



**CCUS**  
I N I T I A T I V E

# CCUS IN MEXICO FOR A LOW CARBON ECONOMY

September 19, 2018

**CARBON CAPTURE, UTILIZATION, AND STORAGE (CCUS)**

A CLEAN ENERGY MINISTERIAL INITIATIVE

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# SOME HOUSEKEEPING ITEMS

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# AGENDA

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## Welcome & Introductory Remarks

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## Presentation

- Mexico's Experience in CCUS implementation  
Leonardo Beltrán, Deputy Minister, SENER.
- Mexican CCUS Center  
Diego Arjona, Executive Director of Mexican CCUS Center.
- WB and Mexico Alliance for CCUS  
Guillermo Hernández  
WB
- International Cooperation as a driver to accelerate CCUS  
Peter Warren, Senior Advisor, Business, Energy and Industrial Strategy, UK Gov.

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## Question and Answer Session



## LEONARDO BELTRÁN

Deputy Minister for Planning and Energy Transition  
Mexico's Ministry of Energy (SENER)

Mr. Leonardo Beltrán holds a Master's in Public Administration in International Development from Harvard Kennedy School. He also holds a bachelor of Science in Economics from the Autonomous Technological Institute of Mexico (ITAM), and studied Law at the Faculty of Law at the National Autonomous University of Mexico (UNAM).

From 2005 to 2012, Mr. Beltran joined SENER, as Director of International Negotiations and Director General of Information and Energy Studies. He worked as consultant for the Inter-American Development Bank, the World Bank, the Organization for Economic Cooperation and Development and the United Nations Industrial Development Organization.

Mr. Beltrán is member of the WEF Global Agenda Council in the Future of Energy from 2016 to 2018. In 2017, he became a member of the Administrative Board of Sustainable Energy for All (SEforALL) initiative.



## **DIEGO ARJONA**

Executive Director of the Mexican CCUS Center and  
Director General of the National Institute for  
Electricity and Clean Energy (INEEL)

Diego Arjona received the degree of Mechanical and Electrical Engineer by the National Autonomous University of Mexico (UNAM), a Master in Electrical Engineering at the George Washington University in Washington D.C., and a PhD in Power Transmission and Energy Conversion in the same university.

In the public sector, Diego worked as Deputy Under-Secretary for Research, Technological Development and Environment in SENER. He was also executive secretary at the National Commission for Energy Savings and served as an advisor for the Under-Secretary of Energy Operations. In 2017, he was appointed as Director General for the National Institute for Electricity and Clean Energy.

In the private sector, he worked as Director General of Tuto Energy, Director of Renewable and Sustainable Energy, Chief of Sustainability and Process Officer in BioFields, General Manager for Energy Works developing generation and cogeneration projects.

Diego is a member of the Pan-American Academy of Engineering and has served as Technical Secretary for the Mexican Union of Engineering Associations.



## **GUILLERMO HERNÁNDEZ**

Energy Specialist  
World Bank

Guillermo is an Energy Specialist with the World Bank's Energy and Extractives Global Practice. He holds a PhD and a Master's degree from the University of Toronto, Canada, both in Power Engineering. He is an electrical and electronics engineer from the National and Autonomous University of Mexico (UNAM).

Guillermo started his professional activity at *Luz y Fuerza del Centro* carrying out load flow and short circuit studies to accommodate new demand. He participated in a joint project (Natural Resources Canada and CYME international) to enhance renewable energy capabilities. Guillermo became a faculty member at Tecnológico de Monterrey in 2010, until he became Energy Specialist for the World Bank in 2012.

Guillermo's current activities include general supervision support for projects for Carbon Capture and Storage (CCS) in Mexico, among other.



## PETER WARREN

Senior Policy Advisor and Senior Climate Finance  
Investment Lead  
Business, Energy & Industrial Strategy, UK  
government

Peter Warren is a Senior Policy Advisor and Senior Climate Finance Investment Lead at the Department for Business, Energy & Industrial Strategy (BEIS), UK Government. He leads the department's work on climate finance for CCUS, clean energy innovation and technical assistance.

Peter previously led the department's work on evidence and policy for smart energy technologies. Peter is also currently a part-time lecturer at UCL and teaches energy and climate policy to Masters students. Prior to working in government, Peter worked in the International Energy Agency (IEA)'s energy efficiency in emerging economies team.

Peter has a PhD in energy policy from UCL, two Masters degrees in the energy field and a Bachelors degree in Geography.





# CCUS IN MEXICO FOR A LOW-CARBON ECONOMY

Mexico's experience in CCUS  
implementation

Leonardo Beltrán

Undersecretary of Planning and Energy Transition

Mexico's Ministry of Energy

# CCUS IN THE MEXICAN CONTEXT

## Public Policy

- ❑ In **2009**, Mexico looked at CCUS as a mean to reduce GHG emissions in the energy sector.
- ❑ In **2010**, the **National Strategy of Energy** pointed out the relevance of creating a sustainable sector and include Energy Efficiency and Clean Energies.
- ❑ By **2012**, the **General Law on Climate Change** gave certainty of the federal commitment on tackling Climate Change. Then, the **Energy Reform** opened the market for private investment and aimed to guarantee Energy supply, and the reduction of GHG.

# CCUS IN THE MEXICAN CONTEXT

## Development

Mexico's Geological  
CO<sub>2</sub> Storage Atlas

North American Carbon  
Sequestration Atlas

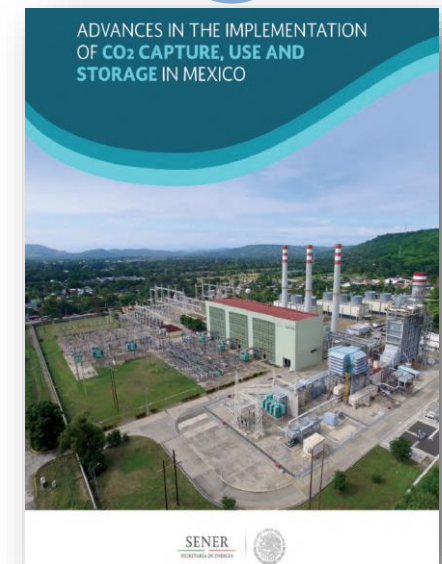
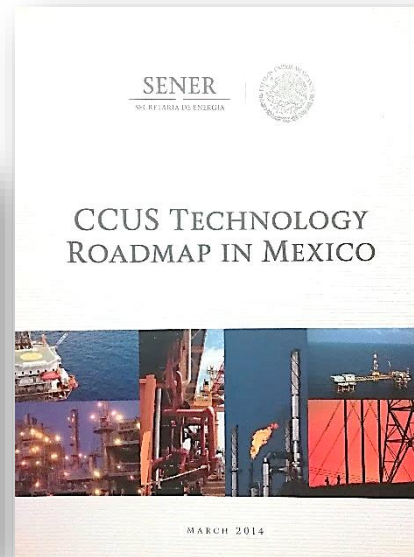
Technology Roadmap  
of CCUS in Mexico

Advances in CCUS  
implementation in  
Mexico

2012

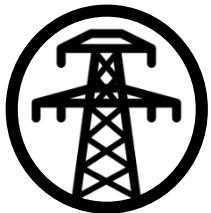
2014

2018



# WHY CCUS?

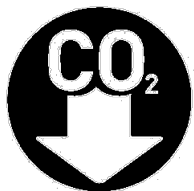
Mexico has ambitious commitments for Energy and GHG reduction:



CLEAN POWER GENERATION

## Targets

- 25% - 2018
- 35% - 2024
- 50% - 2050



GHG REDUCTION

## Targets

- 22% - 2030
- 36% - 2050



Mexico is moving towards a cleaner and sustainable energy future



# TECHNOLOGY ROADMAP OF CCUS IN MEXICO

- ❑ In **2014**, the **TRM-CCUS** in Mexico was published to establish the critical pathway to follow for the technology implementation.
  
