PHILIPPINE PRESENTATION ON CARBON CAPTURE AND STORAGE

Philippines
DEPARTMENT OF ENERGY

"Determining the Potential for Carbon Capture and Storage in Southeast Asia"

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PHILIPPINE COUNTRY REPORT SUMMARY

CO_2 Emission Profile

The Energy Sector generated 68.91 $MtCO_2$-eq of emissions in 2009 which is a 38% increase from the 50 $MtCO_2$ emissions in 1994.

CO_2 EMISSION	
Electricity Generation	39.9%
Transport	35.6%
Industry	17.0%
Commercial, Agricultural and Residential	7.5%

CO_2 Emission Profile

2009 CO_2 EMISSION PROFILE		
Combustion of Oil	36.59 $MtCO_2$-eq/y	53.1%
Combustion of Coal	24.85 $MtCO_2$-eq/y	36.1%
Combustion of Natural Gas	7.47 $MtCO_2$-eq/y	10.8%

8. Projected CO_2 Emissions

CO_2 EMISSION FROM ELECTRICITY GENERATION	
2010	33 Mt
2030	90Mt

AVERAGE CARBON INTENSITY	
2009	0.45 kg CO_2/kWh
2030	0.54 kg CO_2/kWh

Carbon Emission Sources

CO_2 EMISSION SOURCE (Candidate for CCS)
500MW Quezon Coal-Fired Power Plant
1,000MW Sta. Rita Gas-Fired Power Plant
500MW San Lorenza Gas-Fired Power Plant
1,200MW Ilijan Gas-Fired Power Plant

Carbon Capture Plants.

CO_2 EMISSION SOURCE (Candidate for CCS)	
Ilijan Gas-Fired Power Plant	3.1 $MtCO_2/y$
Sta. Rita Gas-Fired Power Plant	2.8 $MtCO_2/y$
San Lorenza Gas-Fired Power Plant	1.4 $MtCO_2/y$
Quezon Coal-Fired Power Plant	3.1$MtCO_2/y$

… and by 2020

CO_2 EMISSION SOURCE (Candidate for CCS)	
550 MW San Gabriel Natural Gas Power Plant	1.5 $MtCO_2$/y

CARBON STORAGE

The different geological formations that were considered for use as CO_2 storage facilities are sedimentary basins (conventional storage) – oil and gas fields, saline aquifers and unconventional storage sites such as geothermal field, ophiolites, coal beds and shales.

1. Oil and Gas Fields

Fourteen (14) oil reservoirs were identified with assessed cumulative CO_2 capacity of 35 $MtCO_2$.

West Linapacan Oil Field	**20 $MtCO_2$**

And five (5) gas fields were identified with assesed cumulative CO_2 capacity 287 $MtCO_2$.

Malampaya Gas Field	**260 $MtCO_2$**

2. Saline Aquifers

Among the 16 sedimentary basins, only two, the Cagayan and Central Luzon Basins have sufficient data for initial CO_2 storage screening. The Central Luzon Basins lies within 50 km of the CALABARZON and is relatively clear of faults, thus it was evaluated first as possible storage site. The theoretical storage capacity of 23 Gt. CO_2 for deep saline aquifers in the two basins could hold the total CO_2 emissions from CALABARZON for more than 100 years.

Current Understanding of Storage Capacity – The Philippines

Source: APEC, 2005

3. Geothermal Fields

Geothermal fields and prospects would need further study or pilot testing for CCS especially in areas that are within reasonable distance of identified CO_2 sources. Located in CALABARZON are the Mabini geothermal prospect in Mabini, Batangas, the producing Mak-Ban geothermal field in Laguna-Quezon and the unproductive geothermal wells in the Mt. Natib geothermal prospect in Bataan about 80 kms east of Metro Manila.

