Innovation Ecosystems in a Sustainable Bioeconomy

A Finnish case study for OECD

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Agenda

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2) Country position and policies for bio- and circular economies
3) Description of case study value chain
4) Ongoing developments to extend the value chain and diversify to new business areas in higher value-added sectors
5) Overall synthesis of findings

Introduction

Background of the work

- Bioeconomy in Finland is mainly based on the structures that rely on the forest sector value chains
- However, the forest based biomass is finding new higher value added applications than the sectors that it has traditionally been used for
  - Government strategy aims to double the current bioeconomy turnover from 60 billion euros to 100 billion euros before 2025[1]
- The aim of this project is to understand the prerequisites for sustainable innovation development in this context through investigations of development pathways in two specific application areas:
  - Cellulose based textiles
    - Non-woven fiber market is estimated to be 47,7 billion euros in 2020[2]
  - Bioproducts and biocomposites replacing plastics
    - Bioplastic market (especially drop-in-biopolymers) is estimated to be 3,4 billion euros in 2020[3]

1) Government 2017, Bioeconomy 2014 2) Markets and Markets 2016 3) Markets and Markets 2015b

Introduction

Method of the study

- The study is based on interviews and a literature review
  - 20 interviews were made with large companies, SMEs and startups and research organizations, as well as a public private partnership and a funding organization as specified in the table below
  - Five interviews were cellulose based textiles specific
  - 11 interviews related to bioproducts and biocomposites
  - Two interviewees had expertise on both of these application areas
  - Three interviewees were knowledgeable on policy issues

Aalto University	Marimekko	Stora Enso Biomaterials	Valio
Business Finland	Metsä Fibre	Sulapak	VTT
CLIC Innovation	Neste	University of Borås/Tampere University of Technology	Infinited Fiber Company/ VTT
Elastopoli	Paptic	UPM	Åbo Akademi
Kotkamills	Spinnova	Welmu	Woodio

Country position and policies for bio- and circular economies

Definitions

According to **the Finnish Bioeconomy Strategy**[1], bioeconomy refers to an economy that "relies on renewable natural resources to produce food, energy, products and services. The bioeconomy will reduce our dependence on fossil natural resources, prevent biodiversity loss and create new economic growth and jobs in line with the principles of sustainable development."

Circular economy, as defined by the Finnish Innovation Fund Sitra[2], "strives to maximize the circulation of products, components and materials and the value bound to them as much as possible in the economy. In a circular economy, production and consumption create the smallest possible amount of loss and waste."

1) Ministry of Economic Affairs and Employment (2014) – The Finnish Bioeconomy Strategy , 2) Sitra – Leading the cycle – Finnish road map to a circular economy 2016-2025

