Climate in relation to other policies

The impact of inertia and capital accumulation

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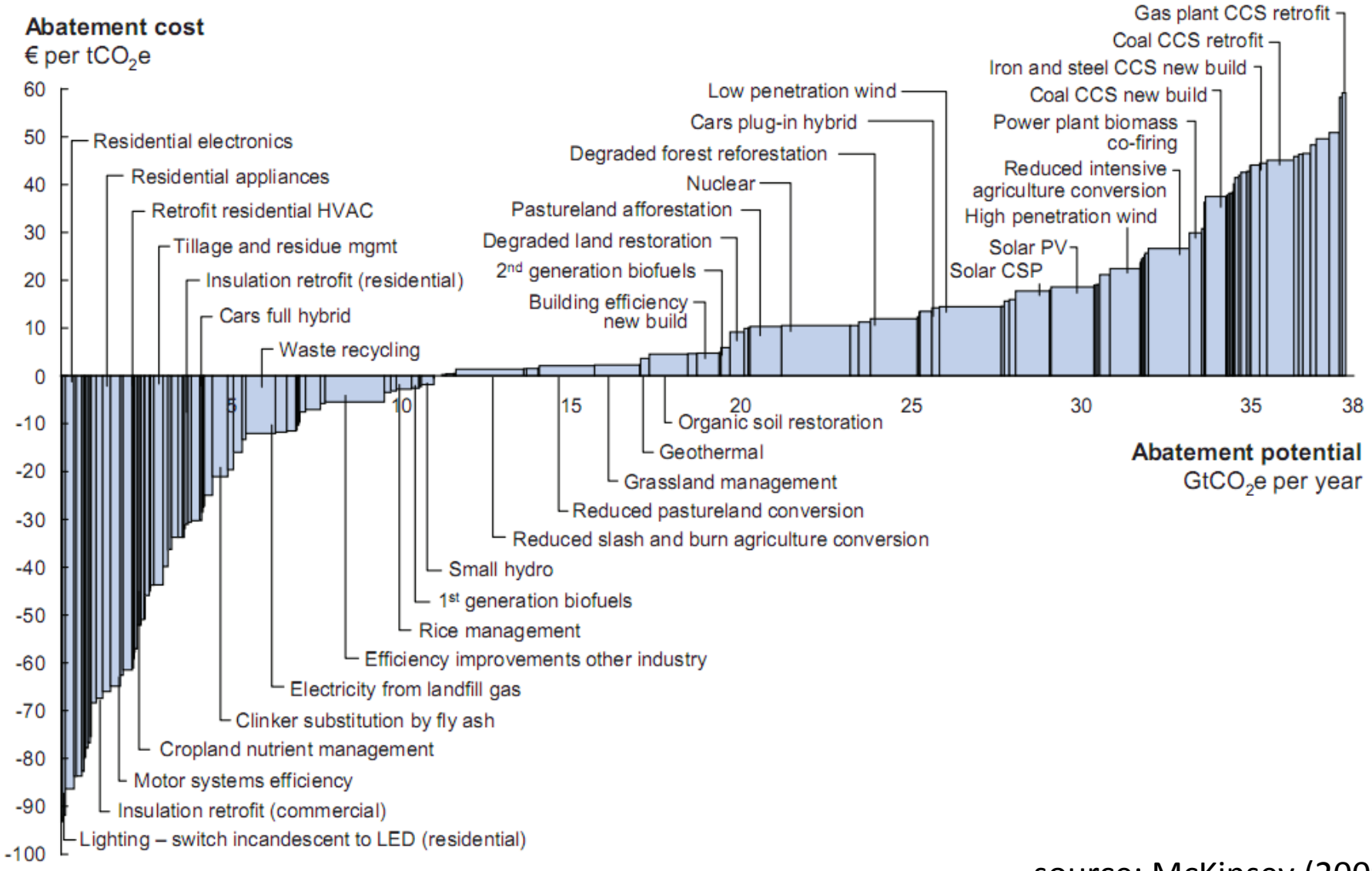
There are two issues

- The world has multiple market and government failures
  - Can environmental policies help correct non-environmental failures? (Assuming they cannot be solved before hand)
  - *Can one instrument help with two objectives?*
- Most countries have implemented multiple (overlapping) policies to mitigate climate change (e.g., EU-ETS + feed-in tariffs)
  - Is a carbon price sufficient, or do we need additional (sector scale) policies? (overlapping policies)
  - *Can one objective requires two instruments?*

MACCs report information on abatement costs and potentials for a set of mitigation activities



source: McKinsey (2009)

