CCUS application in building sector

05 June 2024 | 9:00 -17:30 (GMT+8)
ASIA CLEAN ENERGY FORUM 2024

Accelerating the Clean Energy Transition and Ensuring Energy Security and Affordability – Time for Urgent Action Now

Chao, Zhao
CEO
CLEANCO2

Featured Speaker
INTRODUCTION

China's CCUS mineralization technology pioneer and industrialization leader

- Low Carbon Transition - CS1: Carbon utilization and storage technologies for construction industry to combat climate change
- Turning Concrete into a Carbon Sink for the Earth
- **Mission**: Recovering the carbon balance of the ecosystem by artificial method
- **Vision**: Reduce global CO₂ emissions by 1%

—–Clean Carbon (Beijing) Technology Co., Ltd
THE PROBLEM

The construction industry is under great pressure to reduce CO₂ emissions.

- CLD creates long-term economic value for stakeholders while complementing CapitaLand’s business by contributing to the environmental and social well-being of the communities in which it operates.

—IEA, UN environment program
The captured CO₂ is used and stored in the production of concrete building materials.
THE BUSINESS MODEL - STAKEHOLDERS

**stakeholders**

**Industries**
For high-emission enterprises, providing a way of large-scale commercial utilization and storage of CO₂ after capture

**Concrete producer**
Providing concrete production enterprises with low-carbon transformation technology solutions

**Construction enterprise**
Provide low-carbon options for construction and infrastructure enterprises

**Capture & Utilization solution**
- Capture equipment
- Transportation
- Commercial utilization pathway

**Technology Licensing**
- Low-carbon transition
- Technology Licensing
- Device Selling
- Low carbon certification

**Low-carbon Production selling**
- Green supply chain commitment
- Green building materials procurement
- Production selling
- Source reduction

Multi-win-win & Value is realized by all stakeholders
MAEKTES OF OPERATION AND INTEREST

1). 2 trillion traditional concrete low-carbon transition opportunities

In the global concrete market, China is a single large market, and the future market increment is mainly concentrated in the Belt and Road countries. By the end of 2020, there were more than 1,200 prefabricated plants with a scale of more than 30,000 cubic meters in China. In 2020, nearly 200 new precast concrete production enterprises; In 2020, the main business income of concrete and cement products industrial enterprises above designated size will reach 1,790,651 billion yuan, Up 3.8% on the previous year. Concrete and cement products industry are greatly influenced by the downstream industry demand, Closely related industries include: Construction, infrastructure investment, water management industry.

2). 300 billion new markets for CCUS technology

Shown in the “Roadmap for the Development of Carbon Capture, Utilization and Storage Technology in China (2019) ”, The output value of CCUS by 2025 will exceed 20 billion/year, More than 330 billion yuan per year by 2050, In 2025-2050 average annual growth rate of 11.9%. McKinsey &Company estimate. By 2030, Co2-based products could be worth between $800 billion and $1 trillion, only co2 is used in the manufacture of concrete products, production of fuels and chemical utilization can reduce annual 1 billion metric tons of greenhouse gas emissions.

3). The potential carbon trading value of concrete carbon sequestration is estimated to exceed 30 billion

Mineralization can not only produce economically valuable products, At the same time can realize stable storage, Apply for carbon trading. The carbon sequestration potential of concrete in China exceeds 100 million tons.

According to the “China CCUS technology development trend analysis ” forecast, Amount of CO2 sequestration by CCUS technology in China will continue to improve, It will reach 20 million tons in 2022, By 2050, it is expected to reach 97 million tons, Compound annual growth rate of 16.8%. If the current EU carbon price calculation (close to $70 / ton), Only concrete carbon technology of carbon trading will exceed 30 billion yuan.
Technical Principle of CO₂ Mineralization Utilization.

\[(\text{CaO})_x(\text{SiO}_2)(\text{H}_2\text{O})_y + x\text{CO}_2 \rightarrow x\text{CaCO}_3 + \text{SiO}_2(\text{H}_2\text{O})_t + (y-t)\text{H}_2\text{O}\]

- CO₂ mineralization reaction can be carried out spontaneously at room temperature (20~25°C).
Key Technology Innovations of CO₂ Mineralization Utilization

**Material end**
- Customized formula in different regions
  - Aggregate (industrial solid waste) more than 90%
  - Add internal curing material, Fiber reinforced material
  - 30% reduction in cement use
  - Carbonated gel material carbon fixation effect increased by 15%
  - The concrete composite has rich pore structure

**Device end**
- Production line Transition
  - Concrete preparation system
    - Grinding | stirring | forming | pre-curing
  - CO₂ Mineralization reaction system
    - Mineralization curing reactor | gas injection reactor | mineralization strengthening reactor

