IEA Bioenergy
Technology Collaboration Programme






Task 45 - Climate and sustainability effects of bioenergy within the circular bioeconomy

“Metod-annexet” inom IEA Bioenergy

Task 38: 1995-2018

Klimat

Task 45: 2019 ->

Hållbarhet

Brasilien	(Australien)
Danmark	(EC)
Finland	(Frankrike)
Holland	(Italien)
Irland	(Norge)
Kina	
Schweiz	
Sverige	
Tyskland	
UK	
USA	
Österrike	

“Metod-annexet” inom IEA Bioenergy

Key objectives of work programme
1. Develop, refine, compare and promote **methods and data for assessing the climate and sustainability impacts** of bioenergy systems
2. Identify how **regulatory systems** governing land use and bioenergy supply chains can be improved in terms of their **ability to monitor, assess and promote** the achievement of economic, social and environmental objectives of landowners, biomass users and society as a whole
3. Promote **international cooperation and dialogue** to develop common views on key **technical and methodological issues.** Discuss and further develop **governance models.**
4. Assist decision-makers in identifying and promoting **implementation strategies that reflect the local/regional context** and relevant legislative and policy developments, taking a **systems perspective.**

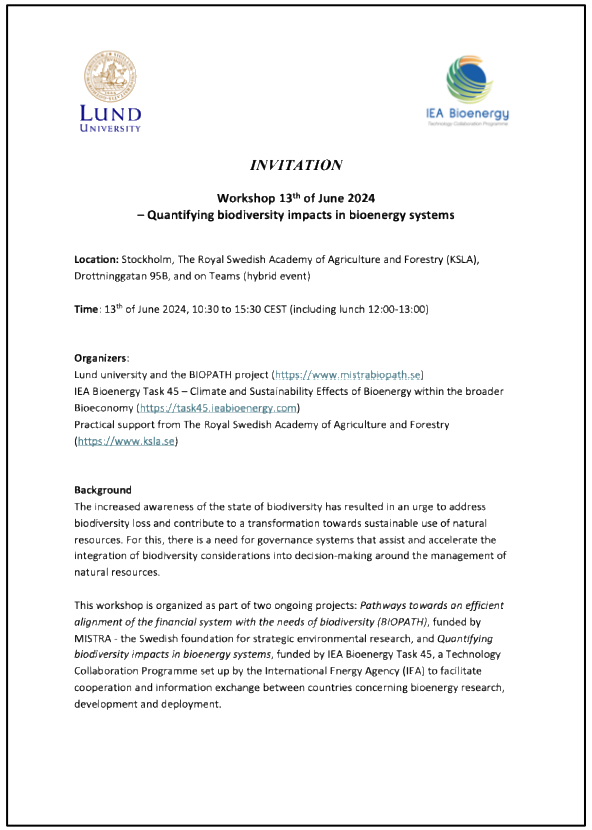
“Metod-annexet” inom IEA Bioenergy

2025-2027: tre temaområden

Work packages
WP1 – Land Enhance the knowledge in identifying, planning and implementing sustainable land use systems that support biodiversity while providing biomass and other ecosystem services to society
WP2 – Systems Refining, demonstrating and disseminating methods and tools for assessing the climate and sustainability effects of bioenergy and other bio-based systems through time.
WP3 – Governance Analyse governance instruments relevant to the biobased economy and bioenergy systems and to support their implementation by policy makers and industry

Några exempel på aktiviteter & publikationer

Quantifying biodiversity impacts of bioenergy systems



LUND UNIVERSITY

IEA Bioenergy

INVITATION

Workshop 13th of June 2024
– Quantifying biodiversity impacts in bioenergy systems

