

CLIMIT



# ANNUAL REPORT 2014

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## THE CLIMIT PROGRAMME

CLIMIT IS THE NORWEGIAN NATIONAL PROGRAMME FOR RESEARCH, DEVELOPMENT AND DEMONSTRATION OF TECHNOLOGIES FOR CARBON CAPTURE AND STORAGE (CCS). THE PROGRAMME COVERS THE RESEARCH COUNCIL OF NORWAY'S SUPPORT PROGRAMME FOR RESEARCH AND DEVELOPMENT (R&D PART) AND GASSNOVA'S SUPPORT FOR DEVELOPMENT AND DEMONSTRATION (THE DEMO PART).

### CLIMIT'S VISION:

ACCELERATE COMMERCIALISATION OF CCS THROUGH FINANCIAL STIMULATION OF RESEARCH DEVELOPMENT AND DEMONSTRATION OF CCS TECHNOLOGY.

#### EDITORS

Hans-Christian Vadseth  
Liv Lønne Dille  
Hans Jörg Fell

#### PHOTO

Geir Mogen  
iStock  
SINTEF  
Styrk Fjærtoft Trondsen  
Sverre Jarild

#### PRODUCTION

Design: Fete typer  
Printing: Erik Tanche Nilssen As



# MAKING A DIFFERENCE!

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CLIMIT is a unique enterprise in a global context. Norway is a world leader when it comes to supporting research within carbon capture and storage (CCS). The idea of CLIMIT therefore poses great opportunities and great responsibility for those tasked with managing these public funds on behalf of the Norwegian society.

It is rewarding to see that projects implemented with funding from CLIMIT – within both R&D and demonstration – are continuing to yield answers and insight that take us closer to solving the world's climate challenges. Because, as the International Energy Agency reminds us, CCS is the third most important climate measure for reaching the temperature goals set by the world community.

In this annual report, we have chosen to take a special look at the many skilled experts in the CLIMIT Secretariat, and the work they do to assist in developing applications and projects that are awarded funding from CLIMIT. The level and diversity of the overall expertise available to CLIMIT in its important work is impressive, not to mention their strong dedication and desire for their work to bear fruit.

One of the results you can read about in this annual report, is the work being done at Reinertsen in Trondheim, where they are testing razor-thin filters that capture CO<sub>2</sub>, while at the same time letting hydrogen through. The funding from CLIMIT has been a precondition for implementing the demonstration project. It is also a very good example of the potential upside for industrial companies that choose to contribute their own resources in such projects.

This project is just one of the multitude that makes up the CLIMIT portfolio. CLIMIT wants to fund a broad range of technologies, some of which move more quickly from testing to general use than others. However, they all have the potential to contribute in the important global struggle against climate change.

This is why CLIMIT is important, and this is why it's uplifting to see that our work is making a difference!



A handwritten signature in black ink, appearing to read 'Hans Roar Sørheim'.

**Hans Roar Sørheim**

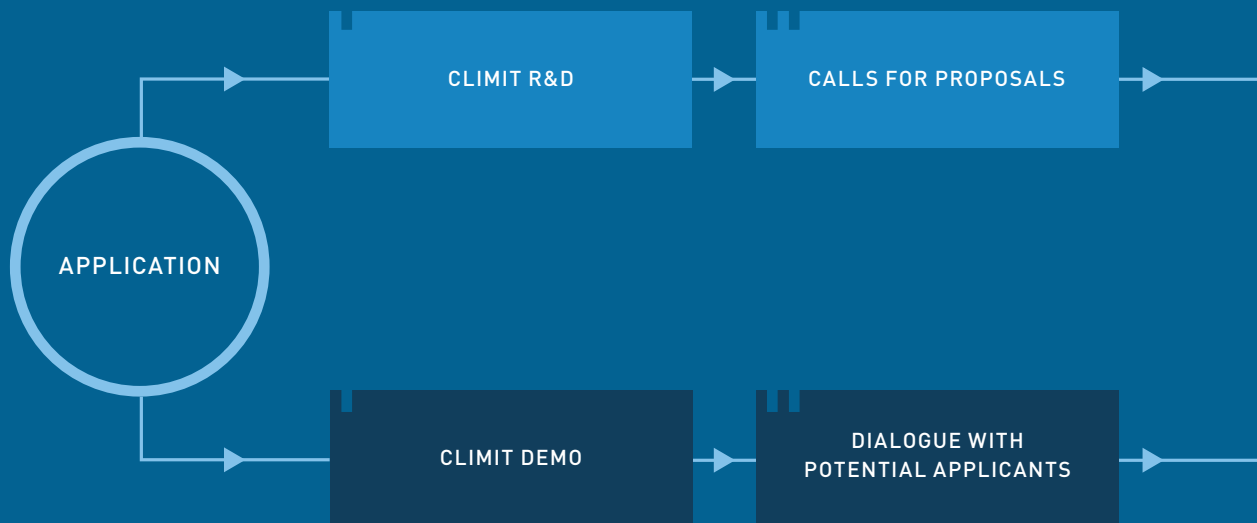
Chair of CLIMIT's programme board

# THE CLIMIT APPLICATION PROCESS

**Applications to CLIMIT R&D** are based on specific announcements and are assessed by international experts. These experts are chosen based on their experience and knowledge. A primary meeting is held, during which the applications are reviewed. The experts evaluate the scientific content of the applications, and the Secretariat assesses the applications' relevance in relation to the announcement text and the CLIMIT programme objectives. Based on results from these evaluations, the Secretariat presents a proposal to the Programme Board, which makes the final decision.

