

The role of the LULUCF sector and emission removal technologies in reaching carbon neutrality in 2050

13.12.2022



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Agenda

10.00-10.10 **Welcome and framing** (moderator Kaidi Tamm, SEI Tallinn senior expert)

10.10-10.35 **Carbon Dioxide Removal options in the National Long-term Strategies of EU Member States: visions for sustainable land use and reaching carbon neutrality** (Brigita Tool, Peter Walke, SEI Tallinn)

10.35-11.10 **Panel discussion: The potential and risks in the LULUCF sector in reaching climate neutrality in the EU**

11.10-11.25 **Q&A and discussion with the audience**

11.25-11.30 **Summary and wrap-up**

Ground rules

- **For questions to the panel please use the Q&A function.**
Please specify to whom is the question directed. **NAME: question**
- You can **upvote** questions you find relevant and would like to see answered by clicking „thumbs up“ under the question.
- **Please use the chat for any other comments** you want to share with the audience and speakers. We are not likely to pick them up during the event though.
- **The discussion is being recorded and will be made available online at www.climatedialogue.eu afterwards.**

Carbon Dioxide Removal options in the National Long-term Strategies of EU Member States

Peter Walke and Brigita Tool
SEI Tallinn
13.12.2022



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Background

IPCC report (AR6 WR1) links limiting global heating to **1.5°C to climate neutrality by 2050**. Approximate carbon budget of **±500 Gt CO₂e**.

- In the EU, after reaching climate neutrality, **net negative emissions must be achieved**.

All outstanding emissions must then be balanced through:

- **Natural removals** in six land-categories: **forest land, cropland, grassland, wetlands, settlements, other land** (LULUCF + harvested wood products)
- **Technological removals** – Bioenergy with Carbon Capture and Storage (BECCS), Direct Air Capture (DAC), +...

Additional contribution by technological options that **avoid additional emissions** – Carbon Capture and Storage (CCS), Carbon Capture and Utilization (CCU)

How are these factors included in the decarbonisation plans of Member States?

- Each EU Member State is required to adopt and regularly update a **holistic decarbonisation strategy until 2050, known as a long-term strategy (LTS)**.

LULUCF in the EU

- Over the last 30 years, **total** emissions in the EU have **decreased**, but recently so has the **carbon sink**
 - 336 Mt CO₂e** in 2009 and **-230 Mt CO₂e** in 2020)
 - LULUCF absorbs approximately **10%** of emissions
- Forest removals > LULUCF removals.** HWP notwithstanding, other sub-sectors are a net source
- Sink targets:**
 - by 2030: **-310 Mt CO₂e** (Fit for 55)
 - by 2050: **±400 Mt CO₂e** (Clean planet for all)
 - by 2035: **climate neutral combined land sector** (Fit for 55)
- But sink projections are smaller:
 - By 2030: **-209 Mt CO₂e** (WAM EEA database)
 - By 2030: **-258 Mt CO₂e** (EU Reference scenario)
 - By 2050: **-271 Mt CO₂e** (EU Reference scenario)

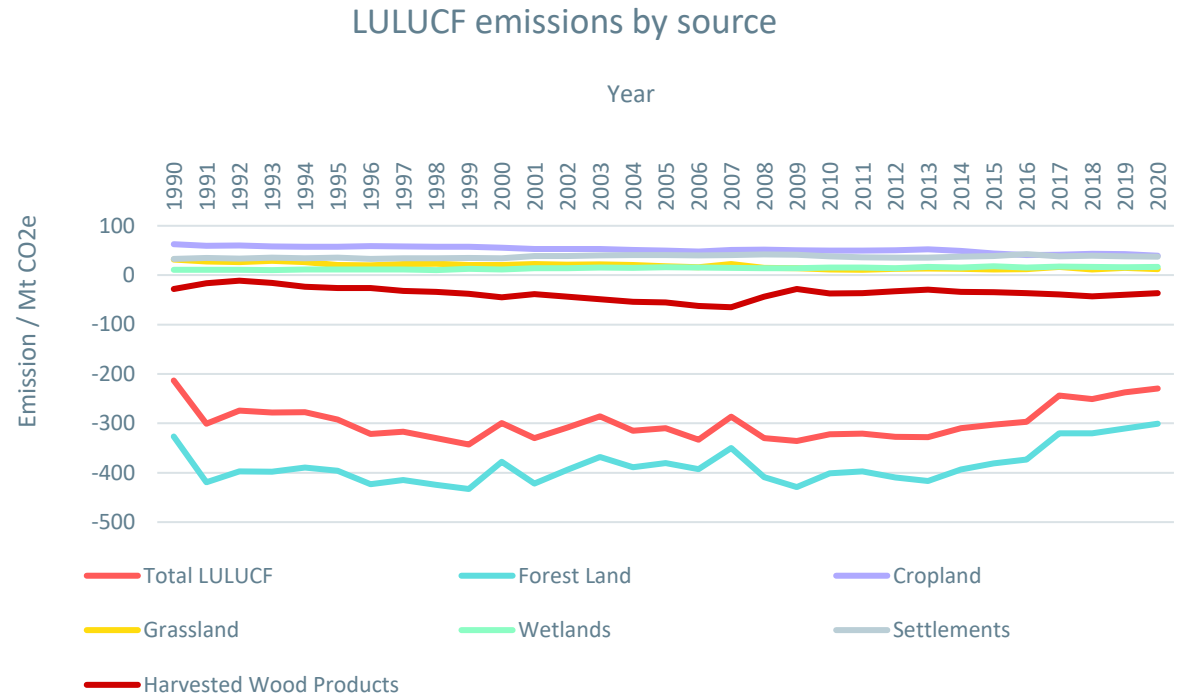


Figure 2. LULUCF emissions by source (EEA)

Aim of the report

This report seeks to:

- **highlight** the role played by both **natural and technological removals** in the national LTSs of the 22 EU member states who had submitted their strategies by 31st of August 2022,
- **highlight the measures** in the LULUCF sector, and the intersections that exist in relation to **bioeconomy, agriculture, and climate adaptation**,
- draw out **comparisons and critical issues** across the plans of the Member States as a whole and establish an overarching picture of the role negative (or avoided) emissions can play in tackling the climate crisis in Europe.

Emissions removals must not be used as an alternative to rapid mitigation!



