

CO2 Capture and Storage: impact of accounting rule to energy system and climate

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**The views are solely those of the individual authors and do not represent
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Outline

[1] Background

[2] Model Framework

[3] CCS and Accounting Rule Sensitivity

[4] Summary and Conclusion

[1] Background

UNFCCC and IPCC Concerns on CO2 Sequestration (Policy and Science)

* Policy

National GHG Inventories

– New Guideline under negotiations

National Communications

GHG Registry and Kyoto Mechanism

* Science(IPCC)

Fourth Assessment Report

Special Report on

Carbon Dioxide Capture and Storage³

Comprehensive CO2 Sequestration Potential Assessment

ARCS Research Consortium

**Accounting
Rule
Framework
Proposal**

**Yoshigahara, et.al.,
(Reference #1)**

**Possible Options for
CO2 Accounting**

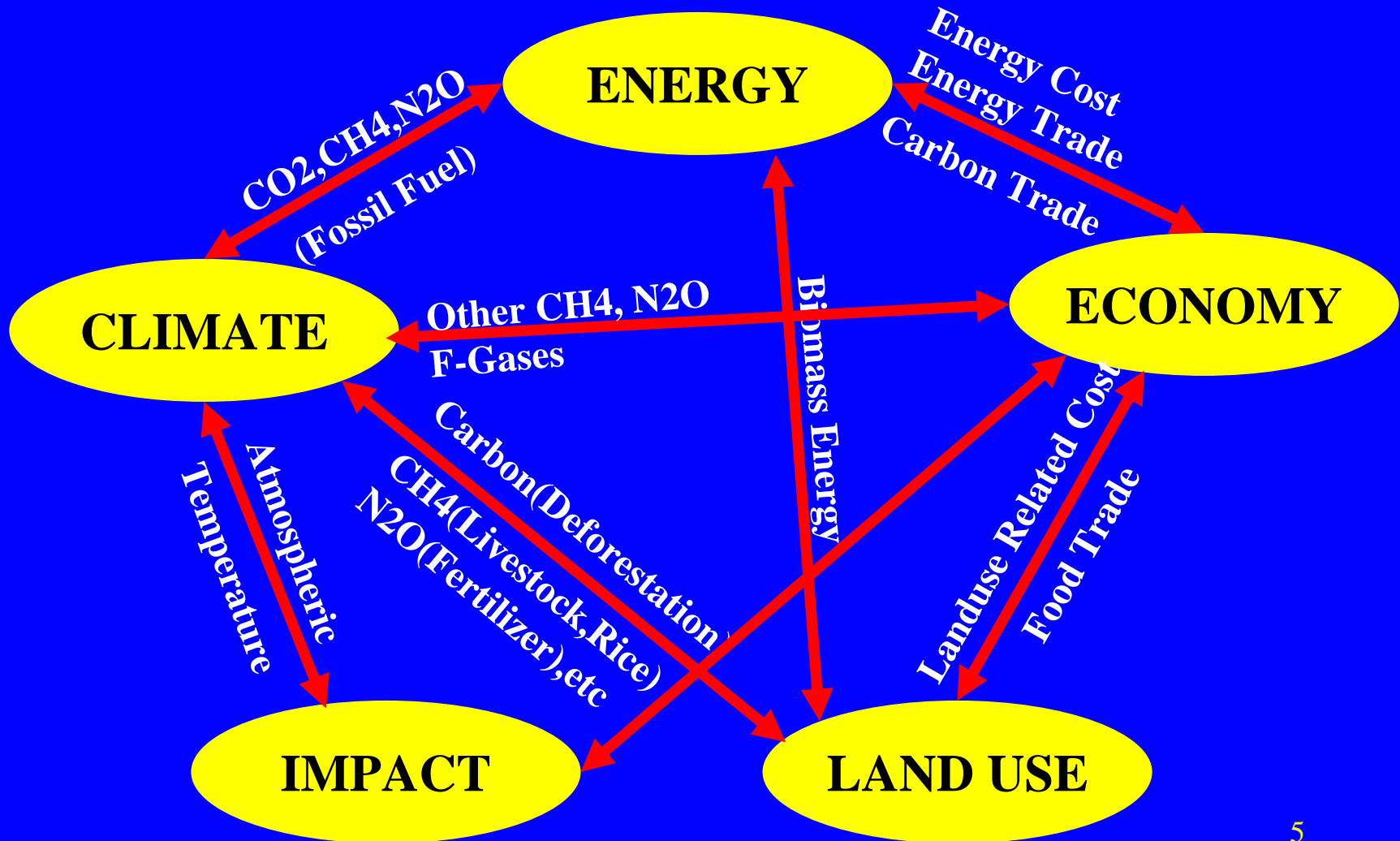
**Geological
& Ocean
Modeling**

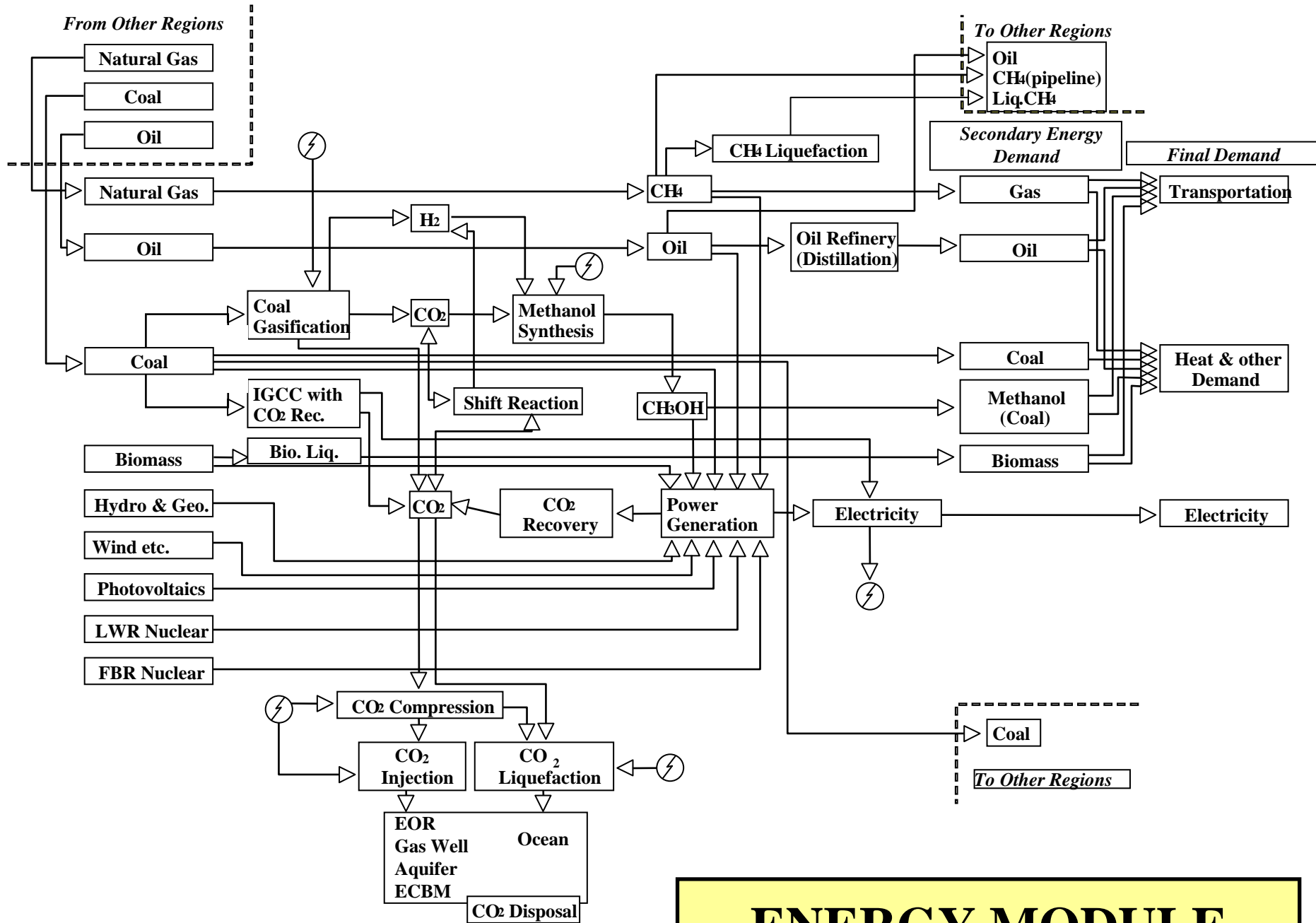
Leakage Estimate

**Realistic
Economic
Potential
Estimate
by
Integrated
Assessment
Model**

[2] Model Framework

GRAPE (Global Relationship Assessment to Protect the Environment)





ENERGY MODULE

[3] CCS and Accounting Rule Sensitivity

Fossil Fuel Generation with CO₂

Capture – Available after 2020

5 Storage Options and Constraints

**Geologic (*1, *3) - EOR, Sal. Aquifer,
Dep. Gas Well, ECBM**