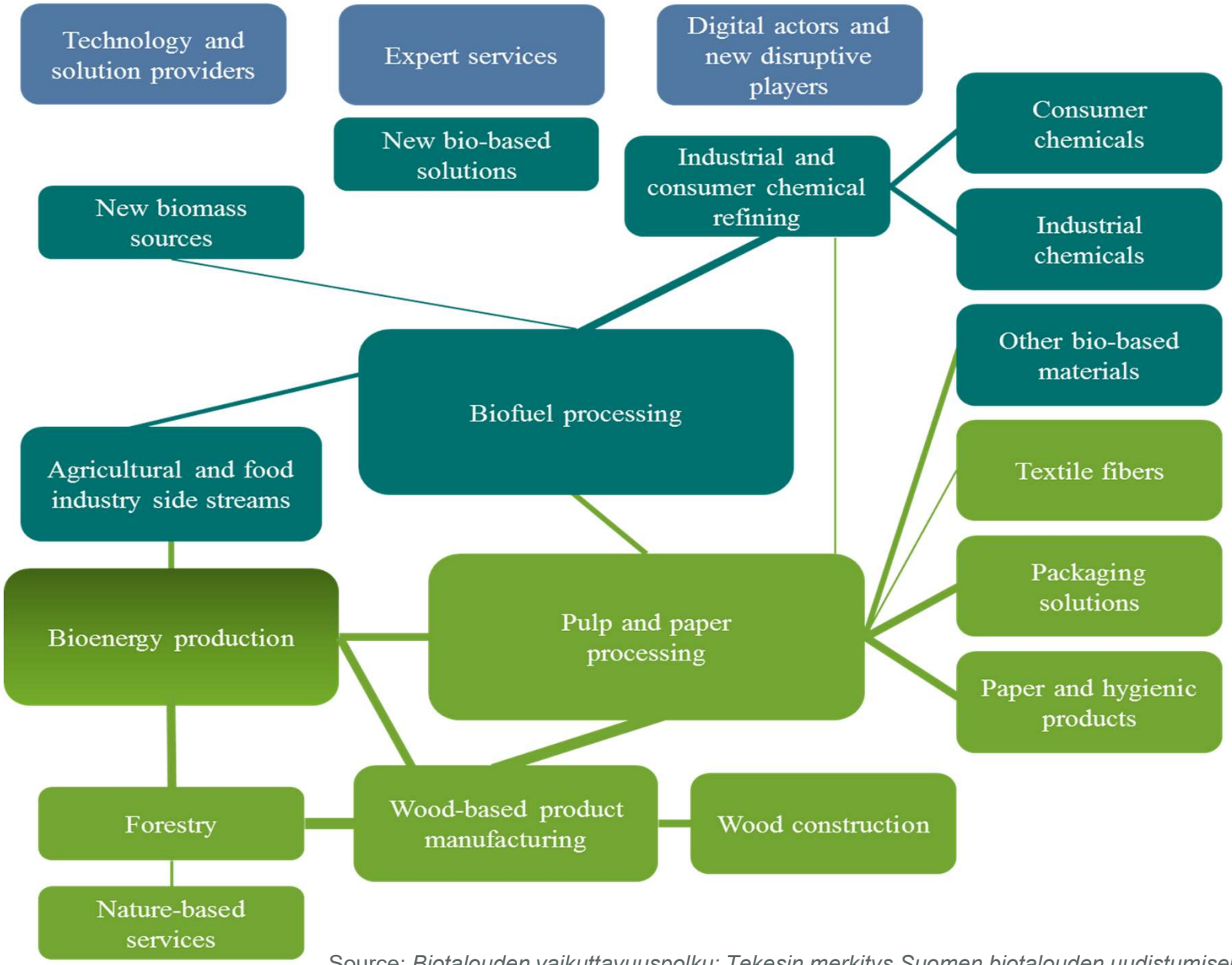
Country position and policies for bio- and circular economies

Main strategies, visions and road maps

- Finnish Bioeconomy Strategy was launched in 2014 with the following goals:
  - To promote 1) a competitive environment for the bioeconomy, 2) new business from the bioeconomy, 3) a strong bioeconomy competence base, and 4) accessibility and sustainability of the biomasses
- The Finnish Innovation Fund Sitra has published a road map for circular economy for years 2016-2025
  - Circular economy as a new cornerstone for the Finnish economy
  - Finland is the model country for the challenge of scarcity
  - As a society Finland will be a pioneer rather than an adapter
- Prime Minister Juha Sipilä's government has as one of five strategic priorities "bioeconomy and clean solutions"
  - Key projects to increase, diversify and grow the value of the wood used in Finland, and leverage the growing opportunities enabled by circular economy and clean solutions
- Academy of Finland has published its strategy for scientific research including bioeconomy with 21 related research priorities

