4FRONT

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Impact Study: World-class Ecosystems in the Finnish Economy, Part A – A New HoPE

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1. INTRODUCTION

Background

"International billion-euro ecosystems" are defined as significant drivers of future growth in the current government programme.[1] Ecosystems are also featured strongly in the National Research, Development, and Innovation (RDI) Roadmap and previous policy statements.[2] The importance of business ecosystems and addressing societal challenges has been acknowledged in the Business Finland (BF) strategy (2018) and its emphasis on Finnish companies forming "strong and attractive ecosystem nodes to gain critical positions in global business ecosystems, driven by global challenges". The strategy also highlights the importance of access to knowledge, competence and talent as well as establishing "significant large-scale real-life experimental platforms and environments, attracting leading global companies".[3]

BF focuses on recognising the seeds of *high performing ecosystems* (HPEs) and supporting their development towards maturity and billion-euro business. To achieve these aims and support the development of business ecosystems, BF has introduced new specific support instruments, including various pilots, refined BF programmes (merging R&D funding and export promotion services) and the Growth Engines, which have so far provided funding for 15 enterprise-driven business ecosystem seeds.

"World-Class Ecosystems and Competitive Business Environment" is also one of BF's strategic impact targets, as agreed between BF and the Ministry of Economic Affairs and Employment (MEAE)[4]. The realisation of this impact target is evaluated once every two years by conducting an impact study. This study is the Part A of the impact study commissioned by BF, to assess the contribution and impact of activities towards fostering business ecosystems.

Purpose and structure of this report

The purpose of the Part A in the study is to describe the current portfolio of BF-funded ecosystems and to form a view to evaluability of the ecosystems' development and contribution of BF activities. This report provides a mapping of the current *business ecosystems* (see definitions in Appendix 1) funded by BF as well as identification of potential future ecosystem areas. On the basis of this analysis, the report presents a framework for monitoring ecosystems and for assessing BF impact in supporting the development of the ecosystems (to be conducted as a separate study in autumn 2020).

This report:

1. Provides an **overview of all BF-funded business ecosystems**, based on available (non-statistical) data and information about the ecosystems (Chapter 2)

[1] Finnish Government (2019). Programme of Prime Minister Sanna Marin's Government 10 December 2019. Inclusive and competent Finland - a socially, economically and ecologically sustainable society, p. 106.
[2] Ministry for Education and Culture (2020). Kansallinen tutkimuksen, kehittämisen ja innovaatioiden tiekartta (RDI Roadmap). https://minedu.fi/tki-tiekartta
[3] Business Finland (2018). Business Finland Strategy 2018.
[4] MEE (2018). Business Finlandin tulostavoiteasiakirja vuosille 2019-2022.

2. Constructs a more detailed **statistical overview of selected 15 ecosystems** as well as an **analysis of the development paths and bottlenecks** of these ecosystems, based on 15 interviews with ecosystem managers/coordinators (Chapter 3)
3. Identifies **potential thematic areas** that can be seen as potential but currently lacking in (BF-funded) business ecosystems (Chapter 4)
4. Provides a concrete and executable **framework for monitoring ecosystems and for assessing BF impact** in supporting the development of the ecosystems (Chapter 5)

Approach in brief

The approach of this study is descriptive and analytical, contributing to a separate summative evaluation (Part B of the impact study), which will assess the contribution and additionality of the BF activities, and discuss the future role of BF in supporting ecosystems.

The study focuses on 33 business ecosystems, which have been funded by Business Finland through different funding services ('BF-funded ecosystems'). The list of these ecosystems is based on Business Finland's updated list of high performing ecosystems (HPEs). 15 ecosystems were selected out of the long list for a more detailed analysis (in Chapter 3) in collaboration with the project steering group to represent the overall portfolio and ecosystems with different industrial base and life cycle phase.

For analysing the characteristics of the ecosystems, a set of criteria and dimensions were identified based on a synthesis of previous literature regarding ecosystems. This discussion has been summarised in Appendix 1.

Besides the overview presented in this report, ecosystem-specific 'data sheets' for each ecosystem were prepared as part of the study. Due to the sensitive nature of some of the ecosystem-specific data, these data sheets are not published but can be used as internal tools by BF and BF-funded ecosystems.

2. OVERVIEW OF BUSINESS FINLAND -FUNDED BUSINESS ECOSYSTEMS

In total, there are 33 BF-funded high performing business ecosystems (as identified by BF). The ecosystems vary in many dimensions, most notably by their lifecycle phase, focus and participant profile. This section provides an overview of the ecosystems. Firstly, the ecosystems are presented on a general level. After this initial phase, different classifications of the ecosystems are presented – these include examinations by lifecycle, sector group and ecosystem type.

Basic information of BF-funded ecosystems

All identified 33 BF-funded ecosystems are listed in Table 1. . A more detailed summary of all ecosystems and summary of their main characteristics is presented in Appendix 6.

Table 1. BF-funded ecosystems in this study.

Official name	Operator/Orchestrator	Lifecycle phase
4Recycling	CLIC Innovation	Exploration
BatCircle	Aalto University	Exploration
Digital and Physical Immersion in Radiology and Surgery	Tampere University	Exploration
FinnGen	University of Helsinki	Exploration
Green Electrification	CLIC Innovation	Exploration
Intelligent Industry	DIMECC	Exploration
New modalities	Orion	Exploration
SEED	VTT	Exploration
Telaketju 2	VTT	Exploration
Baltic Offshore Wind Ecosystem	Gaia Consulting	Experiment
CleverHealth Network	HUS	Experiment
KODA (Kotidigi)	CGI	Experiment
Flexens Growth Engine	Flexens	Experiment
ForBest	Fortum	Experiment
IBM Finland Cognitive Healthcare Cluster of Innovation	IBM Finland	Experiment
SiloBrain AI ecosystem	Silo Ai	Experiment
Awake.AI	Awake.Ai	Experiment
KEKO Smart Building Ecosystem	VTT	Experiment
LuxTurrim5GPlus	Spinverse and Nokia	Experiment
Reboot IoT Factory Phase II	VTT	Experiment
Self-Tuning Mine	Sandvik	Experiment
Smart Mobility Ecosystem	Kyyti Group	Experiment
Smart Otaniemi	VTT	Experiment
MI Demo	Metsä Spring	Experiment
Vedia CaaS	Vediafi Oy	Experiment
Adaptive Industrial Loops	MEX Finland	Expansion
ELASTRONICS Connected Health Ecosystem	University of Tampere, VTT and GE	Expansion
Internet of Locations	ICEYE	Expansion
Project Carbon Negative	Compensate	Expansion
One Sea - Autonomous Maritime Ecosystem, stage II	DIMECC	Expansion
Plastic Waste Refining Ecosystem	Griffin Refineries	Expansion
Platform of Trust	Suomen Tilaajavastuu Oy	Expansion
Red Compartida	Nokia	Established

Most ecosystems are in the experimentation phase

Ecosystems can be categorised into four different phases (see Appendix 1). In this study, these phases were named as: 1. Exploration, 2. Experimentation, 3. Expansion and 4. Established. The **exploration phase** is characterised by a focus on (applied) research, with universities, other research organisations and corporate R&D having a prominent role in the ecosystem. The **experimental phase** is characterised by a variety of competing initiatives and a number of startups and spinoffs (from research organisations or corporations) and a focus on finding a solution-market-fit through piloting and demonstration. In the **expansion phase** the ecosystem expands its borders to

new markets and leading companies/platforms emerge. The expansion phase is typically characterised by intensified global competition and increased amount (private) investments. In the **established phase**, ecosystem has managed to achieve a strong role in the global markets and its key companies are among the global leaders within their sector.

The majority of the ecosystems (16 ecosystems) were considered being in the phase two (experiment). The second most frequent phase among the ecosystems was the exploration phase, with nine ecosystems categorised in this initial phase. From the remaining eight ecosystems, all but one was categorised into the third phase (growth/expansion), with one categorised to the established phase.

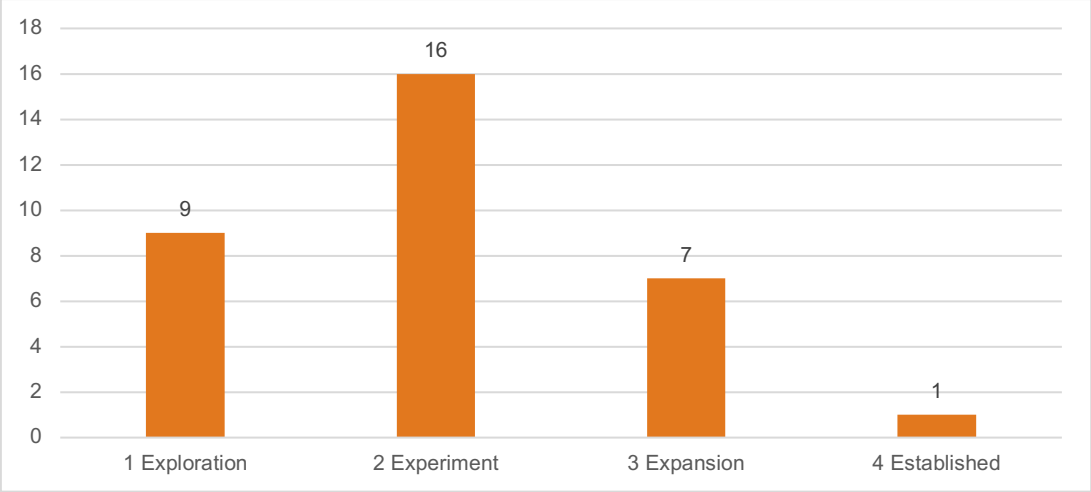

Figure 1. BF-funded ecosystems by their lifecycle phase.

Overall the focus of BF 'ecosystem portfolio' seems to be balanced and in line with literature findings (see Appendix 1) arguing that the role of public sector (especially public funding) should focus on the earlier stages of ecosystem lifecycle, while the more mature ecosystems should be more business-driven.

Ecosystems cover various sectors

Examining the ecosystems by their sector group, seven different groups were identified: 1) Bio and circular economy, 2) Health, 3) Mobility and logistics, 4) Energy, 5) Manufacturing, 6) ICT and 7) Other. Seven out of the 33 ecosystems were identified operating in the field of Bio and circular economy. Five ecosystems focused in energy sector, while six ecosystems were operating in the health sector. Both manufacturing and mobility & logistics, as well as the ICT sector included four ecosystems.

However, it should be noted that business ecosystems are (by definition) cross-sectoral and in each ecosystem, there are typically companies from many different sectors. Therefore, the sector of the ecosystem should be understood in more general terms, describing the main 'application sector' for the solutions of the ecosystem rather than a characteristic of all ecosystem participants.

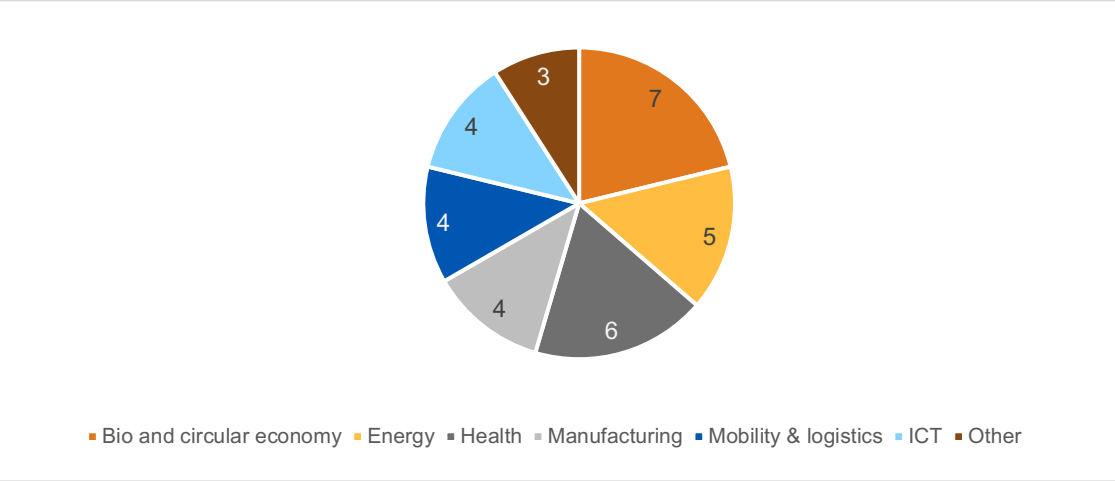

Figure 2. BF-funded ecosystems by their sector groups.

The second phase (experiment) is the most prominent phase in five sectors (Energy, Health, Manufacturing, Mobility & logistics and ICT). Among Bio and circular economy sector, the ecosystems in the initial lifecycle phase were the most frequent. This finding is in line with general understanding of the overall evolution of the sectors and core technologies. For example, many new bio and energy technologies are still in exploration phase, while many other technologies (e.g. health tech, mobility, ICT) are already in being broadly experimented or in the market.

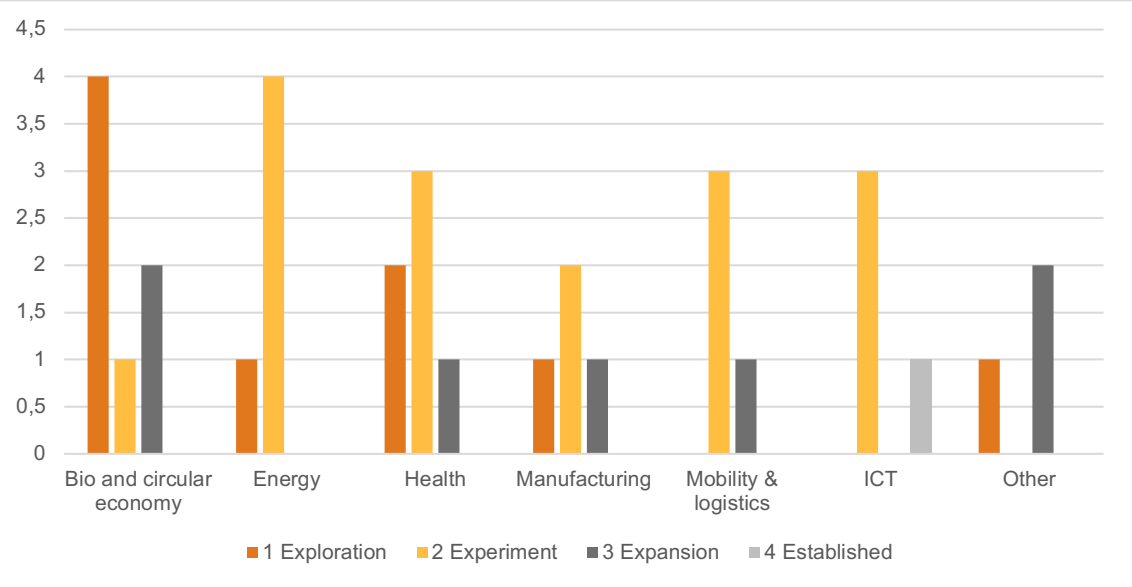

Figure 3. BF-funded ecosystems by their sector group and lifecycle phase.

Most ecosystems are B2B-oriented but also B2C ecosystems have been funded

Another approach is to examine the main customer groups of the ecosystems. Four different target groups were identified: B2B (Business to Business), B2C (Business to Consumer), a combination of these (B2B & B2C) and Other category for cases which didn't fit the aforementioned categories in a

clear manner. The majority of the ecosystems focused on Business to Business operations (19 ecosystems), with six ecosystems representing the hybrid model and five ecosystems being purely consumer-oriented. This finding is expected as the majority of largest Finnish companies have traditionally focused on B2B business and there has been relatively few large B2C businesses. However, the emergence of some B2C ecosystems is encouraging and highlights further opportunities with B2C sectors.

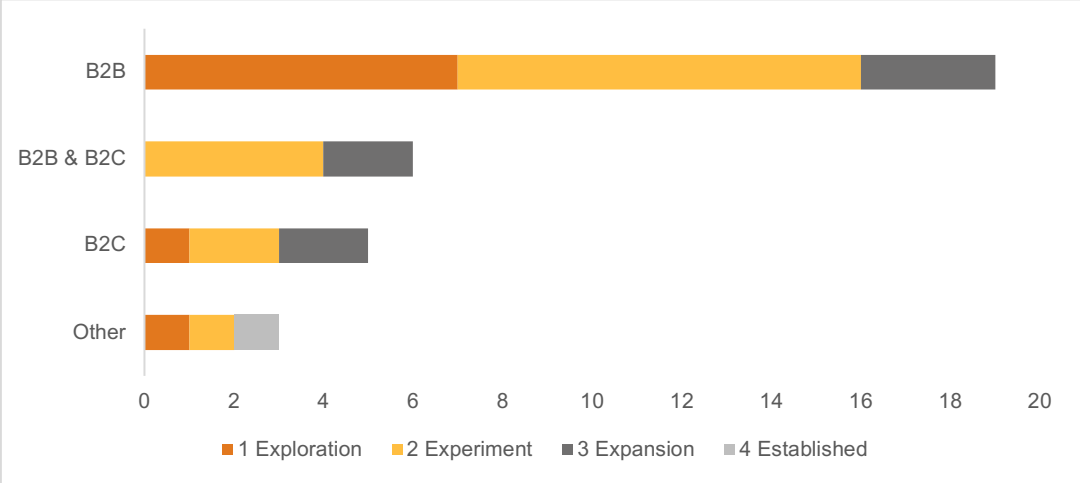

Figure 4. BF-funded ecosystems by their customer focus.

Almost all of the ecosystems are ‘solution’ ecosystems

A total of 31 ecosystems out of the 33 were categorised as solution ecosystems. In these ecosystems, the ‘platform’ enables added value through third-party innovation and integration of third-party innovation through products and services offered from the ecosystem partners with variable degree of independence. Two of the ecosystems – Smart Mobility Ecosystem (Kyyti Group) and Project Carbon Negative (Compensate) – were identified as transaction ecosystems. In these ecosystems, the platform provider ‘owns’ the client/end-user contact; the platform creates the marketplace and creates rents for the platform owner.

The definition between solution and transaction ecosystem is not always clear, and in many cases, ecosystems can have elements from both types of ecosystems. Yet, the lack of ‘pure transaction ecosystems’ highlights the fact that this type of (world-class) ecosystems are very difficult to establish as they typically require a very broad ‘critical mass’ and a globally dominant platform, such as Über or AirBnB.

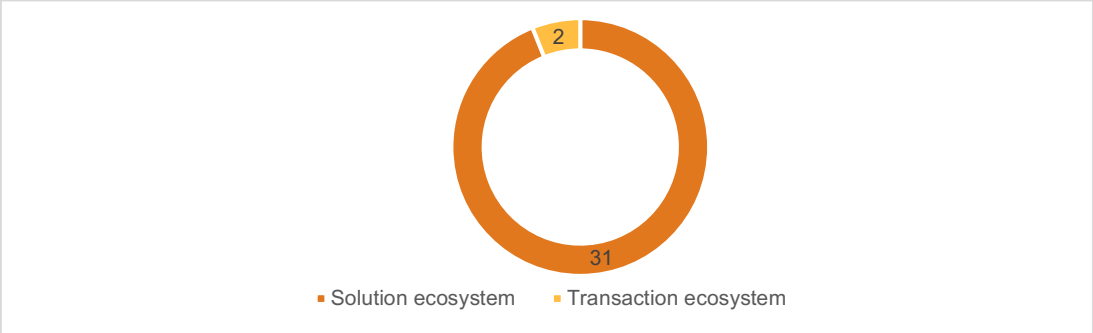

Figure 5. BF-funded ecosystems by ecosystem type.

The most common members of the ecosystem are companies

The following figure presents the profile of participating organisations (types of participants/members) in the ecosystems. Looking at the fractions, on average over 80 % of the ecosystem members are enterprises. Most ecosystems also have at least one research organisation (university, college or research institute) or administrative body as a member.

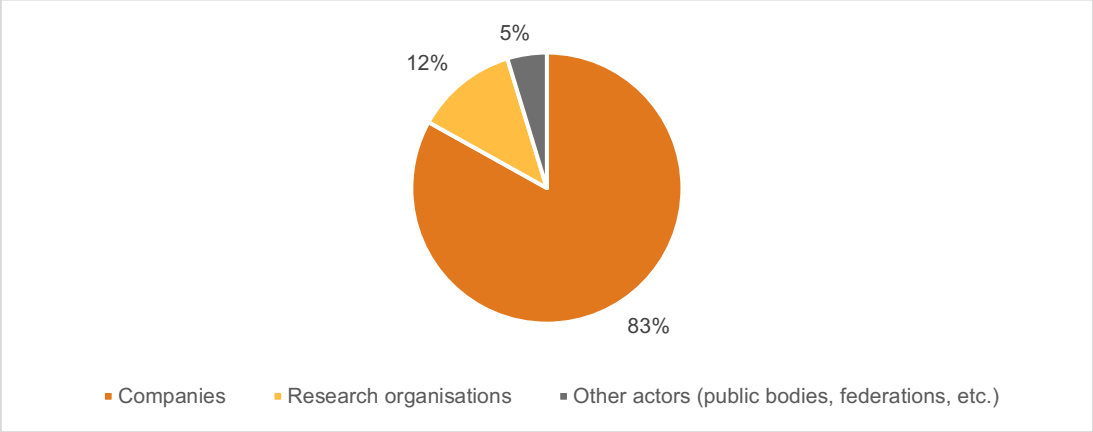

Figure 6. Profile of participating organisations in the ecosystems .

