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Updates of CCS Status in Taiwan

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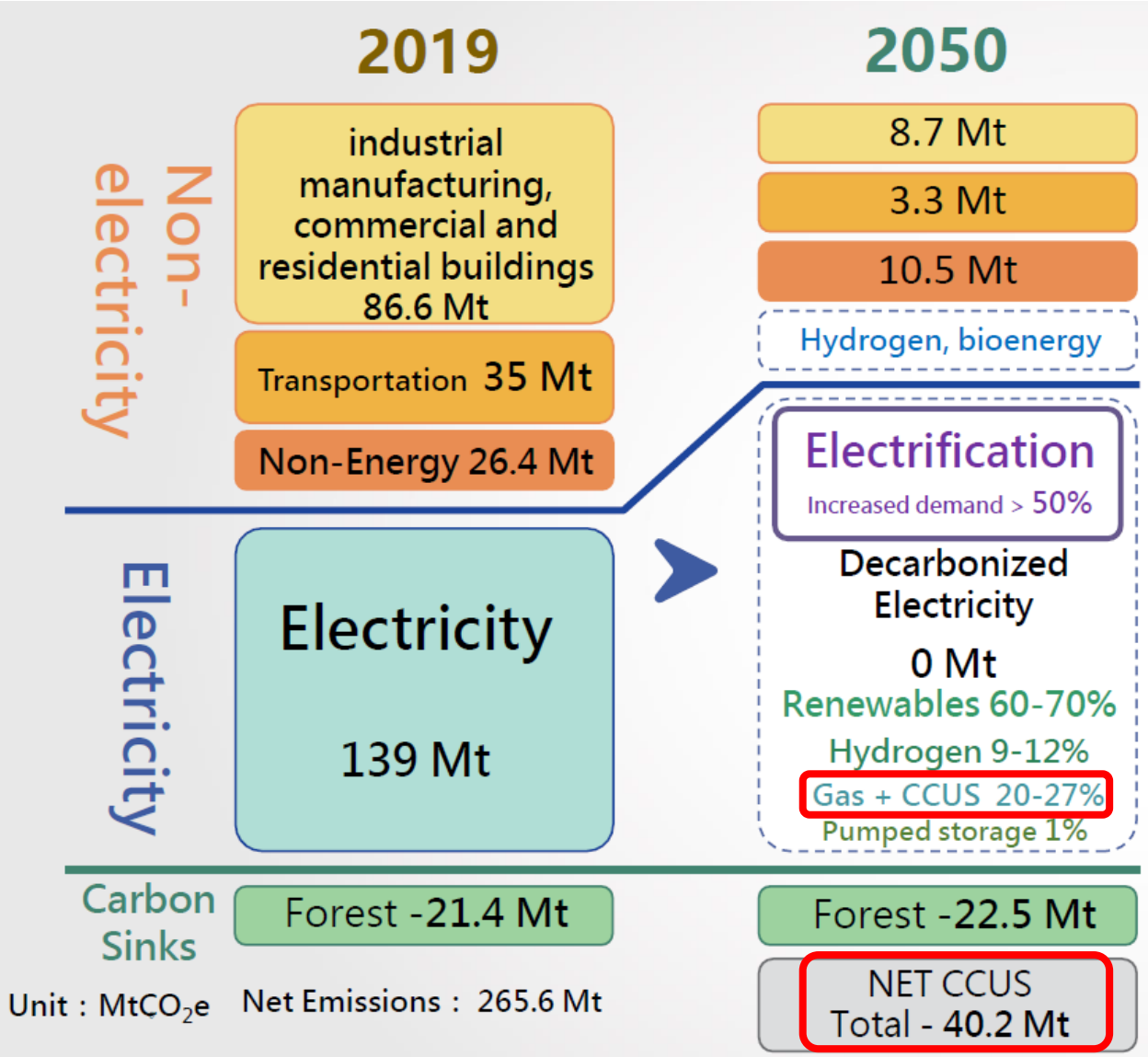
5th International Workshop on Offshore Geologic CO_2 Storage, New Orleans, Louisiana
May 19, 2022

Taiwan's 2050 Net-Zero Emissions Plan



It is based on the 4 major transition strategies of "**Energy Transition**", "**Industrial Transition**", "**Lifestyle Transition**", and "**Social Transition**", as well as the 2 governance foundations of "Technology R&D" and "Climate Legislation".

