REVIEW 330/2016

# How to Improve Global Competitiveness in Finnish Business and Industry?

## Impact study

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Tekes – the Finnish Funding Agency for Innovation
Tekes is the main public funding organisation for research, development and innovation in Finland. Tekes funds wide-ranging innovation activities in research communities, industry and service sectors and especially promotes cooperative and risk-intensive projects. Tekes' current strategy puts strong emphasis on growth seeking SMEs.

Tekes programmes – Tekes´ choices for the greatest impact of R&D funding
Tekes uses programmes to allocate its financing, networking and expert services to areas that are important for business and society. Tekes programmes have been contributing to changes in the Finnish innovation environment over twenty years.



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# Foreword

Finnish wellbeing is based on the wealth and jobs created by the success of Finnish companies on the global market. In terms of wellbeing, Finland ranks among the top countries according to several different indicators. The Finnish business sector had been adapting successfully to global competition until the recession in 2009.

The Finnish economy is struggling to grow at the moment. The decrease in the export of goods from Finland was primarily caused by the country's economic structure and the simultaneous decrease of exports in main industries. Finland's exports are characterized by a high share of investment goods. The problems have also been manifested as decreased productivity.

In the current economic crisis, it is possible to observe not only economic fluctuation but also accelerated structural change both at the global and national level. The renewal of the business sector in Finland has sped up through so-called "creative destruction", which means that less productive companies leave the market and more productive companies are created.

To tackle these problems Finland needs strong export-based economic growth. Finland must ensure the functionality of the innovation environment in order to cope with the challenges posed by the global value nets and business ecosystems.

In order to succeed in international markets, companies must be able to continuously renew and reinvent themselves and increase turnover via high added-value products and services. It is found that most of Finnish industrial products and services have no longer strong competitive advantages, in other words, operational effectiveness is high but capabilities to create new innovations to the global markets is low. During this current period of industry-wide structural change, renewal and radical changes are needed more than ever.

Main question of this evaluation was how Tekes activities succeed to improve the global competitiveness of the Finnish economy? The general conclusion of the evaluation is that Tekes has a distinct role in fostering the emergence of new business ecosystem but long-term impact requires improved synergies between Team Finland agencies.

For a new or emerging business innovation ecosystem to achieve global competitiveness requires a multi-faceted and multi-actor approach. The main impact of Tekes is through triggering and nurturing over a longer run period the emergence of new technology based ecosystems that help restructure traditional sectors or develop new high-value added activities.

A key lesson from the study is that to achieve global competitiveness, the business ecosystems require tailored and diverse forms of support that often stretch beyond the remit and resources of Tekes alone. This applies in terms of the development of the new business models nationally (e.g. regulatory or policy changes lagging technology) as well as internationally (e.g. attracting strategic investors, etc.).

This impact study was carried out by Technopolis Group Eesti OU and 4Front Oy. Tekes wishes to thank the evaluators for their thorough and systematic approach. Tekes expresses its gratitude to steering group and all others that have contributed to the evaluation.

Helsinki, May 2016

Tekes – the Finnish Funding Agency for Innovation

# Yhteenveto

## Miten parantaa suomalaisen elinkeinoelämän ja teollisuuden kansainvälistä kilpailukykyä?

Kilpailukyky on paljon käytetty käsite: taloustieteilijät määrittelevät sen eri tavoin, poliitikot lupaavat pitää yllä ”kansallista kilpailukykyä ja työpaikkoja” samalla, kun media kertoo tarinoita yritysten ylä- ja alamäistä. Yksittäiselle kansalaiselle kilpailukyky saattaa vaikuttaa uhkaavalta ajatukselta, kun heidän työpaikkansa ovat vaarassa maailmanlaajuisten markkina- tai teknologiatrendien takia.

Tämä selvitys tarkasteli, mikä Tekesin rooli on ollut, ja mitä se voi tehdä tulevaisuudessa suomalaisten yritysten kansainvälisen kilpailukyvyn parantamiseksi, eli miten Suomessa luotu arvo saadaan jäämään Suomeen ylläpitämään korkeaa elintasoa, laadukkaita työpaikkoja ja sosiaalista hyvinvointia.

Kansantaloudet ja erityiset liiketoimintaekosysteemit eivät toimi eristyksissä, vaan ne ovat avoimia maailmanlaajuisille haasteille ja kansainväliselle vuorovaikutukselle. Siinä missä suomalaiset päättäjät voivat enemmän tai vähemmän suorasti pyrkiä parantamaan sisäisiä tekijöitä (esim. kysyntää kotimarkkinoilla, liiketoimintakulttuurin puitteita, yritysjärjestelmää, koulutusta ja tutkimusta, rahoitusjärjestelmää, sääntely- ja verotusjärjestelmää) on paljon vaikeampaa vaikuttaa maailmanlaajuisiin tekijöihin (esim. kansainväliseen kysyntään, alakohtaisiin kauppamalleihin, kohdemarkkinoiden poliittiseen ja sääntely-ympäristöön, maailmanlaajuisten arvoketjujen rakenteeseen ja dynamiikkaan).

Selvityksen mukaan kansainvälistä kilpailukykyä ei siksi pitäisi mitata ainoastaan viennin kasvulla, vaan pikemminkin yritysten kyvyllä saavuttaa strateginen asema kansainvälisissä arvoverkostoissa. Samalla herää kysymys missä määrin kansalliset politiikkatoimenpiteet vaikuttavat arvon luonnin ohella myös arvon ‘tuontiin’ (value capture).

## Tulevaisuuden kilpailukyvyn neljä moottoria

Suomen **kilpailukykypolitiikka on keskittynyt neljään painopistealueeseen** 2000-luvun keskivaiheilta lähtien: biotalouteen, puhtaaseen teknologiaan, terveydenhoitoon ja digitalisatioon. Myös Tekes on kohdistanut merkittäviä investointeja liiketoimintaekosysteemien kehittämisen edistämiseen näillä neljällä kohdealueella.

Selvityksen mukaan **kolme sisäistä kilpailukykytekijää ovat erityisen ongelmallisia:** Rajoittunut kotimarkkinoiden kysyntä, talouden/viennin rakenne ja sääntely-/verotusympäristö. Tekesin suorat toimenpiteet keskittyvät vastaamaan näihin haasteisiin talousrakenteen uudistamiseen ja monipuolistamiseen kohdennetuilla ohjelmilla, jotka keskittyvät em. painopistealueisiin. Monet Tekesin ohjelmat pyrkivät kehittämään uusia ekosysteemejä tai edistämään uusia liiketoimintamalleja, joita voidaan testata kansallisesti ja näin mahdollisesti kasvattaa kysyntää uusille tuotteille tai palveluille. Pieniin kotimarkkinoihin Tekes pyrkii vastaamaan suoremmin joko omien ohjelmiensa kansainvälistymistoimien kautta tai yhteistyössä muiden Team Finland -toimijoiden kanssa.

**Ulkoisten kilpailukykytekijöiden** osalta arviointi korosti, että suomalaiset liiketoimintaekosysteemit ovat erityisen herkkiä ulkoisille tekijöille ja ”shokeille”. Alakohtaiset liiketoimintamallit (esim. korkean teknologian tuotteiden viennin hiipuminen jne.) tarkoittavat, että maailmanlaajuisten markkinoiden tai arvoketjujen muutoksilla voi olla erityisen vakavia taloudellisia vaikutuksia. Toinen kilpailukykyä heikentävä tekijä on, että Suomi suoriutuu yllättävän heikosti ulkomaisten korkean lisäarvon tai teknologiaintensiivisten yritysten investointien sekä lahjakkaiden yksilöiden houkuttelemisessa. Vastauksena näihin haasteisiin Tekes ja Team Finland ovat vahvistaneet toimia, jotka on suunniteltu ennakoimaan tällaisia muutoksia, edistämään yritysten markkinoillepääsyä ja nopeaa kansainvälistymistä, sekä houkuttelemaan ulkomaalaisia investointeja.

Tekesillä on ollut selkeä rooli uusien liiketoiminta-ekosysteemien edistämisessä, mutta pitkäaikainen vaikutus edellyttää parempaa synergiaa Team Finland -toimijoiden välillä.

Uusille tai alkuvaiheessa oleville liiketoimintaekosysteemeille kansainvälisen kilpailukyvyn saavuttaminen vaatii monitahoista ja monen toimijan lähestymistapaa. Tekesin tärkein vaikutusmekanismi on se, että se auttaa pidemmällä aikavälillä rakentamaan teknologista perustaa uusille ekosysteemeille, jotka auttavat uudistamaan perinteisiä toimialoja tai kehittämään uusia korkean lisäarvon tuotteita ja palveluita. Suomalaiset yritykset näkevätkin Tekesin ensisijaisen roolin edelleen teknologisen kehityksen rahoittajana. Varhaisen vaiheen teknologisten ratkaisujen tukeminen on ensiarvoisen tärkeää ei ainoastaan taloudellisesti, vaan myös siksi, että Tekesin rahoitus auttaa uuden tuotteen tai palvelun toimivuuden todentamisessa. Tämä puolestaan auttaa sijoittajien ja kumppaneiden hankkimisessa.

Tekesin rooli yhteistyön tai arvoverkostojen rakentamisessa sekä kansallisesti että etenkin kansainvälisesti on sen sijaan vähäisempi. Jotkin toiminnot, kuten SHOK-ohjelmat, ovat auttaneet rakentamaan arvoverkostoja Suomessa. Kuitenkin monilta suomalaisilta ekosysteemeiltä näyttäisi puuttuvan sellaisia kyvykkyyksiä, jotka vaativat täydentäviä investointeja tai sidoksia kansainvälisiin kumppaneihin.

Selvityksen keskeinen johtopäätös on, että liiketoiminta-ekosysteemien kansainvälisen kilpailukyvyn edistäminen vaatii räätälöityjä ja monipuolisia edistämistoimia, joiden tarjoaminen ylittää Tekesin valtuudet ja resurssit. Tämä koskee uusien liiketoimintamallien kehittämistä kansallisesti (esim. sääntelyn tai politiikan muutoksia) kuten myös kansainvälisesti (esim. strategisten investoijien houkuttelu, jne.)

Selvitys esittää kuusi ehdotusta liittyen Tekesin ja Team Finlandin rooliin kansainvälisen kilpailukyvyn kehittämiseksi:

- Tekesin pitäisi Team Finland -verkoston osana keskittyä ennemmin systeemisiin vaikutuksiin kuin yksittäisiin innovaatioihin tai ratkaisuihin.
- Erilaisten ekosysteemien edistäminen vaatii erilaisia keinoja sekä joustavia kumppanuuksia muiden toimijoiden kanssa. Ei ole olemassa yhtä, kaikille ekosysteemeille sopivaa toimintamallia.
- TKI-projektien rahoittamisen rinnalla Tekesin tulisi yhteistyössä muiden Team Finland -toimijoiden kanssa edistää eri toimijoiden välistä koordinointia ja tukea toimia, jotka auttavat kartoittamaan ekosysteemien eri toimijoita tai arvoketjuja (esim. kartoittaa johtavat toimijat, teknologiat, taidot, infrastruktuurit, jne.), Suomessa ja kansainvälisesti.
- Tekesin tulisi yhteistyössä Team Finlandin muiden toimijoiden kanssa edistää sellaisten uusien keinojen vakiintumista, joilla voidaan rakentaa yhteistyötä sekä suurien ja vakiintuneiden että uusia, arvoketjuja muuttavia liiketoimintamalleja kehittävien yritysten välillä. Tässä mielessä uudet kilpailupohjaiset instrumentit (esim. Challenge Finland) vaikuttavat lupaavilta, mutta todennäköisesti lisää investointeja mallien kehittämiseksi tarvitaan.
- Team Finlandin toimijoiden tulisi kiinnittää enemmän huomiota strategisten suorien ulkomaisten investointien houkutteluun kehittyviin ekosysteemeihin (joko uusien investointien tai yritysostojen kautta), ja niiden yhdistämiseen pitkäjänteisiin TKI-investointeihin.
- Team Finlandin toimijoiden tulisi kiinnittää enemmän huomiota paikallisten (kaupunki- tai aluetason), kansallisen innovaatiopolitiikan ja kansainvälisen kilpailukykypolitiikan välisten synergioiden kehittämiseen.

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# 1 Framework

## 1.1 Objective and scope of the study

This study provides a forward look at how Tekes, both individually and in collaboration with other Team Finland agencies, can succeed in enhancing Finnish competitiveness. In order to inform the forward view, the study team assessed the impact of Tekes support for global competitiveness of Finnish enterprises in four priority areas. The study findings, addressing the questions set by the terms of reference[1] (Figure 1), are set out in three chapters:

- Recent trends and future success factors of Finnish global competitiveness: the context for Tekes and Team Finland operations (chapter 2)
- Backward look: how has Tekes contributed to fostering Finnish Global competitiveness (chapter 3)
- Forward look: How can Tekes, in collaboration with Team Finland, best succeed in reaching their global competitiveness objectives? (chapter 4)

In line with the terms of reference, the main body of this report is kept to approximately 20 pages and structured in an easily readable format. Additional background material and supporting analysis are provided in annexes.

**Figure 1. Research questions.**

| | |
|---|---|
| **WP1** | **Finnish competitiveness: trends, drivers and barriers** |
| 1.1 | What is historical, present and future state of the global competitiveness of the Finnish business and industry (value added for potential sectors, value chains, business networks and ecosystems, etc.)? |
| 1.2 | What are the main forerunning and laggard factors for global competitiveness in Finland (competitiveness rankings etc.)? |
| 1.3 | What kind of success factors should be formed for the future competitiveness of Finland? |
| 1.4 | What are the risks to invest in the Finnish innovation activities) (country risk, regulations, taxation, investing atmosphere, etc.)? |
| **WP2** | **How has Tekes contributed to fostering Finnish Global competitiveness** |
| 2.1 | What has been the role of Tekes in improving global competitiveness of Finnish business and industry? |
| 2.2 | Which factors in the Finnish operating environment in general help and prevent the impact of Tekes activities when considering improvement actions to competitiveness? |
| 2.5 | How other innovation agencies are tackling the challenges of global competitiveness? |
| **WP3** | **How can Tekes, in collaboration with Team Finland, best succeed in reaching their global competitiveness objectives?** |
| 2.3 | What are the best tools and overall possibilities for Tekes to have the highest impact on competitiveness? (Impacts of Tekes have been expanded from the R&D activities to several new areas such as innovation activities, working life (leadership, motivation) and business ecosystems) |
| 2.4 | How the new Tekes strategy will challenge companies for change and renewal of Finnish products and services? |
| 2.6 | What are the future suggestions and recommendations how Tekes can improve its impact on the global competitiveness in the Finnish business and industry? |
| 3.1 | What are the expected impacts of closer collaboration between public organisations (especially Tekes, Finpro and Finnvera) over the next five years? (firm growth, internationalisation, networking in global value networks) |
| 3.2 | Recommendations on how actors of Team Finland (especially Tekes, Finpro and Finnvera) can improve their impact on the future growth of Finnish companies' global business. |

[1] Questions are numbered in reference to the evaluation questions as specified in the terms of reference.

## 1.2 Global competitiveness: key concepts and analytical framework

### 1.2.1 Scoping the factors that influence national competitiveness

The term competitiveness is widely used in policy circles, however, there is no single definition and various concepts are employed interchangeably. For Scott and Lodge (1985) "national competitiveness is a country's ability to create, produce, distribute and/or service products in international trade while earning rising returns on its resources". Orlowski (1982) defined it simply as a "nation's ability to sell". Other authors equate competitiveness with the ability to achieve certain national outcomes, such as a higher standard of living, job creation and increased welfare, etc. (e.g. Fagerberg 1988; Aiginger 2006; Kohler 2006; Janger et.al. 2011).

The OECD's Growth Agenda and the EU's 2020 strategy are inspired by a **productivity-based approach** to competitiveness. Porter (2000) argued that productivity encompasses both the value (prices) that a nation's products command in the market and the efficiency with which units are produced. Delgado, Ketels, Porter and Stern (2012) define "foundational competitiveness as the expected level of output per working-age individual given the overall quality of a country as a place to do business", where "both the productivity of employed workers and the ability to employ a large share of the available labour force influence overall prosperity".

An increasing emphasis is given to the **link between resources and national competitiveness**. As resources (raw materials, water, energy, etc.) are sourced on global markets, a country is exposed to price evolutions and competition for resources so that costs or shortages undermine production and export potential (Schneider 2012). Resource constraints are increasingly significant drivers/barriers to economic performance and social stability. Hence, resource efficiency and environmental sustainability become part a more balanced competitiveness concept (UNDP 2011).

There is a broad consensus that **policy frameworks and institutions** play a central role in national competitiveness. For Garelli (2004) "national competitiveness is essentially how countries create and maintain an environment which sustains the competitiveness of its enterprises". Porter and Ketels (2003) suggest "sound macro-economic policies and stable political, legal and social institutions create the potential for improving national prosperity". Similarly, the World Economic Forum defines competitiveness as a set of factors, policies and institutions that determine the level of the productivity of a country (WEF 2007).

Schwab (2004) goes further to say that, as todays economy is ever more globalised, countries need to be increasingly creative to maintain a competitive edge. Hence **creativity and innovation** are decisive factors of national competitiveness. In the **national innovation system** school of thought, competitiveness depends on the way in which societies create, store and transfer the knowledge, skills and artefacts that contribute to innovation. Hence innovation performance depends not only on how individual organisations perform, but on how they interact with each other and on their interplay with social institutions (values, norms and legal frameworks).

Below the macro/national level, patterns of industrial specialisation and trade composition highlight that specific sub-sectors or **clusters** are an important factor in successful economic development (Hausmann and Klinger 2006; Delgado, Porter and Stern 2012). Delgado et.al. (2012b) found that new regional industries emerge where there is a strong cluster environment. The postulates is that business performance is dependent on the quality of networks (suppliers, distributors, customers, competitors, government agencies, universities) and information rich environments where knowledge is accessible and shared (Mason and Brown 2014). The premise is that businesses are faced by constantly evolving relationships and conditions to which they have to adapt in order to survive.

Drawing parallels with biological systems this has also been termed the **business ecosystem approach**. Autio & Thomas (2014) define an innovation ecosystem as "*a network of interconnected organisations, organised around a focal firm or a platform, and incorporating both production and use side participants, and focusing on the development of new value through innovation*"?

Innovation systems do not function in isolation, but are open to global influences and interactions. In particular, **technology upgrading** is highly dependent on the extent to which key national businesses are positioned in **global value chains (GVC)**[2]**.** A related factor is the ability to attract **foreign direct investment**, particularly firms in knowledge intensive activities or well-positioned in GVC (Garelli, 2000).

Hence, global competitiveness is not measured in terms of export growth but on the capacity to gain a strategic position in global value chains (Brennan and Rakhmatullin, 2015). Similarly, involvement in international R&D networks can favour learning and adaptation (Mathews 2002). This raises the question of the extent to which policy

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2 Global Value Chains are the full range of activities that firms engage in to bring a product from its conception to its end use, including design, production, marketing, distribution and after-sales. GVC can be divided among multiple firms and dispersed across wide geographic spaces. www.globalvaluechains.org

interventions lead to not only value creation but, in particular, 'value capture' in an economy. According to Ali-Yrkkö & Rouvinen (2013b), there are three ways to capture oversized wages and profits in GVCs:

- to be the orchestrator and/or
- brand owner of a value chain, to control the customer/user interface, and/or
- retain a gate-keeping position, e.g. via cornering the market for a key input.

These value chain positions imply high-level service tasks that typically have a supporting role as well as to the creation and management of intangible assets.

To sum up, the national competitiveness debate has oscillated around a number of economic concepts, which Berger (2009) grouped under four broad headings:

- Ability to sell: costs and trade performance orientation
- Ability to earn: productivity and performance orientation
- Ability to attract: place attractiveness for investment and talent
- Ability to adjust: innovation, flexibility and openness.

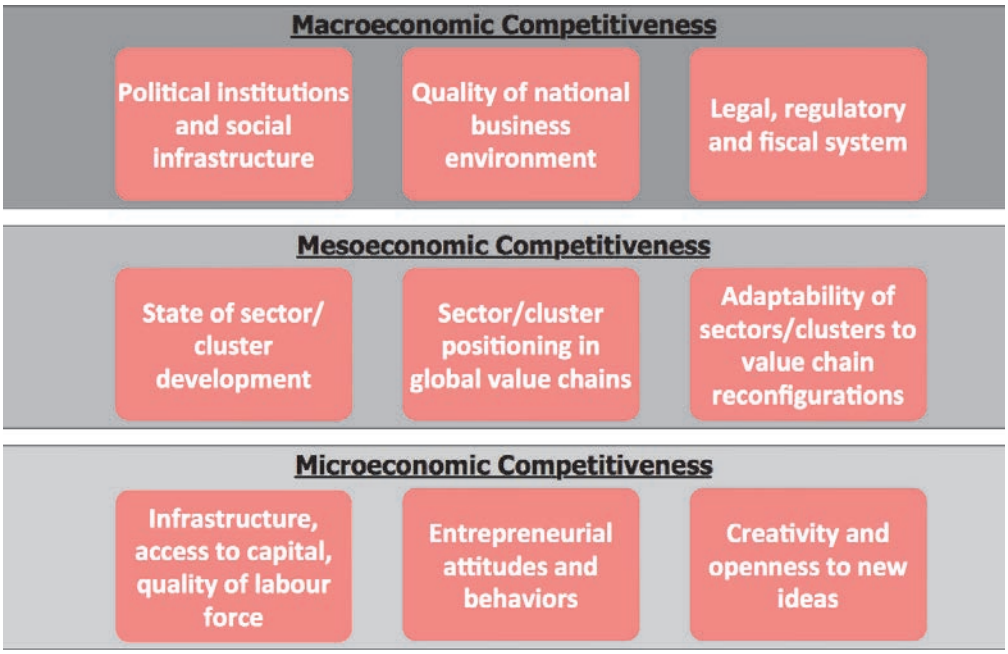
### 1.2.2 A framework for analysis

To help structure the analysis, the study distinguishes between three levels within a national economy and the factors that influence each level (see figure 2):

- **Macro-economic (national level) factors** comprise institutions and norms that establish and regulate business environment and set the framework conditions for a country's competitiveness;
- **Meso-economic (business ecosystem) factors** influence the structure and dynamics of business networking and clusters and determine the development trends and competitive success of emerging industries;
- **Micro-economic (company level) factors** determine behaviour, attitudes and norms at firm level that have impact on productivity, exports and innovation.

Given the remit of the study, the ex-post analysis (chapter 3) focuses on the meso-level by analysing the impact of Tekes on four priority 'ecosystems'. The working hypothesis is that Tekes is (most directly) able to influence the development of selected business ecosystems that have been strategically targeted by because they are considered to have the highest potential to drive value creation (nationally) and capture (from a global value chain perspective).

**Figure 2. Conceptual framework: macro- meso- and micro competitiveness factors.** Source: authors

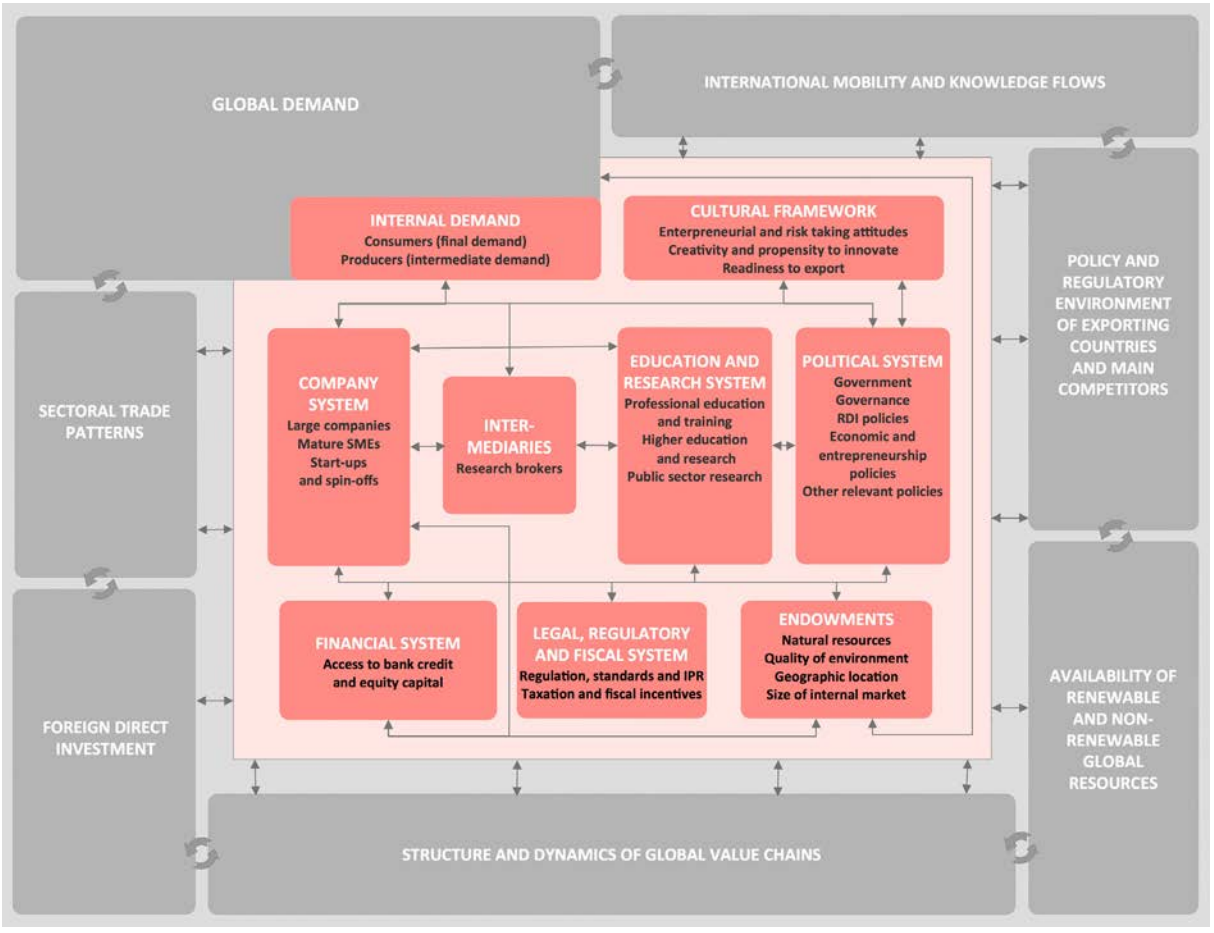


In contrast, Tekes, given its mission and role in the Finnish policy system can only have, at best, an indirect influence or impact on macro- and micro-level competitiveness factors. At the same time, the impact of the direct interventions of Tekes on the priority areas will be influenced by the broad set of competitiveness factors, which for the purpose of analysis are split between (Figure 3):

- **The internal dimension** (light red in diagram) includes the factors that are managed/influenced 'directly' by the core actors of the national innovation system namely: companies, political system, education and research system, research intermediaries, and wider framework conditions (e.g. financing, legal, regulatory and fiscal system, endowments, internal demand and cultural framework). Each component of the system needs to work at least at an acceptable quality and efficiency and the inter-linkages between them need to function well. Business enterprises are principal actors in the system and the articulation of effective demand is central to stimulating entrepreneurship and innovation
- **The external dimension** (grey area in diagram) conveys the principle of openness of the national innovation system but also underlines that a series of factors are beyond the direct control of national governments or agencies like Tekes. Policy interventions can only mitigate the negative and/or incentivise the positive effects of external determinants such as global demand, global value chain dynamics, resource prices/availability, etc. Export-driven growth that is based on innovative business activities is highly dependent on inward and outward flows of knowledge and ideas, hence mobility and supportive frameworks that facilitate knowledge circulation are crucial.

The next chapter provides an overview of the evidence for each internal and external factor influencing Finnish competitiveness. This provides a context for the assessment of the impact of Tekes interventions in favour of the four priority areas in chapter 3.

**Figure 3. A systems approach to analysing global competitiveness.** Source: authors, adapted from Arnold E. & S. Kuhlman (2001)



# 2

# Finnish competitiveness: trends, drivers and barriers

## 2.1 Finnish competitiveness: an overview

Given the framework set out above, a literature review of Finland's competitiveness standings and the relative important of various factors in explaining recent trends was undertaken. The full analysis is included in Appendix B. Finland has experienced difficulties since 2008 to maintain rates of economic (GDP) growth relative to the other EU28 Member States and other major competitors. The structural challenges of the Finnish economy are notably linked to declining cost competitiveness that is not offset by relatively higher productivity growth (indeed productivity has fallen in manufacturing and has barely increase in business services over the last decade). Beyond the impact of the global financial crisis, the Finnish economy has been negatively influenced by the decline of electronic manufacturing ('Nokia effect') which is visible in both export and relative specialisation trends. Finnish electronic exports did not recover post crisis unlike other sectors.

From 2008-2013, Finnish specialisation (relative to the EU28) in activities related to ICT manufacturing (computer & electronics, electrical equipment) declined, while other highly specialised sectors (forestry and logging, coke & refined petroleum, wood, fishing, residential care) achieved a steadily increasing contribution to value added. Specialisation in manufacturing of paper and paper products has slightly decreased in the recent years, but this industry still represents the second most important sector in Finland in terms of value added relative to EU average. However, value added per employee (as a proxy indicator of productivity) is not particularly high in the sectors in which Finland is the most specialised, except for coke and refined petroleum. Despite considerable policy efforts to boost the Finnish service sector, the share of services in total GDP is below the OECD average, yet the share of jobs requiring high-level service skills is one of the highest in the EU. This partly reflects the "servitisation" of manufacturing but there remain opportunities to raise business service productivity.

Finnish technological specialisation (patent data) is relatively strong in ICT fields but has declined since 2005. Specialisation in biotechnology and nanotechnology increased during the 2000s, peaking in 2009-10, but remain lower than in competitor countries. In comparison with global competitors, Finland is relatively specialised in two main technology fields: paper and electricity (but with declining specialisation in the last decade) followed by physics, mechanical engineering and fixed construction.

Finland was well integrated in electronics global value chains (GVCs) from the late 1990s. In 2009, nearly 15% of Finnish exports were derived from electronics GVCs. However, as the electronics sector shrank, new opportunities for participation in GVCs need to be found to revive output growth and exports. While traditional sectors like chemicals and metals are already well integrated into GVCs, Finnish companies in promising new areas such as games, bio-technologies and bio-medicine and green technologies, require support to grab a foothold at key points in relevant GVCs.

Finland remains relatively well ranked in despite slipping down the rankings of the various index that track 'global competitiveness' (World Economic Forum, etc.). Finland has a number of short and medium term challenges (see also the OECD Economic Survey, 2016) but also various long term strengths (notably in terms of institutional quality, health and education systems, technological readiness, etc.). However, there is no guaranteed relation between current performance in such rankings and future competitiveness

The analysis points to a number of dichotomies in the Finnish competitiveness situation which call for concerted action, these include:

- a highly educated workforce and a high level of 'national well-being' (e.g. see OECD Better Life Index) versus relatively high unemployment and low employment rates
- Finland's international reputation as an 'innovation leader' versus low rates of R&D intensive foreign direct investment and declining business (and related d government R&D spend) – leading to a risk of 'hollowing out' the innovation lead.
- A positive regulatory environment for 'doing business' (e.g. ranked 10th globally by World Bank in 2016) versus low rates of entrepreneurial activity (low rate of start-ups and 'creative destruction') and notably 'gazelle' type firms.

- Strong position in international higher education rankings versus poorer performance on openness to novelty and creativity and
- Significant public-private (R&D and industrial) investments in bioeconomy and cleantech versus poor material productivity, high carbon emissions and on energy and material import dependency.

## 2.2 Synthesis of competitiveness factors in relation to TEKES activities

The table below (Figure 4) sums up the Finnish competitiveness strengths and weaknesses for the set of internal and external dimensions (see appendix C for details) and relevant past or current Tekes (or Team Finland) activities addressing the competitiveness factors (see Appendix A for a list of programmes by strategy period). The same framework is applied, in chapter 3, allowing a more finely grained analysis of specific factors influencing the four selected case study ecosystems.

Three out of 10 internal competitiveness factors (Figure 4), are considered particularly problematic: the scale of internal demand, the economic structure/export diversification and the regulatory/tax environment. Related to these three factors, the direct interventions of Tekes are mainly focused on the renewal and diversification of the economic structure through various targeted programmes in the priority areas. Various Tekes programme seek to develop 'upstream' in the 'policy value chain' new 'ecosystems' or foster new business models which can be tested nationally (by the relatively sophisticated Finnish consumer or business clients), potentially stimulating national demand for new products or services. However, the limited internal demand is addressed more directly through the various internationalisation activities either embedded in specific Tekes programmes or as related 'downstream' services of other Team Finland agencies.

The assessment of **external competitiveness factors** confirms that while Finland has a number of internal 'drags' on competitiveness, the global competitiveness of Finnish businesses is particularly sensitive to external factors and shocks. The sectoral trade patterns (intermediate goods,

**Figure 4. Synthesis of internal competitiveness factors.** Source: compilation by authors

| Competitiveness factor | Finland's competitive strengths (green), opportunities (yellow) and weaknesses (red) | Tekes / Team Finland activities |
|---|---|---|
| Internal demand and markets | Small markets, limited competition, deep recession. Major disadvantage? | Public procurement initiatives (role marginal) |
| Company system and economic structure | High dependence on few export sectors. Major industrial restructuring in process. Some positive signals. | Tekes programmes for promoting renewal of industries and innovation |
| Financial system | Relatively good access to finance, strong financial institutions + very small domestic financial market. Difficulty to attract international financing, except for some specific sectors (ICT) | Initiatives to bridge the gap between private and public financing (e.g. VIGO); Tekes equity financing |
| Regulation, taxation | Low level of flexibility and adaptability, relatively high taxation | Awareness raising (role marginal) |
| Education and research system | High quality of education and highly educated workforce. Some worrying trends in level of education, internationalisation and lack of leading edge research. | Funding for research organisations, collaboration with the Academy of Finland |
| Intermediaries and knowledge transfer | Strong intermediary institutions and leading edge initiatives | Facilitation of collaboration between research and industry (e.g. SHOKs) |
| Institutions, governance | Strong institutions and good governance | In-house culture of evaluation and commissioning of policy studies Developing Team Finland co-operation with other agencies |
| RDI policy / innovation | One of the relative strengths, although recent trends include major budget cuts and indicate deterioration of competitiveness. | Tekes is the key actor in RDI policy. Traditionally support in form of funding but increasingly shifting to provision of services |
| Cultural (entrepreneurial) framework | Has been a weakness but positive signs of change | Programmes such as VIGO contribute to promoting an entrepreneurial culture |
| Endowments | Population decline and ageing – possible opportunities in silver economy (health)? Poor resource/material efficiency given significant R&D in cleantech and related investments. | Thematic programmes (incl. SHOKs) on important societal issues and utilisation of national resources |

declining trend in high-tech exports, etc.) means that external shocks in terms of global demand or global value chain repositioning can have particularly severe economic impacts. In this respect, Tekes, and Team Finland partners, have given increasing emphasis to activities designed to anticipate such shocks and favour market access and rapid internationalisation.

In terms of the risks associated with investing in Finnish innovation activities, most international observers rank country (investment) risk in Finland as low, with most pointing only to the dependence on trade with Russia (e.g. the OECDs January 2016 economic survey) or the declining competitiveness and economic restructuring (in electronics and forestry-paper), already discussed above. High household debt also tends to be pointed a finger (even if Finland is relatively no more exposed than other Nordic countries).

Overall, rather than focusing on 'risks', the main issues hindering investment innovation appear to be more related to perceived 'returns':

- Weak internal incentives to engage in innovation and create or develop fast-growing highly productive businesses (despite the range of support measures and relatively high R&D spend) and
- An ambivalent external perception of Finland as a country worth considering for investments in high-value added or technology intensive (R&D functions, etc.) business activities or to which individuals consider to move to pursue advanced studies or careers.

What is striking is the similarity between this conclusion and the Tekes 2005 strategy headline "Productivity, growth entrepreneurship and Finland's foreign appeal pose challenges". This is not to say that a decade on, there has been no progress and that Tekes strategies and interventions have not had an impact (this is the subject of the next chapter), what it does suggest is that the success factors for future competitiveness have not fundamentally changed.

The application of the extended 'innovation system' model to analyse competitiveness factors underlines that policies aimed at 'boosting exports', 'accelerating start-ups' internationally or focusing on 'growth companies with global ambitions' can only succeed if rooted in a highly performing national innovation system and the component 'business innovation ecosystems. National and global competitiveness are two sides of the same coin.

**Figure 5. Synthesis of external competitiveness factors.** Source: compilation by authors

| Competitiveness area | Finland's competitive strengths (green), opportunities (yellow) and weaknesses (red) | Tekes / Team Finland activities |
|---|---|---|
| Trends in global demand | External shocks in key sectors have crucially eroded competitiveness | Future Watch, foresight activities |
| Sectoral trade patterns | Low diversification of export – highly open to external shocks. Proportion of products intended for end-use has fallen and the proportion of intermediate products has increased.<br>Exports of Finnish high-technology products with high R&D intensity have decreased | Thematic programmes (incl. SHOKs)<br>VIGO programme<br>Market access<br>Internationalising business<br>Export Finland Growth Programs<br>Future Watch<br>Invest in Finland (Team Finland) |
| Foreign direct investment | Inward FDI close to EU average, outward higher (notably to Russia) but similar to other Nordic countries. Low R&D intensity of foreign affiliates an issue. | Invest in Finland (Team Finland), Growth Programs |
| Structure and dynamics of global value chains | Increasing integration in global value chains but economy highly sensitive to changing structure of GVC (e.g. electronics case) | Thematic programmes (incl. SHOKs)<br>VIGO programme<br>Market access<br>Internationalising business<br>Export Finland Growth Programs<br>Future Watch<br>Invest in Finland (Team Finland) |
| Availability of renewable and non-renewable global resources | Finland's export sectors are highly dependent on material and energy imports, notably from Russia | Tekes cleantech / material programmes |
| Policy and regulatory environment of main export and competitor countries | Export markets regulatory frameworks may not match with Finnish business models. Changing regulatory landscape (e.g. in health care) may provide business opportunities for strong Finnish sectors. | Future Watch, foresight activities; Growth Programs |
| International mobility and knowledge flows | Relatively low in-flow and out-flow of students, difficulties in recruiting researchers to work in Finland and low-retention of international graduates | Fidipro progamme<br>(Tekes co-funding)<br>Tekes National NCP |

# 3

# Tekes – impact on global competitiveness

This chapter addresses two main research questions concerning the role of Tekes in supporting the global competitiveness of Finnish business and industry.

- What has been the role of Tekes in improving global competitiveness of Finnish business and industry?
- Which factors in the Finnish operating environment help or hinder the impact of Tekes activities to improve competitiveness?

The 2011 Tekes strategy target group was defined as SMEs seeking growth in internationalisation. Tekes aimed to step in with small investments in a large number of seed stage enterprises and continue to fund the most promising ones with a significant input. Together with other actors, Tekes aimed to provide pre-conditions for generating new fast-growth enterprises and facilitating their access to private capitals. Tekes programmes were developed along two lines:

- targeted long-term development of skills of anticipated future importance, stressing public research.
- SMEs' needs catered for through a 'separate and agile model of programme activities'.

The 2015 Tekes strategy saw a shift away from a focus on funding of individual companies towards actively building Finland's 'innovation ecosystem'. The strategy aims to create thriving businesses and the world's best innovation environment in Finland. Similar to the 2011 strategy, half of Tekes' funding is available for any excellent business R&D projects suggested by customers. The other half is targeted at four thematic focus areas. The thematic focus of Tekes support has evolved over time but broadly speaking the focus areas (since 2005) have been:

- Energy & environment: evolving overtime to absorb forestry and other natural materials and split into two overlapping priorities: cleantech and the bio-economy
- Information and communications technologies and digital services
- Well-being and health.

## 3.1 The impact of Tekes support on four priority areas

The analysis of the impact of Tekes support for the four main priority areas was carried out based on a literature review, an analysis of Tekes data on companies in each priority area that received funding since 2010 and interviews with key stakeholders and companies. For each priority area, a specific sub-priority was selected for more in-depth analysis as an example of Tekes support over time to boosting the global competitiveness of an 'ecosystem". 'The full analysis of each priority area and the respective ecosystem case is presented Appendixes E, F, G, H.

The table below (Figure 6) summarises the scale of support (number of companies, budget) and the main programmes per area. It proved surprisingly difficult to collate precise data on projects, companies and funding per priority area and per year. This is partly due to the fact that priority areas do not correspond exactly to industrial classifications (used to segment firms), it also reflects the significant overlap between bioeconomy and clean teach projects and synergies between health and digital.

Concerning the overlap between bioeconomy and cleantech, according to Tekes, 75% of the bioeconomy projects can also be classified as cleantech projects and only 25% as 'pure' bioeconomy projects. All biofuel producing companies and the largest proportion of renewable energy is categorised in cleantech. When the Tekes categorisation of 'pure' bioeconomy is applied, annual funding is approximately €55m.

The focus of health related programmes since the mid-2000s has covered a number of sub-topics including pharmaceuticals. However, there has been a constant stream of activity related to remote health care, home care, health monitoring and personalised care, all of which require the development of digital applications, ICT solutions, etc.

In order to investigate the relative performance of Tekes 'client' firms in the four priority areas, data on turnover, employment and exports was analysed for the period 2010-14, the key conclusions are as summarised in the table below (Figure 7).

**Figure 6. Synthesis of Tekes support per priority area (2010-14).** Source: authors, compilation based on data and reports from Tekes

| Priority area | Scope and scale of funding | Main programmes |
|---|---|---|
| **Bioeconomy** | 2006-13: 565 projects involving 304 companies – total funding of €456m (not including SHOK) | NeoBio (2001-5)<br>SYMBIO (2006-11)<br>SHOK Bioeconomy<br>BioRefine (2007-12)<br>Smart City (2013-17) |
| **Cleantech** | 2010-2015: 1432 companies participated to projects<br>– Renewable energy 155 companies – €168m in funding<br>– Energy and resource efficiency = 711 companies – €620m<br>– Future electricity & energy systems 77 companies – €104m<br>– Environmental protection 601 companies – €447m | Sustainable community (2007-12)<br>BioRefin (2007-12)<br>Fuel cells (2007-13)<br>Water (2008-12)<br>Groove (2010-14)<br>Green Growth(2011-15)<br>Green Mining (2011-16)<br>Smart City (2013-17) |
| **Digital-ICT** | 2010-15: €544m allocated to ICT industry of which €365m for computer programming (most of any single industry).<br>Increase since 2010 in funding to computer programming and decreased for ICT manufacturing<br>650 digitalisation projects with an annual budget of approximately €100m | FENIX (2003-7)<br>GIGA (2005-10)<br>VAMOS (2005-10)<br>VERSO (2006-10)<br>UBICOM (2007-13)<br>DPP (2008-12)<br>SKENE (2012-15)<br>TRIAL (2011-2014<br>5th Gear (2014-19)<br>Industrial Internet (2014-19 |
| **Health** | 2010-14: average of €50-60m per year – total of more than 900 companies.<br>Tekes divides health companies into four groups: 1) Recognition of illnesses; 2) Treatment of illnesses; 3) Self-care & monitoring; 4) Support services & products for processes. | Safety and Security (2005-7)<br>Innovations in social and health care services (2008-15)<br>Pharma – building competitive edge (2008-11)<br>BioIT (2012-14)<br>Innovative cities (2014-17)<br>Bits of Health (2014-18) |

**Figure 7. Tekes client firms performance 2010-14.** Source: data Tekes, Statistics Finland, calculations authors

| | Turnover | Employment | Export |
|---|---|---|---|
| **Bioeconomy** | 25% | 2% | 31% |
| **Cleantech** | 47% | 29% | 54% |
| **Digitalisation projects** | 43% | 31% | 39% |
| **ICT** | 73% | 71% | 96% |
| **Health** | 35% | 21% | 35% |

Based on a dataset of 416 firms selected randomly from the Tekes client database, an econometric model (see Appendix D) was estimated to check for the (short term) impact of Tekes funding on turnover and employment. The performance of the firms supported by Tekes were benchmarked with respect to the overall business sector in order to control for the trend of the sector. Due to data availability it was not possible to test the model for cleantech (annualised funding information was unavailable) or control for exports. The table below (Figure 8) summarises the results.

**Figure 8. impact of Tekes support per priority area on employment and turnover.** Source: authors calculations based on data from Tekes and Statistics Finland

| Priority area | Employment | Time lag/duration | Turnover | Time lag/duration |
|---|---|---|---|---|
| **Bioeconomy** | Positive impact | Impact after one year, lasts for two | Positive impact for entire period | No observable impact per year |
| **Digital** | Positive impact | In year one only | No observed impact | n.a. |
| **ICT** | No observed impact | n.a. | Positive impact | In year two only |
| **Health** | Positive and significant | Impact after one year, lasts for three | Positive impact | From year two onwards |

**Figure 9. Meta-evaluation findings for each priority area.** Source: authors, based on documentary review and interviews

| Priority area | Meta-evaluation synthesis |
|---|---|
| Bioeconomy | • Early programmes (NetBio, SymBio) built up expertise but the commercialisation levels of new knowledge and technologies failed to match the initial expectations. Incentivised numerous R&D activities that were carried out before market readiness.<br>• Tekes investment contributed to building up knowledge base and novel business models supporting development of of a bioeconomy cluster and structuring value chains.<br>• BioRefine programme was successful in offering a platform to build up new technological know-how; however, the business value only emerges in the future. |
| Cleantech | • Smart-grid case study underlines important of Tekes support to technological development during 'valley of death' phase and SHOK Cleen Oy fosteed industrial partnerships and bringing together value chain participants. |
| Digital-ICT | • An evaluation of five telecommunication programmes implemented between 1997-2010 found that participants were satisfied with the short-term technical outcomes but that economic results were not so evident. Evidence of impact on the creation of domestic networks was found but internationalisation support was considered inefficient.<br>• Evaluation of the VAMOS and VERSO also concluded on positive networking and supply chain effects (including international clients) but limited commercial results. The programmes were considered successful from a point of view of building the 'software industry ecosystem'.<br>• Learning from previous programmes led to a more successful outcome for UBICOM including better knowledge of global markets and international interactions. |
| Health | • Evaluation of Tekes pharma and other health programmes from 2000s identified effects on scientific knowledge and technological development but limited evidence of the creation of new business activities and internationalisation<br>• More recent programmes have focused on building health care ecosystems/clusters involving public and private organisations (e.g. Smart Aging Network)<br>• Self-monitoring case study points to critical role of Tekes in support early-stage R&D but also of on-going support over time including critical 'non-financial' support for 'market entry (e.g. in China) |

In terms of employment, a positive impact is observed for both bioeconomy and health for the overall period. The analysis differentiated the impact by years after funding and in this case, a positive effect was observed for bioeconomy, digital and healthy from year one, but in the case of digital for the first year only. The impact on turnover is less important with only bioeconomy recording a positive impact for the whole period. ICT and health recorded a positive impact on turnover but this occurred only after a time lag of a year. The model did not allow to differentiate the year of impact for bioeconomy, suggesting that the turnover effect is spread over time.

While the econometric findings should be treated with caution (given data limitations), they are in line with programme evaluations finding for the priority areas. A common observation is that **impact on firm growth performance was limited** (at least in the short term) and that **effects were observed more in terms of networking, technological development and (more recently) 'ecosystem' or value chain development** (including public-private partnerships.

## 3.2 Key findings for the four business ecosystems

The case study analysis focused on the impact of Tekes' on the global competitiveness of 'emerging ecosystems' in the four priority areas. The 'ecosystems' were selected based on a number of criteria, as summarised in the table below (Figure 10).

The cases examine:

- The position of the ecosystem in in global value chains and challenges faced in responding to global market trends
- How Tekes programmes and services are helping to improving the ecosystems global competitiveness;
- How can Tekes (& Team Finland) best support in the future the business ecosystem to create and capture value in the future.

**Figure 10. Selected business ecosystems per Tekes priority area.** Source: compiled by authors

| Priority area | Ecosystem | Scale/value chain position/ ecosystem development | Criteria for selection |
|---|---|---|---|
| **Bioeconomy** | Bio-based chemicals | • Finnish chemical industry accounts for 23% of exports, around a third of companies use bio-based raw materials<br>• Finnish firms in lower-value added end of value chain<br>• Significant investment by Tekes in bioeconomy over last decade including in bio-products, etc. | • Use of bio-raw materials is on increase in chemical sector – with significant turnover growth forecast<br>• Development of biorefining provide prospects for niche businesses to move up global value chains |
| **Cleantech** | Smart Grid | • Around 7% of Finnish cleantech companies working in smart grid niche (50 firms)<br>• Relatively new field but robust value chains forming in Finnish industrial landscape<br>• Ecosystem combines traditional 'utilities' and new business models – Tekes support via a mix of direct grants and SHOK. | • Finland 'global leader' in Smart Grid applications<br>• Dynamic global value chain emerging incl. major internet/telecom giants<br>• Potential for Finnish companies to provide platform solutions gaining strong position |
| **Digital ICT** | Game industry | • 260 companies, 2500 employees, turnover €1.8b<br>• Dominated by two 'star' firms but many small start-ups<br>• At least 10 year investment by Tekes in ecosystem | • 20% of ICT industry<br>• Highly profitable and rapidly growing industrial niche<br>• Challenge to position more game companies higher up global value chain |
| **Health care** | Self-care & monitoring | • Currently about 50 companies, turnover €154m, 860 employees<br>• Early stage ecosystem supported by Tekes<br>• Market access challenge | • Links to national e-health strategy<br>• Technology intensive products-services<br>• Facing intense international competition from 'global giants' |

### 3.2.1 Bioeconomy – bio-based chemicals

The bio-based chemicals ecosystem was chosen for in-depth analysis for a number of reasons. The utilisation of bio-resources as building blocks for a wide range of goods and services that can substitute those based on fossil fuels represents the core of the so called 'new' bioeconomy. It implies the reconfiguration of old industrial structures and formation of long, entirely new global value chains that span from biomass processing to consumer product distribution.

There is a high political momentum to the concept of bio-based products as a cornerstone to the transition to bioeconomy, yet real-life value chain formation is only at its infancy and full-fledged ecosystem development will take a long time.

As chemical and forest-based industries will remain locked into their own ways of working, assets and capabilities for a foreseeable future, support is needed to companies that transform biomass into intermediate inputs that the chemical industry can readily integrate in their processes.

Currently the Finnish bio-based chemicals industry that produces bio-based chemicals intermediaries is dominated by large companies and a small number of SMEs. These companies are key drivers of the ecosystem as the market uncertainty and significant entry barriers are discouraging start-up activities. For these large and medium-sized companies, Tekes support for R&D has provided important stepping stone in new business line creation. Due to the lack of sufficient actors at this early stage of ecosystem development, Tekes should further promote collaborations between Finnish companies and global actors with cutting edge knowledge.

The SMEs in the newly emerging bioeconomy value chains lack industry connectivity and access to markets. Support via brokering services and large scale open-access pilots suitable for a range of applications would be beneficial for speeding up local value chain formations and development of niche businesses within bio-based chemicals ecosystem.