Ocean (*2, *3)

(*1) Limit on Cumulative Storage

(*2) For NOLEAK case

- Annual Ocean CCS quantity is not more than 5% of REF CO₂ emissions.

(*3) For other CO₂ Conc. Target Cases

- Diversification of storage options
- For each CCS option, annual quantity is less than 5% of NOLEAK emissions.

Storage Options and Leakage

- * EOR and Depleted Gas Well

Seal Robustness is High. → Conduit Model

Leakage Rate = 0

- * Aquifer, ECBM

Seal Robustness Varies. → Membrane Model

2000m depth, 100m thick cap rock

Permeability

Low (10 μ d:LP), Middle (MP), High (1md:HP)

- * Ocean

Area Dependent

3000m Depth

Leakage to Surface = 0

(during Simulation Periods)

CO2 Storage Accounting Schemes

Type	Monitoring	Remarks
Whole Injection (WI)	Not Required	No Concern on Leakage. Admit Whole Storage.
Discounting (DISC)	Not Required	Disc. Cum. Leakage for 1000 yrs. EOR, Gas Well : zero Aquifer, ECBM : LP (23%) to HP (100%) Ocean : Area Dependent (19% to 40%)
Whole Injection and Leakage (WILP)	Required	Admit Whole Injection Initially, Count Leak. as Em. Afterwards
Temporary (TEMP)	Not Required	Temporary Credit. Compensation by non-CCS Credit after 50 years
Compensation for Leakage (CPLK)	Required	Every 20 years, Compensation through Verification by non-CCS Credit (50% added in first verification year). Permanent after 200 years. ⁹

Case Studies

17 cases

* No Climate Policy (REF)

