
Asia-Pacific
Economic Cooperation

# CCS Capacity Building in Mexico

**Asia-Pacific Economic Cooperation's Energy Working Group**

**May 2015**


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Economic Cooperation

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**APEC Energy Working Group**

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**Acknowledgements**

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The authors wish to thank the following for their contributions to this effort. Dr. Moises Davila Serrano, Mexico's CCS Coordinator, facilitated coordination of the workshops and assisted the project team in engaging with CCS stakeholders in Mexico. We would also like to thank Mr. Leonardo Beltran of SENER, Rodolfo Lacy of SEMERNAT and Ms. Jazmin Mota of CFE for their support

We would also like to thank PEMEX and Mr. Frank Mourits of the World Bank for their support of this project.

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# 1. Introduction and Project Objectives

## 1.1 Introduction

Mexico is the 7th largest emitter of $CO_2$ in the APEC region. Approximately 80% of the electricity produced in Mexico is generated using fossil fuels. Although renewable energy sources to generate electricity will increase in the future, fossil fuels will continue to provide a majority of Mexico's energy needs for at least two more decades. Given these challenges, Mexico is planning to reduce its $CO_2$ emissions through carbon capture and storage (CCS)[1] and has emerged as one of the first developing APEC economies to make a commitment to introduce CCS.

According to the International Energy Agency (IEA), CCS is the only technology that can achieve deep $CO_2$ emissions reductions from fossil fuel use in power plants and other large-scale emitters, while minimizing the overall costs of the portfolio of abatement options. The IEA has forecast that CCS will need to contribute one-fifth of the required global emission reductions by 2050. Given the large potential of CCS, developing APEC economies need to start gaining a good understanding of all aspects of CCS, including technical, economic, financial, legal, regulatory and social issues, and to increase their capacity to assess the potential of implementing this technology within their own economies.

This project seeks to support Mexico in developing and implementing CCS by building capacity among stakeholders in government, industry and academia. As described in greater detail below, the project comprises a series of workshops, a technical protocol for assessment of storage, and an on-line training program. The educational components of the project include three workshops targeted at specific audiences, especially the provision of training to key CCS educators. The technical track comprises the development of technical protocols for the assessment of the storage potential of deep saline formations in Mexico and other APEC economies.

The workshops disseminate CCS knowledge and know-how covering key issues concerning the CCS chain including capture, transport, use and storage in the context of Mexico's circumstances and based on Mexico's CCS Roadmap initiated in December 2013 to develop CCS technology. As a result of attending the workshops, delegates acquired an understanding of the current status of $CO_2$ geological storage, knowledge of existing best practices, and appreciation of challenges ahead for commercial deployment of CCS/CCUS.

This project continues a series of APEC CCS capacity building workshops that started in 2005. APEC workshops held under the title "Increasing the Knowledge and Awareness of Carbon Capture and Storage: Capacity-Building in the APEC Region" were hosted in South Korea (Phase II – EWG 02/2004); China and Mexico (Phase III – EWG 07/2005); Indonesia and China (Phase IV – EWG 09/2008); and Viet Nam and Mexico (Phase V – EWG 05/2010A). The APEC CCS capacity-building workshop held in Mexico in 2007 (EWG 07/2005) was credited with widely introducing CCS concepts to senior decision-makers from government, industry, and academia. The second APEC capacity-building workshop in Mexico, held in June 2012 (EWG 05/2010A), focused on explaining $CO_2$ storage concepts to undergraduate students in the geosciences. This focus was based on Mexico's approach to building CCS capacity and awareness from the bottom up – that is starting with schools and universities. A third APEC project (EWG 04/ 2010) conducted an initial assessment of Mexico's laws and regulations for permitting CCS in 2012, which included meetings with stakeholders from the government, industry, academia and civil society as part of the regulatory assessment and capacity building efforts.

Mexico is aggressively pursuing the development of CCS. Discussions concerning the adoption of CCS by Mexico have been ongoing since CCS technology was introduced in the National Climate Change Strategy developed in 2007. Starting in 2012, Mexico initiated work on detailed assessments of its considerable $CO_2$ storage potential and evaluations of CCS pilot plant options. In December 2013, a government-led process was initiated to develop, with the participation of all CCS stakeholders in Mexico, a national CCUS Roadmap that will integrate the various CCS activities, including capacity building. Mexico, with support from the World Bank, launched in 2014 projects to assess the technical feasibility of a commercial-scale CCS plant and an assessment of Mexico's laws and regulations

[1] CCS is understood to include CCUS technology (carbon capture, utilization and storage), in which all or some of the captured $CO_2$ will be utilized rather than directly stored.

to support Mexico's development of a legal framework for CCS.

The Mexico CCUS Roadmap sets an aggressive timeline for adoption of the CCUS technology including planning for two pilot programs that could launch as early as 2016. Site selection for the first EOR pilot program is scheduled to begin in early 2015, followed by laboratory analysis and test design. The second pilot project will be a $CO_2$ capture pilot from a power plant, fired by either coal or natural gas.

As Mexico is one of leading developing APEC economies in building CCS knowledge and capacity, and assessing its storage resources, lessons learned from Mexico will be widely applicable and can be transferred to other developing APEC economies.

### 1.2 Project Objectives

The three key objectives of the project are to:

Organize three targeted workshops to train the following stakeholders to support the development of CCS technology in Mexico:

□□□□□□□□□□□□□Geologists from industry, academia and other institutions involved in $CO_2$ storage capacity assessments. This workshop was held in August 2014 in Mexico City. Events were held at northern universities, because this region is a major generator of industrial $CO_2$ emissions.

□□□□□□□□□□2□□Students and faculty linked to the National Association of Schools of Engineering. This workshop was held at the CFE Technology Museum in Mexico City in September 2014. The workshop concentrated on the different stages of CCS, involving the capture, transport and injection of $CO_2$.

□□□□□□□□□□3□□Undergraduate students in the earth sciences of universities not included in the June 2012 workshop on CCS held in Mexico City. This workshop was held at the University of Sonora in Herosillo Mexico in January 2105. The workshop location was selected to assist northern universities.

Develop technical protocols and staff capability for the assessment of $CO_2$ storage capacity in selected deep saline formations, with a focus on the particular characteristics of the basins of the Sabinas and Burgos Basins.

Provide comprehensive on-line CCS training to and certification of selected teachers/educators in the earth sciences. Topics included CCS in industry, legal and regulatory frameworks, and public outreach and education. The on-line training is designed to prepare CCS professionals for dealing with stakeholders.

### 1.3 Recommendations for Future Action

Mexico is emerging as a center for CCS among developing economies. Its efforts are both to support its own national goals, but will also be for the purpose of outreach to other APEC economies. Our recommendations are aimed at supporting Mexico both in its domestic objectives and potential opportunities for outreach.