Offsetting about 22.5 Mt from refractory emissions by Carbon Sinks

New fuel CCUS process application: Hydrogen, Biomass, CCUS (Steelmaking, chemical materials, cement industry and other process emissions)

Fossil fuels Equipment Electrification:
Industry : Fossil fuel equipment
Buildings : household and service appliances
Transportation : electric vehicles

2050 Electricity Demand Scenario

Average annual growth $2 \pm 0.5\%$

Demand : 427.5 – 573.1 TWh

Emissions and absorption achieve the Net-Zero target

Base Year (2005) : 268.6 $MtCO_2e$

Peak (2007) : 280.0 $MtCO_2e$

6

Source: National Development Council. March 30, 2022. Taiwan's Pathway to Net-Zero Emissions in 2050. https://www.ndc.gov.tw/en/Content_List.aspx?n=B927D0EDB57A7A3A&upn=A2B386E427ED5689

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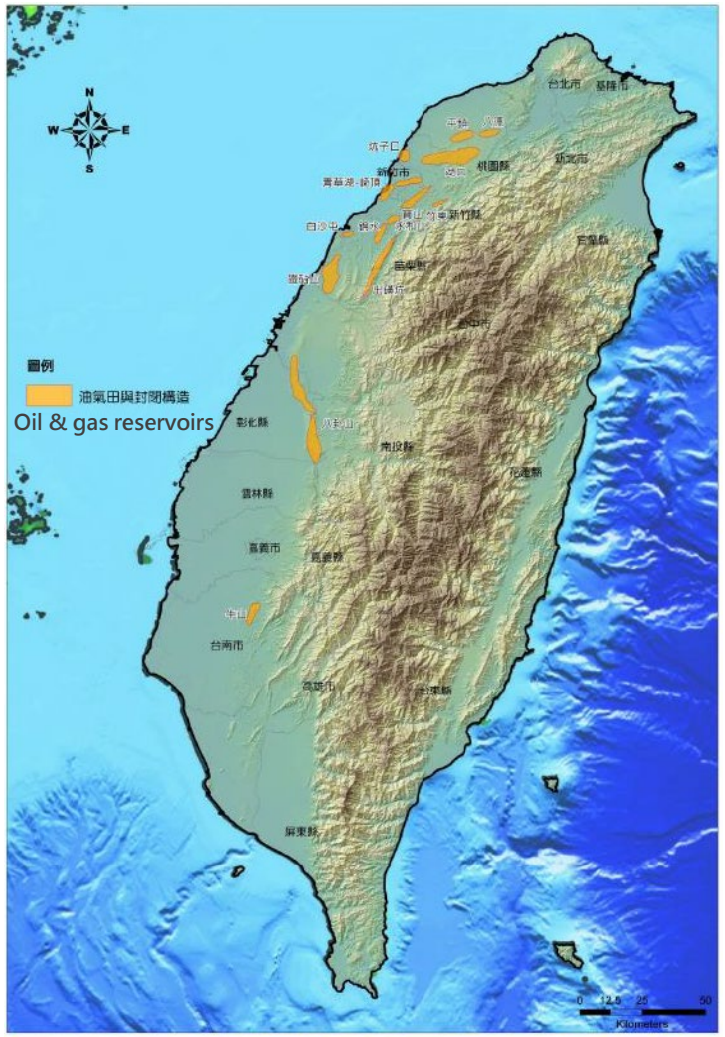
Site Selection and Characterization



Onshore (2.8 Gt)

Plane, nearshore, and offshore (45.9 Gt)

(Lin et al. , NEP Ⅱ · 2014)

Major CO_2 Emission in Taiwan

(Taiwan GHG Emissions Registry · 2020)

台灣中油股份有限公司
CPC Corporation, Taiwan

Source: Lin et al. NEP II. 2014. Atlas for Geological Storage of Carbon Dioxide in Taiwan. (台灣二氧化碳地質封存地圖集)
Taiwan EPA. 2020. Taiwan GHG Emissions Registry

