Brussels, 10.12.2025

RULES INSTEAD OF LIMITS?
TAKING THE CDR INTEGRATION DEBATE TO THE NEXT LEVEL.

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With funding from the:

KOPERNIKUS Ariadne PROJEKTE
The Future of Our Energy

Federal Ministry
of Research, Technology
and Space

Taking the CDR integration debate to the next level..?

COM(2025) 524: **proposal to amend the Climate Neutrality framework:**

(7) "[…] Incentives will be developed on the occasion of the review of Directive 2003/87/EC of the European Parliament and of the Council in **2026**, where the Commission envisages to provide for domestic permanent carbon removals in the system for greenhouse gas emission allowance trading within the Union ('EU ETS') to compensate for residual emissions from hard to abate sectors."

European Scientific Advisory Board on Climate Change (Feb, 2025)

"Setting targets for both minimum levels of removals and maximum contributions from removals towards net emissions goals can provide the flexibility needed to pursue cost-effective solutions, while safeguarding against market failures and mitigation deterrence."

Our idea in a nutshell: from fixed volumes to adaptive volume rules.

Similar to ETS allowance cap principles,

1. Env. precautionary principle suggests a **fixed, low CDR integration** time path post 2030 safeguard against **abatement deterrence/CDR supply risk**. Setting full time path "now" creates high certainty for market.

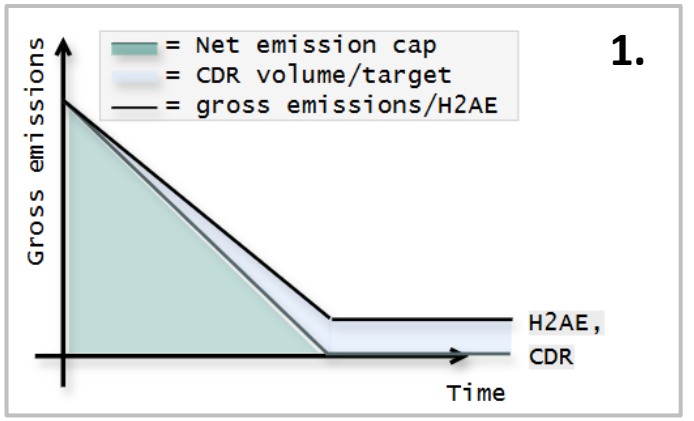
2. … but fixed, low volumes can lead to significant **ETS cost-ineffectiveness risk** due to "future" uncertainty in actual hard-to-abate emissions (H2AE) & CDR supply volumes/ costs.

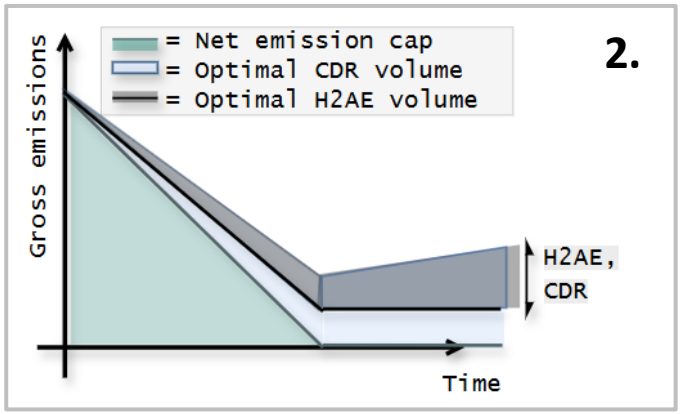
Example: permanent CDR becoming much cheaper would require upwards adjustments of integration volumes in a discretionary manner.

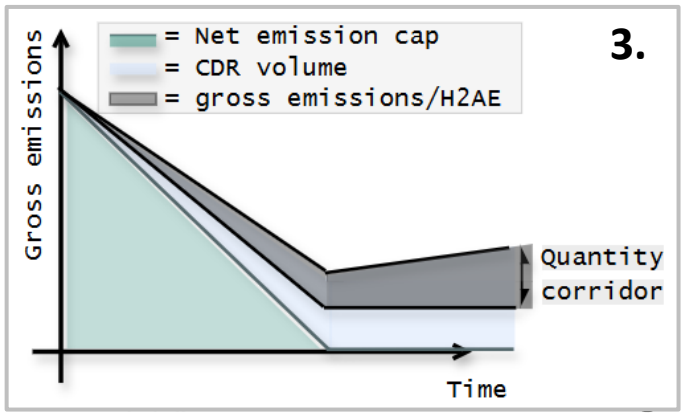
3. *IDEA:* **CDR integration corridor** (MSR-like) can balance the **two risks** in a **rule-based manner** by avoiding discretionary policy intervention.

- **Cost-ineffectiveness risk**: CDR integration volumes can adjust upwards according to observed H2AE & CDR supply. How?
  - Directly: emitters buy CDR credits from suppliers up to adjusted limit
  - Indirectly: COM procures CDR and adjusts EUA volume (e.g. MSR-like)
- **Abatement deterrence risk**: predefined rules and fixed corridor width should provide sufficient volume certainty.

→ Depending on how risk unfold over time: narrow/wide corridor.







Building on & extending the current frontier

European Scientific Advisory Board on Climate Change (2025). *Scaling up carbon dioxide removals Recommendations for navigating opportunities and risks in the EU.*

Eve Tamme. *How to include permanent carbon removals in the ETS*? Blog: *Accessed* 12-**2025**.

Carbon gap (2025). *Divide to deliver: Why 2040 separate targets for carbon removal are feasible and necessary to reach EU net-zero.*

Clean Air Taks Force & **CONCITO (2024).** *The Balancing Act: Risks and Benefits of Integrating Permanent Carbon Removals into the EU ETS*.

La Hoz Theuer, S. et al. **(2025).** *ETS, RELOADED? Designing Emissions Trading for Net-Zero and Net-Negative Societies*. **International Carbon Action Partnership**.

UK government (2025). *Integrating greenhouse gas removals in the UK Emissions Trading Scheme: main response.*

… & Many others more.

Overview

1) Are we all on the same page? **Main integration rationale & options on the table.**

2) What are **main challenges** related to the first-order decision: **“When” & “How much”?**

3) Moving from strict limits to **pre-committed rules.**

1) Are we all on the same page? **Main integration rationale & options on the table**.

Climate Law CDR-ETS integration rationale & options

› **Rationale**:

› Permanent carbon dioxide removals (CDR) for offsetting limited amounts of residual/ hard-to-abate emissions (H2AE)

› *Def. H2AE*: (i) technological infeasible or uneconomically to abate emisions, whether or not (ii) with social or political considerations (ICAP, 2025)

› **Options**: "when" & "how much"