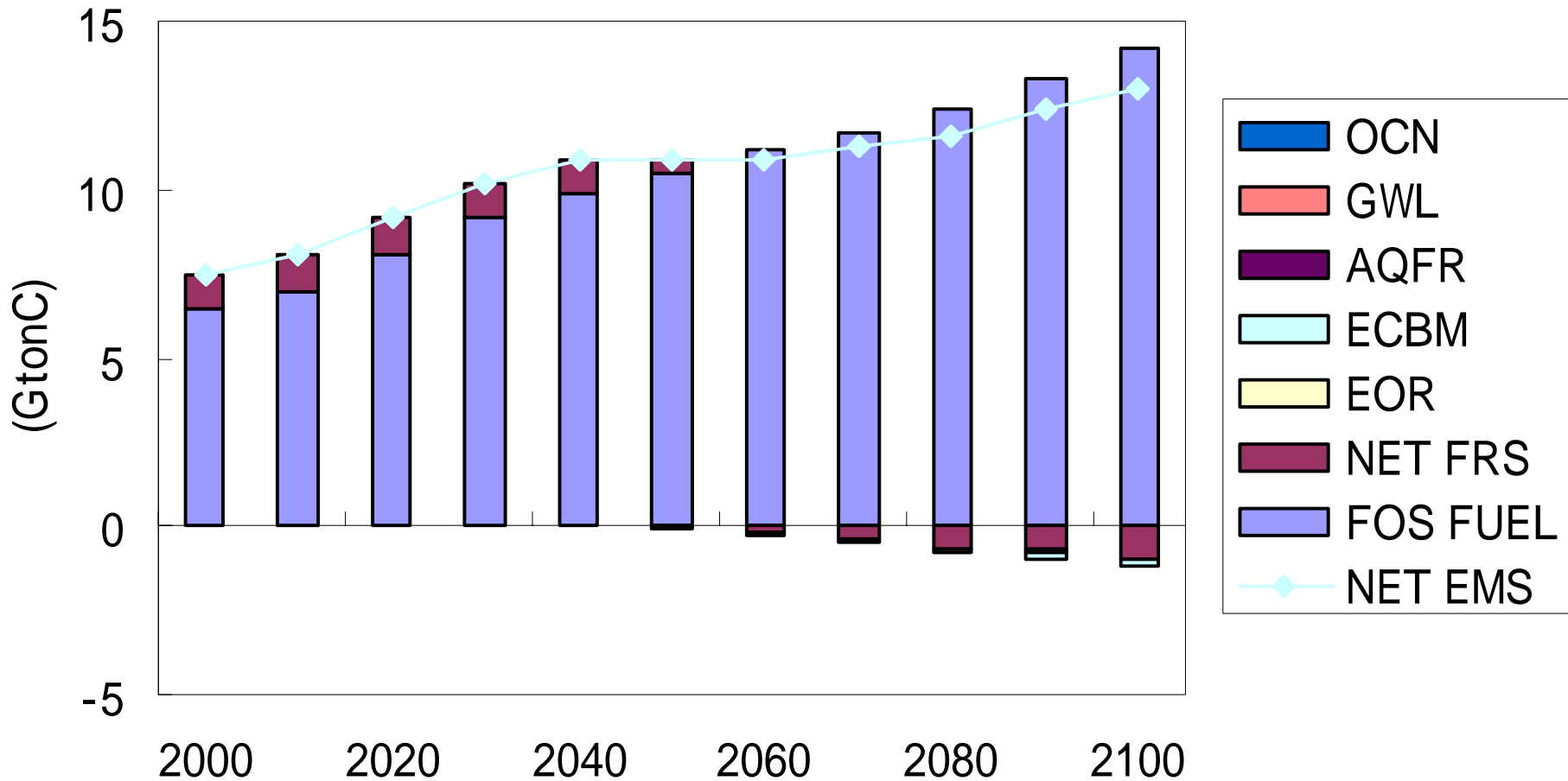
* 550ppm CO2 conc. Target, No Leakage (NOLEAK)

* 550ppm CO2 Target, Leak from Aquifer and ECBM

Permeability	Low	Middle	High
Accounting			
Whole Injection	WI-LP	WI-MP	WI-HP
Discounting	DISC-LP	DISC-MP	DISC-HP
Whole Inj. & Leak.	WILK-LP	WILK-MP	WILK-HP
Temporary	TEMP-LP	TEMP-MP	TEMP-HP
Compensatn. for Leak.	CPLK-LP	CPLK-MP	CPLK-HP

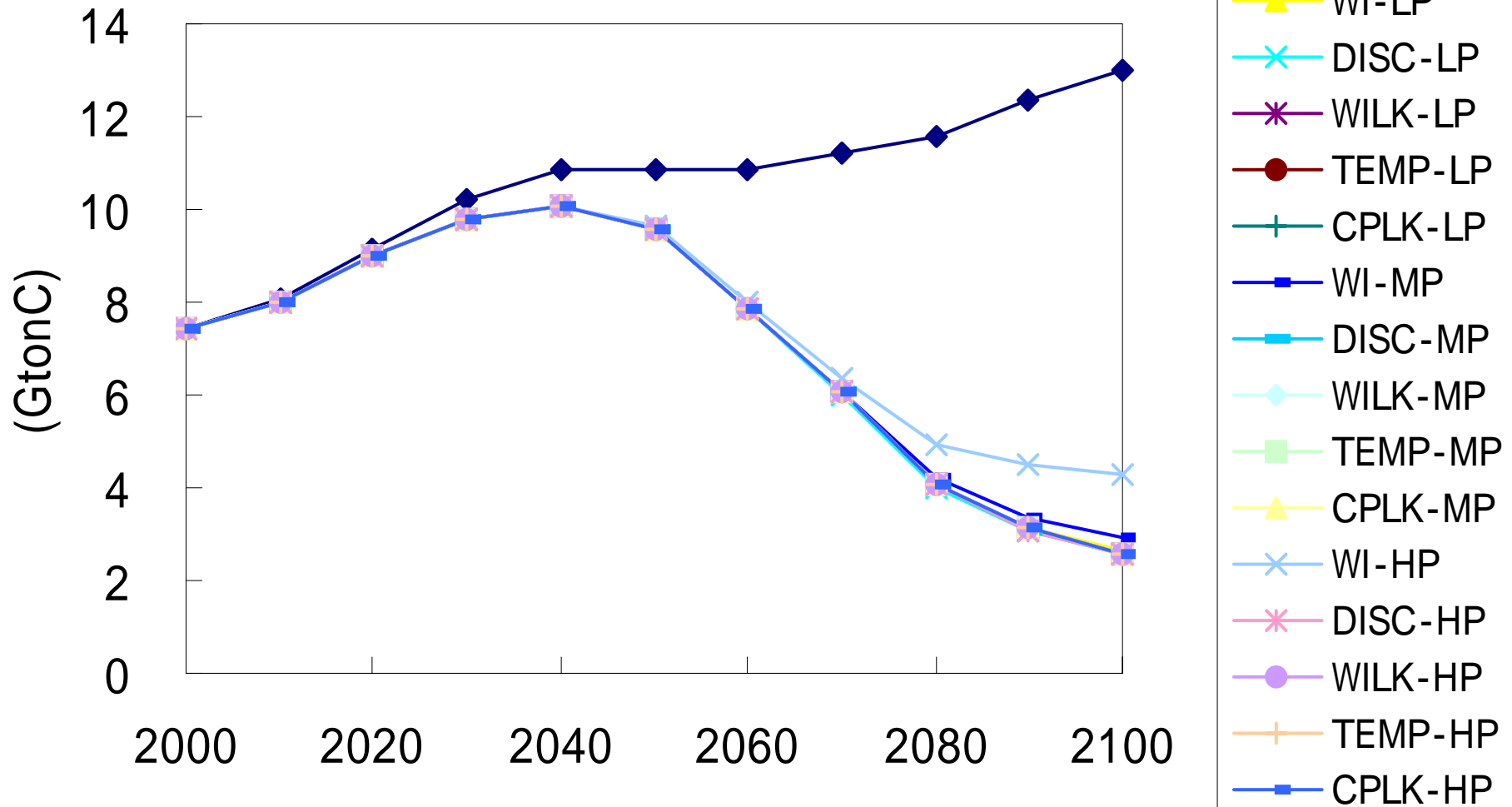
*** CCS activities in REF case are for additional fossil fuel resources.**