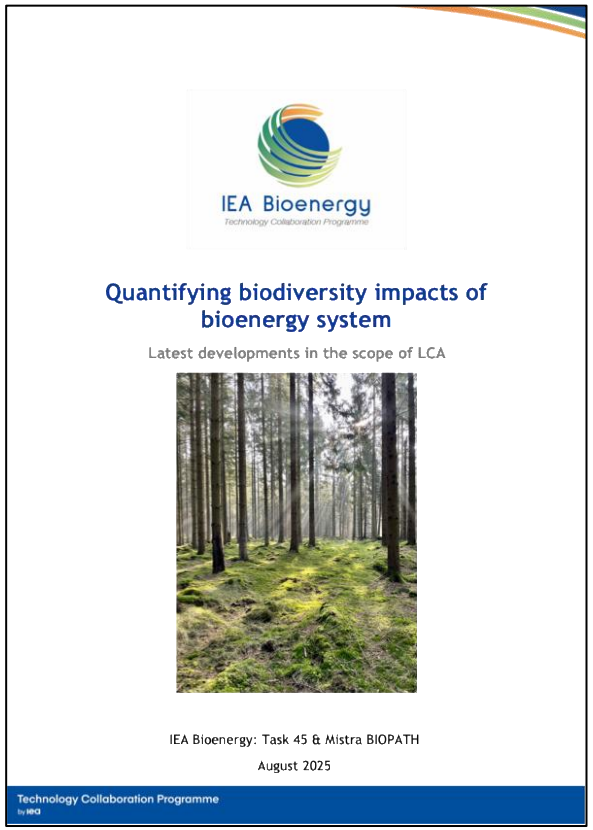
Location: Stockholm, The Royal Swedish Academy of Agriculture and Forestry (KSLA), Drottninggatan 95B, and on Teams (hybrid event)

Time: 13th of June 2024, 10:30 to 15:30 CEST (including lunch 12:00-13:00)

Organizers:
Lund university and the BIOPATH project (https://www.mistrabiopath.se)
IEA Bioenergy Task 45 – Climate and Sustainability Effects of Bioenergy within the broader Bioeconomy (https://task45.ieabioenergy.com)
Practical support from The Royal Swedish Academy of Agriculture and Forestry (https://www.ksla.se)

Background
The increased awareness of the state of biodiversity has resulted in an urge to address biodiversity loss and contribute to a transformation towards sustainable use of natural resources. For this, there is a need for governance systems that assist and accelerate the integration of biodiversity considerations into decision-making around the management of natural resources.

This workshop is organized as part of two ongoing projects: *Pathways towards an efficient alignment of the financial system with the needs of biodiversity (BIOPATH)*, funded by MISTRA - the Swedish foundation for strategic environmental research, and *Quantifying biodiversity impacts in bioenergy systems*, funded by IEA Bioenergy Task 45, a Technology Collaboration Programme set up by the International Energy Agency (IEA) to facilitate cooperation and information exchange between countries concerning bioenergy research, development and deployment.



IEA Bioenergy
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Quantifying biodiversity impacts of bioenergy system