- ❑ Key actions:
  - **Framework Agreement:** between **SENER, SEMARNAT, PEMEX and CFE** as the main stakeholders
  
  - **National CCUS working group:** **18 national institutions** from government, academia and industry
  
  - **Analysis of Mexican regulatory framework:** in collaboration with SEMARNAT to prepare **the Mexican Mandatory Standard on CCS and CCUS**
  
  - **International cooperation:** CSLF, GCCSI, Mission Innovation, North American Energy Ministers Trilateral (NAEMT), CCUS Initiative of CEM, bilateral and trilateral cooperation with U.S.A, Canada, UK, Norway, Australia, among other.

# STRATEGICAL ACTIVITIES

## ➤ NATIONAL CCUS STRATEGY

- Evaluation of deep saline aquifers for CO<sub>2</sub> Storage
  - Evaluation of oil and gas fields for CO<sub>2</sub> – EOR
  - Assessment of power generation plants
  - Assessment of CO<sub>2</sub> large sources (industry)
- 
- 2 PILOTS** in the short-term
  - 10 demonstrative and large scale potential** projects in the middle and long-term.

## ➤ REGULATORY

- Participation in the **ISO TC 265** (led by SEMARNAT)
- Preparation of the **Mexican Mandatory Standard** of CCS and CCUS



## NATIONAL ATLAS OF CCUS

<https://dgel.energia.gob.mx/ccus/>

# CAPACITY BUILDING

Capacity building and specialized training are crucial to enable the deployment of CCUS.



## CCUS MASTER PROGRAM

16 graduate students.

Led by UNAM with the collaboration of the University of California.



## SPECIALIZED TRAINING PROGRAM ON CCUS

Participation of over 150 professionals from government and industry.

In collaboration with national and International partners

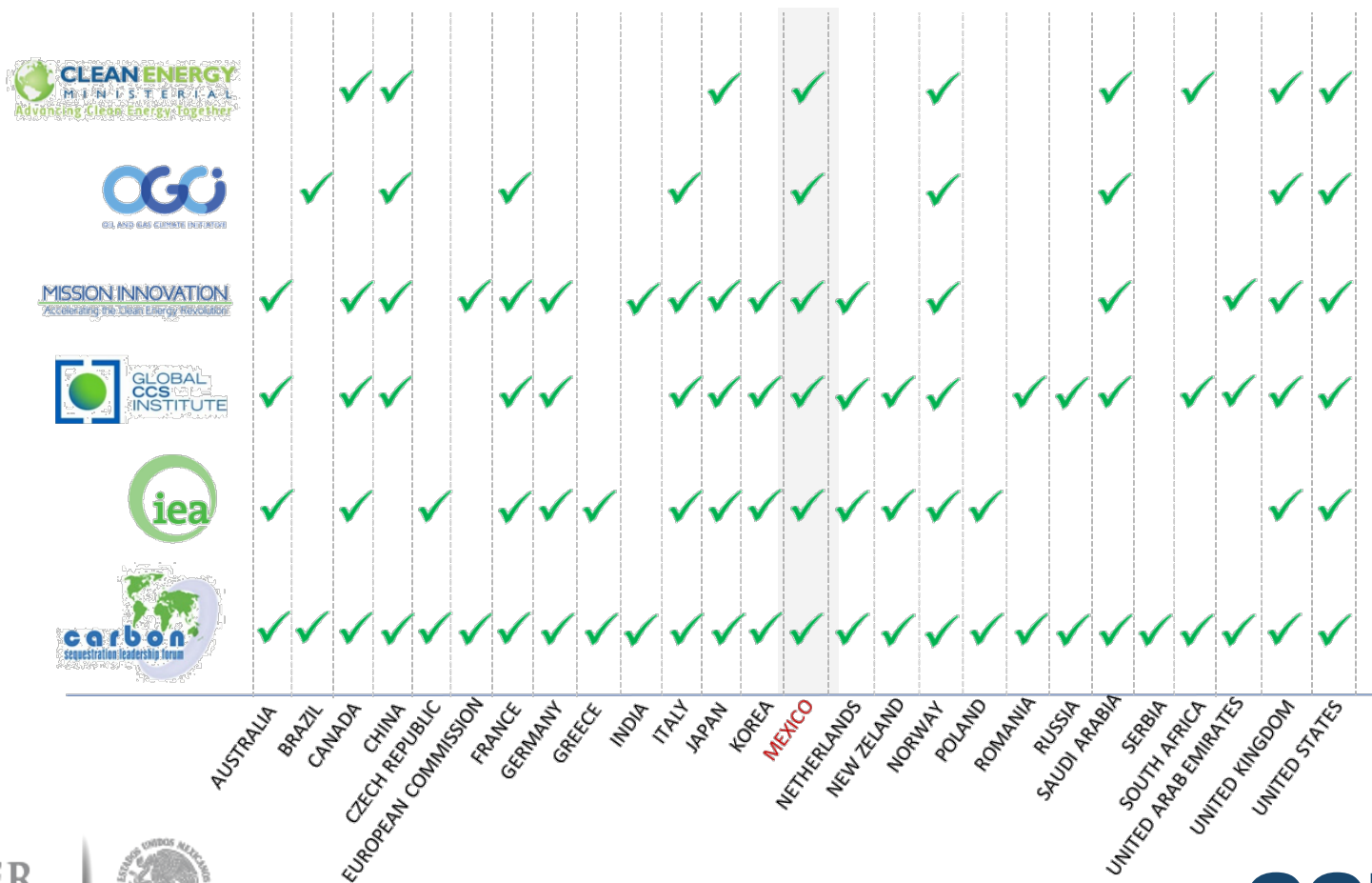
# THE MEXICAN CCUS CENTER AND PILOT PROJECTS

- The **Mexican CCUS Center** is created to promote the integration of main institutions of academia and industry to develop applied research and technology development to accelerate CCUS implementation in the country.
- The Center represents a big step forward to strengthen CCUS and create **international networks**, as well as a technical entity to **support and advise government and decision makers**.
- **2 pilot projects** will be developed by the Center in **collaboration with PEMEX and CFE** and with the finance and technical **support from the World Bank**
- The total investment for the next 4 years is about **85.5 million USD**: **65 million from Government of Mexico and 20.5 million from WB CCS Trust Fund**.