Carbon Balance (REF)



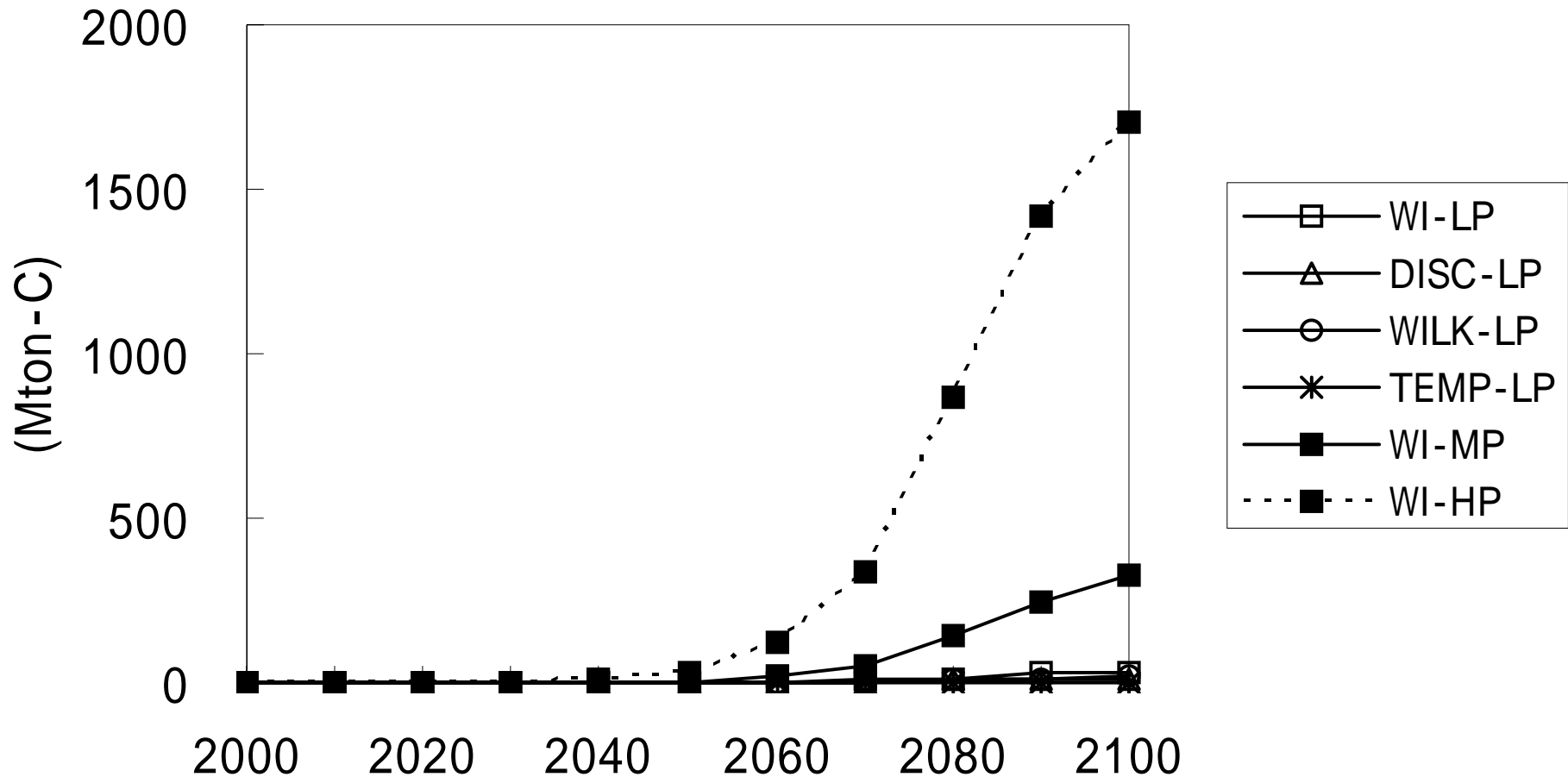
* Combination of WI and high leakage rate changes net CO2 emission profile.