**Process end**
- High efficiency process design based on theoretical study
  - Gas-liquid-ion mass transfer model
    - Mineralization kinetics | Mineralization thermodynamics
  - The correlation between mineralization process and macroscopic durability

**Key value**
- Carbon sequestration
- CO₂ footprint reduction >85%
- CO₂ uptake 50.27kg / t-product
- Product quality
- Product strength increased by 10%
- All performance indexes are up to standard
- Curing time
  - Traditional Steam curing time 10-14 hours
  - Clean CO₂ curing time 2-4 hours

INTERNAL. This information is accessible to ADB Management and staff. It may be shared outside ADB with appropriate permission.
Key Technology Innovations of CO₂ Mineralization Utilization

- Improving interface
  - Multi-solid waste formula
  - Syngenetic alkaline activation
  - Pore structure adjustment

- Multiple low-carbon products

[Images of concrete bricks, ready-mixed concrete, and lightweight aggregate]
BUSINESS PROCESS

With the fastest commercialization progress in the field of domestic mineralized building materials.

**Yangtze River Delta region**
- **Xian in Shanxi** Application of Carbon Fixed Concrete Bricks in Capitaland Plaza Phase II Project
- **Yulin in Shanxi** National Energy Group Jinjie Power plant capture-mineralization integration project

**Greater Bay Area**
- **Beijing** First application of carbon-fixed aerated concrete blocks

**Northern and Central and western parts of the Greater Bay Area**
- **Huzhou, Zhejiang** Build a demonstration base for the mineralization and utilization of carbon fixed ready-mixed concrete
- **Hangzhou, Jiaxing in Zhejiang** Build a production base for carbon fixed concrete blocks

**Hangzhou, Jiaxing in Zhejiang**
- The first large-scale application of carbon fixed ready-mixed concrete in China

**Jiaozuo in Henan**
- The first CO2 mineralized carbon fixed concrete solid brick industrial demonstration line in China

**Hong Kong, Guangdong**
- Signed strategic cooperation with China State Construction to jointly promote the development of low-carbon building materials in the Greater Bay Area
- **Shenzhen in Guangdong** Cooperating with Biosphere 3 and Vanke Construction, the two sides will strategically collaborate on the commercial application, promotion, investment and financing, and sea going of carbon dioxide mineralized concrete
- **Hong Kong, Guangdong** OPARK2 Hong Kong
- **Hang Kong Plaza** Shenzhen in Guangdong

**Lanxi in Zhejiang**
- The first CO2 mineralization carbon gas filling block building materials industrial demonstration in China

**Capital Land Hangzhou Plaza**
- Capitaland Hangzhou plaza
- State Grid Corporation of China’s New Substation Project
- Capitaland Hangzhou Jinggaofu

**Northern and Central and western parts of the Greater Bay Area**
- **Hang Lung Plaza**
- **Capitaland Hangzhou Plaza**

**Hong Kong, Guangdong**
- **Hang Lung Plaza**
- **Capitaland Hangzhou Jinggaofu**

**Yulin in Shanxi**
- National Energy Group Jinjie Power plant capture-mineralization integration project

INTERNATIONAL. This information is accessible to ADB Management and staff. It may be shared outside ADB with appropriate permission.
BUSINESS PROCESS

1. CO\textsubscript{2} mineralization curing technology : The first industrial demonstration and commercial Application. (2018~2022, Finished)

<table>
<thead>
<tr>
<th>The Key Index</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial solid waste content</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>CO\textsubscript{2} conversion rate</td>
<td>&gt;95%</td>
</tr>
<tr>
<td>The compressive strength</td>
<td>&gt;15MPa</td>
</tr>
<tr>
<td>CO\textsubscript{2} curing time</td>
<td>~6h</td>
</tr>
</tbody>
</table>

Jiaozuo City, Henan Province

Hong Kong Organic Resource Recovery Centre O-Park2 Project (March, 2022)

Conducted by CSCEC & CleanCO\textsubscript{2}, 2022

Commercial Application
2. The Commercialization Progress in CO₂ Mineralization for Ready-mixed Concrete (2022~2023, Finished)

ZJU & State Grid Zhejiang Electric Power Co. LTD
The first application of carbon fixed ready-mixed concrete

Huzhou City, Zhejiang Province

<table>
<thead>
<tr>
<th>The Key Index</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-carbon concrete</td>
<td>&gt; 1400 m³</td>
</tr>
<tr>
<td>Cementitious material reducing</td>
<td>~ 6.3%</td>
</tr>
<tr>
<td>Strength grade</td>
<td>C35</td>
</tr>
<tr>
<td>CO₂ reducing</td>
<td>~ 23.95 kg/m³</td>
</tr>
</tbody>
</table>
2. The Commercialization Progress in CO$_2$ Mineralization for Ready-mixed Concrete (2024~, In progress)

Collaborating with Vanke's logistics brand, Wanwei Group, to apply carbon fixed commercial concrete in the Jiaxing logistics park, reduce hidden carbon emissions in the project, and jointly promote carbon reduction at the source of commercial concrete.

