

Innovation for sustainable growth

Evaluation of Tekes Cleantech programmes
Climbus, Densy, Groove, Green Growth, EVE and
Green Mining

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Evaluation Report

gaia 

Tekes

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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

Finland has been one of the forerunner countries in cleantech with over 3000 companies offering solutions for the area. Plentiful natural resources such as forests, water and minerals have been a traditional strength here. As an active player, Tekes has put considerable effort in developing the area by running multiple programmes over the years. These programmes have provided funding and helped to build up business, expertise, networks and platforms for collaboration.

In this context, six cleantech programmes of Tekes were evaluated. The focus of Climbus (Business opportunities mitigating climate change, 2004-2009), Densy (Distributed energy systems, 2003-2007), Groove (Growth from renewables, 2010-2014), Green Growth (2011-2015), EVE (Electric vehicle systems, 2011-2015) and Green Mining (2011-2016) was on clean energy, electric vehicles, mining and the broader field of green growth. Additionally, Tekes and Finpro are going to be integrated from the beginning of 2018. For this reason, the evaluation not only analysed those six programmes but also had a look at the collaborative effort between Tekes programmes and other cleantech-related public programmes in Finland, especially the ones of Finpro.

Summing up, the objective of this evaluation was to produce a review of results, impacts and efficiency of the evaluated programmes and to produce forward-looking recommendations for further development.

As a result, the evaluation produced solid findings and forward-looking recommendations for future Business Finland programmes and activities. The key recommendation from this evaluation was that the new Business Finland organization should add focus on customer-driven business development, on facilitating interfaces and on promoting renewal.

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

Helsinki, November 2017

Tekes – the Finnish Funding Agency for Innovation

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Summary

Over the past twenty years, the Finnish Funding Agency for Innovation (Tekes) has put in considerable effort to strengthen cleantech know-how and business in Finland. This report covers the evaluation of six major Tekes cleantech programmes from years 2003-2016 that focused mainly on clean energy, mining and the broader field of green growth.

Specifically, this evaluation includes the ex-post-evaluation of Climbus (the mitigation of climate change impacts) and Densy (distributed energy systems) programmes and the final evaluations of Groove (growth from renewables), Green Growth, Electric Vehicle Systems (EVE) and Green Mining programmes.

Global cleantech market

The cleantech sector is being shaped by several global drivers. The three most significant cleantech drivers relevant to this evaluation were: 1) digitalisation, 2) innovations in value creation, and 3) planetary constraints. It is necessary to understand both likely impacts and uncertainty associated with these drivers, and in particular their tangible effects on cleantech markets and business. While more flexibility and responsiveness will be needed to take advantage of rapidly arising opportunities, business development activities must also be guided by a strong strategic insight on the future development.

In other countries, innovative public instruments, measures, tools and partnerships are being developed to help the businesses to better access international markets. The focus is on 1) supporting customer-driven innovation and co-creation, 2) enabling international market access and growth as well as 3) strengthening business ecosystems. These themes are highly relevant for Finland as well and cover some of the most critical bottlenecks in the Finnish innovation system.

Companies in the programmes

Altogether about 400 companies took part in the programmes. About 250 of these were SMEs (small and medium-sized companies). The total programme funding including company and research projects was 607 million euros, of which 310 million euros came from Tekes. Out of

Tekes funding 57 percent was allocated to SMEs. In total, 98 companies that participated in the evaluated programmes were also involved in Team Finland's growth programmes. Of these, 67 were SMEs.

The growth of the SMEs participating in the programmes have been positive. However, this data alone is not enough to understand the role of Tekes and the evaluated programmes on the growth of the businesses as the growth is a result of many company and market related factors. In the case of SMEs, it appears likely that Tekes support had a significant role in revenue growth. However, the results are not as clear in the case of large participating companies.

Results of the Green Growth programme

The goal of the Green Growth programme (2011-2015) was to identify and support potential new growth areas within the sustainable economy as defined by low energy consumption and sustainable use of natural resources. Hand-picking of potential businesses and projects into the programme as well as activation of companies brought in customers with interesting business models and growth prospects. Several specific business innovations can be directly traced back to the programme. The potential for continued international growth is expected over a period of becoming years.