The following recommendations are drawn from workshop results, survey results and project participants:

- Mexico's domestic training efforts could be emulated or, with appropriate adjustment for local conditions, adapted for use by other developing economies;
- Support on economics of CCS could facilitate Mexico's efforts in developing and maintaining its CCS Roadmap;
- Creation of a CCS Center to provide ongoing resources for continued development of CCUS in Mexico;
- Additional training workshop to support Mexico's proposed CCUS pilot projects; and

- Promote Mexico's planned CCS Masters program among other APEC economies.

# 2. Workshops

## 2.1 Workshop 1: Geological Training

### *2.1.1 Workshop Overview*

August 26-27, 2014
Mexico City
DF IPN Auditorium
Approximatley 50 Participants and Speakers

The workshop was attended by 50 geologists from industry, academia and research institutions. Participants were drawn from government, industry and academia and expert organizations.

The workshop covered a range of topics in order to assist Mexico in its current efforts to adopt CCUS technology. The workshop opened with presentations by SENER of Mexico's CCUS Roadmap, described in greater detail below, and a presentation by SEMERNAT describing the CCUS lifecycle in the context of Mexico. Several speakers presented on Mexico's geology including PEMEX's efforts to date on EOR applications, monitoring, measurement and verification (MMV), and risk management. Other presentations focused on the business case for CCUS and Mexico's laws and regulation relevant to CCUS-EOR.

The workshop featured exchange of expertise among APEC economies on the development of CCUS projects in Mexico. □□□□workshop included presentations by PEMEX and Universidad Nacional Autónoma de México (UNAM) focusing on EOR opportunities in existing fields, as well as the Burgos and Sabinas deep saline aquifers in Mexico, which are also the subject basins for the storage assessment protocol for this project. Experts from the United States and Canada presented experience from the Weyburn-Midale CCS project (North Dakota and Saskatchewan), and the Plains $CO_2$ Reduction (PCOR) Partnership Program's Bell Creek (Montana) and Fort Nelson (British Columbia) CCS projects funded by the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Program. The U.S. company Summit Power presented on the business case for CCUS. Experts from UNAM, University of North Dakota, University of Alberta, the Global CCS Institute and Peoples University of China presented on subsurface geology and techniques, MMV and regulatory issues.

### *2.1.2 Workshop Agenda*

| ADVANCED WORKSHOP FOR $CO_2$ STORAGE | |
|---|---|
| **Tuesday 26 August 2014**<br>**DF IPN Auditorium** | |
| **8:30 AM** | **Registration** |
| **9:00 AM** | **Welcome – *Mauricio Pico, FECIT*** |
| **9:15 AM** | **Introduction & Overview on APEC – *Bob Wright, US DOE*** |
| **9:30 AM** | **$CO_2$ Sources and Climate Change – *Rafael Acosta, CFE*** |
| **10:00 AM** | **Mexico CCUS Roadmap – *Dr Moises Davila, SENER*** |
| **10:30 AM** | **CCUS Life Cycle Analysis - *Deputy Secretary, Rodolfo Lacy – SEMERNAT***<br>**Case Study: Mexico** |
| **11:15 AM** | **Global Status of CCS/CCUS – *Meade Harris Goodwin, GCCSI*** |
| **11:35 AM** | **Coffee/Tea Break** |
| **12:00 AM** | **Basics of Geologic Storage – *Neil Wildgust, GCCSI***<br>➢ Site selection<br>➢ Site characterization<br>➢ Trapping mechanisms |
| **12:30 PM** | **CCS R&D Programs in the US – *Ed Steadman, PCOR & EERC***<br>➢ **Examples from the Regional Partnerships** |
| **1:00 PM** | **Lunch** |
| **1:30 PM** | **Well Logging for Petrophysics – *Ricardo Castrejon, UNAM***<br>➢ Example of the Sabinas Basin |
| **2:30 PM** | **$CO_2$ Storage Capacity Assessment – *Ed Steadman, PCOR & EERC***<br>➢ Methodological differences<br>➢ Storage efficiency factors<br>➢ $CO_2$ Storage Assessment Scales & resolution<br>➢ Basin and/or Regional Scale screening<br>➢ Desirable Characteristics and Eliminatory Criteria of Sedimentary Basins |
| **3:30 PM** | **EOR versus Storage – Ed Steadman, PCOR & EERC**<br>➢ Examples of EOR & Storage Case studies- Bell Creek<br>➢ EOR & Storage Case, Weyburn – Neil Wildgust, GCCSI |
| **4:30 PM** | **Storage Capacity Estimation and Atlas Documents – *Bob Wright, US DOE*** |
| **5:00 PM** | **Wrap of day 1 – *Mauricio Pico, FECIT*** |

| **Wednesday 27 2014**<br>**DF IPN Auditorium** | |
|---|---|
| **8:30 AM** | **Registration** |
| **9:00 AM** | **Welcome** – ***Mauricio Pico, FECIT*** |
| **9:15 AM** | **Modeling $CO_2$ Injection into Saline Aquifers** – ***Dr Gonzalo Zambrano N, University of Alberta***<br>➢ Analytical modeling techniques<br>➢ Numerical modeling techniques |
| **10:15 AM** | **Monitoring, Measuring and Verification (MMV)** – ***Dr Gonzalo Zambrano N, University of Alberta***<br>➢ Surface and near-surface monitoring<br>➢ Overburden monitoring<br>➢ Injection zone monitoring |
| **11:30 AM** | **Coffee Break** |
| **12:00 AM** | **CCS Risk Analysis** – ***Neil Wildgust, GCCSI***<br>➢ Confining system<br>➢ Well integrity and leakage pathways<br>➢ Induced seismicity |
| **1:00 PM** | **PEMEX's EOR Strategy for $CO_2$ Injection** – ***Dr Fernando Rodriguez De la Garza, PEMEX***<br>➢ **Case Studies in Mexico** |
| **2:00 PM** | **Lunch** |
| **3:00 PM** | **CCS/CCUS Regulatory Framework for Mexico** – ***Craig Hart, Renmin University of China*** |
| **3:30 PM** | **Business Case for CCUS** – ***Sasha Mackler, Vice President, Summit Carbon Capture – Summit Power*** |
| **4:00 PM** | **Monitoring for Green House Gas Compliance** – ***Pam Tomski, GCCSI*** |
| **4:30 PM** | **Wrap –up and conclusions** – ***Neil Wildgust, GCCSI & Meade Harris Goodwin, GCCSI*** |
| | |

