European Commission

Drivers of the Bioeconomy in Europe towards 2030

Short overview of an exploratory, model-based assessment

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2015

1. Background and approach

Economic growth and job creation, climate change, natural resource depletion, population growth and environmental degradation, to name but a few, are posing challenging questions for policy makers. As a significant political and economic player on the world stage, the European Union (EU) has taken a pro-active role in areas relating to greenhouse gas (GHG) emissions reductions, renewable energy usage and the greening of its agricultural policy. In 2012, the European Commission (EC) released a policy strategy paper (EC, 2012) for a sustainable model of growth which could reconcile the goals of continued wealth generation and employment with sustainable resource usage.

Over the last years the bioeconomy sector has been growing, although at a slower rate than expected and hoped for.

With a time horizon towards 2030, we use a forward-looking tool to analyse the potential of the bioeconomy to contribute to Europe's goal number one: economic growth and job generation.

The study employs a state-of-the-art neoclassical multi-region CGE model known as the Modular Agricultural GeNeral Equilibrium Tool (MAGNET). In addition to the "traditional" bio-based sectors, the model has been extended to explicitly represent sources of biomass supply (i.e., residues, plantations and pellets), second generation biofuels based on thermal and biochemical technologies and biochemical activities.

A *baseline narrative* up to 2030 captures medium term market developments under a business as usual set of assumptions conditioned by macroeconomic, technological, biophysical and policy developments. There is no deviation from existing policy thinking. Thus, emissions reductions beyond the EU's foreseen 2020 limits continue follow a status quo path, whilst biofuels mandates are simply maintained at pre-pledged blending limits. Trade policy shocks only capture existing free trade agreements, or those which are ratified. Finally, agricultural policy (CAP) includes agreed budgetary spending limits up to 2020 and the greening of 30% of pillar 1, whilst the structure of CAP support (i.e., coupled/decoupled split; pillar 1 and pillar 2 split) remains unchanged.

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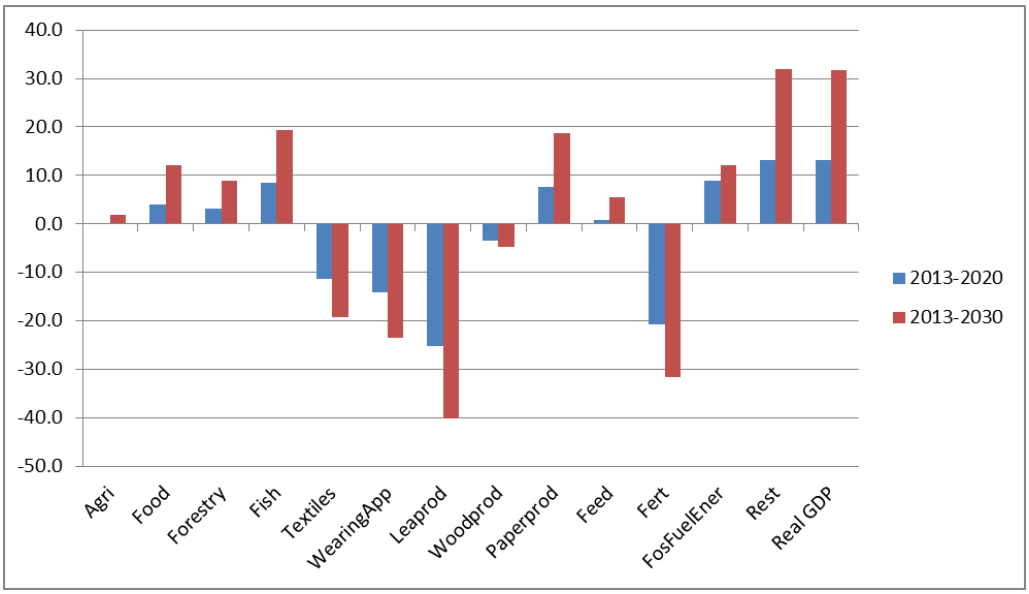
Figure 1: Output changes (%) in EU activities



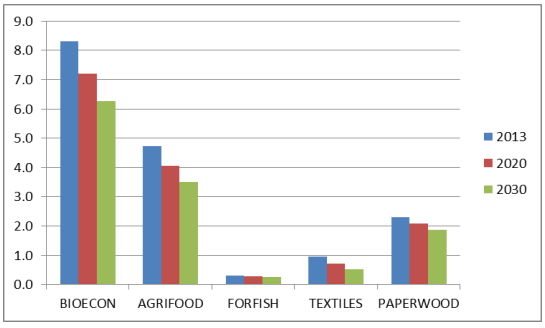
2. Economic development towards 2030

The trend across the EU's activities is that of output growth, given the assumptions on productivity, capital and labour endowments and EU28 real GDP growth of 31.7% between 2013 and 2030.

