

# Final report

## 1. Project details

<b>Project title</b>	IEA Bioenergy – Climate and sustainability effects of bioenergy within the broader bioeconomy
<b>File no.</b>	64018-0549
<b>Name of the funding scheme</b>	IEA TCP
<b>Project managing company / institution</b>	Københavns Universitet, Institut for Geovidenskab og Naturforvaltning
<b>CVR number</b> (central business register)	29979812
<b>Project partners</b>	Københavns Uni Universitet, Institut for Geovidenskab og Naturforvaltning
<b>Submission date</b>	06 March 2024

## 2. Summary

### *English version*

The purpose of this project is to ensure access for the Danish bioenergy sector to knowledge and information on climate change effects and other sustainability issues of bioenergy. The purpose is met through Danish participation in the global IEA Bioenergy network, in a new task focusing on climate and sustainability effects of bioenergy.

The new task has as its objective to identify and address critical issues related to climate and other sustainability effects of bioenergy and biobased product and systems. A central aspect concerns the development and application of science-based methodologies and tools for assessing the effects of biobased systems.

The new task's workprogramme is divided in three workpackages (WP). WP1 focus on metrics, methods, and tools for assessing climate change effects of bioenergy, WP2 focus on metrics, methods and tools for assessing sustainability effects, other than on climate change, of bioenergy, and WP3 looks at involving sustainability stakeholders and implementation approaches (governance).

Dissemination is a critical part of this project and WP4 works on transferring knowledge and insights from the IEA Bioenergy network to Danish bioenergy stakeholders in Danish through newsletters and an open seminar.

The Danish utility sector consumes a lot of biomass to meet our reduction targets on greenhouse gas emissions. A large and increasing part of that biomass is imported and much attention is drawn on ensuring that the biomass provides real climate change mitigation and that the biomass is sourced sustainably. With this project the Danish bioenergy sector and its stakeholders gets access to knowledge and development from a

global network of research, development and business that share the focus on sustainable bioenergy and works with development and implementation of methods and tools to analyze the sustainability of bioenergy.

In summary, the project and Denmark's participation in task 45 has benefited through the task providing a platform for scientific collaboration and knowledge exchange between University of Copenhagen and other universities and research institutions, as well as participation in the task enabled us to inform the debate in Denmark as well as lifting the concerns raised and discussed in Denmark, particularly over imported biomass, to a global audience both within the task 45 network and more broadly through joint publications.

#### Dansk version

Formålet med dette projekt er, at sikre den danske bioenergibranche adgang til og indflydelse på forskning og udvikling inden for klima- og andre bæredygtighedseffekter af bioenergi. Formålet søges opfyldt gennem dansk deltagelse i det faglige netværk IEA Bioenergy, i en ny netværksgruppe (task) med fokus på klima og øvrige bæredygtighedseffekter af bioenergi.

Den nye task har som formål, at adressere kritiske elementer i forhold til klimaeffekter og andre bæredygtighedseffekter ved anvendelsen af biomasse til energi og biobaserede produkter. Det er et centralt mål for den nye task at øge forståelsen af miljømæssige, sociale og økonomiske effekter ved at producere og bruge biomasse til energi gennem udvikling og anvendelse af forskningsbaserede metoder og værktøjer til at kvantificere effekten af biomassebaserede produktionssystemer.

Taskens arbejdsprogram er delt op i tre arbejdsplaner (WP). WP1 beskæftiger sig med udvikling og vurdering af metoder og værktøjer til at analysere klimaeffekter af bioenergi, WP2 ser på metoder og værktøjer til at analysere andre bæredygtighedseffekter end klima af bioenergi, mens WP3 arbejder med implementering og interessentinvolvering i forhold til anvendelse af værktøjer udviklet i WP1 og 2.

Formidling til danske interessenter er en central del af dette projekt og WP4 beskæftiger sig med formidling på dansk af resultater fra task arbejdet til den danske bioenergibranche og dens interessenter. Formidlingen vil ske gennem elektroniske nyhedsbreve og et åbent seminar.

