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FORESIGHT FOR BUILDING A REGIONAL CLUSTER PLATFORM: CELLULOSIC FIBRE VALUE CHAIN TECHNOLOGY ROADMAP IN GREEN TRIANGLE REGION, SOUTH AUSTRALIA

Toni Ahlqvist

VTT Technical Research Centre of Finland, Itäinen Pitkäkatu 4, Turku P.O. Box 106, 20521 Turku, Finland.

E-mail: toni.ahlqvist@vtt.fi

Mikko Dufva

VTT Technical Research Centre of Finland, Tekniikankatu 1, Tampere, P.O. Box 1300, 33101 Tampere, Finland.

E-mail: mikko.dufva@vtt.fi

John Kettle

VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland

E-mail: john.kettle@vtt.fi

Nafty Vanderhoek

VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland

E-mail: nafty101@gmail.com

Ville Valovirta

VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland

E-mail: ville.valovirta@vtt.fi

Torsti Loikkanen

VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland

E-mail: torsti.loikkanen@vtt.fi

Göran Roos

Entrepreneurship, Commercialisation and Innovation Centre (ECIC), University of Adelaide, South Australia

E-mail: goran@roos.org.uk

Abstract

The practice-oriented paper reflects on the results of a strategic technology roadmapping project realised in the Green Triangle region of South Australia. The project integrated different methods in order to provide policy recommendations for the renewal of the forest industry in the region. Firstly, the project created a multi-criteria assessment framework for the evaluation of the present state of local companies. Secondly, the project made three value chain depictions: one that described the present value chain based on physical, monetary and information flows, and two so-called 'potential' value chain descriptions. Thirdly, the project formulated technology roadmaps and assessed the potential for forest industry renewal. Fourthly, the project provided detailed policy recommendations based on the findings in the project.

The integrated methodological approach of the project provided a robust basis for construction of policy recommendations. The company assessment grouped the local companies in four categories for comparative assessment purposes: forest owners, harvesters and hauliers, sawmills, and specialised suppliers. For the roadmap construction, the main information categories were drivers, markets, regulation,

customer needs, solutions, and enabling technologies, and the specific dynamics connected to all these categories. This information was structured into three temporal spans: present, short term (ca. 3-5 years) and long term (ca. 5-10 years).

There are, at least, three novel aspects of the project. Firstly, the integration of multi-criteria evaluation, value chain analysis and roadmapping creates new opportunities, but also new challenges. Secondly, the future-oriented view of the Australian forest industry is a new aspect. Thirdly, the project also had a strong regional policy perspective, especially connected with the discussions on path dependency and path creation in the regional development context.

The project had both practical and managerial implications. Firstly, the company assessment identified the domains where each individual firm had weaknesses as well as where the group as a whole lagged global best practice. Secondly, the value chain analysis showed strengths and weaknesses of the present structure, but also delineated the necessary components to be developed in order to move towards higher value added production. Thirdly, the roadmaps showed the frontiers of research and business in advanced cellulose fibre-based industries, and made possible the positioning of the Green Triangle region.

The project had two wider implications for policy. Firstly, the integrated methodological approach of the foresight exercise enabled the production of detailed policy recommendations that were embedded in the local industrial context. Secondly, the project open a window of opportunity to consider so-called platform policies, that is, policies that aim to develop the fragmented regional structure of the Green Triangle's forest industry towards an integrated cluster-based platform, which would enable the region to benefit from agglomeration economics through a collaborative strategy.

Keywords: Foresight, forest industry, cellulose, value chain, technology roadmap, cluster, regional platform, policy, Green Triangle, South Australia

Introduction

Forests cover approximately 19 per cent of Australia's land area. The 355,000 hectare (ha) Green Triangle region is the largest plantation based wood fibre producing region in Australia. The Green Triangle straddles the state borders of South Australia in the South East and Victoria in the South West. The forest consists of significant areas of both Pinus radiata (softwood) and Eucalyptus globulus (hardwood) plantations. The South Australia portion of this region is 188,100 ha of plantation resources, of which 128,400 ha is of softwood and 59,700 ha is hardwood (12.5% and 6.1% of Australia's total respectively) (Cunningham 2011).

The forest and wood products industry, with its associated value chain, has experienced a very difficult decade in South Australia, driven in recent times by the exceptional circumstances created by the global financial crisis and its aftermath as well as increased globalisation. This coupled with internal factors such as a lack of re-investment, aging equipment and poor management decisions has resulted in a significant reduction in industry profitability and a loss of employment opportunities. This has created the atmosphere of crisis that existed at the start of the project. Several company closures and the change in the ownership situation of the forest resource, where the South Australian Government through its statutory body Forest SA sold off forward timber rotations of its forest resources in the Green Triangle region to OneFortyOne Plantations for A$670 million whilst retaining the ownership of the land as well as the water and carbon rights associated with the land, left the region in an uncertain state. The forest sector in the region thus needed actions to boost and renew and lift the industry to a new level.