Description of case study value chain

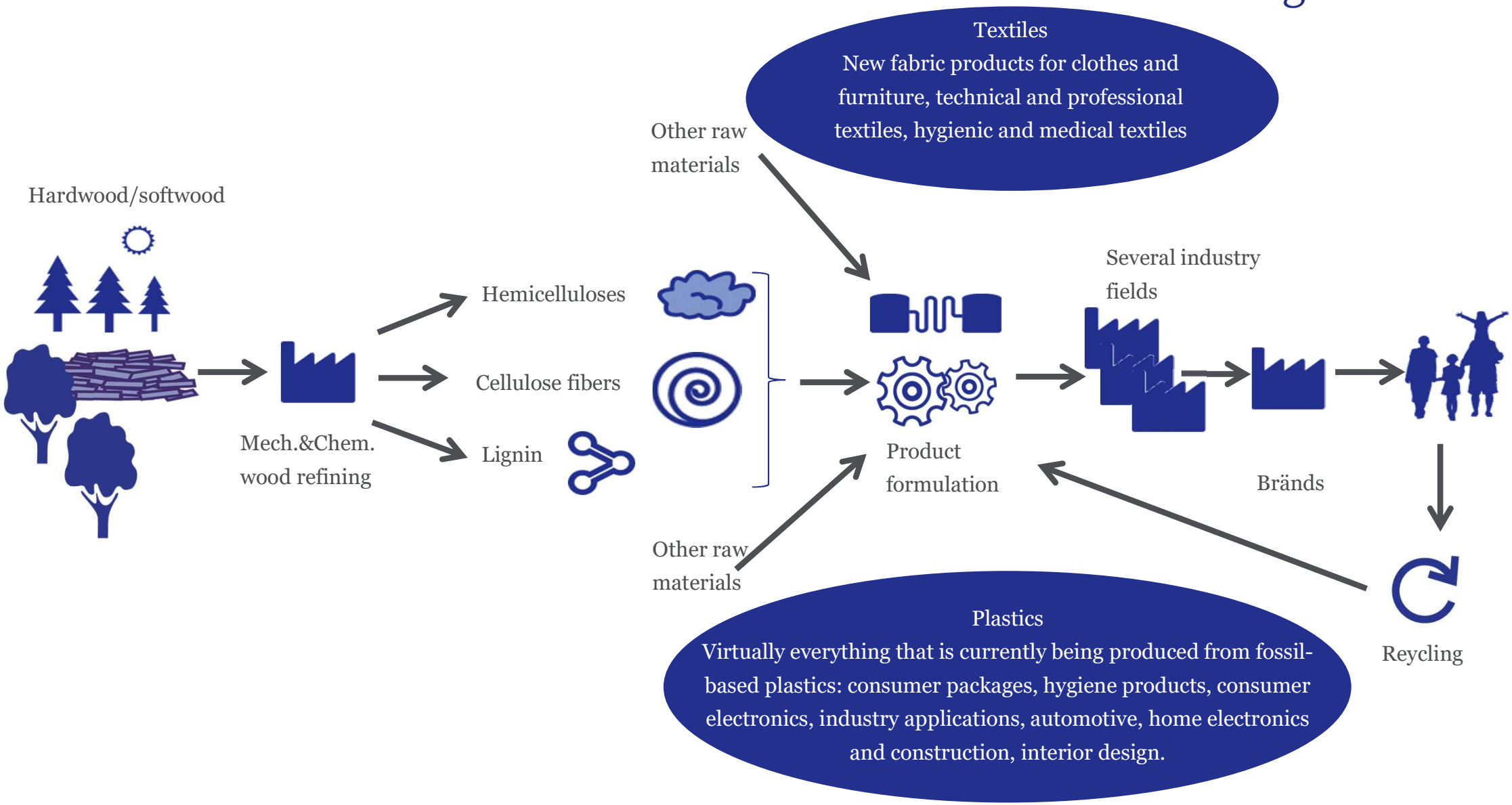
Overview of the bioeconomy ecosystem in Finland



Source: *Biotalouden vaikuttavuuspolku: Tekesin merkitys Suomen biotalouden uudistumiselle (2018)*

