CAGS Workshop II,
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Potential contribution of CCS in China

中国CCS的潜力与贡献

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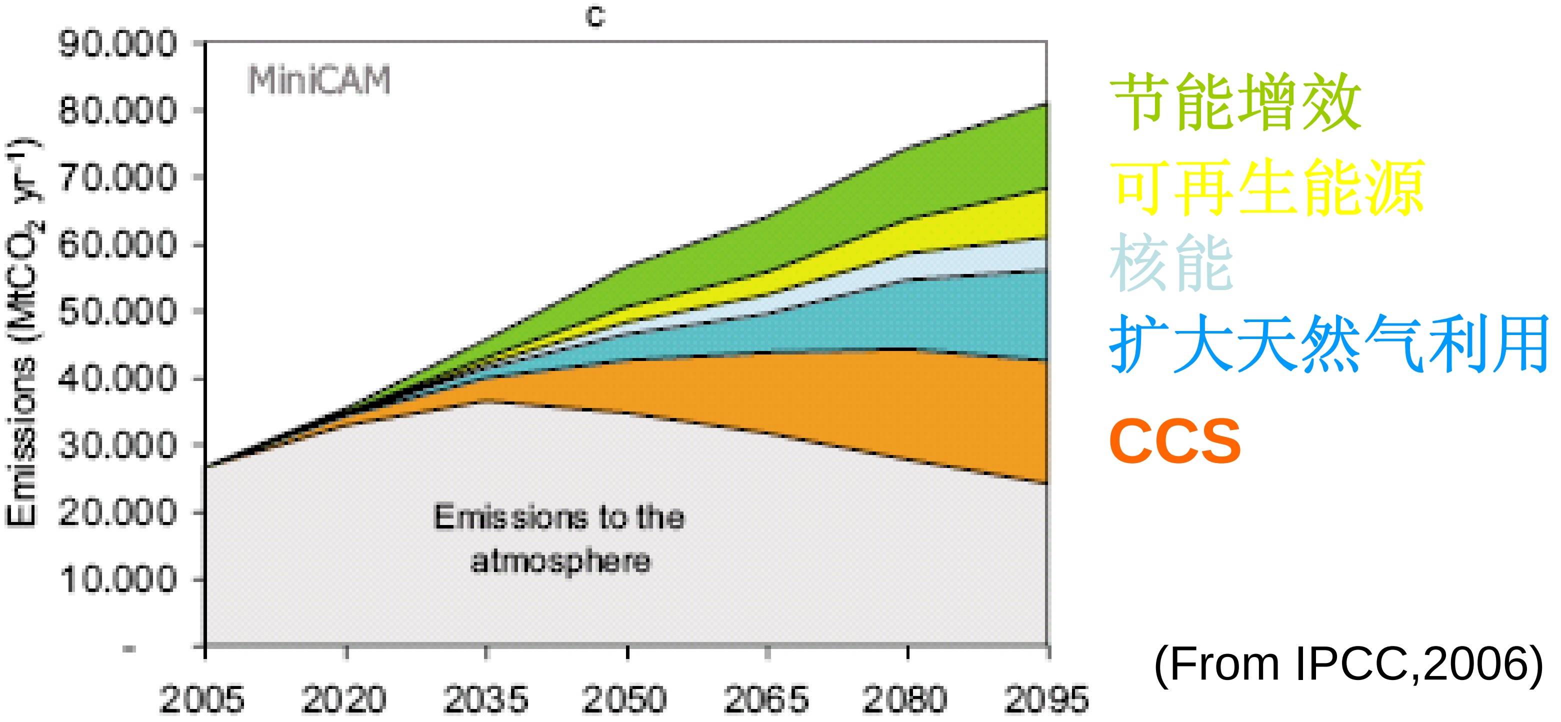
CCS importance from global perspective



(From IPCC,2006)

- **Sustainable use of fossil fuels, flexible policy and overall cost-down**
- **CCS contribution was predicted as 15-55%（IPCC、IEA）**
- **G8 agenda, CSLF, GCCSI, 40B$**

各国家及地区政府对 CCS 的资金投入

国家或地区	资金（亿美元）	说明
加拿大	85亿加元（合83.8亿美元）	联邦政府提供65亿加元(合64亿美元); 埃尔伯塔省(Alberta)提供20亿加元（合19.8亿美元）
欧盟	10.5亿欧元（合15亿美元）； 3亿EU-ETS单位的拍卖额	其中10.5亿欧元属于欧盟经济复苏计划，支持欧洲7个CCS项目；3亿EU-ETS单位的拍卖额为CCS与新能源共有，
澳大利亚	40亿澳元（34.9亿美元）	其中政府提供25亿澳元(合22亿美元); 各省政府承诺提供5亿澳元(合4.3亿美元); 煤矿企业提供10亿澳元(合8.6亿美元)
美国	34亿美元	2009年经济复苏政策
英国	约95亿英镑（合143.5亿美元）	2010年能源法案，承诺资助2~4个完整的CCS示范项目
挪威	9.05亿美元投资; Mongstad CCS项目的建设投资和运营费用 3,000万美元/年的研发经费	为欧盟新成员提供1.4亿欧元(约合2.05亿美元)的资助；为欧洲CO_2技术中心Mongstad (European CO_2 Technology Center Mongstad)提供43亿挪威克朗(合7亿美元); 承担Mongstad CCS项目的建设投资和运营费用，并且每年为CCS的研发提供1.8亿挪威克朗(合3,000万美元)
日本	1,080亿日元（合11.6亿美元）	自2008年起，用于CCS的研发和示范

(From Climate Group, 2010)

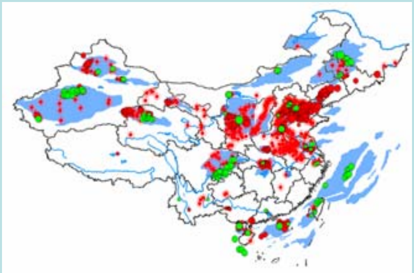
报告内容　Outline

If China needs it, how much can CCS contribute?