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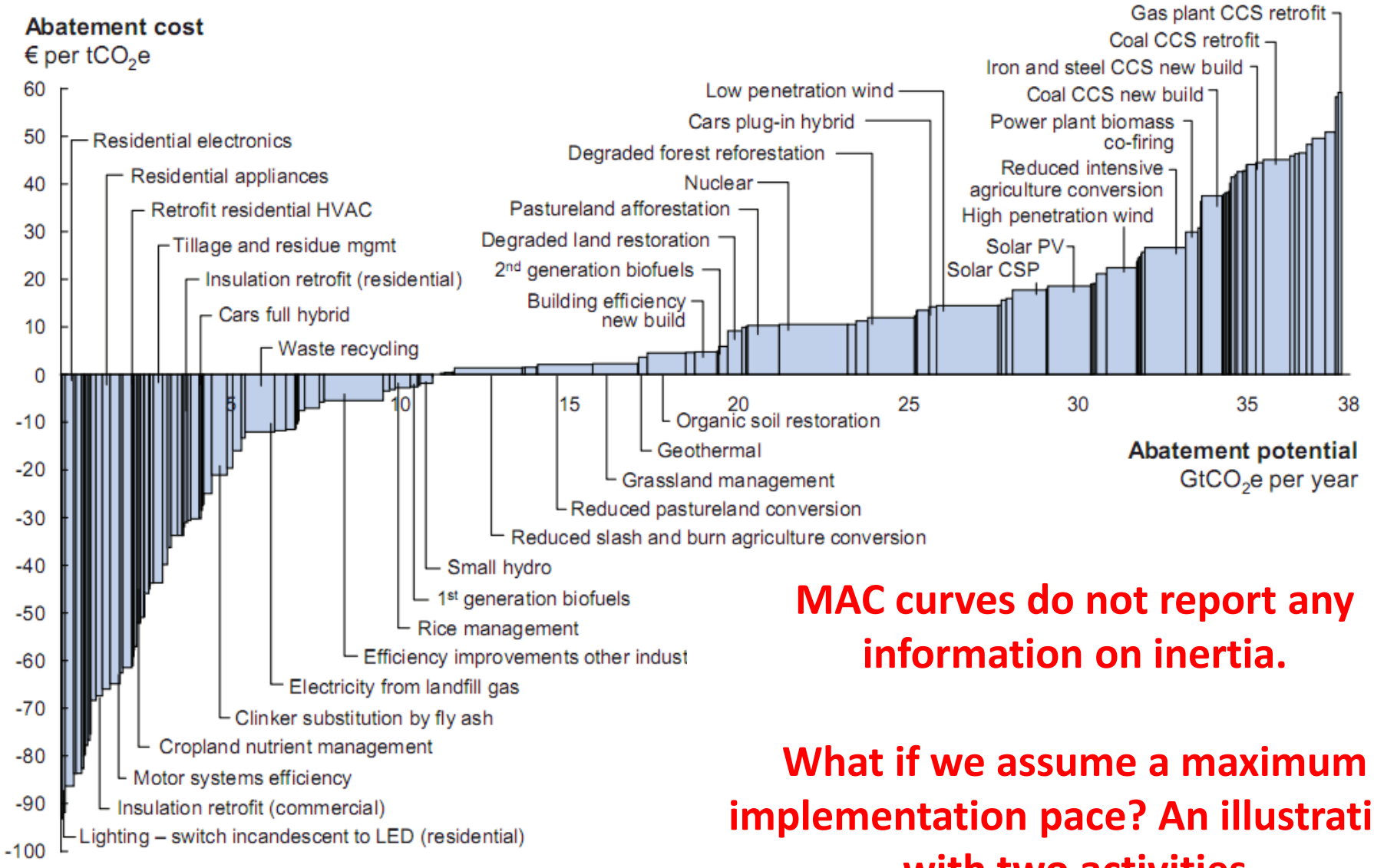
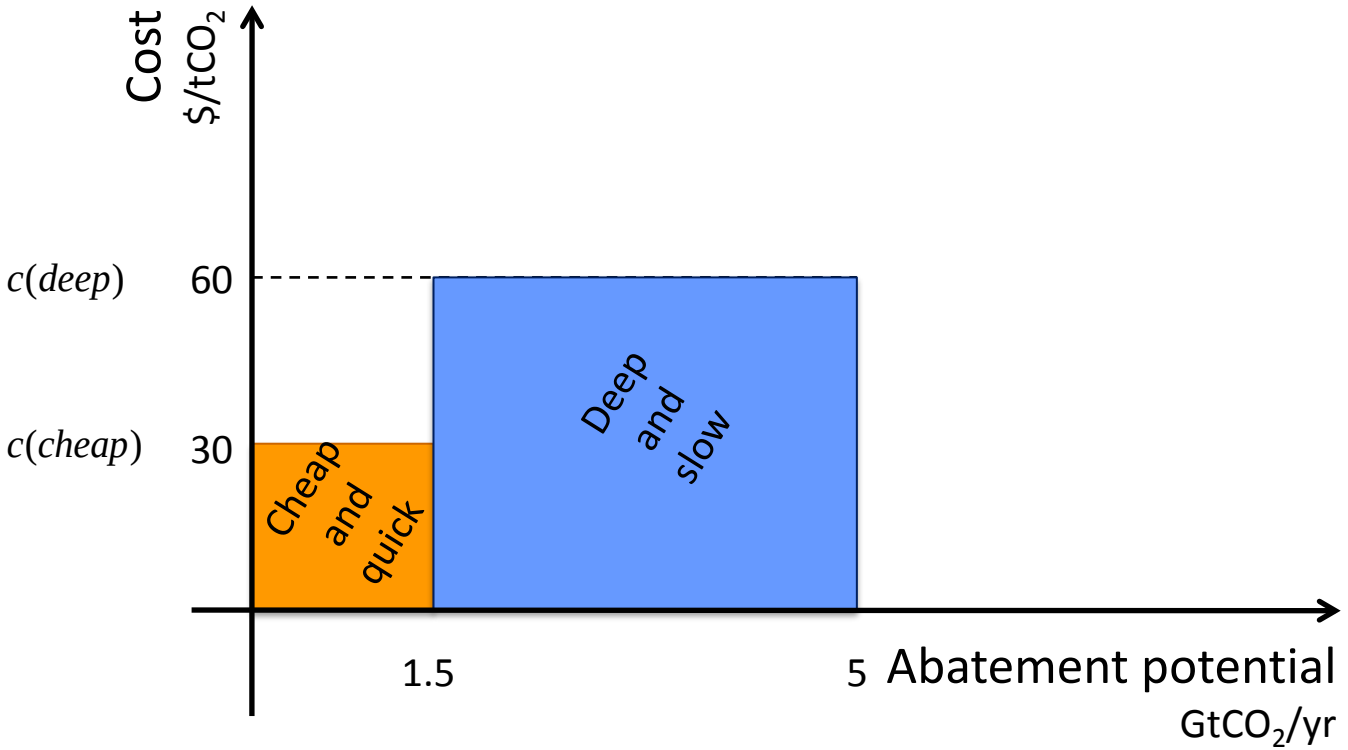


MAC curves do not report any information on inertia.

What if we assume a maximum implementation pace? An illustration with two activities

