

Towards a bioeconomy cluster in Central Finland



1. Introduction

1.1. What is a bioeconomy?

In the bioeconomy, biomass resources are transformed into competitive bioeconomy products. The total bioeconomy includes (EC, 2012^[4]):

- the traditional (100%) biobased sectors such as agriculture, horticulture, forestry, fisheries, food & feed, and pulp & paper; and
- the new biobased sectors such as biotextile, biochemistry, bioenergy and biotechnology.

As EU and national statistics do not split biobased and fossil-based activities within the textile, chemistry, energy and technology sectors, the RDI2CluB project uses data about the whole textile, chemistry, energy and technology sectors for approximating and indicating the future potential of the regional bioeconomy. Further, RDI2CluB applies tools that were developed in the BERST project (<http://www.berst.eu/>) in order to create Regional Bioeconomy Profiles for its five partner regions.

1.2. What is a bioeconomy cluster?

A bioeconomy cluster is perceived in RDI2CluB as a geographically proximate group of interconnected firms and associated institutions that have the common aim to develop the bioeconomy. In this cluster, firms are tied to other firms through 1) formal linkages (i.e. the input-output linkages) and 2) untraded interdependencies (norms, trust and a strong local network of private and public institutions). Given the broad coverage of bioeconomy sectors, bioeconomy clusters might be rather heterogeneous in their specific focus.

1.3. How to develop the bioeconomy cluster in Central Finland?

The bioeconomy cluster usually starts in one economic sector and in the course of time more economic sectors get involved due to cross-over activities that are explored. The development and strengthening of the cluster follows a collective learning process of active and open minded entrepreneurs, R&D institutes and policy makers, who together continuously develop new technical knowledge, adopt innovations, and adapt to changing local and global circumstances (see Figure 1 for conceptual framework). This learning process can be translated into a strategic roadmap of the biocluster at stake.

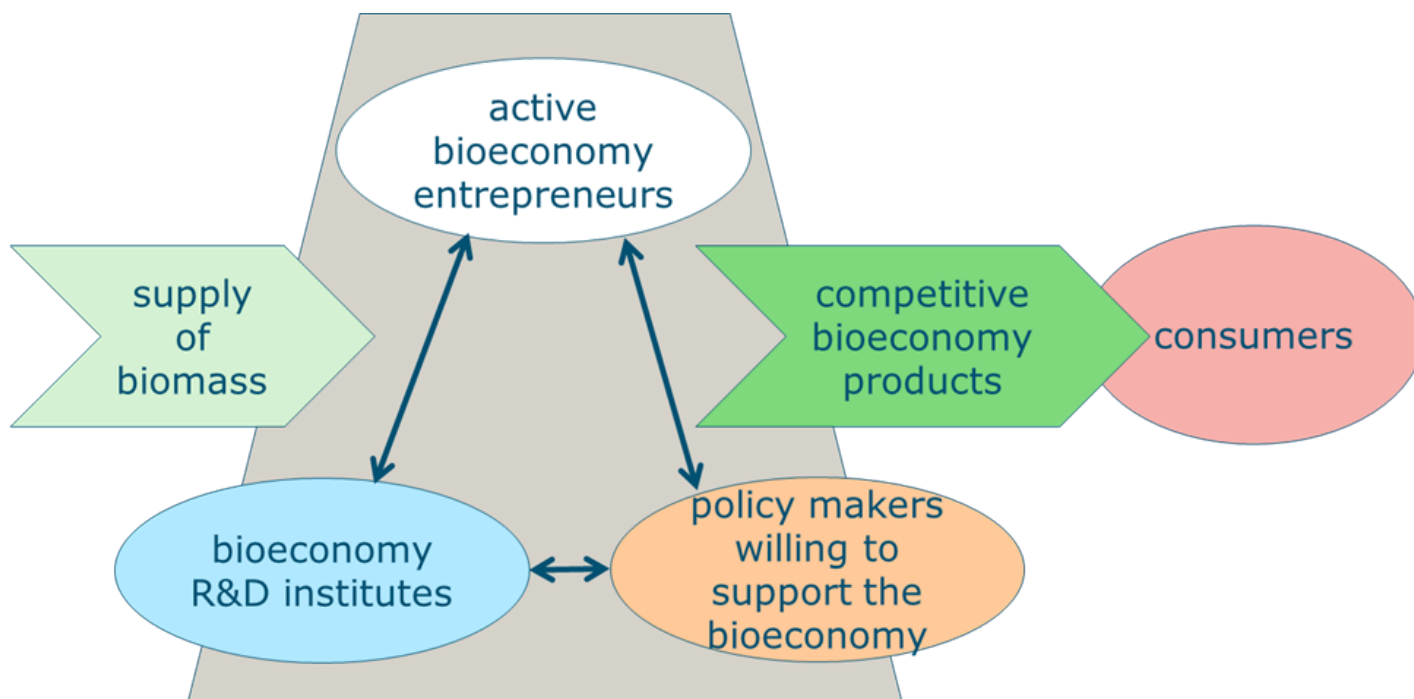


Figure 1 Conceptual model for the analysis of the strategy of a bioeconomy cluster

^[4] European Commission (2012), *Innovating for Sustainable Growth: A Bioeconomy for Europe*; Brussels, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2012) 60 final, February 13.

1.4. Aim of this regional profile report

This report provides an overview of the current state of the bioeconomy in Central Finland, suggests lessons for developing a bioeconomy cluster, and gives recommendations for instruments and measures. These ingredients can be helpful in drafting a smart development strategy for a bioeconomy cluster in Central Finland. The strategies for developing the regional bioeconomy should fit within the overall regional RIS3 strategy priorities that have been set by the region ([smart specialisation platform S3](#)). RDI2CluB can contribute to the RIS3 strategy approach as follows:

- the focus of RIS3 is on strategy targeted to develop the regional economy in general, and involves a process of developing vision, identifying competitive advantage, setting strategic priorities, making use of smart policies to maximise the knowledge-based development potential of any region, strong or weak, high-tech or low-tech;
- like in the BERST project, the focus of RDI2CluB is on developing smart strategies for the bioeconomy sectors, which could be linked to corresponding S3 priorities determined in the RIS strategy ([Eye@RIS3](#)).
- the roadmap in Section 5 can be used as guideline for where and how the bioeconomy cluster could best be developed or strengthened. Strategic discussions could be organised in regional Community of Practice meetings where entrepreneurs, R&D institutes and policy makers participate.

