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Two scenarios for carbon capture and storage in Vietnam

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Founded in 2014, building a world-class interdisciplinary research team with the mission to contribute to the green growth of the energy sector in Vietnam and other South East Asian countries.

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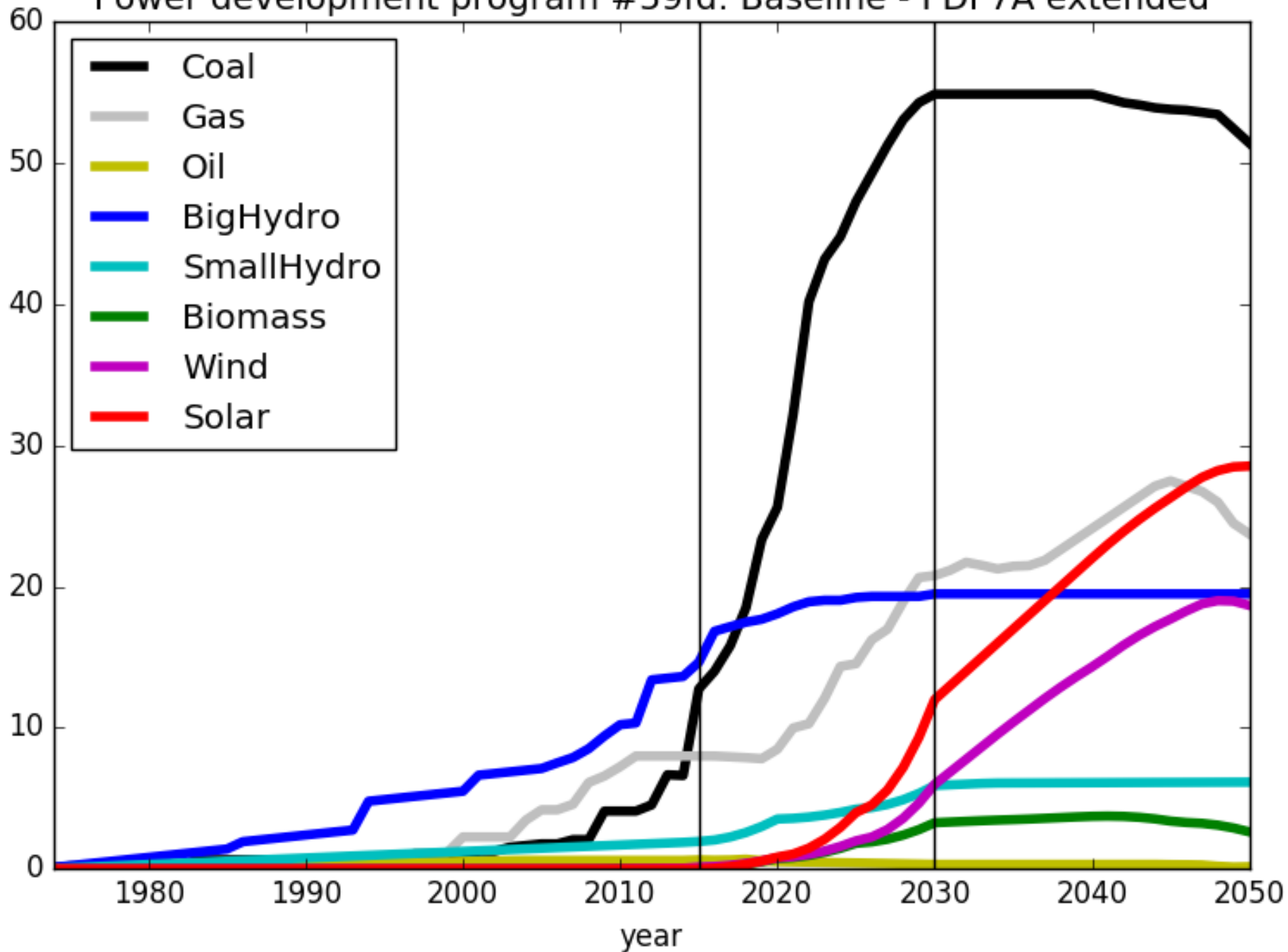
1. Context highlights

- CCS is relevant for Vietnam: power capacity from coal and gas is expanding faster than +1GW per year
- Lack of policy interest and the CCS costs are the biggest barriers for CCS development in Vietnam
- Capture readiness would lower the costs of using CCS in Vietnam, but is not mandatory today