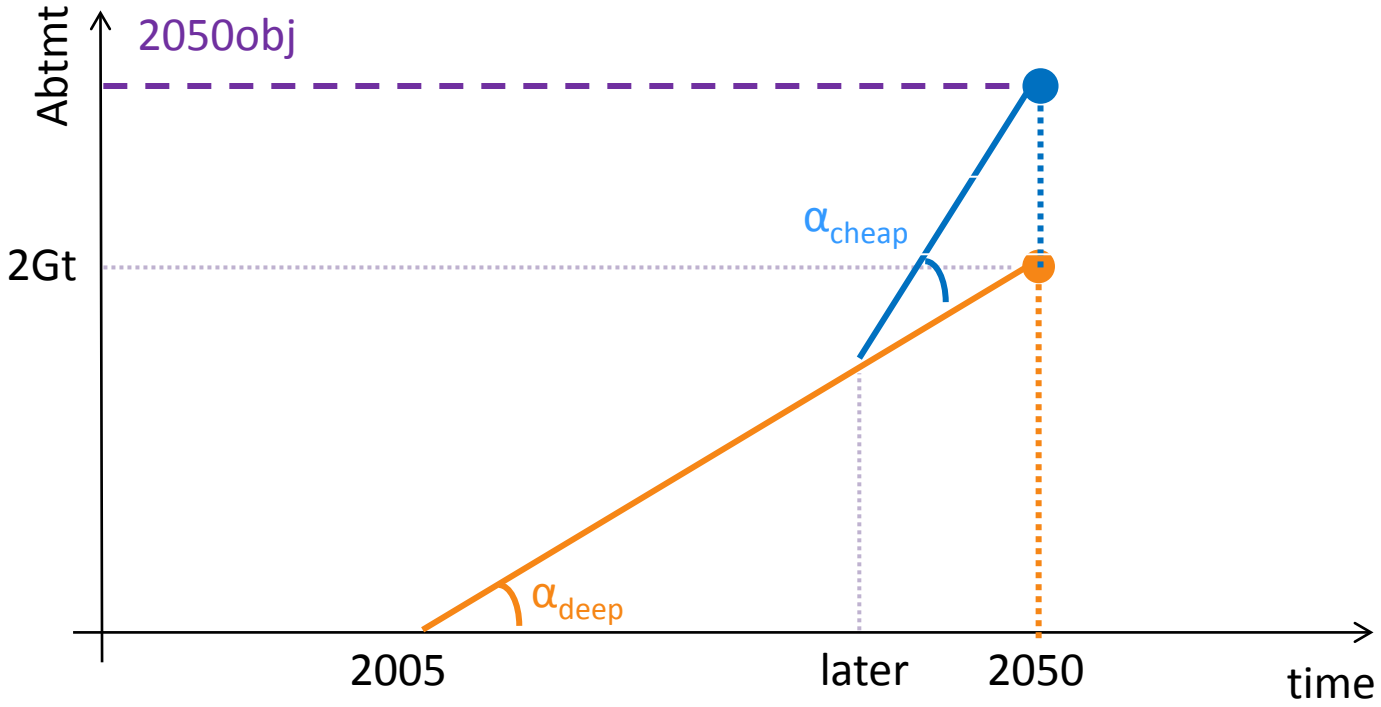
Illustrative MACC with two activities



"Cheap and quick" can be switching from coal to gas

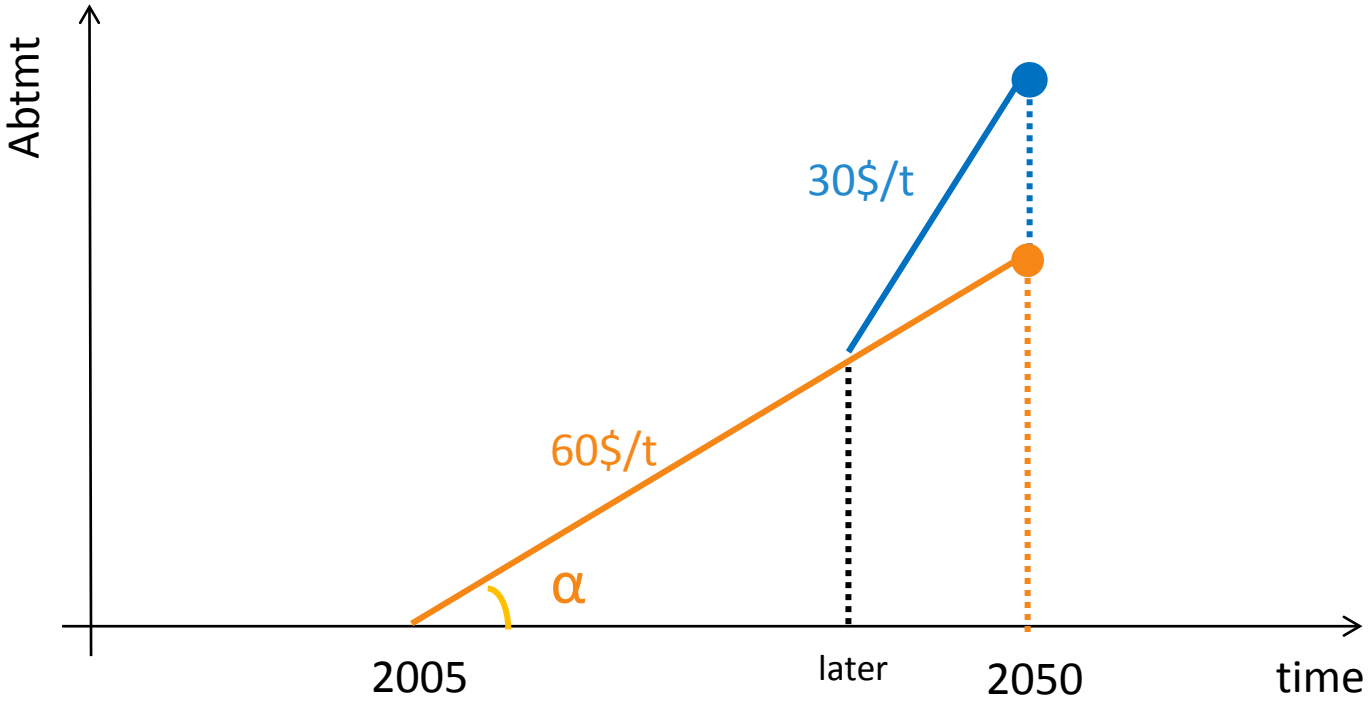
"Deep and slow" can be retrofitting buildings

With an objective in 2050…..



1. If the optimal abatement from building retrofit in 2050 is 2Gt
2. Retrofitting so many buildings takes time – we need to start now
3. Cheaper but faster-to-implement options required in 2050 may enter later

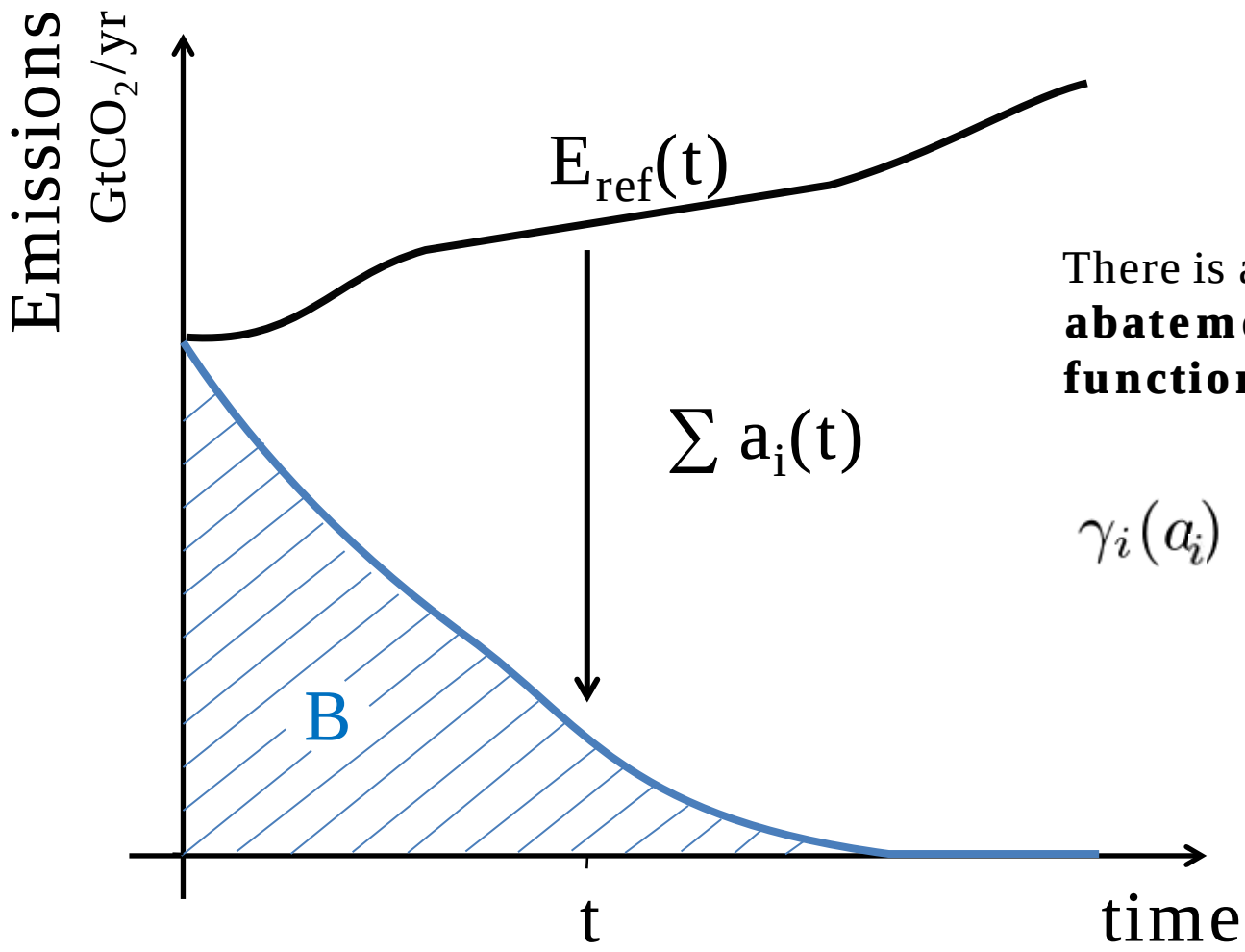
How to decentralize such a strategy?