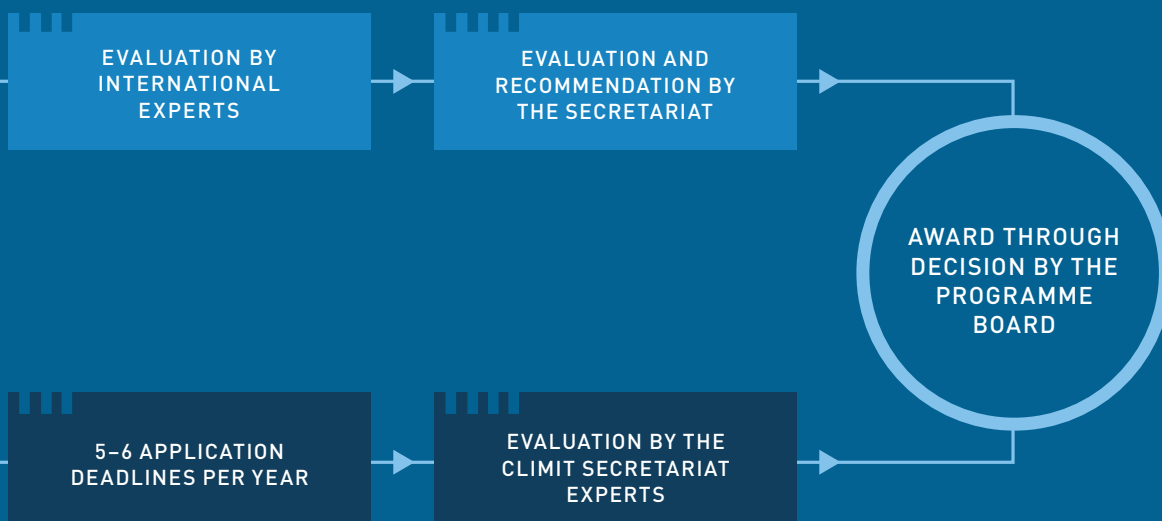
**CLIMIT-Demo** has an open announcement based on the programme plan, which refers to the programme's mandate and regulations. CLIMIT Demo applications are processed by the CLIMIT Secretariat's technical experts. A technology adviser and deputy are assigned to the application and are responsible for processing the application up to decision. The application processing involves the Leader of the Secretariat and multiple people in the CLIMIT Secretariat. Each application is thoroughly reviewed by the Secretariat's experts within technology, economics and law and regulations. Based on the result of the application processing, a proposal is presented to the Programme Board which makes the final decision. Application processing and decision normally takes about eight weeks from when the application is received.

## THE APPLICATION PROCESSES





THE CLIMIT PROGRAMME IS A COLLABORATION BETWEEN GASSNOVA SF AND THE RESEARCH COUNCIL OF NORWAY, THE RESEARCH COUNCIL IS RESPONSIBLE FOR R&D APPLICATIONS, WHILE GASSNOVA IS RESPONSIBLE FOR DEVELOPMENT, PILOT AND DEMONSTRATION PROJECTS. THE RESEARCH COUNCIL'S SPHERE OF RESPONSIBILITY IS OFTEN CALLED CLIMIT R&D, WHILE GASSNOVA'S PART IS CALLED CLIMIT DEMO.



# ON THE PATH TO THE FUTURE



CLIMIT's Programme Board, from left: Hans Jörg Fell (Leader CLIMIT secretariat), Ingar Steinsvik (observer from The Ministry of Petroleum and Energy), Eva Halland, Hans Roar Sørheim, Anita Utseth, Olav Kårstad, Marianne Holmen, Per Aagaard and Per Reidar Ørke. Not present when picture was taken: Elisabeth Rose, Kim Dam-Johansen and Nils Røkke.

## The CLIMIT Programme Board meets five times each year to process applications for both R&D and demonstration projects.

The ten board members have a couple hundred years of experience between them within industry and research. In other words, there is a lot of expertise gathered around the meeting table when CLIMIT applications are processed and approved.

“Does it feel like you’re sitting for an exam when you present the Secretariat’s proposals at the Programme Board meetings?”

CLIMIT Secretariat Leader Hans Jörg Fell smiles. “Yes and no. The Programme Board meetings are not strict and overly formal. But we obviously put out hearts and souls into preparing the cases so that all aspects are considered, and to answer any and all questions posed by the Programme Board. The objective of the Secretariat’s work is for the applications to be adequately reviewed so that the processing in the Programme Board can take place without complications or surprises for the board members.”

“Are you suggesting a rubber-stamp process?”

“No, not at all! We have good discussions in the Programme Board, and we often end up with good input for the further process. What I’m trying to say, is that we always, to the best of our ability, ensure that the pre-

parations maintain a sufficiently high level to avoid uncertainties or questions we can't answer."