Net CO2 Emissions



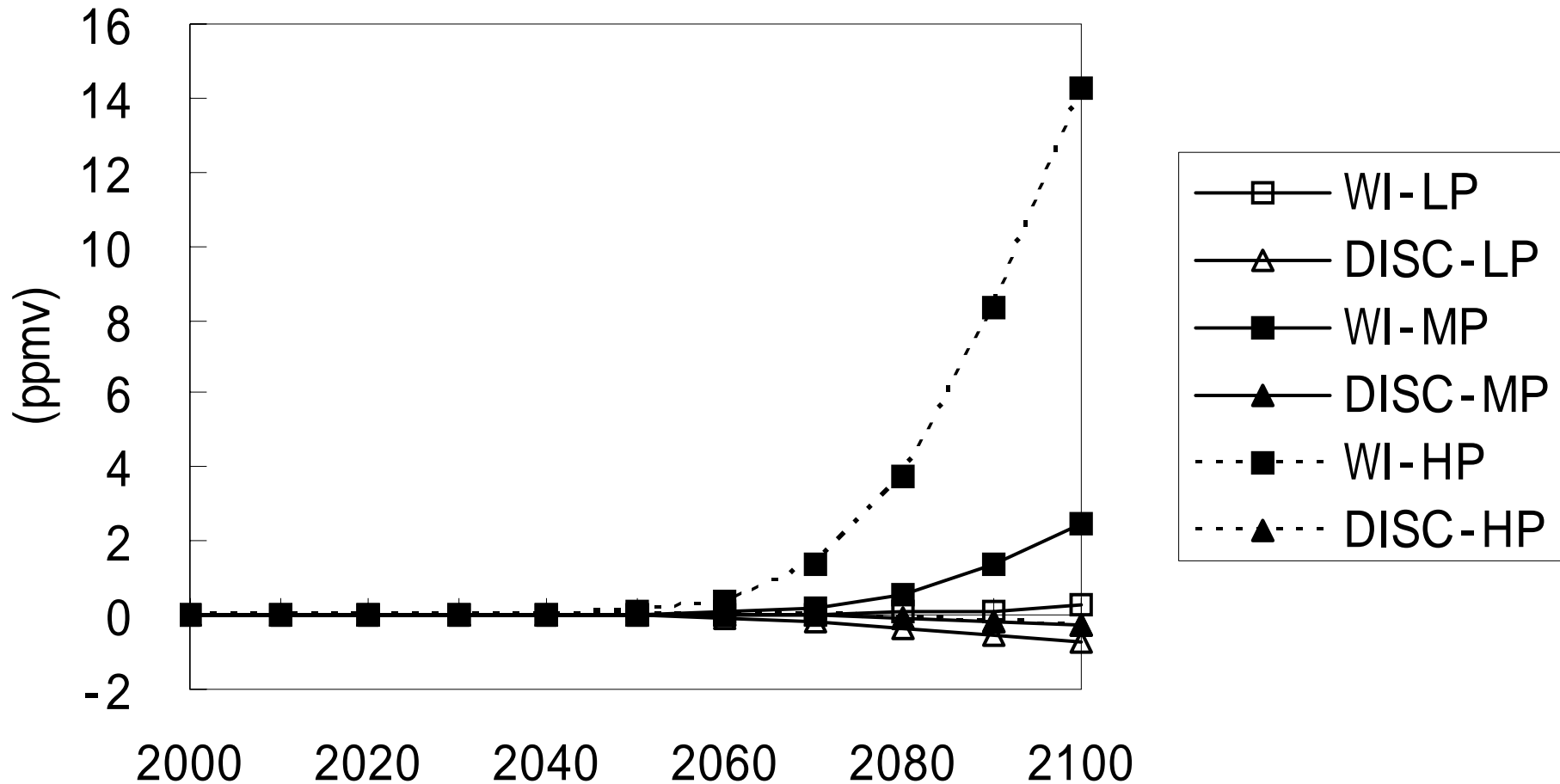
*** CO2 leakage of WI-HP and WI-MP is not negligible.**

CO2 Leakage from Aquifer and ECBM



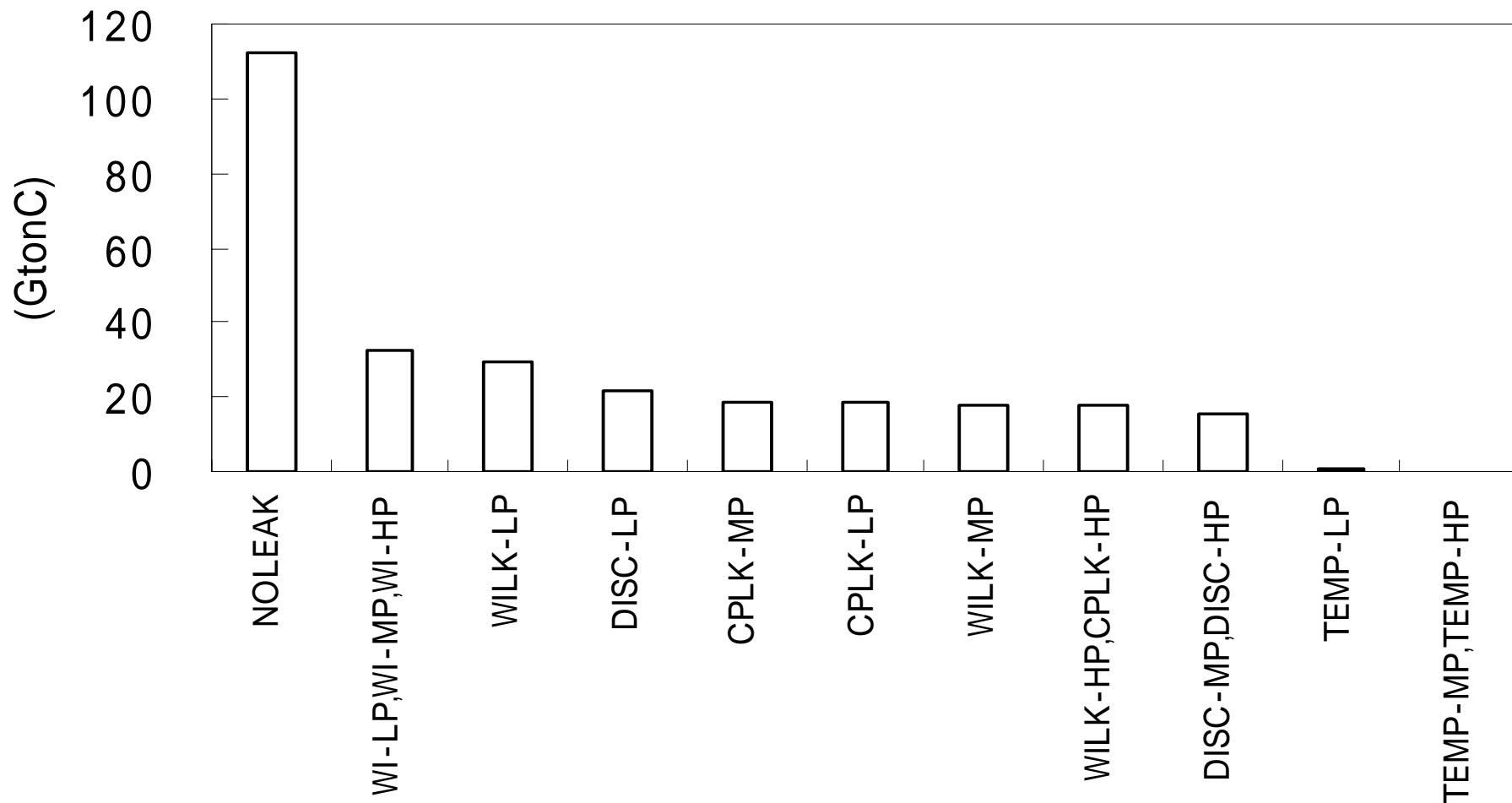
* The emission difference affects atmospheric CO2 concentration.

