Biomass and bioenergy in energy system models for Norway - Status and improvement possibilities

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Content

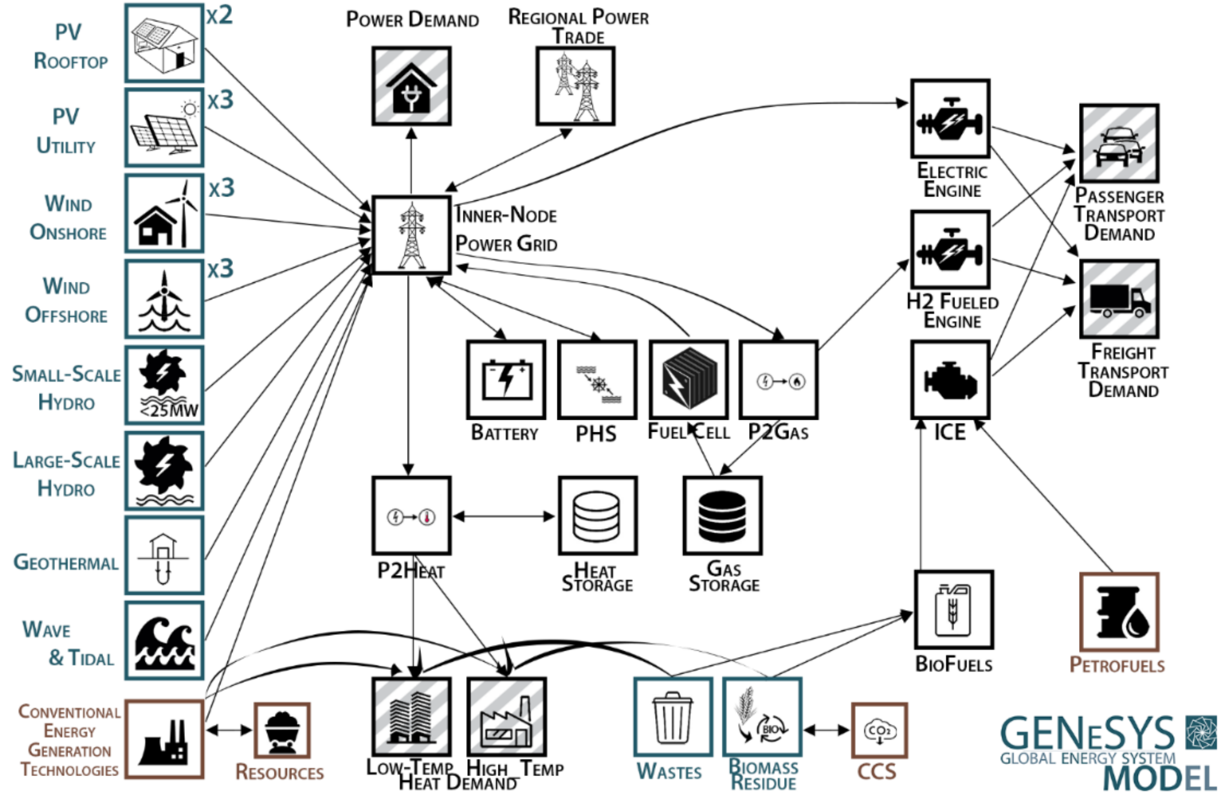
- Objectives
- Energy system models for Norway - how biomass and bioenergy are accounted for and improvement possibilities
- Potential availability of harvest residues from forestry
- Nordic Energy and Climate Plans - Recommendations for future plans for Norway
- Needs and suggestions for future work
- Conclusions

Objectives

Investigate what can be gained by increasing the level of detail for the bioenergy sector in an overall energy system model

- How can we take advantage of sector-specific tools for bioenergy (e.g., forest sector - LULUCF)
- How do different assumptions on bioenergy in an energy system model affect the analysis (e.g., current and future potential of biomass from forest harvest residues (GROT))
- How will the use/evolution of bioenergy influence the LULUCF sector

Energy System Model GENeSYS-MOD



: Abstracted overview over the model structure and available technology options.