Methodology

1. General information (Publication date, length, goal of climate neutrality)
2. Current emissions/removals in the LULUCF sector and future projections
 - Size of current emissions/removals (WEM)
 - Projected emissions/removals based on the EU Reference Scenario

3. Modelling and Targets

Quantitative metrics on emissions/removals:

- Sink requirements (targeted removals to reach climate neutrality (if specified) as percentage or value)
- Inclusion of modelling projections
- Differentiation by removal type (natural vs technological solutions requirement for carbon neutrality)

4. LULUCF

- Separate sector or integrated with agriculture
- Extent of description for agriculture, overlaps with LULUCF, adaptation measures

- Inclusion and description in the LTS
- General targets (qualitative and quantitative) and proposed measures

5. Bioresources

- Inclusion and description in the LTS
- General targets (qualitative and quantitative)

6. CCS/CCU

- Inclusion and description in the LTS
- General targets (qualitative and quantitative)
- Discussion regarding research, funding and sectors targeted

7. DAC/BECCS

- Inclusion and description in the LTS
- General targets (qualitative and quantitative)
- Discussion regarding research

Modelling/Targets for Climate Neutrality

Can we estimate **minimum sink requirements** for each country?

We used a standardised approach from the LTSs:

- If specified, the value from the LTS was used (based on most ambitious modelling scenario / target)
- If no direct modelling or LULUCF target was included, the targeted emission reduction (excluding LULUCF) to reach climate neutrality was used
- For less ambitious targets than climate neutrality by 2050, outstanding emissions were also added
- If no clear emission reduction target was given, an 85% reduction on 1990 levels was used (excluding LULUCF). This was also applied for countries that do not yet have a published strategy.
- Remaining emissions (*e.g.*, 15%) inform the size of the needed sink for climate neutrality
- Any specified values for technological removals / options were added on to the required sink.

The obtained values could then be compared to the EU Reference scenarios 2020 for the LULUCF sector

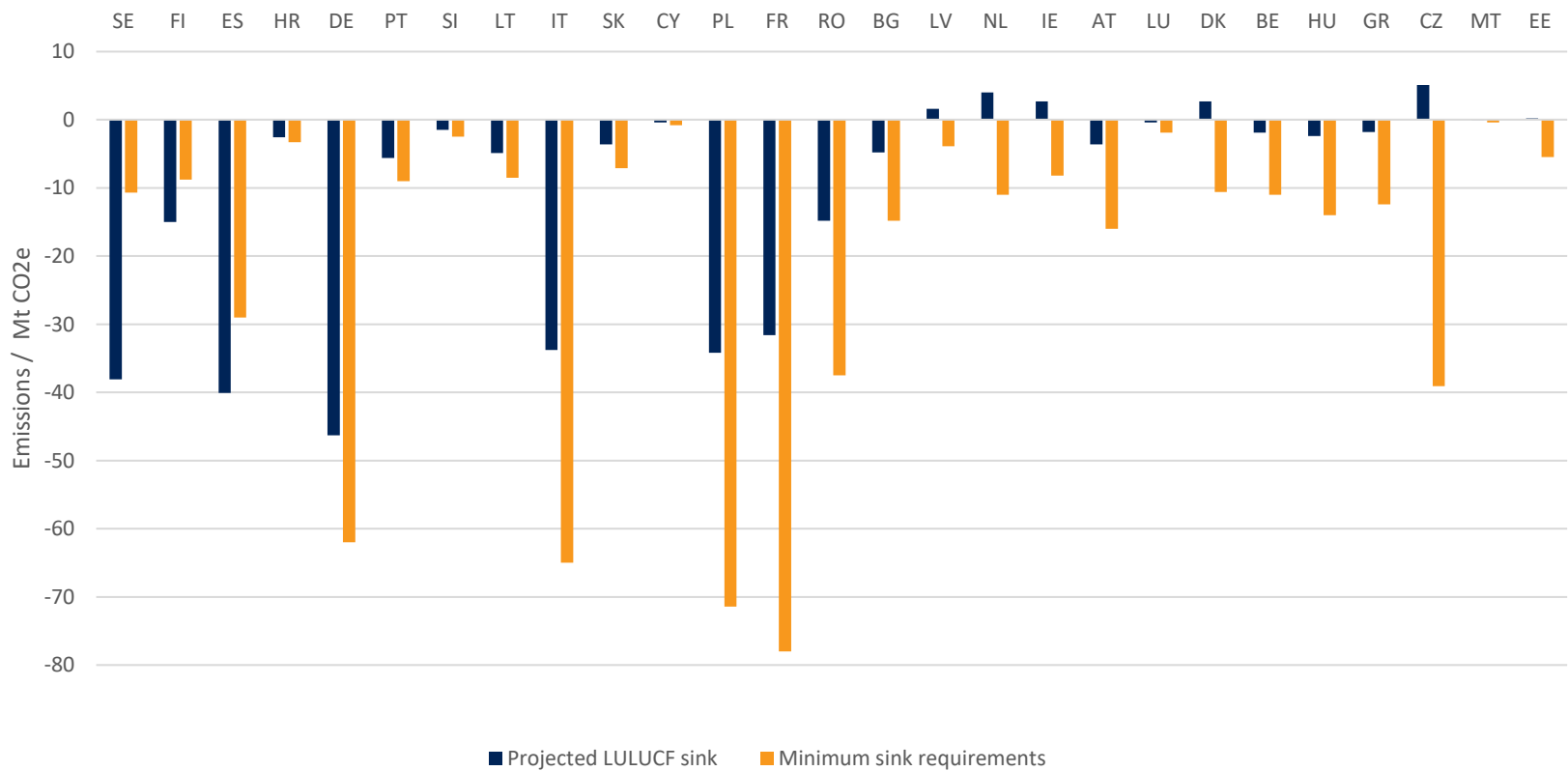
Many uncertainties – simply aim to establish **an approximation for each country**

Modelling/Targets for Climate Neutrality

Country	Reduction (year)	Method	Country	Reduction (year)	Method
Austria	80 % (1990)	Modelling	Belgium	85 % (2005)	Target
Bulgaria	85 % (1990)	Assumption (no LTS)	Croatia	89.4 % (1990)	Modelling
Cyprus	85 % (1990)	Assumption (No LTS)	Czech Republic	80 % (1990)	Target
Denmark	85 % (1990)	Assumption	Estonia	85 % (1990)	Assumption
Finland	87.5 % (1990)	Modelling	France	83 % (2015)	Modelling
Germany	95 % (1990)	Target	Greece	95 % (1990)	Modelling
Hungary	88 % (1990)	Modelling	Ireland	85 % (1990)	Assumption (no LTS)
Italy	87.5 % (1990)	Modelling	Latvia	85 % (1990)	Assumption
Lithuania	≥80 % (1990)	Target	Luxembourg	85 % (1990)	Assumption
Malta	80 % (1990)	Target	The Netherlands	95 % (1990)	Target
Poland	85 % (1990)	Assumption (no LTS)	Portugal	90 % (2005)	Modelling
Romania	85 % (1990)	Assumption (No LTS)	Slovakia	90 % (1990)	Modelling
Slovenia	90 % (2005)	Modelling	Spain	91 % (1990)	Modelling
Sweden	85 % (1990)	Target			