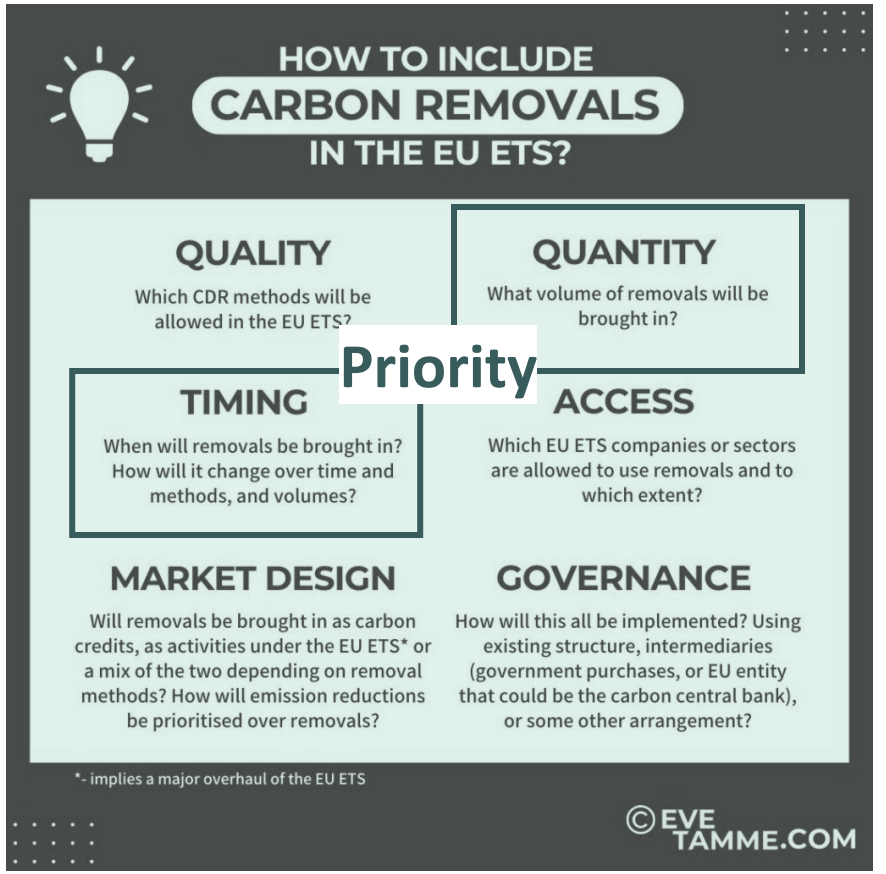
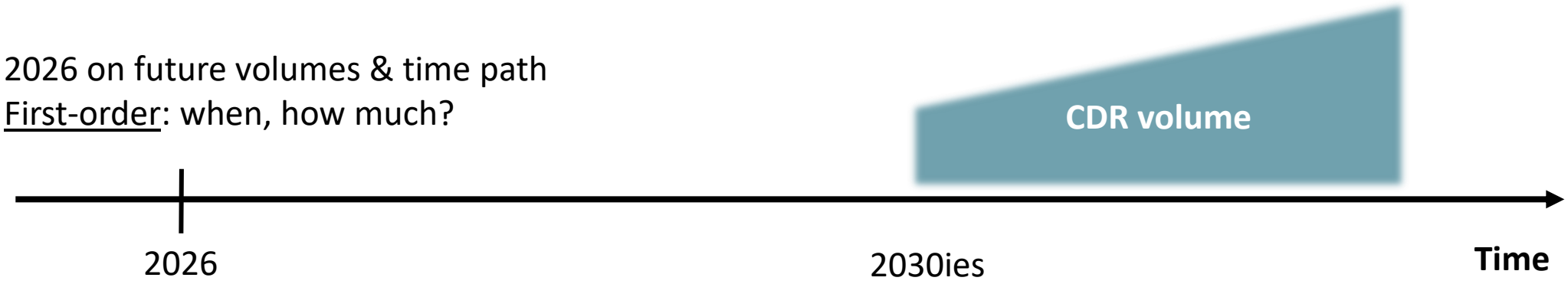


Fig. Different options/dimensions for CDR integration (blog – Eve Tamme)

First-order decisions: “When?” & “How much H2AE/CDR?”

› Decision-making to create certainty for market on CDR supply & H2AE path:
  › **When?** About start of CDR credits entering the ETS
  › **How much?** About H2AE/CDR volumes

Decision 2026 on future volumes & time path
→ First-order: when, how much?



Mock proposal for how draft legislation could look like:

COM(2026): "Article XX: By 203X, Y Mt of permanent CDR increasing to Z Mt by 2040 shall be integrated [directly|indirectly] in the EU ETS".

Second-order decisions: Net/gross cap, direct/indirect? ECCB?

› **Second-order decisions** = institutional layer, related to <u>policy preferences</u>, not directly affecting volumes & timing.

→ **not focus in this presentation; more info in appendix**

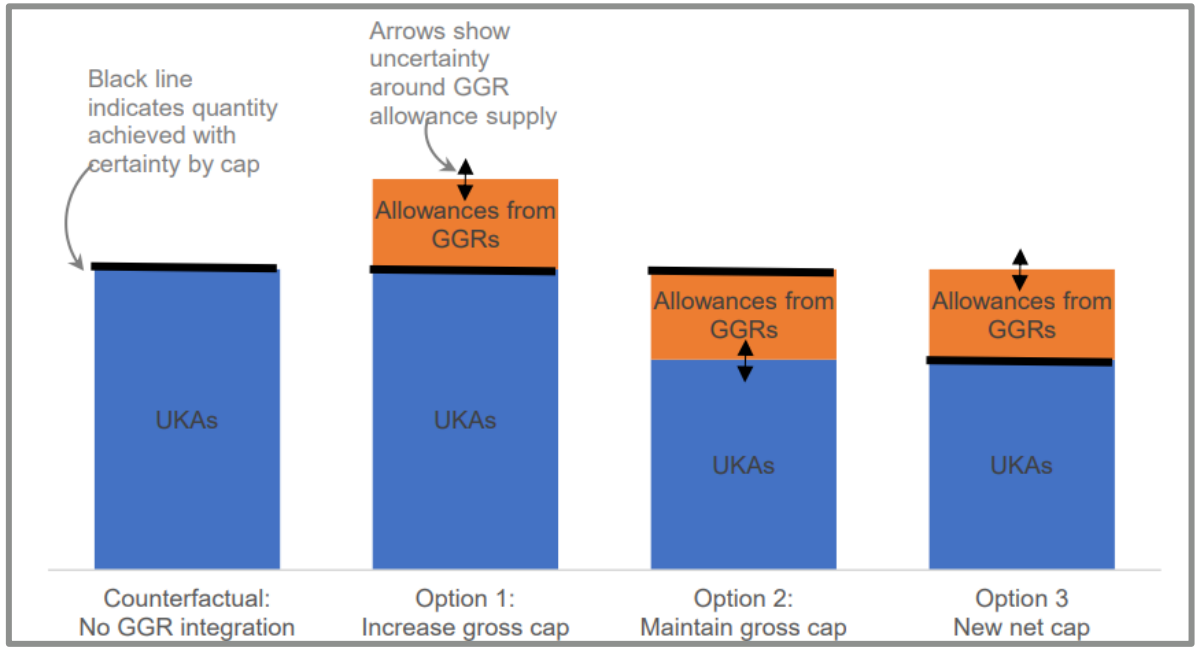


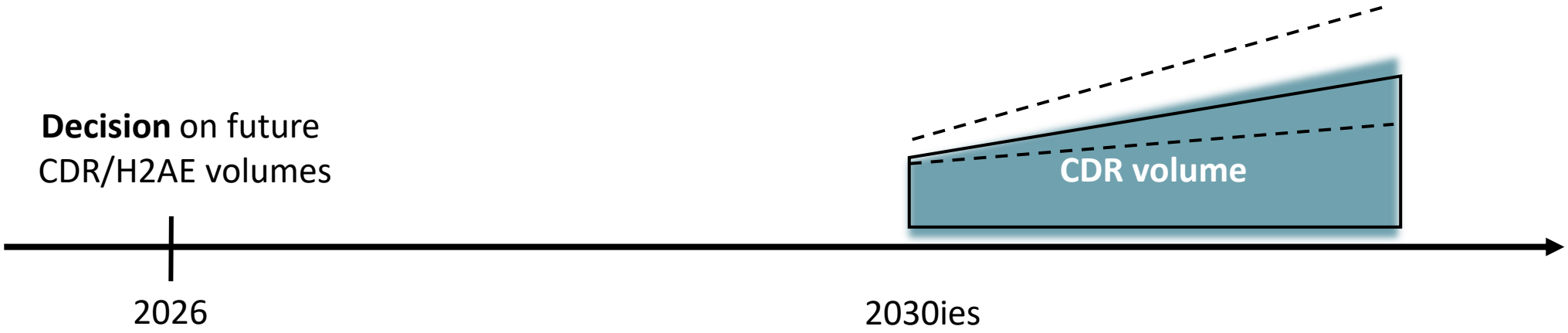
Fig. UK cap options for CDR integration.
Net (option 1 & option 3) vs gross (option 2)
(UK government, 2025)

2) What are **main challenges** related to the first-order decisions?

