BSR S3 Ecosystem

Support manual

Adopting a Value Chain approach to inter-regional S3 collaboration across the Baltic Sea Region

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Introduction from BSR S3 Directors' Network

We are delighted to endorse this support manual as a crucial resource in supporting the regions across the Baltic Sea to accelerate their innovation-focused collaboration efforts. This resource is a key output from the Interreg BSR S3 Ecosystem project. The manual has brought core findings from 3 analysis reports which have explored challenges and opportunities for Smart Specialisation (S3) collaboration across our macro-region. It offers a flexible pathway with step-by-step guidance for interregional, innovation / S3 collaboration, through tools and practices that will help our regions to identify 'common ground' and complementary industrial opportunities across our regions.

Furthermore, the manual is strongly aligned to a new era of opportunity as the EU (and the world) emerges from the global health pandemic yet we are grappling with the unfolding impacts of Russia's invasion of Ukraine. The EU's Recovery and Resilience Facility, Green Deal, the updated Industrial Strategy and the post-2020 financial framework are all setting a new direction for the EU's rebound, as a strong international actor. Boosting new, collaborative growth opportunities will allow us to strengthen our social and 'green' values with international partners.

Aligned to this vision the manual promotes the benefits of undertaking value chain analysis and mapping, to identify shared, industrially-focused cooperation opportunities. In keeping with the EU's direction, we are delighted that the manual highlights urgent need for our regions to transform smart specialisation strategies to sustainable smart specialisation strategies. The BSR S3 Directors' Network is delighted to be playing a part in a new EU Pilot Action. This aims to support territories to address twin transition challenges and opportunities by applying S3 principles and priorities. In turn, we will make a contribution to the co-creation process behind the updating of the Pilot Action's draft Playbook. This is a significant opportunity for the whole of the BSR macro-region, as we aim to share and diffuse learning from this important exercise across our BSR partners and territories. The Directors' Network is committed to championing this effort of co-creating industrial innovation opportunities which support energy and digital transition objectives and by adopting a more holistic approach to policy upgrading. This implies that we look beyond our R&I policies and governance structures.

We call on our regions to apply the ideas and insights in this manual to help the BSR to carve out a new collaborative innovation pathway, bringing together our industries, knowledge institutions, citizens and public sector communities.

The ambition outlined in this manual reflects the vision of our Directors' Network – to create new value by deepening our innovation collaboration, through the BSR S3 'ecosystem'. We invite you to join with us and to use this manual as a flexible resource, offering an outline 'roadmap' to join forces with new and existing partner regions across the Baltic Sea.

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1. Introduction: context and scope of the manual

Chapter summary

This chapter focuses on:

- Making the case for a BSR approach to S3 inter-regional collaboration, supported by VC analysis and mapping
- The need to adopt a 'trial and error' approach, with the manual guidance providing a support 'framework'
- Clarifying audience for the manual – the BSR's quadruple helix innovation ecosystem actors (mainly national and regional policy makers; businesses, industrial associations and clusters; knowledge institutions including researchers, experts and academics; civil society including NGOs and trade unions
- The EU's new policy framework –the global health pandemic, a changing geopolitical landscape and upgraded EU policy priorities and investments (the Green Deal, Next Generation EU and the post-2020 multi-annual financial framework) – sets out new priorities which provide a very important backdrop for the BSR's inter-regional S3 agenda
- Defining value chain mapping – the manual adopts a flexible approach to value chain mapping which takes account of the geography, direction and depth of analysis desired across partner regions
- Key stages of inter-regional collaboration are introduced to offer a stimulus for regional and inter-regional 'self-assessment' regarding the readiness of regions to take forward discussions, plans and actions related to collaboration

Setting the scene – S3 and innovation in the BSR

This manual has been created through a process of discussion, validation and upgrading with BSR innovation actors and EU stakeholders. It is part of an Interreg BSR project – BSR S3 Ecosystem - forming a key output and building on three reports[1] delivered in the first year of the project (2019-2020).

The manual was supported by an intensive consultation programme, based on four events with BSR stakeholders and wider EU innovation experts. These events generated a great depth of content and evidence concerning the guidance required by BSR S3 / innovation actors, to build stronger capacity across the macro-region for S3 place-based, inter-regional collaboration.

The manual aims to support the BSR macro-region in advancing a stronger approach to Smart Specialisation (S3) through inter-regional collaboration, supported by a value chain orientation. The manual focuses on those aspects that may bring the highest value added to S3 policy making – both at regional and macro-regional levels. A new era of S3 policy and practice is emerging, recognising the new challenges presented by the Green Deal's twin transitions. Holistic responses - including governance, investment frameworks and wider, strategic objectives - to the Green Deal can be harnessed through S3 principles, acknowledging that these have relevance and resonance far beyond the regional innovation setting.

Overall, the manual outlines guidance and key steps to bring a sharper focus to the BSR's place-based approach to S3 collaboration, underpinned by a value chain approach. The manual is targeted at BSR innovation/ S3 actors and can be applied across any sector or domain with respect to the BSR territory.

Driving a new macro-regional approach to S3

The BSR's capacity and commitment for cooperation is underpinned by its macro-regional status. Combined with the EU´s inter-regional logic to S3 – with the aim of improving international competitiveness – there is a significant opportunity for the BSR to upgrade capacity, ambition and direction for stronger innovation collaboration. Concentrating and upscaling the BSR's place-based approach to S3 can generate new innovation potential, and drive an improved market-led approach to innovation investment. In turn, this creates new opportunities for individual BSR regions, encouraging them to 'raise their innovation game', while generating stronger visibility of the macro-region as an important innovation partner of choice for wider EU and international actors.

1. Two of the reports were delivered by https://www.efiscentre.eu/ and the third one was authored by The Baltic Institute of Finland .
The reports can be accessed at the following links: First stage guidance manual for value chain analysis and mapping
High Level Value Chain Mapping in the BSR - the example of the Circular Bioeconomy Smart Specialisation in the BSR

Who is this manual for?

The intended audience of the manual is BSR national and regional policy makers (including those with responsibility for regional innovation / S3), innovation support organisations, business (cluster managers, business associations) and other relevant S3 / innovation stakeholders, according to regional innovation systems. Sector specialists from knowledge institutions, industry and public authorities would also benefit from the learning and insights detailed in this manual. The Green Deal and its associated energy and digital transitions – places more importance on the engagement of civil society in actions / changes which will impact on their lives.

The manual has an important status in the Interreg project, supporting a legacy for enhanced capacity building across the BSR macro-region in the area of inter-regional and trans-national Smart Specialisation collaboration. Strong foundations already exist across the BSR for collaborative, place-based innovation cooperation. However, these efforts often lack a strong strategic focus and suffer from fragmentation which means that a short-term 'project' orientation is often adopted. A continuous and sustained approach to S3 will be difficult to achieve when the main driver of this effort is time-bound projects. The post-2020 EU funding framework includes new tools to support both innovation ecosystem development and joint innovation investment. It will be important for Baltic Sea regions and partnerships to engage with these new instruments.

Building on existing BSR frameworks and actions – including the new EU strategy for the BSR, many innovation focused projects and the BSR S3 Regional Directors' Network – there is fresh momentum to provide a stronger and long-term approach to industry-driven innovation and collaboration across the macro-region. This manual aims to set-out a pathway to support this.

Structure of the manual

The manual has been structured to support the BSR to adopt a stronger approach to BSR S3 inter-regional collaboration. The EU's post-2020 S3 agenda is characterised by a stronger S3 inter-regional orientation, positioning S3 as an accelerator of joint innovation investment by adopting a cross-regional approach to value chain analysis and mapping. This signals a new direction for the EU's S3 agenda – one which is currently not widely practised or well-understood across the BSR.

It should be noted that the stages of development in adopting an interregional, value chain-driven approach to S3 are very fluid and interconnected. Activities and outcomes at each stage influence progress and direction for subsequent stages. This is therefore a very dynamic process and, in practice, requires a 'trial and error' approach which might entail retracing steps to take different options and pathways.

The guidance in this manual should be used flexibly, according to collective needs and decision making. Indeed, S3 inter-regional collaboration is not static, nor is it underpinned by a pre-determined process. However, is should be guided by a framework to instil confidence and offer direction in embarking on this type of joint working, not least in working towards innovation investment to deliver commercial outputs.

To support regions in this journey, the manual has been structured according to the key stages of the process. Each chapter of the manual has been structured to allow for easy navigation of the content and to provide insights / real examples which can help to make the process easier to understand and engage with. As such, each Chapter contains:

- a description of the main activities
- insights drawn from EU evidence and practice
- good practice examples from across the BSR concerning tools, projects and practices which support inter-regional S3
- Insights into relevant skills and competences
- Relevant web references for further information

How does the manual relate to post-2020 EU Policy?

Since 2014, when S3 became a 'conditionality' for regions and member states, a wide range of resources and guidance has been produced, not least through the European Commission's Smart Specialisation Platform.

The post-2020 S3 agenda is characterised by a new drive to boost EU innovation through improved collaboration beyond the 'domestic context' (region /member state). As such, 'international collaboration' features as one of seven, new 'enabling conditions' in the EU's post-2020 S3 policy framework. Furthermore, the post-2020 S3 agenda is supported by an inter-regional innovation investment (I3) instrument to address gaps in, and boost performance towards, collaborative investment.

Responding to a growing demand across EU territories for enhanced S3-focused, inter-regional working, a new raft of guidance is emerging to navigate this pathway.

For the BSR – a highly heterogeneous territory, with differing capacities for high-performance innovation - a number of obstacles are holding back the macro-region from adopting a more ambitious and cohesive approach to inter-regional S3. By facilitating a stronger alignment of S3 interests across more and less innovative BSR regions, there is significant scope to generate a new, improved momentum for the BSR's approach to S3 inter-regional collaboration.

The BSR S3 Ecosystem project has sought to respond to this challenge and to position the inter-regional S3 manual at the core of the project. A method to support value chain analysis and mapping lies at the centre of this effort, since this approach to collaborative working is strongly aligned to the EU's post-2020 competitiveness agenda. EU 'industrial ecosystems' - underpinned by 6 identified, strategic value chains - aim to mobilise, align and scale-up industrial efforts to improve the EU's international competitiveness. This is generating a new approach to industrial 'clustering' of EU innovation efforts. Industrial strengths and local endowments can be brought together in different geographical 'spaces' across the EU – within and across regions of the same member state, cross-border, macro-regionally and inter-regionally – to scale up innovation capacity and performance.

Furthermore, the EU's Green Deal and related 'twin transitions' (energy and digital) are encouraging an innovation direction which emphasises future competitiveness through this 'green, digital innovation lens'. The EC's Smart Specialisation Platform is placing new emphasis and support to EU regions in transforming their economic sectors in line with the Green Deal's energy and digital transitions. Tools and guidance to support the development of sustainable smart specialisation strategies are emerging, to build regional capacity in the process of green innovation upgrading. The BSR S3 Directors' Network is engaging in a 12-month Pilot Action sponsored by the EC's JRC and the Committee of the Regions. This will provide insights and learning into new tools, analysis and methods to support twin transitions at the regional level, through S3 principles.

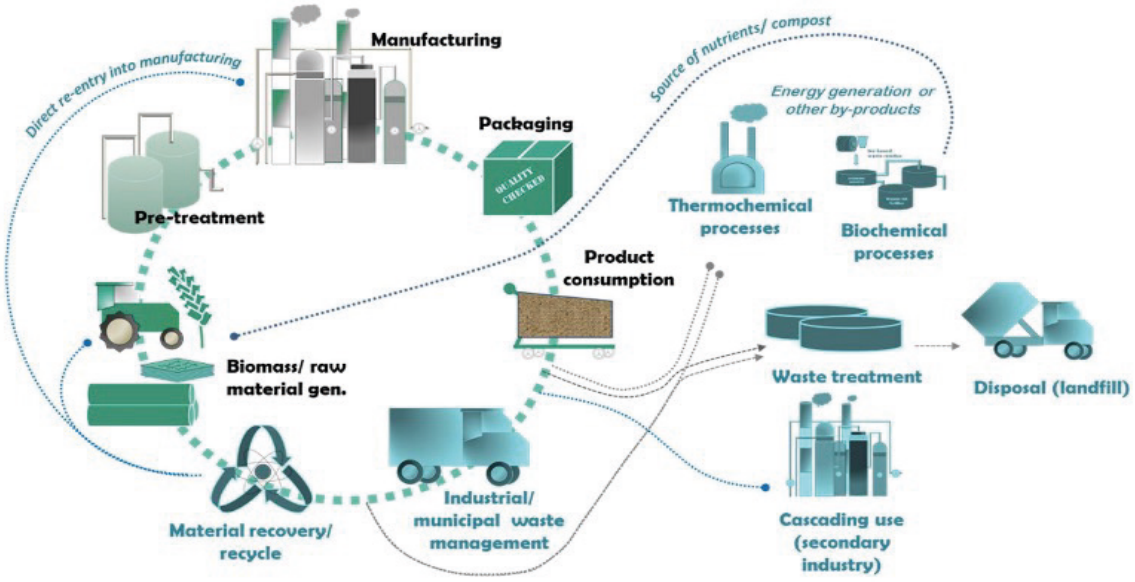
This manual defines (high-level) **value chain mapping as an analytical and visual tool that helps understanding with how a particular innovation ecosystem is organised spatially, as well as size wise and direction wise.**[2] It should improve understanding of value flows and aggregation within the specified 'system' in an organised and integrated manner.

This means that value chain mapping and analysis can generate very different results depending on the factors for analysis and interpretation of the findings. The territory covered by the value chain, the depth of the linkages in the chain and the investigated scope to seek out wider connections or opportunities (e.g. in how the deployment of technologies might affect the value chain) are all elements which provide different insights and trajectories for the overall scope of the value chain. This is why clarity of purpose is required regarding what the analysis is for, together with a willingness to adopt a flexible approach to the direction of the analysis. There is no single method for doing this, nor is this a scientific approach. Rather it requires a 'learning by doing' ethos, while acknowledging that results are unlikely to be realised in the short-term.

By way of example the diagram below outlines the main components / linkages of a value chain for the Circular Bioeconomy. Clearly, further depth at particular stages of the chain can be reviewed, and can then set a new and different direction for the value chain. The territory to be covered by the value chain will also determine the 'depth' of activity which exists at various stages in the chain. Indeed, some linkages might be missing /lacking strength, while others might be strong when viewed across a defined territory. This poses questions concerning whether there is an opportunity to address gaps or to focus on particular strengths within the value chain.