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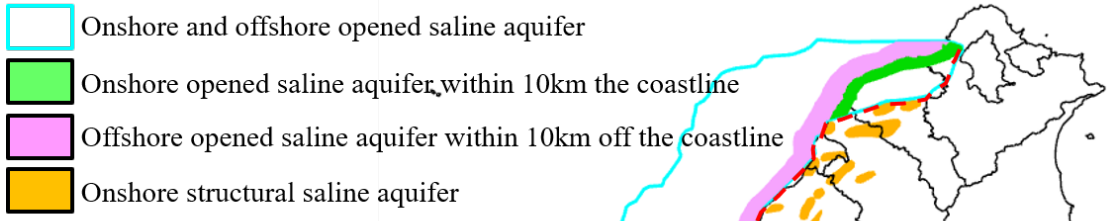
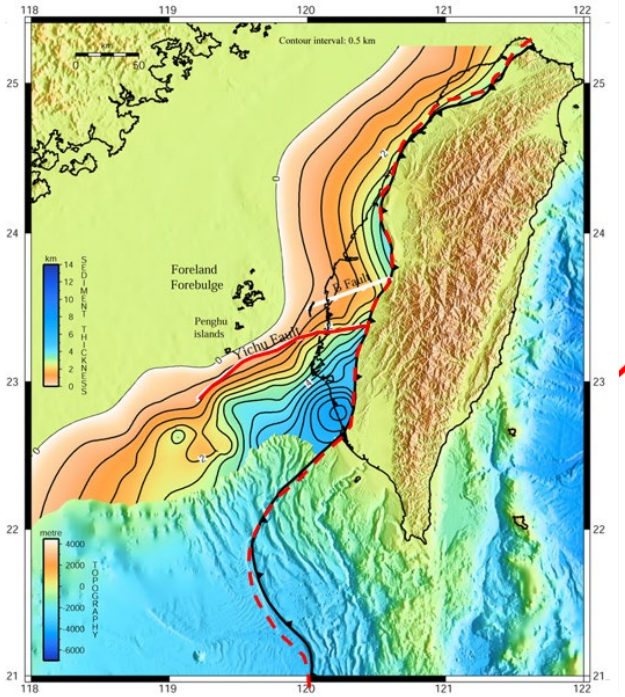
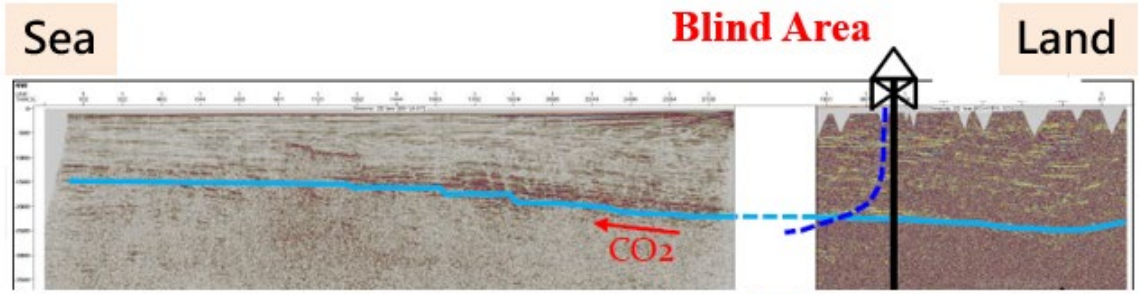
Geological Survey in CPC



(EPBD, CPC, 2022)