This practice-oriented paper depicts one such action: it describes a South Australian Cellulosic Fibre Value Chain Technology Roadmap project (henceforth abbreviated: SA project). The project was conducted as a ca. one year long project during the period 2012 - 2013 in the Limestone

Coast region, South Australia, which forms part of wider region known as the Green Triangle. The objective of the project was to provide the region with a basis for future strategy to renew its industrial basis. The project was funded by Department of Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) and led by VTT Technical Research Centre of Finland (Ahlqvist et al. 2013a; 2013b).

The key challenge the paper aims to address is: how to renew a traditional locally oriented regional industry with relatively low technological level, faced with global competition that challenges the industry to its core.

Methodological approach

The key theoretical basis for this paper is found in the theories of path dependence (e.g. Martin and Sunley 2006), path creation (Schienstock 2007; Gáspár 2011), and the theories emphasising evolutionary aspects of economic agglomerations and emergence of clusters (e.g. Sölvell 2009; Porter 1990). Here, these theories are connected to the practice of strategic roadmapping in order to build a model for industry renewal, stimulating collaboration, and forming a basis for regional path creation (see e.g. Blackwell et al. 2008; Phaal and Muller 2009; Ahlqvist et al. 2014; Ahlqvist et al. 2012a; 2012b). We have built a conceptual model that sets strategic roadmapping in the context of the SA project (figure 1).

There were three different stages of the project, executed in parallel but with different analytical orientations, spatial scales, and knowledge production modes. At stage 1 the mode was analytical and the spatial scale was local/regional, focused on the Green Triangle region. The main aim was to generate and synthesise knowledge about the present situation in the region, through assessing forest industry firms and sawmill companies using a multi-criteria framework (Pike and Roos 2007) created for the project (see Ahlqvist et al. 2013a, Dufva et al. 2013). At stage 2, the knowledge production moved to explorative mode, and the spatial scale was opened towards global state-of-the-art. The aim was to juxtapose the “local realities” with a strategic foresight knowledge showing the global level research and development frontiers and opportunities. This stage was realised through strategic roadmaps and potential future value networks positioned in different perspectives (lenses), and also by executing wide-ranging background analyses including feasibility study, market analysis, policy analysis, risk assessment, focused patent analysis, assessment of biorefinery technology options, as well as a workshop process among key technology experts at VTT Technical Research Centre of Finland to ensure that key relevant input was not overlooked. At stage 3, the orientation was integrative, that is, the results of the explorative stage were integrated with the local level analytical stage. In the SA project, the explorative stage was utilised as a platform to construct regionally embedded future pathways at the integrative stage in two temporal horizons: 3–5 year time horizon and beyond 5 year time horizon. The stage 3 also included the crafting of detailed recommendations for the potential next steps that were explicitly set in the context of the Green Triangle.

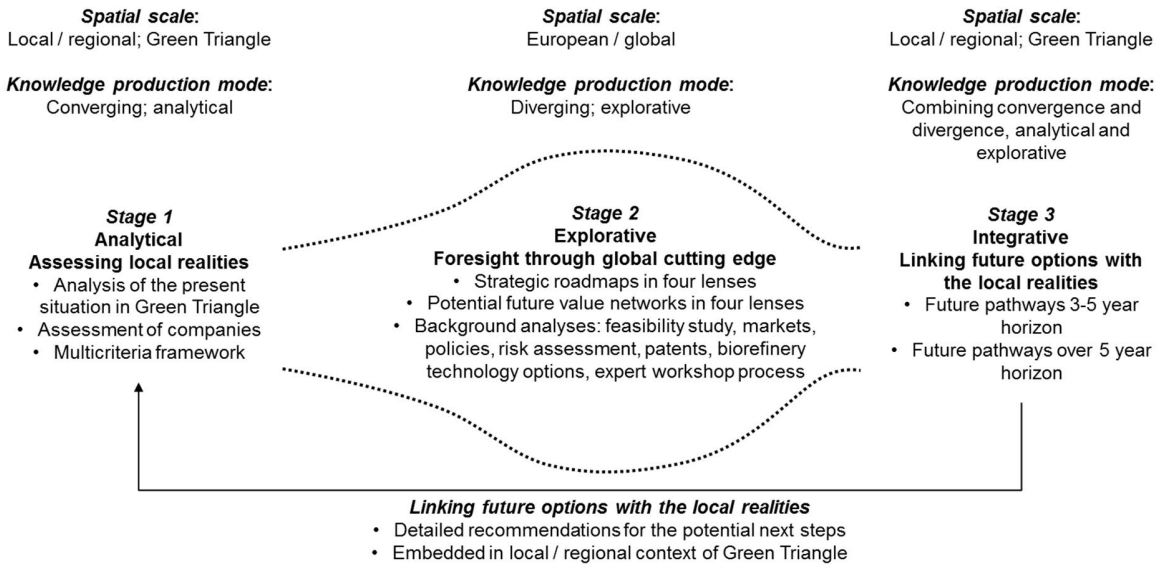

Figure 1. Spatial scales, knowledge production modes and stages in a project aimed at strategic industry renewal: case Green Triangle.