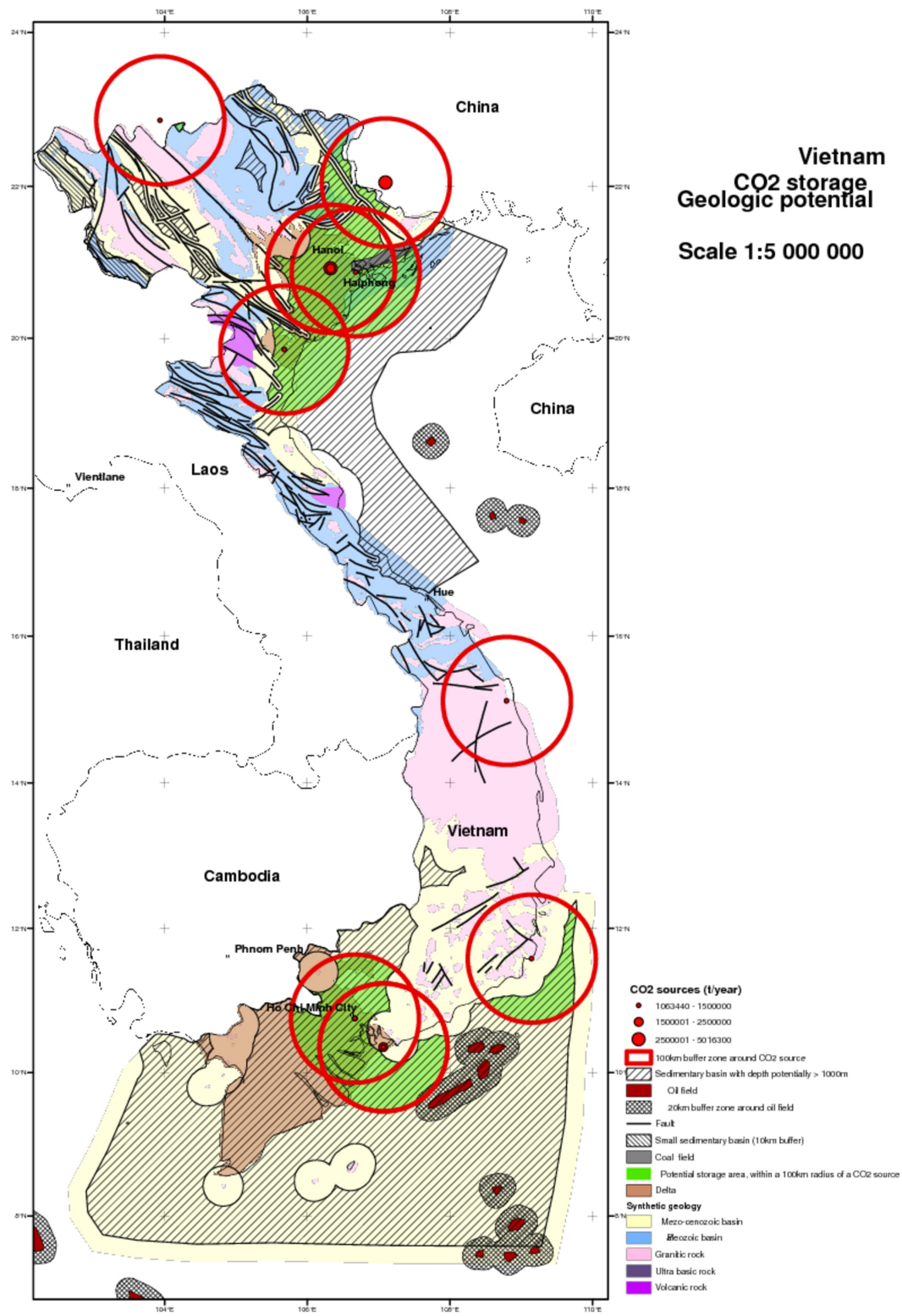
Power capacity from coal and gas planned expansion in Vietnam

Generation capacity by technology, 1975 - 2050

Power development program #59fd: Baseline - PDP7A extended



Near-shore CO2 storage possible



Lack of policy interest

The players

| | Low stakeholder interest | High stakeholder interest |
|----------------------------|--|---|
| High stakeholder influence | Policy makers Local community/government Electricité du Vietnam VinaCoMin Local and international media Investors | CCS industry and researchers International carbon finance Fossil-fuel power industries PetroVina |
| Low stakeholder influence | Renewable energy industries Domestic environmental NGOs Education and training institutes | |

Could Government of Vietnam do a pro-CCS policy ?

