



ieaghgsummerschool
tenth anniversary
2007 - 2016

IEA GREENHOUSE GAS R&D PROGRAMME



International Energy Agency

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IEAGHG would like to thank all contributors to this booklet, without their input, it would not have been possible to create such a record of the past 10 years of the IEAGHG Summer School Network.

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Quotes used throughout this publication have been taken from completed feedback forms submitted by the students at the end of the week

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Background of the School

Carbon dioxide capture and storage (CCS) is now generally seen as a major contributor to reducing emissions of CO₂ into the atmosphere. In particular global implementation of CCS could allow large scale reductions of CO₂ emissions to be achieved before the end of the century. Presently, the potential of CCS is being explored in more than 100 projects around the world and international conferences serve as platforms to exchange the results from these activities amongst experts.

For wide scale deployment however, it is necessary to broaden the knowledge base in industrialised and developing countries, particularly at an academic level. Training courses or summer schools are one way of contributing to this, by accelerating and supporting the dissemination of knowledge on the potential for CCS to students around the world.



"The Summer School has exceeded my expectations. It is great that you are able to get so many leading experts to come and support us."

Introduction

The IEAGHG CCS Summer School was initiated to provide students with diverse academic backgrounds a broad understanding of the issues surrounding CCS and encourage their active participation in this area. The inaugural Summer School was held in Kloster Seeon, Germany in 2007 and the success of this event prompted IEAGHG to commit to an annual series at different locations around the world.

Having now held the 10th event in this series, we wanted to celebrate the milestone through this publication. With the help of the alumni and previous hosts, we have tried to capture the experiences of the week and share this through testimonials, an overview of the programme, statistics and photographs.

These Summer Schools could not be run without the financial support of the Series and Local Sponsors who we have listed on pages 6 and 7 and to whom we are indebted. The gratitude is also extended to the Expert Mentors who have so freely given their time and expertise to deliver the programme over the last 10 years.



Svalbard, Norway - Location of the 4th IEAGHG Summer School, 2010

Series Sponsors

Current Sponsors



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Rotation/Locations

"Keep doing such interesting Summer School for students interested in CCS"

2nd - Vancouver Island, Canada, 2008

4th - Svalbard, Norway, 2010

7th - Nottingham, UK, 2013

10th - Regina, Canada, 2016

6th - Beijing, PR China, 2012

8th - Austin, Texas, USA, 2014

5th - Champaign, Illinois, USA, 2011

1st - Kloster Seeon, Germany, 2007

9th - Perth, Australia, 2015

3rd - Lorne, Victoria, Australia, 2009

Programme

The Summer School is a week long exercise with presentations and discussion groups led by international experts in the field of CCS. In addition to the discussion programme, the students are broken into teams to undertake short research activities on issues of importance within the CCS area, with a presentation to their peers at the end of the week. Time is also allocated for networking and for informal discussions with the assembled experts. Students leaving at the end of the week will have developed a network of contacts in the field of CCS and will have gained a broad overview of the issues surrounding technology development and implementation in CCS.

The summer school programme covers every aspect of CCS and aims to present the most recent information available in each field. The topics covered include:

- Sources of CO₂
- Capture of CO₂
- Transport of CO₂
- Underground geological storage
- Mineral carbonation and industrial uses of CO₂
- Safety
- Costs and economic potential of CCS
- Regulatory regimes
- Implications of CCS for GHG inventories and accounting

"Understanding the perspectives of the industry, developed countries and NGO's really helped me get to know what the challenges and opportunities China is facing."