**Figure 11. Bio-based chemicals ecosystem - global competitiveness overview.** Source: authors, based on literature review and interviews

| Competitiveness area | Finland's competitive strengths (green) and weaknesses (red) | Tekes / Team Finland activities |
|---|---|---|
| **External factors** | | |
| Trends in global demand | ++ Climate and energy debate is fostering market creation and driving the demand for bio-based products<br>– – Market is still very much price sensitive and low oil prices are reducing the competitiveness of bio-based chemical industry | No direct role |
| Foreign direct investment | – Investors are not very familiar with the opportunities in the sector, but it may change in near future | ++ Commitment of long-term government support to the area give positive signals also to investors |
| Structure and dynamics of global value chains | – Finnish companies occupy the lower end of the value chain, namely biomass processing<br>+ But they appear to be well integrated in global value chains and have managed to move up in production of bio-based chemical intermediaries | ++ Instruments targeted on ecosystem development in the future can help to secure favourable position in global value chains |
| Policy and regulatory environment | – – Standardisation and regulation of bio-based products is still in progress, which influence market uncertainty. There is no politically created market yet for bio-based chemicals as in the case of biofuels. | No role |
| International mobility and knowledge flows | ++ Strong presence in international knowledge networks related to wood-based chemistry | + Significant support to RDI has contributed to the entry in internationally unique knowledge networks in biorefining |
| Availability of renewable and non-renewable resources | +++ Scarce availability of quality forest-based biomass in Europe and globally is an opportunity for Finland | No role |
| **Internal factors** | | |
| Internal demand and markets | + Demand on increase<br>– – Small internal market and price still key determinant for industrial producer and customer choice | No role |
| Company system and economic structure | – – – Domination of traditional forest-based and chemical industries in silo structures | ++Tekes role in creating favourable environment for new ecosystem actors or reorientation of existing actors to forge new value chains |
| Financial system | – – Lack of venture capital due to long time for return on investments | +++ Team Finland role in ensuring access to finance |
| Regulation, taxation | – Lack of standardisation of bio-based chemical products, but this is firstly an EU level issue | No role |
| Education and research system | +++ Strong know-how and competence base | ++Considerable Tekes contribution to industrial RDI and industry-academia collaboration |
| Natural endowments | +++ Abundance of forest-based biomass | No role |
| Intermediaries and knowledge transfer | +++ Well developed RDI infrastructure, including internationally unique facilities | ++Considerable Tekes contribution to new pilot plants, testing facilities and other RDI facilities |
| RDI policy / innovation | +++ Significant support to RDI in bio-based chemicals industry as one of strategic areas within government bioeconomy priority | +++ Tekes is an important part of the RDI system with tools to influence ecosystem development |
| Cultural (entrepreneurial) framework | – – Higher risk aversion as as new business activities require important investment | +Tekes support measures contribute to increasing awareness and interest in emerging business opportunities |

### 3.2.2 Cleantech – Smart Grid ecosystem

The rationale for selecting Smart Grid ecosystem for a more in-depth analysis is based on the observation that, despite the fact this is a relatively new field of development, there is already evidence of robust value chain structures forming within Finnish industrial landscape. The ecosystem integrates incumbent energy and telecommunication industry with a 'smart' value added layer of new business models that provide wide range of consumer offerings and 'intelligent home' solutions. This opens up good opportunities for innovative start-ups and more established businesses.

**Figure 12. Cleantech Smart Grids ecosystem – global competitiveness overview.** Source: authors, based on literature review and interviews

| Competitiveness area | Finland's competitive strengths (green) and weaknesses (red) | Tekes / Team Finland activities |
|---|---|---|
| **External factors** | | |
| Trends in global demand | – Still low level of consumer awareness about Smart Grid benefits | No role |
| Foreign direct investment | + A number leading energy companies have chosen Finland for cutting edge R&D work | ++ Investment in internationally unique pilot and test facilities increases also attractiveness for FDI |
| Structure and dynamics of global value chains | ++ Dynamic and evolving ecosystem that presents opportunities for innovative SMEs as well as large incumbent industries | +++ Tekes support could potentially play a significant role in advancing and securing Finnish company positions in emerging global value chains |
| Policy and regulatory environment | – – Lack of international standards hampers interoperability and increases deployment costs | No role |
| International mobility and knowledge flows | ++ A number leading energy companies have chosen Finland for cutting edge R&D work, strong Finnish presence in international knowledge networks related to Smart Grid | + Tekes support has helped to create favourable conditions for knowledge circulation advancing the creation of cutting-edge R&D in Finland |
| **Internal factors** | | |
| Internal demand and markets | +++ Good societal awareness about positive benefits from energy efficiency measures; rollout of smart metering instalment in 95% of Finnish households have created a platform for future Smart Grid services | + Tekes support has helped to create favourable conditions for internal market creation supporting cutting-edge R&D in Finland |
| Company system and economic structure | ++ Small ecosystem, but clear signals of healthy formation of new value chains between previously disconnected industries | ++ Tekes support has been a very important source of funding for a dynamic development of companies that add the 'smart' layer to the grid |
| Financial system | – Limited access to venture capital for companies that are beyond the start-up phase but do not generate yet significant profit | +++ Tekes R&D projects helped to bridge this funding gap |
| Regulation, taxation | – – Current regulatory regime does not balance the asymmetries in costs and ultimate benefits of the Smart Grid R&D activities | No role |
| Education and research system | +++ Highly skilled ICT talent pool available for several technology sub-domains relevant for Smart Grid; Finland is a global leader in Smart Grid R&D | ++ Tekes support has been significant factor for advancing the creation of cutting-edge R&D in Finland |
| Intermediaries and knowledge transfer | ++ Internationally unique pilots, test facilities and Living Labs available in Finland; more knowledge transfer infrastructure will be needed in the future for upscaling new Smart Grid solutions | ++ Tekes investment has significantly contributed in setting up new piloting and testing facilities |
| RDI policy/ innovation | +++ Political support to Smart Grid development and strong innovation system that enables it | +++ Tekes is an important part of the RDI system with tools to influence ecosystem development |
| Cultural (entrepreneurial) framework | ++ Finnish people are a technology savvy nation with a quick adoption rate of new innovations | + Tekes support measures contribute to increasing awareness and interest in emerging business opportunities in key government priority areas |

Generally, Smart Grid is expected to become an important growth sector of tomorrow. Currently Finland is a global leader in developing and implementing Smart Grid applications; hence better understanding of this Finnish business ecosystem and key drivers and barriers for its integration into global value chains is important for fostering Finnish global competitiveness.

Smart Grid represents a dynamic emerging ecosystem that offers interesting opportunities for agile innovative SMEs as well as large incumbent industry, such as energy and telecommunication corporations. Due to specific natural circumstances and favourable innovation framework conditions, Finland has emerged as a global leader in developing and implementing Smart Grid applications. Hence Finnish companies are well positioned to be in the vanguard of new global value chain formation.

Tekes support has been a very important source of funding for company development in the Smart Grid area. This support has helped to develop technological solutions that later, in some instances, became the key to company value proposition. Tekes funded R&D project contribution also has been recognised in relation to opening up new connections among previously unrelated industries. It can be said that Tekes support helped Smart Grid companies to develop in much more dynamic pace, thus increasing their competitive prospects in the emerging global market.

Smart Grid is a continuum from today's system towards a next generation vision. In order to promote value generation and value capture in Finland, further support is needed for business-oriented experiments of Smart Grid applications and Living Labs. A Smart Grid is a comprehensive system that requires a gradual step-by-step development approach, Finnish firms pioneering role can be exploited in strengthening their value chain positions. For instance, by controlling the supply of system technologies that provide the baseline platform for more advanced Smart Grid applications, Finnish companies could ambition to become central nodes in Smart Grid value chains. Equally, a strong position in user interface application development could help companies to capture significant value from the emerging future market.

### 3.2.3 ICT-Digital: Games industry ecosystem

The games industry is an interesting example for assessing Tekes impact on the development of business ecosystems. First, the global gaming market has transformed fast and profoundly during the last decade due to development of digital distribution channels and the emergence of new business models. This has forced Finnish game companies to develop not only technology but also new business competences. Second, the development of the Finnish game industry highlights the importance of value capture in global competition, especially in IP-based industries. Third, Tekes has been actively involved during the whole lifecycle of the game industry ecosystem.

The case highlights the fact that the growth of an ecosystem is dependent on both external and internal competitiveness factors. External factors include the rapid growth in global demand, technological development of mobile devices and emergence digital distribution channels. Internal factors include the existing strong ICT competence (Nokia's 'heritage'), high quality education, and investments to mobile technology. The structural changes of the Finnish ICT sector helped to boost the start-up boom in the game industry. The case highlights the importance of grassroots activities as 'fuel' for the emergence of new talented entrepreneurs and ecosystem dynamism (e.g. Finnish demo scene and hobbyist culture). Strong networks, institutions and common culture within the ecosystem were important success factors.

Tekes funding has provided companies with an opportunity to invest in technological development and improve their competence. Typically, many companies focus only on developing content. Tekes funding helped them to pay more attention to the technological basis, which foreign investors value, and develop stronger foundations for long-term development. Companies interviewed reported that Tekes funding has helped to convince investors of growth ambitions and is a valuable 'proof of concept' for many investors.

In terms of strengthening industry networks Tekes' role has been more marginal and viewed mainly as a funding stream with collaboration between companies and projects quite limited. Hence, the role of Tekes among games industry firms seems to be predominantly as a funder for *technological* development, not other types of innovation or the development of business models. Nevertheless, while difficult to single out the contribution of a single actor in developing an entire business ecosystem, there is strong evidence that Tekes' investment in the game industry has contributed to its growth and generated broader impacts to the Finnish economy.

**Figure 13. The Games Industry ecosystem – global competitiveness overview.** Source: authors, based on literature review and interviews

| Competitiveness factor | Finland's competitive strengths (green), opportunities (yellow) and weaknesses (red) | Tekes / Team Finland activities |
|---|---|---|
| **External factors** | | |
| Trends in global demand | +++ Popularity of gaming increased, especially due to development of mobile devices. | No role |
| Foreign direct investment | +++ Influx of foreign investments after international success. | +++ Tekes an important 'proof of concept' towards foreign investors |
| Structure and dynamics of global value chains | +++ Emergence of global distribution channels enabled access to global markets | ++ Investments to mobile technology helped to build competence in mobile markets |
| Policy and regulatory environment | – No single digital market in EU, regulation between EU and other countries a disadvantage | No role |
| International mobility and knowledge flows | – Some difficulties in attracting foreign talent | FiDipro |
| **Internal factors** | | |
| Internal demand and markets | – Very small internal markets a disadvantage but forces companies go global. | No role |
| Company system and economic structure | +++ Many young startups with ambitions for international growth. | +++ Tekes an important source of financing for many startups |
| Financial system | – Relatively good access to finance, lack of financing for 'grassroots companies' or cultural content | |
| Regulation, taxation | + No major regulatory barriers on national level (specific for game industry) | No role |
| Education and research system | + Game education relatively strong, but future sufficiency a concern | No role |
| Intermediaries and knowledge transfer | +++ Strong intermediary institutions and very strong 'ecosystem' enable efficient knowledge transfer | + Tekes role as networker only limited |
| RDI policy / innovation | +++ RDI policies highly supportive for game industry. | +++ Tekes an important part of the RDI system |
| Cultural (entrepreneurial) framework | +++ Game industry one of the pioneers of new entrepreneurial culture | + Tekes role limited but actively involved in promoting entrepreneurial culture |

### 3.2.4 Health – Self-care & monitoring ecosystem

Finland has high quality healthcare related research and higher education system, expertise in different areas (e.g. ICT and mobile) with applications to self-care and monitoring, a well-functioning start-up ecosystem and strong entrepreneurial culture, an increasing acceptance of health prevention and self-monitoring among the population, a high coverage healthcare system with strong movements towards electronic and mobile health (e.g. digital healthcare registers), and one of the best market conditions for the mHealth businesses in the EU. These factors provide a basis for the development of a thriving self-care and monitoring sub-sector eco-system.

Certain obstacles, nevertheless, need to be overcome for this ecosystem to become more visible and competitive not only nationally but also internationally. While the small home market forces Finnish companies to go international almost from the very beginning, it is a challenge to grow well-established mid-size companies. Transferring the IT platform (on which some of the self-care and monitoring products are built) is not a problem (as such), rather the barriers relate to: integrating new self-care and monitoring applications to global platforms (Apple, Microsoft) and the fact that self-care and monitoring is at the intersection of a state-regulated healthcare system and a consumer driven market. There are very diverse market structures, incentives and regulations in place across different countries and various actors in the healthcare system play different roles, making it difficult for young companies to navigate through other national set-ups.

**Figure 14. Self-care & monitoring ecosystem – global competitiveness overview.** Source: authors, based on literature review and interviews

| Competitiveness area | Finland's competitive strengths (green) and weaknesses (red) | Tekes / Team Finland activities |
|---|---|---|
| **External factors** | | |
| Trends in global demand | +++ People are realising more the need for health prevention and the role of self-care and monitoring in it.<br>– – Health providers are not fully ready to accept self-monitoring | No role |
| Foreign direct investment | – Self-care and monitoring businesses are not that known to foreign investors as yet but it can build on the popularity of ICT/mobile applications (e.g. gaming industry) | +++ Support from Tekes to SMEs is an important confidence builder for the investors |
| Structure and dynamics of global value chains | – – – Integration into global platforms is needed in order to penetrate global markets | ++ Tekes support to the development of mobile technologies and mobile markets is important here as self-care and monitoring is often linked to mobile technologies |
| Policy and regulatory environment | – – Healthcare markets are regulated; each national healthcare systems has its own peculiarities | No role |
| International mobility and knowledge flows | – Sufficient local talent; established international research links but some difficulties in attracting foreign talent | ++ Tekes role in supporting R&D (which in many cases involves international cooperation)<br>+ Team Finland built networks between Finnish SMEs and health care markets in other countries (e.g. UK and USA)<br>+ Formation of Smart Aging Network Finland (focused on joint innovation and expert activities) as a result of Tekes funded programme |
| **Internal factors** | | |
| Internal demand and markets | – – Very small internal markets (in terms of end-users, although the interest in population is high); healthcare system is not yet focused on prevention | + At least one Tekes programme (Innovations in Social and Healthcare Services) had a goal to develop preventive social and healthcare services<br>+ Tekes involvement in creation of innovation clusters (ongoing programme Innovation Cities 2014-2017) aiming at home care as a commercialisation platform |
| Company system and economic structure | +++ Many young startups with ambitions for international growth<br>+++ Cross-linkages with other more international linked sectors (e.g. ICT) | +++ Tekes an important source of financing for many startups |
| Financial system | + Appearance of specialist business accelerators for wellness, health and wearables | |
| Regulation, taxation | – – Healthcare system is regulated; data protection | No role |
| Education and research system | ++ High quality education and research; many health areas relevant to self-care & monitoring (e.g. physiology, sports medicine) | No role |
| Intermediaries and knowledge transfer | ++ Strong knowledge transfer nationally; start-up mentoring eco-system | + Tekes national role as a networker |
| RDI policy / innovation | +++ Support to cross-sectoral RDI (e.g. application of ICT in biology) leading to inventions in the self-care and monitoring sub-sector | +++ Considerable support from Tekes to RDI |
| Cultural (entrepreneurial) framework | ++ Entrepreneurial culture (but driven not by researchers but mostly by entrepreneurs) | + Tekes involvement in creation of innovation clusters (ongoing programme Innovation Cities 2014-2017) aiming to develop universities campuses as an innovation platform for companies |

The self-care and monitoring sub-sector is an interesting example of Tekes support for the development of a niche eco-system that can contribute to both the national economy and, ultimately, society as a whole. The self-care topic is increasingly important on the political agenda due to the ageing population, low population density and limited available healthcare support. These drivers coupled with long-term R&D investments as well as business expertise in the mobile technology and communications area led to an increase in start-up activities in the field of mobile and e-health (with the vast majority of products and applications linked to self-care and monitoring). The ecosystem is also supported through research projects of the SHOK Health and Well-being (SHOK – SalWe).

The support from Tekes, and the wider Team Finland network, has played an important role in developing Finnish small-medium sized in the self-care and monitoring ecosystem. Interviewees stressed that Team Finland internationalisation services to (e.g. USA Health 2.0 event, Chinese mission) assist the visibility and credibility of Finnish companies and help them make the necessary links with commercial partners and public authorities.

In the future, the following issues should be taken into account:

- The sub-sector is still in its early stages of development and support is needed of a varied nature and over a longer period of time. For instance, technological innovations need to be aligned with the organisation of health care provision in other countries to ensure the transferability of platform.
- Finnish self-care and monitoring sub-sector needs success stories visible internationally to build positive (and wider) publicity and trust;
- Cross-sectoral linkages (as happened between mobile communication and healthcare in creating self-care and monitoring mHealth applications) need to be nurtured and supported with a goal of creating more cross-sectoral combinations and, as a result, new companies.

# 4

# Tekes and Team Finland: future impact on global competitiveness

This final section draws on the learning from the past Tekes interventions and combines it with insights the experience of other innovation agencies in tackling the challenges of supporting global competitiveness of emerging sector. Short 'learning snapshots' from four European countries each with a focus on specific ecosystems were developed (see Appendix H): Denmark (Copenhagen) – CleanTech; Sweden – Bio-economy, Germany (Berlin) – digital health, Ireland – ICT. In these cases, the focus was largely on the 'policy ecosystem' examining how different agencies and policy instruments are used to support a value proposition for global competitiveness.

## 4.1 Tekes and Global Competitiveness: key findings

The evidence collated during the study underlines that for a new or emerging business 'innovation ecosystem' to achieve 'global competitiveness' requires a multi-faceted and multi-actor approach. Based on the findings, the key takeaways are as follows:

- The main impact of Tekes's is not on short-term (turnover, exports, etc.) growth of individual 'client firms' but rather through the triggering and/or 'nurturing' over a longer run period the emergence of new technology based 'ecosystems' that help restructure 'traditional' sectors or develop new high-value added activities.
- Companies continue to view Tekes' principal role as funding technological development. Such support for early-stage investment in technology solutions is viewed as critical, not only in monetary terms but also because Tekes provides a quality label ('proof of concept') in the eyes of (foreign) investors and partners.
- Tekes is viewed as less effective in fostering collaboration or value chains linkages both nationally and, particularly, internationally. However, other initiatives including, the previously Tekes funded, SHOKS have helped to structure value chain relations within Finland. In some cases, the Finnish ecosystems miss key competences (e.g. in industrial biotechnology) that requires complementary investments or establishing linkages with international partners.
- The ecosystem cases underlined the significant role of larger or leading 'anchor companies' in the creation of ecosystems and their evolution. At the same time, 'incumbent' larger firms (e.g. in biofuels) may be both 'critical for the development of new value chains and 'slow' to shift towards the new business models (e.g. due to cost of adapting to new processes, etc.). The quality of interaction between such large or lead firms in ecosystems and smaller/start-up companies can be critical.
- Across all four ecosystems, converting 'national rising stars' into 'global players' proved challenging, with notable exceptions such as in games. The specific obstacles differ but common themes included access to international market intelligence, regulatory differences/approval (e.g. self-care, smart grids), early integration/positioning in global value chains, or securing opportunities for piloting or testing products or 'platforms' in foreign markets.
- A key lesson from the study is that to achieve global competitiveness, the various business ecosystems require tailored and diverse forms of support that often stretch beyond the remit and resources of Tekes alone. This applies both in terms of supporting the development of the new business models nationally (e.g. regulatory or policy changes lagging technology) as well as internationally (e.g. attracting strategic investors, etc.).

## 4.2 Enhancing the impact of Tekes on Finnish competitiveness

The study team were asked to formulate an opinion on the best tools and overall possibilities for Tekes to have the highest impact on competitiveness. The Finnish Government's May 2015 Strategic Programme reconfirmed bioeconomy, clean tech, digitalisation and health and wellbeing as core drivers of future Finnish competitiveness. At the same time, the programme foresaw a significant cut in Tekes funding and noted that 'funding should be increasingly directed to growth-oriented businesses and radical innovations.' Within the Finnish policy system, Tekes has traditionally funded *"pioneering RDI projects aimed at making breakthroughs. In other words, Tekes funding is targeted to projects that create the greatest benefits for the economy and society in the long-term"* (Evaluating Tekes Activities, 2015, pg. 11).

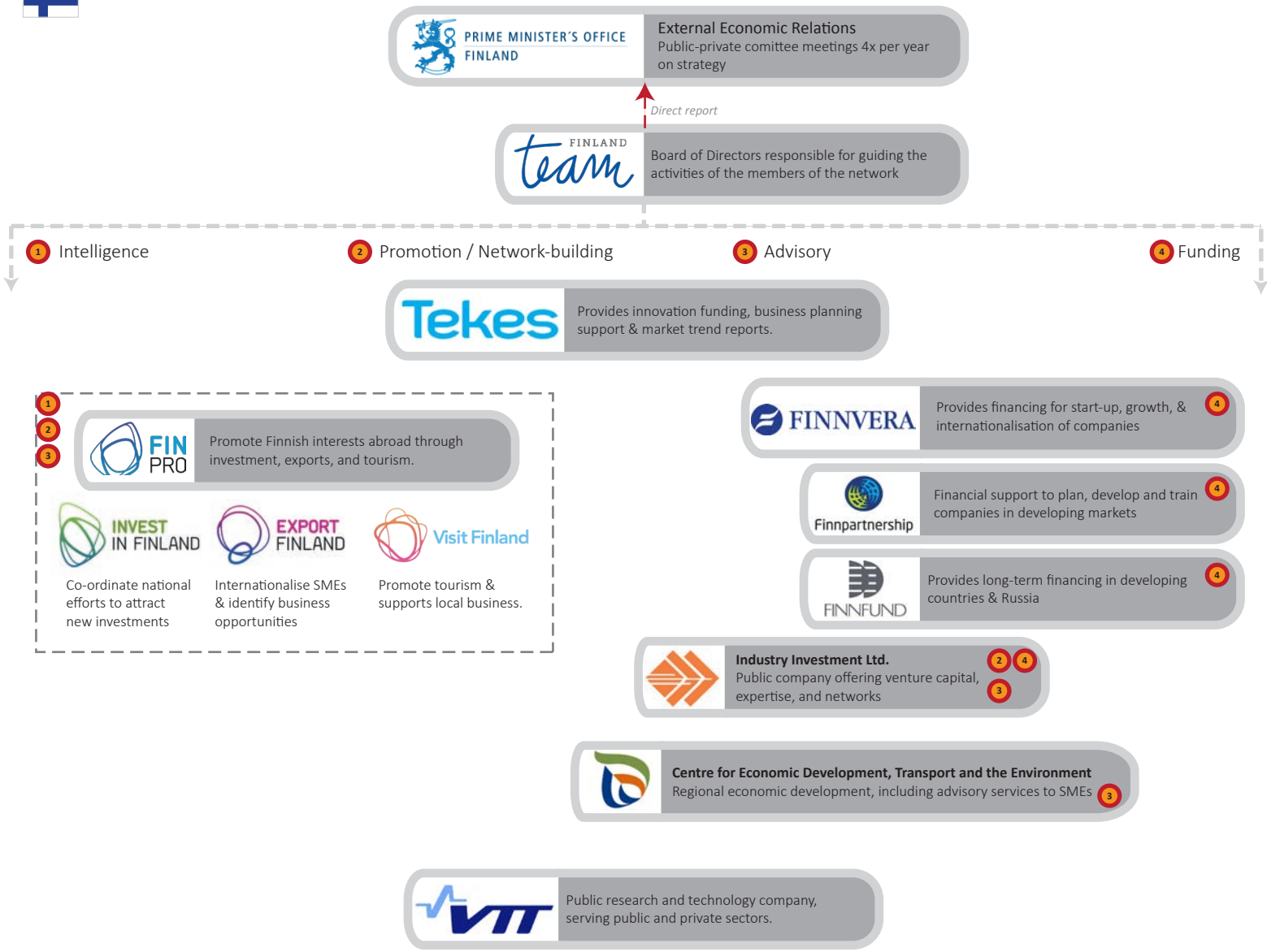
The case studies suggest that maintaining the specific function of a 'long-term pioneering investor' within the policy system is critical for the emergence of new business models and 'business ecosystems'. At the same time, they also underline that technological development tested in a relatively small home market is not sufficient to ensure global competitiveness. While the Tekes strategy places an emphasis on support to innovation ecosystems, the past programmes have tended to act essentially as funding streams. This leads to some suggested orientation for the future:

- Tekes should focus on systemic impact, rather than individual 'innovation events'. It is impossible to predict the future development of an ecosystem and the global market environment. Hence, greater attention to developing the foundations for promising ecosystems is required. This implies a systemic model where collaboration between Tekes and other Team Finland ministries and agencies and other stakeholder is enhanced to ensure that Tekes funding or services are matched by required actions on regulatory or other enabling conditions, etc.
- It is important to be able to identify and assist the development of new ecosystems and contribute to the construction of industrial renewal and competitiveness. For some ecosystems, this may require the active construction of networks (in conjunction with other Team Finland operators), while for more strongly networked ecosystems (e.g. gaming) the role may be more of a passive 'background financier'. In other words, the promotion of various ecosystems requires a different mix instruments and flexible partnerships.
- The development of coordination and support actions, in parallel to Tekes funding for RDI projects, that map ecosystems or value chains (leading players, technologies, skills, infrastructures, etc.), both in Finland and internationally, and support companies to identify investment opportunities for pilot or demonstration actions/investments, strategic foreign direct investment, brokering and matchmaking, etc.
- Multidisciplinary and dynamic ecosystems are natural platforms for innovation and renewal, but they are not created equally in all sectors or in all markets. Their emergence and development generates a discontinuity in existing market and production structures, as well as traditional business practices. Tekes should pay attention to strengthening cooperation between large/incumbent firms and firms with new business models that acting as disruptors or enablers (e.g. digitalisation of bioeconomy) in reconfiguring value chains. In this regard, new competition based instruments (e.g. Challenge Finland) may be a promising model.

The 'open innovation system' model used in this study has proved to be an effective tool for analysing the factors influencing national as well individual business ecosystems competitiveness. It makes it easier to identify external drivers and barriers to internationalisation such as value chains dynamics, regulatory issues, etc., it also helps to pinpoint a variety of obstacles and weaknesses in the system that would otherwise remain undetected (for example, social welfare and the importance of health system structures for the development of health technology ecosystem). In addition, the framework helps to identify the role of Tekes' in innovation ecosystem as a single operator or as an enabler to a greater extent. Based on the study, Tekes should further examine the role of a systemic frame of reference for the promotion of global competitiveness (along with the effectiveness of the model currently in use).

**Figure 15. Tekes & Team Finland – innovation and investment landscape.** Source: authors

## Innovation and investment landscape



## 4.3 Global competitiveness: a team game!

The study team were asked to consider two specific issues related to Tekes role within the Team Finland family (see the simplified organisational chart in Figure 15)

- What are the expected impacts of closer collaboration between public organisations (especially Tekes, Finpro and Finnvera) over the next five years? (firm growth, internationalisation, networking in global value networks)
- How Team Finland actors (especially Tekes, Finpro and Finnvera) can improve their impact on the future growth of Finnish companies' global business ?

The ecosystem case studies point to a number of areas where current levels of collaboration are still insufficient to fully support the development of emerging business models and ensure they gain access to new markets. The four 'learning snapshots' also highlight a number of possible options for Tekes and Team Finland to further improve their impact on global competitiveness.

- More attention to attracting strategic foreign direct investment (either new investment or through acquisitions) into emerging ecosystems. For example, Ireland's industrial policy instead of concentrating on increasing national companies 'organic growth', aims to attract high value foreign multinationals and build an ecosystem around these players.
- The importance of developing strong synergies between 'place-based' (city or regional) strategies and strengths (Berlin for digital health) and national innovation and global competitiveness policies and agencies. Globally 'visible' cities within smaller countries (e.g. Copenhagen in Denmark) help attract not only investment to more broadly dispersed business ecosystems, but also to attract talented and creative people. This may require reflection on past experience with programmes such as INKA or draw on smart specialisation type strategies at regional level to focus investments and international promotion.

In terms of measuring the future impact of both Tekes and Team Finland, the study suggests that measuring impact on global competitiveness requires a balance between an impact model (and related indicators) that measure ecosystem 'health' nationally and a more 'granular' monitoring of Finnish companies position in international networks. Recommendations include:

- The study team found it difficult to collate information on Tekes support for companies classified under the BCDH priorities and there is a need to strengthen 'tagging' (companies are often working across priorities or ecosystems so need to be allocated correctly while avoiding double counting) and monitoring of outcomes in client management systems.
- This said, measuring impact via short-term growth indicators (turnover, exports, employment) of Finnish businesses while a standard way to track progress may lead to over-estimating long-term impact on value creation and capture. There is a need to develop indicators that help track the extent to which value in relevant global value chains is captured in Finland, rather than focus on export growth, etc.
- Ecosystem success is measured, ultimately, by competitive differentiation (value proposition) and hence requires, in addition a qualitative understanding of the successful positioning of a significant number of Finnish firms in global value chains. This implies the need to establish a baseline mapping and regularly update the changing position of Team Finland client firms in GVC.

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# Appendix A. Tekes programmes (as of September 2015)

## Tekes programmes by strategy period

| Period | Name | Total budget[3] | Sector | Description / aims |
|---|---|---|---|---|
| **Programmes started during Tekes strategy period 2015-2017** | | | | |
| 2015-2019 | BEAM – Business with Impact | 50m € (Tekes+MFA 25m) | Cross-sectoral | The aim of Tekes and the Ministry for Foreign Affairs' joint programme BEAM – Business with Impact, is to generate new, sustainable business in developing countries. BEAM assists Finnish enterprises and other actors in using innovations to address global development challenges, by converting such innovations into successful and sustainable business in both Finland and developing countries. |
| Programmes started during Tekes strategy period 2011-2014 | | | | |
| 2014-2019 | 5th Gear | 100m € | ICT | The 5thGear programme aims to solve challenges related to the next generation wireless data communications, the creation of new business, and rocketing Finland as the leading target for international investments. |
| 2014-2019 | Industrial Internet | 100m € | Cross-sectoral | Industrial Internet – Business Revolution programme funds projects in which digitalisation is utilised for developing new services and business models to aim at international growth.<br>The programme aims to renew the business operations of companies through the Industrial Internet and encourage companies from different fields to engage in new kinds of cooperation. |
| 2014-2017 | Arctic Seas | 100m € | Cross-sectoral | Arctic Seas programme aims at turning Finland into an internationally attractive centre of Arctic know-how. Goals: 1)<br>Finland is an Arctic know-how hub Europe and world-wide, 2) create new Arctic business activities, 3) network Finnish actors into internationally significant investment projects |
| 2014-2018 | Bits of Health | 100m € | Health | The Bits of Health programme pursues to make Finland a renowned expertise and business hub for digital health, perceived as an interesting partner and a central site for innovation activities. |
| 2014-2017 | Innovative Cities (INKA) | Approx. EUR 30m €/year[4] | Built environment / cities | The aim of the programme is to create internationally attractive innovation clusters in Finland based on top-notch talent. Innovation clusters include companies aiming for growth that are capable of creating brand-new products and services for the international market. |
| 2013-2017 | Witty City | 100m € (40m from Tekes) | Built environment / cities | The aim of the Witty City programme is to provide people with better living and working environments and companies with opportunities to bring new products and services on the market. Cities will play a key role in the programme as they are central players in such areas as planning, procurement and the choice of energy sources. |
| 2013-2016 | Smart Procurement | 60m € | Cross-sectoral | The programme will speed up the introduction of innovations through procurement excellence and the development of markets. |

[3] Tekes contribution approximately 50 % of the programme budget if not specified.
[4] State: EUR 10 million, cities: EUR 10 million, ERDF: some EUR 10 million.

| Period | Name | Total budget[3] | Sector | Description / aims |
|---|---|---|---|---|
| 2012-2018 | Liideri | xxxx | Cross-sectoral | The objective of the Liideri programme is to renew the business operations of companies through developing management and forms of working and actively utilising the skills and competencies of their personnel. |
| 2012-2018 | Feelings | 100m € | Cross-sectoral | The programme wants to raise customer experience, emotions and meanings as key business drivers besides technology and expertise. In addition to emotions and customer experience, the programme encourages companies to exploit all of their intangible assets better, including brands, reputation and knowledge capital. |
| 2012-2015 | Skene – Games Refueled | 70m € | ICT | Tekes' Skene – Games Refueled programme aims to strengthen Finland's position as hotspot for gaming and entertainment industry. Skene offers funding, business development sparring, matchmaking services for meeting foreign gaming companies, publishers and investors, networking and market surveys. |
| 2012-2014 | BioIT | 10m € | Bio / cleantech | The focus in the programme BioIT – Solutions for Biological Information was on the building of new value networks and cooperation between traditional ICT players with such experts as biologists, geneticists and environmental scientists. |
| **Programmes started during Tekes strategy period 2008-2011** | | | | |
| 2011-2016 | Green Mining | 60m € | Bio / cleantech | The main objective of the Green Mining Programme by Tekes is to make Finland a global leader of sustainable mineral industry by 2020. |
| 2011-2015 | EVE | 100m € | Manufacturing | The EVE – Electric Vehicle Systems programme is aimed at companies and research institutes that work with electric vehicles and machinery and the components and systems used in them. The aim of the EVE programme is to create a community of electric vehicle and support system developers with close contacts to international research and business networks. The programme also focuses on developing test environments and standards for the industry. |
| 2011-2015 | Green growth | 80m € | Bio / cleantech | The aim of the Green Growth programme is to identify potential new growth areas for the sustainable economy business, which are essentially based on lower energy consumption and sustainable use of natural resources. The programme aims at a leap forward in energy and material efficiency of production and service chains over the entire life span of products. |
| 2011-2015 | Learning solutions | 50m € (Tekes 30m) | Education | The Learning Solutions Programme was launched by Tekes in 2011 to develop internationally competent learning solutions as well as new approaches and skills for modern learning and educational environments. The goal is to develop products and services that serve international markets, too. |
| 2011-2014 | Trial | 30m € | ICT | The aim of Tekes' Trial Environment for Cognitive Radio and Network programme is to transform Finland into a globally attractive cluster of expertise and unique trial environment for cognitive radio and networks. |
| 2010-2014 | Groove – Growth from Renewables | 95m € | Bio / cleantech | The Groove – Growth from Renewables programme enhanced the business capabilities of Finnish small and medium-sized enterprises working with renewable energy by improving their international competitiveness and developing networks with the financier network. |

| Period | Name | Total budget[3] | Sector | Description / aims |
|---|---|---|---|---|
| 2009-2014 | Built Environment | 75m € (Tekes 37m) | Built environment / cities | The basis of the Built Environment programme is on the users´ needs of the built environment and the demands set by them for the practices in real estate and construction sector. The programme increases the functionality of the built environment by developing the practices of real estate and construction field. |
| 2009-2012 | Sapuska | 34,5m € | Food industry | The aim of the Sapuska – Added Value for International Food Markets programme was to improve the business of small and medium-sized enterprises in the Finnish food industry, increase research, development and innovation and promote networking with regard to international markets. |
| 2008-2012 | Digital Product Process | 100m € (Tekes 40m €) | Cross-sectoral | The Digital Product Process programme boosts the competitiveness of companies with better use of information technology in product processes. The goal of the programme is to increase customer orientation and productivity in company networks that design and deliver products, systems and services to global markets. |
| 2008-2012 | Spaces and Places (TILA) | 73m € | Cross-sectoral | The programme has enabled the networking of companies and research institutions from a number of sectors. In the projects funded by the programme the focus on spaces has been adopted as part of the companies' business operations and strategic management of organisations. |
| 2008-2012 | Water | 12m € | Cross-sectoral | The Water programme reforms business operations, products and services in the water sector in Finland and promotes Finnish expertise in the sector on the international market. The focus of the reforms includes not only utilising modern technology but also innovation in the water sector's business models, customer-focused services concepts and comprehensive solutions. |
| **Programmes started during Tekes strategy period 2005-2007** | | | | |
| 2007-2013 | Fuel Cell | 140m € | Bio / cleantech | The Fuel Cell programme aimed to speed the development and application of innovative fuel cell technologies for growing global markets. The programme's focus areas included stationary fuel cell applications, fuel cell power modules for utility vehicles and portable low-power solutions. |
| 2007-2013 | Functional Materials | 150m € (Tekes 70m) | Manufacturing | The Functional Materials Programme aimed to develop new applications and competitive advantage through materials technology for Finnish industry. |
| 2007-2013 | Safety and Security | 160m € | Cross-sectoral | The Safety and Security Programme aimed at developing commercial solutions to the international markets. The programme funded and fostered innovations in the field of safety and security. |
| 2007-2013 | Ubicom | 294m € (Tekes 117m) | ICT | Tekes' Ubicom – Embedded ICT programme focused on developing and piloting embedded IT solutions. The programme strengthened the research in ubiquitous computing, increased the resources available for the industry's commercial competitive offerings, enhanced the international cooperation and spurred on cooperation between different branches of industry by enhancing new industry networks and industry standards. |

| Period | Name | Total budget[3] | Sector | Description / aims |
|---|---|---|---|---|
| 2007-2012 | Sustainable Community | 91m € (Tekes 47m) | Built environment / cities | The main themes of the Sustainable community programme were land use planning, energy efficient building and the integration of renewable energy production in built-in environments. |
| 2007-2012 | BioRefine | 250m € (Tekes 100m) | Bio / cleantech | The BioRefine – New Biomass Products programme developed business related to new value-adding products or new process or business concepts that utilise biomass in a variety of forms, as well as related technologies, equipment production and services. |
| 2007-2011 | Concepts of Operations | 92m € | Manufacturing | he Concepts of Operations programme enhances and strengthens the knowhow and skills of Finnish business manufacturing / operations. The programme networks parties in different industrial sectors and recognises manufacturing / operations issues as a key part of strategic planning in Finnish companies. |
| 2007-2011 | Boat Programme | 25m € (Tekes 15m) | Manufacturing | Boat Programme provides incentives for companies to develop their business and apply the best available expertise. The result of the programme is better boats and services for the consumer. These are provided by profitable and competitive Finnish businesses. |
| 2006-2013 | Serve | 224m € | Services | Programme encourages Finnish companies to become global forerunners in the customer-centric, knowledge-based service business. Serve aims at the creation of new knowledge in service innovation and encouraging the development of innovative and internationally competitive service concepts in companies by challenging traditional ways of doing things both at the strategic and the operational level. |
| 2006-2012 | Tourism and Leisure Services | 26m € (Tekes 15m €) | Services | The programme encouraged R&D activities by companies producing leisure services. Development focused on new service concepts, new ways of producing services and the creation of new spatial concepts, such as those utilising virtual technology. The central aim of the programme was to develop innovative, customer-oriented service concepts. |
| 2006-2011 | SymBio | 80m € | Bio / cleantech | The Tekes SymBio programme renews industrial processes and environmental cleansing using biotechnology. SymBio boosts the application of biotechnology across different industries. |
| 2006-2010 | Liito | 78m € | Cross-sectoral | The Liito – Innovative Business Competence and Management programme aimed at improving the international competitiveness of enterprises operating in Finland by developing new business know-how and innovative operating models. The programme promoted the development of cutting-edge applied business studies in Finland, carried out in close cooperation with enterprises. |

Sources: Web content and materials available at the Tekes website http://www.Tekes.fi/en/programmes

## Other relevant Tekes and Team Finland programmes and services

| Launch | Name | Description / aims |
|---|---|---|
| 2014 | Team Finland LetsGrow[5] | Team Finland LetsGrow is a financing programme for SMEs seeking international growth. Companies can receive loans from Finnvera for investments and working capital, grants from Tekes for innovation services and advice from Finpro for international growth. Combines different existing instruments (no additional programme budget). |
| 2009 | VIGO[6] | Vigo is a business accelerator programme for innovative young companies with global potential and desire to grow. It interconnects innovative business ideas, internationally experienced professionals in entrepreneurship and both public and private funding. Public funding approximately 45m € for first 3 years (Tekes share approx. 30m). Currently 9 accelerators in operation. |
| 2008 | SHOK[7] | SHOKs or Strategic Centres for Science, Technology and Innovation carry out long-term cooperation in fields most crucial for the future. The results are breakthrough innovations of global importance, which can be agilely transformed into growth in business life and wellbeing in society. Currently 6 SHOKs in operation, each has several programmes. Tekes funding for 2008-2012 was 372,5m €. |
| 2006 | FiDiPro[8] | Finland Distinguished Professor Programme offers funding to projects recruiting highly merited international researchers in Finnish universities and research institutes to create long-term collaboration in science and technology. |
| 2006 (as FinNode) | Team Finland Future Watch[9] | With the help of the Team Finland Future Watch service, companies get international foresight information to support their business planning and development work. |
| 1999 (GAP) | Market Access Programs (MAP)[10] | Finnish SMEs get a tailor-made market entry plan from business professionals who are doing MBA degree in world's top universities. The market entry plan provided consists of strategy, marketing and management analysis and analysis on expansion to foreign markets. Market Access Programs:<br>– Global Access Program GAP (USA)<br>– Fudan iLab Program (China)<br>– Tsinghua SEM (China)<br>– UCLA NUS Management Practicum (Southeast Asia) |

Information on other services provided by Team Finland network are available at: http://services.team.finland.fi

5 Additional information: http://letsgrow.fi/
6 https://vigo.fi
7 www.shok.fi
8 http://www.Tekes.fi/en/programmes-and-services/grow-and-go-global/fidipro/
9 http://www.Tekes.fi/en/programmes-and-services/grow-and-go-global/team-finland-future-watch/
10 http://www.Tekes.fi/en/programmes-and-services/grow-and-go-global/market-access-program/

# Appendix B. Finnish global competitiveness – a review

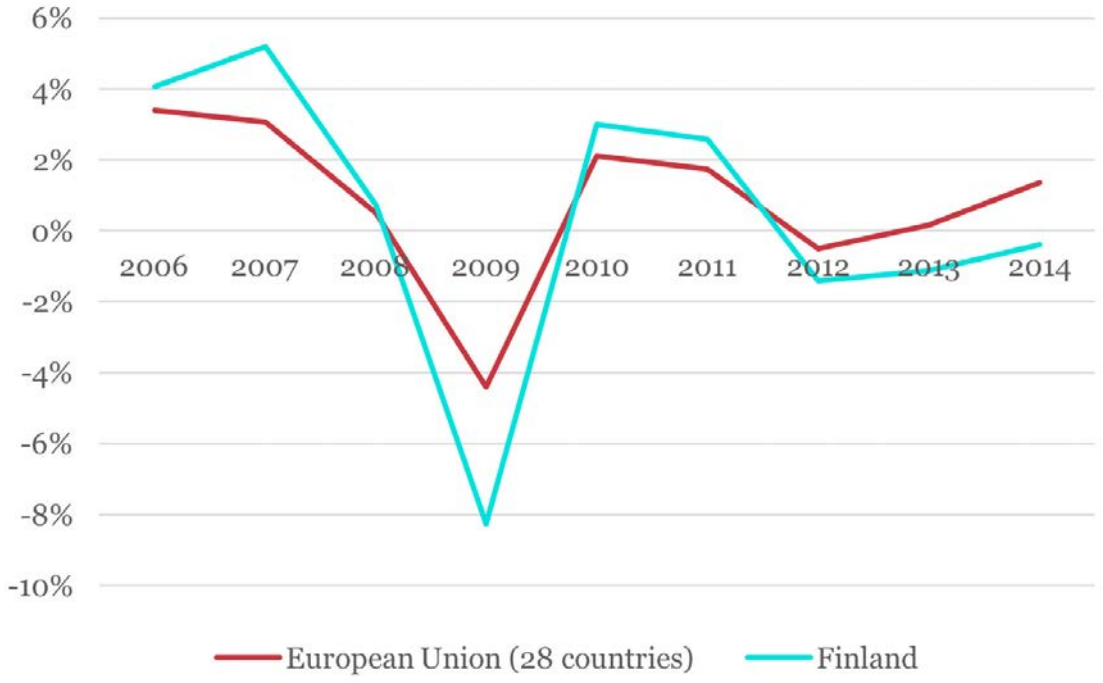
## B.1 Trends in overall global competitiveness

Finland's economy has gone through a 'rough patch' since the global financial crisis and the euro zone crisis that followed it. After outperforming its rivals for much of the 2000s, Finland's GDP growth rate fell dramatically both in 2008 and 2009. In 2009, Finland had negative GDP growth (-8.3%), for the first time since the deep economic recession of the 1990s. After a brief recovery in 2010 and 2011, the economy has further dipped. In fact, 2015 is the fourth consecutive year that the economy has either contracted or stagnated, despite the seeming recovery in the rest of Europe (WEF 2015).

Finland has slipped in the ranking of the most cost competitive economies in the world published by the International Institute for Management Development (IMD) dropping from 18th to 20th place in 2015. The country also continues to slide down the Global Competitiveness Index published by World Economic Forum (WEF) and ranks now in 8th position in the 2015-2016 edition.

Finland currently takes 8th position in Global Competitiveness Index 2015-2016. Historically characterized by relatively low diversification of economic sectors and export destinations, the Finnish economy has suffered successive shocks to its main industries (information technology and paper) and one of its largest export markets (the Russia). Its trade balance turned negative in 2011, and in 2014 its GDP was still 6% smaller than in 2008. Yet robust fundamentals could help Finland to overcome the current crisis. Its public institutions are transparent and efficient (1st), its higher education and training system is among the best in the world (2nd), and its business sector is one of the most innovative (2nd overall and 4th for PCT patent applications per capita). To facilitate the recovery, Finland should fix long-standing rigidities in its labor market (26th), especially the centralized wage-bargaining system (140th, the most centralized in our rankings), which contributes to unemployment (currently at 9.5%). Although still one of the best among advanced economies, its macroeconomic environment has also deteriorated significantly during the crisis, with public debt increasing by 20 percentage points as a proportion of GDP since 2006 and public deficit further increasing in 2014 to 2.7% of GDP.

**Figure 16. GDP growth - Finland vs. EU28.** Source: Eurostat (chained linked volumes)



Pajarinen & Rouvinen (2014) argue that a good ranking in global competitiveness comparisons (such as IMD or WEF) does not necessarily guarantee positive economic development in the future. However, the *changes* in rankings may indicate the direction of future development. Overall, the indices reveal that **Finland has short and medium term challenges but also various long-term strengths** (WEF index focusing on the latter), which may help it regain future competitiveness. However, the **short-term challenges may turn into long-term problems,** if, for example, unemployment erodes the skills base or economic uncertainty decreases R&D expenditure. In addition, a challenging short-term situation may lead to policies that weaken long-term competitiveness. A negative correlation between good rankings and future GDP growth hints that countries may become complacent and do not pay enough attention to their strengths. Thus, Finland needs to pay attention to both optimising its short-term and maximising its long-term competitiveness. As Pajarinen & Rouvinen (2014) conclude competitiveness is a result of several factors that vary over different periods.

## B.2 Trends in specialisation

Finnish competitiveness policy (Europe 2020, 2015) has focused on four areas since the mid-2000s: bioeconomy, cleantech, health and digitalisation. From 2014-17, the Government has dedicated €100m to restructure industry in the four target areas. These areas do not follow the standard statistical classifications (NACE for industry, IPC for technology) due to their cross-industrial or cross-technology nature, but they can be tracked using various indicators. For instance, Figure 17 shows that the value added of Finland is much more concentrated in sectors related to bioeconomy (forestry and logging, paper, wood) than the EU average. Computer & electronics and residential care are others activities of the top five sectors in which the Finnish economy is the most specialised.

From 2008-2013 (Figure 18 and Figure 19) Finnish specialisation in activities related to ICT manufacturing (computer & electronics, electrical equipment) declined, while other highly specialised sectors (forestry and logging, coke & refined petroleum, wood, fishing, residential care) expe-

**Figure 17. Finnish sectors with a relative specialisation index (value added) above 1 (2013).** Source: Eurostat

| Sector | Nace code | Specialisation[11] |
|---|---|---|
| Forestry and logging | A02 | 10.2 |
| Man. of paper & paper products | C17 | 4.4 |
| Man. of computer/electronics | C26 | 2.8 |
| Man. of wood | C16 | 2.4 |
| Residential care and social work activities | Q87-Q88 | 2.0 |
| Man. of coke/refined petroleum | C19 | 1.9 |
| Fishing | A03 | 1.4 |
| Man. of other machinery and equipment | C28 | 1.4 |
| Man. of electrical equipment | C27 | 1.2 |
| Construction | F | 1.2 |
| Electricity, gas, steam and air conditioning supply | D | 1.2 |
| Repair and installation of machinery & equipment | C33 | 1.2 |
| Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities | J58-J60 | 1.1 |
| Man. of basic metals and fabricated metal products, except machinery and equipment | C24-C25 | 1.1 |
| Education | P | 1.1 |
| Information and communication | J | 1.1 |
| Human health activities | Q86 | 1.1 |
| Printing and reproduction of recorded media | C18 | 1.1 |
| Real estate activities | L | 1.1 |
| Man. of chemicals and chemical products | C20 | 1.0 |

[11] For a given sector, the share of Finnish value added (VA) in EU VA divided by the share of Finnish VA in EU VA for all sectors. A specialisation index above 1 indicates that Finland is more specialised in the corresponding sector than the EU average.

rienced a steadily increasing concentration of their value added. Specialisation in manufacturing of paper and paper products slightly decreased, but this industry is still the second Finnish sector in terms of value added concentration relative to EU average. Value added per employee is not particularly high in the sectors in which Finland is the most specialised, except for coke and refined petroleum.

The priority areas of Finland are also stressed in the top 10 exports goods: the country excels in exports related to pulp & paper products (and other forestry-related goods), communication equipment, electricity transformers, medication and medical instruments (Figure 20).

**Figure 18. Top 3 specialisation sectors – value added.** Source: Eurostat. Size of circles: productivity (VA/employment)

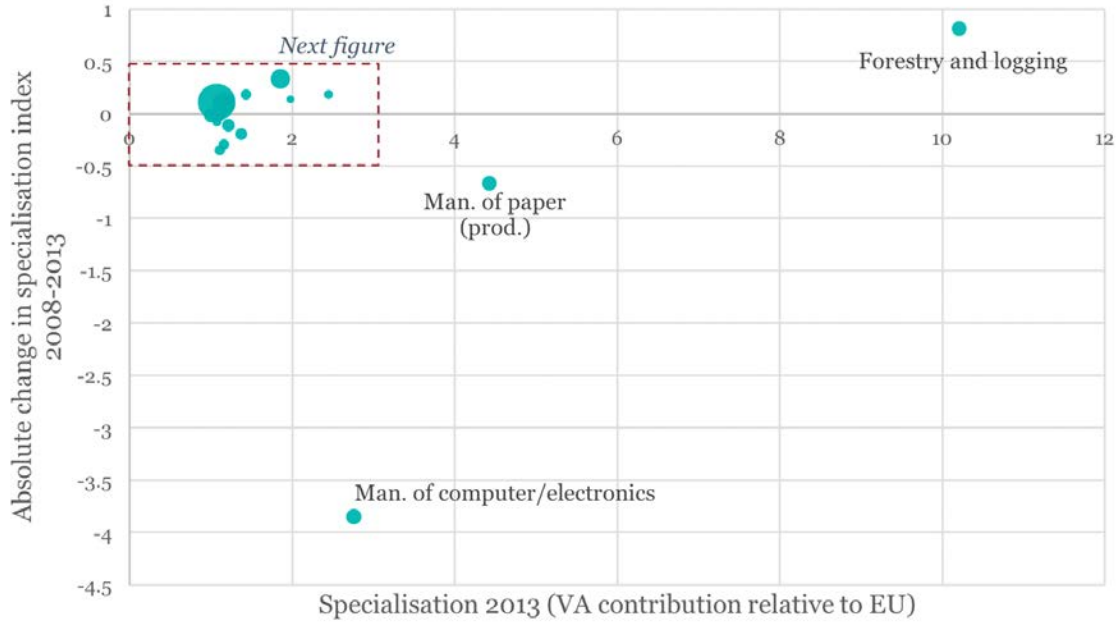



**Figure 19. Top 4 to 20 specialisation sectors.** Source: Eurostat. Size of circles: productivity (VA/employment)

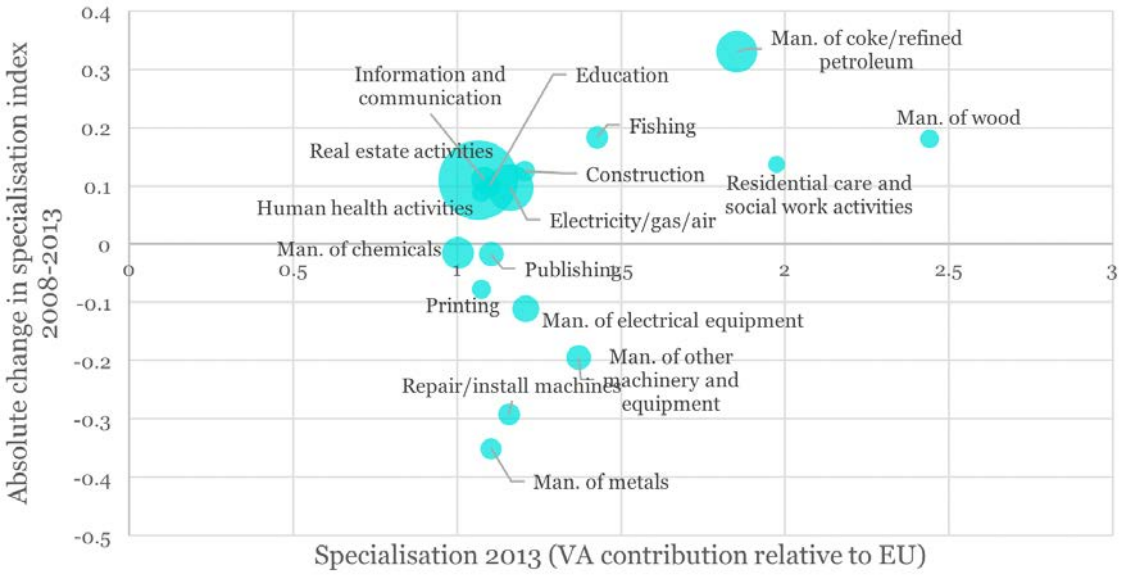


**Figure 20. Top 10 Finnish export goods.** Source: Board of customs (as cited in Bosman and Rotmans, 2014)

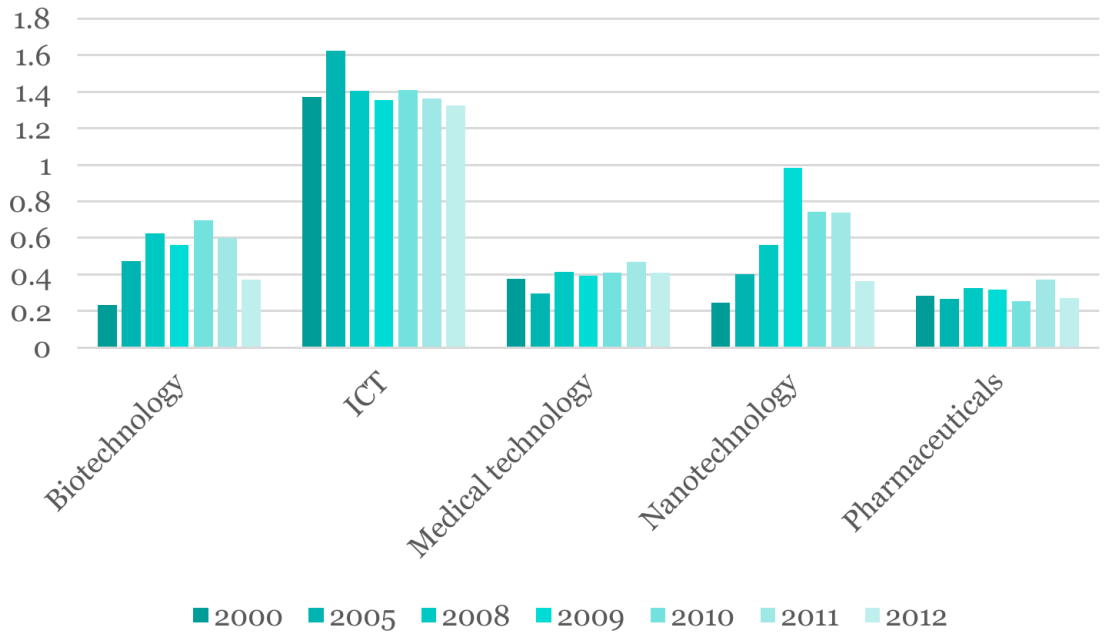
| Products | Exports (Billion euros) |
|---|---|
| Dieselfuel | 6.1 |
| Coated paper and paperboard | 4 |
| Stainless steel | 2.1 |
| Mobile phones (and other communication equipment) | 1.5 |
| Uncoated paper and paperboard | 1.4 |
| Sawn goods | 1.2 |
| Pulp | 1.2 |
| Electricity transformers and frequency changers | 1 |
| Medication | 0.9 |
| Medical instruments | 0.8 |

In 2009, Finnish exports were strongly affected by the slowdown of the global demand. Exports in electronics were particularly hit, following the Nokia decline, and did not recover in the following years unlike other sectors (Bosman and Rotmans, 2014).