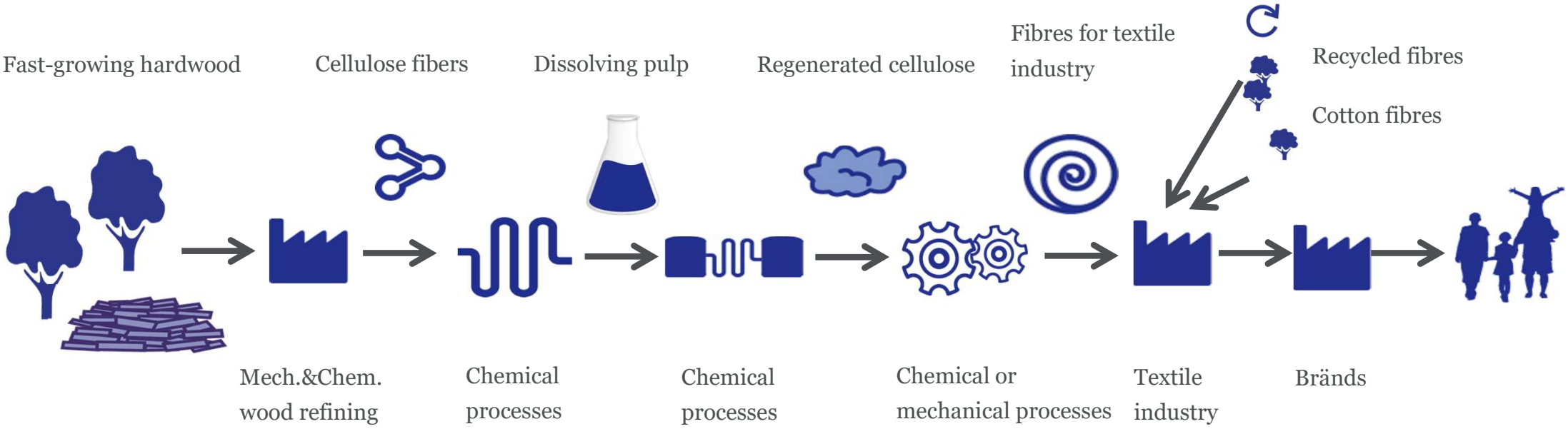
Description of case study value chain

Biomass as raw material



Description of case study value chain

Cellulose based textiles

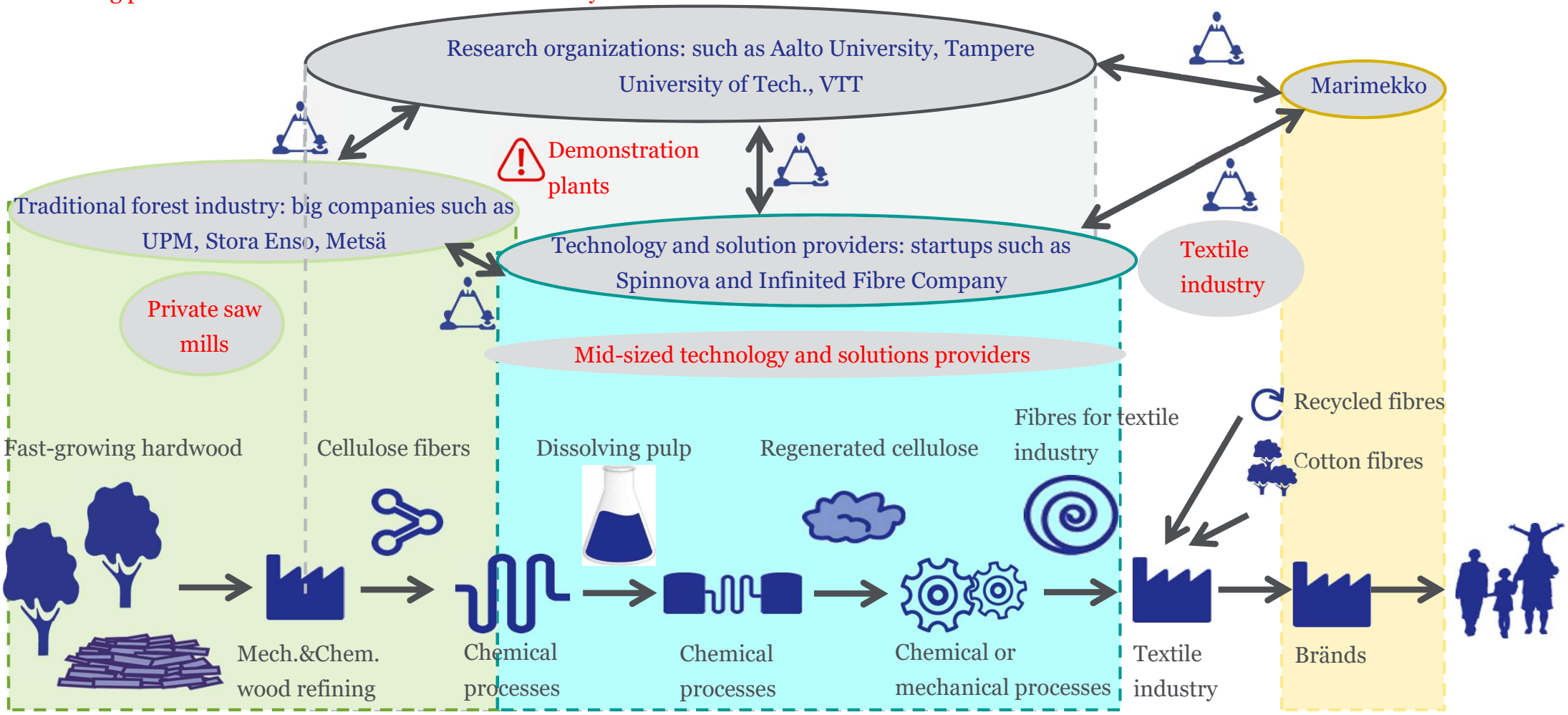


Description of case study value chain

Example of Finnish cellulose based textiles innovation ecosystem

Existing parts of cellulose based textile innovation ecosystem

Missing parts of cellulose based textile innovation ecosystem



Description of case study value chain

Biomass as raw material

- Softwood and/or hardwood is the primary biomass being processed further
- Wood is refined by mechanical and chemical processing techniques to cellulose fibers, lignin and hemicelluloses which are used as raw materials for new biobased applications
- For cellulose based textiles, dissolving pulp is the main raw material used
  - Dissolving pulp can be mixed with other raw materials such as recycled cotton or even recycled paper or carton
  - As special requirements, dissolving pulp needs to be extremely pure with low hemicellulose content and the fibers need to have an active surface
- For biocomposites and bioproducts in most cases there are no specific requirements for the raw materials being used
  - However, for nanocellulose based biocomposites, compatibilization is often needed for the hydrophilic biomass fibres to mix well with the hydrophobic polymers