Results, discussion and implications

As the a case study, the paper depicts a strategic roadmapping project to renew the cellulosic fibre value chain in the region of Green Triangle, South Australia (SA project). The basic aim of the project was to construct grounded recommendations for raising the value-added component in the local forest industry and mapping out realistic and grounded pathways into a higher value added and more sustainable future for both the individual firm and the industry a whole. Currently, the Green Triangle's industrial structure is based on traditional forest activities, like harvesting, hauling, sawmilling, and the production of low value added products, like chips or logs cut to length.

The project was commissioned by the South Australian government and it had direct linkages to policy-making. The project has two types of wider policy implications. Firstly, the integrated methodological approach of the foresight exercise enabled the production of detailed policy recommendations that were embedded in the local industrial context. Secondly, the project opened a window of opportunity to consider so-called platform policies (see Cooke 2008; Asheim et al 2011), that is, policies aimed at developing an integrated cluster-based platform, which would enable the region to benefit from agglomeration economies through foresight and collaborative strategy making.

The local interaction part of the SA project included 23 interviews with South Australian companies, 6 steering group meetings, and 3 strategic workshops, where technology experts in forestry, biotechnology and cellulosic fibre industries crafted strategic technology roadmaps for the region. Also, a simulation model was applied to evaluate the flows of biomass in the regional system and to assess the production costs of different bioenergy routes.

Assessing local realities: present state of forest industry in the Green Triangle

In phase 1, semi-structured interviews with the local companies were executed (see Ahlqvist et al. 2013b). These companies were categorised in four groups: 1) forest owners; 2) hauliers and harvesters; 3) sawmills; and 4) specialised suppliers.

On the basis information gathered through the interviews, the SA project identified the unstructured as well as limited collaboration as a key challenge in the Green Triangle forest industry value chain (see Ahlqvist et al. 2013b). This situation corresponds well with the generic picture of the Australian innovation system (DIISRTE 2012: 66): "despite the benefits of collaboration … Australian innovative businesses do not seem to be collaborating as much as they should". The general lack of collaboration within the Australian National Innovation System has been pointed out in several studies (e.g. Roos, Fernström and Gupta, 2005; DIISR, 2010; Matthews & Sawang, 2010; DIISR 2011; Dodgson et al. 2011; DoI 2013)

The interviews revealed that the current structures of collaboration in Green Triangle forest industry were weak and fragmented. There was a lack of collaboration especially in the hauling, harvesting and the processing of the wood. However, we found that there were existing structures for regional collaboration, but the interviewed companies did not value these very highly. Also, there were no strong indications of significant collaboration in the core business areas of the companies. As a result, the timber industry did not speak with a single voice, when compared, for example, with the local wine industry.

We assessed, however, that there is a potential for collaboration. The most important argument for this assessment is that, based on the interview data, the awareness for the need to collaborate was clearly emerging among the regional players. Also, some interviews took a positive view by identifying that in the end the collaboration is not a matter of industry, but of people. With this attitude, the industry could stand a chance of overcoming the existing barriers.

Summing up, the interviewed companies could be divided into following three groups on the basis of their orientation towards the future:

1. Those companies who had not adopted a forward-looking attitude, and had a wish for the industry to normalise back into a stable position after the current downturn.
2. Those companies who perceived that adoption of more efficient production methods, for example by modernisation of existing equipment, would be the most plausible way to move forward. In short: industry would still do what it has always done, but it would do it more efficiently with modern capital equipment.
3. Those proactive companies who envisioned new opportunities for the industries by using the existing residual biomass. The view of a "super mill" or a biorefinery was commonly identified as the core future opportunity in interviews. However, in our view the potential of the biorefinery was not fully understood by those interviewed. For example, the potential of a totally new bio-industry based on the production of new chemicals or materials was not really identified, with discussions concentrating more on traditional variants such as pellet production or biofuels. Further, it was commonly stated by this group of most proactive players that there is a need for a new collective regional actor or a new private player to show interest and to act as a catalyst.

Foresight through global cutting edge: strategic technology roadmaps using four lenses

At the stage 2, the SA project went into an explorative mode and emphasised the European and global state-of-the-art (see Ahlqvist et al. 2013a). The SA project applied strategic technology roadmapping. To structure the roadmapping process, we utilised a so-called "lens-based" approach, adapted from Kettle et al. (2012) and Manufacturing Works strategy (MW 2012). In this case it meant that we analysed the futures of forest and wood products industry through four perspectives or lenses (figure 2).