Biomass resource types

- Grass
- Wood
- Roundwood
- Residues
- Paper_Cardboard
- Biogas

Understanding the Nordic biomass dataset

- openENTRANCE: 4 decarbonisation scenarios
- 29 European countries, Norway detailed in 5 regions
- Biomass resource availability decrease
- Based on projections and extrapolation from relatively old data (2008)
- Predefined ratio between different biomass types (same for all Nordic countries)
- Regional split in Norway based on area size
- One price for each biomass type across Europe

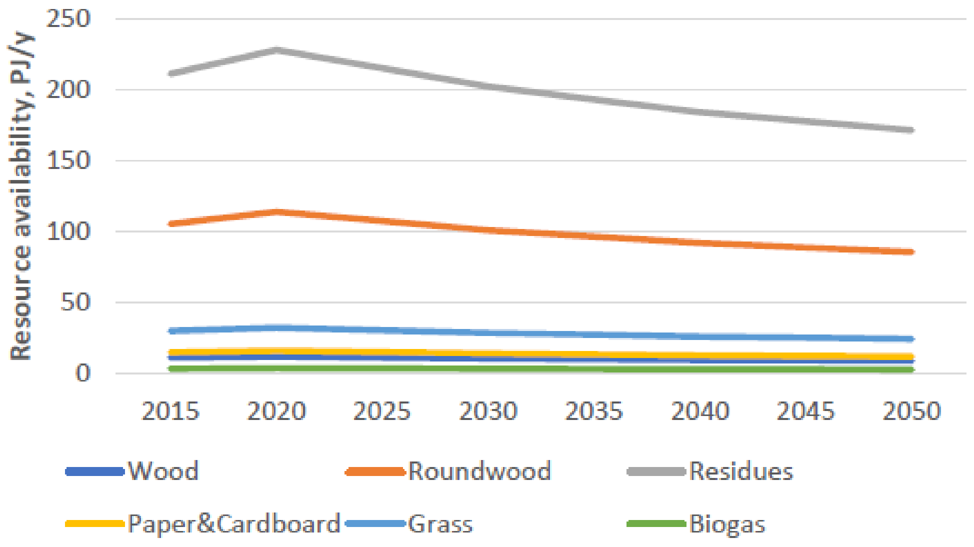


Figure 3-7: Original data from the openENTRANCE dataset for biomass availability in Norway

The impacts of biomass resource availability on the Norwegian energy system

- 3 scenarios (ref, constant, added GROT resources)

- Key insights
  - No effect on installed capacities (power, heat for buildings and industry)
    - Installed capacity for power from biomass decreases to almost nothing in 2050
  - The model makes use of all resources available (except roundwood)
    - Until 2040 > 90% exported Draft has been developed
    - From 2040 biomass gets partly converted to biofuel and then exported
  - There is potential for more biomass use if the price is below 8 M€/PJ.

Potential availability of harvest residues from forestry

Potential availability of harvest residues from forestry

Background

- Forest harvest residues
  - ✓ Low market value
  - ✓ Typically left on site after forestry operations

Play a role in the bioenergy sector both in the short & long term

Potential availability of harvest residues from forestry

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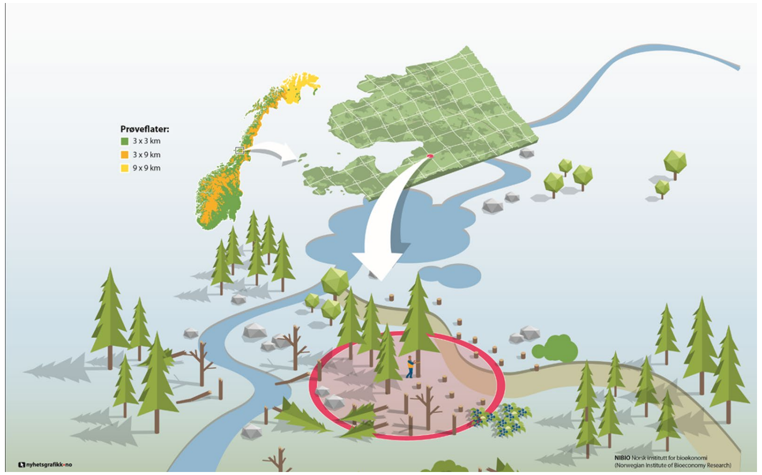
Material and methods

- National Forest Inventory (NFI) data
  - ✓ 13 554 plots (≈ 12.5 million ha)