The programme increased confidence in the ability of the Finnish cleantech business ecosystem, including SMEs, to develop and commercialise globally marketable cleantech solutions. However, there are mixed results when it comes to creating tangible synergies between companies and projects in the programme. As of this writing, the realisation of broader systemic outcomes and impacts, and the development of cooperative innovation platforms and business ecosystems have been difficult to identify and track.

Results of the Green Mining programme

The Green Mining programme (2011-2016) supported the national Minerals Strategy policy goal. Its objectives were quite ambitious and the relative starting point of the whole sector was demanding as the industry was domi-

nated by large companies and was not integrated. The programme did not meet all of its targets, for example, boosting SMEs' international business growth was weaker than expected.

On a positive note, the programme increased mining sector research and education activities. E.g. new opportunities for mining education were established at the University of Oulu. The programme helped the Finnish mining industry to function in a more integrated fashion through joint project demonstrations led by large companies. Also, connections were established to mining sectors in other countries. It is likely that the programme helped to create networks within the Finnish mining sector (e.g. the Finnish Network for Sustainable Mining).

Results of the Groove programme

The Groove (Growth from renewables, 2010-2014) programme sought to improve the ability of Finnish renewable energy SMEs to access global markets. It did not fully reach its targets largely due to companies' lack of internal capacity to expand into global markets. Some participating SMEs were locally operating companies with no ambition to internationalise their business. This probably could have been tackled by more careful selection of companies into the programme. A relatively broad programme focus resulted in a wide range of projects (e.g. ICT). This appeared to have caused inefficiency in Tekes programme execution as significant effort was devoted to managing a variety of projects, taking focus away from the most promising cases.

Due to its emphasis on international networking activities, the programme operated quite similarly to Finpro, and this served as an intended new experiment for Tekes. Also the coaching of companies by private investors was an innovative tool to increase the internal capacity of SMEs to develop and globalise their businesses.

Results of the Electric Vehicle Systems (EVE)

The EVE (2011-2015) programme had a strong international focus and sought significant revenue growth in the Finnish electric vehicles and machinery sector. Programme management was proactive in recognising and communicating the global need for electric vehicles and related business development. Despite the fact that Finnish regulatory and market development did not fully support EV concepts, participating companies have nonetheless been successful in developing new business concepts, partnerships, testing environments and growth in international markets. There are clear examples of Finnish companies realising international EV sector revenue growth, but whether the programme helped to catalyse such growth remains unclear.

The programme improved the coordination between Finnish EV businesses and public sector actors. However, beyond a few specific strategic partnerships, there is little evidence that the programme resulted in broader domestic and global business ecosystem development. The programme management model – consortia strongly led by companies – efficiently screened and selected companies and projects in alignment with programme's goals and objectives.

Impacts of the Densy (Distributed Energy Systems) programme

The Densy programme (Distributed Energy Systems, 2003-2007) was focused on the increasing global market for distributed energy generation. The programme sought to reach out to a broad range of systems and services in small scale production, system integration, and energy storage. Programme results and impacts varied significantly among the focus areas reflecting differences in market maturity, timing and regulatory development.

There is evidence that the programme's electric system and ICT projects successfully created knowledge that can be utilised to create smart grids enabling future distributed energy. On the other hand, some focus areas, including small scale cogeneration and fuel cell solutions, were not entirely successful due to the lack of market maturity and other factors. Regarding business models, wind power has been growing and overtaking other solutions, consumption driven focus has increased, and digitalisation has provided new tools and opportunities which were not seen during the programme.

Impacts of Climbus programme

The objective of the Climbus programme (2004-2008) was to identify and promote technologies to mitigate climate change. It was successful in encouraging companies to view climate change as a business opportunity and supported the development of national climate and energy policy. Today, many Finnish companies are strategically positioned to provide climate and energy-efficient solutions globally.

