

MANAGING VARIATIONS IN THE EUROPEAN ELECTRICITY SYSTEM WITH BIOMASS:

EMISSION TARGETS AND INVESTMENT PREFERENCES

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BACKGROUND

- Reaching 1.5 and 2 degrees targets requires decarbonisation of electricity system and very likely also net negative emissions
- Wind and solar power are expected to play a large role in decarbonising the electricity system, but their generation is intermittent
- In integrated assessment models negative emissions are often placed in electricity sector
- It is unclear how much biomass should be used in electricity sector and at what cost it is available.
- Better understanding of how variable renewables and negative emissions can exist together is needed

AIM

To provide an answer to following questions:

- What forms of biomass use are cost-effective in a future electricity system?
- What is the willingness to pay for biomass in the electricity sector?
- How does availability of negative emissions affect the system composition?
- How do different emission targets affect the system composition?
- What are the attitudes towards investments in different technologies?

ELECTRICITY SYSTEM MODELLING

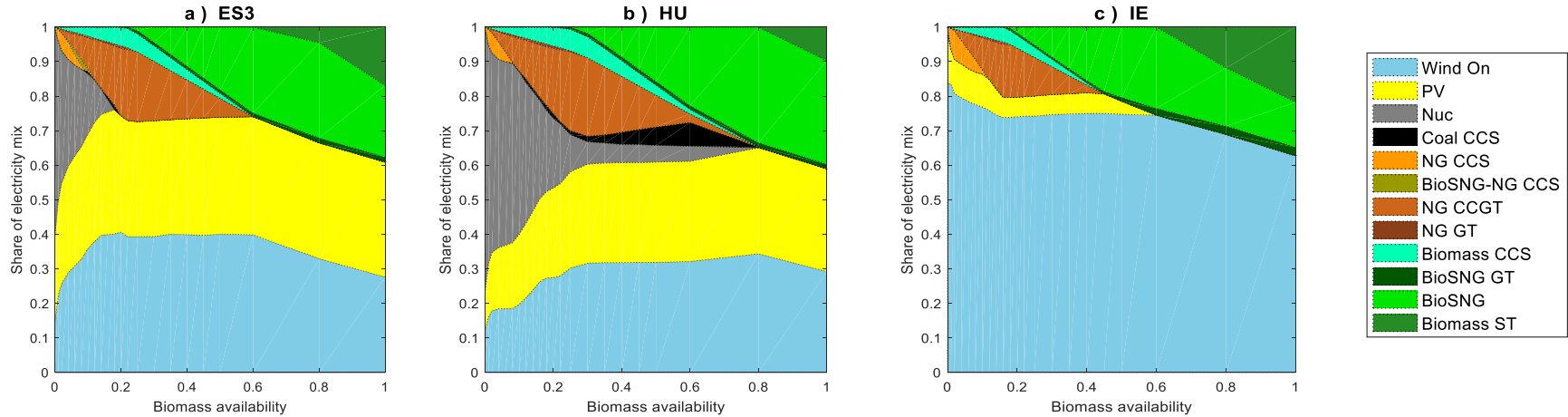
ENODE

- One region green field model with high time resolution
- Time horizon: 1 year
- Represent electricity system around 2050
- Does not include transmission, hydro power and existing capacities

ELINEPOD

- Covers 27 EU member states as well as Norway and Switzerland divided into 50 regions
- Uses a database of existing powerplants and HWDC grid
- Time horizon: 2020-2050
- Representative days used to capture variability of wind and solar power

THE EFFECT OF AVAILABILITY OF BIOMASS TO ELECTRICITY SYSTEM COMPOSITION



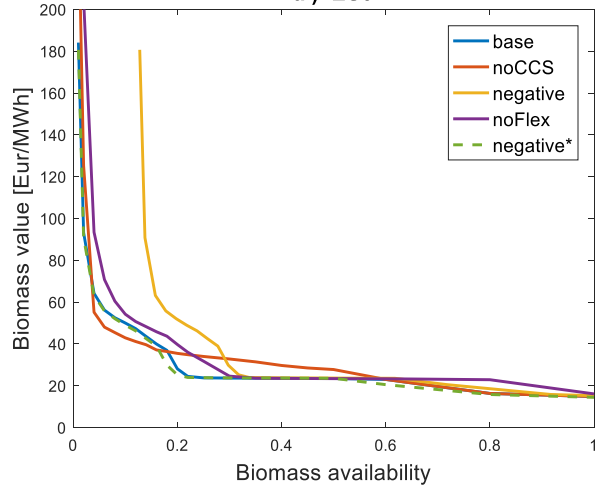
Johansson, Lehtveer, Göransson, 2019

- Increased biomass availability usually helps to integrate variable renewables
- There is a trade-off between nuclear and biomass, if little biomass is available nuclear power becomes cost effective option
- If allowed BECCS and natural gas combination is used to manage variability