Highlights from BF expert assessment of the ecosystems

As a part of the study, the ecosystem account managers (experts from BF) conducted a 'self-assessment' of the ecosystems. The assessment included multiple criteria (see the full list in Appendix 5). At the time of writing, in total of 20 ecosystems were assessed. The following radar chart is an aggregate of the average of all assessed ecosystems.

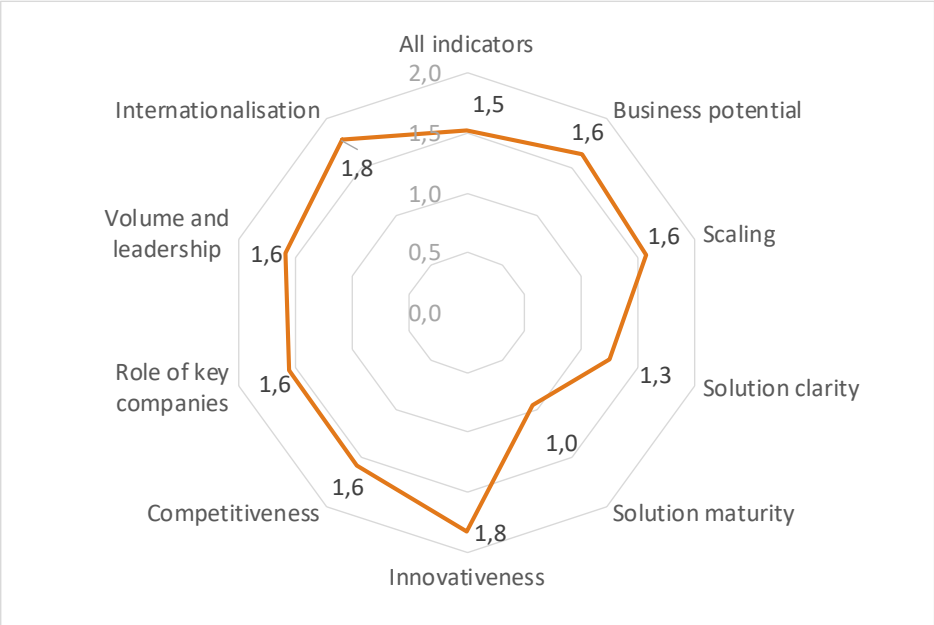

Figure 7. Overview of BF expert assessments of BF-funded ecosystems (N=20). (Scale: 0/1/2 larger is 'better', c.f. Appendix).

According to the assessment, the BF-funded ecosystems (on average) rank highest on *Innovativeness* and *Internationalisation* (both 1,8 on a scale 0-2), highlighting the novelty, export potential and level of international collaboration of the ecosystems. Importantly, the lowest average score was given to the *Solution maturity*. This further validates the findings that most BF-funded ecosystems are still in the early phases of their lifecycle.

3. ANALYSIS OF SELECTED ECOSYSTEMS

This section describes a more detailed analysis of the selected 15 ecosystems. The selected ecosystems were identified in collaboration with Business Finland, with the aim to cover different types of ecosystems. For this purpose, both ecosystems in different lifecycle phases and with different customer focus were identified. The availability of data was considered as one selection criteria, leaving out some of the ecosystems. Table 2 presents an overview of the selected ecosystems.

Table 2. Selected ecosystems and their lifecycle phases.

	1. Exploration	2. Experiment	3. Expansion	4. Established
B2C	Identified: 1 Selected: 2 Tekstiilin kiertotalous / Telaketju 2	Identified: 2 Selected: 1 Smart Mobility	Identified: 2 Selected: 2 GE Connected Health & Elastronics	Identified: 0 Selected: n/a

B2B / other	Identified: 8 Selected: 2 FinnGen	Identified: 16 Selected: 5 BatCircle; CleverHealth Network; Fortum eco-village; Smart Otaniemi	Identified: 5 Selected: 2 OneSea; Mex Finland	Identified: 1 Selected: 0

3.1. Characteristics of the selected ecosystems

As there were no ready-to-use lists of ecosystem members, the members and their business IDs were identified manually in collaboration with Business Finland. Based on these business ID lists, an analysis of statistical data from BF business register was conducted. This chapter presents the findings from this analysis. Due to the report schedule and a need for manual work to identify the ecosystem members, the analysis here is limited for the selected ecosystems (in total of 301 members, including also public organisations).[5]

3.1.1. Industry, region and company structure

IT and waste management most represented industries

The following figures present the ecosystem profiles (among the selected ecosystems) on an aggregate level. The most common industries in the ecosystems are presented in Figure 8. TOP 20 industries are based on Standard Industrial Classification (TOL 2008). The figure shows the cross-cutting nature of members as well as strong industrial background in IT. Besides IT, a clear focus on circular economy can be noticed, as evidenced by the prevalence of waste management enterprises among the partners. Similarly, the ecosystems are quite well linked with universities and colleges.

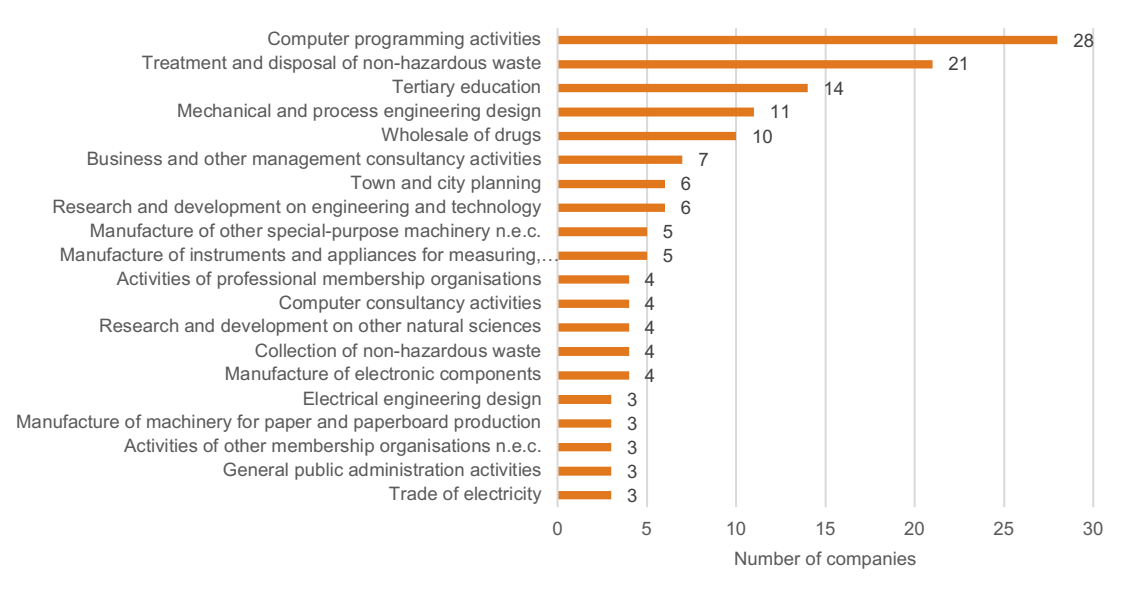

Figure 8. TOP 20 registered industries among the ecosystem members.

[5] The mapping has since been extended to cover the business IDs for companies in all 33 BF-funded ecosystems for the basis of future extended analyses.

Geographic focus in the Uusimaa region

Regionally, as expected, the majority of ecosystem members were located in the Uusimaa region. The following figure represents TOP10 locations where the ecosystem partners are legally registered. The prevalence of the capital region is explained partly with the fact that many (if not most of) large enterprises are registered in Helsinki or Espoo (the location of the headquarters).

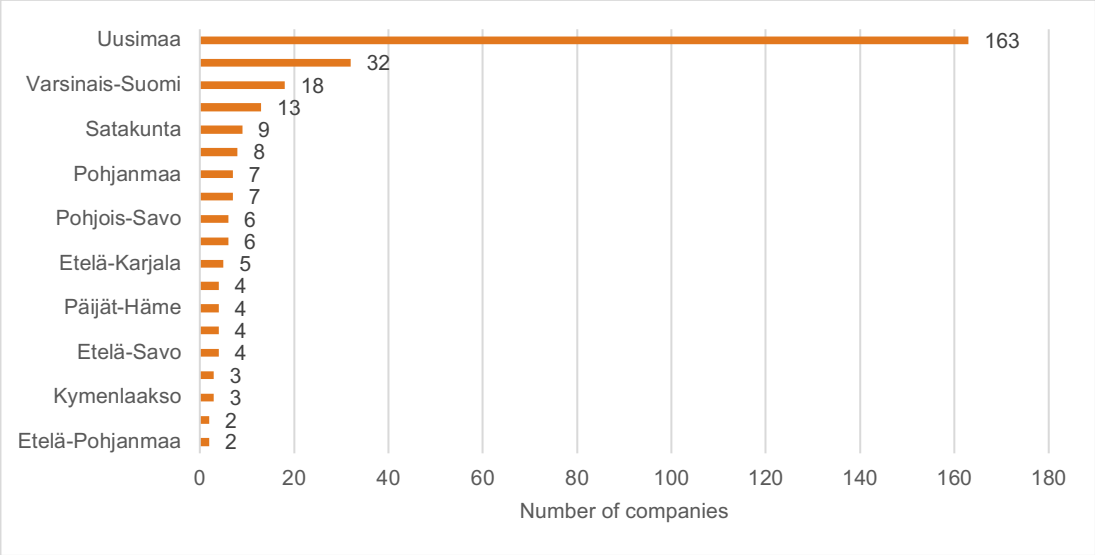

Figure 9. TOP10 locations of registered office among the ecosystem members.

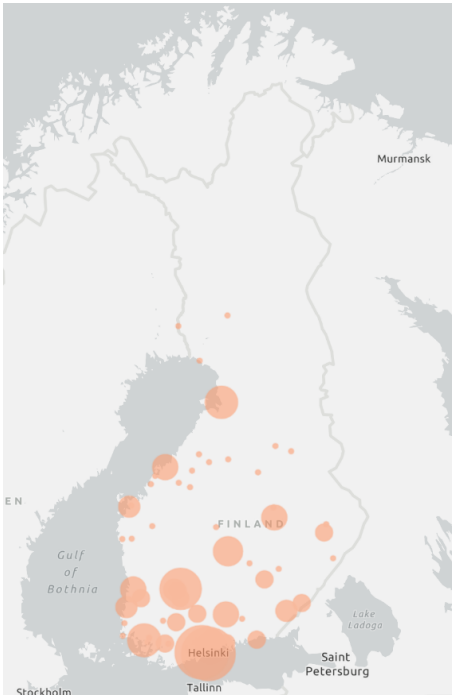

Figure 10. Geographical dispersion of the ecosystem members. The size of the dot is proportional to the number of members.

Large enterprises are predominant in the networks

When analysing company size, it reveals that large companies (n=112) represent 40 percent of all member companies in the BF-funded ecosystems. This may seem surprising, since large companies represent less than a percent of total companies in Finland. However, the finding is in line with the theoretical discussion, which highlights the importance of larger companies in ecosystems.

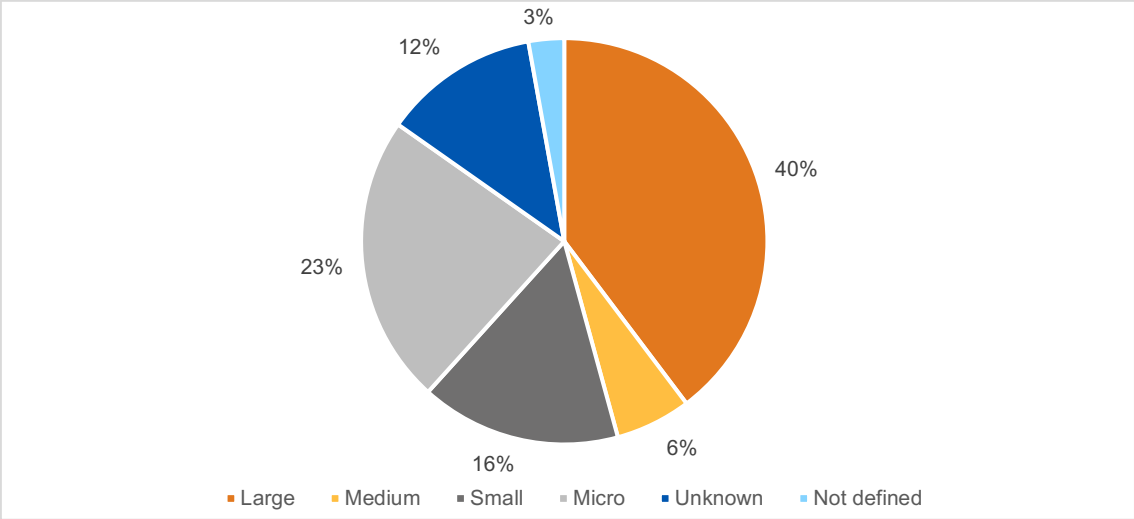

Figure 11. Share of ecosystem member companies based on company size.

3.1.2. Economic indicators

The following presents the findings from an analysis of economic indicators (turnover, employment, added value and exports). The data is based on tax authorities' company level data, received through Business Finland. As above, the analysis is limited to the 15 selected ecosystems. The data covers the years 2010–2019. However, due the lack of data points for the year 2010 and the recency (and relative lack of data) of 2019, these years were left out of the analysis.

The findings should not, however, be considered as indicators for the success of the ecosystems or their activities, rather than as indicators of the ecosystem members' characteristics. Most of the ecosystems are still relatively early in their life-cycle, and thus historical economic performance of the participant is not a direct indication of the ecosystems' future performance or the impact of ecosystem building activities. As is evident in the following figure, the data did not include observation for all enterprises for all years, as such cumulative numbers will like be skewed to the direction of larger amount of observations. Furthermore, especially in the case of large enterprises, the figures are indicative since the company level data does not take into account which share of the companies' business is relevant for the ecosystem in question.

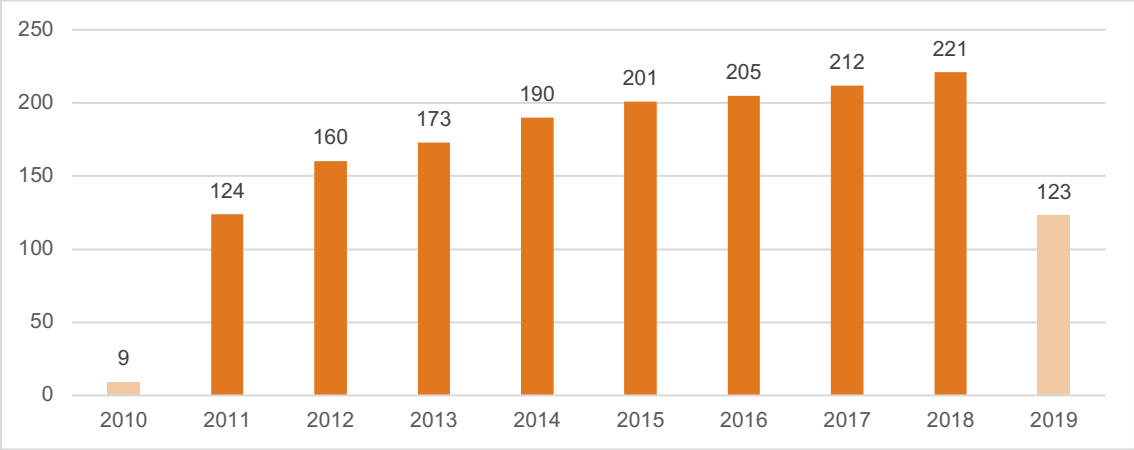

Figure 12. Number of observations (enterprises) per year included in the data (turnover).

Turnover

The **average turnover** of the ecosystem member companies within the lifecycle phases 3-4 was over €290 million in 2018. In comparison, in the lifecycle phases 1-2 the average turnover of companies in 2018 was €170 million.

The average turnover of the member companies (especially for the ecosystems in the lifecycle phase 1-2) has significantly *decreased* since 2011. Although the trend is worrying, this should not be considered as an indicator for the impact of the ecosystems' activities (since many of them have been launched recently), rather than a reflection of broader economic development. It should also be noted that, as there are many large companies included, changes in the turnover can be explained by changes in the turnover of individual ecosystem members.

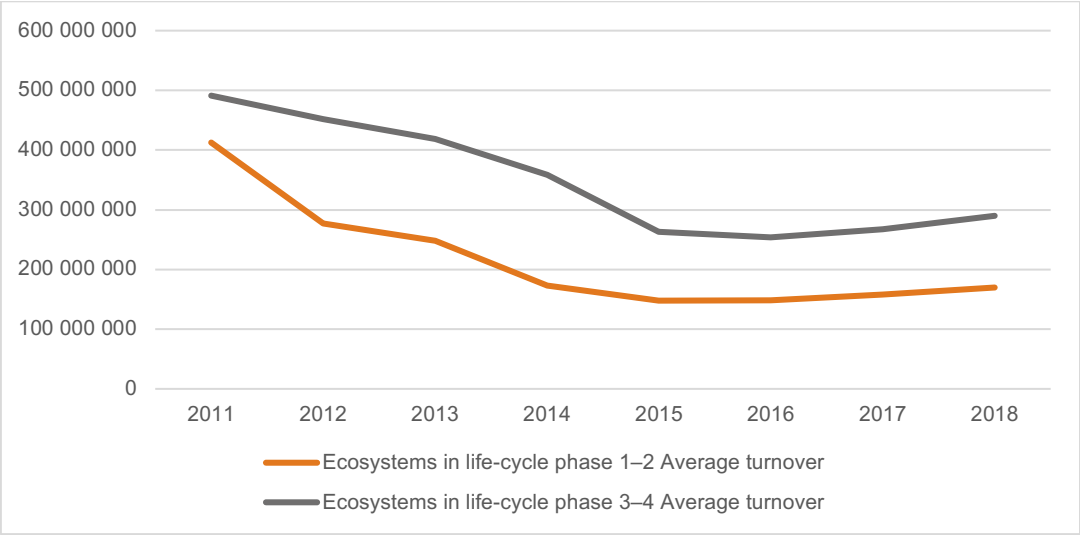

Figure 13. Average turnover of the member companies in the BF-funded ecosystems in 2011–2018 by lifecycle phase.

On one hand, the findings seem to validate the initial classifications of the ecosystems into four lifecycle phases as companies in more mature ecosystems are likely to be larger than companies in less mature ecosystems. On the other hand, the analysis is not as straightforward: the company level data does not yet indicate, which share of the companies' business is relevant for the ecosystem. This is especially problematic in the case of larger companies, as for many, only a small share of their business might be linked to the ecosystem – especially at the earlier phases of the ecosystem lifecycle.

An analysis of **'ecosystem level' average turnover** reveals that the average ecosystem-level turnover (total sum of member companies' turnover) in 2018 was €3.8 billion. The average has declined since 2011 (€6.2 billion). This trend is largely explained by the development of the three largest ecosystems (when measured by the total turnover of their member companies) and therein restructuring of large individual enterprises.

In 2011 all three largest ecosystems had turnover of more than €15 billion each, more than €60 billion combined. In 2018 the total combined turnover of these three ecosystems was only €28 billion. In all remaining 12 selected ecosystems the total turnover of member companies has been less than €5 billion between 2011–2018. In 2018, the total turnover was less than €1 billion in three of the selected ecosystems.

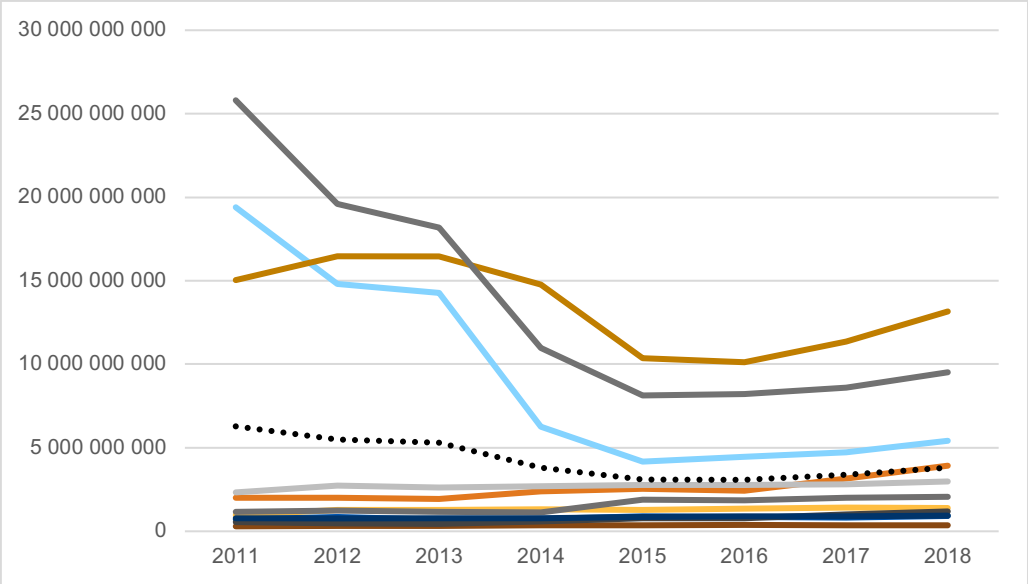

Figure 14. Total turnover of the member companies (euro) in the selected 15 ecosystems (dotted line = average).