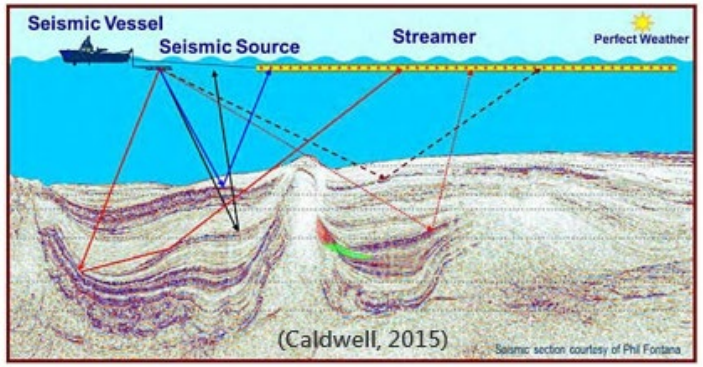


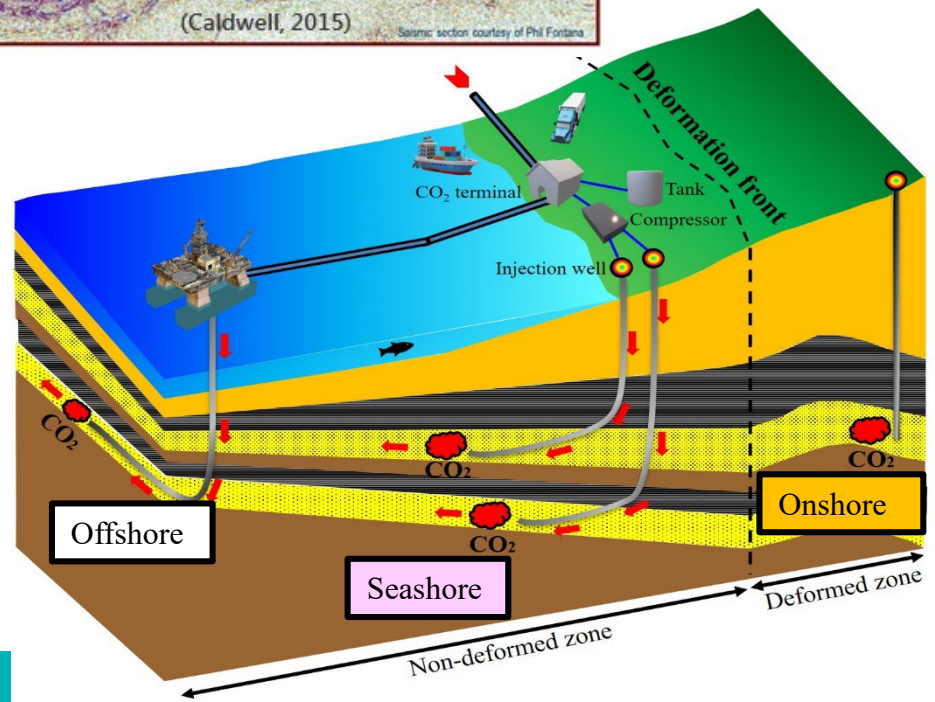
(Lin, A. T. and A. B. Watts, 2002)



(EPBD, CPC, 2022)

Marine Seismic Survey



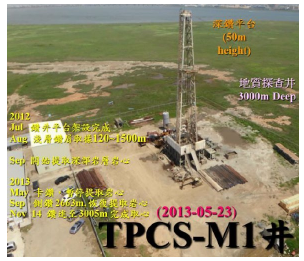


CPC have launched the marine seismic survey to collect the essential data this year, and CPC will complete the site selection and characterization by 2023.