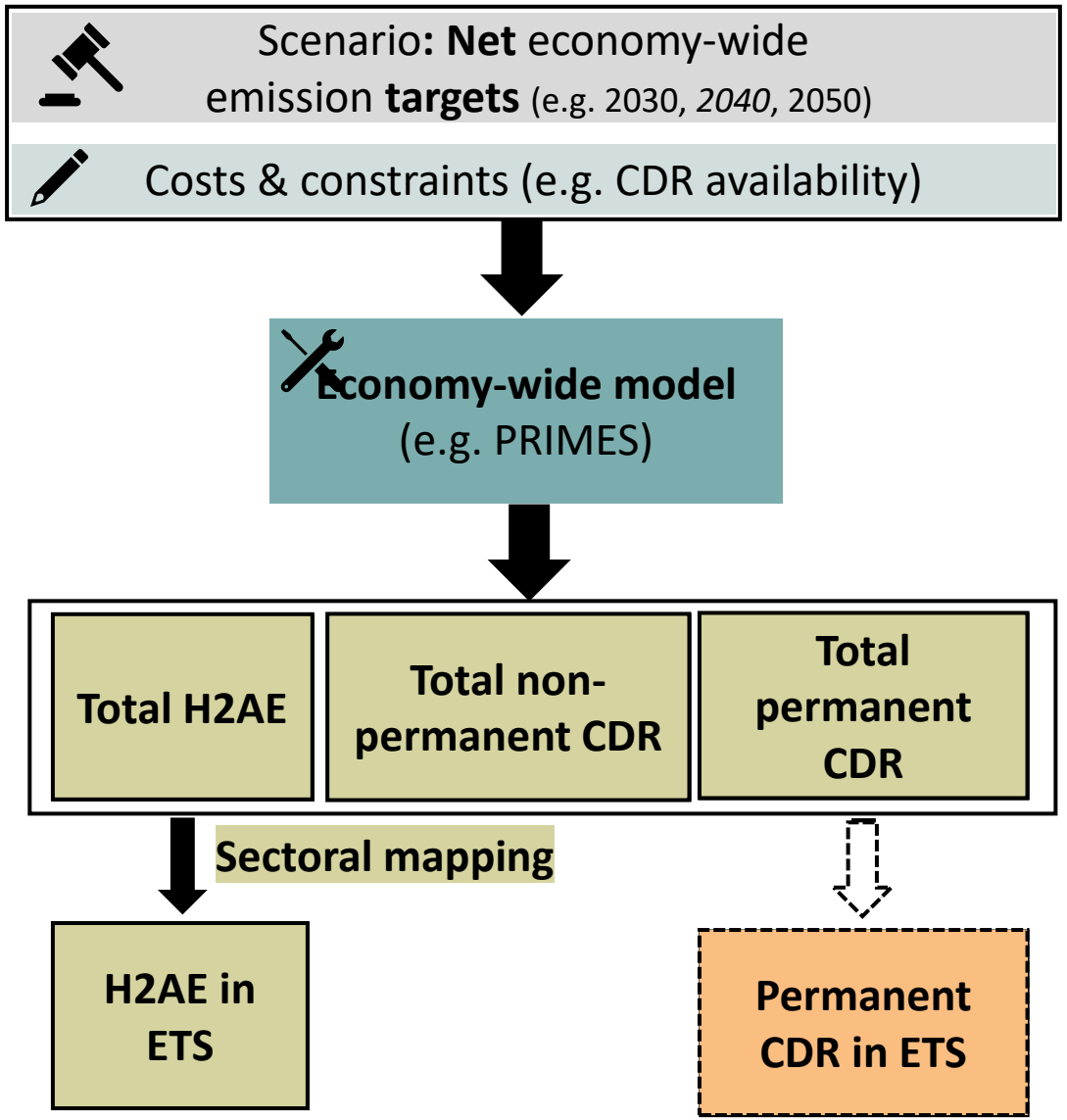
“When” & “How much?”

Main challenge is uncertainty, primarily in costs and availability of permanent CDR & abatement technologies

- Uncertainty in costs creates uncertainty in volumes
  - *Recall def. H2AE*: (i) technological infeasible or **uneconomically** to abate emissions, and/or (ii) with social or political considerations (ICAP, 2025)
  - **Uneconomically**(?): in relation to cost of abatement, cost of CDR & net emission targets



"When & how much?" – what do models tell us?



- Models can help to determine H2AE, CDR volumes & time-path
- BUT confirm **high uncertainty range in H2AE & (permanent) CDR** due to uncertainty in inputs:
  1. Technology developments/costs & availability of:
     - (i) Abatement tech.
     - (ii) CDR

     → grows the further we project in the future
  2. (Policy) scenario: net emission trajectory & flexibility
     (e.g. international carbon credit: 85% + 5%)

H2AE uncertainty across models is high & grows over time

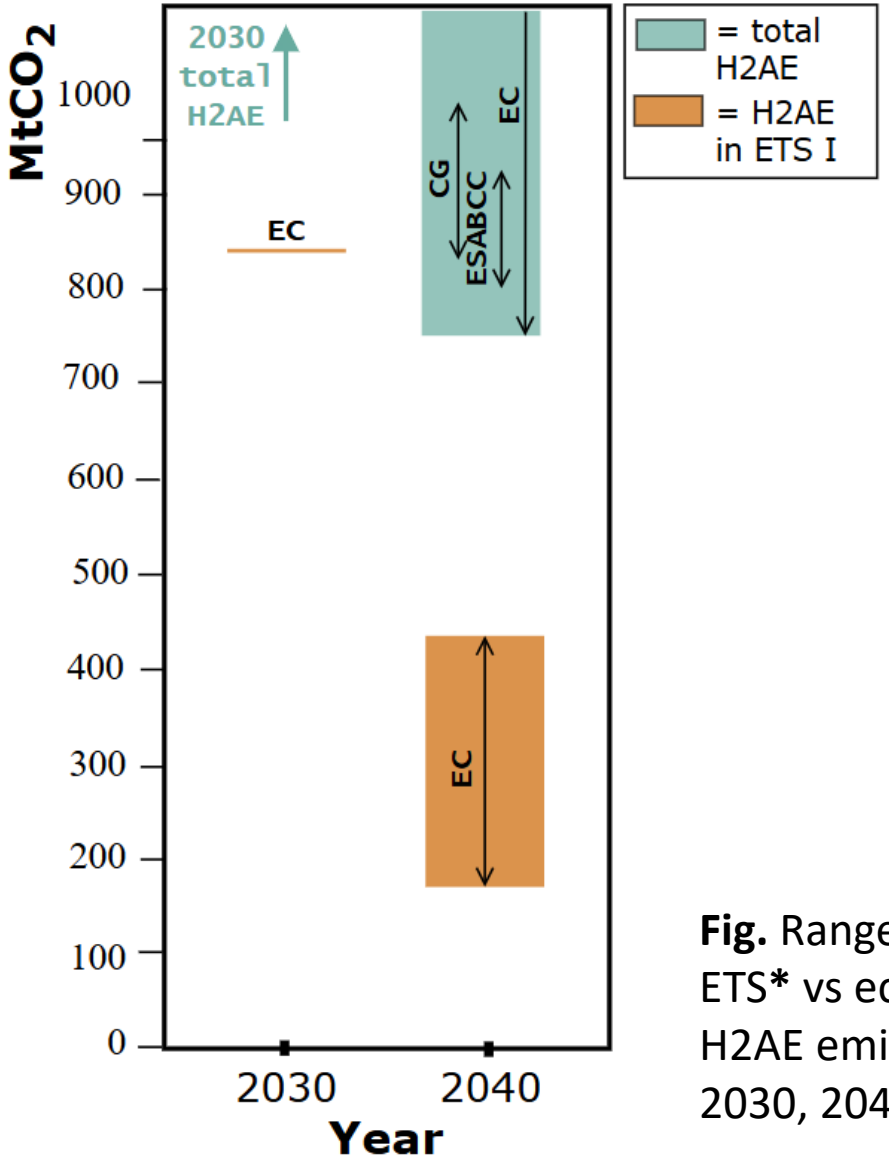


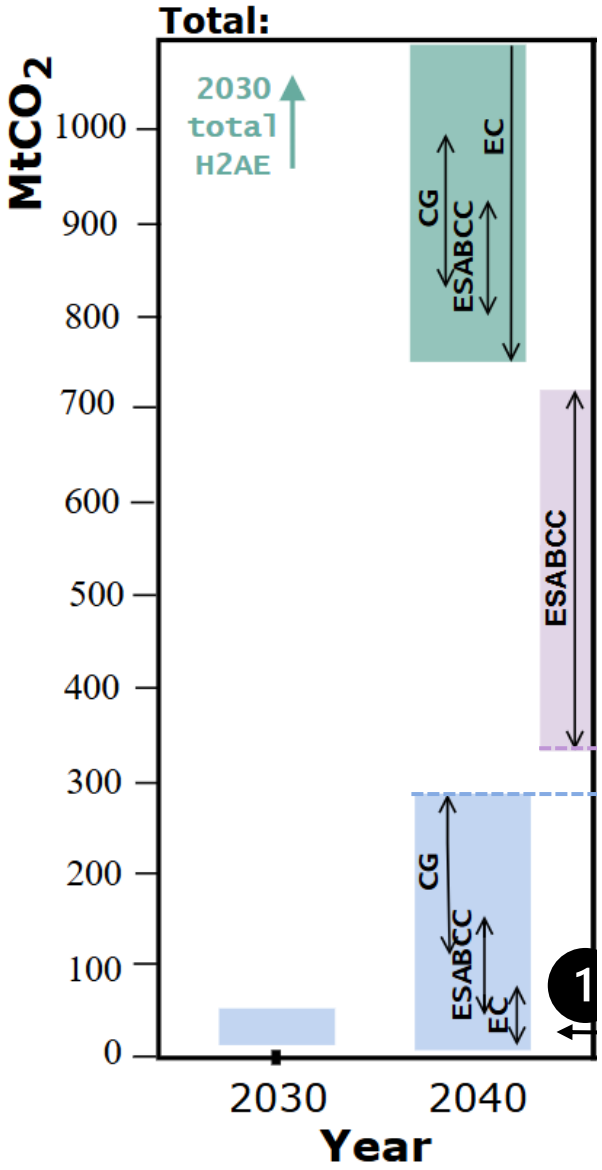
Fig. Range of H2AE in ETS* vs economy-wide H2AE emissions for both 2030, 2040.