Specialisation indexes related to technology fields (based on patent counts) show that Finland has a strong comparative advantage over global competitors[12] in ICT, but it has been decreasing since 2005 (Figure 21 and Figure 22). Specialisation in biotechnology and nanotechnology increased in the 2000s and peaked in 2009-2010 but remain lower than in competitor countries.

In comparison with global competitors, Finnish patents are also highly concentrated in technologies related to paper (Figure 23 and Figure 24), which is in line with previous figures over value added and exports, and electricity (with a negative trend over the 2000's). Finland is also more specialised in technologies in the fields of physics and fixed construction, but the difference is less pronounced.

**Figure 21. Specialisation in technology fields (PCT patent applications)[13].** Source: OECD. Calculations by authors




[12] Besides EU countries, top countries in the GCI were used as comparators: Canada, China, Japan, South Korea, Norway, Singapore, Switzerland and US.

[13] This index is calculated for a given technology field as the share of Finnish PCT patent applications in EU applications for this field divided by the share of Finnish applications in EU applications for all fields.

**Figure 22. Specialisation in technology fields (PCT patent applications, 2012).** Source: OECD. Calculations by authors

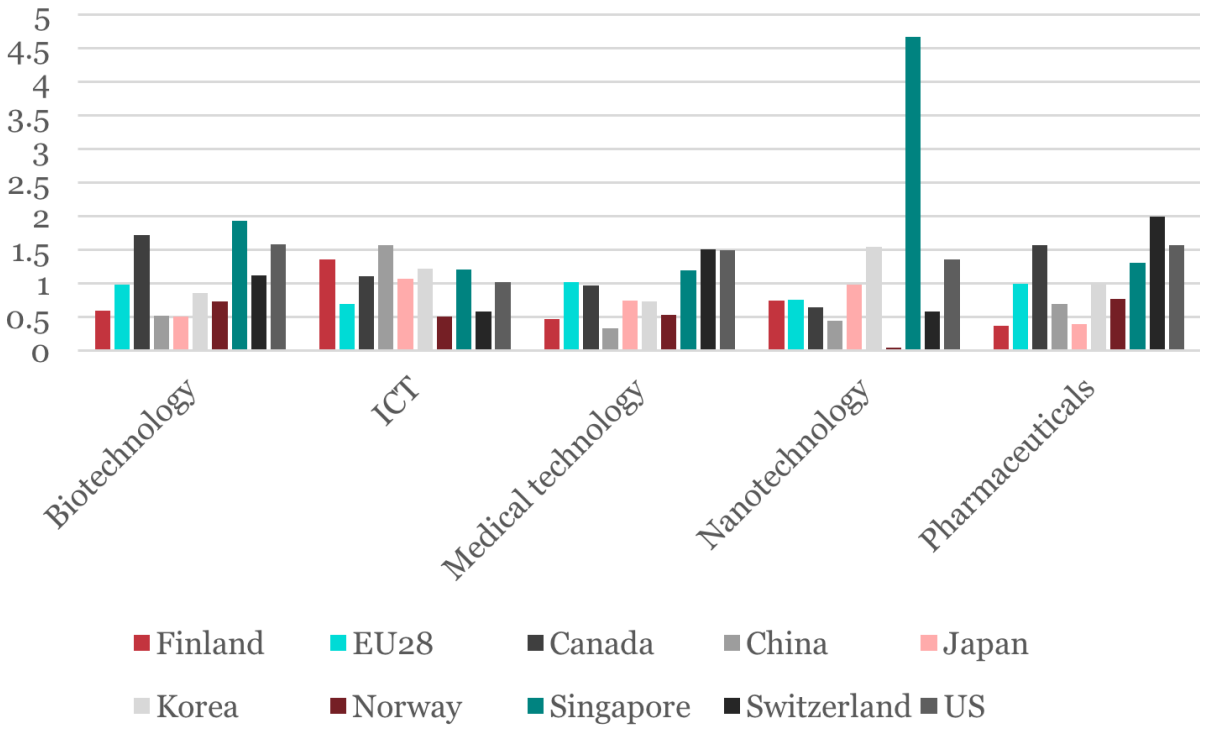



**Figure 23. Specialisation in technology fields: IPC sections (PCT patent applications).** Source: OECD

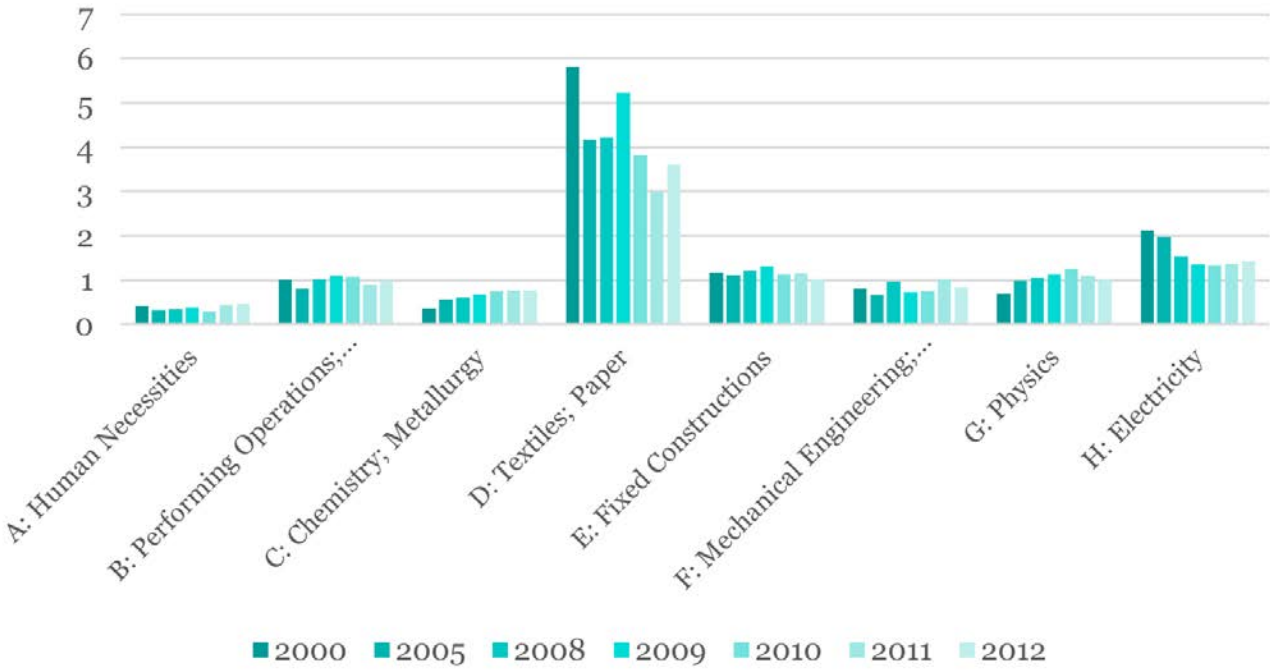
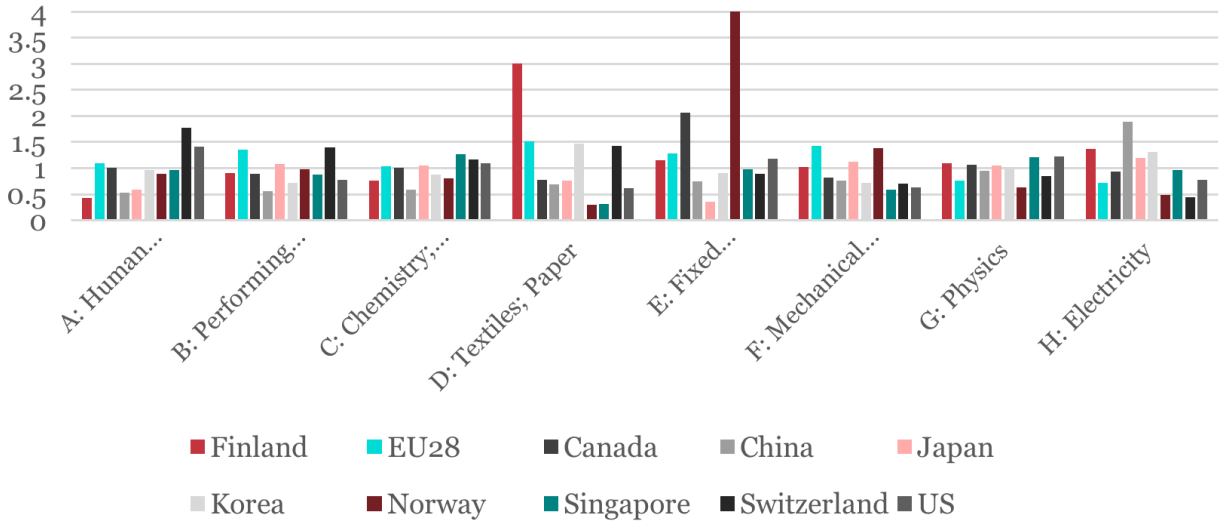


**Figure 24. Specialisation in technology fields: IPC sections (PCT patent applications, 2012).** Source: OECD. Note: vertical axis capped at 4 but value for fixed construction in Norway is 8.9.




## B.3 Internal dimension of Finland's competitiveness

### B.3.1 Productivity and cost competitiveness (short term)

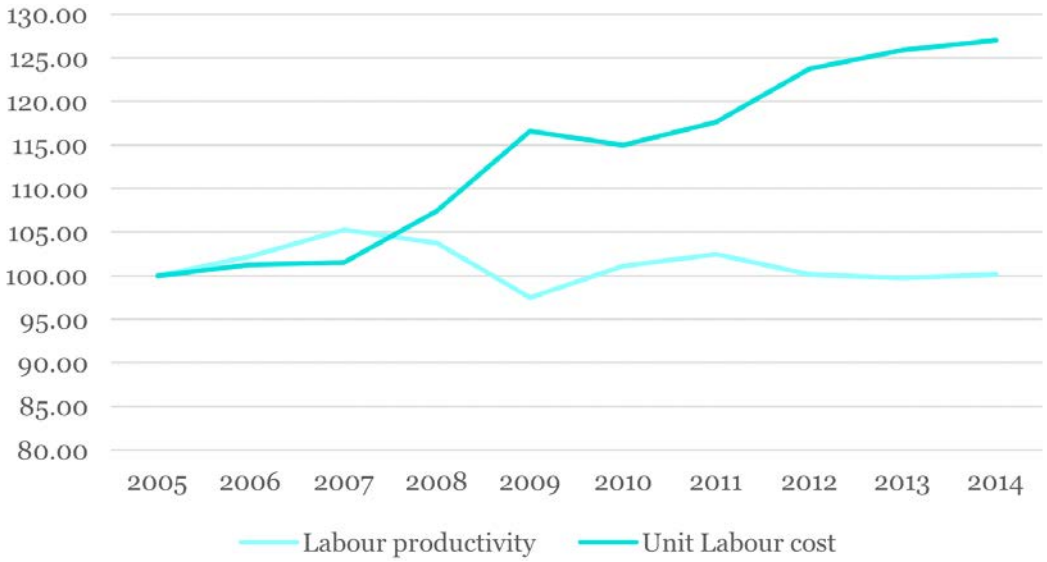
Much of the recent national discussions on Finnish competitiveness has focused on high **unit labour costs**. Although the appropriate level of the labour costs, as well as their role in Finland's competitiveness, is debated, it is evident that the unit labour costs have increased in Finland faster than in many comparison countries, especially in 2008-2009 and further in 2010-2011 (OECD 2014). It has been estimated that labour costs have rocketed in Finland increasing by about 20% since 2008 (EconoMonitor 2015), although data from the OECD suggest that while Finnish unit labour costs have grown faster than other competitors, the grow is more like 5% compared to the Euro area average, still enough to undermine competitiveness.

According to European Commission country report, the generous wage settlements (reflecting pre-crisis conditions) together with output losses in electronics sector led to increased unit labour costs and declined cost competitiveness. The rises in unit labour costs exceeded the rise in export prices, which led to decreased profits in the manufacturing industry (European Commission 2015). Maliranta (2014) argues that Finnish cost competitiveness started to decline already in the early 2000s and it is explained by both relatively slow productivity and rapid increases in wages.

According to Kotilainen (2015), in addition to maintaining the wage growth in moderate levels, competitiveness of Finnish export production can be improved by active development of new products and by increasing **productivity**. Labour productivity fell by 0.4% on average during 2009-2013. This was mainly caused by the global economic downturn and production cuts in high tech -products and paper industry. Labour productivity is estimated to increase in the next 10-year period, 2015-2025, even though the on-going shift in productivity towards service sector somewhat slows down the growth. For Kotilainen (2015) productivity can be improved by better utilising new technologies both in private and public sector, maintaining the high level of university education and research and by introducing liberalisations in trade and investments at international level. Mäki-Fränti (2015) emphasises the role of investments in intellectual capital, such as research and product development, intangible rights and organisational redevelopments in improving Finland's productivity. According to Mäki-Fränti, the state should promote economic growth through restructuring activities that improve housing supply, reduce measures that restrict competition and increase labour supply.

Moreover, Holmström et.al. (2014) identify productivity challenges behind the current economic challenges and highlight that productivity has dropped significantly, not only in the "Nokia cluster", but also in other industries. Although low productivity has been a challenge for most advanced economies, the development in Finland has been especially weak. This, combined with relatively fast growth in wage costs, has quickly eroded Finnish cost competitiveness (Holmström et.al. 2014).

**Figure 25. Trends in labour productivity and unit labour costs in Finland (2005 = 100).** Source: Eurostat




## B.3.2 Internal demand and markets

As a small economy (approximately 1% of EU population), the scale of the internal market means national demand provides only a limited springboard to compete globally. The economic and financial crisis has further decreased internal demand.

Although **unemployment** has grown relatively modestly (in July 2015 the unemployment rate was 8.4%, 1.4% higher than a year before, Statistics Finland), rising unemployment is a worrying trend and is likely to further contract internal demand. In addition, other factors such as rapidly ageing population, growing public debt, cuts in public spending are likely to further weaken internal demand. In 2014, households' disposable income decreased by 1.2% in real terms[14].

According to the SME barometer survey, the economic outlook in the beginning of 2015 was negative, for the first time since 2009. Only 13% of all SMEs expected growth in investments in the next 12 months (compared to 34% of companies who expected investments to decrease) (Malinen and Lemmelä 2015). According to Vihriälä (2015), the contraction of the available work force as well as pressures to increase taxes may also lead to declining investments both in Finland and from abroad.

Dynamic internal markets and domestic competition is important from the perspective of global value chains as it stimulates innovativeness by encouraging companies to develop better products and/or improve productivity. Governments can contribute to internal demand also more directly by providing markets for new companies and their products through **public procurement** (see e.g. Ali-Yrkkö & Rouvinen 2015). Ali-Yrkkö & Rouvinen (2015) suggested allocating a larger share of public funding for innovation to promoting innovative public procurement. In WEF Global Competitiveness Index 2015 Finland ranks relatively low (33rd) in government procurement of advanced tech products. In addition, the trend seems to be negative as the ranking in 2014 was 22nd (Schwab 2015; 2014).

## B.3.3 Company system and economic structure

### Structural changes

According to Holmström et al (2014) the current economic recession can be traced back to the **collapse of electronics industry**, combined with a **more gradual decline in other metal industry and forest industry**. The growth of the Nokia-led ICT cluster is seen to have enabled the exceptional economic growth in the 2000s. However, the Finnish (manufacturing) electronics sector has contracted from 6% of total value added in 2007 to around 1%. The turnover of the electronics sector has collapsed by 48% between 2009-2013 (OECD 2014). Also an another traditionally strong sector, namely the wood and paper industry, has eroded: Its share of total outputs has gradually decreased to only around 2% (OECD 2014).

14 www.findicator.fi

Recently there have been some very positive trends especially in **service sectors,** whereas turnover in the manufacturing industry sector dropped by -15% and employment by -15.1% (MEE 2015). However, despite all the promise, these new rising sectors have not been able to compensate the decreased outputs and exports (or jobs) of the manufacturing sector (OECD 2014). The share of services in total GDP in Finland is below OECD average. Yet, the share of jobs requiring high-level service skills is one of the highest in Europe (also in manufacturing). For Pajarinen et.al. (2012) this reflects the blurred division between services and manufacturing. During the last decade, many of the largest Finnish manufacturing companies have undergone a transformation, which has significantly increased the role of services in their business. According to Pajarinen et al (2012), it is vital for Finnish manufacturing companies to be able to add service elements to their manufacturing products.

**Economic dynamism**

Another important aspect of the Finnish economic structure has been the high dependency on a few large companies (most notably Nokia[15]). In 2013, out of 17,838 export companies only 17 companies constituted 41% of the value of Finnish product exports and large companies (with over 250 employees) constituted 83.6% of all products-exports. However, since 2010 SMEs share of combined turnover has increased while at the same time large companies' share of both employment and turnover is decreasing (MEE 2015). Although this may help Finland to be less dependent on large companies, it may also lead to lower growth as smaller firms tend to be less productive.

Despite the total number of existing companies has risen since 1995 (and even during the economic crisis after 2007), the annual number of new established companies is lower than in any other year since 2007 (MEE 2015). According to a cross-country comparison between 15 OECD countries by Calvino et al (2015), the start-up rate as well as net job creation by surviving start-ups in 2001-2011 have been relatively low in Finland when compared to the 14 other countries in comparison, including the likes of Sweden, Denmark, Norway and Netherlands (Calvino et.al. 2015). Finnish SMEs are also older than in many comparison countries (Criscuolo et.al. 2014). Close to 60% of small businesses (firms below 50 employees) are older than 10 years (average over 2001-2011), which is also an exceptionally high ratio compared to countries like Sweden, Norway, United States or Netherlands, where the ratio is closer to 45% (Criscuolo et al 2014). Compared with other countries, that means a relatively large share of small companies represents businesses that do not grow but still survive (EC 2015). This indicates the **relatively low level of economic dynamism**.

According to European Commission country report (2015), "the low rate of start-ups and other small businesses prolonged the restructuring process of the economy to regain its competitiveness". According to Maliranta et.al. (2015), the low level of "creative destruction" in the 1990s and early 2000s could at least partly explain the current Finnish challenges. What is positive is that creative destruction seems to be intensifying– although it may take years to fix the collapse in productivity.

Most new companies remain small, and a significant share of the new jobs and revenue is generated by a very small proportion of high growth companies or "gazelles" (e.g. Anyadike-danes et al 2014). Therefore, the rate of *growth-oriented* start-ups (see 4.8.) and high-growth firms is more relevant for competitiveness. According to a study on gazelles in Nordic countries by Napier et al (2012), the number of gazelles in Finland was significantly lower compared to Sweden and Norway or OECD average. On the other, the Finnish gazelles grew faster than their Nordic counterparts. However, also in Finland most of the gazelles remained quite small, highlighting the difficulties in scaling the promising companies.

According to the spring 2015 Finnish SME barometer, 7% of Finnish SMEs have high growth ambitions and 35% are planning to grow if opportunities arise. The figures have not changed significantly since 2009 despite the economic recession. (Malinen & Lemmelä 2015)

**Business R&D investment**

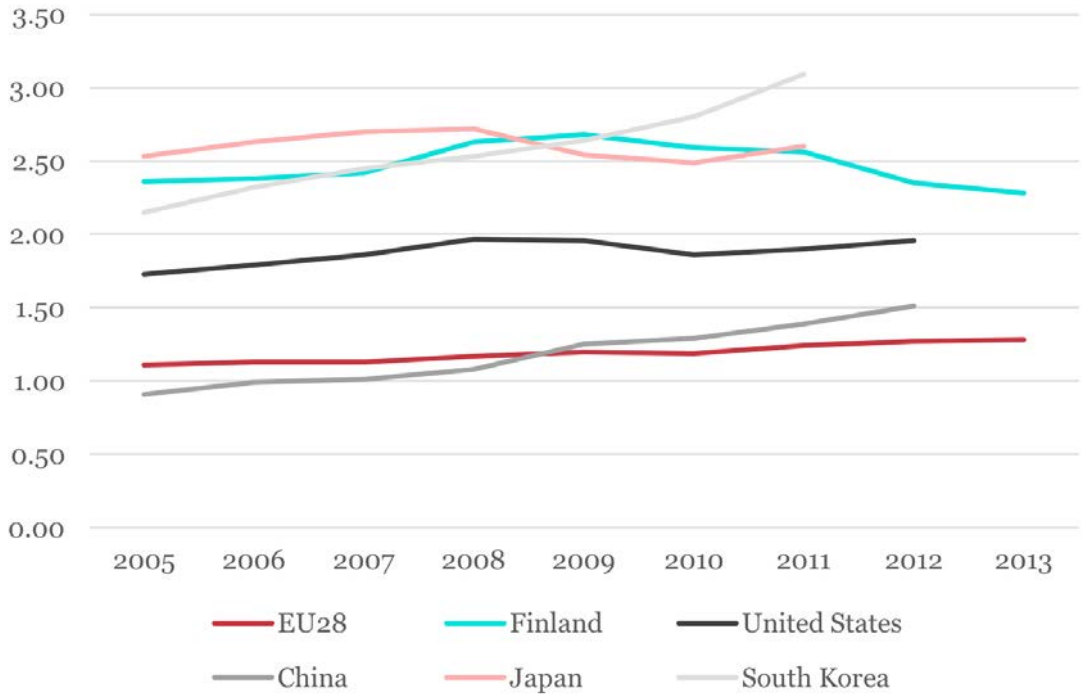
Investments in R&D have been acknowledged as an important competitiveness factor (for example both WEF and IMD include R&D indicators in their indices). Traditionally, investments in R&D have been among the highest in Finland (see chapter 4.10). Yet, Finland has been a low performer in high-growth entrepreneurship – a phenomenon labelled as the "Finnish paradox" (Autio 2009).

Although the investments on R&D are still on high level compared to many other OECD countries (Figure 26), the recent declining trend can be considered as a worrying signal – although much of it is probably explained by Nokia's declining R&D investments. According to Ali-Yrkkö et.al. (2013b), Nokia's share of corporate R&D expenditure was around 40% in 2009 but only 31% in 2012 and 17% after the acquisition of Nokia mobile business by Microsoft.

**Finland faces challenges to convert high R&D investment into successful export products and services.** Limited investment in production capacity over recent years

[15] In 2000 Nokia accounted approximately 1% of total employment and 4% of total GDP in Finland. By 2014 the share of total employment had dropped to (estimated) 0.2% and share of GDP to around 0.5% (estimated). (Ali-Yrkkö et al 2013b)

**Figure 26. Business R&D expenditure (% of GDP).** Source: Eurostat




is one possible explanation for this lack of success. Recent success stories are found mainly in the ICT-related services sector, such as the gaming industry. These industries invest modestly in physical capital, but a well-functioning infrastructure for companies in the service sector is a necessity. There are also strengths in manufacturing, which is still driving a large part of real production growth. In manufacturing, much of the focus has recently been on investing in clean technology products and a better use of ICT in manufacturing processes (European Commission 2015).

### B.3.4 Financial system

Access to finance is an important factor for the growth and competitiveness of companies (see e.g. European Commission 2012; Vihriälä (2015) argues that Finland's current economic challenges are not a result of strict monetary or financial policy. In contrast, Vihriälä considers that Finnish financial policy has been more invigorating than in most EU countries during 2009-2014.

According to European Commission SME Access to Finance Survey (Doove et al 2014), access to finance in Finland has been very good in general compared to other countries. More than 50% of Finnish companies do not consider access to finance as barrier to growth. In fact, Finland has been among the top performers in relation to access to bank loans and availability of private equity funding (Doove et al 2014). However, the good availability of financing in general does not mean that access to financing would not be a challenge for some companies. This is especially relevant when it comes to growth-oriented companies aiming for international markets (see e.g. Halme et.al. 2015).

A record number of Finnish companies (281) received equity funding in 2014. In relation to GDP, venture capital investments to Finnish companies were the second highest in Europe. In addition, Finnish buyout investments to Finnish growth companies were approximately €470m, compared to average of around €250m in the early 2000s (FVCA 2015). Also the amount of business angel investments in 2014 (€21m) was record high (€11m in 2013). The number of companies receiving business angel investments in 2014 was 238 (164 in 2013).

### B.3.5 Regulation and taxation

Finland ranks well internationally for the regulatory environment placed 5th in Europe for Regulatory quality (behind Denmark, Luxembourg, the Netherlands and Sweden) by the World Bank Governance Indicators (2011). It also ranks top for Property rights and Intellectual property protection in the WEF Global Competitiveness Index.

### B.3.6 Education and research

According to Academy of Finland report, the state of scientific research has remained fairly unchanged throughout the 2000's. However, at the same time many other countries have cached up and Finland is in danger of falling behind the top performers. The report maintains that Finnish universities and research organisations will have to specialise, increase collaboration and invest in new initiatives (Academy of Finland 2015). Finland is ranked among the top performers in the overall quality of universities (see e.g. OECD 2013b; Schwab 2015), yet only University of Helsinki ranks among the best universities in international rankings (e.g. Shanghai ranking). In short, it seems that Finland does well in terms of higher education in general but needs more state-of-the-art, leading edge research. According to the international evaluation of the Finnish national innovation system (Veugelers et.al. 2009), the fragmentation of Finnish higher education and public research system makes it more difficult to focus resources and provide high-level research. This challenge has been partly addressed through recent structural reforms of the universities and it is also listed as one priority area in the latest government programme.

Although there certainly is room for improvement in terms of research and higher education quality, the strong human resource base, highly educated workforce and ICT expertise is still definitely one of the core strengths of Finland and provide a solid foundation for future competitiveness (see e.g. Holmström et.al. 2014). It remains to be seen how the significant cuts to higher education introduced by new government will affect Finland's position.

An assessment by OECD in 2013 pointed out that in order to better harness its strong human resources, more active labour market policies, improved work incentives and investments in skills and education for youth is required (OECD 2013). Another challenge for Finland has been its ability to attract foreign talent.

The education level (as measured by years of education) of Finnish working age population is among the highest in the world, however well behind the most highly educated countries. Also the share of highly educated people of the working age population is high, but significantly lower than for example in Canada and Russia. All in all the share of highly educated working age population has increased – but slower than in OECD countries in general (OECD 2014).

### B.3.7 Intermediaries and knowledge transfer

Finland performs very well in the collaboration between research and industry. European Innovation Scoreboard Finland ranks among the top performing countries in international scientific co-publications (OECD, 2013) whereas in WEF Global Competitiveness Index 2015 Finland ranked first in university-industry collaboration in R&D (Schwab 2015). Finland is also well-known for its various initiatives and instruments – many of them associated with Tekes (e.g. Tekes programmes, SHOKs) – to promote industry-research-collaboration. There are also various "grassroots" initiatives related to open innovation.

Various initiatives have been launched to bridge the gap between entrepreneurs and start-ups with financers and other stakeholders. VIGO business accelerators, Tekes YIC funding and grassroot-level activities at the universities (especially SLUSH and Startup Sauna at the Aalto University) and municipalities. In fact, Finland is considered as one of the frontrunners in these areas (see e.g. Lilischkis, S. 2011).

### B.3.8 Cultural framework

European social survey data suggests that Finnish 'social culture' performs rather averagely in terms of willingness to try new and different things and rather weakly compared to other Nordic countries and competitors on the importance given to new ideas and being creative. These findings are somewhat surprising given Finland's international ranking for innovation and an external image of a 'creative society'.

Global Entrepreneurship Monitor (GEM) found that fear of failure is not a particular barrier to entrepreneurship but entrepreneurial intention is weaker than average. **Moreover, only 22% of early-stage entrepreneurs were innovatively oriented in 2013**, well below the average for innovation-driven economies. This does not appear to be due to a perception of lack of opportunities but may be more related to perceived limitation in terms of capabilities.

There is a broad consensus (both amongst policy-makers as well as in public opinion) that Finland needs new start-up companies. The quest for finding" the new Nokia" has now become the quest for finding hundreds of new "mini-Nokias". The recent "start-up boom", manifested for example by the world-renowned start-up event SLUSH, is an important development. All in all, the overall policy framework towards entrepreneurship and risk-taking has developed significantly recently.

Entrepreneurs' educational background has also changed, with an increasing number having higher education. In 2013, 25% had at least a bachelors' level degree. The number of entrepreneurs with foreign background and/or foreign language has steadily increased throughout the 2000s (MEE 2015). **However, the international orientation of Finnish early-stage entrepreneurs is low.** Only 11% of them expect the share of international customers to be more than 25%, which was one of the lowest values among the innovation-driven economies in 2013 (EC 2015).

### B.3.9 Endowments

An ageing population is highlighted as a concern in many recent reports, including the European Commission's European semester recommendations. Demographic projections show that the working age population in Finland will decline by over 5% in this decade, which could have a significant impact on the economy's growth potential. Old age dependency ratios are particularly high in rural areas of Finland (Nordregio, 2013).

*To review further:*

- *are there specific skills deficits or challenges for specific sectors in terms of labour availability ?*
- *are there opportunities related to the 'silver economy' for Finland?*

The Finnish economy is based strongly on added value obtained from natural resources. At the same time Finland has abundant natural resources in terms of the clean forest, fresh water as well as peat, mineral reserves and arable land. Finland ranks second in the European 'eco-innovation index' (Eco-innovation observatory, EIO[16]), just behind Sweden. The performance is notably due to a remarkable level of eco-innovation inputs, namely Government spending on the environmental R&D, R&D personnel as well as the total value of green early stage investments, which are 80-200% higher than the average of all Member States. For example, the country invested €38m per million inhabitants on green initiatives whereas the European average was €12m per million inhabitants (EIO, 2013).

However, resource efficiency outcomes are below the EU average and eco-innovation needs and challenges of Finland are strongly associated with material efficiency. Performance in material efficiency is low because of the large share of energy and material intensive industries such as pulp and paper industry, base metal industry and chemical industry. The greatest eco-innovation challenge concerns **high material consumption, as well as low material productivity**, energy-efficiency and high GHG emissions, which result from energy intensive industrial sectors, freight transportation and traffic as well as extensive earthworks and hydraulic engineering.

In 2013, direct material inputs used by the national economy totalled around 244 million tonnes, of which domestic inputs made up 77%. A majority of domestic inputs is produced in the use of minerals, mines and construction minerals. Biotic inputs are estimated to have a share of one-quarter of the weight, including wood, cereal, root vegetables and fodder plants, as well as fish and game. Total material requirement rose to over 570 million tonnes in 2013[17]. **Natural resource usage calculated per person is relatively high in Finland compared to other EU member states.**

Indeed, Statistics Finland (2014) report[18] that the material economy did not "*peter out like the national economy did*", in 2013. Indeed, material requirements as a direct input in the national economy were 4.7% higher than in the previous year. For example, logging (forestry) increased by 9%, and altogether more metal ores, industrial minerals and useful stone were extracted from mines than ever before. The use of imported goods remained similar to the previous year and, even though, the use of stone, like gravel and crushed stone, in construction fell to, or below, the level of the recession year 2009, a similar collapse in the material requirement as seen in the recession of the early 1990s or in 2009 is not visible for the moment.

### B.3.10 Political system and government policies

Overall state spending in Finland is higher than in other Nordic welfare countries and countries with traditionally strong public sectors such as France. However, the total share of government expenditure in GDP is less important than the composition of expenditure (e.g. share on higher education, R&D, modern infrastructure, etc.)

Traditionally the level of R&D investments has been very high in Finland. However, although Finland is still among the top ranked countries in this area, its R&D expenditure has significantly decreased recently. In 2014, R&D investments totalled around €6.4m, approximately 11% less than in 2011 (around €7.2m). Gross domestic expenditure on R&D (GERD, as % of GDP) has declined from around 3.9% in 2009 to estimated 3.1% in 2014 – already below the 1999 level (MEE 2015). A large share of the decline in R&D is explained by Nokia's fall..

However, the public funding of R&D has declined significantly in recent years. Moreover, the OECD estimates that Finland has one of the lowest rate of direct governance funding of BERD (when tax incentives for R&D are included).

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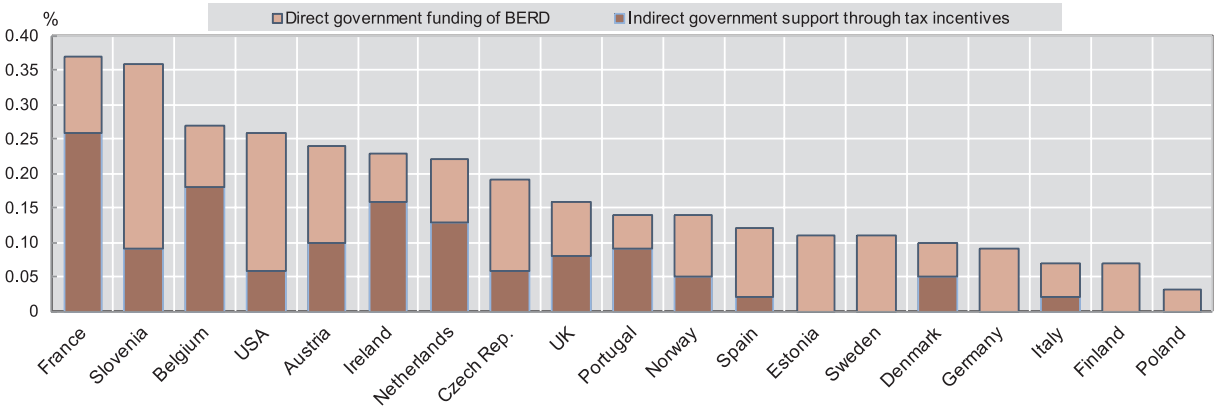
16 http://www.eco-innovation.eu

17 The material generated in the utilisation of natural resources that is not transferred into input in the economy is called domestic hidden flows and hidden flows of imports. The total domestic and foreign hidden flows are higher than direct inputs, around 326 million tonnes. Of this amount, around 120 million tonnes were generated in Finland, for example as wall rock, logging waste and soils from construction.

18 The economic downturn has not affected the use of natural resources. Published 20 November 2014. Available at: http://www.stat.fi/til/kanma/2013/kanma_2013_2014-11-20_tie_001_en.html

**Figure 27. Direct government funding of business R&D and tax incentives for R&D (2012), as a % of GDP.** Source: OECD R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm and OECD, National Accounts and Main Science and Technology Indicators, December 2014

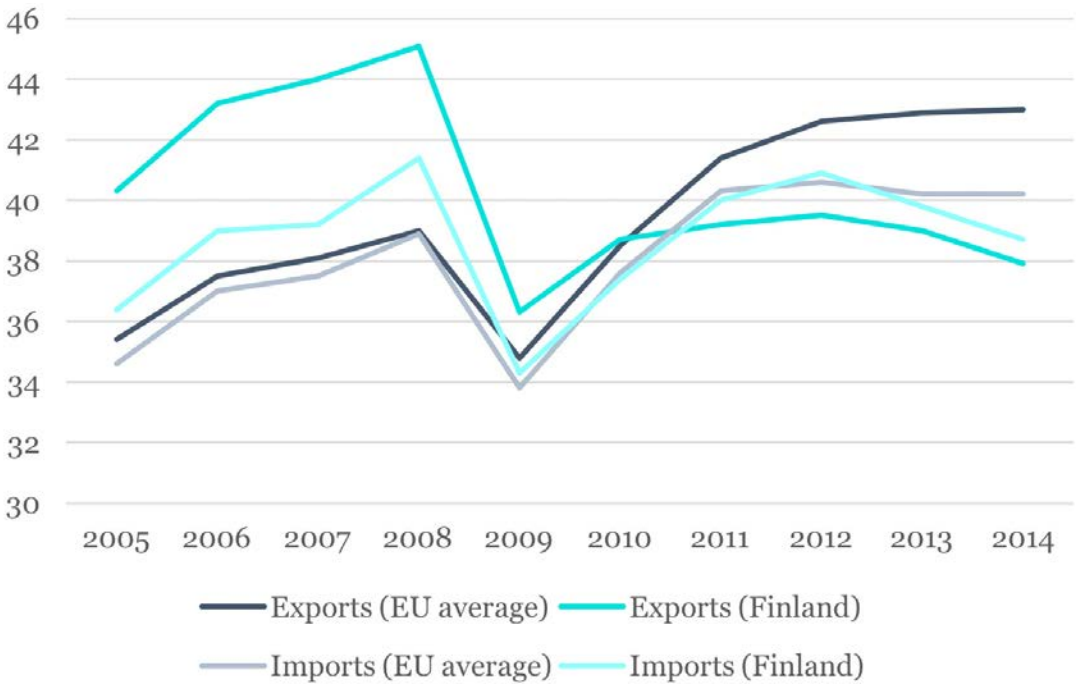



## B.4 External dimension of Finland's competitiveness

### B.4.1 Global demand and Finnish exports

Finland was hit by an **asymmetric shock in the form of the loss of external demand for electronic and paper products – areas that Finland is heavily specialised in** (Holmström et.al. 2014; Vihriälä 2015). Nokia in 2000 accounted for 4% of Finland's GDP, but its fortunes reversed dramatically following the launch of the Apple iPhone and Android devices on the market. By 2013 it accounted for less than 0.5% of the country's output (WEF 2015). The Pellervo Economic Research of Finland forecasted that pulp and paper production in Finland will decrease remarkably in the next two years due to weak economic growth in Europe and the replacement of paper by electronic means. The pulp and paper sector is one of the most important industries of Finland, accounting for about 2% of its GDP and half of its exports (Finland Times 2015). Also metals processing has suffered from low market prices (Holmström et.al. 2014). This led to substantially lower exports and a loss in output that could not easily and quickly be replaced by other products. The effect on GDP and exports of the decline in the electronics and paper industry has not yet been overcome (EC 2015).

**Figure 28. Exports and imports of goods and services (% of GDP).** Source: Eurostat



Although such challenges are not unique to Finland and external shocks are not avoidable, **Finish business ecosystems have not adapted quickly enough during the crisis** (Vihriälä 2015). Finnish **export performance has declined significantly** since the onset of the international financial crisis in 2008. In fact, between 2008 and 2013, Finnish export market share deteriorated more than in any other EU Member State (32%). This is seen to be resulting from the decreasing demand for Finnish products in global markets. On short term, the contraction of Russian economy and challenging political environment further contribute to weak export performance, as Russia is Finland's third-largest export destination (EC 2015).

### B.4.2 Sectoral trade patterns

Finland is an open economy, however, not more so than other countries of a similar size. Total Finnish trade (exports and imports combined) is around 80% of GDP, lower than in other Nordic countries (such as Sweden and Denmark) or Germany (EC 2015). **Almost half of the country's exports are raw materials and intermediate goods used in manufacturing** and a further third are investment goods. Yet neither manufacturing nor the pace of corporate investment are growing at a sufficient pace to boost Finnish trade prospects (WEF 2015).

Due to the relatively **low level of diversification** in exports, Finland is highly exposed to external shocks and changes in global demand (Kaitila and Virkola 2014). The Finnish export sector is specialised in products that have a relatively low share in international trade (in particular wood, paper and basic metal production) (EC 2015).

In recent years, the structure of exports has evolved in an unfavourable direction, in the sense that the **proportion of products intended for end-use has fallen and the proportion of intermediate products has increased.** In Sweden and Germany, in contrast, this has not happened, which means that Finland's real competitiveness relative to these countries has deteriorated (Holmström et.al. 2014). Moreover, the **exports of Finnish high-technology products with high R&D intensity have decreased** from 25.1 % of manufactured exports in 2005 to 7.2 % in 2013 (WDI 2015). Hence, Finnish competitiveness is not only a problem of costs, but also of innovation. The export of services has remained more or less on same level (Holmström et. al. 2014).

According to the IMF export quality index, **the quality of Finnish exports** in the forest industry has dramatically decreased since the 1990s, and even more so after 2007 (for wood manufactures). Meanwhile, machinery and metal industry have not been so much affected. Unfortunately, the data does not yet cover the years after 2010, a year when Nokia started to lose its market share.

**Figure 29. Exports by sector (% of total gross exports).** Source: OECD (TiVA)

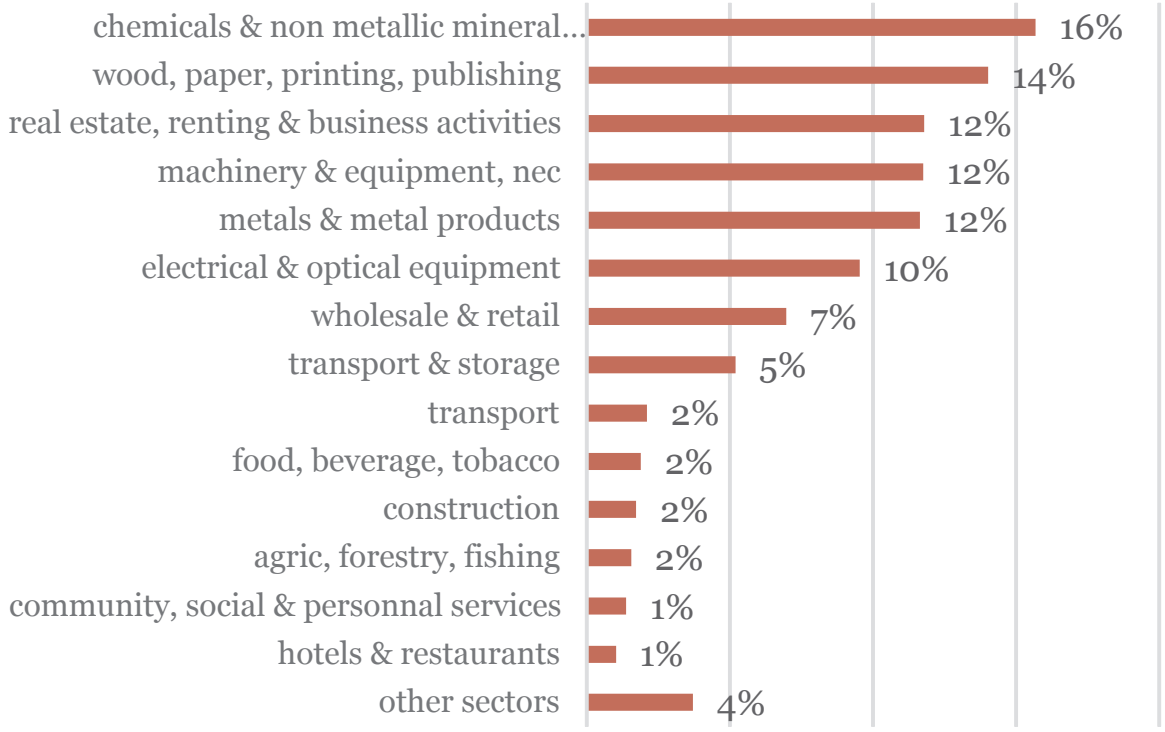


**Figure 30. Export diversification index.** Source: IMF Export Diversification and Quality Databases (Spring 2014)

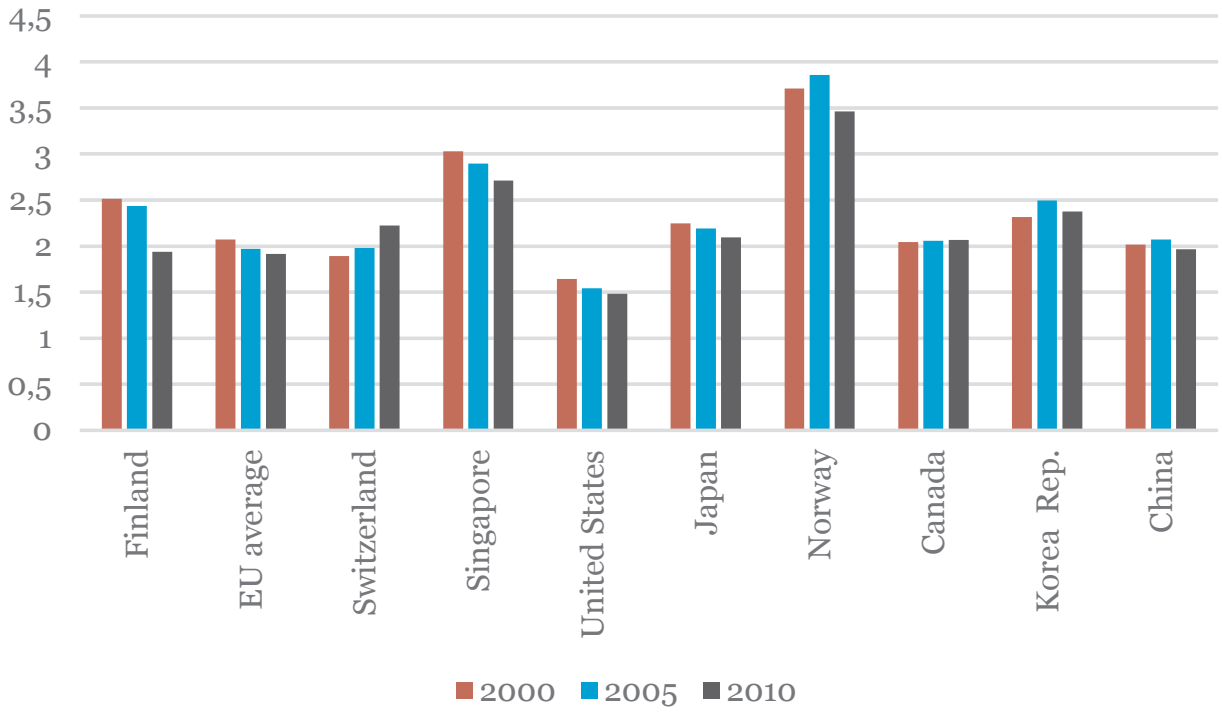



**Figure 31. Quality of exports. Data based on IMF Export Diversification and Quality Databases (Spring 2014).**

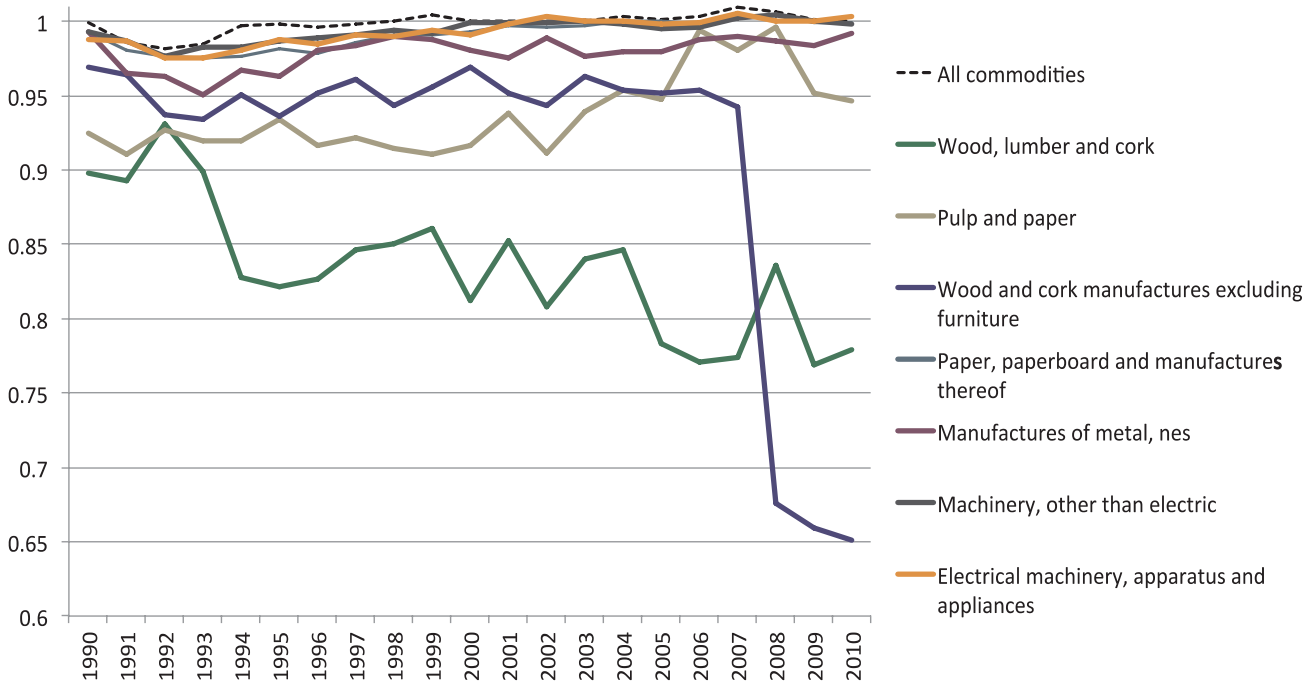


**Figure 32. Export quality index – trend.** Source: IMF Export Diversification and Quality Databases (Spring 2014)

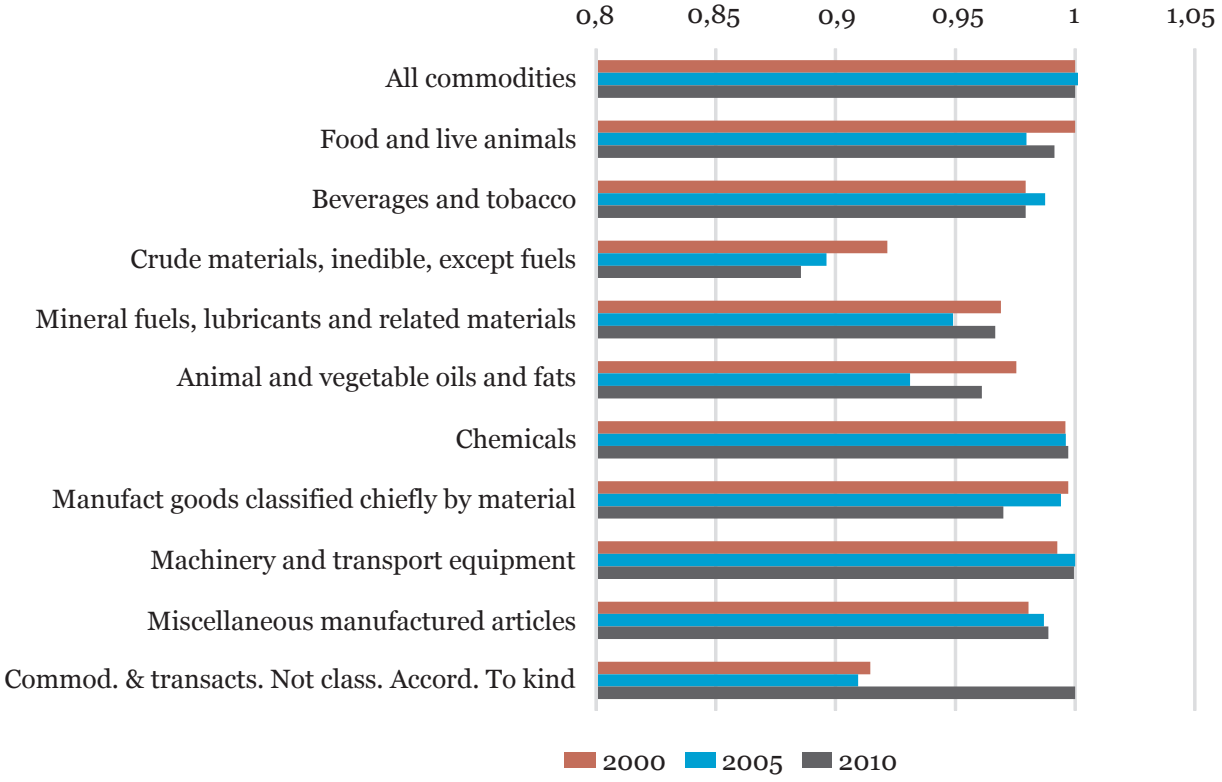
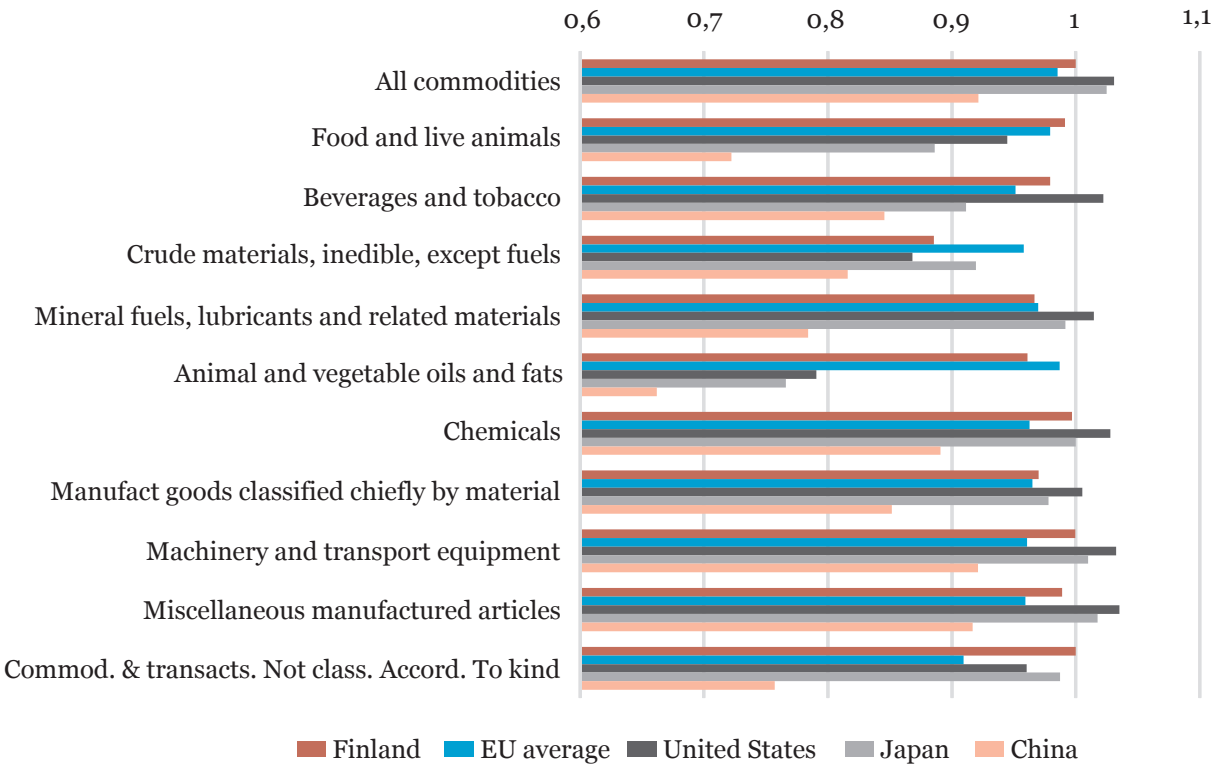



**Figure 33. Export quality index – international perspective.** Source: IMF Export Diversification and Quality Databases (Spring 2014)



### B.4.3 Foreign direct investment

Limited foreign direct investment is one reason for Finland slipping in the IMD global competitiveness index (IMD 2015). Both the inward and outward foreign direct investment stock was close to the EU average in 2013. Although the outward activity of Finnish multinationals is high, it is comparable to multinationals from other Nordic countries (EC 2015).