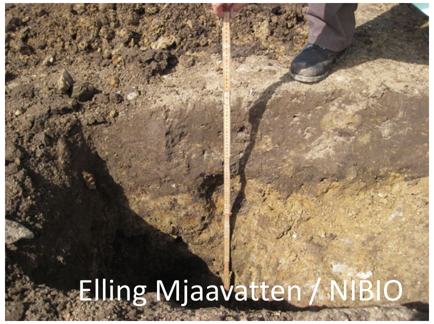
LANDSSKOG-TAKSERINGEN 1919-2019 100 ÅR



- Simulation period: 2020 - 2100
- SiTree framework: suitable for simulating the development of NFI plots based on projections at the individual tree level
  - ✓ Different forest management
  - ✓ Changes in growth conditions (climate)
  - ✓ Connected to soil model Yasso07

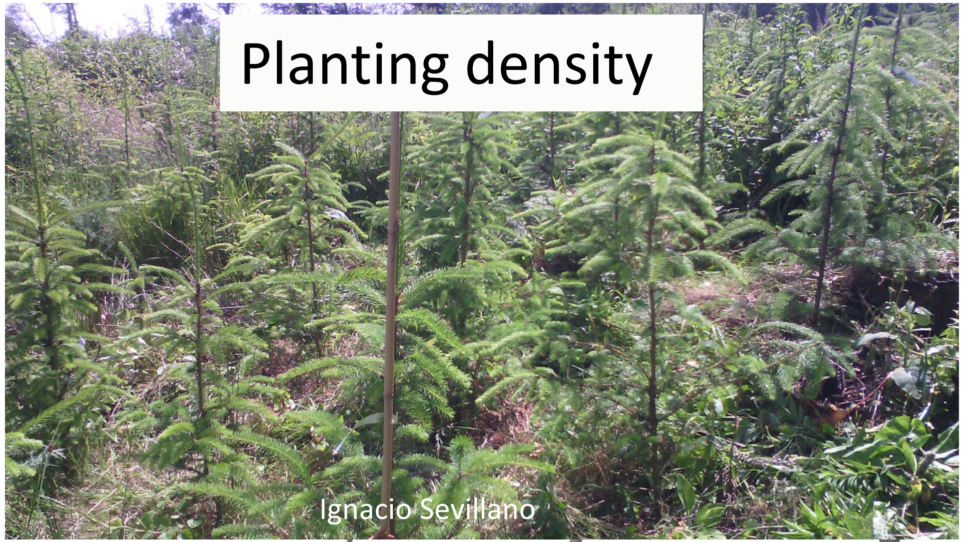
Living biomass (different forest management; changes in growth conditions)

Soil carbon (connected to soil model Yasso07)



Potential availability of harvest residues from forestry

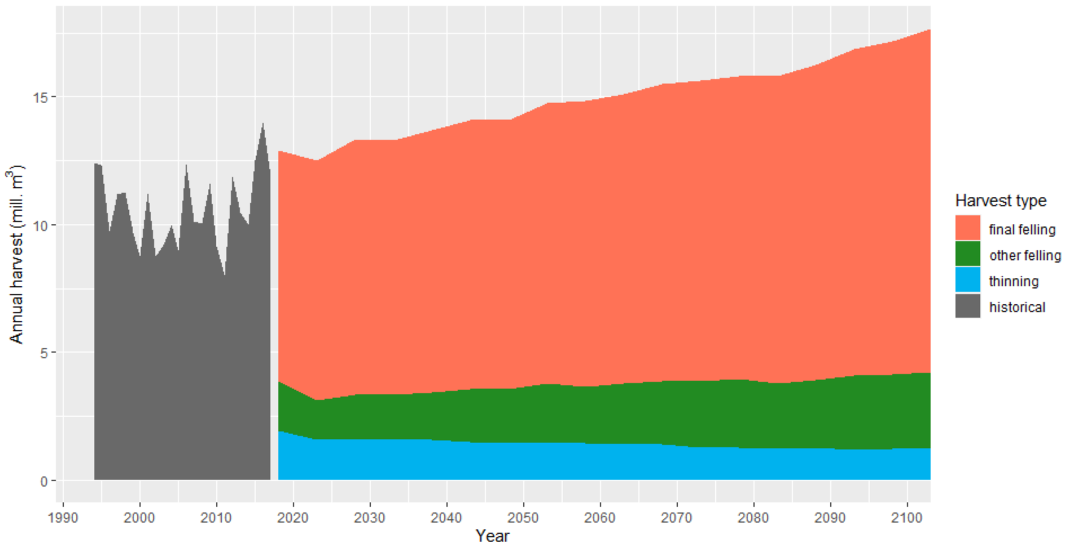
BAU scenario - Forest management practices considered