2. First stage guidance manual for value chain analysis and mapping.

Figure 1: A visualisation of the circular bioeconomy value chain



Source: Lokesh, K. et al (2018)
The full reference for this: https://www.researchgate.net/publication/325322282_Bridging_the_Gaps_for_a_'Circular'_Bioeconomy_Selection_Criteria_Bio-Based_Value_Chain_and_Stakeholder_Mapping/link/5b05a1914585157f8709292a/download

For the BSR, this represents a new opportunity to explore and upscale the macro-regional innovation environment, by highlighting opportunities for joint, industry-led collaboration and applying a value chain orientation to aligning related efforts, across any selected domain / sector where this is sufficient interest to explore collaboration potential.

S3 offers a useful 'compass' for this type of collaboration because it encourages regions to identify common strengths and priorities for further innovation investment. Therefore analysis of regional S3 priorities offers a useful first step in identifying and bringing together related innovation interests from different regions.

Evolution of inter-regional smart specialisation

The diagram below illustrates a number of stages – from early forms of cooperation through to strongly embedded ways of working – to underpin inter-regional collaboration for S3. Key – and incremental - stages of inter-regional collaboration are introduced to offer a stimulus for regional and inter-regional 'self-assessment' regarding the readiness of regions to take forward discussions, plans and actions related to collaboration. BSR actors will have very different capacities and motivations for this type of working. The content of the manual provides support across this spectrum.

Figure 2: Stages of inter-regional collaboration

Reference: https://s3platform.jrc.ec.europa.eu/s3-implementation-handbook

2. Inter-regional co-operation, smart specialisation and value chains

Chapter summary

- This chapter provides concrete examples and signposting to support S3-focused inter-regional collaboration (e.g. the EU's Thematic Smart Specialisation Platform and related Partnerships)
- A market-led, industry focus is emphasised, as a 'lens' to direct efforts
- Insights are provided into the role of governance in helping / hindering S3 inter-regional collaboration
- The evolution of the method underpinning EU-driven, S3 inter-regional collaboration is described, based on the efforts of both the Vanguard Initiative and the S3 Platform
- The ethos of inter-regional collaboration differs at regional levels, and depends on regional experience, culture and appetite for risk-taking

EU innovation-focused, inter-regional collaboration: the role of S3 and the EU's value chain orientation

In the context of European innovation and industrial policies and smart specialisation strategies (S3), EU guidance encourages matching of specialisations and complementary expertise within inter-regional (pan-European) or macro-regional 'innovation systems'. Over the last decade, there has been a shift from a more traditional form of EU inter-regional co-operation through 'exchange of experience' type projects. A deeper form of collaboration is emerging, which is demand-driven and highly associated with the joining up of innovation priorities, across regions and member states. Increasingly, these efforts are seeking out ways to strengthen respective and collective innovation performance through (for example) the pooling of resources (e.g. expertise, technical innovation skills, industrial infrastructures and joint investment). These actions lie at the heart of co-investment for innovation across regional innovation systems. However this way of working is far from mainstreamed across the EU.

Some examples of where joint innovation working is taking place is detailed below.

Figure 3: Examples of relevant entities and resources for mapping inter-regional S3 collaboration potential

Initiative	Web-link
Vanguard Initiative	https://www.s3vanguardinitiative.eu/
Thematic Smart Specialisation Partnerships	https://s3platform.jrc.ec.europa.eu/de/thematic-platforms
European Strategic Cluster Partnerships	https://www.clustercollaboration.eu/eu-cluster-partnerships
Macro-regional strategies and S3	https://www.interreg-baltic.eu/about-the-programme/priorities/innovation.html

From 2013 or so onwards, the Vanguard Initiative led the way in piloting new approaches to inter-regional co-operation based on S3. The Vanguard Initiative seeks to lead by example in developing inter-regional cooperation and multi-level governance for supporting clusters and regional eco-systems to focus on smart specialisations in priority areas for transforming and emerging industries. An initial methodology was developed with the support of the European Commission (Reid & Miedzinski, 2014) for the process of developing 'Pilots' in advanced manufacturing for the Vanguard Initiative.

In recent years, S3 Partnerships have become the main route to delivering inter-regional S3, driven by mutual market-driven innovation interests. These Partnerships are hosted by the S3 Platform. There is a growing trend for this approach to be accompanied by a stronger societal-driven orientation, whereby societal challenges (such as SDGs and addressing climate change) are emerging as key drivers for delivering new, industrial growth (often referred to as 'green growth'). Present-day challenges in addressing (e.g.) climate change in the context of the health pandemic imply that significant cooperation is required, across EU regions and member states to generate the momentum and scale necessary, for successful transitions in energy, digitalisation and industry.

This type of S3-focused, collaborative working is generating a clear EU-centred value chain orientation, which could not be achieved through regions working in isolation. The 'value' focus on this type of analysis is important, and is directly related to the question of what can be achieved by working together that cannot be generated when working alone. Value chain analysis and mapping shines a spotlight on areas of industrial and research / scientific excellence which – when joined together – offer new innovation opportunities. Such diversification provides the stimulus to explore new commercial opportunities. Therefore, the evidence gathered needs to offer demonstrable benefit for industry, through joining up the efforts of different regional innovation systems.

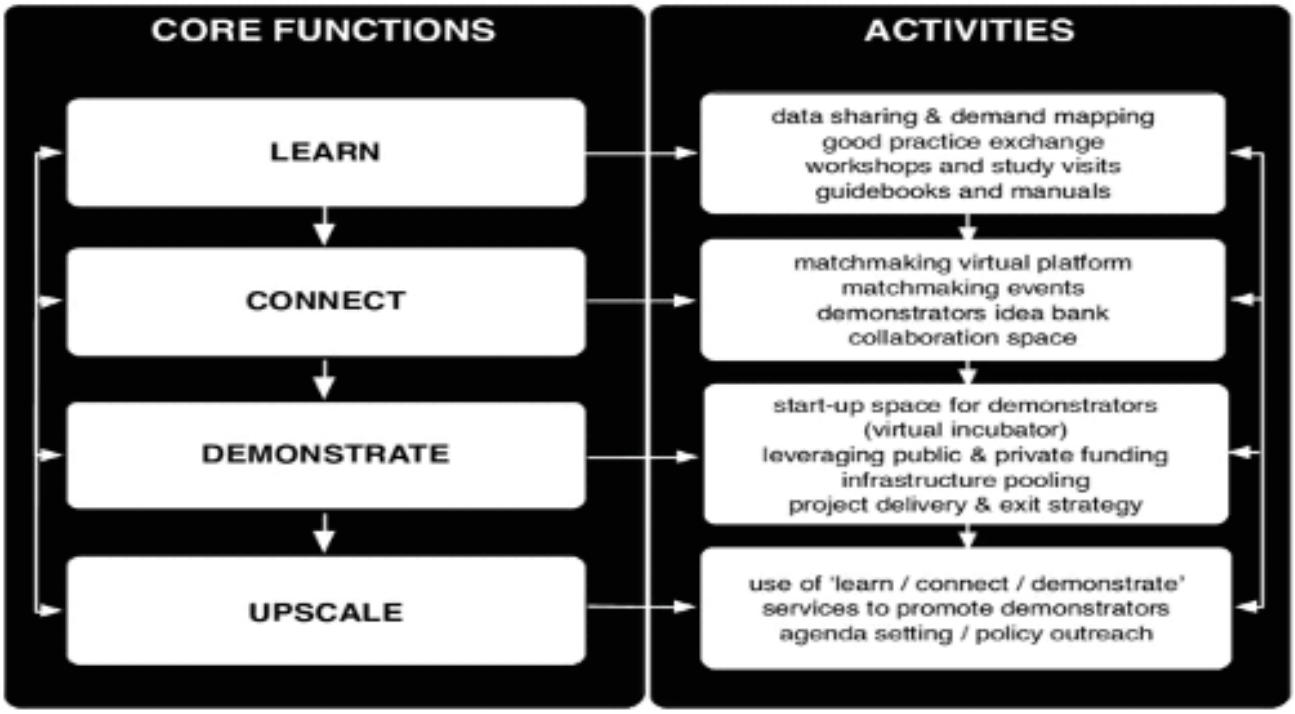
This manual has adopted the emerging evidence from this new approach to EU inter-regional collaboration and has adapted it to the BSR macro-region. The manual includes selected examples of inter-regional S3 good practices from across the macro-region, which were collated in a Good Practices report. These examples and case studies have an important role to play in supporting how the BSR further develops its approach to S3 inter-regional collaboration, and offer guidance on creating sustainable foundations for BSR-focused S3 Partnerships. This requires leadership, commitment and investment from regions. At the core of this, innovation governance differs very significantly across regions, according to size, capacity, expertise and the region's appetite for international engagement.

Insight: S3 governance and prospects for successful inter-regional collaboration

A number of studies (including a recent EC Pilot Action on S3 Partnerships[3]) and evidence sources (including a related project report on S3 in the BSR) point to the influence of innovation governance on the ability of regions to engage successfully with inter-regional S3 cooperation. Where innovation / S3 governance tends to be driven by a 'top-down' centralised approach (often member state-led), this can create a rather 'space-blind' approach to innovation, giving insufficient attention to the innovation needs and opportunities of regions. In such cases, there is often little scope or strategic priority given to cross-regional working, especially outside of the member state. This can make it difficult for regions to build sufficient commitment and capacity for S3-focused collaboration, largely because such a change does not 'fit' with the intended, strategic direction. Conversely, regions with more 'autonomy' in this area are likely to be better able to adjust local governance mechanisms to facilitate inter-regional S3 working. This is an important consideration for all regions who are seeking to explore the potential to increase collaboration efforts. Challenges can arise when the decision-making routes and timescales (e.g. from regional to national levels) are slowed down or ineffective, and can sometimes result in regions stepping back from inter-regional efforts, due to inadequate 'framework conditions' to support this.

3. The European Commission has not yet published the results of this study. A summary of key findings can be accessed here':
https://s3platform.jrc.ec.europa.eu/en/web/guest/w/joint-event-thematic-s3-platforms

Figure 4: Core functions and activities of a smart specialisation partnership



Source: Reid & Miedzinski (2014)

The experience of the Vanguard Initiative regions in piloting inter-regional S3 was the basis for the thematic smart specialisation platforms, developed and promoted by the EC's Joint Research Centre (JRC), in partnership with other EC DGs notably DGs GROW, ENER and REGIO, in three areas: agri-food, energy, industrial modernisation. Many S3 Partnerships have (5 agri-food, 6 energy and 21 advanced manufacturing) are operational, with many having received financial support including in some cases funding from the EU (e.g. through Interreg and Horizon projects).

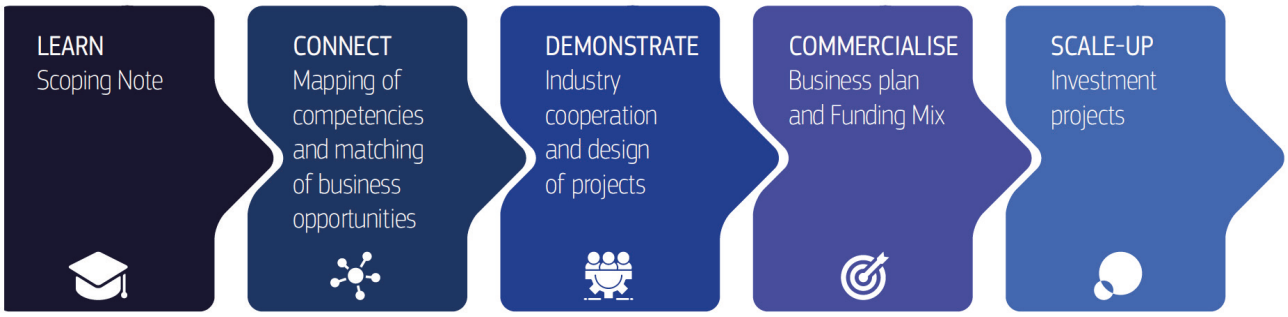
The Regional Co-operation Networks for Industrial Modernisation Initiative (ReConfirm[4]), was an EU-funded project designed specifically to assist European regions and industrial stakeholders in implementing action plans under the Smart Specialisation Platform for Industrial Modernisation.

Rakhmatullin et al (2020) They summarised the experience of the S3 Partnerships in a methodological manual for developing thematic inter-regional partnerships for smart specialisation. They propose an adapted version of the original four-step model piloted by the Vanguard Initiative by adding a commercialisation step, signalling the need for S3 Partnerships to create new value from their combined efforts in generating innovation investments, linked to commercialisation opportunities.

This 'new' step of S3 Partnerships is significant as it sets out the challenge and potential for S3 to act as a driver in supporting the EU's future international competitiveness, through inter-regional S3. This backdrop has provided both a framework and inspiration for this BSR-focused manual.

4. https://s3platform-legacy.jrc.ec.europa.eu/reconfirm

Figure 5: Work-flow steps in the Thematic S3 approach



Source: Rakhmatullin et al (2020)

The geography of Value Chains – global and European

The value chain concept has been integrated in this stream of work to varying degrees and from a number of angles. At the level of a business, a value chain describes the full range of activities that firms engage in to bring a product from its conception to end use and beyond. This includes design, production, marketing, distribution and support to the final consumer. The activities that comprise a value chain can be contained within a single firm or divided among different firms, across different geographies. Value chain activities can produce goods or services and can be contained within a single geographical location or spread over wider areas. Global Value Chains (GVCs) are value chains that can be divided among multiple firms and dispersed across wide swathes of geographic space (Brennan & Rakhmatullin, 2015).

Changing dynamics in international trade (including Brexit), together with supply and demand side limitations imposed by the Covid-19 health pandemic have encouraged EU policy makers to review security of supply linked to GVCs. In turn, this is encouraging a stronger post-2020 drive towards the 'Europeanisation' of value chains in strategic areas, with less dependence on 'external' suppliers. This emerging approach is sometimes referred to as 'strategic autonomy'.

The manual adopts an EU-centric approach to Value Chain mapping, in line with the EU's post-2020 direction of travel. This does not mean that the wider, international dimension is ignored or less relevant. Indeed, understanding international markets and reviewing scope /opportunity for international alliances remains a key priority in EU trade and competitiveness policy. As the world emerges from the health pandemic, a new geopolitical context is surfacing with new and different international alliances. The EU's updated Industrial Strategy sets out a new direction for the EU to shift from less dependence on international actors and value chains, especially in sectors of strategic importance.