Finnish investment in Russia has increased over the last decade and at a faster rate than the total outward Finnish FDI stock. This reflects the business opportunities of above average profits in Russia. In 2013, the stock of direct investment stood at 1.4% of Finnish GDP, Russia being the 6th largest destination of FDI from Finland. Finnish companies operate mainly in Russia in retail, construction and manufacturing industries. The Russian investment stock in Finland has remained stable at 0.4% of GDP over the past 5 years. In 2013, Finland generated net primary income from direct investments in Russia of about 0.3% of GDP (in line with a very high rate of return of 24% in 2013) (EC 2015).

Finland is at the bottom of OECD rankings (Figure 35) for the share of R&D expenditure carried out by foreign affiliates as a % of total BERD, in sharp comparison to countries like Ireland and Belgium and to other competitors such as Germany, Norway and Sweden. A study, using data from 2007, found that the sectoral share of Finland's inward investment was lower in high-tech industry and that inward investment company's in Finland tended to be more internationalised in terms of production than R&D (which may point to explanations for this result) (EC 2012).

**Figure 34. Foreign direct investment (inflows and outflows as a % of GDP) – international perspective.** Source: OECD (2013), except for FDI inflows in Finland and Switzerland (2012)

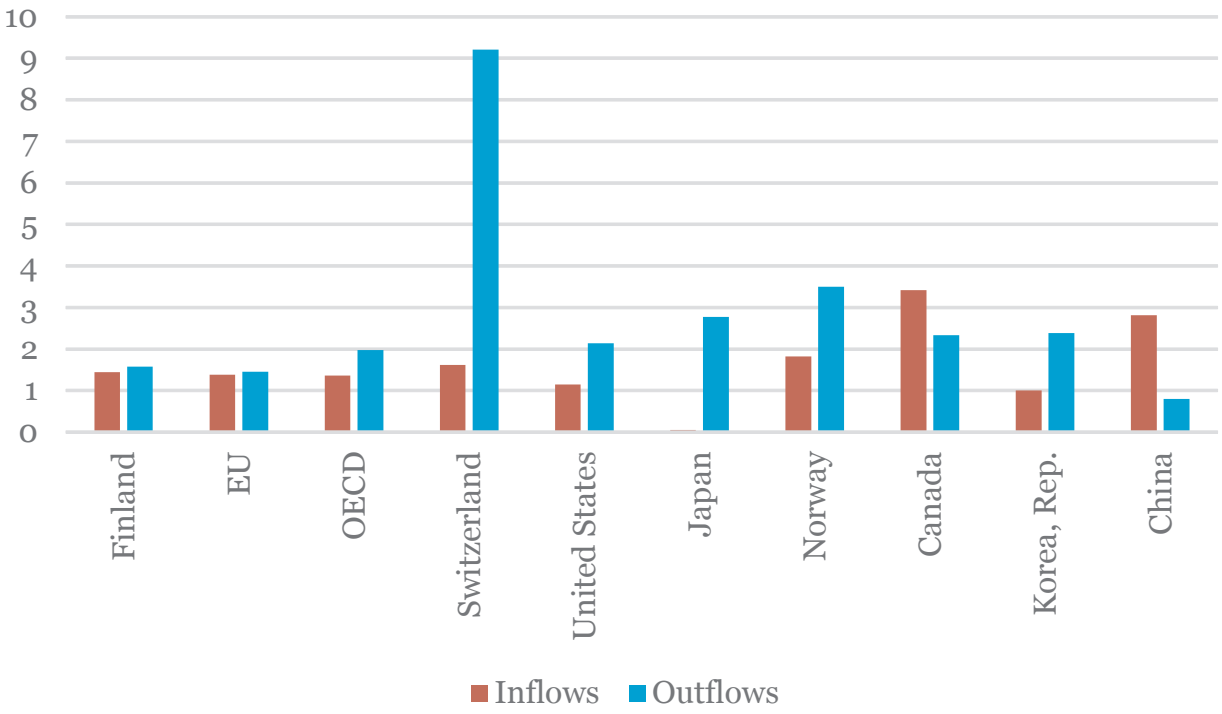
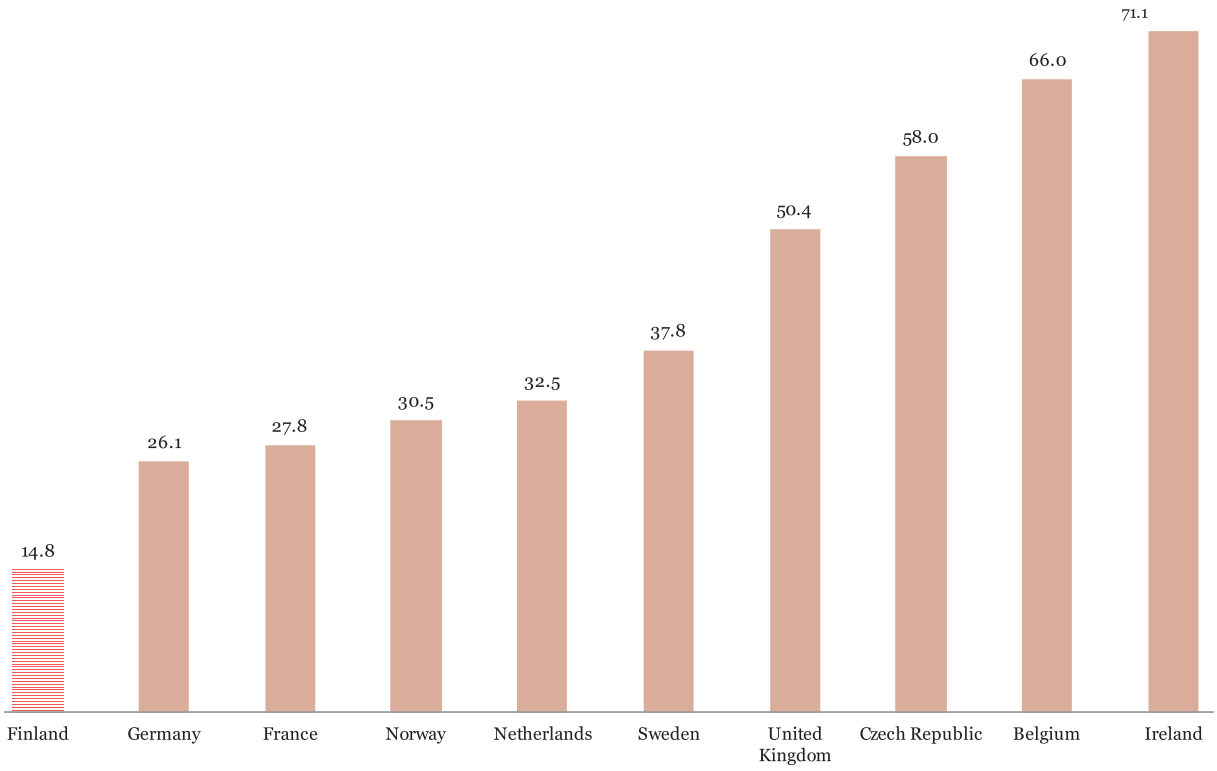


**Figure 35. R&D expenditures of foreign affiliates, % of total business R&D expenditure.** Source: OECD, latest available year




## B.4.4 Structure and dynamics of global value chains

Since the mid-1990s the Finnish business system has become integrated to global value chains via two processes. First, flagship companies in both the forest-related industries and in the ICT sector have drawn suppliers and service providers into global value chains. Secondly, foreign MNCs have acquired subsidiaries of Finnish-based diversified corporations and start-ups. Both processes have been supported by the national innovation system. Even in peripheral corporate towns the legacy of investments in technological development and of upgrading engineering and managerial staff has provided knowledge-intensive platforms that have helped in the fights for global mandates and for new roles in global value chains (Lilja et.al. 2011).

Production of goods and services has become increasingly integrated into global value chains (GVCs) over the past decades. Integration into GVCs offers huge opportunities to generate revenue from competitive advantage in specific areas. Finland benefitted from being well integrated into electronics GVCs from the late 1990s until recently. In 2009, the latest year for which data are available, nearly 15% of Finnish exports were due to participation in electronics GVCs. However, as the electronics sector has shrunk, new opportunities for participation in GVCs need to be found to revive output growth and exports. While traditional sectors like chemicals and metals are already well integrated into GVCs, developments in new areas, such as electronic games, bio-technologies and bio- medicine and green technologies, are promising (OECD 2014).

A study of 45 brand holder companies (all but three) headquartered in Finland anlaysed the operation of specific GVCs for individual products using internal firm data. It concluded that generally, value added is dominated by the intangible aspects of GVCs, i.e., market and internal services as well as the creation and appropriation of intellectual property. Value added shows some tendency to migrate to either the earlier or later stages of the value chain at the expense of assembly/processing or service provision toward the middle. The examples of digital services suggest that the case companies and their headquarters locations can capture large shares of the value added, with little dribbling to locations where the service is consumed. In non-digital services, however, value added has a certain tendency to be captured at locations of provision and consumption (Ali-Yrkkö 2015b).

**Figure 36. Industry domestic value added contribution to gross exports.**[19] Source: OECD (TiVA), % of domestic VA in total exports of all sectors

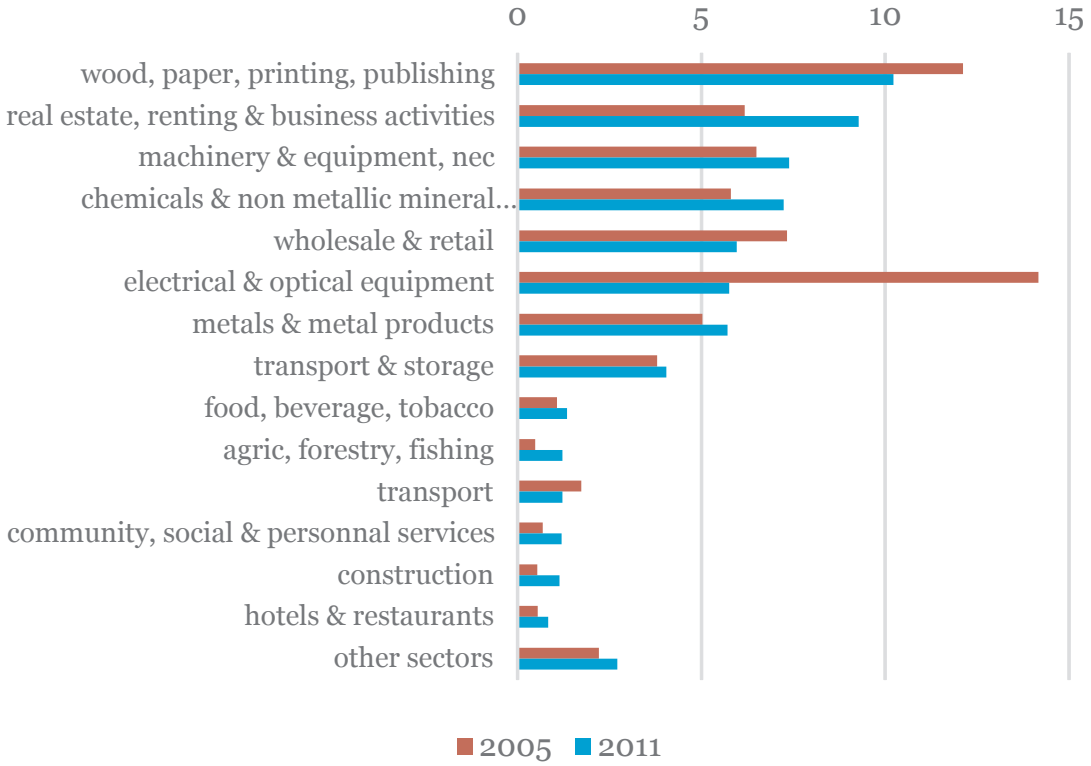
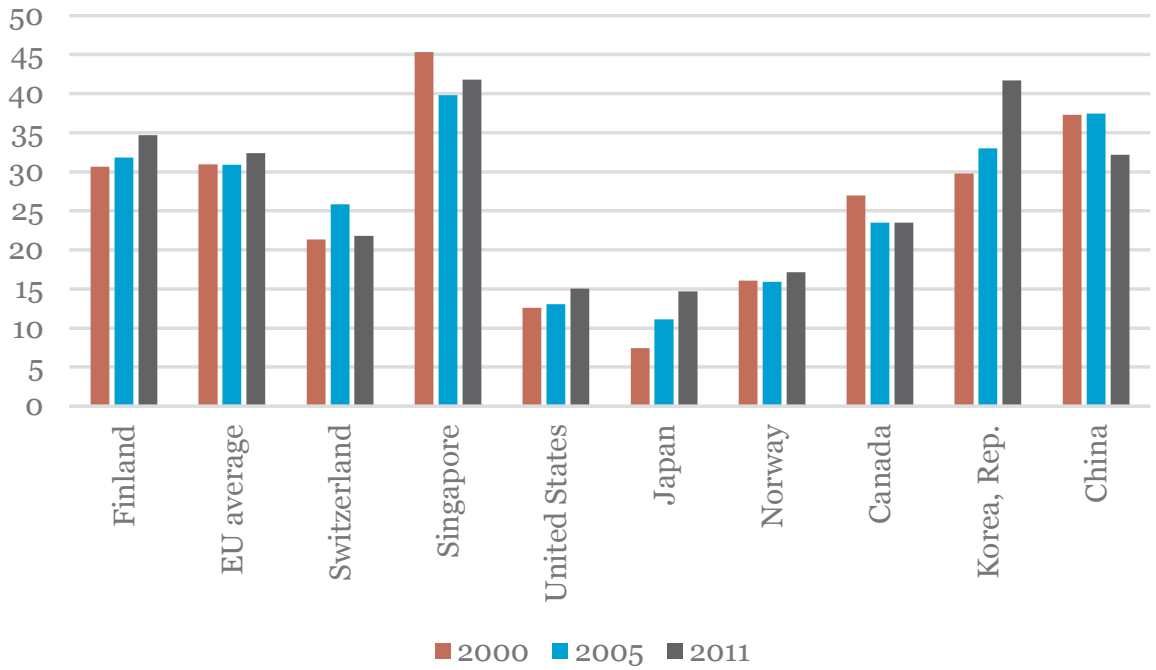



**Figure 37. Foreign value added share of gross exports.** Source: OECD (Tiva). EU average is the unweighted average for EU28 countries[20]




19 "Industry domestic value added contribution to gross exports, in %, is calculated as domestic value added in gross exports of industry i divided by total gross exports of all industries. While the domestic value added share of gross exports measures the intensity of domestic value added in an industry's exports, industry domestic value added contribution to gross exports captures the magnitude compared to other industries" (OCDE, TiVA).

20 "Foreign value added share of gross exports is defined as foreign value added in gross exports divided by total gross exports, in %. It is and 'FVA intensity measure' often referred to as 'import content of exports' and considered as a reliable measure of 'backward linkages' in analyses of GVCs" (OECD, TiVA).

### B.4.5 Availability of renewable and non-renewable global resources

Finland's national economy is strongly linked to global material cycles. About half of all material flows related to domestic production are used for manufacturing products for export. The other half are linked to meeting the demand from domestic consumers. The most significant imported natural resources are the metals, minerals, chemicals and fuels needed in the pulp and paper, metallurgical and chemical industries. Some of these imports are critical with regard to the refinement of other raw materials and the use of high technology. Plenty of information and resources also flow between rural areas and larger settlements. Future solutions will require extensive collaboration both within Finland and internationally (Veugelers et. al. 2009).

There is a need to reduce dependency on imported natural resources, enhance the security of supply, and ensure that critical raw materials remain available also from international markets. Russia is Finland's first source of imports, mainly of raw materials, especially of crude oil and natural gas. In 2013, the value of crude oil and natural gas imports amounted to roughly 70% of total imports from Russia. Finland imports 100% of its natural gas and nearly 90% of its oil and coal from Russia. (EC 2015). **The availability of reasonably-priced energy threatens to become an investment bottleneck in Finland.**

### B.4.6 Policy and regulatory environment – main export and competitor countries

According to the World Bank "Doing business 2015 index", there is a favourable environment for business in Finland. The overall ranking of Finland in 2015 was 9th (8th in 2014), the third highest of European Countries after Denmark (4th), Norway (6th) and United Kingdom (8th). Finland ranked among the top 20 countries in *Resolving Insolvency* (time and cost to resolve bankruptcies, ranking 1st), *Trading Across Borders* (the costs and procedures involved in importing and exporting, 14th) and *Enforcing Contracts* (the ease or difficulty in enforcing commercial contracts, 17th) indexes. The lowest scores Finland received in *Protecting Minority Investors* index (ranking 76th), the sixth lowest of all OECD high-income countries. In other areas Finland ranked between 21st and 38th (World Bank 2015).

### B.4.7 International mobility and knowledge flows

International mobility and knowledge flows can be a key factor in both strengthening internal competitiveness and helping to foster international linkages of the national innovation system. The key indicators relate to educational and researcher mobility as well as the share of foreign nationals in the workforce (notably in science and engineering based professions).

In terms of international mobility of students, Finland performs below the EU28 average lagging significantly countries like Germany and Sweden in terms of the inflow (a measure of attractiveness) of the higher education system. However, it should be noted, that countries like Denmark and the UK lag further behind. The Global Mindedness survey (CIMO, 2015) found a positive impact of mobility on Finnish student: "a clear majority of the respondents felt that the mobility period had improved their social skills, interactive skills, ability to function in other cultures, understanding of how to act with people from different cultures, and curiosity".

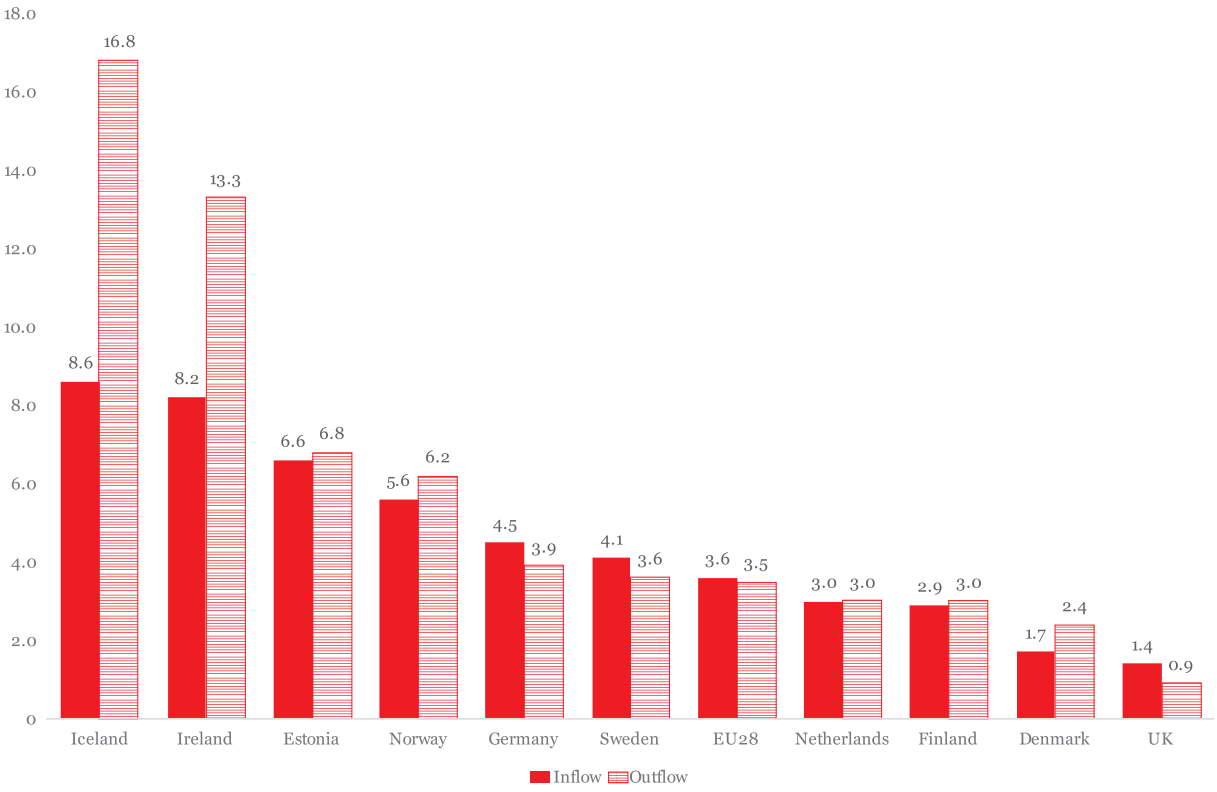
According the European Commission's 2014 "Researchers report" for Finland (EC, 2014), in 2011, the percentage of doctoral candidates (ISCED 6) who were citizens of another EU27 Member State was 6.4% in Finland compared with 9.1% among the Innovation Union reference group (Denmark, Germany, Finland and Sweden) and an EU average of 7.7%. In the same year, the percentage of non-EU doctoral candidates as a percentage of all doctoral candidates was 6.8% in Finland compared with 14.4% among the Innovation Union reference group and an EU average of 24.2%.

Moreover, in 2013, the number of researcher posts advertised through the EURAXESS Jobs portal per thousand researchers in the public sector was 7.2 in Finland compared with 47.6 among the Innovation Union reference group and an EU average of 43.78. This reflects the fact that the inward flow of foreign researchers to Finland is clearly below the EU average. According to Viljamaa et.al. (2010) this relates partly to the non-competitive salary in the public and higher education sectors.

**The relatively low "attractiveness" of Finland as a place to study or carry out research may be a factor impinging on access to knowledge flows.**

In addition to 'below average' attraction of foreign students and researchers, data from Statistics Finland analysed by CIMO (2012), found that "more than half (51%) of the international students with a higher education degree in Finland thus end up using their skills and competences outside the Finnish working life, either by choice or involuntarily. CIMO argue that **'The Finnish labour market does not appear to make very active use of foreign nationals' skills'**.

**Figure 38. Students (ISCED 5-6) inflow from/outflow to another EU-27, EEA or Candidate country (as % of all students) (2012).**
Source: Eurostat, Tertiary education participation [educ_itertp]



# Appendix C. Impact model results

The following model was estimated in order to assess the (short term) impact of Tekes funding on turnover and employment:

$$Performance_{it} = \alpha \log(X)_{it-1} + \beta Funded_{it} + \delta_i + \varepsilon_{it}$$

where *Performance* is the difference between the growth rate of employment (or turnover) of the firm and the growth rate of the sector, *X* is turnover (or employment) as a control factor for the level of the variable in the previous period, *Funded* is a dummy variable equal to 1 if the funding of firm i has started before year t, and δ is a time invariant factor that captures firm-specific characteristics that determine the dependent variable.

The idea here is that the performance of the firm is benchmarked with respect to the business sector in order to control for the trend of the sector. A positive and significant coefficient (positive coefficient with at least a star) for the *Funded* variable would imply that the performance of the firm was better after being funded by Tekes, and that this increase in performance is not observed in the rest of the sector.

Firms for which the first year of funding was after 2010 were analysed as for the firms that started with Tekes before 2010, almost no financial data was available before they started, so it was not valid to do the before-after comparison for them. This reduced the sample, so that the number of observations is not the number of firms, but firms x years. This is still sufficient for the regression.

Based on the results, Tekes support for bioeconomy and health appear to have led to a positive impact on employment. (Figure 39)

The same regression was run but differentiating by year after funding. The positive employment effect of appears to take place directly after the beginning of the funding. (Figure 40)

**Figure 39. Effect on employment.**

| | All | | Bio-economy | | Digital | | ICT | | Health | |
|---|---|---|---|---|---|---|---|---|---|---|
| Funded | 0.142*** | (0.044) | 0.150* | (0.080) | 0.090 | (0.065) | 0.039 | (0.067) | 0.305*** | (0.112) |
| log(empl.)$_{t-1}$ | -0.996*** | (0.179) | -1.315*** | (0.398) | -1.340*** | (0.221) | -0.854*** | (0.137) | 0.083 | (0.223) |
| Constant | 2.921*** | (0.506) | 4.370*** | (1.291) | 3.791*** | (0.598) | 2.345*** | (0.335) | -0.150 | (0.584) |
| N | 427 | | 118 | | 105 | | 116 | | 88 | |
| Adjusted R-sq. | 0.417 | | 0.550 | | 0.615 | | 0.539 | | 0.211 | |

Note: dependent variable = Employment performance; Fixed-effect estimates; ***(**,*) = stat. significant at the 1% (5%, 10% level); cluster-robust standard errors in parentheses.

**Figure 40. Effect on employment – by year.**

| | All | | Bioeconomy | | Digital | | ICT | | Health | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1y after funding | 0.121** | (0.047) | 0.111* | (0.065) | 0.106* | (0.063) | 0.049 | (0.071) | 0.308** | (0.121) |
| 2y after funding | 0.179*** | (0.052) | 0.204* | (0.111) | 0.074 | (0.079) | 0.060 | (0.080) | 0.309*** | (0.118) |
| 3y after funding | 0.144** | (0.062) | 0.170 | (0.160) | 0.079 | (0.122) | -0.045 | (0.081) | 0.259* | (0.135) |
| log(empl.)$_{t-1}$ | -1.023*** | (0.186) | -1.349*** | (0.424) | -1.325*** | (0.212) | -0.855*** | (0.133) | 0.106 | (0.273) |
| Constant | 2.991*** | (0.524) | 4.474*** | (1.363) | 3.750*** | (0.570) | 2.353*** | (0.325) | -0.206 | (0.714) |
| N | 427 | | 118 | | 105 | | 116 | | 88 | |
| Adjusted R-sq. | 0.418 | | 0.551 | | 0.608 | | 0.546 | | 0.196 | |

Note: dependent variable = Employment performance; Fixed-effect estimates; ***(**,*) = stat. significant at the 1% (5%, 10% level); cluster-robust standard errors in parentheses.

In terms of turnover, the model only found a significant effect for Tekes support to bioeconomy for the entire period, however health and ICT show a positive impact with a time lag. (Figure 41)

The impact on turnover only occurs after two years and the impact on bioeconomy disappears (not significant at 10%) probably because the effect is diffused over time. (Figure 42)

**Figure 41. Effect on turnover.**

| | All | | Bioeconomy | | Digital | | ICT | | Health | |
|---|---|---|---|---|---|---|---|---|---|---|
| Funded | 0.838** | (0.328) | 0.871** | (0.371) | 0.464 | (0.285) | 1.473 | (1.095) | 0.361 | (0.237) |
| $\log(turn.)_{t-1}$ | -3.513*** | (1.031) | -3.205*** | (0.802) | -4.262*** | (1.304) | -4.043* | (2.234) | -1.902*** | (0.439) |
| Constant | 26.358*** | (7.362) | 26.569*** | (6.420) | 32.773*** | (9.524) | 27.549* | (14.344) | 13.764*** | (2.976) |
| N | 442 | | 117 | | 112 | | 122 | | 91 | |
| Adjusted R-sq. | 0.316 | | 0.197 | | 0.635 | | 0.316 | | 0.380 | |

Note: dependent variable = Turnover performance; Fixed-effect estimates; ***(**,*) = stat. significant at the 1% (5%, 10% level); cluster-robust standard errors in parentheses.

**Figure 42. Effect on turnover – by year.**

| | All | | Bioeconomy | | Digital | | ICT | | Health | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1y after funding | 0.474 | (0.423) | 0.142 | (0.431) | 0.491 | (0.367) | 1.225 | (1.447) | -0.039 | (0.256) |
| 2y after funding | 1.285*** | (0.416) | 1.847 | (1.143) | 0.431 | (0.368) | 1.816* | (1.086) | 0.795* | (0.446) |
| 3y after funding | 0.934** | (0.370) | 0.971 | (0.598) | 0.463 | (0.554) | 1.354 | (0.980) | 0.814** | (0.334) |
| $\log(turn.)_{t-1}$ | -3.637*** | (1.035) | -3.454*** | (0.908) | -4.258*** | (1.308) | -4.122* | (2.203) | -2.137*** | (0.480) |
| Constant | 27.219*** | (7.388) | 28.519*** | (7.210) | 32.744*** | (9.548) | 28.065** | (14.172) | 15.313*** | (3.205) |
| N | 442 | | 117 | | 112 | | 122 | | 91 | |
| Adjusted R-sq. | 0.323 | | 0.226 | | 0.628 | | 0.307 | | 0.442 | |

Note: dependent variable = Turnover performance; Fixed-effect estimates; ***(**,*) = stat. significant at the 1% (5%, 10% level); cluster-robust standard errors in parentheses.

# Appendix D. Tekes impact on global competitiveness of the bioeconomy sector

## D.1 The bioeconomy sector

### D.1.1 Scope of the priority area

Finland is one of the leading European countries in terms of setting a steady course towards low-carbon and resource efficient development. A key factor in reaching this goal is the transition to a sustainable bioeconomy. The bioeconomy is broadly defined as the production, and use of biological resources and innovations in order to provide sustainable goods and services in all economic sectors; hence it is a horizontal concept rather than a specific business sector.

The Finnish focus on bioeconomy has followed a similar trend to that observed at the European level (in the research and innovation policies agenda). Throughout the 2000s the policy emphasis was to support biotechnology as a cross-cutting technology focus area. During the 2008-10 Tekes programming period, the prioritised biotechnology application areas included energy environment and wellbeing, systems biology, computational methods and bioprocess technology. There was also a focus on the forest industry, notably biorefining, as a key element of the national industrial base.

Only in the 2011-14 period, the concept of bioeconomy as a prioritised sub-theme was introduced within the programme on natural resources and sustainable economy. The most prominent emphasis has been placed on new forest and biomass solutions. The scope of bioeconomy within Tekes strategies was confined to the following sectors:

- Food (agriculture and food industry)
- Bioeconomy products (products processed from raw materials, mostly wood e.g. furniture, construction products)
- Biofuels
- Renewable energy (energy produced from biomass)
- Water treatment (e.g. re-use of water)
- Services for bioindustry (e.g. software, consulting for bioindustry companies)
- Machinery and equipment (e.g. machines for forest and paper industry).

From 2015 onwards, bioeconomy has been given a prominent role as a key strategic priority area for the Finnish Government and strongly features in Team Finland activities. The bioeconomy focus of Team Finland initiatives is primarily concentrated on the following sub-areas:

- Chemical forest industry
- Mechanical forest industry and wood construction
- Biorefining, including bioenergy, biomaterials, biochemicals and biofuels
- Bioeconomy equipment
- Bioeconomy services, including ecosystem services.

### D.1.2 Importance to the Finnish economy

The importance of bioeconomy for the Finish economy is considerable. According to Statistics Finland the total turnover of Finnish bioeconomy is around €64b and more than 285,000 people (or 11% of all employees) are directly employed in bioeconomy sectors[21]. Bioeconomy exports account for approximately €17b or one third of the value of all Finnish goods exports and. The Finnish bioeconomy strategy estimates that around 16% of Finnish GDP is related to bioeconomy products and services.[22]

The most notable contributor to Finnish bioeconomy is the strong forestry and pulp and paper industry. Currently four out of the top 10 Finnish export products are related to forest-based industry, namely coated paper and paperboard, uncoated paper and paperboard, sawn goods, pulp.[23] However, since global demand for paper is in decline due to digitalisation, the industry is under pressure to develop new products and tap into new markets. Despite the fact that specialisation in manufacturing of paper and paper products is slightly decreasing in the recent years, the industry still represents the second sector in Finland in terms of value added concentration relative to EU average. In comparison with global competitors, Finnish patents are also highly concentrated in technologies related to paper.

The forestry industry produces almost 70% of Finland's renewable energy, although often in the form of traditional biomass. In relation to bioeconomy, technology exports are

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21 Data for 2013

22 Ministry of Employment and the Economy, Ministry of Agriculture and Forestry, Ministry of Environment (2014) Sustainable growth from bioeconomy: The Finnish Bioeconomy Strategy

23 Bosman, R. and Rotman, J. (2014) Benchmarking Finnish and Dutch bioeconomy transition governance

also significant, for instance, forest industry machinery and equipment for more than a billion euros each year. Another sector that is core to bioeconomy is the chemical industry, which has evolved out of refining side streams of pulp and paper industry, producing, for example, bio-based chemicals, yeast or enzymes. This sector makes up around 23% of Finnish exports with a value of €13.3b. Also there is a growing importance of digital technologies for bioeconomy, for example, through applications such as GPS systems for efficient timber harvesting.

While an integral part of the bioeconomy definition, in economic terms the agriculture and food sector play a less visible role in Finland. The pharmaceutical and construction industries do not seem to be playing an important role in the current Finnish bioeconomy discussions[24].

There are high hopes for the future economic potential of Finnish bioeconomy. The Finnish Bioeconomy Strategy estimates that turnover could reach €100b over the next 10 years leading to the creation of 100,000 new jobs. Estimates suggests that new products developed by the forest industry could increase its value by €6b (22%) by 2020[25]. The forest industry is anticipated to expand its current operations to product groups such as composites, biofuels, bio-chemicals and services. New bio-products are estimated to account for half of all export revenues in the forest sector by 2030.

### D.1.3 Evolution of Tekes and Team Finland support since 2008

Throughout the last decade Tekes activity focused on supporting biotechnology development as an overarching key enabling technology. Two consecutive programmes were implemented: NeoBio Novel Biotechnology Programme (2001-2005) and SymBio From Biotechnology to Industry (2006-2011). NeoBio had a budget of €78m, of which Tekes contributed €48m. SymBio programme had a total budget of €65m, of which Tekes funded around a half. Through these programmes, Tekes attempted to advance the development and application of modern biotechnology methods in product R&D, as well as to foster the emergence of new, internationally competitive businesses and to promote networking in the biotechnology sector in Finland and internationally.

In subsequent Tekes programmes a particular emphasis was put on increasing productivity in sectors and clusters which are essential for the Finnish economy; hence the renewal of forest industry and development of a knowledge-base for biorefining became a central focus area. The support activities included, notably, the launch of a thematic Strategic Centre for Science, Technology and Innovation (SHOK) on bioeconomy, Fibic Oy, and the programme BioRefine – New Biomass Products.

SHOKs were established as a policy concept in 2007 and organised as public-private partnerships in the form of non-profit limited companies. The aim of **Fibic SHOK** was to elaborate novel research and innovation programmes and to help accelerate the process of innovation and renewal of Finland's industrial clusters. Through open innovation and new ways of networking between companies, researchers and end-users Fibic SHOK aimed to create new competences and induce radical innovations at the system level for successful transition to bioeconomy.

The Tekes **BioRefine** (2007-2012) programme was launched with the aim to develop innovative new products, technologies and services based on biomass refining and biorefineries, strengthen the existing biomass know-how in the energy and forest industries and extend it into new areas, promote the cooperation between companies from different industrial clusters and sectors for innovation and encourage smaller firms to develop niche products and to operate in niche markets. The total funding volume was around €242m constituting the third largest Tekes programme launched during 2000s. The budget of BioRefine programme was concentrated on relatively few companies: the 10 largest industry participants accounted for over 90% of the project funding. The challenge was also to include smaller firms, but according to the programme evaluation this was not successful.[26]

During the 2011-14 period the bioeconomy was a focus area under the theme 'Natural resources and sustainable economy'. The emphasis was put exclusively on the development of forest and biomass solutions. For instance, the **Green Growth** programme (budget €79m) aimed at a leap forward in energy and material efficiency of production and service chains over the entire life span of products.

Tekes **Innovative Cities (INKA)** (2014-2020) programme also targeted bioeconomy development as a subtheme. The aim was to create internationally attractive innovation clusters in Finland based on top-notch talent. The objective was to create a sense of community for entrepreneurs, innovators and change agents to foster high-growth companies that are capable of creating brand new products and services for the international market. Joensuu and its partner cities Jyväskylä and Seinäjoki were designated as responsible for the bioeconomy theme. It included four selected bioeconomy themes: 1) sustainable processes and logistics of bioeconomy; 2) high value added bioeconomy products; 3) city development platforms for bioeconomy; 4) international bioeconomy.

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24 Bosman, R. and Rotman, J. (2014) Benchmarking Finnish and Dutch bioeconomy transition governance

25 Ministry of Employment and the Economy (2013) Industrial Competitiveness Approach: Means to guarantee economic growth in Finland in the 2010s. https://biobs.jrc.ec.europa.eu/policy/finland-industrial-competitiveness-approach

26 Luoma, P. et.al. (2015) Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources

It is important to note that Tekes funded activities in the area of bioeconomy must be viewed as highly intertwined and complementary to initiatives implemented by other organisations. Fibic SHOK emerged on the basis of Forestcluster Ltd., which was founded by the key Finnish forest companies, main research institutes and universities to build-up industry-driven research programmes. Fibic SHOK programme Fubio (€21m) was part of the Tekes BioRefine Programme and played a central role in supporting biomaterial and biochemical R&D. The Ministry of Employment and the Economy has provided vital pilot and demonstration funding for second-generation biofuels for transport to enhance their introduction to fuel markets. Moreover, an international biorefinery competition was launched by the Ministry to accelerate the commercialisation of biorefinery innovations. Important sources of additional funding, especially for demonstration plants, were EU level programmes.

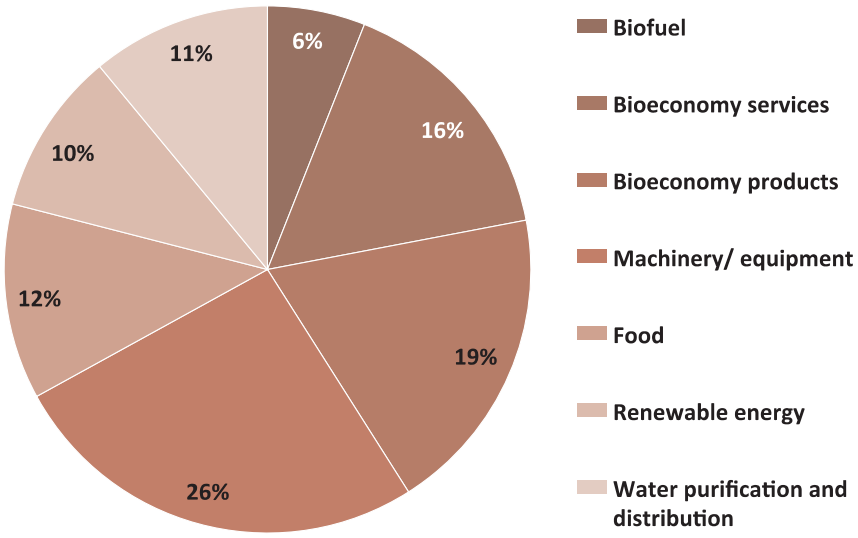
From 2015 onwards, Tekes is shifting the focus towards business ecosystem development targets, which will be promoted in collaboration with other Team Finland actors. The overarching aim of Tekes support activities is to identify business spearheads with a strong international growth potential and to foster the development of supporting business ecosystems in the bioeconomy.

## D.1.4 Mapping Tekes support

In total, bioeconomy investments in Finland amount to roughly €1.5b.[27] The estimate of Tekes funding for bioeconomy companies is highly dependent on the definition used[28]. Based on one estimate, between 2006 and 2013 Tekes funded a total of 565 bioeconomy related projects involving 304 companies. Total project funding was around €456m. The largest sectors within the Tekes bioeconomy portfolio were machinery (26%), bioeconomy products (19%) and bioeconomy services (16%).

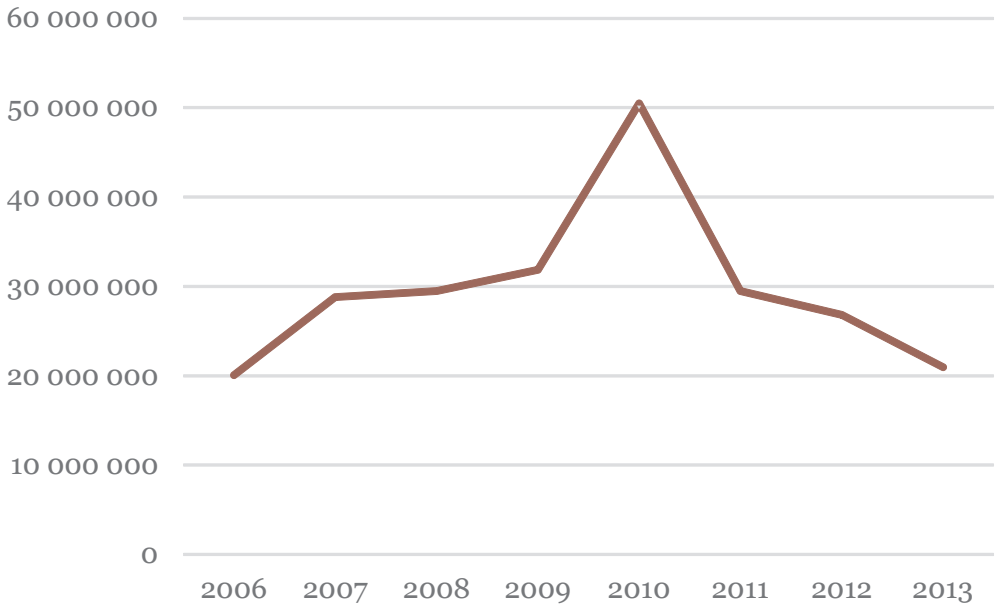
However, according to Tekes, 75% of the bioeconomy related projects can also be classified as cleantech projects and only 25% as 'pure' bioeconomy projects. All biofuel producing companies and the largest proportion of renewable energy is categorised in cleantech. The food industry weight is greater in bioeconomy. If Tekes categorisation for 'pure' bioeconomy is used, the funding is approximately €55m per year[29]. Applying a statistical approximation, bioeconomy funding amounts to €140m per year. Another estimation highlights that in 2013 alone Tekes funding for bioeconomy amounted to €162m[30]. Plotting the total Tekes funding awarded just to bioeconomy related companies, most of funding to companies has been released in 2010

**Figure 43. Tekes funding for bioeconomy related projects (2006-2013).**
Source: Adapted from Pietilä (2015)




27 Ministry of Employment and the Economy (2015) From forests to pioneering bioeconomy: Final report on the Strategic Programme for the Forest Sector (MSO)
28 Pietilä, K., "Cleantech-selvitys", Power Point Presentation (2015)
29 Pietilä, K., "Cleantech-selvitys", Power Point Presentation (2015)
30 Ministry of Employment and the Economy (2015) From forests to pioneering bioeconomy: Final report on the Strategic Programme for the Forest Sector (MSO)

**Figure 44. Evolution of Tekes funding for bioeconomy companies.** Source: Technopolis Group calculations based on Tekes data




(see Figure 44), when support amounted to around €50m. This calculation excludes funding that went to public partners and large public-private partnerships such as SHOKs.

With the adoption of Finnish Bioeconomy Strategy there is a significant policy emphasis placed on the development of the thematic area. The Government's 2014 growth package included an additional permanent annual commitment of €20m to be used by Tekes for bioeconomy and cleantech priorities.

## D.1.5 Evidence of impact on global competitiveness in past evaluations

An overall conclusion from the assessment of Tekes investment in fostering competitiveness of the Finnish biotechnology industry throughout 2000s has been that the commercialisation levels of new knowledge and technologies failed to match the initial expectations of the programmes. The evaluation of NeoBio programme concluded that it was too large an injection of funding "to handle for an, in some aspects, immature industry, populated by a handful of large companies and a broad range of relatively small knowledge intensive SMEs, two categories of companies with diametrically different needs in terms of R&D"[31]. The programme incentivised numerous R&D activities that were carried out before market readiness, hence the expected business creation activity and associated economic benefits did not materialise. However, the programme did contribute to the development of expertise, increase of R&D personnel in companies and the establishment of international networks in the biotech area.

According to the SymBio evaluation[32], the programme contributed significantly to raising the awareness of industry needs in the research system. The programme also increased international collaboration as SymBio facilitated involvement in international biotech networks such as ERA-IB and access to EU Framework Programme funding. Collaboration among Finish biotech actors was continued by the Industrial Biotechnology Cluster Finland. While some spin-offs were reported as outcomes, the expected level of commercialisation did not take place. The evaluation noted that some universities developed considerable co-operation with foreign companies instead, since the domestic companies were too small and unable to bring the results from research to the market.

Despite this assessment, data shows that the biotechnology sector has grew rapidly in Finland during the 2000s both in terms of sales and employment suggesting that the biotechnology business is slowly emerging as a viable sector.[33] The entry and exit rates of companies in the biotechnology sector do not significantly differ from the average rates of other industries. The Finnish biotechnology industry as a whole has found a position in the global industry, reflecting specific strengths and the knowledge pool within the sector.

31 Stern, P. et.al. (2014) Evaluation of the NeoBio and SymBio programmes. Report to Tekes.
32 Stern, P. et.al. (2014) Evaluation of the NeoBio and SymBio programmes. Report to Tekes
33 Nikulainen, T., Tahvanainen, A., Kulvik, M. (2012) Expectations, Reality and Performance in the Finnish Biotechnology Business

The SHOK evaluation highlighted that the bioeconomy cluster influence on the industry renewal seems to be of the opinion building kind. The cluster has been able to enhance novel ways of thinking within industry. The research organisations and responsibilities in companies have been changed to better connect to the SHOK. While it would be too early to assume significant changes in the behaviour of the whole industry, Fibic SHOK has incentivised the development of long value chains around a common table, and it has brought industry and research players closer to each other[34].

The BioRefine evaluation[35] noted that the programme had highly relevant objectives and timing given the growth of the biofuel market. It significantly contributed to the launch of new biofuel products on the market by placing a focus on demonstration. The programme represented a major R&D investment in biorefinery technology, both domestically and globally, enabling the development of several new biorefinery concepts. Investment on this scale would not have occurred without Tekes support.

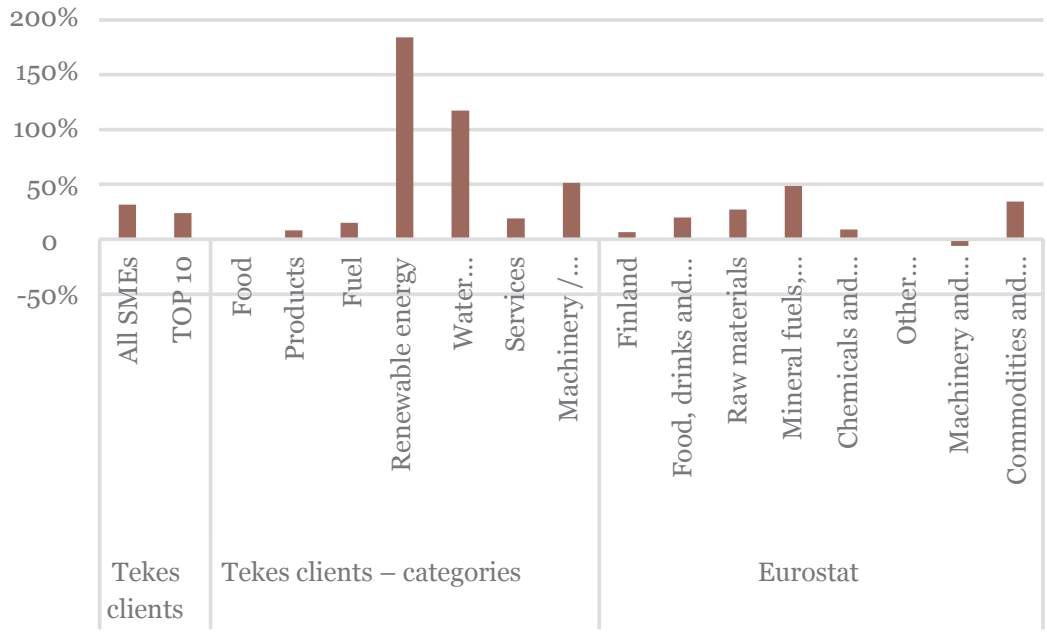
Despite the fact that many of the biorefinery concepts still lack funding or are seen as economically unviable, Finland has achieved an international reputation and expertise in this technology and its commercialization, in part due to the BioRefine programme. The BioRefine and FuBio programmes together with the pilot and demonstration funding of the Ministry of Employment and the Economy have formed an extensive network of collaboration in biorefining that is internationally unique and is expected to have a pioneering role in global markets[36]. Overall, BioRefine was one step on Finland's path towards the bioeconomy. It increased the general understanding on the business possibilities within this area and strengthened a positive attitude towards bioeconomy. However, there is still a lot of work to be done to ensure large scale systemic change.[37]

## D.1.6 Statistical analysis

Data on Tekes supported bioeconomy companies shows that these companies have experienced sales growth of 25% from 2010 to 2014 and exports have increased by 31%. The export growth has been particularly important in the renewable energy and water purification sectors (see Figure 45). Also machinery and equipment and service sectors appear to show some positive trend in export growth.