The programme's most significant market results were realised in those areas in which EU directives or national legislation help to drive market development. The programme attempted to shift the focus from energy production to energy efficiency, but further pressure was needed to take this more seriously. Business impacts varied significantly between programme focus areas depending on market and regulatory development. Climbus activities served to highlight the need for market-stimulating RDI policy measures, and was part of a continuum of several other Tekes programmes.

Conclusions and recommendations

The evaluated programmes together with other Tekes activities have played a key role in shaping Finnish cleantech innovation. The programmes identified future cleantech needs, defined market opportunities, and resulted in several interesting results and market opportunities for participating companies. Measurable programme business results and focus area impacts vary significantly depending on market sector, regulatory environment, and the capacity of participants to undertake international business.

The growth of the Finnish cleantech companies is not so much limited by the size of global markets but the competitiveness and attractiveness of their solutions and the degree to which Finnish companies can access international ecosystems. Market timing is also a critical success factor, especially as cleantech regulatory constraints often play an important role. First-mover cleantech companies often need to also invest time and money to create the market.

The capacity of participating companies to capitalise on their innovations and generate international business varied significantly both within and between the programmes. The cleantech companies often have very different paths to international expansion and growth. The companies also varied in their ability and mindset to apply and benefit from public support and tools, including Tekes programmes and Finpro's growth programmes.

In addition to Tekes, new actors are taking an active role in facilitating and funding cleantech development. The cleantech innovation landscape is definitely becoming more agile and versatile than it used to be. These changes in the cleantech innovation landscape challenge also the way Tekes cooperates and positions itself in this new landscape.

The recommendations for Tekes and Business Finland, their future programmes, innovation activities and policies regarding cleantech are:

Look for customer-driven business development

1. Focus on new ways of creating value
2. Support innovation partnerships and co-creation
3. Target international markets at the inception of RDI
4. Find new funding instruments to open global markets
5. Find feasible ways to coach companies, especially SMEs
6. Put focus on market access

Facilitate interfaces

1. Highlight cooperative innovation projects
2. Demand for agile and open innovation practices in cleantech
3. Facilitate business out of the boundaries of know-how and actors

Promote renewal

1. Understand the critical success factors of cleantech companies
2. View programme customer selection as significant strategic choices
3. Design attractive service packages.
4. Work to increase the dynamism in the Finnish cleantech ecosystem
5. Advertise the accomplishments of successful companies to encourage others.

1.1 Background and objectives

There is a globally growing market for innovative and sustainable solutions to the increasing need for food, water, energy, housing and mobility. Cleantech¹ companies are leading the transformation in the ways we produce and use resources to create environmental and societal benefits. Many Finnish companies have been successful in this global market, and the growth of these businesses has been highly important for the Finnish economy.

As a cleantech industry leader, Finland has the potential to continue to have a strong global role in developing and monetising innovations in sustainable growth. However, in these fast-changing markets, companies need to continuously improve their businesses and business models to stay competitive.

The Finnish Funding Agency for Innovation (Tekes) has put considerable effort in strengthening cleantech know-how and business in Finland. Several Tekes cleantech innovation programmes have been implemented over the last 20 years. Tekes has been the most important public cleantech funder in Finland. In recent years, about half of Tekes' total funding has been focused on cleantech.

This report documents an evaluation of six Tekes cleantech programmes focusing mainly on clean energy, mining and the broader field of green growth. Specifically, this evaluation includes the ex-post-evaluation of Climbus (the mitigation of climate change impacts) and Densy (distributed energy systems) and the final evaluations of Groove (growth from renewables), Green Growth, Electric Vehicle Systems (EVE) and Green mining programmes. Collectively, the evaluated programmes are defined as "the programmes" throughout this report.

The evaluation aims to understand specifically how Tekes cleantech programmes have benefitted the growth of the Finnish businesses. Thus the focus of the evaluation is on specific companies and company projects that were part of the Tekes programmes². The evaluation was conducted in accordance with Tekes' impact analysis model.