一、分析方法	**1. Methodology**
二、全国的贡献	**2. Nation-wide contribution**
三、地区分析	**3. Regional contribution and features**
四、早期机会	**4. Early opportunities**
五、结言	**5. Summary**

Methodology (cooperation with PNNL)

CCS GIS database



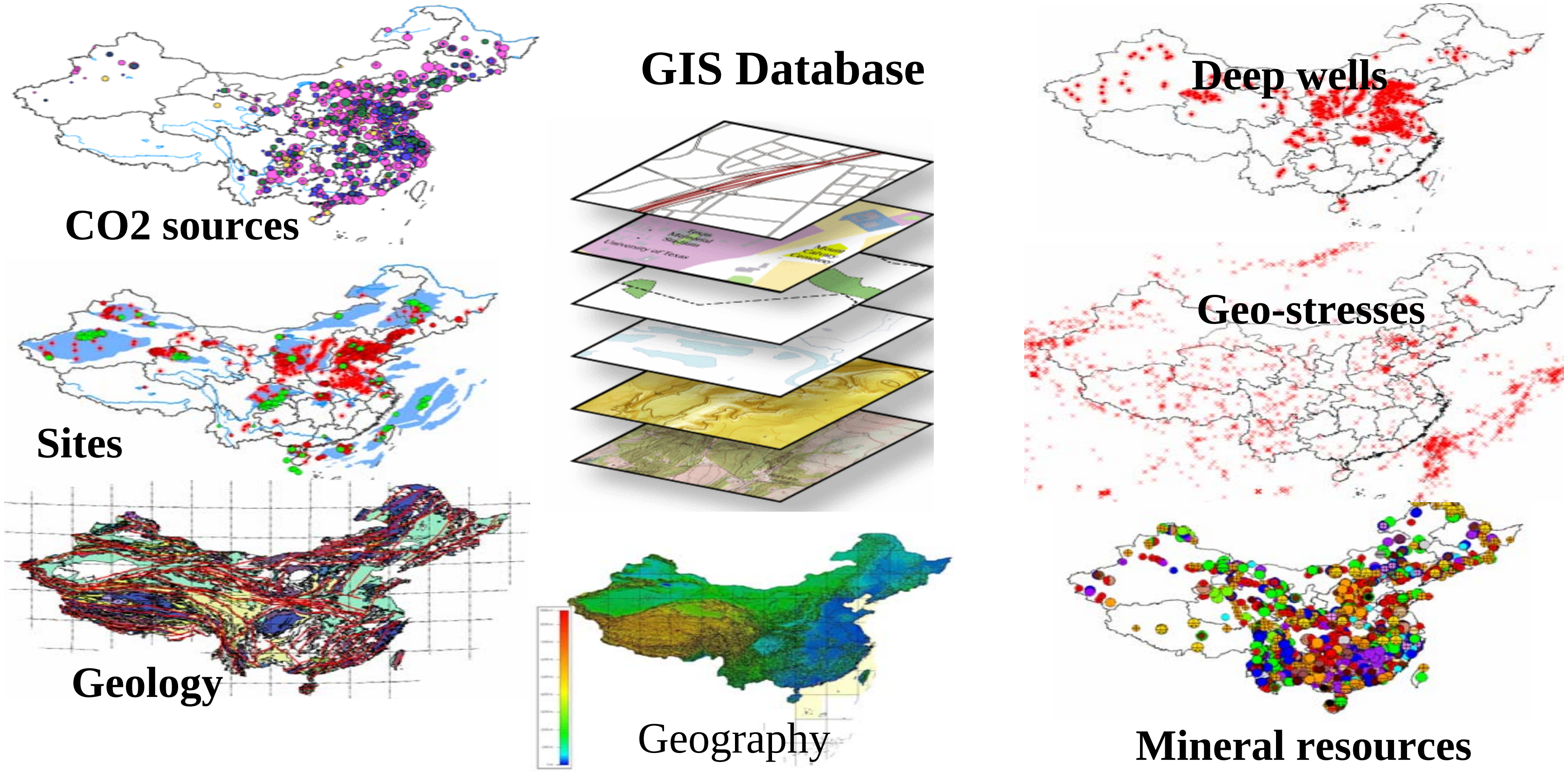
Pairing list: within 240km

Economy model: Transport + Site survey + Injection + MMV + Revenue

Optimization: Overall minimum cost, capacity more than 20 years lifetime

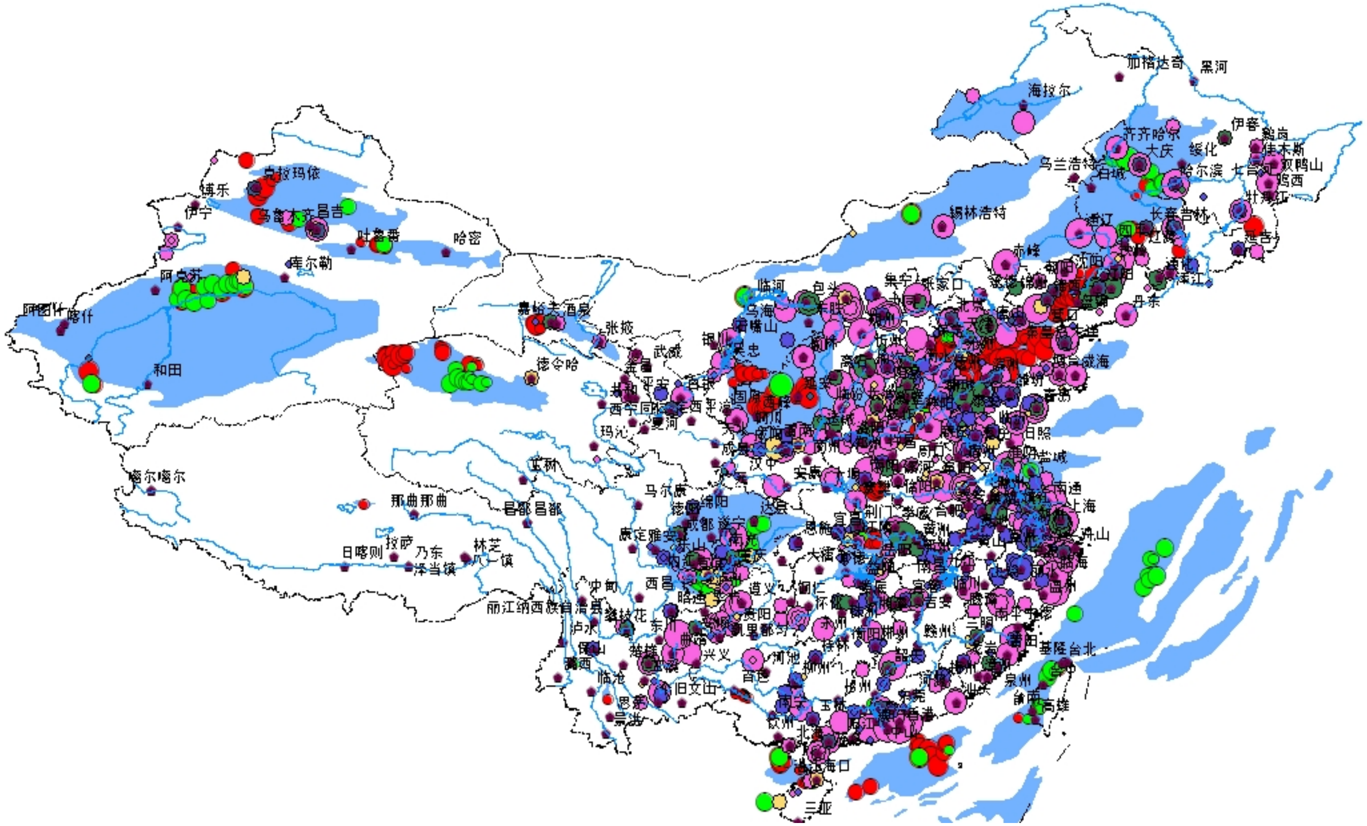
Active pairs with the cost of each known

