biomonitor POLICY BRIEF #5

Framework for Assessing the Development of a Circular Bioeconomy

Abstract

Measuring the progress of the circular bioeconomy requires quantifying a range of indicators that determine its development. This broad palette of indicators makes it harder for policymakers to consider all of them in their decisions. We devised a theoretical framework that accommodates any number of well-defined quantitative indicators to make it easier for decision-makers to see the overall development of the circular bioeconomy. We found that the circular bioeconomies of ten EU countries generally progressed over the period of 2006–2016, but not all indicators exhibited this general development.

Key points

- **Examining only a few indicators can bias the picture of a country's circular bioeconomy**
- **Quantitative targets for all indicators should be determined**
- **Data on indicators need to be collected for all EU Member States consistently**

Note

This policy brief is based on a paper by Kardung and Drabik.

Introduction

The circular bioeconomy can be an effective approach to tackling societal challenges, such as climate change, unsustainable use of natural resources, and growing economic inequality between rural and urban areas. Given the urgency of these problems, substantial progress in solving them is needed. Transition to the circular bioeconomy requires policy actions that promote the sustainable use of natural resources, high expenditures on the research and development (R&D) of new technologies, and education for new and restructured jobs. Policymakers can promote a sustainable transition by proposing bioeconomy strategies that target the whole circular bioeconomy and by using policy actions that address specific policy areas (such as the German Renewable Energy Sources Act, which targets renewable energy).

Measuring the progress of the circular bioeconomy requires quantifying a range of indicators that determine its static and dynamic impacts on the economy, the environment, and society. Many indicators can accomplish this goal—from measuring the share of organic farming areas to determining the rate of biowaste recycling. Indicators have already been established for supporting policy decisions. There are 27 indicators supporting the Europe 2020 Strategy, 100 European Union (EU) Sustainable Development Goals (SDGs) indicators, 231 United Nations SDGs indicators, and 1,600 World Bank world development indicators. In existing bioeconomy monitoring approaches, 269 distinct indicators that measure a wide range of impact categories, such as food security, biodiversity conservation, and resilience of biomass producers, have been found (Bracco et al., 2019). Lier et al. (2018) proposed 161 indicators, and the BioMonitor project 84 indicators, for a bioeconomy monitoring framework. This broad palette of indicators also means that it is not easy for policymakers to track these indicators' progress and consider all of them in their decisions.

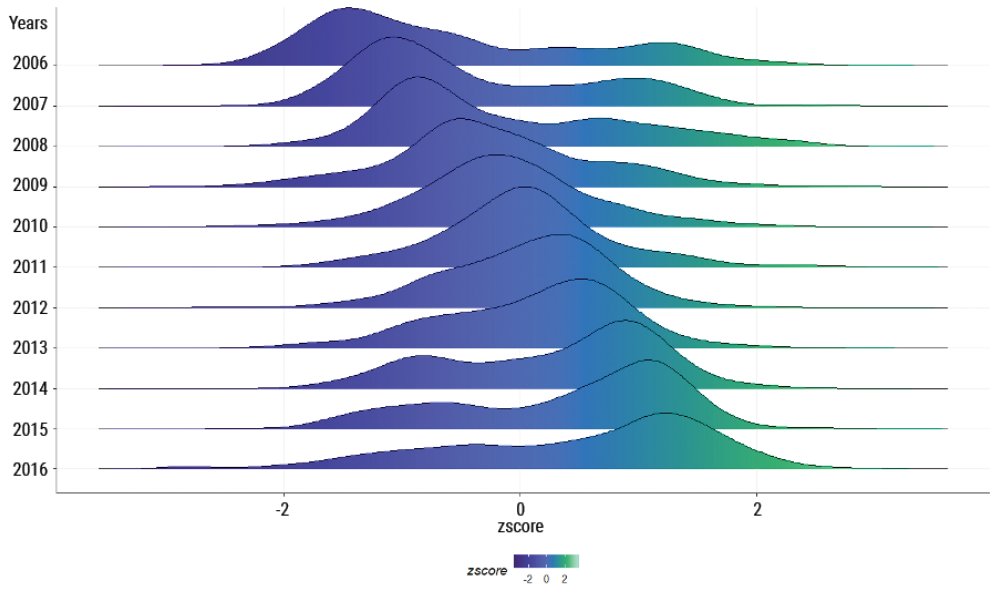
In the BioMonitor project, we try to make it easier for decision-makers to see the big picture of the development of the circular bioeconomy. Moreover, we want to inform them of important nuances. Therefore, we devise a theoretical framework that accommodates any number of well-defined quantitative indicators, and

we empirically analyze 41 of them. We describe the situation of the EU circular bioeconomy between 2006 and 2016 and analyze its nuances in Finland, France, Germany, Italy, Latvia, the Netherlands, Poland, Portugal, Slovakia, and Spain.

Tracking the progress of the circular bioeconomy

We collected time series data from Eurostat's "indicator set to measure the progress towards the SDGs" and from the "monitoring framework on the circular economy." We narrowed the selection of indicators down to the ones that are related to the circular bioeconomy. We then cleaned the data and interpreted individual indicators consistently so that a higher value corresponds to a more desirable outcome. We faced the critical challenge of making the varied empirically used indicators comparable for any meaningful analysis. This can be accomplished using several methodologies that have distinct advantages and disadvantages. A restriction with the indicators we used was that targets, which would have enabled us to calculate the percentage of meeting a target, were not available for individual indicators in most cases. Therefore, we used z-scores to compare the indicators.