- ETS scope itself is uncertain prompting <u>sectoral mapping:</u>
  - **Most H2AE not in ETS I** (yet)!!! (agriculture, "other" energy sectors, waste ≠ ETS I)
  - Quite some H2AE at residential & services => **ETS II**
- → **H2AE** as a **"moving target"**

Data sources: *Carbon gap (CG), European Commission (EC) Impact Assessment report (2024), European advisory board on climate change (ESABCC) (2023)*

* Applied to data from EC impact assessment report only, following SERI (2025) approach using current ETS I sectors

Permanent CDR uncertainty across models is high & grows over time



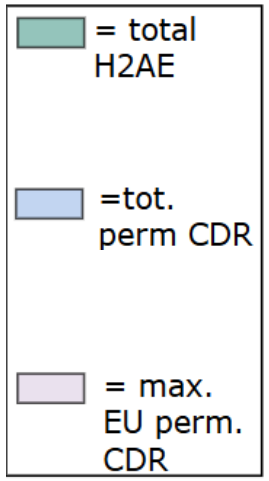


Fig. Range of total H2AEvsCDR and range of H2AEvsCDR in ETS for both 2030, 2040.

› Wide permanent CDR ranges

- › What is "permanent"? (e.g. biochar)

› Unclear/ very low permanent CDR volumes in ETS

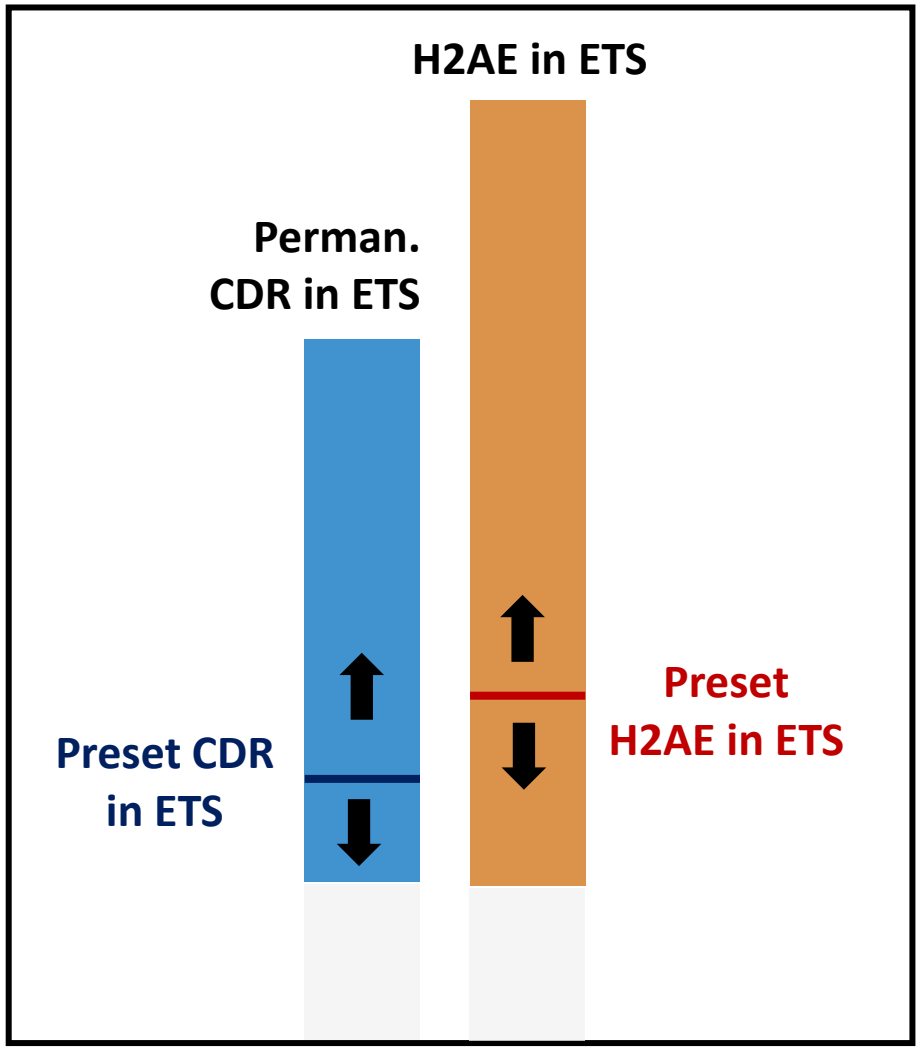
1. No clear CDR-ETS mapping available by most econ.-wide models. Need for:

   (i) stricter ETS constraints in models ("like-4-like", ETS cap), or
   (ii) ETS-specific models e.g. LIMES.

2. Most scenario results (2030, 2040): H2AE in ETS >> (total) permanent CDR

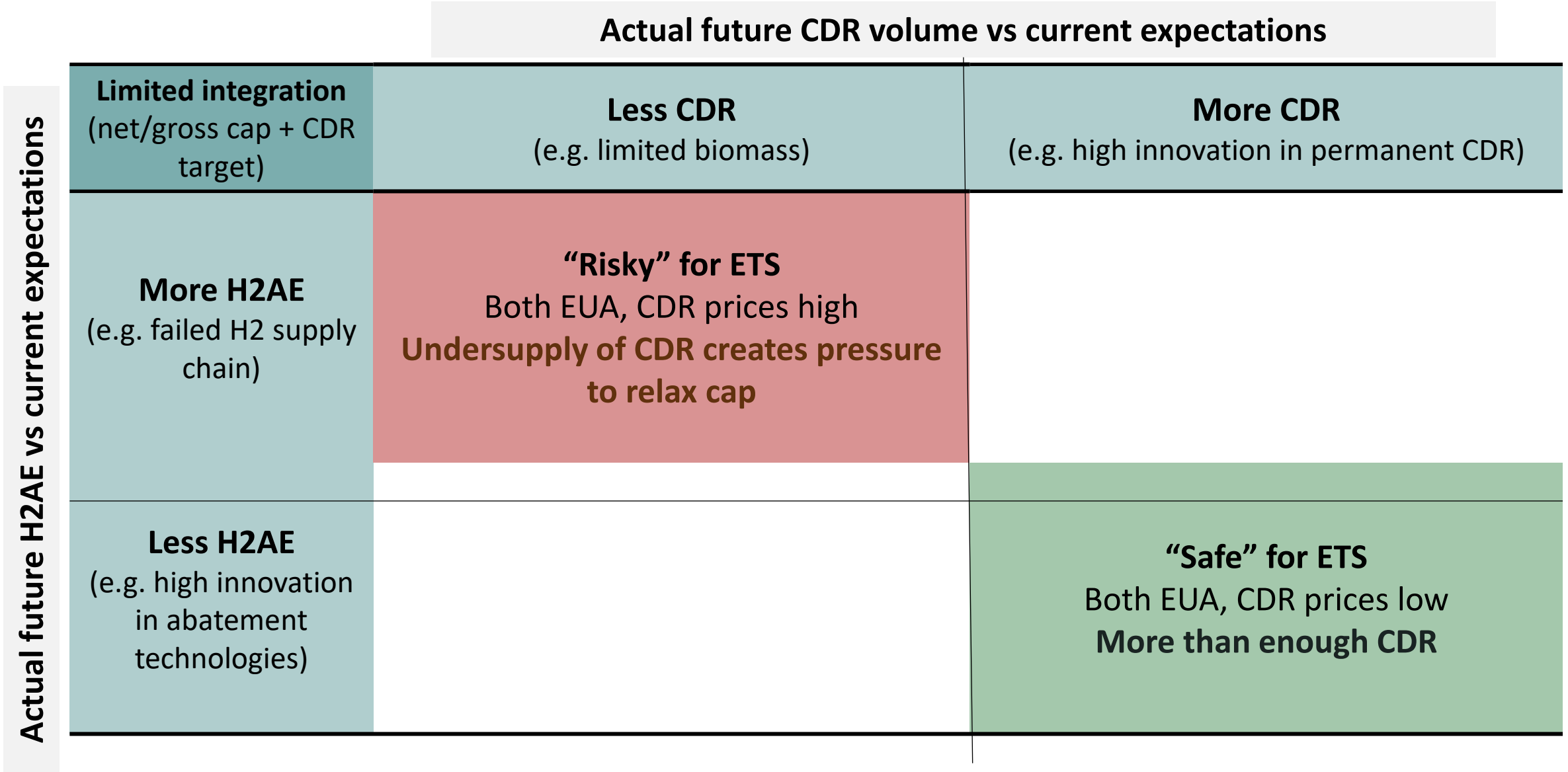
Data sources: *Carbon gap (CG), European Commission (EC) Impact Assessment report (2024), European advisory board on climate change (ESABCC) (2023)*