Nevertheless, an examination of individual sectors reveals a more heterogeneous pattern of change.

Figure 1 shows the output changes for aggregate bioeconomy sectors, feed, fertilizer, fossil fuel and an aggregate sector of non-bio-based activities.

Figure 2: Share (%) of value added attributed to the bioeconomy in EU28 over time



"Traditional" bio-based sectors decline

Examining more closely, it is the assumption of faster rates of macro real growth in non-EU regions, and the resulting erosion in EU competitiveness which is driving the output reduction in these EU28 sectors. This is particularly evident in traditional bio-based sectors (i.e., textiles, wearing apparel, leather and wood products), as well as fertilizer production, which are more open to rival trade from abroad. On the other hand, EU paper production, which is considerably less exposed to foreign trade, fairs better. In other (non-bio-based) sectors where trade openness is greatly reduced (e.g., services, transport), these sectors are allowed to grow.

As a result of slower growth in the bio-based sectors, the share of value added in the EU which is attributed to the bioeconomy, shrinks.

Agrifood sectors remain fairly stable

Agricultural output remains fairly static over the seventeen year time period; whilst higher value added processed food production also increases at a slower rate than that of the EU macroeconomy (12%).

The projections shocks boost agricultural growth 5% (2013-2030), although this is mitigated by significant improvements in land productivity in non-EU regions, which also detriments the competitiveness of EU28 agriculture. Moreover, with lower income elasticities, domestic demand driven growth in agrifood sectors is expected to be more modest.

"New" bioeconomy sectors

Of significance is the rate of growth exhibited by 'new' bio-based sectors (albeit from a smaller production base in many cases), in particular the sources and processing of biomass (i.e., plantations, residue sectors, pellets), bio-based

chemicals, and most notably, first and second generation bio-fuels.

The world price projections for fossil fuels (Table 1) have an important role to play in shaping market trends in these sectors, in particular bioenergy production. Given the general uncertainty surrounding this variable, different outcomes under different sets of fossil fuel market conditions can be expected.

Table 1: Energy prices over time, %change

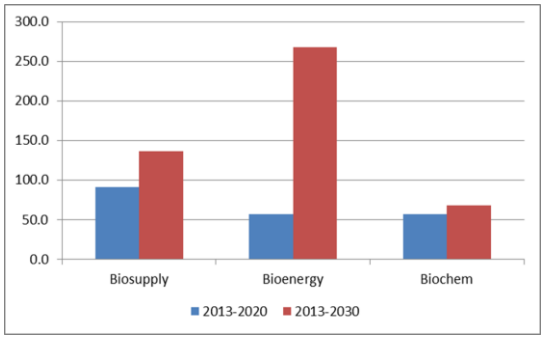
	2007-2013	2013-2020	2020-2030
Coal	28.6	-11.7	20.5
Crude oil	46.3	-30.9	22.8
Gas	31.2	-7.4	9.3

Source: World Bank (2015a, 2015b)

Output in the biochemical sector increases by a factor of 1.4, in biomass by a factor of 2.4 and in bioenergy production by a factor of 3.7.

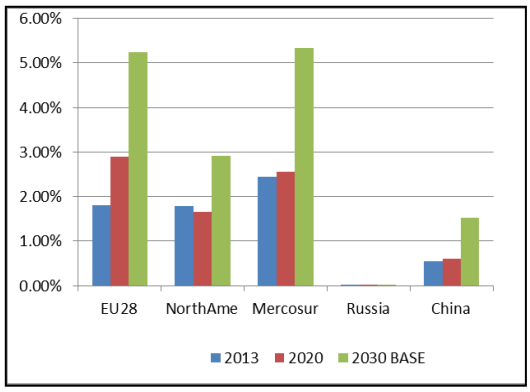
As expected, the blending mandate promotes first and second generation biofuel production, although the response is muted to some extent by the assumption that crude oil prices are falling considerably in the 2013-2020 period. This implies that under conditions of pure market forces, blending activities would substitute away from bio-based energy sources. In the 2020-2030 period, the opposite effect occurs where forecasts of significant crude oil price rises generate strong substitution effects in favour of bio-based energy supplies. Even in the absence of any mandate, between 2020 and 2030, the results suggest that bioenergy usage continues on a strong upward path. As a result of increased biomass supply, there is also a positive knock-on effect to other using sectors such as bioelectricity and biochemicals.