Jiaxing City, Zhejiang Province
3. \(\text{CO}_2\) Mineralization for Demolished Concrete to Prepare Low-carbon Recycle Concrete Aggregates and Concrete \((2023\sim, \text{In progress})\)
3. **CO₂ Mineralization for Demolished Concrete to Prepare Low-carbon Recycle Concrete Aggregates and Concrete (2023~, In progress)**

**CLEANCO2 & Hang Lung Properties Limited Strategic cooperation was signed for 2 years**

- In-depth cooperation in the technology R&D of CO₂ mineralization enhancing RCA the commercial application of carbon fixation concrete
- Reduce the hidden carbon emissions of Hang Lung’s new commercial projects.
- Westlake 66, Hangzhou, will be the first commercial development on the mainland to use solid bricks made of CO₂ mineralization technology.

**Capitaland CSXC 2023 TOP 10**

- Pilot demonstration in Hangzhou: Creating mature process and market mode on CO₂ mineralization for Low-carbon RCA and Concrete
- Commercialization: Supplying 500m³ concrete product to the real estate project.
- Industrialization: Establishing a 200,000 m³ Low-carbon concrete production line.
BUSINESS PROCESS

3. CO₂ Mineralization for Demolished Concrete to Prepare Low-carbon Recycle Concrete Aggregates and Concrete (2023~, In progress)

CLEANCO2 & Capitaland

• The application of carbon fixing concrete building materials in the Hangzhou Capitaland Jinggaofu and Xi’an Capitaland Plaza Phase II projects aims to reduce hidden carbon emissions in the projects and jointly promote the reduction of carbon emissions from concrete building materials.

Vanke Strategic Cooperation

• Both sides will cooperate strategically in the commercial application, promotion, investment and financing, and export of carbon dioxide mineralized concrete to promote carbon reduction of raw materials for concrete building materials
• Construct a "promise" sculpture building at Vanke headquarters, inspired by rings, to tell the story of humanity's commitment to climate change.
4. The CO₂ capture and mineralization integration demonstration line. (2022~, In progress)
4. The CO$_2$ capture and mineralization integration demonstration line. (2022~, In progress)

Key R&D Programs of 14$^{th}$ Five-Year Plan

<table>
<thead>
<tr>
<th>The Key Index</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cementitious material</td>
<td>&gt; 200,000 m$^3$/y</td>
</tr>
<tr>
<td>CO$_2$ sequestration</td>
<td>10,000-20,000 t/y</td>
</tr>
<tr>
<td>Solid waste content</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>Main production</td>
<td>Concrete Brick</td>
</tr>
</tbody>
</table>

Scale up in 5 years

<table>
<thead>
<tr>
<th>The Key Index</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cementitious material</td>
<td>&gt; 1,000,000 t/y</td>
</tr>
<tr>
<td>CO$_2$ sequestration</td>
<td>&gt; 100,000 t/y</td>
</tr>
<tr>
<td>Solid waste content</td>
<td>100%</td>
</tr>
<tr>
<td>Main production</td>
<td>Ready-mixed concrete, Precast concrete, Concrete Brick</td>
</tr>
</tbody>
</table>

Supported by

Ministry of Science and Technology of the People's Republic of China

China National Energy Corporation (CNEC)
BUSINESS PROCESS

5. 10,000 t-CO$_2$/y capture and mineralization curing for aerated concrete block demonstration. (2021~, In progress)

Zhejiang Province Energy Group - Lanxi Power Plant was built with four 600,000-kW supercritical coal-fired units in the first and second phases. Currently, the total installed capacity is 2.4 million kW, making it the largest inland green power plant in Zhejiang Province. At present, the power plant has a 10,000-ton/year CO$_2$ capture device, and the captured CO$_2$ is transported through pipelines to the adjacent aerated concrete plant for mineralization and production of B06-grade low-carbon aerated concrete blocks.

Lanxi City, Zhejiang Province

10,000 t-CO$_2$/y capture facility in Lanxi
CO$_2$ curing workshop
CO$_2$ mineralization curing chamber
BUSINESS PROCESS

5. 10,000 t-CO$_2$/y capture and mineralization curing for aerated concrete block demonstration. (2021~, In progress)

Supported by

Science and Technology Department of Zhejiang Province

&

<table>
<thead>
<tr>
<th>The Key Index</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO$_2$ sequestration</td>
<td>10,000 t/y</td>
</tr>
<tr>
<td>Main production</td>
<td>Aerated Concrete</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>3.5Mpa</td>
</tr>
<tr>
<td>Density</td>
<td>~650 kg/m$^3$</td>
</tr>
</tbody>
</table>
THANKS

Make every breath of the building “negative-carbon”