Uncertainty in actual future outcomes: distinguishing 4 cases



4 cases:	H2AE	CDR	
1	↑	↑	*"More of both"*
2	↑	↓	*"CDR shortage"*
3	↓	↓	*"Less of both"*
4	↓	↑	*"CDR abundance"*

Evaluation of preset H2AE, CDR volumes under uncertainty

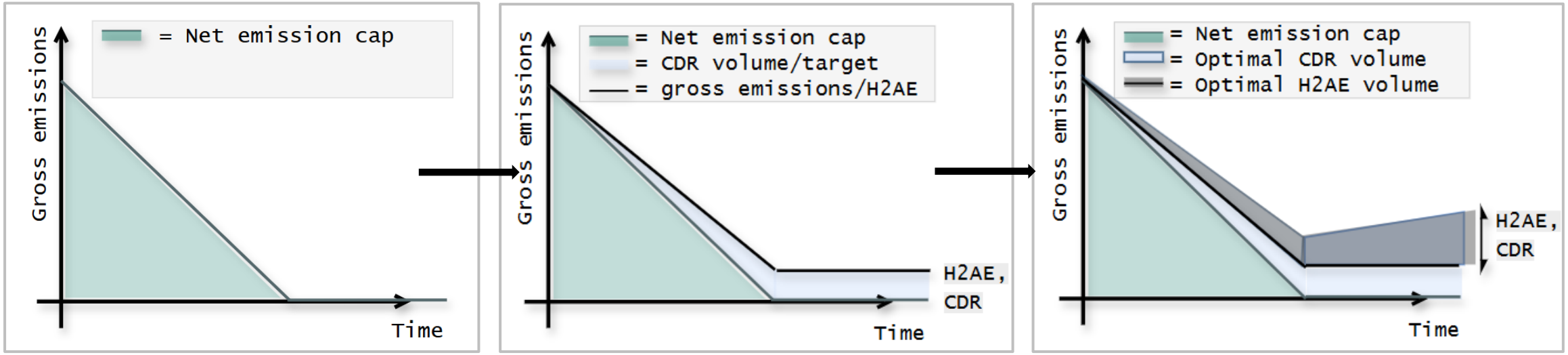


Evaluation of preset H2AE, CDR volumes under uncertainty

Actual future H2AE vs current expectations	Actual future CDR volume vs current expectations: **Limited integration** (net/gross cap + CDR target)	**Less CDR** (e.g. limited biomass)	**More CDR** (e.g. high innovation in permanent CDR)
	More H2AE (e.g. failed H2 supply chain)	**"Risky" for ETS** Both EUA, CDR prices high **Undersupply of CDR creates pressure to relax cap**	**"Safe", IF limit is raised**: too narrow volumes high EUA prices > CDR prices **Intervention: increasing volume of H2AE & CDR*** (*strict target = binding upper limit)
	Less H2AE (e.g. high innovation in abatement technologies)	**"Safe", IF limit is lowered**: too large volumes Low EUA prices < CDR prices **Intervention: reducing volume of H2AE & CDR*** (*only needed when strict target under indirect procurement)	**"Safe" for ETS** Both EUA, CDR prices low **More than enough CDR**

Uncertainty in H2AE & CDR calls for moving target approach

From no CDR **…to limited integration with preset H2AE & CDR targets…** **recognizing uncertainty**



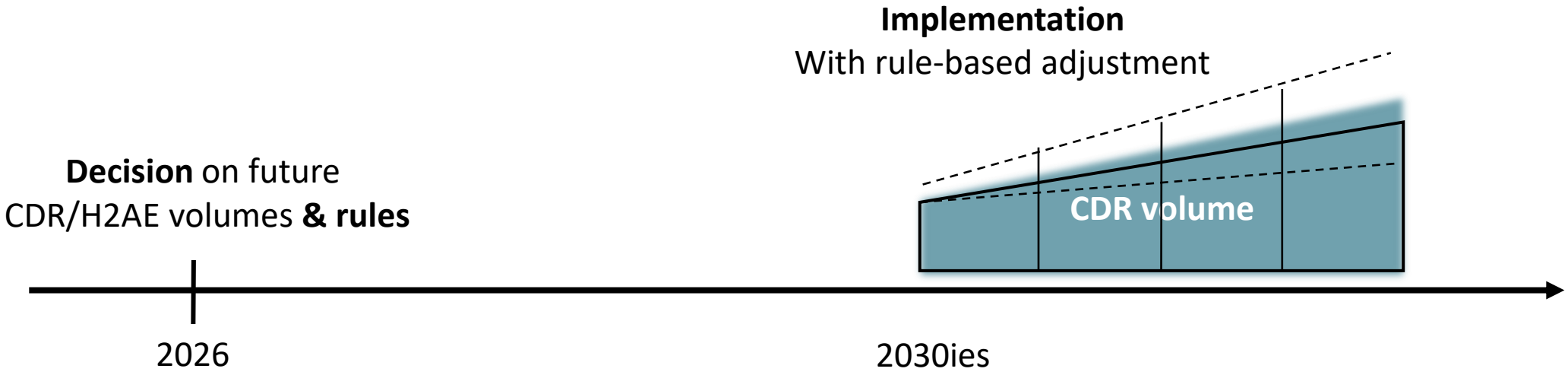
3) Moving from strict limits to precommitted rules

Introducing flexibility by defining a corridor

› Rules to allow for pre-committed flexibility in reaction to decreasing CDR volume and cost uncertainty as time evolves

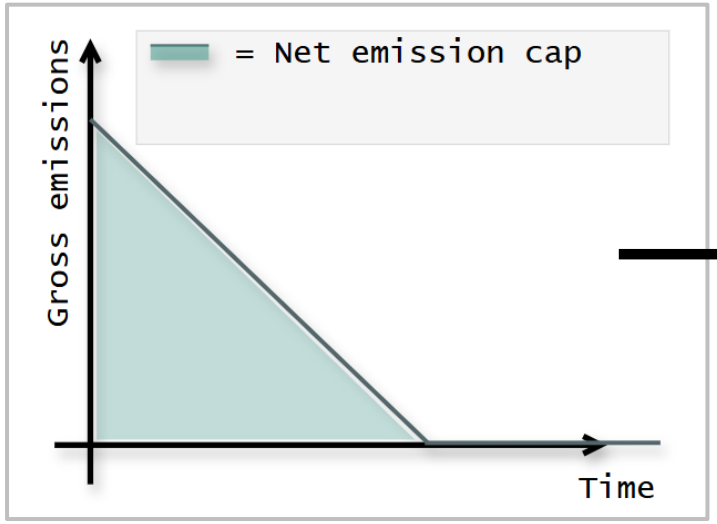
European Scientific Advisory Board on Climate Change (Feb, 2025)

"Setting targets for both minimum levels of removals and maximum contributions from removals towards net emissions goals can provide the flexibility needed to pursue cost-effective solutions, while safeguarding against market failures and mitigation deterrence."