China CCS Database



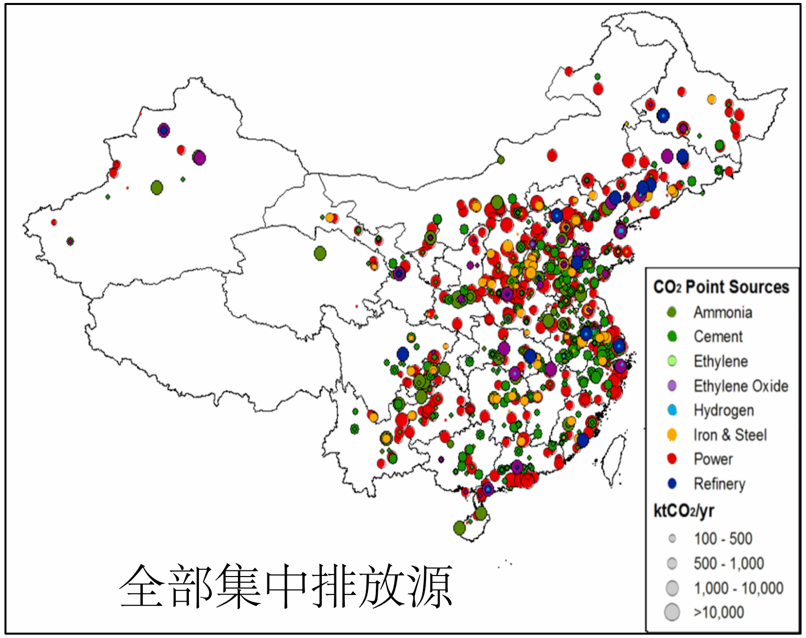
地质：地质图、资源分布、深钻孔、地应力、构造、火山、地热、地震、
地面：排放源、人口、经济、交通、气候
分析：场地筛选、源汇匹配、封存成本分析

China CCS Database

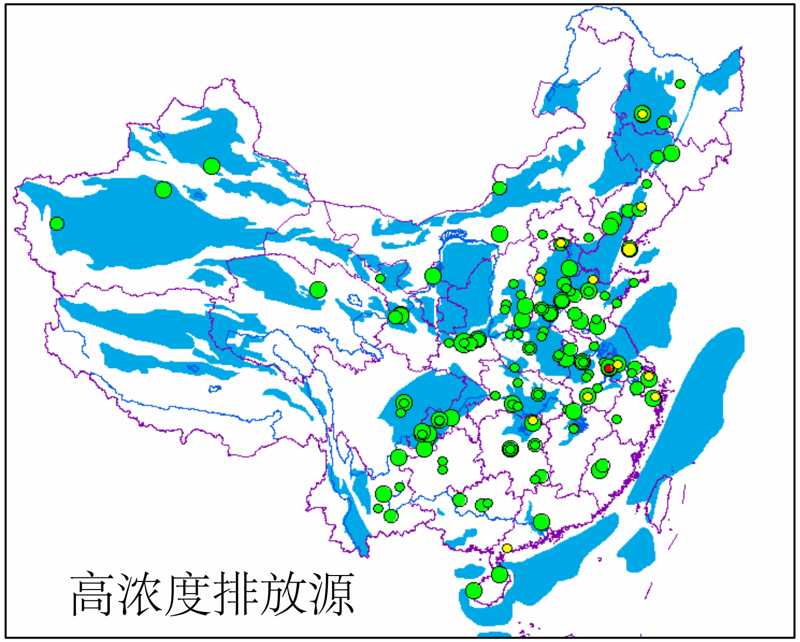


Support nation-wide and regional potential analyses, site selections and early opportunity searches

