

2011 2011 2011 2011 2011 2011 ANNUAL REPORT 2011 2011 2011 2011 2011

CLIMIT

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Page 9

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Page 10

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Page 18

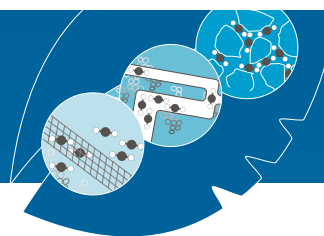


Table of contents

“The game is <i>not</i> over yet”	.4
CLIMIT’s main goal	.6
2011 – a summary	.8
International cooperation	.11
“Decreasing climate interest is a challenge	.12
Key figures and comments in 2011	.14
«Kjos and Stordalen inspire CCS»	.16
Programme Board’s activities	.18
Evaluation of the CLIMIT programme	.21
“In my head it’s like a vaccine”	.22

“The game is *not* over yet”



KJELL BENDIKSEN

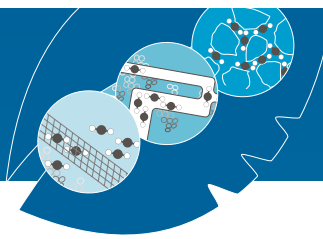
Chairman of the CLIMIT Programme Board

“What are you most proud of in 2011?”

“Pride is not a word I use lightly. I would rather look at it as what we have *achieved* in CLIMIT. Oxford Research has evaluated the six first years of CLIMIT. It concludes, among other things, that CLIMIT has contributed to maintaining Norway’s leading position in many areas within CCS (carbon capture and storage). And we have started a strategy process in light of the conclusion of the start phase of the programme. The third, but most important factor, is the *results* achieved. But *CLIMIT* does not achieve these results. We finance and facilitate, but the projects and the people who head and manage these projects create all the results!”

“Oxford Research concludes that there is a very high **additionality in CLIMIT compared with other R&D programmes under the direction of the Research Council of Norway. What does this mean for us laypeople?**”

“In simple terms, Oxford Research defines additionality with the question: ‘Would you have started this project without support from CLIMIT?’ A very high percentage say they would *not* have done so. So the support from CLIMIT has had a triggering effect, or was at least a strong contributing factor for the implementation of these projects. This is very good feedback, but the flipside raises questions as to whether this is partially caused by us being risk averse.”



“Could CLIMIT have been bolder and tried to reach even higher?”

“Well, this is a key question for the Programme Board, particularly in the work that is ongoing on a new strategy for CLIMIT towards 2020. But research funds are scarce in Norway, and they shouldn’t be wasted on projects that you know, or *should* know, cannot succeed. That would be both wrong and irresponsible. Projects up to now have mainly been close to market implementation in technology that can be utilised from today and towards 2020. CLIMIT *has*, according to the evaluation, also provided important knowledge in the area that forms a good basis for future research and development towards more cutting edge technologies. However, in the next action plan we will to a greater extent encourage and stimulate research and technology that will be commercial *after* 2020.”

“What has been the greatest knowledge CLIMIT has reaped through the six-year start phase?”

“Both the increase of expertise in Norwegian research environments and the contributions to the large industry projects. One example is Aker Clean Carbon’s capture technology which will now be tested at Mongstad (TCM). There have been several projects in CLIMIT that have made significant contributions to this type of amine-based CO₂ capture. There have been many impressive efforts, but I must mention SINTEF and NTNU (Norwegian University of Science and Technology) as the main contributors within capture. And then there is storage. The fact that two unique storage test laboratories are being established in Svelvik and Longyearbyen, is very positive. A number of other major and important R&D projects have been carried out, for instance at the Universities of Bergen and Oslo.”

“The game is over! The critics claim it is too late and expensive to save the world...”

“Quite the contrary! If we can succeed with CCS, this will perhaps contribute more than anything else. Fossil energy sources currently represent more than 80 per cent of global energy consumption. And regardless of what people say, the percentage is still increasing. Both the International Energy Agency (IEA) and the EU have estimated in their most recent forecasts that approx. 20 per cent of the total emission reductions required towards 2050 *must* come from CCS. Renewable energy sources must take their share, but so far they do not even cover the *growth* in energy consumption. CCS will give countries like China, India and Brazil an opportunity for economic development using their own fossil energy sources. We *have* to succeed with CCS, or we will never achieve the 2-3 degree goal in 2050. These efforts are important, and *urgent*!”

“So, what are your biggest expectations for 2012?”

“The Mongstad technology centre is a major thing. The size of that thing is underrated in Norway. Very much so! You don’t replace 80 per cent of the current energy supply with a completely different technology without noticing a thing. It is important that Norway is able to utilise the Mongstad technology centre. The Government has a big job to do in the rest of the world. There will be more such facilities, but Mongstad is unique in the sense that it is there and can offer state-of-the-art infrastructure *today*! The ambition must be to establish TCM as a European and perhaps *global* test centre for new CCS technologies in a ten-year perspective!”

CLIMIT's main goal



CLIMIT's main goal is to accelerate commercialisation of CCS through financial stimulation of research, development and demonstration.