2. The bioeconomy cluster in Central Finland

2.1. Brief description of the bioeconomy cluster in Central Finland

Central Finland's S3 identifies the bioeconomy as one of its priorities, with a focus on:

- new innovations and business models enabling the development of circular economy (RDI);
- circular economy and bio-based side streams;
- full endorsement of agricultural potential.

The Central Finland region has a good biomass availability, especially forest-based biomass. It has a strong tradition in pulp and paper and related economic activities like machinery enabling wood processing. New, promising bioeconomy growth is in biogas production and consumption (especially transport), and in construction (wooden buildings). Though there is no bioeconomy cluster, Central Finland region has strong actors, e.g. the Institute on Bioeconomy, the forest industry, the RDI in wood fibers, and the mechanical forest industry. The focus of the bioeconomic development is to establish more cooperation, and to encourage SMEs for RDI cooperation with knowledge institutes for creating new bio-based products and services. There are several initiatives in place, including ERDF and national instruments, while political support for development is strong.

2.2. Barriers for the development of the bioeconomy clusters in Central Finland

RDI in Central Finland is very much dependent on public funding and driven by public RDI institutes. Bioeconomy firms in rural areas of Central Finland are mainly micro firms, and the focus is more on self-employment than on extensive growth. There exists a big forest-based industry in the region, but middle size companies in the bioeconomy are few. Since cluster organizations do not exist, there is no strong tradition in cooperation among bioeconomy firms.

3. Quantitative and qualitative indicators of the bioeconomy cluster in Central Finland

3.1. Regional structure

In a bioeconomy cluster, entrepreneurs, R&D institutes and policy makers closely cooperate to transform biomass into new, competitive biobased materials and products. In order to measure the state of the total bioeconomy in Central Finland we use a number of quantitative and qualitative indicators which we have grouped into criteria (classes) and indicators:

- *environmental criteria* provide information on biomass availability in the region and the attractiveness of the region as a place to settle for entrepreneurs and researchers;
- *economic criteria* reflect on the size of the total bioeconomy and that of economic sectors in which processing of new biobased products usually starts, the availability of public and private funding for the bioeconomy cluster, and the extent in which the regional actors are willing to innovate;
- *social criteria* report on the presence of a bioeconomy strategy in the region, the management of the biocluster, demographic characteristics and the quality of the work force.

Annex 1 gives the list of criteria and indicators used, as well as explanations why these indicators have been selected, their reliability and how they have been calculated.

The *quantitative indicators* for the total bioeconomy in Central Finland in 2016 are compared to its national average levels in Finland in order to get insight in the performance of criteria describing the regional total bioeconomy in the national context (i.e. z-score in Table 1 and the *Bioeconomy Readiness wheel* in Figure 1).

The *qualitative indicators* for the total bioeconomy have been valued by regional stakeholders as weak, moderate or strong (Table 2). These scores have been obtained from a survey.

Note that the data used to calculate the indicators for the Polish regions are a mixture of the years 2015, 2016 and 2017. The data used to calculate the indicators for the Finnish and Norwegian regions refer to the year 2015.

Table 1. Indicators describing the potential bioeconomy in Central Finland in 2016 compared to Finland average

Criteria	Indicator	Central Finland	Finland	Central Finland (z-scores ¹)
Land use	Forestry land density (% of total land)	87.9	87.3	0.06
	Agricultural & horticultural land density (% of total land)	5.3	7.2	-0.26
Biomass availability	Agricultural biomass production (kg/cap)	670.3	1,213.0	-0.58
	Blue biomass production (kg/cap)	1.1	2.4	-0.08
	Forestry biomass production (kg/cap)	33,671.7	19,742.7	0.69
	Waste production (kg/cap)	5,607.5	6,315.9	-0.13
Innovation	SME birth rate (% of total firms)	6.2	7.1	-0.46
	R&D expenditure (index)	1.4	1.1	0.43
Employment structure	R&D employment (% of total employment)	2.7	2.3	0.34
	Total Bioeconomy employment (% of total employment)	7.5	7.2	0.09
	Chemical employment (% of total employment)	0.2	0.8	-1.18
	Energy employment (% of total employment)	0.3	0.5	-0.92
	Paper & Pulp employment (% of total employment)	1.1	0.6	0.57
	Textile employment (% of total employment)	0.1	0.3	-0.67
Firm structure	Total bioeconomy firms (% of total firms)	29.6	23.1	0.59
	Chemical firms (% of total firms)	0.2	0.3	-0.47
	Energy firms (% of total firms)	0.4	0.4	0.13
	Paper & pulp firms (% of total firms)	0.0	0.1	-0.43
	Textile firms (% of total firms)	0.4	0.5	-0.68
Demographics	Population growth (% per year)	0.2	0.4	-0.36
	Population 15-65 years (% of total population)	61.9	62.9	-0.38
	GDP (PPP) - index	90.20	120.03	-1.22
Quality of workforce	Secondary & Tertiary education (% of total population)	86.8	79.1	0.83

Source: BERST report 1.1 'Criteria and Indicators describing the regional bioeconomy, 2014; Eurostat, RIS, National statistics; 1) Z-scores compare the regional value with the national average (corrected for standard deviation) (see Annex 2 for explanation).

Further note that:

- Yellow coloured indicators in Table 1 are also presented in Figure 2
- Green coloured indicators in Table 1 are also presented in Figure 3
- Orange coloured indicators in Table 1 are also presented in Figure 4