CO2 concentration difference vs NOLEAK



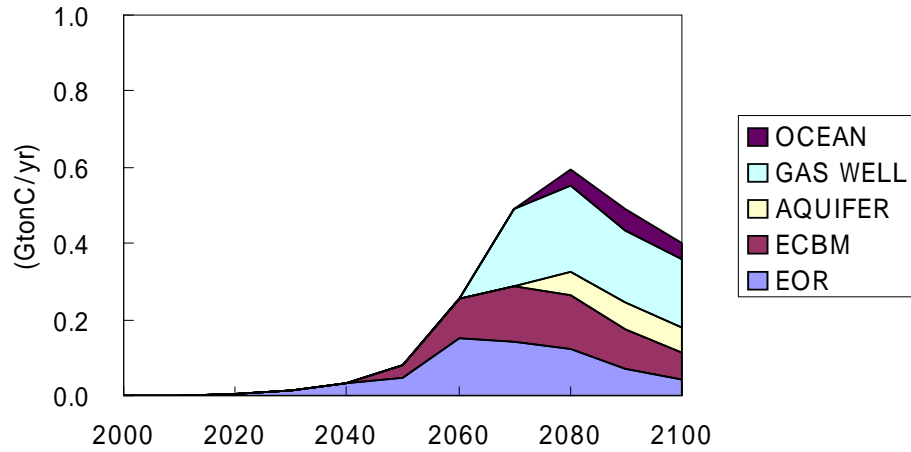
* Temporary credit (TEMP) eliminates CCS.

Global Cumulative Carbon Sequestered in 2100

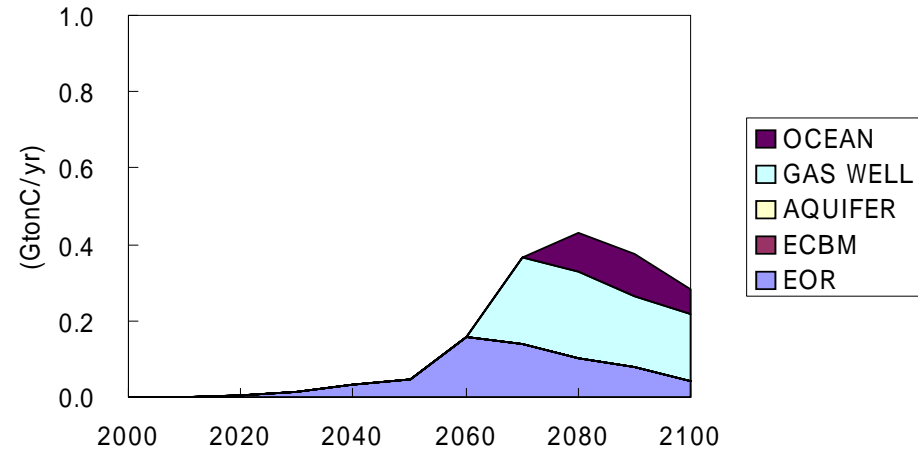


* Permeability changes CCS portfolio. (Saline aquifer and ECBM are decreasing).

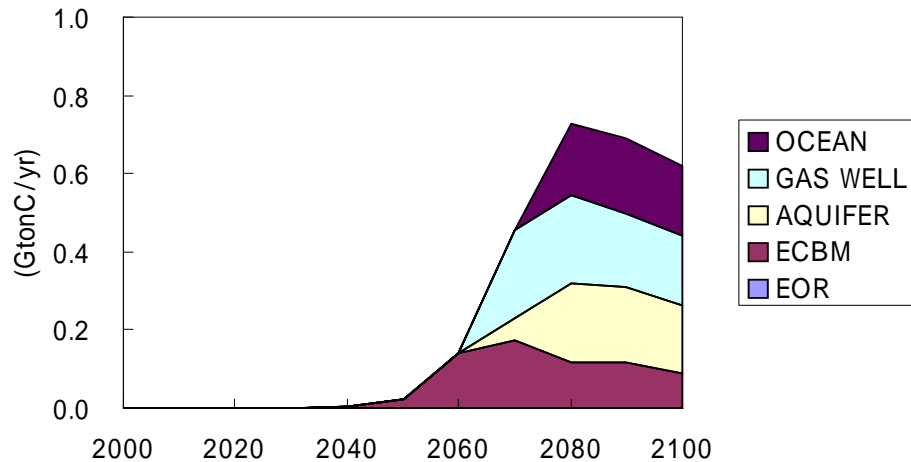
CARBON SEQUESTED (DISC-LP)



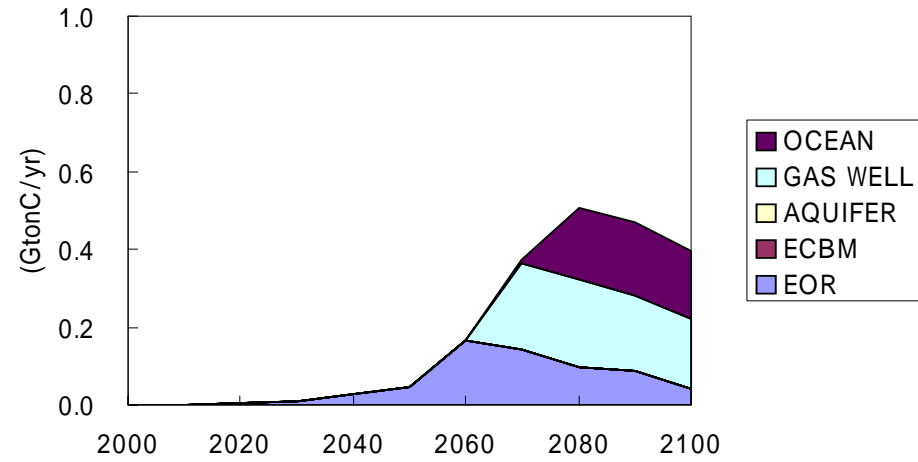
CARBON SEQUESTED (DISC-MP)



CARBON SEQUESTED (WILK-LP)