The first was a mass lens: it emphasised more efficient traditional forest and wood products industry. Basically, the question was about making the existing type of forest and wood products industry more efficient by forming strategies for how to modernise the old technology, and how to make the production processes more efficient. This is the lens that underpins the present traditional logging, wood chip and timber sector in Australia. The mass lens represents a lowest level of value adding and is somewhat vulnerable in a high operating-cost environment unless the activity domain is moved to high value adding products like engineered wood solutions (e.g. CLT, OSB). For a more detailed discussion on success criteria and requirements in high operating cost environments see e.g. Roos (2014a; 2014b)

The second was an energy lens. This lens focused on the potential of industry renewal through extracting energy from cellulose. It focused especially on how much energy can be obtained from the forest production side streams, like branches, bark, saw dust or excess chips. This lens also underpins the existing and emerging industries that focus on heat and energy generation, as well as ethanol and biodiesel production (normally via a first generation biorefinery). In this lens, there are pockets of high value opportunities, such as biodiesel, bioethanol and aviation fuel.

The third was a molecular lens, emphasising radical industry renewal through diversified biorefineries. This is the lens that shows emerging opportunities based on second and third-generation biorefineries that have the potential to replace existing chemical production based industries. The lens could include specialty chemicals that are recyclable, such as bioplastics for soft drinks bottles.

The fourth was an atomic lens, with a focus on radical industry renewal through new biomass and fibre-based production. This lens emphasises high value-added products and services that require exceptional technological understanding and R&D. The lens, for example, pulls together the production of a wide range of new or modified materials, such as biodegradable lightweight cellulose nanocrystals (CNCs) with a tensile strength exceeding that of steel, or cellulose foams to be used as insulators for the construction industry, and transparent paper replacing petroleum-based materials, like plastics.

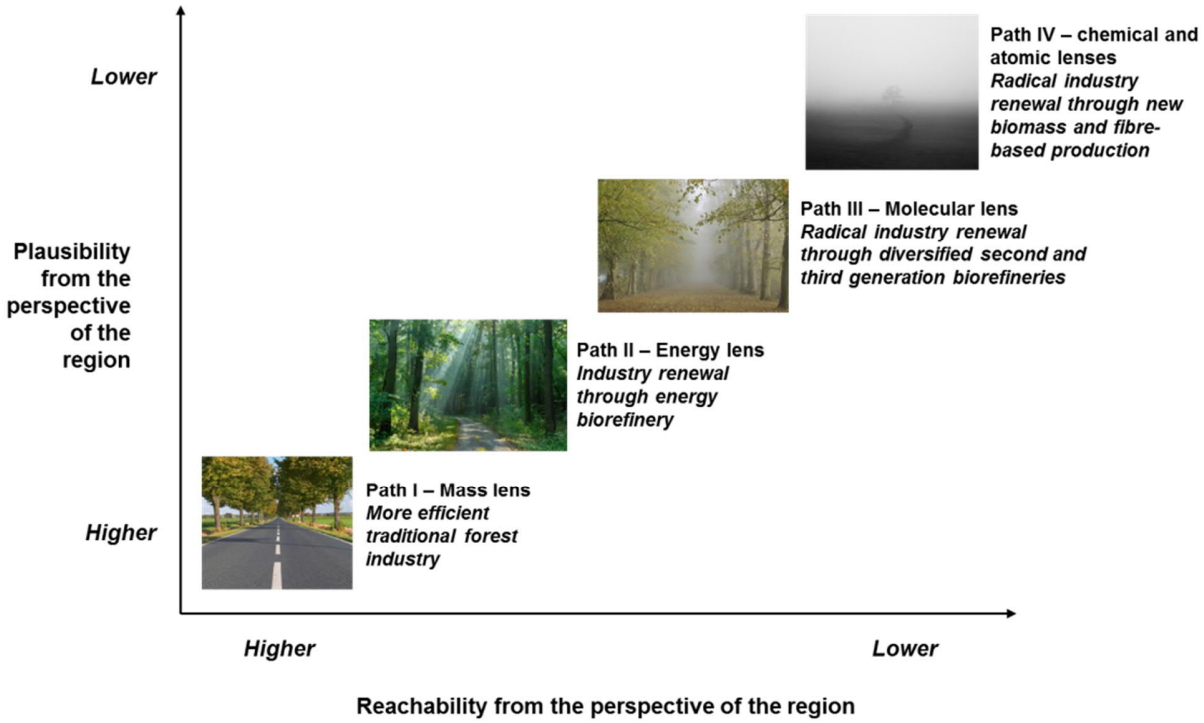

Figure 2. Roadmap lenses and their connection to the regional knowledge base.

Highlighting the regional collaboration: prospective value network analysis

The SA project also executed a prospective value chain analysis focused on the horizontal and vertical linkages in the regional forest industry (see e.g. Porter 1985; Christensen and Rosenbloom 1995). The figure 3 presents a future-oriented example constructed through this analysis: the potential value network that combines the molecular lens and the atomic lens. The molecular lens emphasises the potential of second and third generation biorefineries that have the potential of producing specific chemicals, and replace plastics (bioplastics). The atomic lens goes even further down this road towards manipulation of nanoscale properties of wood fibres. The atomic lens could, for example, open opportunities for the production of nanocellulose (MW 2012: 42–43).

In order to realise this value network structure in the Green Triangle region, significant advances must be made in collaborative practices in the R&D space: the industry must have continuous and organic linkages with world-class universities and research and technology organisations that are active in the relevant fields. The industry should thus move towards a new global configuration, here called advanced biomass-based process industry.

