Status of CCS in India and its related Policy Framework

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Introduction

- COP 21 in Paris, Most countries have now made their emissions commitments.

- But on all estimates there is a **sizable gap** between the total country commitments to the COP 21 talks and what science tells us we need to do

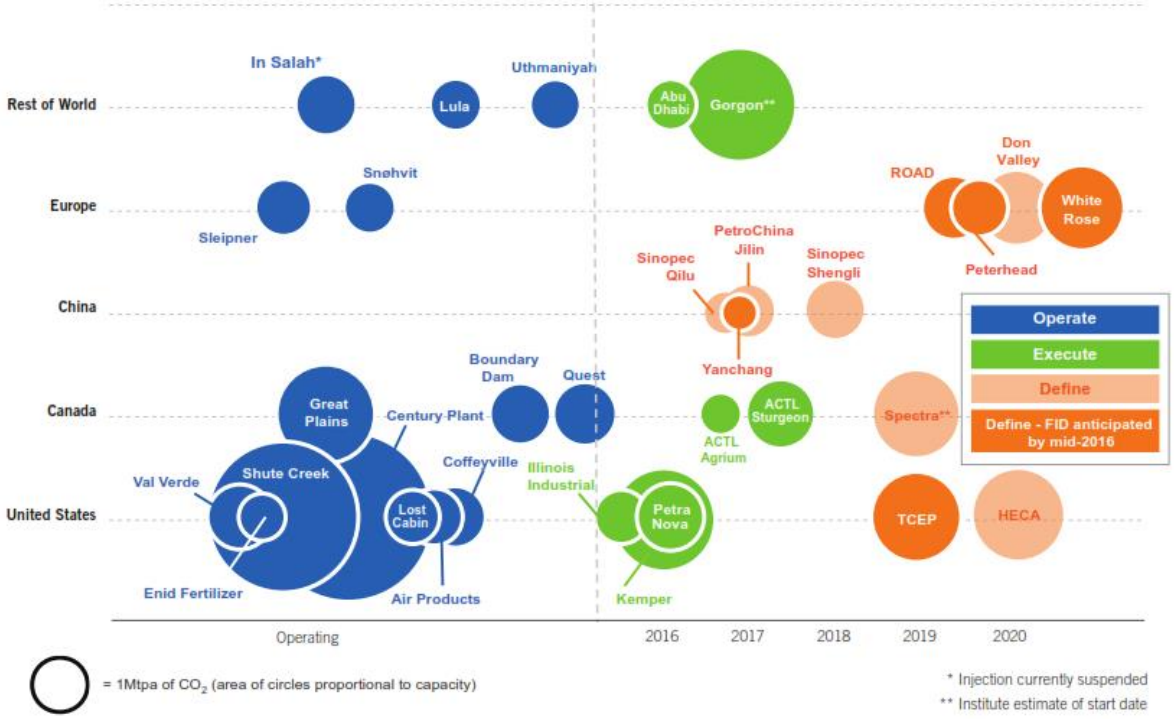
- IPCC's Fifth Assessment Synthesis Report found **that most climate models could not meet** emissions reduction targets without CCS.

- Crucially, **without CCS, the cost of mitigation would more than double** – rising by an average of 138 per cent.