Analysing Value Chains – 'top-down' and 'bottom-up'

As will be seen in the outline method which follows, analysis of value chain opportunities requires to take both 'top-down' and 'bottom-up' perspectives. Looking at data, governance, profiles of innovation actors and networks at different scales and perspectives (e.g. EU-wide, country-wide and regional) can generate different findings. Acknowledging that a 'complete picture' will be impossible to achieve, it is important to ensure that many angles and insights are brought together to inform the evidence base – especially across and between regions. Furthermore, data gaps (especially at NUTS 2 and NUTS3 levels) often exist, and encourage greater use of qualitative information in generating credible evidence concerning how market opportunities can be improved by joint efforts across regions.

Insight: example of BSR joint governance to improve industry cluster opportunities – 'innoBB25'

The German capital region has brought together the states of Berlin and Brandenburg to share innovation capacity and set-out a new approach to Clusters across the territory, and improving international innovation performance. This is a strong example of 'bottom-up' collaboration, across territories. The Joint Innovation Strategy set out a clear example of changing governance structures to drive new market-led potential beyond existing State 'boundaries'. The 'innoBB25' approach is also underpinned by ambitions linked to upscaled digitalisation, upgrading the territory's 'test bed' infrastructure and setting out a new direction for 'Work 4.0', through the skills / competences needed to compete successfully in the greener, digitally-driven work environment. Five interstate clusters will also be upgraded:

- Healthcare industries
- Energy technology
- Transport, mobility, logistics
- ICT, media, creative Industries
- Photonics

The interstate model is invested in, in three ways – the states, the national level and EU funds.
innobb_2025_-_joint_innovation_strategy_of_the_states_of_berlin_and_brandenburg_0.pdf

Data analysis, at a number of scales, is essential to provide sufficient insight into the nature of both supply and demand-side factors, when reviewing a specific domain / sector / market opportunity. This task can be complex and time-consuming. The skills / competences to undertake this within regional authorities is often limited. Correspondingly, these tasks are often contracted out to data experts.

The complexity of the data analysis exercise could encourage stakeholders to 'skip' this step or undertake a light touch approach. This is often why value chain analysis focuses more on 'mapping' than data analysis. Insufficient attention to an early stage of analysis can create problems at a later stage if there are missing data / inaccurate assumptions about the nature of the market / opportunity under question. Furthermore, important geographical data can be overlooked, leading to an incomplete picture of possible regional partners or even risking unhelpful duplication of efforts. The presence of industry clusters can often provide important insights into geographical strengths and specialisations. Therefore, analysis of industrial clustering efforts and investments can be a helpful inclusion and can take both a 'top-down' analytical approach (e.g. to identifying clustering activity) and a 'bottom-up' investigation (e.g. by taking a more regional / local perspective of strengths). At the local level, this might be usefully defined in the regional S3. Therefore, the analysis of regional innovation strategies / S3 can offer a useful route to understanding strengths the S3 priorities of neighbouring regions.

The six strategic and future-oriented 'value chains[5]' referred to at the outset of the manual can offer a 'top-down starting point' to review regional priorities for industrial competitiveness. Here, regions can review the extent to which their innovation strengths align with a wider EU direction. This is also strongly linked to the EU's post-2020 ambition of generating a stronger industrial ecosystem approach across the EU, with the aim of better coordinating industrial efforts in specific fields / sectors / domains. This could help to address the industrial coordination challenges which the EU (and its territories) often face when seeking to identify and align relevant and related industrial activities across the EU, with the aim of scaling up efforts and creating stronger network effects through strengthened collaborative efforts. The six value chains which are believed to hold significant international competitive advantages for EU industry are:

- connected, clean and autonomous vehicles
- hydrogen technologies and systems
- smart health
- industrial internet of things
- low-carbon industry
- cybersecurity

5. Following the Covid-19 global health pandemic, the European Commission is reviewing a further refinement of its future approach to strategic value chains, linked to a wider effort to better position the EU in the global trading landscape.

Here the value chain concept is broadened to include actors, networks, enterprises engaged in activities which relate to the value chain. Strategic values chains (SVCs) should be of systemic importance and make a clear contribution to growth, jobs and competitiveness. According to an expert group – appointed to promote ideas and recommendations for the EU's industrial competitiveness - they are characterised by three dimensions:

- t**echnological innovativeness**, i.e. the value chain is based on the exploitation of strategic key enabling technologies, technological breakthroughs, major outcome of R&D or disruptive innovation (e.g. autonomous driving, low carbon technologies).
- **economic and market potential**, i.e. the value chain has considerable economic weight, actual or potential.
- **societal and political importance**, i.e. the value chain makes an important contribution to societal challenges and/ or policy goals (e.g. climate change, ageing population).

Komninos et al (2018) suggest that, in more practical terms, three core questions need to be addressed:

- **How can I identify the region's/country's areas/sectors/capabilities that are part (or could possibly become) of an integrated value chain and what is the position of my region in this chain?** The main challenge is the identification of the specific activities that seem to create value through their connection to activities conducted in other regions.

- H**ow can I identify opportunities for repositioning in the value chain in order to create further value?** The strategic approach to value chains refers to assessing the value that is added in each activity of the chain and the ability to undergo specific transformations in order to reposition in the chain into an activity with higher value.

- **With which regions could I explore collaboration** and how could I build synergies within the framework of inter-regional initiatives?

These questions are strongly geared to a 'bottom-up' approach to value chain analysis, and assume a clear place-based approach and sensitivity to understanding motivations and dynamics which can spur regions to exchange ideas and take steps towards understanding the potential and benefit for joint innovation working. Again, S3 can provide a useful 'compass' to support such an exercise by better understanding respective industrial innovation priorities and where there is scope for collaboration. The questions place a strong emphasis on value creation – i.e. the opportunity for a region, through inter-regional collaboration, to create new value (e.g. through upscaling or diversifying current industrial efforts).

Answering these questions is not easy and goes well beyond a technical analysis. By exploring these questions with actors across the regional innovation system, barriers and challenges are likely to emerge concerning capacity, investment and political commitment. There is no clear-cut, predictable pathway for embarking on an inter-regional 'journey' to explore innovation collaboration potential. For some regions, this 'distance' from a usual comfort zone of operation is considerable. In turn, this could impact upon commitment to engage in this type of cooperation.

Skills and competences to support S3 inter-regional collaboration

Tukiainen and Hongisto (2020a) point to the need for 'strategic capabilities for cross-regional working'. Inter-regional S3 working remains far from the 'norm' for public policy innovation actors across the EU. Therefore, taking bold steps to engage with this way of working requires a level of risk-taking, experimentation and a 'learning by doing' ethos. Where innovation systems are characterised by rules and approaches which disincentivise new ways of working and / or seek to preserve traditional approaches, it can be difficult to gain political support and investment for S3-focused inter-regional collaboration.

3. Outline method for high-level inter-regional value chain analysis and mapping

Chapter summary

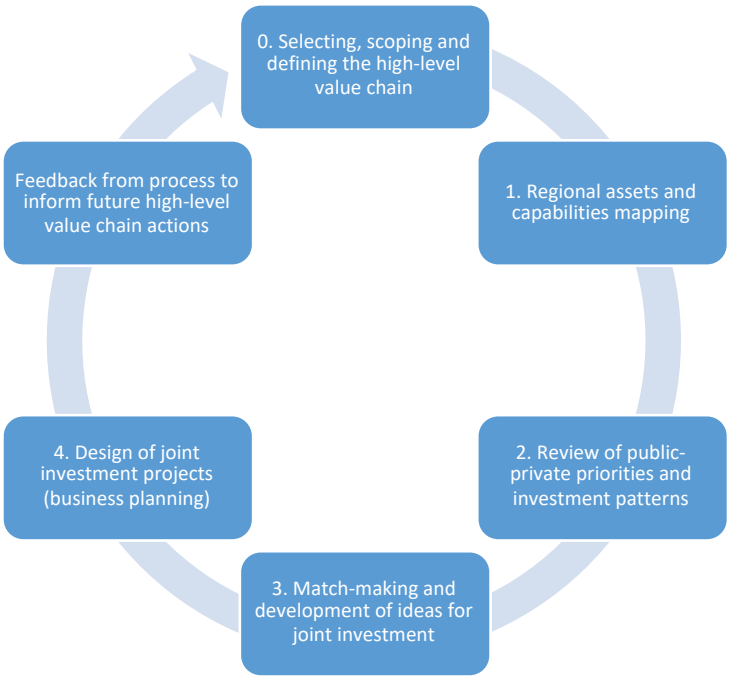
- A broad-based and flexible process for value chain analysis and mapping is outlined, to support partner regions in taking early steps toward S3-focused, inter-regional collaboration
- The EU's post-2020 programming period includes a new Horizon Europe work programme, focused on 'connecting' and 'scaling up' the efforts of innovation ecosystems
- The process requires a strong 'trial and error' and pioneering approach, with strong management of stakeholder expectations
- The process of value chain analysis and mapping is highly dynamic and requires flexible responses as new insights and evidence are uncovered about opportunities for collaboration
- Engaging the quadruple helix across partner regions is critical, as well as understanding the key roles to be played by regional actors who can help to diffuse messages about the status and progress of collaboration efforts, and 'boundary spanners' who operate at the interface of the inter-regional partnership and their regions
- Effective inter-regional S3 engagement is heavily influenced by the quality and responsiveness of regional innovation ecosystems, and the related Entrepreneurial Discovery Process (EDP) of each region

The core method proposed in this manual derives from a number of sources. It includes the learning from a pilot exercise of the first stage analysis of the BSR's CBE value chain, undertaken in early 2020. This method draws on a number of existing sources, tools and concepts for regional benchmarking, mapping and matching. It also draws on experience of the S3 Partnerships within the S3 Thematic Smart Specialisation Platforms (TSSPs).

At the outset of any value chain analytical exercise, it is necessary to adopt a 'high-level' approach – i.e. a rather broad perspective of the domain/ sector in question. Starting from a narrow perspective could 'close down' or overlook options (e.g. regional activities, technology expertise) which are relevant to considering future innovation capacity. For this reason, a first-stage analysis of ideas and evidence will include a number of possible options which will be (later) discounted due to (e.g.) a lack of scale, expertise, capacity across the regions / geography involved in the exercise. After testing the first-stage analysis, a more detailed and defined focus for the value chain analysis can be adopted, normally necessitating a second round of deeper investigation and analysis. It is this 'analytical funnel' which will – in time – lead to defining specific, market-driven business cases. This manual has focused mainly on the first-stage, high-level analysis which comes at the beginning of the inter-regional effort.

For the purpose of this manual, we define (high-level) **value chain mapping as an analytical and visual tool that helps understanding with how a particular innovation ecosystem is organised spatially, as well as size wise and direction wise**. It should improve the understanding of value flows and aggregation in the economic and innovation system in an organised and integrated manner.

Figure 6: Outline steps to underpin high-level value chain mapping



Adapted from original model designed by EFIS

The high-level value chain mapping method is designed in four main phases (see Figure 6) with a preliminary step related to pre-selection of the key value chains, at macro-regional level, and a final feedback loop to inform future exercises in other value chains. It should be noted that – while these phases provide an outline 'roadmap' for such an exercise, the relative importance of different steps / stages and the sequencing of different efforts and actions can often follow a different pathway. This is linked to the 'trial and error' ethos of this process, where some actions will be very difficult to generate while others might be addressed with relative ease.

The feedback and pre-selection stages are also the precursors to taking new / improved steps. For this reason, the feedback step is not covered in this manual. The 'pre-selection' step is detailed below through a real example.

0. **Selecting, scoping and defining the high-level value chain** – this stage concerns the rationale, starting point and stimulus for considering an inter-regional approach for S3 collaboration
1. **Regional assets and capabilities mapping** – this is mainly concerned with analysing secondary data (e.g. national and regional data sets concerning trade flows, market size etc). International market analysis should also be undertaken, at this stage, to better understand the state of supply and demand from a global perspective
2. **Review of public-private priorities and investment patterns** relevant for the value chain and investment patterns in the macro-region. Here, the data analysis starts to take on a more granular perspective and is likely to include at least an element of qualitative data. This could include primary data collection, e.g. through a questionnaire with related regions / innovation actors. This step should assess linkages with EU level innovation and industrial value chains and ecosystem to identify specific macro-regional strengths vis-à-vis the EU level.
3. **Matchmaking and development of ideas for joint investment** – here, industry and financial sector actors should begin to play a stronger role in assessing the ideas presented by the inter-regional partnership. By bringing companies together to test 'matchmaking' potential (i.e. the scope for collaboration) partnerships are faced with a reality check concerning the feasibility of S3-focused collaboration. Concrete investment ideas should begin to take shape at this stage
4. **Design of joint investment projects (business planning)** – investment ideas and business cases should be scoped and should be able to pass a 'why at a (inter-) macro-regional level' test. For example, why does the investment idea require involvement of players from two or more countries in the regions? What does each public or private partner bring to the project in terms of complementary skills, resources (material or financial), technologies, etc?

Connecting Innovation Ecosystems

The model above places significant emphasis on mobilsing regional innovation ecosystems to prepare for 'connecting' at the inter-regional level. This involves key networks/clusters/innovation centres as well as knowledge creation and diffusion actors (e.g. universities, research centres, research and technology organisations, centres of excellence, innovation platforms, research infrastructures and testbeds). Significant coordination efforts are required, supported by actors that play a role as 'boundary spanners' in regional innovation systems, such as cluster managers and other industry-led networks.

These 2 'sets' of actors – from the industrial community and from the academic, research and scientific community – form the 'backbone' to the quadruple helix regional innovation system. However, it should be noted that the other 2 groups of actors – public policy and social sector – are also important considerations at the early stage of value chain analysis. In most cases, the social and citizen sectors will take a lead coordination role in supporting inter-regional S3 collaboration. As such, they normally play a key role early in the process.

The EU's Green Deal and twin transition (energy and digital) objectives call for stronger visibility, engagement and 'voice' of civil society across regional settings. Understanding and acceptance of the transformational change which accompanies Green Deal ambitions is imperative. This requires holistic responses from innovation ecosystems, making the case for the quadruple helix even stronger. Civil society, NGOs and trade unions are playing a stronger role in influencing the direction of regions, as they seek to navigate the complex journey of energy and digital transition. This will affect the fabric of local communities, bringing significant change, for example, to public services, jobs and transport systems. Regional innovation ecosystems need to reflect these momentous changes, so that complex transformations are well-managed at local levels.

The EC has created a new work programme under Horizon Europe to 'connect' and upscale' innovation ecosystems. This programme will allow regions – especially those who have more limited experience of working in inter-regional innovation settings - to connect innovation ecosystems. It aims to improve inter-regional industry connections by linking strong and modest innovator regions, through promoting open innovation ecosystems. There is a strong focus on coordinating structures and networks to improve innovation (and industrial) collaboration.