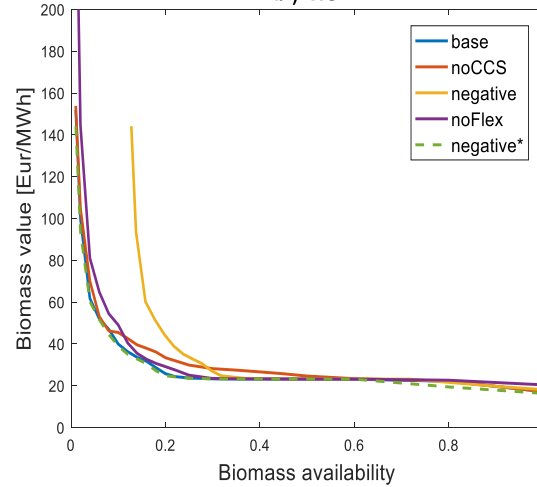
ENODE

WILLINGNESS TO PAY FOR BIOMASS IN ELECTRICITY SYSTEM

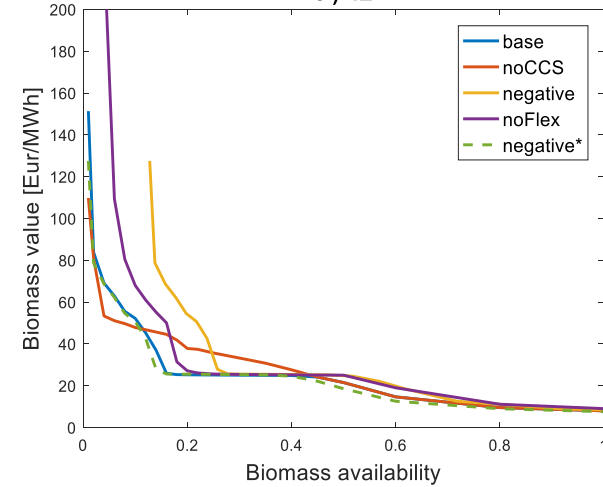
a) ES3



b) HU



c) IE

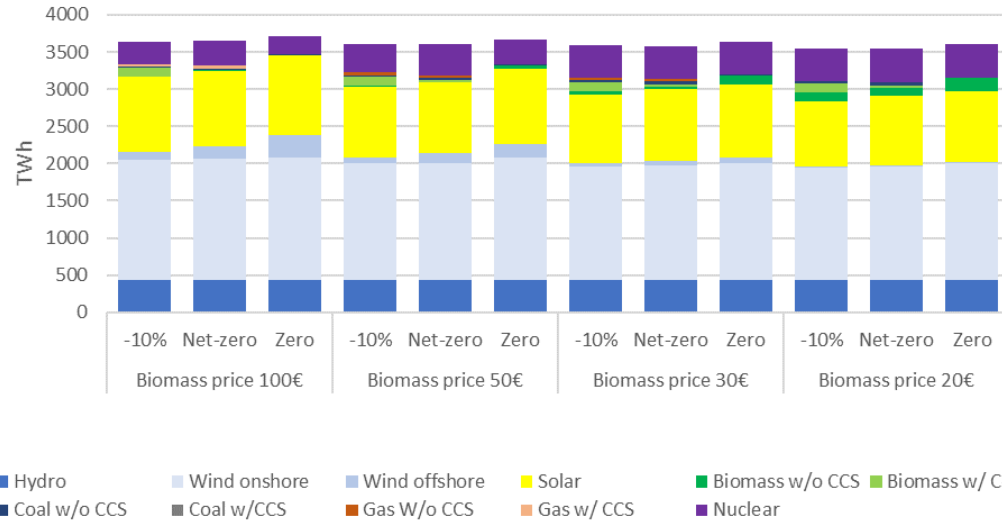


Johansson, Lehtveer, Göransson, 2019

ENODE

ELECTRICITY GENERATION IN EUROPE BY SOURCE AT 2050

Preliminary results



- Lower biomass use but some biomass used even with high cost in already existing facilities
- Biomass complements the existing nuclear power instead of competing with new investments
- There is a trade-off between investments in biomass and offshore wind
- If allowed BECCS + fossil combination is used to balance variations

