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Friday energy letter

CCS 기술 로드맵

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KOREA INSTITUTE OF ENERGY RESEARCH

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*** 출처 : 'Technology Roadmap - Carbon capture and storage' - IEA (2010)**

1. 핵심 시사점

○ Carbon capture and storage (CCS)는 저비용 이산화탄소 배출 감축 포트폴리오에 있어서 중요한 수단으로, IEA는 2050년까지 2005년 수준으로 이산화탄소 배출을 감축하는 경우, CCS가 고려되지 않는 경우, 총 비용이 70%가량 증가할 것으로 분석함. 본 로드맵은 이산화탄소 배출 감축을 위하여 2020년까지 100개, 2050년까지 3,000개의 CCS관련 프로젝트가 추진되는 야심찬 CCS 성장전망에 기반함.

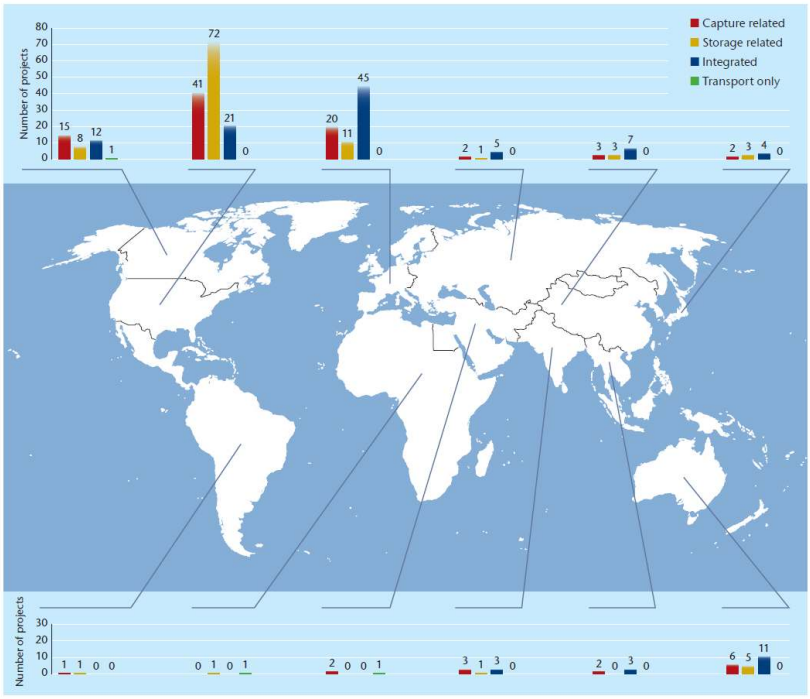
○ CCS는 청정석탄을 위한 대안 뿐만 아니라, 바이오매스나 천연가스를 이용한 발전분야, 연료전환이나 가스처리 분야, 그리고 철강, 시멘트, 화학, 제지 산업과 같은 이산화탄소 다배출 산업분야에도 반드시 적용되어야 함.

○ CO_2 포집 기술은 현재 상용화되어 있는 기술이지만, 추가적인 비용저감과 상업용 규모에서의 충분한 실증연구가 필요함.

○ CO_2 저장공간에 대한 전세계적인 협력연구가 시급히 요구됨. 저장소로서는 석유 가스층도 저비용의 대안이 될 수 있으나, 장기적으로는 대염수층을 활용하는 것이 가장 현실적인 대안임.