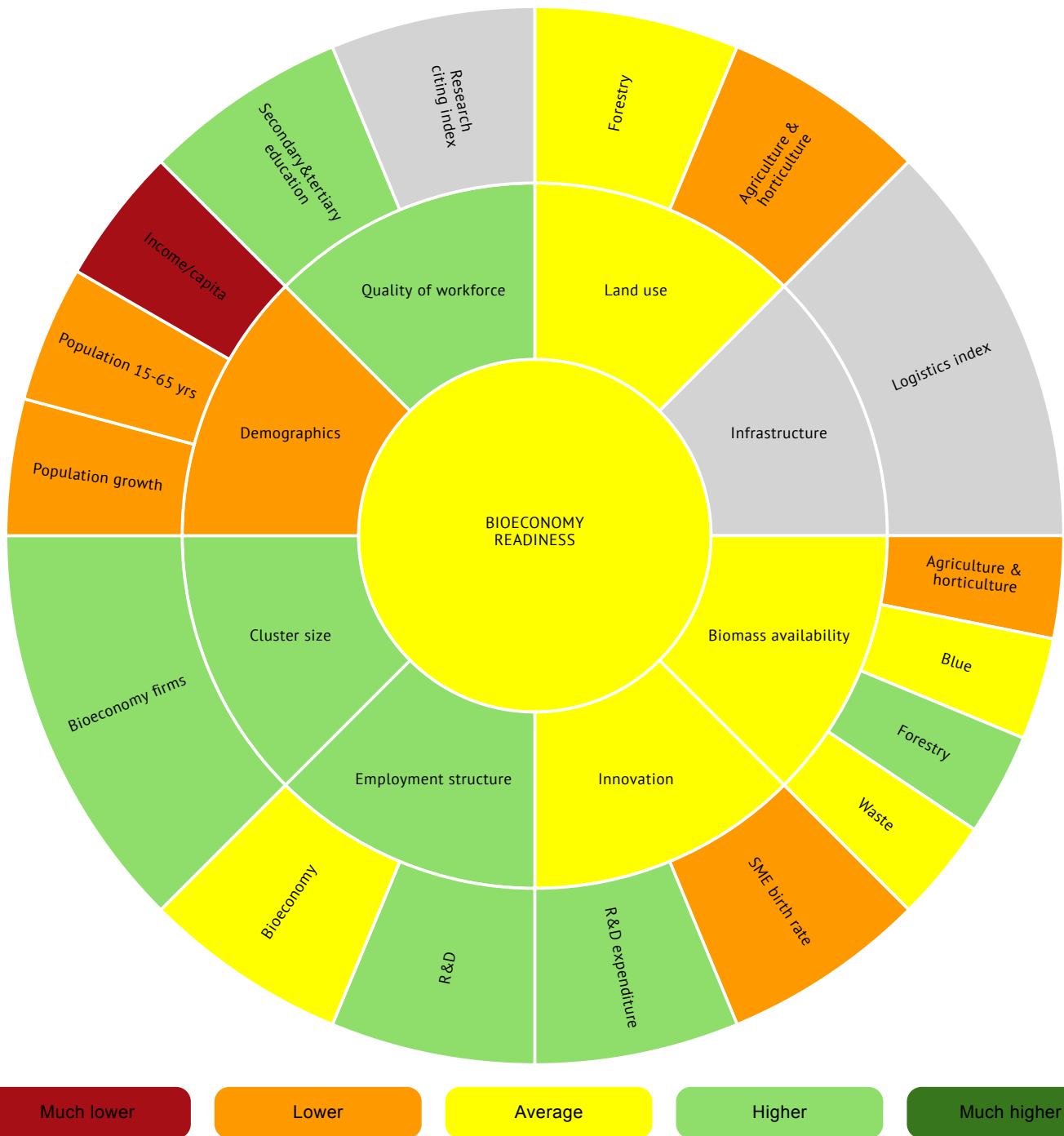


Figure 2. Bioeconomy Readiness for Central Finland in 2016 compared to Finland

The inner circle of Figure 2 gives the key criteria that describe the regional bioeconomy. The outer circle gives the indicators that measure a specific criterion. Each indicator has the same weight.

Annex 1 gives the list of criteria and indicators used, as well as explanations why these indicators have been selected, their reliability and how they have been calculated.

How to read the bioeconomy readiness wheel?

The criteria and indicators used in the readiness wheel should be regarded carefully and with knowledge about characteristics of the region under study. The criteria and indicators have been selected based on literature reviews, and they have been verified by the BERST regions. In principle they should be applicable to any European region, though from practice it has become clear that it is difficult to find a unique combination of indicators that is equally meaningful to all regions. First, this is due to the fact that some criteria simply lack a clear indicator which has consistently been measured across all European regions; e.g. the indicator *university ranking* is available in public sources for the criteria *Quality of workforce*, but unfortunately not all European universities are on the ranking list. Second, regions have different views on which indicator should be taken into account in some cases. What makes sense for the one region is not per se the case for the other region. For example, *Baltic regions* regard the availability of untapped *agricultural land* (measured in ha) as a key indicator for illustrating the potential bioeconomy development. On the other hand, the size of agricultural land is less important for e.g. the Dutch region *Westland* in which agricultural area consists mainly of horticultural area with a high product intensity per hectare. The potential of the supply side of the bioeconomy in the Westland could be better indicated by the *availability of biomass* (measured in tonnes) indicator. Third, regions are now compared to the national average, without any indication how the country scores in the EU or in global context. A region might score high in a national context, but low in an EU context (and vice-versa). In the RDI2CluB project, we have added a benchmark option that compares region x in country x with region y in country y, as long as data for EU regions have been collected under the BERST and RDI2Club projects.

"Start from what is available in the region and make strategy around it. That is valid to ALL regions in the world" according to Rogier van der Sande (rapporteur of Committee of the Regions) in his presentation at the Open Days of the Regions in Brussels; 13 October 2015.

Therefore, the colours of the traffic lights are NOT indicating a 'bad' or a 'good'. However, the colouring can be helpful to regional stakeholders where to make smart specialized strategy in order to best develop or strengthen the potentials for bioeconomy development.