As proposals become more concrete, individual companies should start to feature more prominently in Partnership discussions, bringing specific requests / ideas for collaboration.

Overall, the group of inter-regional actors involved in discussions will change over time and depending on the stage of development / focus, different actors will play more / less visible and influential roles. As S3 area(s) for joint consideration across the inter-regional setting become more detailed, it is also likely that some regions and actors will decide to 'step back' from discussions. This could be due to the direction of the options / effort or because there are challenges which prevent committed engagement.

It is difficult to pinpoint the precise point when the collective effort of the regions starts to look and feel more like an 'S3 Partnership'. While commitment at an early stage can boost the overall inter-regional effort, it takes time for individual regional ecosystems to review options and make concrete decisions about this.

Good practice examples from BSR linked to the regional Entrepreneurial Discovery Process (EDP):

1. Hamburg's EDP and the role played by the quadruple helix in updating S3
Hamburg's approach to updating its innovation strategy – including S3 – demonstrates a very strong commitment to engaging social sector partners. This has been fundamental in shaping the region's commitment to social innovation. Furthermore, it has generated a new momentum for interaction across the innovation ecosystem, and has been instrumental in driving new perspectives for a more cross-sectoral and future-oriented innovation strategy. The region invested heavily in a consultation process – at the root of their EDP – to deliver structured workshop sessions, an on-line survey and a benchmarking survey.

With the EU's post-2020 agenda focusing on economic recovery and renewal as well as climate action and 'twin transitions' (energy and digital), it is critically important that future innovation investments are place-based and driven by local stakeholders who can champion the regeneration of the region's social fabric. Increasingly, this 'voice' is needed in S3 inter-regional partnerships and can serve a high value purpose in influencing the direction of value chain analysis and mapping activities. Future BSR S3 Partnerships should consider how to engage and embed the social sector in their set-up and structures.

2. Päijät-Häme's road-mapping approach – sectoral analysis through stakeholder engagement
The region has adopted a permanent process to engage regional stakeholders in reviewing / updating S3 priorities. It has recently expanded its learning of this model through an Interreg Europe project – BIOREGIO – with an inter-regional partnership focusing on the Bio-based Circular Economy sector. These foundations to support S3 priority monitoring and upgrading will support the region to play a strong role in BSR S3 Partnerships, linked to their priority fields, not least because industry stakeholders are well-engaged in the process.

3. Tampere: using open data to better understand regional innovation performance
Tampere Region monitors and provides an annual update of innovation activities through a 'Situational Picture of Innovation'. This relies on open data and evidence gathered across the local innovation ecosystem, to generate a process for joint vision building. The data is collected across some 50 sources and details: value network capability, company growth, RDI funding, higher education institutes, digitalisation and internationalisation. This depth of knowledge of the region's innovation ecosystem is critical in supporting the region's inter-regional efforts, since a strong evidence base already exists to guide decision making for inter-regional S3 investment.

4. Step 0: Selecting, scoping and defining the high-level value chain

Chapter summary

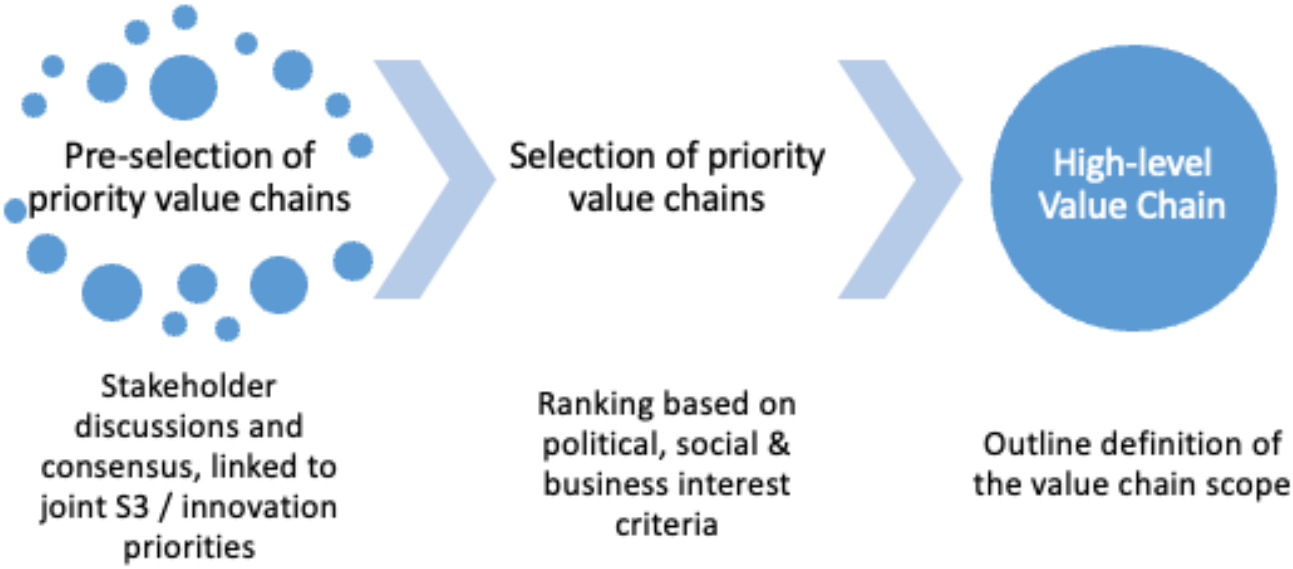
- 'Step 0' reflects the need for partner regions to prepare for inter-regional collaboration by reviewing 'local conditions' and ensuring a strong enabling environment, to derive maximum benefit from collaboration.
- High-level endorsement – e.g. from senior decision makers, politicians and industry actors – can accelerate progress in the early stages of S3 inter-regional collaboration
- A first stage to sharing and presenting ideas for joint collaboration should focus on identifying 'hot spots' of joint interest. These can usually be identified in S3 / innovation strategies, including the EU's eye@RIS3 database, where the currency of data should be carefully checked
- Data reliability and availability can be challenging at regional / sub-regional levels and also in industrial sectors and sub-sectors where data is not (yet) routinely collected (e.g. Bioeconomy and Circular Economy)
- First stage discussions across partner regions are important for setting the tone of working together and should be supported by early cross-regional scoping work
- An outline, working definition should be drafted (to be reviewed and updated) of the area / VC under scope
- Increasingly, inter-regional S3 efforts are underpinned by industrial transition objectives (energy and / or digital), promoting the case for a shift in S3 towards a more holistic policy and analytical framework, allowing regions to adopt a more pervasive approach to planning and delivering the Green Deal's twin transitions. Value chains which promote green technologies are a significant enabler of this

The first stage in the process of value chain analysis and mapping is referred to as 'Step 0'. This reflects the need for partner regions to prepare for inter-regional collaboration by reviewing 'local conditions' and ensuring a strong enabling environment, to derive maximum benefit from collaboration. This requires a level of 'ground work' within each partner region.

While regional innovation / S3 priorities offer a clear 'starting point' as a stimulus for discussion across partner regions, each territory should consider how they plan to take forward their engagement in the collaboration process – e.g. who needs to be involved at an early stage? What data and evidence can the region rely on (e.g. concerning industry priorities) to share with partner regions? What are the regional priorities for collaboration, and what 'depth' of data can be used to support ideas and early proposals for joint working?

The number of high-level value chains in a macro-region, such as the BSR, is potentially rather large given the number of industrial and trade service sectors (clusters) that are operating and present in at least a sub-set of the regions and member states (MSs) that form the macro-region.

Figure 7: Pre-selection of high-level value chains at macro-regional level



Source: EFIS report

What influences the early selection process?

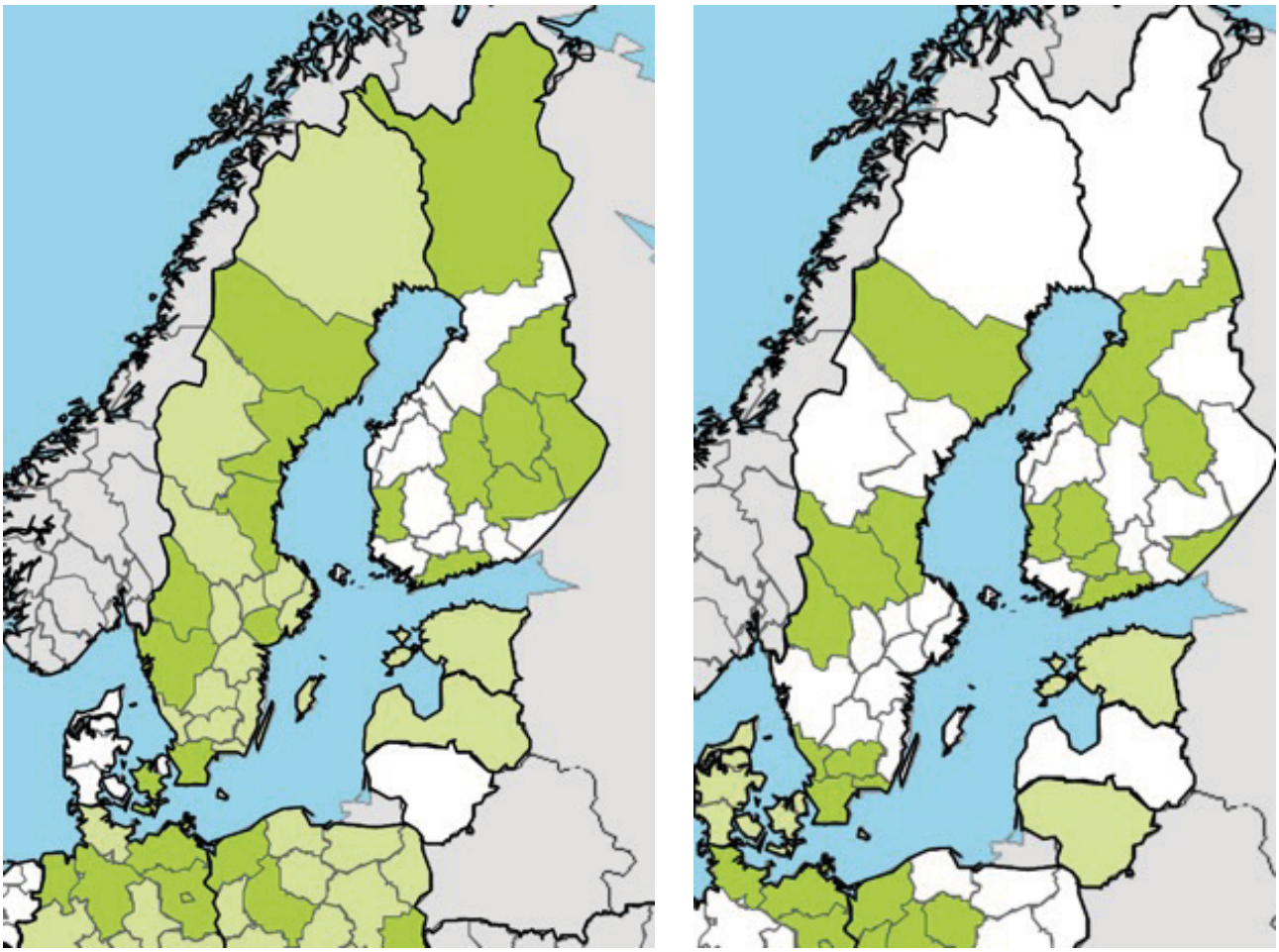
In the case of the associated BSR pilot action in the CBE field, the decision to focus on the value chain was driven by the high-level priority given to the circular and bioeconomy both at EU level (therefore, a 'top-down' driver) and within the MSs and many of the regions. Furthermore, this was a direct request from the Interreg BSR Joint Secretariat, given their knowledge of the interest and demand for closer collaboration across the BSR in this domain.

When selecting a high-level value chain area for further review, there is usually a need to generate endorsement from an influential stakeholder community. In the case of the CBE domain, this was supported by the BSR S3 Directors' Network[6] along with representatives of the BSR S3 Ecosystem project partner regions. Taking the CBE domain as a starting point, the high-level data gathering and mapping exercise took these foundations as a starting point to identify 'S3 hotspots' across the macro-region by identifying key assets, innovation actors and evidence of innovation performance in the CBE domain.

As a first step for identifying the relative focus on S3 priorities in each region, the eye@RIS3 tool provides a quick means of checking current priorities across EU / BSR regions[7]. The two maps below in Figure 8 show the relative importance of bioeconomy versus e-health as priorities for the BSR regions, underlining the relatively strong emphasis on the broad bioeconomy topic.
The eye@RIS3 tool offers a first level insight into regional priorities that needs to be validated, updated and then developed at a more refined level of granularity. With the likelihood that many regions will update their Smart Specialisation Strategies for the post-2020 programming period, it cannot be assumed that the data is wholly up-to-date.

6. This group was set-up in 2018 and is based on voluntary engagement of senior actors from 13 BSR regional / national authorities.
7. It should be noted that not all EU / BSR regions and Member states are registered in the S3Platform, nor are the priorities from registered regions necessarily up-to-date.

Figure 8: Relative importance of bioeconomy versus e-health as a S3 priority in BSR



Source: eye@RIS3

Insights from BSR projects: identifying regional and inter-regional S3 priorities:

1. GoSmart project

Girejko et al (2019) outline a methodology for transnational S3 based on the work carried out under the GoSmart BSR project, including the checking and validation of common priorities by combining 'stated priorities' in S3 documents with location quotient (LQ) type analysis. The LQ is a way of quantifying how concentrated a particular economic branch, industry, or sector is in a specific region compared to a larger geographic unit (e.g. country, macro-region). The results from the analytical review suggested that the initial smart specialisation priority areas cannot all be verified by the data. The authors suggest this is due to (i) political reasons or (ii) statistical restrictions. This point helps to explain that the process of creating regional /national innovation priorities for S3 is characterised by a number of factors which are not all – necessarily – driven mainly or purely by data analysis.

2. LARS

This Interreg BSR project focuses on analysis to seek out innovation ecosystems with similar priorities, and encourages learning and exchange across identified partner regions. It also supports regions to generate regional value chain analysis, so better equipping regions to join forces with other regions at the stage of inter-regional value chain analysis / mapping.

In the CBE pilot exercise, the process for narrowing down the value chain topic began with a round of general consultations involving the BSR S3 Directors' Network and project partners, based on an initial set of qualitative and 'top-level' quantitative information.

This early scoping aims to create a first-stage dialogue with key influencers and decision makers to receive initial feedback concerning demand for value chain analysis in the proposed domain.