Description of case study value chain

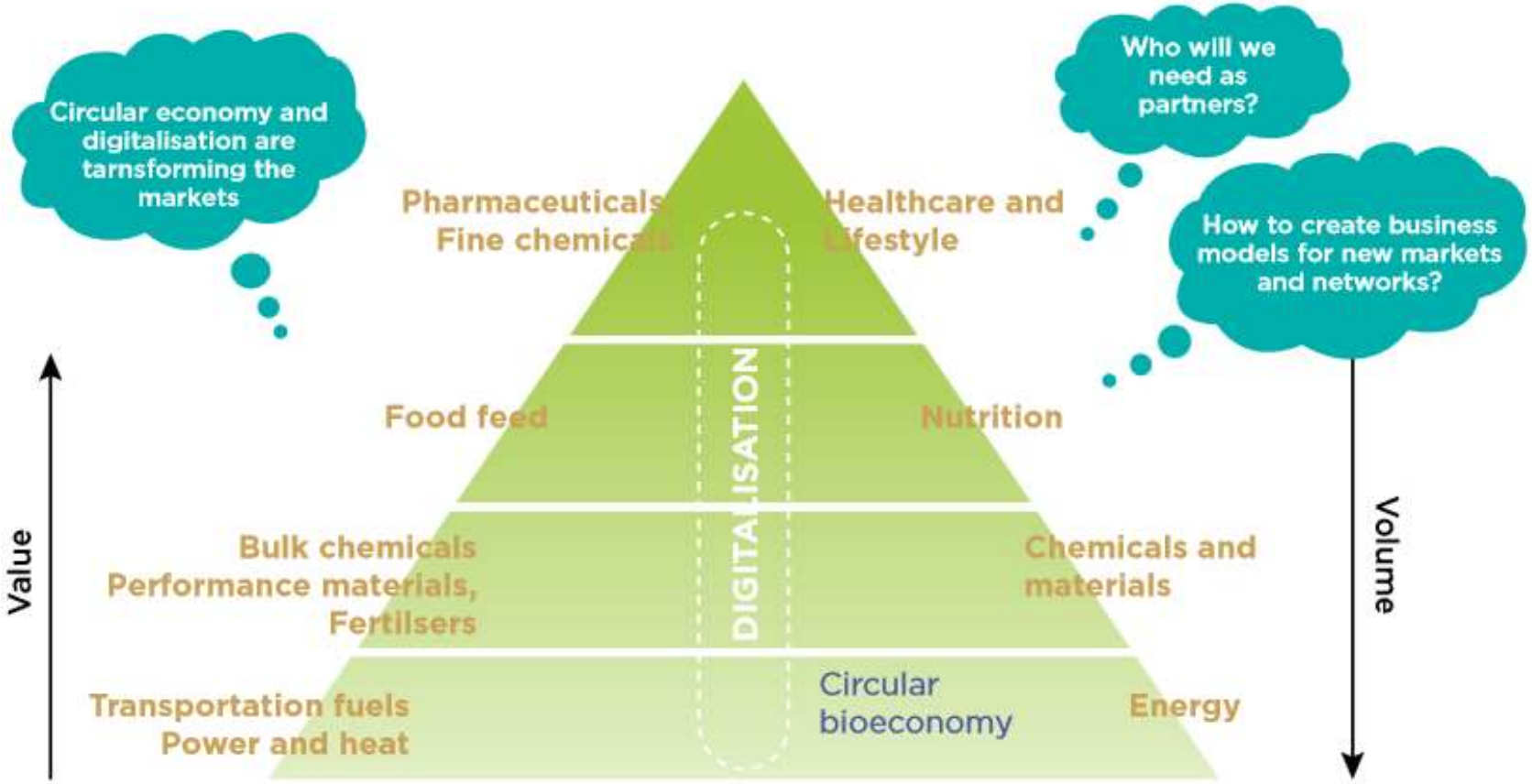
Products and processes being developed, and main ecosystem companies

- In the textile value chain: new fabric products for clothes and furniture, technical and professional textiles, hygienic and medical textiles
  - In general textiles replacing cotton and viscose
- In the bio-based plastics and composites value chain virtually everything that is currently being produced from fossil-based plastics can be replaced by bio-based ones
  - Examples: consumer packages (e.g. food and drink, cosmetics), hygiene products (e.g. toothbrush), toys, consumer electronics (e.g. cell phone covers), industry applications (e.g. air and water filtration)
  - Can also be used as reinforcement material in e.g. automotive, home electronics and construction industries, and interior design

- The Finnish company ecosystem consists of:
  - The traditional forest industry company giants such as UPM, Stora Enso and Metsä Group
  - A number of innovative startups like Paptic, Spinnova, Infinited Fiber Company, Woodio, Sulapac and Welmu
  - Research organizations have an important role in the commercial ecosystem through commercialization and applied research

Ongoing developments to extend the value chain and diversify to new business areas in higher value-added sectors

Forest-based bioeconomy value chains



Source: *Ministry of Economic Affairs and Employment - Wood Based Bioeconomy Solving Global Challenges (2017)*

Ongoing developments to extend the value chain and diversify to new business areas in higher value-added sectors

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Experiments, ventures, and measures to facilitate their naissance

- **Open access pilot facilities** exist around Finland focused on biofuels and thermochemical conversion, biomass processing and pulp production, chemical process technology and industrial biotechnology, and biobased materials
- **New ventures in cellulose based textiles** are for example Ioncell-F (in commercialization phase), Spinnova and Infinited Fibre Company
- **New ventures in biocomposites** are for example Aqvacomp, Sulapac, Paptic and Woodio
- Tekes and Fipro that have now merged as **Business Finland** have been the main funding bodies for facilitation of naissance of the new business areas
  - Tekes: Various programs throughout the past 10-15 years and even before, also relevant SHOKs (Strategic Centres for Science, Technology and Innovation), funding for applied research and commercialization
  - Finpro: internationalization services for companies via its growth programs
- **Academy of Finland** has more recently focused funding to this sector through its programs and other applied research instruments
  - E.g. as one of the two first flagship programs, CERES – the Competence Centre for the Materials Bioeconomy: A Flagship for our Sustainable Future was selected for funding