The chair of the Programme Board, Hans Roar Sørheim, agrees with Fell's description.

"I've experienced a large degree of consensus between the Secretariat and Board. This is because the application processing and the Secretariat's preparations maintain a very high level of quality. We do, however, have a lot of good, important discussions on the Board. They often revolve around assessing concrete applications vis-à-vis the current strategy," says Sørheim

The activities of the CLIMIT Secretariat and Programme Board are founded in documents that set out a direction and focus areas for the years to come. The two most important documents are the CLIMIT strategy document and CLIMIT programme plan. These documents are crucial guidelines and are used extensively.

"Both changes in the landscape surrounding CLIMIT and potential changes to framework conditions by the authorities are important factors the Programme Board must be aware of," says Sørheim, and continues:

"Our work is founded on the important guidelines in our strategy documents and the programme plan. If they are to remain effective management tools, they must incorporate important trends. We are currently in a process examining whether, and potentially how, developments in our surroundings and policy frameworks create a need for updates and changes to the strategy and programme," says Sørheim.

In addition, the Programme Board is concerned with ensuring that CLIMIT has a varied and well-composed portfolio of projects at all times, and that these projects are in line with the overarching goals of the CLIMIT programme.

"It is clearly challenging to stimulate the industry side to participate in good demonstration projects. The Secretariat is very aware of this, and the Programme Board is also concerned with this issue," says Sørheim.

The CLIMIT Programme Board is appointed by the Ministry of Petroleum and Energy (MPE), and an MPE representative also participates in the board meetings as an observer.



**Hans Jörg Fell (48)**

I sometimes think of myself as a football coach. My job is not to be the best football player, but rather to make the others better. As head of the CLIMIT programme, I'm responsible for making sure that our experts can do what they do best. I'm also the interface between the Programme Board which approves the applications, Gassnova and the industry. I'm a physicist and researcher by trade, with extensive experience from both the traditional energy sector and the renewables industry. This is a good background for understanding both the applicants' challenges and the need for good, thorough application processes.

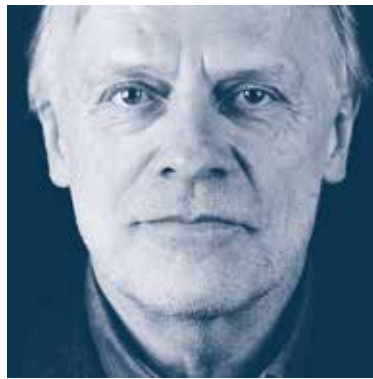
# THE CLIMIT STAFF

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**Tore Hatlen (47)**

A job ad from Gassnova caught my eye, as if it was written for me, and that's how I came to Gassnova after 15 years in the energy and telecom industry. My job is to follow up applications and projects from A to Z. It's inspiring to help good projects get started. With support from CLIMIT, a small start-up called Inflowcontrol has developed a valve that can help reduce the cost of carbon storage.



**Svein Bekken (56)**

CLIMIT works! I've been a case officer for the major SOLVit project, which started in 2008 and is still under way. Through this project Aker Solutions has developed its technology for carbon capture processes. At any given time I'm also a case officer for 5-10 other large and small projects. Like many of my colleagues, I'm a chartered engineer and have previously worked in the industry, both in Norway and abroad, for example with development of process equipment for CO<sub>2</sub> absorption. This is valuable experience in my present position as technology adviser. Working for CLIMIT is meaningful, because CCS is an entirely necessary measure to reduce human-induced climate change.



**Jørild Svalestuen (53)**

It's inspiring to work for CLIMIT knowing that expert communities around the world are interested in what's happening in Norway. One example of this is the project I'm following up at the Norcem cement plant in Brevik, which, in an international perspective, is the most exciting climate project in the cement industry. Norcem is testing, with support from CLIMIT, four different technologies for capturing CO<sub>2</sub> from cement flue gas. From my time spent in Norsk Hydro I have broad experience from both research and production, as well as managing projects with international co-operation. This gives an inside perspective on the applicants' challenges.





**Åse Slagtern (55)**

2014 was an exciting year, and 2015 will be even more so! Last year, we invited researchers to find new ground-breaking concepts within carbon capture. The Programme Board chose four of them. We'll see the first results sometime this year. I'm excited to follow their development. These projects are good examples of how we work on R&D: First, we think about what we want to achieve in the programme, then we design the announcements so that these goals can be achieved. It's an advantage in such work to have a background from both research and industry, like my own from SINTEF and Aker Solutions.



**Svein Mofossbakke (54)**

CLIMIT manages vast assets on behalf of the Norwegian society. It is therefore important to ensure that all applications comply with statutes and regulations, and that impartiality, confidentiality and other formal aspects are taken into consideration. This is perhaps my most important job. I have both a law and a business degree and I have extensive experience in planning and following up both private and public projects. I am responsible for the legal and commercial assessment of applications. I sometimes say that I'm a necessary annoyance. My personal motivation for going to work every day is participating in an interdisciplinary team and working with exciting and important climate projects.