4. Ophiolites

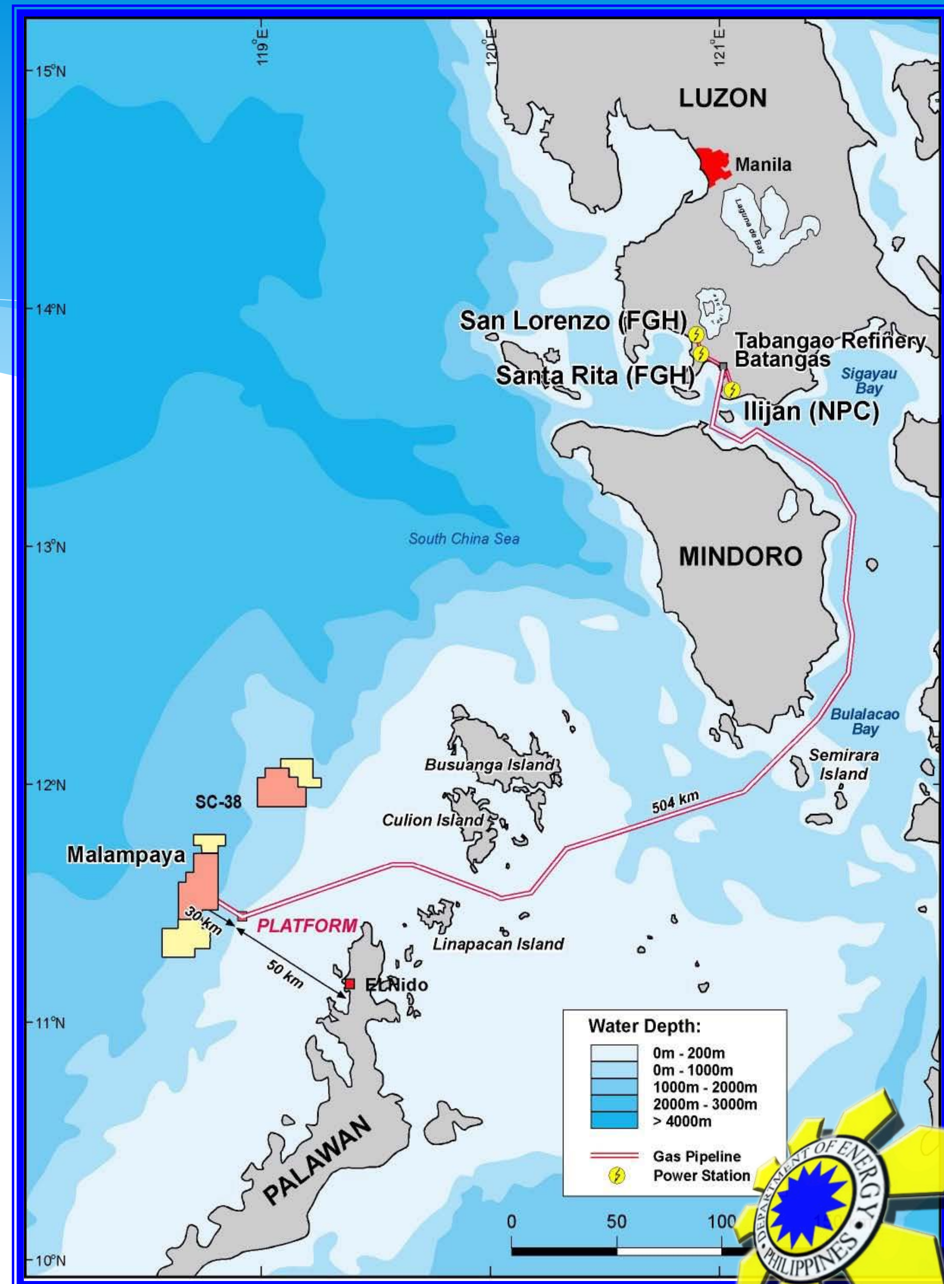
The Zambales Ophiolite, located west of the Central Luzon Basin, is the most promising among the ophiolite bodies for storage. However, substantial research on permeability and sealing is needed to assess their potential for carbon storage.

5. Coal Beds and Shales

A study on an enhanced production process similar to Enhance Oil Recovery (EOR) called Enhanced Coal-Bed Methane (ECBM) recovery in coal mines is being conducted by the DOE. Unfortunately, the coal mines where the project is implemented are located far from CO_2 emission sources in CALABARZON. Therefore, none of the coal mines were considered for carbon storage in this study.

SOURCE-SINK MATCHING

The Malampaya gas field can accommodate an annual CO_2 emission of 11 Mt/year from the four candidate capture plants in CALABARZON for at least 20 years or the 3.32 Mt CO_2 emission per year of Ilijan, which is the most viable candidate capture plant, for at least 80 years.



CARBON TRANSPORT

In the absence of other viable storage options in the near- an long- term, it is logical and practical to use the existing 504-km natural gas pipeline for transporting CO2 from CALABARZON to the storage site in Malampaya.

Economics of CCS

The study illustratively evaluated the cost impacts of including CCS on a super-critical pulverized coal (PC) power plant and a natural gas combined cycle (NGCC). CCS incrementally adds $2,806 /kW to the total capital costs of a super-critical PC, resulting in a 74% ($64/kWh) increase in the levelized cost of electricity (LCOE). Similarly, CCS incrementally adds $1,444/kW to the total capital costs of an NGCC, resulting in a 47% ($31/MWh) increase in the LCOE.

The resulting abatement costs for super-critical PC and NGCC with CCS are \$93/t and \$97/t CO_2 avoided. The estimated long-term power tariff of \$95/MWh could approximately cover the LCOE of an NGCC with CCS of \$97/MWh. However, the NGCC with CCS may still need to be compensated for the loss of profit margins.

POLICY AND REGULATORY FRAMEWORK

As with other countries in the region, Philippine already has several laws and regulations that could potentially be used to regulate CCS projects. The country's various energy laws (i.e., oil and gas, coal, geothermal) could provide models for specific elements of a CCS regulatory framework, such as those for exploration permits and service contracts for energy development.

Environmental laws could cover provisions for ongoing liability for negligence or intentional misconduct in carrying out a CCS project. Nevertheless, specific provisions of law are needed to address, among others, ownership and long term steward of injected CO_2 on State land; containment structures, and monitoring, measurement and verification requirements.

PUBLIC PERCEPTION AND SOCIAL ACCEPTANCE

Significant Barrier in Developing CCS

- High cost in installing CCS.
- Affordability of the electricity when CCS is installed.
- Public awareness of CCS is relatively low as compared to their awareness of climate change.

Government needs to demonstrate its commitment to pursuing CCS through public statements, funding of CCS activities at a low but effective level, institution of a basic "capture ready" policy and initiation of public engagement on CCS.

Piloting to Commercial Projects:

There are limited opportunities for large-scale deployment of CCS in the country before 2024.

- One option may be to focus the pilot on the technical details of reversing the circulation from the Malampaya OGP in Batangas to the Malampaya carbon storage site.
- Another approach may be to undertake early work to pilot and test unconventional storage options (e.g. Geothermal Fields and ophiolites) for CO_2 generators that may not be able to easily access conventional CCS storage such as Malampaya.

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