Early questions to support this exercise draw on the focus of S3 across the territories of the BSR, and could include the following:

- Is the sector / domain proposed for further review asa field of priority in S3 strategies?
- If yes, how is this field defined - broadly or more narrowly?
- If more narrowly, what specific niche or sub-value chains are of most relevance across each region?
- If no, what other specialisation fields are of most interest (given their regional priorities defined in RIS3 or other strategies)?
- Are there cross-cutting or key technologies that are viewed as being of critical importance for the priority specialisation field(s)?

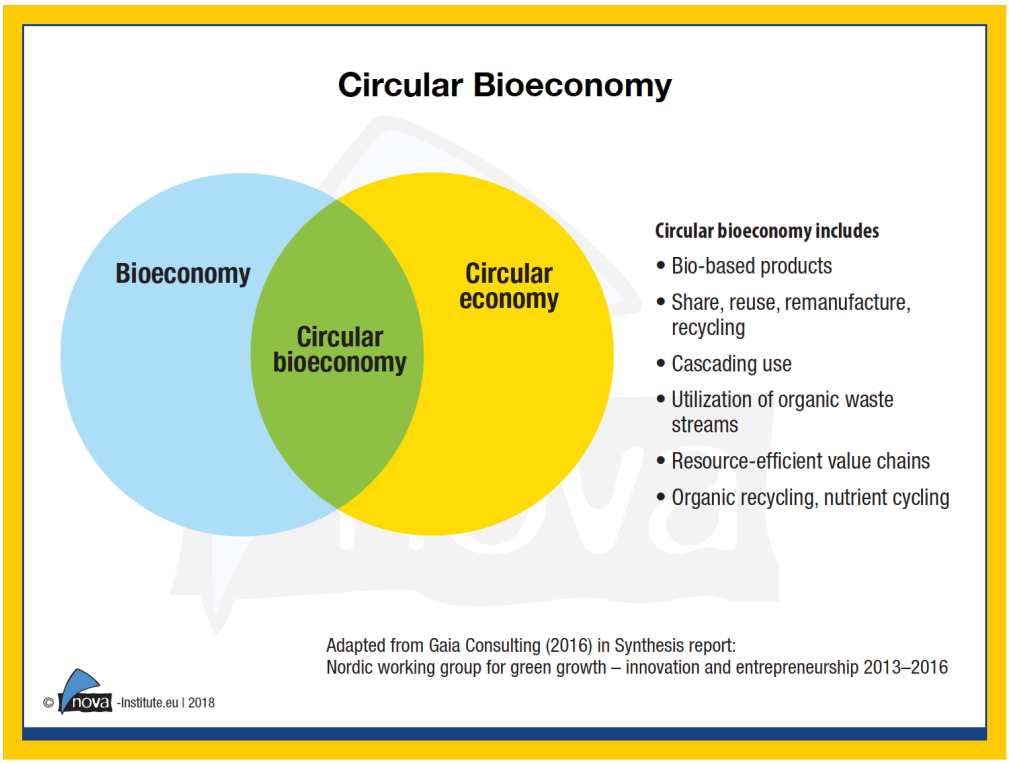
Under the CBE pilot exercise, a first round of consultation led to the decision to focus on this topic as it was considered to be a particularly promising, emerging area of activity in the BSR (and indeed, at Nordic and EU levels) with a cross-sectoral dimension that made it highly relevant for the pilot exercise.

The scoping of the circular bioeconomy concept was done through a rapid scan literature review of the topic of circular bioeconomy leading to the adoption of a working definition based on existing literature.

This first step is important as it sets out broad parameters for the analysis, mapping and matching steps. At the same time, the analysis and mapping may lead to refinement of the initial concept or a focus on specific links in the value chain or specific sub-value chains. This commences a process of 'trial and error' whereby initial ideas require further review or even need to be withdrawn, owing to limited data, an absence of demand or unclear evidence of industrial potential.

In the case of the pilot exercise, a definition of the CBE was agreed upon to provide a foundation for the direction of the subsequent data gathering phase of work.

Figure 9: Definition of Circular Bioeconomy (CBE)



Insights from EU evidence and practice: green, technology-driven S3 priorities at the core of EU S3 Partnerships

The **EU's Green Deal** – and the twin transitions of energy and digital – is driving transformational change in regional economic structures. Increasingly, regional and inter-regional S3 priorities are adopting a strong 'green', and technology-driven dimension. This reflects a growing need for regions to support their industries to engage with the EU's Green Deal and related technologies which can transform and diversify regional innovation and economic performance. As such, value chain analysis will be heavily influenced by these factors (e.g. the presence and uptake of different green technologies within the territory / territories under investigation) and the extent to which innovation actors can readily engage with these technologies to support their transition. Clearly, transition pathways are highly differentiated across EU regions. This will affect if and how different regions are able to engage in a new wave of S3 inter-regional collaboration efforts.

The **EC's S3 Platform** is developing new support and guidance tools to help regions to build capacity in making the shift o a an S3 agenda more aligned to the challenges posed by energy and digital transitions.

To boost S3 inter-regional collaboration as a response to accelerating 'green recovery' from the health pandemic, a call in 2020 from DG Regio was launched to support a **new wave of S3 Partnerships** "to help regions catch the opportunities emerging from the crisis, develop resilience and build on green and digital transformation for the recovery of the most affected sectors, such as health and tourism"

In addition, DG Regio has published a new toolkit, targeted at managing authorities, to support regions in their **sustainable transition journeys**. The toolkit emphasises the role of innovation in achieving a 'just transition'.

5. Step 1: Regional assets and capability mapping

Chapter summary

- Step 1 of the process requires strong support at the regional and inter-regional levels for data sourcing and analysis
- Early findings from these efforts should be shared with key decision makers. The interpretation and presentation of results should be tailored to different audiences, to promote their understanding and engagement
- Early data analysis should include: international markets; trade flows; market size; the role / importance of technologies (both development and deployment); skills and employment; and investment (e.g. current levels of public / private investment in the area being reviewed)
- There are many secondary data sources available and accessible at EU level. An outline list of these is provided in this chapter
- Supplementary information – especially to explore more qualitative elements of the area under review – can be accessed through mapping questionnaires. The process for gathering data should be carefully designed and managed.
- A mapping questionnaire and more in-depth follow-up in partner regions can also highlight the role and value of signposting resources, networks and intermediaries

Once the high-level value chain has been selected, the first step is to review the known regional assets and capabilities in the selected domain, and across the territory under review. There is generally a need for significant data sourcing and analysis at this early stage. Much of this will be publicly available data while other sources might require deeper investigations to locate. it is a task requiring specific data sourcing and analysis skills. Furthermore, those undertaking this task must be able to interpret the findings for different audiences.

Insights: Skills and competences for data-focused value chain analysis and mapping

Statistical and economic (often, econometric) skills and analysis are required to capture evidence and data relating to (e.g.) international market analysis, trade flows, market size and potential opportunities. Sourcing data sets is often easier to access at national level. However, at regional level (especially NUTS2) data can be hard to come by. This is also the case relating to new / emerging sectors and domains such as bio and circular economy.

Beyond sourcing and interpreting data, there is also a need to 'translate' data into meaningful language for different innovation actors / audiences. Visual maps depicting trade flows and value chains across regions and member states can be a very useful way to capture sources of expertise / specialisation.

The analytical angles may cover the following areas (non-exhaustive):

- Review of the most recent size, employment and other economic dimensions of the strategic priority area; aspects like presence of multinationals and human capital characteristics, etc. can be included;
- Economic specialisation analysis by applying location quotients[8] to examine how concentrated an industry is within a region relative to other regions;
- Analysis of scientific and research potential through publication and patent analysis; data on Framework Programme participations and previous public sector (national and EU) investments addressing the priority area can be a good proxy for assessing comparative research potential;
- Technological specialisation analysis through mapping regional expertise and know-how in key technologies;
- R&I actor mapping, including also quadruple helix considerations:
  - Knowledge creating and brokering actors – research centres and infrastructures, RTOs, universities, centres of excellence, demonstration and piloting facilities
  - Innovation diffusion actors – e.g. clusters and industry-led networks, as well as social entrepreneurs / social innovation actors and organisations with expertise in the domain under review
  - Industrial presence and financial / investment support – for the latter, this could include public, private and public / private funding bodies, either in a generic capacity or specific to the domain
- Internationalisation potential determining trade patterns and global value chain links with other (regional) economies.

These broad groupings are coherent with Franco et al (2020) who isolated seven classes of structural factors that play a prominent role in determining regional innovation patterns and trends: (1) geo-demographic factors (for example, size of the market, age structure of the population); (2) human resources (for example, STEM graduates, skills profiles); (3) technological specialisation (for example, patenting activity); (4) sectoral specialisation; (5) company structure (for example, firm-size distribution); (6) trade openness; and (7) institutions and values (for example, multi-level governance, social capital, entrepreneurial attitudes).

8. This requires a statistical analysis measuring the extent of industrial specialisation and comparing to that of a larger geographic unit (e.g. EU) in order to gain insights into relative strength across the domain under review

Figure 10: Indicative list of information and data sources

Topic	Data source
Regional economic and innovation profiles	
Regional Innovation Scoreboard	https://interactivetool.eu/RIS/index.html
Eurostat Regional Statistics	https://ec.europa.eu/eurostat/web/regions/data/database
Regional Competitiveness Index	https://ec.europa.eu/regional_policy/en/information/maps/regional_competitiveness/
Mapping R&I ecosystem actors	
Cluster mapping	https://www.clustercollaboration.eu/cluster-mapping
Digital Innovation Hubs	https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool
Living Labs	https://enoll.org/network/living-labs/
EU industrial R&D investment scoreboard report	https://ec.europa.eu/info/news/2019-eu-industrial-rd-investment-scoreboard-report-2019-dec-18_en
Research infrastructures	CATRIS Portal https://www.portal.catris.eu/home (incorporating former MERIL database) EOSC Portal : https://marketplace.eosc-portal.eu/services Specific networks in BSR region: Baltic Tram (https://www.baltic-tram.eu), Baltic Sea Underground Innovation Network (http://bsuin.eu/), etc.
EIT Knowledge and Innovation Communities	https://eit.europa.eu/our-communities/eit-innovation-communities
Industrial infrastructures (pilot and demonstration facilities, testbeds, etc.)	Depending on the domain, there are various EU level actions mapping such facilities, e.g. in the bioeconomy field https://biopilots4u.eu/about
Scientific & technological specialisation	
Advance technologies for Industry (former KETS observatory)	https://ati.ec.europa.eu/ (national level)
Technological specialisation	OECD Patents by Region https://stats.oecd.org/Index.aspx?DataSetCode=PATS_REGION EPO PatStat https://www.epo.org/searching-for-patents/business/patstat.html (requires paid account)
Scientific specialisation	SCOPUS, Web of Science etc. (requires account). For guidance, see for instance : http://scientificprofile.s3platform.eu/
European Research Infrastructure for Science, technology and Innovation policy Studies (RISIS) - datasets	https://www.risis2.eu/risis-datasets/
Trade and GVC analysis	
Trade datasets and tools	DG JRC EU Trade tool: https://s3platform.jrc.ec.europa.eu/s3-trade-tool (data out of date) UNCTAD : https://unctadstat.unctad.org/EN/ (national level)
Company datasets – e.g. ORBIS	https://www.bvdinfo.com/en-gb/our-products/data/international/orbis (requires paid account)

Source: compilation EFIS

The on-line S3 toolbox provides a useful range of tools for analysing such data: and Rakhmatullin et al (2020) provide a summary of different analytical tools that can be applied.

In addition to consulting the range of available European or international datasets that are available (see above), it is useful to collate and summarise on-going work in the regions or MSs covered by the mapping exercise. For instance:

- Have any of the regions carried out value chain or cluster mapping exercises in relevant fields?
- Given the priority specialisation field, what data exists at regional level on public-private investment in this field during the current period (e.g. 2014-20).
- Which of the regions have begun work on refreshing their RIS3 (or similar regional strategic plans for innovation/ development) ? Are there any early conclusions on new priority fields ?

Good practice example from BSR: Asset and Capability Mapping for CBE

The pilot exercise for CBE highlighted the difficulty of exploiting the more standard statistical datasets which often do not provide the right degree of granularity (e.g. when the field is an emerging value chain or of a cross-sectoral/technological nature). Hence, the option of complementing the available data through a mapping survey completed by each region was used to capture additional information and data (see Annex 2 for a copy of the questionnaire, which can be readily adjusted to support a similar exercise across any sector / cross-sector / domain).

Undertaking a survey exercise across regions can help to raise awareness of the value chain mapping exercise with stakeholders / experts who can provide valuable insights which might otherwise be overlooked. In addition, a survey questionnaire with key stakeholders can uncover significant detail where this is completed as a collaborative exercise. While this can present logistical challenges, a collated response (e.g. at a regional / sub-regional level) can generate richer details concerning the status of the domain under review than can be achieved through individual responses. During the pilot exercise for CBE, Covid-19 restrictions made face-to-face group consultations impossible. ICT proved to be very effective in supporting on-line meetings within regions and in supporting the collation of a single questionnaire response within the region. This helped to optimse response rates of the survey.

This is another example of the necessary 'trial and error' approach to value chain analysis and mapping, given that complete information is unlikely to be available. Interpretation of data – especially where additional, qualitative sources have been used – should be undertaken carefully, with clear definitions of assumptions, data gaps and challenges. Limitations should be understood by decision makers, in order to clarify the potential risks involved concerning overall reliability of the data and evidence.

Mapping questionnaires notably cover the following areas:

Figure 11: Main topics addressed by the mapping questionnaire

Source: EFIS report

BSR Good Practice example: Central Finland, S3 and the Bioeconomy

A successful sectoral or domain-driven approach to inter-regional collaboration should be underpinned by clear evidence from regional partners that the sector / domain under joint investigation is considered a key priority at the regional level. In the absence of strong regional commitment to the sector / domain being targeted by the regional partners, the cross-regional evidence gathering exercise will be very challenging. In the long-term, it will be difficult to sustain commitment and cooperation efforts when regions cannot demonstrate clear sector-driven support to underpin S3 cooperation efforts.

Conversely, regions who can clearly demonstrate their commitment to the sector / domain under review can help to drive the overall direction of the inter-regional effort. Taking the example of the Bioeconomy, Central Finland has invested significant effort and resources in positioning this sector at the core of their S3 collaboration ambitions. The region played a critical role in setting up a **Biobord Platform**[9] with four other BSR regions, based on intensive regional profiling of the Bioeconomy and culminating in a joint action plan to join forces and scale-up inter-regional efforts across the sector. This resource provides signposting and networking support to over 250 innovation actors from across the inter-regional partnership, and has strong potential for upscaling.