Strengths

- The ability to issue policies regarding CCS industry

Weaknesses

- Lack of technical knowledge
- Lobbied by other industries

Opportunities

- Giving subsidies, framework for co-operations
- Lobbied by CCS industry

Threats

- Do not pay attention to CCS deployment

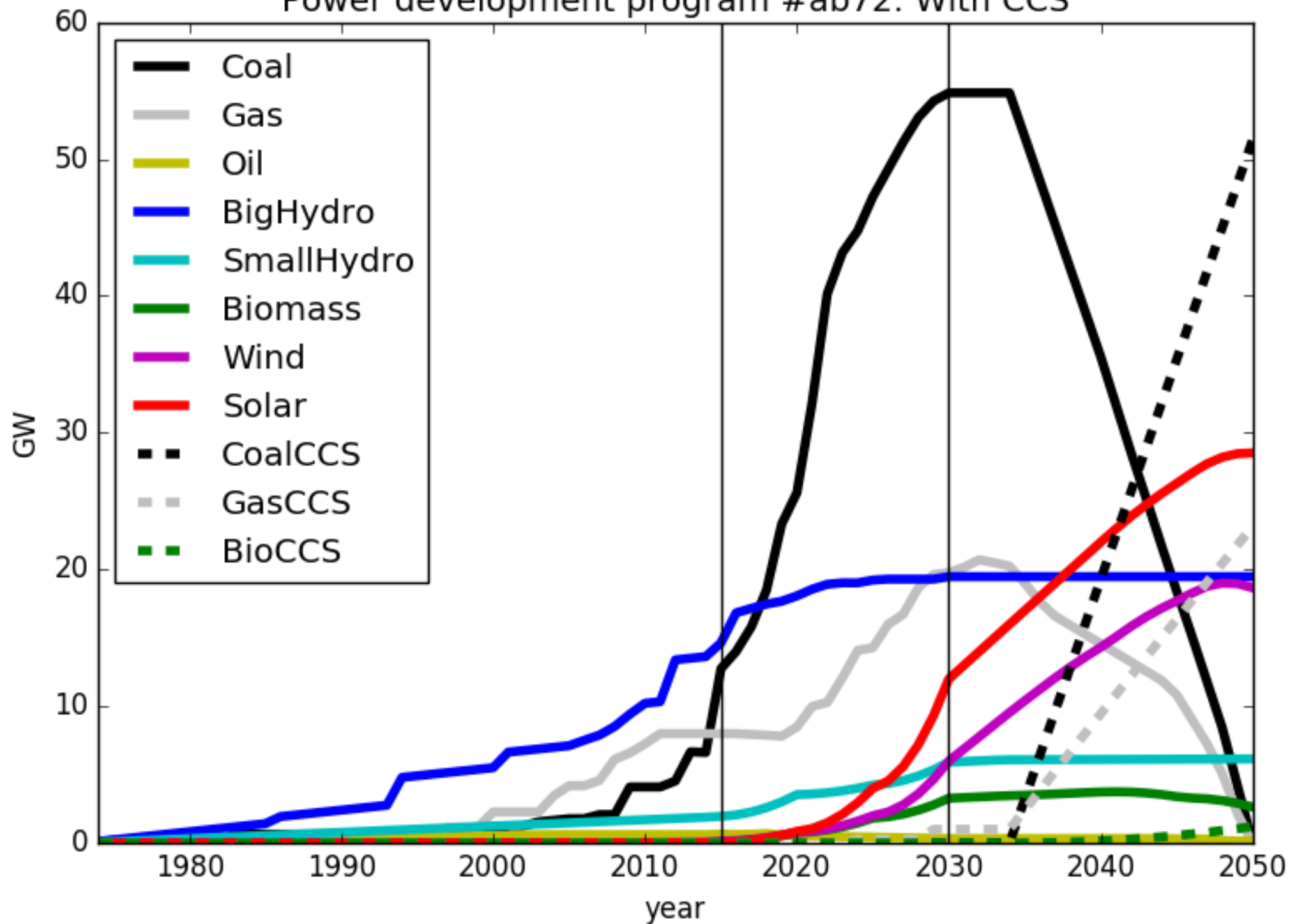
2. Two scenarios

- A) 1GW pilots in 2030, gas-fired CCS, supported by EOR and carbon finance, then stop.
- B) Do pilots, then each year from 2035 until 2050:
- retrofit 3.2 GW coal CCS
 - install 1.2 GW gas with CCS

