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Roles of bioenergy in energy system pathways towards a "well-below-2°Celsius (WB2)" world

Workshop report (Berlin, 25 November 2019) and synthesis of presented studies

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SUMMARY

The central aim of the Paris Agreement is to strengthen the global response to the threat of climate change by limiting a global temperature rise this century to well below 2 degrees Celsius (WB2) above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C (UNFCCC 2015). Many scenarios that limit global warming to well below 2 (or 1.5) degrees Celsius (WB2 world) include a significant and increasing contribution of biomass-based energy supply (bioenergy), often in combination with carbon capture and storage (CCS) to remove CO2 from the atmosphere and store it underground in depleted oil and gas fields or deep saline aquifers (Bioenergy with CCS, BECCS). Scenarios may also include other options for CO2 removal (CDR) such as afforestation/reforestation for in-forest carbon storage and direct air capture of CO2. In the absence of CDR, WB2 scenarios may include more bioenergy since larger fossil fuel emissions reductions will then be needed to limit the temperature increase.

Achieving the level of bioenergy and BECCS deployment found in many global WB2 scenarios will require a large increase in the biomass supply for energy and also establishment of CCS infrastructure to enable BECCS. However, most countries and regions have not investigated potential BECCS pathways in detail. This may be considered a reflection of inadequate ambition, but it also reflects the difficulties of transposing global agreements into national or regional strategies, policies and regulations. In addition, there are concerns that large scale deployment of bioenergy and BECCS for reaching the WB2 target is difficult to reconcile with the achievement of the sustainable development goals (SDGs).

Under the IEA Bioenergy Inter-task project 'The Role of Bioenergy in a WB2/SDG world', a workshop was held in Berlin, on 25th November 2019. The objective of the workshop was to examine, synthesize and disseminate information from recent studies that investigate how bioenergy and associated technologies may contribute to achieving the reductions in greenhouse gas (GHG) emissions that are needed to meet the WB2 target. The workshop report summarises the workshop contributions and discussions, assesses the role of bioenergy in WB2

strategies, identifies the current state of knowledge as well as gaps in knowledge that need to be addressed.

Studies come to widely different conclusions concerning the future bioenergy supply potential, due to using different methods and data when estimating the size and availability of biomass resources. It is not possible to specify the future bioenergy supply potential to a narrow range due to inherent uncertainties concerning critical factors, including priorities among a multitude of societal objectives. But studies employing improved databases and modelling capacity have over time improved the understanding of how various factors influence the supply potential, e.g., future diets, crop yields, cropping intensity and land use efficiency in meat and dairy production, and land reservation for nature conservation. They have also shown that both positive and negative effects may follow from increased biomass use for energy. We propose that 100-250 EJ/a can be used as a first approximation concerning the global bioenergy potential in the 2050-2100 time frame, while acknowledging that studies also report smaller and larger supply potentials.

Bioenergy provision is embedded in national and regional energy systems, industrial infrastructure, land uses and value chains, but also energy system transformation strategies towards WB2. Countries differ concerning biophysical conditions for bioenergy and other energy sources, geological CO2 storage capacity, gas and electricity grids, public transport infrastructure, etc. The attractiveness of different bioenergy options therefore differs between countries and bioenergy strategies should not be prescribed at global/continental level, but rather developed within each country, reflecting the local context.

Integrated Assessment Models (IAMs) are used to analyse and assess complex interactions between human and natural systems. They can provide important insights about the role of biomass and bioenergy within the broader energy, economy, and land use systems, including the role of BECCS vis-à-vis other CDR options. They support exploration and learning about our “solution space” assessing the effects and uncertainties of several technical, socio-economic and policy developments. IAMs make significant simplifications concerning the systems they represent. This simplification causes certain ambiguities concerning input parameters, elasticities, and system boundaries, which can make interpretation and communication of results, and development of insights difficult. Moreover, sustainability criteria are applied in different ways, between the various IAMs, and the broader SDG trade-offs are not yet explored at depth in IAM modelling.

Looking forward, several steps are foreseen that will help inform deployment of bioenergy and BECCS to support energy system transitions towards a WB2 world.

1. Decisions concerning development of biomass resources and bioenergy systems are determined by the global as well as national and regional context. Therefore, analyses using models with different geographic scope and spatial resolution, ranging from global IAMs to more fine grained models (covering individual countries/regions and/or individual sectors or technologies), are needed. Non-OECD countries need to be better represented in national and regional models.