Is a carbon price sufficient? Or do we need a carbon price for "quick" changes, and additional policies for high-inertia sectors (e.g., urban planning, innovation, building retrofit) ?

An approach based on marginal abatement costs

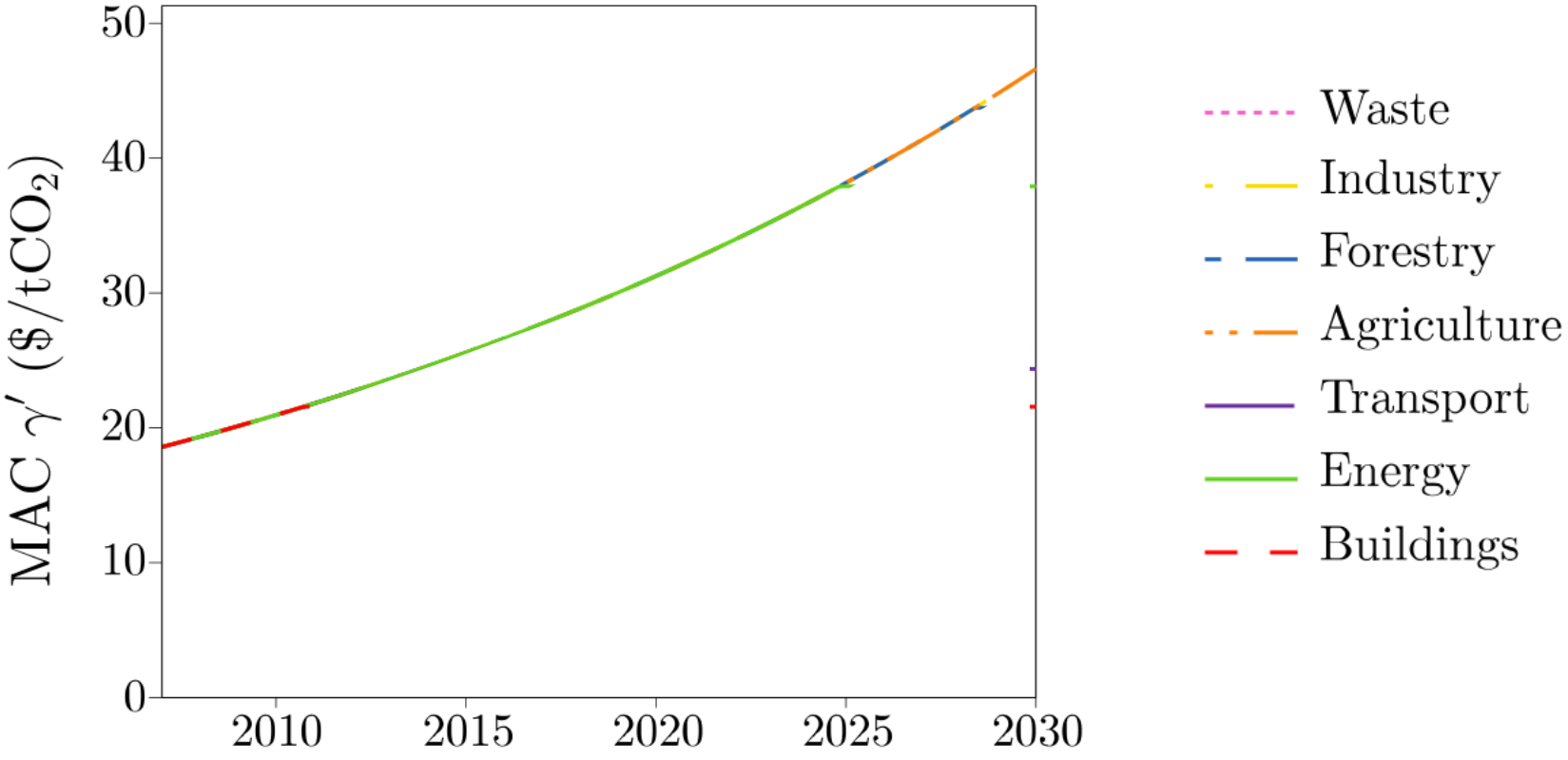
The social planer copes with a carbon budget by choosing, at each point in time, a level of abatement on the marginal cost curve



There is a **convex abatement cost function** in each sector :