Potential availability of harvest residues from forestry

Assumptions – BAU scenario

- Harvest volume under BAU scenario (estimations based on observed harvest intensity in 2003-2017)



- Future climate changes corresponding to RCP 4.5: intermediate emissions (CO_2 emissions increase only slightly before decline commences around 2040)
- Constant forest area from 2017: land use changes over time not included

Potential availability of harvest residues from forestry

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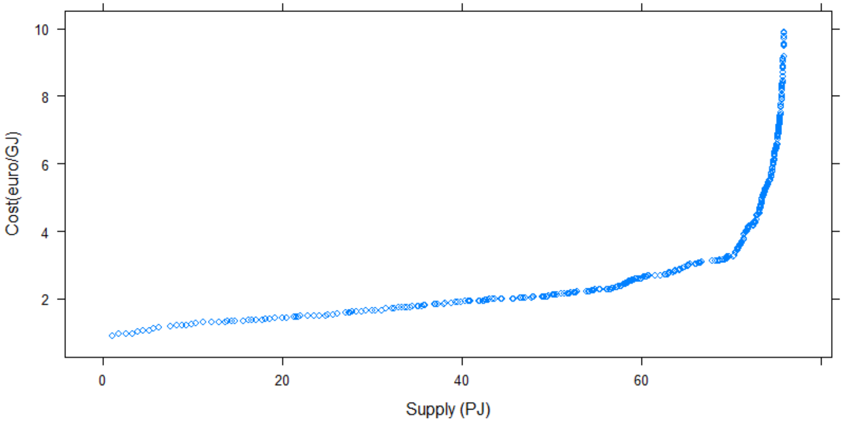
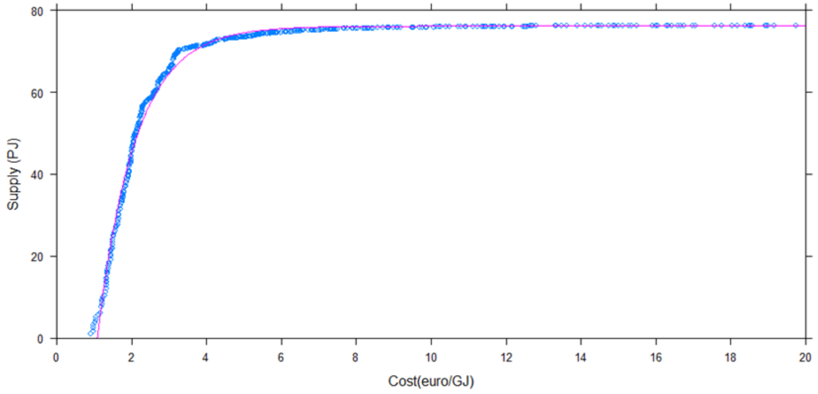
Development of cost-supply curves for harvest residues

- Supply (cumulative)
  - ✓ Species-specific tree allometric equations & calorific values
- Extraction costs from plot to roadside
  - ✓ Loading, transport & unloading
- For each 5-year period & NordPool region

Nord Pool region - Norway	County-Norway
NO1	Innlandet + Viken
NO2	Vestfold og Telemark + Agder + Rogaland
NO3	Møre og Romsdal + Trøndelag
NO4	Nordland + Troms og Finnmark
NO5	Vestland