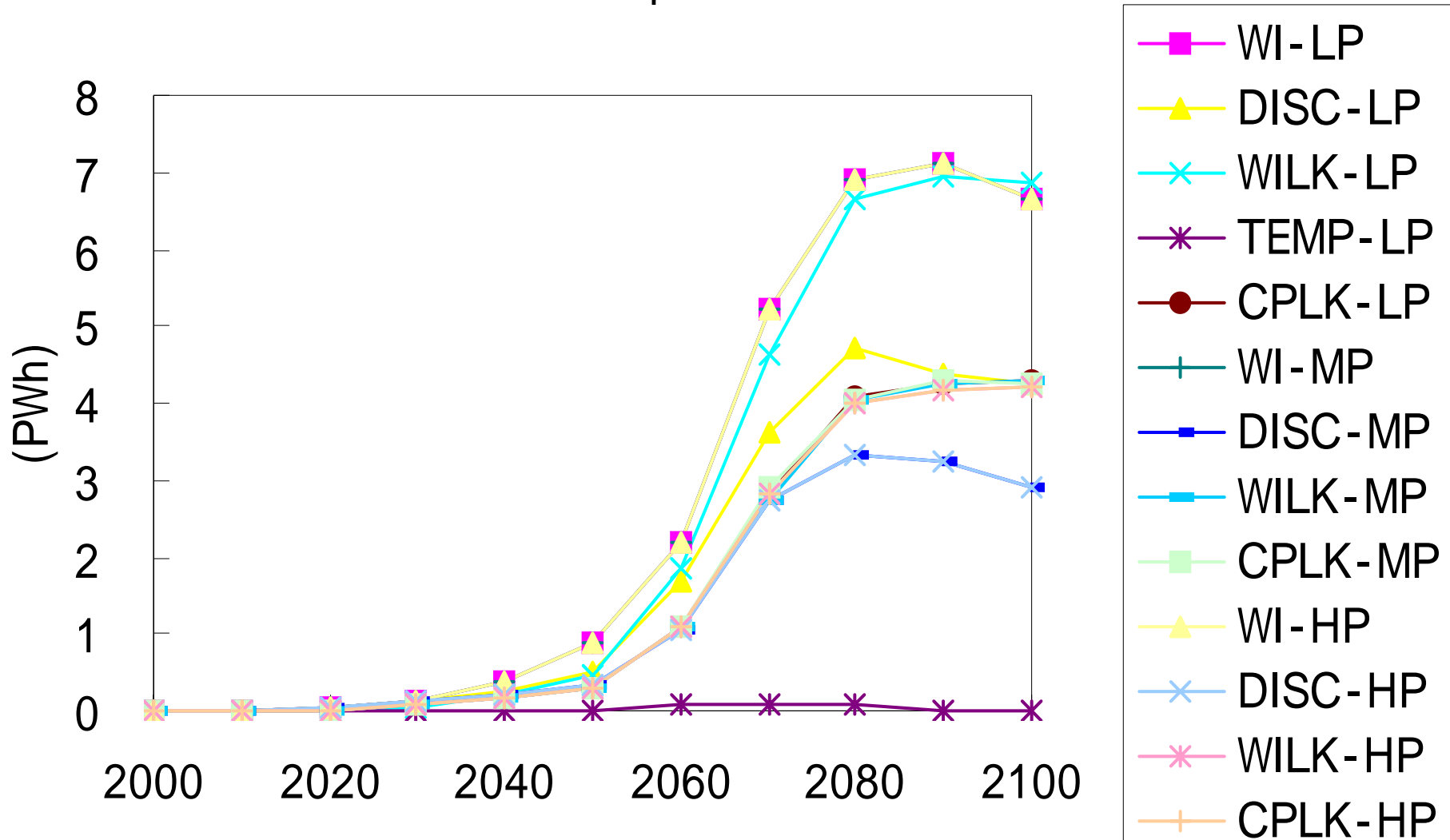


CARBON SEQUESTED (WILK-MP)



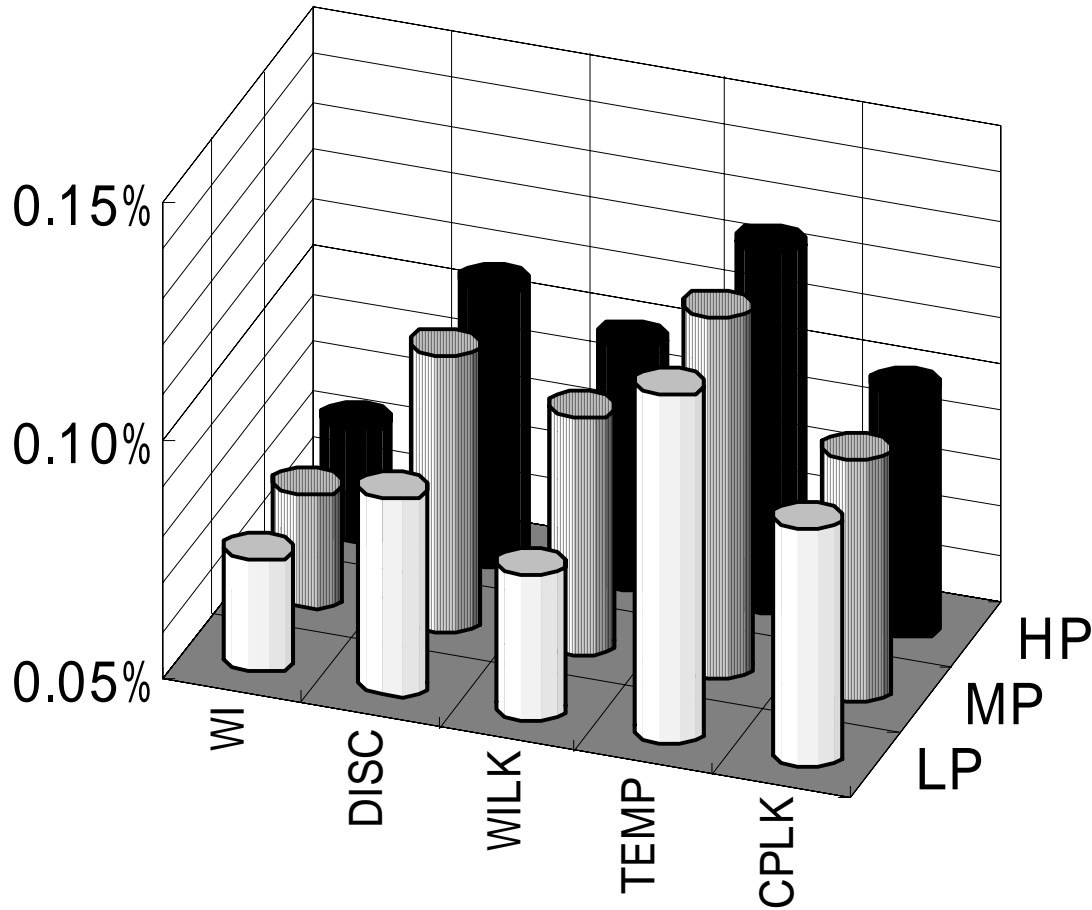
*** Carbon capture generation will penetrate into power market.**