As mentioned above, the data does not yet indicate, how large share of the companies' total turnover is linked to the ecosystem. Table 3 presents rough estimates of average net turnover at the level of the ecosystem, with different rates of turnover linked to the ecosystem is used for the larger enterprises (i.e. if 25% of all the turnover of the participating large enterprises would be linked to the ecosystem activities, the total net turnover of the ecosystems would be €950 million).

Table 3. Estimates of ecosystem level turnover linked to the ecosystem, average of selected 15 ecosystems.

Share of members' turnover linked to the ecosystem	Ecosystem level turnover in 2018 (average of 15 ecosystems)
100 %	€3.8 billion
50 %	€1.9 billion
25 %	€950 million
10 %	€380 million
1 %	€38 million

Employment

The **average employment** (average number of employees**)** of the ecosystem member companies in the lifecycle phases 1-2 was 334 in 2018. In turn, the ecosystems representing the lifecycle phase 3-4 had the average number of employees of 450 in 2018. In contrast to turnover, there is no significant decrease (nor growth) in employment between 2011 and 2018.

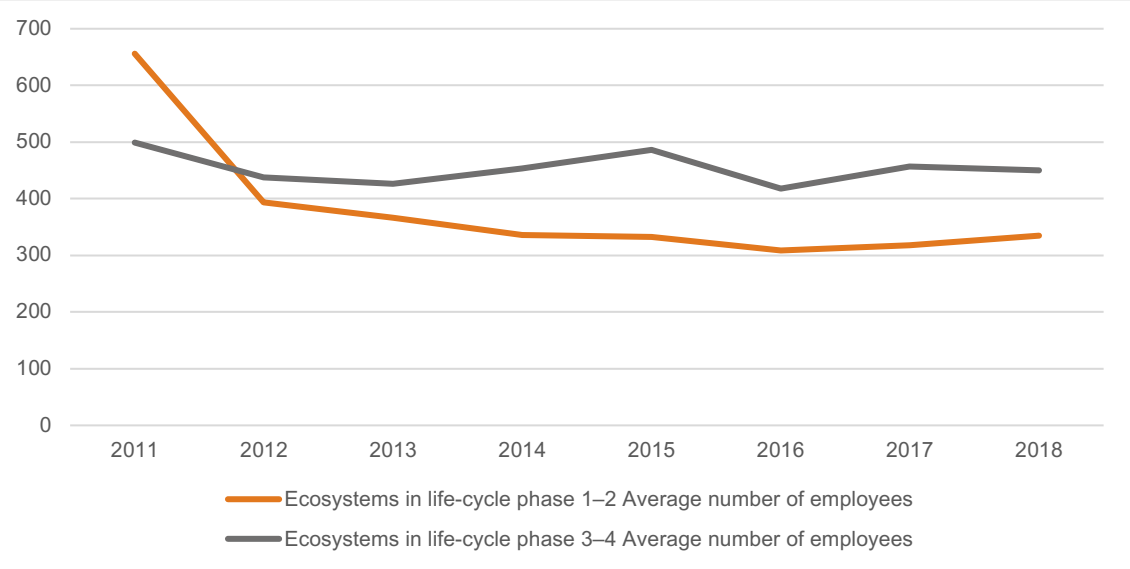

Figure 15. Average number of employees in the member companies of the BF-funded ecosystems in 2011–2018 by the lifecycle phase.

The average **ecosystem level employment** in 2018 was 6 200, while in 2011 it was 6 100. In 2018 the total employment was between 1 200 and in total 9 200 in all selected ecosystems. In three ecosystems the total employment was less than 3 000 in 2018. In all other (9) ecosystems the total employment was more than 5 000 (but less than 9 200) in 2018.

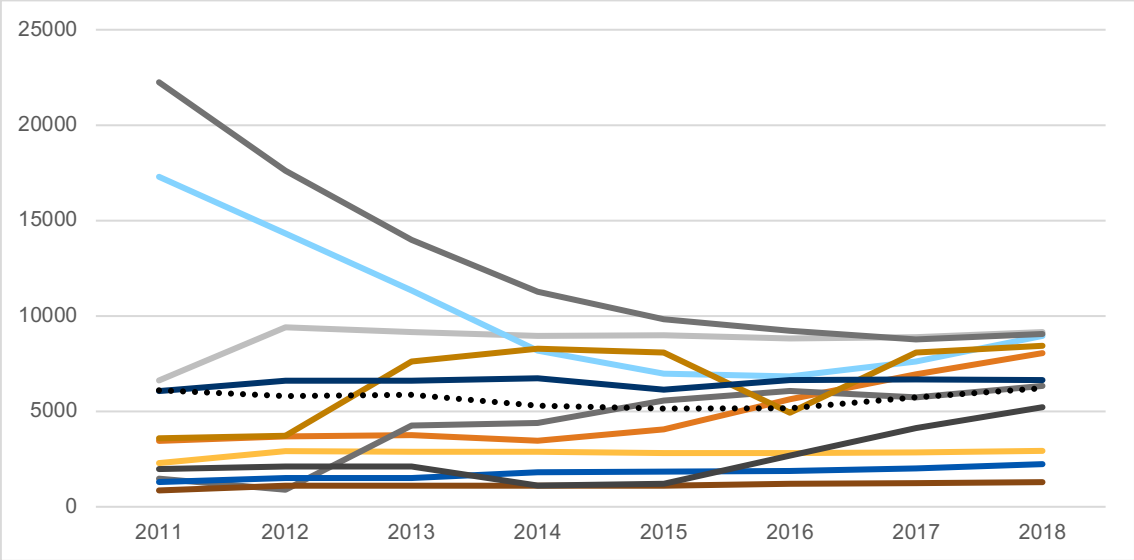

Figure 16. Total employment in the member companies of the selected 15 ecosystems (dotted line = average). The names of the ecosystems have been exluded due to the sensitive nature of the data.

Exports

The **average export turnover of ecosystem member companies** in the lifecycle phases 1-2 was €93 million in 2018. In the ecosystems representing lifecycle phase 3-4 the average export turnover was €202 million in 2018. In addition, the export turnover of member companies has decreased between 2011 and 2018.

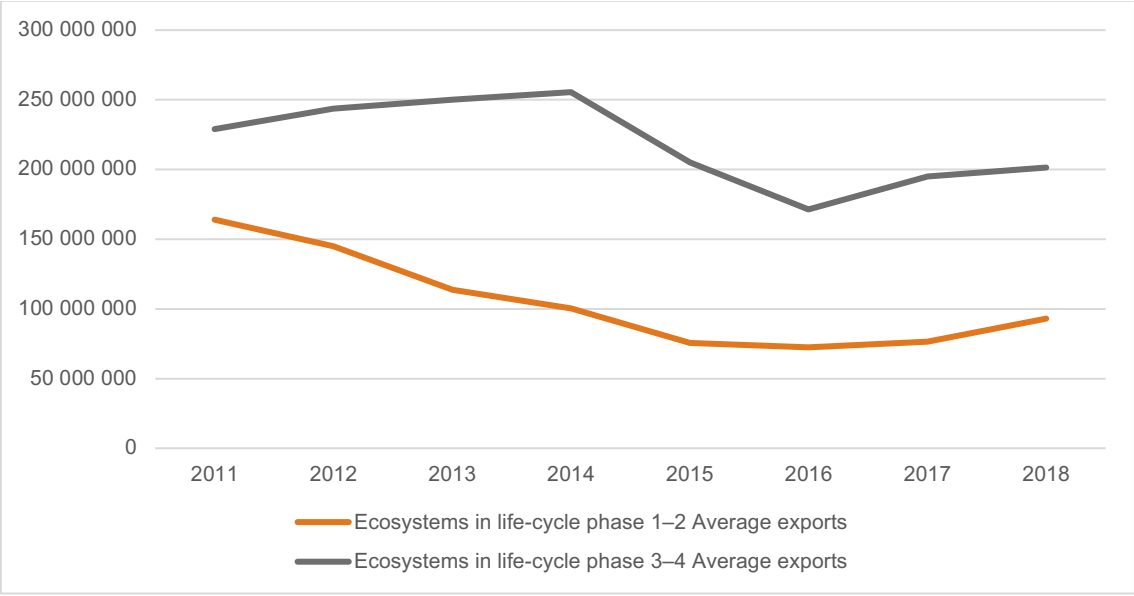

Figure 17. Average export turnover (euro) of the companies in the BF-funded ecosystems in 2011–2018 by the lifecycle phase.

The following figure, in turn, presents a trend of export turnover in the ecosystem member

companies.

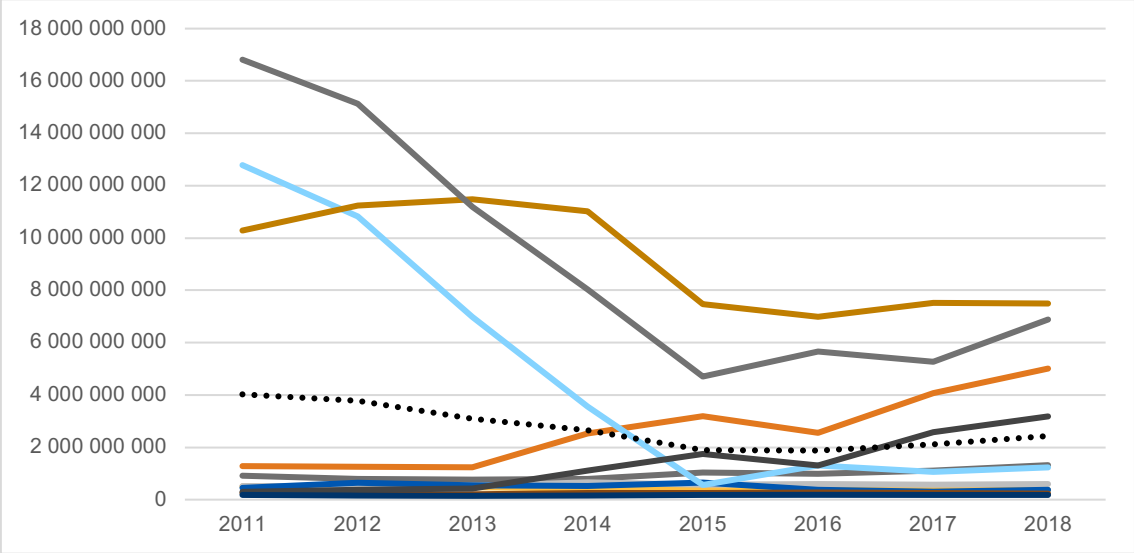

Figure 18. Total export turnover (euro) in the member companies of the selected 15 ecosystems (dotted line = average). The names of the ecosystes have been excluded due to the sensitive nature of the data.

Value added

A similar negative trend can be seen in the value added of the member companies as it applies in the turnover. However, the average value added is higher for the ecosystems in the lifecycle phases 1-2 than for the ecosystems in more mature lifecycle phases. Again, this should not be interpreted as an indicator for the success of ecosystem rather than as a characteristic of ecosystem members. Nevertheless, the finding is interesting as, in theory, the value added of the ecosystem should *increase* as the ecosystem matures. To further assess the ecosystems' value added, a more sophisticated analysis of the ecosystem members (and the share of the business relevant for the ecosystem) would be needed.

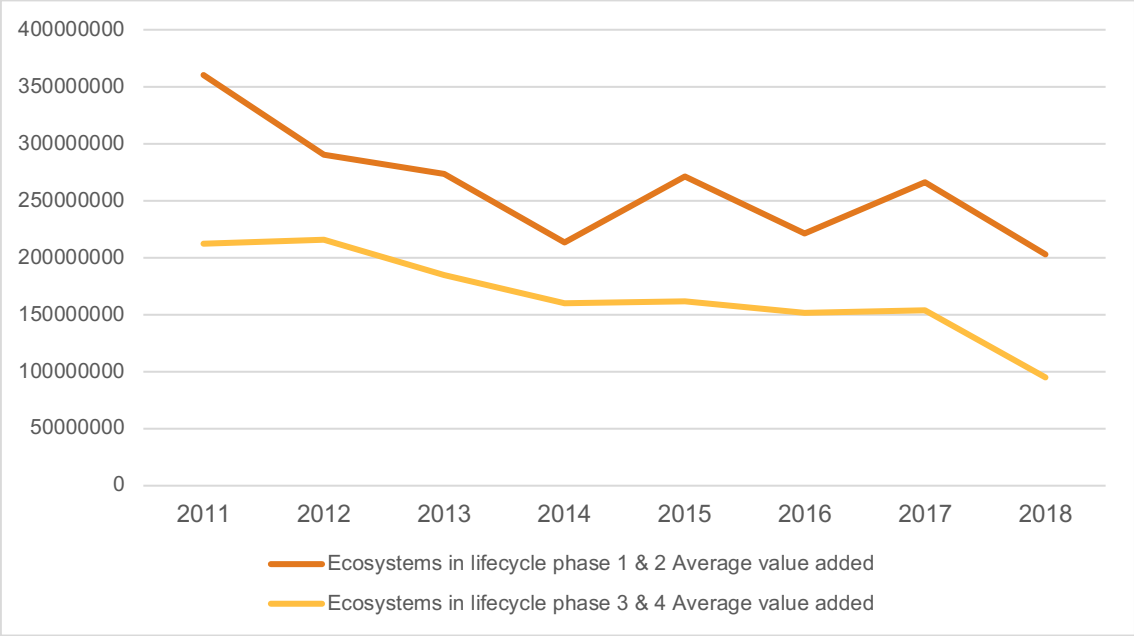

Figure 19. Average value added of the companies (euro) in the BF-funded ecosystems in 2011–2018 by the lifecycle phase. (values for value added for some individual enterprises were missing for the last year, affecting the results for individual ecosystems, they were filled in with values for the previous year)

The ecosystem level decomposition shows that, on average, all ecosystems have developed unfavorably in terms of value added. This further highlights the importance of the goal of renewing the economy through ecosystem activities.

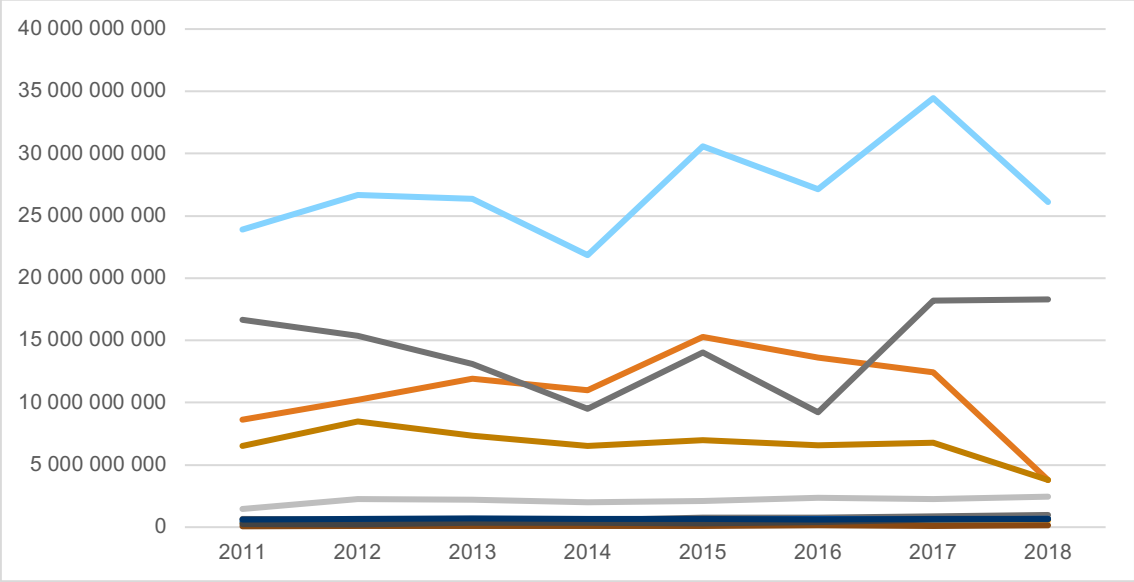

Figure 20. Total value added in the member companies (euro) of the selected 15 ecosystems (dotted line = average). The names of the ecosystems have been excluded due to the sensitive nature of the data. (values for value added for some individual enterprises were missing for the last year, affecting the results for individual ecosystems, they were filled in with values for the previous year)

Decomposition analysis

To better understand the role of the largest companies in the ecosystems' economic performance, a separate analysis of economic indicators without the three and ten largest individual enterprises as 'outliers' (by turnover) is presented hereinafter.

As illustrated by the following figures, the economic performance of the ecosystem members is largely dominated by the three largest 'outliers', as in multi-national enterprises (MNEs) with orders of magnitude larger turnover than the average enterprise. This applies to all indicators (turnover, employment, export turnover, value added). Especially the large decrease in turnover, exports and value added between 2011 and 2015 is largely down to the performance of the three largest companies (as measured by turnover), who – as it seems – after a rapid decrease between 2011 and 2015 had not yet managed to return to the 2011 level by the end of 2018. As a result, the gap between the 'regressed' outliers and others is much less significant in 2018.

However, it should be noted that even without the outliers, the trend in BF-funded member companies' economic performance is mainly negative. While turnover has been stable, if stagnating, and exports have even risen especially between 2013 and 2016, employment and especially value added have declined; for all but the 3 largest enterprises the average value added has declined two thirds from 2011 to 2018. While large enterprises dominate the analysis, it seems that when outliers are taken out, the development of enterprise financials is on average in steady decline. The trend is worrisome for future competitive position of Finnish industry, as the figures signal possibly economy-wide decline in productivity; as productivity is the quotien of value added and employment in FTE, the decline in value-added directly signal declining productivity.

Again, the figures should not be considered as an indicator for the impact of BF ecosystem activities, which have mainly started since end of the period under review. If anything, as noted, the figures highlight the urgent need and rationale for supporting the economic renewal of the Finnish economy.

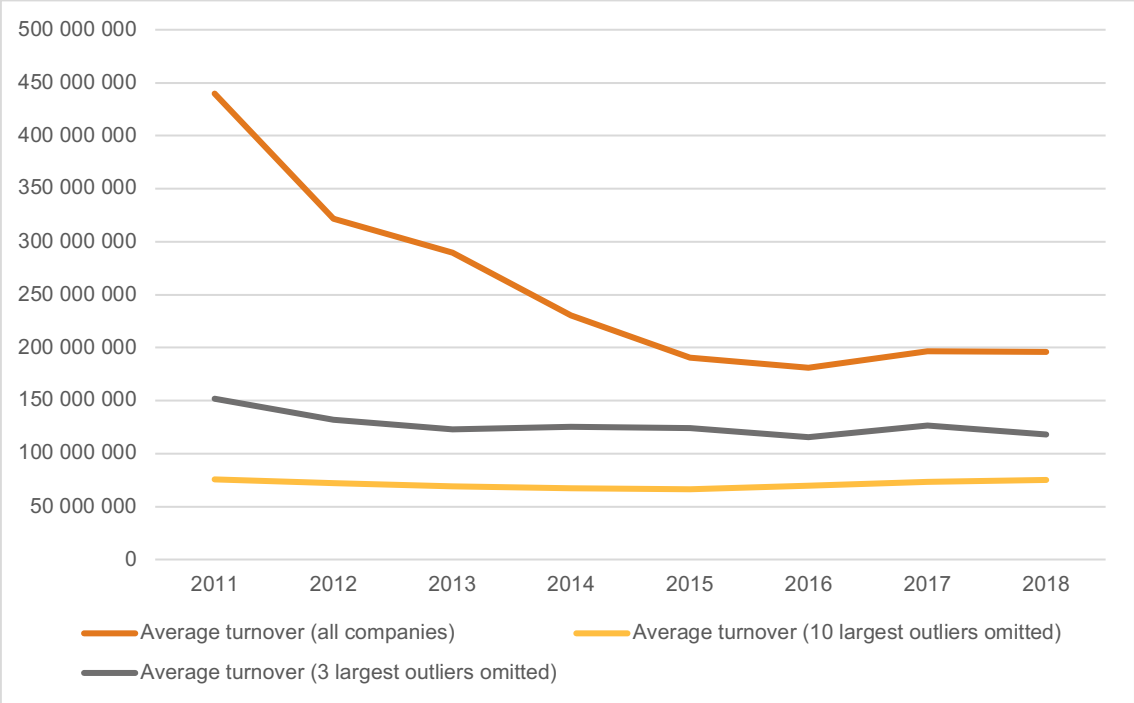

Figure 21. Average turnover of member companies (euro) in the BF-funded ecosystems, 3 and 10 largest outliers by *turnover* (euro) excluded.