### *2.1.3 Workshop Participants*

| Name | Organization |
|---|---|
| Bernardo Martell Andrade | CFE |
| Carmen Reynoso Martínez | CFE |
| Rocío Carbajal Martínez | CFE |
| Jazmín Mota Nieto | CFE |
| Rafael Acosta Quevedo | CFE |
| Raúl Portillo Reséndez | CFE |
| Guillermo Ortega Rodríguez | CFE |
| Tomás Grijalva Rodríguez | CFE |
| Diego Amancio Rojas | CFE |
| Erik Medina Romero | CFE |
| Graciela Hernández | CMM |
| Gerardo Ríos | CMM |
| Roberto García de León | IMP |
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| Rubén Hernández Monter | SEMARNAT |
| Erika Guzmán Torres | SEMARNAT |
| Ricardo Pérez Zamora | SEMARNAT |
| Martín Carlos Vidal García | UNAM |
| Beatriz Mónica Pérez Ibarra | UNAM |
| Daniel Vázquez Medina | UNAM |
| Cristina Ayala Monroy | UNAM |
| Diego pacheco Osorio | UNAM |
| Juan Sánchez Pérez | UNAM |
| Ricardo Castrejón Pineda | UNAM |
| Mayumy Amparo Cabrera Ramírez | UNAM |
| Ricardo José Padilla y Sánchez | UNAM |
| Martín Cárdenas Soto | UNAM |

### *2.1.4 Workshop Presentations*

Workshop presentations are reproduced four slides per page below. If viewed using a PDF reader, slides can be enlarged in high resolution.

## 2.2 Workshop 2: Engineering Training

### *2.2.1 Workshop Overview*

September October 13-14, 2014
Mexico City
CFE Technology Museum
200 Participants

The workshop was attended by a broad audience of 200 individuals comprising students, professors, educators and officials of major engineering faculties.

With leading international speakers from the USA, Canada, Norway and Belgium, the meeting provided a high level summary of the status of CCS/CCUS projects and programs, both globally and with specific reference to Mexico. The workshop opened with presentations by the DOE and CFE which first discussed climate change and $CO_2$ emissions. Both presentations gave the context as to why CCUS is seen as a critical mitigation technology if we are to successfully address climate change. The Global CCSI Institute reported on the global status of CCUS/CCS projects, and on the opening of Saskpower's Boundary Dam project in Canada on October 1, 2014 – the first CCS project involving a coal fired power station.

SEMERNAT described the CCUS lifecycle in the context of Mexico. Several speakers presented on Mexico's geology including PEMEX's efforts to date on EOR applications, monitoring, measurement and verification (MMV), and risk management.

As the audience for this particular workshop included students who may have not have prior experience with CCS/CCUS concepts, The workshop gave delegates a detailed overview on $CO_2$ capture technologies, including post-combustion, pre-combustion, oxy-combustion, and $CO_2$ capture in industrial processes. Also, presentations covered the basic geology of CCS/CCUS-EOR introduced subsurface concepts.

The workshop featured the sharing of experience in CCUS-EOR projects. PEMEX reported on their overall CCS EOR strategy as well as a case study on their projects in Southern Mexico. Experts from the United States and Canada presented experience from the Weyburn-Midale CCS project (North Dakota and Saskatchewan). Attendees learned about the largest carbon capture project in the world, the TCM Mongstad project based in Norway. The US DOE presented on RD&D CCUS projects supported by the US Government.

Workshop participants exchanged ideas around the value of knowledge sharing in Mexico and identified key networks, which could help enable knowledge transfer. In addition to the wok of the Global CCS Institute in this area, two more technical networks are the EC Project which shares knowledge between European projects and the Capture Test Network which has participants from the US and Norway.

Other presentations focused on issues such as public engagement and Mexico's laws and regulation relevant to CCUS-EOR. One of the key points is that CCS demonstrations are being planned all over the world, with many different cultural and social situations. The site-specific nature of engagement makes a ‘one size fits all approach’ impractical. However there are common experiences that can be shared and applied.

The Mexico CCUS Roadmap presented by SENR set an aggressive timeline for adoption of the CCUS technology including planning for two pilot programs that could launch as early as 2016. Site selection for the first EOR pilot program is scheduled to begin in early 2015, followed by laboratory analysis and test design. The second pilot project will be a $CO_2$ capture pilot from a power plant, fired by either coal or natural gas. The World Bank presented an overview of its activities in support of the Mexican Government in advancing CCUS Roadmap in Mexico.

The workshop closed with a discussion of opportunities for students in the CCS/CCUS field and then a final overview session, both led by the Global CCS Institute.

### *2.2.2 Workshop Agenda*

**WORKSHOP FOR CIVIL, CHEMICAL, ELECTRICAL, ENVIRONMENTAL AND MECHANICAL ENGINEERS: INTRODUCTION TO CAPTURE, USE AND GEOLOGICAL STORAGE OF $CO_2$**

| **Monday 13 October 2014**<br>**DF CFE Technology Museum** | |
|---|---|
| **14:30 PM** | **Registration** |
| **15:00 PM** | **Welcome – *Mauricio Pico, FECIT*** |
| **15:15 PM** | **Introduction & Overview on APEC – *Robert Wright, US DOE*** |
| **15:30 PM** | **$CO_2$ Sources and Climate Change – *Rafael Acosta, CFE*** |
| **16:00 PM** | **Global Status of CCS/CCUS – *Dr Elizabeth Burton, GLOBAL CCS INSTITUTE*** |
| **16:30 PM** | **CCUS Life Cycle Analysis - *Deputy Secretary, Rodolfo Lacy – SEMARNAT***<br>**Case Study: Mexico** |
| **17:15 PM** | **Coffee/Tea Break** |
| **17:45 PM** | **Overview on Capture Technologies - *Guido Magneschi, GLOBAL CCS INSTITUTE***<br>**CCS systems overview**<br><br>**Post-Combustion**<br>➢ **Technology description**<br>➢ **State of the art: chemical absorption with amine-based solvents**<br>➢ **Large post-combustion systems: main developers**<br>➢ **New technologies for post-combustion**<br>**Pre-Combustion**<br>➢ **Technology description**<br>➢ **State of the art: absorption with physical solvents**<br>➢ **New technologies for pre-combustion**<br>**Oxy-Combustion**<br>➢ **Technology description**<br>➢ **State of the art: atmospheric oxy-combustion**<br>➢ **Oxygen production: Air Separation Units (ASU)**<br>➢ **Future developments in oxy-combustion**<br>**$CO_2$ capture in industrial processes**<br>➢ **Oil and Gas Refining**<br>➢ **Cement production**<br>➢ **Iron & Steel production** |
| **18:45 PM** | **Capture technologies - *Case study on projects - Ron Munson & Guido Magneschi, GLOBAL CCS INSTITUTE***<br>➢ Port Arthur project in Texas<br>➢ Snovit Project in Norway<br>➢ Peterhead project in Scotland |
| **19:30 PM** | **Close of day 1 – *Mauricio Pico, FECIT*** |

