Climate vs biomass sustainability targets: are they compatible under a well below 2 °C trajectory?

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Aims

Compare regional biomass resource availability assumptions under well below 2ºC scenarios in a global Integrated Assessment Model (TIAM-UCL) with a bottom up national biomass resource model (Tyndall Centre's BRM). Focusing on two countries, the UK and Romania, we then discuss sustainability and policy implications of these assumptions.

Methods

TIAM-UCL global model

- Energy systems model that assesses different cost-optimal ways of meeting current and future energy demand under climate constraints
- Model split into 16 regions with explicitly defined fossil and renewable resources (including biomass) and trade flows between regions out to 2100

http://www.ucl.ac.uk/energy-models/models/tiam-ucl/tiam-ucl-description

Tyndall Centre's Biomass Resource Model (BRM)

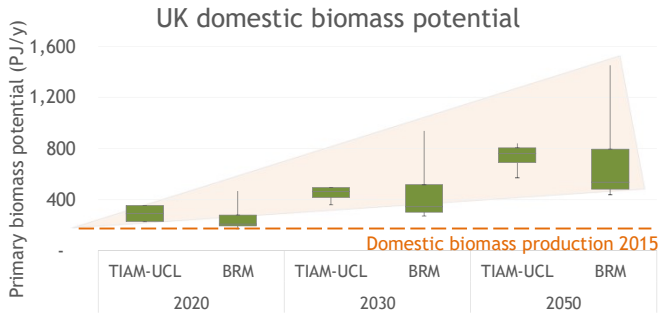
- Bottom-up resource modelling tool designed to calculate the current practical potential and forecast scenarios of biomass resource availability for a chosen geography
- BRM can be applied to analyse both the potential availability of resources for the bioenergy sector and the forms and extent of bioenergy that may be generated from these resources

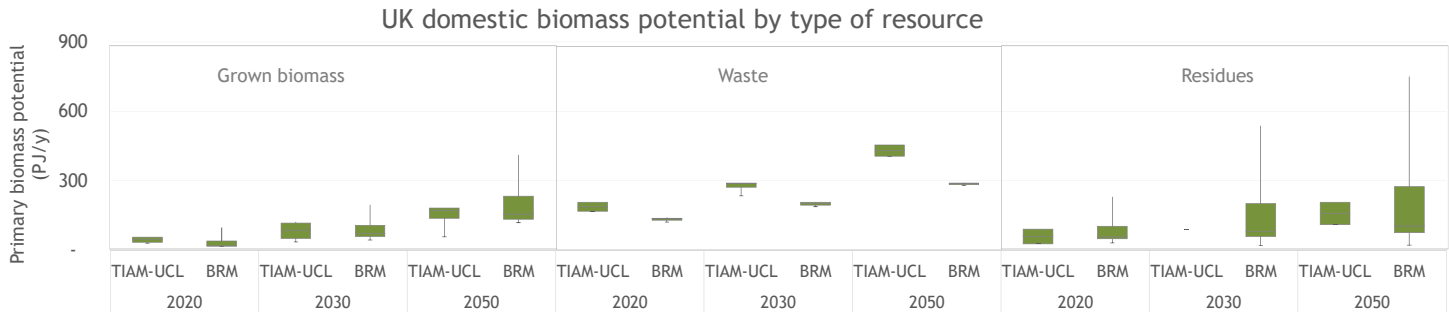
Welfle, A., Gilbert, P. & Thornley, P., 2014. Energy Policy 68, 1-14. https://doi.org/10.1016/j.enpol.2013.11.079

Model scenario definition and comparison

- In both models the drivers of development match the narrative of SSP2 (middle-of the road scenario)
- Both models use the "food first" rule for land allocation, i.e. TIAM-UCL considers only marginal land for grown biomass (woody and grassy energy crops, SRF, SRC, etc.), while BRM gives priority to food production when balancing competition for land
- TIAM-UCL was run under several scenarios of low and high global biomass availability and "well below 2ºC" global pathways, which were compared in terms of domestic biomass production against BRM runs focusing on 'Energy', 'Food', 'Economic' and 'Conservation'