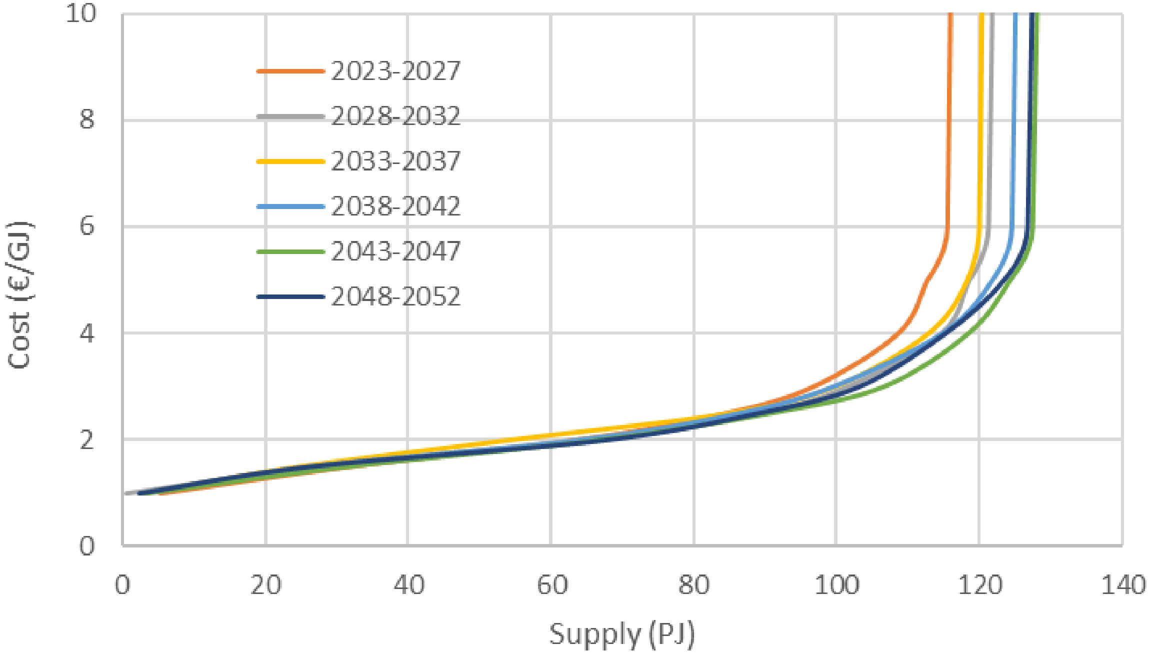




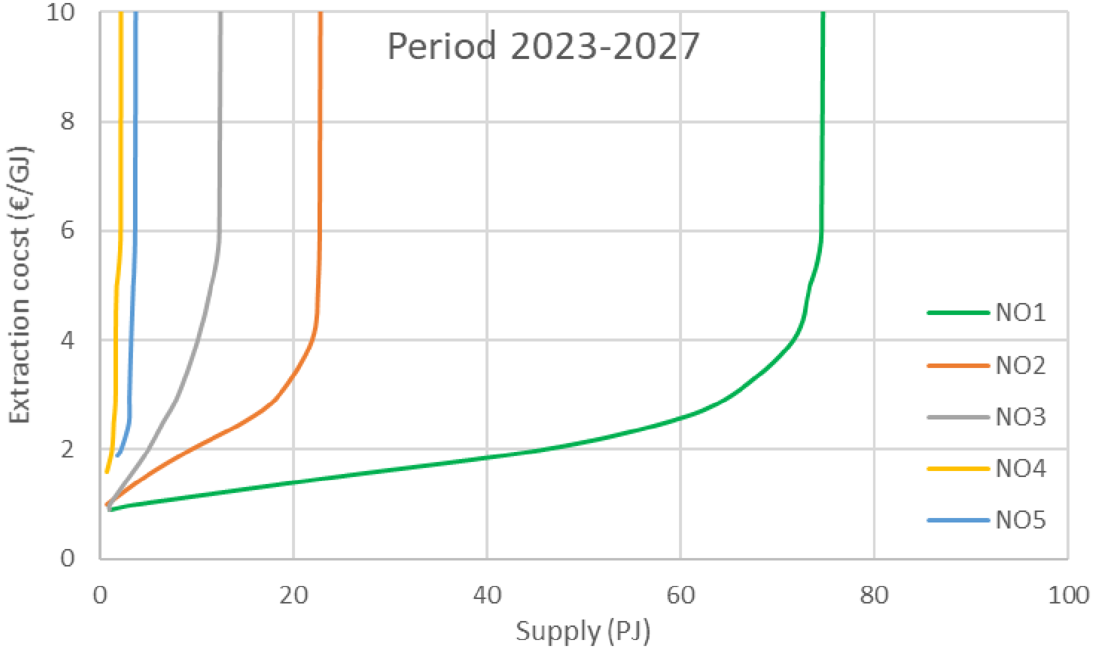
Potential availability of harvest residues from forestry