Presentations at the 6th Summer School, Beijing, PR China, 2012



Students at the 1st Summer School, Kloster Seeon, Germany, 2007



Students at the 6th Summer School, Beijing, PR China, 2012

IEAGHG SUMMER SCHOOL

Sun. July 17th

"I really like learning about economics and finance since, as a geologist it is so outside of my field"

"The information that I learned at the school really helped put my theoretical work into perspective"

18.00 - 18.30
Aboriginal Dancers and
Pre-Dinner Drinks

18.30 - 19.00
Welcome

19.00 - 20.00
Buffet Dinner

19.30 Onwards
Dinner Speakers

21.00
Evening Closes

Mon. July 18th

07.45 - 09.00

Networking Breakfast

09.00 - 09.30 Welcome and IEAGHG Overview

Jürgen-Friedrich Hake, FZJ; Tim Dixon IEAGHG; John Kaldi, CO2CRC; Mike Monea, SaskPower; Rhonda Smysniuk, SaskPower

09.30 - 09.50 Climate Change Overview

Beth Hardy, SaskPower

09.50 - 10.20 The Global CCS Scene

Tim Dixon, IEAGHG

10.20 - 10.50

Break

10.50 - 11.50 Storage 1 - Reservoirs, Traps, Seals & Storage Capacity

John Kaldi, CO2CRC & Uni. Adelaide

11.50 - 12.30 Storage 2 - Migration Pathways

Eric Nickel, PTRC

12.30 - 13.30

Lunch

13.30 - 14.00 Capture 1 - Oxyfuel

Max Ball, SaskPower

14.00 - 14.30 Storage 3 - EOR

Mike Monea, SaskPower & Ken From, PTRC

14.30 - 15.00 Capture 2 - Post-Combustion

Howard Matthews, SaskPower

15.00 - 15.30

Break

15.30 - 16.00 Policy - International
Jürgen-Friedrich Hake, FZJ

16.00 - 16.30 Legal and Regulatory, Carbon Accounting - International
Tim Dixon, IEAGHG

16.30 - 17.00 Policy - National
Beth Hardy, SaskPower

17.00 - 17.30 Introduction to Group Work & Presentation Skills
John Kaldi, CO2CRC & Sian Twinning, IEAGHG

17.50 - 19.00 Group Allocations and Dinner

Sian Twinning/John Kaldi

19.00 - 23.00
Group work

23.00 - Limit of Work Day

Tues. July 19th

07.45 - 09.00

Networking Breakfast

09.00 - 09.30 Storage 4 - Modelling
John Kaldi, CO2CRC & Uni. Adelaide

09.30 - 10.00 Storage 5a - Onshore & Offshore Monitoring & Verification (Shallow)

Katherine Romanak, Uni. of Texas

10.00 - 10.30 Storage 5b - Monitoring & Verification (Deep) Onshore

Kyle Worth, PTRC

10.30 - 11.00

Break

11.00 - 11.40 Storage Risk & Uncertainty
Simon O'Brien, Shell

11.40 - 12.00 CO₂ Utilisation
David Wassell, SaskPower

12.00 - 12.20 Hubs & Clusters
Tim Dixon, IEAGHG

12.20 - 13.20

Lunch

13.20 - 15.30

Group work

15.30 - 15.50

Break

15.50 - 16.40 Costs, Economics & Financing of CCS & Commercial Models
Peter Versteeg, SaskPower/Knowledge Center

16.40 - 17.30 Public Engagement & Communications
Rhonda Smysniuk, SaskPower & Norm Sacuta PTRC

