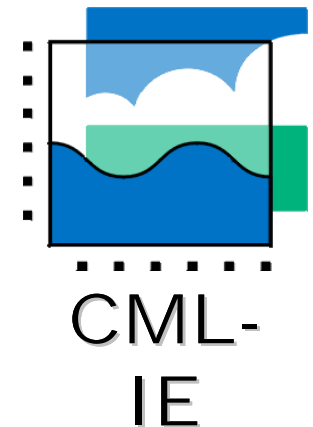


**A CARBON DEPOSIT SYSTEM FOR GLOBAL CLIMATE POLICY**  
**Changing the global carbon metabolism,**  
**with a quantified application to the EU going alone**

**Gjalt Huppes,**  
**CML, Department Industrial Ecology**  
**Leiden University**

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# 1. Decarbonizing = Dematerialization:

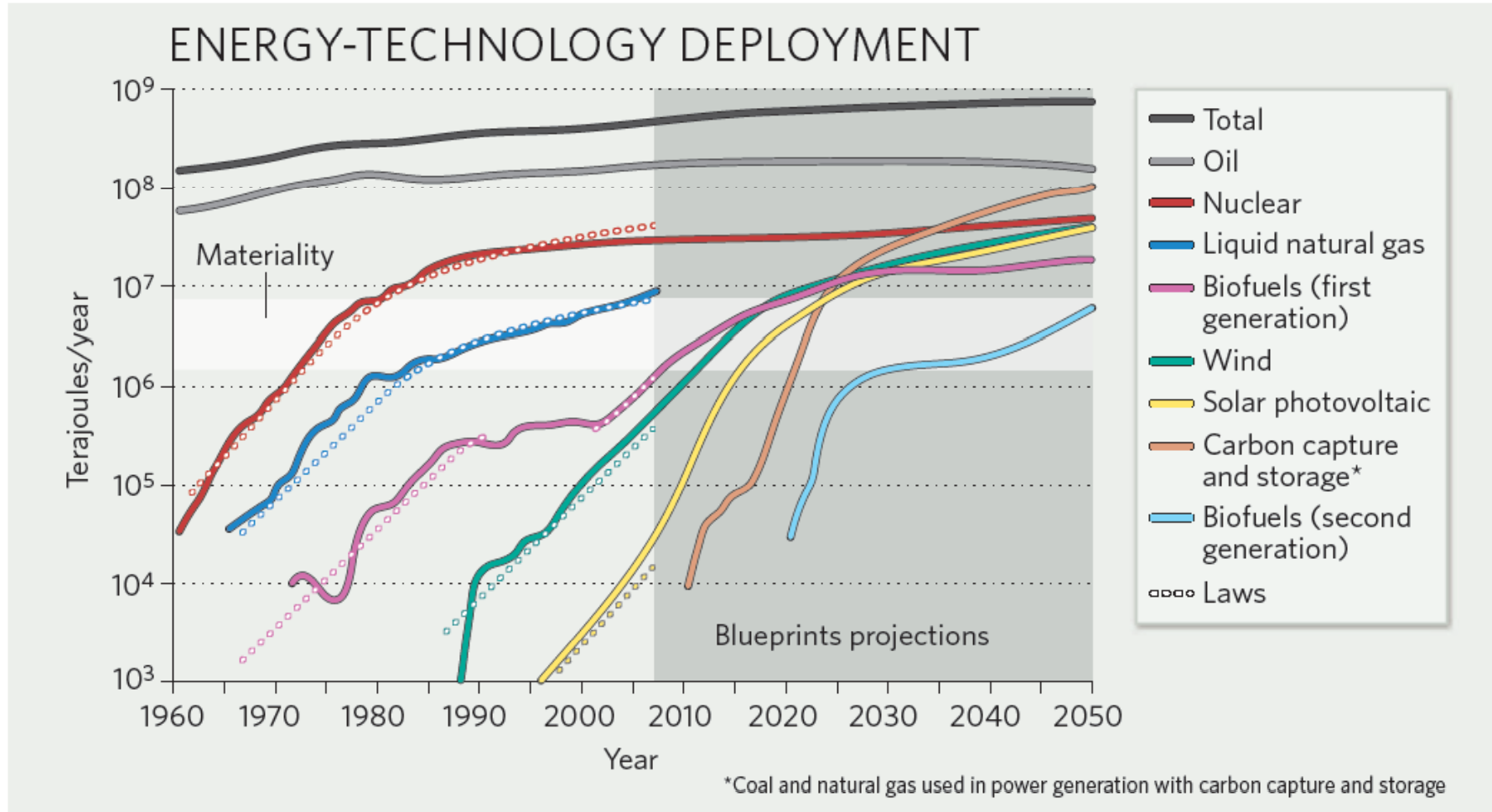
A Post-Kyoto longer term view

1. ***Material Flow Accounting*** as the basis for ***indirect measurement of CO<sub>2</sub> emissions***
2. ***Carbon by far the largest materials / resource flow: 8150 Mt Carbon (= 30000 Mt CO<sub>2</sub>)***
3. Global implementability of carbon pricing?  
***Emission Tax, as a Carbon Deposit System***
4. ***Realism:*** Some countries will not join  
***post-Kyoto++ Border problems to be solved***

# Renewables grow fast, but from a small base: Fossil remains dominant, unless .....

(Kramer & Haigh, Nature)