Scenario driving forces

| | Low scenario: CCS only EOR | High scenario: CCS in power |
|----------------------------|---|--|
| Government stance on CCS | Laisser-faire. Climate policy instruments are generic | Intervention to promote it with specific incentives. |
| Economic growth until 2050 | Trapped at middle-income level | Catches up with South Korea and Japan |
| CCS technology costs | A global ban on coal hurts CCS scale up. | General adoption of CCS in China and elsewhere push costs down |
| Carbon price trajectory | Implicitly weak, below 30USD/tCO ₂ in 2050 | Most nations adopt a notional price of carbon reaching 50 USD/tCO ₂ in 2050 |
| Social acceptance | No, an international convention against onshore CCS is discussed. | Yes, most storage in Vietnam is offshore |
| Alternative technologies | Solar and wind win the cost race | Coal with CCS remains more expensive for new capacities, but capture-ready plants are retrofit rather than closed. |

Power development program #ab72: With CCS



National energy mix simulation model

- Computes the system Levelized Cost of Electricity Generation (LCOE) and greenhouse gases emissions.
- Standard bottom-up, no optimization, storage or within-year time slices
- Technologies: coal, gas, oil, big hydro, solar, wind, small hydro, biomass, coal CCS, gas CCS, bio CCS, and imports.
- Subset of Howells et al. (2011) OseMOSYS limited to the equations blocks about Objective, Total Discounted Cost, Operating Cost, Capital Costs, Salvage Value, Emissions
- Python 3.5. For more details, code and data are available under the Creative Commons Attribution Sharealike International license at : <https://github.com/MinhHaDuong/VN-CSS-Scenario>.

Parameters

- Today's installed capacities: EVN (2016) inventory.
- Future capacity addition up to 2030: Power Development Plan 7 revised in 2016
- Median value of studies reported in:
 - Technical and economic parameters: OpenEI Transparent Cost Database (2017)
 - Technology emission factors: IPCC SRREN (Moomaw et al. 2011, Table A.II.4 page 982).
- LCOE : 6% discount rate, no external costs.

Simulation results

| | Baseline | High CCS | difference | Units |
|----------------|-----------------|-----------------|-------------------|--------------|
| Power produced | 6385 | 6385 | 0 | Twh |
| System LCOE | 60.5 | 69.9 | +9.4 | USD/MWh |
| Total cost | 386 | 446 | +60 | bn USD |
| CO2 emissions | 11.1 | 8.9 | -2.2 | GtCO2eq |
| CO2 capture | 0 | 2.7 | 2.7 | GtCO2 |

3. Discussion

CCS scenario **fails** cost-benefit analysis under these cost of carbon assumptions :

- Zero until 2020
- 50 USD/tCO₂eq in 2030
- 100 USD/tCO₂eq in 2050

| | Baseline | High CCS | difference | Units |
|---------------------------|-----------------|-----------------|-------------------|--------------|
| Total cost | 386 | 446 | +60 | bn USD |
| CO ₂ cost | 173 | 139 | -34 | bn USD |
| Cost with CO ₂ | 559 | 585 | +26 | bn USD |

Challenges

- Financial : international mechanisms only plausible option
- Legal : government could align incentives with other low carbon technologies
- Energy security : CCS increases imports

Vietnam energy policymakers should not defer thinking hard about CCS

- Decisions on CCS will have to be made before 2030, conditional on the today's choices about capture ready.
- The White Tiger project shows there are options to explore for EOR by CO₂ injection in Vietnamese oil fields.
- Vietnam might benefit from future international or bilateral agreements to finance CCS projects in developing countries. Networking and capacity building, such as joining global CCS institutes & research forums, would help to prepare.

Conclusions

- Technical potential : Promising geological formations for CO₂ storage less than 100km away from present and future fossil-fuel power plants.
- No commitment to the technology in Vietnam, not even much interests in CCS research and development.
- A scenario in which CCS is used in fossil-fuel power plants in Vietnam cannot be excluded. There is a real option value to building capture-ready power plants today.