17.30 - 18.00 Storage 6 - Wellbore Integrity
Kyle Glazewski, EERC

18.00 - 19.00
Group work

19.00 - 20.00

Dinner

21.00 - 23.00
Group work

23.00 - Limit of Work Day

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SCHOOL 2016 PROGRAMME

| Wed. July 20 th | Thurs. July 21 st | Fri. July 22 nd |
|--|--|--|
| Breakfast to go. Depart at 07.30, arrive Shand Power Station 10am | 07.45 - 09.00 Networking Breakfast | 07.45 - 09.00 Networking Breakfast |
| 07.30 Leave University of Regina | 09.00 - 09.40 CCS for Industrial Sources <i>Rouzbeh Jafari, Cansolv</i> | 09.00 - 09.20 Outline of the Day |
| 10.00 Arrive at Boundary Dam | 09.40 - 10.10 Health & Safety <i>Glenda Barton & Kevin Schwing, SaskPower</i> | 09.20 - 10.20 Final Preparations |
| Safety Orientation and PPE | 10.10 - 10.40 Capture 3 - Pre-Combustion <i>Raphael Idem, Uni. of Regina</i> | 10.20 - 10.50 Break |
| Tour of the Power Plant and Capture Facility | 10.40 - 11.00 Transport <i>Melanie Jensen EERC</i> | 10.50 - 14.00 Group Presentations |
| 12.00 - 13.00 Lunch at Boundary Dam | 11.00 - 11.30 Break | |
| 13.00 - 13.30 Aquistore Presentation | 11.30 - 11.50 Environmental Impacts of Capture <i>Erik Gjernes, Gassnova</i> | |
| 14.00 - 15.30 First Groups Depart for Shand Refreshment Break and Shand Tours | 11.50 - 12.10 Environmental Impacts of Storage <i>Katherine Romanak, Uni. of Texas</i> | 14.00 - 15.00 Lunch |
| 14.45 and 15.20 Buses Depart from Shand | 12.10 - 12.30 Induced Seismicity <i>Kyle Worth & Erik Nickel, PTRC</i> | 15.00 - 16.00 Technical Writing <i>Amr Henni, Uni. of Regina</i> |
| 18.15 Arrival at University of Regina | 12.30 - 12.50 NGO Perspective <i>Tim Dixon, IEAGHG</i> | |
| | 12.50 - 13.10 CCS & Renewables <i>Doug Opseth, SaskPower</i> | |
| | 13.10 - 14.10 Lunch | |
| | 14.10 - 16.20 Group Work | |
| 19.30 - 20.00 Refreshments and Nibbles | 16.20 - 16.50 Break | 16.00 - 19.00 Free Time |
| | 16.50 - 17.40 Energy Systems Modelling <i>Doug Opseth, SaskPower</i> | |
| | 17.40 - 18.40 General Qs & As | |
| | 18.40 - 19.00 IEAGHG SS2016 - A Conclusion <i>Jürgen-Friedrich Hake, GFZ; Tim Dixon IEAGHG; John Kaldi, CO2CRC</i> | |
| | 19.00 - 20.00 Dinner | |
| 20.00 - 23.00 Group work | 20.00 - 23.00 Group Work | 19.00 - 21.00 Final Dinner and Awards |
| 23.00 - Limit of Work Day | 23.00 - Limit of Work Day | |