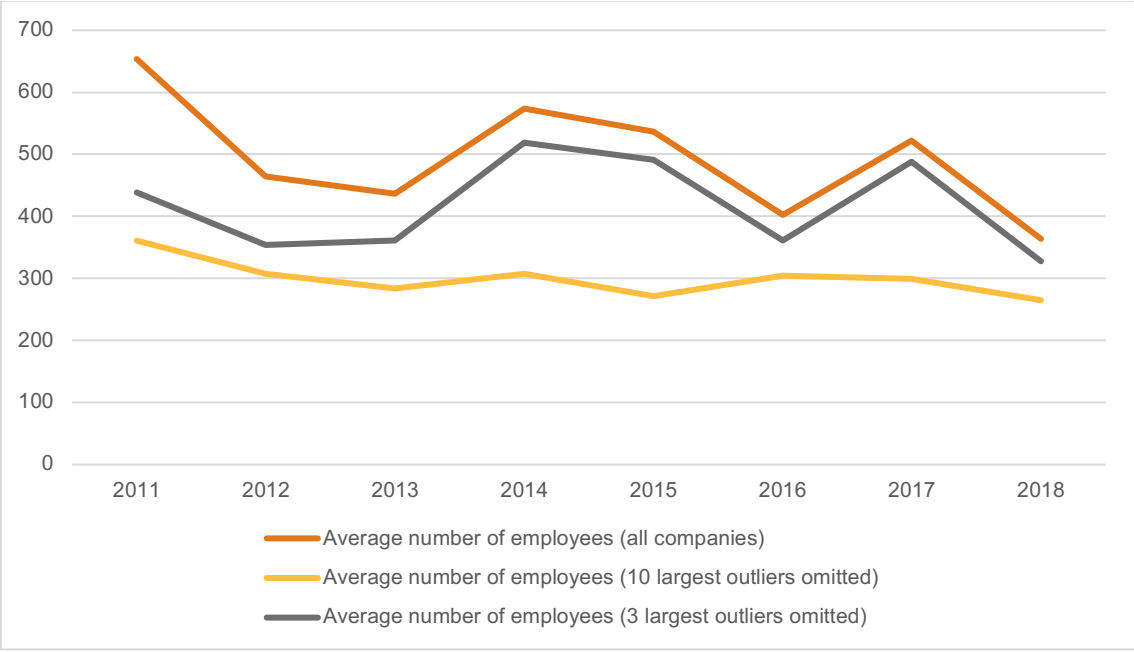

Figure 22. Average employment of member companies in the BF-funded ecosystems, 3 and 10 largest outliers by *turnover* (euro) excluded.

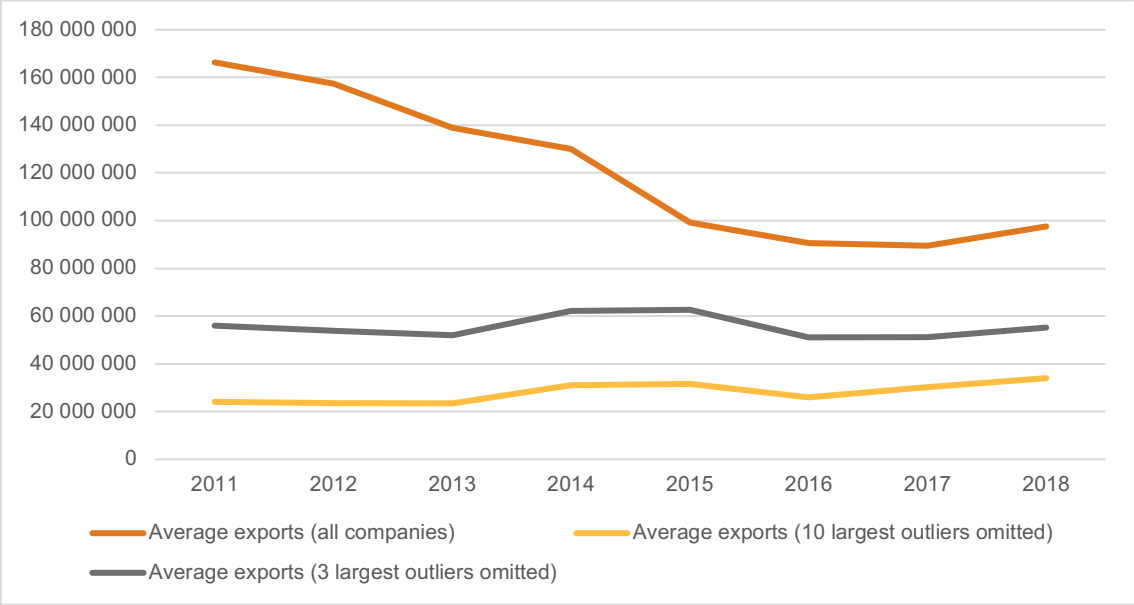

Figure 23. Average export turnover of member companies (euro) in the BF-funded ecosystems, 3 and 10 largest outliers by *turnover* excluded.

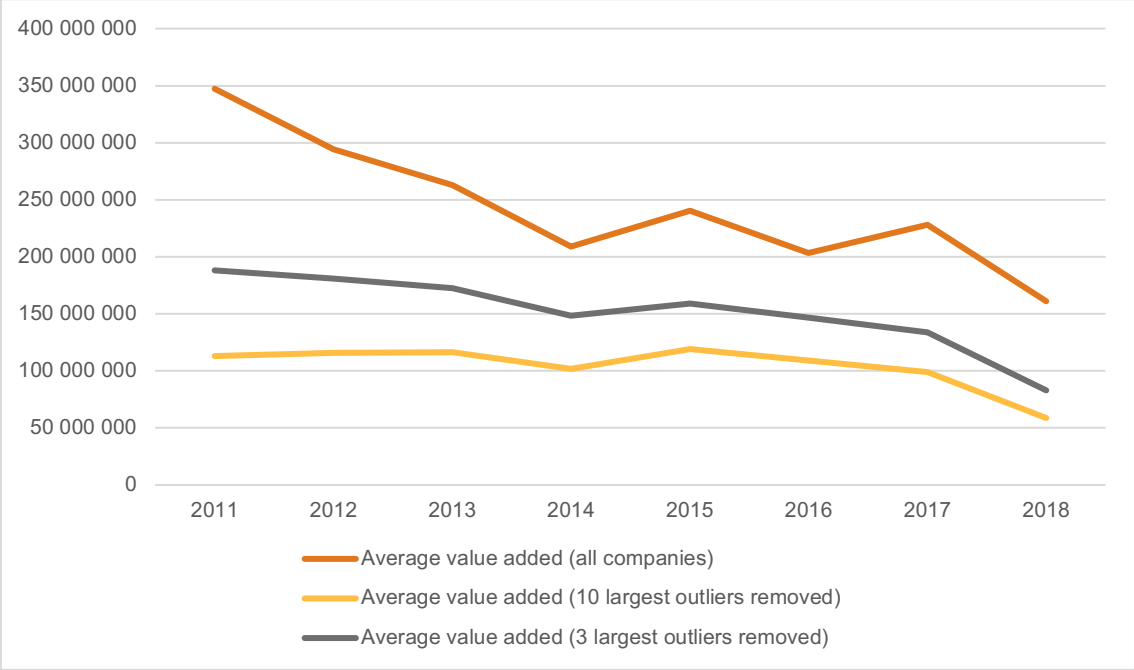

Figure 24. Average valude added of member companies (euro) in BF-funded ecosystems, 3 and 10 largest outliers by *turnover* excluded. (values for value added for some individual enterprises were missing for the last year, affecting the results for individual ecosystems, they were filled in with values for the previous year)

3.2. Development paths and bottlenecks

The development paths and bottlenecks of the ecosystems were analysed based on the available data including e.g. the interviews of the BF account managers representing each ecosystem. **The ecosystems overlap thematically, as well as in terms of** members. The following figure illustrates these linkages between the different ecosystems. The figure is formulated based on the interviews conducted among the ecosystems and data of ecosystem members or partners. (see Figure 25).

The interviews as well as other data higlight that, within a given business area or industry, there is a limited number of actors. This is evident in three interconnected 'macro-ecosystems' or 'ecosystems of ecosystems' focusing on a) health, b) recycling of raw materials, and c) machinery and mobility. In each of these macro-ecosystems, a handful of large enterprises from their respective industries, are partners in all of the ecosystems in some capacity.

What further illustrates the layering of the various ecosystems, is the emergence of rather **clear crosscutting themes**: digitalisation, and particularly new data driven operating/business models across 'traditional' industries, including healthcare, machinery, mobility and logistics; recycling/upcycling waste and raw materials; and as a smaller theme, renewable energy technologies.

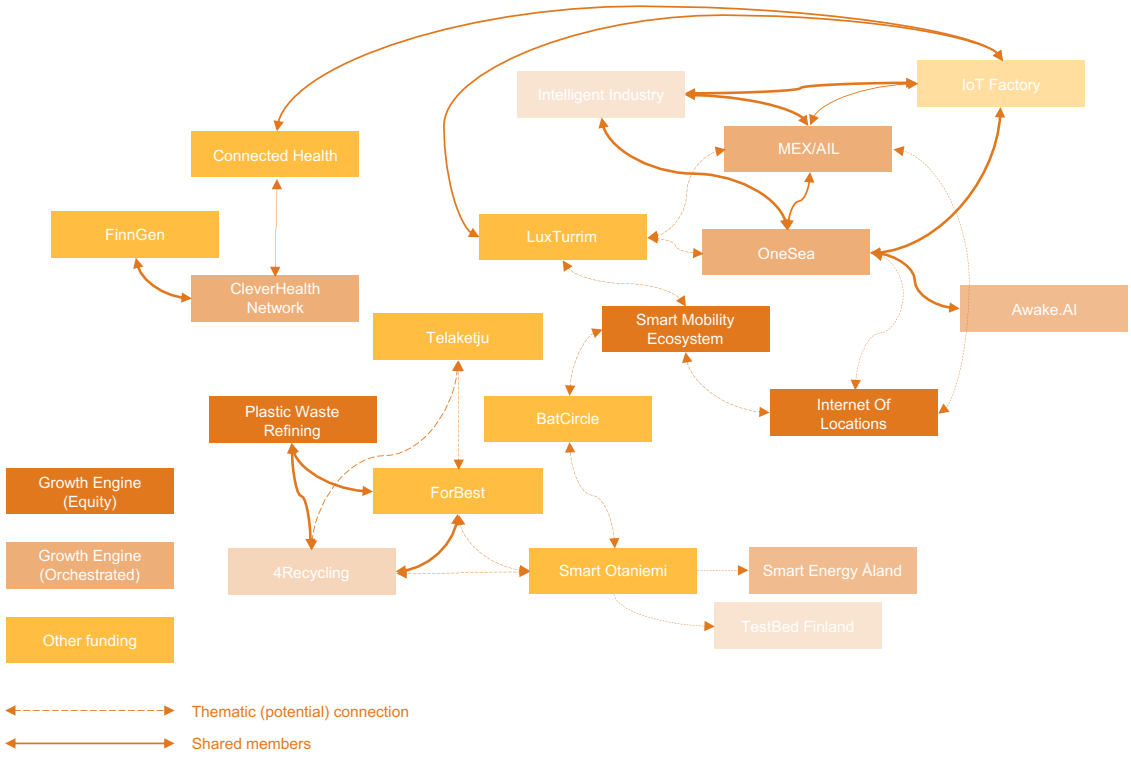

Figure 25. Illustration of the linkages between the selected ecosystems.

Some of the ecosystems aim to be **'ecosystems for ecosystems'** or innovation platforms that will output ecosystems. The operating logic for these is ecosystems is to raise funding for project

portfolios that will grow into new eocsystems of their own. This concerns foremost the orchestrated ecosystems, where the orchestrator is a third party in the direct value chain. This is a feature of the incentive structure, as the orchestrators are the main nexus of the partner network, but without the means or intention to scale innovation to markets for themselves, they aim to create a large portfolio of projects that conceivably produce innovation (-s) that will be commercialised and scaled up by some of the partners. As such, they are functionally interchangeable with 'traditional' accelerators, innovation platforms, innovation cluster organisations, or technology transfer offices.

The interviews validated the finding that **most of the ecosystems are in the birth or start-up stage**. The background of the ecosystems is in most cases a mix of enterprise- or opportunity-driven and facilitated, or policy-driven. The health area is an example of the latter, a central impetus for the development of the health and well-being is to a large extent the (need for a) healthcare reform and the associated system building activiites. The data availability, or lack thereof, may indicate that **many of the ecosystems are not organised to have stable processes** internally or externally. For example, a list of members/partners were readily available of few ecosystems, which may indicate that the partnership has not been stabilised.

Taking on average, almost regardless which funding or services have been offered to the ecosystems, it seems to be common that the development **of initial trust between partners and committment takes approximately the first 2-year funding period**. According to the interviews, even previous common RDI projects do not remove the need for building mutual trust and negotiating practices for collaboration. The central issue is to build trust and commitment to common goals and to settle requisite RDI activities to achieve them. As one interviewee indicated "*we can draw boxes and put organisations' logos there all we want, but actual commitment is always a question before serious activities ramp up".*

When commitment has been secured, usually internal dynamics give way to innovation activites. As a whole, actual RDI projects rarely pose a problem for the ecosystems. Although it is to be noted that there is a degree of survivorship bias; the study looked into ecosystems that are either in the hopeful first stages of development or have survived the initial turmoil.

The typical bottleneck for ecosystem development lies at the late stages of innovation. Multiple interviews indicated that **the ecosystems tend to get stuck in the piloting and demonstrations stage**. It is commonly recognised that (outside possibly IT) international sales projects are long and capital is needed to fund sales process. For many ecosystems, the market is relatively conservative with governmental or other institutional buyers, and the products are capital goods with long lifecycles. Consequently the buyer wants to be relatively certain that a solution provider is a stable enterprise that can deliver and support the solution lifecycle as needed also on the long-term. Additionally, the ecosystem needs to be able to react to potentially large orders. **The fundamental challenge seems to be finding an engine who will commit to bear the risk of scaling the innovation to international markets**. As one of the interviewees put it

> *"when you offer this [innovative capital good] to [a foreign institutional buyer], once they find out the seller is a relatively small business on the other side of the world, you can't get the time of day. And even if you get into the negotiations, and manage to secure an order, the next problem comes if they say 'alright then, we need 3000 [of these] by the end of the year'. Often in practice, the face of the product needs to be an multi-national enterprise to assure the buyer that they will not simply disappear at the first major challenge."*

All these factors point towards the direction that the sooner an ecosystem has a large enterprise with international standing and credibiltiy committed as the engine who will scale the innovation, the less negotiation and waiting at the experimentation stage is expected. IT makes an exeption to the rule; the IT markets are typically purchasing solutions from SMEs and the sales processes and product cycles are significantly shorter.

Based on the interviews, one of the major bottlenecks is time. The ecosystems are funded with the understanding that nominally a billion euro of new export-led turnover is expected after five years. Whether this is realistic or not, depends on the industry and typical technology and product cycle. If an ecosystem is to supposed to develop organically from recognition of opportunity to negotiating a joint set of goals, formation of a portfolio of co-innovation projects, which will result in joint RDI that leads to commercial products and services that are scaled up into export markets, all of these stages can take years in themselves. In health and especially biomedical field, 10-15 years is roughly considered a normal product development cycle and up to 20 years is not unheard of. Advanced microelectronics and advanced engineering products, such as machinery with complex embedded systems have a similar development cycle. Many of the interviewees mentioned the challenge of funding a “ten-year development project” in a risk-averse and short-cycled environment.

Consequently, many of the interviewees criticised the stability of funding. Funding two years at a time gives a wrong signal of expectations and further acts as a disincentive for committing to the necessary time and effort to achieve the goals. The stakeholders would rather see a longer roadmap drawn, where both the funding agency and partners would commit to agreed milestones over a longer prospective funding period, that could be put under review yearly or semi-annually based on achievement of goals for the period.

3.3. Role of Business Finland and other public sector actors

Ecosystem formation is a challenging on multiple dimensions that set a framework for BF and other third-parties to innovation. One dimension relates to dynamics of RDI and product development. As indicated by the interviews, typically if the (potential partner) enterprises are ready to deliver a product for the market in the near future, they are already locked in to their proprietary solutions, business models, and technology, and any joint development or co-innovation is relatively superficial. Thus **development of an organic ecosystem should start with joint definition of market and needs, and a mutually owned business case, that goes on to co-innovation of solutions.** This, however, sets the goal of market entry and scaling innovation far into the future, as discussed, and in practice these projects tend to fall in between actors’ interest. Five to ten year RDI projects are stereotypically hard to market in the internal dynamics of large enterprises and tend to be financially unviable to SMEs, which makes BF’s role elemental.

Another dimension is that the enterprises who own the market, and the enterprises who would need to renew their business models and to innovate to retain competitive position, are not necessarily the same enterprises that have novel ideas ideas and drive to innovate. Thus the role of funding agencies, intermediaries and other third parties is to push with a rope, to offer suggestions and ask informed questions, to get the three interest to align in one consortium.

Based on the interviews, **BF has played an active role in several of the analysed ecosystems**. Particularly the health area has been a subject to system building activity. This relates to the ongoing healthcare reform and various activities in developing applications and services around healthcare data, that mirrors the development of evidence-based management in the public health sector. Another example is the mobility area, where Mobility as a Service (MaaS) was introduced as a concept late in the Witty City programme (2012–2017) and continued into the Smart Mobility programme. MaaS ties into the reform of the Transport Act and liberalisation of fared mobility services. Outside these clear cases, more ecosystems have borne out of BF programmes and other activities, and BF has been active in the inception.

Table 4. The summary of ecosystem dynamics and the role of Business Finland.

Ecosystem	Role of network engine	Scaling path	BF Role
BatCircle	Aalto University Major industrial partners are developing a value chain	Partnering major manufacturing enterprises develop recycling technologies and value chain to be scaled to global markets.	Industry-led initiative, BF has been active in the area
FinnGen	University of Helsinki coordinates with biobanks	Pre-competitive research, unclear scaling path, but partnering biomedical enterprises are expected to develop products and scale innovations. FinnGen essentially is an innovation platform and infrastructure project.	BF has been active in inception, FinnGen is one of the early ecosystem pilots
Telaketju 2	VTT Turku polytechnic, South-Eastern Finland Waste Management	The partners have built value chain for textile recycling and piloted technologies, a plant for domestic textile recycling is being built. Unclear path to global markets.	Industry-led initiative, BF has been active in the area
CleverHealth Network	HUS coordinates with the industrial partners	Unclear, partnering biomedical enterprises are expected to develop products and scale innovations. CleverHealth has aspects of innovation platform project and is an important role in HUS RDI.	BF has been active in inception, CleverHealth is one of the early ecosystem pilots.
ForBest	Fortum is a clear network engine with strong ties to selected partners	Partnering major manufacturing enterprises develop recycling technologies and value chain to be scaled to global markets	Industry-led initiative, BF has been active in the area
LuxTurrim5GPlus	Nokia is a clear network engine with strong ties to selected partners	Technology development is successful and being piloted, scaling path is unclear	BF has a long history in the ICT sector and has facilitated the ecosystem inception.
Smart Mobility Ecosystem	Kyyti Group is the engine	The network engine has a clear value proposition and aims to enter the global market.	BF has facilitated the ecosystem in the Growth Engine process.
Smart Otaniemi	VTT coordinates the partners	Unclear, an ecosystem of ecosystems in a pre-competitive phase. Has aspects of an innovation or piloting platform, complementary to the Test Bed Finland -concept.	BF has facilitated the ecosystem in its inception. The ecosystem is rooted in the Smart Energy programme.
Adaptive Industrial Loops	MEX Finland is the orchestrator with major industrial partners	Partnering major manufacturing enterprises develop new digital business models and solutions for global markets	BF has facilitated the ecosystem in the Growth Engine process. BF has a long history in manufacturing and machinery.
Connected Health Ecosystem	GE is a clear network engine with strong ties to selected partners	The major industrial enterprise develops a product line and a digital platform that will be scaled to global markets.	BF has been active in inception, Connected Health is one of the early ecosystem pilots.

Ecosystem	Role of network engine	Scaling path	BF Role
Internet of Locations	ICEYE is the engine	The network engine has a unique value proposition and aims to enter the global market.	BF has facilitated the ecosystem in the Growth Engine process.
One Sea	DIMECC is the engine Former network engine defaulted out of the business area	Unclear, the ecosystem is in restructuring phase and searching for scaling paths	OneSea is an industry-initiated ecosystem, BF has a long history in the maritime sector.
Plastic Waste Refining Ecosystem	Griffin Refineries is the engine	The network engine aims to enter the global market with a modular value chain comprising the partners.	BF has facilitated the ecosystem in the Growth Engine process.

Besides system building, **BF has been rather active in enterprise- and opportunity-driven ecosystems in the inception**. The added value of BF expertise is the ability to **ask informed questions and introduce enterprises to each other**. Reportedly enterprises benefit from new ideas and enrichment from external advice of BF or intermediaries, when developing the consortium and project portfolios. As such, the roles of BF and separate third-party orchestrators are similar in the ecosystems' lifecycle. The major difference is that the role and incentive for the orchestrators is developing project portfolios, matchmaking and secondarily funding administration.