HISTORIC DATA: OECD/IEA/PREDICTIONS: SHELL INTERNATIONAL



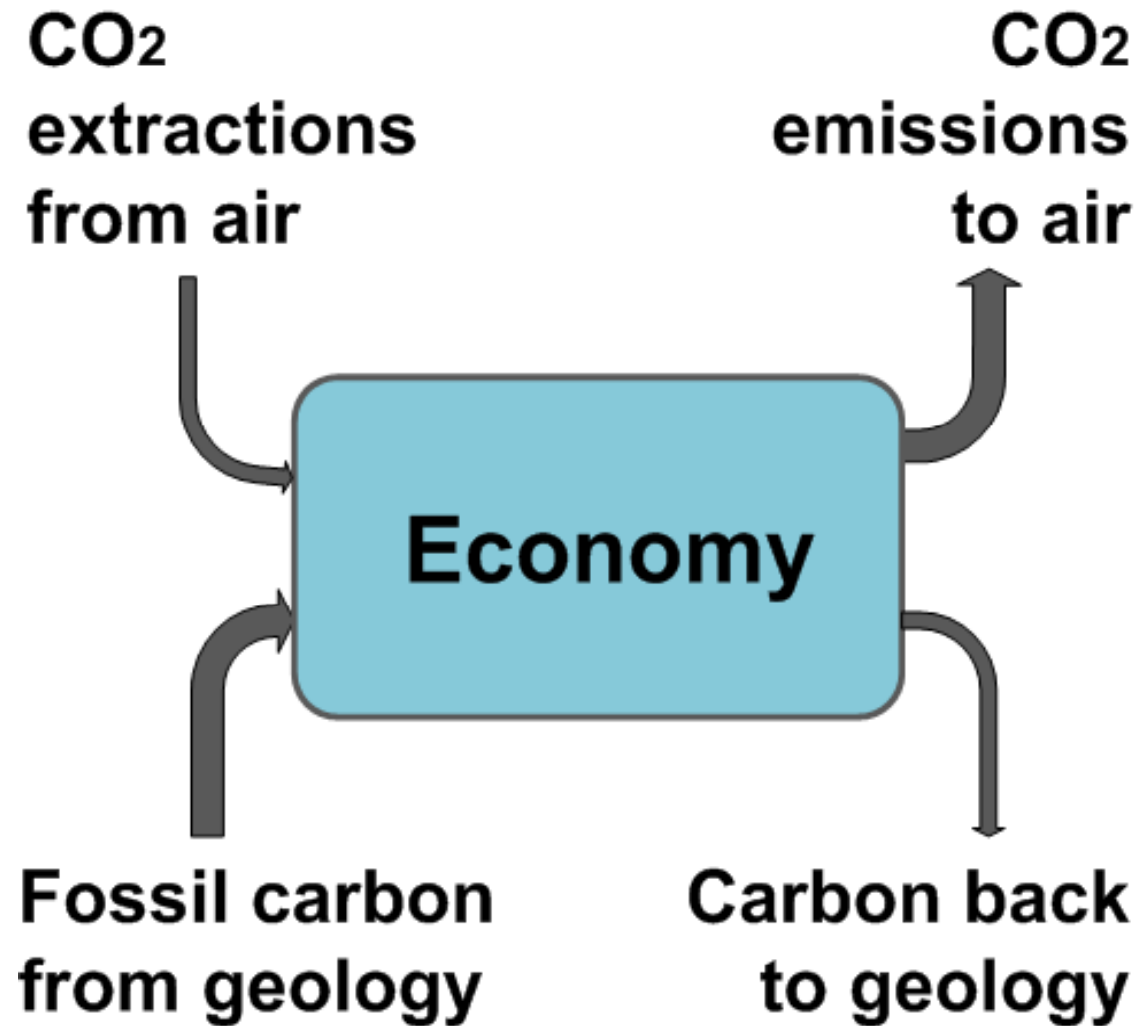
Bottlenecks for energy efficiency & non-carbon energy:

## ***other materials resources required***

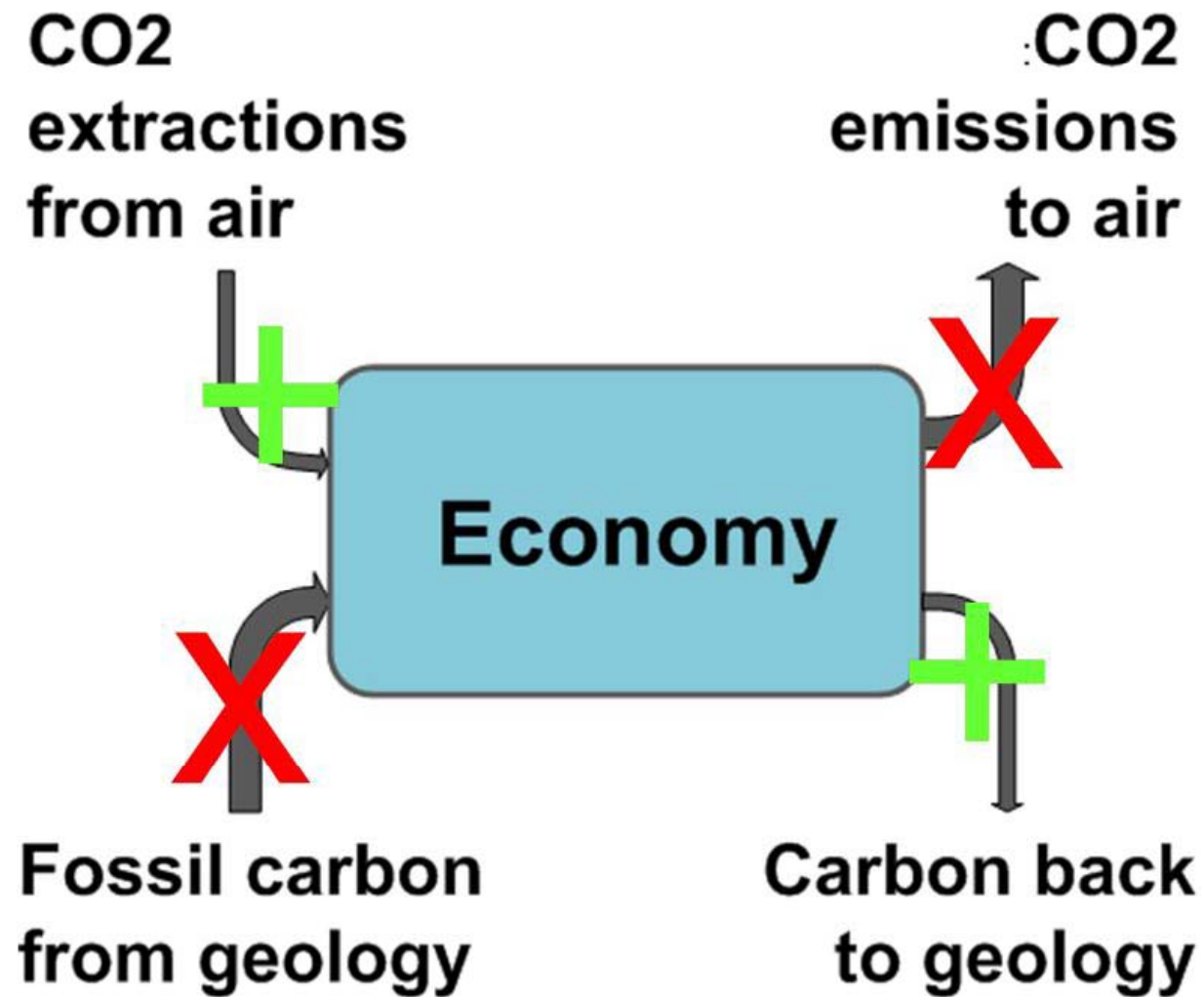
Forgetting all others you don't know

- Higher volume of bulk resources: Iron; Copper; Zinc; Phosphates; etc. Well possible, but **Rematerialisation: more and more varied composition**  
Nickel +500%; Copper +7000%; etc.
- Rare metals and (not so rare) rare earthes: serious bottleneck for moving to low carbon society:  
Neodymium; lithium, cobalt, lanthanum, palladium, tellurium, indium, germanium, gallium, rhenium, etc. Source: Kleijn et al (2011) Metal requirements of low-carbon power generation. *Energy* 36(9): 5640-5648
- Bottlenecks for materials supply:
  - up-chain speed of investment; money and procedures: **All**
  - political scarcity (neodymium example: uncertainty) **Rares**
  - real scarcity (palladium, etc.) **Very rares**

## 2. Material Flow Accounting: Carbon



## 2. (cntd) MFA-defined climate goals



### 3. DeCarbonizing: by Cap-and-Trade or Emission Tax?

- Proponents of emission taxes, diverse:
  - Nordhaus; Joel; Poterba; Pearce; Tol; Ackerman; Hansen; Aldy/Barrett/Stavins; Jeffrey Sachs; Roger Pielke; Komanoff (Carbon Tax Centre); Yan Dong;  
...

- ***Emission tax*** investigated here  
Core question: ***how to implement*** in a world where direct emission measurement is the exception?



***as Carbon Deposit System***

## 4. Requirements on **effective** low-carbon policy: **efficient, feasible, equitable**

- Economic optimality: efficient
- Feasibility
  - Physical
  - Administrative & Legal
  - Political
- Distributional justice

Overall requirement:

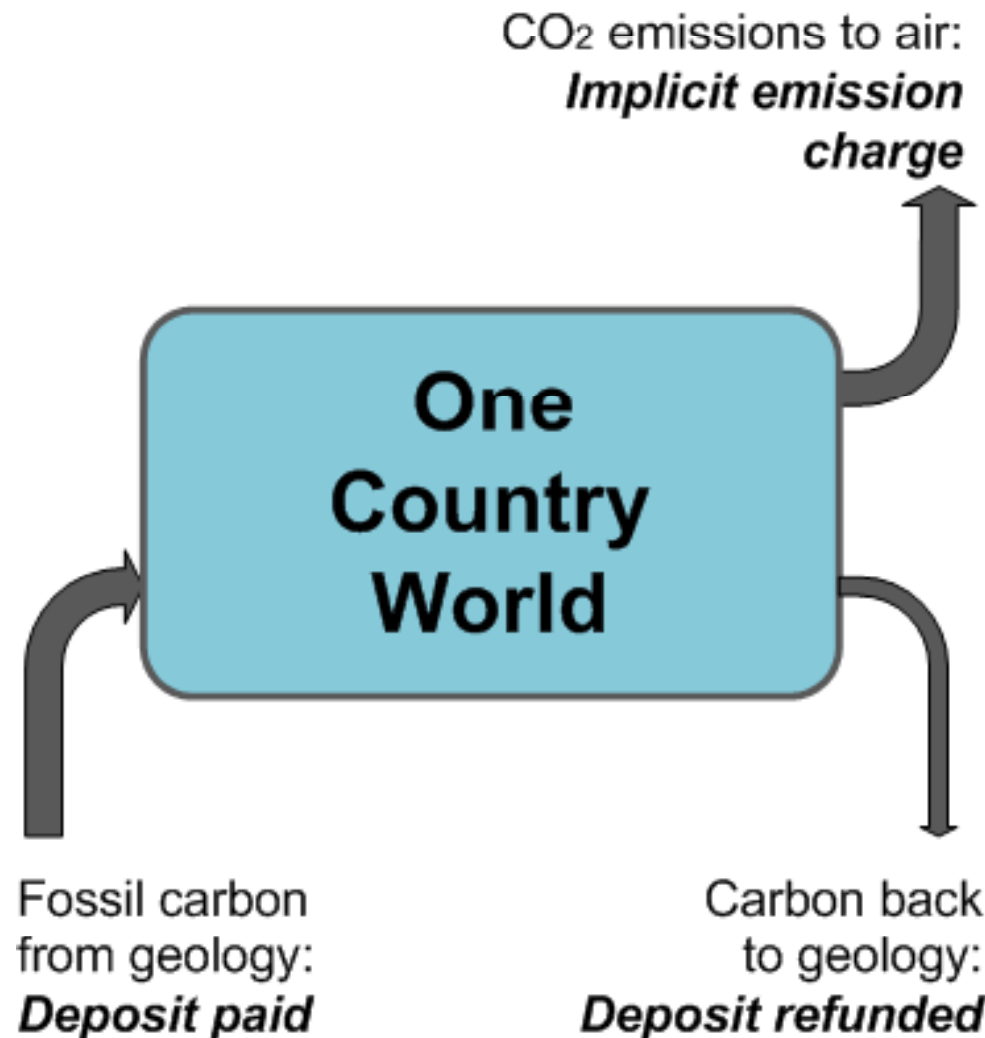
*equal treatment, of any emission, anywhere:*

***All countries to join the same system (not)***

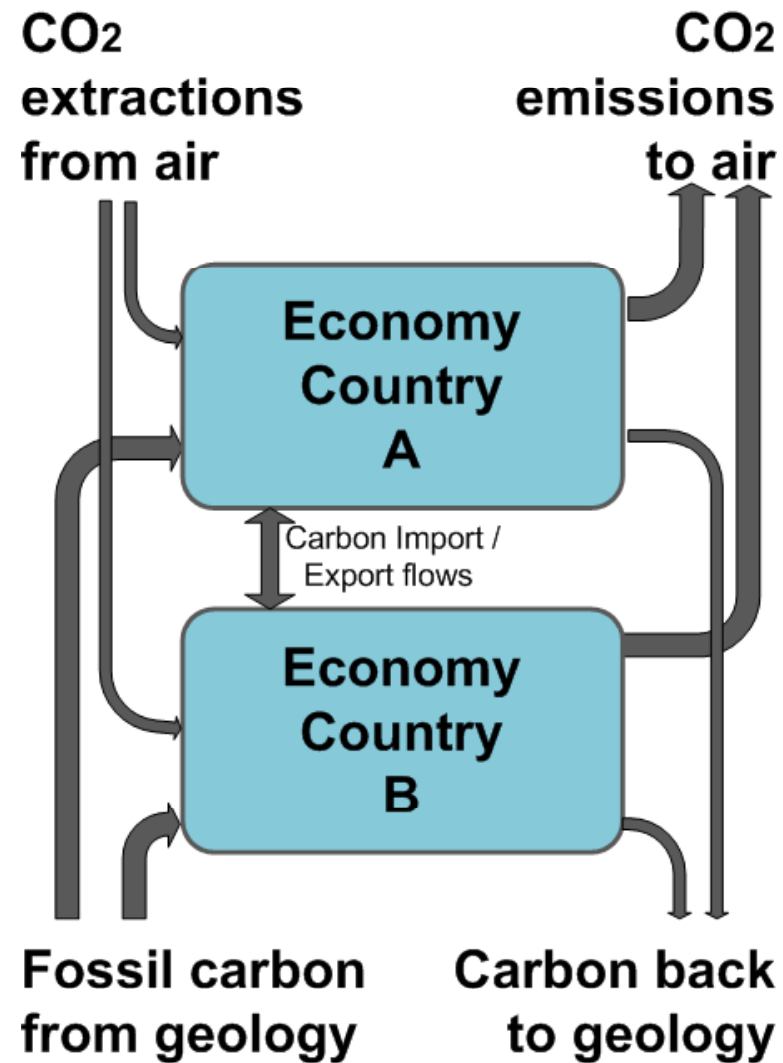
***Substantial additional policies required***