Overall synthesis of findings

Technology innovation system analysis

Functions and indicators	Findings
Entrepreneurial Experimentation and production	• Traditional forest industry companies control the beginning of the value chain. They concentrate mainly on bulk production: selling large volumes of bulk to few clients rather than developing higher value products to more fractioned market. New application are only tiny fraction of their total production. • Innovations are spinning from start-ups and SMEs who are purchasing biomass from the forest industry companies. New applications are not on the priority list of traditional companies who would have the production capacity, so the innovation process is slowed down. • Some start-ups have outsourced almost everything else than portfolio management and marketing. Their strategy is to utilize the existing linear value chain to develop and produce the new applications. This would allow prompt large scale production of innovations. • New industries don't evolve because big companies buy innovative SMEs when they succeed. Medium sized companies are missing, and the Finnish market consist of existing big companies and micro companies.
Knowledge Development	• The main knowledge gaps are related to the end of the value chain: lack of market knowledge of the new industry. Networking within the extended value chain is critical and cooperation with brand owners is needed. Applies to all case study organizations. • The market knowledge is increased by integrating target market players already at product development phase. • Lack of textile industry knowledge. • Customers and end-users are lacking knowledge about the features (e.g. sustainability aspects) of the new materials/products/technologies.
Knowledge exchange	• In order to speed up commercialization, companies should be integrated in earlier phase into the innovation processes of research organizations. Also brand owners and end-users should be more involved especially during product development.
Guidance of the Search	• In Finland, strong government focus on bioenergy guides the development in a opposite direction (away from new material innovations). • Focus should be shifted to value adding new materials/technologies/products.
Market Formation	• Currently, the higher production prices are hindering the market demand and willingness to invest in large scale production. The question is how much the end-user is willing to pay for the added value. The opinions of the price competitiveness of the new bio based solutions varies between SMEs/start-ups (competitive price) and forest industry companies/brand owners (more expensive). • The future market size is expected to be big for both applications (replacing cotton and plastics). Demand is growing and traditional raw material sources are depleting.
Resource Mobilization	• When the technology is completely new it is difficult to find competent human resources. Also, companies with remote location or inherent risks (start-ups) have experienced difficulties in recruit. • Financing for R&D is not sufficient for implementing mid-sized production facilities (between 1M€-100M€). Demonstration infrastructure (for company demos) is crucially needed and it should be located nearby companies. • Lack of (financial) support for production, commercialization and globalization/export activities. More support is needed for pilot projects which are crucial for getting into the market (technological and commercial proof of concept).
Counteract resistance to change/legitimacy creation	• The innovation process is long, it might take 10 years to commercialize the solution. Companies should be integrated into the innovation processes of research organizations already in the beginning. Big companies are needed research partners to bring knowledge on end user needs, commercialization might be necessary through new ventures.