2. 대규모 CCS 프로젝트 추진 및 계획 현황

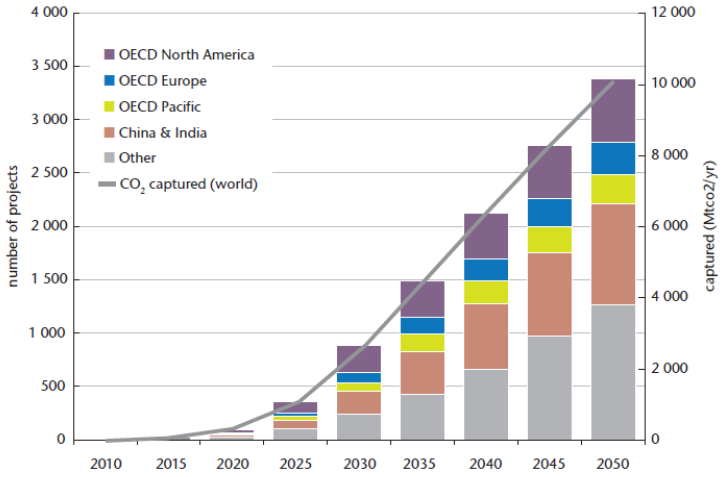
○ 대규모(over 1 $MtCO_2$/year) CCS 프로젝트가 전세계적으로 100개 이상 계획, 5개 이상 추진중임.



Source: Strategic Analysis of the Global Status of Carbon Capture and Storage: Report 1 Project Status (forthcoming), prepared for the Global CCS Institute by WorleyParsons Services Pty Ltd. (2009).

3. CCS기술을 이용한 이산화탄소 감축목표

○ CO_2 감축목표 달성을 위해서 2050년까지 급속한 CCS 시장 확대 전망



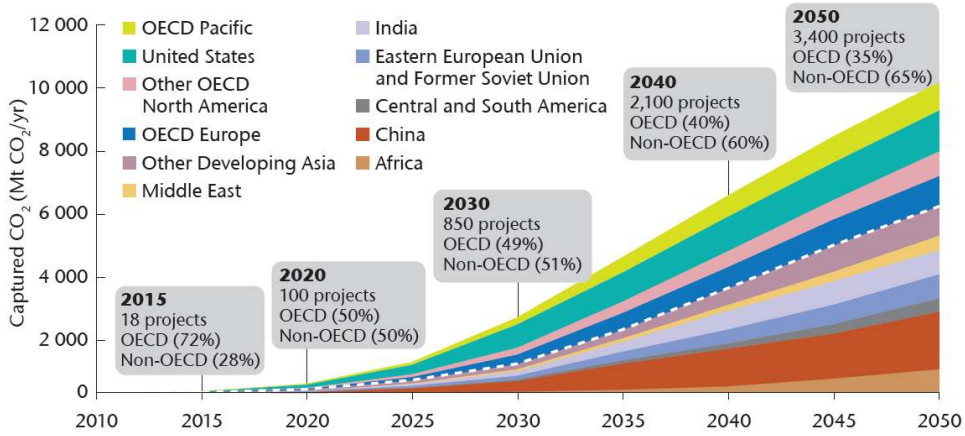
	Number of projects in 2020	Number of projects in 2050	Additional cost 2010-2020 (USD bn)*	Additional cost 2010-2050 (USD bn)*	Total invest. 2010-2020 (USD bn)**	Total invest. 2010-2050 (USD bn)**
OECD NA	29	590	23.6	1 635	61.7	1 130
OECD Europe	14	320	6.8	590	15.8	475
OECD Pacific	7	280	5.9	645	14.1	530
China & India	21	950	7.6	1 315	19.0	1 170
Non-OECD	29	1 260	9.7	1 625	19.8	1 765
World	**100**	**3 400**	**54**	**5 810**	**130**	**5 070**

* *Includes cost of transport and storage*
** *Does not include investment in transport and storage*

Notes: OECD NA = USA, Canada, Mexico; OECD Europe = Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, UK; OECD Pacific = Australia, Japan, New Zealand, South Korea; Non-OECD = the rest of the world.

4. 지역별 CCS 보급전망

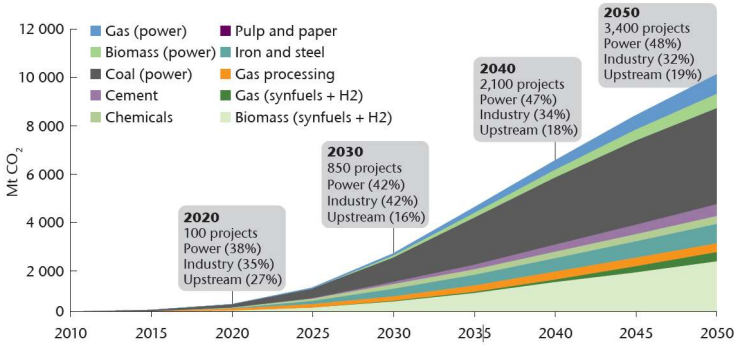
○ 기술실증단계에서의 OECD 국가들의 선도가 필요하나, 이후 기타 지역으로의 급속한 확대 가능



Note: The dashed line indicates separation of OECD/non-OECD groupings.