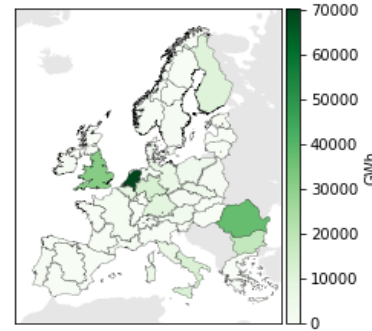
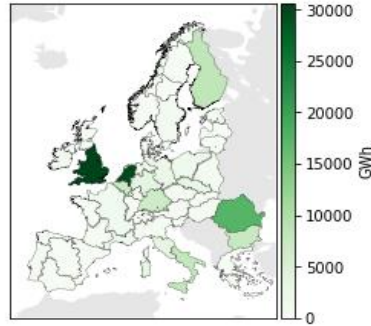
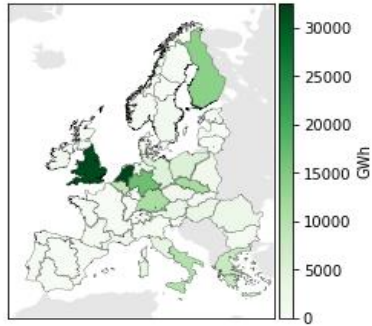
ELINEPOD

Lehtveer and Fridahl, 2020

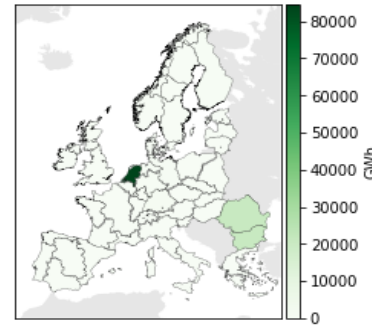
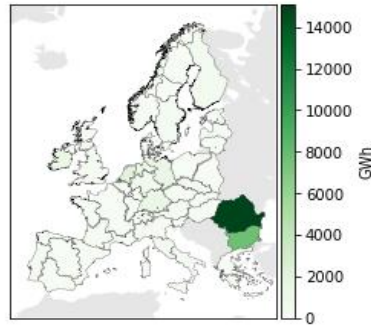
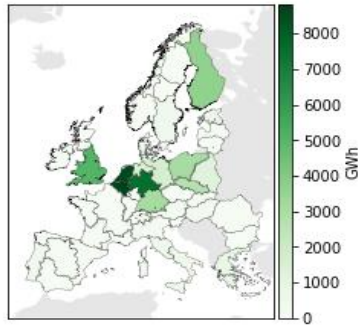
ELECTRICITY GENERATION FROM BIOMASS AT 2050

Preliminary results

20€/MWh_{th}



50€/MWh_{th}



Zero

Net-Zero

-10%

ELINEPOD

Lehtveer and Fridahl, 2020

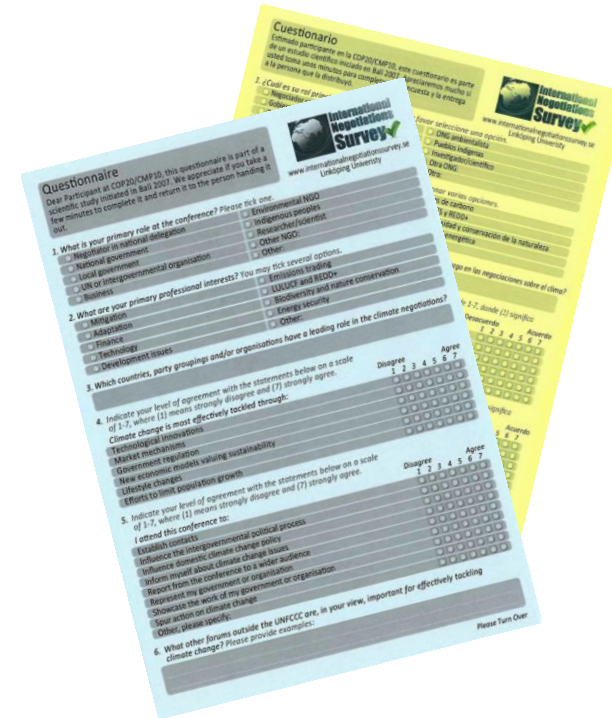
INTERNATIONAL NEGOTIATIONS SURVEY

UNFCCC meetings at:

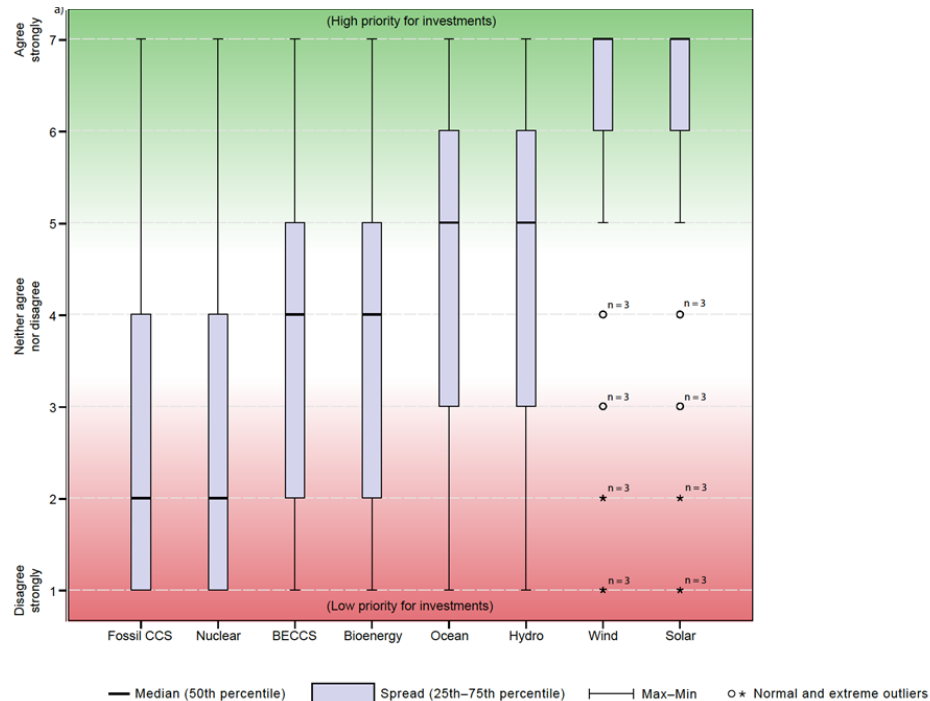
- the 42nd Subsidiary Bodies meeting in Bonn, June 2015
- the 21st Conference of the Parties (COP) in Paris, December 2015
- COP22 in Marrakech, November 2016
- COP23 in Bonn, November 2017
- COP24 in Katowice, December 2018