Idet vi i Danmark anvender meget biomasse til energi til at opfylde vores reduktionsforpligtelser for drivhusgasudledninger, samt at en stor og stigende del af biomassen importeres, er der meget fokus på at sikre at biomassen bidrager med en reel klimagevinst og at biomassen indkøbes fra bæredygtige kilder. Med dette projekt sikres den danske bioenergibranche og dens interessenter adgang til viden og udvikling fra et globalt netværk af forskere, udviklere og virksomheder, der har samme fokus på bæredygtig bioenergi og arbejder med udvikling og implementering af metoder, værktøjer til at analysere bæredygtighed.

Samlet set har projektet og Danmarks deltagelse i task 45 bidraget til videnskabelig udvikling gennem fælles publikationer og konference bidrag, samt til at informere en danske debat om bioenergi og bæredygtighed.

## 3. Project objectives

The purpose of the project was to participate and collaborate in an IEA Technical Collaboration Platform, more specifically in IEA Bioenergy Task 45 on climate and sustainability effects of bioenergy within the broader bioeconomy

Participation in the task ensures the Danish bioenergy sector access to and influence on research and development within climate and other sustainability impacts of the use of biomass for energy.

Task 45 was a new working group starting up in 2019 building on work carried out in earlier working groups, mainly task 39 on climate and sustainability impacts of bioenergy and task 43 on biomass resources and supply chains.

Task 45 has the objective to support a sustainable development of a bio-based economy by ensuring a high level of knowledge sharing and information dissemination to owners and managers of land, to companies, authorities and stakeholders in general within the field of bioenergy.

The task emphasize in increasing the understanding of environmental, social and economic impacts of production and consumption of biomass for energy through the development and deployment of research based methods and tool to quantification of the impacts on climate and the environment of bio-based production systems.

Task 45 has three work packages.

- WP1 focus on metrics, methods, and tools for assessing climate change effects of bioenergy.
- WP2 focus on metrics, methods and tools for assessing sustainability effects, other than on climate change, of bioenergy.
- WP3 looks at involving sustainability stakeholders and implementation approaches (governance).

The outcome of the task is a series of open workshops, seminars, webinars, publication of technical reports and scientific papers.

The activities in task 45 will be coordinated with relevant stakeholders on the global bioenergy scene as the International Renewable Energy Agency (IRENA), the Global Bioenergy Partnership (GBEP) and the Food and Agriculture Organisation of the UN (FAO).

Apart from participation in task 45, this project also aim to disseminate relevant information and outcomes of task work to a Danish audience.

## 4. Project implementation

The project was significantly affected by the Corona situation. Task 45 managed to organise a physical upstart meeting in Stockholm in winter 2019 and a workshop in Utrecht in the Netherlands in May 2019. During the Corona pandemic all task leadership meetings as well as conferences, seminars, workshops and field trips were either cancelled or transformed into online events.

## 5. Project results

Although the Corona situation significantly influenced the execution of the project, in the big picture, the project succeeded in meeting its aim and purpose. The project has resulted in publications, organisation or contribution to conferences and workshops and newsletters to a Danish audience. The project has distributed three newsletters in Danish to stakeholders. The number of newsletters did not meet the expectations, which can be explained by 1) a slow start of the task work in 2019 and 2) the Corona situation, which reduced activities in the task and reduced the number of task 45 relevant activities in the bioenergy field.

## 5.1 Publications

In November 2019, Task 45 published a response to a report on bioenergy published by the European Academies Science Advisory Council (EASAC). The response: The use of forest biomass for climate change mitigation: response to statements of EASAC is available here: [https://www.ieabioenergy.com/wp-content/uploads/2019/12/WoodyBiomass-Climate\\_EASACresponse\\_Nov2019.pdf](https://www.ieabioenergy.com/wp-content/uploads/2019/12/WoodyBiomass-Climate_EASACresponse_Nov2019.pdf)

Nielsen AT, Bentsen NS, Nord-Larsen T (2020). CO2 emission mitigation through fuel transition on Danish CHP and district heat plants: Carbon debt and payback time of CHP and district heating plant's transition from fossil to biofuel. IGN Report, November 2020. Department of Geosciences and Natural Resource Management, University of Copenhagen, Frederiksberg. 83 p. ill. [https://curis.ku.dk/portal/files/251578680/IGN\\_Report\\_CO2\\_emission\\_mitigation\\_Nov2020.pdf](https://curis.ku.dk/portal/files/251578680/IGN_Report_CO2_emission_mitigation_Nov2020.pdf)

Furthermore, a number of publications in refereed journals with contributions from Inge Stupak and/or Niclas Scott Bentsen and building directly or indirectly on the work carried out in Task 45 or the network behind have been published over the project period.