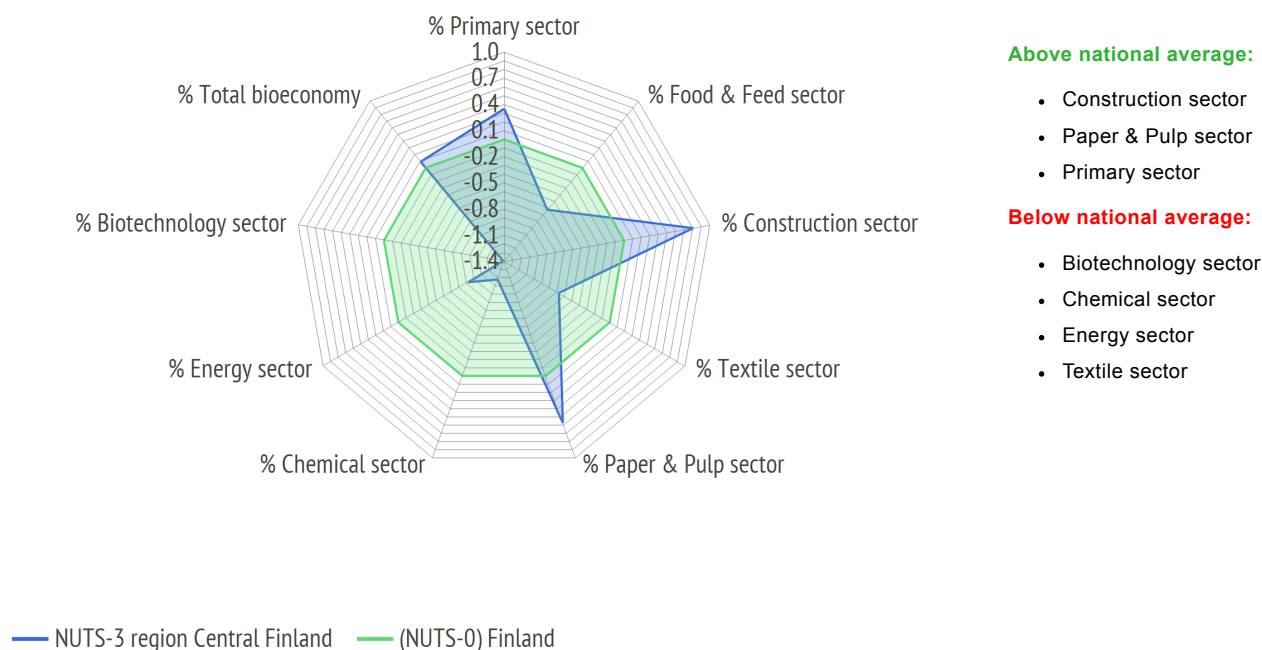
Region is relatively strong in:

- Forestry biomass production (kg/cap)
- Total bioeconomy (firms)
- Paper & Pulp sector (employment)
- R&D expenditure (index)
- R&D employment (% of total employment)

Region is relatively weak in:

- GDP (PPP) - index
- Chemical sector (employment)
- Energy sector (employment)
- Textile sector (firms)
- Textile sector (employment)
- Agricultural biomass production (kg/cap)
- Chemical sector (firms)
- SME birth rate (% of total firms)
- Paper & Pulp sector (firms)
- Population 15-65 years (% of total population)
- Population growth (% per year)
- Agricultural & horticultural land density (% of total land)

Figure 3 shows the employment structure of bioeconomy sectors (sectoral employment as % of total regional employment) in Central Finland compared to the national average (value 0 is the national benchmark value; the blue line shows how far the region deviates from the national average). A value below 0 means that the regional sector share is less than the national average; a value above 0 means that the regional sector share is higher than the national average. Similarly, Figure 4 shows the firm structure (number of firms in a sector as % in total regional firm number) of the bioeconomy sectors in Central Finland.



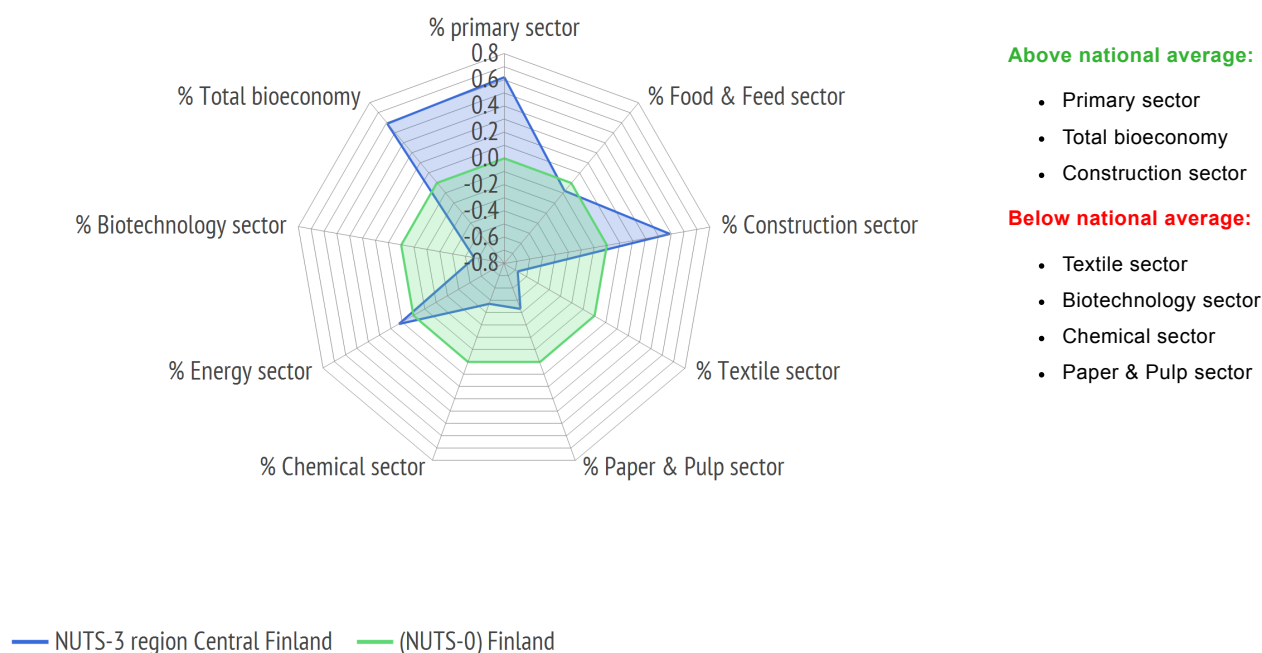
Above national average:

- Construction sector
- Paper & Pulp sector
- Primary sector

Below national average:

- Biotechnology sector
- Chemical sector
- Energy sector
- Textile sector

Figure 3. Employment structure (%) in Central Finland in 2016 compared to Finland



Above national average:

- Primary sector
- Total bioeconomy
- Construction sector

Below national average:

- Textile sector
- Biotechnology sector
- Chemical sector
- Paper & Pulp sector

Figure 4. Firm structure (%) in Central Finland in 2016 compared to Finland

3.2. Assessment of the qualitative indicators

The focus of the regional profiles relates to exploring bioeconomy clusters, which originates in one of the following sectors: chemicals, energy, paper & pulp and textiles. A series of qualitative indicators in Central Finland must be valued by regional stakeholders for one or two of these potential bioeconomy clusters (see Table 2).