Results – cost-supply curves

Period level



Regional level

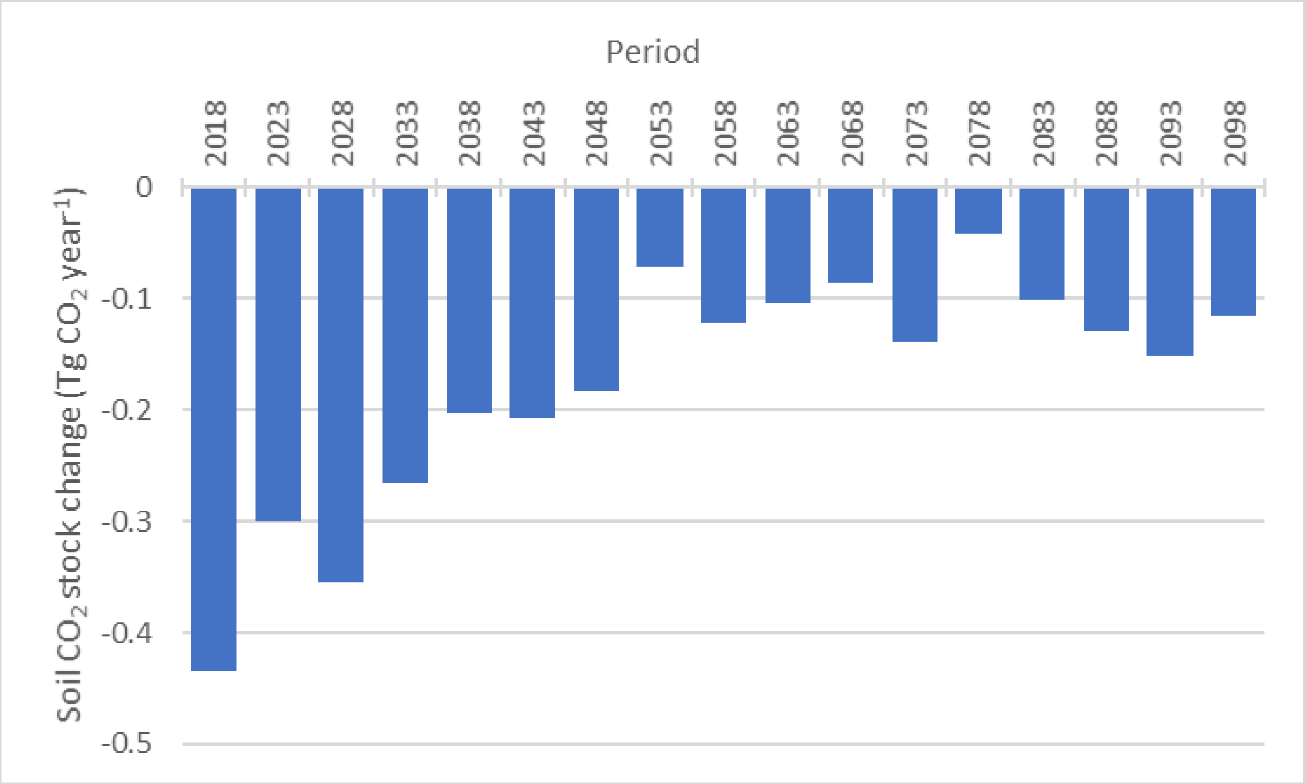


* Potential supply of harvest residues is relatively stable over time
* Region NO1 (where most productive forest are located) has the largest supply