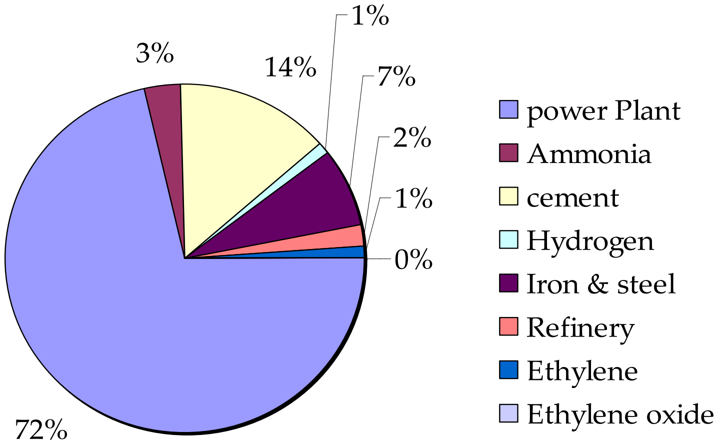
CO_2 point sources



全部集中排放源



高浓度排放源

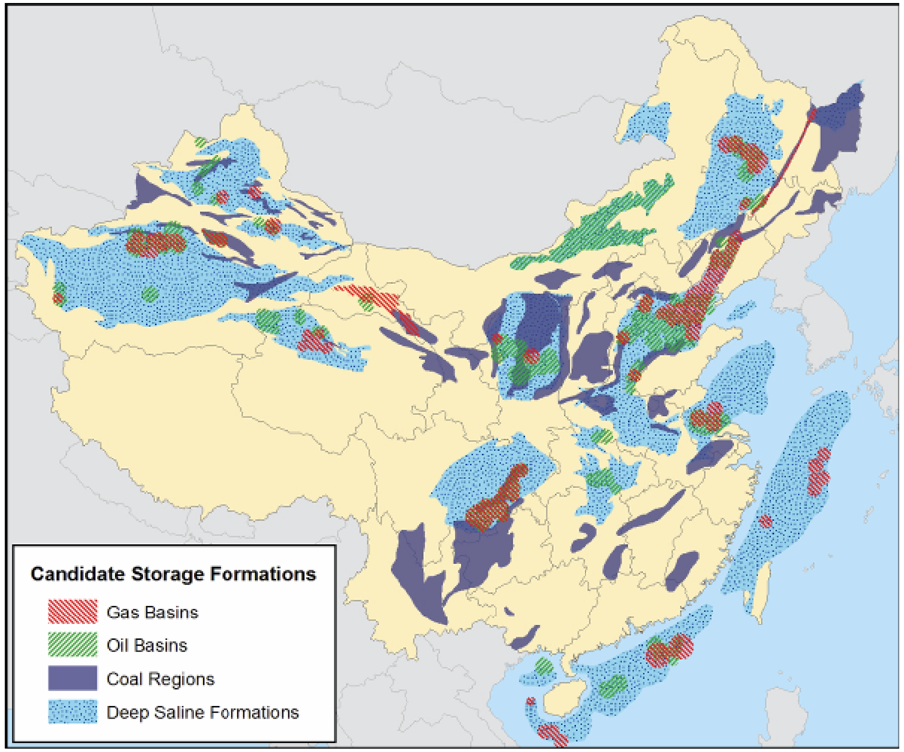


- **1623个(>10^5t/a)，年排放量39亿吨(2007)**
- **燃煤电厂、水泥和钢铁占 93%**
- **每年1.3亿吨高浓度排放（煤化工）**
- **排放源平均年排放量：273万吨CO_2**

Theoretical storage capacity

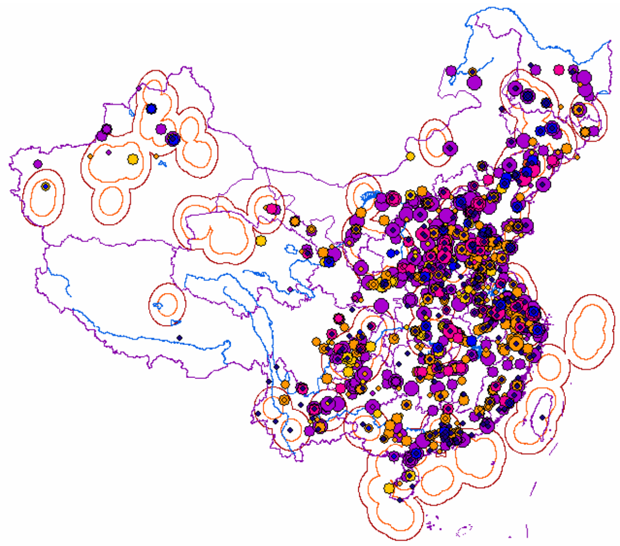
咸水层：	30660亿吨
油田：	48亿吨
气田：	52亿吨
煤层：	120亿吨
总和：	30880亿吨

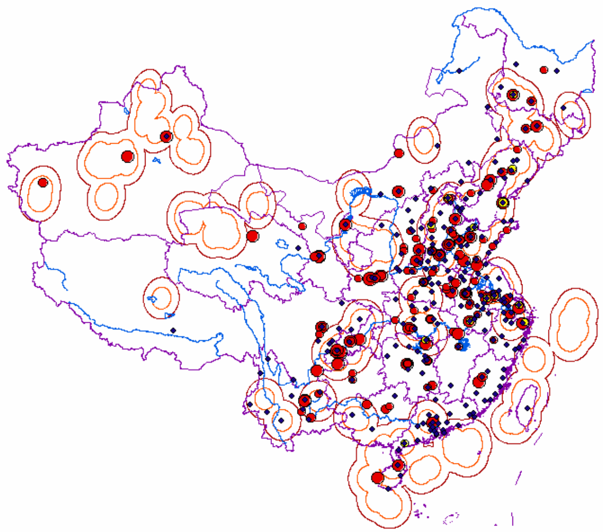
集中排放量：39亿吨/年



Only a small fraction of the theoretical capacity is feasibly available for storage

Source-site matching



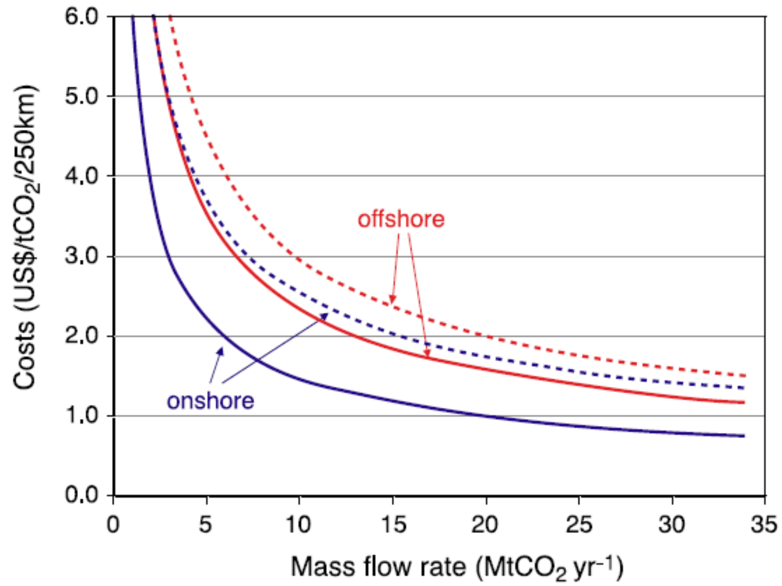


	全部排放源	高浓度
盆地内	**54%**	**45%**
80km以内	**83%**	**75%**
160km以内	**91%**	**92%**

Economy model

Transport cost

- Pipeline cost ($) = d · 398,519 · Q (0.4055) + 466,464
d – distance in miles; Q - annual CO2 mass throughput in MtCO2/a