In this scenario, hauling and harvesting would become more like supporting activities that have a role to play in the traditional end of the forest value network. Thus, there is the opportunity that hauliers and harvesters could widen their activities to encompass higher value-adding activities, and move from the harvesting and transporting activities towards activities, like on-site first tier processing for diversified purposes. This could include, sorting the raw material for three uses: high quality timber for wood industry; high quality slightly processed biomass for biorefineries; and high quality fractionated forest surplus biomass.

In this potential network, the sawmills need to become more diversified and specialised. There would be different types of sawmills: traditional sawmills with modernised and more effective process technologies; sawmills that are specialised towards more value-adding high-end products; and sawmills specialised on the needs of biorefineries. Thus, the role of the sawmills would be moving towards more generic integrated processing of biomass: the sawmills would thus be "biomass flow regulators". These "future sawmills" would be similar to process factories that provide several biomass-based products just-in-time for different purposes.

The role of specialised suppliers will also be more diversified. There would still be needs for traditional supporting industries, like breeding, genetics and nurseries. However, there would also be need for new specialised inputs. The first input would be implementable R&D outcomes through continuous and long term co-operation with selected research and technology organisations and universities. This would be important for two basic reasons: firstly, it takes time for the R&D activities to produce results that would be utilisable in the regional industry system, and, secondly, the building up of a regional absorptive capacity for using advanced R&D would also require long term efforts. The second input would be advanced product development services that would push the regional industry towards more product-centred and design-oriented pathways. The third input would be market research and testing, required in order to raise regional capacity to find markets for the developed products and services (for a discussion of servitization of production firms see e.g. Roos (2015).

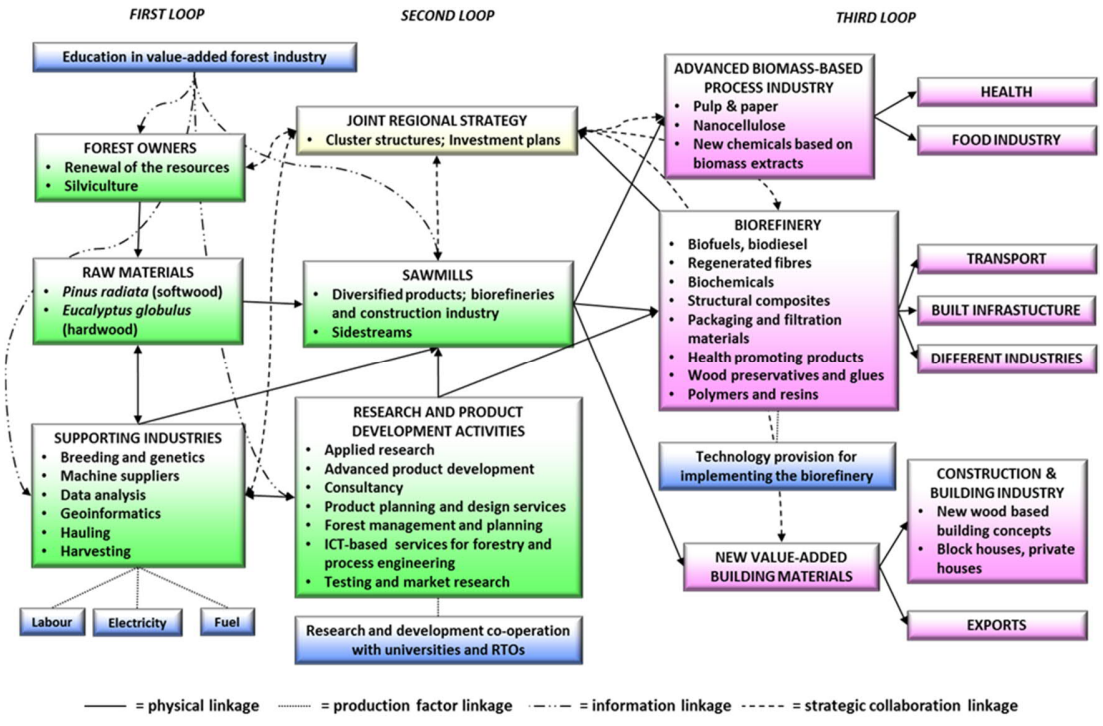

Figure 3. A potential future value network for forest industry in Green Triangle: molecular lens & atomic lens. The shaded green colour depicts the key functions in the value network, the shaded purple depicts key output directions, and shaded blue colour designates key external inputs.

Linking future options with the local realities: future pathways for the region

At the stage 3, the results of the explorative and global phase were embedded in the local context (see Ahlqvist et al. 2013a). In the SA project this was realised through the creation of seven future pathways and related recommendations: three main pathways with a 3 to 5 year time horizons and 4 pathways with a longer than 5 year time horizon (table 1).