| **Tuesday 14 October 2014**<br>**DF CFE Technology Museum** | |
|---|---|
| **8:30 AM** | **Registration** |
| **9:00 AM** | **Welcome – *Mauricio Pico, FECIT*** |
| **9:15 AM** | **Overview on compression and transport of $CO_2$ – *Neil Wildgust* & Ron Munson, *Global CCS Institute*** |
| **9:30 AM** | **International Knowledge Networks- *Guido Magneschi, Global CCS Institute* & *Vegar Stokset, Test Centre Mongstad***<br>➢ Test Centre Network (TCN)<br>➢ EU CCS Demo Network |
| **10:00 AM** | **Progress made and the way forward at the World's biggest CCS Test Centre in Norway – *Vegar Stokset, Test Centre Mongstad*** |
| **10:30 AM** | **Basics of Geologic Storage – *Neil Wildgust, Global CCS Institute***<br>➢ Site selection<br>➢ Site characterization<br>➢ Trapping mechanisms |
| **11:00 AM** | **Coffee/ Tea Break** |
| **11:30 AM** | **EOR & Storage – *Neil Wildgust, Global CCS Institute***<br>Examples of EOR & Storage Case studies: Weyburn |
| **12:00 AM** | **PEMEX's EOR Strategy for $CO_2$ Injection – *Dr Fernando Rodriguez De la Garza, PEMEX***<br>Case Study on Mexico |
| **12:30 PM** | **Lunch** |
| **13:30 PM** | **Life Cycle Analysis for PEMEX EOR-$CO_2$-CCS Project in Southern Mexico –**<br>➢ ***Miguel Angel Morales, PEMEX*** |
| **14:00 PM** | **Examples of CCS R&D Programs in the US - *Dr Robert Wright, US DOE*** |
| **14:30 PM** | **Why does public understanding matter?- *Meade Harris Goodwin, Global CCS Institute*** |
| **15:00 PM** | **CCS/CCUS Regulatory Framework for Mexico- *Pamela Tomski, Global CCS Institute*** |
| **15:30 PM** | **Mexico CCUS Roadmap – *Dr Moises Davila, SENER*** |
| **16:00 PM** | **Overview of World Bank Activities in Mexico- *Dr Frank Mourits, World Bank*** |
| **16:30 PM** | **Panel discussion on future opportunities for Students- *Led by Pamela Tomski, Global CCS Institute*** |
| **16:45 PM** | **Wrap –up and conclusions – *Dr Elizabeth Burton, Global CCS Institute*** |

### *2.2.3 Workshop Participants*

| Name | Organization |
|---|---|
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| Ulises Salgado Villarreal | IPN |
| Mariana Almaraz Espejo | UNAM |
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| Lesly Yanauri García Chávez | IIE |

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| Luis Alfonso Muñozcano Alvarez | SEMARNAT |
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| Margarito Sánchez Álvarez | PEMEX |
| María Andrea Suárez García | UNAM |
| María del Carmen Reynoso Martínez | CFE |
| María Rafaela Gutiérrez Lara | UNAM |
| María Ulbaldina del Rosario Álvarez Rivera | UNAM |
| Martha Angélica Elizondo Sámano | UNAM |
| Martha E. Toral Solórzano | PEMEX |
| Martín Carlos Vidal García | UNAM |
| Maudiel Aguilar Domínguez | PEMEX |
| Mauro Castillo Hernández | ITTLA |
| Miguel A. Morales Mora | PEMEX |
| Miguel Ángel Urbina Hernández | PEMEX |
| Miguel Balcazar | ININ |
| Miriam Velasco Villarreal | UNAM |
| Moisés Magdaleno Molina | IMP |
| Nicanor Álvarez Lozada | GRUPO ETANOL DE MÉXICO |
| Norma Estela González Barrera | UNAM |
| Omar Santillán Serrano | ININ |
| Oscar Javier Dosta Rodríguez | COFEMER |
| Oscar Quintero | SLB |
| Paulina Serrano Trespalacios | PEMEX |
| Pedro Javier López | UNAM |
| Rafael Acosta Quevedo | CFE |
| Raúl Hinojosa Franco | SENER |
| Raúl Portillo Reséndez | CFE |
| Ricardo Pérez Zamora | SEMARNAT |
| Ricardo Ramsés Arreguin Juárez | SEMARNAT |
| Roberto García de León | IMP |
| Roberto Isaac Juárez Vázquez | ININ |
| Rocío Carbajal Martínez | CFE |
| Rodrigo Martín Sánchez Flores | UNAM |
| Roeb García Arrazola | UNAM |
| Rogelio Franco López | CFE |
| Rosa María Jiménez Olmos | UNAM |
| Rosalba Cruz Jiménez | EMBAJADA CANADÁ |
| Rubén Hernández Monter | SEMARNAT |
| Samuel Feregrino Gómez | ITTLA |
| Simón López Ramírez | UNAM |
| Sofía del Pilar Mendoza Castillo | SGM |
| Tania Huerta Flores | BUAP |
| Thomas Weber | JUPITER OXIGEN |

| | |
|---|---|
| Yolanda Araceli Balderas Ramírez | CFE |
| Yoselín Gómez Peña | UNAM |

### *2.2.4 Workshop Presentations*

Workshop presentations are reproduced four slides per page below. If viewed using a PDF reader, slides can be enlarged in high resolution.

## 2.3 Workshop 3: Earth Sciences Training

### *2.3.1 Workshop Overview*

January 22 - 23, 2015
University of Sonora, Hermosillo, Mexico
Hermosillo CFE Capacity Auditorium
225 Participants

The third workshop was held at the University of Sonora in northern Mexico. Although primarily designed for students and professors, more than 200 participants, including geologists, geophysicists and reservoir engineers with an interest in $CO_2$ (carbon dioxide) geological storage and enhanced oil recovery (EOR), attended the workshop. Mexican partners for the event included SECRETARÍA DE ENERGÍA (SENER), Comisión Federal de Electricidad (CFE), FECIT, PEMEX, Universidad Nacional Autónoma de México (UNAM), Instituto Politécnico Nacional (IPN) and Fondo de Sustentabilidad Energética.

The workshop was held in Northern Mexico in order to encourage the participation of northern universities (e.g., University of Sonora, Nuevo Leon, Tamaulipas), given the fact that the largest generation of $CO_2$ is in the north and $CO_2$ use opportunities are also greatest in the north.