Current Global Status

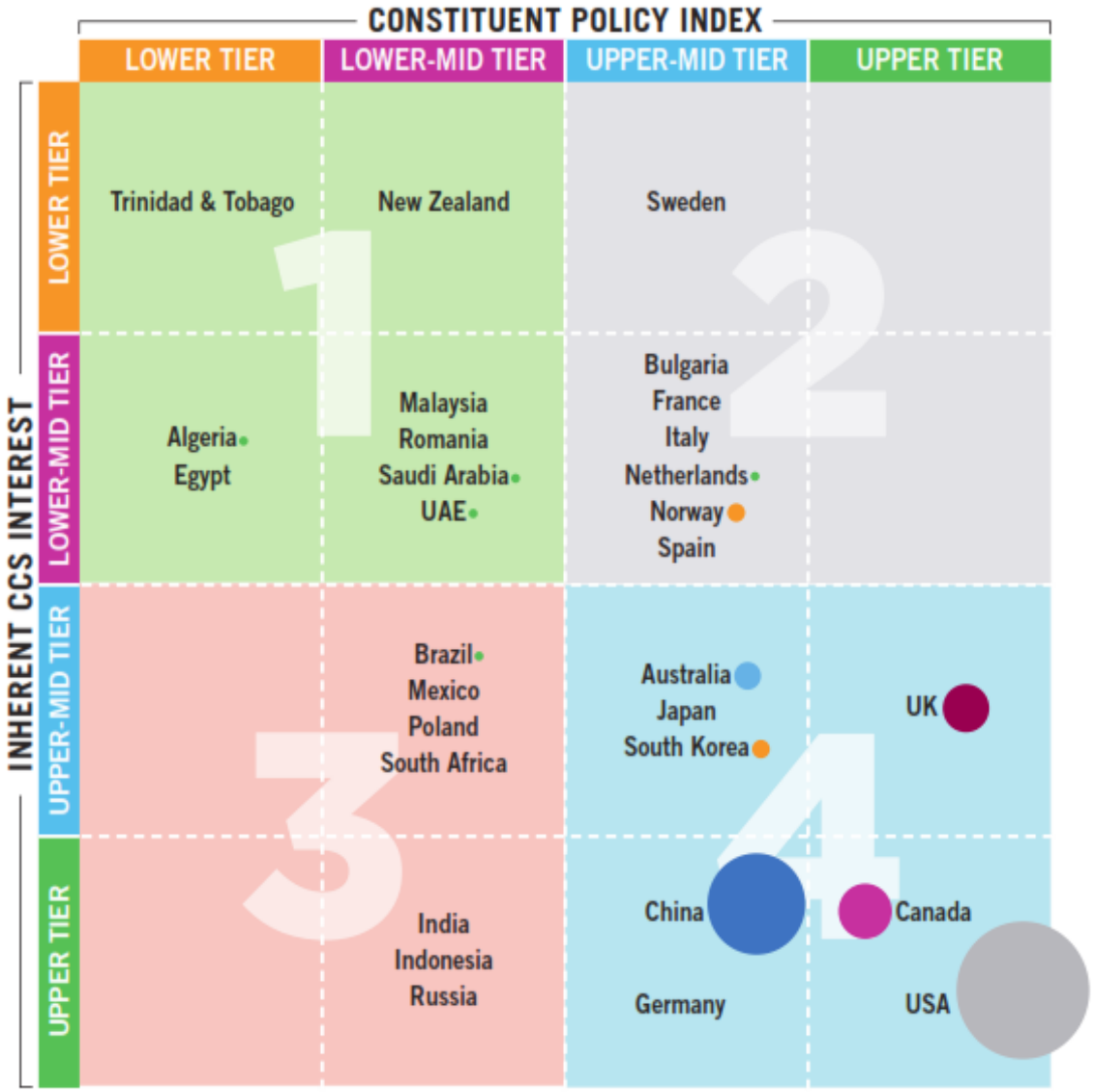
- World's first large-scale CCS project in the power sector, at SaskPower's Boundary Dam facility in Saskatchewan, Canada, has just celebrated two year in operation.
- Two more large-scale CCS projects on power is expected in 2016
- World's first steel plant with large-scale CCS in Abu Dhabi will be launched in 2016

Global CCS Institute report



Global CCS Institute report

World Policy Framework Scenario



COUNTRY		TOTAL SCORE (out of a possible 87)
BAND A: CCS-specific laws or existing laws that are applicable across most parts of the CCS project cycle (5 countries)		Average score: 65
	Australia	67.0
	Canada	65.5
	United Kingdom	65.0
	United States	64.0
	Denmark	62.0
BAND B: CCS-specific laws or existing laws that are applicable across parts of the CCS project cycle (27 countries)		Average score: 47
BAND C: Very few CCS-specific or existing laws that are applicable across parts of the CCS project cycle (21 countries scored)		Average score: 26