The table 1 presents central pathways and recommended next steps in the time horizon of 3 to 5 years in no particular order of preference. There were also pathways with a longer than 5 year time horizon. They were: (4) Development of absorbents and membranes for local opportunities; (5) Cellulose fibres in textiles; (6) Bio-based chemicals and polymers; and (7) Opportunities in nanocellulose. However, these pathways are not presented in this paper (see Ahlqvist et al. 2013a).

Table 1. Three main pathways in a nutshell: the time span is 3–5 years.

Recommended next steps in no particular order	*RECOMMENDED STEPS IN THE PATHWAYS*			
PATHWAY 1: New wood products from under-utilised Green Triangle log supplies	1.1 Oriented Strand Board (OSB)	1.2 Veneer based engineered wood products (EWP)	1.3 Improved sorting and better yields by X-ray scanning	1.4 Specialised sawmilling by using smaller and shorter logs
PATHWAY 2: Value-adding opportunities for construction industry using existing outputs	2.1 Cross-laminated timber (CLT) and high storey houses	2.2 Glued Laminated Timber (gluelam)	2.3 Wooden bridges	2.4 Bio-composites
PATHWAY 3: Biorefinery - opportunities for underutilised wood fibre and residues	3.1 Bio-oil by fast pyrolysis	3.2 Biochar by torrefaction	3.3 Power and heat by gasification	3.4 Biofuels and biochemicals

The figure 4 presents a synthesising assessment, made by VTT's technology experts, of the key recommendations in 3 to 5 year time horizon. The idea is to show in a simplified manner how the recommended next steps would fit with the present structure of forest and wood products industry in the Green Triangle.

As can be seen, the recommendations are positioned, with minor exceptions, in the upper right corner of the matrix. Some recommended actions would require more changes in the industrial structure, but it would also mean that the value-added component would have higher potential. Some recommended actions would require less changes in the industrial structure, but their expected value-add would also be lower. Thus, it can be concluded that all the recommendations have the potential to raise the value-adding component in the regional industry, and all the recommendations would require modifications to the present industrial structure in the Green Triangle in order to be effective.

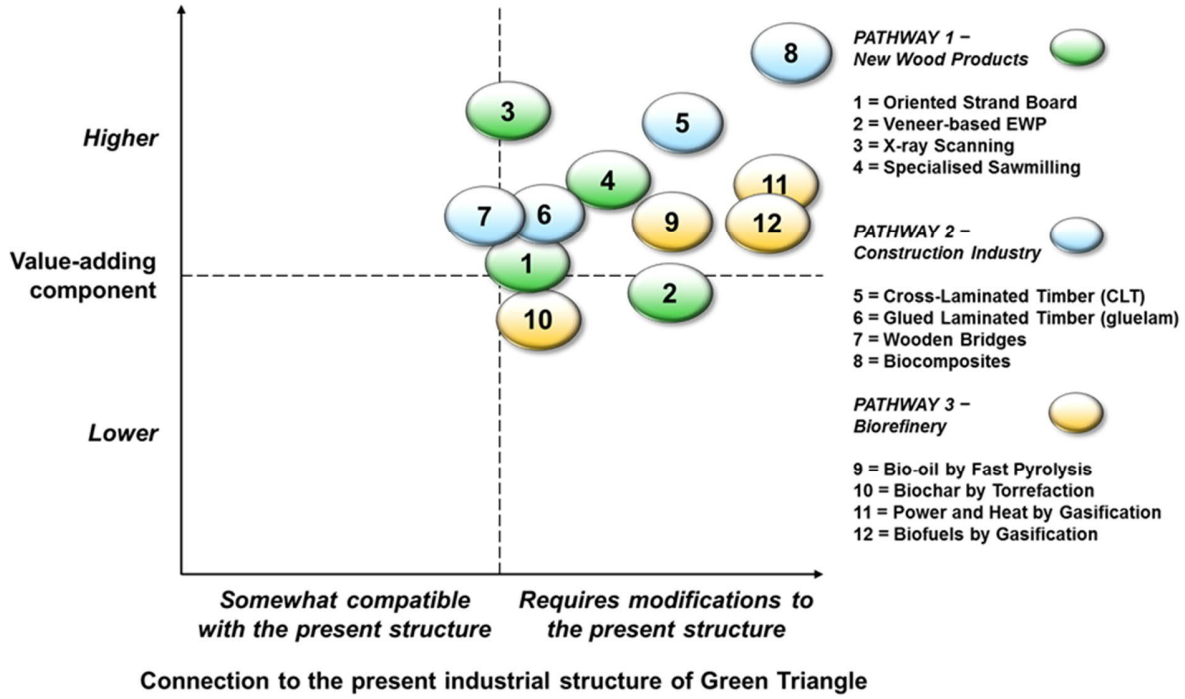

Figure 4. Key recommendations in a matrix.