# INTERNATIONAL COOPERATION AND INITIATIVES TO ACCELERATE CCUS GLOBALLY

Mexico is one of the countries highly committed to CCUS and actively participating in International initiatives





Saudi Arabia



United States



South Africa



Norway



Japan



United Kingdom



United Arab Emirates



China



Canada



Mexico



# CCUS IN MEXICO FOR A LOW-CARBON ECONOMY

## The Mexican CCUS Center

Diego Arjona

National Institute for Electricity and Clean Energy

# Consortium

Leader:



Advisory Committee:



Members:



Pilot projects:

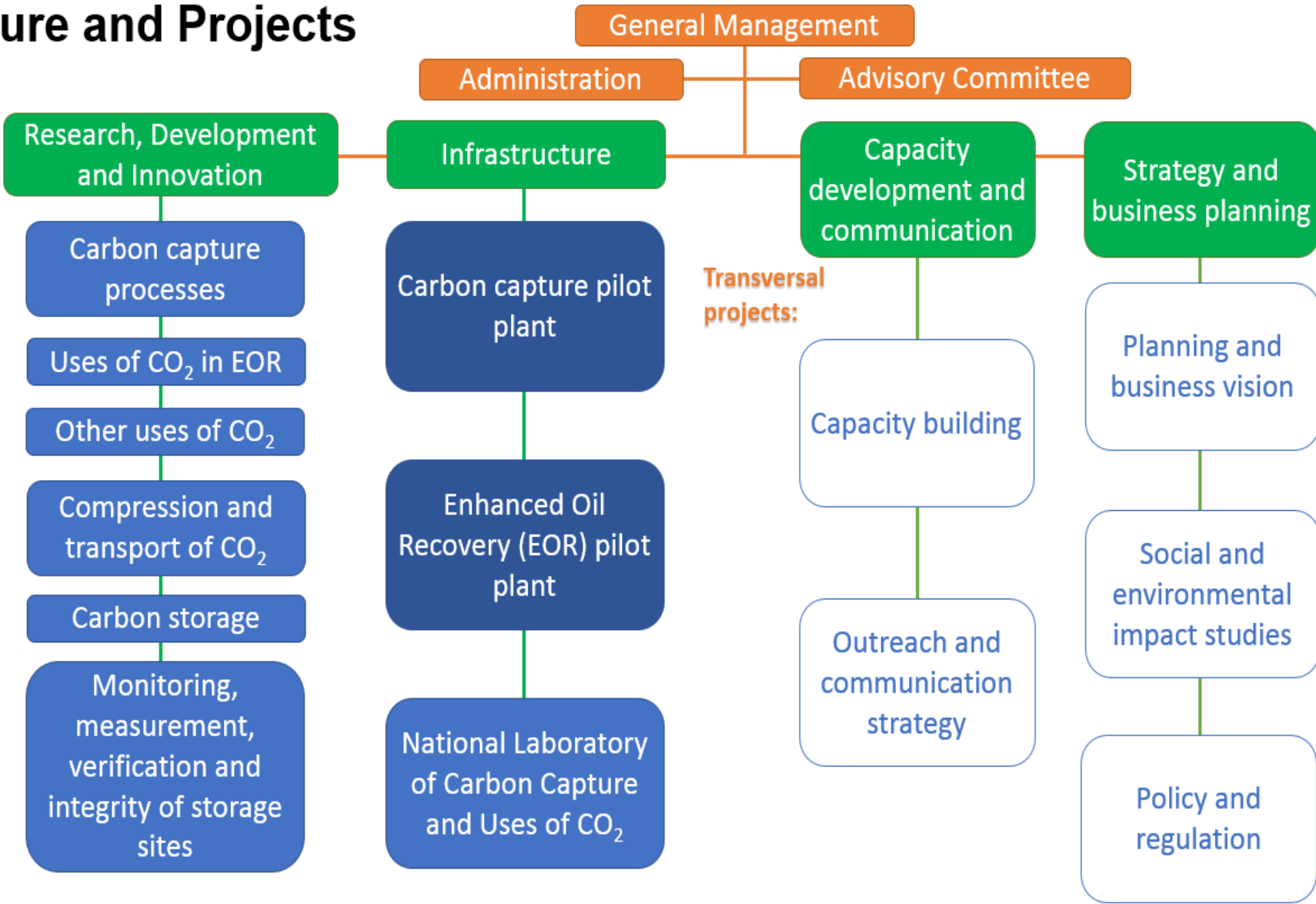


Interested companies:



# Structure and Projects

Technical projects:



# CCS Pilot projects

Latitud: 21.396086 Longitud: -78.855068

EN

Poza Rica  
Carbon Capture  
Plant



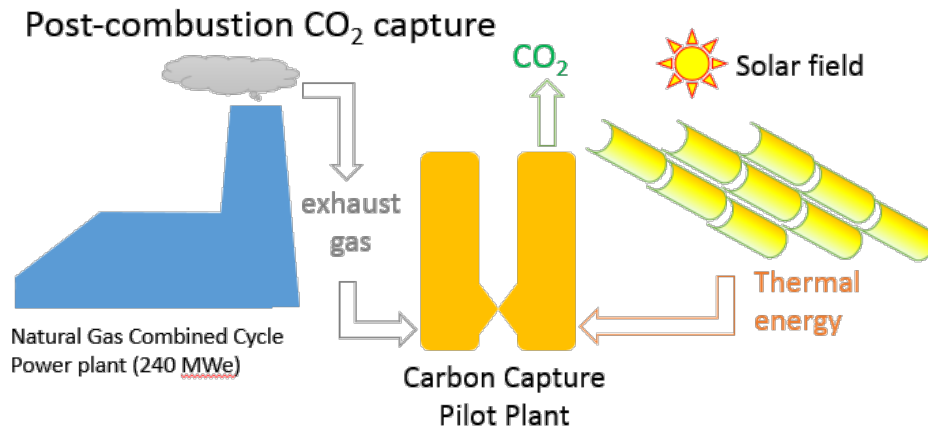
Brillante Oil Field



Source: <https://dgel.energia.gob.mx/ccus/>

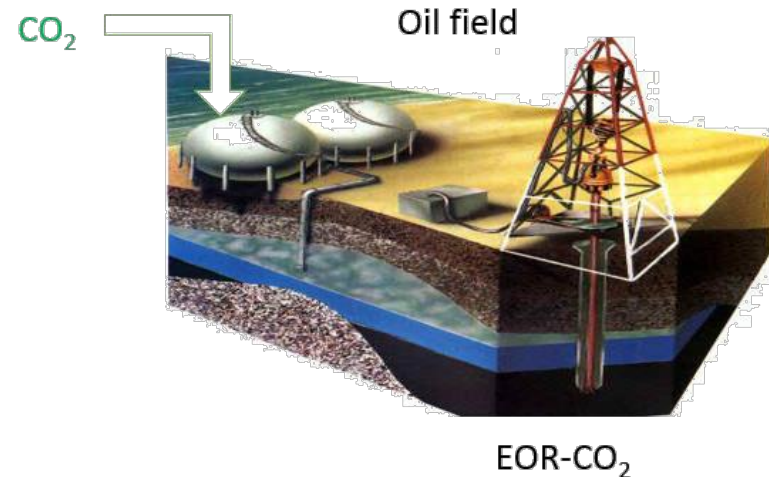
# CCS Pilot projects

## Carbon capture pilot plant



- ✓ 1 % of NGCC flue gases
- ✓ Capture 20 ton CO<sub>2</sub>/day
- ✓ Assessment of 3 amines