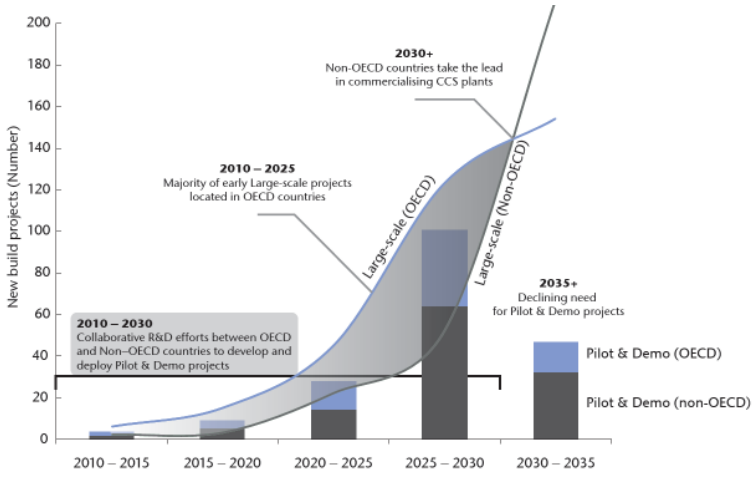
5. 분야별 CCS 보급전망

○ 이산화탄소 감축목표 달성을 위하여 청정석탄 분야 외에 기타분야에 대한 CCS 적용 필요



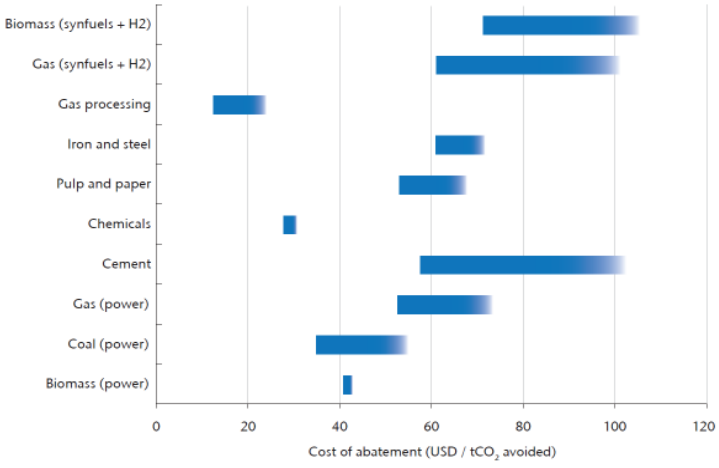
6. CCS 기술 상용화 전망

○ 2010년부터 2030년사이 OECD국가들과 Non-OECD 국가 사이의 협력연구노력이 중요



7. CCS 비용

○ 본 분석을 위해서 아래 그림과 같이 기술적용 분야별 CCS 비용을 가정



Source: IEA Analysis, based on IEA, 2008b.

8. 이산화탄소 포집기술에 대한 마일스톤

○ IEA CCS Roadmap 회의, CSLF CCS Technology Roadmap, IEA CleanCoal Centre Roadmap 등에 기반한 기술개발 마일스톤