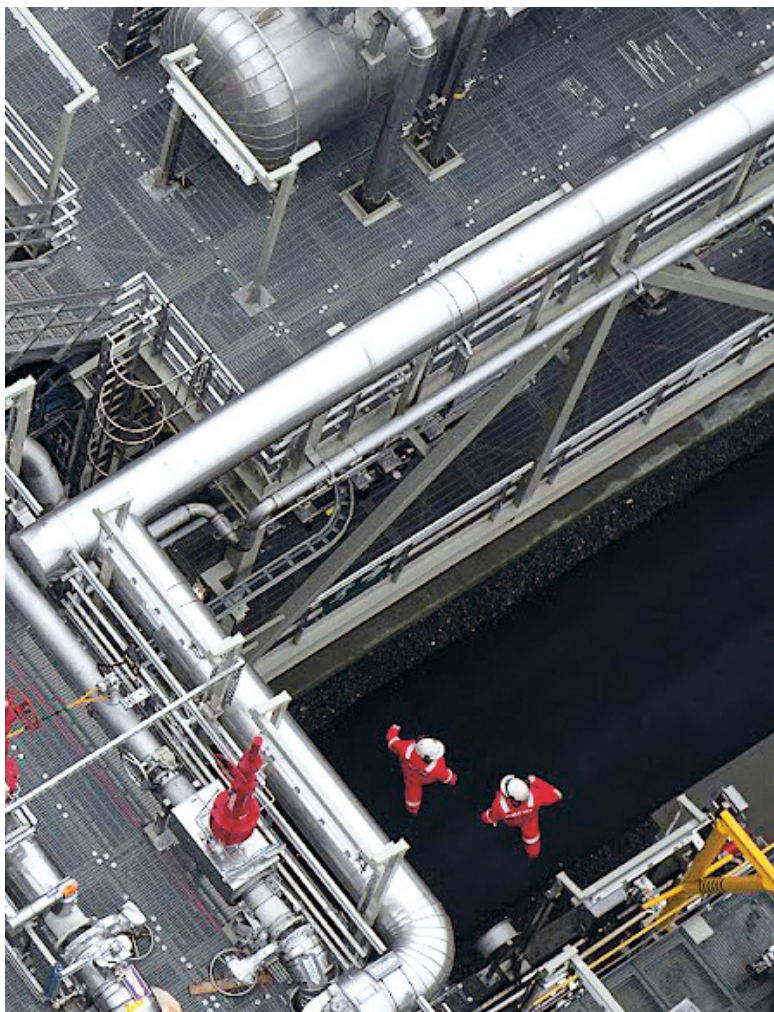
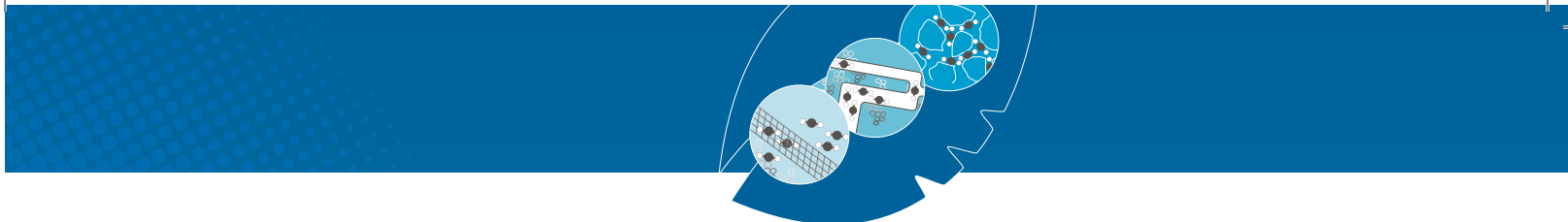
The Ministry of Petroleum and Energy established CLIMIT in 2005 to support development of technology for CCS for gas power plants. In 2008, the subsidy scheme was expanded to power production based on all fossil fuels, and industry emissions were also included in 2010.

The programme is a collaboration between Gassnova and the Research Council of Norway. CLIMIT comprises the Research Council of Norway's subsidy

scheme for research and development (the research part), and Gassnova's support for development and demonstration (the demo part). Gassnova has the overall responsibility and heads the programme secretariat.

The efforts in CLIMIT must be seen in context with the Norwegian authorities' ambitious climate targets, which have entailed considerable efforts in CCS, illustrated by the following overview:

- In 2012, a full-scale capture and storage chain for CO₂ is being planned from the thermal power plant at Mongstad.



The objective of the CLIMIT programme is to:

Accelerate the commercialisation of CCS by financial stimulation of research, development and demonstration.

- The Norwegian Petroleum Directorate has prepared an atlas ("CO₂ Storage Atlas Norwegian North Sea") of possible storage reservoirs for CO₂ on the Norwegian shelf.
- The MPE has asked operators on the Norwegian shelf to nominate areas in the North Sea for geological storage of CO₂. Five companies have nominated such areas.
- TCM - Technology Centre Mongstad – will be operational in 2012, with two capture facilities with an overall capacity of 100,000 tonnes of CO₂ per year.
- In 2011, on behalf of the MPE, Gassnova started a study to assess possibilities for CCS investment projects in Norway beyond Mongstad.
- A considerable research effort has started at the two research centres for Environmentally Friendly Energy (FME) on CCS and three FMEs within social science.

In an international context this represents a very considerable investment in CCS. The effort is also anchored in the Climate Cure report and Energy 21, which emphasise CCS as one of the most important technologies for achieving Norway's climate and energy targets.

2011 – a summary



2011 has been an eventful year for CLIMIT with a wide spectrum of projects that cover the different disciplines within CCS. NOK 170.2 million has been allocated to CLIMIT projects – NOK 75.3 million through CLIMIT Demo and NOK 94.9 million through CLIMIT R&D.

CO₂ in the Svelvik sand

In Hurum, CO₂ has been injected at Svelvikryggen to find out how early leaks and undesirable CO₂ migration may be detected using today's technology. The project has gained international attention within field trials, and the CO₂ Field Lab project will provide us with new knowledge on how we can monitor stored CO₂.