**Thelma Bergheim (50)**

I'm an accountant by trade, so you can understand that technology is not my speciality. I also have a master's degree in administration and management, and I'm good at administering and keeping things in order. Among other things, my job involves keeping track of all the applications we receive, as well as following up the projects' finances. My experience is that quality in preparation yields quality in case processing. People sometimes ask whether I find it tedious to be the one in charge of ensuring everything is done 'by the book'. The important tasks assigned to Gassnova and CLIMIT give me energy, even in the sometimes dreary workdays.



**Niels Peter Christensen (61)**

I've been working with CO<sub>2</sub> since 1996, and I can honestly say that I know or know of most of the prominent people within the discipline on a global scale. My primary responsibility is to be a liaison and door-opener vis-à-vis technical and research communities in other countries. The key to a good outcome in a CLIMIT project is often found in these communities. I'm Danish, but I have no problem admitting that Norway is not only far ahead of Denmark within CCS, but also most other countries. CLIMIT is a very noteworthy programme and has a budget large enough to make a difference globally.



**Svein Eggen (62)**

My wife was the one who wanted to move 'home' to Porsgrunn. I honestly didn't think I'd find an exciting job here in the intersection between climate and technology, but then the CLIMIT job in Gassnova appeared. I work on large and small projects within carbon storage, with everything from giant corporations to independent inventors with a good idea. I'm able to use all my expertise as a geologist, and all my experience from working in the Norwegian Petroleum Directorate and the oil industry. I like creating arenas for developing ideas. Things sometimes move slower than I'd like, but I always find motivation in the fact that what we do actually affects the global climate.



**Karl Erik Karlsen (64)**

In the Demo part of CLIMIT, we help applicants find out whether their ideas work in practice, or what will make them work. The experience we as technology advisers bring from our time in the industry is thus highly important. It allows us to both help applicants see the challenges and potential solutions, even when the path to success twists and turns in ways that were unexpected. One effect of the CLIMIT project, is that support from us often triggers other financing, from the industry itself. One example of this is CO<sub>2</sub>Pipetrans, which is working on safe, efficient pipeline transport of CO<sub>2</sub>.



**Aage Stangeland (43)**

I'm an incurable optimist when it comes to carbon capture and storage. To the extent that the 'oil' is the problem, CCS is part of the solution. This is why I go to work every day inspired. We help start projects that, by themselves, are often highly specialised and have narrow focus. However, together they make up the big picture, and help us find good solutions. I've had many other jobs, including in Bellona. Working for CLIMIT, I feel that I can use my education, work on important climate measures and help realise exciting projects.



**Ståle Aakenes (53)**

Many of my colleagues in CLIMIT have cutting-edge expertise in key CCS technology. My expertise is in understanding the commercial and political context of the projects and the industry that may utilise the technology. When we work on applications for projects, we need to understand the entire innovation process, how technology is developed and commercialised. Furthermore, we need to understand the barriers for commercialisation of CCS technology and how we as a representative of the State may play a vital role to contribute in the best possible way. My MSc in Business and Economics and Technology Management in addition to 18 years in Hydro, provide a good starting point for contributing to this end.



**Aslak Viumdal (39)**

In CLIMIT, we as employees have different types of expertise that complement each other. Along with Ståle, I make up the analysis group. When applications are to be assessed, it's important to understand what happens around the CCS work. What's happening in the energy markets? What framework conditions can be expected? What will the industry need, and when? Who are the actors, and what is their agenda? This is where we come in when applications are assessed. Because CLIMIT Demo is supposed to be close to the market, it is important to understand and predict what the needs will be in the future as well. This is where my Master of Business and Economics [MBE], with specialisation in strategy, is really beneficial.

# SUCCESS STORY

## – From R&D to demo using membranes

**Get some cling film from your kitchen, and pull out about a half-meter. This is what one of the future carbon capture methods may look like!**

We are at Brattøra in Trondheim, visiting the Reinertsen company. The door to managing director Torkild Reinertsen of this venerable family company says “Dr. ing”. Inside the office is another engineer with a Ph. D, Frode Roness, who is heading the membrane project.

For our convenience, they will be talking straight Norwegian, not engineer-speak, about the carbon capture project they are working on. Not a daunting task for either, as they both are good communicators.

“Imagine a thin, thin membrane. Thinner than aluminium foil. Then imagine you manage to make this membrane so that it lets hydrogen molecules pass, but stops and captures carbon molecules on the inside. This is what we are working on,” Reinertsen says with passion.

The membrane is made from palladium, and is three-to-four micrometres thick. It was developed and patented by SINTEF. The first stage of the development and testing to commercialise this technology, was therefore an R&D project in partnership with SINTEF. The project assessed whether the technology had the technical and financial potential to scale from the laboratory to full industrial size. The first R&D stage was funded by CLIMIT. The project has moved on to the demo phase, where the technology is tested in a format large enough to see whether it can be applied at a grand scale for the industry. This phase is also funded by CLIMIT, with a total of 49 MNOK out of a budgeted 75 MNOK. The remainder is covered by Reinertsen.

“We here in Reinertsen like to be part of something bigger. We have been involved in gas transport for three decades, and we believe gas will be a major part of the future energy mix. However, capture methods must be in place. It would be very beneficial for us to develop such a membrane, but we do not have the financial muscle to carry the development costs by ourselves. CLIMIT is thus an excellent partner for us,” Reinertsen says.