Following a review of the fundamental principles of geological storage, experts from the US, Canada and Mexico delivered technical presentations on:

- storage capacity assessment;
- risk analysis and predictive modeling;
- monitoring and verification; and
- storage associated with $CO_2$-EOR.

The meeting also provided participants with a high level summary of the global status of CCS/CCUS projects and programs, an overview of the CCS Roadmap for Mexico and key policy drivers in both the United States and Mexico, an update on capture technologies and best practices in public engagement. Speakers from the World Bank and the US Department of Energy described programs and progress in CCUS deployment in Mexico and in the US.

### *2.3.2 Workshop Agenda*

| **Thursday 22 January**<br>**University of Sonora, Hermosillo** | |
|---|---|
| **8:00 AM** | **Registration** |
| **8:30 AM** | **Welcome – *Mauricio Pico, FECIT*** |
| **8:40 AM** | **Introduction & Overview on APEC – *Robert Wright, APEC & US DOE*** |
| **9:00 AM** | **$CO_2$ Sources and Climate Change – *Rafael Acosta, CFE*** |
| **9:20 AM** | **Global Status of CCS/CCUS- *Dr Elizabeth Burton, Global CCS Institute*** |
| **9:45 AM** | **Basics of Geologic Storage – *Neil Wildgust, Global CCS Institute***<br>➢ Site selection<br>➢ Site characterization<br>➢ Trapping mechanisms |
| **10:30 AM** | **Coffee/Tea Break** |
| **10:45 AM** | **$CO_2$ Storage Capacity Assessment – *Neil Wildgust, Global CCS Institute***<br>➢ Methodological differences<br>➢ Storage efficiency factors<br>➢ $CO_2$ Storage Assessment Scales & resolution<br>➢ Basin and/or Regional Scale screening<br>➢ Desirable Characteristics and Eliminatory Criteria of Sedimentary Basins |
| **11:15 AM** | **Monitoring, Measuring and Verification (MMV) – *Neil Wildgust, Global CCS Institute***<br>➢ Surface and near-surface monitoring<br>➢ Overburden monitoring<br>➢ Injection zone monitoring |
| **12:00 PM** | **Lunch** |
| **1:00 PM** | **Enhanced Oil Recovery & Storage – *Neil Wildgust, GCCSI***<br>➢ Examples of EOR & Storage Case studies- Bell Creek & Weyburn |
| **1:45 PM** | **PEMEX's EOR Strategy for $CO_2$ Injection- *Dr Fernando Rodriguez De la Garza, PEMEX***<br>➢ **Case Studies in Mexico** |
| **2:15 PM** | **Life Cycle Analysis for PEMEX EOR-$CO_2$-CCS Project in Southern Mexico – *Miguel Angel Morales, PEMEX (Invited)*** |
| **3:00 PM** | **Coffee/Tea Break** |

| | |
|---|---|
| **3:30 PM** | **CCS Risk Analysis - *Neil Wildgust, Global CCS Institute***<br>➢ Confining system<br>➢ Well integrity and leakage pathways<br>➢ Induced seismicity |
| **4:00 PM** | **Overview on compression and transport of $CO_2$ – *Neil Wildgust & Ron Munson, Global CCS Institute*** |
| **4:30 PM** | **Overview on Capture Technologies- Ron Munson, *Global CCS Institute***<br>➢ CCS chain overview<br>➢ Explanation of mature capture technologies<br>a. Pre-Combustion<br>b. Post-Combustion<br>c. Oxy-Combustion<br>➢ Case Study on the Port Arthur project in Texas |
| **5:00 PM** | **End of Day 1** |
| **Friday 23 January**<br>**University of Sonora, Hermosillo** | |
| **8:00 AM** | **Registration** |
| **8:30 AM** | **Welcome – *Mauricio Pico, FECIT*** |
| **8:40 AM** | **Examples of CCS R&D Programs in the US - *Robert Wright, APEC & US DOE*** |
| **9:00 AM** | **CCS/CCUS Regulatory Framework for Mexico- *Pamela Tomski, Global CCS Institute*** |
| **9:20 AM** | **Why does Public Understanding Matter?- *Meade Harris Goodwin, Global CCS Institute*** |
| **9:40 AM** | **Mexico CCUS Roadmap – *Jazmin Mota, SENER*** |
| **10:15 AM** | **Overview of World Bank Activities in Mexico- *Dr Frank Mourits, World Bank*** |
| **10:40 AM** | **Questions, Wrap –up and conclusions –*Dr Elizabeth Burton, Global CCS Institute*** |

### *2.3.3 Workshop Participants*

225 participants attended the workshop, primarily from universities in the northern Mexico area. Due to the student status the participants, we omit the list of names.

### *2.3.4 Workshop Presentations*

Workshop presentations are reproduced four slides per page below. If viewed using a PDF reader, slides can be enlarged in high resolution.

## 2.4 Workshops Speakers Biographies

**Miguel Angel Morales**
**PEMEX**
Miguel A. Morales has served as Vice Manager Environmental Protection in PEMEX-PETROQUIMICA since 2006. He is responsible of the environmental management of five petrochemical complexes owned by the company. He worked for 14 years as an environmental specialist in Morelos Petrochemical complex prior to joining the corporate function at PEMEX-PETROQUIMICA.

He is a specialist in environmental management systems aimed at the reduction of pollution at the source and integrated management: Biological Treatment Plants/Cleaner Production/Eco-efficiency/Life Cycle Assessment/Carbon Footprint/Environmental Risk Assessment and Environmental Management Systems in the petroleum industry. He has published 12 publications in journals included in the Science Citation Index.

Mr. Morales holds a Ph.D. from the Central University Marta Abreu de Las Villas, Cuba. He is a member of the National System of Researchers Level-1 of CONACYT and member of the register of accredited evaluators CONACYT (RCEA), Seven Area: Engineering and industry.

**Elizabeth Burton**
**General Manager, The Americas – Global CCS Institute**
Dr. Elizabeth Burton joined the Global CCS Institute in June 2014 and is General Manager for The Americas. Prior to joining the Institute, Dr. Elizabeth Burton was the Technical Director of the DOE West Coast Regional Carbon Sequestration Partnership (WESTCARB) and a project manager in Carbon Management at Lawrence Berkeley National Laboratory. Dr. Burton brings over 25 years of experience in the energy sector, carbon management, and climate change research and policy. Dr. Burton has extensive experience at the federal and state level in providing technical consultation for energy policymakers, including as a team member in developing the Energy-Water Report to Congress and Energy-Water Roadmap, in leading the Assembly Bill 1925 effort at the Energy Commission to report to the California Legislature on recommendations as to how to facilitate commercial-scale CCS adoption in the state, and as a member of the Technical Advisory Committee to the California CCS Review Panel. Dr. Burton has worked internationally and in the United States and Canada on basic and applied research, technical and capital project management, and outreach and education. Dr. Burton has also worked at Lawrence Livermore National Laboratory, Chevron, and Northern Illinois University. Dr. Burton is the author or coauthor of over 100 published technical papers and a college textbook on oceanography. Dr. Burton received a PhD from Washington University in St. Louis, a MS from the Rosensteil School of Marine and Atmospheric Sciences in Miami, and a B.S. from Bryn Mawr College in Pennsylvania.