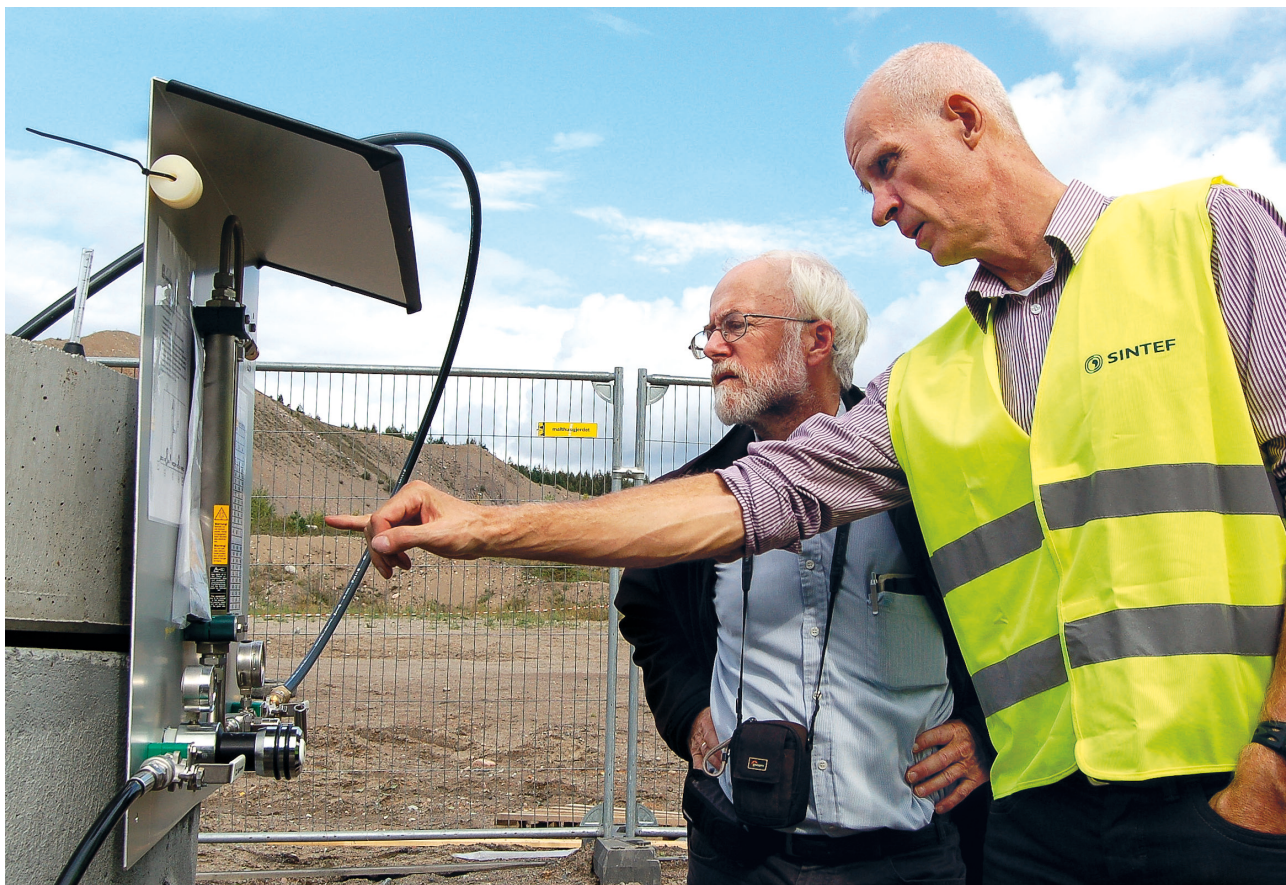
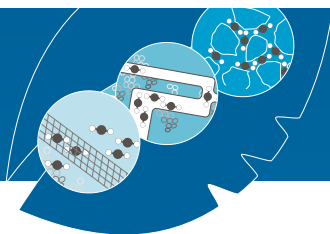
SOLVit in new phase

On the capture side, the major SOLVit project (headed

by Aker Clean Carbon) has now entered its second phase. The project now deals with developing more energy-efficient chemicals and processes for CO₂ capture from flue gas in gas and coal power plants. The results from the first phase are good, and further work will focus on the environmental aspect while also attempting to make the solvent more stable.

First industry project

CLIMIT Demo's first industry project was started at Norcem's cement factory in Brevik in 2011. The project *CO₂ capture test facility at Norcem's cement plant in Brevik* will assess the decision basis for investment in a test facility for post-combustion CO₂ capture. The facilities will be located at Norcem's plant in Brevik. Cement production causes significant CO₂ emissions, and Norcem and its owner



Erik Lindeberg, SINTEF and Svein Eggen, Gassnova in connection with the tests at Svelvik.

HeidelbergCement Group want to work together with the organisation European Cement Research Academy (ECRA), to start testing CO₂ capture technologies that could be relevant for the cement industry.

Health and environment

It has been questioned whether amine emissions from CO₂ capture facilities constitute a health risk. CLIMIT has answered this challenge. Through awarding a total of NOK 35 million to 12 projects since 2008, the problem has been mapped and the risk picture is significantly reduced. The conclusion is that the HSE challenges in relation to amine-based CO₂ capture are manageable.

Use of CO₂

In 2011, there were more applications than before for

projects where CO₂ will be used in products or for other purposes *after* the carbon dioxide has been captured. CLIMIT generally only supports projects that are planning long-term storage of CO₂. Use of CO₂ where the CO₂ is eventually released again is therefore not relevant. Support has been allocated to a pre-project for life cycle analyses to gain insight into the carbon accounting when the carbon is used in products.

Next generation capture technology

The programme has exciting projects that focus on developing the next generation's capture technology. This includes projects that study use of membranes for separating different gas components. In addition, advances have been made within Chemical Looping Combustion (CLC), a method based on an advanced



Åse Slagtern and Aage Stangeland work on administrative tasks.

combustion process which generates pure oxygen. CLC is a technology with a significant potential for a very efficient CO₂ capture process.

Modelling CO₂ storage

At the University of Bergen, advanced mathematics is used to determine where CO₂ can be safely stored. Extensive analyses have been carried out of several mechanisms for storage of CO₂. The results show that dissolving CO₂ in water is a more important mechanism for CO₂ storage than previously assumed. This entails that more accurate models can now be made for CO₂ storage, which will be important for large-scale CO₂ storage.

International cooperation

It is important to establish research partnerships with major foreign players on the road towards industrial users and commercialisation of research results. Since 2007, CLIMIT has supported a major project for combustion of hydrogen with SINTEF. Both a French gas turbine manufacturer and a German research centre are participating in the project, thus linking expert environments in different areas. The second phase of the project started in 2011. The capture and storage project in In Salah in Algeria is an example of a major international project where Norwegian players participate with support from CLIMIT. Development of monitoring methods is a part of the research here.

International cooperation

CLIMIT prioritises international work highly. In announcements for research projects, emphasis is placed on prioritising applications with international cooperation. In addition, the programme, from 2011, introduced annual announcements of support for strategic work in technology platforms, EERA (European Energy Research Alliance) and IEA's technology network.

The programme's secretariat also coordinates Norwegian players in connection with preparation of applications within CCCS for the EU's framework programme.