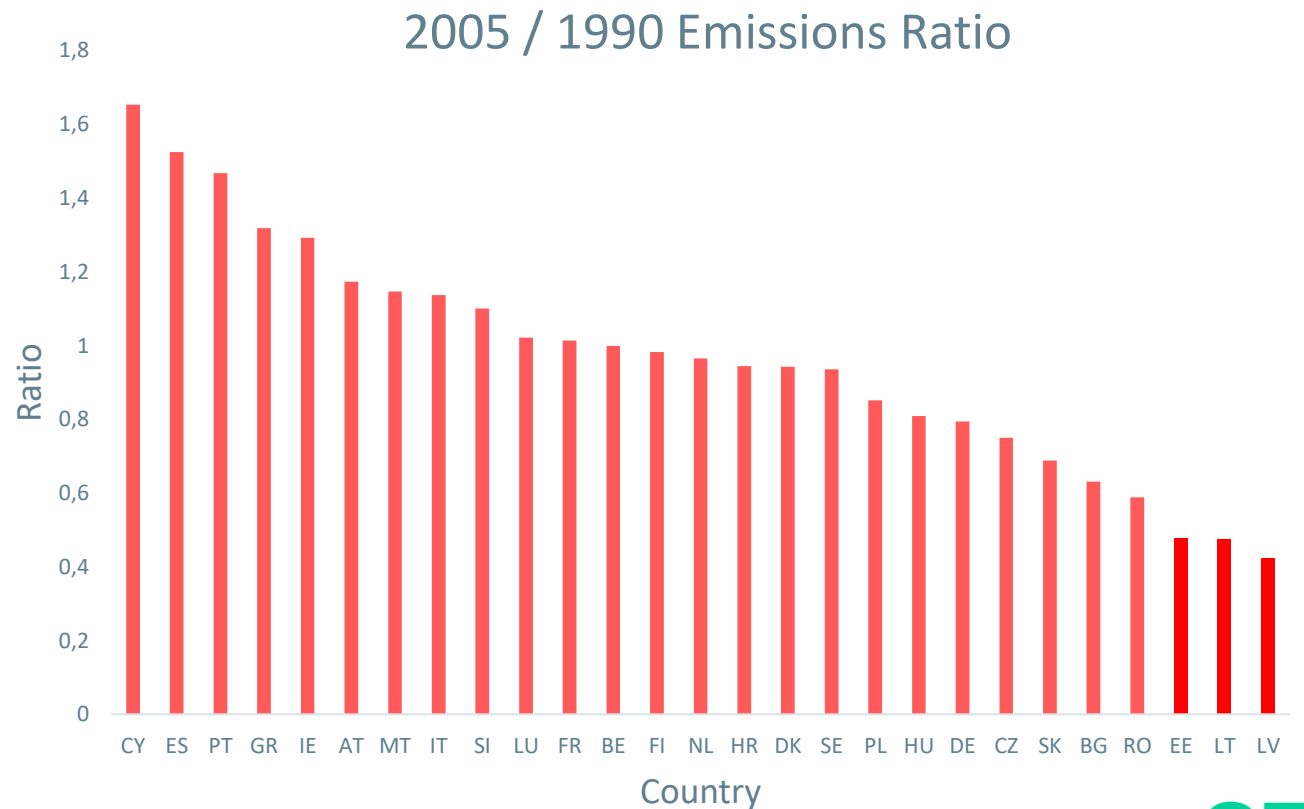
Comparing targeted and projected sinks

Comparison of projected LULUCF sink in 2050 and estimate of total required sink for neutrality



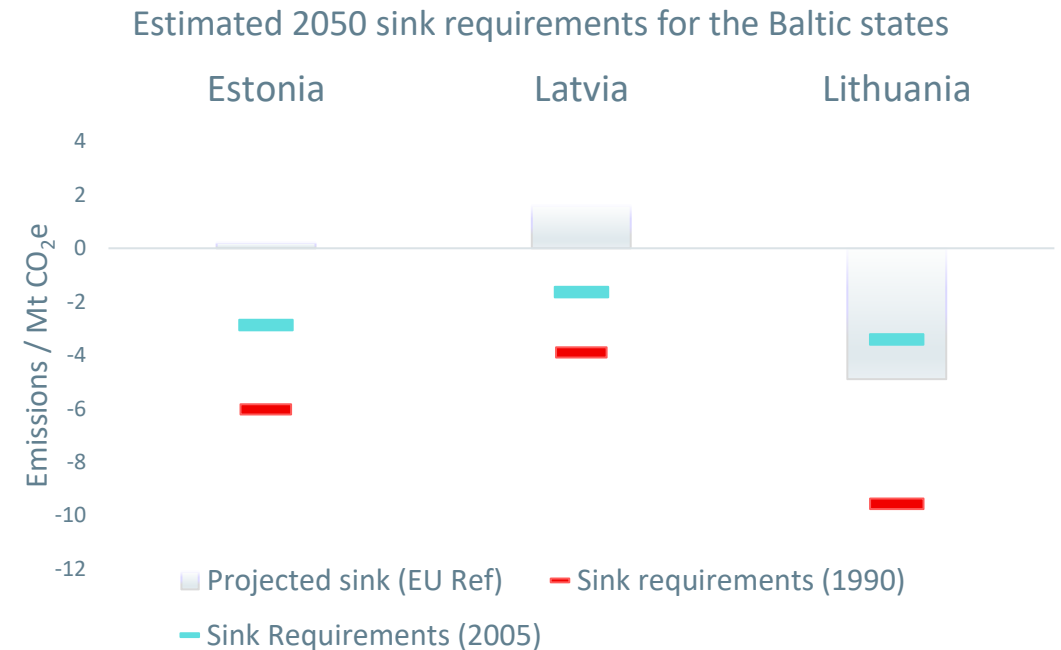
Caveat: analysis is very simple!

- For example, 1990 is not a good reference for the Baltic states
- What if we update the targets to 85% reduction on 2005 levels?



Caveat: analysis is very simple!

Country	Total Emissions 1990 / Mt CO ₂ e	Total Emissions 2005 / Mt CO ₂ e	Sink 85 % (1990) / Mt CO ₂ e	Sink 85 % (2005) / Mt CO ₂ e
Latvia	26	11	-3.9	-1.6
Lithuania	48	23	-9.6	-3.4
Estonia	40	19	-6.0	-2.9



Still only Lithuania is 'on track' using EU reference scenario projections

How do the countries compare?