CO_2 capture	Technology status In 2010	Near-term RDD&D needs 2010–2020	Long-term goals 2020–2030 and beyond
All technologies	**Availability**: No commercial systems applicable for power plants and most industrial applications available today. Retrofit of CCS technologies unproven. **Efficacy**: Industrial facilities will require new sources of heat and power for CCS applications. Collection systems for disparate sources on, for example, petroleum refineries and LNG production trains. Complex integration and cost issues. **Costs**: Capital cost of plant prohibitive for new developments. Efficiency penalty increases cost of production.	**Efficiency**: Reduce energy penalty through process design and heat optimisation. Increase operating temperatures and pressures in all boiler and turbine combinations. By 2015: Prove technologies at large power plant scale. Identify most effective options for industrial applications: • Identify optimised design to maximise heat and power use in cement kilns and blast furnaces. • Prove centralised heat and power systems with CCS for fuel transformation facilities. • Identify appropriate CCS options for biofuel refineries. **Costs**: Reduce capital costs by 10% to 12%.	**Efficiency**: By 2025: • Commercially available systems with >85% capture rate available for all fuel types. • All capture systems, all coals, all firing configurations 45%+, LHV, including CO_2 capture after 2030. By 2030: Commercial pulverized fuel ultra supercritical (USC) boilers operating >700/720°C and >35 megapascals (MPa). **Costs**: Reduce capital costs by an additional 10%.
Pre-combustion technologies:	**Availability**: Several coal IGCC plants in operation around the world. Several demo projects under development. No integrated system with warranty available from vendors. **Technical challenges**: • Scale and integration for large IGCC plants. Unproven for high availability baseload power generation. **Costs**: High capital and operating costs. Lack of warranty for large plants with CCS.	**Availability**: Integrated IGCC CCS plants with high availability and high-efficiency turbines for H_2 combustion. **Efficacy**: By 2015: • Reduce steam requirements for shift conversion. Reduce energy penalty to 7% . By 2020: • Prove hydrogen combustion with high-efficiency CCGTs.	**Availability**: By 2025: • Demonstrate biomass IGCC with physical solvents. **Efficacy**: Reduce energy penalty to ~6%. • Emergence of commercial systems with gas separation membranes to replace shift converter. • Demonstrate novel methods including pressure swing adsorption, electrical swing adsorption and possibly cryogenics. **Costs**: Reduce capital costs to be competitive with conventional PF power generation.
Oxyfuel technologies	**Availability**: Trials of small-scale plants in progress in the power sector (<30 MW) under development. 250 MW plants proven in blast furnaces. **Technical challenges**: High capital and operating costs. Lack of warranty.	Rotary kiln for oxy-fuel for cement.	Commercial USC combustion operating 30MPa and temperatures of 600°C/620°C by 2025.

CO_2 capture	Technology status in 2010	Near-term RDD&D needs 2010–2020	Long-term goals 2020–2030 and beyond
Post-combustion technologies:	**Availability:** Existing technologies with hundreds of plants in operation around the world in gas processing and chemicals industry. Largely unproven for large-scale flue gas mixtures. No warranties from vendors for large-scale combustion application. Technical challenges: • Scale and integration of complete systems for combustion gases. • Combustion gas stream composition and solvent. **Costs:** By 2020: • Reduce capital and operating costs by 10% to15%. Provide warranty.	**Availability:** Large-scale plants commercially available for new build and retrofit applications. Warranties offered on proven technologies by 2017. PF-USC plants at ~25 MPa and 600/620°C are commercially available. **Efficacy:** By 2015: • Prove at commercial scale (>40 MMscm or c.4.0 $MtCO_2$/yr in the case of a coal-fired plant). • Prove sustainable solvent usage rates (e.g., hindered amines). Manage corrosion issues. • Develop solvents with lower reactivation temperatures to reduce heat requirements for regeneration. Reduce energy penalty to <8%. • Demonstrate integrated systems with flue gas pre-treatments and availability >85%. **Costs:** By 2020: • Reduce capital costs by 10% to 15% for large-scale systems. • Reduce operating costs by 2% to 3%.	**Availability:** Widespread availability of commercial plant (new and retrofit) with warranties by 2025 for all coal types and CCGTs gas plants. CCS plants with high-efficiency PF-USC boilers operating at ~35 MPa and 700/720°C are commercially available. **Efficacy:** By 2030: • Prove innovative capture options – chemical looping tested for coal and gas.

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