People associated with the CLIMIT secretariat represent Norway in several international partnerships:

- Norwegian representative in IEA Greenhouse Gas R&D Program
- Norwegian representative in EII CCS (European Industrial Initiative on CCS)
- Member of Government Group in the EU's technology platform ZEP (Zero Emission Fossil Fuels Power Plants)
- Member of ZEP task force on Policy and Regulations (ZEP TF P&R)
- Member of ZEP task force on Technology (ZEP TF T)
- Members in the CCS group in TRI (Nordic Top-level Research Initiative)
- Head of FENCO NET (network which is a direct follow-up of the previous ERA network)

Through participation in these forums, the administration has ensured extensive knowledge sharing with Norwegian players.

CLIMIT's administration also participates in the ESFRI project ECCSEL, where the goal is to establish European infrastructure for R&D within CCS. The



Dr. Klaus Schöffel, director of Technology and Expertise and head of CLIMIT's secretariat.

participation ensures optimal coordination of the CLIMIT programme against European efforts in research infrastructure.

The administration also follows up the NORDICCS centre which is established under the Nordic Top-level Research Initiative (TRI). This is a Nordic centre which will lay the groundwork for realising CCS facilities in the Nordic countries.

“Decreasing climate interest is a challenge”



RESPONSIBLE FOR PROJECT: Aker Clean Carbon AS

BUDGET: 176,1 MNOK

FINANCING: 37 % from CLIMIT

PROJECT PERIOD: 2008 -2012

KNUT SANDEN

project manager SOLVit

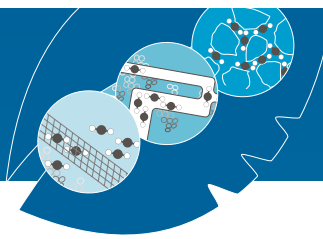
“The aim is simply to develop the best amine solution that can be combined with our hardware type solutions for the facility and achieve a competitive and financially sustainable concept.”

Project manager Knut Sanden makes SOLVit sound like a piece of cake with technology development that will result in a type of solvent or amine to capture CO₂, but this project is not *quite* as easy as it seems! The road towards the perfect amine is both long and expensive for Aker Clean Carbon, NTNU and SINTEF.

“We develop the facility at our in-house CO₂ facility, but then there is the actual solvent, which can be compared with software for these purposes, which can be improved with new compositions and formulas. So there are actually three main goals of improving an amine mixture: The *energy* that has traditionally been a major cost driver, and the *environmental effect* which has been discussed significantly in the last six months – and finally the *stability* of the solvent so it is not destroyed by itself or the exhaust gases.

“And how good has the amine become so far?”

“In phase one of SOLVit we spent approx. NOK 100 million on developing an amine ready for use with energy improvement of about 35 per cent, and we had nearly



achieved this by the end of the first phase in March 2011. In the next phase, the environmental aspect has received more attention. We will deliberately develop an amine that is not linked to a health risk. And in the last year we created a solvent with corresponding energy figures *without* a link to health effects. The testing has not been completed yet, but it looks promising.”

“But when is enough, enough?”

“We would love to have even better energy figures and stability, so we will continue research. The special thing about SOLVit is that we are going from test tubes and laboratory equipment and *highly* competent theoreticians that carry out assessments and laboratory analyses, to general tests in SINTEF’s pilot facility at Tiller. We then carry out tests in industrial environments in our mobile test unit that is now connected to coal power plants in the US. It is a thorough and extensive process which combines accelerated conditions in controlled environments with realistic conditions in the final testing.

“How important has CLIMIT been as a financial contributor?”

“CLIMIT represents the largest part of the financing along with Aker Clean Carbon. We are right on the edge of being able to implement the programme. We are talking about more than NOK 300 million in total for all three phases. This includes CLIMIT, industrial partners, SINTEF and Aker Clean Carbon. This might be the largest programme in Norway, and the fact that this went through the Aker system is positive because of the size of the research efforts. If we had not included CLIMIT with about 37 per cent of the financing, it would have never worked.”

“What is the incentive for spending as much money on this research as Aker does?”

“There are two sides to this. One is that Aker as a group is involved in production of fossil fuels, so the climate aspect gives us a responsibility. And the other is the commercial aspect, just because we think it will be a market. At least we *had* faith in it. The climate conferences show that the willingness to take the climate challenges seriously is not *very* high. The fact that climate interest in the world is decreasing is a challenge. This has made it more difficult in the last year to obtain internal support for putting more efforts into technology development. SOLVit might not make it to phase three.”

“Do you ever feel that you are researching your way to results that no one is interested in spending money on?”

“It does strike me sometimes. One can sometimes fear this, but I believe it would be wrong. We know that the technology we’re working on is an important contributor for reducing greenhouse gases, and I think it is necessary. Everything indicates that fossil fuels will continue to dominate for a long time, and we *must* combine this with capture and storage of CO₂.

“During the year, the test facility at Mongstad will give SOLVit knowledge that shows a large-scale effect, but what is the greatest challenge for Sanden and the project?”

“Our biggest challenge is that the focus on climate has been significantly reduced, and this entails that it will take longer than previously expected before we, as a technology supplier, can operate in a nearly commercial market.”

Key figures and comments in 2011

CLIMIT aims at a broad project portfolio including:

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

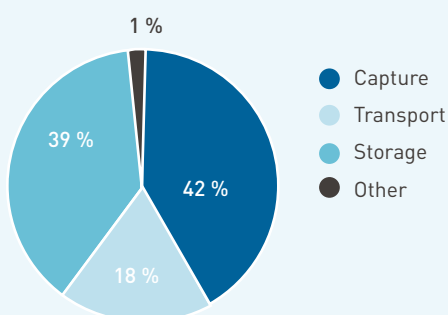
The following overview shows the distribution of the portfolio at the end of 2011/beginning of 2012 between the technology areas within CLIMIT R&D and CLIMIT Demo, respectively.

The overview shows a balanced distribution between capture and storage in the entire development chain. There is considerable R&D activity within transport, but few projects within the demo part of the programme. This also reflects the areas with the greatest challenges related to costs and technological risk.