Simply put, the vision is for capture to take place inside a large pipe. This pipe is filled with a mixture of hydrogen and CO<sub>2</sub>. The big pipe is also filled with smaller pipes. The palladium membrane is packed around each pipe, just like you would cling film food. The hydrogen molecules pass through the membrane and into the tin pipes, while the carbon is kept outside.

“Making thick membranes is not difficult. The problem is that they get pretty dense, so nothing gets through. The thinner we make them, the more efficient they will be,” Roness says, adding:

“The laboratory trials have shown that this works in a smaller format. The challenge is to get this to a interesting for the industry. This is the phase we are in now.”

The plan is to develop a test facility that can be transported around the world for presentation and demonstration purposes. Reinertsen starts laughing:

“Imagine selling the membrane in jugs! That would be real traditional for the Trøndelag region! But this is what we are actually trying to do. If we manage to get this to work in this format, we would sell the membrane in cans across the globe.”

They are still in the testing stage. Reinertsen and Roness say that there still are many challenges to solve. In autumn of 2017, they will know if it works, and if it can be scaled up further.

“We’re doing this while the world economy is facing tough times, and especially the oil and gas sector. It is a difficult balance to strike when you make such investments in a recession, but we are a family business, and we have the luxury of being long-term in strategy while also having short decision-making processes. This can be an advantage in a project like this, because we can be very hands-on and keep costs under control,” Reinertsen says.

Torkild Reinertsen (on right) and Frode Roness have great expectations for the membrane technology now being subjected to extensive testing by Reinertsen AS, with support from CLIMIT Demo.



# A SELECTION OF CLIMIT'S PROJECTS

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Through supporting projects in the entire chain from research to demonstration, CLIMIT will help develop knowledge, expertise, technology and solutions to provide important contributions to cost reductions and spur a broad international rollout of CCS. CLIMIT will also contribute to utilisation of national advantages and development of new technology and service concepts with international potential.

## CO<sub>2</sub> CAPTURE

The knowledge basis for CO<sub>2</sub> capture from power-intensive industry has been considerably strengthened through a CLIMIT R&D project at Tel-Tek that was completed in 2014. Different capture methods and a new method for re-using amine waste were assessed. Both the Norcem Brevik cement plant and electrolysis hall in Hydro's aluminium plant at Sunndalsøra have been important in contributing to the research in the project, under which significant expertise has been developed. Two doctorates were completed in connection with the project. The project has delved deeper into CO<sub>2</sub> capture from point source emissions in processing industries and from power plants, and an important knowledge basis has been established for the industry partners.

CLIMIT Demo supports Norcem with its partners Heidelberg Cement and ECRA (European Cement Research Academy), which through its project will test and assess four post-combustion capture technologies in relation to CO<sub>2</sub> capture from cement flue gas: amine technology (Aker Solutions), membrane technology (NTNU, DNV, GL, Yodfat Engineers), solid sorbents (RTI, US) and carbonate looping (Alstom). Furthermore, the technologies will be studied in a full-scale perspective. While the maturity of the technologies is vastly different, all have shown promising results through the tests conducted in 2014. This project is one of very few projects in the world testing CO<sub>2</sub> capture from cement flue gas and has garnered major international interest.

Another technology which CLIMIT R&D has supported is Chemical Looping Combustion (CLC). This is an oxy-combustion technology which prevents extensive separation of CO<sub>2</sub> after combustion. The technology is in an early phase and has the potential of being more effective than other types of technologies. Projects at SINTEF and NTNU are working on developing more effective and less expensive materials that are required in the process. In 2014, they completed construction of a 100 kW reactor that will be used in combustion testing in 2015. They are collaborating with international research partners within the area in both CLIMIT R&D projects and EU projects.

SOLvit is an extensive research, development and demonstration programme for CO<sub>2</sub> post-combustion capture technology divided into three phases from 2008 to 2015. The total budget is 340 MNOK, of which 133 MNOK was allocated from CLIMIT Demo. The project owner is Aker Solutions with SINTEF and NTNU as research partners and multiple industry partners have been involved. CLIMIT R&D also supported an educational programme at NTNU as part of the project. The project's main focus is developing chemicals for use in post-combustion CO<sub>2</sub> capture plants to reduce the costs of implementing CO<sub>2</sub> capture.

CO<sub>2</sub> capture at Tiller in Trondheim. ■



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## CO<sub>2</sub> TRANSPORT

Using CLIMIT support (Demo and R&D), sound infrastructure has been developed for research on transport with test rigs at Statoil in Trondheim, the Institute for Energy Technology (IFE) at Kjeller and SINTEF.

The primary focus of CLIMIT projects is the effect of impurities in the CO<sub>2</sub>, as well as the impact of potential accidents. Important thermodynamic data have been obtained at SINTEF and NTNU that can be used in CO<sub>2</sub> transport models. IFE carried out a successful Demo programme to determine the effect of impurities in CO<sub>2</sub> during pipeline transport. In cooperation with the industry, DNV GL carried out full-scale tests of depressurisation of CO<sub>2</sub> from pipelines, and released data from the trials to research and industry environments. Models were prepared at the University of Bergen to calculate consequences of CO<sub>2</sub> emissions in the event of accidents in pipelines on the seabed.