## Enhanced Oil Recovery (EOR) pilot project



- ✓ **First Test:** HUFF&PUFF 1 well, 7 days of injection, 106 metric ton CO<sub>2</sub> per day
- ✓ **Second test:** 1 injection well, 4 oil wells production, CO<sub>2</sub> injection rate 740 metric ton per day during 1 year



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# CCUS IN MEXICO FOR A LOW-CARBON ECONOMY

World Bank and Mexico Alliance for CCUS

Guillermo Hernández

Energy Specialist

World Bank



# World Bank Support for CCUS

- World Bank **CCS Trust Fund** (CCS TF) was established in December 2009
- Main objectives are
  - To support strengthening capacity and knowledge building
  - To create opportunities for developing countries to explore CCS potential
  - To facilitate inclusion of CCS options into developing country low-carbon growth strategies and policies
- Supported by three CCS TF donors:
  - UK government
  - Norway government
  - Global CCS Institute (*in the process of withdrawing*)
- Total funds allocation to date of **USD 55.8 million** across two phases

# World Bank Support for CCUS

- Phase I of the World Bank CCS TF
  - Completed in 2015
  - Allocated funds: USD 7.9 million
  - Nine countries/regions
  - Provided capacity building and undertook desk-top CCUS studies and analysis
- Phase II of the World Bank CCS TF
  - Commenced in 2014
  - Allocated funds: USD 47.9 million
  - Focussed on South Africa and Mexico
  - Provides support for four CCUS pilot projects - two capture, two storage

Country/region	Allocation (USD)
Botswana	1.4m
South Africa	1.35m
China	1.8m
Mexico	1.3m
Indonesia	0.85m
Kosovo	0.4m
Egypt	0.3m
Jordan	0.15m
Maghreb	0.4m
<b>TOTAL</b>	<b>7.9m</b>