Figure 3: Output change bio-based sectors



The developments in the EU bio-based energy markets also shape the evolution of biofuel production in third countries. Figure 4 shows the share of energy production which comes from bioenergy production for five regions. By 2030, the EU's share is estimated to pass 5 percent, compared with 1.8% in 2013. A similar pattern is in evidence in North America, Mercosur and China. Results show that, in part, EU biofuel policy is motivating bioenergy output rises in other regions through increases in import demands.

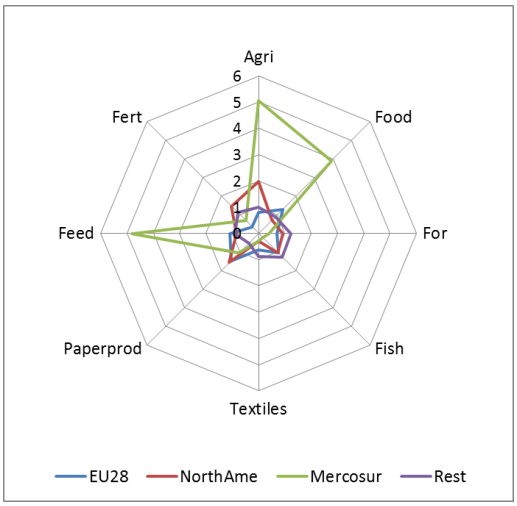
Figure 4: Share (%) of bioenergy in total energy production



Measuring trade competitiveness

The cobweb diagram (Figure 5) reveals the relative trade competitiveness of a selection of EU bio-based activities and fertilizers, compared with North America, Mercosur and the Rest of the World. Employing a well-known Balassa index, scores greater than one indicate trade competitiveness.

Figure 5: Revealed comparative advantage. Balassa Index 2013



The EU's trade competitiveness is concentrated in the food and paper industries. North America appears to have considerable comparative advantage in agriculture, whilst Mercosur is extremely trade competitive in agriculture, food and feed sectors.

3. Jobs

In all of the bio-based sectors, employment is falling below 2013 levels, except for bioenergy, biosupply and biochemical (Table 2). In absolute numbers, employment in the bio-based economy is estimated to fall from approximately 17.7 Mio to 13.6 Mio (Table 3).

Table 2: Employment (index 2013=100)

	2020	2030
Agriculture	92.1	85.2
Food	92.1	84.3
Forestry	88.9	76.7
Fish	98.4	92.1
Textiles	79.7	62.2
WearingApp	77.0	58.5
Leather	67.5	46.4
Wood	85.5	71.6
Paper	96.0	91.0
Biosupply	228.9	248.1
Bioenergy	144.0	290.5
Biochemicals	99.3	105.1
Feed	88.5	78.8
Fertilisers	72.8	59.1
Fossil Fuel	94.3	91.7
Rest	103.5	107.5
Total	102.3	105.1

The reasons for this decline can be explained as follows: The growth of global GDP goes hand in hand with a productivity effect, which means that less production factors (including labour) are required per unit of output. In addition, with slower rates of macro growth in the EU, there is a gradual competitive shift toward non-EU regions. These two combined effects are negatively affecting bio-based employment more than the positive impulse associated with rises in EU28 GDP output growth, incomes and domestic demand.

Owing to the significant increases in biofuel and biochemical production highlighted in the previous section, these bio-based sectors are the only examples of increasing bio-based employment over the time horizon of our experiment (albeit from a small base).

4. Decomposing drivers

A specific key feature of this research is the precise decomposition of the isolated impact of each exogenous policy or projection shock on outputs and prices.

Figure 6 gives an example of this technique, describing the impact of different drivers on sector outputs.

Macro-economic factors

As the figure indicates, exogenous projections of GDP and population growth, labour force and capital accumulation and land productivity have a significant role to play in propelling the progress of most individual sector activities.