However, this growth only generated a 2% increase in overall employment. Renewable energy and water purification sectors show a significant employment growth accounting for a rate of 25% and 20% respectively, but the employment rate in the area of machinery and equipment has contracted by around 4% (see Figure 46).

**Figure 45. Comparison of bioeconomy company export growth (2010-2014).** Source: Technopolis calculations




[34] Ministry of Employment and the Economy (2013) Licence to SHOK? External Evaluation of the Strategic Centres for Science, Technology and Innovation.
[35] Luoma, P. et.al (2015) Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources. Report of Gaia Consulting to Tekes
[36] Makinen, T., Alakangas, E. and Holviala, N. (2012) BioRefine – New Biomass Products Programme 2007-2012
[37] Luoma, P. et.al (2015) Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources. Report of Gaia Consulting to Tekes

Figure 47 maps sales and export revenues of companies supported by Tekes according to the defined bioeconomy categories. From 2010-14 renewable energy sector has intensified export by around 180% and water purification and distribution sector achieved sales growth of around 120%. This confirms claims that Finland is a global leader in renewable energy and water chemistry technologies.

**Figure 46. Comparison of employment growth (2010-2013).** Source: Technopolis calculations

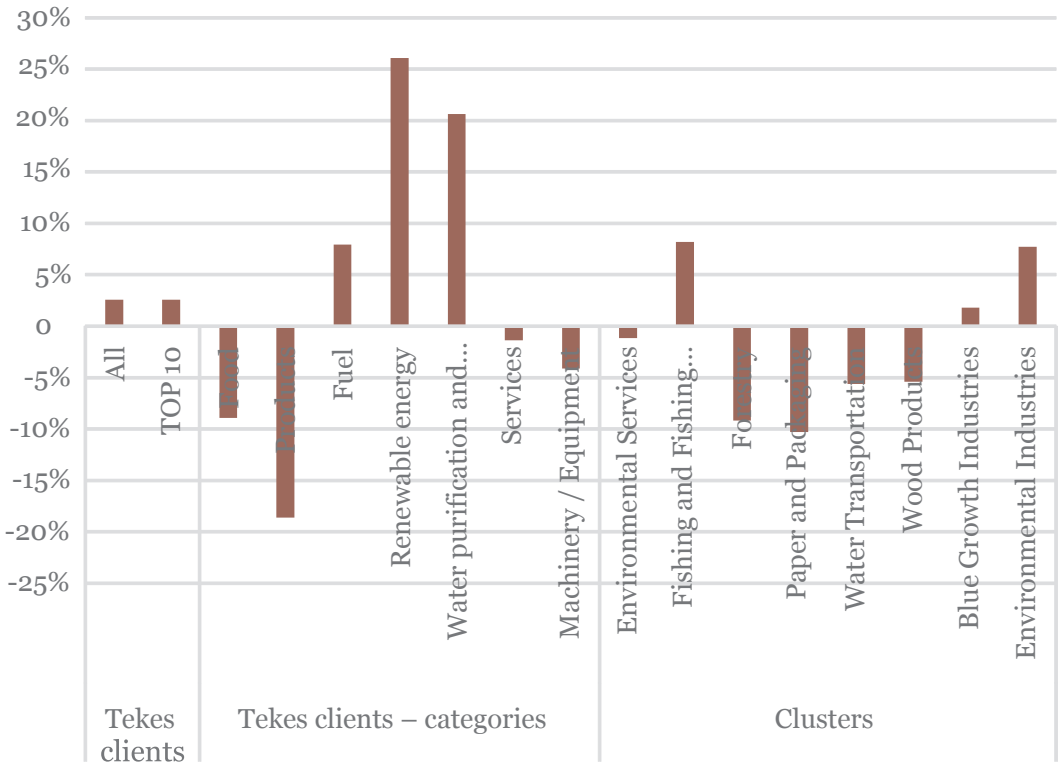
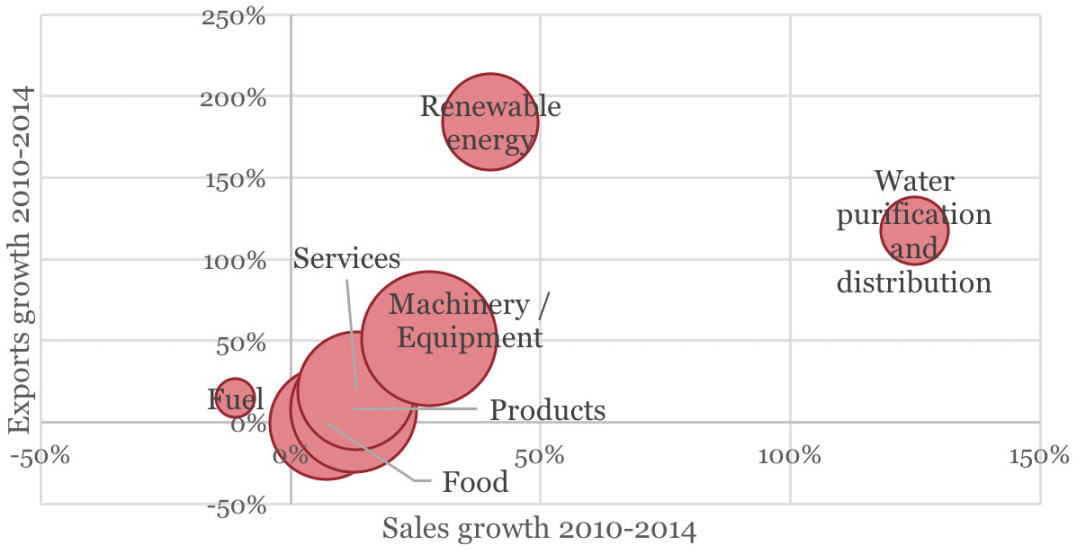



**Figure 47. Performance of Tekes clients in bioeconomy categories (size of circles is employment in 2014).**
Source: authors calculations based on statistics Finland data



## D.2 Bio-based chemicals ecosystem case analysis

The bio-based chemicals ecosystem was chosen for in-depth analysis for a number of reasons. The use of bio-resources as building blocks for a wide range of goods and services that can substitute those based on fossil fuels represents the core of so called 'new' bioeconomy. It implies the reconfiguration of old industrial structures and formation of long, entirely new global value chains that span from biomass processing to consumer product distribution. A key factor in a successful bio-based economy will be the development of biorefinery systems allowing highly efficient and cost effective processing of biological feedstocks to a range of bio-based products, and successful integration into existing infrastructure. The Finnish Government set out a clear strategic direction of economic diversification through bio-based products that reflects the climate, energy and resource efficiency discourse. Similar political incentives in other European and third countries are driving the global demand for bio-based chemical technologies, facilities and know-how. There are first signals of incipient value chain structures forming from biomass producing sector to chemical industry in Finland. Deeper insight into the early formation of bio-based chemicals ecosystem and Tekes contribution in this process is vital for furthering understanding how to support Finnish industry for better global positioning and greater value capture from this emerging business area.

### D.2.1 Role of bio-based chemicals industry in Finnish economy

The Finnish Chemical industry has used bio-based raw materials for decades, long before the bioeconomy was on the policy agenda. This evolved out of refining side streams of the distributed pulp and paper industry. For example, the industrial production of xylitol from a side stream of the wood pulping process is a Finnish innovation developed in the 1970s[38].

Currently the chemical industry, which evolved out of refining side streams of the pulp and paper industry, makes up around 23% of Finnish exports with a value of €13.3b.[39]It is estimated that around a third of Finnish chemical industries use bio-based raw materials[40]. Many of the products, such as tall oil based chemicals, CMC, xylitol, renewable diesel and bioethanol, are almost entirely made of renewable raw materials. In other products, such as paints, adhesives, cosmetics and rubber products, some of the raw materials are plant-based. Finnish bio-based chemistry examples that are close to consumer include advanced biofuels, cellulose gum as yoghurt thickening agent, tall oil for production of glues, car tyres containing natural rubber and oils, bio-based materials for packaging and medicine, paints containing binders based on vegetable oils, etc.

The use of biological raw materials, biowaste and biotechnology within the chemical industry is on the increase[41]. It is expected that the continued development of bio-based chemicals and polymers in biorefinery complexes will lead to new feedstock demands, new technology development and new economic opportunities. Economists estimate that new products developed by the forest industry comprising such product groups as composites, biofuels, biochemicals and the service business could raise its value by €6b (22%) by 2020. New bioproducts are estimated to account for a half of all export revenues in the forest sector by 2030[42].

### D.2.2 Finnish bio-based chemicals industry in global value chains

Finnish companies are closely interlinked in the global value chains, particularly in the new bioeconomy sectors where there is a rather level playing field globally. Yet, Finland does not have large consumer product brand owners, hence industry is restricted to the lower-added value part of the value chain, namely, production and processing. The part of the ecosystem that relates to sourcing of wood supply and accompanying processing technologies is well established and Finnish companies have a strong role in this link of the chain.

Bio-based chemical intermediaries are still in their infancy and Finnish companies are actively building up their position in global value chains. There are few small and medium sized companies operating in this part of the ecosystem which is dominated by already established large industrial firms, such as UPM, Stora Enso, Metsä Group, Neste Oil, that drive developments in the field. Some smaller and more specialised companies are also present, for instance, ForChem that successfully commercialises intermediary and final products based on tall oil. Yet, all these companies are taking side stream valorisation approaches, rather than exploiting biorefining technologies that allow feeding solid biomass into the chemical sector on an industrial scale.

There is a general pattern that Finnish forest companies collaborate with big foreign chemical companies to

38 Trade association of the Finnish chemical industry: www.kemianteollisuus.fi
39 Bosman, R. and Rotmans J. (2014) Benchmarking Finnish and Dutch bioeconomy transition governance
40 Trade association of the Finnish chemical industry: www.kemianteollisuus.fi
41 www.bioeconomy.fi
42 Ministry of Employment and the Economy (2013) Industrial Competitiveness Approach: Means to guarantee economic growth in Finland in the 2010s. https://biobs.jrc.ec.europa.eu/policy/finland-industrial-competitiveness-approach

tap into the global value chain. While there are some larger players in the field, as a whole the Finnish chemical industry is quite fragmented and does not have the critical mass to provide competition to global consumer brand owners. Finnish intermediary products are sold mostly to brand owners in Europe and North America. Recently, stronger positions were gained also in Asia collaborating mainly with Chinese companies. Nevertheless, over the years Finnish companies have moved slightly up the bio-based chemicals value chain[43], and with developments in biorefining technologies there are good prospects for many niche businesses to develop within the ecosystem.

## D.2.3 Key drivers, enablers and barriers

### Ample supply of biomass

One obvious inherent strength for the development of Finnish bioeconomy is that 60% of the country is covered in forests, which has led to a strong presence and development of forestry and related industries. Calculated per capita, the biocapacity of Finland is the highest in EU and Finnish forest area represents around 11% of European forest area. Globally viewed Finland's biocapacity is the fourth largest in the world[44]. This provides Finland a natural competitive advantage.

### High-level of know-how and RDI competences

The Finnish Bioeconomy Strategy recognises that due to the abundance of renewable natural resources, industrial strengths and high-level know-how and competences in research, technology development and innovation, Finland is well placed to become a global bioeconomy pioneer. Finland has plenty of expertise in chemistry, biochemistry and processes connected to handling biomasses. The availability of highly educated work force and well-developed R&D infrastructure has made Finland an excellent breeding ground for innovation, including radical innovation, with a wide range of innovation projects and demonstration activities carried out to develop knowledge base for a transition to bioeconomy. Due to strong support to R&D, Finland also appears to be well networked in global knowledge circles.

### Global trends driving the market demand

Several interconnected global trends are driving the demand and markets for new bio-based products. These include the need to mitigate climate change, to reduce the dependency on increasingly expensive fossil fuels, and to improve the security of energy supplies. Policy support and industry investments in biochemicals and biomaterials are on the rise globally. For instance, the market for bioplastics is expected to triple by 2018, with a large share of the capacity increase in Asia. Similarly, the market for biochemicals with unique properties is also growing. These include biobased chemicals with functionalities that are useful in various products, for example food ingredients, nutritional supplements and specialty chemicals.[45] A common feature of the biomaterials and biochemicals markets is the general design principle of utilising raw materials in a holistic manner. Raw materials are used for various products ranging from high-value niche products to biofuels and energy stemming from residual streams. This enables efficient production, which can compete on the global marketplace without subsidies.

Despite the fact that bioeconomy as a concept has been enthusiastically embraced in the policy making circles, there are a range of barriers for transforming the policy vision into concrete industrial reality.

### Dominance of strong forest-based and chemical industry regimes

Sectorial silo structures such as the dominance of historically very strong forestry and chemical industry regime is an important barrier to new value chain formations. This is an impeding factor largely because it is very difficult to prompt radical changes in mechanisms that still works fairly well. ETLA has analysed the value chain formation in Finnish bio-based chemicals ecosystem and concluded that there are indeed signals of some incipient structures forming from biomass producing sector to chemicals industry[46]. Yet, it appears that the strongest links are still between the oil and gas industry that feed inputs into chemicals industry. This denotes that generally value chain structures are largely the same as they have already been for decades[47]and that not much actual value chain reconfigurations have materialised by now.

### Uncertainty of the future business operating environment

Bio-based chemicals ecosystem comprises very heterogeneous value chains that develop around new product development and services. Generally, there is great uncertainty about the future operating environment in an emerging area where the bio-economy rules of the game are still being worked out[48]. Current oil prices are also a non-fa-

43 Interview with Christine Hagström-Näsi
44 Trade association of the Finnish chemical industry: www.kemianteollisuus.fi
45 Pursula, T. (2016) Biochemicals and biomaterials are attracting investments http://www.gaia.fi/news/columns/biochemicals_and_biomaterials_are_attracting_investments.2181.news
46 Tahvanainen, A-J. and Adriaens, P. (2016) On the potential of the Bioeconomy as an Economic Growth Sector
47 Interview with Antti-Jussi Tahvanainen
48 Trade association of the Finnish chemical industry: www.kemianteollisuus.fi

vourable factor to bio-based chemicals industry as wood prices are staying relatively constant. Bio-based chemicals market is not politically created as in the case of biofuels and demand is driven mainly by consumer preferences; hence market prospects are much more price sensitive. This makes it difficult for new industry entrants to assess the cost-competitiveness of innovative products and services and weight the risks for investment in equipment and machinery consequently discouraging start-up activities.[49]

**Lack of venture capital funding**

New bio-based technologies are in large part at too immature stage for direct commercialisation requiring longer time span and additional investments for piloting and demonstration.[50] This is coupled with the lack of capital and funding, since the investments in emerging bioeconomy have a long life cycle and are capital intensive, while at the same time the sector is not very familiar to potential investors or even customers.[51] Limited access to finance for new market entrants lead to the lack of dynamism in the whole business ecosystem.

## D.2.4 Tekes impact on bio-based chemicals industry competitiveness

From 2006-13, Tekes funding to bioeconomy products constituted 19% and biofuels 9% of the total funding allocated to bioeconomy projects (see Figure 43). The BioRefine programme (€242m) constituted the greatest funding injection for the ecosystem. The focus of the first call was biomass-based fuels for transport (autumn 2007) and a second call targeted other biomass based products like chemicals and materials (spring 2008).

Tekes role has always been the R&D project funder, predominantly to help SMEs carry out R&D. In the Finnish bio-based chemicals field there are smaller companies, but in most cases large enterprises drive the ecosystem. So those activities that Tekes supported for SMEs and start-ups were not that important from the market capture perspective in the bio-based chemicals area.[52]

The BioRefine programme was successful in offering a platform to build up new technological know-how; however, in many cases the business value of the technologies will only be seen in the future. The BioRefine evaluation[53] highlighted that the programme had highly relevant objectives and timing regarding the growth of the biofuel market and significantly contributed to the launch of new biofuel products to the market by putting focus on demonstration. However, it noted that in addition to substantial RDI investments, this development has been strongly facilitated also by regulatory and market changes and support from other EU and national policy instruments.

In biomaterial and biochemical sector, market drivers have not been that clearly defined. BioRefine enabled the development of several new biorefinery concepts many of which, however, still lack funding or are seen as economically unviable. The programme enabled, for instance, the development, piloting and demonstration of technologies on alcohols and chemicals, focusing on ethanol production. Within the associated FuBio programme of Fibic SHOK advances in chemical technologies for extracting feedstock for bioplastics have been made. There have been few successful consortiums bringing together different actors in the value chain (such as integrated fast pyrolysis), while others did not succeed to produce synergies. Advancements in nanocellulosic technologies created cutting-edge knowledge and capacities within companies, but the lack of a market meant the Finnish economy did not yet reap the benefits. Overall, in bio-based chemicals field there are indications of relevant and unique knowledge created as the result of Tekes programmes, yet the innovations are much further from the market than in the area of biofuels.

These results have raised the difficult issue of balancing an ambitious future-orientation of R&D with the concrete readiness of the companies to invest in R&D. In new areas, such as bio-based chemicals, there is lack of accumulated knowledge and partners that provide a basis for further development. Finland is lacking strong enough international actors within this field and this forces Finnish companies to be extremely active to access the markets.[54]

Perhaps the most important overarching value added of Tekes investment has been to push biorefineries, bio-based chemicals and biofuels on to the industrial innovation agenda of all Finnish. Tekes programmes served as tools to increase the awareness and encourage business interest in the supported areas[55].

## D.2.5 Views on the future role of Tekes

The Bio-based chemicals ecosystem is dominated by established industries that find it very costly to adapt to biomass based input processing technologies. The ecosystem is missing smaller companies that are able to transform biomass into intermediate inputs that the chemical industry

49 Interview with Christine Hagström-Näsi
50 Jensen, L.H. (2015) Presentation of Biocluster.dk at Global Bioeconomy Summit in Berlin 25-26 November 2015
51 Gaia Consulting (2014) Creating value from bioresources: Innovation in Nordic Bioeconomy
52 Interview with Christine Hagström-Näsi
53 Luoma, P. et.al (2015) Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources. Report of Gaia Consulting to Tekes
54 Luoma, P. et.al (2015) Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources. Report of Gaia Consulting to Tekes
55 Interview with Christine Hagström-Näsi

can easily integrate into existing processes. IT driven small firms could find their niches in developing a 'smart' layer to the existing industries, digitalisation of bioeconomy. Yet, such new entrants are lacking industry connectivity and the leverage to access markets. Established industries and these new business models need to be brought together.

One interviewee suggested that Tekes could facilitate the bio-based chemicals ecosystem by boosting the emergence of these connections through investment in large scale pilots that would be openly accessible to all ecosystem actors. Large-scale demonstration sites suitable for a range of applications would be very important for promoting the upscaling of bio-based chemistry processes and product development. Another option is to accelerate the development of partnerships that promote collaboration between enterprises and innovative high-growth companies. Support to brokering and matchmaking between start-ups and established industries could prove helpful. Such services would lower the transaction costs for companies in forging new value chains.

It was pointed out that, in the case of bio-based chemicals, companies should strive to be integrated in global value chains from the beginning. In order to promote the creation of globally competitive businesses, Tekes should facilitate partnerships with best collaborators rather than confining project to Finnish actors. In the area of bio-based chemicals, the key enabling technology is industrial biotechnology. While some Finnish companies do have good expertise in certain areas of industrial biotechnology, generally the competence levels are not globally leading. For building-up a highly competitive bio-based chemicals ecosystem in Finland, there is a need to foster a complimentary investment in increasing industrial biotechnology capacities locally.

### D.2.6 Synthesis and key takeaways

- There is a high political momentum to the concept of bio-based products as a cornerstone to the transition to bioeconomy, yet real-life value chain formation is only in its infancy and full-fledged ecosystem development will take time.
- The Chemical and forest-based industries will remain locked into their own ways of working, assets and capabilities for a foreseeable future, hence support is needed to companies that transform biomass into intermediate inputs that chemical industry can readily integrate.
- Currently the Finnish bio-based chemicals industry that produces bio-based chemicals intermediaries is dominated by large companies and a small number of SMEs. These companies are key drivers of the ecosystem as the market uncertainty and significant entry barriers are discouraging start-up activities. For these large and medium-sized companies Tekes support for R&D has been an important stepping stone in new business line creation. Due to the lack of sufficient actors at this early stage of ecosystem development, Tekes should further promote collaborations between Finnish companies and global actors with cutting edge knowledge.
- SMEs in newly emerging bioeconomy value chains lack industry connectivity and access to markets. Support via brokering services and large scale open-access pilots suitable for a range of applications would be beneficial for speeding up local value chain formations and development of niche businesses within bio-based chemicals ecosystem.

# Appendix E. Tekes impact on global competitiveness of the cleantech sector

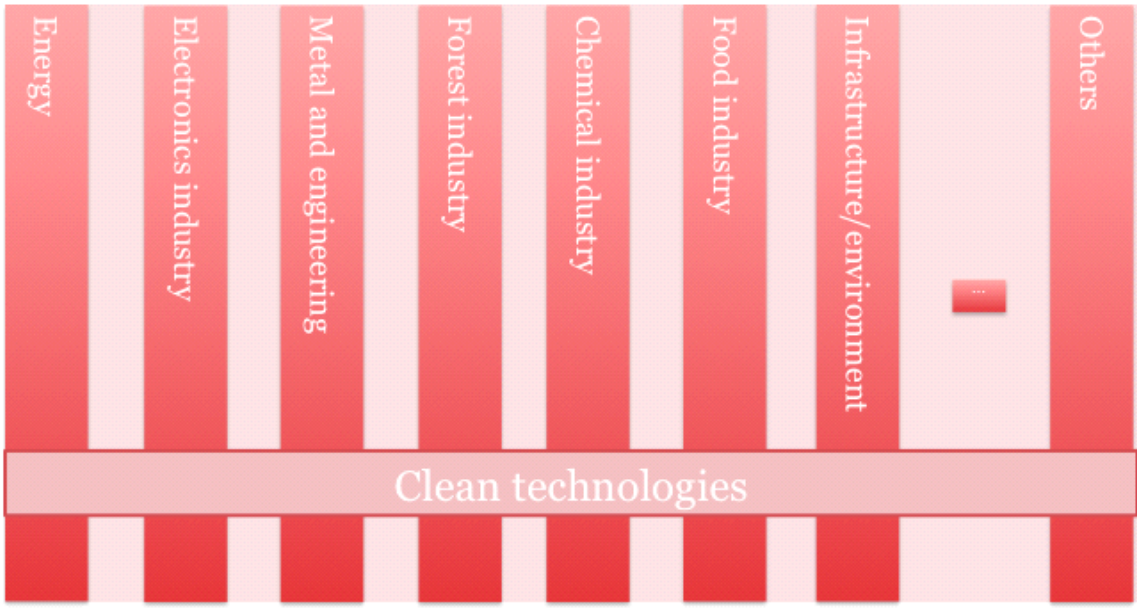
## E.1 Cleantech sector

### E.1.1 Scope of the priority area

Finland has the second highest energy consumption per capita in Europe with practically no indigenous fossil fuel resources. These factors call for for both industry and society to minimise energy consumption and cleantech has become a political priority in the last decade.[56]

State funding for innovative energy-efficient Finnish SMEs to develop pioneering technologies has been available since the early 2000s. In 2007, the Finnish national action plan to develop environmental business "Cleantech Finland, Improving the Environment Through Business" was adopted[57]. The Cleantech Finland[58] concept was launched with the aim to make Finland the leading country in the global environmental business. In 2008, the government adopted the "Long-term Climate and Energy Strategy for Finland"[59]. The strategy, updated in 2013 by National Energy and Climate Strategy[60], sets climate policy measures to 2020 and recommendations to 2050. Furthermore, the Ministry of Employment and Economy aims to increase the turnover of the cleantech industry to €50b by 2020 and to create 40,000 new jobs through the 2013 Cleantech Strategic Programme[61]. In 2014, the Council of State approved the National Cleantech Strategy,[62] which also has an objective to position Finland as one of the world's leading cleantech countries.

**Figure 48. The cleantech concept in Finland.** Source: Sitra (2007) Cleantech Finland - improving the environment through business




56 Cleantech Finland web-page: http://www.cleantechfinland.com/content/about-cleantech-finland
57 http://www.sitra.fi/julkaisut/muut/Ympäristöraporttiengl.pdf
58 http://www.cleantechfinland.com
59 Summary in English is available at: https://www.tem.fi/files/20587/Climate_Change_and_Energy_Strategy_2008_summary.pdf
60 https://www.tem.fi/files/36292/Energia-_ja_ilmastostrategia_nettijulkaisu_ENGLANNINKIELINEN.pdf
61 https://www.tem.fi/en/current_issues/pending_projects/project_and_programme_archive/strategic_programme_for_the_cleantech_business/programme
62 https://www.tem.fi/files/40668/Government_Strategy_to_Promote_Cleantech_Business_in_Finland.pdf

Traditionally metal as well as pulp and paper industry have been two main investors in environmental technologies in Finland focussing predominantly on air and water pollution minimisation. In recent years the scope and definition of the cleantech sector used in Finland has widened to cover a variety of sectors, technologies and services. Finland's national action plan (2007) defined Clean technologies (cleantech) to include "*all products, services, processes and systems whose use results in less harmful impacts on the environment than their alternatives*"[63]. Cleantech should offer clients added value while reducing harmful impacts on the environment directly or elsewhere along value chains.

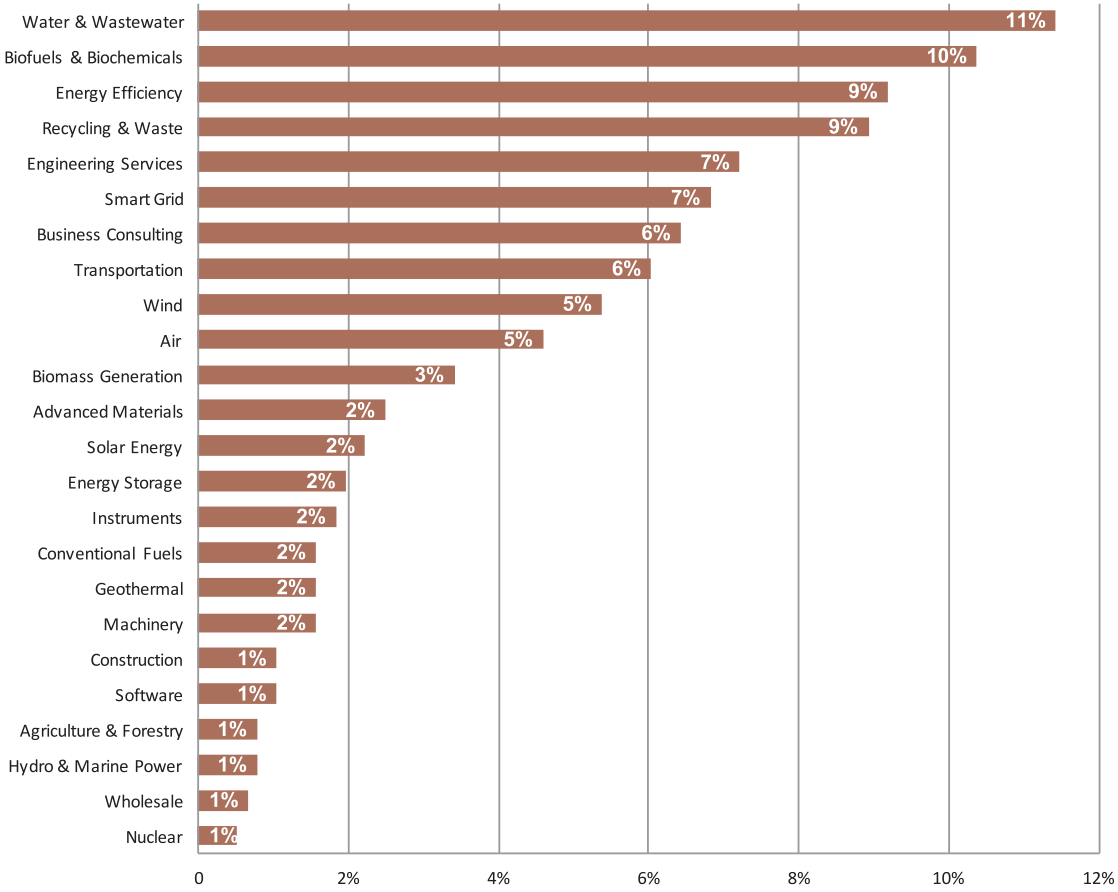
ETLA's 2015 report on cleantech similarly defines cleantech as a concept rather than a sector. "First, cleantech is not an industry in its own right. It comprises technologies, products, services, processes, practices and investment classes that promote sustainable development and greening of incumbent and emerging industries as well as societies. Second, through efficiency gains or entirely novel alternatives it reduces the unsustainable exploitation of natural and societal resources in industry, business and consumption. Third, it provides industries, businesses and consumers with superior value propositions when compared to conventional solutions."[64]

## E.1.2 Importance to the Finnish economy

As cleantech is not an industrial sector as such, the exact number of cleantech companies is hard to pinpoint. However, some estimates give on overview of the magnitude ranging from an estimate of 3000 cleantech firms by the Confederation of Finnish Industries, 2000 by Invest in Finland or an estimate of 762 cleantech intensive companies by ETLA[65] (see Figure 49).

Cleantech is one of the faster growing Finnish business ecosystems: while the rest of the economy has stagnated in recent years, cleantech turnover grew by 15% in 2012 (total turnover €24.6b). Cleantech firms that have participated in

**Figure 49. Distribution of Finnish companies by cleantech sector.** Source: ETLA (2015)

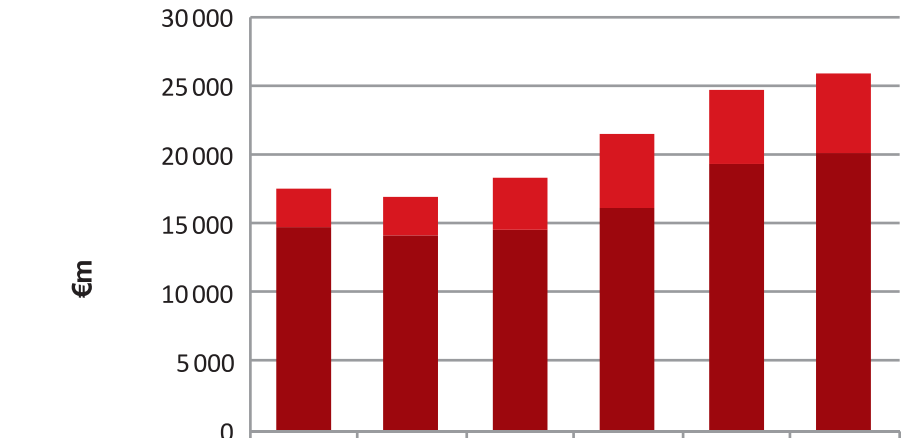



63 Sitra (2007) Cleantech Finland - improving the environment through business. Available at: http://www.sitra.fi/node/75374

64 Annu Kotiranta, A., Tahvanainen, A. J., Adriaens, P., Ritola, M. (2015) From Cleantech to Cleanweb - The Finnish Cleantech Space in Transition. Available at https://www.etla.fi/en/publications/from-cleantech-to-cleanweb-the-finnish-cleantech-space-in-transition/

65 Pietilä, K. (2015) Cleantech-selvitys. Power Point Presentation

**Figure 50. Annual turnover of cleantech companies.** Source: Cleantech Finland (2014)

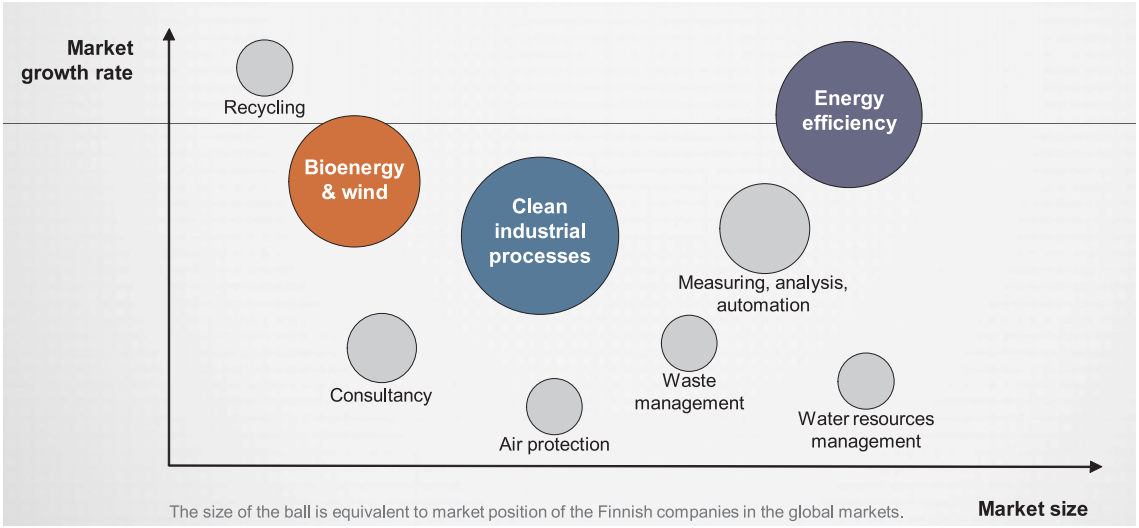



| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| Other cleantech companies | 2 949 | 2 876 | 3 646 | 5 291 | 5 451 | 5 890 |
| Top 10 companies | 14 631 | 14 082 | 14 553 | 16 145 | 19 186 | 19 994 |

Cleantech Finland annual surveys[66] report a growth in turnover since 2008 (see Figure 50). Finland's share of the global cleantech market is over 1% and its share of the global GDP is approximately 0.4%, hence relative to GDP Finland is a leading cleantech country.

The sector is also an important employer. Cleantech businesses in Finland currently employ around 50,000 people with the expectation that there will be 40,000 new jobs created by 2020.[67] The political ambition of becoming a superpower in clean technologies is supported by public funding. Currently more than 40% of Finnish public R&D funding goes to the energy and environment sector, and more than a third of all public R&D investment is to the cleantech field.

**Figure 51. Areas of Finnish cleantech companies relative to the global market.** Source: Tekes (2013) Finnish Cleantech Cluster and Tekes Activities




66 In 2011 survey n=104, in 2012 survey n=103, in 2013 survey n=115, in 2014 survey n=105. The turnover figuures do not include forestry or energy production.

67 Cleantech Finland web-page: http://www.cleantechfinland.com/content/about-cleantech-finland

According to a 2014 survey, Finnish cleantech is very export-oriented with 53% of turnover exported. In 2013, the most significant export markets were Sweden, Germany, Russia, UK and China. Moreover, 88% of the survey respondents planned to expand into new international markets. From Finnish cleantech companies' perspective the most interesting growth prospects in the coming years are to be found in China, Russia, Germany, USA and Sweden. Figure 51 represents the global market position of Finnish cleantech companies indicating that they are already global leaders in the areas of energy efficiency, clean industrial processes and bioenergy.[68]

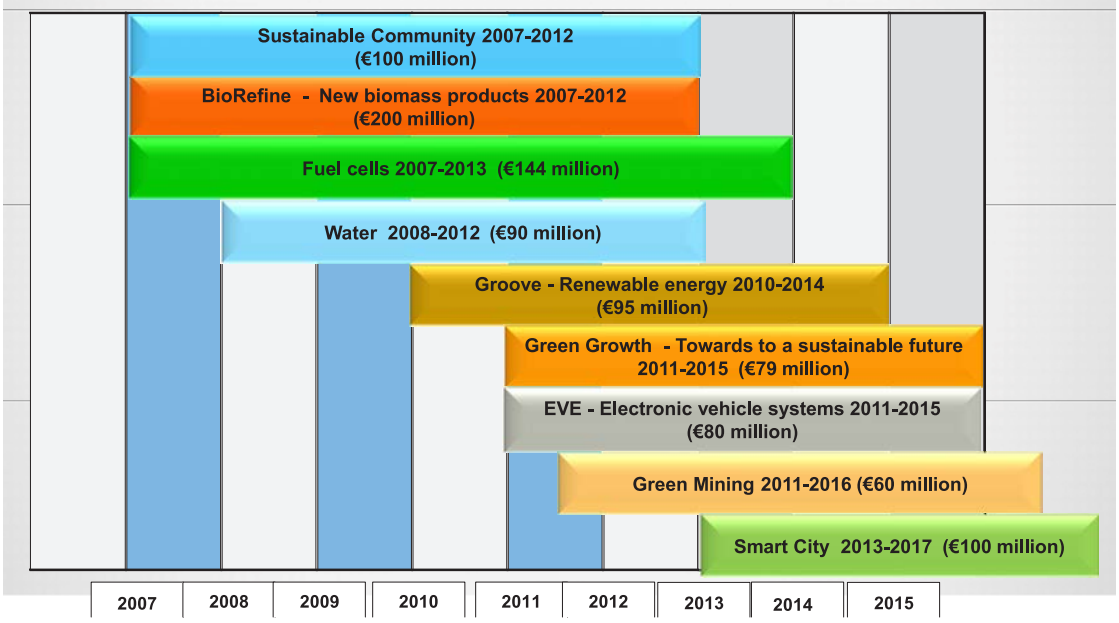
## E.1.3 Evolution of Tekes and Team Finland support since 2008

Figure 52 presents an overview of the main Tekes funded energy and environmental programmes in the period of 2007-2017. During the Tekes strategy period 2005-2007, three programmes were started. First, Sustainable community programme (budget €100m, of which Tekes contributed €47m) focussed on land use planning, energy efficient building and the integration of renewable energy production in built-in environments. Secondly, Fuel Cell programme (budget €144m) aimed to speed up the development and application of innovative fuel cell technologies for growing global markets. The programme's focus areas included stationary fuel cell applications, fuel cell power modules for utility vehicles and portable low-power solutions. The third programme, BioRefine, is discussed in more detail under the bioeconomy chapter of this report.

In the 2008-11 strategy period five major programmes were started:

- The **Water programme** (budget €90m, of which €12m were provided by Tekes) aimed to reform business operations, products and services in the Finnish water sector and promoted Finnish expertise in the sector on the international market. The focus included not only utilising modern technology but also innovation in the water sector's business models, customer-focused services concepts and comprehensive solutions.
- The **Groove – Growth from Renewables** programme (budget €100m, of which Tekes contributed €47m) aimed to enhance the business capabilities of Finnish small and medium-sized enterprises working with renewable energy by improving their international competitiveness and developing networks with financier networks.
- The **Green Growth programme** (budget €79m) aimed to identify potential new growth areas for the sustainable economy business, which are essentially based on lower energy consumption and sustainable use of natural resources. The programme aimed at a leap forward in energy and material efficiency of production and service chains over the entire life span of products.

**Figure 52. Main Tekes energy and environmental programmes (2007-2017).** Source: Tekes (2013) Finnish Cleantech Cluster and Tekes Activities




[68] Lahti-Nuuttila, T. (2013) Finnish Cleantech Cluster and Tekes Activities. Tekes report. Available at: https://www.tekes.fi/globalassets/global/nyt/uutiset/110613_teijal-n.pdf

- The **EVE – Electric Vehicle Systems programme** (budget €80m) aimed at companies and research institutes working with electric vehicles and machinery, as well as component and systems used in them. The aim of the EVE programme was to create a community of electric vehicle and support system developers with close contacts to international research and business networks. The programme also focused on developing test environments and industry standards.
- The main objective of **Green Mining Programme** (budget €60m) was to make Finland a global leader in sustainable mineral industry by 2020.

During the 2011-14 programming period, one additional cleantech programme was launched. The aim of the Witty City programme was to provide people with better living and working environments and companies with opportunities to bring new products and services on the market. Cities were expected to play a key role in the programme as they are central players in areas such as planning, procurement and the choice of energy sources.

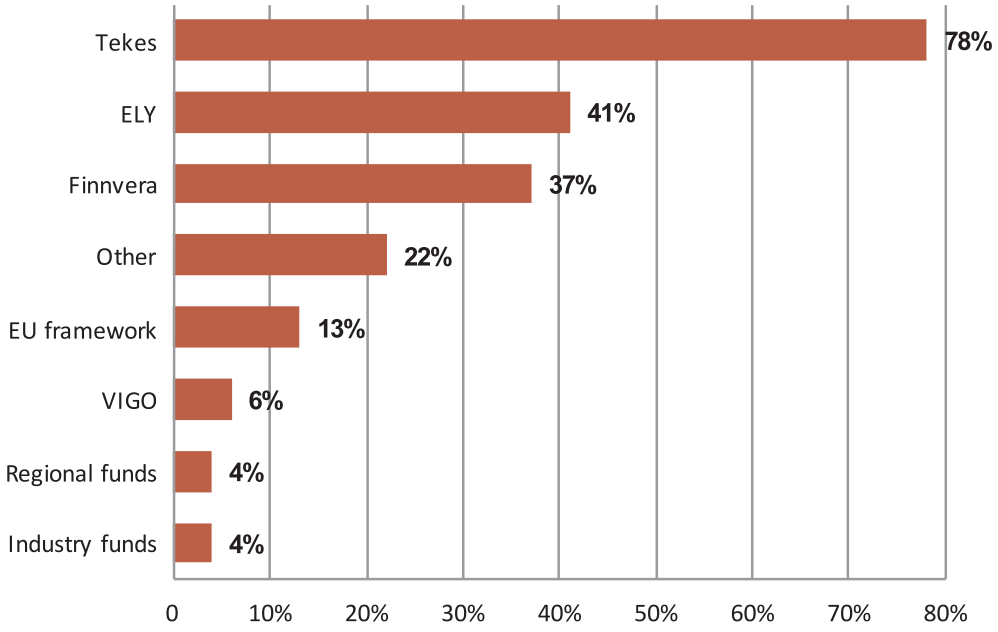
The export-oriented activities of Finnish Cleantech programmes were supported by Cleantech Finland. The organisation helps its member companies in their marketing activities supporting branding and strengthening cleantech angle in companies' image, especially in target foreign markets.

## E.1.4 Mapping Tekes support

According to the survey of Cleantech Finland carried out in 2014, the largest share (78%) of public funding in Finland used by cleantech companies came from Tekes (see Figure 53). This underlines the importance of Tekes funding in supporting the growth of the Finnish cleantech sector. In 2014, nearly half of Tekes' €570m budget went to cleantech, with energy efficiency one of the main focus areas.[69]

According to Tekes's, instead of a wide concept of cleantech, more specific sectors should be detailed to develop a better view on the area. For this purpose, Tekes identified the following key categories within cleantech: 1) renewable energy, 2) energy and resource efficiency, 3) future electricity and energy systems, 4) environmental protection, and 5) fossil fuels and nuclear power. These categories were further divided into 22 sub-categories. Table 1 presents the number of funded companies in each of the main categories (one company can be listed in several categories). Between January 2010 and June 2015, the total number of companies that participated in cleantech projects was 1432.[70]

**Figure 53. Public growth funding instruments used by Finnish cleantech companies.**
Source: Cleantech Finland (2014)

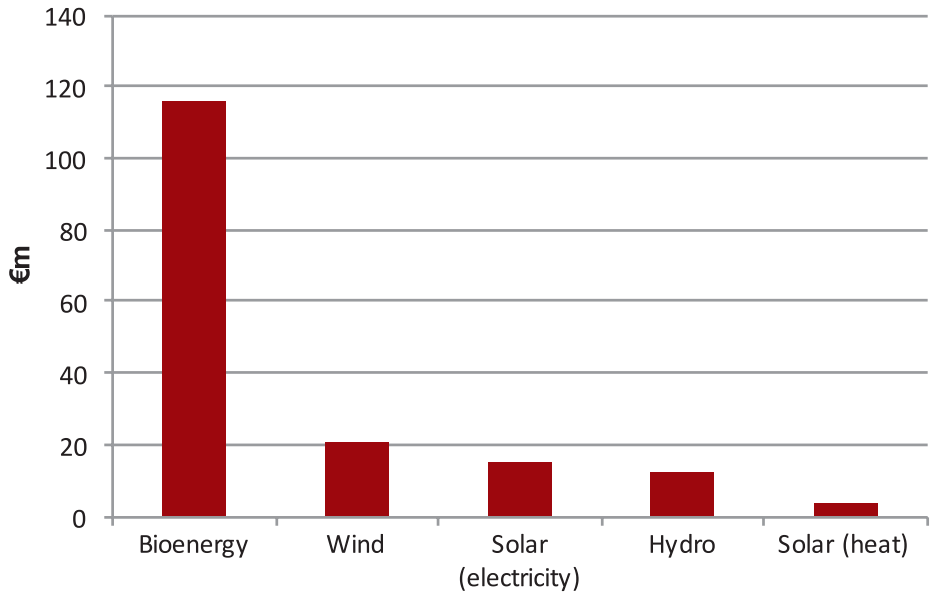



69 http://www.greentechmedia.com/articles/read/is-clean-tech-finlands-next-nokia
70 Pietilä, K. (2015) Cleantech-selvitys. Power Point Presentation

**Table 1. Number of companies funded by Tekes according to defined categories (2010-2015).**

| Renewable energy (155) | Energy and resource efficiency (711) | Future electricity and energy systems (77) | Environmental protection and others (601) |
|---|---|---|---|
| Solar heat (10) | Waste energy use (34) | Transmission of electricity and electricity supply (36) | Emission cleaning technology (7) |
| Solar electricity (28) | District heating and cooling (10) | Energy storage (10) | Coal combustion and conversion (2) |
| Bio energy (82) | Traffic energy use (220) | Energy system research (16) | Other energy (47)[71] |
| Wind power (30) | Energy use in buildings and households (230) | Generation of electricity (17) | Other energy use (e.g. mobile networks, LED) (106) |
| Water power (6) | Industrial energy use (250) | Fusion (3) | Environment protection (449)[72] |

**Figure 54. Total Tekes funding for renewable energy category (January 2010 - June 2015).**
Source: Tekes (2015)




The total number of Tekes funded companies in the **renewable energy** category was 155, of which 100 were SMEs. Overall funding (between January 2010 and June 2015) for these companies amounted to €168m, of which almost 70% was allocated to bioenergy. (Figure 54)

In **energy and resource efficiency** category, the total number of funded companies was 711, of which 500 were SMEs. Overall funding (between January 2010 and June 2015) for these companies reached €620m, of which around 48% was allocated to industrial energy use. (Figure 55)

In the category of **future electricity and energy systems** the total number of companies was 77, of which 62 were SMEs. Tekes funding (between January 2010 and June 2015) for these companies was €104m, of which around 38% was allocated to transmission of electricity and electricity supply. (Figure 56)

[71] E.g. process planning and management, market studies, internationalisation

[72] Consists of projects not related to energy, mostly waste management, recycling, monitoring, water treatment and water protection, environment friendly products and processes

**Figure 55. Total Tekes funding for energy and resource efficiency category (January 2010- June 2015).** Source: Tekes (2015)

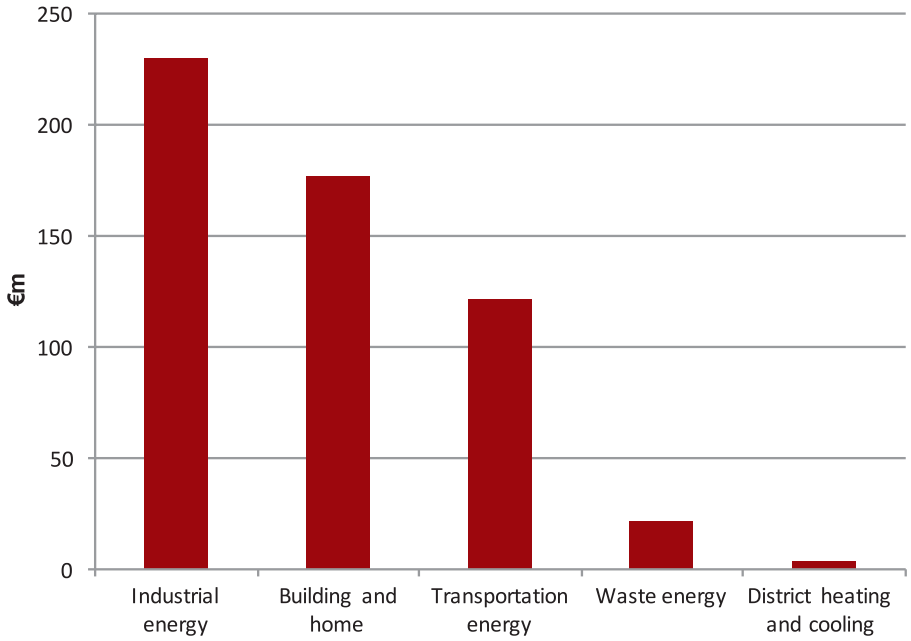



**Figure 56. Total Tekes funding in the future electricity and energy systems category (January 2010- June 2015).** Source: Tekes (2015)

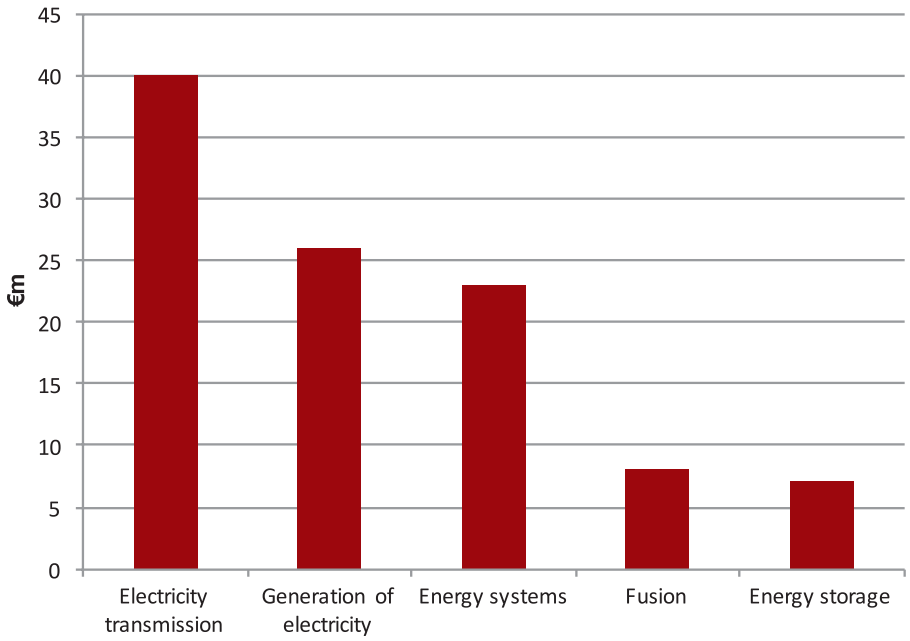
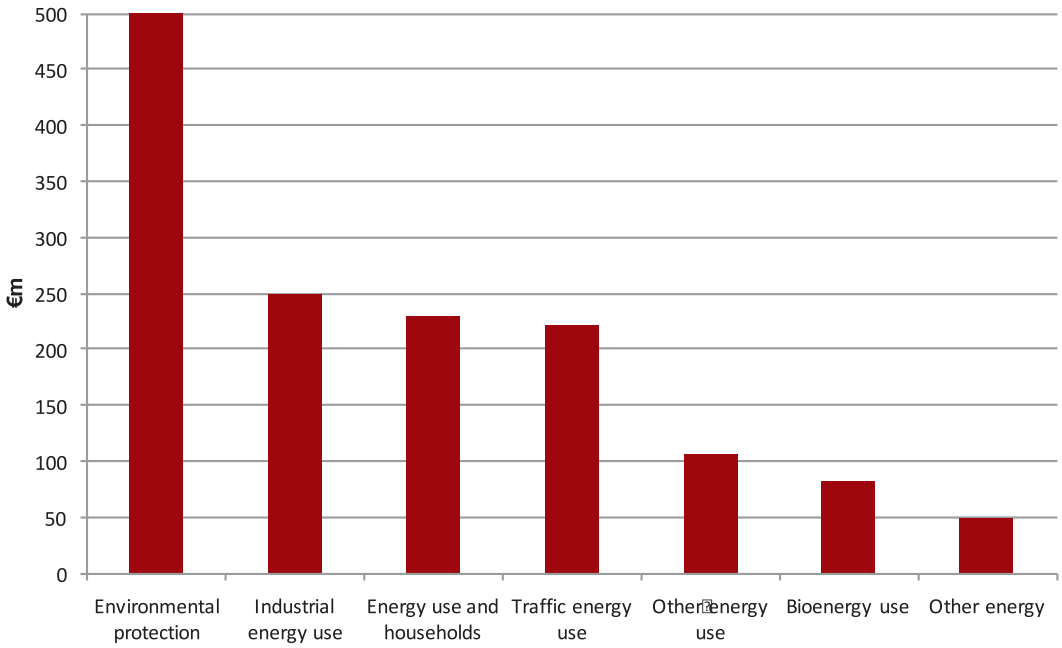


**Figure 57. Share of Tekes client companies in each category.** Source: Tekes (2015)




A total of 601 companies were funded under the category **environment protection and others**, of which 470 were SMEs. Total Tekes funding (between January 2010 and June 2015) for these companies was €447m, of which around 62% was allocated to projects related to environmental protection (e.g. waste management, recycling, monitoring, water treatment and water protection, environment friendly products and processes). Figure 57 shows that the categories with most Tekes clients companies are environment protection (28%), industrial energy use (16%) and energy use in buildings and households (14%).