Summer School Alumni



506 Students



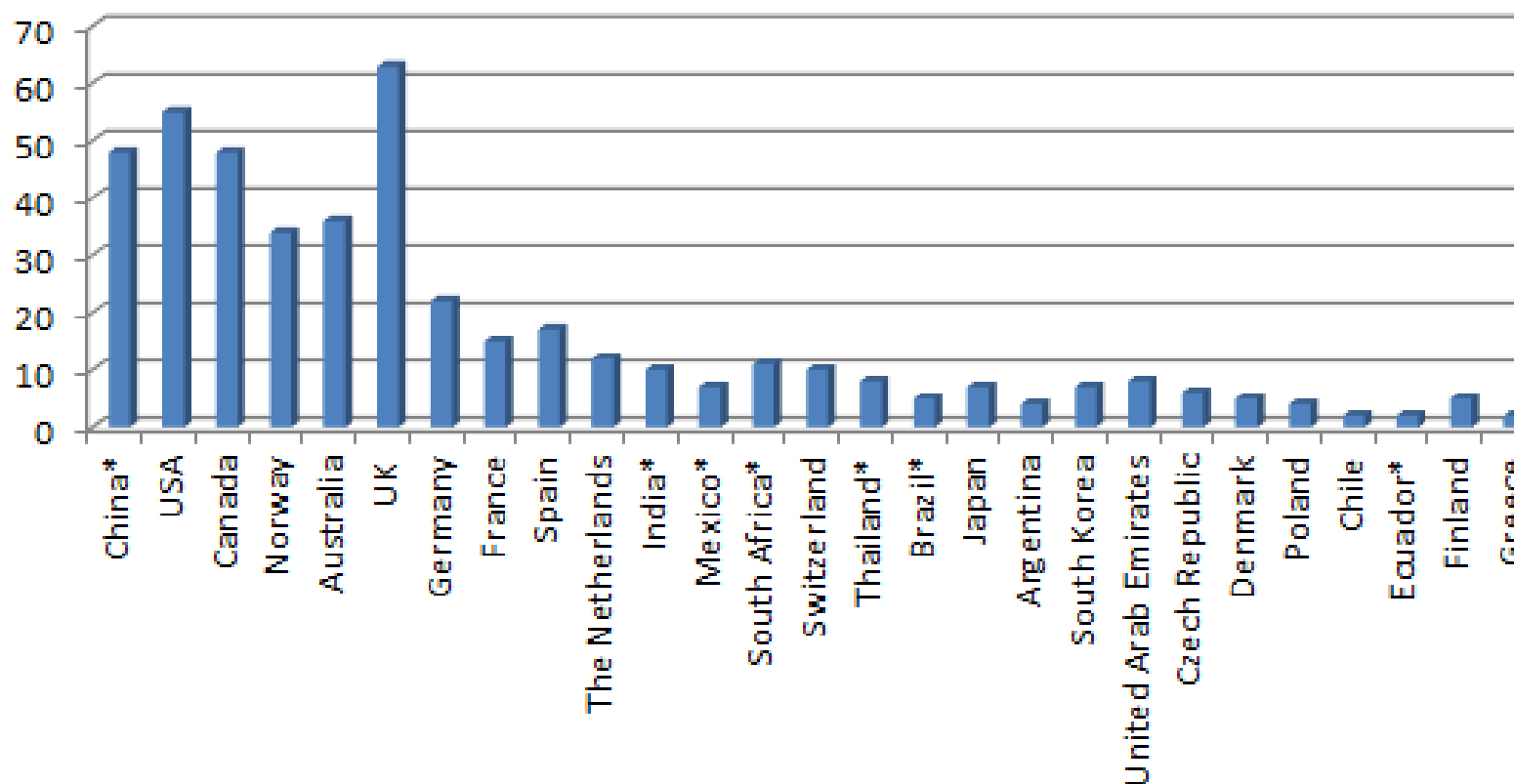
53 Countries



102 from 18 Developing Countries



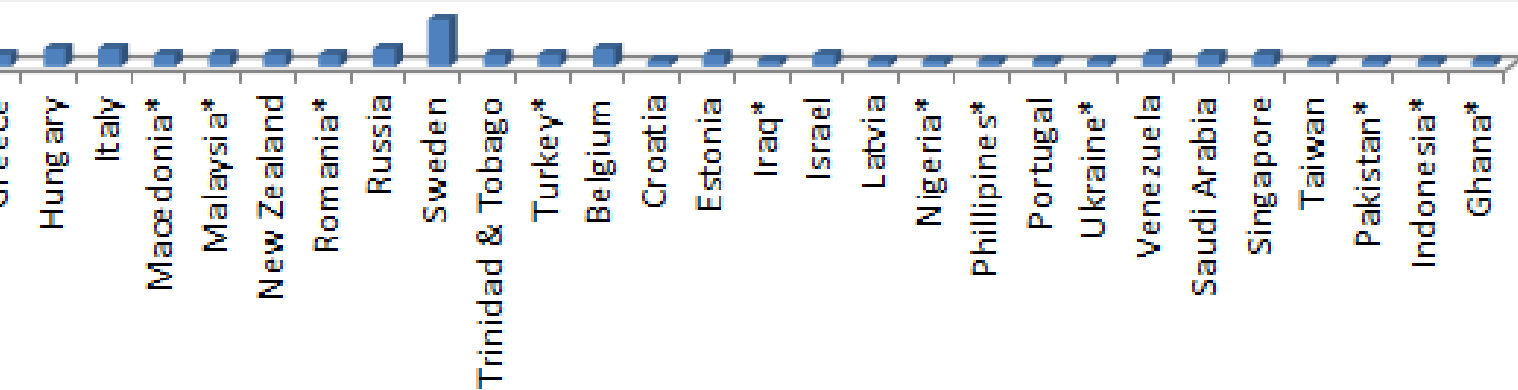
Many more nationalities represented



"The School will help immensely in the development and deployment of this technology in my country."



Attendees of the 8th Summer School in Austin, Texas, 2014



Blog from 2015, Perth, Australia

This blog was written by Karl McAlinden, Weparn Julian Tay and Kate Stechly, who are PhD students at the University of Nottingham, Imperial College London and University of Sheffield, respectively and received travel funding by the UKCCSRC to attend the 9th IEAGHG CCS Summer School in Australia.



Perth City Centre, Australia; Location of the 2015 Summer School

Three of us were very lucky to be selected among thirty participants from all over the world to attend the 9th IEAGHG CCS Summer School at University of Western Australia (UWA) in Perth in December 2015. A Summer School in the middle of December sounds a bit crazy, however, during this time Australia is preparing for the Christmas holidays with sunbathing, because the temperature at that time is about 30°C. All of us brought back good memories and it was definitely a remarkable experience to see a Santa in shorts and hearing Christmas carols such as 'Jingle bells' in such hot and sunny weather.

The summer school is a week long programme with presentations and group activities led by academics and industry experts in the field of CCS. This event brings together people with different backgrounds, such as engineering, geology, socio-economics etc. with the main focus being on CCS. The presentations topics include technical information on various capture technologies, storage site selection, capacity monitoring and modelling, wellbore integrity and transport; as well as other issues such as regulations, health and safety and public communication.

The summer school started on Sunday evening with the Welcome Reception and an Ice Breaker led by Brian Allison from DECC, which gave us a great opportunity to get to know each other.

Group Work

The participants were divided into groups of six with two mentors (the presenters) allocated to each group. We were all given different questions regarding CCS and we had to prepare a 15 minutes presentation followed by 15 minutes of a grilling Q&A session by the expert panel. We felt this was a good opportunity to apply the knowledge we learnt during the week as well as having in-depth discussions about different topics of CCS. The mentors were really helpful and great in supporting us throughout the entire week.