Table 3: Employment (in 1000)

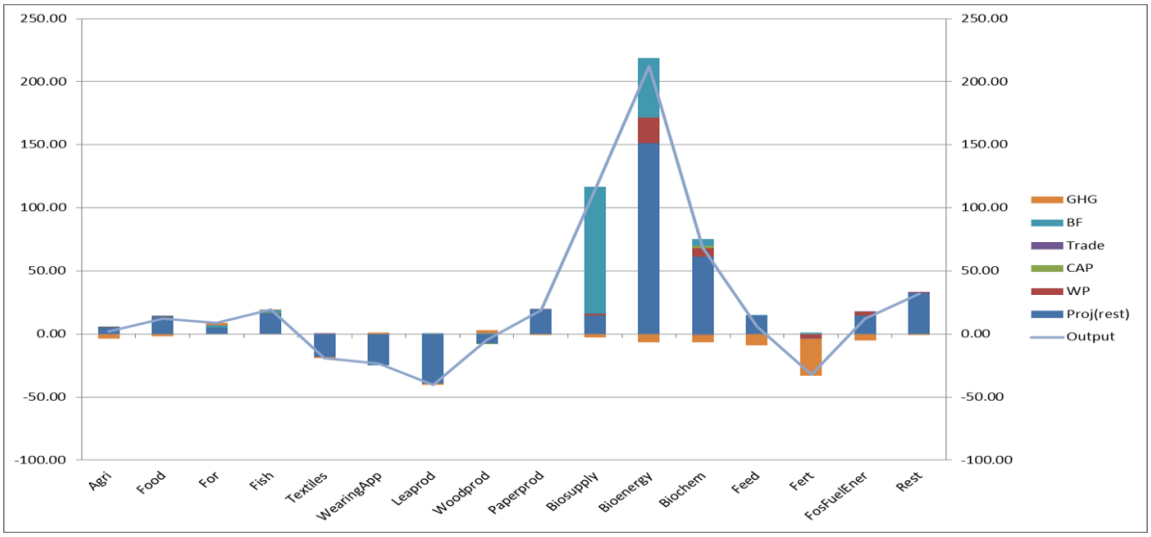
	2013	2020	2030
Agriculture	9,980	9196	7,837
Food	4,676	4307	3,631
Forestry	505	449	344
Fish	173	170	157
Textiles	226	180	112
WearingApp	375	289	169
Leather	158	107	50
Wood	1,043	892	639
Paper	593	569	518
Biosupply*	n.a.	n.a.	n.a.
Bioenergy	19	27	79
Biochemicals	26	26	27
Bio-based	17,774	16,212	13,563
Total	219,903	224972	236,407

* Absolute "biosupply" employment numbers are not available as this sector includes new and very small activities such as plantations for biomass.

Notwithstanding, in other sectors, the projections generate falling output, due to the slower relative rate of EU growth compared with other regions and the loss of competitiveness. As discussed above, these factors depress output in more open sectors, particularly traditional bio-based sectors such as textiles, wearing apparel, leather and wood products.

As a result of the conflicting impacts of land productivities, slower EU macro growth, rising capital and labour endowments on output change in the primary agricultural sector, the 'net' impact of the projections is found to be small.

Figure 6: Output decomposition



Importantly, as a relatively large source of non CO2 greenhouse gases (GHGs), the falls in emissions have a recognisable downward impact on agricultural output in the EU, which as a main supplier to downstream food industries, also affects processed food production.

In addition, Figure 6 reveals that the impacts of tighter GHG cuts in the EU not only affect more emissions intensive activities (i.e., fossil fuels, fertilisers), but also has ramifications for the biomass supply, bioenergy and biochemicals sectors as blending and chemical industry input demands contract.

Non-traditional bio-based sectors, which are largely non traded, are influenced positively by macro-economic factors, whilst both the biofuel mandate (2013-2020) and the substitution toward bio-based fuels in blending sectors due to rising fossil fuel world prices in the 2020-2030 period has a strong positive impact on output in the biomass supply, biochemcals and biofuels sectors.