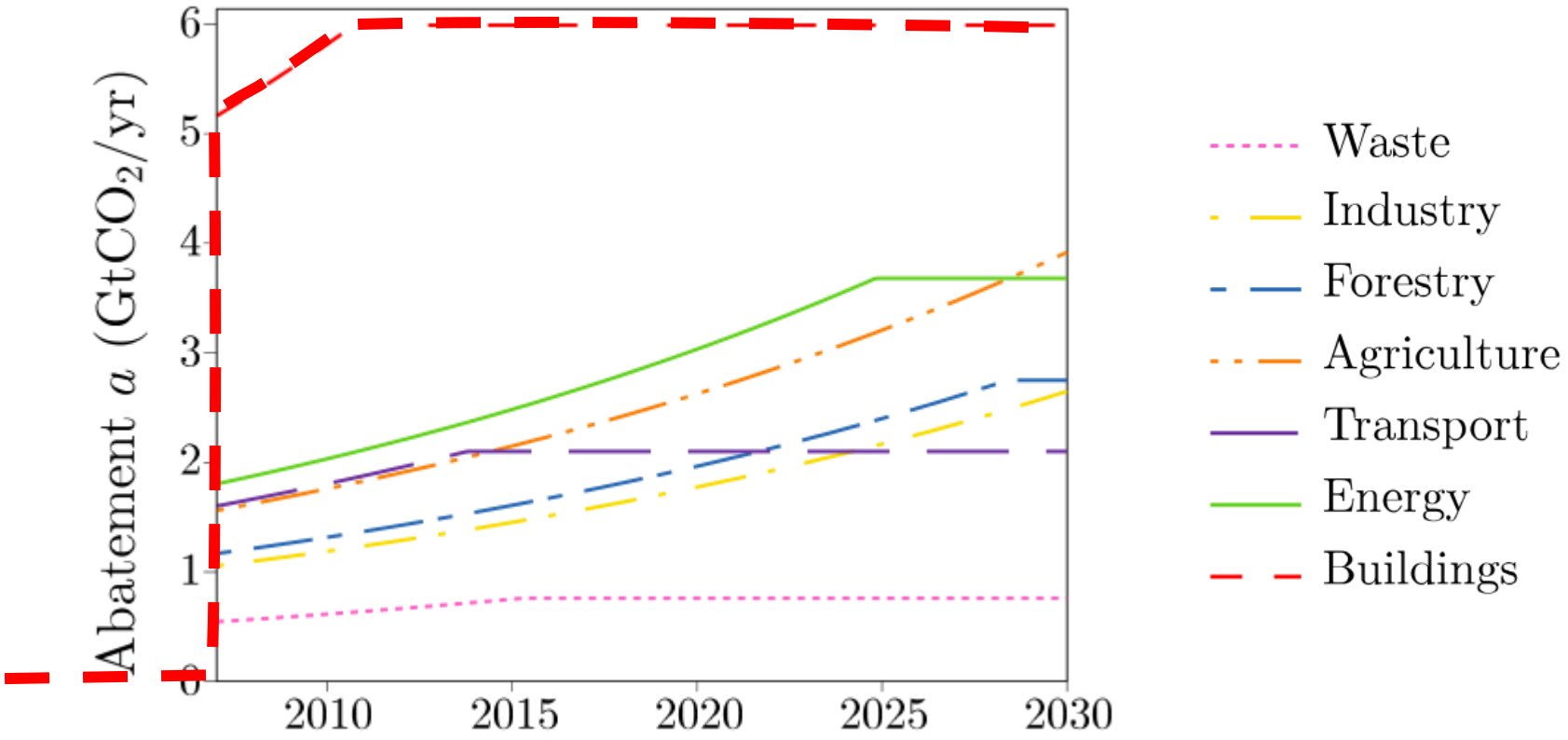
$$\gamma_i(a_i) = \frac{\gamma_i^m}{2} a_i^2$$

The optimal strategy is to equalize Marginal Abatement Costs (MAC) across sectors

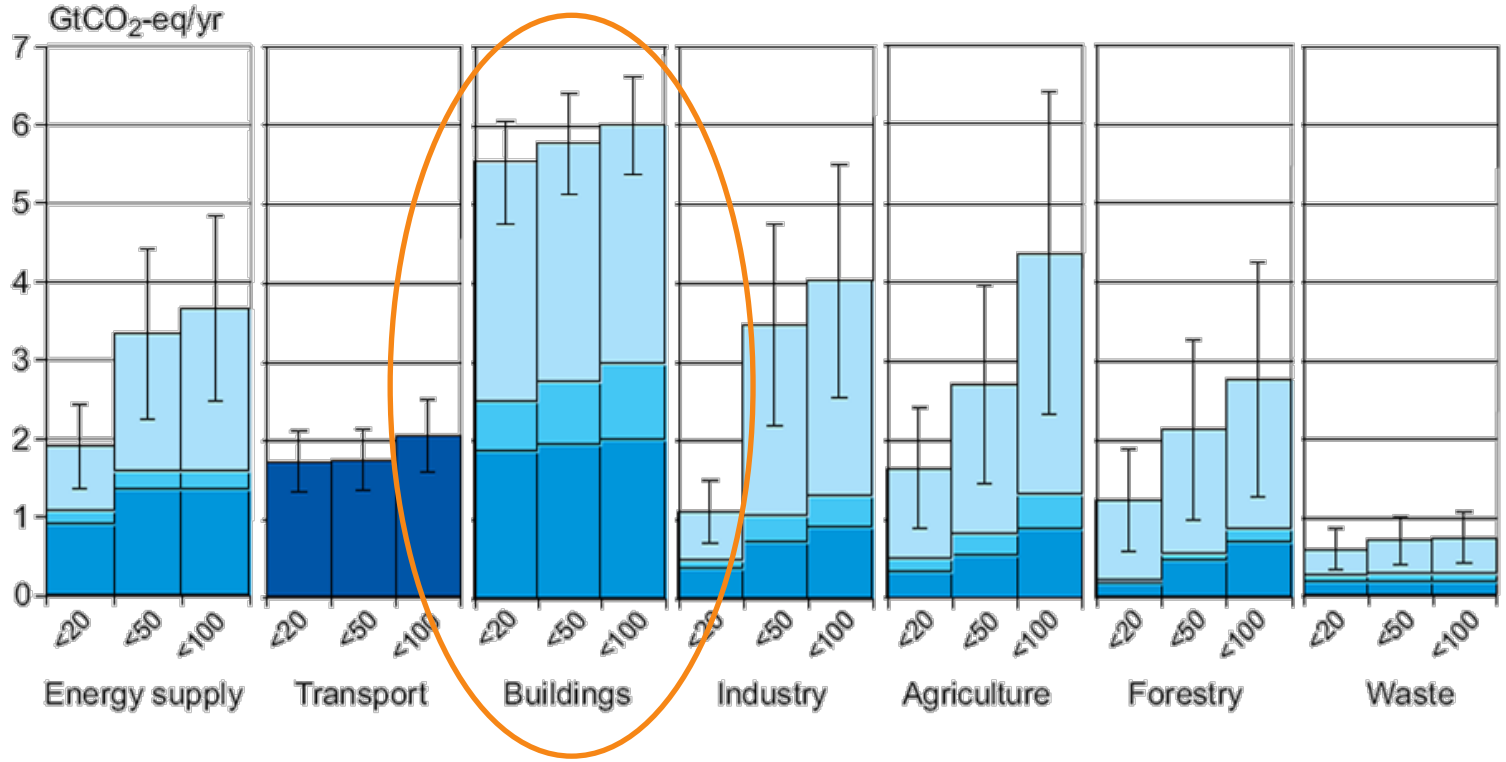


This model leads to unrealistic pathways at the sector level

All buildings should be retrofitted in 3 years (?)