## E.1.5 Evidence of impact on global competitiveness in past evaluations

Tekes programmes have supported various types of cleantech firms through funding R&D projects, promoting networking among business and industry, transferring research results to SMEs, fostering business internationalisation and business skill development and other activities. No comprehensive evaluation has been undertaken to scope the impact of Tekes support within the overall cleantech priority area. In fact, very few of cleantech priority programmes have undergone an in-depth external evaluation. The existing evidence suggests that Tekes' impact has been rather diverse across the various cleantech sub-subsectors.

For instance, the Fuel cell programme (2007-2013) facilitated the development of successful fuel cell and hydrogen technologies and services, where the international industrial base is still modest but advancing. The business potential in this area was judged as huge due to the variety of possible applications and space for technical advances in areas were the Finnish industry is traditionally strong, such as telecommunication and nanotechnology. More than 70 projects were successfully completed and more than 60 companies were involved in the programme. The programme promoted synergies between and within research projects creating a strong basis for the emergence of a national fuel cell competence network. The programme review concluded that it helped to create viable new businesses and business models, by bringing together key players along the fuel cell value chain.[73]

However, Tekes support to the water sector did not lead to equally successful outcomes. The evaluation of the Water programme (2008-2011)[74] noted that reform and internationalisation objectives were overly ambitious and even unrealistic, considering the competiveness of the Finnish water sector, specifically the risk aversion of the sector to adopt innovations and companies' small size hindering competition in international markets. The participating companies had very limited capacity to take full advantage of the programme services, especially those related to global market development. The key barriers to programme success were the highly fragmented sector and difficulties to identify objective strengths of the Finnish water sector internationally. Overall, the programme partic-

[73] Tekes (2013) Fuel cells and hydrogen in Finland: Finnish Fuel Cell Programme 2007-2013
[74] Luoma, P. et.al (2015) Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources. Report of Gaia Consulting to Tekes

ipants appreciated the Tekes support in facilitating discussion and bringing actors together in the water sector, but the achievements and results on growth remained weak.[75]

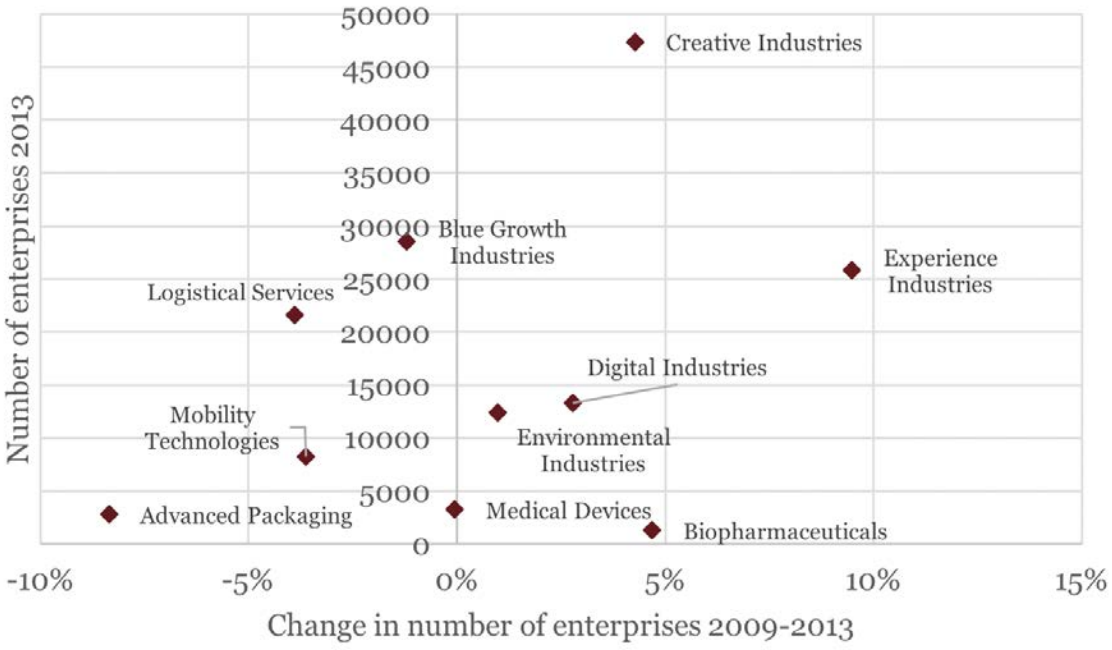
Cleen SHOK evaluation[76] highlighted that the positive effects of this Tekes supported public-private partnership relate to the qualitatively more advanced and committed collaboration between industry and academia. However, at the point of the evaluation there was still no evidence on the results and effectiveness of this innovation support instrument. The industry-driven nature of the Cleen Oy activity was welcomed by business, though it the research community was considerably more critically. Hence the value added of Cleen Oy activity has been related to a longer-term commitment of industry, but at the expense of commitment of the academic community for whom the benefits remained unclear. Overall, it was concluded that Cleen Oy initiative did not lead to a qualitative leap to global leadership and excellence in cleantech research and innovation.[77]

### E.1.6 Statistical analysis

In the period 2009-2013, there has not been a significant change in the number of enterprises in environmental industries (see Figure 58). Yet this sector of business activities has experienced the biggest change in relative specialisation over the last couple of years (see Figure 59).

Closer analysis of Tekes supported cleantech companies showed that in the 2011-14 period these companies all together have experienced sales growth of 47% and their exports increased by 54%. Moreover, important export and sales growth trends are evident in all the defined sub-categories of cleantech companies (see Figure 60). This growth is attained with an average increase in employment of 29% (from 20%-35% for separate sub-categories).

**Figure 58. Business demography of emerging industries.** Source: Eurostat, calculation authors




[75] Luoma, P. et.al (2015) Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources. Report of Gaia Consulting to Tekes

[76] Ministry of Employment and the Economy (2013) Licence to SHOK? External Evaluation of the Strategic Centres for Science, Technology and Innovation

[77] ibid.

**Figure 59. Specialisation in emerging industries (size of circle: employment in 2013).** Source: Eurostat, calculations authors

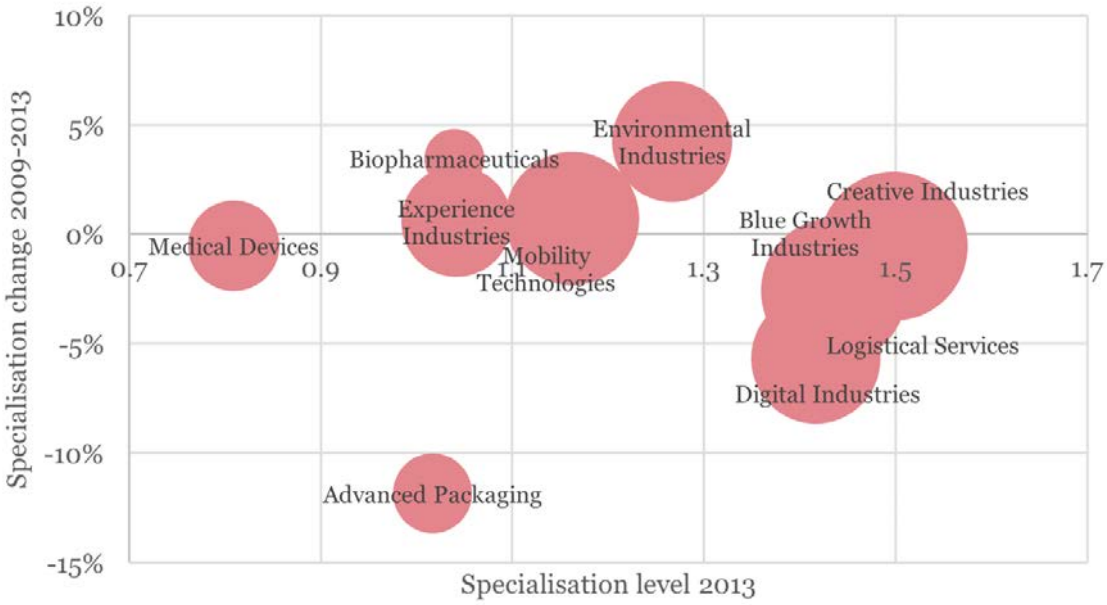
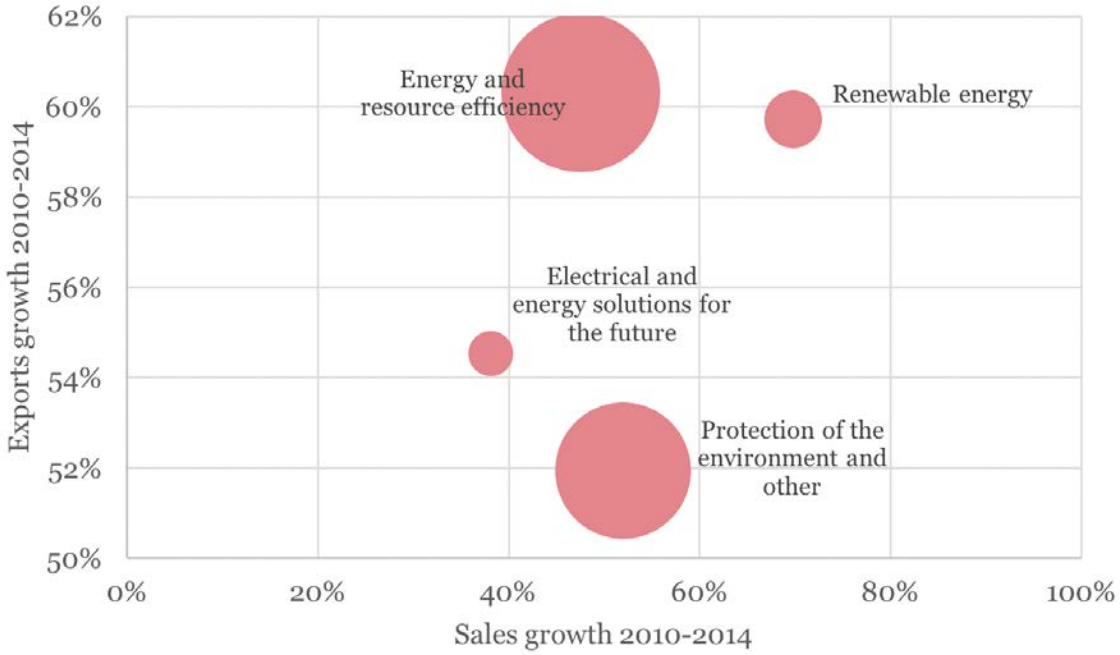



**Figure 60. Performance of Tekes clients in cleantech categories (size of circles: employment in 2014).** Source: Tekes data, calculation authors



## E.2 Smart Grid ecosystem case analysis

Smart Grid refers to a sector of activities related to modernisation of the electricity grid applying state-of-the-art technology. Remote sensors and new type of monitoring and management systems help shape the traditional grid into an intelligent system that keeps track of electricity flows, responds to peaks in energy demand and enables flexible incorporation of different renewable energy sources. The 'grid' refers to the energy production plants, transmission lines, as well as telecommunication networks, while 'smart' refers to ICT-driven systems and application software that enable demand shaping and cost management functionalities.

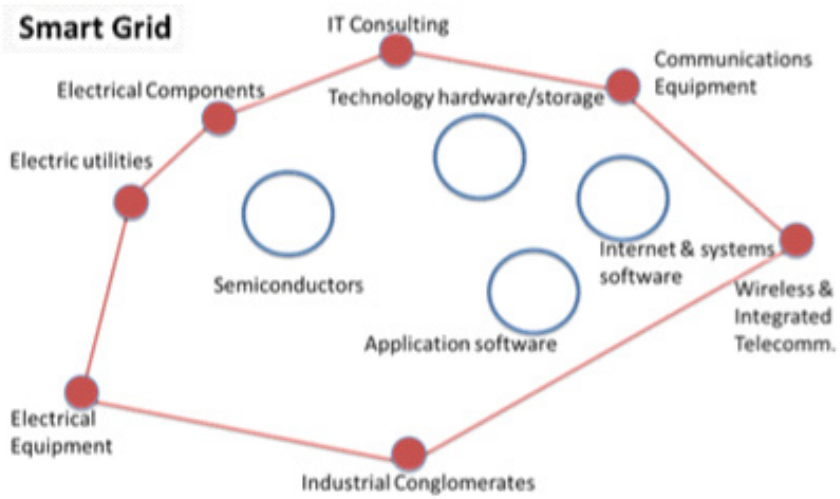
The rationale for selecting the Smart Grid ecosystem for an in-depth analysis is based on the observation that, despite the fact this is a relatively new field of development, there is already evidence of robust value chain structures forming within Finnish industrial landscape. The ecosystem integrates incumbent energy and telecommunication industry with a 'smart' value added layer of new business models that provide wide range of consumer offerings and 'intelligent home' solutions. This opens up good opportunities for innovative start-ups and more established businesses. Generally, the Smart Grid ecosystem is expected to become an important growth sector of tomorrow. Currently Finland is a global leader in developing and implementing Smart Grid applications; hence better understanding of this Finnish business ecosystem and key drivers and barriers for its integration into global value chains is important for fostering Finnish global competitiveness.

### E.2.1 Role of smart grids industry in the Finnish economy

According to ETLA, 7% of Finnish cleantech companies are in the Smart Grid business area (see Figure 49). In total, this represents slightly more than 50 companies; thus Smart Grid is still a relatively small, but continuously growing ecosystem. Concrete contribution of this new business area to the overall Finnish economy and employment is still to be appraised as Smart Grid is a very cross-sectoral field and there are very few companies that operate exclusively in this business niche.

The key players of the Smart Grid ecosystem (see Figure 61) are large energy companies, Fingrid (the company in charge of electricity transmission grid in Finland), telecommunication providers and other industrial conglomerates that are producing, for instance, electric and communication equipment and utilities. These are so called 'anchor' players, as they are still relatively contained in their incumbent value chains and less well connected to the emerging ecosystem. Companies that produce new hardware, such as smart meters, as well as various Smart Grid systems and application software are 'catalyst' players as they integrate the anchor industries and incentivise the formation of new value chains between previously disconnected industries.

**Figure 61. Schematic representation of Smart Grid ecosystem.** Source: Tahvanainen A-J., Adriaens, P. (2016) On the Potential of the Bioeconomy as an Economic Growth Sector. ETLA Brief No 43



## E.2.2 Finnish smart grids industry in global value chains

There are rapid global developments in the Smart Grid business as new players come and go in the market. For instance, a number Internet and telecommunication giants such as Microsoft, Google, NSN and Cisco have either experimented in the area and withdrawn or decided to focus their participation on more narrow aspects of the Smart Grid value chain. From a global perspective, Smart Grid development represents a dynamic ecosystem in the making, where start-ups are actively piloting innovations and large incumbent industries are waiting for advantageous opportunities for mergers and acquisitions.[78]

Finnish companies are well positioned to be in the vanguard of new value chain formation. For instance, the Finnish firm 'There Corporation' provides novel solutions for optimising heating consumption in households through a platform creating a basis for further Smart Grid services; hence the company claims to "brings intelligence to the Smart Grid".[79] There Corporation already has collaborations with energy companies in Norway and Sweden and the ambition is to operate in the whole Nordic region. The German and Central European market seems to fit the solutions offered by Finnish companies as there are many solar panels installed in these regions, which bring additional incentives for customers to adopt intelligent energy systems able to manage the integration of local renewable energy sources. Capturing the market by providing platform solutions to Smart Grid applications would mean a very strong position in the emerging value chains.

## E.2.3 Key drivers, enablers and barriers

### Demand-driving local situation

Due to the cold winters Finland has one of the highest energy use per capita in the world. Additionally, the very low population density exacerbates the challenge of efficient energy transfer. These natural conditions have led Finland to consider energy efficiency issues more seriously than in other countries. Several decades ago the country committed itself to become a leader in clean energy production and intelligent energy demand management. These have been essential prerequisites of today's Smart Grid initiatives. Due to rollout of smart meters and control relays to all Finnish households in the last couple of years, the Finnish grid is currently the most advanced in Europe.[80]

### Energy market conditions

The low level of energy prices also has been a contributing factor to a faster adoption of Smart Grid solutions. There has always been a fierce price competition between energy companies to keep customers, as it is relatively easy to switch providers according to the most advantageous offer on the market. For this reason, energy companies are striving to ensure more permanent customer relationships by providing appealing service packages. New Smart Grid solutions help end-users to optimise their consumption and decrease energy bills, and energy companies benefit by gaining a more loyal customer base. The general trend of increasing renewable energy sources in the overall energy mix also lead to a more volatile energy production. This means that energy producers are interested to incentivise consumer to use electricity when it is necessary and avoid creating peak times of usage. Smart Grid solutions help to achieve this outcome.

### Finland hosts world leading energy clusters

A number leading energy companies originate or have chosen Finland as a site for the early stage R&D work. For instance, such pivotal Smart Grid components as distribution management systems, electricity meters and power electronic base converters are developed and manufactured in Finland. Vaasa region is one of Finland's growth centres and hosts the leading energy cluster in the Nordic countries, which includes more than 140 member companies with approximately 10,000 employees.[81] Vaasa region is responsible for about 30% of Finland's total energy technology exports. Vaasa city is almost entirely covered by smart grids serving as an important pilot facility for new technologies.

### Finns are savvy in developing and adopting new technologies

Finland is considered as tech-savvy with a quick adoption rate of new innovations amongst the population. This is one reason why Finland is an advantageous test market for, e.g. energy-usage apps and mobile energy control solutions. There is also a highly skilled ICT talent pool available for several relevant technology subdomains, including telecommunications and cyber security. In addition, the next generation 5G technology is under intensive development in Finland. All these aspects provide a potential for enabling further Smart Grid applications.

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78 Cleen Oy (2012) Smart grid ICT Ecosystem Model Considerations. Report prepared by Emtele Ltd. in the framework of the project Smart Grids and Energy Markets

79 http://www.therecorporation.com/

80 Interview with Jan Segerstam, chairman of the Finnish programme Smart Grids and Energy Markets, available at: http://www.siemens.com/innovation/en/home/pictures-of-the-future/energy-and-efficiency/smart-grids-and-energy-storage-interview-jan-segerstam.html

81 www.energyvaasa.vaasanseutu.fi

**Persistent technological barriers and lack of standardisation**

The key barriers to Smart Grid are predominantly technological, however, the lack of standards hampers interoperability. This is a prevailing characteristic of emerging system-level innovations. Also comprehensive solutions to cyber security and data privacy are still needed. While a variety of technical solutions exist at component level, large-scale pilots are necessary to validate system solutions, such as the management of generation intermittency. Without clear standardisation and interoperability agreements, the implementation of Smart Grid solutions has considerable deployment costs.

**Market failures and distortions**

The costs and ultimate benefits of the R&D activities in the field of Smart Grid are asymmetric. The investments in Smart Grid development are large and they fall predominantly on the network operators. Benefits are reaped by other stakeholders, including new service providers, end-customers and society at large. The current regulatory regime does not always reflect the actual cost structure, such as actions by individual and corporate grid users.[82] In the long-term this may hamper the most efficient market solutions. Most of the benefits are arising in the long-term and can only be captured when the whole system is in place. This sets the challenge to ensure that at every step of Smart Grid development there are clear intermediary gains and prospects for final benefits to maintain the critical mass of private sector investments.

**Unclear or sluggish international demand**

While the case of Smart Grid investment is very clear from the perspective of Finnish customers, the general EU level demand is still unclear. The lack of customer interest stems not only from the largely low level of awareness about the size of their electricity bills and possible energy efficiency solutions, but also from the very limited understanding of what Smart Grid really is and how its implementation could create value.[83] Hence any ambitions to scale up Smart Grid solutions that work in Finland, first will need to face entry barriers related to societal and cultural factors and energy consumption traditions in target markets.

## E.2.4 Tekes investments in smart grids industry

While statistics on Tekes exact investment in Smart Grid ecosystem is not estimated, it is known that in the period from January 2010 till June 2015, the total number of Tekes funded companies in the defined category of future electricity and energy systems was 77, of which 62 were SMEs. The funding for these companies amounted to €104m, of which around 38% was allocated to the area of transmission of electricity and electricity supply.

Tekes funded projects have contributed to developing Smart Grid solutions, including:

- Underlying mechanisms to shift consumption away from peak times in a controlled way allowing the system to combine all the parts of electricity network, from metering points to electricity suppliers, into a complete value chain;
- Automated response systems that focus on electricity outages due to extreme weather conditions and enable smart grid to speed up electric line's recovery from unpredictable disruptions;
- A concept for minimising energy consumption peaks in order to save energy and to avoid using expensive fuels that are needed in energy production when consumption is higher than usual.[84]

Another important Tekes support measure for the Smart Grid ecosystem has been the Strategic Centre for Science, Technology and Innovation (SHOK) Cleen Oy. The aim of Cleen SHOK was the establishment of an open innovation ecosystem between industry and academia within the area of energy and environment. The Cleen Oy research programme Smart Grids and Energy Markets (SGEM) focused on issues such as smart grid architectures and distribution infrastructure, intelligent management and operation, active resources and market integration and new business models. SGEM programme was implemented in the period 2010-2014 and its total funding amounted to €35m.[85]

Tekes investment was also channelled through the Innovative Cities programme (2014-2020) funding the testing and piloting of novel Smart Grid technology in the village of Sundom in Vaasa. The goal of this globally unique Smart Grid Living Lab is to make electricity delivery more reliable and to establish the preconditions for solar and wind power use in households. The project concerns the entire Sundom village centre with a population of 2500 inhabitant, including a new residential area.

## E.2.5 Tekes impact on smart grids industry competitiveness

As an interviewee stated, Tekes support has been very valuable in bridging the 'Valley of Death' in access to finance. Investors tend to pay close attention to two extremes: either financing a start-up with nothing more than a proto-

82 Giglioli, E., Panzacchi, C. and Senni, L. (2010) How Europe is approaching the smart grid. McKinsey report
83 Giglioli, E., Panzacchi, C. and Senni, L. (2010) How Europe is approaching the smart grid. McKinsey report
84 Tekes (2015) Smart Solutions: Concepts, products and services that make your life easier
85 Jaspers, P. (2014) The Finnish Smart Grid: An overview of renewable energies and smart grid technologies in Finland. PowerPoint Presentation

type in pocket or scouting for high-growth start-ups that can clearly bring millions in revenue. When a company is past the prototype phase, but does not have yet a massive amount of revenues, it is difficult to attract venture capital. Tekes projects have been an important source of funding in company development. In the Smart Grid area this support has helped to develop technological solutions that later became the key to a company's value proposition.

Secondly, being a part of a large projects helped young companies considerably with network formation. It was difficult for beneficiaries to assess how valuable exactly these connections have been, but it is evident that Tekes projects were very important in opening up new connections among previously unrelated industries. As one company put it, it would not be possible to develop at such a dynamic pace without Tekes funding. Hence, Tekes R&D projects significantly helped to increase the competitive position of Finnish companies within the emerging Smart Grid market.

The SGEM programme run by Cleen Oy used the Finnish R&D infrastructure and added value to industrial partnerships and export efforts. Due to the success of the SGEM, numerous industrial and research partners are now heavily involved in Smart Grid R&D programmes leveraging a significant investment.[86] The SHOK evaluation[87] noted that the positive effects of the Cleen activity included the qualitatively more advanced and committed collaboration between the industries and academia. There have are indications that a broader collaboration has enabled the integration of new partners. Thus, if not the sole driver, SHOK has been an important support mechanism for bringing value chain participants closer to each other. Relatively positive feedback from Cleen stakeholders was also expressed in relation to contribution to opening or creating new markets and developing Living Labs and testing facilities with SHOK resources.

### E.2.6 Views on the future role of Tekes

Tekes could play an important facilitator role helping Finnish Smart Grid companies reap the benefits from entering into foreign markets. Funding business-oriented experiments for applications of the developed technologies could prove vital as Smart Grid development requires a step-by-step approach to arrive at system-based solutions. Other countries are also experimenting in Smart Grid applications and constantly searching for latest available technologies. If Finnish companies can provide a package of application solutions, this could give them a competitive advantage on the global market.

The penetration rate of smart meters is an enabler of demand response. In this respect, global potential is still inhibited since only a small proportion of customers have the basic infrastructure. This presents a high growth market opportunity, which is expected to materialise steadily over the next decade. Finnish company position in this development should be facilitated and, where possible, actively supported.

Tekes could explore options for teaming up with innovation agencies in other countries, especially in the Nordics, to foster company contacts and mutually beneficial integration of value chains.

### E.2.7 Synthesis and key takeaways

- Smart Grid represents a dynamic emerging ecosystem that offers interesting opportunities for agile innovative SMEs as well as large incumbent industry, such as energy and telecommunication corporations. Due to specific natural circumstances and favourable innovation framework conditions, Finland has emerged as a global leader in developing and implementing Smart Grid applications. Hence Finnish companies are well positioned to be in the vanguard of new global value chain formation.
- Tekes support has been a very important source of funding for company development in the Smart Grid area. This support has helped to develop technological solutions that later, in some instances, became the key to company value proposition. Tekes funded R&D project contribution also has been recognised in relation to opening up new connections among previously unrelated industries. It can be said that Tekes support helped Smart Grid companies to develop in much more dynamic pace, thus increasing their competitive prospects in the emerging global market.
- Smart Grid is a continuum from systems of today towards the visions of the next generation. In order to promote value generation and value capture in Finland, further support is needed for business-oriented experiments of Smart Grid applications and Living Labs. As Smart Grid is a comprehensive system that requires a gradual step-by-step approach in its development, Finnish company pioneering role can be well exploited in strengthening their value chain positions. For instance, by controlling the supply of system technologies that provide the baseline platform for more advanced Smart Grid applications, Finnish companies could advance ambitions is becoming central nodes in Smart Grid value chains. Equally, a strong position in user interface application development could help companies to capture significant value from the emerging future market.

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86 Helsinki Business Hub: http://www.helsinkibusinesshub.fi/fact/facts-about-helsinki/ecosystems-2/cleantech/smart-grid/

87 Ministry of Employment and the Economy (2013) Licence to SHOK? External Evaluation of the Strategic Centres for Science, Technology and Innovation.

# Appendix F. Tekes impact on global competitiveness of the digital/ICT sector

## F.1 ICT and 'Digital' sector

This section assesses Tekes impact on the global competitiveness of the Finnish ICT/Digi sector. ICT refers here to the information and communications technologies (ICT) industries consisting of both ICT related manufacturing and services. Identification of companies is based on the standard industrial classifications. In line with Tekes's strategy, 'digital' is understood as a horizontal and crosscutting topic and it is not related to any specific industry or sector. Identification of companies is based on Tekes's own categorisation of 'digital projects'.

### F.1.1 Scope of the priority area and importance to Finnish economy

The Finnish government has played active role in developing digital and mobile communications already in the 1970s and 1980s. The government invested heavily in the development of domestic technology and production capabilities through funding for collaborative research involving private enterprises, public agencies, and universities. It also expanded university degree programmes in electronics and information technology and directed technologically demanding government procurement to domestic firms. The ICT sector benefited from public financial support, the extensive collaboration of public research institutes, state technology agencies, universities and other educational institutions, and private companies. As this development coincided with the opening of the Nordic telephone markets, the Finnish ICT sector (especially Nokia) was in an advantageous position. The government was both a developer of technology (government as client) and, primarily, as a creator of conditions (infrastructure, funding, and regulation) (Lemola, 2014).

Although the Finnish economy was seriously hit by a recession in early 1990s, further public investments were targeted at the ICT sector, as mobile communications were among the few sectors growing at the time. A large part of these investments were channelled through Tekes. These decisions were important in enabling ICT sector growth. Indeed, from the mid-1990s onward, Finland enjoyed extraordinary growth and the ICT sector, with Nokia as its flagship, was at the centre of this development. However, electronics and ICT were not the only sectors that developed during this time as practically all sectors improved productivity, developed new products, and increased their exports (Lemola, T., 2014).

If the rise of the ICT sector in the 1990s was exceptional, the decline after the global financial crisis in 2008 can be described with similar words. ICT sector employment decreased by over 10,400 workers, mostly in ICT manufacturing. This was largely a result of the restructuring of Nokia (Pajarinen and Rouvinen, 2015). In 2000, Nokia's share of Finnish GDP was around 4 % and it accounted around 40 % of the sector's value added in Finland. In 2012 Nokia's share of GDP was negative, but in the last few years the share has again increased and is now around 0.5 % of the Finnish GDP. The role of Nokia in terms of export is equally important. In 2000, ICT goods accounted for 24% of Finnish exports. In 2013, the year when Nokia's mobile phone business was sold to Microsoft, the share had dropped to only 2% of exports (Ali-Yrkkö et al, 2015).

Despite structural changes and significant job losses, the ICT sector is still strong and remains a significant employer in Finland. In fact, outside the Nokia cluster, other ICT sectors have not been so severely affected by the economic crisis. The number of workers has decreased only modestly in telecoms, IT wholesale and IT manufacturing and increased in software, ICT consulting and maintenance sectors. In fact, without Nokia's downsizing, the ICT sector employment would have remained about the same (Pajarinen and Rouvinen, 2015). As a result of this development, the core of the Finnish ICT sector has moved from manufacturing products to producing services and software (e.g. game industry, discussed below). Although these emerging sectors are are still young, they are growing quickly.

Today, Finland is only slightly above the OECD average in ICT-specialisation as Finland's industrial structure has again become more dependent on forestry and engineering. According to analysis by Rouvinen and Ylä-Anttila (2015), "while the ICT sector is again making a positive contribution for the Finnish economy, it is unlikely to become the engine of growth it once was". Many established companies struggle to adapt to the drastic digital disruptions. Past succesful transformations of the Finnish ICT sector show that rapid transitions are possible, but building the foundations for the transition may take several decades. (Rouvinen and Ylä-Anttila, 2015)

Currently there are some positive signals of emerging new ecosystems. According to expert interviews, communication networks (led by Nokia Solutions and Networks) is by far the strongest and most significant ecosystem within the ICT sector. Other promising ecosystems include games (see case below) and digital health and wellness (see the self care and monitoring case). Industrial internet and the digitalisation of the machine industry is a major trend and developing a strong ecosystem there could present major opportunities for both ICT and machine industry companies.

### F.1.2 Evolution of Tekes and Team Finland support since 2008

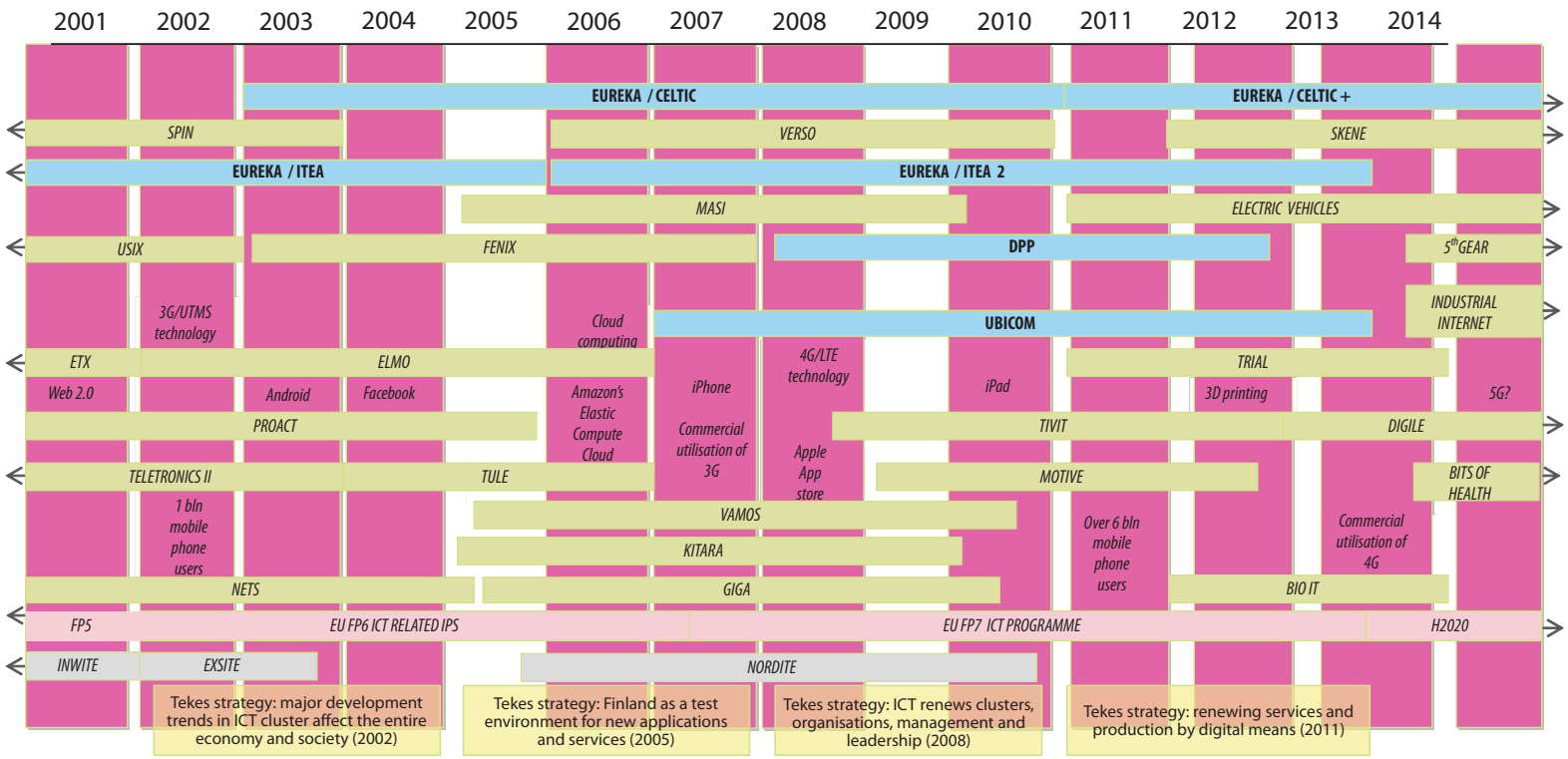
The 2005-7 Tekes strategy period marked a shift from a technology focus towards a knowledge and competence based approach. This was already evident in the FENIX programme (2003-07), which focused on developing user-friendly technologies, applications and services. FENIX was a frontrunner of Tekes programmes in facilitating not only technology but also business development (Halme et al 2015).

During 2005-07, ICT was strongly emphasised through a number of Tekes programmes. **Tekes Converging Networks (GIGA)** programme (2005-2010) aimed to speed up the development of wireless broadband technologies and services. A second aim was to help Finnish SMEs internationalise their markets and cooperation. The objectives of **VAMOS** (2005-10) included facilitating the wide utilisation of mobile solutions across sectors and supporting the development of solutions needed in increasing the effectiveness of processes within companies. The **VERSO – Vertical Software Solutions Technology** programme (2006-10) aimed to boost the success of the Finnish software industry by networking both businesses and research internationally for their mutual benefit. Both VAMOS and VERSO aimed to bring the end user industries and the software industry together. **UBICOM – Embedded ICT** programme (2007-13) focused on developing and piloting embedded IT solutions. With total funding of €117m it was one of the largest Tekes programmes. In addition, some other programmes also targeted ICT indirectly. For example, **MASI** (2005-09) sought to improve the competitiveness of Finnish businesses by fostering the utilisation of modelling and simulation tools in R&D activities (Halme et al 2015).

Along the lines of the 2008 National Innovation Strategy (MEE, 2008), the Tekes 2008 strategy emphasised customer- and demand-driven value creation, as well as the role of users as active participants. ICT was identified as one of the horizontal 'competence areas' along with materials, biotechnology and business competence. The main novelty was the establishment of Strategic Centres for Science, Technology, and Innovation (SHOKs) in 2008. One SHOK, **Digile Ltd** (formerly known as Tivit), focused on ICT and digital business. During the following years, a significant share of Tekes funding was allocated to SHOKs and only one ICT related programme was launched. **The Digital Product Process (DPP) p**rogramme (2008-12) aimed to strengthen the competitiveness of and growth prospects of the Finnish manufacturing industry and services by fostering product management capabilities and better use of information technology in product processes. The goal of the programme was to increase customer orientation and productivity in company networks that design and deliver products, systems and services to global markets. Instead of funding solution based R&D projects, DPP challenged companies to think of next steps in development via new processes, ICT applications, piloting and standards (Halme et al 2015).

The 2011-14 Tekes strategy paid specific attention to *digitalisation* and focused on new ICT-enabled business processes, knowledge and information-based business concepts connecting real and virtual worlds. Digitalisation was seen as cross-sectoral success factors. Six directly and indirectly ICT related programmes were introduced to implement the strategy. **SKENE – Games Refueled** programme (2012-15) aimed to strengthen Finland as a hotspot for the gaming and entertainment industry. The aim of Environment for Cognitive Radio and Network programme **TRIAL** (2011-14) was to transform Finland into a globally attractive cluster of expertise and a unique trial environment for cognitive radio and networks. Intended for companies and research institutes, **5thGEAR** (2014-19) aims to involve developing energy-efficient solutions that adapt to various needs. The **Industrial Internet** programme (2014-19) aims to renew the business operations of companies through the Industrial Internet and encourage companies from different fields to engage in new kinds of cooperation.

**Figure 62. ICT programmes and technological development in Finland 2014.** Source: Halme et al 2015, p. 37



## F.1.3 Mapping Tekes support

Approximately 26% (€544m) of Tekes funding between 2010-2015 was allocated to the ICT industry (industry classes 58-63). By comparison, funding for manufacture of computer, electronic and optical products (class 26) and manufacture of electrical equipment (class 27) combined was approximately €265m (13%) from 2010-15.

Within the ICT industry, computer programming activities (class 62) stands out as it was awarded 18% (€365m) of total Tekes funding between 2010 and 2015. This is many times more than any other individual industry. In addition, the funding for this sector has significantly increased since 2010 (from €55m to over €66m) despite cuts to Tekes funding appropriations in general. Meanwhile, funding for ICT manufacturing has decreased (due to the decline of Nokia Plc., see Figure 63), except for manufacturing of computers and peripheral equipment (class 26200). This latter sub-sector has seen funding multiplied from approximately €3.4m in 2010 to €18.8m in 2015. This is explained by funding for Nokia Solutions and Networks Ltd (€32m between 2012-2015, over €17m in 2015).

Whereas the ICT manufacturing industry is dominated by a few large companies, other sub-sectors, most notably computer programming, are populated by many small companies. This company structure within the ICT industry is reflected in Tekes allocation of funding for small and large companies. In communication equipment manufacturing and computer and peripheral equipment manufacturing, over 80% of Tekes funding was allocated to large companies (especially Nokia and Nokia Solutions and Networks). The other extreme is computer programming industry where 88% of Tekes funding was allocated to SMEs (55% to small companies) (Figure 64).

The adoption of digital technologies in other sectors has been a key strategic priority of Tekes in recent years. Mapping Tekes funding for these actitivies is more difficult as there is not a "digital industry". However, Tekes manually identified that clients with digitalisation projects represented from 2012-14 some 650 projects and €90-100m in funding (excluding SHOKs). This includes funding for ICT sector companies with digitalisation related projects (Table 1).

The projects can be divided into four subcategories (for 2012-2015): digitalisation as a reformer of industries, knowledge-based business concepts, new forms of controlling real processes and combining real and virtual worlds. Funding for these categories is relatively evenly distributed (Figure 65).

**Figure 63. Tekes funding for ICT industries, 2010-15.** Source: Tekes open data source

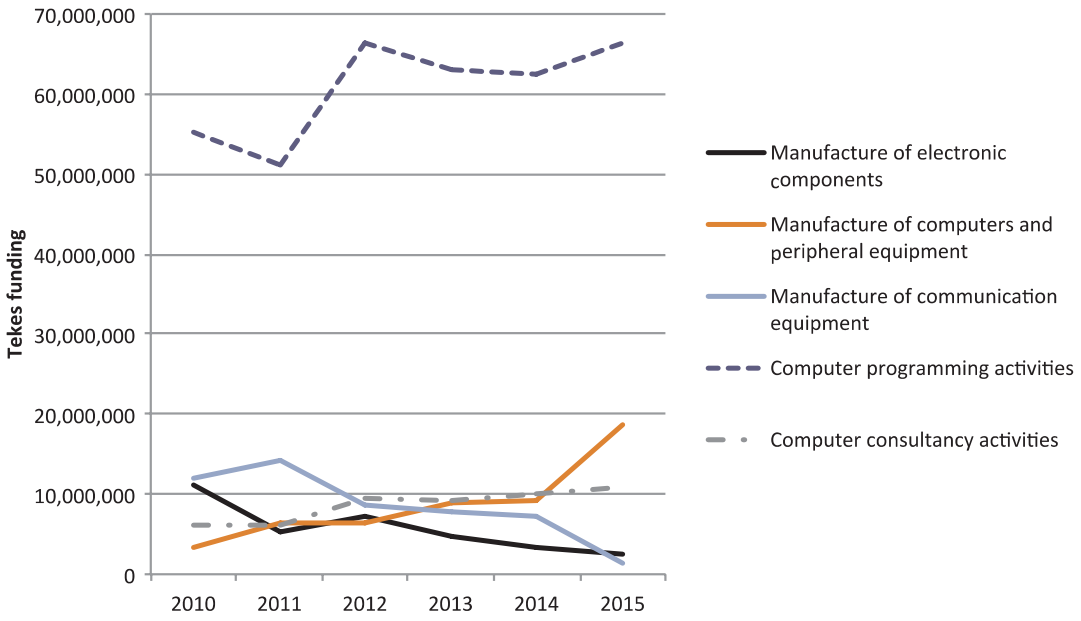


**Figure 64. Tekes funding for key ICT industries in 2010-2015, by company size.** Source: Tekes open data source

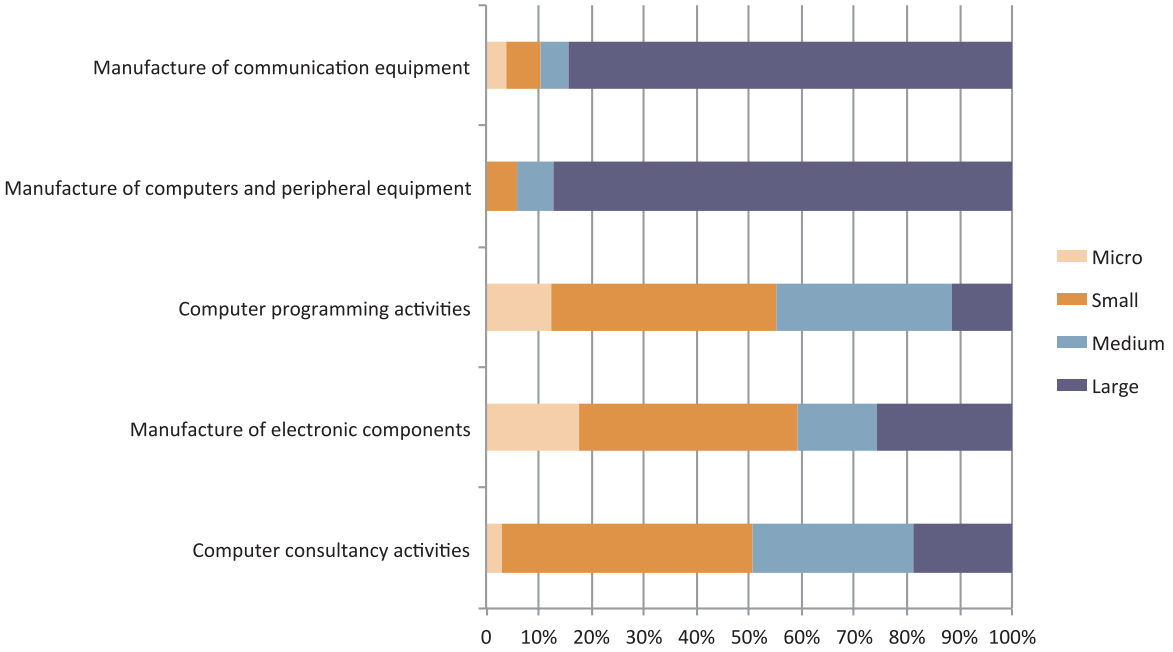
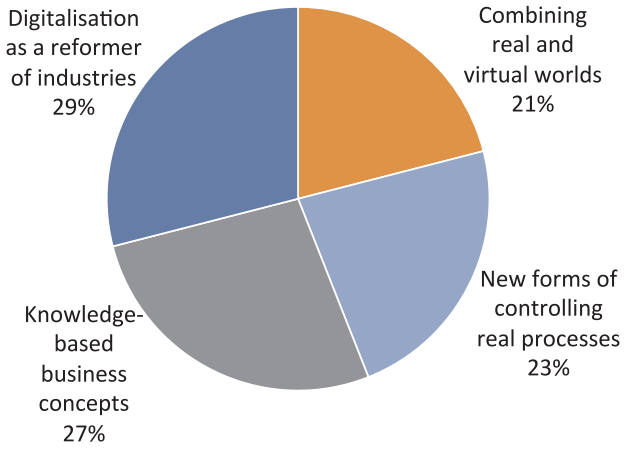



**Table 1. Tekes funding for digitalisation projects 2005-14.** Source: Tekes, Comparison between projects before and after 2012 are not reliable due to different classification principles.

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Funding (€)** | 22m | 35m | 34m | 36m | 32m | 24m | 57m | 107m | 100m | 92m |
| **Number of projects** | 107 | 134 | 138 | 125 | 107 | 110 | 201 | 494 | 649 | 659 |

**Figure 65. Distribution of Tekes funding to digitalisation according to subcategories.** Source: Tekes



### F.1.4 Evidence of impact on global competitiveness in past evaluations

An evaluation of the five Tekes telecommunications programmes was carried out during 2010-2011. The evaluation included two national programmes (GIGA and NETS) and three programmes which were conducted in cooperation with Swedish VINNOVA and the Norwegian research council (NORDITE, EXSITE and INVITE). The programmes were conducted between 1997 and 2010, with GIGA and NORDITE being the most recent programmes (both implemented between 2005-2010). The evaluation pointed out that although almost all of the participants were pleased with the technical results of their projects, the economic outcomes were achieved less often. Thus achieving a short-term technical objective does not guarantee long-term impacts on business growth. The evaluation found some evidence that both GIGA and NETS programmes managed to build domestic networks but Tekes intervention was less efficient in creating international exposure. Nordic cooperation, on the other hand, was boosted effectively in the NORDITE, EXSITE and INWITE programmes (Kotiranta et al, 2011).

VAMOS and VERSO were evaluated together with the older SPIN programme in 2012. According to the evaluation, the added value of VAMOS included increased cooperation with ICT manufacturing and utilising companies and in increased knowledge on potential collaborators, clients and customer industries. It also provided internationalisation help and increased clients' contacts. However, the project outcomes led less often than expected to software products or easily tailorable service products. A successful element of the VERSO-programme was the company-tailored expert sparring service that brought experts from Tekes and elsewhere to share their know-how on business development, business strategies, internationalisation, funding, sales and marketing. The traditional internationalisation model where a large enterprise is expected to take an SME abroad as its partner was recognised as in-effective. Both VAMOS and VERSO had a clear effect on the development of the software industry ecosystem and contributed to the global competitiveness of the software industry by improving the technological knowledge and understanding on business aspects of various small software industry companies (Raivio et al, 2012).

According to the evaluation of Tekes' Digital Product Process (DPP) and Embedded ICT programmes, due to changes in the operating environment (especially the 2008 financial ciris), companies involved in the DPP programme were less willing to develop concepts and products further and the programme ended up targeting a range of industries instead of machinery and construction, as was planned originally. Nevertheless, the projects were mainly successful and resulted in innovations, development of business activities, new products, services and solutions that sometimes also led to increased turnover. The DPP was less successful in creating direct networking opportunities. The perception was that capacities will boost the competitiveness of companies and the programme therefore focused on challenging companies to think of next steps of development via new processes, ICT applications, piloting and standards. Cooperation at the European level also led to a couple of new projects within the 7th EU Framework Programme and international business and/or research projects (Halme et al, 2015).

The evaluation of UBICOM concluded that the programme had a positive impact for the size and quality of companies' projects and the results were utilised more extensively than they would have been if the projects had been implemented as stand-alone projects. UBICOM often functioned as a stepping-stone towards the international level allowing participating projects to access large networks and knowledge. The programme also helped participating projects to follow the development of the field in question. Companies who participated considered the programme objective of "better utilising the opportunities of global markets and increased international interaction in the innovation processes" was met. The objective of creating new networks and businesses that can adjust their services, products and R&D-activities to the requirements of the global networks was also considered as reasonably well met (Halme et al, 2015).

## F.2 Game ecosystem case analysis

The game industry is an interesting example of Tekes impact on the development of business ecosystems. First, the global gaming market has transformed fast and profoundly during the last decade due to development of digital distribution channels and the emergence of new business models. This has forced Finnish game companies to develop not only technology but also new business skills. Second, the development of the Finnish game industry highlights the importance of value capture in global competition, especially in intellectual property (IP) based industries. Third, Tekes has been actively involved during the whole lifecycle of the game industry ecosystem. This case should be considered as a 'best practice' case for better understanding the impact mechanisms of Tekes in promoting global competitive business and industry.

