020		Submitted
WP7	D7.1	D43	Plan for cooperation with relevant organisations	The deliverable wil	UEFISCDI	Confidential	31 Mar 2016	25 Apr 2016		Submitted
WP7	D7.2	D44	Evaluation report on cooperation with relevant or	This deliverable wil	UEFISCDI	Confidential	31 Jan 2021	30.nov.21		Pending
WP7	D7.3	D45	Report from KSW **) 2016	The first workshop	DETEC	Public	31 Jan 2017	05 Jan 2017		Submitted
WP7	D7.4	D46	Report from KSW 2017	The second dissert	UEFISCDI	Public	30 Apr 2018	31 Jan 2018		Submitted
WP7	D7.5	D47	Report from KSW 2018	For the 3rd worksh	MINECO	Public	30 Apr 2019	28 Jan 2019		Submitted
WP7	D7.6	D48	Report from KSW 2019	The 4th workshop	RVO	Public	30 Apr 2020	23 Mar 2020		Submitted
WP7	D7.7	D49	Report from KSW 2020	The last workshop	BEIS	Public	31 Jan 2021	22 Feb 2021	14 Mar 2021	Approved

\*) Confidential = Confidential, only for members of the consortium (including the Commission Services)

\*\*) KSW = Knowledge sharing workshop

## 12. Lessons learned

All projects are incredibly happy to have been funded and to have had the opportunity to share knowledge and results with each other, learn from each other and potentially find synergies.

Project leads (and their WP leads) tell that they appreciate close interaction with their respective national funding agencies, which has been a standard way of operation in some countries.

In order to maximise the progress and output from all ACT projects, the ACT-consortium will strengthen and improve on this point, and unify it – if possible, in all countries.

The ACT consortium is happy to have achieved so many good and promising results, not only as a well-functioning funding mechanism, but also as a provider of knowledge based on international collaboration within the CCUS domain.

### Summing up:

- We have carried out three successful calls
- ACT partners have established themselves as a powerful multilateral funding scheme for research and innovation dedicated to CCUS.
- ACT is a fit-for-purpose, partner-driven, flexible and an easy-to-join funding scheme that serves our ambition: to make CCUS a commercially viable climate mitigation technology.
- Results relevant to the industry and policy makers have been provided, and more results are under way.

## 13. Acknowledgements

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The ACT-funded projects are also thanked a lot for great work and for delivering important results to accelerate the CCUS-deployment at an international level and at scale.

We also want to thank all the external experts for having carried out the assessments of the ACT-projects during the three calls we have had.

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The report reflects only the authors' view, and the Commission is not responsible for any use that may be made of the information it contains.