Sink 'on track' for climate neutrality	Sink 'within reach' of climate neutrality	Sink 'off track' for climate neutrality	
<ul style="list-style-type: none">• Sweden• Finland• Spain	<ul style="list-style-type: none">• Croatia• Germany• Portugal• Slovenia• Lithuania• Italy• Slovakia• Cyprus	<ul style="list-style-type: none">• Poland• Romania• Latvia• Republic of Ireland• Luxembourg• Belgium• Greece• Malta	<ul style="list-style-type: none">• France• Bulgaria• The Netherlands• Austria• Denmark• Hungary• Czechia• Estonia

Simple sink analysis

- Countries vastly differ in sink/emissions sizes. For example, **Sweden, Spain, and Italy** have LULUCF sectors that are currently net sinks and are projected to remain so until 2050. On the other hand, **Denmark, the Netherlands, and the Republic of Ireland** are projected to have net emissions expected across the period up to 2050, consistent with the situation since 1990.
- Out of the countries with projected net sinks, only **three countries were found to have sinks of the necessary magnitude in 2050** based on the 'EU Reference Scenario' – **Spain, Finland, and Sweden.**
- There were countries with significant trends of change, for example, **Estonia and Latvia** have seen recent decreases in their sink sizes, and the LULUCF sector has become a **source of net emissions**. These sinks are not expected to fully recover by 2050 according to the reference scenario.

LULUCF sector overview

How is LULUCF included?

Separate section	Integrated with agriculture	Not included
Belgium, Croatia, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Luxembourg, Slovakia, Slovenia, Spain, Sweden	Austria, Czechia, Latvia, Malta, Portugal, The Netherlands	Denmark, Greece

Common aspects

Land-Planning	Afforestation / Reforestation	Monitoring
Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Italy, Luxembourg, Portugal, Slovenia, Spain	Croatia, Czechia, Denmark, Finland, France, Germany, Hungary, Lithuania, The Netherlands, Portugal, Slovakia, Spain	Belgium, Croatia, France, Hungary, Luxembourg

But the **length and detail** of the LULUCF sections has great variation!

Forestry

- Forests make up **the biggest (or only)** part of the sink
- **Afforestation or reforestation** - most of the strategies
 - Few provided **quantitative targets for forest cover** (Hungary, Spain, Sweden, Portugal).
 - Some small countries – **Malta, Luxembourg, and the Netherlands** – highlighted the **difficulties in increasing tree coverage due to space constraints**.
- Forest management practises, the age structure and quality of the forest may be of greater importance than forest cover!
- **Sink stability was hardly included at all** (except **Austrian and French LTSs**).
- Nearly all countries call for **improved forest management/sustainable forestry** – but often lack in specifics
 - reductions in burned areas – **5 countries**
- Many countries call for the development of **mixed forests of native species** – climate change resilient species – overlaps with adaptation (Luxembourg)

Other land categories

- **wetlands and peatlands** were included the most
- All countries plan to **halt degradation or enhance restoration of wetlands** (or otherwise limit peat extraction)
- Some discussion of **permanent grasslands and croplands**, but to a lesser extent (*e.g.*, Belgium, Luxembourg).
 - efforts **to increase the size or carbon content**
 - numerical details were **rarely included**
- **Cropland, settlements, and other land** were rarely discussed

Country	Land category	Details
Austria		
Belgium	Wetlands, grasslands	Measures (descriptive)
Croatia	Grassland, cropland, wetland	Description
Czechia	Wetlands	Measures (descriptive)
Denmark		
Estonia	Wetlands	Measures (descriptive)
Finland	Wetlands	Description (projection)
France		
Germany	Wetlands, grasslands	Measures (prescriptive), Target
Greece		
Hungary	All	Description (projection)
Italy		
Latvia	Grassland, cropland, wetland	Description (projection)
Lithuania	Wetlands, grasslands	Target
Luxembourg	Wetlands, grasslands	Measures (descriptive)
Malta		
The Netherlands	Wetlands	Description, measures (descriptive)
Portugal	All	Description (quantitative)
Slovakia	All	Description (projection)
Slovenia	All	Description (quantitative), measures (descriptive)
Spain	Wetlands	Description (projection), target
Sweden	All	Description, measures (prescriptive)

Intersections – agriculture, biodiversity, and adaptation

- **Adaptation: Spain** describes the measures the most comprehensively, as well as the interactions between adaptation/mitigation
 - **Portugal, Slovakia, Slovenia and Sweden** also have quite extensive discussion on adaptation.
- **Agriculture: Luxembourg, Slovakia and Slovenia** had the most comprehensive LTSs in these terms. Several countries mention agroforestry.
- **Biodiversity: Slovenia and Belgium** put the most focus on biodiversity in their strategies.
- **Equal focus on the topics:** The **Belgium and Croatian** LTS's are good examples of a **comprehensive strategy**, that equally describes the different sectors (agriculture, biodiversity, bioresources, adaption etc) and the overlaps between them.
 - **Belgium** has a separate section in the LTS about **adaption in the agricultural sector**
 - **Austria** sees the three sectors (biodiversity, mitigation, bioresources) as **competitors and highlights a need to find a balance between them**, however, these could be developed simultaneously.

Increased use of bioresources?

- **Almost all countries plan to increase the use of bioresources**, although some to a bigger extent (**Greece**) than others (**Finland**).
- Some do not give information (**the Netherlands, Malta, and Hungary**) or indicate this clearly (**Germany, Luxembourg**)
- **Finnish and Danish** strategies foresee a modest increase or a stagnation until 2050

Many countries (*e.g.*, Croatia, Latvia) state they want to develop their bioeconomy **sustainably** while not compromising other goals like food sufficiency, biodiversity *etc.*

However, developing bioeconomy results in **greater land use**.