The programme's distribution along the development chain within R&D and Demo, respectively, is illustrated as follows:

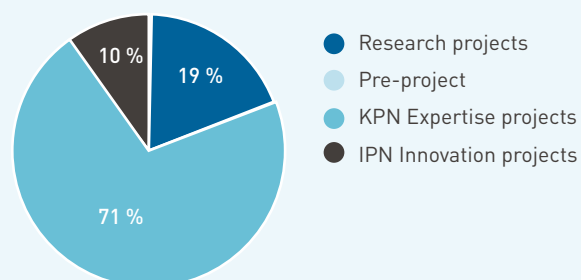
CLIMIT R&D: Distribution by area

Ongoing projects 2011, allocated



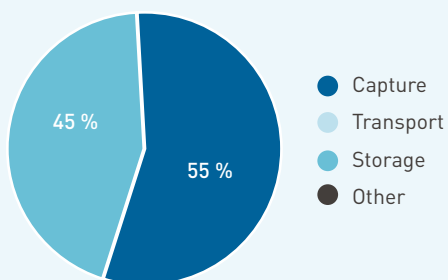
CLIMIT R&D: Per development stage

Ongoing projects 2011, allocated



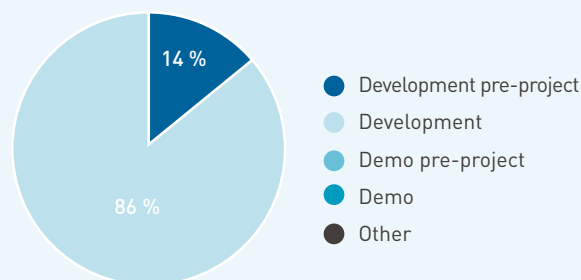
CLIMIT Demo: Distribution by area

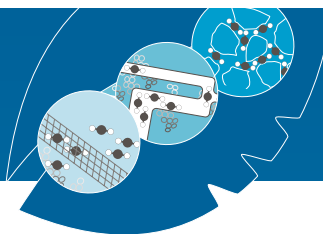
Ongoing projects Dec. 2011, allocated



CLIMIT Demo: Per development stage

Ongoing projects Dec. 2011, allocated



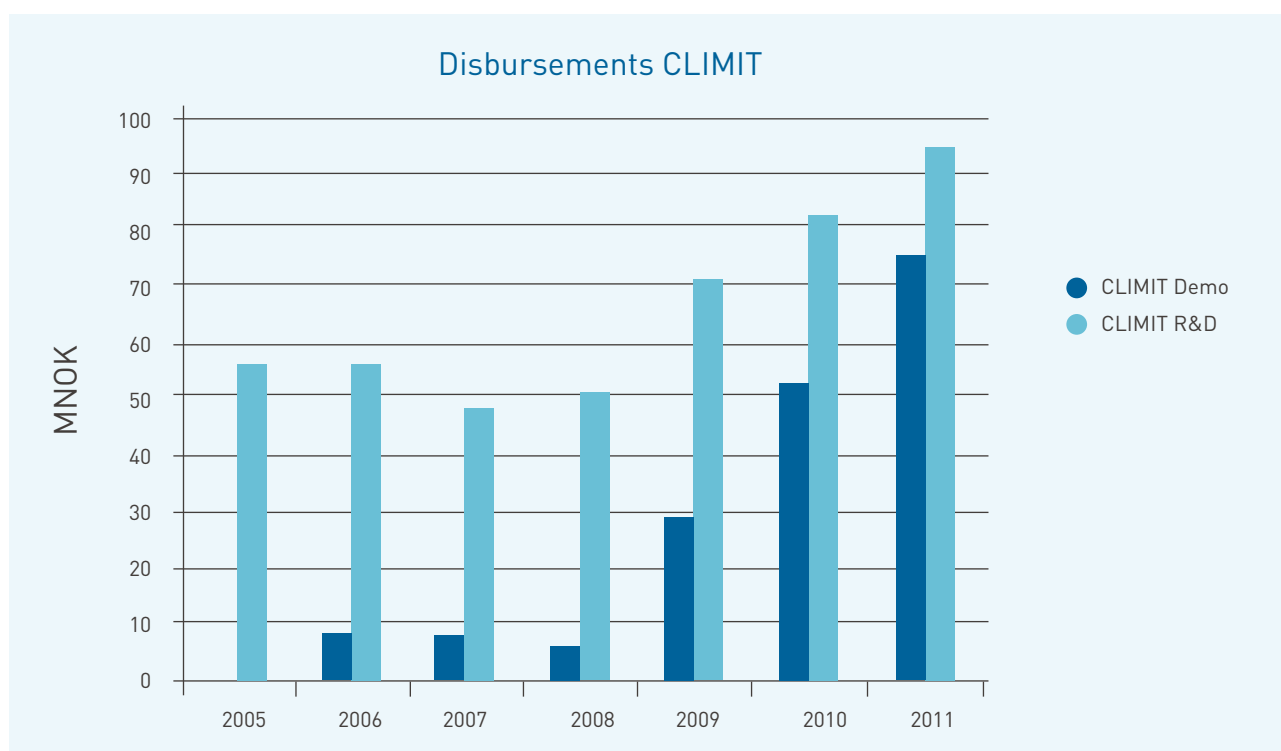


The overview shows that within CLIMIT R&D, approx. 80% of the allocations in the active portfolio are related to projects where the industry is involved, while approx. 19% of the allocations in the portfolio are associated with pure research projects. Expertise projects for the industry include both basic research and applied research, while innovation projects for the industry are directed at applied research. Within CLIMIT Demo, the projects generally fall within the category “development”. Demo projects, which are projects considerably closer to commercialisation, have rarely been used up to now. This is partially because the market is still rather far away from what can be called “commercially functioning”, and the support intensity that can be offered from CLIMIT in this phase is very low (typically 25%).