9. http://www.rdi2club.eu/

6. Step 2: Mapping of policy support and public-private investments in the value chain domain

Chapter summary

- Step 2 of the process requires a deeper level of data trawling and analysis to uncover evidence of efforts, investments and funding opportunities which can help the emerging partnership to 'build their case' in taking forward inter-regional efforts in the area(s) under investigation
- The status of the partnership should be reviewed to understand if gaps and challenges have emerged (e.g. in communications across the partnership, the speed of progress at regional level).
- The partnership should seek to generate incremental commitment to building an effective and sustainable partnership, requiring a general review of key players, the status of the partnership's 'operating environment' and actions related to partnership governance
- Greater strides should have been made in the partnership to boost industry engagement, providing a 'reality check' on the partnership's market-led direction
- Deepening interest and engagement across regional industry actors can be promoted through matchmaking events

The second step is to explore public policy measures, public-private partnerships and patterns of investment in the domain(s) of interest across regions to form an idea of where future value chains may regroup. Within this analysis the following exercises can be performed (non-exhaustive):

- Mapping of relevant policy support measures and analysis of the funding landscape (both public and private sources)
- Charting involvement in international partnerships and collaboration networks (such as Horizon 2020 or Interreg)
- Understanding regional priorities for co-operation from Smart Specialisation strategies and the extent to which partner regions are already engaged in existing, inter-regional S3-related projects and platforms

Good practice examples from BSR: demonstrating strategic capacity for BSR-focused S3 collaboration

1. ClusterFY: promoting the strategic role of clusters in delivering industrial renewal
Lithuania has played a key role in the above project, which has supported stronger positioning of clusters in regional innovation ecosystems, to guide a market-led approach to S3, while reinforcing the role of key enabling technologies (KETs) in promoting industrial renewal. Inter-regional value chain analysis and mapping is often heavily influenced by the presence of clusters, since they signal regional 'hotspots' of industrial strength and connectivity. The ClusterFY project has also delivered a strong outreach role to engaging the wider innovation ecosystem. Regions who adopt this type of approach to cluster policy are better able to position their clusters in inter-regional S3 efforts and to connect clusters to value chain analysis and mapping activities. This generates a strong industry-led approach to S3 inter-regional working.

2. Region Västerbotten – investing in EU networks to promote joint innovation investment opportunities
Region Västerbotten – with its peripheral location - has invested heavily in a number of networks to improve its 'connectivity' to partners of choice and to promote joint innovation and investment prospects. The "North Sweden Regional Innovation Partnership" includes the four northern regions in Sweden, working together to initiate joint projects and make Northern Sweden more competitive and visible in the global market. Cooperating with other northern sparsely and populated areas -NSPA – the region is involved in an Interreg North project that aims to identify joint inter-regional investment needs for industry and develop an Arctic Investment Platform (AIP). Furthermore, Umeå University is part of the Arctic Five - an alliance with The Arctic University of Norway, Luleå University of Technology, The University of Lapland and The University of Oulu - that aims to share knowledge, education and research infrastructure for the development of the Arctic region and its businesses.

Figure 12: Sources of information on policy priorities and public-private investment

ESIF Programmes	Funding in broad categories available via https://cohesiondata.ec.europa.eu/
Regional or national programmes or strategies	There is no single source although the RIO platform at European level do provide insight into national and regional policies and priorities. https://rio.jrc.ec.europa.eu/
R&I Regional Viewer	The R&I Regional Viewer provides a structured, regionalised visualisation (at NUTS levels 1, 2 and 3) of two sets of data: the Horizon funding awarded to the participants of projects sourced from the DG R&I Grant database and the allocated R&I-related investments under the European structural and investment funds (ESIF). A new version of the R&I Territorial Economic Data Viewer is in development (as of February 2022). https://s3platform.jrc.ec.europa.eu/synergies-tool
EIB/EIF – Invest EU	https://www.eib.org/en/efsi/map/index.htm
Venture capital & private equity	https://europa.eu/investeu/home_en (general annual trends) National venture capital and private equity associations may also be able to provide data.

Source: compiled by EFIS

Having generated a first level evidence base, it is not unusual that a lull in activity takes place around this time. This is because taking the next steps requires a level of commitment from across regional partners which implies a forward 'leap' with a level of uncertainty about the outcomes. At this stage, the stakeholders from the respective regions involved in the exercise should review the extent to which the emerging evidence from the value chain data analysis aligns with their ambitions. For some, there will be little / no incentive to continue with the effort as the findings demonstrate little overlap with their ambitions. For others, there might be some (limited) interest in retaining engagement and for others there is likely to be a clear interest in sustaining and accelerating engagement. It is important to assess this stage carefully as decisions taken at this stage will influence the effectiveness of the effort going forward.

It is at this time that each region must invest in domestic discussions concerning if and how they wish to continue contributing to the S3 inter-regional effort. From these discussions, an emerging 'partnership' should be formed, based on those regions with the most interest in pursuing the effort of S3 inter-regional collaboration. This is where the difference emerges between a standard Interreg project and an S3 Partnership. Where Interreg projects focus on depth learning and sharing, S3 Partnerships take forward these efforts to generate joint innovation investment, with an industry-led perspective and with a strong commercialisation focus. The S3 Platform's method manual for inter-regional S3 Partnerships provides extensive guidance on setting up Partnerships. Below, a broad summary of key considerations is offered. To take forward this effort, the interested partners must consider:

- **How the regional innovation ecosystem intends to engage in the Partnership** – who will be directly involved i.e. which partners from the region? How much time and effort can be expended (and the associated, transactional costs involved in this type of rather intense exchange and joint working)? Do they wish to lead the effort of the Partnership, or have a more reactive role?
- **What the 'operating environment' of the Partnership should look like** – this implies a set-up for joint working where there are clear communications, routes for engagement and feedback and consideration of a Partnership coordinator role. In the recent DG Regio Pilot exercise of S3 Partnerships, it was revealed that – in addition to lead region roles – Partnerships can better accelerate and manage their efforts when they are supported by an impartial coordinator, who can moderate communications and (often) arbitrate between differing views across the regions concerning the direction of the Partnership
- **How governance (including lines of communication and decision making) will operate between the Partnership and regional decision makers from across the innovation ecosystem** – this is a point which is often underestimated in Partnership contexts and can create a situation where the Partnership's efforts fail to remain on the 'radar' at the regional level. This can then affect how a region engages with the Partnership and whether they continue to benefit from their engagement. In addition, it is not unusual – with insufficient commitment from the region – for the overall speed and effectiveness of the Partnership to be affected by a lack of 'connectivity' with regional decision makers
- **How regional innovation actors will engage with the Partnership** – each region involved in the Partnership should consider the core group of stakeholders who are likely to be involved in the Partnership's activities. This requires a balance of different roles, where the relative influence of these roles can change depending on the stage of the Partnership's development. Research and scientific input into the overall Partnership effort is critical. It is often through this route that technology expertise and technical, subject-specific knowledge shapes the overall direction of the Partnership. Normally, a nominated individual will take a regional coordination role to manage each region's engagement and to call on different regional actors to provide advice and / or to directly engage in Partnership meetings, activities or decision making. Key actors from across the regional quadruple helix should be involved in this dynamic. Regions with strong innovation ecosystems and effective governance structures are usually more effective in engaging relevant innovation actors in the Partnership effort. A very important question for each region and for the whole Partnership is to decide at what point direct industry engagement with the Partnership will be optimal.

Insight from EU evidence and practice: the challenge of engaging and sustaining industry in the efforts of the S3 Partnership

When regions decide to work together to create a new data / evidence base linked to a specific value chain of mutual interest, it is usually the case that public policy experts will lead discussions. However, in ensuring that a strong market-orientation and 'reality check' is injected into this effort, there is a need to engage with industry experts. In the first instance, this might focus on cluster organisations but direct industrial interest in the efforts of the Partnership are required if a joint innovation investment focus is to emerge, with the aim of generating commercial opportunities and benefits.

Engaging industry actors too early (and too intensively) in the process can limit their long-term commitment. However, bringing them into the process too late can lead to a mismatch of expectations, with the Partnership pursuing a direction which is not compatible with their local industry needs or interests.

Furthermore, there is a need to consider how industrial actors from across the involved regions can be brought together to determine how their mutual interests can be addressed by the efforts of the Partnership. Significant efforts are required at domestic levels to get to this stage. While it is often the case that companies (especially SMEs) are unaware of the presence of other industrial actors or collaborations which exist outside their region or member state', there might be a reluctance to take up such opportunities. Reasons for this include a fear of possible competitive threats / tensions, language and cultural barriers which prevent effective exchange and dialogue, the costs involved in preparing this type of exchange (e.g. a series of meetings, with information exchange / sharing), a lack of knowledge or capacity concerning how to embark upon such a collaboration.

'Matchmaking' events can help to address the above challenge, by providing 'safe' environments for the exchange of relevant market and business information and where industry actors from across different regions of the Partnership can be brought together to improve the market-led orientation of the Partnership effort (explored in the next Chapter).

BSR Good practice example: Mecklenburg-Western Pomerania – generating a business-led S3 orientation

The BSR Interreg project – EmpInno – focused on driving stronger business engagement in S3 opportunities across 13 BSR regions. The inter-regional project focused on the design and delivery of matchmaking events based on sectoral priorities, where SMEs were targeted through open calls. The project placed strong emphasis on refining regional S3 approaches according to the needs / feedback of companies. Significant learning was shared across the regions concerning guidelines to attract and sustain interest from industry, to take part in organised matchmaking sessions. This learning could also be transferred to the 'matchmaking' phase when BSR S3 Partnerships seek to further investigate specific business interests related to value chain analysis. Bearing in mind that many industrial actors (especially SMEs) have limited capacity to seek out partners for innovation collaboration, from outside of their own region / member state, this project offers clear scope and value for the transfer of 'matchmaking' knowledge.

7. Step 3: Matchmaking and development of ideas for joint investments

Chapter summary

- There is a need to regularly monitor the status of the partnership dynamic, especially as industry engagement takes hold. Building a trusting and cooperative partnership is key to sustaining strong relations and cooperation
- As new evidence / insights are uncovered, new decisions and pathways for Partnership direction will emerge – e.g. gaps in the value chain / access to technology; more limited concentration of excellence / competitive advantage
- Tools and techniques to support consensus building across regional ecosystems can help the partnership to overcome obstacles and to 're-set' commitment. The BSR's Innovation Camp method is a good example of this
- The chapter offers insights into skills and competences for S3 inter-regional collaboration, acknowledging that this type of collaborative working is very new for some regions and their innovation actors

A first step is for a number of regions to jointly agree to take forward identified opportunities to strengthen core elements of the high-level value chain in the macro-region. This requires intensive efforts and it is optimal to involve a number of innovation ecosystem actors from across each region, to ensure that a broad range of options are discussed and reviewed and that sufficient credibility is injected into strategic discussions.

Developing strong cooperative and trust-based working relationships is imperative to the effective functioning of the overall inter-regional effort. This takes time and common challenges / barriers are related to the different language, cultures, traditions, structures and approaches which exist across different regions and geographies. Regions with experience of EU inter-regional cooperation (e.g. through Interreg and Horizon projects) are often more aware of these challenges. The Partnership requires to invest time and energy in strong partnership building and to be aware of the role this plays in the overall progress of the Partnership.

This type of analysis can lead to very different outcomes than was originally intended by the value chain analysis and mapping efforts. For example, it might be found that the macro-region has too many gaps in the value chain (or insufficient scale and capacity) to proceed in the intended direction. From this, it might be concluded that the macro-region should focus on 1 or 2 links in the value chain under investigation, and to deepen efforts with this / these area(s) with a view to becoming a macro-regional 'centre of excellence' or industrial ecosystem to service other parts of the EU or even other (related) value chains than the one originally envisaged.

For example, the first stage CBE pilot exercise uncovered that there could be value in further investigating the networking potential of biorefineries across the BSR, to generate new shared knowledge and innovation capacity and to identify possible options for 'opening up' access to the biorefineries to actors beyond the regional / MS boundaries. This type of discussion requires political, policy and technical inputs. For example, a biorefinery operator (from an infrastructure which is publicly funded) who sees the value in opening up access to actors from other regions might be prevented from doing so if there is no political 'will' to support such an action.

Regional stakeholders within Partnerships who play strong 'boundary spanning' roles (e.g. operating across the interface of academic and industry actors) can add significant value to this process, by taking back and 'translating' Partnership level messages and ideas to specific innovation actors from within their regions. It is important that these boundary spanners have sufficient flexibility and seniority to make high level contributions to these exchanges (both into the Partnership and back to domestic partners). Again, there is a clear risk that Partnership efforts slow down or stall at critical points – like this one – in the Partnership's evolution, when complex lines of communication, exchange and 'bargaining' are present across regional boundaries.

Good practice example: Helsinki-Uusimaa / Aalto University – Smart-Up BSR: Innovation Camp

An Interreg BSR project involving 9 BSR countries has successfully piloted an approach to bringing together innovation actors from across the macro-region to address joint challenges (e.g. related to healthy ageing, climate change and smart cities). The methods employed during the 'camp' encourage a highly interactive exchange of ideas to generate solutions with a strong degree of 'buy-in' across the participants. The camp's design is relevant to all quadruple helix actors and relies on high quality facilitation. Moreover, the method is also geared towards generating / building a strong trusting and effective partnership working dynamic.

In the case of newly formed BSR S3 Partnerships, who are engaged in complex discussions (e.g. concerning recommendations for action relating to value chain analysis) the Innovation Camp approach can support the process of consensus-building, while fostering stronger ties for continued cooperation.

Based on the results of the previous steps, the identification of specific joint actions and investments to reinforce the macro-region's potential in the specified value chain can then be developed. Owing to project timing limitations, the process of developing more concrete actions – leading to identified areas for joint investments - was not covered by the CBE pilot action. However, there are a number of sources of inspiration.

The manual for S3 thematic partnerships (Rakhmatullin et al, 2020) provides a good summary of the steps related to developing and pitching ideas in the 'connect phase' to match business opportunities. This phase of work is primarily concerned with engaging industry in the work of the Partnership by providing them with the opportunities to 'pitch' ideas to each other, across the regions. An event of this nature requires considerable planning to ensure that industry actors – from across interested regions – see sufficient benefit in taking part. They should also have received significant briefing from domestic public policy actors to ensure a shared understanding of the purpose. Attracting industry to such an event – especially SMEs who have limited time for this type of activity – can be boosted by the presence of investment specialists, legal advisers and experts in standards and intellectual property, with knowledge of the sector / domain in question.