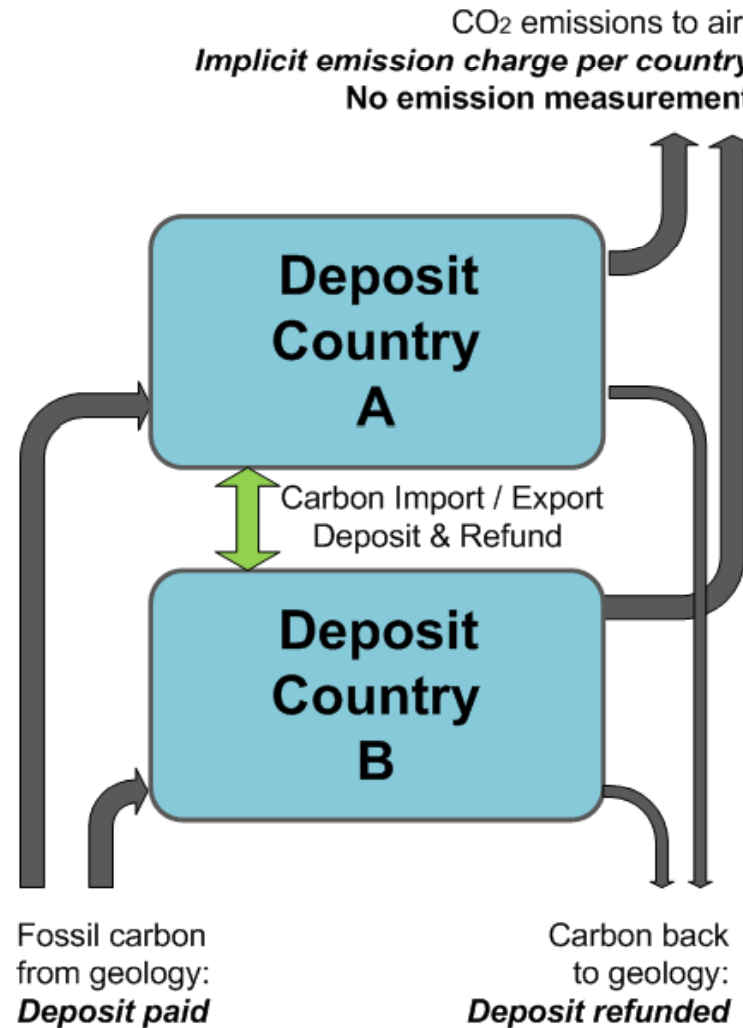
# 6. Global Carbon Deposit in a One-Country World



# 7a. Carbon metabolism 2-Countries



# 7b. Global Carbon Deposit in a Two-Countries world



# Payments in multi-country CD system

↑ Carbon Deposit payment at extraction:  
Oil; gas; coal; CO<sub>2</sub>; ultra heavy oils; shales; etc.

↓ Carbon Deposit refund upon *back to geology*  
CCS; [artificial diamonds production]; ???

↕ Green flows between deposit countries: no market distortion  
***Only statistical measurement for sharing***