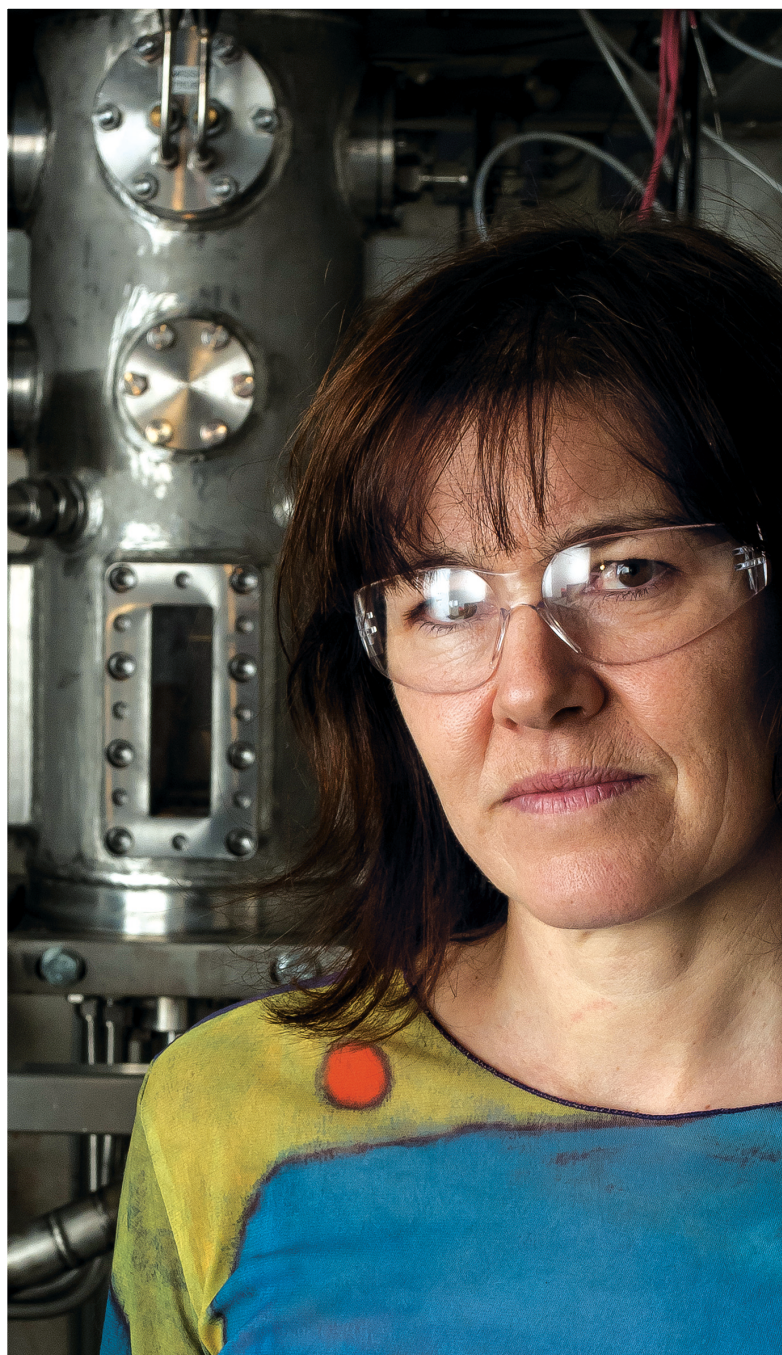
Since CLIMIT was established in 2005, the awards have increased gradually:

From CLIMIT R&D, the disbursements have risen in line with increasing allocations from the Ministry, although with a natural lag as the average implementation time of the projects is nearly four years. For CLIMIT Demo, the increase in disbursements has risen considerably after 2008. This is due both to the fact that disbursements to new projects have increased in the period, and the duration of the projects means that there is a natural lag in the disbursements compared with the allocations. The disbursements in 2011 are in line with annual allocations from the MPE.

High activity within CLIMIT R&D shows that Norwegian research efforts in CCS are extensive. Seen in relation to the activity in CLIMIT Demo, it is reasonable to say that we have not been able to utilise the entire potential represented by the R&D activity. This could be due to the scope of research generally being greater than what the industry can absorb, and the road to a commercial market for CCS is still very long. Without the market receiving significant new investment signals connected to CCS, this trend will continue.



«Kjos and Stordalen inspire CCS»



RESPONSIBLE FOR PROJECT: SINTEF Energy Research

BUDGET: 130 MNOK

FINANCING: 75 % from CLIMIT

PROJECT PERIOD: 2005 - 2011

MONA MØLNVIK

project manager BIGCO₂

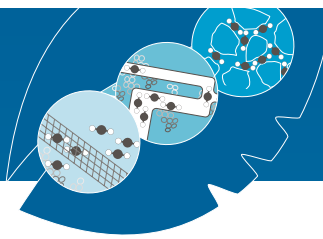
"I am very optimistic! I think these times hold great possibilities. I believe that the people who work on CCS (carbon capture and storage) should be inspired by Bjørn Kjos and Petter Stordalen who are making an effort *now*! The people who dare to be proactive now will be rewarded in a few years. That's my message."

"Tomorrow's winners are putting the environment first today?"

"Yes, I believe so. Kjos and Stordalen are making an effort when others are too timid and they take the risk with both the associated upsides and downsides. And the fact that the Norwegian economy is so strong and we have such vast petroleum resources are strong arguments for Norway continuing its efforts. The future value of the natural gas will largely depend on whether we are able to develop good solutions for capturing CO₂ from gas power plants, I think."

"What is BIGCO₂'s most important achievement?"

"That there are now so many people who know so much about CCS, that is the most important result. Aker joined BIGCO₂ early. This was hardly the *reason* they established their own enterprise for CO₂ capture, Aker Clean Carbon. However, I think there is a very clear connection. Where else would you get the people from and access to the knowledge environments? The results from BIGCO₂ are part of the basis for CLIMIT



Demo's project SOLVit, which is key for the Mongstad test centre. The results will also be used in the partners' strategic decisions. I think we would be surprised if we specifically knew to what extent the partners have used the results from the project – particularly as regards the major international companies that distribute the results from BIGCO₂ to their *entire* organisation.

"So BIGCO₂'s pioneering work has contributed to saving the world or parts of it?"

"CCS is a wide research area. You cannot solve all of the challenges with just one or two researchers. But having such a strong platform, which BIGCO₂ has been, and which will be continued in BIGCCS, *that* helps change the world!"

"In what way?"