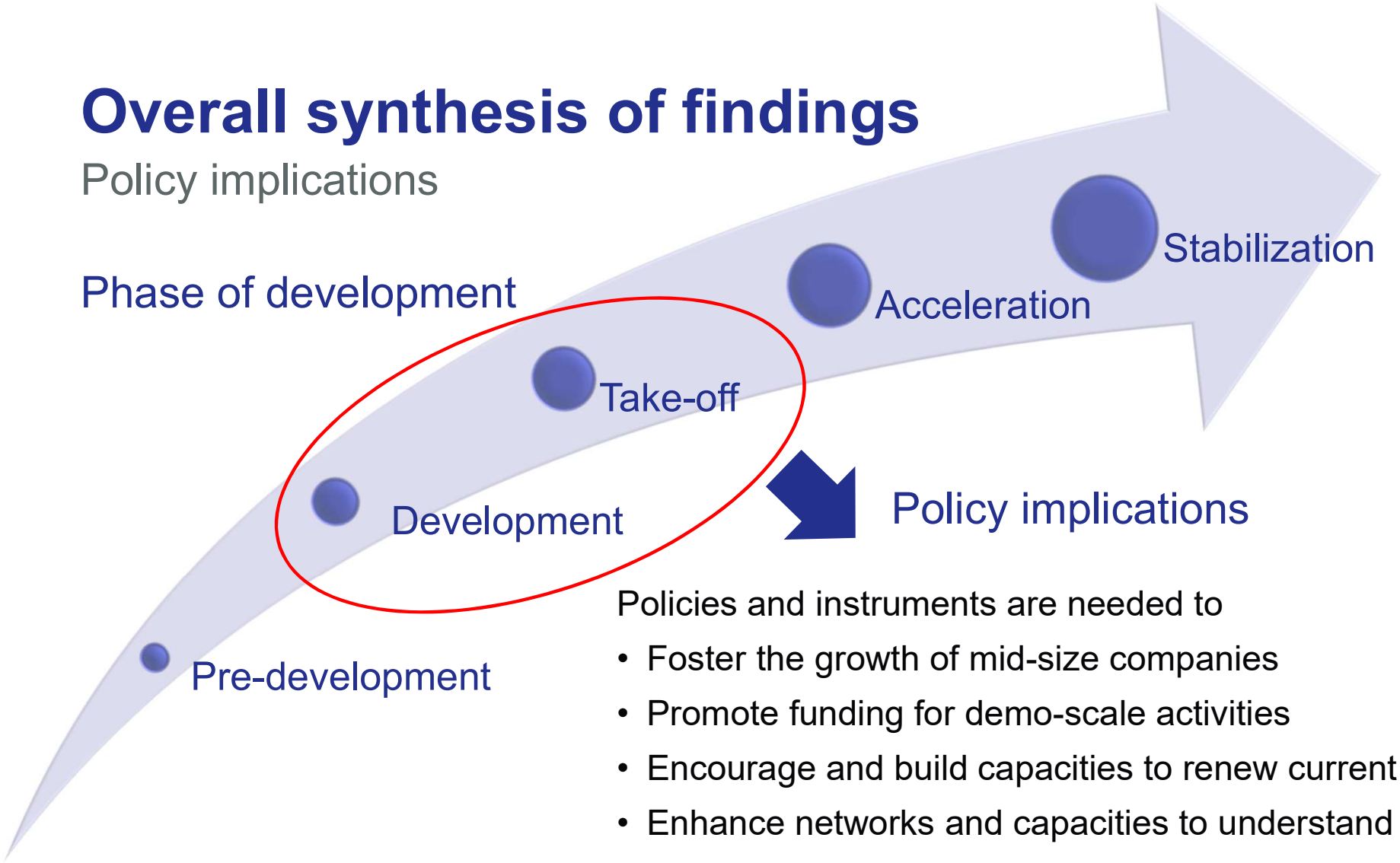
Overall synthesis of findings

Analysis summary

Entrepreneurial experimentation and production	Traditional business models do not match with new needs: selling large volumes of bulk to few clients vs. developing higher value products to more fractioned market
Entrepreneurial experimentation and production	Research organizations are closely involved in the ecosystems Medium sized companies are missing Industrial scale demo factories are missing which is slowing down commercialization
Entrepreneurial experimentation and production	Many start-ups have a business model based on licensing: new concepts are sold straight to brand owners
Knowledge exchange	Networking is crucial to increase knowledge about new business areas and customer need: cooperation throughout the value chain is important in order to ensure meeting client needs
Market information	Product development focus is on consumer segment and the importance of industrial solutions is overlooked
Guidance of search	New standards and EU regulations are needed to fit the new materials and products: industry standards should be renewed to base on functionality and not on materials used, recycling issues vs. materials used in processes should be cleared, also more uniformity is needed

Overall synthesis of findings

Policy implications



Policies and instruments are needed to

- Foster the growth of mid-size companies
- Promote funding for demo-scale activities
- Encourage and build capacities to renew current business models
- Enhance networks and capacities to understand the entire value chain and the client needs
- Pave the way to widen market view from consumer products to possibilities in the industry sector
- Promote at national and international level uptake of standards and regulation accustomed to the specific needs of the sector

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