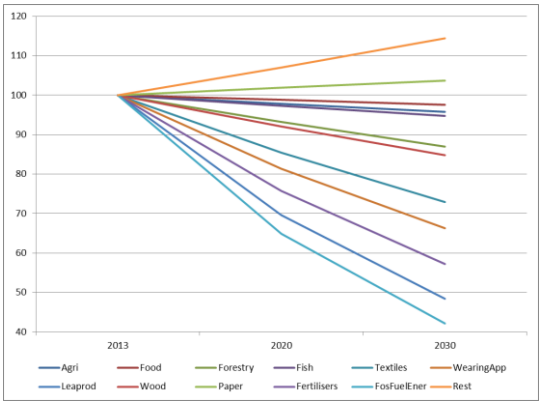
Finally, the driver decomposition analysis reveals that neither EU agricultural policies nor trade policy have much impact on output trends in the period 2013-2030. In the former case, this is to be expected since a large majority of EU agricultural payments are not explicitly

Greenhouse gas effects

Figure 7 shows the changes in EU28 greenhouse gas (GHG) emissions by sector over the three periods. Given the absence of data, bio-based energy, bio-based chemicals and biomass supply sectors are assumed to produce no GHGs. In the same way, with a lack of forestry land sequestration data, we cannot quantify the potentially harmful environmental impacts of the uptake of additional land to meet bio-energy mandates.

EU28 GHG emissions fall by approximately 12% over the period 2013-2030. With emissions reductions impacting disproportionately more on heavier emitting activities fossil fuel extraction and energy emissions fall by 58 index points over the same period, whilst fertiliser, which employs considerable inputs from the chemical and fossil fuel sectors, witnesses an emissions reduction of over 40 index points. Agriculture (-4.4%), forestry (-12.9%) and fishing (-5.1%) emissions reductions are more moderate, whilst in other traditional bio-based sectors (e.g., textiles, wearing apparel, leather and wood products), emissions reductions are more striking owing to the output falls over the 2013-2030 period

Figure 7: Changes in EU28 greenhouse gas (GHG) emissions



6. Discussion and conclusion

The results of this modelling exercise show that, as expected, the macro projections are key drivers in shaping the evolution of bioeconomy markets. The general pattern from the underlying assumptions is that with slower rates of real GDP and capital growth, the competitive position of the EU is gradually eroded over the time horizon of our experiment. This dynamic is particularly pertinent in the case those traditional EU bio-based sectors (i.e., textiles, wearing apparel, leather and wood products) which, due to their exposure to trade, witness significant reductions in output. In the case of EU primary agriculture, a constraining factor on output is the assumed higher levels of land productivities and macro growth in the non EU regions, although higher value EU processed food activities relatively exhibit more optimistic output growth over the period.

In terms of employment trends, with the output decline in a number of bio-based industries and stagnation in the primary agricultural sector (the largest source of bio-based employment), the share of EU employment attributed to the bioeconomy is estimated to shrink from approximately 8% in 2013 to 5.7% by 2030.

Despite the key role of the macro projections, other results also indicate that EU policy can have an important degree of influence, particularly in the infant industries of bio-chemicals and bio-energy. For example, the EU's bio-energy mandate in the period 2013-2020 is found to be an important driver of biomass supply, bio-energy and bio-chemical, not only within the EU, but also in North America and Mercosur. In combination with world fossil fuel prices and technology assumptions in the blending sectors, these 'new' bio-based sectors witness significant growth and employment effects (from small bases).

Elsewhere, reductions in EU greenhouse gases, which are assumed to be more ambitious compared with other regions, act as a key constraint on EU economic growth, with particularly strong impacts on petroleum and fertiliser sectors. In the former sector, this driving mechanism is found to have important implications on the usage of bio-based energy in blending. Work in progress on alternative policy narratives indicates that additional unilateral EU GHG emissions reductions, whilst bestowing important environmental (non-market) benefits, are also expected to carry a significant economic burden to the EU (bio)economy.

Finally, envisaged Common Agricultural Policy (CAP) and trade policy shocks over the period 2013-2030 are not expected to have much impact in shaping production changes in the EU bioeconomy. This is not a surprising result given that the majority of CAP payments are divorced from production, whilst the trade result is, in large part, testament to the generally low levels of tariff barriers on world markets.

This publication is a summary of an exploratory research study by the Joint Research Centre, the European Commission's in-house science service. This short report, undertaken by the JRC-IPTS AGRILIFE unit to contribute as well to the Bioeconomy Observatory, will be followed by a full report. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

How to cite: Philippidis, G.; M'barek, R; Ferrari, E. (2015). Drivers of the Bioeconomy in Europe towards 2030 - short overview of an exploratory, model-based assessment. European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Spain.

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