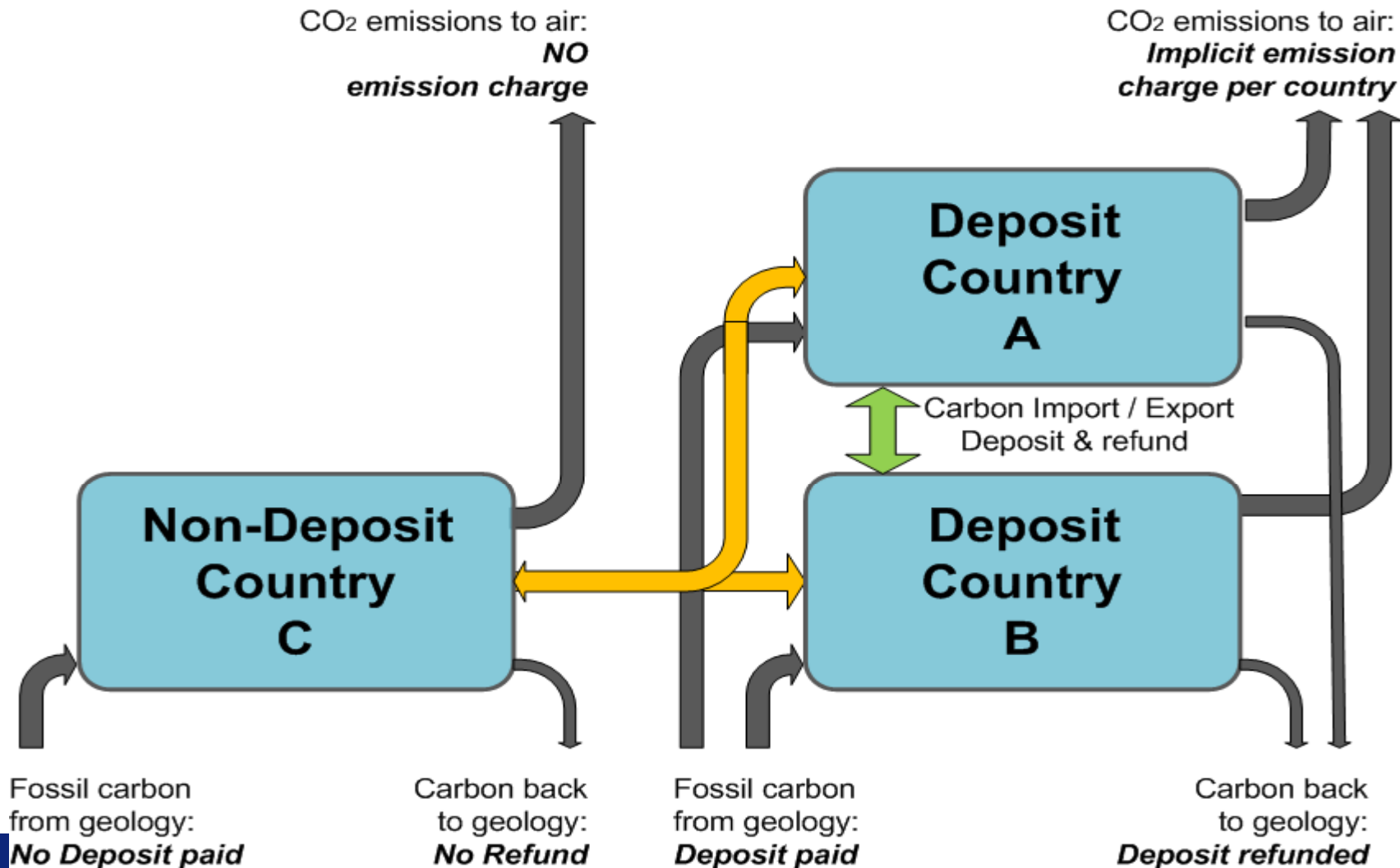
***proceeds between governments***

Net proceeds per country

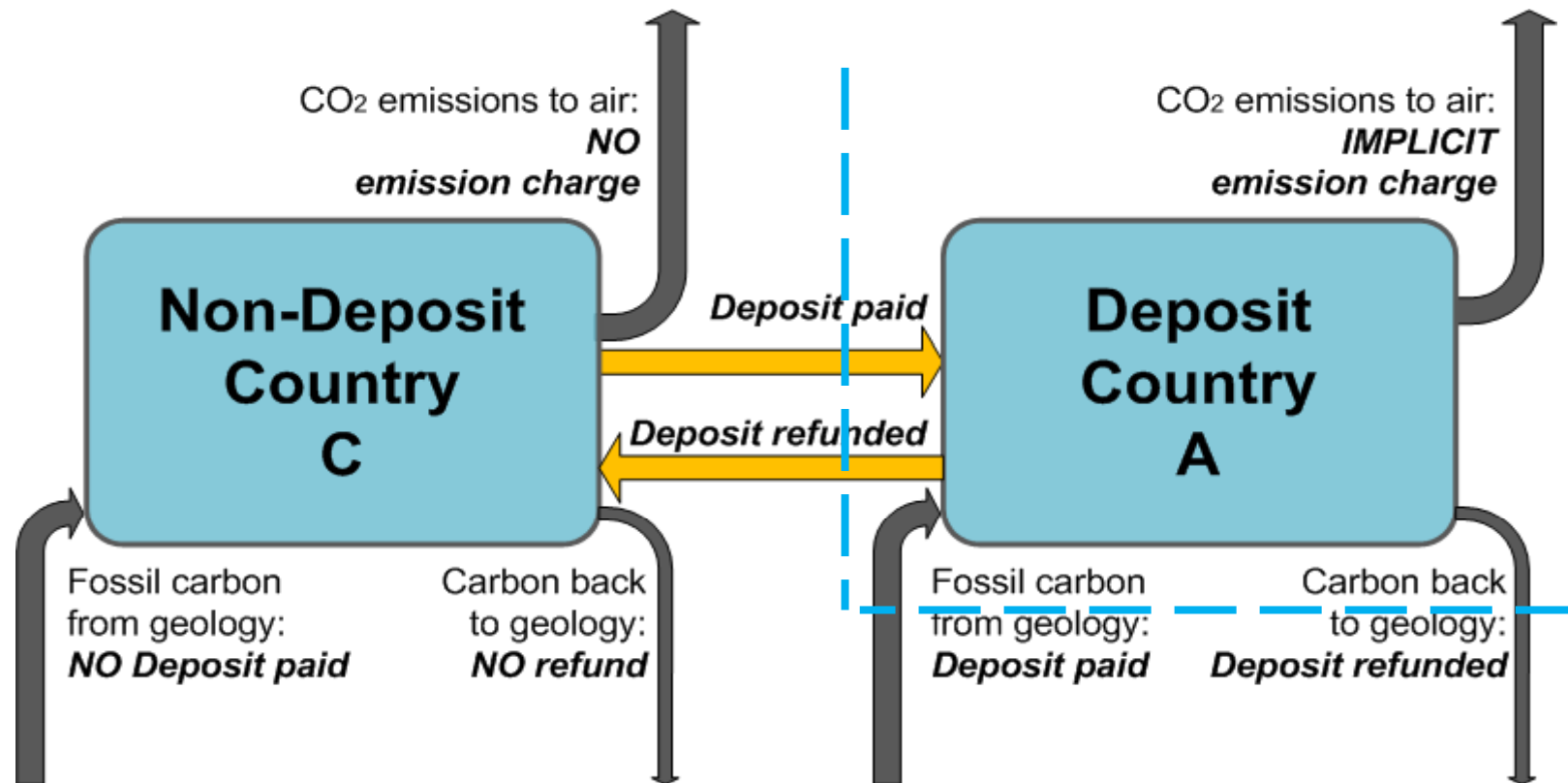
= CO<sub>2</sub> emissions per country x deposit level