"Because we bring forth new knowledge that does not yet exist, and we work at the front lines of international research within combustion, for instance. We have discovered how a hydrogen flame behaves in a gas turbine, which is very intellectually demanding, and important for triggering CO₂ capture. We then create data for how CO₂ as a gas mixture behaves, and how CO₂ storage capacity in a reservoir can increase when producing water. The technical and financial risk would have been greater when CCS is realised *without* this knowledge. BIGCO₂ has made a difference here!"

"Without strong government support, the industry would most likely not have been conscientious and cleaned up after itself until the globe finally called it a day. What does that say?"

"When a company develops its strategies, it is concerned

with finances. And when you have an area with so much associated uncertainty, there will be hesitation. So, I believe the authorities have been clever in saying that *this* is something we will invest in. And if Norway wants, we can assume a leading role, not just in basic knowledge, but in taking the visions further and developing technology that could be exported. We can also attract foreign supplier industry to Norway; opportunities I don't think would have been there without State support. Of course, CCS is more difficult than we thought because we had never done it before, but I am certain the industry will invest. CCS is demanding, but fully possible!"

"A lot needs to be done by 2020..."

"It is challenging to elevate the research results to a level that is closer to what the industry will use. Gassnova's role in Norway must be *strengthened*, I think. And then there are political challenges: Binding international agreements – reasonable quota prices that mean that more people dare to start. You need a predictable policy in order to dare to invest. The head of a company might need to be brave to invest, but not *stupid*!"

"Is it sad that BIGCO₂ is history?"

"It is a little sad to have an older brother taking over and in a way assuming the spotlight – BIGCCS. I see BIGCO₂ as a proud parent in the background and look at the upstarts that have become larger, more visible and even more successful! For me, BIGCO₂ has been an incredibly educational, very motivational and extremely meaningful part of my activity! But it is crucial that the work is continued in BIGCCS. When we work with so many issues within this area, the researchers will always address new topics and find new knowledge. The research never ends – *that* is an important message!"

Programme Board's activities



Seated, from left: Ingar Steinsvik, Randi Viksund, Kristin M. Flornes and Marit Larsen.
Standing, from left: Guttorm Alendal, Kjell Bendiksen, Olav Kårstad, Marianne Holmen, Nils Røkke and Klaus Schöffel.

The Programme Board consisted of the following members in 2011:

- Kjell Bendiksen, IFE - president
- Marit Larsen, Tel-Tek - VP
- Olav Kårstad, Statoil
- Randi Viksund, Gassco, joined December 2011
- Marianne Holmen, Statkraft
- Niels Peter Christensen, Vattenfall
- Nils Røkke, Sintef
- Guttorm Alendal, University of Bergen
- Kristin M. Flornes, IRIS
- Jürgen Mienert, University of Tromsø
- Åse Slagtern, Aker Solutions, resigned June 2011

In addition, the Ministry of Petroleum and Energy has appointed Ingar Steinsvik as an observer and

participant in the Programme Board meetings. Six Programme Board meetings were held in 2011.

New strategy plan

The Programme Board started work on developing a strategy for CLIMIT in December 2010. The work has been discussed in all of the Programme Board meetings in 2011. The new strategy plan will be finalised at the end of the 2nd quarter in 2012. The strategy will apply for the period 2012-2020 and lays the foundation for a new programme plan and action plans for the period.

Events headed by CLIMIT

The CLIMIT secretariat carried out several workshops where top experts from Norway and abroad were invited to discuss the following topics:



WORKSHOP – INNOVATIV CO₂-FANGST

...fra laboratorium til industrisatsing

Amine emissions from CO₂ capture

On 5 and 6 December 2011, CLIMIT, Carbon Capture Mongstad (CCM) and TCM organised a workshop within the health and environment area related to use of amines. The event took place in the Research Council of Norway's offices in Oslo, and there were 52 participants from Australia, Belgium, Finland, Holland, Japan, Norway, Sweden, Germany and the US. The participants represented the environments that have participated in work for CCM, TCM and CLIMIT, and the authorities were represented through Klif and the Norwegian Institute of Public Health. One important objective of the workshop was information exchange across the projects, and ample time was set aside for discussion and questions. New knowledge has emerged, several knowledge gaps have been closed, and it looks promising for handling and understanding this problem.

Mineralisation – CO₂ storage and business idea

On 20 June 2011, CLIMIT organised a workshop called "Mineral storage – climate measure, value creation or both?" The meeting attracted about 25 researchers and experts from institutes, universities and companies within this area. The meeting highlighted different sides

of the mineralisation/value creation area through use of CO₂ through mineral reactions, as well as established a dialogue between different players.

Innovative CO₂ capture

"How do you achieve more innovative CO₂ capture?" This was the question when 30 enthusiasts from different expert environments within industry and research gathered to discuss for two days at the end of November 2011. The group work took place through the "World Cafe" method, and panel discussions and inspirational technical lectures contributed to a very successful workshop. Professor Nils-Otto Ørjasæter from the BI Norwegian Business School, facilitated the workshop. The results from the workshop have provided much useful input for CLIMIT's strategy process.

Amino acid results for CO₂ capture

A "Technology Deep Dive" workshop to highlight international activities and the status regarding salts from amino acids used as solvent in post combustion CO₂ capture was organised in Porsgrunn in February 2011. The event gathered about 30 participants from industry (Siemens, Statoil and Shell) and research environments (TCM, CSIRO, DTU, NTNU, SINTEF and HiT).



Participants at the Innovative CO₂ Capture workshop.

PhD seminar

CLIMIT organised a seminar for all PhD and PostDoc candidates in the programme in November 2011. This is an annual event which drew nearly 50 participants who reported that this was a very useful meeting place with good knowledge sharing and networking opportunities.

Conferences

The CLIMIT days were organised for the second time in 2011, with 140 participants. The conference was particularly directed at project managers in the CLIMIT programme, but other key players also participated in a successful event that presented a total of 31 lectures. The conference will be organised every other year in the future.

The secretariat for the CLIMIT programme has participated in several other major conferences and fairs during the year. Work has also been carried out to highlight the programme, e.g. at the Norwegian Society of Chartered Technical and Scientific Professionals' course days in Trondheim, the Energy Research Conference and the 6th Trondheim CCS Conference (TCCS-6).