**You can find a complete overview of CLIMIT's project portfolio at [www.climit.no/en](http://www.climit.no/en)**

**In CO<sub>2</sub> transport, the CLIMIT programme prioritises operational reliability and lower costs.**







## CO<sub>2</sub> STORAGE

A study examining the combination of full-scale CO<sub>2</sub> capture with storage and application for EOR for oil fields in the North Sea is under way. The study has the aim of identifying necessary technological development related to CCS and CO<sub>2</sub>-based EOR. Financial models and cost models will be developed for the various steps in the CO<sub>2</sub> chain. The study is carried out through analysing several generic CCS chains, where CO<sub>2</sub> is used for enhanced oil recovery. The CO<sub>2</sub> will be transported by ship or pipeline to the relevant field or aquifer. As a special case, the possibility of using an aquifer as interim storage has also been analysed. The project started in 2013 and will be concluded in 2015.

CLIMIT's cooperation with Geoforschungszentrum Potsdam regarding the CO<sub>2</sub> injection project in Ketzin was initiated during a programme board trip to Germany in 2009. Based on a MoU, the CLIMIT secretariat worked over time to achieve a cooperation of the same type as the COMPLETE project. COMPLETE is the final step in a German CO<sub>2</sub> injection project that has been ongoing in Ketzin outside Berlin since 2009. The project deals with shutting down the injection project in Ketzin and entails assessment related to documenting wells and the CO<sub>2</sub> "cloud's" distribution in the reservoir. Through a two-step announcement of project support for participation in the COMPLETE project, two projects were selected and granted support. Both projects are headed by SINTEF Petroleum Research. Work on the

project started in earnest in 2014 and initial deliveries have been made.

Good technological solutions for monitoring CO<sub>2</sub> stores are very significant, and NORSAR is developing new technology based on microseismic. Through field measurements related to injection tests at the Loneyarbyen CO<sub>2</sub> Lab, researchers refined the technology so it is possible to eliminate noise in readings. This means that geomechanical incidents in and around a reservoir for CO<sub>2</sub> storage can be measured with cheap and efficient technology. NORSAR is further developing the concept, and this could become a very important technology for monitoring CO<sub>2</sub> stores in the future.

UNI Research carried out a project that increases the understanding of how cracks and faults in sandstone formations affect CO<sub>2</sub> storage. The goal is to reduce risk during planning and development of potential major-scale CO<sub>2</sub> storage locations. One outcome from the project is that it is now easier to predict how faults impact reservoir properties, and whether there is a risk of leaks along faults. The researchers have learned that measurements of the strength and rigidity of faults in fields can be used to predict the behaviour of rocks during pressure changes. This can in turn be used to predict how suitable a rock is for CO<sub>2</sub> storage. These analyses make it easier to understand the effects observed during CO<sub>2</sub> injection on Snøhvit.

## INNOVATIVE

In 2014, CLIMIT R&D conducted a call for proposals for new concepts within CO<sub>2</sub> capture with the objective of eliciting completely new, ground-breaking concepts. The call was carried out using new evaluation criteria and a two-step process to elicit projects that CLIMIT R&D does not normally support in the ordinary calls. The "new concepts" call emphasised the projects' potential, and accepted projects with far higher risk than in traditional calls. Fifteen applications were submitted to the call. Four projects were selected in the end, with a total budget of 30 MNOK. The projects that were approved are ambitious. One of the projects will use nano-structured solutions to function as both a capture and storage medium. Magnetic separation will be used in another project. The third project will combine new, third

generation solvents and membranes in a novel way. The final project that was supported will compose "Chemical looping" technologies in a new and much more efficient manner.

In autumn 2013, CLIMIT introduced a new open call for pre-feasibility study funds. CLIMIT wishes to mature a wider range of ideas within capture, transport and storage as well as transfer these ideas more quickly to pilot and demonstration projects. The pre-feasibility study fund scheme has been a success. Experience from the scheme shows good response to the call. Nine ideas have received funding. Of these, many moved on to ordinary projects in CLIMIT Demo and at least one patent has been filed. The scheme will be continued in 2015.



# THE SEARCH FOR SOLUTIONS

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We invited Hans Jörg Fell, head of CLIMIT, and Aage Stangeland, senior adviser at the Research Council of Norway to gaze into the crystal ball together.

"We would have to say that there isn't only sunshine, but also some clouds on the horizon," says Stangeland. Fell nods, adding: "Yes, there will always be challenges, due in part to the economic outlook for the industry and the framework conditions for such projects."

When the two of them talk shop, it's mostly about carbon capture, transport and storage. We have challenged them to make some predictions about the field even though, given their backgrounds as researchers, 'prediction' is probably an expression that would prompt some reservations on their part. We therefore moderate their assignment to providing qualified and informed observations regarding developments in carbon capture and storage (CCS) in the coming years – including CLIMIT's role, opportunities and challenges.