In pitching their commercial ideas, companies should respond to a core 'template' of questions, to optimise the time and focus of their interventions, such as the one outlined below. This is especially useful when there are many industry actors taking part.

Figure 13: Template for pitching proposed business opportunity

Each project should be pitched in a few minutes. The presentation format is imposed on the participants: three slides maximum per pitch. The slides must contain the following information:

- *Name of the region*
- *Name of the asset*
- *Thematic area*
- *Brief description of the asset (who, what, why, when, and how);*
- *What type of collaboration is needed/expected from other regions and what are the next steps*
- *Relevant contact for complementary information on the project.*

A template has been pre-filled for the partner to help the work at the region.

Reference - s3p-thematicmanual_-_online.pdf (europa.eu)

Insights from EU evidence and practice: industrial, inter-regional matchmaking events

In 2016, a large-scale matchmaking event was sponsored by the European Commission (DG Regio) and delivered by the Vanguard Initiative, with the aim of bringing together industry actors from across the regions of the Vanguard. Under the 'umbrella' of advanced manufacturing, a number of inter-regional pilot projects (e.g. in the areas of Bioeconomy, 3-D Printing and De and Re-Manufacturing) provided the opportunity for industry actors to 'showcase' and 'pitch' commercial ideas which required industry collaboration to move from idea to reality. The event was the first of its kind at an EU inter-regional scale and was deemed to have been highly successful in 'exposing' EU companies to commercial ideas and generating new industrial interest for this type of exchange.
Ref: Vanguard Initiative

Thematic Smart Specialisation Platforms

As regional demand for engagement in S3-focused inter-regional partnerships has accelerated, the European Commission has responded by setting up the Thematic Smart Specialisation Platforms as a virtual platform to coordinate and support the efforts of voluntary Partnerships. Under three core themes – Agri-Food, Energy and Industrial Modernisation – the Platform is providing strong visibility and support for many S3 Partnerships – at different stages of maturity – to progress on their journeys towards joint innovation investment and commercialisation. The post-2020 period is underpinned by a raft of measures and mechanisms which are aligned to this approach to working (such as industrial ecosystems, the growing place-based focus of the European Institute of Innovation and Technology (EIT) and the direction of funding support under the Inter-regional Innovation Investment - 13 - instrument).

Skills and Competences to accelerate inter-regional S3 collaboration

The 'boundary spanner' role in Partnership settings is essential in connecting regional innovation systems to Partnership developments. The direction of liaison needs to be 2-way (i.e. back to the regional setting and into the Partnership setting) to ensure sustained commitment to Partnership progress. Increasingly, there is a need to secure financing for the core 'operational' efforts of Partnerships. Many regions are considering how to make this is a reality in their Operational Programmes.

Boundary spanners require a number of skills and competences (e.g. in supporting multiple communication channels and connecting actors within and across regions to support inter-regional collaboration). A recent Smart-Up project report outlines the importance of roles (such as this one) in improving inter-regional S3. They suggest the following skills / competences are required:

1. shared strategic perspective;
2. attention to integrity and inclusion;
3. engaged strategic leadership;
4. building and maintaining partnerships;
5. results orientation;
6. sustaining agility;
7. emphasizing solutions;
8. effective communication.

Building effective capacity for Partnership working should also involve diffusion of learning. There is a need to invest in this type of capacity building across the macro-region. This requires a supported process for, and investment in, this type of mutual learning. The BSR's S3 ecosystem ambition is supported by a Directors' Network. Their commitment to this investment will be very influential in ensuring that the relevant skills and competences for S3 Partnership working are sufficiently prioritised.

8. Step 4: Design of joint investment projects (business planning)

Chapter summary

- Step 4 entails a deeper level of industrial commitment and engagement, as the partnership shifts its focus to innovation investment
- Industrial actors will play a key role, here, in supporting the scoping of joint business cases. This is a rather technical exercise taking account of key themes such as the rationale for the market case; role of technologies; financial and business planning; investment sources and investment vehicles
- There is a growing level of EU, supply-side support for this stage of S3 inter-regional collaboration, recognising that more mature levels of innovation collaboration require technical support to develop and then implement (joint) business cases
- The post-2020 period is also characterised by EU support tools to address these challenges, including the Inter-regional Innovation Investment (I3) instrument and the Technical Assistance Facility not available now
- As industry engagement within a partnership setting becomes more concrete, the needs of the partnership take on a different direction, with a greater emphasis on generating a 'shared space' of cooperation, and where competitiveness challenges are managed. Tools such as memoranda of understanding, non-disclosure agreements and data management techniques to work with sensitive, commercial data can be applied
- A general, outline template to support the development of co-investment proposals has been provided to support this phase of partnership development

Depending on the results of interactive discussions across the Partnership, it might be necessary to embark on further evidence gathering to provide deeper insights into proposed opportunities for inter-regional collaboration. There is often a strong technical and technology component to Partnership proposals or outline 'business cases' at this stage.

From a **technical perspective**, there might be a need to engage in outline business and financial planning to generate insights into investment needs. For example, a joint CBE approach to networking refineries across the BSR will incur costs which might be borne by both public and private actors. The split of these costs (relative to the intended benefits) can be complex to calculate and will depend on the nature of the 'model' to be operated. The more risk involved for private sector actors (i.e. industry) the less likely they will be to commit to investment, without support to underwriting their investments.

As things stand at the EU policy level, a funding landscape which can readily accommodate the many different options for inter-regional funding proposals is rather limited. This can act as a strong disincentive for industry engagement. Furthermore, skills and capacity to develop proposals in this way are often missing at the regional policy level. More usually, these skills have to be sourced from contractors and external experts. Partnership funds are required to address this. The EU's industry-driven environment to support joint investment has seen the emergence of both Industrial Alliances and Important Projects or Common European Interest. National governments tend to play key influencing roles here, especially in IPCEIs which benefit from State Aid exemptions.

Recent EU support for inter-regional innovation partnerships has adopted a much needed and more pragmatic response to addressing their increasingly more complex and technical needs.

- The Technical Assistance Facility TAF provides 'project promoters' (i.e. lead support partners from S3 Partnerships) linked to the Smart Specialisation Platform for Industrial Modernisation with expert advice when individual projects / proposals / business cases being worked on within Partnerships have reached a sufficient level of progress. This support comes in the form of (e.g.) funding sources, sales strategies, business and financial planning
- The Inter-regional Innovation Investment instrument (I3) – linked to the post-2020 Cohesion Policy ERDF – operates under two strands which will be based on calls to support inter-regional innovation partnerships who require capacity building for effective cooperation or where a mature structure is already in place and a gap in industry-driven innovation investment needs to be addressed. The post-2020 EU policy and funding framework has sought to improve funding alignment across different tools and instruments. For example, there it is now recommended that direct links between regional ERDF priorities and Interreg projects are identified.

This type of advice and support is rather new in the S3 inter-regional working landscape and has proven to be important in identifying and validating joint investment ideas.

Importantly, private sector entities will seek out advice to ensure that risks (e.g. regarding their intellectual property and proposed financial commitments) can be minimised in a Partnership setting. Legal responses such as Non-Disclosure Agreements and Memoranda of Understanding can help in this regard. Increasingly, technology offers a solution to risk management involved in data sharing.

A memorandum of understanding (MoU) can be used to set out the level of involvement of public-private partners from each region and the timetable for further development of the concept as well as potential investment sources. The outline template below has been used by RECONFIRM to help regions draw up a first-stage idea to pitch to other regions before moving to signing a MoU.

Figure 14: Outline template for an initial co-investment proposal

1. Introduction: proposed investment project
Briefly summarise the political, technological and economic context within which the investment is intended to take place. List briefly what has happened until now to establish the investment idea. Specify expected volume of investment and if possible potential investment sources.

2. Challenges addressed and general market demand
The proposal needs to provide a strong assessment of the challenges that should be addressed by the project and an outline of the investment required to address these. This should include a credible description of how the investment will address the challenges (e.g. what barriers does it address and what benefits does it create in respect to the challenges above?) Specify the customers of the final investment result. Who will be served by the facility/services/products? Be as specific as possible and establish a priority list. Also assess why and how exactly these customers would benefit from the value proposition. This step also requires that international market analysis has been undertaken to better understand shifts / developments in the market and the nature of (international) competition in addressing evidenced demand.

3. Inter-regional dimension
Specify the inter-regional dimension of your project and illustrate the rationale for such an inter-regional dimension. There needs to be a rationale for/or benefit of cooperation to have a successful inter-regional investment project. The rationale and value for inter-regional collaboration must be well-defined – i.e. the presence of expertise, technology, infrastructure across different regions, where there is scope to align and scale-up efforts in a way which cannot be achieved by a region acting alone

4. Collaboration/Request for collaboration
Specify here what parts of your project cannot be best addressed by the lead region (promoter) and which other organisations/regions can cover them.

If not specified yet, clearly specify what inputs are needed across the partnership. This provides clarity to commence dialogue within partner region contexts, in generating a better understanding of what contribution(s) can be made and what benefits can be received

5. Outline revenue sources
Provide a first assessment/identification of what revenue sources the investment will generate. Who will pay for the final product/services and how much (on annual basis, etc.)?

6. Governance model
Think about the partnership's governance model. Who will be the project manager? Who else will be involved and how will they interact? What ambition do you have in the short and long run in terms of managing the project? A visual illustration of the governance model can help to open up this discussion, recognising that the model is likely to change, as the partnership matures.

Source: adapted from RECONFIRM[10] project

10. RECONFIRM was a time-limited, EU support instrument which offered support to inter-regional innovation partnerships to steer them towards a stronger market-led, industry focus

Innovation investment is increasingly focused on green and digital technologies. For the majority of EU SMEs, this presents a very steep learning curve and there is increasing attention at local, national and EU levels for investment in infrastructure and initiatives which bring SMEs together to develop innovation capacity, both within and across EU territories. The new EU Digital Innovation Hubs are intended to support this direction.' This should be hyper-linked to: https://digital-strategy.ec.europa.eu/en/activities/edihs

From a technology perspective, S3 Partnerships are highly influenced by the role technologies can play in (e.g.) boosting the diversification potential of (often, traditional) industries and transforming the way products and processes are developed (e.g. increasing production, reducing costs, reducing carbon footprint in the production process). A high level of technology-driven expertise is required within the Partnership setting to shape and influence these opportunities. This often requires the support of academic researchers and scientists. How this effort is 'translated' into language and meaning at the regional level will influence greatly the extent to which new technologies – driven by inter-regional efforts – will be embraced by regional decision

9. Final thoughts and recommendations for future action

Chapter summary

- Value chain analysis and mapping is a highly iterative process, requiring significant coordination and cooperation across partner regions. For the BSR, where a very strong legacy of cooperation already exists, there is very strong potential to build on the guidance in this manual to generate long-term value for the innovation performance of the macro-region
- EU inter-regional collaboration of the nature outlined in this manual is still rather new. It requires commitment and motivation across the partner regions, not least in 'simplifying the underlying complexity' for domestic audiences and decision makers
- Analysis can lead to the emergence of opportunities which exist in cross-sectoral value chains. This is increasingly the case as the EU gears up for the delivery of the Green Deal and its twin transitions. Correspondingly, this is creating new cross-sectoral opportunities in the shift from S3 to S4. This activity remains somewhat challenged by data availability and technological uncertainty

While the focus of this manual has been on the steps and stages involved in value chain analysis and mapping, it is important to note that good practices and effective working in S3-focused inter-regional collaboration offer strong foundations for successful value chain mapping. Indeed, sustainable S3 Partnerships are critical to ensuring that the results and forward actions generated from specific value chain mapping activities can create longer-term value for individual regions and for the BSR macro-region, as a whole. The value chain mapping process offers a means to an end, and should not be viewed as the pinnacle of successfu.

Examples and insights derived from the BSR's S3 Good Practices report provide a core underpinning to support successful value chain mapping. Leino (2020) notes:

"..the basis for the development of strategic inter-regional S3 is built on a successful EDP, good S3 governance, awareness of innovation ecosystems and sufficient flexibility to adapt to new developments at the regional level. It also requires political will and commitment."

In the absence of these 'ingredients' there is limited scope to realise a strong value chain orientation across the BSR. The BSR S3 Ecosystem project has placed significant emphasis on upgrading and reinforcing these 'ingredients' and in doing this in a way which promotes long-term benefits.

The pilot value chain mapping exercise of CBE in the BSR has undertaken a first stage analysis only. While generating a significant evidence base, it requires further development – based on strong demand for and commitment to S3-focused inter-regional collaboration in the CBE area.

Importantly, the steps and stages undertaken in the pilot exercise provided important insights into the process of value chain analysis and the (further) investment which is required across interested partner regions.

One of the main challenges for the mapping exercise is to organise value chain information that adequately reflects the underlying complexity while being simple enough to analytically represent it either via structured information or graphs. This requires further reflection about possible collaborative actions across the regions of the BSR. Strong 'visuals' offer an excellent way to share and display findings with a wide range of innovation actors from across regional innovation systems.

It should be recognised that high-level value chain analysis and mapping at macro-regional level has only an indicative and signalling value for policy making. These results show trends in value aggregation in a very simplified manner. Actual value chains, especially in such highly interconnected fields as circular bioeconomy, are complex and have a multitude of contributing and contextual factors that explain the value aggregation across actors and activities. As such, the first stage analysis and mapping – while essential to commencing the process – requires significantly more work and investment to reach a stage of sufficient detail and granularity.

It should also be noted that **quantitative data analysis options for cross-sectoral value chain mapping are currently rather limited.** Structured databases (e.g. at EU level) in most cases do not include information on cross-sectoral priority areas which are usually of most interest for S3 policy making. Various databases are established at diverse points in time and their structure is rather path-dependent. Tracking information on new and emerging policy directions/cross-cutting interest areas is hindered. This is especially the case when pursuing a domain focus which is still largely embryonic in its development (i.e. the digitalisation of the circular bioeconomy). There is a significant need for EU level support to provide clear directions and advice to EU member states and regions concerning how to go about this task in the future.

Despite these limitations, there is **potential for exploring opportunities for innovative data linking and new approaches in data mining** in order to generate more granular value chain hotspot mapping. To retrieve policy-relevant conclusions a **good balance between quantitative and qualitative data is necessary,** which impacts the time and resources needed for future value chain mapping exercises.