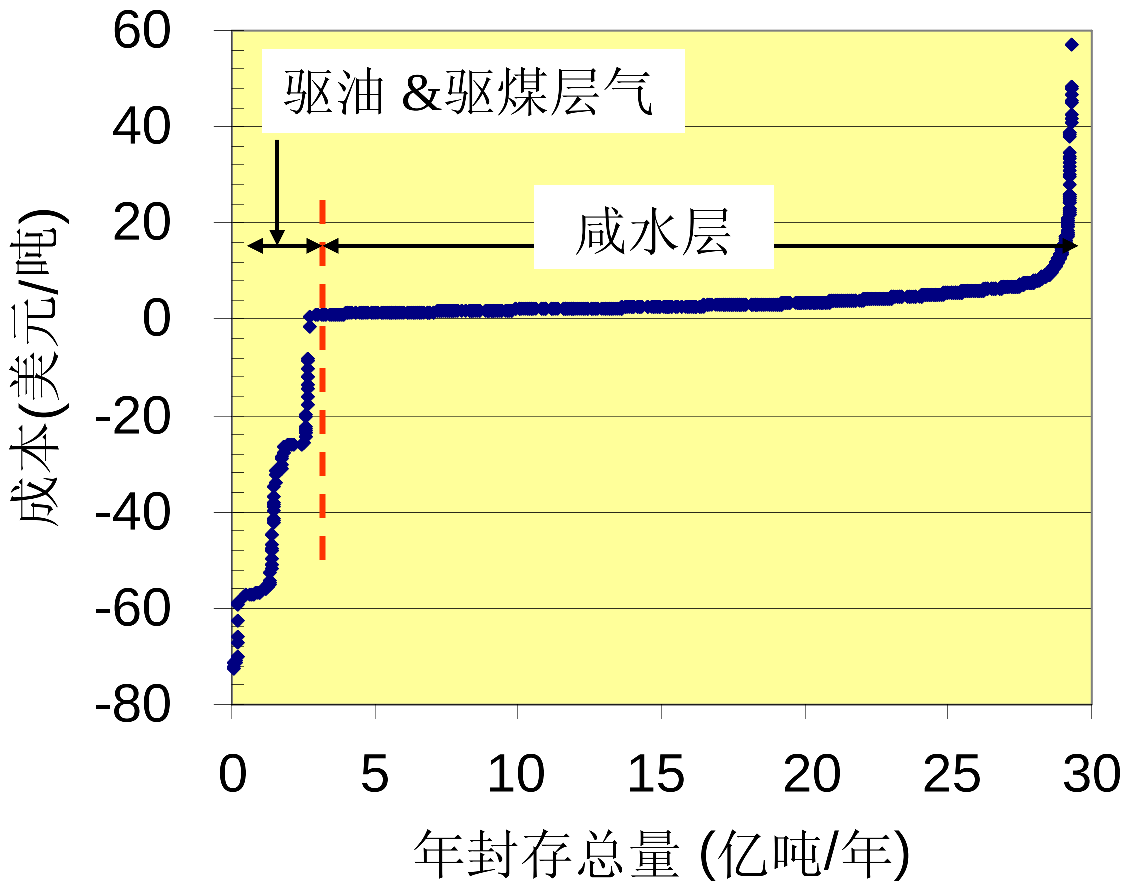
Storage coat

- Site survey: per-ton costs ranging from $0.35/tCO2 to $140/tCO2, averaging about $2/tCO2

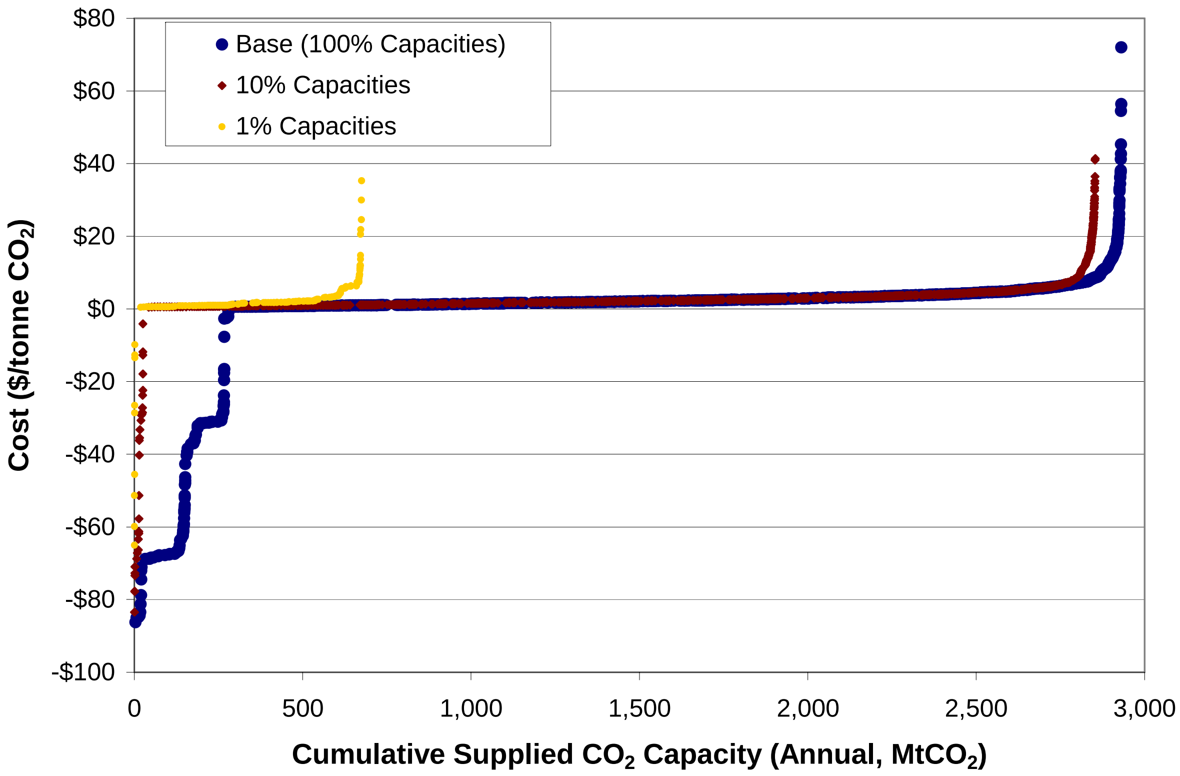
- Well drilling = 1,000,000 · 0.1271e0.0008z + 530.7z   z – well depth in m
- Per-well flowline & connection = 43,600 · (7,389 / (280n))$^{0.5}$ n – numbers of wells
- Annual per-well O&M cost = 24,600 + [13,600 · (7,389 / (280n))$^{0.5}$] + [(5,000z) / 1219]
  z - well depth in m