Increasingly, also **collaboration with regulators and other public institutions** is a feature in the ecosystems. Collaboration ensures data availability and enables development of services within the legal framework as well as development of innovation-friendly regulation. The mobility and health ecosystems are in particular examples, where regulators are important stakeholders and even partners.

The critical question is that external ideas take time to be digested with the partners and achieve committed action. This question ties into the timeline necessary to achieve an organic business ecosystem and how well do the services follow that timeline. The effect of industry and technology lifecycle was discussed above, but additionally, **the internal dynamics of the ecosystem and position in the technology cycle is crucial for setting realistic expectations and tailoring services**. At one end of the spectrum, given an MNE with top management committed to the ecosystem and the technology already in the piloting stage, two-year funding period can bring major outcomes. At the other end, a large consortium where the consortium does not have a sharp common interest and a 'natural' lead enterprise or other self-evident scaling vector, and technology development starts from opportunity recognition, ten years is spent before the billion-euro turnover target is realistic. In the first example, what is needed and expected from BF is risk-sharing, that makes investment into new business palatable to the enterprise(-s) management. In the latter, it is expected that the (prospective) ecosystem needs multiple (kinds of) services over some years to foster formation from an RDI project consortium into a business ecosystem.

4. POTENTIAL AREAS FOR NEW ECOSYSTEMS

One objective for this study was to analyse the thematic portfolio of the ecosystems and identify potential thematic areas for new ecosystem initiatives. For this purpose, key national and EU level policy documents and reports were analysed (Appendix 3). The findings of this analysis are summarised in the following map (Table 5).

The figure organises opportunities in the analysed policy documents into (generic) technology areas (columns) and application areas or ‘sectors’ (rows), focusing on the identified national priority areas. The logic is that technology development creates value, and applying technology captures it by creating business, and thus most impact would be achieved when combining development of technology to a clear value proposition relating to specific application area.

The analysis shows that there are several BF-funded ecosystems in the IT/digitalisation column, which can be considered as traditional Finnish ‘comfort zone’. However, as pointed out in the preceding analysis, bio & circular economy has gained significant traction as well. The areas that still wait for formation of (the BF-funded) ecosystems are the ones linked to the opportunity areas somewhat ‘less traditional’ in terms of Finnish economic history: experience economy, new work and arctic. Especially the lack of (explicitly) ‘arctic ecosystems’ can be considered surprising, given that it has been one of the national priority areas for many years. However, it should be noted that ‘new work’ and ‘arctic’ are very ambiguous and can be inherently included in some of the existing ecosystems. The analysis is based on the same list of identified HPEs that has been the basis for the entire study, so some emerging ecosystem that have not yet risen to the status of HPE may be in the making. It should also be noted that the lack of such ecosystems should be seen as a failure of BF to cover these areas, but rather as an indication of applications BF has received.

Additionally, the Horizon Europe and other EU-policy developments give rise to additional specific opportunities within the map (marked with orange text). Some of the existing ecosystems are adjacent to these opportunities, but have not, at least yet, addressed them. Perhaps the largest opportunity that has quickly risen to European agenda is security policy and the security dimension of RDI.

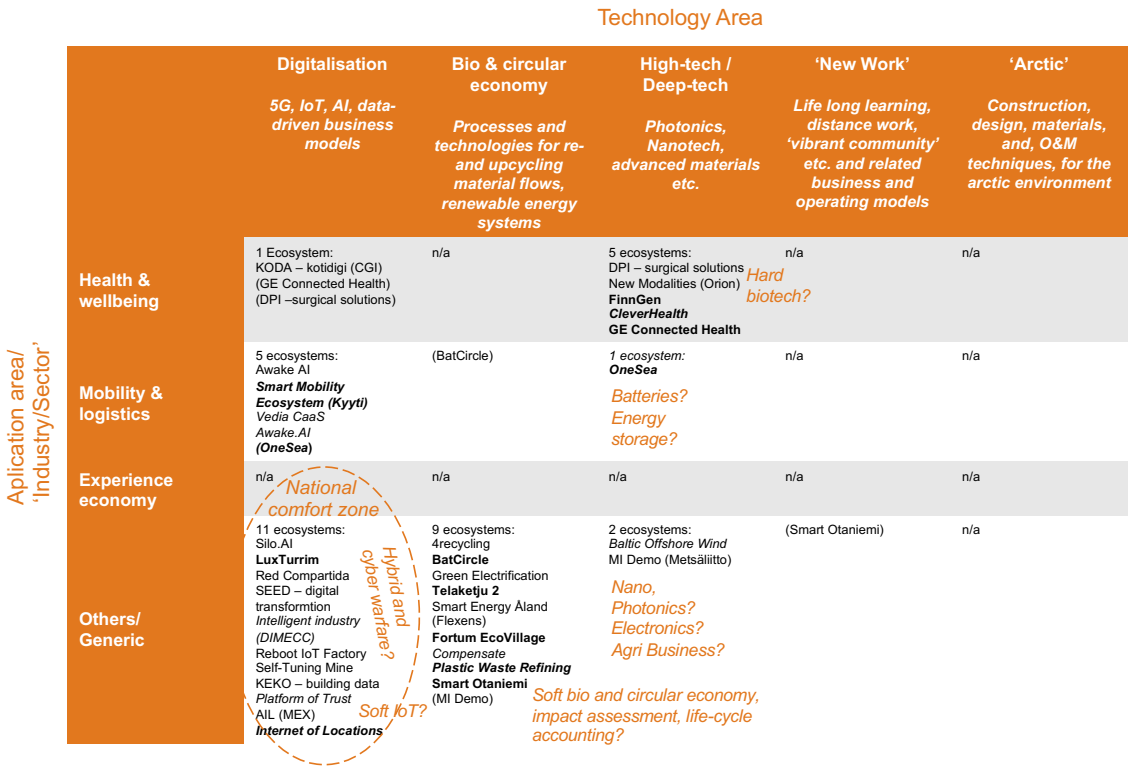

Figure 26. Mapping of BF-funded ecosystems along the recognised opportunity areas (Growth Engines marked in italic style, and the selected case-ecosystems in bold). Orange texts highlight the opportunities recognised in the specific scenarios of the BOHEMIA-study that have not as yet been addressed by the analyzed ecosystems

The previously published Growth Portfolio (MEAE, see Appendix 3) was used in the preceding analysis as an important input. During the time of the writing, MEAE is updating the Growth Portfolio. **Error! Reference source not found.** illustrates how the BF-funded ecosystems are linked to the new and updated (provisional at the time of writing) list of growth opportunities. At this stage, however, the list of growth opportunities does not yet provide any assessment of Finland's competitiveness relating to the opportunities. This assessment will be conducted in the next phase of the Growth Portfolio exercise.

Consistent with the previous, most linkages are found to the effective digitalisation category 'Transformation of business' (Transformations of business models / operating environments – 17 ecosystems). The second most common linkages are to the bio & circular economy opportunities (Sustainable use of natural resources – 13 ecosystems) and energy system (10 ecosystems). The third most common linkages are to Health and Pharma Solutions (10 ecosystems). Additionally, very few BF-funded ecosystems link directly to services or wellbeing, and none of them to food systems and experience economy.

Table 5. Mapping of BF-funded ecosystems (33) against (preliminary) growth opportunities identified in 'Kasvuportfolio 2.0' project (based on a working document dated 27.5.2020, update on-going during the time of the writing). All ecosystems have been linked to two (2) growth opportunities. The translations made by authors.

Growth opportunity area (in Kasvuportfolio 2020)	No. of BF-funded ecosystems with links to the opportunity	Share of all links
Sustainable land use and food production	**0**	**0 %**
Sustainable and safe energy system	**9**	**14 %**
Sustainable use of natural resources	**13**	**20 %**
Transformation of business models and operating environment	**17**	**26 %**
Data economy and platform economy	*6*	*9 %*
New management models and user-centric practices	*5*	*8 %*
Utilisation of key enabling technologies	*6*	*9 %*
Operating models for experience economy	*0*	*0 %*
Renewal of services	**3**	**5 %**
Functioning infrastructure	**6**	**9 %**
New forms of mobility and logistics	**7**	**11 %**
Health and pharma solutions	**10**	**15 %**
Sustainable wellbeing	**1**	**2 %**

5. FRAMEWORK FOR MONITORING AND EVALUATING ECOSYSTEMS

The presented approach for monitoring and evaluating ecosystems is twofold. First, the overall impact logic of ecosystems' (collaboration and co-creation) activities. The purpose of this framework is to help Business Finland and other actors to better understand the development of the (BF-funded) ecosystems and assess their evolution in the future. The framework should be considered as a draft suggestion. Refining the framework and indicators is highly recommendable based on future lessons.

Second, a framework for evaluating and assessing BF impact in supporting ecosystems. This will provide a framework for the impact study to be conducted in autumn 2020. It is suggested that the framework will be further refined at the beginning of the impact study.

5.1. Framework for monitoring ecosystems

The basis for the monitoring is the intended impact and the precedents as laid out in the logical framework in Table 6. In line with the logical framework approach, the framework distinguishes between the activities (and inputs), outputs, direct outcomes and impact (goal) (IOOI).

The **inputs** refer here to the amount of financial and human resources (funding, expertise, time) allocated by different stakeholders to the development of the ecosystem. **Activities** refer to the collaboration and co-creation activities conducted in the ecosystem in order to build collaboration between the ecosystem members. It should be stressed that the focus here is on the *collaboration and joint efforts,* excluding the activities of individual ecosystems members from the analysis.

The **outputs** refer to the concrete outputs resulting from the ecosystem activities. This includes, for example, joint strategies or collaboration projects. It can also refer to the behavioural additionality of ecosystem activities, i.e. changes in the ecosystem members' behaviour. This is indicated for example by increase in the commitment of the members towards the (joint efforts of the) ecosystem.

The **outcomes** refer to the *direct* outcomes of the ecosystem activities such as new products, services and solutions provided (jointly / as a result of ecosystem activities) by the ecosystem members. Outcomes can also refer to new markets accessed (through the networks developed as part of the ecosystem).

The **impacts** refer to the indirect (society level) outcomes, which are linked to BF's impact goals of economic renewal and growth through new billion-euro ecosystems. This can be measured with indicators reflecting the ecosystem participants' turnover, value added, employment, productivity & export growth. The challenge here (as discussed in Chapter 3) is, that monitoring company level data does not yet reflect the development of the ecosystem as it is likely that (especially in large companies), only a fraction of their KPIs reflect the business relevant for the ecosystem. Therefore, these macro-level indicators should be supplemented with additional (qualitative) data.

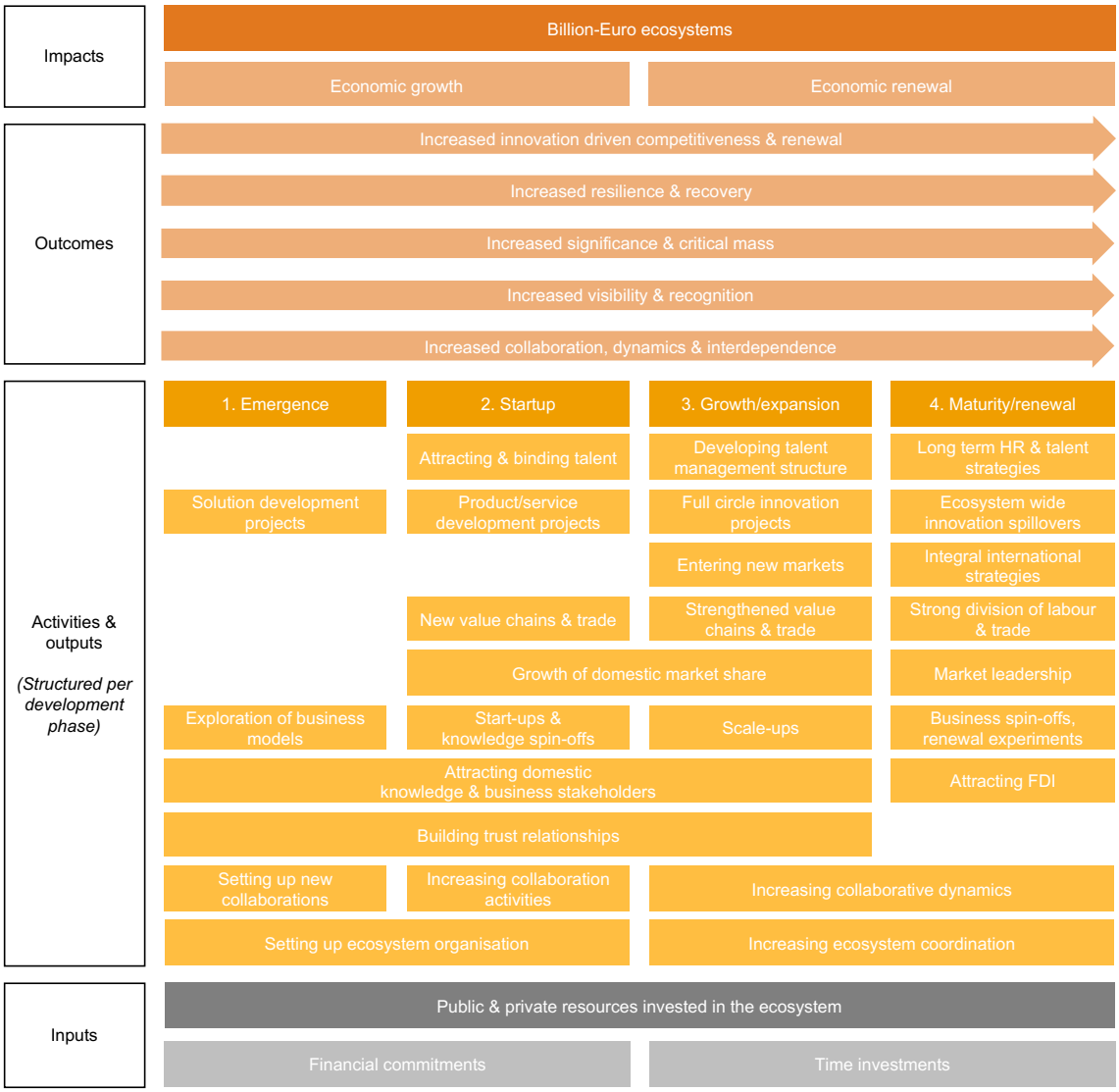

Figure 27: Mapping the generic inputs, outputs, outcomes and impacts (IOOI) of ecosystems and associated activities

Overall, it should be noted that available register data is mainly focused on industry level and, although it can be used to indicate general development within the ecosystem main sector, it does not provide sufficient data on the development of the ecosystems, typically crossing several industry sectors. Furthermore, the data is mostly available on *company* level and, as discussed above, using this data for monitoring ecosystems can be misleading as it is likely that only a fraction of the companies' business is relevant for the ecosystem.

The core of the problem is that economic register data that is based on accounting information is a historical view; turnover, employment and value added capture what has been done and achieved, but not reliably what will happen in the future. The exception in financial figures might be the development of RDI investments, that signal commitment and a degree of trust in new business opportunities. Additionally, the volume of joint RDI projects, and resulting co-patenting may give an indication of substantial ties between partners. Similarly, joint ventures, VC and other investments in

SMEs or start-ups, and FDI may be better indicators than other financials for future potential. The following table is a collection of measures or indicators that can be used to anticipate.

Further, the interviews highlighted the view that especially in the early stages of the ecosystem lifecycle, explicit attention should be paid to quality of work and competitiveness compared to international standard. The challenge is that qualitative assessments are hard to quantify, but some measure of explicit reflection, peer review and/or benchmarking of the activities and initial outputs/outcomes should be included to monitoring to enable more transparent assessment of the development.

Another aspect of measurement is isolating what makes an ecosystem an ecosystem, i.e. more than a sum of its parts. Measuring the ecosystemic aspects entails developing measures for mutual trust in the networks, trust, quality of collaboration. E.g. the BF self-assessment for the ecosystems included measures such as IP-agreement between members, joint strategising, in the form of RDI roadmaps, lobbying and market development activities (c.f. Annex 5). Perhaps one step further is needed, that is, the assessment the quality of joint strategising: Referring to the quote above about organizations' logos in boxes, a competent person writes a strategic agenda and roadmap for an ecosystem relatively routinely, but the crucial question is whether the content is realistic in the context of the members of the ecosystem and their competitive position in a given market, and whether the ecosystem members subscribe to the presented conclusions and commit to the paper. This regrettably puts the onus on the funding agency to 'stay on top of' the ecosystems and verify the quality of activities.

Additional component that relates to future viability of an ecosystem is general development activities towards the sector, such as sectoral strategizing, activities in industry associations and building future capacity through various HR development activities, such as collaborations with various levels of education and research institutions, mentorships and resident researcher programmes etc.

Therefore, it is recommended that in order to better understand the ecosystems, BF gathers regular feedback from both ecosystems' account managers, orchestrators as well as directly from the ecosystem members / beneficiaries, at least once a year in a centralised manner. This should provide BF more systematic feedback on the development of ecosystem and involvement of companies in the ecosystem. The feedback should be recorded preferably on the fly, with a low threshold for noting down impressions.

Lastly, time and life-cycle of an ecosystem needs to be taken into account in monitoring as well. In the first stages of the ecosystem, turnover and similar financials are important to record as a baseline and can be used to estimate the overall health of the members business, but a net impact of ecosystem activities to the members turnover is expected after some years of building and stable operation of an ecosystem. Thus, in the early stages of exploration and experimentation, the bottom half of the following table are more immediately relevant indicators. Once the ecosystem proceeds to scaling and towards maturity, the top lines become relevant.

Table 6. Logical framework for *monitoring* ecosystems (LogFrame) decomposing the path from the goals to specific activities.

Level	Description	Indicators	Means of verification	Assumptions
Goal (impact)	Economic renewal and growth through new billion-euro ecosystems	• Ecosystem participants' turnover, value added, employment, productivity & export growth (annual) – share of business relevant/attributable for the ecosystem • Foreign direct investment, number and volume of investments, fraction of the ecosystems from industry total FDI	• Business register • FDI statistics	New ecosystems are sustainable and generate spill-over effects to broader economy
Outcomes of members activities	Emergence/ evolution of the ecosystems	• No. of new markets accessed • No. of new products, services and solutions developed (and attributable to the ecosystem) • Members' R&D activity, no. of projects, volume, quality of RDI • N • Access to capital, VC investments, equity loans	• Documented evidence (e.g. patent applications, R&D investments, etc.) • Regular feedback surveys for members	Outcomes are globally competitive, there is a stable market that can be captured and held
Outputs from ecosystem	Outputs from ecosystem activities, behavioural additionality of ecosystem activity	• No. of active members, with significant contribution to the network • Fit between partners capabilities, assets, processes and organization cultures • Members' commitment to ecosystems • Joint strategies, projects, new networks, etc. (ecosystem specific)	• Regular feedback surveys for members	Outputs lead to concrete actions and changes in participants' behaviour, including better RDI and larger RDI volume
Ecosystem building activities	Ecosystem collaboration / co-creation activities	• No. and volume of externally and internally funded RDI projects • Quality assessment/internal peer review of RDI activities • Networking, collaboration activities, etc. (ecosystem specific) • Capacity building, research stays, residencies, fellowship, education development • Added value of orchestrator	• Ecosystem manager/ coordinator reports • Regular feedback surveys for members/partners • BF register	Members have the capability and resources for world-class business, there is a viable business idea the members cannot do individually, members are active and committed to the ecosystem
Inputs	Resources allocated to ecosystem activities	• Amount of financial and human resources (expertise, time) allocated to ecosystem facilitation • Estimated capability/competitiveness of the allocated resources	• Ecosystem manager/ coordinator reports; feedback surveys • Peer review/expert estimate	n/a

5.2. Framework for assessing Business Finland impact on ecosystems

The framework above does not yet take into account the impact and additionality of BF activities in supporting ecosystems. For this purpose, a more specific overall impact logic model for BF activities towards the ecosystems was created. An overview of the model is presented in Figure 28. The model, in line with OECD/DAC recommendations, identifies the following criteria for evaluating BF impact on ecosystems.[6] Although the focus of the impact study is on the impact criteria, it is important that also the other criteria will also be considered in assessing the role of BF in supporting

[6] Evaluation Criteria. OECD. https://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm

ecosystems. For example, the relevance and coherence criteria can be equally important in order to ensure that BF activities address relevant 'market gaps' and are in line with other policy interventions.

- **Relevance: Is the intervention doing the right things?** The extent to which the intervention objectives and design respond to beneficiaries' global, country, and partner/institution needs, policies, and priorities, and continue to do so if circumstances change.
- **Coherence: How well does the intervention fit?** The compatibility of the intervention with other interventions in a country, sector or institution.
- **Efficiency: How well are resources being used?** The extent to which the intervention delivers, or is likely to deliver, results in an economic and timely way.
- **Effectiveness: Is the intervention achieving its objectives?** The extent to which the intervention achieved, or is expected to achieve, its objectives, and its results, including any differential results across groups.
- **Impact: What difference does the intervention make?** The extent to which the intervention has generated or is expected to generate significant positive or negative, intended or unintended, higher-level effects.
- **Sustainability: Will the benefits last?** The extent to which the net benefits of the intervention continue or are likely to continue.