Current Indian Status

Department of Science and Technology (DST) of the Indian Ministry of Science and Technology looks after Research and Development (R&D) acti**vities related to CCS for India**

For developing Pure/Applied research and industrial applications, DST set up **National Program on Carbon Sequestration (NPCS) Research** in 2007

Under **the Agreement of Cooperation in Science & Technology** concluded between Government of India and the **Government of Norway, the DST and the Research Council of Norway (RCN)** have started a programme for joint funding of Indian-Norwegian joint research projects in Climate research, including CCS

ONGC Ltd. was in the process of setting up a pilot experimental EOR project in Gujarat, with CO2 (40 MMSCMD of sour gas per day) from the **gas processing plant at Hazira to be supplied to the depleted onshore reservoir at Ankleshwar**, where it would be recompressed and injected for enhanced recovery of crude oil

Current Status

National Aluminium Company (NALCO) plans to set up a carbon capture unit at its coal-fired plant at Angul, Orissa state for bio sequestration

NTPC as part of the Carbon Sequestration Leadership Forum (CSLF), has partnered the **National Geophysical Research Laboratory, India (NGRI)** and the Battelle Pacific North-West National Laboratory, USA, to evaluate the Deccan basalt formation in India as a potential long-term CO2 storage option

NTPC also organized **a national workshop on CCS** in collaboration with the Ministry of Power in September 2011.

Bharat Heavy Electrical Ltd. (BHEL) and APGENCO, the power generating company of Andhra Pradesh, are setting up a 125 MW demonstration IGCC plant in Andhra Pradesh

Current Status

India's first IGCC plant, BHEL is also coordinating with Indira Gandhi Centre for Atomic Research (IGCAR) and NTPC to design, develop and build ultra super-critical boilers

It has also collaborated with **TREC-STEP (Tiruchi Regional** Engineering College – Science and Technology Entrepreneurs Park) to implement a set of initiatives in CCT and CCS, as part of a three year EU funded project

TREC-STEP, in collaboration with Ernst and Young, also **organized an EU-funded 2-day training** programme on 'Introduction to CCS and CCT' in December 2011, and a 3-day 'Skill Leverage Programme on CCT-CCS Technologies' in January 2012

Indian Institute of Petroleum (IIP) has been working on developing new adsorbents for post-combustion CO2 capture

Complicated laws related to regulatory approval and storage challenges is stopping private palyers