The objectives of this evaluation of the programmes are:

- To evaluate results and impacts;
- To understand the effectiveness of the programmes in creating growth in the cleantech business;
- Draw conclusions and recommendations for future R&D and innovation activities, programmes and policies.

1.2 Context of the evaluated programmes

1.2.1 Tekes strategies and other Tekes' programmes

The Tekes cleantech programmes included in this evaluation extend from 2003 to 2016. Tekes' strategies have evolved considerably over this period, and the evolving strategic choices of Tekes are reflected in the scope and content as well as results and impacts of the programmes, for example regarding the role of SMEs³ in the programmes.

In 2002 Tekes' strategy and funding priorities focused on energy production and conservation as well as environmental health and safety. By 2005, strategies and priorities began to focus on sustainable development as a driver that creates and shapes global markets. Environment and energy application focus area concentrated on eco-efficient and environmentally friendly solutions making use of the market potential in mitigating global warming. By 2008, Tekes' strategy began to emphasise clean energy and scarce resources⁴.

Tekes began to put more focus on business renewal by 2011. Cleantech began to be defined as the following: energy and raw material efficiency, renewable energy, new forest and biomass, sustainable mineral resource use, and water consumption. Finally, by 2015 the strategy put greater emphasis on creating opportunities for global growth, promoting customer renewal and supporting the development of new business ecosystems. Tekes was viewed as an active game developer, and Team Finland cooperation was part of the strategy. Overall one can conclude that cleantech, and especially energy, has had a very strong and important strategic priority for Tekes over all the strategy periods.

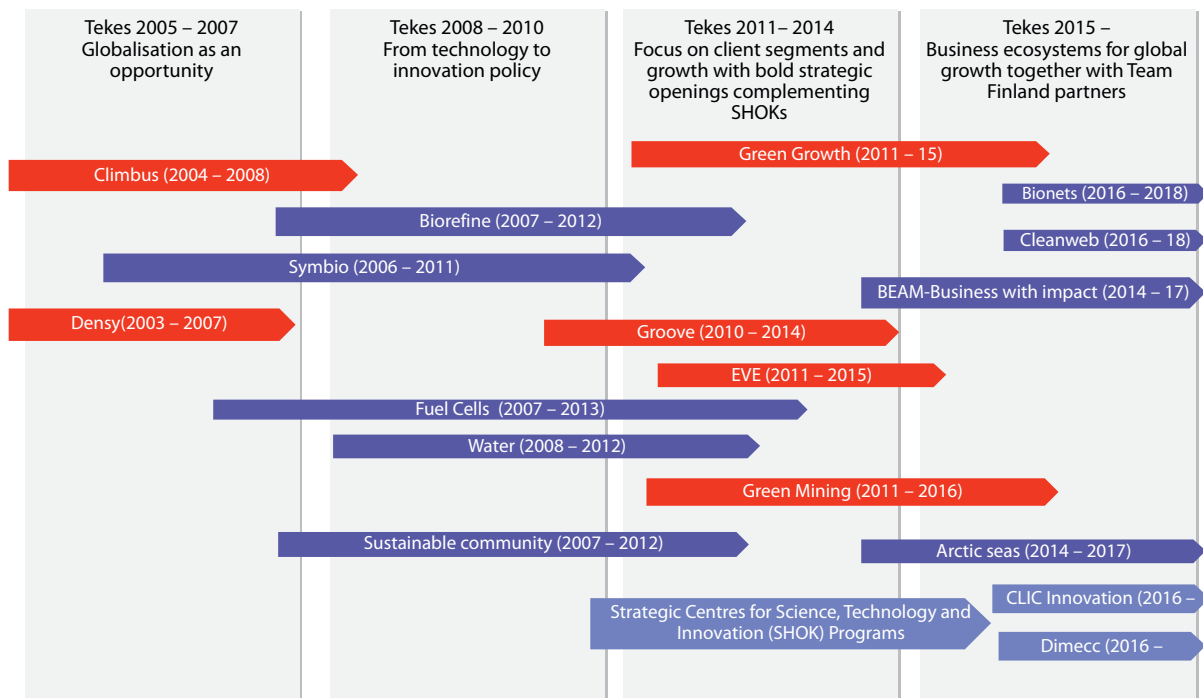
¹ Shortly, cleantech can be defined as solutions that create environmental benefits.