Bioresources – hierarchy of sustainability

- Many countries see **increasing the share of wooden long-lived products** as an alternative to carbon intensive products (*e.g.*, France, Belgium, Croatia, Czechia).
- Although some countries **see more potential in energy use** and mainly discuss this (*e.g.*, Greece, Portugal, Estonia, Denmark).
 - **Use of biomass in district heating systems** is predicted to increase, while consumption in households will decrease (**Croatia, Hungary**).
 - Negative effects of biomass combustion (PM 2.5) - **Lithuania, Portugal and Slovakia**
- **Bioenergy from cultivated crops will decrease**, waste and residues will gain importance (Germany, Greece, Luxembourg, Latvia)
- In the transport sector main potential is seen in **aviation and shipping** (*e.g.*, Sweden, Portugal, the Netherlands, Latvia, Italy)

Bioresources – conflicts

Some countries have potentially **conflicting targets** for bioresources and natural sinks

- Denmark plans to **simultaneously increase the share of forests and bioenergy-based electricity production**, no details on source
- Italy plans to **fully exploit** the potential of biomass, while **emphasizing the importance of sustainable forest management**

Luxembourg states that without new options, the use of biomass will be limited due to the availability of raw materials

Technological options : CCS / CCU

- Coverage varies significantly between countries (as with other sections!)
- Some countries directly rely on CCS for climate neutral models whilst others are highly sceptical
- Mostly targeted for industry (cement, steel, ...)
- Distinction between removals (e.g., BECCS) and options is often highly opaque

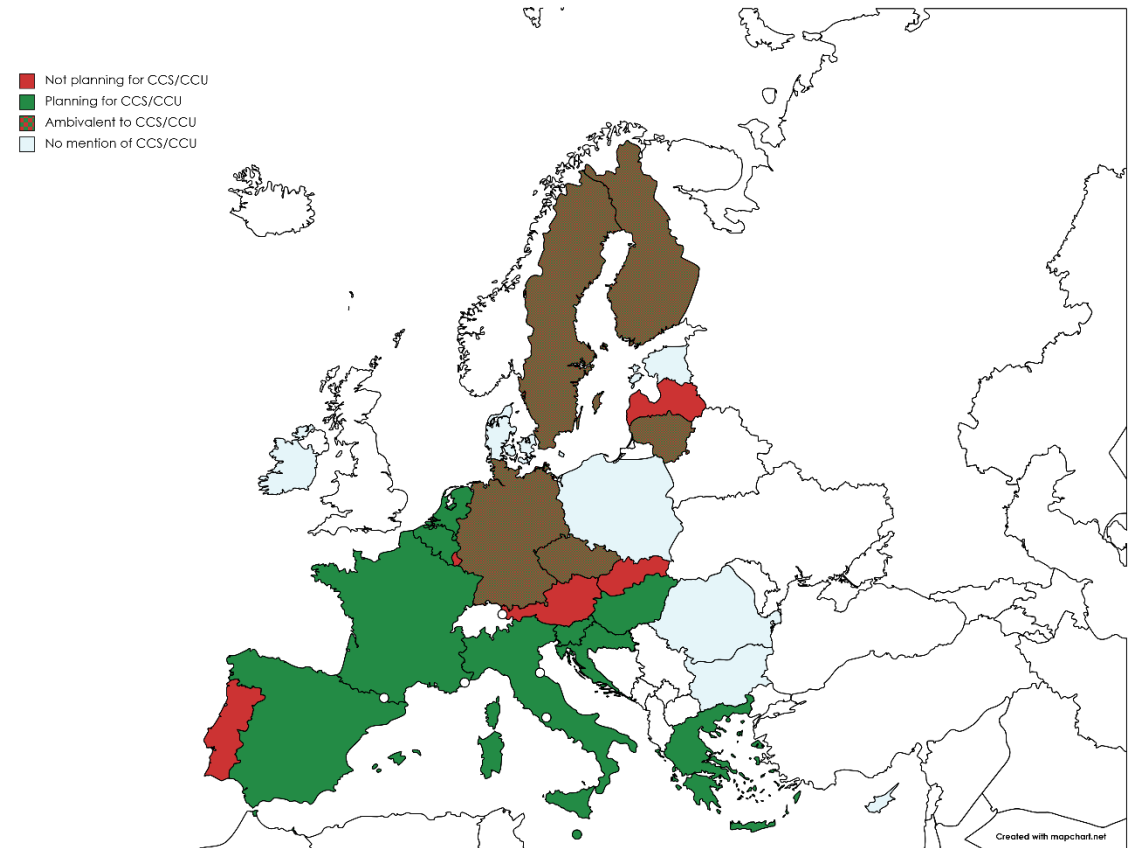


Figure 9. Countries' plans for CCS/CCU

CCS / CCU: Sectoral insights

Country	Plans to use CCS/CCU	Sector(s)	Details
Hungary	Yes	Energy, Industry	Included in both neutrality scenarios (and BAU) 10 Mt CO ₂ e removed in 2040 and 2050 (-2 in 2030). Emphasis on R&D. Only available after 2030 due to current cheaper alternatives Utilisation for fuels and H ₂ (limited storage capacity)
Portugal	No	Industry (cement)	Only viable for cement sector But changes to the sector may lead to impact being too low Utilisation for fuel not cost-effective
France	Yes	Industry	Targeted for 6 Mt CO ₂ e in 2050 – used as soon as conditions allow Limited use with existing infrastructure, but could be a technology export Storage emphasised (large capacity)

Technological removals: BECCS and DAC

- Referenced less often than CCS/CCU (9 countries in total)
- Mostly descriptive, but possible some CCS actually BECCS
- DAC referenced very rarely (Netherlands, Hungary....)

Country	Plans to use BECCS	Details
Portugal	No	Not cost effective based on current technology But EU research priority area
Finland	~	14 Mt CO ₂ e removed in one climate neutrality scenario Not needed in the other scenario that reaches climate neutrality
France	Yes	10 Mt CO ₂ e removed by 2050 Requires centralised biomass Technology uncertain, but likely needed with geological storage for long-term removal

Technologies

- Regarding technological solutions, more focus is clearly put on CCS/CCU rather than BECCS/DAC. However, the distinctions are not always clear from the strategies.
- **Views on CCS/CCU vary greatly.** 10 of the 20 countries that included CCS and CCU appear to view it positively and have some plans for its deployment in the future, however all assert that more research is needed. Countries like France focus more on storage and Hungary, for example, on utilization. Industrial processes such as cement production are the most common areas for which these technologies are targeted.
- The requirement for such technologies reflects levels of mitigation. Based on the current mitigation pledges included in the LTS's and expected required sinks in the 'EU Reference Scenario', most countries cannot reach climate neutrality only through natural sinks. The pan-EU scenarios that reach climate neutrality foresee technological removals or avoided emissions of at least 300-500 Mt CO₂ in 2050. Inter-nation trading in the form of flexibility mechanisms could help achieve union-wide goals.

Recommendations

- While updating the strategies, all countries should **specify the total reductions and targeted sink size** (in absolute terms) in their LTS's to reach climate neutrality.
- **Sink stability** is one key topic missing from the LTS's that has a great influence on the sink and emissions size, which **should be included by all countries in the future**.
- **Better integration with biodiversity** is necessary.
- Countries could **elaborate more on their proposed measures** and how the goals set in the LTS's will be achieved.
- Countries should **put more focus on other land use categories** besides forests as well.
- After revising their strategies, **agriculture and LULUCF should be combined** rather than viewed separately as they have **great overlaps and interaction**. Same goes to **adaptation and use of bioresources** – the topic cannot be viewed with **tunnel vision** only in terms of sink size.