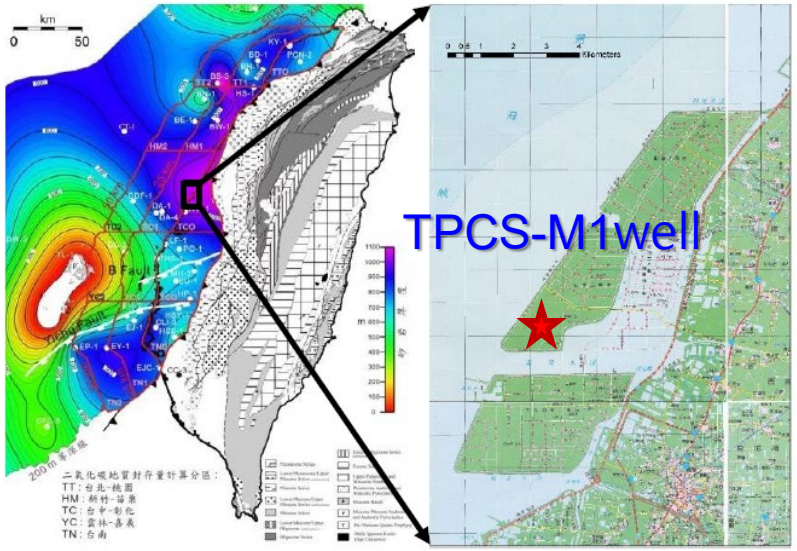
台灣中油股份有限公司
CPC Corporation, Taiwan

The current status of Taipower's carbon storage project

- Taihsi Basin and Changbin Site

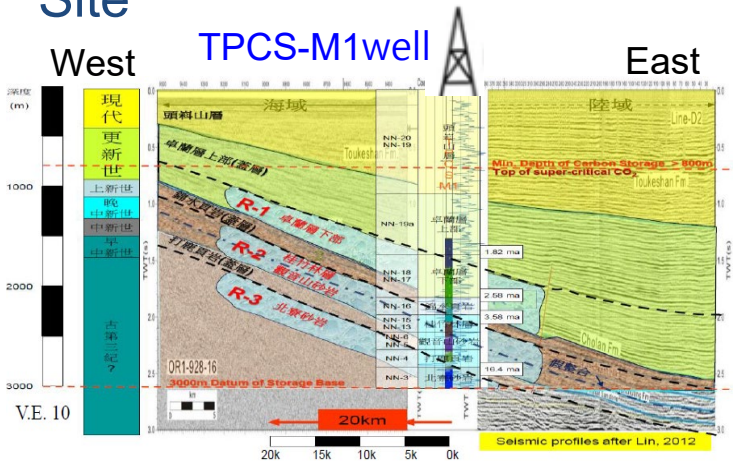


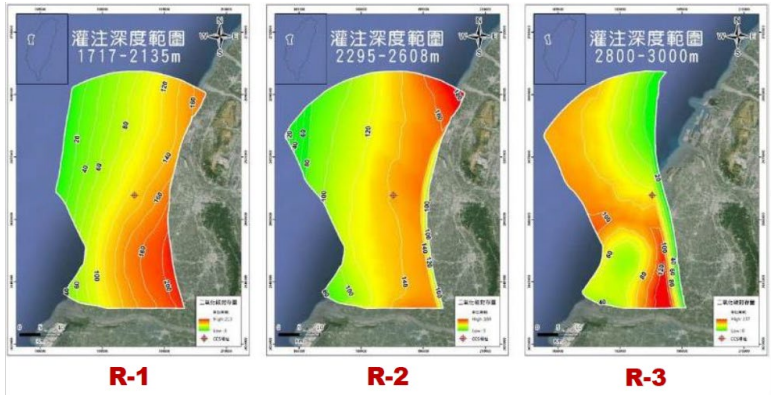
(Taipower, 2022)



(Lin et al. , NEP Ⅱ · 2014)

- Effective Capacity of Changbin Site





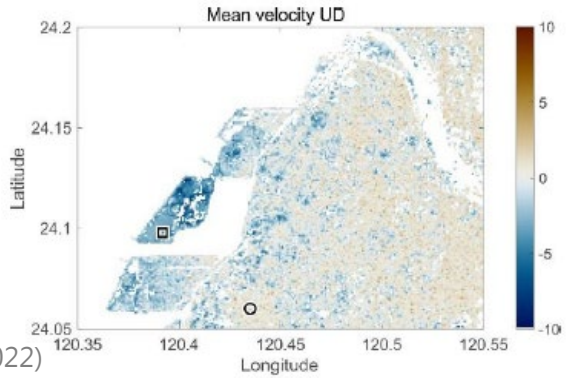
Three reservoirs are identified, and the effective capacities are:

R-1 = 4.9 Gt, R-2 = 6.3 Gt, R-3 = 2.5 Gt

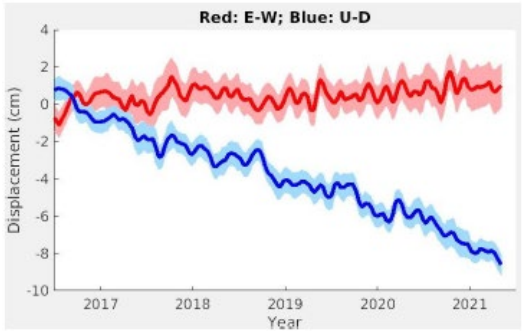
the total is 13.7 Gt

- Environmental monitoring

Surface deformation by GNSS and InSAR



(Taipower, 2022)



Taipower

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Ongoing work of Taipower's carbon storage projects

- The evaluation of potential reservoirs, calculation of the capacity for each reservoir and preliminary matching of sources and sinks in western Taiwan:
  - Practical capacity of the Taihsi Basin near Changbin area
  - Effective capacity of the rest of the basins in western Taiwan
  - Evaluation of different transportation methods
  - Public acceptance survey
- The feasibility study of a small scale pilot injection test site which includes:
  - Pilot storage development plan with 2000 ton/year injection rate
  - Risk assessment
  - Strategy research of next phase procurement
  - Research of legal competition
  - Environment data analysis and report writing of EIA documents