In total more than 3500 responses

1115 responses from EU-27 countries



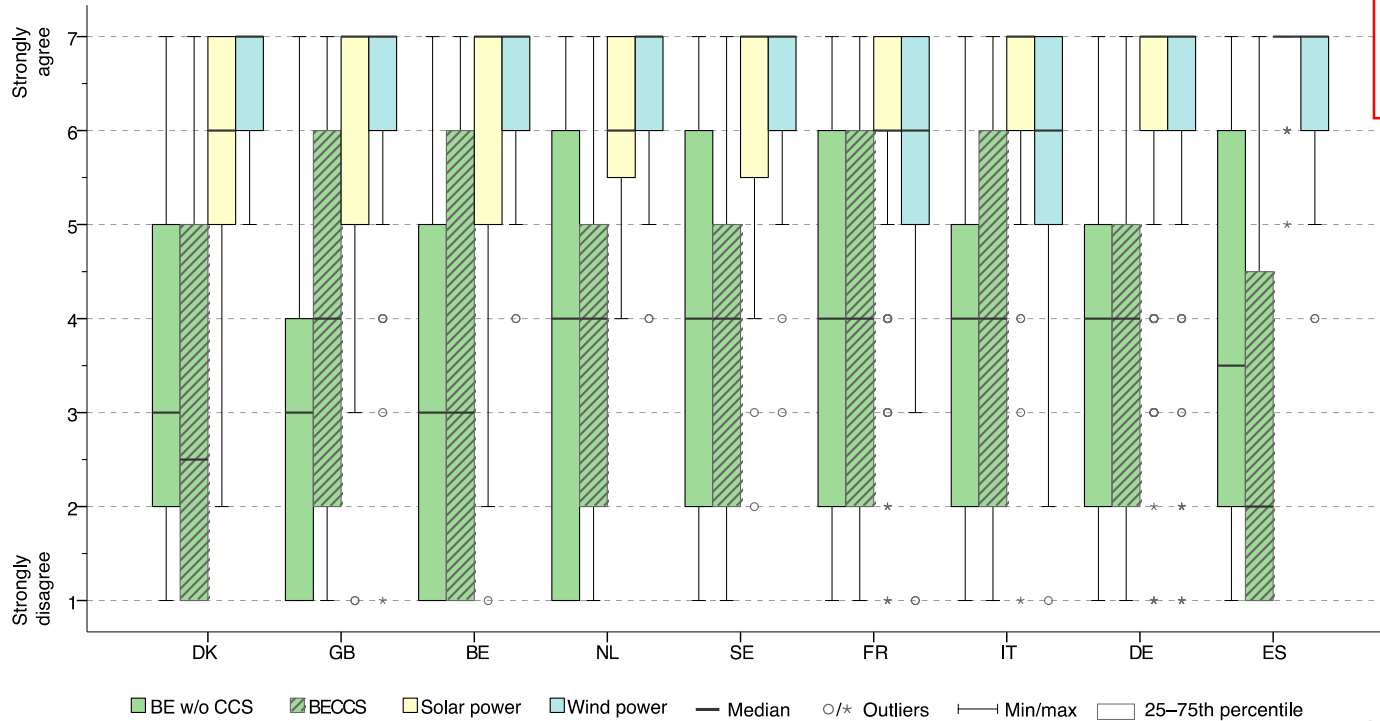
GLOBAL INVESTMENT PREFERENCES



Fridahl and Lehtveer, 2018

ATTITUDES OF UN CLIMATE CHANGE CONFERENCE DELEGATES

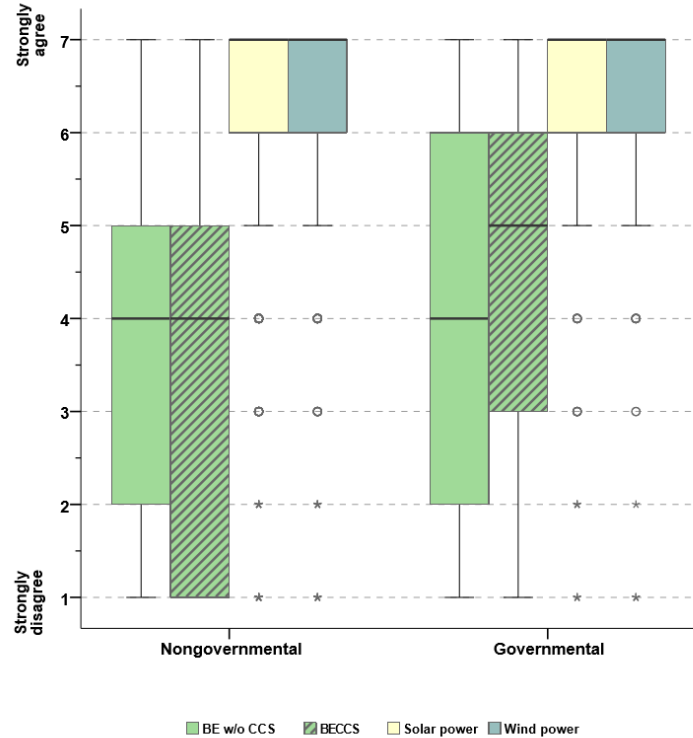
Preliminary results



Lehtveer and Fridahl, 2020

ACTORS' PERSPECTIVES

Preliminary results



Lehtveer and Fridahl, 2020

CONCLUSIONS

- There is a high willingness to pay for limited amount of biomass in the electricity sector
- If only emissions from the electricity sector are regulated, BECCS in combination with natural gas plants is the cost-effective complement to variable renewables
- How emission target is formulated has a large impact on the cost-effective use of biomass:
 - When negative emissions are possible in the system, biomass use becomes very concentrated
 - Requiring zero emissions from all parts of the electricity system facilitates larger geographic spread of biomass-based technologies and also increases the cost-effectiveness of transmission investments

CONCLUSIONS

- Survey respondents indicate that investments should primarily target intermittent renewables, especially wind power in western and northern Europe and solar in southern Europe
- Biomass-based electricity production, with or without CCS, receives low priority for investments
- Adding a CCS component to biomass power technologies can make bioenergy both more and less accepted within a specific country
- NGOs are consistently more skeptical to investing in BECCS than representatives of governments, indicating that controversies around BECCS have been far from resolved



CHALMERS

UNIVERSITY OF TECHNOLOGY