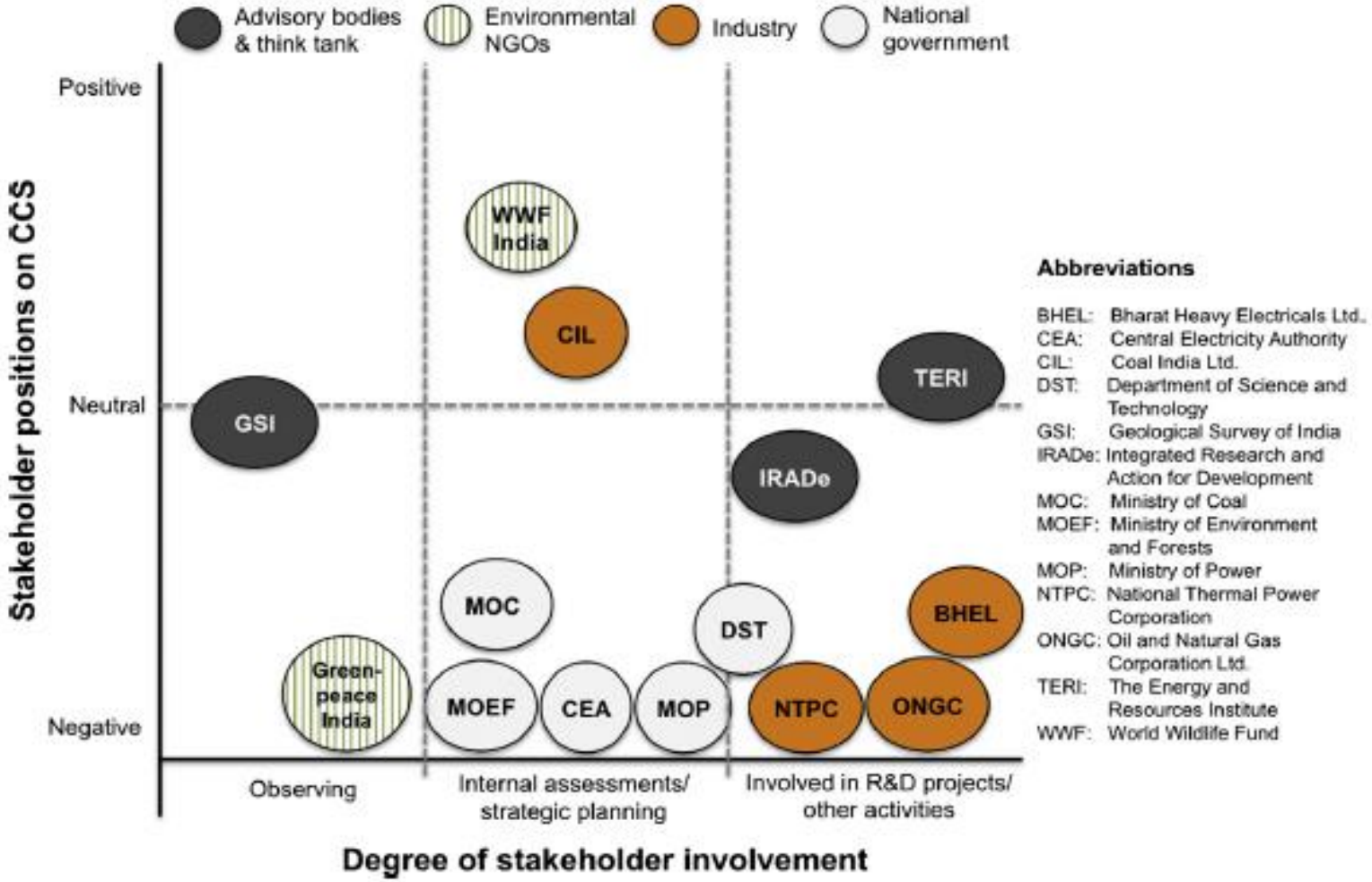
DST Sponsored R&D project on CCS

Sr. No.	Project title	Organisation	Year approved	Duration (years)
1.	Modelling and simulation of Carbon Recycling Technology though conversion of CO_2 into useful multi-purpose fuel	Rajiv Gandhi Technological University, Bhopal	2007-08	3
2.	Pilot Bio-reactor using biological and chemical carbon dioxide sequestration (Integrated Biological and Chemical CO_2 sequestration)	National Environmental Engineering Research Institute (NEERI), Nagpur	2007-08	3
3.	Sequestration of carbon dioxide (CO_2) into geological environment (Gas Hydrate): Laboratory Studies	National Geophysical Research Institute (NGRI), Hyderabad	2007-08	3
4.	Development and Characterization of porous Solid Adsorbents for sequestration of Carbon Dioxide (CO_2) (Metal Silicates for pre-combustion High Temperature CO_2 Removal (IGCC Conditions)	National Chemical Laboratory (NCL), Pune	2007-08	3
5.	Experimental and simulation studies on CO_2 sequestration using solar/ chemical methods	Centre for Energy and Environment Science and Technology(CEESAT), NIT, Tiruchirapalli	2007-08	3
6.	Analysis of Carbon Capture and storage (CCS) technology in the context of Indian Power Sector	Integrated Research and Action for Development (IRADe), New Delhi	2007-08	2
7.	Predicting Soil Carbon changes under different bio-climatic systems in India	National Bureau of Soil Survey and Land Use Planning, Nagpur	2007-08	3
8.	Improving carbon and nitrogen sequestration: A Transgenic approach to lower greenhouse gas	Institute of Himalayan Bio-resources Technology, Palampur, Himachal Pradesh	2007-08	3
9.	Carbon Di-oxide Sequestration through Culture of Medically useful Micro-algae in Photo-bio-reactor linked to Gas outlets of Industries	Department of Botany, Andhra University, Vishakhapatnam	2008-09	3
10.	CO_2 Sequestration using Micro algae – Efficient use of CO_2 from bio-hydrogen production facility	AMM MurugappaChettiar Research Center, Chennai	2008-09	3
11.	Carbon Sequestration by higher plants and algae at elevated carbon di-oxide	Jawaharlal Nehru University and Dehi University, Delhi	2008-09	3
12.	Carbon Di-oxide Sequestration Potential of Agro Forestry System under Irrigated and Rain fed Conditions	Director, National Research Center for Agro-forestry, Jhansi	2008-09	3
13.	Mycorrhizal Symbiosis to Promote Carbon Sequestration for Sustainable Fertility and Environment Safety	Department of Soil Sciences & Agriculture Chemistry, Tamilnadu Agriculture University, Coimbatore	2008-09	3
14.	Mechanism and the dynamics of carbon storage in the Sundarban Mangrove	University of Calcutta, Kolkata	2009-10	3
