Role of Government R&D Project in CO2 Reduction Technology Development:

Case of 21C Frontier CDRS Project in Korea

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Policy Development Team

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OUTLINE

Introducing Korean Government Programs on CO$_2$ Reduction Technology R&D

1. Government R&D Programs on Energy

2. CDRS R&D Center and its R&D Program

3. New and Renewable Energy (NRE) R&D
CDRS Project?

- **PREVIEW**
  - Carbon Dioxide Reduction and Sequestration R&D Project
  - 10-year project (2002 – 2011)
  - Total 100M USD ($75 M from gov, $25 M from industry)

- **TARGET (2012)**
  - CO₂ Reduction of 9 million TC per year (5%)
  - Economic Effect of 1.2 billion USD per year (incl. indirect)
  - Technology Level up to top 10 in the world
  - Joining Global Research Network on CO₂ Reduction
I. Government R&D Programs on Energy

- Energy R&D Program
  - Since 1988, Total 36.2 million USD in 2004
  - Energy Conservation Technology Program (21.2 mil USD)
  - Clean Energy Technology Program (7.2 mil USD)
  - Energy Resource Development (7.8 mil USD)

- New and Renewable Energy (NRE) R&D Program
  - Since 2004 (2004-2012)
  - Focus on Wind, Solar PV and Fuel Cell/Hydrogen,
    210 million USD (2004-2008) for three R&D Centers,
    Biggest single R&D Program in Korea
I. Government R&D Programs on Energy

- **MOST (Ministry of Science and Technology)**
  21 C Frontier R&D Center Program (since 2000)
  - Focus on technology development for industry
  - 15 centers so far, 75 million USD per center (10 year)
  - Two energy-related projects:
    - CDRS, Hydrogen technology
  - Nuclear Technology R&D Program (Since 1980’s)

- **MOE (Ministry of Environment)**
  G7 Program (since 1998)
  - Clean Energy Technology Project
  - Focuses on Clean Coal Technology and High-efficiency Engine
I. Government R&D Programs on Energy - Trends

- Two Themes of Government R&D for Carbon Dioxide Reduction
  - Energy Saving & Efficiency Improvement (70%)
  - New and Renewable Energy Development (30%)

- TRENDS
  - Focusing more on New and Renewable Energy Technology than Energy Saving/Efficiency Improvement Techs
    - Establish new NRE Division in MOCIE (2004)
  - Minimizing Impacts on Industry
  - Using more Market Incentives (Demand-Pull)
  - Technology Export! (CDM)
II. CDRS - CO$_2$ Reduction & Sequestration R&D Center - Intro

- **MOST’s 21C FRONTIER R&D PROGRAM**
  - 10-Year (2002-2011), 3-Phases (3+3+4)
  - Center Director Organizes & Evaluates Research Teams
  - Matching Fund from Industry Required:
    - Among Total 100M USD, 25 M from industry (will increase)

- **CDRS**
  - 4 Major Topics, 33 Research Teams, 297 researchers
  - Topics Selected by Energy-Intensive Industries and Gov.
  - 10% teams will be Expelled after 1st phase
  - 70% will enter Markets in 2nd phase, 30% in 3rd
  - Policy Development Team included
II. CDRS – Targets and Goals

❖ R&D PROGRAM TARGET (2012)
- CO₂ Reduction of 9 million TC per year
- Economic Effect of 1.2 billion USD per year (incl. indirect)
- Technology Level up to top 10 in the world
- Joining Global Research Network on CO₂ Reduction

❖ TECHNOLOGY DEVELOPMENT GOAL
- 5% Reduction of total CO₂ Emission by 2012
- 30% Energy Efficiency Improvement for Energy-Intensive Industries like Petrochemical, Chemical and Steel
- Low Cost (10 USD/TC) Conversion Technology
II. Final Targets of CDRS R&D Center

9 million TC reduction of CO₂ by 2012

International
- Public relations of the nation's efforts for CO₂ reduction
- Export developed technologies

Domestic
- Minimize an impact on economy by implementation of Kyoto Protocol
- Saving energy about 1.2 billion dollars' per year