Figure 1: Estimated indicator distribution by year for all countries



Note: The graph shows the temporally disaggregated z-scores for all indicators.

The z-score of a given indicator in a given year measures how many standard deviations the indicator value is away from the indicator's mean value. A positive (negative) z-score in a given year means that an indicator is doing better (worse) relative to the average over all the years. An important question a policymaker can ask is the ranking of indicators based on their changes with time. Which indicators are improving the most, and which ones are deteriorating? A simplistic analysis would perhaps compare only the beginning and ending years. However, such assessment is problematic because it can easily be biased by year-specific effects. Thus, we propose a more robust and elegant solution. We regress the z-scores of individual indicators on a time trend and use the estimated time coefficients (denoted as β below) to do the ranking. A positive (negative) coefficient reflects the progress (regress) of an indicator.

Progress of the EU circular bioeconomies

We found that the circular bioeconomies of the then EU countries (2006–2016) generally progressed considering all 41

indicators. In Figure 1, the aggregate distribution, including all indicators for each consecutive year, shifts to the right. Overall, the circular bioeconomy indicators improved on average over time for the ten countries. However, not all indicators exhibited this general development, as illustrated by the Netherlands. In Table 1, we look at the five most progressing and five most regressing indicators. (We do this for each Member State in our analysis.)
Overall, while most Member States quickly progressed in their share of renewable energy and recycling and circular material use rates, agro-environmental indicators swiftly regressed in Germany, Latvia, and Slovakia. Economic indicators related to circular economy sectors were among the worst indicators in six countries and were the best in only three countries. The indicators related to R&D generally progressed quickly in the private sector but regressed in the public sector, which suggests that private R&D substituted for public R&D.

Table 1: Most progressing and most regressing indicators in 2006–2016 in the Netherlands

Most progressing indicators	$\hat{\beta}$	Most regressing indicators	$\hat{\beta}$
Share of renewable energy in gross final energy consumption – all sectors	0.296	Government support for agricultural R&D (million euros)	-0.267
Tertiary educational attainment	0.291	Government support for agricultural R&D (euros per capita)	-0.264
Share of renewable energy in gross final energy consumption – heating and cooling	0.286	Long-term unemployment rate	-0.246
Recycling rate of municipal waste	0.284	Private investments, jobs, and gross value added related to circular economy sectors – % of total employment (V16111)	-0.242
Share of renewable energy in gross final energy consumption – transport	0.282	Employment rate of recent graduates	-0.236

Our results show that the circular bioeconomy is multifaceted and that, while it generally progressed during the study period, not all indicators moved in the desired direction. This pattern is exemplified in Germany's circular bioeconomy indicators, which progressed the most on average compared with the rest of the Member States. At the same time, Germany experienced a dynamic development of its circular bioeconomy: indicators sharply differed in their developments, and their relative rankings strongly varied between consecutive years. Certain indicators, such as patent applications and ammonia emissions from agriculture, even regressed rapidly. Moreover, our cross-country comparison revealed that the circular bioeconomies developed at different paces. The circular bioeconomies in Slovakia, Poland, and Latvia developed more rapidly compared with the rest of the studied countries. Their substantial relative progress from 2006 to 2016 was particularly unexpected because their governments did not implement any national policy action for the circular bioeconomy during that period. However, D'Adamo et al. (2020) found that Slovakia, Poland, and Latvia are still lagging behind the rest of the EU regarding socioeconomic performance. Therefore, the fast development of the circular bioeconomies in Slovakia, Poland, and Latvia may be partly explained by a catch-up effect with highly developed circular bioeconomies, such as that of the Netherlands. This finding is consistent with that of Ronzon and M'Barek (2018), who emphasized the potential of the bioeconomy in Central and Eastern Europe.
In contrast, the circular bioeconomies in Finland, Spain, the Netherlands, and Portugal improved the slowest despite

the implementation of dedicated national bioeconomy strategies (moreover, Finland and the Netherlands have additional policies and green-growth strategies).

Conclusions and policy recommendations

We have presented the main results of our investigation of the development of the circular bioeconomies in selected EU Member States. Our framework offers an easy-to-understand and -implement way of assessing the speed and direction of evolution of the circular economies across Europe (and other countries). Although our approach can be applied to any number of quantitative indicators, we had to limit its empirical use to 41 indicators due to special and temporal data gaps over the period we covered (2006–2016). However, the content that could not be presented in this policy brief due to space limits includes an important aspect related to the intradistribution dynamics of the indicators (as opposed to the external shifts of the entire distribution, as depicted in Figure 1), which sheds light on the stability of the position of some indicators in defining the contours of the development of the circular bioeconomy.

Nevertheless, the results of our work lead to some recommendations that policymakers might want to consider.

Policymakers should consider as many indicators as possible.

We recommend that policymakers consider as many indicators as are available in a given period. This is because a country with highly dynamic indicators is likely to progress differently in economic, environmental, and social aspects. Therefore, examining only a few indicators can bias the picture of a country's circular bioeconomy.

More concrete policy actions are needed.

The impacts of the existing policy strategies might be limited. More concrete policy actions are needed, such as an economy-wide carbon tax or targeted investments in bio-industrial initiatives (Philippidis et al., 2018).

Quantitative targets must be established for individual indicators.

Quantitative targets for all indicators should be determined, which would allow us to assess how far we are from reaching them. It would be more insightful to track progress towards meaningful targets.

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This project has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement N°773297.

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