Field Trip

After two days of intensive presentations, a field trip was scheduled on the Wednesday in which we went to a leading research facility, the National Geosequestration Laboratory, part of the Australian Resources Research Centre, ARRC. The ARRC is a research centre which accommodates research students and staff from several research institutes including the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Curtin University, the University of Western Australia, the Australian National Measurement Institute, CO2CRC and other research organisations. Linda Stalker led the session by giving a presentation on the background of the South West Hub project which is a potential on-shore CCS project in Western Australia. We then had a tour around the laboratories where we looked at some mobile containerised laboratories for geophysical and geochemical equipment and monitoring equipment which allow the geologists to undertake both on-shore and off-shore field research. We were then brought to another laboratory with many advanced chromatography and spectroscopy equipment for rocks characterisation experiments. We also looked at a CT scanner and a Micro CT scanner for carrying out different scales of 3D core flooding and imaging experiments. After the lab visit, we travelled to the South West Hub located in Harvey which is famous for its beef and orange juice. The site at Harvey is the South West CO₂ Geosequestration Hub that consists of four CO₂ injection sites. We were first given an overview of the South West Hub Project and a presentation on seismic monitoring and characterisation. We then went to injection site 4 where we saw an injection well alongside a very sophisticated piece of seismic monitoring device. The sub-surface monitoring device gathers seismic data via some geophones buried underground and the data is transferred via optical fibre cables to the main monitoring device. After the field trip, we were given an opportunity to relax by visiting a brewery named the Old Coast Road which offers several kinds of its own brewed beers. One of the speakers, Martin Oettinger who is an Australian football fanatic, introduced us to Australia football. Everyone enjoyed their beers and a few of us had a 'kick about' time during the visit at the brewery. It was definitely a good time to enjoy the wonderful and sunny Australian weather.