- ***Extraction from air*** (by photosynthesis) can be ***left out*** of deposit system: price differential created by deposit system on fossil
- Refund upon Carbon Storage ***also for biogenic CO<sub>2</sub>!***

# 8. Carbon Deposit in a 3-Countries World, one non-participating Country C



# 8. Carbon Deposit in a 2-Countries World, one non-participating Country C



# 8 Deposit on Products flowing between Deposit & Non-Deposit Countries

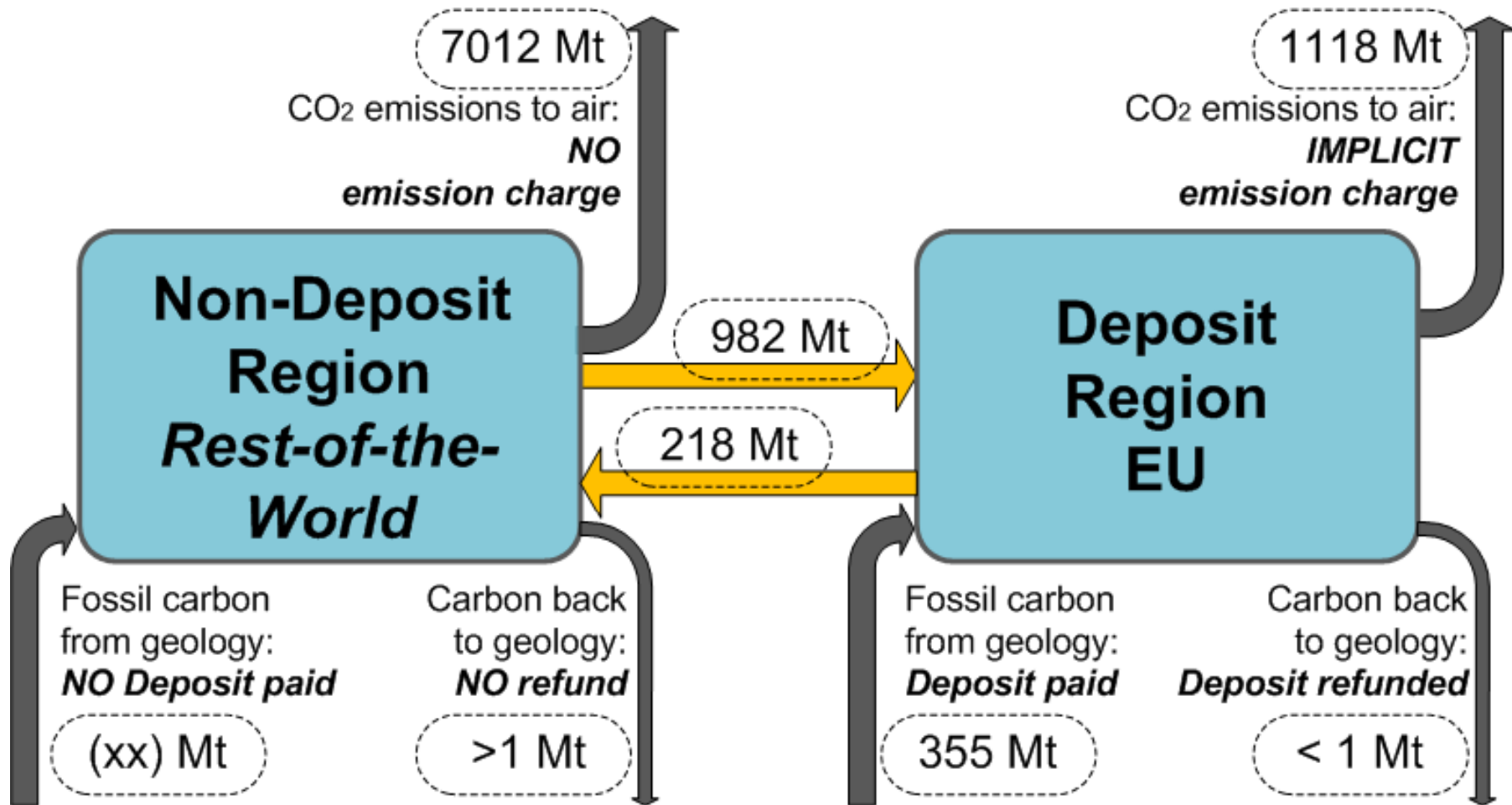
 imports to deposit Country A from non-deposit Country C  
***Country A levies deposit upon import, based on carbon content plus embodied emissions***

 exports from deposit Country A to non-deposit Country C  
***Country A refunds deposit upon export, based on carbon content plus embodied emissions***

***Border corrections, specific per product, (to be made) in line with WTO, to avoid leaking and unwarranted competitive advantage. Cumbersome in any system***

# 9a. Carbon Deposit in the EU *going alone*: Carbon flows

Carbon Flows between EU and Rest-of-the-World and Geology, in Million tons (Mt, 2002)