Support for IEA Summer School 2011-2014

CLIMIT's Programme Board allocated NOK 280 000 in support for the IEA's CCS Summer School for the period 2011-2014. This is an annual event where doctorate students around the world are invited to one week of summer school with lectures by the international CCS elite. The summer school has contributed to promising young students establishing important international networks, while they are also motivated to continue their careers within CCS.

Lange Spor (Research progress on the energy front)

The «Lange spor CO₂» booklet was launched in the summer of 2011, and this publication documents results from over 20 years of research on CCS. The main conclusion is that experiences from CLIMIT, and the predecessors of the programme, have triggered pioneering research results and innovations. The booklet has been discussed extensively at conferences and seminars.

Evaluation of the CLIMIT programme

“The prospect for global spread of CCS technology is more likely now thanks to CLIMIT! The programme has also contributed to maintaining Norway’s leading position in many areas within CCS.”

This was Oxford Research’s conclusion in its evaluation of CLIMIT in 2011. The Programme Board ordered the analysis which includes 199 projects from the first six years of the programme. Oxford Research believes the CLIMIT programme has played an important part by stimulating relevant research, development and demonstration projects. Furthermore, CLIMIT has contributed to considerable knowledge development, and some of the research activities are within areas that could turn out to be next generation technology, according to Oxford Research.

The evaluation provides the following input for CLIMIT’s future strategy:

- Consideration must be given to the fact that the commercial potential for CCS in general and in Norway in particular, is limited in the short term
- The programme should develop a wider project portfolio and accept a higher risk profile
- The programme must facilitate increased international cooperation
- Basic research related to CCS should have a higher priority

One important contribution toward strengthening CLIMIT in the strategy period, is to consider re-notification of the programme to achieve higher government support intensity. Furthermore, a more multidisciplinary and wider international cooperation in the projects should be facilitated. Furthermore, the programme’s work method must be adapted to a situation with weak investment signals, for instance by contributing to create consortiums that can develop and lift major projects together. Finally, it



should be considered whether the programme should to a greater extent outsource tasks in the form of assessments and work related to expertise gaps where relevant applications are not submitted.

“In my mind it’s like testing a vaccine”



RESPONSIBLE FOR PROJECT: SINTEF

BUDGET: 93,763 MNOK

FINANCING: 51 % from CLIMIT

PROJECT PERIOD: 2009-2013

MARIA BARRIO

project manager CO₂ Field Lab

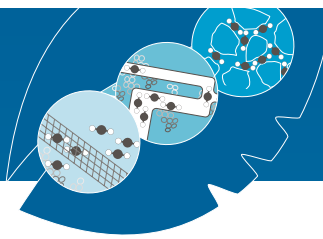
“What we want in the project is to develop a technology that can monitor CO₂. When you store CO₂, it needs to be safe: So we need to be able to say: Here’s the CO₂, and it’s not moving! To be certain the CO₂ does not move into areas it should not, we need equipment that can detect the smallest possible movements. Then we either *have* the technology as of today that is needed based on what exists in the oil and gas industry and other industry, or we *don’t*! This is what we are now testing in a large-scale laboratory at Svelvik in Hurum!”

Maria Barrio is enthusiastic about the project that is receiving steadily more attention because the focus on risk has increased.

“It has to do with public opinion in Europe! Are we doing things right? I often think that people are afraid of the unknown. Gas has been stored in Europe over many, many years without provoking any reactions. Storage of CO₂ is new – that is why it is so important to research what happens to stored CO₂ when the subsurface moves.”

“What is needed to convince the population in Europe and the rest of the world that CO₂ storage really *is* safe?”

“I think it is important to have multiple examples: That you can really travel to field laboratories in Germany,



Norway and several locations with different subsurface conditions and see with your own eyes what happens when you inject CO₂. You must also make it even clearer that *storing* CO₂ is a part of the fight for the climate against global warming.”

“What was the highlight of 2011?”

“The most important project achievement was that we actually injected CO₂! We ran a test last summer where we injected at a 20-metre depth. We had a lot of equipment placed on the ground, also near the injection site, so now we have considerable data on different monitoring technologies. We are still in the interpretation process because there is a lot of data that needs to be produced!”

“What have you found out?”

“Some technologies are better than others. That’s where we need time to process the information. There is still much to learn, as we want to be able to see much *quicker* how CO₂ moves. CO₂ is very special and geology is a major factor. We have seen that several technologies see the same, but we don’t know if it is sensitive enough. This has a lot to do with methods based on seismology and chemistry – are they suitable or not? Seismic is often used to find the *largest* occurrences of gas and oil possible, while here we want to find the answer to how *little* we can see. I am not a geologist, but to me, everything that takes place under the ground – what we cannot see – is a bit of a mystery!”

“What is the next big challenge for CO₂ Field Lab?”

“We want to inject at a depth of 200 metres, but we need to analyse the underlying geology to a greater extent *before* we start. Therefore there are several tests we want to carry out this summer to see how easy or difficult it is to inject CO₂ in these layers that are at depths of approximately 100 and 200 metres. We already *have* sand and clay layers, but it is important to find the correct places for the experiment to gather the most possible data. CO₂ Field Lab is very unique! There is a project in Montana where similar tests are being carried out, but only at depths of *two* metres. We are provoking an undesirable movement to study the technology. In my mind, it’s like testing a vaccine!”

“If the project shows that, as of today, we don’t *have* sufficiently accurate technology – then what happens?”

“Then we either need to test again and find new principles, or develop the technologies further. There is room for both research *and* players that want to establish a position within CCS business that develops technologies that are suitable for CO₂ storage and monitoring.”

“Field studies are expensive?”

“CLIMIT is making a very big effort, but the industry needs to step in as well. I don’t think it’s a lack of interest, but there is an aspect of commercial risk. It is difficult!”

“Otherwise, we see that there is significant interest in the work! We contribute actively to European projects that also use the field tests. It’s like a very large laboratory – and that’s how it should be! We want to contribute to a larger joint project where researchers from other countries can come to Svelvik, and researchers from Norway can go to other sites that are relevant to CO₂ storage.”

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