Latest developments in the scope of LCA

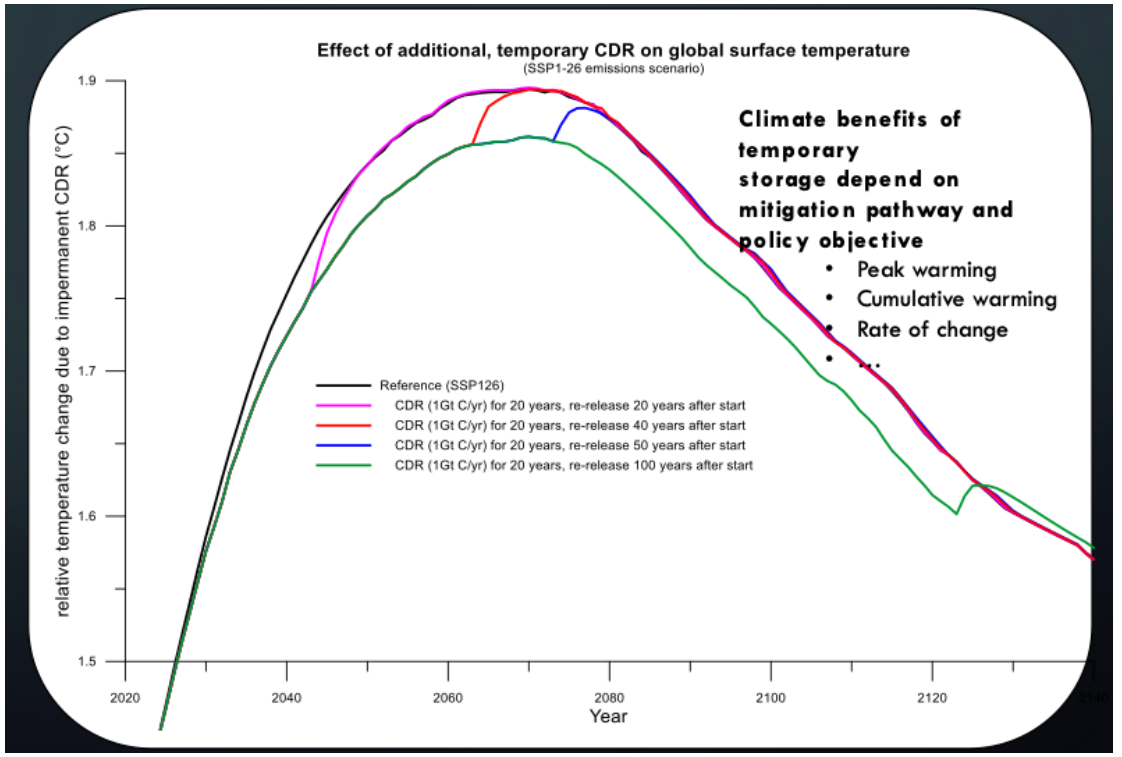
IEA Bioenergy: Task 45 & Mistra BIOPATH

August 2025

Technology Collaboration Programme

Några exempel på aktiviteter & publikationer

Timing of carbon sequestration and emissions

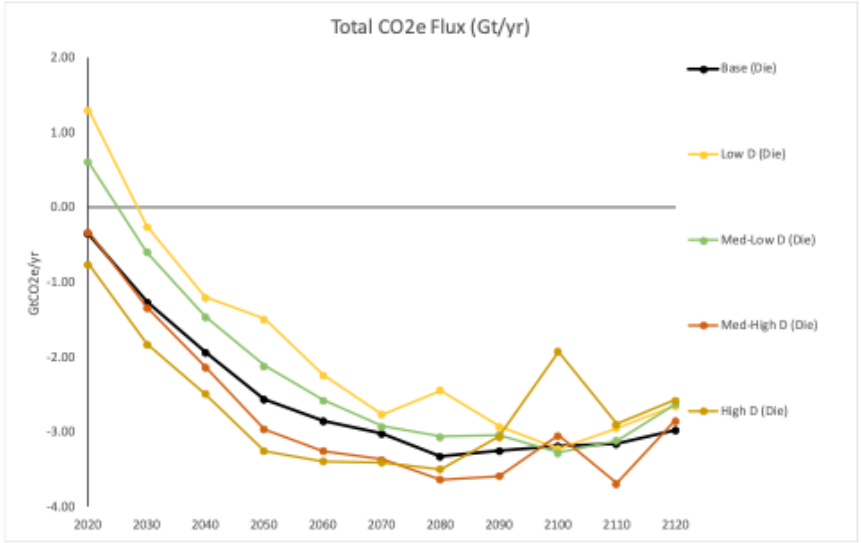


Några exempel på aktiviteter & publikationer

Forest sector responses to policies and markets and resulting impacts on carbon balances

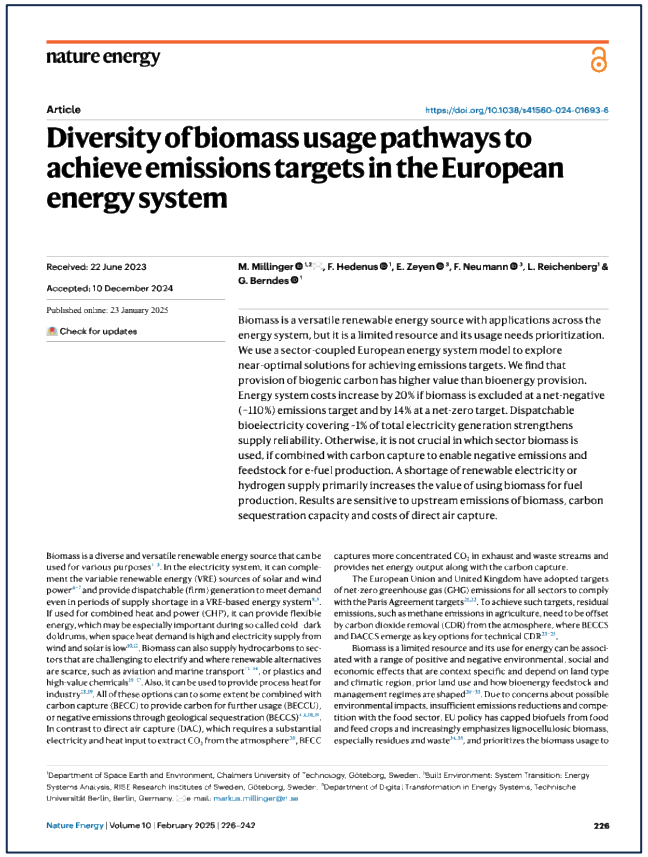
Harvest impacts on flux?