Potential availability of harvest residues from forestry

Results – effect of using harvest residues for bioenergy

Extra-CO_2 storage if GROT is left in the forest



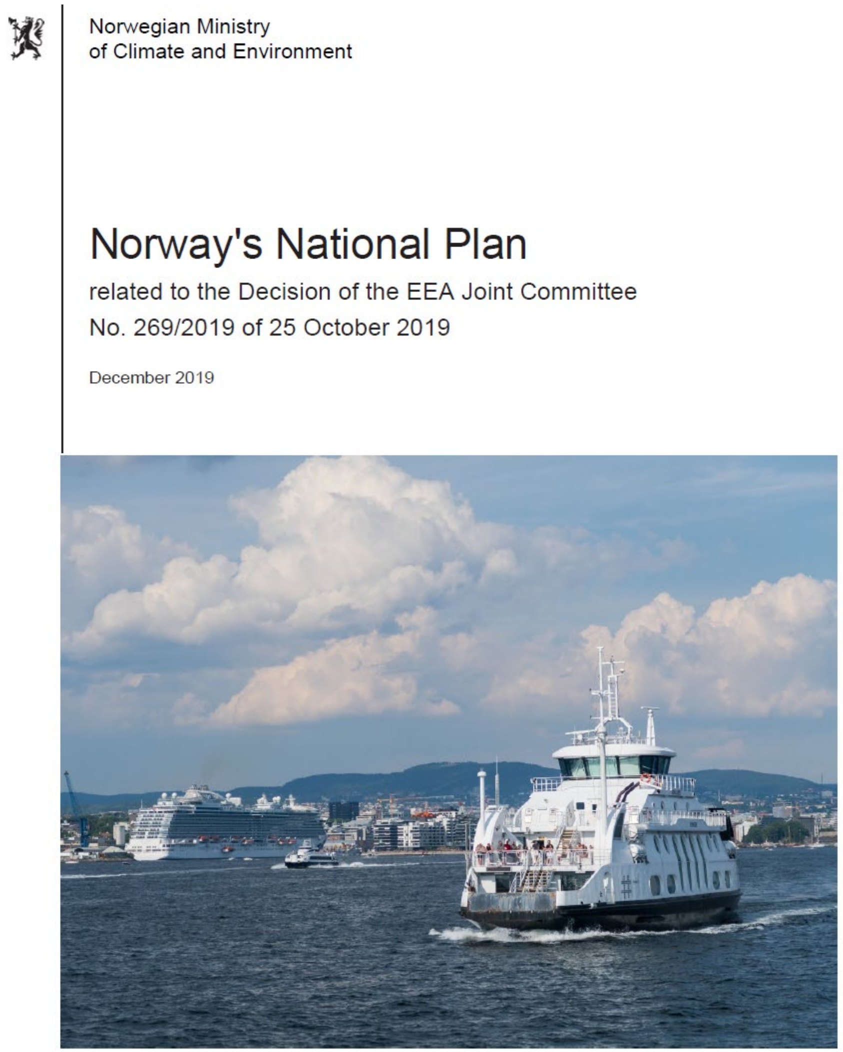
* Decline in forest soils CO_2 sink capacity
* But this decline generally decreased over time

Nordic Energy and Climate Plans

The Ministry of Climate and Environment (Klima- og miljødepartementet) informs that Norway is not obligated to submit NECP to the EU.

However, in 2019 the Government made a plan that shows how Norway shall comply with obligations in regulations for non-ETS sectors and LULUCF, which was submitted on a voluntary basis.

In the following we have made comment to that plan.


Norwegian Ministry
of Climate and Environment

Norway's National Plan

related to the Decision of the EEA Joint Committee
No. 269/2019 of 25 October 2019

December 2019

Nordic Energy and Climate Plans

The plan states:

"The Government will introduce new measures designed to maintain or increase the carbon stock in forests and facilitate greater use of biomass as a substitute for fossil energy sources and fossil-intensive building materials, thus ensuring that forests can continue to play their crucial role in the context of climate change."

This is the only place bioenergy for heat (or electricity), in industry and in commercial and residential buildings can be anticipated to be mentioned, however stressing the use of biomass as a substitute for fossil energy sources. Biofuels for the transport sector to substitute fossil transport fuels are frequently mentioned. Waste-to-energy (WtE) from MSW is mentioned, and the possibility for CCS connected to WtE plants.

Nordic Energy and Climate Plans

The main recommendation from NEO WP1 for Norway is that biomass for stationary bioenergy, especially for heating purposes, should be better represented. This is also the case for national energy system simulation tools and connected national economic models, where a CO_2 reduction target is typically set, and reached by optimising the energy system economics. The following is suggested regarding how the results from the programme can be used:

1) Biomass for stationary bioenergy, especially for heating purposes, should be better presented, and as well included in the models and simulations that lies behind the NECP, if this is not sufficiently included today.