Field Trip at the 2015 school

IEAGHG International CCS Summer School 2015 – Mentors & Participants



Summary

While scientifically and technically comprehensive, the CCS summer school covered a broad range of policy and social issues that made it a truly interdisciplinary meeting of future CCS professionals. With the topics of many CCS events often leaning heavily towards more technical issues, and justifiable so considering the technologies current stage of development, it was refreshing to see that international, policy and social issues had worked its way into the Summer School's programme.

From the outset, the level of, support for and from the local hosts was clear through the keynote speech from the Western Australian Minister Bill Marmion and the wide range of institutions, experts and mentors from the Australian CCS community. With this year being the ninth consecutive year of the school, it was clear that considerable time, effort and resources had been put into the organisation of the week-long event, with success, having been built on the experience from previous years to make it an excellent, although demanding, programme of events.

The IEAGHG CCS summer school is an amazing chance to be part of the CCS community. It combines people from different background, and is therefore an excellent opportunity for networking. It is an exceptional opportunity to meet great people, both from academia and industry, who are truly involved in what they are doing. There is so much motivation, ambition, determination, passion and engagement. Moreover, everyone is very keen to share knowledge and experience with others. Also, this Summer School helps to develop teamworking abilities and defines your role in the group. It is a place for so many discussions, brain storms and creativity. Moreover, it is an opportunity to meet other PhD students and exchange experiences during PhD research. You can realise that your research might be employed in real life, that there is an elite of people who are working on this subject and that there is a sense. It is a truly unique experience, hence we recommend others to apply for this in the years to come.

We would like to take the opportunity to thank IEAGHG for organising this wonderful CCS Summer School and all the presenters and participants for making this Summer School a success and, last but not least, a big thank you to UKCCSRC for the financial support to us.



John Kaldi's (Vice Chair) alter-ego, Dumbledore

Most Outstanding Student Award Recipients

"I am one more person out in the community for CCS... and I vote!"

2007

- Patricia Seevam – University of Newcastle, UK
- Prachi Singh – University of Twente, Netherlands
- Elizabeth Heischkamp – University of Newcastle, UK

2008

- Benjamin Court – Princeton University, USA
- Gareth Johnson – University of Calgary, Canada

2009

- Fen He – Tsinghua University, China
- Mischer Werner – ETH Zurich, Switzerland

2010

- Warren Reimer – University of Regina, Canada
- Gosia Stein-Brzozowski – University of Stuttgart, Germany

2011

- Viktor Andersson – Chalmers University, Sweden
- Carrie Petrik-Huff – University of Massachusetts, USA

2012

- Vivianne Romeiro – University of Maryland, USA
- Neils Berghout – Utrecht University, Netherlands

2013

- Rebecca Allen – King Abdullah University, Saudi Arabia
- Navdeep Kahlon – University of Nottingham, UK

2014

- Luc Steel – Edinburgh University, UK
- Grace Womak – Drexel University

2015

- Cesar Augusto Castaneda Herrera – University of Melbourne, Australia
- Norman McComb – Laing O'Rourke, Australia

2016

- Christophe Jenkins – Hydro-Québec, Canada
- Ruta Karolyte – Edinburgh University, UK



Best Group Recipients at the 9th IEAGHG Summer School, Perth, Australia, 2015

Student Testimonials

"As a technical guy, it was really interesting to see the complexity of CCS."

Cesar Augusto Castaneda Herrera



The Summer School was the perfect place to learn new concepts and improve the old ones. It gave me a better overview of other areas of CCS, even in topics which I am not familiar as capture and transport. Sharing the point of view of experts and fellow researchers helped me to understand how CCS is playing an important role in the new energy policies.