Taipower

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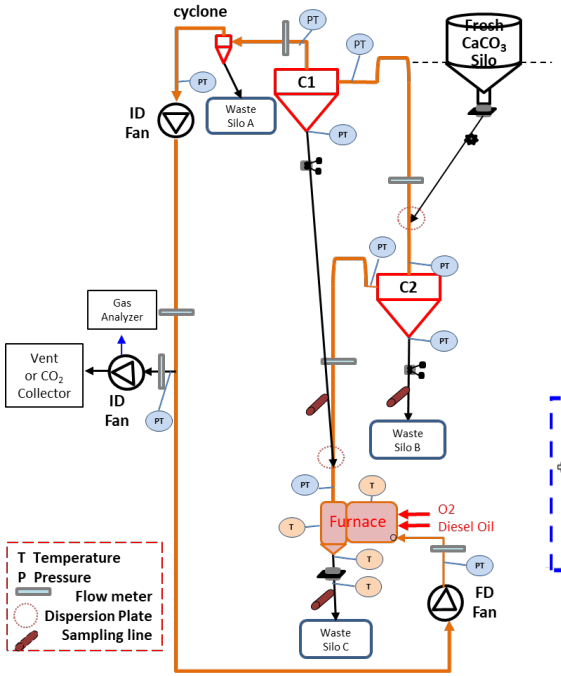
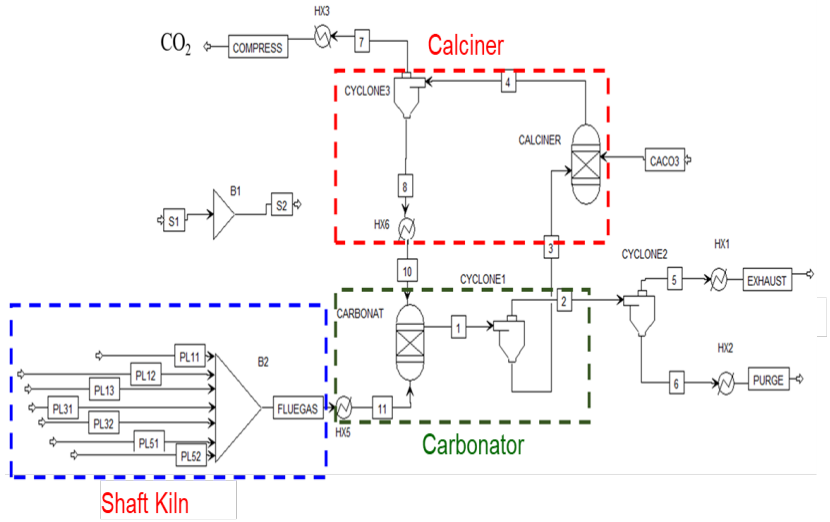
Current Status of CCU Technology in ITRI

CO_2 Capture: Calcium looping & Oxyfuel calcination

- 500kWt calcium looping pilot trials completed
- Simplified process design proposed (reduced from 4 to 2 stages)
- Promotion for scale-up focusing on oxy-fuel combustion calciner (~30,000t-CO_2/yr)
- Case study for converting existing lime shaft kiln to oxyfuel in southern Taiwan