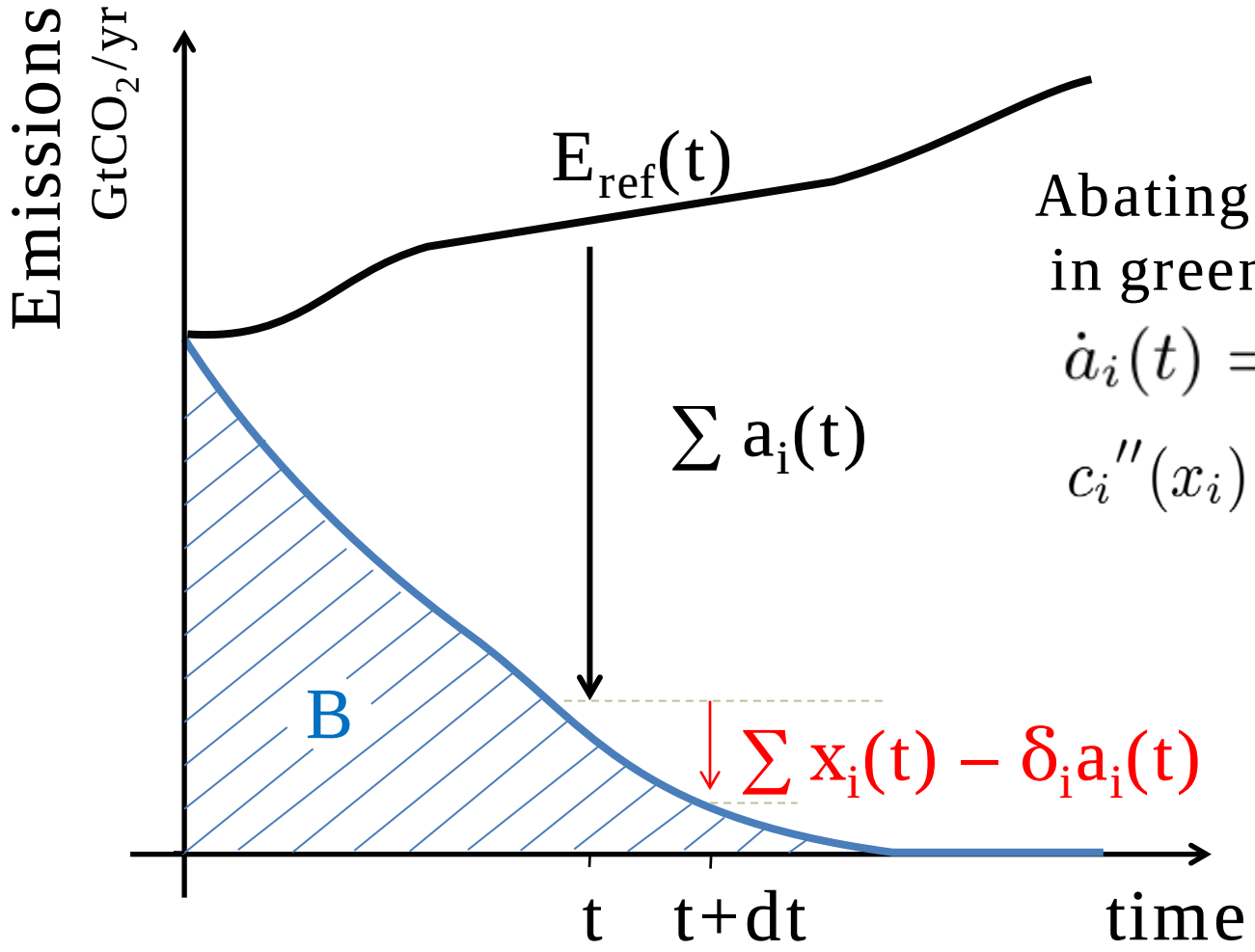
The building sector is the cheapest to decarbonize



In the classical framework, being cheap amounts to being fast

An approach based on
green capital accumulation

Abatement $a_i(t)$ is **path dependent**, the social planner chooses (and pays for) **investments in green capital** $x_i(t)$



Abating with investment in green capital

$$\dot{a}_i(t) = x_i(t) - \delta_i a_i(t)$$

$$c_i''(x_i) > 0$$

Abatement is obtained through investment, convex costs bear on the abatement pace x_i (not the abatement level a_i)

$\mathbf{x_i}$ could be the **pace** in vehicles/year at which zero-emission vehicles are built and introduced in the fleet

- $\mathbf{a_i}$ would be the share of ZEV in the **fleet**
- producing twice many vehicles costs more than twice more :

$$\mathbf{c_i'(x_i)} \uparrow$$

$\mathbf{x_j}$ could be the number of buildings retrofitted **per year**

- $\mathbf{a_i}$ would be their share in the **stock**
- more buildings per year requires to hire skilled workers:

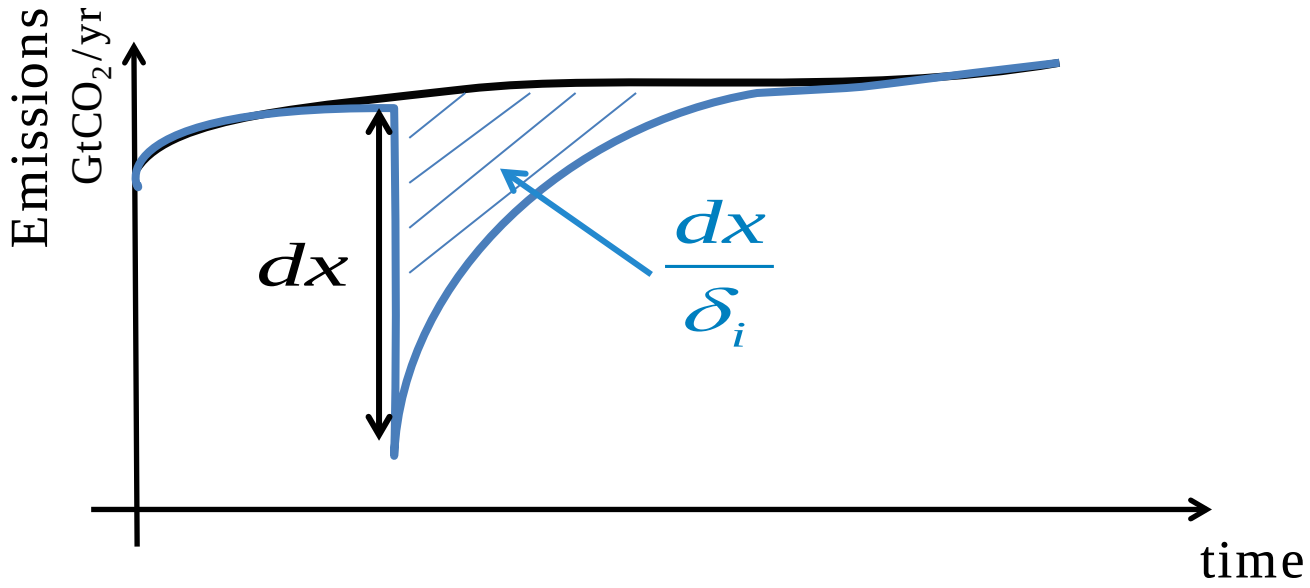
$$\mathbf{c_j'(x_j)} \uparrow$$

We also introduce a maximum amount of abatement that can be achieved in each sector

Different sectors have **different capital lifetimes**, hence **different depreciation rates** δ_i

	Typical lifetime	**δ**
	years	***%/yr***
Energy	40	2.5
Transport	15	6.7
Buildings	60	1.7
Industry	25	4.0
Agriculture	20	5.0
Forestry	120	0.8
Waste	30	3.3

We can define MACs : the marginal levelized abatement costs (per abated ton) (MLAC)



$$\forall x_{i,t}, \quad \ell_{i,t} = (r + \delta_i)\, c_i'(x_{i,t})$$

MLACs $l_{i,t}$ are marginal investment costs c'_i annualized at the rate $(r+\delta_i)$.