**Ricardo Castrejon-Pineda**
Academic background: B.S. Geophysical Engineering, UNAM, 1986; M.S. Exploration Geophysics, UNAM, 2000. Areas of expertise: formation evaluation, borehole geophysics, Petrophysics, well logging. Professional work experience: professor of the Department of Geophysical Engineering at Universidad Nacional Autónoma de México (UNAM) (1989-present). Invited Research Scientist Associate, Bureau of Economic Geology, University of Texas at Austin (2009-2010). Coordinator of Geophysical Engineering Career, UNAM (1999-2000). Geophysical Department Head, UNAM (1999-2000). Field Engineer, Schlumberger Oilfield Services, Africa & Mediterranean (1987-1989). Instructor of Well Logging Acquisition, Instituto Mexicano del Petróleo (1985-1987). Awards: 25 Years as Professor, UNAM; Outstanding Senior in Geophysics, UNAM, 1986. Professional societies: Society of Petrophysicists and Well Log Analysts, 2003-2014; Asociación Mexicana de Geofísicos de Exploración, 1990-2008; Sociedad de Exalumnos de la Facultad de Ingeniería, UNAM, 1986-2014. Miscellaneous activities of a professional nature: External Examiner in Geophysics, Geofísica Internacional Journal, 1995; Evaluation Panel, García Rojas Awards, Instituto Politécnico Nacional, Mexico, 1993-1995. Publications: 1 manual, 2 book chapters, 5 articles peer reviewed, 35 contract reports, 9 course notes. Lecturing: 17 lectures, 47 short courses and workshops, 112 university teaching courses.

**Dr. Moises Davila**
**CCUS initiative leader**
**Ministry of Energy, Mexico**
Dr. Moises Davila is Ph.D. in Environmental Sciences, Msc. Engineering and Bc. in Geological Engineering. He has over 34 years of experience in applied geology studies for infrastructure projects. Until 2013 he was Deputy Manager for Geology at the National Electricity Company from where he got retired after more than 30 years of leading multiple studies with a focus on applied geology to construction and environment. He is author of Books on Applied Geology for Infrastructure Construction and Environmental Geology. He writes and arbitrates on several national and international journals peer-reviewing and actively participates in various forums, especially with the approach of sustainability as in the Mexican Geological Society, institution where he holds the vice-presidency, the Foundation for Earth Sciences, where he is Secretary and co-Founder, and the Mexican Academy of Engineering as a senior fellow and Secretary of Geology Specialty. He teaches in the School of Engineering at National University of México and currently works in the Direction General of Sustainability at the Ministry of Energy where he is leader of the CCUS initiative and advisor for Renewable Energies.

**Meade Harris Goodwin**
**Senior Advisor Capacity Development & Public Engagement**
**Global CCS Institute, Americas**
Meade is an international energy consultant with a decade of experience in the field, and was most recently Senior Advisor to the Global Carbon Capture and Storage Institute's European office in Paris, where she was responsible for building the organisation's relationships with Governments and Corporations in Europe, the Middle East and Africa. Meade joined the Global CCS Institute in 2010, from the London based consultancy CCS TLM, where she was Associate Director- Strategy. Meade also worked as International Policy Manger at the World Coal Institute, where she led the Institute's policy development and represented member companies internationally.

Prior to entering the energy sector, Meade was a BBC Producer, based in the Washington DC Bureau, has been a consultant at Control Risks, specialising in energy issues and was one of the founders of the Climate Change Forum in London. Meade completed her undergraduate degree at the University of New Hampshire, during which time she also studied at Sydney University, before reading for a Master's degree in International Relations & Energy Security at King's College London.

**Craig Hart**
**Renmin University of China, School of Environment and Natural Resources**
Craig A. Hart is the ENN Group Associate Professor at the School of Environment and Natural Resources, Renmin University of China, and a lecturer at Johns Hopkins University's Energy Policy & Climate program. In addition, Craig is a practicing attorney in the fields of project finance, carbon finance and capital markets. He has represented project developers in energy and carbon management projects in the United States, Asia, and China, including on IGCC power projects under China's 863 Program. He has advised industry groups and served as a consultant to international organizations including the UNDP, Asian Development Bank and APEC on greenhouse gas management and regulation in the United States and Asia. He holds a Ph.D. from the Massachusetts Institute of Technology and a J.D. from the University of California at Berkeley.

**Rodolfo Lacy Tamayo**
**SEMERNAT**
Rodolfo Lacy Tamayo holds an M.Sc. oin Environmental and Health Management from the Massachusetts Institute of Technology, and a bachelors degree in Environmental Engineering from the Autonomous Metropolitan University in Mexico City. He is pursuing a PhD in Environmental Sciences and Engineering at the Autonomous Metropolitan University.

Mr. Lacy's career spans more than 30 years, serving as a teacher, consultant and public employee at both the federal and local levels. He currently holds the position of Under Secretary for Planning and Environmental Policy at SEMARNAT.

Previously, he served as Coordinator of Programs and Projects for Studies on Energy and Environment in the Mario Molina Center, Executive Director of Special Projects in the College of Environmental Engineers, Chief of Staff of the Secretary of Environment and Natural Resources, Management Director of the company Environmental

Specialists, SA de CV, General Director of Prevention and Control of Environmental Pollution of the Ministry of Environment of the Federal District Department, and General Manager of Environmental Projects in the General Coordination for the Prevention and Control of Pollution in the Federal District Department.

**Sasha Mackler**
**Vice President, Summit Carbon Capture**
Mr. Mackler manages commercial and policy matters for Summit's Carbon Capture business unit, focusing on the development of carbon-capture power projects and emerging technologies. He also pursues business opportunities for climate-friendly commercial uses of captured carbon, such as enhanced oil production. Over nearly two decades of professional work spanning the private, public, and non-profit sectors, Sasha has held leadership positions in a variety of multi-disciplinary settings.

Prior to joining Summit, Sasha shaped federal energy policies in Washington, DC as the Research Director of the National Commission on Energy Policy and as a founding Director of the Bipartisan Policy Center's Energy Project. Before that, he designed power sector emissions trading programs in the Clean Air Markets Division of the US Environmental Protection Agency. Mr. Mackler began his career at the engineering and design firm ARUP, where he focused on energy analysis and the thermodynamics of high-performance building design. His Bachelor of Science (BS) degree in geo-mechanical engineering is from the University of Rochester. He earned his Master of Public Administration (MPA) and Master of Science (MS) in earth resources engineering from Columbia University.