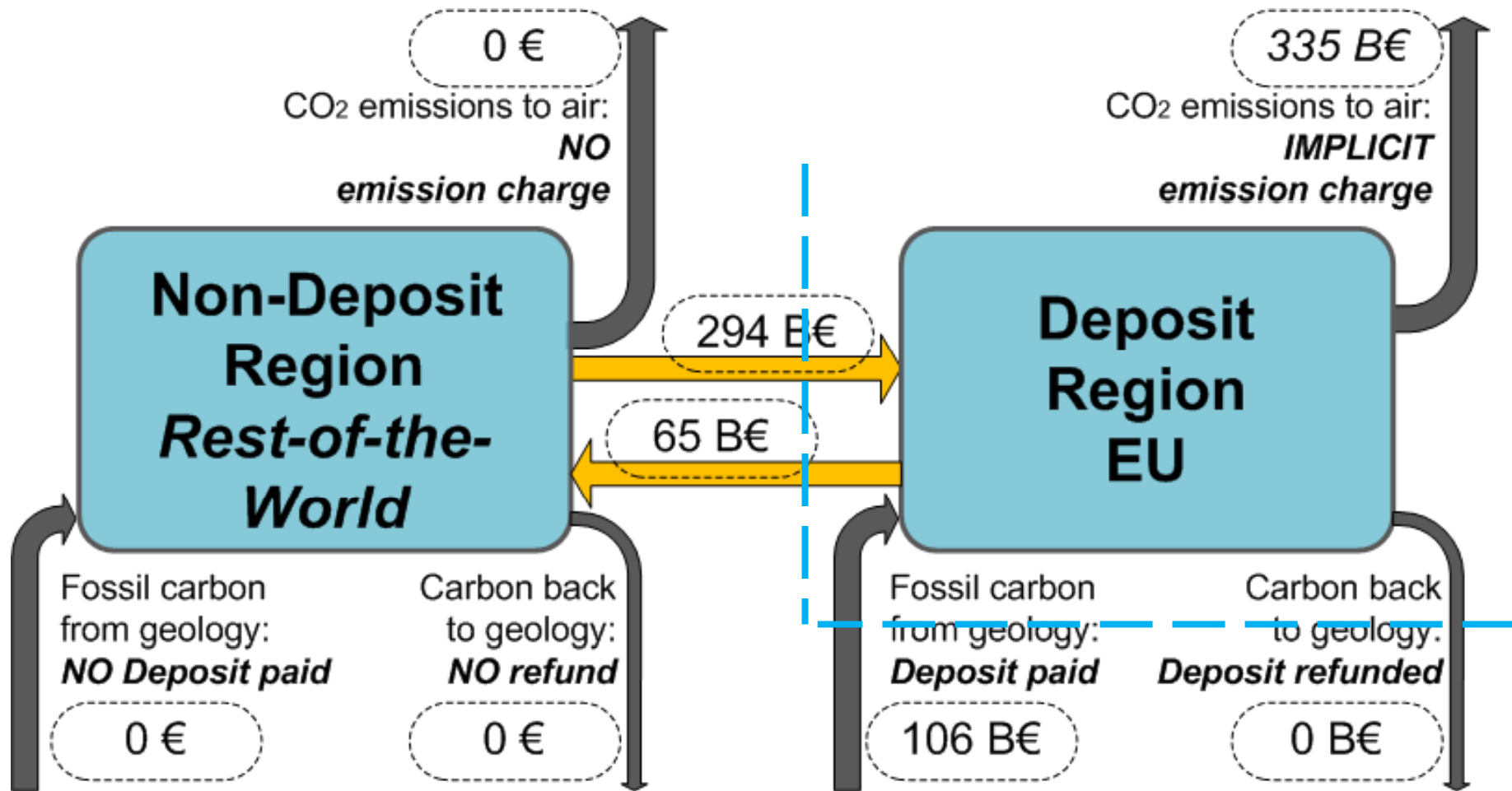
Flows measured as *embodied carbon*

Flows measured as *carbon*



# 9b. Carbon Deposit in the EU *going alone*: Money Flows

Money Flows to and from EU Governments,  
in Billion Euro (B€), 300\$ (230 €) per ton C



Flows measured as **embodied carbon**

Flows measured as **carbon**

# 9. Quantities & Markets

- Carbon and \$ flows for 2008
- Stern (2006): 85 \$ per ton CO<sub>2</sub> (not taken as damage)  
= 311 \$ per ton Carbon = ~ 230 € per ton Carbon  
= ~ 200 SDR = [± level Massimo]
- **Two markets** created, EU-deposit and non-EU-non-deposit market, each with a level playing field.
- Consumers pay the real price, ultimately.
- Income transfers compensated with reducing other taxes: ⇒ no relation with level of public outlays.
- **< 2% of national income, limited share in taxing**

# 10. Work to do: Research Agenda

1. Dynamic deposit/tax levels; how high?
2. International deposit alignment in terms of IMF SDRs, at constant prices
3. Relation to WTO
4. Funding of carbon storage
5. Effects on rent incomes
6. Embodied emissions in products: method

# 10. Work to do: Research Agenda

WARNING, key item for research on  
resource/energy efficiency / intensity

Jevons paradox (1862)

*Technological progress that increases the efficiency with which a resource is used, tends to increase (rather than decrease) the rate of consumption of that resource.*

Cost price natural gas in US now 22 \$ / bl oil<sub>equiv</sub>

# 11. Conclusions on Carbon Deposit

1. **CD reduces the administrative burden and private transaction costs**
2. **CD can cover all emissions (ETS now  $\pm 50\%$ ) equally**
3. **CD not open to (inter)national lobbying interventions**
4. **CD does not curtail growth of fast growing countries**
5. **International agreement on {slowly increasing} tax level**
6. **Can create stable expectations on market correction, essential for innovation and investment**