Creating new paths for the region: towards a collaborative strategy

Figure 5 presents a stylised depiction, in the form of an S-curve, of how the cumulative outcomes could add up to a creation of a new regional path. The key idea is that the Green Triangle region is currently traversing the path of conventional sawmilling, a path that has already become saturated when considering the value-adding opportunities. We identified that selected solutions for the construction industry, such as OSB (oriented strand board), gluelam (glued laminated timber), and LVL (laminated veneer lumber), could act as "gateway products" from the current path towards a potential path of renewed sawmills and biorefinery. These solutions could be realised already in some 3 to 5 year perspective in the Green Triangle, and they could open the path towards more advanced products for the construction industry[1], like CLT (cross-laminated timber) and even biocomposites. These advanced products could be further amended by setting up an energy biorefinery, either in the context of some existing bigger sawmill or as a stand-alone unit.

The core principle underpinning the approach is that the industrial development would be "snowballing": once the key initial steps are taken, these steps open up new opportunities for advancing further on a newly created path. Thus, construction of an energy biorefinery would also open up opportunities for developing an advanced biorefinery that could produce multiple new products, like biochemicals.

[1] For a discussion of the R&D directions of the Construction industry see e.g. Kraatz et al. (2014)

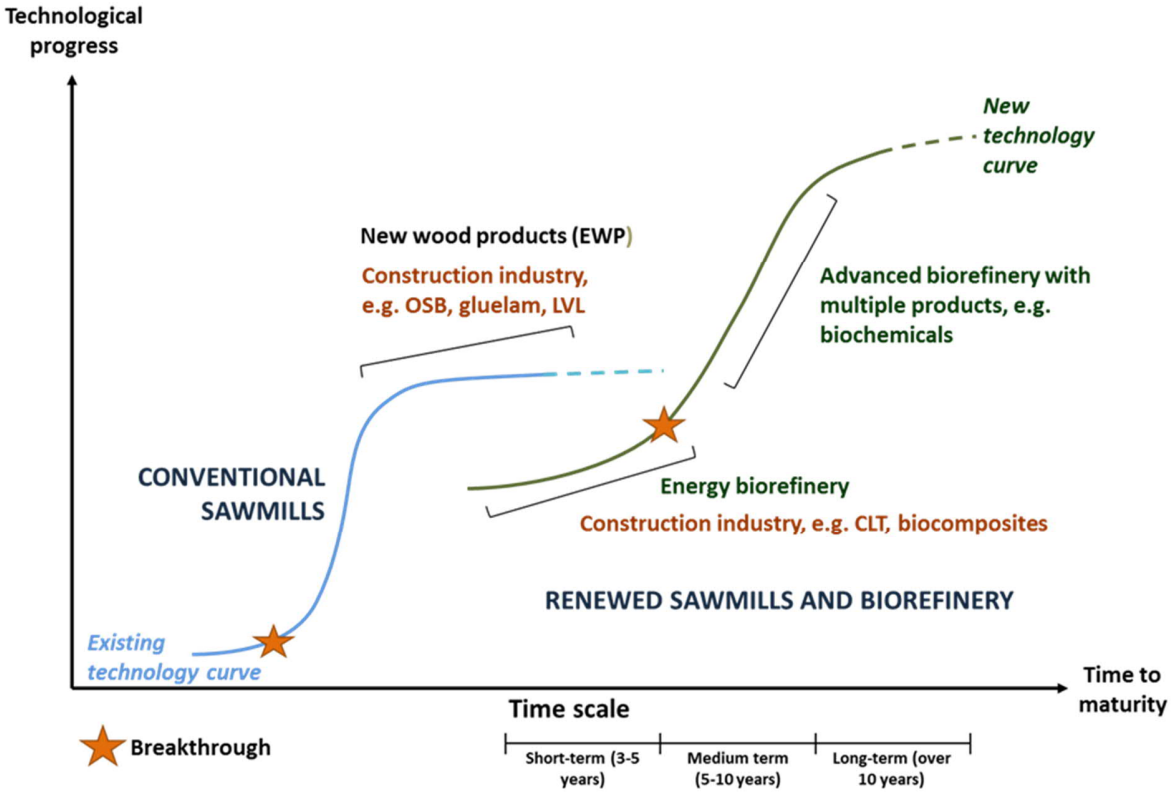

Figure 5. The idea of path creation in the form of S-curves: from conventional sawmilling to renewed sawmills and biorefinery.

Figure 6 takes another perspective to the path creation by drafting a strategy on how to "walk" the main pathways in parallel. The upgrading of the industry could start with process improvements, then move toward value-added products for the construction industry and then towards energy biorefinery. It also confirms the notion that the transformation of the regional industry is a long-term process that should have a strategic perspective of over 10 years or longer. Also, the figure sets an emphasis on the regional collaborations and the strategic perspective that should be jointly constructed and shared by the regional operators. Therefore, the collaboration among the regional operators, and potentially forming cluster structures in the longer term, would be the key to access the new path delineated by the SA project.