# PHASE 1 WORLD BANK SUPPORT FOR CCUS IN MEXICO

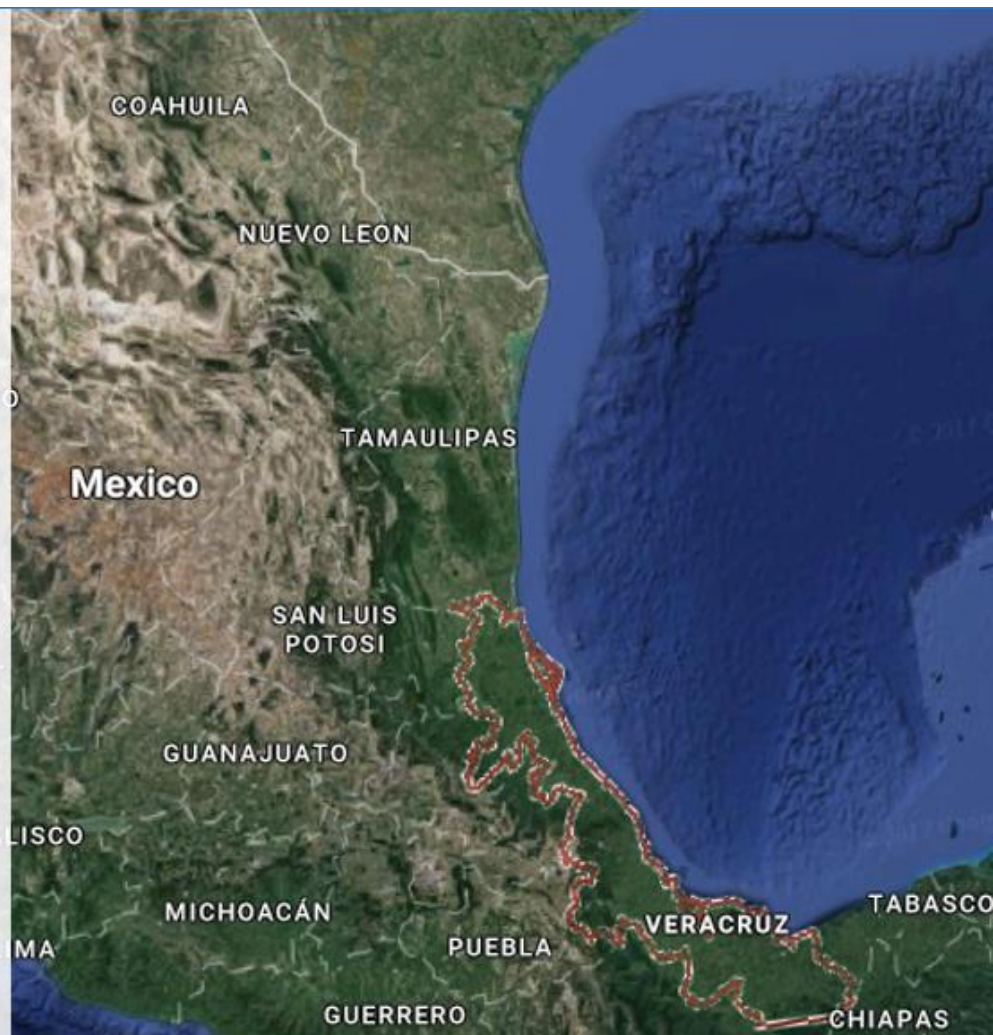
- **Budget**

- USD 1.3 million

- **Comprised of five studies**

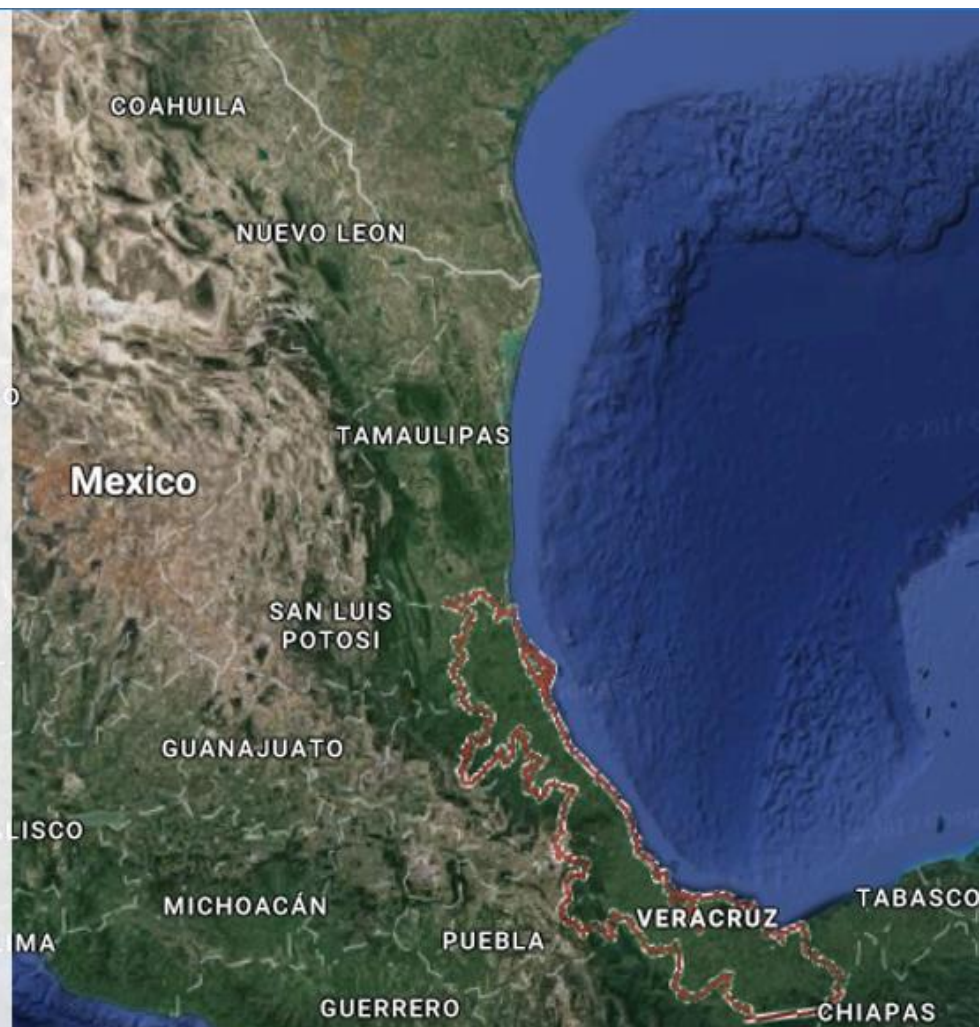
- A prefeasibility study for a capture pilot plant at a natural gas-fired power station
- Assess the monitoring and regulatory requirements for converting EOR sites into permanent CO<sub>2</sub> storage sites
- Undertake a study to establish a legal and regulatory framework for CCUS
- Develop a public engagement strategy
- Support capacity building where opportunities arise

- **Completed in 2015**



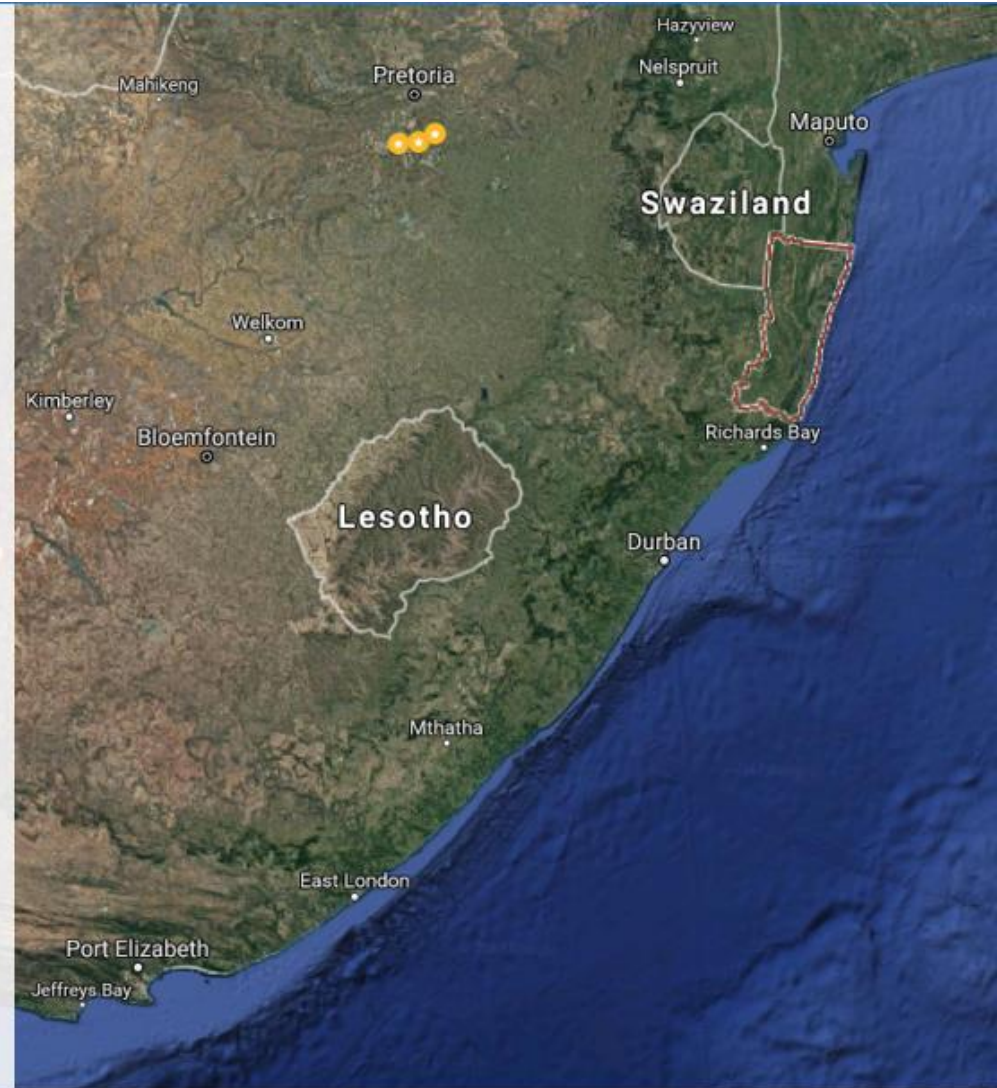
# PHASE 1 WORLD BANK SUPPORT FOR CCUS IN MEXICO

- Led by INEEL and SENER
- Supported by
  - PEMEX
  - CFE
  - Mexican Centre for CCUS
- Total project budget
  - Mexican Hydrocarbon Fund: USD 12.5 million
  - WB CCS TF: USD 20.5 million
- Two components
  - CO<sub>2</sub> Capture Pilot Project
  - CO<sub>2</sub> Storage & EOR Monitoring Project