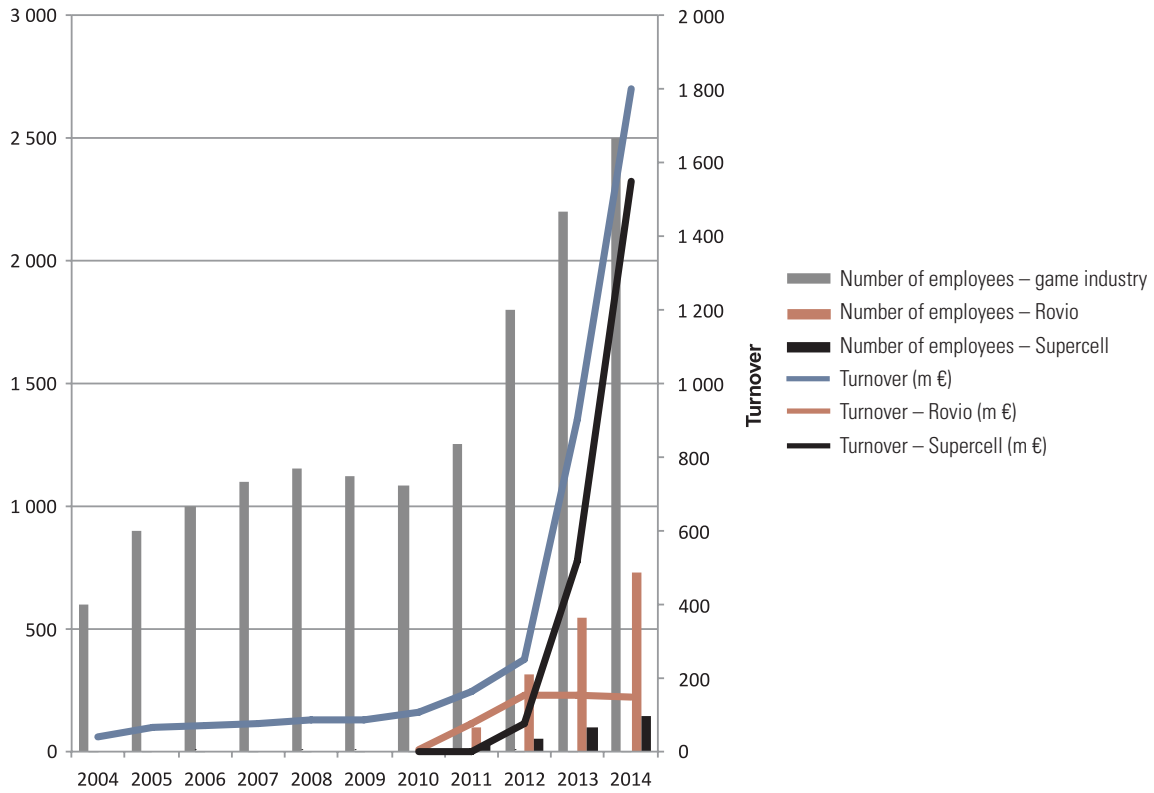
## F.2.1 Role of game 'industry' in the Finnish economy[88]

Analysing the role of the game industry is not straightforward as it is not a statistically defined industry, rather companies belong to different sectors such as publishing or computer programming (software development). Neogames, a non-profit game industry organisation, has identified 260 game development companies at the core of the game industry. The game industry has been one of the most rapidly growing industries in Finland over the last decade. In 2014, the total turnover of the game industry was approximately €1,800m, twice as much as in 2013 (€900m), 17 times more than in 2010 (€105m) and 45 times more than in 2004 (€40m). In 2013, the game industry represented approximately 10% of the total turnover of the ICT industry (€8.3 billion). In 2014 this figure is likely to be around 20%. However, in terms of employment the role is much smaller, with the game industry accounting for approximately 3% of . According to Neogames's estimates, in 2014 the gaming industry employed approximately 2500 people. Although this is more than twice as much as in 2008 (1147 people) and 4 times as much as in 2004 (40), it is relatively modest figure when compared to turnover growth. (Neogames 2015)

The high relative turnover (turnover/employee) – over 0,7m in 2014 is one of the distinguishing characteristics of the game industry growth (and other IP-based industries). However, until around 2010, turnover and the number of employees grew at the same pace and started to diverge only after the revolution in digital distribution channels (see below) – and especially due to Supercell's extraordinary revenue growth, largely enabled by the new distribution channels.

In fact, a huge proportion of the recent turnover growth is dependent on the extraordinary growth by Supercell alone: in 2014 its turnover (over €1.5 billion) represented 86% of the total game industry turnover. Meanwhile, in 2012 Rovio alone was responsible for about 61% of the total turnover with a turnover of €152m. Although Rovio's turnover growth has since stalled, its share of to-

**Figure 66. Estimated Finnish game industry turnover, employment and turnover per employee, 2004-14.**
Sources: Asiakastieto; Neogames 2015




88 Based on: Tekes (2015). 10 years of funding and networks for the Finnish game industry. Tekes. Available at: https://www.tekes.fi/globalassets/global/ohjelmat-ja-palvelut/ohjelmat/skene/aineistot/10-years-of-tekes-funding-and-networks-for-the-finnish-game-industry-2004-2014.pdf; Neogames (2015). The Game Industry of Finland. Report 2014. Available at: http://www.neogames.fi/fgir2015/; expert interviews. Note: The figures include entrepreneurs and employees working abroad. The actual numbers might be a bit higher but as game industry is not an official industry classification, it is impossible to have accurate statistics.

tal employment in the ecosystem is still impressive: 29% in 2014 (this is likely to drop in 2015). In comparison, Supercell's share of total game industry employment in 2014 was only 6%. However, both Rovio and Supercell are rare exceptions, also in global terms (Supercell is regarded as the most profitable game developer company in the world). Therefore, comparing other companies to these two 'outliers' is unfair and does not do justice to rest of the industry. In fact, even when Rovio and Supercell are excluded, turnover and employment has increased between 2010-14 despite the recession.

Another important characteristic of the game industry is the high number of small (and young) enterprises: Only seven game companies have over 50 employees and only 20 companies have a turnover over €1m. The median turnover is under €100,000. Of the 260 game developing companies, 179 (69%) were established after 2011 while only 17 companies are more than 10 years old. 38% of game developer companies are concentrated in the capital area (28% in Helsinki). Although the role of the capital area is decreasing and significant clusters can be found in many other regions, the capital area companies account for most of the jobs and turnover. Public investments, regional education policies and the allocation of structural funds have played an important part in strengthening the regional clusters. (Neogames 2015)

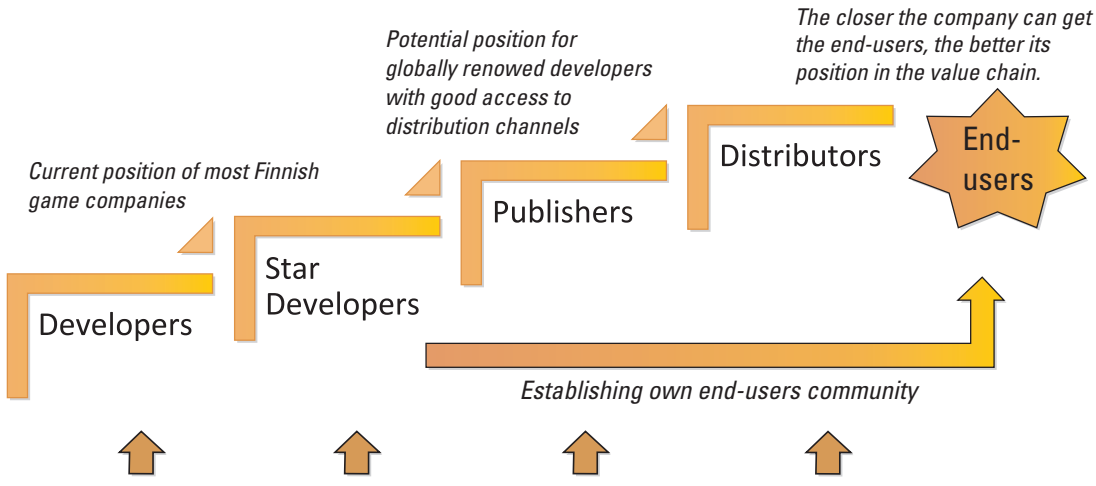
All in all, the Finnish game industry is very healthy as there are dozens of very profitable companies in the high-end of the value chain and new start-ups are constantly joining the ecosystem. The game industry companies are (and have been) very R&D intensive. For example in 2007 the industry's R&D investments (approx. €22m) represented 28% of the total industry turnover (Neogames 2009)[89].

## F.2.2 Finnish game industry in global value chains

Most of the Finnish companies are game developers, who develop games to the platforms provided by the large distributors such as Apple, Google or Sony. The biggest and best known 'star developers' have very close relationships with the distributors, whereas the smaller developers often operate as subcontractors for the better placed 'star developers'. In some cases, the developers who have a good position in relation to distributors may operate as publishers and publish other developers' games. Given that the distributors cannot realistically be challenged, the 'star developer/publisher' is likely to be the best possible scenario for the Finnish game developers. This strategy, currently applied, for example, by Rovio and Fingersoft, requires excellent networks and world wide visibility. In short, the closer a company can get to the end-users, the better its position in the value chain. In many cases the game developers also aim to create their own loyal user base; something that both Rovio and Supercell have managed to accomplish.

Besides moving up the value chain, game companies may seek growth in other industries, however this requires a strong IP brand (e.g. Angry Birds) which can then be applied through licensing outside the core industry. According to interviews, creating value from IP developed by other companies is something that has not yet been fully understood in Finland.

**Figure 67. An illustration of the game industry value chain.** Source: authors




89 Neogames (2009). The Finnish Games Industry. Available at: www.neogames.fi

## F.2.3 Key drivers, enablers and barriers[90]

### Emergence of digital distribution channels enabled access to global markets

The Finnish game industry is profoundly global. According to industry experts' estimates some 95% of the game industry revenue comes from abroad. This has been enabled by the the emergence of digital distribution channels (e.g. Appstore). These channels have improved access to global markets for smaller companies and startups, and helped game developers to capture more value from their products by shortening the value chain. The game developers are also in better position to retain their IP rights and pursue highly scalable IP-based growth and develop new business models. In addition, global distribution channels enable more efficient online marketing. On the other hand, digitalisation and new business models have also brought new risks as game developers are now themselves responsible for marketing and other tasks previously handled by the publishers. As a result, the importance of managing user/client relationships and user communities has become vital. In addition, as the mobile distribution channels are full of new products, gaining visibility has become a major challenge.

### Favourable company structure and internal market dynamics[91]

On average, Finnish game industry companies have been able to adapt to the rapidly changing environment (e.g. digitalisation), especially when compared to the more traditional sectors. One factor behind this agility has been the large number of small startups and the young age of the industry. This has helped the companies and the whole ecosystem to adapt to changes in digital distribution channels and business models when large established companies struggled. Indeed, many Finnish game companies are known for their dynamic innovation processes and culture. The small internal market can also be seen as a potential success factor as it has forced the companies to aim directly at international markets. Furthermore, as the internal market is small, there is only limited competition between the Finnish game studios. This may have helped to foster national collaboration between companies (Hiltunen et al 2013)

### Strong ICT competence and technological base

Another important aspect is the links of the game industry to the broader ICT industry. In particular, the role of Nokia should not be underestimated. First, Nokia was an important client and reference for many game developers through subcontracting. Second, Nokia's phones and N-Gage (despite proving to be unsuccessful) were important enablers of game development as they prepared Finnish companies for mobile markets and the forthcoming changes in the digital distribution market. Third, although many companies of that era did not succeed, the culture and competence laid the foundations for future success. In fact, many key persons in current successful Finnish game companies have their roots in Nokia. Fourth, besides entrepreneurs, Nokia's success (and later decline) has helped game companies by ensuring the availability of competent workforce (Hiltunen et al 2013). Tekes has also contributed through a specific programme for supporting the re-employment of, e.g., ex-Microsoft employees (Digiboosti programme).

Although gaming related education is relatively well in place, and internationally successful companies help recruiting, it is important to attract talents from abroad. The demand for workforce is increasing, which should be recognised in education. (Interviews)

### Supportive cultural framework and entrepreneurial culture

The early development of the game industry in the 1980s and 1990s had its roots in the strong enthusiastic hobby culture, which created the based for demo scene and game development culture. This hobby culture is still vibrant and a good source for potential new game developers and startups. Also the overall culture is very positive when it comes to gaming and games are recognized as a form of culture. Game industry has also been able to utilize the increasingly positive attitudes towards entrepreneurship. (Neogames 2015)

### Strong ecosystem and efficient knowledge transfer

An important enabling factor has been the tight network and strong community. Especially for a relatively new industry, the game industry is well organized and supported[92]. This strong network of intermediaries is seen to have promoted the knowledge transfer and dissemination of tacit knowledge between the companies. Also the exceptionally strong community, rooted in the still vivid enthusiastic hobbyist culture, has been recognized as one enabler for growth. The role of this dynamic ecosystem should not be underestimated, especially when it comes to the current wave of "second round startups", which can benefit from the experiences, knowledge and examples of the successful entrepreneurs, their networks and also investments back to the ecosystem. (Hiltunen et al 2013; Neogames 2015; interviews)

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90 Based on Hiltunen et al 2013; Neogames 2015 and interviews.

91 Based on Hiltunen et al 2013.

92 Neogames, a non-profit game industry organization acts as an umbrella organization for the whole industry, whereas IGDA Finland promotes the development of careers and professional skills of game developers. Finnish Game Developer Studios Association serves the interests of game developer studios.

### Foreign investments and access to finance

The rapid growth of the industry has also attracted foreign investors with approximately €160 million being invested into Finnish game industry between 2011 and 2013. This is stark contrast to many other industries in Finland, where the lack of foreign investments is often a major barrier. The influx of investments has enabled rapid growth and scaling of the companies, but also the availability of valuable experience and competence. Between 2011 and 2014 the number of companies receiving more than €0,5m VC funding was 17, which represents 6,5 % of the total number of game industry companies. 12 out of these 17 investments were targeted to studios focusing on mobile games. The total amount of VC investment in the Finnish game industry was approximately €28m in 2014. (Neogames 2015; Hiltunen 2013; Interviews)

Although the access to finance in now significantly better than even five years ago, funding is still seen as one of the key issues for the development of the industry. Especially the lack of funding for cultural content development is seen as problematic as some of the 'indie' game developers may not aim for high growth but are vital for dynamism and renewal of the ecosystem. (Hiltunen et al 2013; interviews)

### Lack of business competence

It has been argued that there is lack of business competence among the game companies. This is highlighted by the fact that all companies, which have managed to attract significant foreign investments (by 2013), have involved some actors with at least 10 years of experience from the industry. In many cases the companies are still very product-driven, which is seen as a challenge given the current demanding business logics. Sometimes the emphasis on game development may also override growth ambitions and business interests. Thus, funding itself is not enough, also business knowhow is required. For this purpose, there have been calls for establishing more game industry specific incubator and accelerators. (Hiltunen et al 2013; Neogames 2015; interviews)

## F.2.4 Tekes investments in game industry

Tekes has been actively involved in supporting game industry since its early years. The first game industry projects were funded as part of the 'Digitaalisen median sisältötuotteet' (1997-1999), USIX (1999-2003) and SPIN (2000-2003) programmes. Under FENIX (2003-2007) game applications were the biggest of four priority areas: 30% of the budget (total €91m, Tekes share €47m) was allocated to game applications (approximately €14m). After FENIX, game companies were funded through Verso (2006-2010) in which another €14m was allocated (Hiltunen et al 2013).

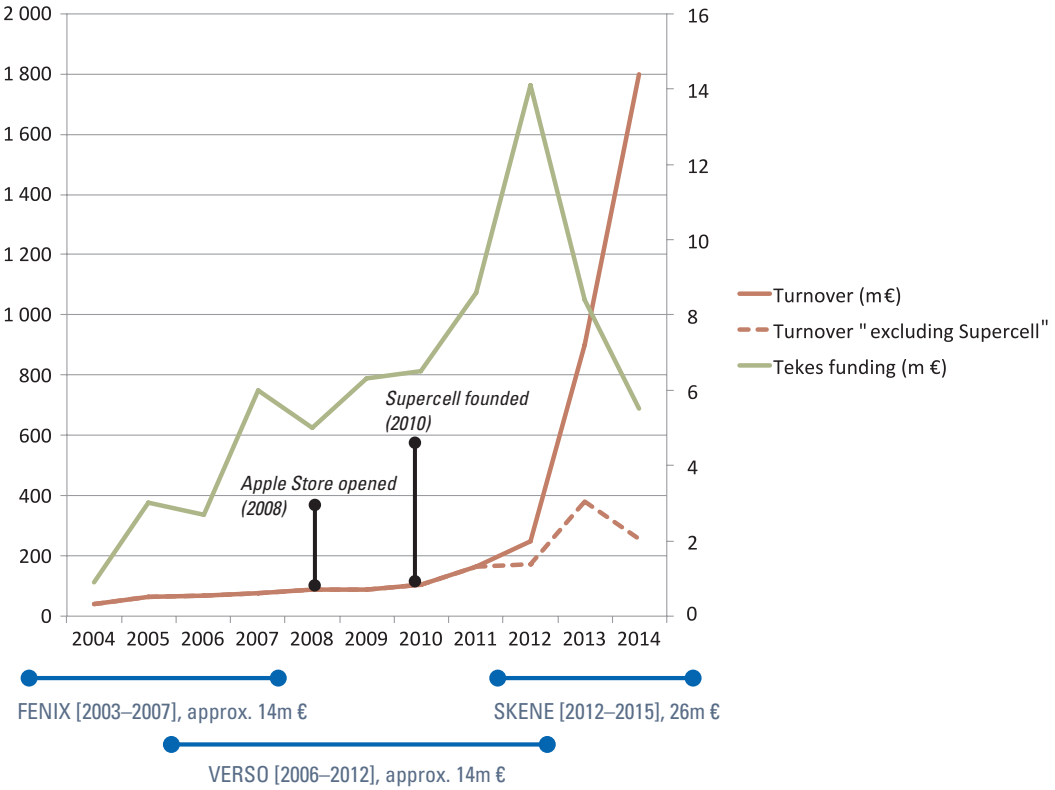
One of the most important Tekes investments to game industry is the recently ended Skene – Games Refueled programme (2012-15). The programme aimed to boost the most promising Finnish game companies in an era when the global markets were in transition (see above). The total budget of the programme (Tekes share) was €28m and overall some 50 companies received funding. This represents around 20% of the total number of companies in the game industry (Tekes 2015).

In total, between 2004-15, Tekes invested approximately €56m in the game industry through three major programmes (FENIX, VERIO, Skene). In addition, game industry companies received funding through other instruments. According to Tekes's estimate (Tekes 2015), funding for the game industry between 2004-14 was €67m. When compared to the size of the whole industry, the investments

**Table 2. Milestones of the Finnish game industry.** Source: adapted from Hiltunen et al (2013) and Neogames (2015).

| Years | Milestones |
|---|---|
| 1982–1991 | Emergence of enthusiastic hobbyist gaming culture; establishment of demo scene which served as a platform for first game studios. |
| 1992–1997 | Organizational development, hobbyists organized game development groups. Beginning of professional commercial game development. |
| 1997–2005 | "IT hype" and (unsuccessful) investments into mobile technology (e.g. WAP) laid the foundation for technological development and competence in mobile gaming business. |
| 2005–2010 | Digitalisation and value chain disruption (e.g. introduction of Appstore in 2008) transformed the industry and enabled access to global markets for Finnish game developers. |
| 2011–2014 | Start-up boom and influx of investments: 179 game developer companies founded between 2011 and 2014. Introduction of the Free to Play (F2P) model enabled new kinds of business models, successfully adopted by Supercell. The success of the Finnish game industry attracted attracted large foreign investments (most notably the acquisition of Supercell by GungHo/ Softbank for €1.1 billion) in 2013. |
| 2015 | Currently the Finnish game industry is characterized by the establishment of "second round" startups by founders with strong prior experience. This highlights the role of serial entrepreneurship and also indicates that the Finnish game industry is become more mature. |

**Figure 68. Tekes funding and development of game industry 2004-2014.** Sources: Tekes 2015; Asiakastieto; Neogames 2015.




have been substantive: For example, according to Neogames (2009), Tekes funding (€7m) covered almost 30 % of the total R&D investments of the game companies in 2007. Over half of the then operational companies had received Tekes funding in the past two years.

## F.2.5 Tekes impact on game industry competitiveness

It has been widely argued that the R&D funding from Tekes was "a major factor behind Finnish game companies' technological competence" (Neogames 2009) and a major enabler for the growth of the game industry in Finland (Hiltunen et al 2013; Neogames 2015; Neogames 2009; interviews). Tekes's investments in the game industry have been lauded by several companies and entrepreneurs, most famously by Ilkka Paananen, CEO of Supercell, who stated that the company would not exist without Tekes[93].

According to the FENIX evaluation, the programme was a frontrunner among Tekes programmes facilitating business development alongside technology. The evaluation states that "projects were often successful in creating new products or bringing additional value to existing ones" and that "competitive advantage, most often in the form of opening new markets, was achieved in a large percentage of projects". Overall the "programme was successful in facilitating R&D and business network creation as well as promoting business ideas based on new applications and services concepts"[94]. As for the Verso programme, Tuominen et al (2014) conclude that it "succeeded in establishing a number of practical, value-added services, which were widely spread also throughout different activities at Tekes". Indeed, one of the focus areas in Verso was to increase transparency, exchange of information and sharing of knowledge between the companies" The evaluation highlights that the game business benefitted from this approach which supported the emergence of some international success stories (Rovio and Supercell who both participated to the programme)[95].

According to the previous studies and interviews, Tekes funding has provided companies opportunities to invest in technological development and improve their

93 Supercell has received Tekes funding 50 000 in 2010, 500 000 in 2011 and €1,35m (of which 600 000 in loan). See for example Yle 18.4.2013 http://yle.fi/uutiset/supercellista_tuli_loistosijoitus_valtiolle_-_19_miljoonan_tuella_saatiin_44_miljoonan_verotulot/6585722 and Helsingin Sanomat 18.4.2014 http://www.hs.fi/talous/a1366209132468

94 Syrjänen, M. et al (2007). Tietoyhteiskunnan uudet toimintatavat mahdollisuutena ja haasteena. FENIX-teknologiaohjelman arviointi. Tekes.

95 Tuominen, M. et al (2014). Verso – Vertical Software Solutions 2006–2010. Katsaus ohjelman toimintaan. Tekes.

competence. Many companies focus typically only on developing content. Tekes funding helped them to pay more attention to the technological basis and develop stronger foundations for long-term development. Also foreign investors value a strong technological basis. Companies reported that Tekes funding helped to convince investors of growth ambitions and that Tekes support is a valuable 'proof of concept' for many investors.

However, in terms of strengthening networks within the industry Tekes role has been less critical. Programmes are seen as an umbrella for funding and collaboration between companies and projects is quite limited. The role of Tekes among game industry companies is predominantly as a funder for *technological* development, not for other types of innovations or the development of new business models.

### F.2.6 Views on future role of Tekes

According to the interviews, the best added value Tekes (as part of the Team Finland network) can provide for the game industry is to act as a background 'guarantee' towards international investors, some of which are well aware of Tekes. The game industry expertise at Tekes was also lauded, although, as the number of game startups increases, the shrinking resources raises concerns. It is important, despite the success of the ecosystem, that Tekes supports new startups and the renewal of the industry.

### F.2.7 Synthesis and key takeaways

The case highlights that the growth of an ecosystem is dependent on several factors. Both external and internal dimensions are clearly evident. External factors include the rapid growth in global demand, technological development of mobile devices and the emergence of digital distribution channels. Internal factors include the existing strong ICT competence (Nokia's 'heritage'), high quality education, and investments to mobile technology. Moreover, the structural changes in the Finnish ICT sector helped boost the start-up boom in the game industry. The case also highlights the importance of grassroots activity as the 'fuel' for the emergence of new talents, entrepreneurs and the dynamism of the ecosystem (e.g. Finnish demo scene and hobbyist culture). The strong networks, institutions and common culture within the ecosystem have been important factors.

Although it is extremely hard to assess the contribution of a single actor in developing an entire business ecosystem, there is strong evidence that Tekes investments in game industry have contributed to its growth and generated a broader impact on the Finnish economy. Indeed, investments in the game industry can be seen as a 'best practice' case, which should be examined for future lessons for other sectors. Here, at least the following aspects should be considered:

- **Focus on systemic impact.** It is impossible to predict future development of an ecosystem and its global environment. Instead of trying to predict the future winners, focus should be on developing and laying foundations for promising ecosystems and adopt a systemic approach where collaboration between different actors, ministries and other stakeholder is vital.
- **Accept uncertainty of outcomes.** It should be accepted that building ecosystems takes time – and the outcomes may be something else (and materialize later) then what was expected. For example investments to WAP technology in the early 2000s did not pay off but on longer term they did have a role in building the ecosystem. On the other hand, without the successes of Rovio and Supercell (both long-term Tekes clients), the story of Finnish game ecosystem would be more modest.
- **There are no one-size-fits-all solutions.** Each ecosystem is different and they develop over time. In the case of the game industry, Tekes was at the right place in right time.
  - First, Tekes was involved with game industry companies in the very **early stages** of the ecosystem.
  - Second, the **investments were sufficient compared to the size** of the industry at that time. The investments had a real impact on the whole ecosystem, not just individual companies.
  - Third, the **company structure of the target industry** (many young and small R&D intensive startups) is likely to have been favourable for Tekes funding instruments to have a broader impact on the whole ecosystem.

# Appendix G. Tekes impact on global competitiveness of the health care sector

## G.1 Health priority area

### G.1.1 Scope of the priority area

Finland's population is one of the most rapidly ageing in Europe[96] and this has been a driver for the Finnish government to invest in the health sector. As a result, Finland has become a country with internationally high standards of medical research and world-class companies in the health technology. There are three national strategies related to the health business sector: the Health Sector Growth Strategy for Research and Innovation activities[97], the Genome Strategy[98] and the eHealth strategy[99].

- The Growth Strategy for Research and Innovation in the health sector was adopted in 2014 and developed cooperatively by various national players: three ministries (the Ministry of Employment and the Economy, the Ministry of Social Affairs and Health, and the Ministry of Education and Culture), Tekes, the Academy of Finland and major health sector players. This ecosystem strategy examines the health sector from the perspective of innovation and business growth.[100] Finland's goal is "to be an internationally renowned forerunner in the health sector research and innovation, investment and new business activities while benefiting people's health, welfare and capacity to act." The strategy defines three business branches: health technology, pharmaceutical industry and biotechnology.
- Finland's Genome Strategy of 2015 sets key measures for ensuring that by 2020, genomic data will be effectively used in healthcare and in the promotion of health and wellbeing. It is expected that in the future, decisions regarding the prevention and treatment of diseases will be increasingly based on an individual's genetic makeup, which makes it important to be prepared for this change.
- Finally, the eHealth and eSocial strategy 2020 has an objective to support the renewal of the social welfare and health care sector and the active role of citizens in maintaining their own well-being by improving information management and increasing the provision of online services.

Health has been included in all recent Tekes strategies. Initially, Tekes mainly invested in the development of the pharmaceutical industry. However, a wider concept of well-being and health appeared in the 2008 Tekes strategy[101]. One of the core themes was a focus on creating health promotion and personalised and extensive care as well as cooperation between private and public actors and a well-functioning market. This topic was kept in the 2011 strategy[102] with one of the foci being vitality of people, which included health promotion, efficient and high-quality social and health care service system, work and learning that regenerate human skills and capabilities and affective and meaningful free time experiences. The most recent strategy (2015)[103] also has one of the focus areas related to 'wellbeing and health'.

Tekes conducted a mapping of the Finnish health sector companies based on Tekes' own client base, supplemented by additional key companies which have not been their clients. Tekes estimate that approximately 80% of the key companies are or have been their clients. The health sector companies based on Tekes' own classification are divided into four groups:

- Recognition of illnesses
- Treatment of illnesses
- Self-care and monitoring
- Support services and products for processes.

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96 Invest in Finland, Healthcare and wellbeing, http://www.investinfinland.fi/industries/healthcare-and-wellbeing/111

97 Ministry of Employment and the Economy of Finland, (2014) Growth strategy for research and innovation in the health sector. https://www.tem.fi/files/40138/TEMrap_16_2014_web_26052014.pdf

98 Ministry of Social affairs and Health of Finland (2015) Finland's Genome Strategy.

99 Ministry of Social affairs and Health of Finland (2015) eHealth and eSocial strategy 2020. http://www.julkari.fi/handle/10024/125955

100 TEM (2014) Growth strategy for research and innovation in the health sector. https://www.tem.fi/en/current_issues/press_releases/press_release_archive/year_2014/growth_strategy_for_research_and_innovation_in_the_health_sector.115253.news

101 Tekes (2008) People, Economy, Environment – Prioroties for the Future

102 Tekes (2011) Tekes strategy. Growth and wellbeing from renewal

103 Tekes (2014) Tekes Strategy 2015-2017

Companies focusing on the **recognition and diagnostics of illnesses** focus mainly on the production of specialised medical equipment. These companies have already commonly established their position internationally. Out of the 42 companies only 10 are start-ups and only five work mainly on the domestic market, although the majority (80%) of the companies are Finnish-owned. A large majority (27) of the companies focus on producing medical equipment. According to Tekes estimates the total turnover of these companies in 2014 was €1,088m and they employed close to 3,000 people. There is a high-level of international competition and high degree of regulation in this sub-sector due to which the R&D activities mainly focus on further development of already existing technologies and solutions.

The **treatment of illnesses** sub-sector (57 companies) is the largest when measured by total turnover (€1,955m) and employment (3,338). The majority of the companies are SMEs and foreign-owned pharmaceutical companies focusing on substances or medical processes. Large companies in this sub-sector are the builders of an ecosystem that bring together smaller specialised companies. Tekes activities can also be steered to assist this process.

The **self-care and monitoring** sub-sector (40 companies) includes the production of heart rate monitors, diabetes monitors and different types of mobile solutions that can produce individualised information on wellbeing and health. Although self-care has recently received a lot of attention this sub-sector's volume is the smallest (turnover €154m, employment 859). The majority of companies are SMEs producing equipment or software to consumer markets. Almost all of the companies are Finnish-owned. International competition in this sector is very intense as companies like Samsung, Google and Microsoft dominate the markets. However, Finnish companies have opportunities to operate as niche producers as part of the ecosystem. A key challenge is the integration of products and services into full service concepts.

Companies producing **support services and products** to the processes of the health care and wellbeing sector (94 companies) are mainly SMEs but large multinational companies are also represented. They mainly produce added value services to IT-platforms and integration software solutions that help to optimise and boost the services and processes provided within the health care sector. This is the largest sub-sector when looking at the number of companies (94) operating within the sub-sector or the number of employees (over 5,000 when one large conglomerate is excluded). Total turnover of the sub-sector is however only €1,155m. A key challenge for companies within this sub-sector is the integration and interoperability of the solutions with other existing platforms and systems (e.g. in hospitals). This calls for strong collaboration within the ecosystem.

### G.1.2 Importance of the sector to the Finnish economy

The health sector is very important to the Finnish economy. Even though the available statistics about the sector have been insufficiently compiled, the rough annual turnover in the health sector (especially health technology and the pharmaceuticals sector) is already approaching €5b and the majority (approx. €2.8b) of products are exported.[104] It is estimated that there are approximately 500 companies active in the health sector, employing 20,000 people. The health sector business activities involve an extremely versatile network of operators, including companies of various sizes, ranging from small domestic firms to large multinational operators, and the extensive public and private sector service system. In terms of the company structure of the sector, a relatively high number of companies are small with a small number of large research-intense companies oriented to production.

Medications and medical instruments are in the top 10 of Finnish export goods.[105] In addition to the United States, Europe (including the Nordic countries), China and Russia are significant export countries for Finnish health technology. In 2014, exports of health technology grew 8.3% compared to the previous year to a new record of €1.8b. With exports continuing to grow faster than imports, Finland's trade surplus in health technology products widened 11% to a record €829m. Health technology is now Finland's largest hi-tech sector, representing nearly half of all hi-tech exports. Companies operating in Finland have clearly developed sustainable global business models: for two decades healthtech exports have increased at an average annual rate of 9%. The fastest export growth has been in the areas of medical equipment and diagnostics.[106]

The pharmaceutical imports to Finland exceed the country's pharmaceutical production and exports. Three companies have operations in Finland. However, their production does not cover domestic demand.[107] As can be seen in the figure below (Figure 70) the exports have slightly decreased in recent years to €885m in 2014.

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[104] Ministry of Employment and the Economy of Finland (2014) Growth strategy for research and innovation in the health sector. https://www.tem.fi/files/40138/TEMrap_16_2014_web_26052014.pdf

[105] http://team.finland.fi/documents/1521018/1647270/Field+for+growth+and+success+-+Finland+fact+book

[106] Healthtech Finland (2015) Finland is a Small Giant of Medical Technology. http://www.finnishhealthtech.fi/industry-overview/42-industry/77-finland-is-a-small-giant-of-medical-technology

[107] Finnish pharmaceutical service system is dependent on imports (2015). http://www.pif.fi/en/statistics-and-reports/exports-and-imports

**Figure 69. Finland's health technology trade 1996-2014.** Source: Healthtech Finland

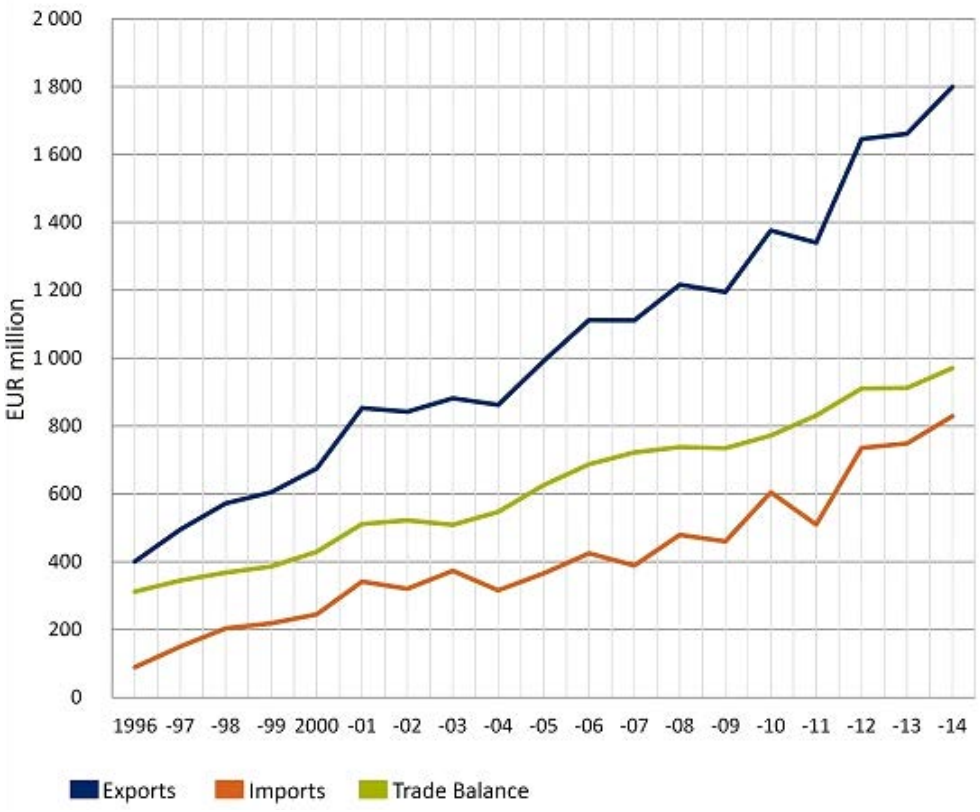
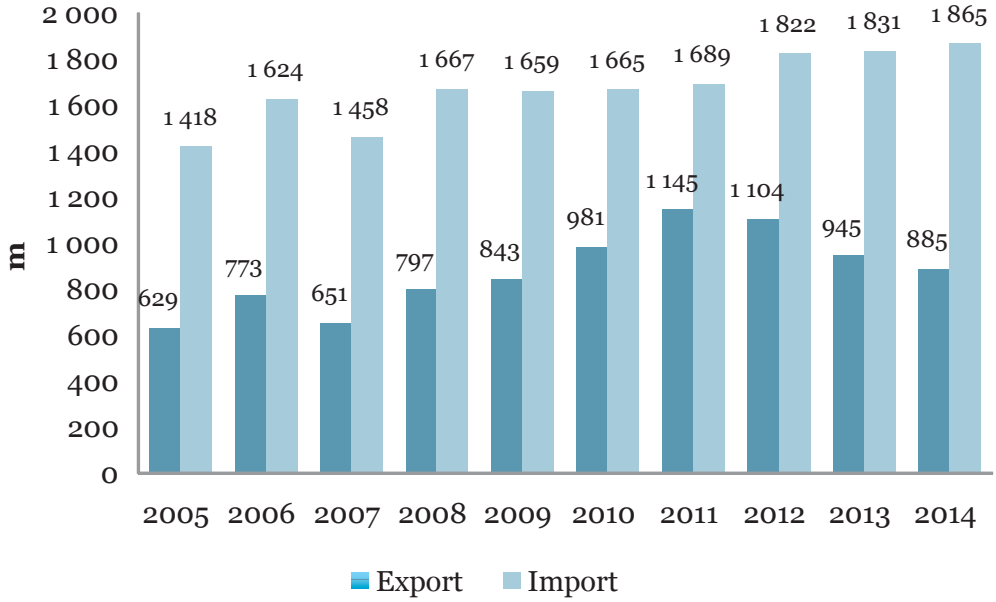



**Figure 70. Finnish Pharmaceutical exports and imports 2005-2014.** Source: National Board of Customs



## G.1.3 Evolution of Tekes and Team Finland support since 2008

According to the Health Sector Growth Strategy for Research and Innovation activities the most important public funders of the health sector research activities include Tekes and the Academy of Finland. A significant amount of the sector's public funding is channelled through applications (a so-called 'bottom-up model').

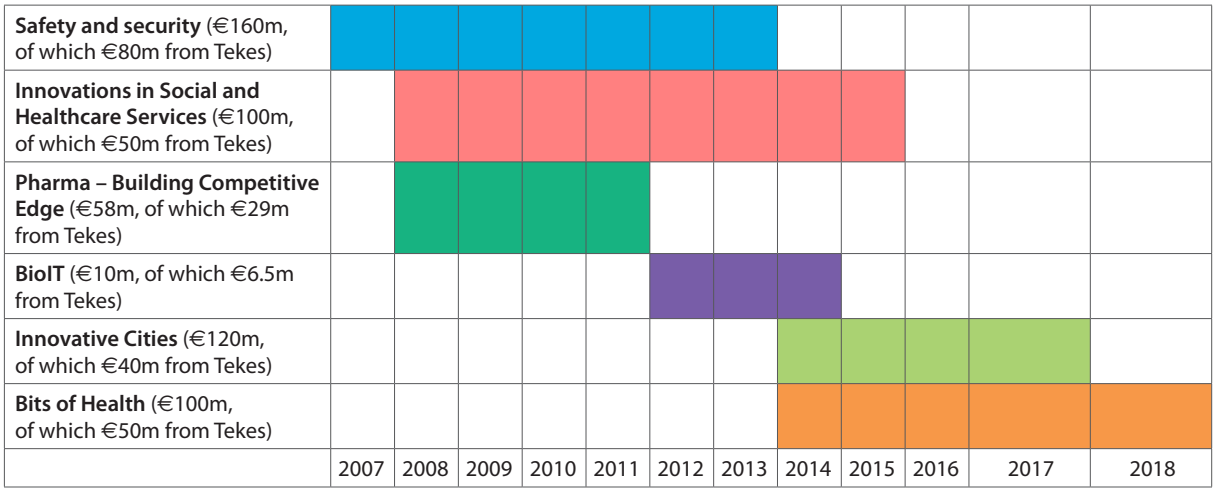
During the 2005-7 Tekes strategy period there was one major programme in this area – **Safety and Security 2007-2013**[108]. One of the eight topics of the programme was healthcare and home, with sub-themes of independent assisted living and prevention of Hospital Acquired Infections. The Safety & Security Programme explored technology adaptation to an elderly-persons home environment and the economy in public investments in such preventive measures. Developed solutions include remote healthcare systems for patients discharged from hospitals and easy to use communication devices that help the elderly keep up with their social network. User experience was developed in a demonstration home and with elderly people. Tekes Safety and Security Programme supported the formation of Smart Aging Network Finland, a company network with joint innovation and export activities. Companies and researchers also worked closely with hospitals to develop a number of innovations designed to prevent outbreak of infection epidemics. The total budget of the programme was €160m, of which €80m came from Tekes. The specific budget spent on healthcare and home topic is not known.

In the 2008-2011 period, the **Innovations in Social and Healthcare Services 2008-2015**[109] programme started with the aim to renew health and social services and increase business opportunities through innovative activities. The goals of the programme were to: 1) improve the customer-centred starting point within social and healthcare services; 2) increase cooperation between the public, private and third sector; 3) develop preventive social and healthcare services; 4) increase the customer choice while securing the cost efficacy, availability and quality of services; 5) help spreading and embedding of good practices; and 6) create new business opportunities. The total budget was €100m, of which approximately half was Tekes funding.

**Pharma – Building Competitive Edge 2008-2011** was another programme which started during period[110]. It aimed to eliminate bottlenecks for the Finnish pharmaceutical industry through the creation of new tools and operational models, as well as the development of processes for products, services, and methods. The budget was €58m, half of which was from Tekes.

During the 2011-2014 period, three programmes were initiated. The **BioIT 2012-2014** (Solutions for Biological Information)[111] programme focused on building new value networks and cooperation between ICT players with biologists, geneticists and environmental scientists. The programme ran for two years and had a budget of slightly more than €10m, with Tekes investing €6.5m of the total.

**Figure 71. Timeline of major health related Tekes projects 2007-2018.**




[108] Safety and Security. https://www.Tekes.fi/en/programmes-and-services/Tekes-programmes/safety-and-security/healthcare--home/
[109] Innovations in Social and Healthcare Services. https://www.Tekes.fi/en/programmes-and-services/Tekes-programmes/social-and-healthcare-services/material/
[110] Pharma - Building Competitive Edge 2008-2011. http://www.Tekes.fi/globalassets/julkaisut/pharma_engl.pdf
[111] BioIT, https://www.Tekes.fi/en/programmes-and-services/Tekes-programmes/bioit/

The **Innovative Cities 2014-2017**[112] programme aims to create internationally attractive innovation clusters in Finland based on top-notch talent. Innovation clusters include companies aiming for growth that are capable of creating brand-new products and services for the international markets. One national theme of the programme is Future Health, which covers Oulu, the Helsinki Metropolitan area, Kuopio, Tampere and Turku. The goals are: 1) Development of health ecosystems; 2) The health technology export sector; 3) Digital well-being services as a commercialisation platform; 3) Home care as a commercialisation platform; 4) Campuses as an innovation platform for companies; 5) Biobanks as an innovation platform for companies; and 6) The Neurocentre as an innovation platform for companies. The financing is approx. €30m/year (the State gives €10m, cities €10m, and the ERDF €10m).

The third programme **Bits of Health 2014-2018**[113] is mainly intended for companies that utilise digitalisation and strive for international growth and that develop products and services promoting health, the early diagnosis of diseases, health monitoring and personalised care. Bits of Health provides services related to the development of a business network-based ecosystem, increasing business and client understanding and comprehending consumer behaviour. The programme offers funding for research, development and innovation projects. Co-creation with end-users and piloting in early developmental phase in real user environments is encouraged. The budget for the programme is €100m, of which approximately half is Tekes funding.

Tekes has contributed roughly €200m through the six programmes since 2007 until now. Moreover, based on the Health Sector Growth Strategy for Research and Innovation activities the most important public funders of the health sector research activities include Tekes and the Academy of Finland. Finland has contributed almost €300m of public funds to health related research annually and has internationally risen to the very top in many science sectors. A significant amount of the sector's public funding is channelled through applications. As a comparison health sector private research investments are currently approx. €300m to €400m according to the Growth Strategy for Research and Innovation in the health sector.

## G.1.4 Evidence of impact on global competitiveness

Finland has invested in health sector research for decades, gathering sample collections and registers and training professional personnel that are at the top of their field globally. This is the biggest competitive advantage of the sector in Finland. It seems that investments are paying off. The growth of health technology has been particularly strong and the investment in biotechnology and the pharmaceutical industry are beginning to result in success stories.[114]

Tekes has supported health related innovation and the promotion of networking through funding of companies for a long time. Most of the funding is channelled through applications (the so-called bottom up model). Between 2000 and 2011 invested Tekes approximately €75m in the development of mainly the pharmaceutical industry. Since 2008 the concept of health has broadened outside the pharmaceuticals sector. In recent years there has been cooperation with wider actors involved in the health and wellbeing sector (i.e. health service providers, academia, large pharmaceutical companies, SMEs and actors on the local community level).[115] The evaluations of Tekes' Pharma programme (2008-2011), the Diagnostics programme (2000-2003) and the Medicine 2000 programme (2001-2006) identified effects on scientific knowledge and technological developments, networking and collaboration. However, success was more limited in terms of the creation of new business activities and internationalisation rate.

Through its health programmes Tekes has supported the development of innovative solutions and services in the healthcare sector (both in companies and research institutions). Also networking activities such as seminars, knowledge exchange activities, creation of partnerships, building new value networks and enhancing cooperation of Finnish companies and public sector have been supported (e.g. formation of Smart Aging Network Finland[116], a company network with joint innovation and export activities). For the pharmaceutical sector funding and expert services for R&D and innovation within the pharmaceutical industry, pharmaceutical service companies and research organisations has been provided. Also enhancing cooperation between different sectors such ICT and health has been supported.

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112 Innovative Cities. https://www.Tekes.fi/en/programmes-and-services/Tekes-programmes/innovative-cities/

113 Bits of Health, http://www.Tekes.fi/en/programmes-and-services/Tekes-programmes/bits-of-health/

114 Ministry of Employment and the Economy of Finland (2014) Growth strategy for research and innovation in the health sector. https://www.tem.fi/files/40138/TEMrap_16_2014_web_26052014.pdf

115 Technopolis Group, VTT, Statistics Finland (2014) The Impact of Tekes Activities on Wellbeing and Environment. https://www.Tekes.fi/en/whats-going-on/news/recent-results-of-Tekes-impact-on-wellbeing-and-the-environment/

116 https://www.Tekes.fi/globalassets/global/ohjelmat-ja-palvelut/ohjelmat/turvallisuus/safety-and-security-ohjelmaraportti/safety-and-security-explore-the-topics/healthcare-and-home-artikkelit/sanf_esite_digi_final_lr.pdf

Moreover, support to health related clusters has been given to: develop health ecosystems; support health technology export sector; develop digital well-being services and home care as a commercialisation platform; and create campuses, biobanks and neurocentres as an innovation platform for companies. Furthermore, companies with specific focus on digital health have been supported with services related to the development of a business network-based ecosystem, increasing business and client understanding and comprehending consumer behaviour.

Through Team Finland programmes Gateway to UK[117] and Health USA[118] companies have been building channels and networks between Finnish health technology SMEs and the health and social care markets in the two countries.

## G.2 Self-care and monitoring case analysis

The self-care and monitoring sub-sector presents an interesting example for assessing Tekes support to the development of a niche eco-system and contribution to the national economy as well as society as a whole. The topic of self-care became increasingly important on the national political agenda due to the ageing population, low population density and limited available healthcare support. Strong long-term R&D as well as business expertise in the mobile technology and communications area led to an increase in start-up activities in the field of mobile and e-health (with the vast majority of products and applications linked to self-care and monitoring). The area's strength is also supported through the research projects conducted under SalWe (the Strategic Centre for Science, Technology and Innovation in Health and Well-being).

### G.2.1 Role in the Finnish economy

Analysing the role of the self-care and monitoring sub-sector is not straightforward as this area is rather small, interacts with other areas (e.g. ICT) and there are insufficient statistics for this sub-sector. More importantly, as confirmed by the interviews performed for this case study, the eco-system is in an early stage of development and it is difficult to define an eco-system due to the many cross linkages with other sectors and fragmentation. Nevertheless, Tekes estimates that the self-care and monitoring sub-sector consists of 40 companies, with an approximate turnover of €154m and a modest (compared to other sub-sectors) employment of 859.

### G.2.2 Finnish self-care and monitoring sub-sector in global value chains

The majority of Finnish companies in the self-care and monitoring sub-sector are smaller firms producing equipment or software to consumer markets. Almost all of the companies are Finnish-owned. International competition in this sector is very intense as companies like Samsung, Google and Microsoft dominate the markets. However, Finnish companies have opportunities to operate as niche producers as part of the ecosystem. A key challenge in this respect is the integration of products and services into full service concepts.

### G.2.3 Key drivers, enablers and barriers

The drivers for the innovation in the Finnish **health sector as a whole** (according to the Health Sector Growth Strategy for Research and Innovation) are the following:

- A comprehensive sector of higher education institutions and higher education based on research
- Considerable and long-term public contributions to the health sector research and innovation activities, including in the framework of universities
- Key researchers are closely networked in the framework of both Nordic research (Nordic EMBL Partnership in Molecular Medicine) and research carried out in the EU (ESFRI and EMBL)
- A good price-quality ratio of the research activities and patients who are committed to research studies
- A significant competence base: high scientific level in several globally significant therapy areas and strong technological competences
- The long-term reinforcement of the health technology sector
- Strongly developing application of data systems and mobile technology in the promotion of health and welfare
- High-quality competences in conceptualisation and architecture related hospital infrastructures
- Statistics, extremely competitive registers and measures promoting the openness of research data as well as the new legislation on biobanks
- Good connections and close cooperation with developing countries with rapidly growing health markets
- Rising public and private sector demand for increasingly effective and cost-efficient products and processes.

[117] Gateway to UK. http://www.Tekes.fi/en/programmes-and-services/Tekes-programmes/bits-of-health/gateway-to-uk/
[118] Health USA. http://www.Tekes.fi/en/programmes-and-services/Tekes-programmes/bits-of-health/team-finland-health-usa/

Finland is considered to be in a good position and a leading country in the research for personalised healthcare. It has top research competences in many therapy areas and versatile competences in health technologies, such as diagnostics and imaging. Finland also has solid ICT competences and a strong technology industry.

The main barrier for the health sector according to the Strategy is that healthcare traditionally has been seen as a cost factor in the state and the municipal budgets and the main focus in the sector so far has been on becoming cost-efficient. This has not allowed identifying the significant potential of healthcare from the point of view of industrial policy – there is a very different attitude towards healthcare compared to, for example, ICT and energy. Moreover, constant decrease in the funding base for research carried out in the service system and small municipal funding allocated for research has caused problems. The issues related to fragmentation and predictability of Finnish innovation system affect the ability of companies to carry out long-term research cooperation with various operators in the public sector.

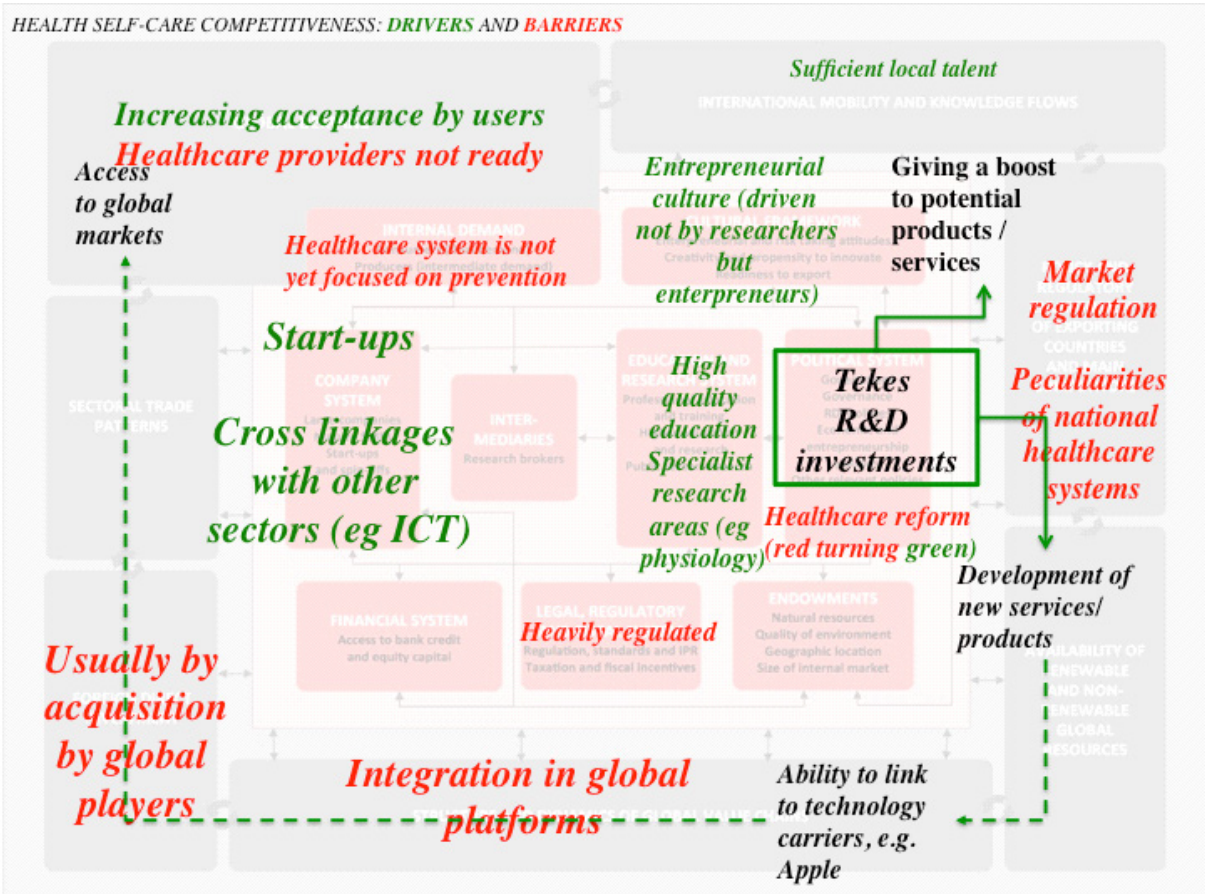
The drivers and barriers for the development of the **self-care and monitoring sub-sector** are summarised in the figure below.

### Start-up ecosystem and cross-linkages with ICT

The Finnish start-up ecosystem (especially in the ICT area) is one of the key drivers in the development of innovative businesses in the self-care and monitoring sub-sector. Finland is one of the leading countries in terms of starting a business (counted as the number of days needed to start a business, the number of necessary start-up procedures to register a business and tax level). It was ranked in 4th place for this dimension in a recent EU mHealth App market ranking.[119] The same survey puts Finland in 3rd place (after Denmark and Sweden) in the overall score of market prerequisites for mHealth business. Such an encouraging development in the ecosystem gives a very positive stimulus for the appearance and growth of new companies in different sectors, including self-care and monitoring area.