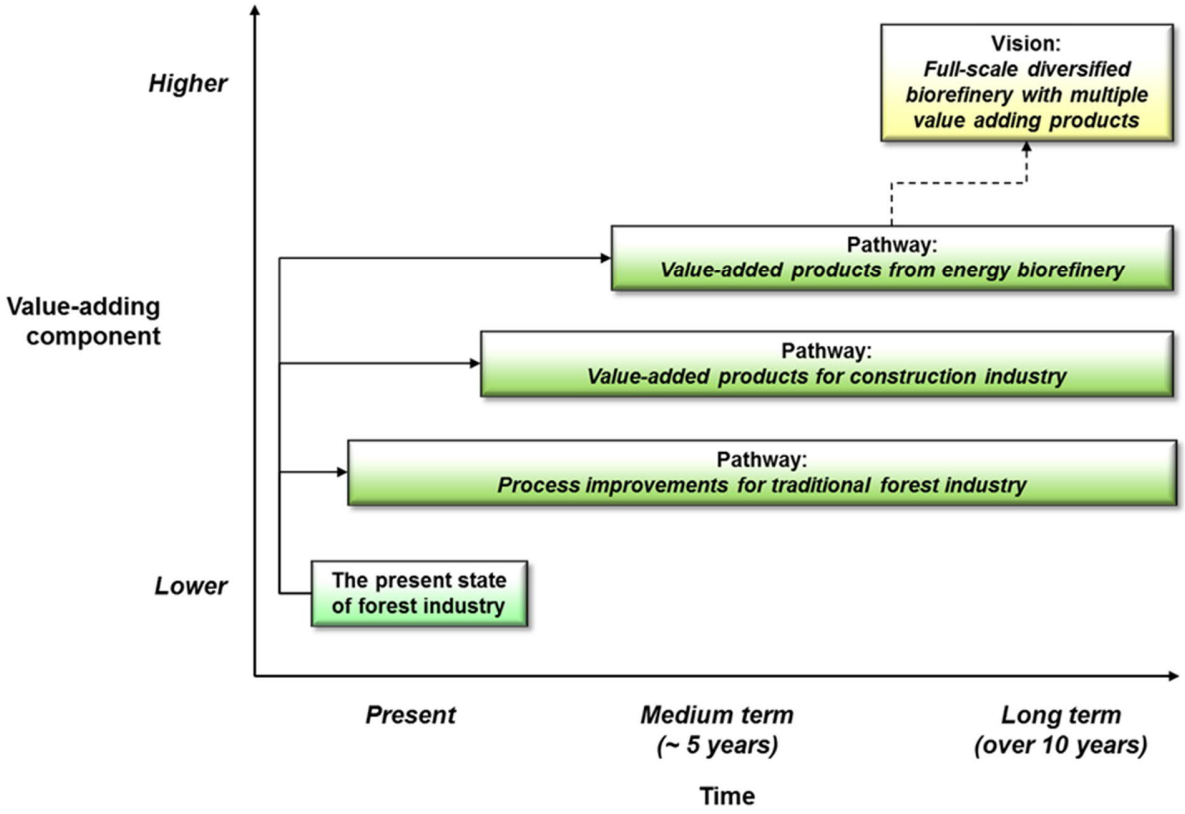

Figure 6. The strategy for the path creation in the Green Triangle.

Conclusions

The main outcomes of the project are the strategic roadmaps, and related recommendation for South Australian government describing (a) how current processes can become more efficient by using existing or commercial ready technological advancements (efficiency gains), and (b) how to potentially diversify into other new and high value products (effectiveness gains) using the raw materials available in the region while taking into account relevant local issues. The second outcome of the project is the catalysis of the regional cluster formation and the initiation of subsequent practices of strategic renewal in the region.

The project had the following practical and managerial implications: Firstly, the company assessment identified domains where individual firms had weaknesses as well as where the group of companies as a whole lagged global best practice. Secondly, the value chain analysis showed strengths and weaknesses of the present industrial structure in the region, but also identified the necessary aspects to be developed in order to move towards higher value added production. Thirdly, the roadmaps showed the frontiers of research and business in an advanced cellulose fibre-based industry, and made possible the positioning of the Green Triangle region accordingly.

The study helps the companies and policy makers in the creation of a future-oriented strategic agenda for the Green Triangle region. The integrated approach formed in the project will also benefit innovation and industry transformation scholars. Individual companies can apply the assessment framework and roadmapping to assist in strategic planning.

It can be concluded – using the feedback from the local companies – that the project has been successful in raising regional awareness on the needs to collaborate. A tangible demonstration of the project's industrial impact is a recent strategy by the South Australian Forest Industry Advisory Board, an influential coalition of local forest industry experts, that used the results of the SA project as a bedrock for building a blueprint for the future of forest industry in the Green Triangle region (see SAFIAB 2014). This in turn have led to the instigation of a South East Forestry Partnerships Program – Second Phase where A$10.46 million will be available to support projects consistent with the recommendations outlined in the Stage Two report from the Cellulose Fibre Value Chain Study (Ahlqvist et al 2013a). The project was also well covered by the media during its different stages (see e.g. Adelaide Advertiser 2013). To this day, there has been different workshops aimed at catalysing collaboration, but it remains to be seen what directions the path creation in the Green Triangle will take in the future.

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