Table 2a. Scores for qualitative indicators of the bioeconomy cluster in the chemical sector in Central Finland

	Central Finland
1 Biomass availability - presence of continuous supply of biomass with constant quality (incl imports)	strong
2 Infrastructure - attractiveness of region as place to settle for entrepreneurs and researchers?	moderate
3a Cluster management - presence of RIS3 with bioeconomy focus?	moderate
3b Cluster management - presence of cluster organisation?	moderate
3c Cluster management - presence of incubator?	moderate
4a Innovation - biocluster integrated in science park	strong
4b Innovation - presence of innovative bioeconomy milieu?	moderate
5a Availability of funding - access to private funds?	moderate
5b Availability of funding - access to public funds?	strong
6 Policy setting - policy commitment?	moderate

Table 2b. Scores for qualitative indicators of the bioeconomy cluster in the energy sector in Central Finland

	Central Finland
1 Biomass availability - presence of continuous supply of biomass with constant quality (incl imports)	strong
2 Infrastructure - attractiveness of region as place to settle for entrepreneurs and researchers?	moderate
3a Cluster management - presence of RIS3 with bioeconomy focus?	moderate
3b Cluster management - presence of cluster organisation?	moderate
3c Cluster management - presence of incubator?	moderate
4a Innovation - biocluster integrated in science park	strong
4b Innovation - presence of innovative bioeconomy milieu?	moderate
5a Availability of funding - access to private funds?	moderate
5b Availability of funding - access to public funds?	strong
6 Policy setting - policy commitment?	moderate

Table 2c. Scores for qualitative indicators of the bioeconomy cluster in paper & pulp sector in Central Finland

	Central Finland
1 Biomass availability - presence of continuous supply of biomass with constant quality (incl imports)	strong
2 Infrastructure - attractiveness of region as place to settle for entrepreneurs and researchers?	moderate
3a Cluster management - presence of RIS3 with bioeconomy focus?	moderate
3b Cluster management - presence of cluster organisation?	moderate
3c Cluster management - presence of incubator?	moderate
4a Innovation - biocluster integrated in science park	strong
4b Innovation - presence of innovative bioeconomy milieu?	moderate
5a Availability of funding - access to private funds?	moderate
5b Availability of funding - access to public funds?	strong
6 Policy setting - policy commitment?	moderate

Table 2d. Scores for qualitative indicators of the bioeconomy cluster in the textile sector in Central Finland

	Central Finland
1 Biomass availability - presence of continuous supply of biomass with constant quality (incl imports)	strong
2 Infrastructure - attractiveness of region as place to settle for entrepreneurs and researchers?	strong
3a Cluster management - presence of RIS3 with bioeconomy focus?	moderate
3b Cluster management - presence of cluster organisation?	strong
3c Cluster management - presence of incubator?	moderate
4a Innovation - biocluster integrated in science park	weak
4b Innovation - presence of innovative bioeconomy milieu?	moderate
5a Availability of funding - access to private funds?	strong
5b Availability of funding - access to public funds?	moderate
6 Policy setting - policy commitment?	moderate

Source: Own elaboration based on [BERST report 3.2 'A representative set of case studies'](#).

4. Further development of the bioeconomy cluster in Central Finland

RDI2CluB especially focuses on the potential of bioeconomy clusters that starts in one of following sectors: chemicals, energy, paper & pulp and textiles. In the bioeconomy, these sectors process biomass and waste resources from the primary sectors (agriculture, horticulture, fishery, forestry) into new biobased materials and products by using knowledge from the R&D sector (Figure 5).

This section selects the focus sector(s) from which the bioeconomy starts. It can be concluded from the analysis above that the size of the paper & pulp in Central Finland is above national average, its energy sector is quite similar and its chemical and textile sectors are below national average.

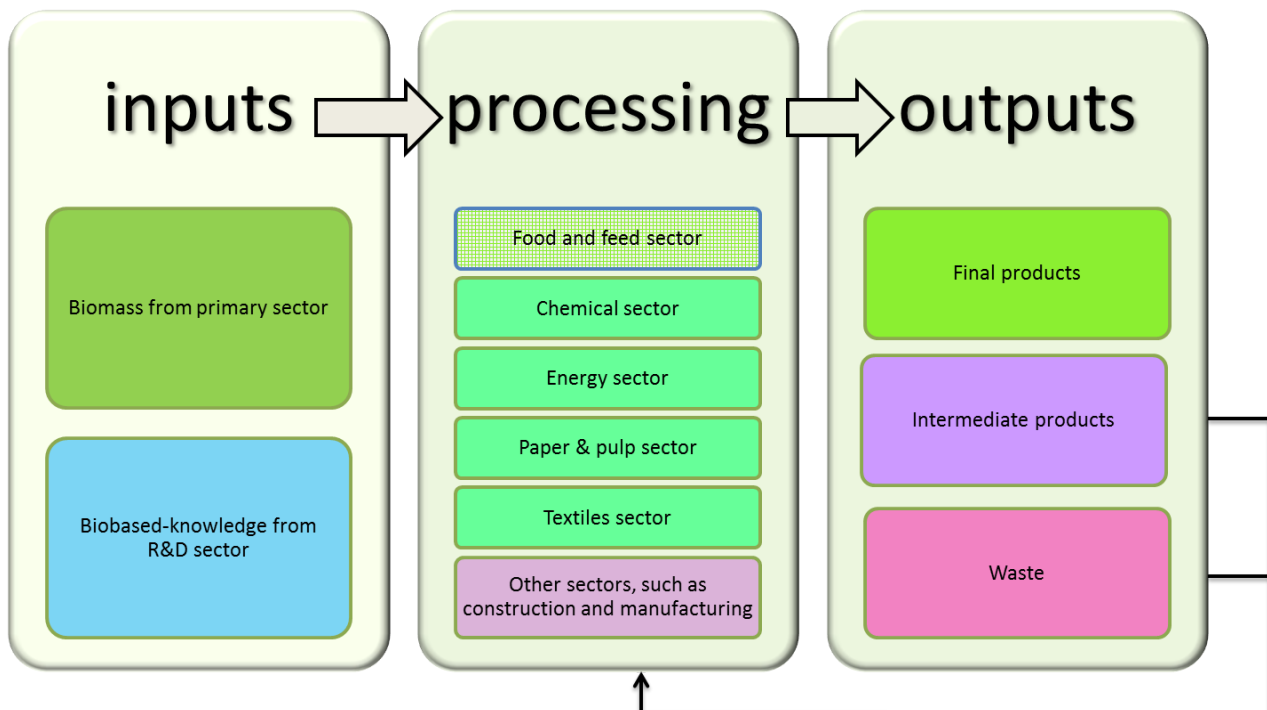


Figure 5. Linkages among economic sectors in biobased economy in RDI2CluB (source: BERST, 2015)