Recommendations

- **Better distinction between CCS/CCU and DAC/BECCS is necessary.** Currently, it is sometimes unclear what kind of technologies the countries plan to use. **Sweden** uses 'negative emissions technologies', **France** is a good example.
- While **emphasis should be on ambitious mitigation and enhancement of carbon sinks**, countries still could make better use of **collaboration** (trading scheme) to reach the common goals. **Sweden** has enough resources to meet requirements of **Malta** as well. The only country who already mentioned this in their LTS was **the Netherlands**.
- Collaboration can also be useful for other activities, such as **better digital monitoring systems**. Hungary and Luxembourg wish to develop **maps of ecosystem services and forest biotypes**, respectively. As this has already been developed in Estonia, good practises could be shared.

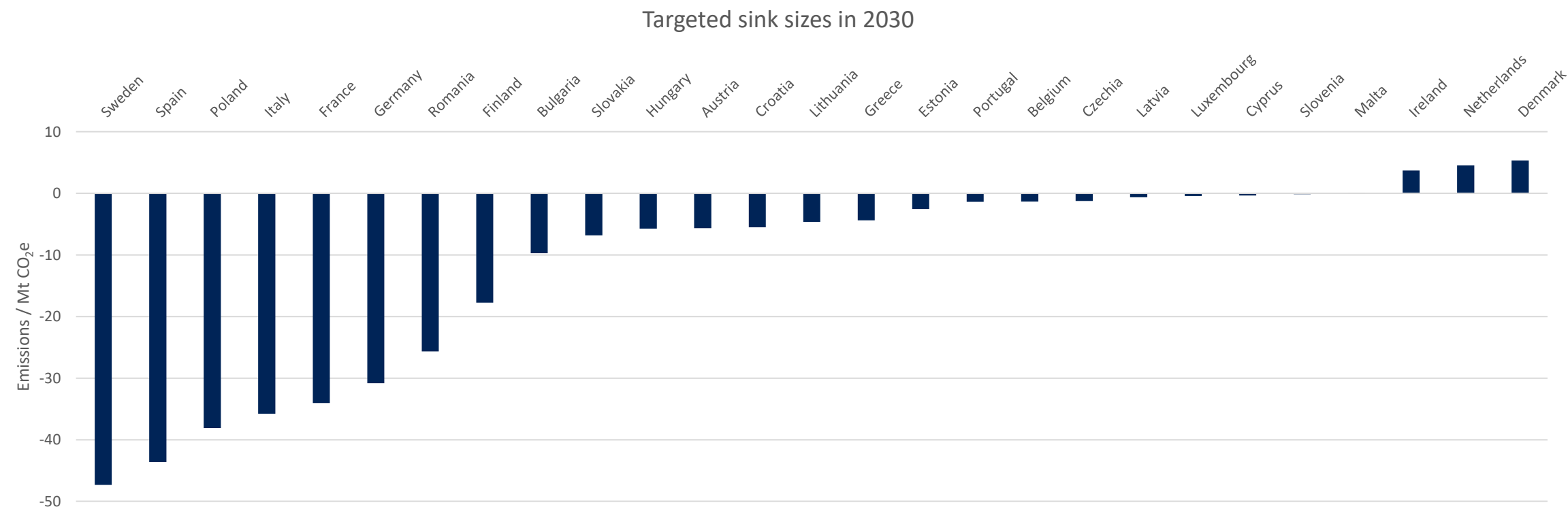
Panel discussion

- **Dr. Hannes Böttcher**, senior researcher and team leader of the group Biogenic Resources and Land Use, Öko-Institut, Germany
- **Kädi Ristkok**, Head of Climate, Ministry of Environment, Estonia
- **Dr. Marina Vitullo**, researcher at the Institute for Environmental Protection and Research (ISPRA), Italy

Thank you!

The analysis "**Carbon Dioxide Removal options in the National Long-term Strategies of EU Member States: visions for sustainable land use and reaching carbon neutrality**" will be published at www.climatedialogue.eu on Thursday.

Targeted sink sizes in the EU based on Fit for 55



BUT....Without further intervention, the size of the LULUCF sink is projected to decrease further!

Natural Carbon Sinks

Forests

- Generally, faster growing tree species absorb more carbon but die quicker
- Sustainable wood use needed to store carbon long-term
- Unmanaged forests can store carbon long-term but sequester slowly

Wetlands

- Wetlands have large carbon stocks but sequester slowly
- Restoration does not fully compensate over short timescales
- Conservation > Restoration

LULUCF in the EU

- Importance of forests to the carbon sink has persisted since **at least 1990** – but not all forests are the same!
- Reduction in sink size is caused by reducing forest sink
- Projections suggests sink size will not increase significantly