Bentsen NS (2019). Biomass for Biorefineries: Availability and Costs. In J.-R. Bastidas Oyanedel & J. E. Schmidt (Eds.), *Biorefinery: Integrated Sustainable Processes for Biomass Conversion to Biomaterials, Biofuels, and Fertilizers* (pp. 37-48). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-030-10961-5\\_2](https://doi.org/10.1007/978-3-030-10961-5_2)

Bentsen NS, Jørgensen JR, Stupak I, Jørgensen U & Taghizadeh-Toosi A (2019). Dynamic sustainability assessment of heat and electricity production based on agricultural crop residues in Denmark. *Journal of Cleaner Production* 213: 491-507. <https://doi.org/10.1016/j.jclepro.2018.12.194>

Bentsen NS, Larsen S, Stupak I (2019). Sustainability governance of the Danish bioeconomy — the case of bioenergy and biomaterials from agriculture. *Energy, Sustainability and Society* 9(1). <https://doi.org/10.1186/s13705-019-0222-3>

Larsen S, Bentsen NS, Stupak I (2019). Implementation of voluntary verification of sustainability for solid biomass—a case study from Denmark. *Energy, Sustainability and Society* 9(1): 33. <https://doi.org/10.1186/s13705-019-0209-0>

Schulze ED et al. (2020). The climate change mitigation effect of bioenergy from sustainably managed forests in Central Europe. *GCB Bioenergy*, 12(3), 186-197. <https://onlinelibrary.wiley.com/doi/abs/10.1111/gcbb.12672>.

Sántha E, Bentsen NS (2020). Ecosystem service benefits and trade-offs-selecting tree species in Denmark for bioenergy production. *Forests* 11(3). <https://doi.org/10.3390/f11030277>

Mather-Gratton ZJ et al. (2021). Understanding the sustainability debate on forest biomass for energy in Europe: A discourse analysis, kan læses her: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0246873>.

Clarke N et al. (2021). Effects of intensive biomass harvesting on forest soils in the Nordic countries and the UK: A meta-analysis. *Forest Ecology and Management*, 482, 118877. <https://www.sciencedirect.com/science/article/pii/S0378112720316467>.

Stupak I et al. (2021). Conceptual framework for increasing legitimacy and trust of sustainability governance. *Energy, Sustainability and Society*, 11(1), 1-57. <https://energysustainsoc.biomedcentral.com/articles/10.1186/s13705-021-00280-x>.

Stupak I et al. (2021). Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes. *Energy, Sustainability and Society* 11, 12. <https://doi.org/10.1186/s13705-021-00288-3>.

Cowie A. et al. (2021). Applying a science-based systems perspective to dispel misconceptions about climate effects of forest bioenergy, er frit tilgængelig og kan læses her: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcbb.12844>.

Nielsen, A. T., Nord-Larsen, T., & Bentsen, N. S. (2021). CO2 emission mitigation through fuel transition on Danish CHP and district heating plants. *GCB Bioenergy*, 13(7), 1162-1178.: <https://onlinelibrary.wiley.com/doi/abs/10.1111/gcbb.12836>.

Titus, B. D., Brown, K., Helmisaari, H. S., Vanguelova, E., Stupak, I., Evans, A., ... & Reece, P. (2021). Sustainable forest biomass: A review of current residue harvesting guidelines. *Energy, Sustainability and Society*, 11(1), 1-32. <https://doi.org/10.1186/s13705-021-00281-w>.

Finally, a collection of papers have been published in the journal "Energy, Sustainability and Society" with the title "Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes". The collection constitute 14 papers on bioenergy from forest or agricultural biomass and biogas and forms a kind of proceedings from a conference held in Copenhagen in April 2018 with the same title. An introduction to the collection can be seen here: Stupak I, et al. (2021). Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes. <https://energysustainsoc.biomedcentral.com/track/pdf/10.1186/s13705-021-00288-3.pdf>.

All papers are freely available via the journal's homepage, <https://www.biomedcentral.com/collections/sbbb>.