New Calciner System Design

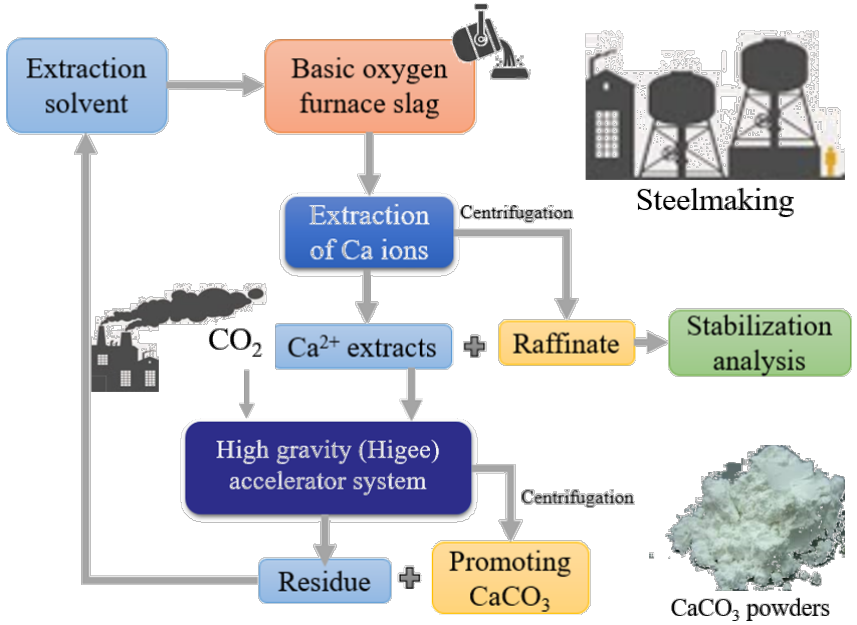


Aspen Plus model

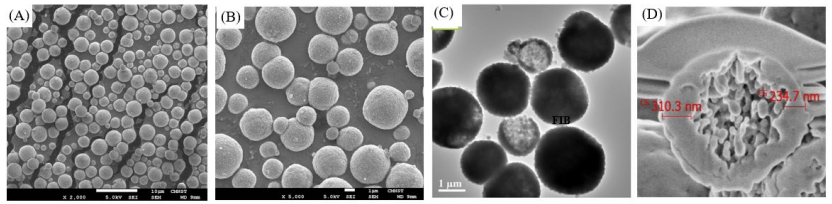
(ITRI, 2022)

Indirect carbonation technique for carbon dioxide utilization

- The indirect carbonation system has been demonstrated using steel slags as Ca source and further to obtain the valuable, uniform, dispersive calcium carbonate ultra-micro powder.



The Hollow structure of $CaCO_3$(s) fabricated by Higee carbonation system



A size range within 1 to 2 μm spherical $CaCO_3$ ultra-microparticles fabricated from BOFs shows the hollow structure by TEM analysis.

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Carbon Storage Research Update in ITRI

Fiber Optic Sensing

• Hybrid fiber-optic sensing integrating BOTDA and FBG for long-range two-parameter measurement in the NTUST lab.

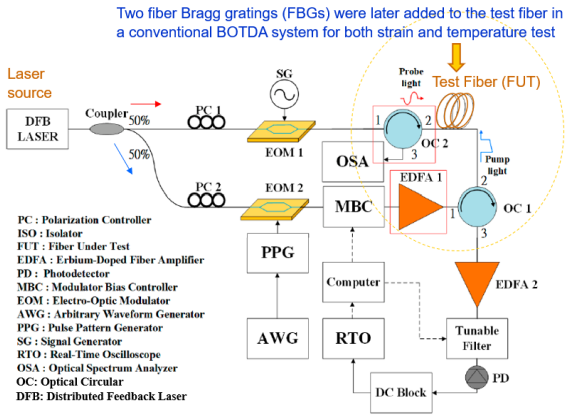
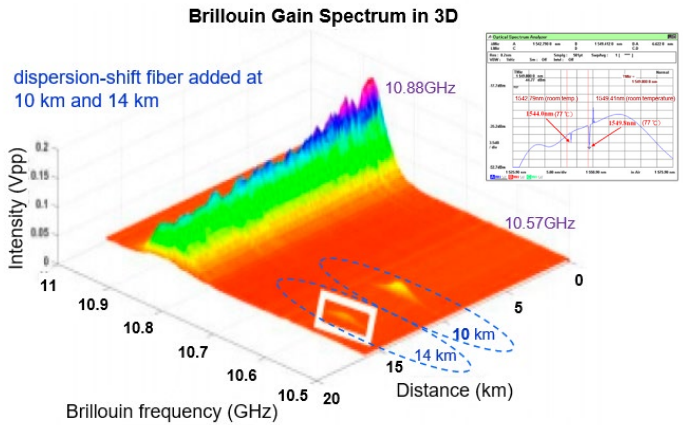
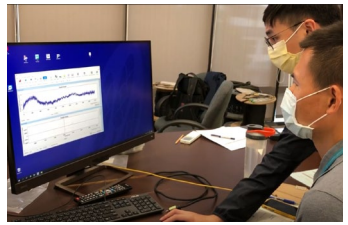


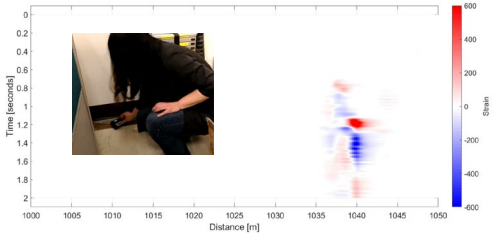
Figure - Hybrid system **base** for combing fiber grating and BOTDA system

(Liaw et al., 2021)



• Current test of DAS sensing indoor. The outdoor tests (near surface and wellbore) will be carried out later this year.