### Research skills and specialist profiles

The sub-sector's evolution is supported by strong research skills and specialist knowledge in various health areas (e.g. physiology, sports medicine) needed for the development of self-care and monitoring businesses. Finland boasts a vast amount of highly capable researchers and long traditions of knowledge. Not only basic academic education,




[119] Research2Guidance (2015), EU Countries' mHealth App Market Ranking 2015. Which EU countries are best for doing mHealth business. https://research2guidance.com/wp-content/uploads/2015/10/EU-Country-mHealth-App-Market-Ranking-2015-Preview.pdf

but also the entire Finnish education system is well rated around the world. Finns have established academic contacts with researchers globally and can tap into international networks.

### Strong entrepreneurial culture driven by entrepreneurs and not research

Finland has developed a strong entrepreneurial culture and supporting environment. Its high-growth entrepreneurial ecosystem developed relatively well even after the financial crisis in 2008 (and even compared to other countries in the region).[120] Finns have a positive attitude towards entrepreneurship, ranking among the top countries in a survey of 44 countries which focused people's attitudes towards self-employment and related topics like the entrepreneurial spirit.[121] The country ranked 2nd (after Israel) in the status of successful entrepreneurs and established business ownership rate (14th our of 60) despite having a very low rank (53rd out of 54) in terms of entrepreneurship as a good career choice[122].

Established and new entrepreneurs as well as researchers are willing to embark on a journey of creating new products or services. As was noted by the representatives of the self-care and monitoring sub-sector, it is less usual for researchers to set up a company in this sub-sector. Rather start-up founders are new (or less experienced) entrepreneurs, with the help of mentors, who are coming up with ideas for new self-care and monitoring products and services.

### Increasing acceptance by users but less so by healthcare providers

The biggest challenge in many countries related to the acceptance of the self-care and monitoring products and services is to change the way people think about healthcare. Population is growing wiser and more accepting of the self-care and monitoring products helping them to understand the opportunities to look after their own health and leading to certain behaviour change (from care to prevention). A high percentage of Finns say that they like monitoring their own health, looking after themselves, and having a say in their treatment if they fall ill.[123] Such adoption of new mHealth or eHealth products by users is extremely valuable in order to warrant investments into the sub-sector in the coming years.

What is happening slower is the acceptance of the self-care and monitoring among the healthcare providers. According to the representatives of this sub-sector self-monitoring is not taken seriously by health professionals in Finland. The healthcare system supports *health care* rather than *health prevention*. And this is in the time when the healthcare costs are increasing. The Finnish Ministry of Finance estimates that age-related treatment and nursing costs will increase by six percentage points by the mid-2030s unless structural reforms are introduced.[124] An increasing number of elderly will also cause a shortage of labour in the social welfare and healthcare sector. This is estimated to be as high as 20,000 people by 2025. Developing electronic self-care and monitoring products and services to take some of the burden off traditional healthcare is one solution to this problem and needs to get high on the political healthcare agenda. The Finnish Health and Social care system is currently in transition with a goal to achieve fully integrated care at national level, which could open more opportunities for the application of self-care and monitoring products and thus boost further development of this sub-sector.

### Evident market potential but slow international entry

Finland has the third best market prerequisites needed for the mHealth business among EU countries according to a survey of over 4,000 app developers, healthcare professionals and mHealth practitioners who were asked to rank countries based on dimensions such as eHealth adoption, level of digitalisation, mHealth market potential, regulations and ease of starting a business.[125] Finland had the highest market readiness and most mature market conditions. However, the barriers for Finnish self-care and monitoring companies lie beyond the Finnish market.

The small home market forces Finnish companies to go international almost from the very launch of their business. The home market is measured not only in terms of users but also the size of labour force needed to grow businesses. Finland is considered too small[126] but getting to the global market and entering global supply chains and succeeding is a weak point. Interviewees considered that it is a challenge to grow well-established mid-size companies in Finland.

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120 Rannikko, R. and Autio, E. (2015) The impact of high-growth entrepreneurship policy in Finland

121 GfK (Gesellschaft für Konsumforschung) Nuremberg (2015) AGER2015. The Amway Global Entrepreneurship Report 2015. Defining the Entrepreneurial Spirit

122 Kelley, D., Singer, S. and Herrington, M. and the Global Entrepreneurship Research Association (GERA) (2016). Global Enterpreneuship Monitor. 2015/16 Global Report

123 http://www.sitra.fi/en/well-being/self-care

124 ibid

125 Research2Guidance (2015), EU Countries' mHealth App Market Ranking 2015. Which EU countries are best for doing mHealth business. https://research2guidance.com/wp-content/uploads/2015/10/EU-Country-mHealth-App-Market-Ranking-2015-Preview.pdf

126 Kulvik, M., Nikulainen, T., Peltonen, I. and Tahvanainen, A. (2015) Finnish Biotechnology Industry: Strategies and Future Prospects

Transferring the IT platform (on which some of the self-care and monitoring products are built) is not a problem as such. The two main barriers are (1) technology carriers and (2) healthcare market. First, the international market of mHealth applications is dominated by large players, such major mobile communications players like Apple, Microsoft, etc. Integrating new self-care and monitoring applications to the global platforms of key players can be achieved quickly but it inevitably (in the majority of cases) leads to the acquisition by global players (thus taking away an opportunity to grown indigenous Finnish companies). Second, the organisation of the health systems in various countries is an important factor for those companies that target healthcare providers directly. The system relates to how the services could be funded and reimbursed and how the health professionals in primary care centres and hospitals reorganise their practice. Thus, technological innovation needs to be aligned with the organisation of health care provision to ensure the transferability of the platform.

**Regulations and other legal issues**

Preventive healthcare (i.e. self-care and monitoring) sub-sector lays at the intersection of a state-regulated healthcare system and a consumer driven market. There are very diverse market structures, incentives and regulations in place across different countries and various actors in the healthcare system play different roles, making it difficult for young companies to navigate through the national set-up.

In countries where regulatory environments have more scrupulous oversight on preventive healthcare products and services the market entry can become thorny. An important factor that companies have to encounter is the requirement for medical certification to prove the claimed health outcomes of a product or service. For example, wearable devices (in case of some self-monitoring products) are rapidly emerging applications intended for daily use under increasingly diverse situations, e.g. from fitness apps to insulin intake reminder devices. To date no single set of standards exists that would evaluate all types of emerging wearable devices. For some wearables more accuracy and consistency in the performance is required, thus also stricter certification rules prevail. Companies engaging in this market niche have to understand in detail the national regulatory requirements, as well as time-scale for applicable certification procedures. These kinds of uncertainties significantly increase the complexities and challenges in upscaling entrepreneurial activities in such emerging healthcare sub-sector as self-care and monitoring.

## G.2.4 Tekes impact on self-care and monitoring competitiveness

Tekes played a crucial role in the support and development of R&D and innovations in Finland. As nicely put by one of the interviewed experts, Tekes' support to R&D rather than any other activities played an important role in the development of the self-care and monitoring sub-sector. If R&D is weak, it is difficult to develop a solid and reliable product and thus take the company to a competitive enough level.

Ongoing support to SMEs (as was the case of companies applying for funding through different Tekes instruments) proved more beneficial than a one-off support. In the latter case, the rationale is that a one-off funding will help kick start needed processes within and around an SME and let it grow to a competitive scale. However, the interviewed experts felt that continuity of support is a more important factor. When relationships in the eco-system shift to the commercial stage (usually when public funding stops), then dynamics in the eco-system change, the motivation of companies to cooperate diminishes and the results are weaker.

Among the support instruments offered by Tekes and the wider Team Finland network, trade mission to foreign countries are considered as highly visible. Team Finland Health had taken a number of the health and wellbeing companies on foreign missions. For example, in the autumn of 2015, Finnish companies showcased themselves in the USA during the sector specific conference Health 2.0 and linked with specialist incubators, local companies, investors and partners. Such international are valuable to the Finnish companies and in some (more closed) countries, e.g. China, can play an important 'door-opening' role. Some interviewed companies expressed a view that Tekes' position as a 'State organisation' is extremely valued abroad and can open doors even in culturally sensitive markets such as China. It is much easier for a Finnish company to enter a foreign market through an introduction from Tekes rather than trying to penetrate the market on its own. Although this is not a direct financial contribution, it is an important step in making a company visible internationally which (over the time) could lead to an established globally competitive position.

### G.2.5 Views on future role of Tekes

Tekes (and the wider Team Finland network) can further support the development of the self-care and monitoring sub-sector through a number of actions:

- Market knowledge / market intelligence from target markets is important for the Finnish companies going global. Such support has been available so far and should be continued;
- Tekes has a unique position in helping the development of several sub-sectors together. In case of self-care and monitoring, several niches work together (e.g. ICT and health) and support is needed to the whole eco-system and not one or another sub-sector. It also means focusing on various players in the eco-system (e.g. larger players as well as healthcare providers and not just small start-ups);
- Getting the delivery of preventive healthcare right is a crucial step for the acceptance of self-care and monitoring products. Finnish healthcare reforms are taking place so it is important for Tekes (and other players) to work closely with the Ministry of Social Affairs and Health in achieving a common understanding of the challenges faced by companies and the opportunities they can bring;
- Tapping into international funding can present an interesting opportunity for the international development of Finnish businesses. Tekes can supplement the funding it gets from the government with that from international sources (of key target markets). For example, according to the interviewees, it could be possible to bring funding from target markets, such as China, where capital is available;
- Some interviewees were of the opinion that Tekes funding rules proects are too inflexible as innovative projects do not always develop as planned. There is, therefore, a need to review granted support and cut funding for products / innovations that are not developing and use the freed resources for other ideas.

### G.2.6 Synthesis and key takeaways

Finland has high quality healthcare related research and higher education, expertise in various areas (e.g. ICT and mobile) with applications to self-care and monitoring, a well-functioning start-up ecosystem and strong entrepreneurial culture, an increasing acceptance of health prevention and self-monitoring among the population, a high coverage healthcare system with strong movements towards electronic and mobile health (e.g. digital healthcare registers), and one of the best market conditions for the mHealth businesses in the EU. All these factors make Finland a good place for the development of self-care and monitoring sub-sector into a thriving eco-system. Certain obstacles, nevertheless, need to be overcome for this sub-sector to become more visible and competitive not only nationally but also internationally.

Over the years support from Tekes and the wider Team Finland network played an important role in developing Finnish SMEs, including in the self-care and monitoring sub-sector. For the future, the following aspects should be taken into account:

- The sub-sector is still in its early stages of development and support is needed of a varied nature and over a longer period of time;
- Finnish self-care and monitoring sub-sector needs success stories visible internationally to build positive (and bigger) publicity and trust;
- Cross-sectoral linkages (as happened between mobile communication and healthcare in creating self-care and monitoring mHealth applications) need to be nurtured and supported with a goal of creating more cross-sectoral combinations and, as a result, new companies.

# Appendix H. International learning cases

## H.1 DENMARK – Cleantech

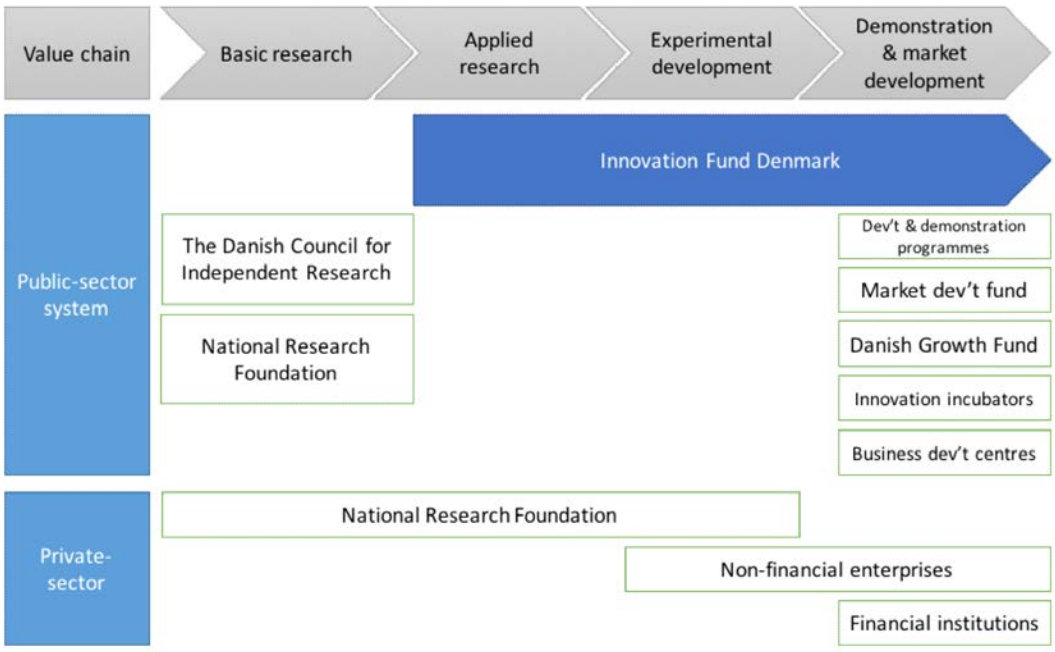
### Unique driver for global competitiveness: Policy convergence across all areas of government and societal challenges

### H.1.1 Strategic vision

R&D and innovation in Denmark serve a dual purpose: solving societal challenges while also promoting economic growth and employment. And it would appear the ordering of these two purposes is very much on purpose. Unlike many other jurisdictions, the innovation ecosystem does not place the ministry responsible for the economy or competitiveness at the centre of the public-sector side of the innovation ecosystem. Rather, the Ministry of Foreign Policy is responsible for attracting foreign investors, and the Ministry of Higher Education & Science holds a primary place in driving direction for research and innovation. Finally, the recently created Innovation Fund Denmark—with representation from both the private and public sector—does not directly report to any particular ministry.

A diagram of the government's view of the innovation ecosystem—and hence how it drives competitiveness—is shown in the diagram below.

Given the focus on societal challenges, it explains the level of policy convergence that is possible across ministries, which helps to drive a vision for innovation. For example, Denmark's government has shown a huge commitment to sustainable development, with initiatives across ministries affecting all facets of society—energy policy supports biogas and new energy infrastructure around hydrogen and electric has strong support. Encouraging co-operation between government and industry is not primarily about supporting the business environment or employment, but about leveraging knowledge.




Source. Innovation Fund Denmark 2015 Strategy

## H.1.2 The Danish value proposition

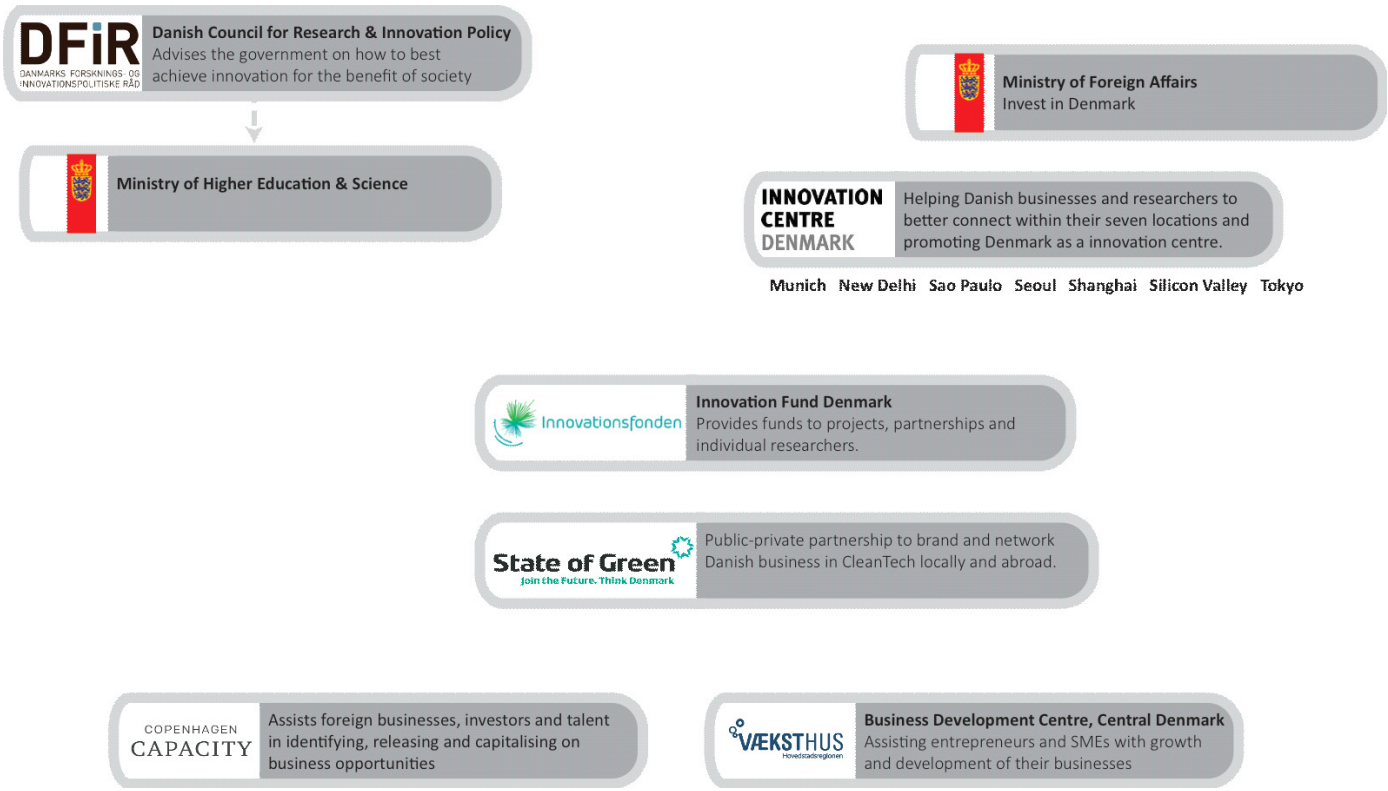
Denmark has a long tradition in the field of CleanTech, with the country home to some of the biggest players in renewable energy, particularly around wind (such as Vestas). Renewable energy became a political priority in Denmark in the 1970s, and the seeds for the industry were planted late in the decade. Many researchers focus on the role of government-set minimum prices for wind energy as well as other state-aid schemes in the industry's growth; however, the growth of a successful cluster in the area owes credit to the creation of a machine testing programme at the Risø National Laboratory in 1978. In much the same way that certification of projects by Tekes, Risø's developed a testing programme—with a certification element added a year later—was initially intended to support the Danish strategy to establish a "safe technical path" for wind energy, but ended up establishing market credibility with Danish technology that was reliable.

Not only does the Danish government play a central role in supporting CleanTech, but the objective of Copenhagen becoming a CO2-neutral city by 2025 also drives investment and provides a testbed for innovative use of technology. Energy (through biogas and wind), the transport system, and other policy areas are primary drivers and attractors of talent and investment.

## H.1.3 Ecosystem for promoting global competitiveness

While there are a number of players in the innovation ecosystem—including the relatively important role played by entities like Copenhagen Capacity at a local level—most of the focus on driving innovation seems to derive from a single entity: Innovation Fund Denmark. This organisation is responsible for funding projects, and using that funding as a springboard for advice to growing companies looking to internationalise.

A wider picture of the support infrastructure in Denmark is presented in the diagram below. While the picture is largely national, Copenhagen has been selected as the focal point to see the role of local organisations.



## H.1.4 Selected instruments for promoting global competitiveness

The following table outlines some of the headline programmes that Denmark is using to improve its innovative ecosystem.

| Theme | Organisation(s) responsible | Activity |
|---|---|---|
| **Intelligence gathering** | Copenhagen Capacity | Market surveys for business development. |
| **Promotion / network-building** | Copenhagen Capacity | Facilitate contacts and networks with potential partners, public authorities and research institutions |
| | Copenhagen Capacity | Introduce you to companies, public authorities and research & knowledge institutions. |
| | Innovation Centre Denmark | Matchmaking with key players within one of their seven local markets and Denmark. |
| **Advisory** | Copenhagen Capacity | Provide advice on legal, financial and corporate structure matters |
| **Funding** | Innovation Fund Denmark | Large Scale Projects. Investments over DKK 5 million of projects raning from basic research to market. Projects are funded along three different areas: thematic, open, and specific societal challenge. |
| | Innovation Fund Denmark | Growth Projects (InnoBooster). Investments of up to DKK 5 million for SMEs on projects with a "high development potential". |
| | Innovation Fund Denmark | Talents. Financial support for industrial PhD and postdocs or entrepreneurs. |

## H.2 GERMANY

### Unique driver for global competitiveness: Strong partnership principles and good fundamentals

### H.2.1 Strategic vision

While Germany presents a strong national brand when it comes to global competitiveness and innovation, the länder remain equal partners in shaping the innovation ecosystem. The position of the national government and the strong role of the länder creates a sense of a two layered system. However, the role of the national government, especially for innovation policy and investment promotion, is very small given the dominant position of the länder. The differences between the individual länder is however rather small, as in general Germany does not have a large portfolio of innovation policies and investment promotion. Most of the attention is directed at supporting the (local) German business environment. Thereby Germany basically expects people to know Germany for its technological expertise, which makes promotion of the country redundant.

At the national level, the German government has developed a high-tech strategy, one of the elements for achieving greater global competitiveness and improving the innovation ecosystem. Their strategy identifies what they define as an "innovation chain" and their strategy aims to improve the conditions around all five areas.


Source. The new High-Tech Strategy Innovations for Germany

Similar to Denmark, Germany has also chosen to focus its innovation activities on particular societal issues, though focussing on prosperity and quality of life. These areas are:

- The digital economy and society;
- The sustainable economy and energy;
- The innovative workplace;
- Healthy living;
- Intelligent mobility; and
- Civil security.

While the national government provides funding for research on these activities, many of the research institutes operate in the marketplace directly, applying for projects like any other private-sector institution. Fraunhofer, with 66 research institutes across the country, is the largest of these organisations, with approximately 70% of its budget deriving from project work, but many other quasi-governmental institutes exist. In the field of health, the relatively specialised institutes of the Paul Ehrlich Insitute and the Robert Koch Institute operate under the supervision of the Ministry of Health, while the Helmholz Association operates under the Ministry of Education and Research, sourcing nearly 30% of its budget from project work.

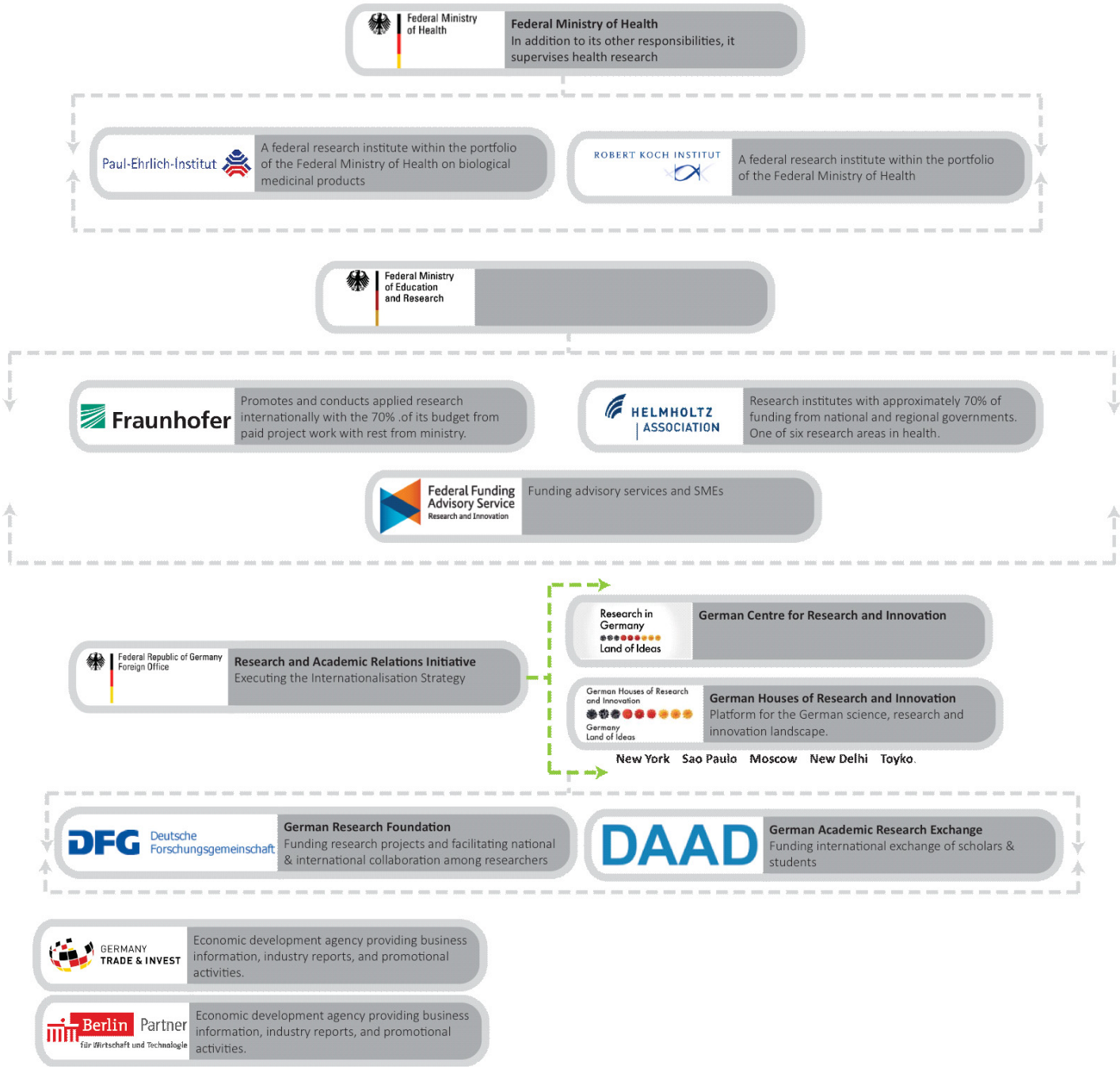
### H.2.2 The German value proposition in (digital) health

Germany is home to one of the largest healthcare companies in the world, namely Siemens Healthcare. Health remains one of the six key areas for Germany's high-tech strategy. While Germany has strengths in the field of health, the real added value to the German proposition in health has been the rising importance of Berlin as a centre for tech, particularly in health (and financial) technologies, ranked only behind London. Berlin has a vibrant start-up scene and has been raising more venture capital than any other location (€2.2 billion in 2014 versus €1.48 billion in London). While analysts still debate over the spark for this vibrant scene—attracting living standards, early successes of key start-ups—there is no doubt that Berlin works as a magnet for attracting talent.

### H.2.3 Ecosystem for promoting global competitiveness

Germany is relatively unique in the hybrid nature of its public institutions that support the ecosystem. While places like Ireland and Sweden have independent bodies responsible for promoting and growing their innovation ecosystems, many German institutions not only run independently, but gain their funding through competition and projects.

A wider picture of the support infrastructure in Germany is presented in the diagram below. While the picture is largely national, Berlin has been selected as the focal point to see the role of local organisations.



## H.2.4 Selected instruments for promoting global competitiveness

The following table outlines some of the headline programmes that Germany is using to improve its innovative ecosystem.

| Theme | Organisation(s) responsible | Activity |
|---|---|---|
| **Intelligence gathering** | German Centre for Research and Innovation | Permanent presence in locations of German Houses of Research and Innovation |
| | Germany Trade & Invest | Events |
| **Promotion / network-building** | German Centre for Research and Innovation | Scientific conferences and symposia. |
| | German Centre for Research and Innovation | Matchmaking between universities. |
| | German Research Foundation (DFG) | Funding for interdisciplinary and international research. |
| **Advisory** | German Centre for Research and Innovation | "One-stop shop" for information on funding opportunities in Germany. |
| | Federal Funding Advisory Service | Inform applicants about federal research structures, funding programmes, and contacts as well as about current funding initiatives. |
| | German Research Foundation (DFG) | Provides scientific policy advice |
| | German Trade & Invest | Market research for German companies. |
| | German Trade & Invest | Project management advice |
| | German Trade & Invest | Location consulting / site selection |
| | German Trade & Invest | Support services, including tax and legal issues, project financing, and incentives. |
| | Berlin & Partners | Provide information on financing, locations in Berlin, talent, and market research. |
| **Funding** | Federal Funding Advisory Service | Funding to provide business financing, improvement of market positions, education and further training |
| | German Research Foundation (DFG) | Fund basic and applied research in the sciences and humanities. |

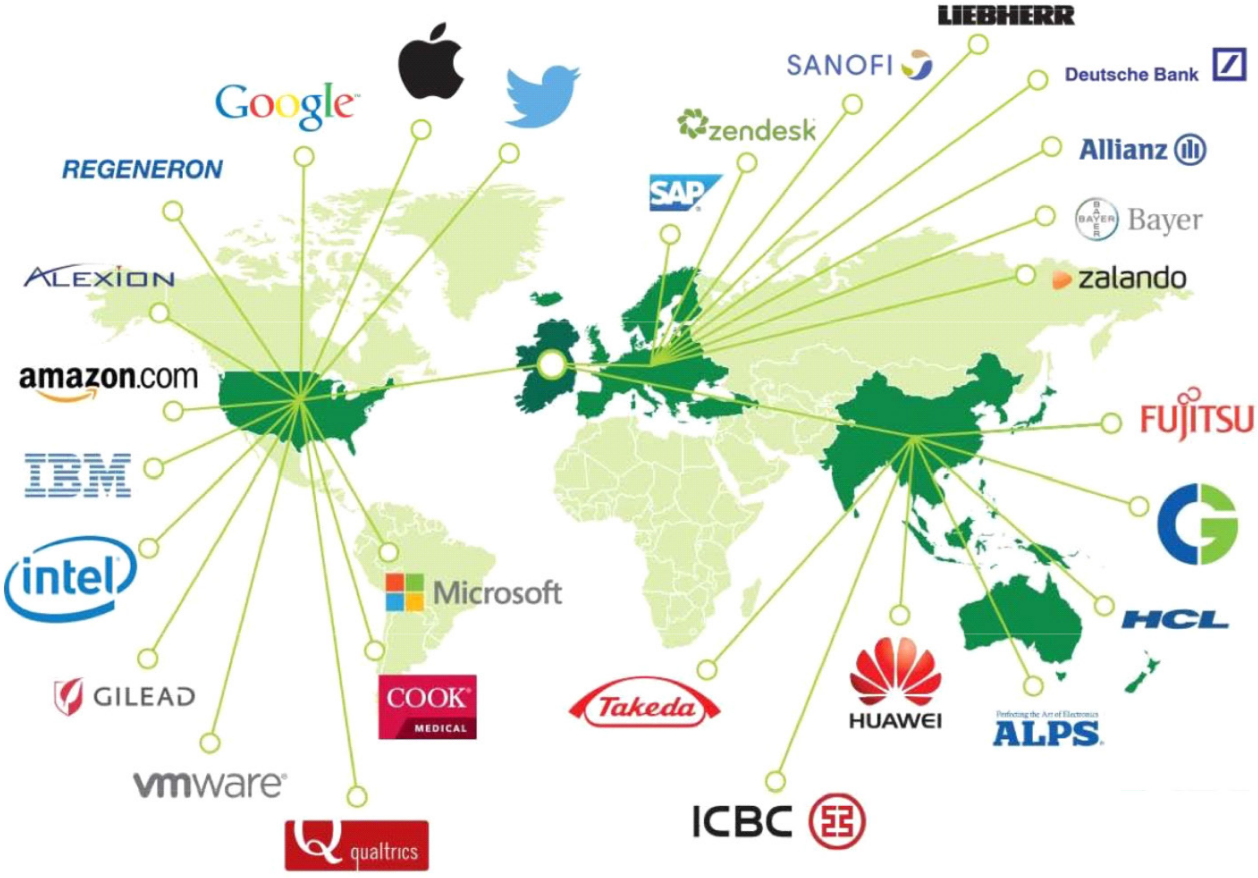
## H.3 Ireland – ICT

### Unique driver for global competitiveness: foreign investment and job creation

### H.3.1 Strategic vision

While most governments acknowledge the connection between job creation and the internationalisation of its business and research environment, the fact that many of the international competitiveness programmes report into the Ministry of Jobs, Enterprise, and Innovation is telling. The prism through which policy is viewed is first and foremost job creation.

Ireland places a particularly heavy emphasis on foreign direct investment as a driver of economic growth and innovative capacity. Some of the headline figures that IDA Ireland markets is the nearly **175,000 jobs** created by firms that they support (with more than 10,000 additional jobs created annually) and that these foreign firms spend **€1.4 billion on research and development** annually.[127]




[127] Winning Foreign Direct Investment 2015-2019, IDA Ireland.

Ireland also heavily markets the presence of tech giants, such as Apple and Google, which have regional headquarters located in the country. While much of the popular focus has been on low corporate tax rates as a reason that Ireland attracts large corporates, the fact remains that Ireland has the skills base to support major activities.

While other countries have their national champions—NXP and ASML in the Netherlands; Infineon and Bosch in Germany—Ireland is not defined by its indigenous firms. Attracting foreign firms who have been conducting R&D in the country, however, has led to a number of spin-offs in highly specialised areas, such as Movidius, who recently signed an agreement with Google to use their processors and software development environment to advance deep learning on mobile devices.[128]

From an innovation perspective, Ireland benchmarks itself against the Scandinavian countries, including Finland. It sees itself as imbalanced in terms of developing its innovation ecosystem, with weaknesses in level of investment in R&D, linkages of research to enterprise, and the creation of patented intellectual assets. One of the main goals for the upcoming period to 2020 as outlined in their public strategy is to bring Ireland to 2.5% spending as a part of GDP, starting the with public funding and then making better use of partnerships between public and private organisations.[129]

## H.3.2 The Irish value proposition in ICT

Like most other jurisdictions that attempt to position themselves for ICT, Ireland claims to have a good base of talent and connected researchers. However, the tax package of incentives that Ireland provides to (foreign) companies has been a unique differentiator. As has been widely reported, Ireland's low corp0rate tax rate of 12.5% has been a key selling point for the country, but arguably another important attractor for certain activities has been Irish rules around profit shifting.

While Ireland's participation in the OECD's Base Erosion and Profit Shifting project and policy moving away from these mechanisms, it has helped to build up a tech base in the country around the many regional headquarters that have been set up in Dublin and beyond. Many of the best known tech brands operate in Ireland.

| City | Company |
|---|---|
| Dublin | Google<br>Facebook<br>LinkedIn<br>Twitter<br>Airbnb<br>Dropbox |
| Cork | Apple<br>Tyco<br>eSentire<br>Netigate |

In terms of technology, Ireland appears to have a relatively deep knowledge of semi-conductor design and electronics, anchored around multinationals such as Intel, Analog Devices, and others.

## H.3.3 Instruments for promoting global competitiveness

Actions by Ireland around improving global competitiveness take place within the "triumvirate" of IDA Ireland, Enterprise Ireland, and the Science Foundation of Ireland. All three of these institutions are state-owned enterprises with a large degree of operational freedom, though each operating under a mandate provided by the Ministry for Jobs, Enterprise, and Innovation.

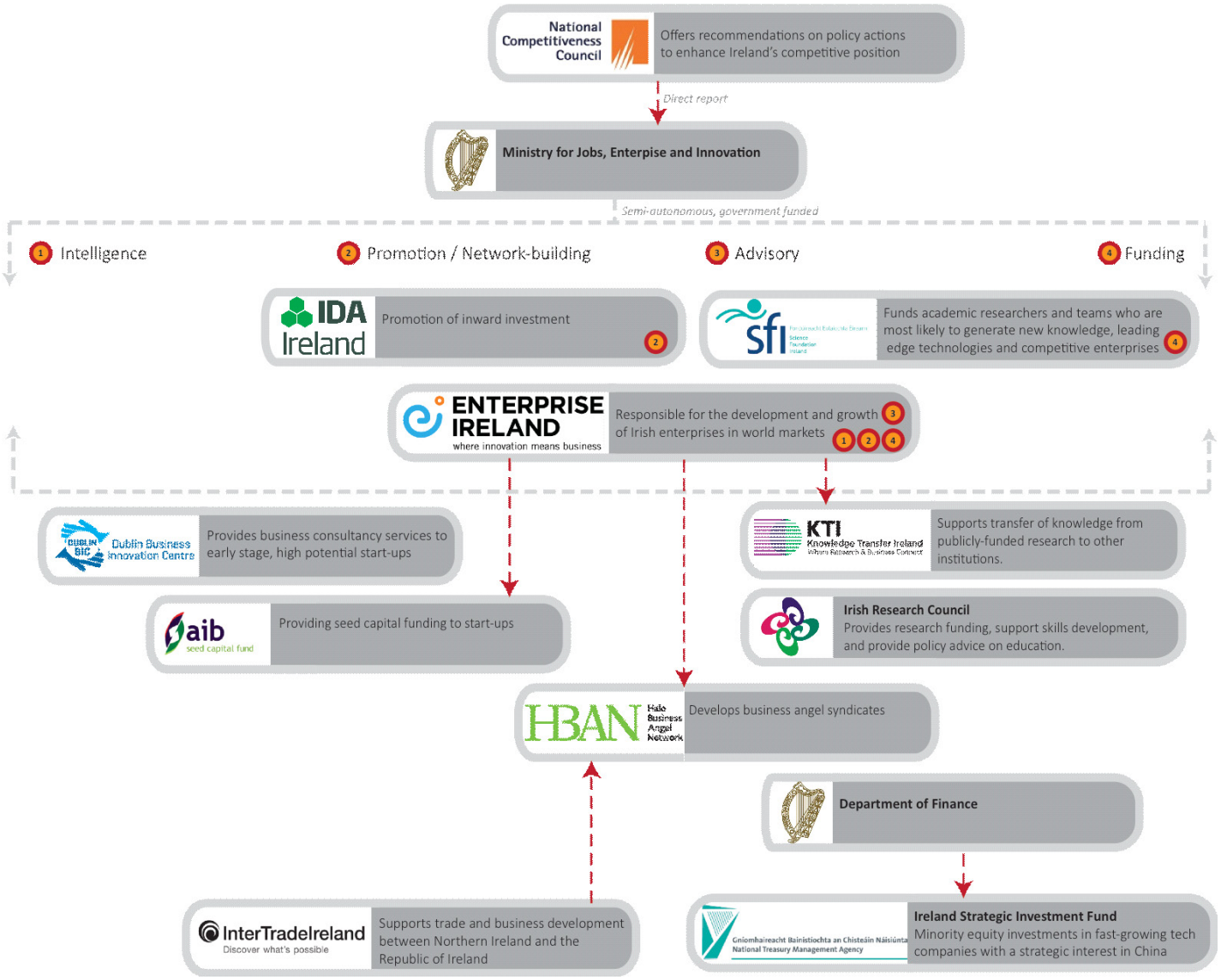
Rather than focus on a particular product or service, each member of the triumvirate holds a mandate aimed at a particular segment of the innovation ecosystem:

- IDA Ireland. Foreign investors
- Enterprise Ireland. Indigenous firms
- SFI. Research community

[128] http://www.movidius.com/news/google-and-movidius-to-enhance-deep-learning-capabilities-in-next-gen-devices

[129] Innovation 2020, Ireland's Strategy for Research and Development, Science and Technology, Interdepartmental Committee on Science, Technology, and Innovation.

A wider picture of the support infrastructure in Ireland is presented in the diagram below. While the picture is largely national, Dublin has been selected as the focal point to see the importance of local organisations. In the Irish context, unlike the other case studies, the national government and institutions seem to dominate.



### H.3.4 Selected instruments for promoting global competitiveness

As governance within the innovation ecosystem focuses on a segment, there is some overlap of instruments, and surprisingly a failure to fully leverage the resources across the main parties. Communication between the triumvirate is very good, and each organisations makes requests of the other to achieve its goals. However, in areas such as network building, each organisation focuses on their own networks and there is little attempt for one organisation to use the network of another.

The following table outlines some of the headline programmes that Ireland is using to improve its innovative ecosystem.

| Theme | Organisation(s) responsible | Activity |
|---|---|---|
| **Intelligence gathering** | IDA Ireland / Enterprise Ireland / Science Foundation Ireland | Networking management (conferences, events) |
| **Promotion / network-building** | IDA Ireland | Match-making with peer companies, industry groups, and research centres |
| | IDA Ireland | Provide information, including on areas such as tax, skills, education and research programmes, labour law, investment opportunities, operating costs, infrastructure, and support services. |
| | IDA Ireland | Maintain portfolio of property, such as business and technology parks |
| | Science Foundation Ireland | Public engagement through Centres for Science, Engineering and Technology (CEST) |
| | Science Foundation Ireland | Match-making with researchers (also by request from IDA Ireland) |
| | Science Foundation Ireland | Maintain publicly available researcher database (http://www.sfi.ie/investments-achievements/researchers/search-researchers.html) |
| | Knowledge Transfer Ireland | Maintain publicly available research database (http://www.knowledgetransferireland.com/About_KTI/Find-a-Research-Provider/) |
| | Science Foundation Ireland | Manage 12 Research Centres along thematic areas, which bring together industry and academia |
| | Enterprise Ireland | A series of offices globally, largely to support exports. |
| | Enterprise Ireland | Trade events and missions |
| **Advisory** | IDA Ireland | Information on aspects of the value proposition |
| | Enterprise Ireland | Market research centre to provide business intelligence |
| | Enterprise Ireland | Graduates for International Growth, matching a recent graduate with an internationally focussed company |
| | Enterprise Ireland | International Selling Programme |
| | Enterprise Ireland | Export Selling workshop series, including information on value proposition & messaging, pipeline management, and partnering |
| | Enterprise Ireland | Fist Flight workshops and mentors to assist with export promotion |
| | Enterprise Ireland | Internet Marketing Unit to help companies exploit online opportunities |
| | Enterprise Ireland | Business Accelerator Programmes |
| **Funding** | Irish Tax and Customs | 25 percent tax credit |
| | Dublin Business Innovation Centre | Angel funding |
| | Dublin Business Innovation Centre | €53 million AIB Seed Capital Fund |
| | Enterprise Ireland | Seed & Venture Capital Programme |
| | Enterprise Ireland | Development Capital Fund |
| | Enterprise Ireland | Innovation vouchers for collaborating with a knowledge provider or registered college |
| | Enterprise Ireland | Technical Feasibility Study Grant for developing new products or services. The grant can also be used to develop FP7 proposals. |
| | Science Foundation Ireland | Grants for researchers, with even split between basic and applied research. |
| | IDA Ireland | Support for capital investments and employment |
| | IDA Ireland | Training grants |

## H.4 SWEDEN – bio economy

### Unique driver for global competitiveness: government as producer and customer

### H.4.1 Strategic vision

Global competiveness in Sweden—like most developed economies—begins with a view on supporting innovation. Here, Sweden sees the government playing a particularly active role as a stakeholder in the innovation ecosystem (what they refer to as the "innovation climate"). Innovation is seen as achieved through improvements in three key areas:

- **A well-functioning framework.** This essentially means a stable policy climate contusive to innovation, such as rules around taxation, the labour market, education, and infrastructure.
- **Innovation in public services.** Perhaps one of the key differentiators from many developed-economy competitors is how the government sees itself as a key provider and customer of innovative services. Government is an example setter and a direct participant rather than simply a funder of activities.
- **Direct measures targeting innovation processes.** These are the activities on which partners of the government would be engaged, supporting entrepreneurship, providing advice, and funding innovative activities.[130]

Given that the government sees itself as a provider and client in the innovation ecosystem, it helps explain some of the governance choices that have been made around public-sector actors. Organisations such as Business Sweden (the country's investment promotion agency) and RISE Research Institutes (a network of research and technology organisations) function as independent institutions with co-ownership between government and various stakeholders. This co-ownership element further solidifies the government's role in the ecosystem.

### H.4.2 The Swedish value proposition in the Bio-Economy

In terms of the value proposition around the bio-economy (arguably, a subset of CleanTech), the capitals of Sweden and Denmark hold some parallels. Both emphasise policies around becoming CO2 neutral, with Copenhagen looking to achieve this by 2025 and Stockholm by 2040 (moved up from 2050 only recently). Like Copenhagen, it ranks very well on indicators around green urban planning, green energy, and green buildings. This is another example of how the public sector is a direct driver of investment in the sector, not just as an entity responsible for the business environment, but also as an important client.

An example of this relationship comes out of the BioEthanol for Sustainable Transport (BEST) project, from 2006 to 2009. This project, supported by the European Union, was meant to promote the use of clean vehicles and fuels. While the project involved 10 regions, Stockholm was the co-ordinating city. Swedish companies such as Scania—who produced some of the bio-fuel buses for the project, also provided direct input.

Given that the bio-economy is cross-cutting, touching on sectors such as resource extraction, transport & logistics, and energy—it can be difficult to disentangle other unique elements of the value proposition. While Sweden is currently developing a national strategy to promote the BioEconomy—with Formas, VINNOVA, and the Swedish Energy Agency taking the lead—this document only further illustrates the size of the umbrella that covers the bio-economy. While the focus of the document is on forestry and agriculture, this report makes clear that the "bio-based economy" should touch on all elements of value chains across sectors. RISE further illustrates this point with roadmap for the bio-economy from 2015-2025, which covers areas as diverse as fuels, materials, and sensors:

- The pulp mill biorefinery;
- Lignin-based carbon fibre;
- Materials from nanocellulose;
- Textile materials from cellulose;
- Bio-based composites;
- Food industry and pulp mills in symbiosis;
- Biofuels for low-carbon steel industry; and
- Sensors for increased resource efficiency.

### H.4.3 Ecosystem for promoting global competitiveness

In Sweden, there is a clear demarcation between innovation and research at a ministerial level, even though the innovation ecosystem clearly works to bring the two together. On the level of funding, one part of the government under the Ministry of Enterprise and Innovation through Vinnova, is responsible for supporting applied research, bringing together business, government, and academia. Basic research, however, is supported under a different area, un-

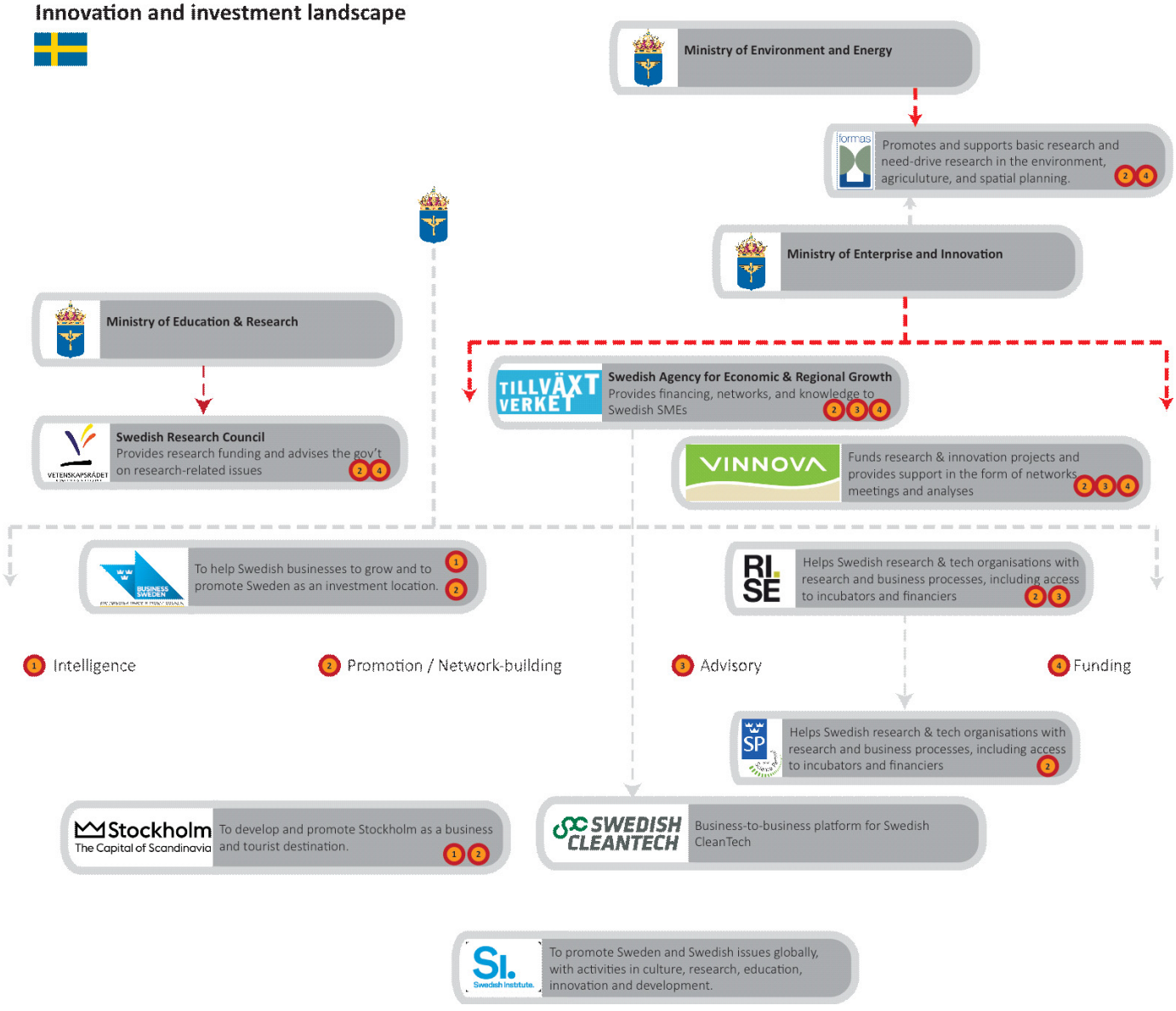
[130] Swedish Ministry of Enterprise, Energy and Communications, Swedish Innovation Strategy, 2014.

der the Ministry of Education & Research. Both sides of the equation promote the internationalisation of researchers (and network building) and help to drive competitiveness; however, the level of co-operation and co-ordination between basic and applied research is unclear.

Added to the equation is Formas, which rather than being tasked with supporting a particular type of research, is rather responsible for supporting specific thematic areas, namely the environment, agriculture, and spatial planning. Reporting to the Ministry for Environment and Energy (though with additional funding from the Ministry for Enterprise and Innovation), Formas first and foremost serves the drive for sustainability, but still remains an important player in the innovation ecosystem.

A wider picture of the support infrastructure in Sweden is presented in the diagram below. While the picture is largely national, Stockholm has been selected as the focal point to see the role of local organisations.

## Innovation and investment landscape



### H.4.4 Selected instruments for promoting global competitiveness

The following table outlines some of the headline programmes that Sweden is using to improve its innovative ecosystem.

| Theme | Organisation(s) responsible | Activity |
|---|---|---|
| **Intelligence gathering** | Business Sweden | Networking management (conferences, events) |
| **Promotion / network-building** | Business Sweden | Matchmaking with other companies as well as government agencies. |
| | Formas | Promotion of international collaboration through incentives in funding. |
| | Swedish Agency for Economic and Regional Growth | Matchmaking and information provision to encourage local co-operation. |
| | Swedish Research Council | Promoting research collaboration across the Nordics, Europe, and globally. |
| | VINNOVA | Mobility for Growth. Support individual researchers to work internationally. |
| | VINNOVA | VINN Excellence Centers. Funding for research centres around universities that work on innovative research on particular themes. |
| | VINNOVA | Strategic innovation areas. Programme to stimulate industry, the public sector and academia to collaborate on investments in research, development and innovation on certain priority themes. |
| **Advisory** | Business Sweden | Strategic investment advice, looking at market dynamics. |
| | Business Sweden | Information on business rules and regulations for setting up. |
| | Formas | Strategy and knowledge overviews in Environment, Agricultural Sciences and Spatial Planning. |
| | Swedish Agency for Economic and Regional Growth | Advice and training on meeting new regulations. |
| | VINNOVA | Verification for Growth. Conduct commercial and technical verifications and validation of research with commercial potential. |
| | VINNOVA | NOVA toolkit to help promote diversity and gender equity for innovation. |
| **Funding** | Formas | Funding for basic and applied research in Environment, Agricultural Sciences and Spatial Planning. |
| | Swedish Agency for Economic and Regional Growth | Business development grants for SMEs looking to internationalise. |
| | Swedish Agency for Economic and Regional Growth | Provide funding to gain advice prior to the start of or development of a company. |
| | Swedish Research Council | Distribute SEK 6.4 billion in funding for basic research. |
| | VINNOVA | The Key Actors Programme. Funding to encourage the research and business community to come together. |
| | VINNOVA | Grant funding for development projects with international potential, with full funding for up to SEK 500,000 and 25-50 percent funding for projects up to SEK 5 million. |

# Tekes' Reviews in English

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