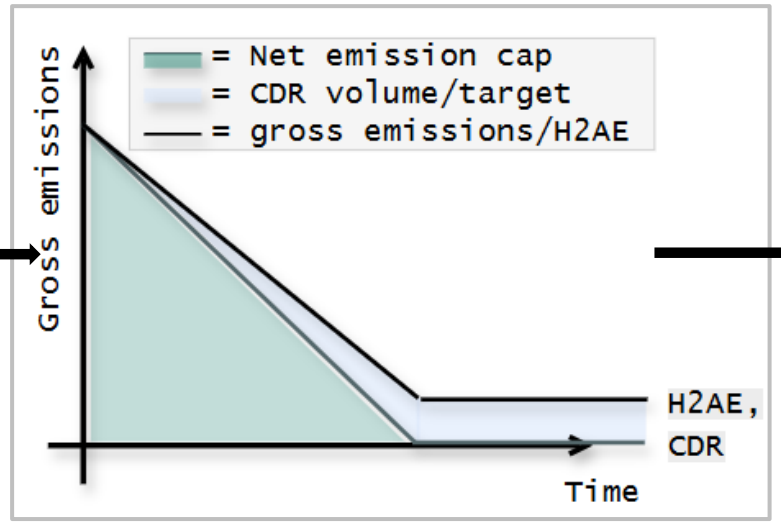


Quantity corridor on CDR/H2AE with predefined rules

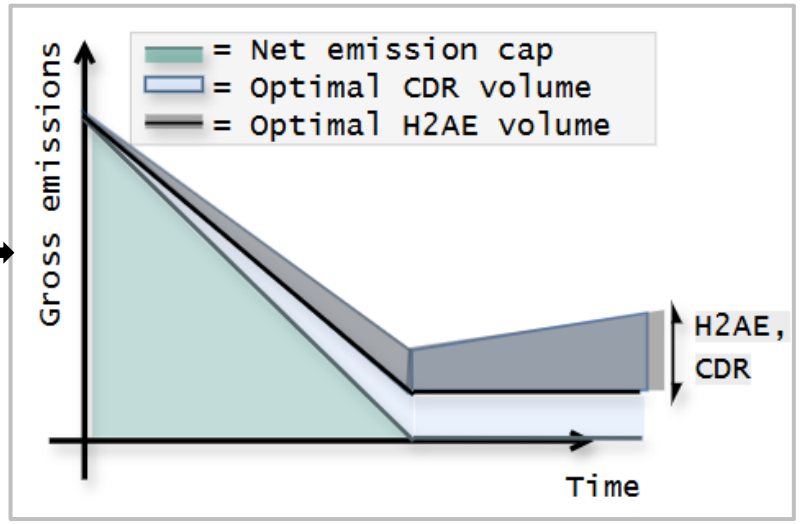
From no CDR



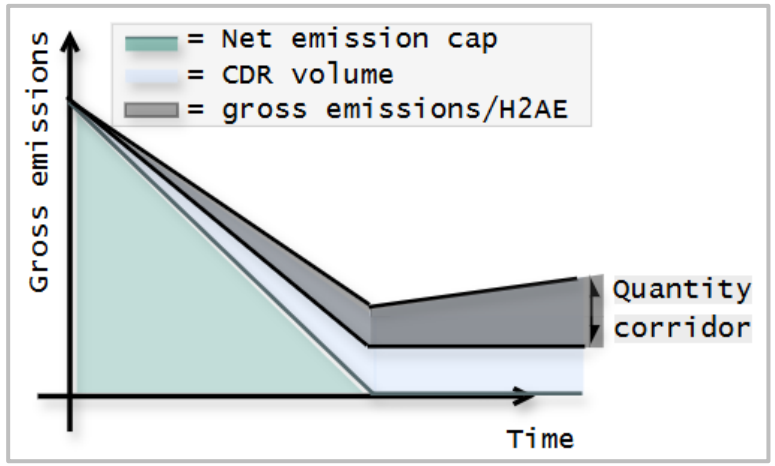
…to limited integration with preset H2AE & CDR targets…



facing uncertainty



.. to rule-based CDR integration with quantity corridors



CDR quantity corridor:
balance between:

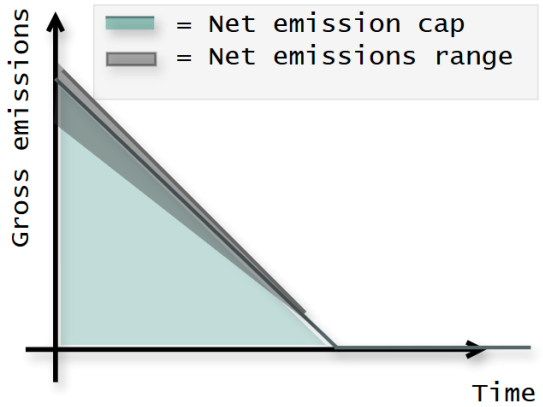
- Cost-effectiveness,
- Abatement deterrence safeguards

Quantity corridor, does this sound familiar?

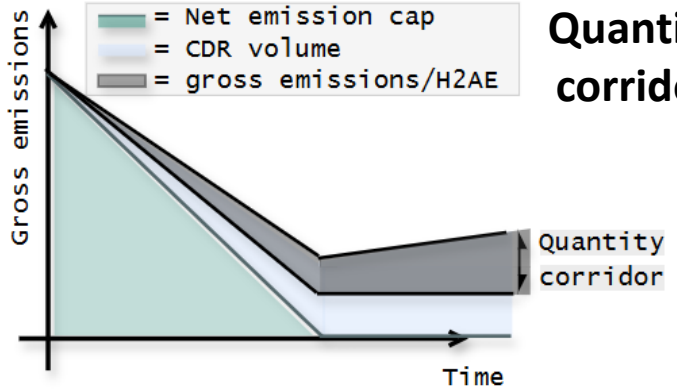
› Both quantity corridor & MSR allow dynamic supply/cap adjustment
  › 4 key elements, different rules
  › Importance over time: MSR shrinking, CDR corridor growing?

› Example for CDR corridor rule in analogy to MSR

Key element	**Market stab. reserve (ETS I)**	**Quantity corridor**
1. Indicator	Total Number of Banked Allowances (TNAC)	e.g. EUA, CDR price difference
2. Trigger levels	Upper & lower trigger on TNAC	e.g. Certain positive and negative Δ in EUA & CDR credit prices
3. Intervention	Intake & release of EUA auction volumes	CDR credits ↑or↓ corresponding to corridor limits & average corridor value
4. Periodic policy updates	With scheduled ETS revisions	Ensure every few years update: reducing corridor width with new information



MSR



Quantity corridor

What is the new option we offer? Features summarised.

1) Fixed time path vs	2) Rule-based corridor
How it works: predefining fixed volumes of H2AE/ CDR over time.	**How it works**: predefining min. and max. volumes of H2AE/ CDR over time with predefined adaptive volume rules.
Features: 1. High certainty now, low future robustness. 2. Prioritizes safeguarding abatement deterrence risk 3. Likely needs discretionary adjustment	**Features:** 1. Lower certainty now, higher future robustness. 2. Balances abatement deterrence and cost-effectiveness risk 3. More complex to define, but rule-defined adjustments.

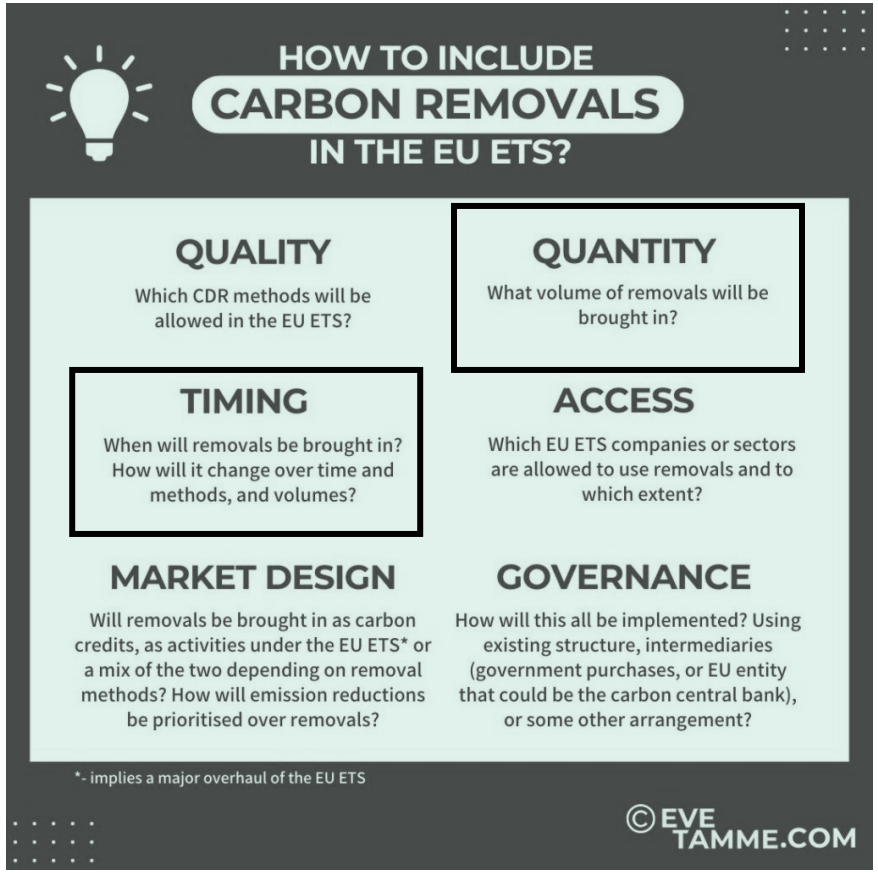


Fig. Different options/dimensions for CDR integration (blog – Eve Tamme)

Next steps: what to discuss and think about?