Nation-wide contribution

- Lower cost: EOR and ECBM， with contribution of 0.26BtCO2/yr
- Maximum contribution: about 24BtCO2/yr with a cost lower than 5US$/tCO2



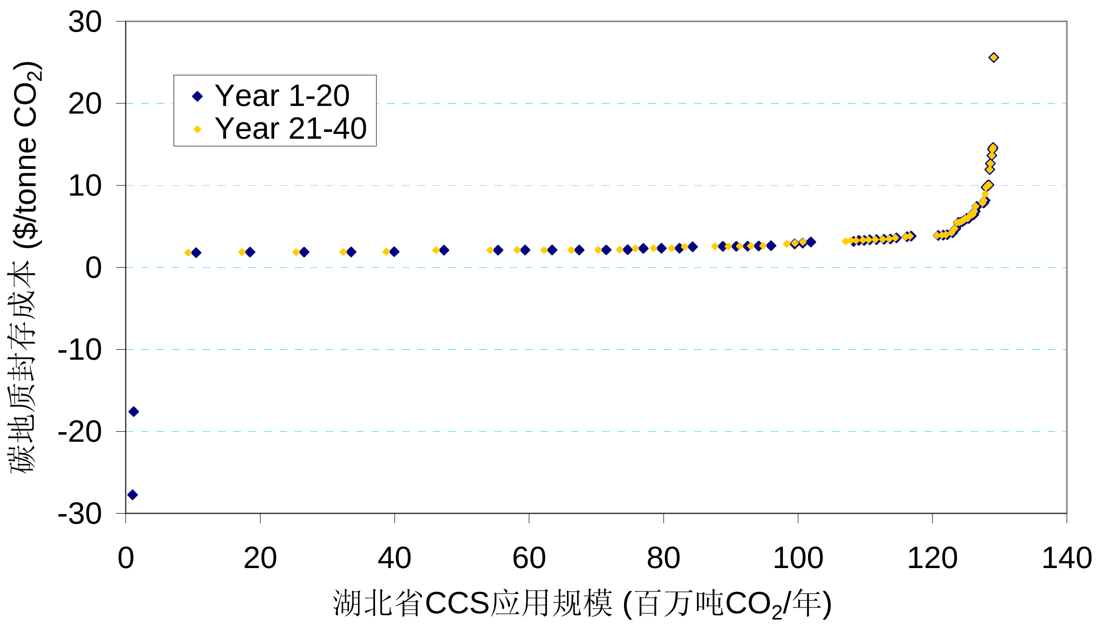
Nation-wide contribution



Assuming 10% theoretical capacity as available, the results is almost same. If 1%, the contribution is 0.5BtCO2/yr.

Regional features- Hubei

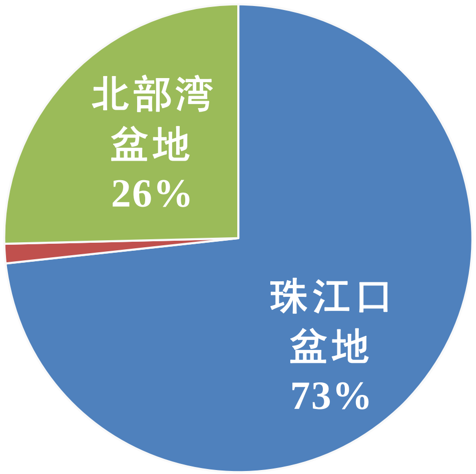
- Lower cost: EOR only in Jianghan oil fields
- Maximum contribution: about BtCO2/yr with a cost lower than 5US$/tCO2