Total LULUCF emissions vs Forest land emissions in the period 1990 - 2020

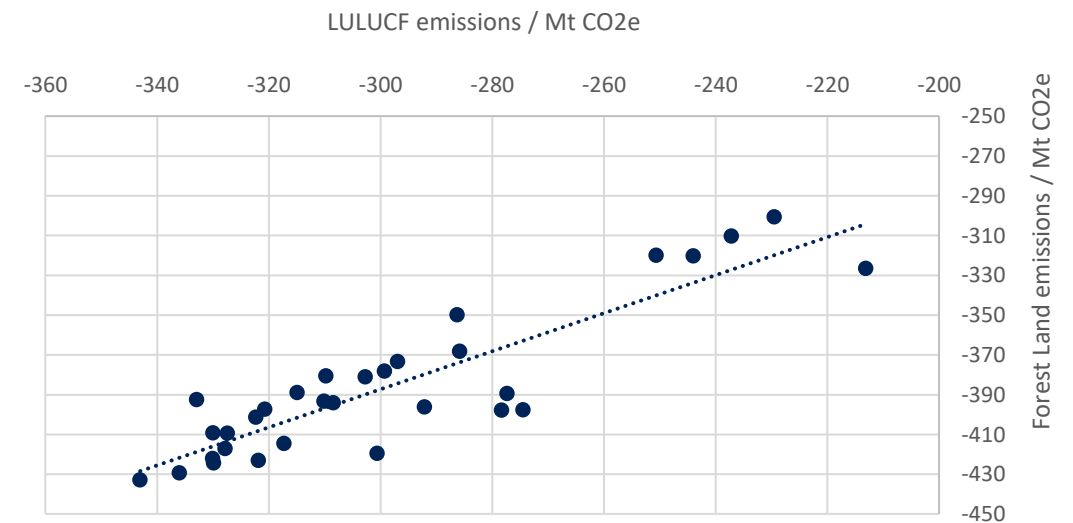
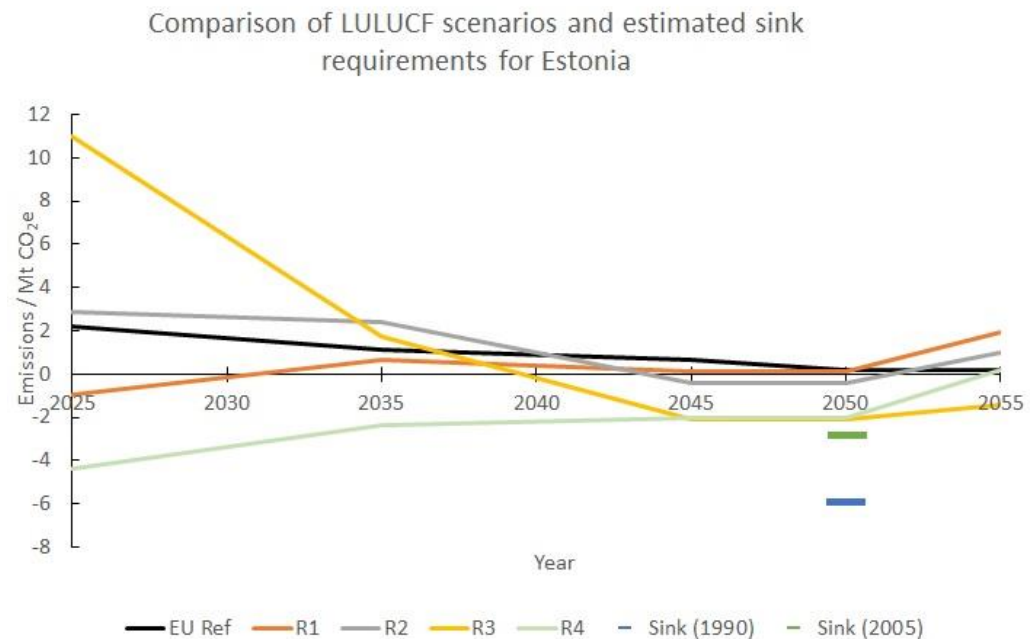


Figure 3. Total LULUCF emissions vs Forest land emissions in the period 1990-2020

Improving the estimates

- The projections from a recent study¹ were used
- Scenarios R3 and R4 come close to requirements for an 85 % reduction from 2005 levels
- But uncertainties about sink stability long term



1. Projections from Valgepea, M., Raudsaar, M., et al . 2021. Maakasutuse, maakasutuse muutuse ja metsanduse sektori sidumisvõimekuse analüüs kuni aastani 2050.

Why 85 % of 1990?

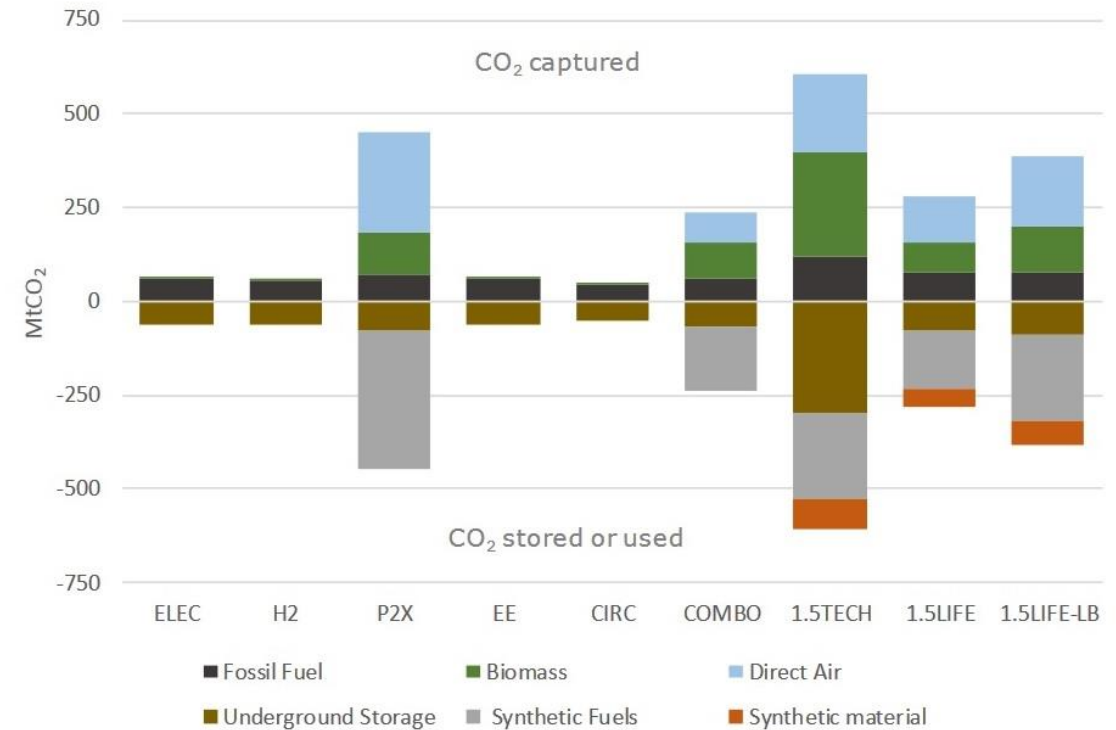
- Median and mean of countries that have given targets was around 86 – 87 %.
- This was simply rounded to 85 %
- Changing the value to 87.5 % will not significantly alter the results

	Targeted / modelled reduction		
	1990	2005	2015
Austria	80		
Finland	87.5		
Germany	95		
Hungary	88		
Italy	87.5		
Lithuania	80		
Malta	80		
Slovenia	89	90	
Sweden	85		
Belgium	85	85	
Croatia	89.4		
Czech Republic	80		
France	85.7		83
Greece	95		
Latvia	85		
The Netherlands	95		
Portugal	85.3	90	
Slovakia	90		
Spain	91		
Median	87.5		
Mean	87.0		

Technological options and removals

We define two forms of 'technological sinks':

1. Removals from point sources
Carbon capture and Storage / Utilisation (CCS/CCU)
Emissions are avoided (never 100 % effective)
2. Diffuse Removals
Bio-energy with Carbon Capture and Storage (BECCS)
Direct air capture
....
Emissions are removed



Source: PRIMES.