**Jazmin Mota**
**Energy Ministry of Mexico**
Jazmin Mota is Director of the Clean Technologies at the Energy Ministry of Mexico. She is in charge of the Carbon Capture, Use and Storage Project and responsible for imlementing Mexico's CCUS Technology Road Map. She has been a consultant to the World Bank supporting initiatives between the World Bank and the Government of Mexico. Previously, she worked at the Federal Comission of Electricity leading $CO_2$ storage capacity projects in deep saline aquifers in order to evaluate the storage potential in the north of Mexico. She has paricipated in forums and outreach programs at various universities in Mexico. Ms. Mota completed her geological engineer degree at the National Autonomous University of Mexico where she also currently teaches.

**Guido Magneschi**
**Global CCS Institute**
Guido has a background in energy engineering and he has previously worked as technical consultant in DNV.GL, contributing to a number of projects in the area of clean fossil power ($CO_2$ capture, biomass co-firing and renewable integration). Guido's current expertise is that of understanding and assessing the technology that are being developed for $CO_2$ capture and how to optimize their implementation in large scale projects. Guido is a native Italian and currently lives in Bruxelles, Belgium.

**Dr. Frank Mourits**
**World Bank**
Dr. Mourits supports the unit managing the World Bank's CCS Trust Fund. His work focuses on setting up a funding framework and initiating projects aimed at developing CCS in South Africa and Mexico. He participates in missions to both countries and meets with stakeholders to develop and execute individual project components.

Before joining the World Bank in 2013, Frank worked for Natural Resources Canada in Ottawa, Canada, for nearly 25 years. First as a Senior Research Scientist and later as a Senior Science and Technology Advisor, he was involved in numerous carbon capture and storage (CCS) and clean coal activities in Canada. He was the government's lead for the IEAGHG Weyburn-Midale $CO_2$ Monitoring and Storage Project. Another recent key responsibility included overseeing the Canadian Carbon Storage Atlas Project and coordinating, in close collaboration with the United Sates and Mexico, the production of a North American Carbon Storage Atlas.

Dr. Mourits has been active in several international organizations involved in the transfer of clean coal and CCS technologies to developing countries. As Deputy Chair of the Asia-Pacific Economic Cooperation (APEC) Expert Group on Clean Fossil Energy, he initiated CCS feasibility studies and capacity-building workshops in the APEC

region. He also sat on the Executive Committee of the Climate Technology Initiative and on the Cleaner Fossil Energy Task Force of the Asia-Pacific Partnership on Clean Development and Climate.

Dr. Mourits holds B.Sc. and M.Sc. degrees in Physical Chemistry from the University of Amsterdam, the Netherlands, and a Ph.D. degree in Physical Chemistry from the University of Regina, Canada.

**Ron Munson**
**Global CCS Institute**
Ron Munson is the Principal Manager, Carbon Capture at the Global CCS Institute. He was formerly a Senior Engineer contracted to the National Energy Technology Laboratory (NETL) in the U.S. Department of Energy (DOE). At NETL, Ron supported greenhouse gas emissions mitigation research, development and demonstration programs including carbon capture and advanced combustion systems. In addition, Ron supported the DOE programs all along the commercialization pathway, from process concept through demonstration. He received both undergraduate and graduate training in Chemical Engineering from Brigham Young University.

**Mauricio Pico**
**Federal Electricity Commission**
Mr. Picio joined the Federal Electricity Commission in 2005; and since 2008 has led its Office of Commercialization of the Management Studies in Civil Engineering. Mr. Pico holds a degree in Administration. He received honorary mention in the Advanced Management Program for Dependencies and Public Entities in the National Institute of Public Administration. He also provides support for Pro Earth Sciences Foundation in organizing courses and workshops for the purpose of obtaining funds for undergraduate scholarship holders

**Dr. Fernando Rodríguez-de la Garza**
**PEMEX**
Dr. Rodríguez-de la Garza holds a bachelor's degree from the National Polytechnic Institute, master´s degree from the University of Mexico, and a Ph.D. from Stanford University, all in petroleum engineering. He has worked for the Mexican Petroleum Institute, Petrobras-Unicamp in Brazil, the University of México and PEMEX.

Dr. Rodríguez-de la Garza joined PEMEX E&P (PEP) in 1991, serving as Manager of Reservoir Management, 1996-2003, Advisor to the Directorate General of PEP, 2003-2005, Technical Manager of Field Development, 2005-2008, and Manager of Exploitation Projects-MNE, 2008-2011. Since 2011, while serving as technical Advisor to the Directorate General of PEP, he has coordinated the Secondary and Enhanced Oil Recovery Program of PEP with active participation in the Akal-Cantarell EOR project.

His areas of expertise include reservoir engineering, with emphasis on naturally fractured reservoirs. He has written more than 70 technical papers published in journals and proceedings of national and international conferences. He has been recognized by the Society of Petroleum Engineers with the 2005-SPE Regional Services Award and the 2007-SPE Reservoir Description and Dynamics Award. He is a member of the Mexican Academy of Engineering, the Society of Petroleum Engineers, the College of Petroleum Engineers of Mexico and the Association of Petroleum Engineers of Mexico.

**Edward N. Steadman**
**Energy & Environmental Research Center**
Mr. Edward N. Steadman is a Deputy Associate Director for Research at the Energy & Environmental Research Center, where he currently oversees the oil and gas research area, including the Plains $CO_2$ Reduction (PCOR) Partnership Program. The PCOR Partnership is one of seven regional partnerships funded by the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Program to assess the technical and economic feasibility of capturing and storing (sequestering) $CO_2$ emissions from stationary sources in the northern Great Plains and adjacent area. Under this program, Mr. Steadman leads a multidisciplinary team of researchers working on an assessment of $CO_2$ sources, potential $CO_2$ storage sites, enhanced oil recovery (EOR) opportunities, saline formations, unminable coal seams, and sequestration infrastructure.

Mr. Steadman's principal areas of interest and expertise include carbon sequestration, chemical transformations during coal combustion, and materials science. He holds an M.A. degree in Geology from the University of North Dakota and a B.S. degree in Geology from the University of Pennsylvania–Edinboro.

**Vegar Stokset**
**Head of Communications, $CO_2$ Technology Centre Mongstad**
Vegar Stokset holds a Bachelor's degree in Journalism from University of Oregon and has been working in the Communications Departments of the Norwegian Energy conglomerate Hydro and Statoil for ten years, serving as Head of Communications of the USD 10 billion gas development project Ormen Lange. Before joining Technology Centre Mongstad (TCM) in 2009, Stokset worked as SVP of Communications in the oil service company Agility Group, now acquired by Wood Group.