2. As BECCS and other CDR options commonly play important roles in WB2 pathways, it is warranted to intensify investigation and implementation of CDR in the near term. Early action also helps to identify potential barriers that prevent or slow down implementation of different CDR options. While there will be competition for funding between CDR options, based on respective cost of removing CO2 from the atmosphere, some CDR options also interact in synergistic ways. For example, land may be used to produce biomass for BECCS or for in-forest carbon storage, or both.

3. Integrated land use planning, applied at the landscape scale, can identify options for deployment of bioenergy and BECCS in ways that support achievement of multiple SDGs. For example, rehabilitation of degraded land through establishment of energy crops can contribute to land degradation neutrality goals (SDG15.3). Strategic integration of short-rotation woody crops can enhance agricultural production by providing windbreaks, hosting beneficial insects and lowering saline watertables. Realisation of these opportunities requires cooperative planning involving a broad range of stakeholders, including landholders, agribusiness and technical experts. It relies on recognition of the potential for integrated policies to deliver multiple benefits through well-designed interventions on the land, supported by effective coordination between local and national governments, and across ministries.

4. Finally, governance is critical to avoid or mitigate adverse side-effects and to promote synergies among important objectives, not the least associated with biomass supply systems. The scope and quality of governance influences biomass availability as well as demand for bioenergy. Policies can also (e.g., through sustainability requirements) influence how the bioenergy systems that satisfy the demand affect other land uses and the environment.

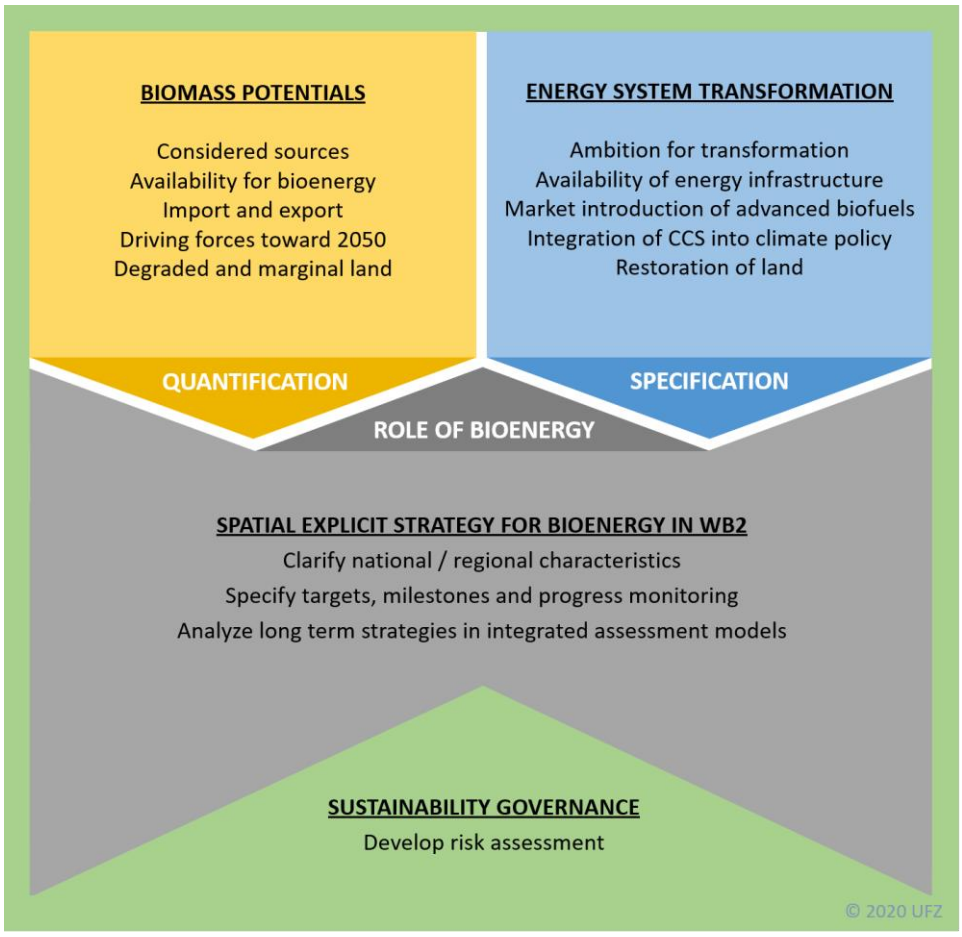

Figure: Assessing and translating bioenergy technology research into practice in a WB2 world