Carbon capture in 'Clean planet for all' scenarios

Other issues: Storage capacity and research

- Nearly all countries call for additional research into CCS/CCU ... but lack specifics
- Targeted annual sequestration provided more often than absolute storage capacity....

Country	Geological storage capacity
Austria	400 – 510 Mt CO ₂
France	1 – 1.5 Gt CO ₂ (on land)
Greece	140 Mt CO ₂
Hungary	Limited
The Netherlands	High

DAC: Sectoral insight

- DAC referenced very rarely (Netherlands, Hungary....)

Country	Plans to use BECCS	Details
Portugal	No	Not cost effective based on current technology But EU research priority area
Finland	~	14 Mt CO ₂ e removed in one climate neutrality scenario Not needed in the other scenario that reaches climate neutrality
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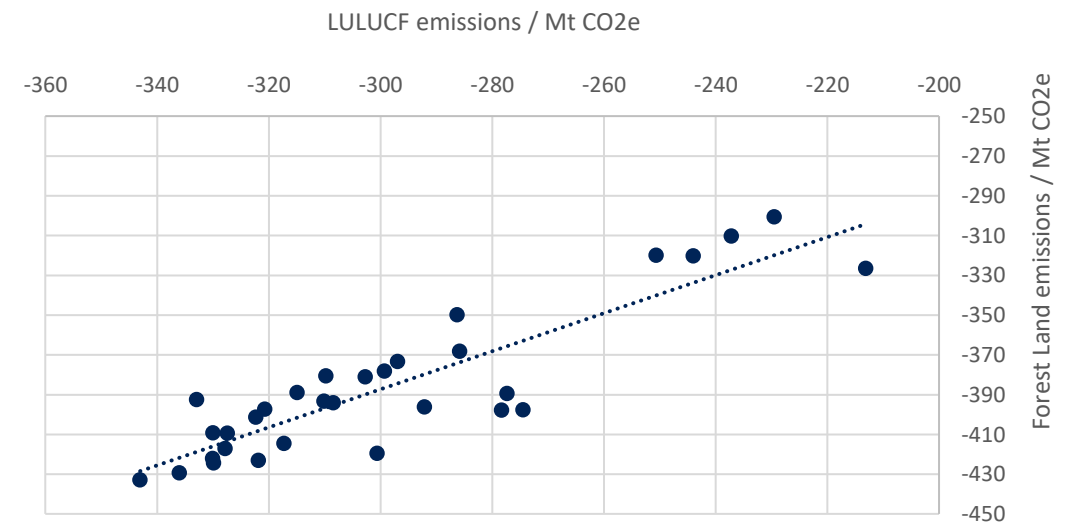
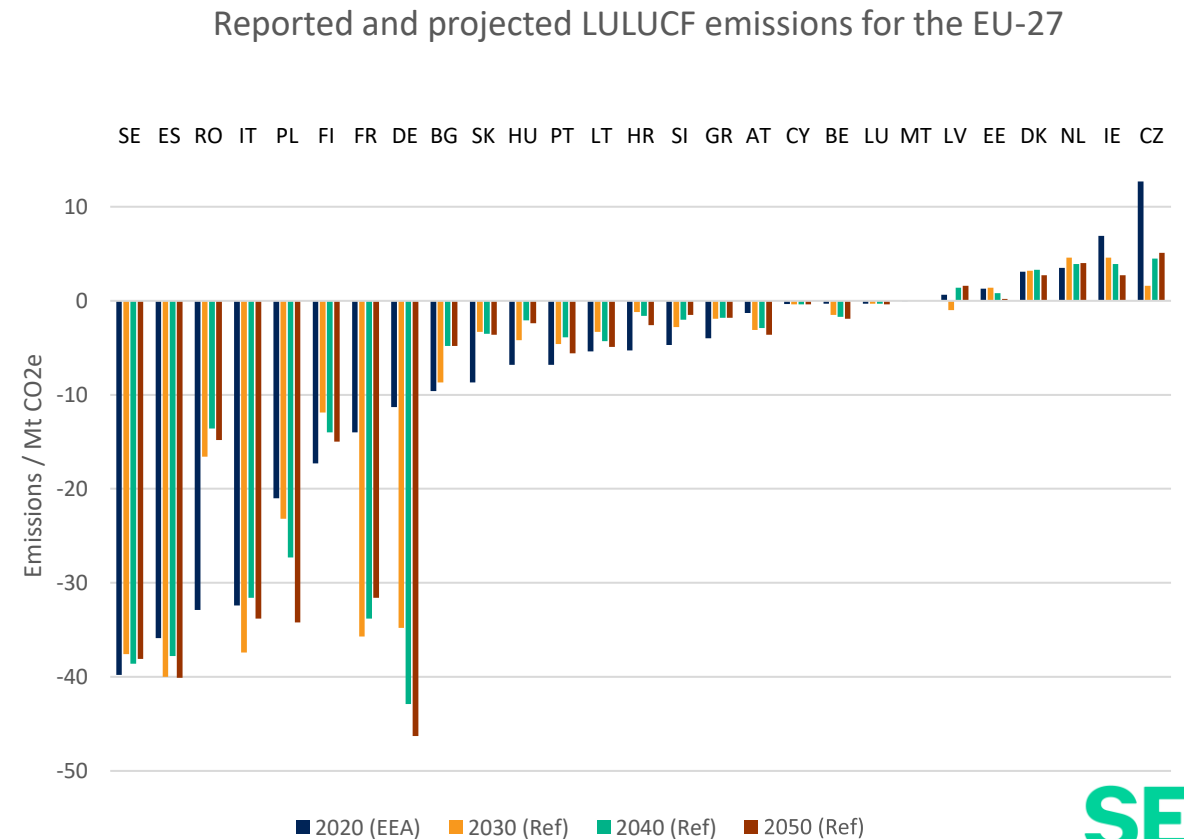


Figure 3. Total LULUCF emissions vs Forest land emissions in the period 1990-2020

LULUCF at the national level

- EU Reference scenario 2020 includes projected LULUCF emissions
- Full coverage of member states at 5-year intervals
- Some sinks stable whilst others show large increases / decreases



Details on reference scenarios 2020 [available here](#)

Figure 6. Reported and projected LULUCF emissions for the EU-27

Diffuse removals - DAC

Sectoral insights

Country	Details
The Netherlands	Atmospheric removals will be necessary to keep to 1.5 °C Role of the country has to be determined in a global context
Hungary	Must be applied at large scale to drive down costs
Belgium	States that it should be considered

Whether and to what extent countries propose to rely on technology – of whatever form – is a pressing key question.