**Pamela Tomski**
**Global CCS Institute**
Pamela Tomski is the Senior Advisor Policy & Regulatory - The Americas with the Global CCS Institute and serves as a Nonresident Senior Fellow of the Energy and Environment Program at the Atlantic Council. She is Founder and Director of the Research Experience in Carbon Sequestration (RECS), an intensive summer program for graduate students and early career professionals on all aspects of CCS / CCUS. Pamela has worked for 15 years advancing CCS / CCUS technology through the establishment of research and development collaborations and demonstration projects to education and capacity building, regulatory frameworks, and policy and market development. She is a Member of the National Coal Council (which advises US Secretary of Energy), Advisory Board Member of the Southeast Regional Carbon Sequestration Technology Training Program, Advisor to the CCUS Research Coordination Network, and served as Director of Education, Outreach and Regulatory Compliance for the Big Sky Carbon Sequestration Partnership. Pamela is a member of the CSLF Financing Task Force, and an expert peer reviewer of the IEA GHG Technologies Conference and IEA Clean Coal Centre. She is Adjunct Professor at Tuskegee University, serves as Advisor to the National Energy Education Development Project and the Inter-University Student Initiative in Carbon Sequestration. She received a BA in International Affairs and Middle East History from The George Washington University.

**Neil Wildgust**
**Global CCS Institute**
Mr. Wilgust is a geologist with over 25 years of industrial and research experience in mining and industrial minerals, hydrogeology and $CO_2$ geological storage. Prior to joining the institute earlier this year as Principal Manager for Storage, Neil was Chief Project Officer at the Petroleum Technology Research Centre in Saskatchewan, Canada where he managed projects including the Weyburn-Midale $CO_2$ Monitoring and Storage Project. Neil holds a BSc (Hons) degree in geology from Southampton University and an MSc in Applied Environmental Geology from Cardiff University.

**Robert J. Wright**
**U.S. Department of Energy**
Dr. Wright is a Senior Advisor in the Office of Fossil Energy, U.S. Department of Energy. He has forty years of experience in energy technologies and electrical power generation, including fossil fuels, nuclear energy and renewable energy. Currently he advises senior management with regard to programs and policies that address climate change, alternative clean technologies (such as gasification) and carbon capture and storage (CCS). Currently Dr. Wright is developing modalities for knowledge sharing in CCS/CCUS large scale tests, demonstration projects and R&D projects between the U.S. and Canada and the U.S. and Mexico. He currently serves as the Designated Federal Official for the National Coal Council, an advisory board to the Secretary of Energy under the Federal Advisory Committee Act (FACA).

He holds a BS from Carnegie Mellon University, a MS from New Jersey Institute of Technology, an MBA from Duquesne University, and a Ph.D. from Rutgers University. He is a registered Professional Engineer in the states of Pennsylvania and Maryland. Dr. Wright served three years as a member of the Maryland Governor's Strategic Energy Investment Fund Advisory Board. He also served as a Congressional Fellow in the U.S. House of Representatives in 2007and as a Legislative Fellow in the U.S, Senate in 2008. Both times he provided advice and counsel regarding a spectrum of issues with regard to energy and climate change. He was elected to the City Council of Rockville Maryland in 1995 and went on to serve 3 two-year terms.

**Gonzalo Zambrano**
**University of Alberta**
Dr. Gonzalo Zambrano-Narvaez is a Research Associate at the University of Alberta. Dr. Zambrano is the Technical Program Manager of Foundation CMG Industrial Research Chair in Reservoir Geomechanics for Unconventional Resources. His doctoral dissertation focused on downhole reservoir surveillance technologies with application on $CO_2$ geological storage, and one of the outcomes of his doctoral work resulted in a Patent of a downhole housing system and method that have been used in Weyburn and Aquistore. CCS projects that he has been involved in are IEA GHG Weyburn-Midale $CO_2$ monitoring and storage project, Penn West $CO_2$-EOR pilot project, Carbon/Storage Enhanced Methane Project (CSEMP) ECBM, CCUS-APEC Study in Peru and Aquistore. Also, Dr. Zambrano has significant experience in the area of characterization and constitutive behavior of reservoirs with focus in geomechanics.

## 2.5 Workshops Photographs

Workshop 1, DF IPN Auditorium, Mexico, City, August 26-27, 2014


Workshop 2, CFE Technology Museum, Mexico, City, September October 13-14, 2014


Workshop 3, University of Sonora, Hermosillo, Mexico, January 22 - 23, 2015

### 2.6 Workshops Surveys and Feedback

Feedback forms were completed by __ participants over the three workshops, rating speakers based on "how useful" the talk for increasing the participant's knowledge of CCUS and relevance of CCUS. Based on a scale of "Low", "Medium" and "High", _____ speakers were rated on average as [highly helpful and relevant] to increasing participant's knowledge of CCUS.

## 3. Online Educational Program

As part of the project, the Global CCS Institute prepared an online training program to be offered to selected Mexican professors and professionals as part of a series of online courses. Participants will receive a certificate of completion from RECS and the Global CCS Institute. Completion of these activities indicates proficiency in various aspects of CCUS including policy and regulatory issues, geologic storage, carbon dioxide capture and public engagement.

The three webinars will focus on the areas of policy and regulatory issues, geologic storage, $CO_2$ capture and public engagement.

### 1. Carbon Capture Systems

Carbon capture systems are now being deployed at scale in the power and industrial sectors. These 1st Generation technologies effectively remove $CO_2$ from flue gases, but capital and energy costs associated with them serve as barriers to more wide-scale deployment. The U.S. Department of Energy is currently supporting the development of 2nd Generation technologies that decrease the costs associated with carbon capture. Several developers are testing these 2nd Generation technologies at pilot scale. This pilot scale testing is intended to prepare technologies for demonstration scale testing starting in the 2020 time frame, with potential for deployment in the 2025-2030 time frame. This presentation identifies several technology developers and highlights some of the ongoing development efforts.

### 2. Policy and Regulatory Issues

The policy and regulatory module will each key characteristics of CCUS regulatory frameworks and highlights from the APEC regulatory assessment for Mexico. This presentation gives an overview of policy and regulatory considerations as Mexico implements its CCUS Roadmap.

**3. Public Engagement**

This presentation gives an overview of the leading practices of public engagement as well as touching upon the work that the Global CCS Institute on education and outreach with major CCUS projects around the world.

**4. Storage Assessment Protocol**

[To be provided by GCCSI]

EWG 17/2013

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