As has been emphasised in this manual, this type of exercise entails a **strong 'trial and error' approach**, where progress made in previous steps might need to be reviewed (and steps re-taken) in the event that ideas / proposals cannot be taken further. In the early stages of the pilot exercise for the CBE, an initial definition of the value chain adopted a digital focus. This had to be reviewed because of a lack of data available at the regional level. Thereafter, a wider scope of the investigated area was introduced. Assuming there is appetite to take forward the exercise across the BSR, it is likely that a narrower scope will have to be found to focus efforts and to identify specific opportunities for joint S3 working.

Finally, a continued drive to generate a stronger, BSR place-based approach to joint S3 collaboration is highly influenced by the macro-region's 'ecosystem' ambition. This ambition has been set-out by the BSR S3 Directors' Network and – while still embryonic – can provide the 'motor' of action, coordination and capacity to underpin the overall effort. This will require sustained commitment and investment. As well as accelerating S3 collaboration within and across the BSR, there is a need for the macro-region to stay strongly connected to the changing EU landscape. This will also stimulate a more robust programme of 2-way learning, with the BSR both influencing and leading on related EU policy and practice, in this area.

Annex 1: Further reading

Ali-Yrkkö, J., & Rouvinen, P. (2013). Implications of Value Creation and Capture in Global Value Chains: Lessons from 39 Grassroots Cases". ETLA Reports No 16. http://pub.etla.fi/ETLA-Raportit-Reports-16.pdf

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European Commission (2019) Strengthening Strategic Value Chains for a future-ready EU Industry - report of the Strategic Forum for Important Projects of Common European Interest. See: https://ec.europa.eu/docsroom/documents/37824

Franco, S., Gianelle, C., Kleibrink, A., & Murciego, A. (2020). "Learning from similar regions: how to benchmark innovation systems beyond rankings". In Quantitative Methods for Place-Based Innovation Policy. Cheltenham, UK: Edward Elgar Publishing. doi: https://doi.org/10.4337/9781789905519.00013

Girejko R., Kruse, M., Urban W., Wedemeier J. (2019) Methodology for Transnational Smart Specialisation Strategy.

Hegyi, F. B., Borbely, L. & Bekesi G. (2020) Factors of Leadership Attitude Enhancing Inter-regional Collaboration. Dynamic inter-regional strategic partnerships' leadership impact on motivation and commitment. EUR 30151EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-17503-2, doi:10.2760/277185, JRC120216

Komninos, N., Panori, A., Kakderi, C., Reid A., Cvijanovi , V., Roman M., Deakin, M. Mora, L., Tiemann, M. & Badii L. (2018) Online S3 mechanism for knowledge-based policy advice. ONLINE S3 (ONLINE Platform for Smart Specialisation Policy Advice) Project. DOI: 10.13140/RG.2.2.29801.60000/1

Mandras, G., & Conte, A. (2020). "Mapping global value chains". In Quantitative Methods for Place-Based Innovation Policy. Cheltenham, UK: Edward Elgar Publishing. doi: https://doi.org/10.4337/9781789905519.0000

Rakhmatullin R, Hegyi F. B.,, Ciampi Stancova K., Gomez J., & Mieszkowski K. (2020) Methodological Manual. Developing Thematic Inter-regional Partnerships for Smart Specialisation. A Practical Guide to Building and Managing Inter-regional Smart Specialisation Partnerships. EUR 30172 EN, Luxembourg: Publications Office of the European Union. ISBN 978-92-76-17907-8, doi:10.2760/564759, JRC116630.

Reid, A., Miedzinski, M. (2014) A smart specialisation platform for advanced manufacturing. Technopolis Group, Brussels. DOI: 10.13140/RG.2.2.12261.19680

Todeva, E., & Rakhmatullin R. (2016a) Industry Global Value Chains, Connectivity and Regional Smart Specialisation in Europe. An Overview of Theoretical Approaches and Mapping Methodologies, JRC Science for Policy Report, European Union, EUR 28086 EN; doi:10.2791/176781

Todeva, E., & Rakhmatullin R. (2016b) Global Value Chains Mapping: Methodology and Cases for Policy Makers, JRC Science for Policy Report, European Union, EUR 28085EN; doi:10.2791/273290

Annex 2: Example of a mapping survey questionnaire

Introduction

This survey is carried out as the next step in the development of a high-level Baltic Sea Region (BSR) value chain mapping exercise with a focus on the **circular bioeconomy**. The exercise forms a critical element of an Interreg BSR project[11], exploring the potential for a stronger inter-regional approach to innovation across the BSR, by aligning smart specialisation and innovation priorities.

With the European Commission's focus on an EU 'Green Deal' and the associated linkages to this with the post-2020 Smart Specialisation agenda – particularly, the shift from 'smart specialisation' to sustainable smart specialisation' – 'S3 to S4' - there are significant opportunities for new, innovation-focused collaborative efforts, for the BSR.

This survey seeks to generate key insights into important projects, actions, plans and strategies across Baltic Sea regions, as well as details about key clusters, industry associations, networks, knowledge and technology institutions. We are also keen to learn more about the nature of your region's **innovation investment environment**, in the circular bioeconomy environment (e.g. public and private sector sources of funding / investment). Please inform us about emerging, new and on-going activities.

In addition, we are seeking to identify key technologies which are being developed and deployed in your region. These could provide important opportunities for diversification and upgrading of industrial strengths.

The combined analysis of the survey returns will contribute to the identification of opportunities for innovation-focused, macro-regional cooperation in the area of circular bioeconomy. This will help us to highlight and target new inter-regional opportunities for innovation / smart specialisation collaboration.

We recommend that the questionnaire is completed through a consultation process that gathers views of a core group of regional experts (e.g. cluster managers, companies, technology experts, policy experts, etc.) to discuss the challenges and priorities for the region in the field of circular bioeconomy and related technological and skills needs.

Circular bioeconomy can be defined as a sphere of bio-economic activities at the intersection of bioeconomy on the one hand side and circular economy on the other and it includes 1) bio-based products, 2) share, reuse, remanufacture, recycling, 3) cascading use, 4) utilisation of organic waste streams, 5) resource-efficient value chains, and 6) organic recycling, nutrient cycling[12].

Where a recent analysis (survey, study) of regional technology know-how and needs exists, this can be used to inform the survey responses.

This template requires only one response per region (or per country, when the whole country belongs to the Baltic Sea Region area) comprising the Baltic Sea Region area.

We would be grateful if you could return us the survey by XXX. The analysis will be provided by XXX

If you need clarification on questions or how to complete the survey, please contact XXX

We look forward to receiving your responses and to sharing with you the analysis and results of the exercise.

11. https://projects.interreg-baltic.eu/projects/bsr-s3-ecosystem-214.html
12. Carus, M. and L. Dammer (2018), „The "Circular Bioeconomy" – Concepts, Opportunities and Limitations", nova paper #9 on bio-based economy 2018-01, p. 4., as in Pursula & Carus 2017, in: Newton et al. 2017.

Contact information

	Region (Country):	
	Person(s) responsible*	
	Organisation	
	Type of Organisation:	**Select one**
Government department		
Public agency (e.g. regional development, enterprise or innovation agency)		
Cluster organisation		
Research and technology organisation		
Other (please specify):		
	Email:	
	Website:	

* i.e. the person who has completed the questionnaire and/or the designated representative of the regional authority

Regional strategic priorities in the field of circular bioeconomy challenges

Circular bioeconomy supports sustainability-driven innovation in creating new local value from waste and biomass. It focuses on helping develop sustainable and climate-neutral technologies and replacing non-renewable fossil and mineral resources with biomass and waste to obtain renewable products and nutrients. Innovations that form the potential for new value chains in circular bioeconomy cut horizontally through the traditional sectors.

1. What are the main challenges facing regional firms in adopting key technologies or introducing innovations in the area of circular bioeconomy? A number of options are suggested but please feel free to list others that you consider important. You should then rank the top 5 challenges for your region (1 - most important to 5 - least important).

Rank	Challenge
	Lack of ambition in the political goals for level of upgrade of underexploited bioresources
	Slow establishment of a stimulatory framework for the new biobased industries which allows introduction of products from new value chains based on biomass, waste and side stream conversion
	Lack of open access test facilities for facilitating the upscaling new processes and products
	Lack of investment and collaboration mechanisms between key matching infrastructures (e.g. biorefineries)
	Limited knowledge, skills and expertise in novel areas of bio-based economy (in public research, business sector, universities, policy makers and regulators)
	Limited business access to international markets and integration in value chains, especially for niche products with high value added
	Limited availability of various complementary actors in the regional business ecosystem

NB: please specify others if necessary

2. On what evidence is the selection and ranking of challenges based – e.g. background study, statistical survey of enterprises, workshop/discussion with cluster managers or representative companies, etc.? Please provide details of the evidence base and explain your ranking.

Strategies and policies addressing the circular bioeconomy

3. In your region, are there public or public-private strategies that address the challenges related to innovation and technological adoption in circular bioeconomy?

Strategy document	**Title of document**	**Year adopted**
Smart specialisation strategy		
Circular bioeconomy strategy		
Specific technology strategies		
Other strategies (please specify):		

4. Please summarise (briefly) the main regional priorities concerning circular bioeconomy and the application of key technologies and concepts (e.g. biorefineries, cascading use, utilisation of waste and side streams, nutrient cycling, bio-based products, etc.). Please specify if there is any emphasis in regional strategies on digitalisation as an accelerator of circular bioeconomy.

Policy measures in support of innovation and technological change in circular bioeconomy

5. Please list up to five major regional or national programmes/initiatives that support the development or deployment of new technologies and their application in circular bioeconomy? These can either be (co-)funded by public funds or supported through public-private partnerships.

Name of initiative	Annual funding	Source of funding	URL (if available)

Regional expertise and know-how in key technologies: Existing expertise in relevant technologies

6. In which of the relevant technologies for circular bioeconomy is your region most advanced/specialised? Rank the 5 technologies in which you consider your region to be specialised in (relative to partner regions or from an EU wide perspective). (1 - most specialised to 5 - least specialised).

Key technologies for circular bioeconomy	**Rank**
E.g. Bioprocess development (e.g. synthetic and systems biology)	
E.g. Plant biotechnology	
E.g. Sustainable chemistry	
E.g. Thermochemical conversion	
E.g. Simulation and modelling	

NB: Add lines as required

7. Please comment your ranking and provide examples – you may alternatively or in addition provide a web link to a study or analysis of regional specialisation in these fields.

8. Please rank the level of importance and the actual level of application of the identified key technologies in regional businesses.

Key technologies for circular bioeconomy	**Importance for regional businesses to adopt technologies** *Rank 1 - critical to 5 - low priority;* *Otherwise: don't know*	**Actual application of key technologies in regional businesses** *1 - state of the art (3 - average with respect to other partner or EU regions) to 5 - not currently used;* *Otherwise: don't know*

**Add lines as required*

9. You may comment or provide examples of specific issues in applying key technologies in regional firms. NB: You may provide evidence of your scoring or examples/issues.

10. Is support for development of these key technologies accessed outside the region? If so please comment on where and which type of support.

Technology providers and demonstration or piloting facilities in your region

11. Please list up to 10 organisations (in your region) involved in the development and demonstration or piloting of key technologies relevant for circular bioeconomy.

Name	Type*	Field of expertise

NB: add more lines as required.

* manufacturers, technology suppliers, university or public research centres, innovation or applied industrial R&D centres, technology training centres, living labs, demonstration centres, pilot facilities, etc.

12. How difficult is it to mobilise financial support for investments/projects in the area of circular bioeconomy? (from 1 – easy to 5 – very difficult).

Ranking	Comment

Existing regional involvement in European, inter-regional or international partnerships in circular bioeconomy

13. Please list existing involvement (on-going projects) of regional organisations (public, private, research, clusters, etc.) in European (ERA-NETs, Horizon 2020, COSME, etc.) as well as inter-regional such as INTERREG and international programmes.

Name of project (duration yyyy-yyyy, e.g. 2014-2016)	Organisations involved	Objective / topic

NB: add more lines as required.

Regional priorities for co-operation

Priority topics for inter-regional co-operation

14. Given the challenges and the priorities at regional level, in which specific topics do you consider there is the most value to be created by inter-regional co-operation in the area of circular bioeconomy?

Topics (describe briefly the proposed topic)	Rank from 1 to 5 in order of importance

15. If you wish to propose additional topics, please use the box below.

Type of joint actions or activities

16. Please identify and rank (from 1 - top priority to 5 - lowest priority) top five priority activities for inter-regional co-operation and where relevant comment on your ranking.

Type of activity	Ranking	Comment
Mapping specialist expertise in relevant technologies in each region		
Mapping leading regional firms in circular bioeconomy value-chains to identify potential synergies		
Partner search, matchmaking and brokerage services for partnership development		
Sharing of best practices with regard to the implementation of new technologies in circular bioeconomy		
Co-development of technological and innovation infrastructures (biorefineries, testing sites, pilot facilities, etc.)		
Create an inter-regional network of research and innovation centres that businesses can access (e.g. using an inter-regional innovation voucher)		
Co-investment in pilot applications, technology validation actions, etc.		
Cooperation on mobilising financial support for investments/projects e.g. pooling of regional funds through a joint programme initiative, development of an investment platform		
Others (please add details):		

NB: You can add more lines as required

Thank you for your time!

Annex 3: Summary of important BSR projects demonstrating good practice in S3 inter-regional learning

Project	Key output	Description
RDI2Club	Biobord Platform	Digital platform that connects bioeconomy public, business and research actors in the BSR. Supports RIS3 implementation and inter-regional cooperation in the long term.
GoSmart BSR	Trans-S3 methodology	A tool for identifying shared/complementary S3 areas and economic actors with mutual interests
Smart-Up BSR	Inter-regional innovation camp	Enables experts from different countries to come together and find concrete solutions to common challenges. Requires good preparation and relevant facilitation skills.
ClusterFY	Recommendations to improve European cluster policies	Finding ways to enhance cooperation between European clusters and business networks
EmpInno	Recommendations for managing authorities on how to increase business involvement in RIS3	Joint workshops with managing authorities and business development organisations. Thematic inter-regional business matchmaking trips in selected S3 areas
S34Growth	Recommendations to facilitate inter-regional industry-led investments	Demonstration projects and action plans related to e.g. inter-regional innovation vouchers and ERDF-funded parallel projects in different regions. The activities continue in the Vanguard Network
BIOREGIO	Action plans towards Bio-based circular economy	Learning from other regions with related S3 priorities and development of action plans related to selected S3 areas to support the RIS3 implementation
BSR Stars S3	Developing innovation ecosystems within circular economy	Well-prepared and focused study visits and stakeholder engagement within circular economy
LARS	Triple-helix gap analysis	Methodology to identify deficiencies and good cases of innovation ecosystems to support regional S3

region västerbotten

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

BSR S3 Ecosystem