However, knowledge was not the only thing I got from the Summer School, I also met and make good friends. Coming from South America, studying in Australia and meeting all the other students from all over the world gave me a better understanding on how with my research I can contribute to CCS and how positions and interests of countries regarding CCS are different.

One of the things I will remember the most will be the group project. During the week of the Summer School, you need to develop a project CCS related with a group of fellow students who have different background. At the beginning, I saw it more as a challenge, which transformed in a more difficult one, but at the end

produced an excellent result. Starting my group did not communicate correctly but with time the ideas appeared and we were able to show a good display of our project. I learnt a lot about working in group, communication, creativity and leadership. The experience was so good that my group mates and I made a good friendship until now.

I definitely recommend other students interested in CCS to attend the Summer School, it will not be only an opportunity to learn the most updated information in CCS, but also the place where you can share experiences, meet people, practice skills and plan for your future.



Students at the 5th Summer School in 2011 Illinois, USA

Photo Courtesy of Lori Gauvreau of Schlumberger Carbon Services

Christophe Jenkins



The IEAGHG summer school has been an amazing experience. It is an incredible opportunity to learn about every aspect of CCS and even go into the fine details. The multidisciplinary thinking made that event interesting for students coming from diverse background not even directly related to CCS. The summer school not only teaches students about CCS but it is also creating the next generation of scientist. It is really appealing to have that experience in your resume because it will distinguish you from other candidates. During the event you can develop a wide international network with researchers and professionals which can open new opportunities for continuing studies or jobs.

At first, as an environmentalist, I didn't think I would be selected but I was, so don't hesitate to apply. The week was more fun than I had hoped for, thanks to the amazing IEAGHG team, and I recommend it to everybody that wants to learn more about this new environmental technology.



Students on a field trip at the 8th Summer School in 2014 Austin, Texas, USA



Core Samples at the 7th Summer School, 2013, Nottingham, UK



Students at the 4th Summer School in 2010 Svalbard Norway

Ruta Karolyte



I was delighted to have been offered a place at the IEAGHG Summer School and hoped off the plane in Regina excited to make the most of it. The week-long programme presented me with a valuable chance to put faces on some of the names I have been coming across in CCS literature for a while now, and equally, learn some new names I'm sure I will be hearing about in the future.

There are many social, economic and political issues on the way to wide-scale CCS deployment, many of which we had an opportunity to discuss during the week. As our group work experience showed, there are always plenty of solutions available if a number

of dedicated and enthusiastic people come together with a goal to answer a tough question.

That same principal really came to light during our visit to the Boundary Dam power plant, which is a wonderful case study of a successful CCS project only made possible by the collaborative efforts from the local government, research groups, industry and stakeholder organizations. I was impressed to learn how the local community in Saskatchewan has been involved in the project from the early stages. In fact I learned a lot about the reservoir characteristics at Aquistore from chatting to the catering team providing food for our excursion before we even visited the site – it was great to see the locals proud and very knowledgeable of the project.

One week in Regina offered me plenty of new connections and ideas that will stay with me for a long time on my professional path. I was honoured to be awarded the most outstanding student prize and to find out that my efforts and enthusiasm throughout the week have been noticed. Most importantly, I left Regina feeling I became a valued member of a truly resourceful and dedicated community of people, which certainly keeps me motivated at my day to day work back in Edinburgh.



Group Work at Nottingham, 2013,
location of the 7th Summer School

Group Work

In addition to the presentations provided by the Expert Mentors, the students are formed into groups at the beginning of the week and given a question on CCS to address and present the results to their peers on the Friday morning. The questions are designed to promote consideration of all aspects of CCS, to draw on the information provided in the programme as well as engaging the mentors and tapping into the knowledge each student brings with them. Teamwork is an essential part of the process and encourages inter disciplinary and cultural understanding, cementing the relationships built throughout the week.