4.1. Lessons for the development of a bioeconomy cluster from Good Practice regions

Europe has examples of regions where the bioeconomy cluster is already in a mature stage. These bioeconomy clusters can serve as 'Good Practices' for other regions that want to develop their bioeconomy cluster. From the analysis of the development path of the Good Practices' bioeconomy clusters (BERST report D3.2), it appeared that a bioeconomy cluster usually starts its activities in one economic sector. By making crossovers to other sectors over time, the cluster will develop to a mature stage covering several economic sectors. Table 3 lists a number of Good Practice regions and the sector in which their bioeconomy cluster has started.

Table 3. Good Practice regions in BERST and the economic sector in which their bioeconomy cluster started

Regions with mature biocluster	Start sector of biocluster
Toulouse (FR), Manchester (UK), North Rhein Westfalen (DE)	Chemical sector
Keski Suomi (FI), Ghent (BE)	Energy sector
Keski Suomi (FI)	Paper & pulp sector
Ghent (BE)	Textile sector

Source: BERST report 3.1 'Good Practices in selected bioeconomy sector clusters; a comparative analysis'

From the analysis of the development path of the bioeconomy clusters in the Good Practices, a number of key findings emerged that can be considered as enabling factors for bioeconomy clusters:

- active actors organize the cluster as a bottom-up process and keep it moving by intensive networking;
- the presence of a cluster board that takes care of the organization of the cluster and communication;
- the cluster makes use of the strong points of the region;
- first, the cluster is mainly supported by public funds; later private funds become also available; the cluster starts with activities in one economic sector;
- biomass resources may originate from both local and external supply.

These enabling factors may serve as lessons for developing the bioeconomy cluster in Central Finland.

4.2. Supportive instruments and measures to develop the bioeconomy cluster

The BERST project found that Good Practices have used specific instruments and measures in order to stimulate its bioeconomy cluster. Table 4 gives examples of such effective instruments and measures.

Table 4. Useful Instruments and Measures for developing the bioeconomy cluster in the energy sector in Central Finland (select the I&Ms that refer to the bioeconomy cluster(s) the region want to develop)

Measures directed at	Start sector of biocluster
<i>Chemical sector</i>	
Getting access to public funding	Bavarian Research Alliance, Unit Environment, Energy & Bioeconomy: https://berst.vito.be/node/787
Getting access to private funding	Biocat: https://berst.vito.be/node/34
Support for setting up a science park	Centre of Excellence for Companies in the Renewable Raw Materials sector: https://berst.vito.be/node/470
Support for setting up an incubator	BioCubator- Business Incubator for Companies in the Renewable Raw Materials sector: https://berst.vito.be/node/470
Support for financing the cluster board	Matchmaking events: https://berst.vito.be/node/480
Support for infrastructure	Centre of Excellence for Renewable Resources Straubing: https://berst.vito.be/node/476

<i>Energy sector</i>	
Getting access to public funding	Bavarian Research Alliance, Unit Environment, Energy & Bioeconomy: https://berst.vito.be/node/787
Support for setting up a science park	Shared Research Centre Biorizon: https://berst.vito.be/node/763
Support for financing the cluster board	Biotech Umea: https://berst.vito.be/node/33
Support for infrastructure	Regional land use plan (Central Finland): https://berst.vito.be/node/753
Support for the improvement of the supply of biomass	Entrepreneurs Platform: https://berst.vito.be/node/483
<i>Paper & Pulp sector</i>	
Support for the improvement of the supply of biomass	Action plan for the use of renewable raw materials: https://berst.vito.be/node/21
Support for setting up a science park	Center of Excellence for Renewable Resources Straubing: https://berst.vito.be/node/476
Support for setting up an incubator	BioCubator-Business incubator for Companies in the Renewable Raw Materials sector: https://berst.vito.be/node/47
Support for financing the cluster board	Biotech Umea:
Support for infrastructure	Center of Excellence for Renewable Resources Straubing: https://berst.vito.be/node/476
Support for improving human resources	BioCon Valley: https://berst.vito.be/node/468
<i>Textile sector</i>	
Support for the improvement of the supply of biomass	Action plan for the use of renewable raw materials: https://berst.vito.be/node/21
Support for setting up a science park	Center of Excellence for Renewable Resources Straubing: https://berst.vito.be/node/476
Support for setting up an incubator	BioCubator https://berst.vito.be/node/33 -Business incubator for Companies in the Renewable Raw Materials sector: https://berst.vito.be/node/470
Support for financing the cluster board	Biotech Umea: https://berst.vito.be/node/33
Support for infrastructure	Center of Excellence for Renewable Resources Straubing: https://berst.vito.be/node/476
Support for improving human resources	BBioCon Valle: https://berst.vito.be/node/468

Source: Catalogue of Instruments and Measures

4.3. Recommendations for the further development of the bioeconomy cluster in Central Finland

In RDI2Club we especially focus on the potential of bioeconomy clusters, that originate in one of the four following sectors: chemicals, energy, paper & pulp and textiles. In the bioeconomy, these sectors transform biomass resources from the primary sector into new biobased competitive products by using knowledge from the R&D sector (Figure 5).

This section describes the recommendations for the development or strengthening of the bioeconomy cluster in Central Finland. This section describes the recommendations for the development or strengthening of the bioeconomy cluster in Central Finland, based on analyses of strengths and weaknesses in previous sections.

The paper and pulp sector in Central Finland is strong. It has strong traditions and future perspectives are positive. Especially the pulp production developed strongly during the past years. The pulp industry could utilize unused potential of side streams, and Central Finland could have a leading role here. E.g. lignin-based added value products. Also, cellulose-based new fiber products, in packing and textiles etc. will have great importance when replacing fossil-based materials with bio-based materials.