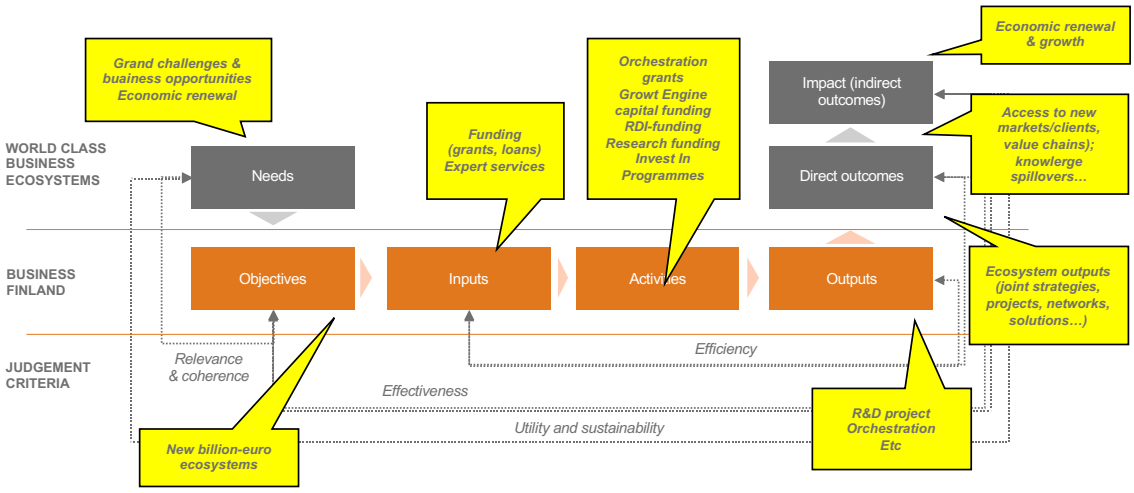

Figure 28. Logic for BF impact on ecosystems.

For assessing the impact (indirect outcomes) of the BF activities, the following four impact mechanisms were identified:

1. Ecosystem facilitation support (including both funding and non-financial services
2. R&D support (e.g. R&D grants and loans, research funding)
3. Network & expert services (e.g. BF programmes, export promotion and market access services)
4. Investment attraction

Overview of the mechanisms and their impact logic (additionality) is presented in Table 7. It is recommended that the impact study focuses on the first mechanism (ecosystem facilitation support), which can be considered as the primary (and most recent) type of intervention for supporting ecosystems. However, the other mechanisms should not be neglected and their role in ecosystems should be explored on a case-by-case basis. Additionally, one aspect not captured in the table is the role of selection of (prospective) ecosystems and the associated criteria. The first fundamental step in the process is selecting the beneficiaries with the most ability to leverage the BF funding and services to develop world-class ecosystems.

Table 7. BF services for the ecosystems and a summary of their impact logic (additionality).

Mechanism	BF inputs / activities	Outputs	(Intended/assumed) Additionality
Ecosystem facilitation support	Growth Engine orchestration grants	Ecosystem orchestration	Joint vision, increased collaboration between ecosystem actors, broader networks and new capability combinations
	Growth Engines capital funding	Ecosystem collaboration	'Solution stacks', new business models, access to new markets
	BF programmes	Programme events for beneficiaries and stakeholders, meetings, networking, matchmaking (depending on the programme)	Networking, new capability combinations, knowledge dissemination, international linkages…
	Non-financial support for ecosystems	Sparring, goal setting, etc.	Ambition, directionality, broader networks, new partners and new capability combinations
R&D support	R&D funding (grants and loans) for companies	Enterprise-led R&D-projects	New products and services Knowledge spill overs, Increased collaboration between companies & research organisations
	Co-innovation, co-creation, research to business (TUTLI) -funding	Joint applied research projects	
	Testbed Finland funding	New / scaled testbeds	
Network & expert services	BF thematic programmes Export promotion & market access services	Networking events, market information, client meetings	Knowledge dissemination
Investment attraction	Invest In –activities	Increased visibility of investment and collaboration opportunities, positive country and business environment image	New R&D investments and companies in Finland; global attractivity

5.3. Lessons on the evaluability of BF-funded ecosystems

Based on the findings and experience from this study, several lessons regarding the evaluability of BF-funded ecosystems can be drawn. These lessons have been elaborated on in Table 8.

Table 8. Lessons on the evaluability of BF-funded ecosystems.

Risks / challenges	Mitigation / lessons
Gaps in data on BF-funded ecosystems (e.g. members, services provided, etc.)	Focus on ecosystems with most data available to grasp BF impact; build on existing data and findings of this study
Difficulties in analysing large companies' business register data	Apply methodological triangulation and use multiple evaluation methods; Provide estimates of shares of 'ecosystem-relevant business' through interviews and surveys and/or company-specific register analysis
Vague definition of business ecosystems; various theoretical perspectives	Adopt pragmatic approach, focus on collaboration and co-creation elements within the ecosystems
Confidentiality issues	Focus on key overarching lessons, not on individual ecosystems / members; pay attention to the engagement of ecosystem actors and key companies
Multiple impact mechanisms	Adopt either case-by-case approach with each intervention and their contribution/additionality separately, and/or black-box the interventions and focus on outcome of BF in ecosystems with long enough history, an/or focus specifically on activities towards ecosystem facilitation.
Measuring the ecosystem residual	Additional focus on indirect measures of collaboration strength, including mutual investment, generated IP, cross- and co-ownership, joint ventures, strategies and binding mutual agreements.

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https://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm

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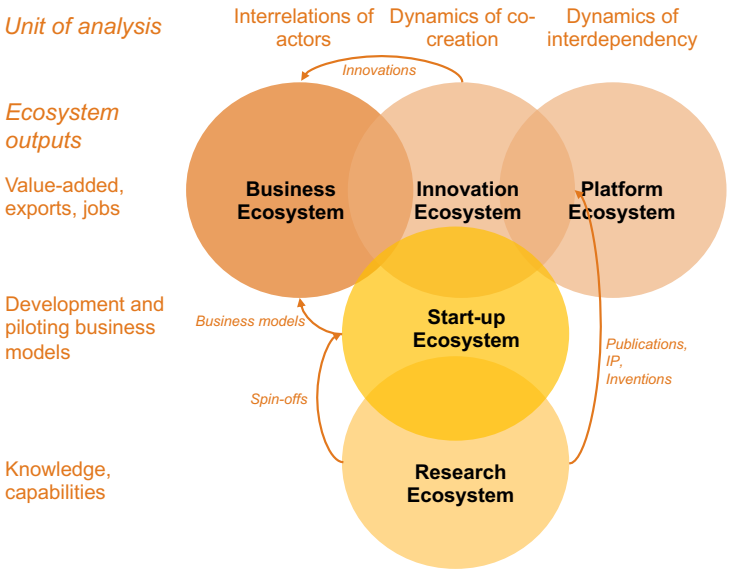
Ministry for Education and Culture (2020). Kansallinen tutkimuksen, kehittämisen ja innovaatioiden tiekartta (RDI Roadmap). https://minedu.fi/tki-tiekartta

MEE (2018). Business Finlandin tulostavoiteasiakirja vuosille 2019-2022.

APPENDIX 1: THEORETICAL PERSPECTIVES AND ANALYTICAL FRAMEWORK

Understanding ecosystems

Literature on ecosystems has proliferated in the last few years, with a multitude of perspectives. In short, as summarised e.g. by Thomas and Autio[7], researchers and practitioners have very different perspective to (industrial or economic) ecosystems, depending on the aims for the ecosystem activities and varied disciplinary conventions and theoretical lenses. The Appendix 1. Figure 1. illustrates these different perspectives.



Appendix 1. Figure 1. Types of (industrial or economic) ecosystems. Adapted from Thomas and Autio.

A regular point for discussion when applying the concept of ecosystems is that what is the difference between a cluster and an ecosystem. In the extant literature the definitions of a cluster reflect the cluster boom of the 1990s and the influence or feedback from policy interventions on the conception of a cluster, especially regarding the regional dimension. In turn, the definitions of ecosystems reflect somewhat excessive focus on B2C IT enterprises' business models. Discounting for those, the definitions are functionally interchangeable; an ecosystem is a cluster that works, or a cluster for the 21st century.

[7] Thomas, L. D. W., and E. Autio (forthcoming), "Innovation ecosystems", Oxford Research Encyclopaedia of Business and Management. Aldag, R. (Editor). UK: Oxford University Press.

Appendix 1. Table 1. Comparison between the properties of networks, clusters and ecosystems (adapted from Valkokari et al[8]).

	Ecosystems	Clusters	Networks
Purpose and goal	Growth of the ecosystem around customer needs and competition against other ecosystems; increased added value for ecosystem participants	Growth and competitiveness of the cluster regionally/nationally (jobs, GDP); competition against other clusters	Effective value creation, resource sharing, innovation
Means	Development of solutions and services on a common platform ('solution-stacks' / modules)	Innovation and creation of new business by sharing resources and knowledge	Clear roles and processes, mutually reinforcing partnerships
Members	Global network; network engine/platform provider(-s), suppliers, collaborators, stakeholders	Anchor companies/network engine(-s), other enterprises, stakeholders, intermediaries, universities in a certain geographic region	Transactional networks that develop into partnerships
Common factor	Platform, technology, services	Technology, services/resource sharing, value chain; geographic proximity, region	Technology, resource sharing, business interests
Collaboration	Co-opetition, co-evolution	Co-opetition; co-evolution	Transactional relationship
Management	Network engines / platforms orchestrate, de-centralised, self-organising	Network engines orchestrate; Facilitation by intermediaries / cluster organisations has a larger role	Transactional relationship
Public sector role	Regulation Less active direct role, knowledge production, IP generation	Knowledge production, IP generation	No large role in transactional networks, support for developing partnerships
Time scale	Time to maturity 20+ years, co-evolution	Time to maturity 20+ years, co-evolution	<1 – multiple years, depending on relationship type
Examples	Apple, Google, Nokia (?)	Forest cluster, Silicon Valley, Finnish ICT/telecom cluster	Sub-contracting networks
Perspective / roots	Management perspective; business strategy (e.g. Moore)	Competitiveness / policy perspective (e.g. Porter, Krugman)	Business Admin/Management research and practice

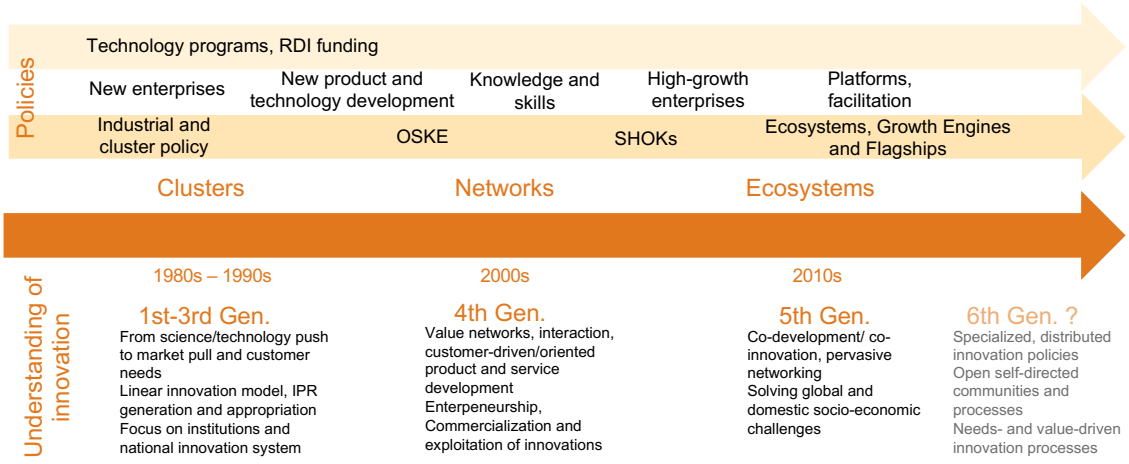
To sum up, despite the lack of clear definition, some common characteristics for ecosystems can be identified. These include, for example:

- Global and inter-regional nature
- Blurring of industry and sector borders
- Dynamic interaction and co-opetition
- Common goals, interests and values
- Self-directing and regulating, distributed responsibilities and decision-making
- Open knowledge exchange
- Adaptability to new environments
- End-users/customers have an active part in value creation

[8] Valkokari et al. (2014). Ekosysteemit ja verkostojen parviäly. Tulevaisuuden liiketoiminnan suuntaviivoja. VTT Technology 152, p.38.

Ecosystems in Finnish policy context

To contextualise the discussion in the evolving landscape of research, development, and innovation (RDI) and industrial policy, industrial ecosystems and policies to foster their formation and growth have not borne from a vacuum. There is a long-standing tradition of building networks, public-private -partnerships between various actors within the Finnish economy and innovation system. The following figure concisely illustrates that the policy rationale and goals have slightly varied, but the same core idea has followed in innovation policy since the 1990s. The basic need has been to support building competitive advantage of domestic industry, by fostering collaboration between research, development and innovation actors. Around this basic policy rationale, the terms and understanding of the dynamics of collaboration has evolved together with accumulation of research into industrial dynamics and competitive advantage.



Appendix 1. Figure 2. Overview of the development leading up to ecosystem policies. Source: Authors.

Understanding a business ecosystem

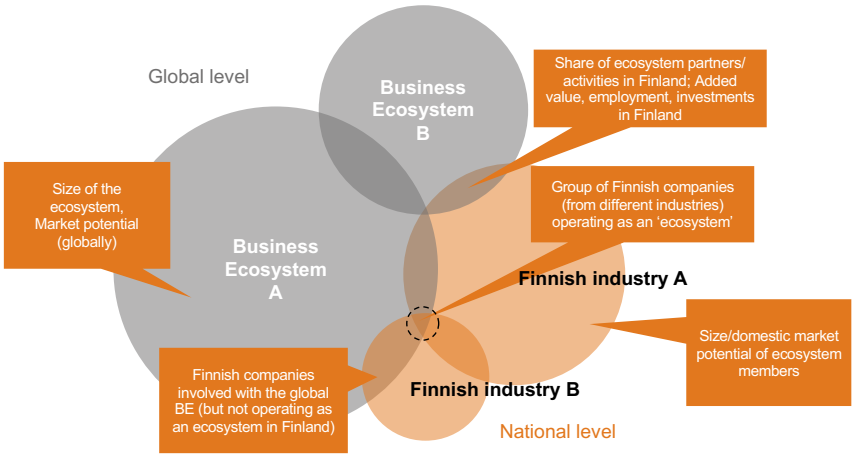
In this impact study the focus is specifically on *business ecosystems*. The concept of business ecosystem was first introduced by Moore (1993), who argued that a company should be "*viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries*". In a business ecosystem, according to Moore,"*companies co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations.*"[9]

Since then, the concept of business ecosystem has been further explored in academic and business literature. One of the most recent contributions was introduced by the authors from Boston Consulting Group (BCG), who suggested that business ecosystem should be seen "*as a solution to a business problem, as a way to organise in order to realise a specific value proposition*". According to the authors, "*a business ecosystem is a dynamic group of largely independent economic players that create products or services that together constitute a coherent solution."*Therefore, as argued by the authors, "*a business ecosystem is a governance model that competes with other ways of organising the creation of a product or service, such as a vertically integrated organisation, a hierarchical supply*

[9] Moore, J.F. (1993). Predators and Prey: A New Ecology of Competition. Harvard Business Review, May-June 29913, p. 76.

chain, or an open-market model." [10] Thus, (joining an) ecosystem should not be considered as an end itself, but as a mean to achieve something, to create more value than would be possible without it.[11]

However, mapping a business ecosystem is very difficult, and, as argued by Lansiati and Levien (2004), "drawing the precise boundaries of an ecosystem is impossible and, in any case, academic exercise".[12] The following figure further illustrates some practical challenges in drawing the 'ecosystem boundaries' in the context of this study.



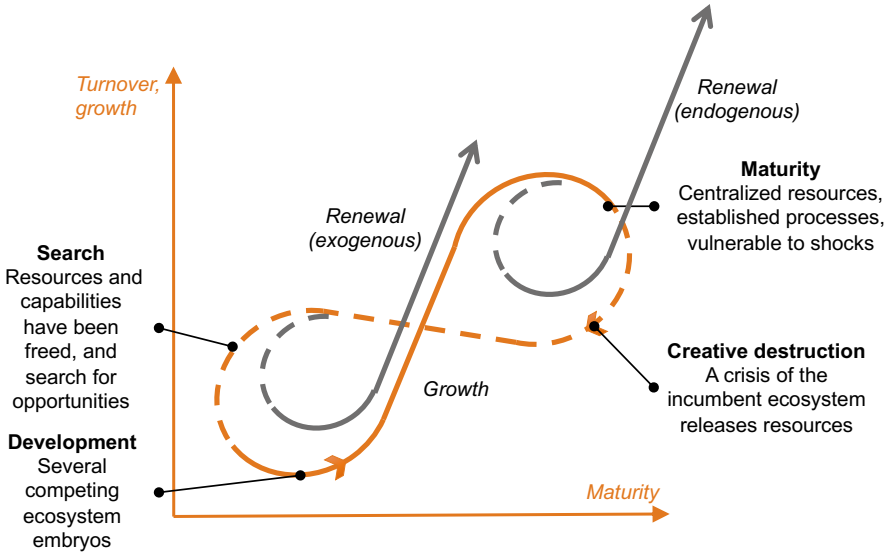
Appendix 1. Figure 3. Illustration of analytic dimensions of an ecosystem. Source: Authors.

Ecosystem lifecycle phases

Business ecosystems are typically categorised into different lifecycle phases. Moore (1993) labelled these phases as 1) Birth, 2) Expansion, 3) Leadership and 4) Self-renewal. Although other authors have introduced slightly different categorisations (e.g. exploration/search/emergence, birth/inception/development/start-up, growth/expansion, maturity/leadership), analysing the business ecosystems according to their lifecycle phase is an important tool to better understand the ecosystems and their (policy) needs.

As summarised by Salminen and Halme[13], ecosystems are in an evolution loop that forms an 'endless S-curve'. Following the S-curve path, an ecosystem is born when technology and market demand are brought together through entrepreneurial experimentation, and the competing solutions are "tested" in the market. Once adoption of an innovation reaches critical mass and a dominant design emerges, the ecosystem starts growing and refines the technology, products and services. Once the market saturates and technology is mature, the ecosystem is also mature and also most vulnerable to external shock and competition from substitutes. The ecosystem can either adapt to new market needs and competing technologies and products and services through internal renewal, or if another dominant design merges, it may enter a period of creative destruction and reorganisation or collapse, which in turn free up resources to seek new entrepreneurial opportunities.

[10] BCG (2019). Do You Need a Business Ecosystem? Boston Consulting Group, September 27, 2019. https://www.bcg.com/publications/2019/do-you-need-business-ecosystem.aspx
[11] BCG (2019). Do You Need a Business Ecosystem? Boston Consulting Group, September 27, 2019. https://www.bcg.com/publications/2019/do-you-need-business-ecosystem.aspx
[12] Iansiati, M. & Levien, R. (2004). Strategy as Ecology. Harvard Business Review, March 2004, p. 71.
[13] Salminen & Halme, 2017, Ekosysteemit uuden elinkeino- ja innovatiopolitiikan kohteena, TEM julkaisuja 3/2017



Appendix 1. Figure 4. Overall phases of an ecosystem lifecycle. Source: Salminen & Halme, op. cit.

For the purposes of this study, and to identify the lifecycle of BF-funded ecosystems, the following set of criteria for each phase was developed. Appendix 1. Table 2 posits the lifecycle phases with criteria or markers to distinguish the phases based on observable qualities of the ecosystem.

Appendix 1. Table 2. Characteristics of ecosystem lifecycle phases. Source: Authors.

Characteristic	1. Exploration	2. Experiment	3. Expansion	4. Established
Main / dominating actors	Universities, RTOs	Start-ups, spin-offs	HGFs, scale-ups, corporations	(Incumbent) Corporations, MNEs, global platforms
Main funding sources	RDI funding	RDI, seed, VC (local)	VC/ Growth (international)	Net cash flow, FDI, M&A/ Buyout
Time to (global) market / (TRL[14])	Very long / not known (TRL 1-4)	5+ years (TRL 5-7 [-8])	2-3 years (TRL [8-] 9)	Present < 2 years
Competition mode	Very few / no business initiatives	Various competing initiatives	Some emerging leading companies	One / few dominant companies / platforms
Strategic focus	Problem-solution-fit	Product/solution-market-fit	Business-model-fi	Establishing leadership, maintaining control of market, maximising share

Role of platforms, transactional vs. solution ecosystems

Besides lifecycle, another important aspect in analysing the ecosystems is to understand the role of (technical/digital) **platforms**. In some sources, platforms are said to be essential to ecosystems. However, the question is not necessarily so straightforward. In **transactional ecosystems**[15]

[14] TRL, technology readiness levels go from 1-9, where 1=basic principles observed; 4=validated in laboratory; 5=validated in a relevant environment; 7=prototype system proven in intended operational environment (demonstration); 8= actual compelte system proven in simulated environment 9= actual system proven in operational environment
[15] BCG (2019) op. cit.