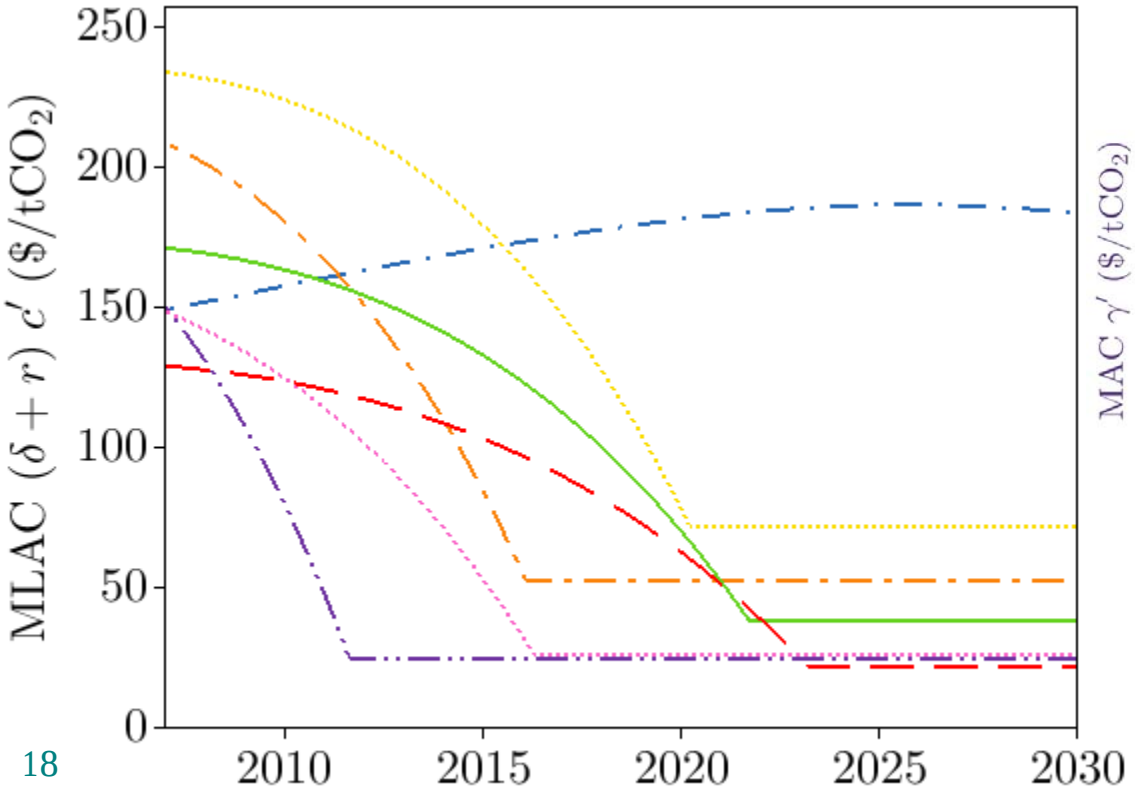
Optimal **marginal efforts** are now **different across sectors**

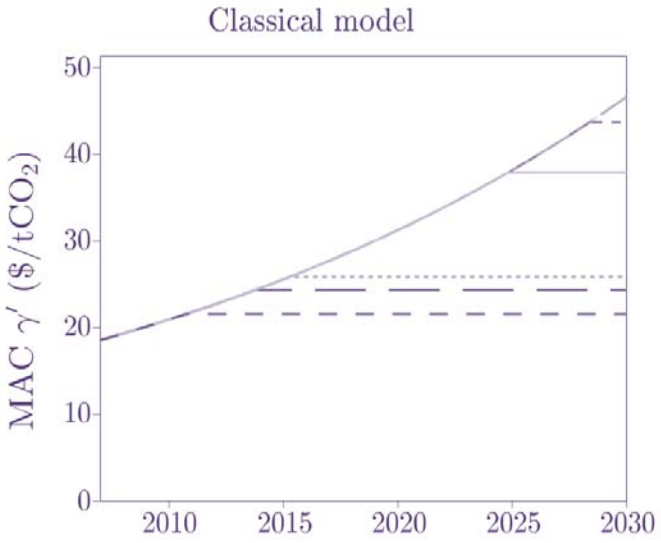
Noting T_i the dates when the sectoral potentials are reached, optimal MLACS read:

$$\ell^*_{i,t} = \mu e^{rt} r\left(1 - e^{-\delta_i (T_i - t)}\right) + e^{-(r+\delta_i)(T_i - t)} (r + \delta_i)\, c_i'\left(\delta_i \bar{a}_i\right)$$

Unique carbon price

Depends on the sector i !