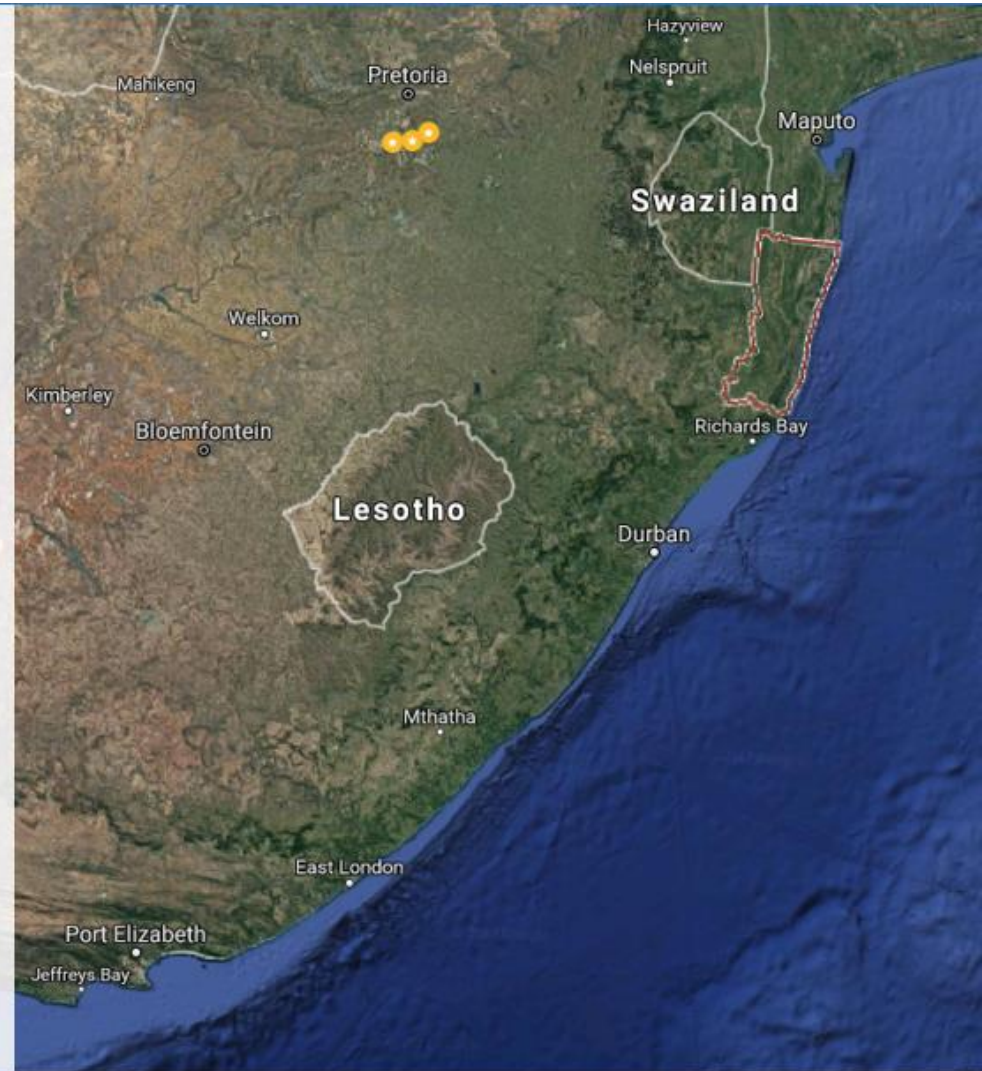
# PHASE 1 WORLD BANK SUPPORT FOR CCUS IN SOUTH AFRICA

- Budget
  - USD 1.35 million
- Comprised of five studies
  - Regulatory review to enable the implementation of the Pilot CO<sub>2</sub> Storage Project
  - Techno-economic assessment for deployment of CCS Technology in South Africa
  - Capacity Building for CCS in South Africa
  - National and Local Public Engagement Plan for the Pilot CO<sub>2</sub> Storage Project
- Completed in 2015



# PHASE 1 WORLD BANK SUPPORT FOR CCUS IN SOUTH AFRICA

- Led by SANEDI
- Supported by
  - Department of Energy
  - Council for Geosciences
  - Petroleum Agency of South Africa
  - Eskom
- Total project budget
  - South African Department of Energy: USD 15 million
  - WB CCS TF: USD 27.4 million
- Two components
  - CO<sub>2</sub> Capture Pilot Project
  - Pilot CO<sub>2</sub> Storage Project



# POTENTIAL FUTURE CCS TF ACTIVITY

- Consideration of the role of **CCUS in industrial decarbonization**
- **CCUS use** in different **industrial sectors**
  - High-purity sources
  - Cement
  - Iron and steel
  - Refineries
- **CCUS use** with different **industrial fuels**
  - Natural gas
  - Biomass
- Developing and emerging economy potential for **CCUS in industry**
- Develop county case-studies and lessons learned from CCUS in industry
- International collaboration and partnering – ADB, IEA, etc.



# CCUS IN MEXICO FOR A LOW-CARBON ECONOMY

International collaboration as a driver to  
accelerate CCUS globally

Peter Warren

International Climate & Energy Directorate

Department for Business, Energy & Industrial Strategy (BEIS)