(stereotypically consumer-oriented/B2C), where the platform provider 'owns' the client / end-user contact, the platform is the marketplace and creates rents for the platform owner. Ecosystems as a concept have been popularised through cases such as Google/Android, Apple iOS/Apple Store, Facebook, Amazon, Über and AirBnB. Focus on these examples have resulted in excess focus on the role of the platform.

In **solution ecosystems**[16] (often B2B), the platform might be e.g. a network, or an EDI standard, a set of application interfaces (APIs), or a data pool/cloud for e.g. machinery operating data. In these types of ecosystems, the platform is not the entire marketplace, but enables added value through third-party innovation and integration of third-party innovation through products and services offered form the ecosystem partners with variable degree of independence.

As summed up by BCG (2019), while the purpose of a transaction ecosystem is matchmaking ("identifying the best fit between the specific needs of a customer and the specific offering of a producer, and facilitating the subsequent transaction"), the purpose of a solution ecosystem is to "create a coherent solution".[17]

Another conception of a platform is an **intermediary organisation** that orchestrates the ecosystem. A good intermediary may be beneficial at the inception, but a working business ecosystem outlives the usefulness of an intermediary. The bottom line is that the platform can be *many things,* in the different stages of the ecosystem, that enable connecting businesses to create more value than they could otherwise.

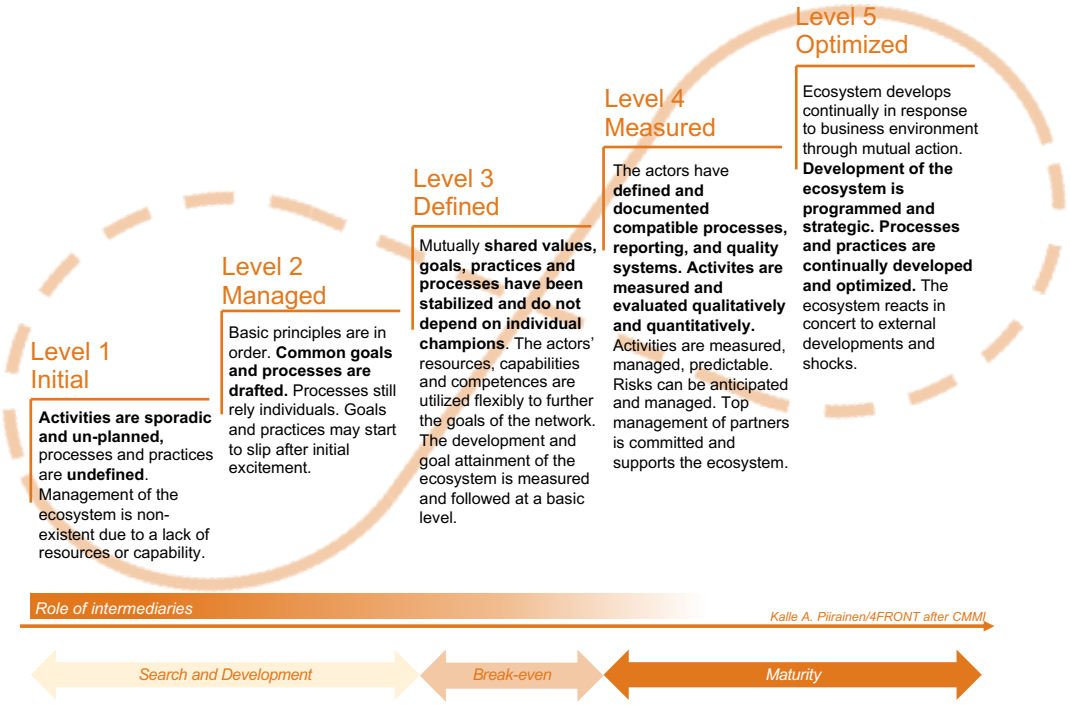
Appendix 1. Figure 5. The roles of a platform in a business ecosystem with illustrating examples.

Internal dynamics and co-ordination

Finally, business ecosystems can be analysed according to the maturity of the internal processes and level of coordination. Typically, in the search and development phases, the ecosystem layer is

[16] BCG (2019); for role of platforms, see also BCG (2020). How Do You "Design" a Business Ecosystem? Boston Consulting Group, February 20, 2020. https://www.bcg.com/publications/2020/how-do-you-design-a-business-ecosystem.aspx
[17] BCG (2019).

rather loosely defined, and the development of collaboration is sporadic and relies on individuals or intermediaries. Towards entering the growth phase, the partners forge a mutual understanding of common goals and value added, and practices and processes for collaboration are stabilised. In the mature stages, the processes are formalised and get built into the core operations of the enterprise, and the (core) partners form a strongly co-dependent relationship. As the relationships continue to evolve, the role of intermediaries diminishes in the mainline business activities.



Appendix 1. Figure 6. Development of internal dynamics in an ecosystem. Source: Authors.

APPENDIX 2: OVERVIEW OF BUSINESS FINLAND ACTIVITIES FOR SUPPORTING ECOSYSTEMS

BF objectives regarding ecosystems

The importance of business ecosystems and addressing societal challenges has been acknowledged in the Business Finland (BF) strategy (2018) and its emphasis on Finnish companies forming "strong and attractive ecosystem nodes to gain critical positions in global business ecosystems, driven by global challenges". The strategy also highlights the importance of access to knowledge, competence and talent as well as establishing "significant large-scale real-life experimental platforms and environments, attracting leading global companies".[18]

"World-Class Ecosystems and Competitive Business Environment" is also one of BF's strategic impact targets, as agreed between BF and the Ministry of Economic Affairs and Employment (MEAE)[19]. In the steering agreement it is agreed that:

- BF incentivises different size enterprises, research organisations and (other) public actors with RDI funding and program activities, to develop collaborations with one another and co-develop solutions, based on national areas of strength
- Developed solutions are predominately digital
- Innovative/pre-commercial public procurement will create reference markets
- Business Finland activities are attached to MEAE and university municipalities' strategic agreements to reinforce globally competitive ecosystems
- Business Finland is in its part in charge of developing means to attach to European networks, capabilities and funding
- Invest in -activities are linked to ecosystem development, and will be properly resourced

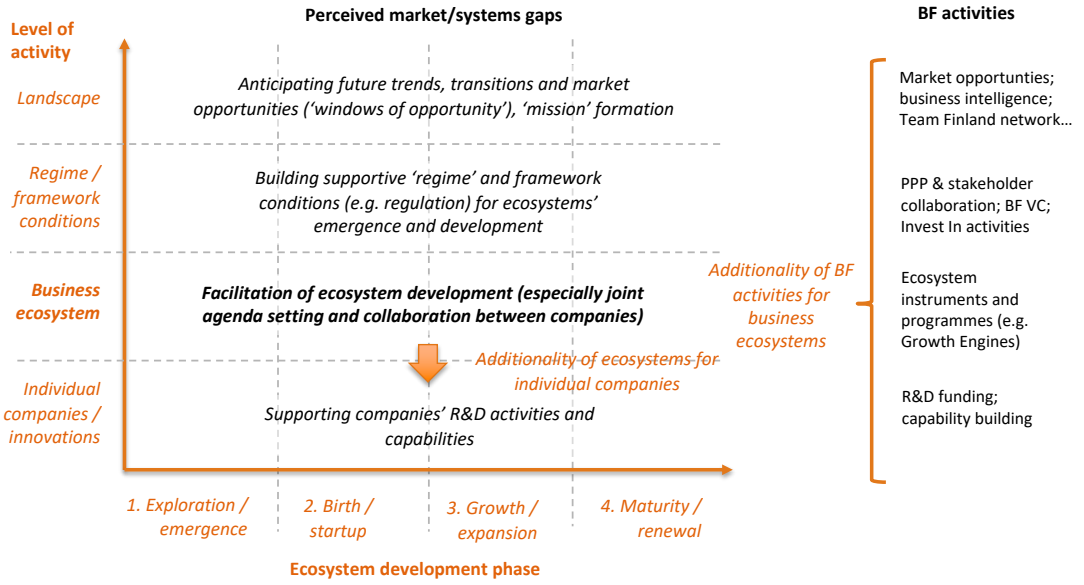
The quantitative target specifically related to ecosystems is that BF funds yearly 3-5 new 'ecosystem projects', which have the aim and a path to a billion euro new revenue by 2025.[20] To unpack the goal, it is understood, that each year BF picks a number of the most promising ecosystem embryos and assigns effectively an account manager to foster their growth. The rationale behind the numbers is that there is "deal flow" towards fostering significant exporting business ecosystems. Separately BF holds a bi-annually updated list of approximately 20-40 potential future high performing ecosystems (HPEs), that are recognised at a given time as the most potential initiatives to reach the billion-euro target within the ongoing strategy period.

Instruments for supporting ecosystems

BF focuses on recognising the seeds of high performing ecosystems (HPEs) and supporting their development towards maturity and billion euro business. To achieve these aims and support the development of business ecosystems, BF has introduced new specific support instruments, including various pilots, refined BF programmes (merging R&D funding and export promotion services) and the Growth Engine programme, which has so far provided funding for 15 enterprise-driven business ecosystem seeds.

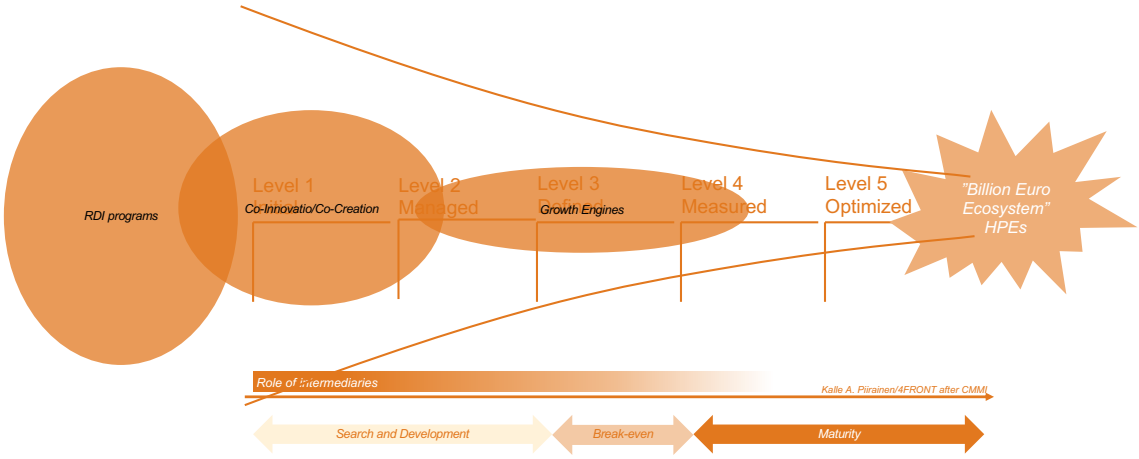
[18] Business Finland (2018). Business Finland Strategy 2018.
[19] MEE (2018). Business Finlandin tulostavoiteasiakirja vuosille 2019-2022.
[20] Ibid.

More generally, BF's *financing instruments* are RDI grants, loans (convertible to grants), and equity loans (non-convertible). These instruments are tailored into multiple *funding services* that comprise both financing as well as *expert services*. In addition, BF can support ecosystems with several non-financial services such as networking activities (e.g. in programmes) or export promotion activities (previous Finpro activities). Also Invest In -activities (attraction of enterprises and FDI) are relevant tools for supporting ecosystems. In this study, the focus is on funding instruments and services. The following figure illustrates the organising logic of ecosystem activities.



Appendix 2. Figure 1. BF services and the level of intervention. Source: Authors.

Companies typically enter BF services through the RDI programmes, if not initially innovation voucher or explorer grants. As they develop their business and more demanding RDI projects they find a place or are 'shepherded' into different types of co-innovation consortia and/or 'ecosystems'. Regarding HPEs, the basic logic is that BF beneficiaries are ushered from RDI projects, towards co-innovation consortia, which are encouraged to develop their potential towards becoming HPEs.



Appendix 2. Figure 2. BF instruments over the lifecycle of an ecosystem. Source: Authors.

Growth Engines

Growth Engines (Kasvumoottorit) is a relatively new service, or family of services. It was established in 2018 based on one of the spearhead initiatives of the Finnish government. Growth Engines comprise a family of services, that in practice split to two distinct service paths. The first path is an **orchestrator grant** for intermediaries that act as an orchestrator for an ecosystem (c.f. below), and the second path is **an equity loan** for the anchor enterprise of the ecosystem. These can be coupled with other types of funding or services for the individual ecosystem members.

The following figure illustrates the intended make-up of Growth Engines: they comprise a network engine or alternatively anchor enterprise, called *operator/platform company*, an *orchestrator* or facilitator, which is an intermediary to steward RDI planning and growth, and a network of *partners* which may include enterprises, research organisations and public/government entities.

Appendix 2. Figure 3. Intended structure and roles in Growth Engines[21]

Business Finland service offering for the Growth Engines includes all of the services from Business Finland, including the global network, various funding services, and an account manager, and three specific services for the Growth Engine orchestrators and operators/platform enterprises:

– The orchestrators, i.e. intermediaries which facilitate an ecosystem, are eligible for a grant, or orchestration funding (max 100 kEUR of 50 % subsidy for two years (at a time), provided the criteria in the following table is fulfilled after the first two years and every two years subsequently).
– The ecosystem platform enterprises, i.e. network engines or literally platform enterprises, are eligible for an equity loan (max. 400 kEUR, 75 % subsidy level, for 10 years, with an interest of 1 % according to 2018–2019 rules).
– The latest addition is the Growth Engine Competition, where selected Growth Engines have been granted further equity loan for ramping up the operations. These loans have been between 2 and 10 MEUR with variable runtime.

[21] BF Growth Engines – Orchestration of Ecosystems, BF Document #2045643.

Expectations for the Growth Engines[22] are presented alongside the selection criteria for the first round of funded Growth Engines, that represent the first service path. The notable fact is that from the BF side, the only specific KPIs in effect are (expected) business growth (altogether 5 criteria) and number of partners. Otherwise, the criteria are very much open to interpretation, and only a few criteria mention explicitly quality or participation of activities. The explicit criteria for the Growth Engine are presented in the following table.

Appendix 2. Table 1. Expectations for Growth Engines vs. selection criteria for innovation cluster funding (2018)[23].

Expectations for Growth Engines	Criteria for 1st phase (initial grant)	Criteria for 2nd phase (equity loan)
Aims at over billion euro new export business and/or investments in Finland	**1. Clear impact** - Orchestrator can argue the ecosystem/Growth Engine: has global market potential - will add new innovation-driven turnover and/or export growth and/or inbound FDI a billion euro a year The specific quantitative selection criteria are (current at the baseline year (2017) and estimates in 5 and 10 years after): - Current/Expected new turnover - Share of new exports from previous - New jobs (FTE) - New FDI - Paid taxes in Finland - New turnover and jobs outside Finland	**1. Growth Engine has KPI and explicit impact logic** - a monitoring system and determined KPIs exist The specific quantitative KPIs are (current at the baseline year (2017) and estimates in 5 and 10 years after): - Current/Expected new turnover - Share of new exports from previous - New jobs (FTE) - New FDI - Paid taxes in Finland - New turnover and jobs outside Finland
Develops holistic solutions to global market disruption	**3. Clear Growth Vision and preliminary roadmap** - Concrete and specific vision that supports the partners' (business and research organisations') mutual goals - Based on or creates disruption, the goal is to have a new radical approach or goal - Networking beyond industry or cluster boundaries, and with public actors (case-by-case) - Demand-driven, clear value proposition for the partners and end-users - Agreed on openness: clear and transparent rules for adding new partners (threshold criteria for orchestration funding) **4. Systematic and resolute action plan for developing the Growth Engine and fostering RDI activities** - A plan for different areas of development, nationally and globally - Description of activities to enable disruption and the risks and challenges associated with it - plan for first new co-development projects, pilots and demonstrations, and associated needs for knowledge and expertise - Description of the role of RDI projects in the vision for the ecosystem, a plan for generating RDI projects	**2. Internationalisation of the Growth Engine is determined and systematic. The Growth Engine has an internationalisation action plan** - Growth Engine has co-development projects or business with international partners - Growth Engine has created international visibility of partners **4. Detailed plan for development of international activities in practice** - A detailed plan for specific international operation between the partners, and resources - A plan of necessary joint projects, where the best actors in the world are involved - Business solutions are piloted/demonstrated with clients/users
Operates an open platform to foster collaboration between different actors and attract FDI (level of openness agreed separately)		**3. Clear vision, growth and renewal** - Vision has been focused into specific business models or new businesses - Business disruption and demand-driven nature is clearly present either through market studies or joint projects - Core partners are committed. There are several new committed partners, whose roles in the network are clear, and new projects are generated - New partners have joined (including MNEs, SMEs, stat-ups, and ROs) .- The Growth Engine is a front-runner. It has provided enterprises and
Is based on a joint vision and a plan (roadmap) to achieve the goals (growth vision)		

[22] Ibid.
[23] BF (2018). Ecosystem orchestration – Criteria for innovation cluster funding, Document #2053738.

Expectations for Growth Engines	Criteria for 1st phase (initial grant)	Criteria for 2nd phase (equity loan)
		opportunity for renewal. What actions have been taken for disruption, what steps will be taken next? What opportunities and risks are associated with those? - Key public actors for renewal of business environment have been recognised, and collaboration has been started.
Creates new value to end-users and partners		
Creates RDI projects, pilots and demonstrations, and market openings	**5. Added value of orchestrator** - The orchestrators added value, incentives and role in growing and developing the network (including internationally) Organisation, resources and management model of the Growth Engine, including funding model, rules for adding new partners, and folding in individual projects into the Growth Engine	**5. The role of the orchestrator, management model, added value and plan for self-sufficiency** - Partner feedback for the orchestrator, business and management model, value added - Fit of orchestrators' skills and resources for the second phase. Resources and organisation, including funding of orchestration, plan for broadening, plan for funding outside BF.
Comprises a credible consortium of enterprises, research organisations, public actors, and end-users	**2. There is a clear business lead** - Description of the Growth Engine, the consortium and target partners - Clear market niche and commitment of the consortium, roles of the partners Quantitative minimum 10 committed enterprises.	

APPENDIX 3: MAPPING OF THEMATIC AREAS AND PRIORITIES

The opportunity analysis (see Chapter 4) is based on a desk study of Finnish and European RDI policy papers and technology trends. The following summarises the findings from these documents.

Analysis of national level documents

The key documents at the national level are:

- National RDI roadmap (Kansallinen TKI-tiekartta), 2020
- MEAE Growth Portfolio (Kasvuportfolio), 2018-19 + on-going update 2020
- BF own strategy and steering documents

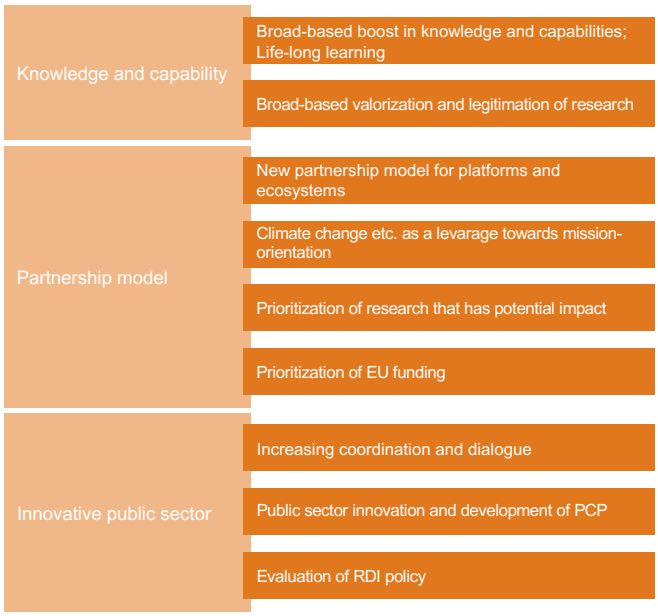
To a lesser extent:

- Outlook for Finland's innovation policy (Innovaatiopolitiikan lähtökohdat), MEAE reports 18/2019
- RIC Vision and roadmap (Tutkimus- ja innovaationeuvoston visio- ja tiekartta), 2017

The latest RDI policy document, and possibly the highest in the order of precedent, is the **National RDI roadmap**, published in April 2020. The proposed actions or activities are organised into three workstreams that focus on:

- Building capabilities and knowledge
- Re-orienting and vitalising PPP (Public-Private-Partnership)-tradition
- Increasing coordination within and capability of public sector to enable innovation e.g. through pre-commercial/ innovative procurement (PCP)

The main thrust of the RDI roadmap is on the development of RDI framework, innovation system as it were, and indirectly enabling innovation through more concerted actions through various policy sectors and levels of government. As for specific opportunities, the only one more specific is heavier emphasis on PCP.