The format of the presentation is open for the students to decide and we have seen anything from standard powerpoint presentations to hand puppet videos and game shows. Once the students have finished, the mentors take their turn to grill the students so knowledge of the background information used to compile the presentation is essential.

"I now have a better understanding of the international situation – co-operation is crucial!"

To recognise the effort the students put into the group work over the week, members of the International Steering Committee award the title of best group based on the presentations and questioning on the final day. Students receive a certificate and small gift celebrating the award. In addition, with assistance from the Expert Mentors two students are chosen to receive the Most Outstanding Student award, this is based on communication, team working, networking and analytical skills in addition to general and technical aptitude, enthusiasm, intellectual curiosity and conscientiousness.



Group Work at the 7th Summer School, Nottingham, 2013

International Steering Committee

The members of the International Steering Committee are responsible for overseeing the continual progression and development of the Summer School.

- Jürgen-Friedrich Hake, Forschungszentrum Juelich GmbH (Chair)
- John Kaldi, CO2CRC (Vice-chair)
- Tim Dixon, IEAGHG (Co-chair)
- Brian Allison – DECC
- Britta Paasch/Sveinung Hagen - Statoil
- Åse Slagtern - The Research Council of Norway
- Tim Bertels/Owain Tucker – Shell
- Gunter Siddiqi – Swiss Federal Office of Energy
- Sian Twinning – IEAGHG

"I now have an idea how to speak to people about CCS to increase awareness in my community."

Participants at the 2nd Summer School, 2008, Vancouver Island, Canada



Jürgen-Friedrich Hake, Forschungszentrum Juelich GmbH (Chair of the International Steering Committee)

Students at the 7th Summer School, Nottingham, UK, 2014



Message from the 2015 Host



I was at an IEAGHG Monitoring Network meeting in Canberra, Australia when the subject of Australia hosting a future IEAGHG CCS Summer School first came up. Previously, Australia hosted the 3rd meeting in Victoria, on the east coast (and handy for the CO2CRC Otway Project). It wasn't until the GHGT-12 meeting in Austin, Texas, that Prof. John Kaldi and Tim Dixon approached me to see if I would participate on the organising committee with them. Naturally, I jumped at the chance to host the Summer School, this time on the west coast, where we could showcase the South West Hub CCS Project! All agreed it had to be in the summer (not the northern hemisphere summer, but Australian summer).

"Networking and information / knowledge provided by this Summer school will help the future collaboration among overseas researchers."

The meeting was held at the picturesque University of Western Australia Campus and aside from a total washout of a BBQ on the first evening (worst December day in 50 years or so), the rest of the week was glorious sunshine.

We received tremendous benefit from hosting this meeting from a number of perspectives; firstly we met a wonderful group of truly motivated students, eager to learn, inquisitive, engaged and really ready to apply the knowledge they were gaining. Secondly, we met a group of mentors and speakers from a range of international organisations, at the top of their CCS game, with direct hands-on knowledge of commercial scale CCS activities in other countries. Here we got first-hand information on what was going out there! Thirdly, we were able to showcase experience, expertise and our activities in Australia to the international community through the local talent that joined as mentors and speakers for the school. The field trip to the South West Hub took everyone into the middle of the community of Harvey to see exactly how the project was perceived by the Shire President and locals in the region. Many got up close and personal with a well head and field equipment, an opportunity that isn't so readily done in industry.

By the end of the week, I'm fairly sure that there was some lifelong networking instigated and a massive acceleration in the knowledge acquired by the students of the summer school. Being able to facilitate the program and deliver this experience was a real privilege. I can't wait to attend one of these as a mentor myself!

*Dr Linda Stalker
CSIRO National Geosequestration Laboratory
Host of the 9th IEAGHG Summer School in Australia, 2015*





Students at SaskPower's Boundary Dam project as it achieves its millionth tonne, at the 10th Summer School, Regina, Canada



Students at the 7th Summer School, Nottingham, UK 2013

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