The energy sector in Central Finland is heavily relying on wood-based raw materials. There is a growing interest in the utilization of biodegradable wastes for energy into biogas. Biogas for transport use could decrease its fossil fuel dependency. There are still obstacles, e.g. lack of infrastructure. Simultaneously, there is a growing interest of biogas production and consumption.

Mechanical forest industry, i.e. sawmills and construction, has great importance for Central Finland. SMEs in this sector have potential to grow, especially since the growing demand of wood for pulp industry means also increased availability of logs for mechanical forest industry.

Both textile and chemistry sectors are derived from the already strong bioeconomy sectors paper & pulp and energy. The chemical sector in Central Finland is not considered as a very strong one. The bio-based chemical industry is very much relying on the paper & pulp sector. At the moment the further development of green chemistry is lacking. Though strong knowledge organizations are present in the region, the entrepreneurial activity in green chemistry is very low. Availability of the various raw materials and side streams (circular economy in paper & pulp) should be better utilized in the region. The textile sector is nearly there in Central Finland. Wool processing exists on small scale, but industrial sized textile sector is absent. The promising new innovations in wood-based textiles could change the situation, and Central Finland has prominent start-ups in this field.

5. Roadmap for developing a strategy for a bioeconomy cluster

The information on strengths and weaknesses of the regional bioeconomy, the lessons from the Good Practice regions and the overview of supportive measures and instruments may serve as input for further steps in developing the bioeconomy cluster in Central Finland. The roadmap in Table 5 can be used as starting point in the discussion on developing such a strategy in a **regional Community of Practice of entrepreneurs, R&D institutes and policy makers**. Guidelines for the regional CoPs and questions to be answered, see box in Table 5.

Table 5. Roadmap for further development of the bioeconomy cluster in

Target	Activities needed to achieve the target	By whom?	Timeline-when?
E.g. Increase the capacity of local actors by learning them to cooperate, to use networks, and to assess their situation in the broader local and global context			
e.g. Improve the cooperation and trust among firms and R&D institutes			
etc.			

Source: Regional CoPs

Guidelines for the Regional CoPs and questions to be answered in order to fill table 5

For developing a Regional Profile structure that is applicable in practice, regional exercises are organised to test and discuss the RDI2Club tools and the regional profile in the partner regions and to get to know how to use the tool in the processes of strategic decision making.

It is advised to do this in a small, but diverse group, including cluster managers, regional government (preferably one public officer, one politician) and some entrepreneurial representatives (from biomass producers, from biomass processor, or representatives of the entrepreneurs). Duration of the meeting is approximately 1,5 hour and the meeting should be organized in October or November 2018.

Here are examples of questions to be addressed at the workshop. Please answer them and **make a short report immediately after workshop**:

Strengths, weaknesses, strategic choices

- Do the data help you in detecting the strengths of the region?
- Which comparative advantages can be detected, and how could they be transferred to strategic decisions on the smart specialization?
- How to deal with weaknesses – make connections with certain aspects of the value chain or resources outside the region
- What is missing in the Bioeconomy Readiness test – how can we improve?

Instruments, measures, cluster management

- What I&Ms are you using?
- What are interesting I&M from the database?
- What can you learn from wp2 analysis and the good practice regions?
- how to improve the cluster management?

Regional profiling

How do you use the assets of SWOT and I&M to show yourself (in the regional profile) the way you wish to profile yourself as a “certain” biobased region (e.g. biochemical region, bioenergy region, etc.), your organization and the way you are operating?

Annex 1. Indicators used in BERST for describing bioeconomy potential

Environmental criteria	Indicators	Unit/metrics	Reason for indicator choice	Quality of indicator
Biomass availability	Domestic production of biomass (agriculture & horticulture, forestry, blue, waste)	Kg/capita	In most regions biomass is produced domestically, rather than imported	Fair, indicator gives very good insight into criteria, but data is estimated from national data using regional employment, rather than directly observed
	Presence of continuous supply of biomass with constant quality	qualitative *)	Addresses issue of sustainability and is ambiguous about source of supply	Good, indicator is a direct observation of regions' biomass supply, although qualitative rather than quantitative
Land use	Forestry land (as % of total land area)	%	Land use for primary biomass purposes most relevant to bioeconomy suitability	Good, indicator gives good quantitative insight into bioeconomy-relevant land use
	Agricultural & horticultural land (as % of total land area)	%		
Infrastructure	Attractiveness of region as place to settle for researchers and entrepreneurs	qualitative	Attractiveness of place is outcome of state of infrastructure; perhaps better than quantitative measure of networks	Good, very relevant indicator, although qualitative rather than quantitative

*) A qualitative indicator is valued by regional stakeholders as weak, moderate or strong

Economic criteria	Indicators	Unit/metrics	Reason for indicator choice	Quality of indicator
Cluster size	Firms in total bioeconomy sector as % of total firms in region	%	Where the number of firms in relevant part of bioeconomy sectors is high it suggests a strong degree of potential clustering. This includes firms in the 'traditional' non-biobased sector as well as bioeconomy firms; the 'traditional' base is key to future development of the sector, particularly in the chemical and energy sectors, as they have the most potential to substitute fossil fuel inputs with bio-based equivalents.	Good, quantitative indicator which is strongly related to overall size/strength of cluster
	Firms in chemical sector as % of total firms in region	%		
	Firms in energy sector as % of total firms in region	%		
	Firms in paper & pulp sector as % of total firms in region	%		
	Firms in textile sector as % of total firms in region	%		