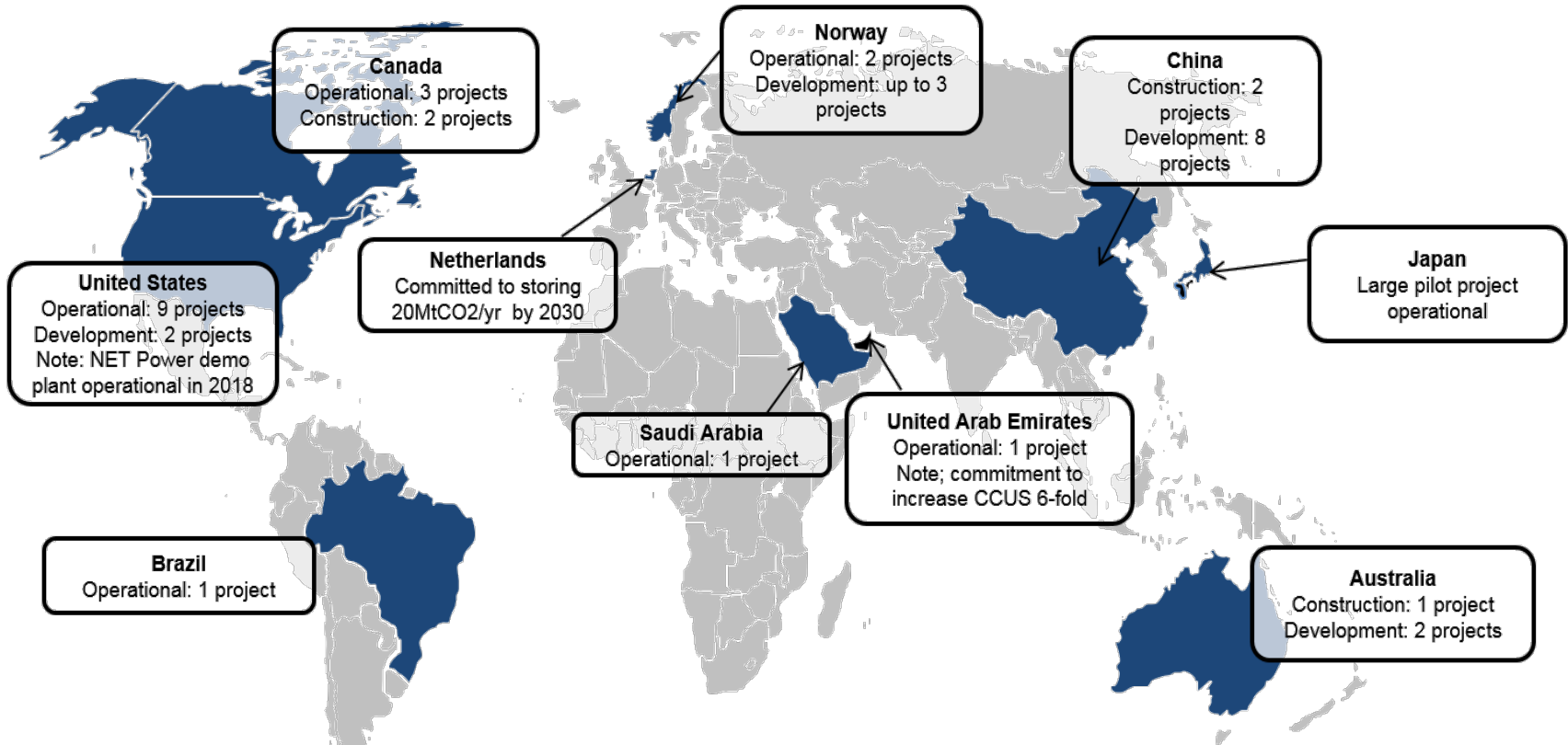
UK Government



12-14% of global decarbonisation efforts from CCUS to meet 2°C Paris Agreement targets.

>40% more expensive (~US \$3.5 trillion) to meet targets without CCUS.

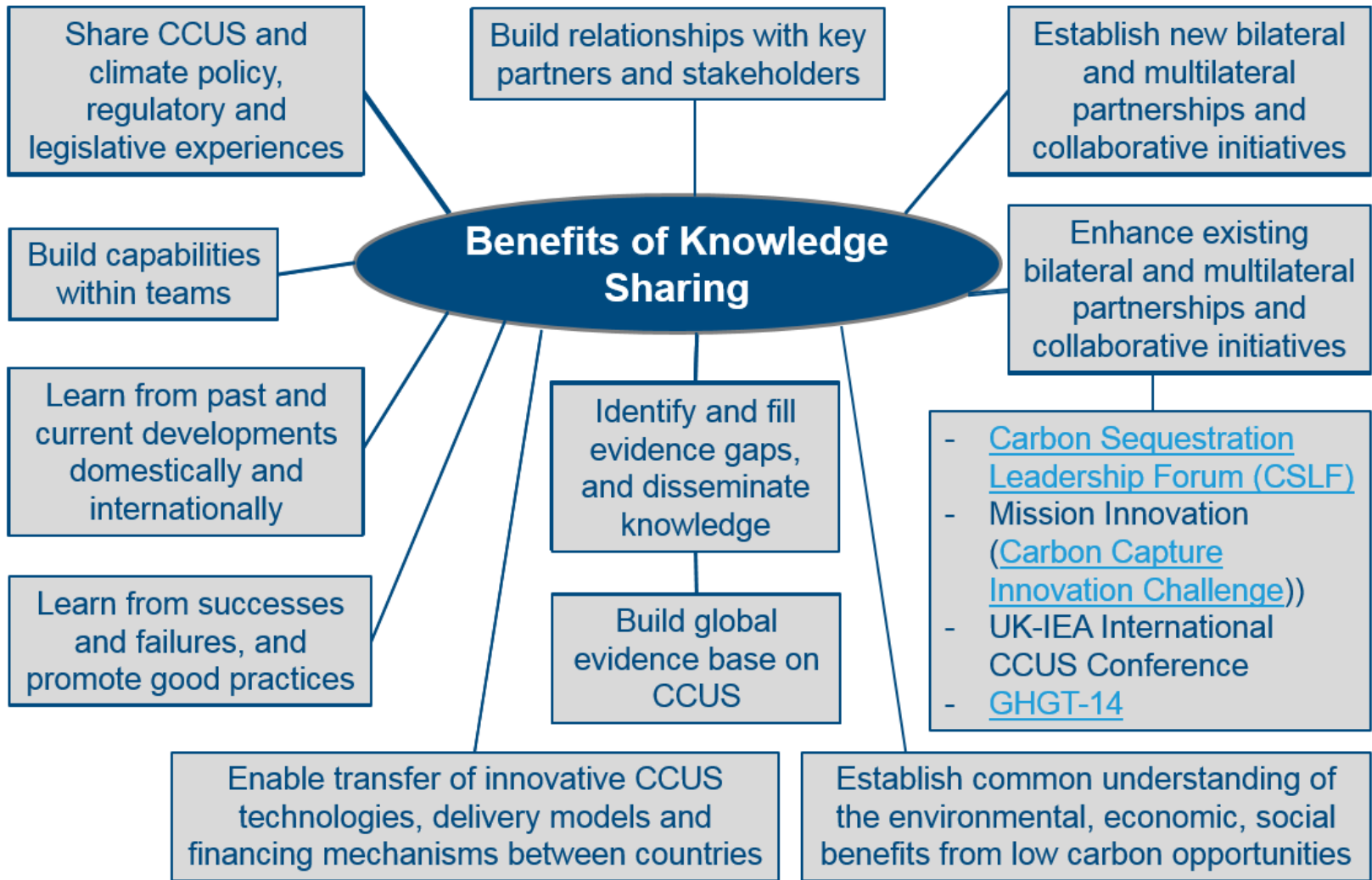
**Applications beyond power sector:** decarbonising industrial sectors, clean hydrogen production, and decarbonising gas production and gas processing.



- 22 large-scale CCUS plants globally
- Only 5 large-scale facilities not reliant on CO<sub>2</sub> for Enhanced Oil Recovery



# Benefits of International Collaboration



# UK International Collaboration

*“We will work with industry and other governments to drive down the cost and accelerate deployment of CCUS.”  
Clean Growth Strategy, 2017*

- Co-leading the Carbon Capture Challenge under **Mission Innovation** along with Mexico and Saudi Arabia.
- Members of US CCUS initiative under the **Clean Energy Ministerial**.
- Work with the **North Sea Basin Taskforce**, **Carbon Sequestration Leadership Forum** and **IEA GHG programme**.
- Work with the **Oil and Gas Climate Initiative** and keen to engage with other private sector initiatives.
- Keen to strengthen **bilateral engagement** with other leading CCUS countries.