15.	Marine cyanobacteria a promising candidate for carbon-dioxide sequestration with multiple utilization	Bharathidasan University, Tiruchirappalli	2009-10	3
16.	Carbon sequestration potential in wetlands of Vedaraniam, south east coast of India	Bharathidasan University, Tiruchirappalli	2009-10	3
17.	Carbon Sequestration through Afforestation for Mitigating CO_2 emission from Thermal Power Station	Jadavpur University, Kolkata	2009-10	3
18.	Chemo-photosynthetic conversion of carbon dioxide into algal biomass with biotech potentials	Department of Biotechnology School of Life Sciences, North Maharashtra University	2009-10	3
19.	Monitoring of Carbon sequestration	G.B.U.A.&T. Ag. Research	2009-10	3

TERI, 2013

Very less funding for geological storage

CCS Stakeholders in India



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Barriers to CCS implementation in India

- A degree of confidence will be gained in the technology only after **conversion of demonstration phase to commercial scale** projects worldwide
- **Lack of accurate geological storage** site data, before capture technology can be installed in power plants or other sources, i.e, source sink matching
- Implementation of CCS drastically **increases the cost of electricity** while reducing net power output is often cited as being one of the biggest barriers to acceptability of CCS in India.
- Enhanced Oil Recovery (EOR) is worldwide one of the most attractive options for CO_2 storage, since the **cost of storing the CO_2 is offset by the revenues** accrued by the hard-to-extract oil that can be recovered from depleted oil fields by this procedure.
- In the Indian scenario, however, it has been stated by stakeholders in the petroleum sector that there **are few oil fields which are sufficiently depleted** for EOR to be required at present
- EOR is **dependent on the miscibility characteristics** of the oil with the extracting fluid, it may not be suitable in all cases.

Barriers to CCS implementation in India

- Unmineable coal seams may become mineable with technology development in future
- Deployment of CCS on a large scale requires **specialised manpower** and suitable infrastructure, which may not be available in India at present.
- **Monitoring** the stored CO_2 to assure against leakage is essential if the central purpose of CCS implementation is to be fulfilled
- **Legal issues** related to land acquisition; ground water contamination, CO_2 leakage, etc. need to be addressed before any large scale transport and storage of CO_2 can be permitted.