Few are better qualified to do that than these two – Fell as the head of the CLIMIT secretariat and Stangeland as one of two RCN researchers working on R&D projects at CLIMIT. The two see the following potential developments:

- **The economic situation is affecting the industry's commitment**

"It means for some years ahead that we will probably see less activity and less spending on CCS projects by industry. I believe we are talking about a five-year perspective before developments cause it to 'take off' again," says Stangeland.

- **CLIMIT's role will become more important.**

"I agree with your assessment, Aage," says Fell. "A consequence of this is that CLIMIT's role will take on greater importance in this period, because industry will focus even more on public funding of research. Foresighted actors will choose to take

the initiative regardless, giving them an opportunity to gain an edge over other actors."

- **New concepts**

"We have initiated research projects that have higher risk and higher potential than we've had before. We risk of course that none of the four we started last year will succeed. But if one or more kicks in, we will have paved the way for exciting demonstration projects of great relevance and interest to the industry," both point out.

- **Arenas will become even more important**

"I also think we will see that the international arenas where research and industry intersect will become even more important. This is often how partners behind various projects come together. In such contexts, our role is to facilitate, to be the catalyst," says Fell.

- **Framework conditions may be changed.**

"In the long term, there is reason to believe that there will be requirements and framework conditions that will make it more attractive for industry to develop cost-effective solutions for CCS. Canada, where the industry works under different framework conditions, is a good example. This means that they have to be even more forward-leaning than in our part of the world," says Stangeland.

"But it is important to emphasise that creating the framework conditions is not our job. We're only trying to say which direction developments are heading," says Fell.



Hans Jörg Fell (on left) and Aage Stangeland accepted the challenge and talked about what they expect the future to bring in terms of CCS.

# KEY FIGURES 2014

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**A total of 199.7 MNOK has been awarded in project funding from the CLIMIT Programme in 2014. As many as 43 new projects have received funding. The total disbursements for CLIMIT Demo during 2014 amounted to 129.0 MNOK, the highest figure since the Fund was established in 2005. 89.4 MNOK was paid out for the R&D part, which is somewhat less than the total paid out in 2013.**

Since the CLIMIT Programme started in 2005, the path toward a commercial market for CCS technology has not grown shorter, in spite of the significant development and maturation of technology. While the market situation has worsened and certain key players have opted to substantially reduce their commitment, there are still some players that stand firm. At the same time, Norwegian technology communities are attractive partners for national and international players, a fact which has resulted in international projects with significant Norwegian content.

CLIMIT focuses on ensuring a broad and diverse project portfolio as regards:

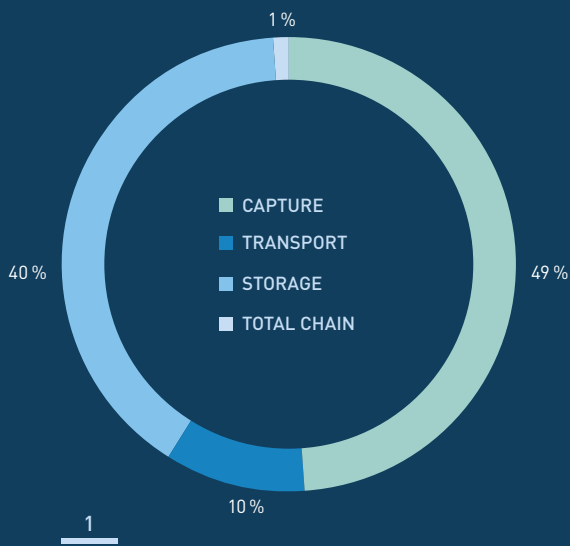
- a) Technology areas (capture, transport and storage)
- b) Development chain (research, development and demonstration)

**Diagrams 1 and 2** show the allocation per area, and reveal a good distribution between capture and storage, throughout the entire development chain. There is a higher level of R&D activity within transport and storage, while there are fewer projects within the Demo part of the programme. This also reflects the areas which face the greatest challenges as regards costs and technological risk.

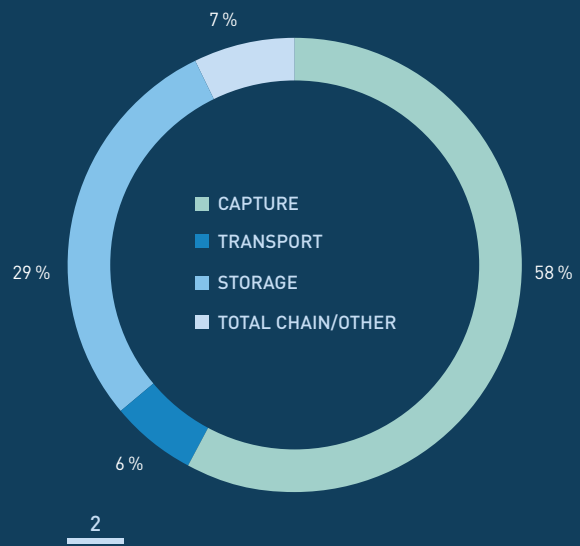
**Diagrams 3 and 4** show the Programme's allocation along the development chain; these show that 62% of the allocations within CLIMIT R&D are in the active portfolio linked to projects where the industry is involved, while nearly 36% of the allocations in the portfolio are linked to pure research projects.