Impact

Steel industry
- Reduction technology
- Oxy fuel burner
- Integrated reaction/separation
- Wasted heat recovery

Petro-chemical Industry
- Sequestration
- CO₂ sequestration

Power plant
- Cement plant
- Steel mill plant

Application

Core technology

Oxy fuel burner
- Wasted heat recovery
II. CDRS – Research Topics

- 4 Major Research Topics:
  3 Reductions & 1 Sequestration (33 sub-topic research teams)

  • 1. Oxy-Fuel Combustion System: 2M TC reduction
    - Steel Industry, system oriented
  • 2. Wasted Heat-Recovery System: 4M TC reduction
    - Residential/Commercial Heating, system oriented
  • 3. Integrated Reaction/Separation Process: 3M TC
    - Petrochemical Process, individual process
  • 4. Sequestration: Separation/Sequestration/Conversion
    - Basic Research Stage
II. Target System for Oxy-Fuel Combustion Topic
II. Target System for Wasted Heat Recovery Topic
II. Research Flow of Integrated Reaction/Separation Topic
II. Research Flow of CO₂ Sequestration Topic

1. CO₂ emission → Recovery → Treatment
2. Recovery: Dry Sorbent Separation
3. Treatment: Recycle, Chemical Biological, Storage, Under Sea Underground
II. Technology Roadmap of CDRS R&D Center

<table>
<thead>
<tr>
<th>Phase</th>
<th>1st Phase</th>
<th>2nd Phase</th>
<th>3rd Phase</th>
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<tbody>
<tr>
<td>Goal</td>
<td>Fundamental Technology</td>
<td>Proven Technology</td>
<td>Pratical Technology</td>
</tr>
<tr>
<td>Year</td>
<td>2002</td>
<td>2003</td>
<td>2004</td>
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**Oxy-Fuel Combustion**

- Low cost O₂ separation → PDU scale (3ton/day)
- Analysis and control of oxy-fuel combustion → Combustion system development (0.3MW)
- Ceramic materials for high temperature → PDU scale reheat furnace (20ton/day)
- Process development of the capacity of 30 ton/day → Intelligent combustion system (2MW)
- Intelligent reheat furnace (5ton/charge)
II. Technology Roadmap of CDRS R&D Center

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<tr>
<td>Year</td>
<td>2002 2003 2004</td>
<td>2005 2006 2007</td>
<td>2008 2009 2010 2011</td>
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Integrated Reaction / Separation Process:
- Integrated reaction / separation process
- Advanced NCC Process
- New reaction / separation process

Wasted Heat Recovery:
- Recovery / conversion
- Transportation / storage
- Supply / utilization

System optimization
- PDU scale (Capacity of 20kg/hr)

Process design (100ton / charge)

Optimized heat recovery / utilization
- Wasted energy utilization network
- PDU scale energy network (HVAC load of 30Gcal/hr)
II. Types of 33 Sub-Topics (Research Teams)

- Sequestration: 22%
- Energy Efficiency: 60%
- Energy Recycle: 18%

- Individual Technology: 36%
- System Technology: 64%

CO₂ Reduction Methods

Technology Types
II. CDRS – This Year

- 1ST PHASE EVALUATION

- Evaluation Criteria & weights set via AHP (Analytical Hierarchy Process)
  - 4 major (Technical, Market, Production, and Social)
  - 15 sub, and 58 sub-sub categories
  - Biggest - Social, Lowest - Production

- Technology - Product - Consumer (industry) Diagram
  - Linkages among Tech Producers and Consumers
  - Helps to Keep researches on Target
  - Survey to Proposed Consumer scheduled

- Direct & Indirect Reduction Effects for each team
  - Input - Output Tables used
II. CDRS – Next Year

- 2ND PHASE PREPARATION

  - 2nd Phase to start on 2005
  - Eliminated 5 teams on 2004, 3-5 more on 2005
  - Management Teams added for Each of 4 Major Topics
  - Technology Transfer/Licensing Team will be added
  - New and Renewables may be added
III. NRE Development Program by MOCIE