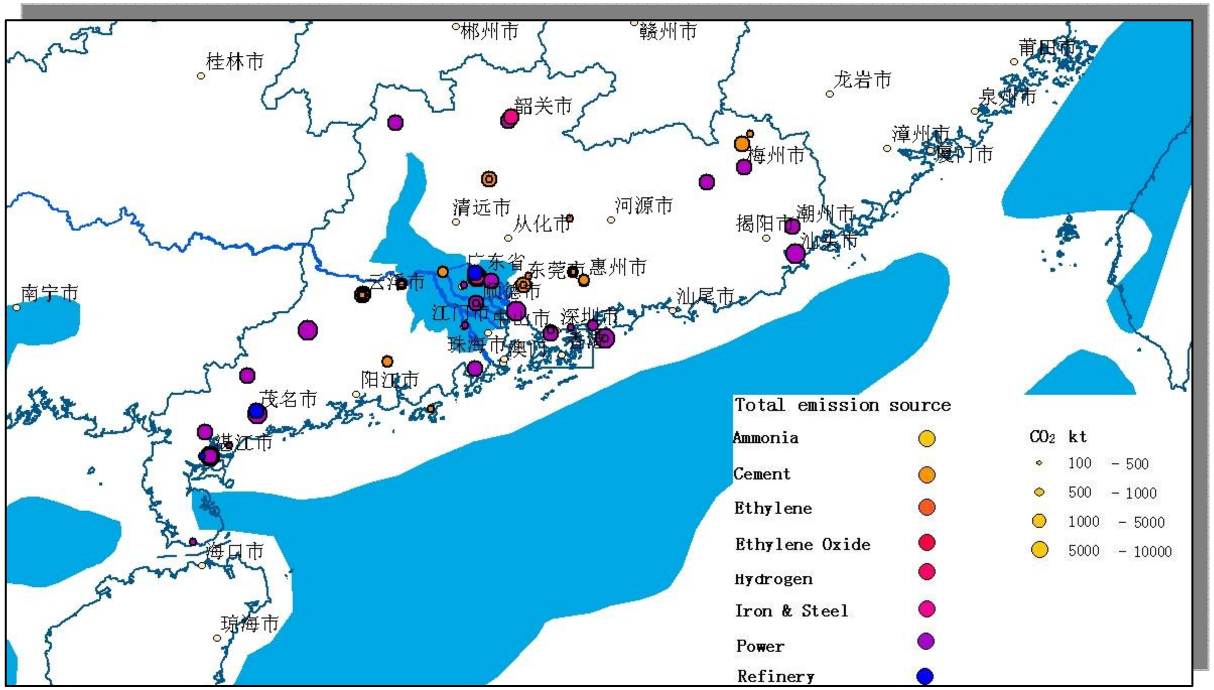


Regional features- Guangdong

	煤电	水泥	合成氨	乙烯	制氢	钢铁	炼油	总计
年排放量（Mt/a）	179.0	26.5	1.2	3.4	0.5	8.6	8.0	227.3

封存方式	深部咸水层	油田	气田	煤层	总计
封存容量（Gt）	93.76	0.06	0.01	0.00	93.83





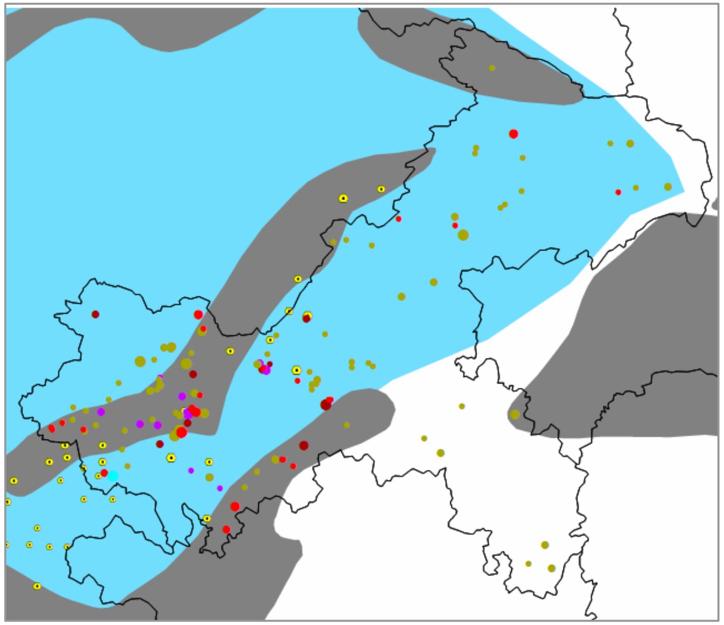
Coal fired power plant

+ off-shore aquifers

Regional features- Chongqing

	火电	水泥	合成氨	钢铁	总计
年排放量（Mt/a）	31.19	35.78	4.10	14.50	85.57

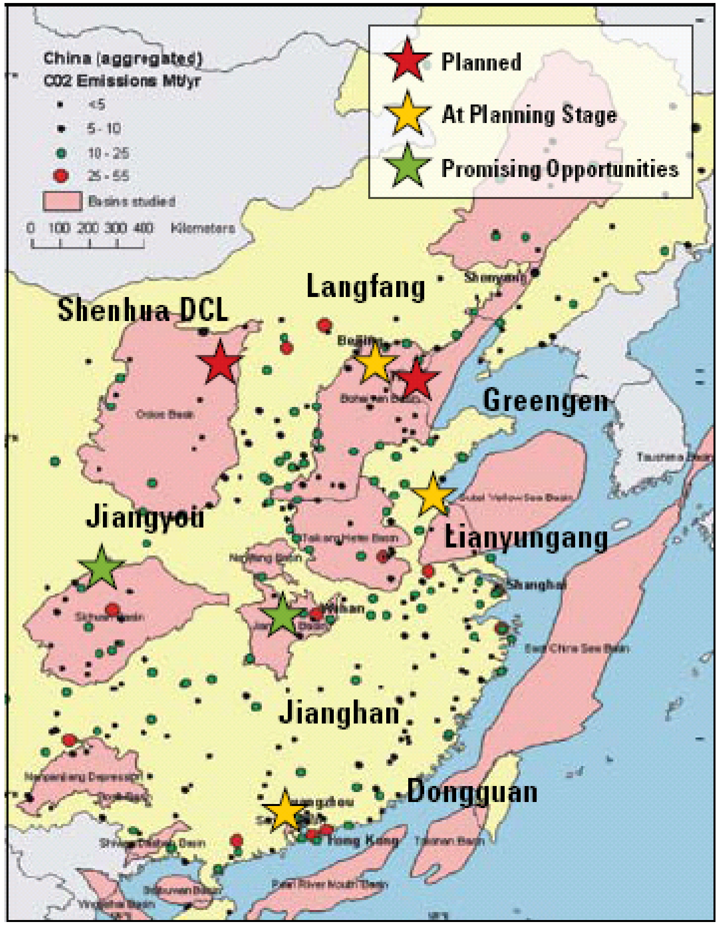
封存方式	咸水层	气田	煤田	总计
封存容量（Gt）	23.91	0.42	0.04	24.37