Carbon Capture Generation

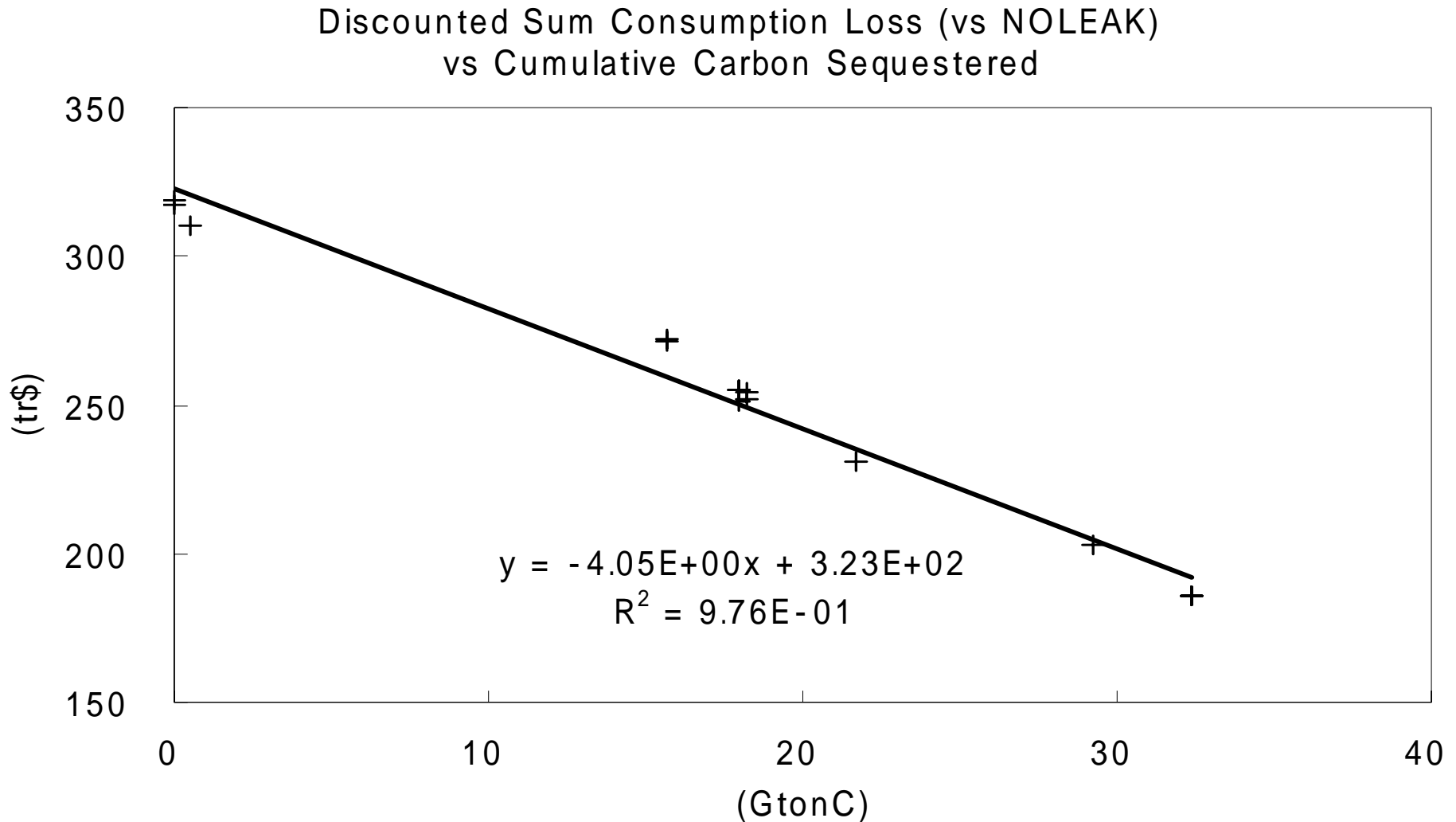


* Economic loss of the leakage and tight rule is not small.

Discounted Sum of Global Consumption Loss in 2100
(vs NOLEAK)



*** Approximately linear relationship is observed between cum. economic loss vs cum. carbon storage.**



[4] Summary and Conclusion

Summary

- * Aquifer storage is dominant CCS option in NOLEAK case because of its storage potential and cost. Assumption of leakage from CO2 storage site would diversifies storage options.
- * (TEMP-MP, TEMP-HP)
Combination of 'Temporary' CCS credit scheme design and high permeability anticipation will result the shift to non-CCS mitigation options.

Summary (cont.)

* (WI-cases)

If CCS leakage is not counted, net CO₂ emissions will exceed CO₂ AAU (Assigned Amount Unit), especially in high leakage rate case. This possibility leads to the violation of CO₂ concentration stabilization target.

* Among fossil fuel generations with CO₂ capture, IGCC and natural gas are selected based on energy and carbon economics.

Summary (cont.)

- * Economic effects by CCS leakage will depend on leakage rate and accounting rules. 'Temporary' scheme virtually denies economic value of CCS.

Conclusion

CCS : various kinds of barriers

*** Economics**

*** Legal Infrastructure**

(Accounting Rule, Guideline, Legal System)

*** Public Outreach, etc.**

**Analysis on
Economics and Accounting Rule**

Accounting rule and leakage anticipation range will change CCS activities.

e.g. Temporary CCS credit conflicts with economics.