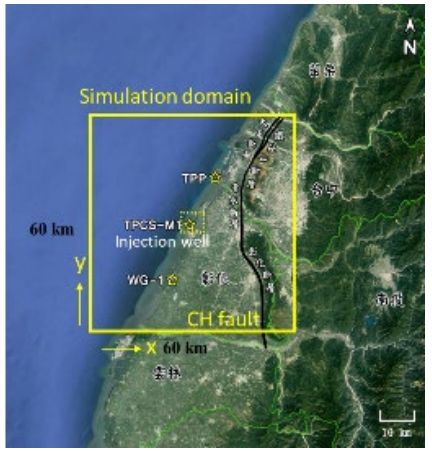




(ITRI, 2022)

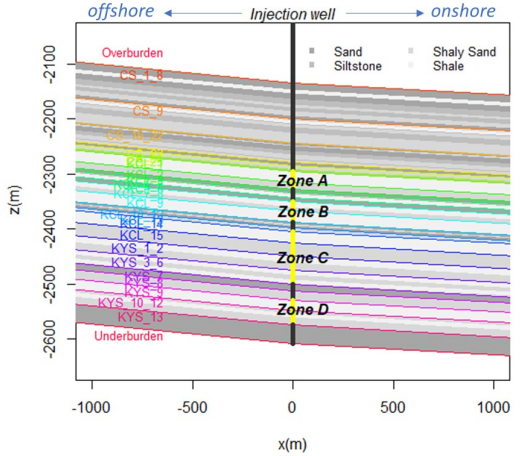
Risk Assessment

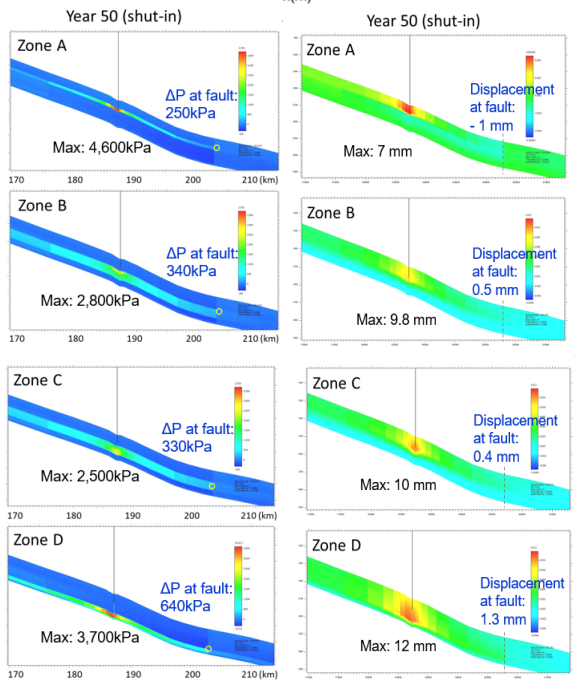
• Induced seismicity risk evaluation for the major CH fault



- 1 Mt of CO_2 were injected by 1-km horizontal well for a period of 50 years with a post-injection period of 450 years.
- Four injection scenario are: Zone A, B, C and D.
- The ΔP are one order of magnitude smaller than the minimum values of analytical estimates of critical pressure changes. The vertical displacements are tiny at the fault.

• Additionally, leakage risk assessment research will be carried out for new potential sites.





(Hsieh et al., 2021)

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Source:
S.K., Liao et al., 2021. Hybrid Fiber-Optic Sensing Integrating Brillouin Optical Time-Domain Analysis and Fiber Bragg Grating for Long-Range Two-Parameter Measurement. *Sensors*, *21*(12), p.4224.
B.Z. Hsieh et al., 2021. Preliminary Evaluation of Potential Induced Seismicity Risk at a Nearshore Carbon Storage Candidate Site. *Available at SSRN 3814571*.

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Thank You

Comments and Questions

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