Design of rules & instruments

1. How does the **UK proposal** compare to the proposed rule-based CDR supply path?
2. How to choose the trigger levels and what could be potential parameters (indicators) to **design rules**? Do different parameters affect CDR upscaling differently?
3. Do first-order decisions benefit from certain **second-order decisions** (policy/institutional preference)?
4. By **whom** should rules be overseen & periodically updated?
5. Which **complementary policy support** instruments would be needed to ensure sufficient CDR supply?

Uncertainty range estimation

1. What are **key sources of uncertainty**?
2. What is the relative likelihood of **undershooting versus overshooting** required total CDR volumes & CDR volumes within the ETS?
3. How **significant** are the consequences and **risks** associated with wrongly estimating CDR volumes ex-ante?
4. To what extend can **models**, existing(?) **market data** or **other forecasts** capture **ranges** of uncertainty and identify min. and max. CDR integration volumes?

WHAT ARE YOUR THOUGHTS?

Contact:

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References used in the slides

› **Data sources**:

- European Commission (2024), Impact Assessment report: Part 3/5. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52024SC0063
- Carbon gap (2025), Divide to deliver: Why 2040 separate targets for carbon removal are feasible and necessary to reach eu net-zero. Technical analysis. https://carbongap.org/wp-content/uploads/2025/09/Sept-25-Divide-to-deliver-technical-analysis.pdf
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› **Figures/ background info**:

- Sultani, Darius and Osorio, Sebastian and Günther, Claudia and Pahle, Michael and Sievert, Katrin and Schmidt, Tobias and Steffen, Bjarne and Edenhofer, Ottmar, Sequencing Carbon Dioxide Removal into the EU ETS (2024). CESifo Working Paper No. 11173, Available at SSRN: https://ssrn.com/abstract=4875550 or http://dx.doi.org/10.2139/ssrn.4875550
- Buck, H.J., Carton, W., Lund, J.F. *et al.* Why residual emissions matter right now. *Nat. Clim. Chang.* 13, 351–358 (2023). https://doi-org.kuleuven.e-bronnen.be/10.1038/s41558-022-01592-2
- F. Verbist, J. Meus, J. A. Moncada, P. Valkering, and E. Delarue, “Carbon removals meet Emission Trading System design: A precautionary path towards integration,” *Energy Economics*, vol. 145, p. 108389, May 2025, doi: 10.1016/j.eneco.2025.108389.
- UK government, Scottish government, Welsh government, Department of agriculture Environment and Rural Affairs of Northern Ireland (2025) Integrating Greenhouse Gas Removals in the UK Emissions Trading Scheme: Main Response. https://assets.publishing.service.gov.uk/media/689cda8487bf475940723f5b/uk-ets-ggrs-main-response.pdf

References used in the slides

- S. La Hoz Theuer, V. Ortiz Rivera, and K. Biedenkopf, “ETS, RELOADED? Designing Emissions Trading for Net-Zero and Net-Negative Societies.” International Carbon Action Partnership, Mar. 2025. [Online]. Available: https://icapcarbonaction.com/system/files/document/ets-reloaded-paper_final.pdf
- Clean Air Taks Force and CONCITO, “The Balancing Act: Risks and Benefits of Integrating Permanent Carbon Removals into the EU ETS.” Dec. 02, 2024. Accessed: Dec. 01, 2025. [Online]. Available: https://concito.dk/en/udgivelser/the-balancing-act-risks-and-benefits-of-integrating-permanent-carbon-removals-into-the
- European Scientific Advisory Board on Climate Change, “Scaling up carbon dioxide removals Recommendations for navigating opportunities and risks in the EU,” Feb. 2025, doi: 10.2800/3253650.
- S. La Hoz Theuer, B. Doda, K. Kellner, and W. Acworth, “Emissions Trading Systems and Net Zero: Trading Removals.” International Carbon Action Partnership, 2021.
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APPENDIX.

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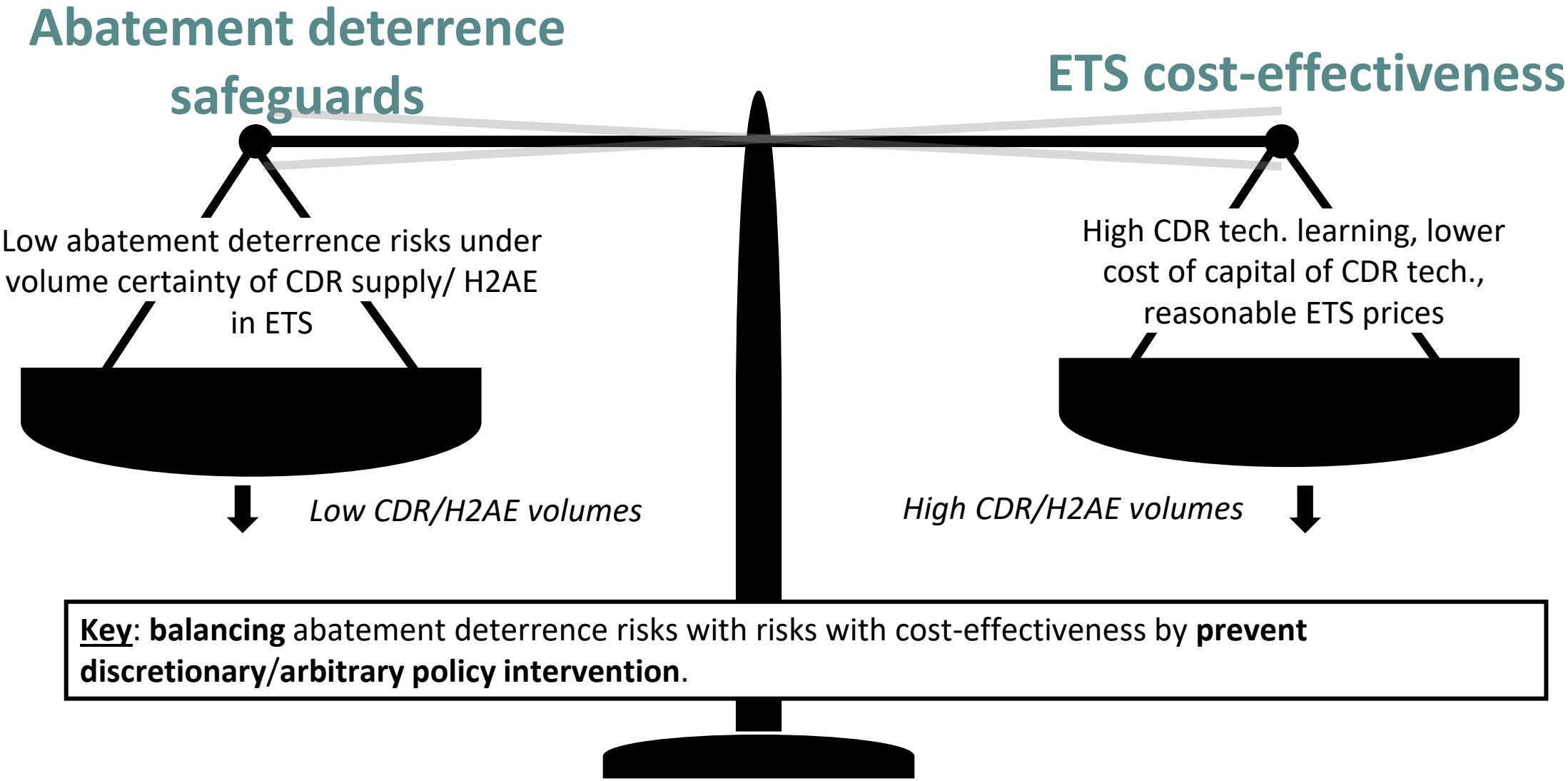
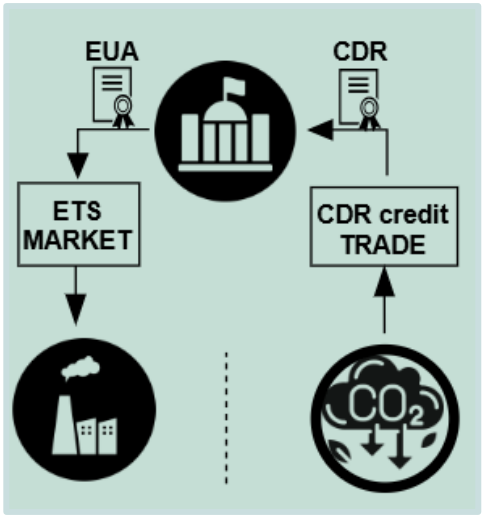
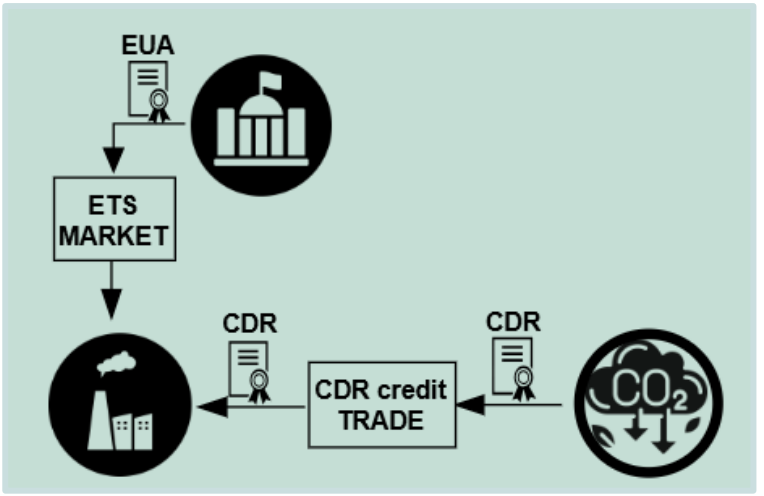
CDR integration stipulates a balancing logic