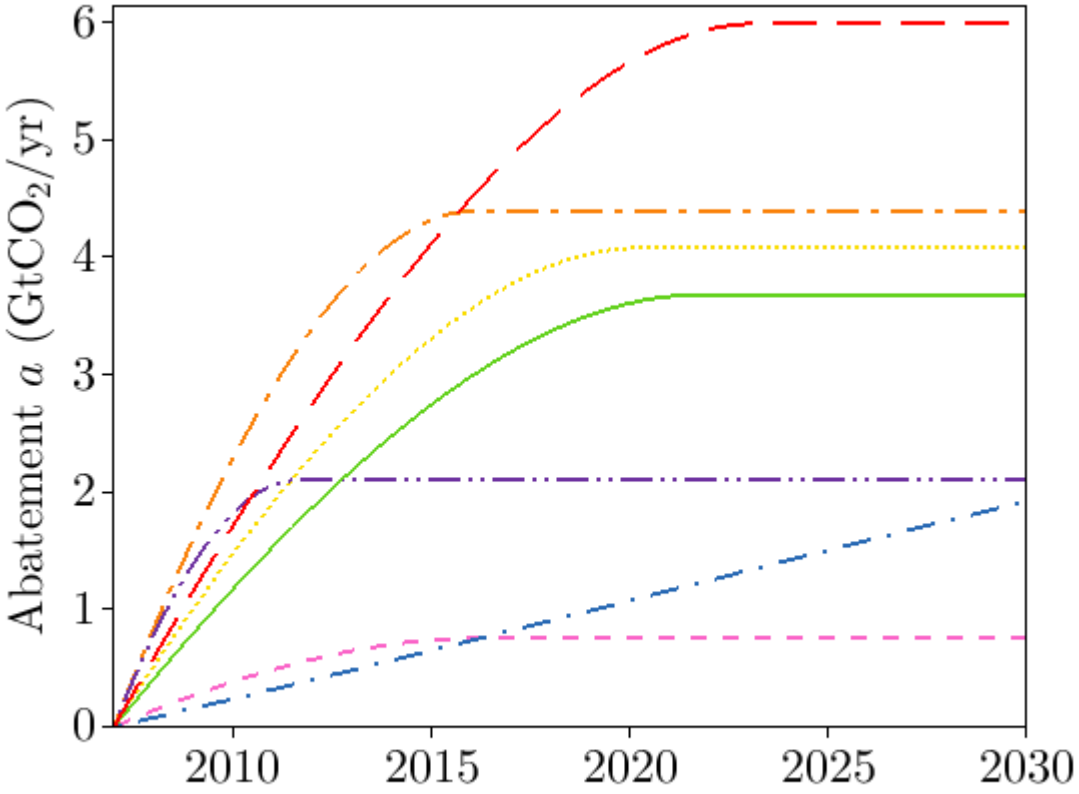


Waste
Industry
Forestry
Agriculture
Transport
Energy
Buildings

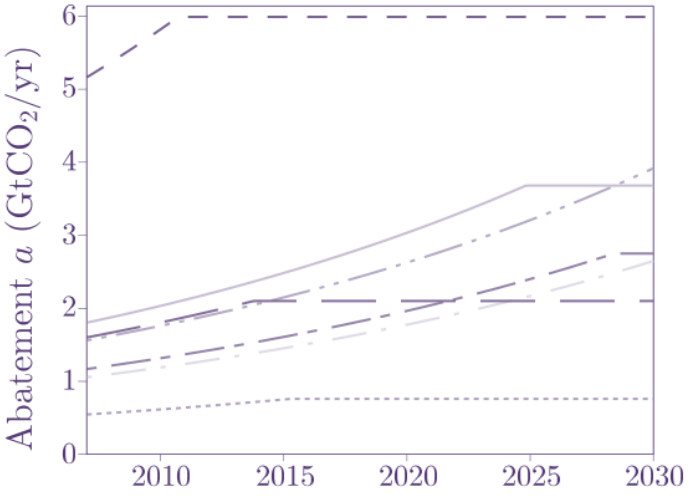
The swimming-pool-fence effect

The new **abatement** pathways are **smooth** and more **realistic**

Low carbon capital accumulation



Abatement cost functions



What about the equi-marginality principle?

- To be equal across sectors, Marginal Abatement Costs need to be defined differently, using an accounting value.

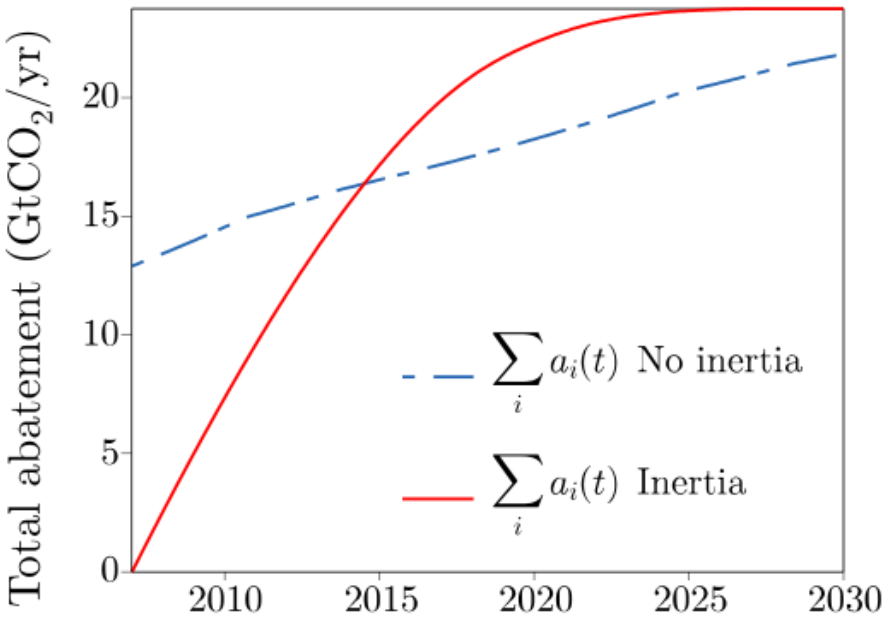
- Jorgenson (1967) : the marginal productivity of capital should **not be equalized to investment costs**, but to the **implicit rental cost of capital** (IRCC)

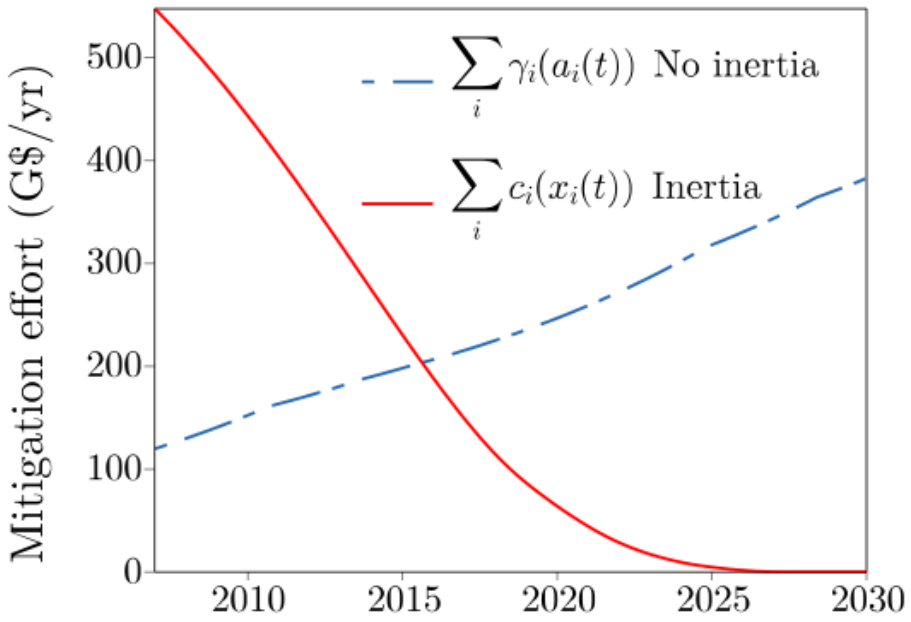
- We define the **marginal implicit rental cost of capital (MIRCC):**

$$\forall i, \ , \forall t \leq T_i, \quad p^*_{i,t} = (r + \delta_i)\ {c_i}'(x^*_{i,t}) - \frac{d{c_i}'(x^*_{i,t})}{dt} = \mu e^{rt}$$

- We can demonstrate that equalizing MIRCC to the carbon price is a **necessary** conditions, but is **NOT a sufficient** condition (there are an infinity of pathways that do so).

A green transition?





- With abatement cost functions, efforts to mitigate grow over time
- With low-carbon capital, it is optimal to **invest massively now.**

Conclusions

1. We propose a **new model** that describes explicitly **green capital deployment.**
2. Using MACs in their usual definition (marginal levelized abatement cost):
   - MACs *should* ***not*** **be equal to the carbon price**
   - MACs should **not be equal across sectors**
   - **Abatement efforts trigger a transition and are bell-shaped.**
3. We can define a new MACs (different from common practice) so that MACs are equal across sector. But they cannot be used to decentralize abatement decisions.
4. There are several **sectoral or local mitigation policies** out there, e.g : EU-ETS, Green quotas, Fuel efficiency standards (CAFÉ),Feed-in tariffs, Urban plans

   As far as they are related to green capital deployment, we find that they cannot be discarded based on the argument that they set **different marginal efforts in different sectors**