- Share of NRE in Total Energy Supply: 1.4% in 2002

  - Economic Impact: Import Substitution of $520M
  - CO₂ Reduction of 8.8 Mt (TC)
  - If Large Hydro (0.6%) included, the share would be 2.0%

<table>
<thead>
<tr>
<th>Source</th>
<th>Consumption</th>
<th>Share</th>
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<tbody>
<tr>
<td>Solar Thermal</td>
<td>Solar Heating 187,000 Units, Solar Water Heater: 3,000 units</td>
<td>1.2%</td>
</tr>
<tr>
<td>Solar PV</td>
<td>12,000 sites: 5,419.</td>
<td>0.2%</td>
</tr>
<tr>
<td>Wind</td>
<td>50 units: 8,000.</td>
<td>0.1%</td>
</tr>
<tr>
<td>Bio</td>
<td>Liquor and food process: 100 sites</td>
<td>4.0%</td>
</tr>
<tr>
<td>Wastes</td>
<td>MSW Incineration &amp; LFG in Major Cities: 500 units</td>
<td>93.5%</td>
</tr>
<tr>
<td>Small Hydro</td>
<td>30 sites: 42MW</td>
<td>1.0%</td>
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</table>
III. NRE R&D Development by MOCIE

- Development Target
  - Enhancement of Indigenous Technology up to Top 5
  - Solar PV: 3rd Place; Fuel Cells: 4th Place (2011)

- Supply Target

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
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<tr>
<td></td>
<td></td>
<td>2006</td>
<td></td>
<td>2011</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>BaU</td>
<td>Policy</td>
<td>BaU</td>
<td>Policy</td>
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<tr>
<td>Supply (mil TOE)</td>
<td>2.92</td>
<td>4.00</td>
<td>7.73</td>
<td>5.80</td>
<td>13.76</td>
<td></td>
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<tr>
<td>Share (%) (electricity)</td>
<td>1.4 (2.0)</td>
<td>1.7</td>
<td>3.0 (2.4)</td>
<td>2.2</td>
<td>5.0 (7.0)</td>
<td></td>
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</table>
### III. Government Investment Schedule for NRE Facilities

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>2004</th>
<th>2006</th>
<th>2011</th>
<th>Total (04-11)</th>
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<tbody>
<tr>
<td></td>
<td>B. Won</td>
<td>Share</td>
<td>B. Won</td>
<td>Share</td>
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<tr>
<td>Wind</td>
<td>80.0</td>
<td>41.5</td>
<td>210.0</td>
<td>26.1</td>
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<tr>
<td>Solar PV</td>
<td>66.3</td>
<td>34.4</td>
<td>446.3</td>
<td>55.4</td>
</tr>
<tr>
<td>Fuel Cells</td>
<td>7.2</td>
<td>3.7</td>
<td>24.8</td>
<td>3.1</td>
</tr>
<tr>
<td>Small Hydro</td>
<td>11.0</td>
<td>5.7</td>
<td>100.0</td>
<td>12.4</td>
</tr>
<tr>
<td>IGCC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OTEC</td>
<td>-</td>
<td>-</td>
<td>2.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Bio</td>
<td>28.3</td>
<td>14.7</td>
<td>22.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Total (Mil USD)</td>
<td>192.8 (161.5)</td>
<td>100.0</td>
<td>805.4 (674.9)</td>
<td>100.0</td>
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Summary

- **CDRS - Carbon Dioxide Reduction & Sequestration R&D**
  - Energy Saving & Efficiency Improvement (60%)
  - Energy Recycling (18%) Sequestration (22%)
  - 2nd Phase (2005-2007) to Enter Markets

- **RECENT TRENDS OF KOREAN GOVERNMENT R&D PROGRAMS**
  - Focusing more on New and Renewable Energy Technology than Energy Saving/Efficiency Improvement Techs
  - Minimizing Impacts on Industry
  - More Market Incentives (Demand-Pull)
  - Requires Technology Export
Thank You

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