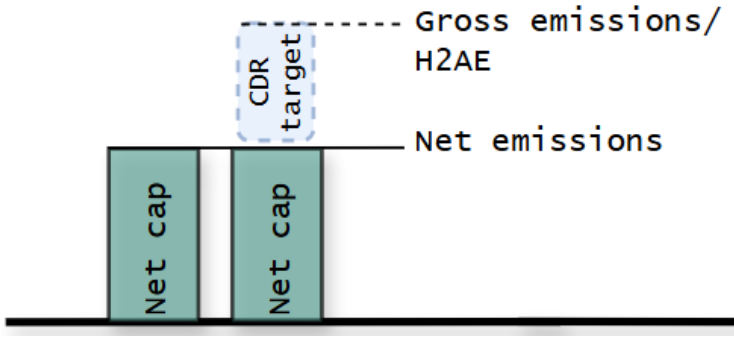
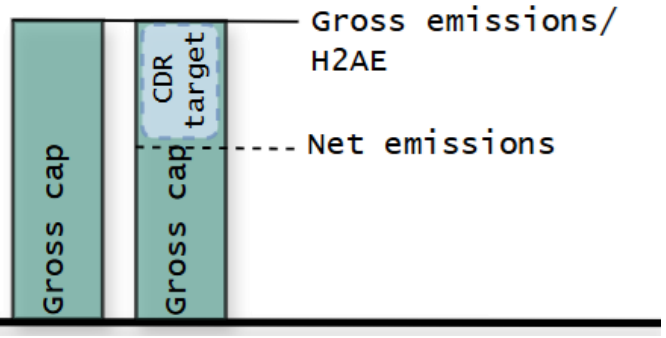


Key: **balancing** abatement deterrence risks with risks with cost-effectiveness by **prevent discretionary/arbitrary policy intervention**.

Putting corridor in practice: Indirect vs direct CDR trade

Aspect	Indirect	Direct
Definition **Indirect/direct** is defined in relation to **CDR credit trade** between **removers & emitters*** **conform with ESABCC report.*	Intermediary procures CDR volume & releases credits as EUA on ETS market confirm with CDR target 	Emitters buy CDR credits directly from removal market/entities with max. CDR credit supply restriction (CDR cap) next to EUA on ETS market (net cap) 
Implementation	**Net or gross cap**	**Net cap (ETS market)**
CDR price risk/gains	European Commission	Emitters

Putting corridor in practice: Net vs gross cap

Aspect	Net Emission Cap (+ CDR target)	Gross Emission Cap (+ CDR target)
Definition	CDR credits (target) on top of existing cap/EUA supply	CDR credits (target) replacing EUA allowances
Same starting point: - same gross emissions/H2AE, - same net emissions.		
Fixed by cap	**Net emissions**	**Gross emissions (H2AE)**
Fixed by cap & CDR target	**H2AE** = net cap + CDR	**Net emissions** = gross cap (H2AE) – CDR
Net or gross? First-order (rationale): no difference. Second-order (institutional): cap adjustment preference		
Example: under stringent climate policy:	Short term: **adjust** the current cap downwards Mid-to-long term: **keep** the current trajectory	Short term: **keep** current cap level, but transform to gross cap Mid-to-long term: **adjust** the current cap trajectory upwards (allowing H2AE)

Putting corridor in practice: Net vs gross cap

› **Net cap**: H2AE volume is increased by <u>increasing the amount of CDR credits</u> entering the market

› **Gross cap**: H2AE volume is increased by <u>increasing the gross cap</u>, i.e. the amount of EUA supplied & equivalently increasing the CDR credits procured

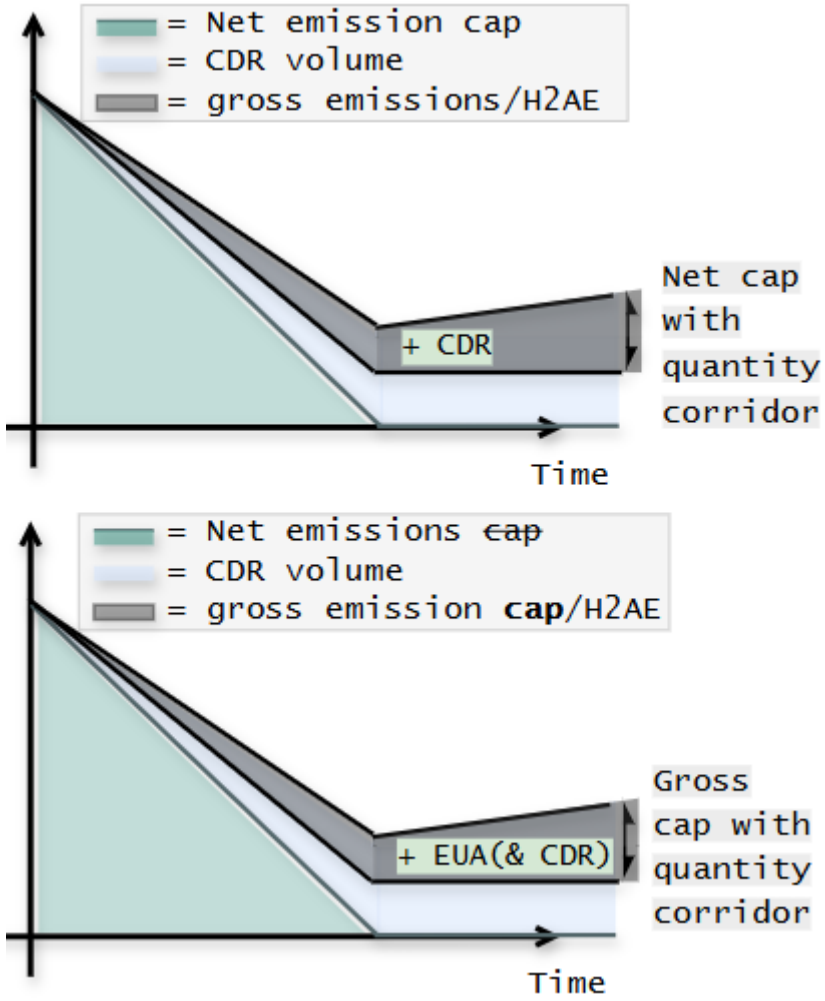


Fig. Net & Gross cap adjustment under a CDR quantity corridor.

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