Nordic Energy and Climate Plans

2) There should be a focus on the substitution effect of biomass resources not only for substituting fossil fuels, but also for substituting hydropower electricity that could rather help reduce CO_2 emissions in other sectors instead of the extensive use of direct electric heating that we have in Norway today. This would also relieve the pressure on the electricity grid and the private consumers feeling the economic effect of expensive electricity. This electricity might also be partly imported as well as partly be of non-renewable origin.

3) BECCS (Bioenergy CCS) should be presented as one future option, giving net negative CO_2 emission reductions.

4) Biomass export/import should be considered, as transport of biomass between countries happens to a large extent already today. In general, the Nordic perspective is lacking and should be more highlighted, as energy stored in biomass and MSW and as electricity flows easily across borders.

Nordic Energy and Climate Plans

Furthermore, we have the following suggestions for how national energy system models should be improved to provide better and more precise results to be utilised for NECP:

1) The presentation of the biomass resources available for energy production (including their geographic distribution) or alternative uses should be completed and more detailed. This includes both forest and agriculturally based biomass, as well as all relevant biogenic waste streams.

2) The presentation of the bioenergy technologies should be expanded to all the technologies significantly contributing to the Norwegian energy system today, e.g. space heating with wood stoves, as well as those which could become significant contributors in the future.

Nordic Energy and Climate Plans

3) Alternative non-energy uses of biomass should be included in detail, including their CO_2 savings potential (amount and timeframe) as well as connected costs. The circular society will be of importance here, as it will impact especially the WtE sector when it comes to energy production but also other energy intensive industries, e.g. metal production, where today fossil reductants and materials are used to a great extent, but where biobased alternatives (e.g. biocarbon) are available and wanted.

4) Enhanced energy system models with more comprehensive and correct representation of biomass resources and biomass conversion technologies and their connected economics, could provide better advice on how to best reach Norway's CO_2 reduction targets. At the same time, all significant alternative uses of the biomass should be included to enable a realistic optimisation of the complete system.

5) Biomass export/import should be better described.

Nordic Energy and Climate Plans

It is fundamental to understand the implications of an increased use of biomass for energy purposes. Land use, land-use change, and forestry (LULUCF) have a fundamental impact on the carbon balance in the atmosphere.

At the same time biodiversity must be conserved.

An increased use of biomass for bioenergy might have an influence on LULUCF, and further energy system analyses with detailed enough national energy system models are needed to provide recommendations for the future biomass use to reduce CO_2 emissions both in the short and the long-term.

The time horizon (short vs long-term) is crucial from a forest management (and LULUCF) perspective, since many measures in the sector might not have a significant effect in the very short-term (e.g. 2030 climate targets).

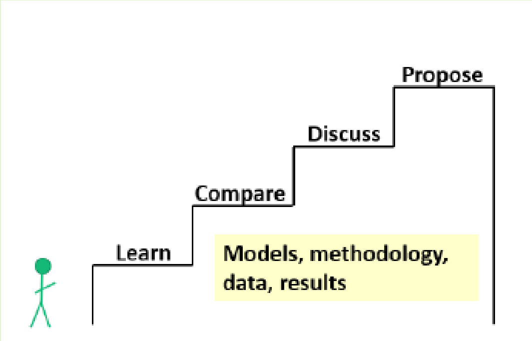
For example, it is expected that a small number of measures (e.g. fertilisation, reduce deforestation) will have an impact in the short term.

On the other hand, some measures, such as large-scale spruce forest planting, would have a negative impact in the short-term but would result in a positive effect on climate change mitigation after the second half of the century.

Therefore, it is important to consider the trade-off between short and long-term effects, as well as the uncertainty associated with models and future projections, which increases with increasing time horizons.

Needs and suggestions for future work

Joint efforts & collaboration is essential



Improvement of datasets/ input data

* Updated, accurate, realistic & representative data
* SINTEF/NIBIO experience extrapolated to a Nordic context
* Open, accessible and well-documented datasets
* High quality resource potential, studies & expertise

Deliver policy-relevant and fact-based decisions

Conclusions

- Energy system models: need for better representation of biomass and bioenergy
- Forest biomass: need for additional low-price biomass
  - ✓ Increase harvest levels & residues supply
  - ✓ Increase use of roundwood for energy purposes (at the expense of pulpwood)
- NECP: should to a greater extent take biomass and bioenergy into account, and the Nordic context should be caretaken

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