Appendix 3. Figure 1. Summary of the work streams and main goals proposed in the National RDI roadmap.

The most direct steering paper is the previously cited **steering agreement** between BF and MEAE. In short, the BF mission is to fund internationalisation and growth by funding RDI in enterprises and research organisations. The main industrial and innovation policy goals expressed in the steering agreement are: a) bringing global customer needs to Finnish enterprises, b) leveraging national strengths and global networks, and c) renewal of enterprises and industry structure. BF have determined strategic themes, that are:

– Bio-economy
– Digitalisation
– Health & Wellbeing
– Consumer business

After a hiatus, the **Research and Innovation Council (RIC)** was reorganised 2017 under the Ministry of Education and Culture. RIC published its vision also 2017, which defines general systemic outlines for RDI policy. The goals expressed by the RIC vision are more focused on institutional and structural elements and precedents of RDI than outlining specific areas of opportunity. Digitalisation and AI are the exception, the digital/platform economy is outlined as one of the key areas to be developed and AI is seen as an enabler.

In the **MEAE Outlook for Innovation policy** from 2019, the key tenet is: ‘Finland is a competitive creator, quick adopter and the best applier of new technology and innovation’. The outlook stresses the need to pick areas of concentration/specialisation to develop relative advantage in international competition – in reference to the Growth Portfolio. Key threats and weaknesses include small and fragmented inward-focused actors, investments and activities, lack of network engines and major new PPP-initiatives, focus mostly on incremental improvements, general ‘loss of faith’ in innovation and de-legitimisation of RDI policy. Main thrust is in systemic and institutional factors and

government-as-an-enabler type of actions. Digitalisation/'digital discontinuity' is the exception as a more substance focused proposal for action.

The Growth Portfolio has been a separate process of participative deliberation that was started in 2018 with stakeholder discussions and resulting identified promising growth areas which were published in the Outlook for innovation policy. Appendix 3. Table 1 presents the identified opportunities.

Appendix 3. Table 1. The Growth Portfolio (2019) identifies promising growth areas or opportunities.

Promising growth areas		
Digital disruption, new sources of value, enabling technologies		
Platforms, disruption in value chains AI and analytics Blockchain	5G, IoT, ubiquitous connectivity InfoSec Virtualisation, VR, gamification	Synthetic biology, photonics, electronics Space technology and applications Arctic
Mobility and logistics	**Resource smart growth**	**New industrial age**
Seamless and carbon neutral mobility Safety Marine technology	Circular and bioeconomy Smart grids and energy solutions	Smart factories Sustainable healthy food New functional materials
Health and wellbeing	**Renewing consumerism**	**Vibrant communities**
Improved patient/customer paths Individualised and participatory healthcare	Tourism and experience economy, "meaningfulness" Life-long learning New commerce solutions	Changing work Sustainable living Interactive service networks

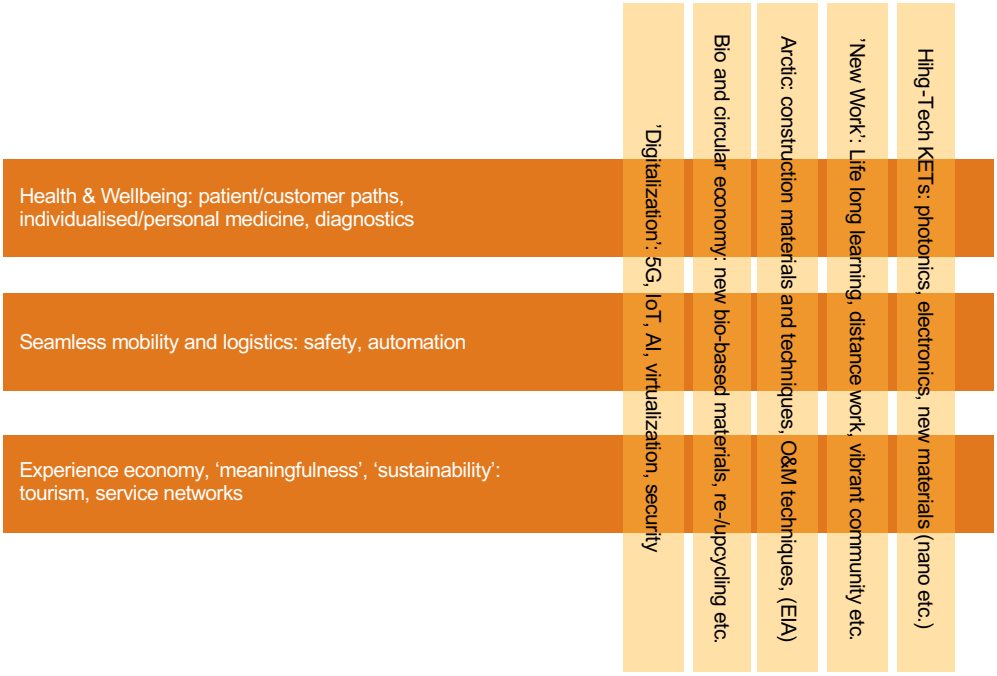
Notably, there **IT and digitalisation appear as an overarching theme** in all cited strategy documents. While IT is a strong suit in Finnish economy, there is a threat from the global IT giants, and Finnish industry needs to position themselves to that challenge one way or the other; either by developing a cross-cutting strong capability throughout, or, positioning themselves to the value network of the GAFM-enterprises[24].

With regards to the Growth Portfolio (2019), in practice, every major industry/cluster has their own growth area. It also validates the BF strategic themes and introduces two new ones, Tourism and Arctic, to complement the three 'traditional' ones: Bio & Circular economy; Digitalisation; Health & Wellbeing. According to preliminary information, the Growth Portfolio 2.0 (in process by the time of writing, see also Chapter 4) focuses on three pillars: "Clean and healthy environment", "New forms of value creation", and "Functional society", all of which have sub-themes, based on the changes or development needed in Finnish society.[25]

To sum up, many, if not most, of the identified opportunities are generic/enabling technologies or KETs (Key Enabling Technologies). However, generic technologies need application areas; developing generic technologies enable creating value, applying them in relevant problems is a way to capture the value. For example, developing technologies for recycling of batteries or up-cycling used clothes for new semi-synthetic fibers is all well, but offering sustainable batteries for new

[24] Google, Amazon, Facebook, Microsoft – the quartet of enterprises that dominate the global web, cloud, and office productivity markets.
[25] MEAE, Growth Portfolio 2.0: Updated list of recognized growth opportunities, 27.5.2020.

mobility solutions, or guilt-fee 'sustainable' fashion, are business opportunities with a specific and desirable value promise for the client/end-user.



Appendix 3. Figure 2. Growth opportunities organised into application opportunities (horizontal) and enabling technologies (vertical).

Analysis of EU-level documents

In the European view, high on the strategic EU agenda are the Green Deal, Digital Transformation and Partnership with Africa.

The Green Deal[26] provides specific guidance for the areas of activity and RDI as they relate to sustainability of society and the economy. According to the Commission, the required actions include, but are not limited to these:

– "investing in environmentally-friendly technologies
– supporting industry to innovate
– rolling out cleaner, cheaper and healthier forms of private and public transport
– decarbonising the energy sector
– ensuring buildings that are more energy efficient
– working with international partners to improve global environmental standards"

The Green Deal is also coupled with "Just Transition Mechanism", to help transition to sustainability and is envisioned to mobilise 100 Billion EUR investments.

[26] A European Green Deal. European Commission. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

While digitalisation has been on the Finnish RDI agenda for a long time, also the **EU Digital Transformation and European Digital Agenda**[27] have major potential implications as, among other things, it is planned to harmonise regulation and introduce a Digital Services Act to improve access to digital services and digital markets continent wide, as well as to develop a framework for transporting, and to analyse and utilise health data European-wide. A similar framework is planned also for finance technology (FinTech).

In short, in the **Partnership with Africa**[28], the EU agenda seems to be to stabilise the continent with diplomacy and investment into development of civil society and RDI. While the link may not be obvious, it is foreseen that the partnership will be very important in the following years, as some of the major challenges for the EU relate to stability in the near regions. The partnership also relates to the Green Deal and the aim to reinforce EU's environmental diplomacy. The EU sees also major potential for RDI, innovation, and market development in the partnership.

The BOHEMIA study[29] was a high-level foresight exercise that acts for its part as a basis for preparation of Horizon Europe Work Programmes. The study outlines four transitions, which can also be viewed as needs or drivers for RDI. These transitions are 1) quality of life, 2) general sustainability, 3) broad-based RDI, and 4) using RDI and science diplomacy as leverage in geopolitics.

Within these themes, the study identified **19 specific scenarios**, all linked RDI opportunities or needs. The specific scenarios bring more specific contents into topics like "New Work" and as such provide guidance on the possible future Horizon Europe working programmes and themes of possible future calls.

What is notable, **security and hybrid/cyber warfare** is explicitly and implicitly embedded into several specific scenarios and thematic priorities. Most of the IT topics, where Finnish enterprises have generally fared well, are cyber security and warfare oriented.

Another finding is that **traditional 'high' or 'deep tech' is not on the forefront in the thematic priorities**, and there are more multidisciplinary/soft topics related to deep tech and KETs. The deep tech topics that are represented, bio-based industrial processes, precision medicine, tissue cultures etc. are not necessarily Finnish strong suits. Therefore, Finnish technology companies would most likely need strong (European) partners to qualify. All of this underlines the need for ecosystems, and particularly anchor companies or network engines that have European and global reach.

Meanwhile, in general EU RDI policy, the role of entrepreneurship, SMEs and also KETs continues strong. The particular angle is how to develop a smoother access for SMEs towards KETs by various means and partnerships[30].

Besides the discussed specific substance areas, European RDI policy is developing also structurally. In the upcoming Horizon Europe Framework Programme the role of clusters, missions and next-

[27] A Europe fit for the digital age. European Commission. https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age_en
[28] EU paves the way for a stronger, more ambitious partnership with Africa. European Commission. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_373; Opening statement by President von der Leyen at the 10th EU-AU Commission-to-Commission meeting plenary session. European Commission.https://ec.europa.eu/commission/presscorner/detail/en/speech_20_342
[29] ref
[30] IDEA(2018). Study on Access of SMEs to KETs technological centres. EASME/COSME/2015/024. https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/grow_study_march_2018-sme_access_to_ket_centres-final_report.pdf

generation European partnerships gain importance, besides the traditional work programmes. This is likely to have some bearing also on the Finnish actors' participation.

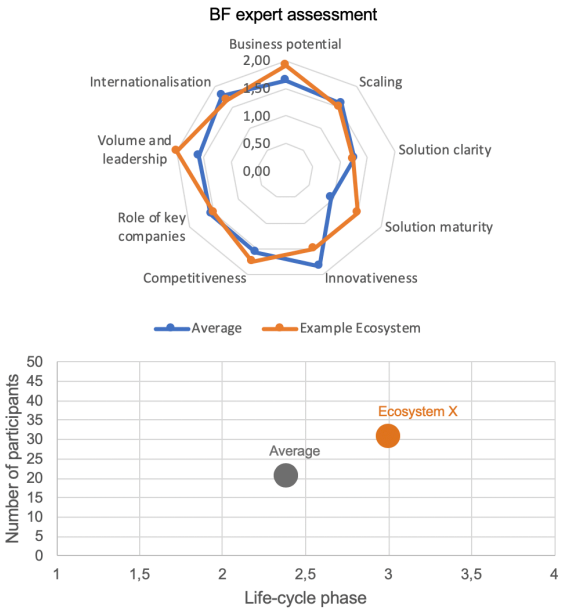
APPENDIX 4: EXAMPLE DRAFT OF ECOSYSTEM DATA SHEET

The following figure provides an example of the ecosystem-specific data sheet. Similar sheets have been prepared for all BF-funded ecosystems. Due to the sensitive nature of some of the ecosystem-specific data, these data sheets are not public but can be used as internal tools by BF and BF-funded ecosystems.

Example data sheet

Ecosystem name: Ecosystem X

Brief description:	The ecosystem combines xxx to provide solutions for yyy. The ecosystem combines xxx to provide solutions for yyy. The ecosystem combines xxx to provide solutions for yyy.
Orchestrator:	Orchestrator Y
Anchor companies:	Anchor company X
Sector(s) / KETs:	E.g.: 'ICT / 5G'
Customer focus:	B2B / B2C
Ecosystem type:	Solution / transaction ecosystem
Life-cycle phase:	E.g. Expansion (Phase 3)
Starting year:	2020
No. of participants:	30
Total turnover:	xxx
Total employment:	xxx
Total export turnover:	xxx
Role of BF:	e.g. 'Growth Engine capital funding (30m €) in 2020'
Website	Xxxx



APPENDIX 5: SELF-ASSESSMENT CRITERIA AND SCALE

The following table represents the lists of the criteria and scale for scoring utilised in self-assessment of BF-funded ecosystems conducted by BF experts. Translations are provided by the authors and also the grouping of the criteria (A-H) has been slightly refined by the authors. By the time of writing, 20 ecosystems had been assessed. A summary of these assessments is provided in Chapter 2.

A. Business potential (0 points; 1 point; 2 points)
• Existence of market (unknown = 0p;emerging =1p; existing and verified =2p)
• Side of global market is several billion euros and market share over a billion? (unknown =0p; possible = 1p; verified =2p)
• Potential for developing new business and value of enterprises (no or unclear = 0p; preliminary hypothesis =1p; clear path =2p)
• Country risk in target markets (significant country risk =0p; unclear =1p; controlled and/or distributed to various markets =2p)
• Opportunity to shape/design markets and needs (no =0p; maybe =1p; yes =2p)
B. Scaling (0 points; 1 point; 2 points)
• Relevant knowledge of buyer behavior, standards, purchasing processes and sales infrastructure (no, or unclear; standardising and process are being built, string)
• Scalability of customer relations and market, including between geographical markets (no; maybe; yes)
• Effect of regulation into growth prospects (unfavorable; unclear, variable, or prone to change; enhancing)
• Market, attitude climate, societal and other trends foreseen effect into market development (unfavourable; unclear, variable, or prone to change; enhancing)
C. Solution clarity (0 points; 1 point; 2 points)
• Product, service and of solution offering (unclear; preliminary documentation; clear, explicit and documented)
• Business model and earning logic (not available, unclear; variable, prone to change; clear business model and earning logic)
• Scalability (significant changes/tailoring to offering is needed between clients and/or markets; variable; easily scalable
• Productization/offering, incl. product-service-solution packaging, organization, processes, data infrastructure, brand capability (no or unclear; in development; strong brand and offering)
• Definition of customer/segment (unclear who is the customer; clear industry/sector and organization types are identified; customer and/or end-user as co-developing the product)
D. Solution maturity (0 points; 1 point; 2 points)
• Maturity of solution (TRL<6; demonstration in relevant operation environment (TRL 6-8); complete product, which enables significant sales by 2025)
• Time to market (>3 years; 1-3 years; ready product)
Innovativeness
• Innovativeness (unclear; incremental; disruptive)

• Novelty and position to state of the art is known (unknown; partially known; known)
E. Competitiveness (0 points; 1 point; 2 points)
• Main competition, product or solution (unknown; partially familiar; competitors' solutions are well known)
• Realistic competitive position (unknown; partially familiar; own competitive advantage is recognized and independently validated)
• Kompetitive advantage and Unique Selling Points unknown; partially familiar; known and well documented)
• Market position (no standing in the market; bridge head with different offering or other market access; established standing and clear growth plan)
F. Role of key companies (0 points; 1 point; 2 points)
• Orchestrator/engine or "Primus motor" (unknown; maybe; the ecosystem has a orchestrator engine who steers the network forward)
• Network engine (unclear; engine is an SME; credible large or MNE
• Credible integrator (in target market, in case primary market is public sector) (unknown; one; several)
• Value network (unclear; known; working)
• Ability and willingness for collaboration, identification and commitment (unclear; willingness to co-operate; mutual agreements for IPRs, common strategy and/or roadmap)
• Ability and willingness to grow, including ability to invest in growth (unknown or inexistent; somewhat; mutually agreed goal of billion euro new business)
G. Volume and pioneering (0 points; 1 point; 2 points)
• Ecosystem breadth and diversity (unclear; less than 10 orgs.; more than 20, incl. Large/MNE, Mid-Cap, SME, RTO, GO, NGO)
• Collaboration with complementary research (ecosystem) (none; some; lots)
• Interaction with start-ups and SMEs (none or unclear; value vhain, investments; buy-outs; SMEs in a significant disruptive role)
• Organized research and pilot or demonstration collaborations in BF or EU-funded projects (none, one, several)
• Openness (closed; unclear or partial; ecosystem is open for new partners)
H. Internationalisation
• Exports potential, int'l client (unclear, none; one; several)
• Int'l collaboration with ROs, industry associations, PPPs, lobbying (no int'l partners; few partners; many partners)
• Investment potential (R&D centers, direct investment) and country brand support (none; maybe; clear FDI potential and complement to country brand)

APPENDIX 6: SUMMARY OF BUSINESS FINLAND -FUNDED ECOSYSTEMS

Official name	Operator/Orchestrator	Sector group	Lifecycle phase	Type	Customer focus
4Recycling	CLIC Innovation	Bio and circular economy	Exploration / emergence	Solution ecosystem	B2B
BatCircle	Aalto University	Bio and circular economy	Exploration / emergence	Solution ecosystem	B2B
Digital and Physical Immersion in Radiology and Surgery	Tampere University	Health	Exploration / emergence	Solution ecosystem	B2B
FinnGen	University of Helsinki	Health	Exploration / emergence	Solution ecosystem	Other
Green Electrification	CLIC Innovation	Energy	Exploration / emergence	Solution ecosystem	B2B
Intelligent Industry	DIMECC	Manufacturing	Exploration / emergence	Solution ecosystem	B2B
New modalities	Orion	Other	Exploration / emergence	Solution ecosystem	B2B
SEED	VTT	Bio and circular economy	Exploration / emergence	Solution ecosystem	B2B
Telaketju 2	VTT	Bio and circular economy	Exploration / emergence	Solution ecosystem	B2C
Baltic Offshore Wind Ecosystem	Gaia Consulting	Energy	Birth / startup (experiment)	Solution ecosystem	B2B
CleverHealth Network	HUS	Health	Birth / startup (experiment)	Solution ecosystem	B2B & B2C
KODA (Kotidigi)	CGI	Health	Birth / startup (experiment)	Solution ecosystem	B2C
Flexens Growth Engine	Flexens	Energy	Birth / startup (experiment)	Solution ecosystem	B2B
ForBest	Fortum	Bio and circular economy	Birth / startup (experiment)	Solution ecosystem	B2B & B2C
IBM Finland Cognitive Healthcare Cluster of Innovation	IBM Finland	Health	Birth / startup (experiment)	Solution ecosystem	B2B & B2C
SiloBrain AI ecosystem	Silo Ai	ICT	Birth / startup (experiment)	Solution ecosystem	B2B
Awake.AI	Awake.Ai	Mobility & logistics	Birth / startup (experiment)	Solution ecosystem	B2B
KEKO Smart Building Ecosystem	VTT	ICT	Birth / startup (experiment)	Solution ecosystem	B2B
LuxTurrim5GPlus	Spinverse and Nokia	ICT	Birth / startup (experiment)	Solution ecosystem	B2B
Reboot IoT Factory Phase II	VTT	Manufacturing	Birth / startup (experiment)	Solution ecosystem	B2B
Self-Tuning Mine	Sandvik	Energy	Birth / startup (experiment)	Solution ecosystem	B2B
Smart Mobility Ecosystem	Kyyti Group	Mobility & logistics	Birth / startup (experiment)	Transaction ecosystem	B2C
Smart Otaniemi	VTT	Energy	Birth / startup (experiment)	Solution ecosystem	Other
MI Demo	Metsä Spring	Manufacturing	Birth / startup (experiment)	Solution ecosystem	B2B & B2C
Vedia CaaS	Vediafi Oy	Mobility & logistics	Birth / startup (experiment)	Solution ecosystem	B2B
Adaptive Industrial Loops	MEX Finland	Manufacturing	Growth / expansion	Solution ecosystem	B2B
ELASTRONICS Connected Health Ecosystem	University of Tampere, VTT and GE	Health	Growth / expansion	Solution ecosystem	B2C
Internet of Locations	ICEYE	Other	Growth / expansion	Solution ecosystem	B2B
Project Carbon Negative	Compensate	Bio and circular economy	Growth / expansion	Transaction ecosystem	B2C
One Sea - Autonomous Maritime Ecosystem, stage II	DIMECC	Mobility & logistics	Growth / expansion	Solution ecosystem	B2B & B2C
Plastic Waste Refining Ecosystem	Griffin Refineries	Bio and circular economy	Growth / expansion	Solution ecosystem	B2B
Platform of Trust	Suomen Tilaajavastuu Oy	Other	Growth / expansion	Solution ecosystem	B2B & B2C
Red Compartida	Nokia	ICT	Maturity / leadership	Solution ecosystem	Other

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