Task 45 also contributed to the general debate on bioenergy and sustainability through Task 45 through a short note which can be seen here: <https://www.ieabioenergy.com/blog/publications/campaigns-questioning-the-use-of-woody-biomass-for-energy-are-missing-key-facts/>.

## 5.2 Conferences and workshops

1.-3. May 2019, Inge Stupak co-organised a workshop in Athens, Georgia, USA on acceptance and feasibility of Forest Management Unit level and risk-based certification for ensuring sustainability of wood pellet supply chains.

23. May 2019 in Utrecht - Governing sustainability in biomass supply chains for the bioeconomy, <https://www.ieabioenergy.com/publications/ws24-governing-sustainability-in-biomass-supply-chains-for-the-bioeconomy/>

21.-22. October, Inge Stupak co-organised a session on trans-Atlantic dialogue on challenges to documenting wood and wood fuels from sustainably managed forests the conference at the conference Sustainable Forestry Initiatives (SFI) annual conference "Risk-Based Approaches to Identifying and Managing Sustainability Risks in Sensitive Forests in the US" held in Richmond, Virginia, USA.

13.-14. May 2020 online - IEA Bioenergy Task 45 workshop on forests and the climate, <http://task45.ieabioenergy.com/iea-bioenergy-t45-ws-13-14-may-2020/>

In April 2021, IEA Bioenergy og Joint Research Center of the European Commission (JRC) organised an on-line workshop building on JRC's report on bioenergy from January 2021, Camia, A. et al. (2021). The use of woody biomass for energy production in the EU. <https://publications.jrc.ec.europa.eu/repository/handle/JRC122719>. The purpose of the workshop was to discuss the report's scenarios and assumptions to improve the scientific foundation for such analyses the the future. Niclas Scott Bentsen participated in the workshop.

Inge Stupak organised an international workshop in October 2021 with the goal engage stakeholders and bring them together to discuss the benefits and challenges to governing sustainability within a forest management context, with particular emphasis on forest bioenergy, including the calculation and modeling of forest carbon and climate change impacts.

The conference gathered more than 100 participants, hereunder a number of Danish stakeholders to four sessions on

1. Sustainable forest management and bioenergy in the Baltic states
2. Verification of compliance with sustainability requirements for forest bioenergy
3. How to calculate and model where and when forest bioenergy can help to save carbon emissions?
4. Research to underpin future policies related to sustainable forest management and wood end-uses

Conference material and program can be found here: <https://nordicforestresearch.org/n2020-06/>.

Three newsletters have been distributed to a Danish audience contributing to the dissemination of information and news related to the work in Task 45 with particular interest of Danish stakeholders. The newsletter was distributed to 80 recipients.

## 6. Utilisation of project results

The project responds to a significant need for valid information building on sound science on the climate and environmental impacts from the use of biomass for energy purposes. In Denmark, there is a fierce discussion on the sustainability of using biomass for energy. Still, biomass plays a significant role in the Danish energy supply and, according to the Danish Climate Council, probably will continue to do so in order for Denmark to meet its climate goals. Many other countries experience the same discussion and face the same challenges regarding information and disinformation.

Consequently, it is valuable that Denmark participate in and contribute to the global network of IEA Bioenergy from a scientific, an educational, as well as a political point of view.

From a scientific point of view, participation in task 45 provided a platform for scientific collaboration and knowledge exchange between University of Copenhagen and other universities and research institutions. As can be seen from the list of publications above, many papers and reports are outcomes of joint research efforts made possible through the participation in task 45.

From an educational point of view, many of the insights gained from participating in task 45 are disseminated to university students through course activities.

From a political point of view, participation in task 45 enabled us to inform the debate in Denmark as well as lifting the concerns raised and discussed in Denmark, particularly over imported biomass, to a global audience both within the task 45 network and more broadly through joint publications.

## 7. Project conclusion and perspective

This project and participation in the IEA TCP network does not yield tangible conclusions. However, participation in task 45 has:

- Strengthened scientific collaboration between University of Copenhagen and other universities and research Institutions.
- Provided a platform and forum for discussion of sustainability and climate issues, which are relevant to policy making in Denmark and to the bioenergy sector.
- Resulted in a number of publications, conferences and insights relevant to the Danish bioenergy sector either directly from task activities or indirectly through contacts, data or network facilitated through task participation.
- Disseminated information directly to the Danish bioenergy sector and stakeholders through newsletters in Danish.