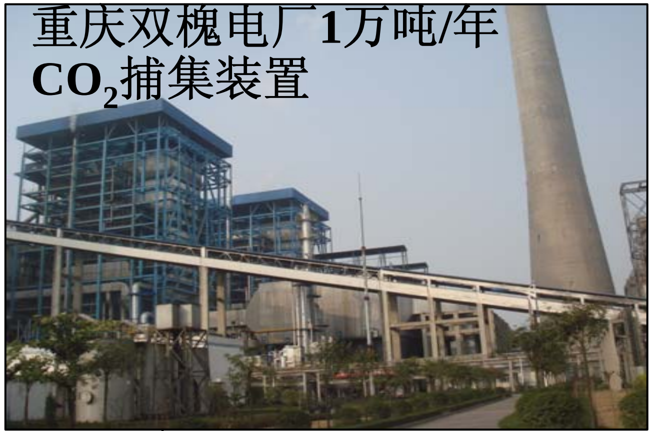


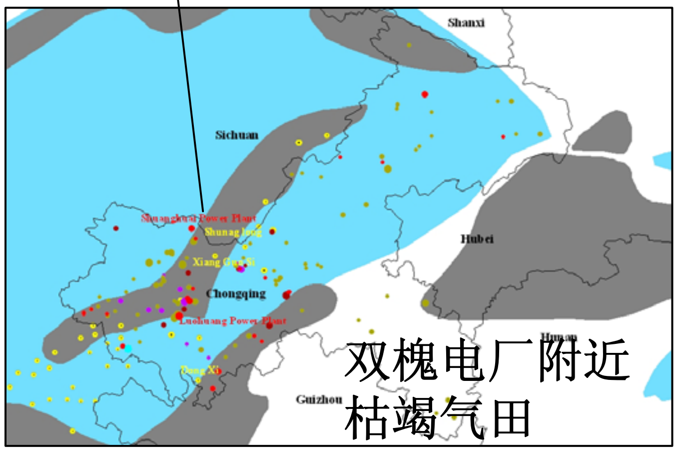
早期机会：合成氨+气田　深度减排：水泥、煤电+咸水层

Early opportunities

基于数据库和实地查访，发现了一批早期机会



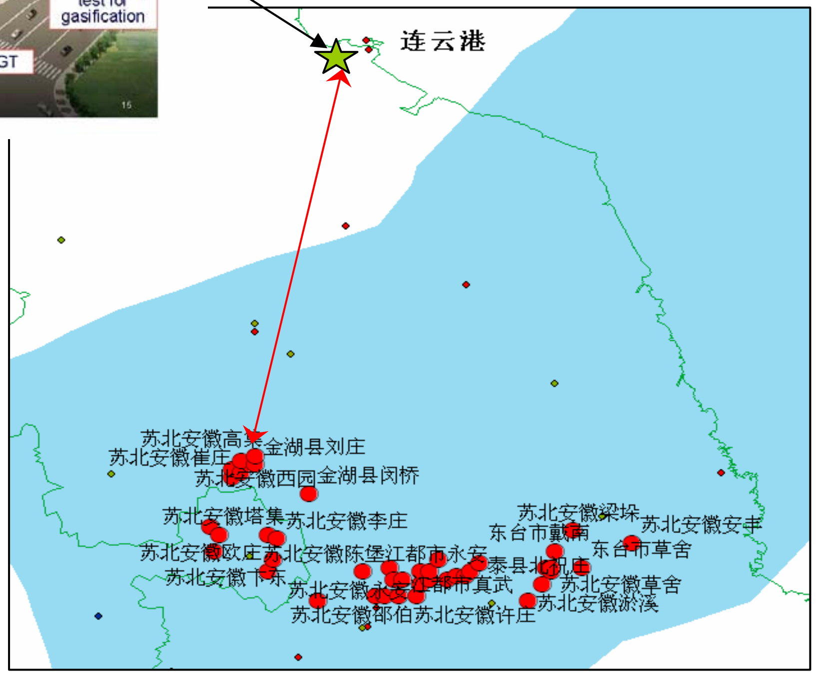


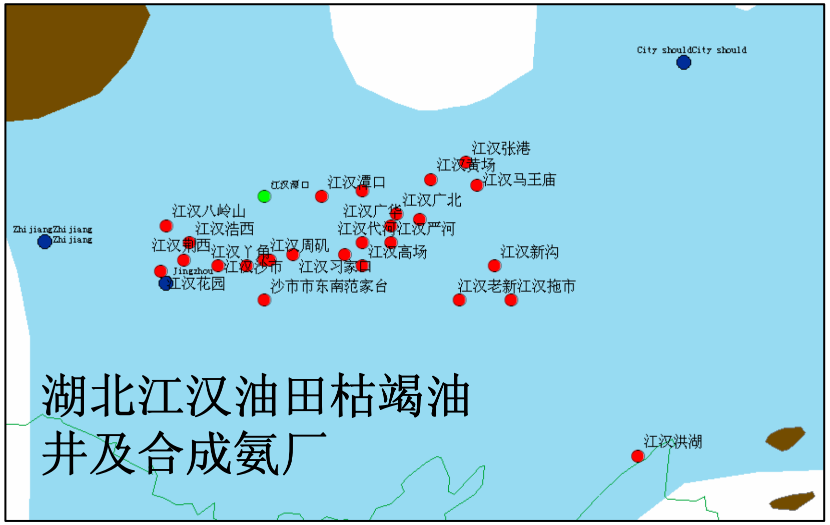


By NRDC， 2009

Early opportunities

江苏连云港IGCC装置
及江苏油田





湖北江汉油田枯竭油
井及合成氨厂

Early opportunities

- 神华：10万吨/年，全流程
- 2010底开始注气
- 3口深2450米井
- 提供技术支持：选址、定井、测试、答疑

鄂尔多斯煤制油厂（3Mt CO_2/a)

Summary

- Huge potentials:

  -- A large number of point (1623个) and large quantity of annul emission (3.9Gt/a) + a great storage capacity (3Tt) + a favorable source-site matching (54% with basins)

  -- Potential contribution of the order of $BtCO^2$/yr
- Many early opportunities:

  Combinations of high-concentration sources, EOR, existing capture plants and nearby aquifers, may serve as a bridge leading to the wide deployment of CCS.
- A great contribution requires Power Plan + Aquifer