- Assess a deviation of timber harvesting over time on carbon flux.
- All else equal
- Higher demand increases flux and vice-versa.
- Suggests globally more wood consumption increases carbon flux into forests.
- Each 1 m^3 of additional wood harvest leads to about 1 ton of additional flux out of the atmosphere, but this diminishes over time.



Några exempel på aktiviteter & publikationer

Diversity of biomass uses in low-carbon energy/industry/transport sectors



nature energy

Article

https://doi.org/10.1038/s41560-024-01693-6

Diversity of biomass usage pathways to achieve emissions targets in the European energy system

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Accepted: 10 December 2024

Published online: 23 January 2025

Check for updates

M. Millinger, F. Hedenus, E. Zeyen, F. Neumann, L. Reichenberg & G. Berndes

Biomass is a versatile renewable energy source with applications across the energy system, but it is a limited resource and its usage needs prioritization. We use a sector-coupled European energy system model to explore near-optimal solutions for achieving emissions targets. We find that provision of biogenic carbon has higher value than bioenergy provision. Energy system costs increase by 20% if biomass is excluded at a net-negative (−110%) emissions target and by 14% at a net-zero target. Dispatchable bioelectricity covering ~1% of total electricity generation strengthens supply reliability. Otherwise, it is not crucial in which sector biomass is used, if combined with carbon capture to enable negative emissions and feedstock for e-fuel production. A shortage of renewable electricity or hydrogen supply primarily increases the value of using biomass for fuel production. Results are sensitive to upstream emissions of biomass, carbon sequestration capacity and costs of direct air capture.

Biomass is a diverse and versatile renewable energy source that can be used for various purposes[1–3]. In the electricity system, it can complement the variable renewable energy (VRE) sources of solar and wind power[4–7] and provide dispatchable (firm) generation to meet demand even in periods of supply shortage in a VRE-based energy system[8,9]. If used for combined heat and power (CHP), it can provide flexible energy, which may be especially important during so called cold dark doldrums, when space heat demand is high and electricity supply from wind and solar is low[10,11]. Biomass can also supply hydrocarbons to sectors that are challenging to electrify and where renewable alternatives are scarce, such as aviation and marine transport[12–14], or plastics and high-value chemicals[15–17]. Also, it can be used to provide process heat for industry[18,19]. All of these options can to some extent be combined with carbon capture (BECC) to provide carbon for further usage (BECCU), or negative emissions through geological sequestration (BECCS)[4,20,21]. In contrast to direct air capture (DAC), which requires a substantial electricity and heat input to extract CO_2 from the atmosphere[22], BECC captures more concentrated CO_2 in exhaust and waste streams and provides net energy output along with the carbon capture.

The European Union and United Kingdom have adopted targets of net-zero greenhouse gas (GHG) emissions for all sectors to comply with the Paris Agreement targets[23,24]. To achieve such targets, residual emissions, such as methane emissions in agriculture, need to be offset by carbon dioxide removal (CDR) from the atmosphere, where BECCS and DACCS emerge as key options for technical CDR[25–28].

Biomass is a limited resource and its use for energy can be associated with a range of positive and negative environmental, social and economic effects that are context specific and depend on land type and climatic region, prior land use and how bioenergy feedstock and management regimes are shaped[29–31]. Due to concerns about possible environmental impacts, insufficient emissions reductions and competition with the food sector, EU policy has capped biofuels from food and feed crops and increasingly emphasizes lignocellulosic biomass, especially residues and waste[24,32], and prioritizes the biomass usage to

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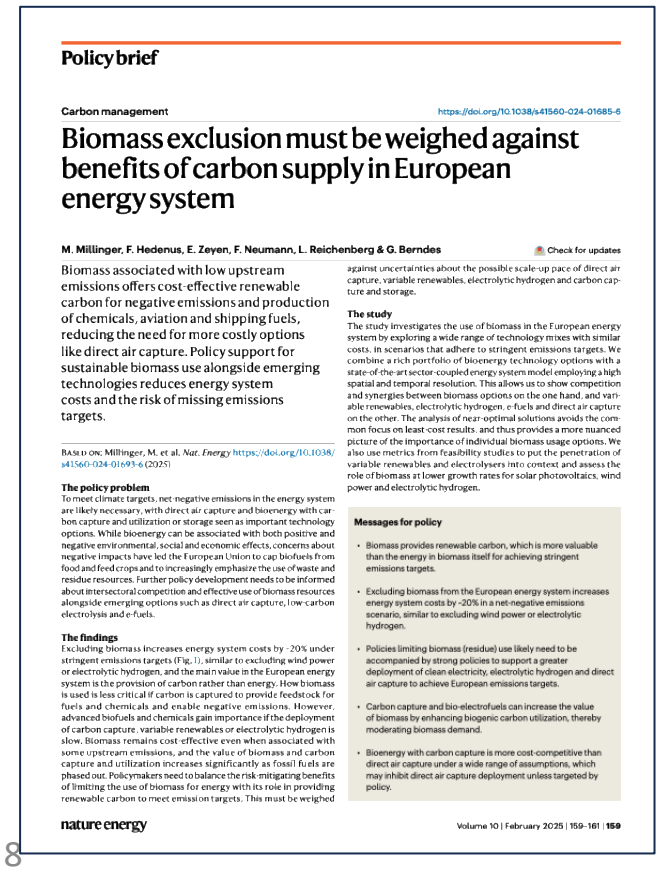