# UK-IEA International CCUS Summit and Conference

- **CCUS Summit** hosted by UK Minister Claire Perry and IEA Executive Director Fatih Birol on 28 November 2018. Will **gather world energy leaders** from governments and industry to discuss concrete actions to scale up CCUS globally.
- Accelerating CCUS: A **Global CCUS Conference** will take place between 28-29 November:
  - ❑ **28 November**: half-day event, hosted by UKCCS Research Centre on the research and innovation priorities for CCUS and how to improve knowledge sharing of existing CCUS projects. This will be followed by a networking dinner and reception.
  - ❑ **29 November**: one day event, hosted by the UK Government and the Global CCS Institute on the pivotal role of CCUS. This will be followed by a networking reception.
- These invitation-only events will gather speakers and delegates from governments, industry and academia, and leading experts from around the world. The conference will discuss the **value of CCUS**, explore **business models**, and the **future of CCUS technologies** whilst seeking practical solutions and actions to **accelerate the deployment of CCUS** globally.
- Invitations for the Global CCUS Conference are currently being issued. Further details: <https://www.gov.uk/guidance/uk-carbon-capture-and-storage-government-funding-and-support>

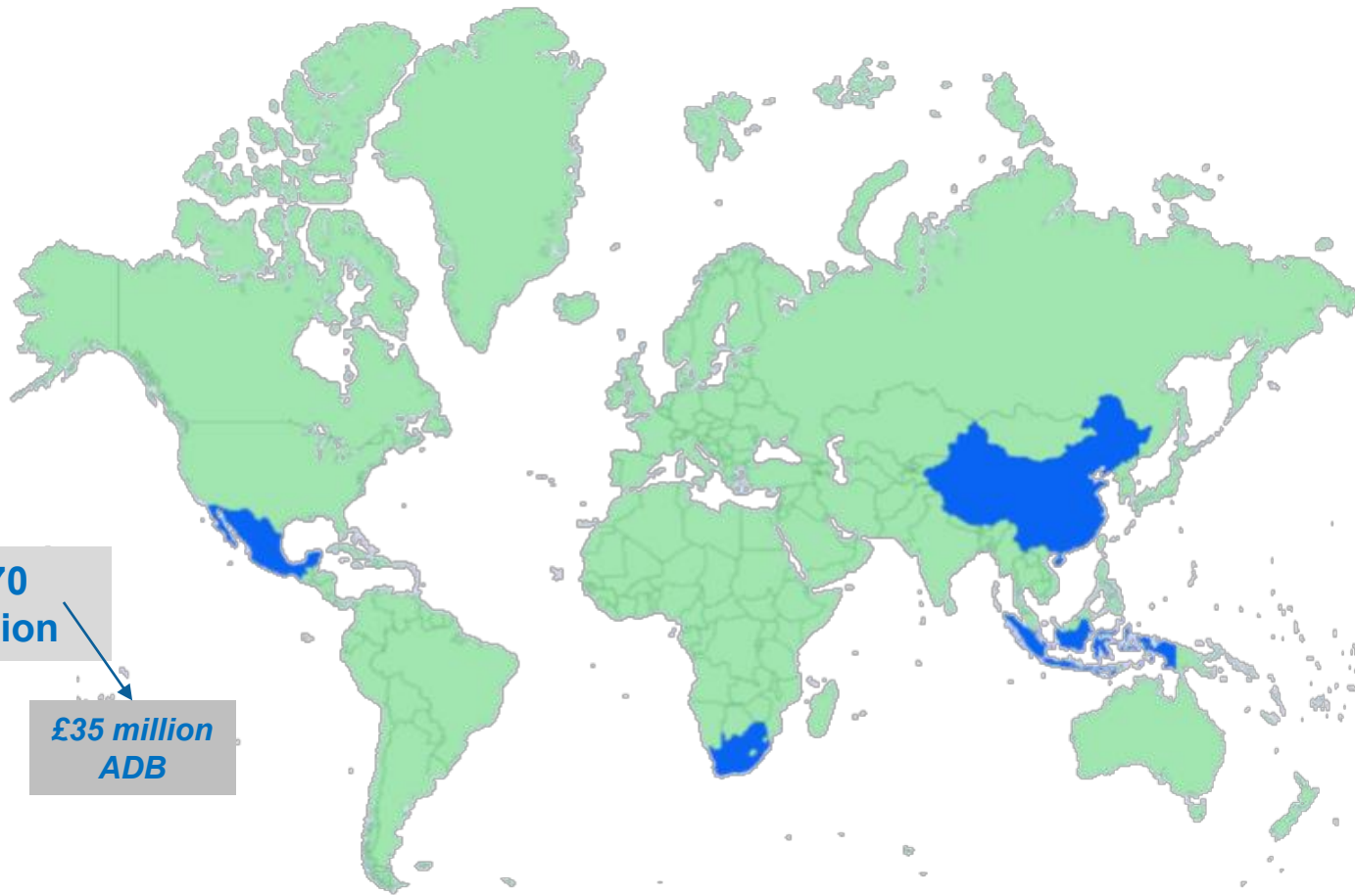


# UK International Support for CCUS

- Since 1990, the UK has **reduced its emissions by 42% whilst growing its economy by 67%**.
- The UK's **International Climate Finance** uses Official Development Assistance (ODA) to help developing countries to tackle climate change and move to sustainable economic growth.
- UK spent **£3.87 billion** of ODA on international climate finance between 2011-2016 and **£5.85 billion between 2016-2021**. This delivers the UK's share of the US \$100 billion/year by 2020 climate finance commitment under the Paris Agreement.

Department for  
Business, Energy  
& Industrial Strategy





- Supported Mexico and South Africa (through WB) and China and Indonesia (ADB)
- Activities (examples):
  - CCUS Centres of Excellence
  - Training and knowledge-sharing events
  - Capacity building workshops to develop policy and regulatory frameworks
  - Feasibility studies and pilot projects



# UK International CCUS Programme

- **UK is the largest multilateral ODA (aid) investor in CCUS.** We extended our funding by £10 million in December 2017.
- **£70 million** provided since 2012 to support the development of CCUS in emerging economies and developing countries.
- The [2018 International CCUS Programme Annual Review](#) summarises progress.
- Important for **more OECD countries to support non-OECD countries** on CCUS, either through the WB or ADB CCUS Funds or bilaterally.



# UK CCUS Support to Mexico

➤ *Through the World Bank CCUS Trust Fund:*

## ☐ CCUS pilot projects:

- **US \$4 million programmatic technical assistance** for the preparation of a 5MWe **CO<sub>2</sub> capture pilot** project at the Poza Rica gas power plant
- Supporting the construction of the **CO<sub>2</sub> capture pilot** project
- Supporting the development of a **CO<sub>2</sub> storage pilot** project

## ☐ Feasibility studies:

- **Regulatory framework** for the CO<sub>2</sub> capture and CO<sub>2</sub> storage pilots
- Transitioning **EOR projects to permanent storage** projects assessment
- Pre-feasibility study on a **CO<sub>2</sub> post-combustion** pilot capture plant

☐ **UK £5 million extension** in December 2017 to support CCUS activities in Mexico





# UK CCUS Policy and International Collaboration on CCUS Innovation

- ❑ UK's new approach to CCUS: see [Clean Growth Strategy](#)
- ❑ **Deploy CCUS at scale in the UK during the 2030s** (subject to sufficient cost reductions) – deployment pathway to be published by the end of 2018
- ❑ Work internationally to **reduce CCUS costs through innovation** (e.g. through Mission Innovation, CSLF, IEA GHG, ERA-NET, etc.)
- ❑ **£130 million invested in CCUS RD&D** to date
- ❑ Domestic CCUS innovation funding: **£100 million CCUS and industry fund** to achieve cost reductions
- ❑ International CCUS innovation funding: **£70 million ODA programme** to support ODA-eligible countries to develop CCUS. Forthcoming work on innovation for **industrial decarbonisation**



# QUESTION AND ANSWER SESSION



**Leonardo Beltrán**

SENER

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Webinar recordings provided on  
YouTube

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**THANK YOU!**

**Your Participation is Appreciated!**