The projects in CLIMIT Demo largely fall within the "development" category. Nevertheless, 16% of ongoing projects are classified as Demo projects. These are projects that are approaching commercialisation.

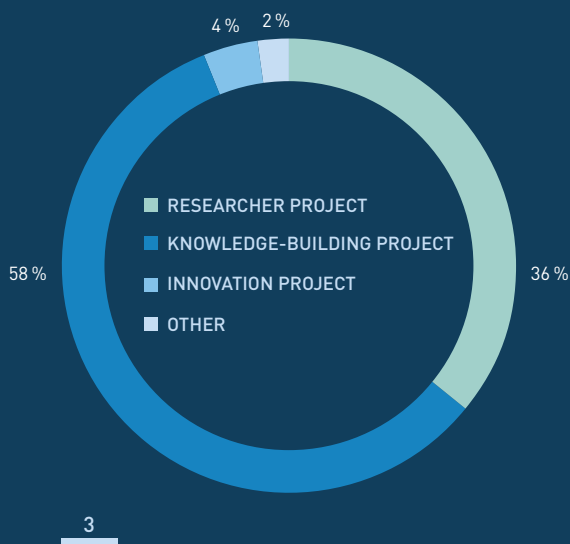
Since CLIMIT started up in 2005, the trend has been towards rising funding disbursements. The disbursements from CLIMIT R&D are somewhat lower than the level for the record year 2012, while record disbursements were made now in 2014 for CLIMIT Demo. When decisions are made to support the various projects, the funds are earmarked for the project while there is some lag in the actual disbursements. Typical projects last over 2–3 years. Therefore, the substantial disbursement in 2014 is closely connected to funding decisions made in previous years.



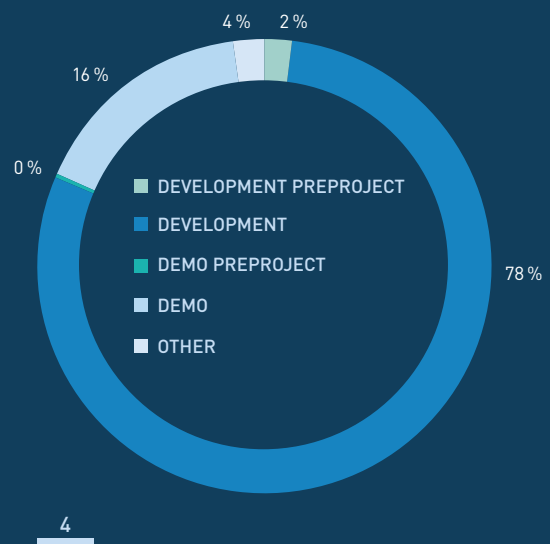
1  
CLIMIT R&D: ALLOCATION PER AREA  
ONGOING PROJECTS 2014, ALLOCATED



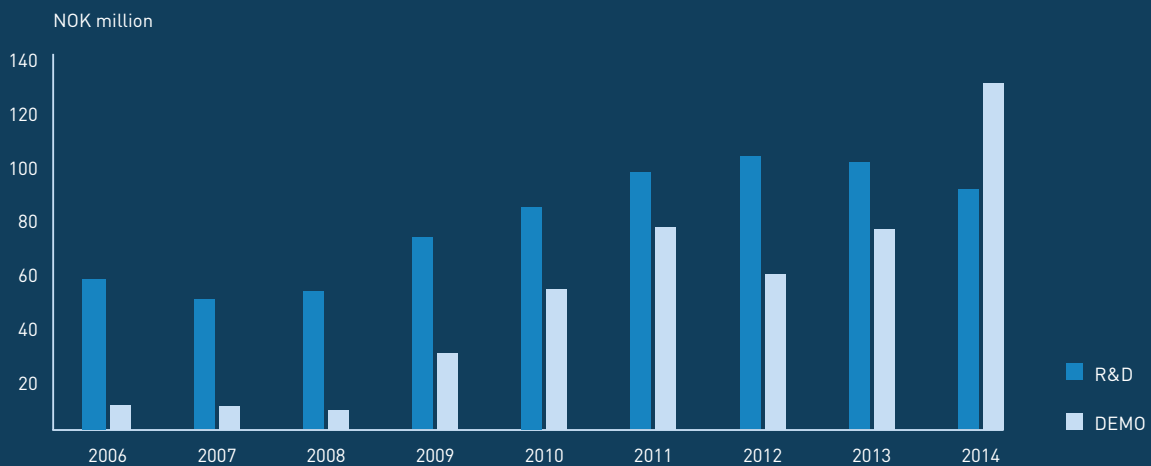
2  
CLIMIT DEMO: ALLOCATION PER AREA  
ONGOING PROJECTS 2014, ALLOCATED



3  
CLIMIT R&D: ALLOCATION PER DEVELOPMENT STAGE  
ONGOING PROJECTS 2014, ALLOCATED



4  
CLIMIT DEMO: ALLOCATION PER DEVELOPMENT STAGE  
ONGOING PROJECTS 2014, ALLOCATED



5  
DISBURSEMENTS TO PROJECTS, R&D AND DEMO



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