Policy brief

Carbon management

https://doi.org/10.1038/s41560-024-01685-6

Biomass exclusion must be weighed against benefits of carbon supply in European energy system

M. Millinger, F. Hedenus, E. Zeyen, F. Neumann, L. Reichenberg & G. Berndes

Check for updates

Biomass associated with low upstream emissions offers cost-effective renewable carbon for negative emissions and production of chemicals, aviation and shipping fuels, reducing the need for more costly options like direct air capture. Policy support for sustainable biomass use alongside emerging technologies reduces energy system costs and the risk of missing emissions targets.

Based on: Millinger, M. et al. *Nat. Energy* https://doi.org/10.1038/s41560-024-01693-6 (2025)

The policy problem

To meet climate targets, net-negative emissions in the energy system are likely necessary, with direct air capture and bioenergy with carbon capture and utilization or storage seen as important technology options. While bioenergy can be associated with both positive and negative environmental, social and economic effects, concerns about negative impacts have led the European Union to cap biofuels from food and feed crops and to increasingly emphasize the use of waste and residue resources. Further policy development needs to be informed about intersectoral competition and effective use of biomass resources alongside emerging options such as direct air capture, low-carbon electrolysis and e-fuels.

The findings

Excluding biomass increases energy system costs by ~20% under stringent emissions targets (Fig. 1), similar to excluding wind power or electrolytic hydrogen, and the main value in the European energy system is the provision of carbon rather than energy. How biomass is used is less critical if carbon is captured to provide feedstock for fuels and chemicals and enable negative emissions. However, advanced biofuels and chemicals gain importance if the deployment of carbon capture, variable renewables or electrolytic hydrogen is slow. Biomass remains cost-effective even when associated with some upstream emissions, and the value of biomass and carbon capture and utilization increases significantly as fossil fuels are phased out. Policymakers need to balance the risk-mitigating benefits of limiting the use of biomass for energy with its role in providing renewable carbon to meet emission targets. This must be weighed against uncertainties about the possible scale-up pace of direct air capture, variable renewables, electrolytic hydrogen and carbon capture and storage.

The study

The study investigates the use of biomass in the European energy system by exploring a wide range of technology mixes with similar costs. In scenarios that adhere to stringent emissions targets. We combine a rich portfolio of bioenergy technology options with a state-of-the-art sector-coupled energy system model employing a high spatial and temporal resolution. This allows us to show competition and synergies between biomass options on the one hand, and variable renewables, electrolytic hydrogen, e-fuels and direct air capture on the other. The analysis of near-optimal solutions avoids the common focus on least-cost results, and thus provides a more nuanced picture of the importance of individual biomass usage options. We also use metrics from feasibility studies to put the penetration of variable renewables and electrolysers into context and assess the role of biomass at lower growth rates for solar photovoltaics, wind power and electrolytic hydrogen.

Messages for policy

- Biomass provides renewable carbon, which is more valuable than the energy in biomass itself for achieving stringent emissions targets.
- Excluding biomass from the European energy system increases energy system costs by ~20% in a net-negative emissions scenario, similar to excluding wind power or electrolytic hydrogen.
- Policies limiting biomass (residue) use likely need to be accompanied by strong policies to support a greater deployment of clean electricity, electrolytic hydrogen and direct air capture to achieve European emissions targets.
- Carbon capture and bio-electrofuels can increase the value of biomass by enhancing biogenic carbon utilization, thereby moderating biomass demand.
- Bioenergy with carbon capture is more cost-competitive than direct air capture under a wide range of assumptions, which may inhibit direct air capture deployment unless targeted by policy.

Frågor?

www.ieabioenergy.com