Results



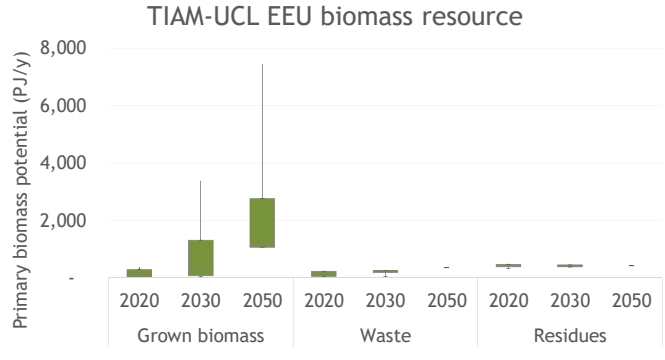


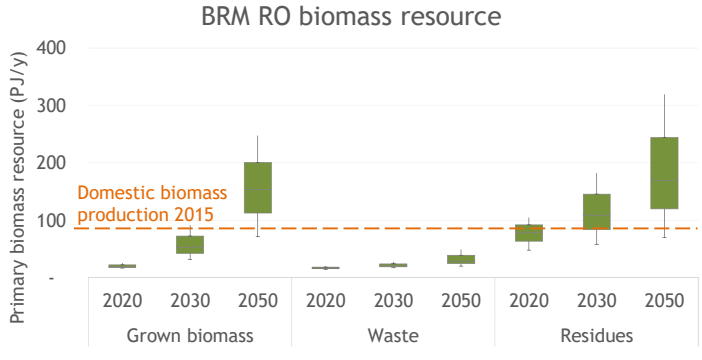
Agreement on the increased role played by bioenergy in the UK to 2050

- Agreement on the magnitude of resource potentially available
- The global model assumptions are at the upper level of the national estimations

Different projections for individual biomass fractions, suggesting different energy pathways:

- TIAM-UCL suggests more residues available for use in large scale BECCS/ "negative emissions" vs
- Biomass Resource Model (BRM): more waste fraction, available for biogas/ heating

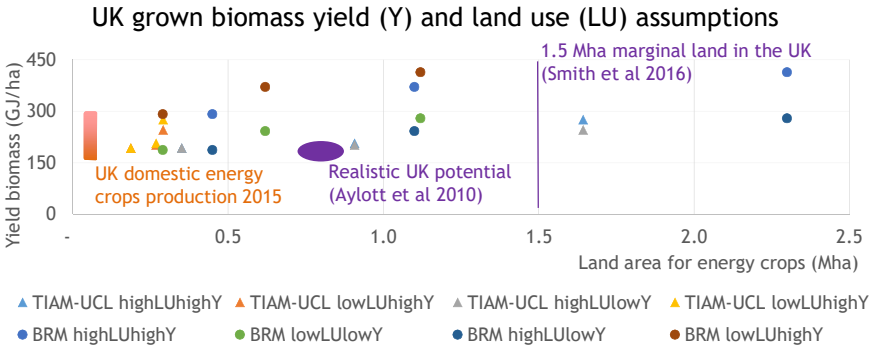




- TIAM-UCL's aggregated analysis for Eastern Europe (EEU) highlights the greatest regional resource opportunity will come from the grown biomass fraction
- BRM's analysis resolution is at the country scale, for Romania both residue and grown categories of biomass resource are forecast to have particular future potential
- Both models confirm the small role for waste fraction in the EEU, driven by the current and predicted low priority of energy recovery within waste management strategies

Sustainability implications

Grown biomass UK: exponential leap in land use and yields of energy crops, with substantial implications for sustainability of production

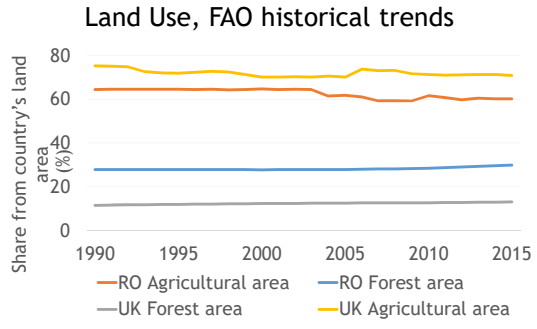


Residues: high variability and uncertainty driven by (1) sustainability criteria, so they can be used for bioenergy without impacting natural systems, and (2) competing demands of different industries

Waste fractions: sustainability influenced by waste generation & waste management policies => need alignment of waste and energy strategies

Policy implications

- Compared to current levels, both models highlight large domestic bioenergy potential in both the UK and Romania. Strong growth and efforts are needed to achieve the higher resource availability - up to 6 times more bioenergy by 2050 in the UK vs 8 times more in Romania
- Both models assume several fold increase in grown biomass by 2050, vs historical decline in agricultural area in both countries. This would require bold changes in agrarian policies to increase sustainable production on available land, including marginal land
- BRM highlights the important role that residues from ongoing activities, such as agriculture and industry, could play in both countries. Clear policies are required to increase the mobilisation of the residues



- Policy support mechanisms, e.g. Renewable Obligation, drive bioenergy growth. In the UK it led to growth of large scale bio-power production based on biomass imports, raising debate on feedstocks sustainability and calling for increased mobilisation and use of domestic resources
- Both models assume a modest role for waste residues. However, if strategies to increase the demand for recycled materials are not put in place in both the UK and the EU, including Romania, bioenergy from waste could potentially deliver GHG reduction and complete the move away from landfill

Further challenges and Recommendations

- Global IAMs are useful for suggesting energy pathways consistent with global climate targets, but their results are too aggregated to guide local policies. Our work shows synergic use of IAMs with national analyses, especially useful for countries not represented individually in global models, e.g. Romania
- BRM suggests high potential of residues in both countries, however more efforts are needed to improve global estimates
- To avoid "emissions leakage" between countries, global sustainability criteria need to be defined and harmonised

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