Challenges of CCS in India

- **High cost of CCS** – One of the most important objections of the Indian government officials to suggestions of implementation of CCS in India were the factor of high costs. Most officials **objected to the high costs both in terms of loss of power** and high capital costs that India will have to face to implement CCS.
- **Technology customization and adoption** – There is widespread belief that the IGCC and CCS technologies have not been extensively tested and customized for Indian conditions. Since **India has not been involved with any of the current projects,** the understanding of the technology and its adaptation in India is low.
- **Government Opposition and Apathy –** There is considerable opposition from the government due to the above reasons as well as economic reasons stemming from the belief that since the ***current accumulation of greenhouse gases is not of India's doing***, and so it should not have to bear the costs of emissions reductions.
- **Lack of cooperation –** The Carbon Sequestration Leadership Forum (CSLF) includes India but the capacity building contact is currently **limited to the central environment and science and technology ministries**. The cooperation would have to reach the organizations putting up the plants as well as the relevant state governments.
- CCS is not expected to be applied in India before 2030 in current global and regional modelling studies

Modification of Existing Policy

- **Oil and gas**
- Indian Petroleum Act, 1934: Rules for production and transportation of petroleum products. It can be applied for transportation of compressed CO_2.

- The Oilfields (Regulation and Development) Act, 1948 (53 of 1948): Royalties in respect of mineral oils. It can be applied for EOR.

- The Petroleum Mineral Pipelines (Acquisition of Right of User in Land) Act, 1962: Provides for the acquisition of user in land for laying pipelines for the transport of petroleum and minerals. This law may be applied for transportation of compressed CO_2 to storage sites.

- The Oil Industry (Development) Act, 1974: An act to provide for the establishment of a Board for the development of oil industry and for that purpose to levy a duty of excise on crude oil and natural gas and for matters connected therewith. It can be modified for levying a duty of excise on crude oil and natural gas produced during EOR.

- Petroleum and Natural Gas Rules, 1959: An act to provide petroleum exploration license and mining leases. This law will for development of sites for EOR and EGR.

Modification of Existing Policy

- **Transport**
  - The Petroleum Mineral Pipelines (Acquisition of Right of User in Land) Act, 1962: Provides for the acquisition of user in land for laying pipelines for the transport of petroleum and minerals and for matters connected therewith.
  - This law may be applied for transportation of compressed CO_2 to storage sites.
- **Groundwater**
  - Water (Prevention and Control of Pollution) Act 1974 enacted by Ministry of Environment and Forest, GOI provide for **the prevention and control of water pollution**, and for the maintaining or restoring of wholesomeness of water in the country.
  - This **Act levies and collects cess** on water consumed by persons operating and carrying on certain types of industrial activities.
  - CCS has environmental impacts in terms of **chances of groundwater contamination** and this act could be suitably modified to include contamination of groundwater in case there is any leakage of stored CO_2.

Modification of Existing Policy

- **Environmental impact assessment**
  - Amending the Environmental Protection Act, 1986 is likely to be the most effective way to facilitate demonstration projects and may be done on a project-specific basis before broader amendments can be established.
  - Since CO_2 may need to be transported across states and be stored in a region different to the point of collection**, regional coordination groups** will need to be established to address issues related to CO_2 transport and storage.
- **Financing and investment**
  - Given the higher initial investment as well as operating costs, CDM (Clean Development Mechanism) and carbon markets in their present form **may not be sufficien**t to support and promote CCS.
  - Ideally, policy for financing and investment should be such that the **additional energy penalty due to retrofitting of the power plant for CCS** is partly or wholly covered by earnings from CDM/carbon markets.
  - Towards this, while **multilateral financing institutions** like the World Bank, International Monetary Fund, and the Asian Development Bank may take a lead in developing specific financial packages and instruments,
  - those countries that are **technologically advanced in CCS should come forward** in supporting, including capacity development, initial CCS projects in India.

Policy Suggestions for CCS in India

- Liability Bill need to be introduced based on Nuclear Liability bill to develop confidence
- Direct regulation to require power generators to reduce emissions intensity
- Government funding of large-scale CCS projects and R&D
- Fiscal and market-based incentives, including carbon pricing and tax credits
- Supportive legal and regulatory frameworks governing CO2 storage
- CCS specific law and regulation
- cross-border movement of CO2, post-operational transfer of operator's liability, and all liabilities in the event of post-operations transfer, as critical issues largely unaddressed by India's national legal and regulatory regimes.

Thank You