Economic criteria	Indicators	Unit/metrics	Reason for indicator choice	Quality of indicator
Employment structure	Employment in total bioeconomy sector as % of total employment in region	%	Detailed employment data shows current size of potential bioeconomy. This includes firms in the 'traditional' non-biobased sector as well as bioeconomy firms; the 'traditional' base is key to future development of the sector, particularly in the chemical and energy sectors, as they have the most potential to substitute fossil fuel inputs with bio-based equivalents.	Good, quantitative indicator which is perfect measure of employment structure
	Employment in chemical sector as % of total employment in region	%		
	Employment in energy sector as % of total employment in region	%		
	Employment in paper & pulp sector as % of total employment in region	%		
	Employment in textile sector as % of total employment in region	%		
Availability of funding	Availability and access of bioeconomy cluster to public funds	qualitative	Gets to centre of issues around role of government in providing funding	Good, are key questions, but only qualitative (no useful quantitative data on this criteria)
	Availability and access of bioeconomy cluster to private funds	qualitative	Is the key question around availability of funds	
Innovation	R&D expenditure	index	R&D expenditure has a direct impact on supply of innovation. The R&D expenditure index was taken from the Regional Innovation Scoreboard, produced by European Commission. The R&D expenditure in public and private sectors were calculated as a percentage of regional gross domestic product.	Good, R&D expenditure is strongly linked to innovation performance
	SME birth rate (number of starting firms in total firm number)	%	High levels of firm creation are indicative of strong innovation culture	Good, relevant indicator and quantitative measure
	Sector dynamics (% micro firms in bioeconomy subsector x as % of micro firms in all sectors in region)	index	Measures role of small firms relative to 'whole economy' tendency towards small firms – and small firms tend to be most innovative	Fair, less strongly linked to innovation performance than two indicators above but still relevant
	Number of competitive bioeconomy products brought to the market in last 3 years	number	Measures level of success in bringing innovative products to market in the sector	Good, direct measure of innovation outcomes rather than just supply-side
	Presence of an innovative milieu directed at the bioeconomy cluster	qualitative	Environment can help to foster innovation supply and demand	Good, very relevant to criteria, but only qualitative measure

Social criteria	Indicators	Unit/metrics	Reason for indicator choice	Quality of indicator
Cluster management	Presence of a RIS3 with bioeconomy focus	qualitative	Demonstrates a public-sector focus on bioeconomy	Good, although does not reflect quality of public sector strategy/focus
	Presence of a cluster organization which coordinates, manages and facilitates the biocluster	qualitative	Incubators are likely to lead to more business start-ups and higher survival rates	Good, reflect quality of cluster management, although no indication of incubator quality
	Presence of an incubator	qualitative	Incubators are likely to lead to more business start-ups and higher survival rates	Fair, less clearly related to cluster management
	Biocluster is integrated or closely tied to a science/technology park	qualitative	Links to existing parks likely to make business expansion easier	Fair, less clearly related to cluster management
Demographics	Population growth (% per year)	%	Key indicator of demographic movements	Good, closely related to key demographic trends
	Population between 15-65 years (share of total population)	%	Key indicator of size of potential workforce	Fair, data does not distinguish based on skill level of population
	Income per capita	Euro/capita	Higher income owner can lead to greater demand for bioeconomy outputs	Good, reflects ability of population (regardless of size) to pay for outputs of bioeconomy
Quality of workforce	Population with secondary & tertiary education	%	More skilled workforce more likely to be able to perform high value-added roles in bioeconomy	Good, very strong measure of workforce quality
	Access to know-how index (good <i>indicator is missing</i>)	qualitative	Reflects specific knowledge needs of the bioeconomy workers	Fair, the indicator shows how the quality of workforce reflects on the needs of businesses, but it is only qualitative data
Policy/regulation setting	Commitment of regional policy makers and regional biocluster policy	qualitative	Indicates their willingness to adapt policy/regulation to make business easier for the bioeconomy	Good, the indicator demonstrates the policy/regulation setting, although it is only qualitative

Where are indicator (data) gaps (white areas in Figure 1)? Figure 1 gives a flavour of the data gaps faced in developing the BERST toolkit. A white area means that EU and national statistics do not provide a useful measurable indicator (missing). Such an indicator is however needed in the provision of evidence how it's corresponding criterion contributes to describing the regional bioeconomy.

Especially, BERST faces problems in retrieving meaningful and measurable indicators for the criteria infrastructure, access to know-how centres and access to financial funds. Useful indicators for these criteria are not available in statistics at the EU NUTS2 and NUTS3 levels. Alternatively, BERST has solved this omission by asking regional stakeholders to give qualitative scores to the aforementioned indicators. However, that method was only applied to the 7 BERST regions, meaning that the data gap problems remain for the rest of the European regions.

Annex 2. What are Z scores?

Z score: a measure to calculate the deviation of indicator value(s) in a specific region, e.g. Biobased Delta (NUTS3), compared to the average value(s) of the same indicator(s) in a region at a higher geographic level, e.g. North Brabant province (NUTS2) or the Netherlands (NUTS0). With this transformation the unit of the specific indicator disappears, which enables the comparison of indicators with different units.

Example 'percentage employment of energy sector in total regional employment'

In the Netherlands the share of the energy sector in total employment is 49%. At the NUTS3 level the share of energy sector in total employment differs and shows a big spread. Suppose that the average deviation per NUTS3 region compared to the Dutch national average (49%) is 22% (22% is the standard deviation). This means that as long as the share of energy sector in total employment in a NUTS3 regions is 22% more or 22% less than 49%, it is seen as an 'average deviation'. In other words, in the Netherlands the share of the energy sector in total employment per NUTS3 region lies between 27% and 71%.

Suppose that the share of the energy sector in total employment in 'North Limburg' (NUTS3) counts 85%. We use the z score to indicate whether this percentage is an average, more than average, or less than average level. The z score is calculated as $(85\% - 49\%) / 22\% = 1.7$. Alternatively, in 'Utrecht' (NUTS3) the share of energy sector employment counts to 50%, which means a z score of 0.1 $(50\% - 49\%) / 22\% = 0.1$.

In case that the share of energy sector employment is more or less the Dutch average, the z score is around 0.

A specific NUTS3 region with a 27% share of energy sector employment, has an average deviation of the share of energy sector in total employment. The z score value is calculated as $(27\% - 49\%) / 22\% = -1$. A negative z score means that the share of energy sector in total employment is below the Dutch average level. At a 71% share of energy sector employment, the z score counts to 1, which is above the Dutch average level.

Qualification (disclaimer)

The BERST tool helps to recognize the current status of the regional bioeconomy (what are enabling factors? What are barriers?), with help of a catalogue with Criteria and Indicators and a catalogue with Case Study regions (i.e. Good Practice regions and the BERST regions).

BERST also provides tools that could support the making of smart specialization strategies for developing the future regional bioeconomy, like a catalogue with instruments and measures that could be effective to smooth the barriers or to stimulate innovation, and a catalogue with lessons from Good Practice bioclusters.

The BERST toolkit is a combination of quantitative and qualitative data and information. It is a valuable concept to provide a quick, global bioeconomy readiness check for in principle any region. The BERST project ended in December 2015. The RDI2Club project has been used to further improve and extend the BERST toolkit.

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