² Next to the company projects a variety of research projects and organisations were part of the programmes.

³ Small and medium-sized enterprises. In addition to the staff headcount ceiling (< 250), an enterprise qualifies as an SME if it meets either the turnover ceiling (≤ 50 million euros) or the balance sheet ceiling (≤ 43 million euros), but not necessarily both.

⁴ Tekes (2008)

Figure 1.1. Evaluated programmes and a selection of other Tekes' programmes.



The programmes included in this evaluation and a selection of other relevant Tekes' cleantech programmes are shown in Figure 1.1. In addition to the programmes listed in Figure 1.1, several other Tekes' programmes have been linked to cleantech during these years as well as before and after.

A recent analysis of Tekes' role in the international growth of Finnish cleantech companies revealed that they have participated in a very wide variety of Tekes programmes with cleantech programme funding comprising only a part of their Tekes financial support⁵.

1.2.2 Other relevant policy actions and programmes

Other Finnish policy actions and programmes have important linkages to the Tekes programmes included in this evaluation. Since 2012, the Team Finland⁶ network has been strengthening its cooperation to help companies to enter and thrive in global markets. To further strengthen the mission and boost Finnish companies' global growth, Tekes and Finpro activities are planned to be merged into a single trade promotion organisation in the beginning of year 2018, with the working title Business Finland. Business Finland will gather all services related to innovation fund-

ing and internationalisation under one roof. This is an opportunity to find new synergies between innovation and internationalisation of companies, and thus this evaluation is well-timed to support that process⁷.

Growth programmes run by Finpro have been one of the Team Finland's tools to support companies in the global market. They have had a strong focus on cleantech. The Cleantech Finland growth programme, started in 2008, sought to support growth of companies that operate in the environmental technology sector. Also, other growth programmes, including AgroTechnology, Beautiful Beijing, Developing Markets, Innovative Bioproducts, Mining, Waste to Energy, and Bioenergy (currently Energy) cover cleantech companies⁸.

Between 2007 and 2009 six Strategic Centres for Science, Technology and Innovation (SHOK) programmes⁹ were launched to strengthen Finnish innovation activities and to carry out long-term cooperation in fields crucial to future breakthrough innovations of global importance. The SHOKs conducted large research programmes with strong cleantech links. SHOK financing typically included 60% Tekes funding and 40% company funding. Between 2008

⁵ Gaia Consulting Oy (2016)

⁶ Team Finland brings together state-funded internationalisation services. More: <http://team.finland.fi/en/frontpage>

⁷ Ministry of Economic Affairs and Employment (2017)

⁸ However, none of the companies participating in the evaluated Tekes programmes has been part of Finpro's Agrotechnology or Innovative bioproducts growth programmes.

⁹ Cleen Ltd (in the area of environment and energy), Fimecc Ltd (in the metals industry), Finnish Bioeconomy Cluster Fibic Ltd (in the area of bio-based innovation), Rym Ltd (in the built environment sector), and Tivit Ltd (in the ICT and digital services sector, later named Digile). Today Cleen and Fibic have merged to Clc Innovation and Digile and Fimecc to Dimecc.

and September 2012, Tekes provided over 343 million euros to these SHOK programmes¹⁰. Today, they are mainly funded by other sources than Tekes.

1.3 How Tekes creates results and impact?

The evaluation is structured in accordance with Tekes' new impact assessment model. The simplified impact model illustrated in Figure 1.2. A detailed model is included in Annex 1. The model is comprised of four steps: 1) selecting and targeting instruments, 2) outcomes and direct impacts, 3) indirect impacts 4) other societal impacts. It provides a comprehensive estimate of Tekes's potential impacts across all its instruments and services. The model can be modified and applied to the analysis of individual programmes or other instruments as well. In the concluding chapter of this report an insight on how well the impact analysis model worked in this task and how it could be improved is provided.

The model puts a strong emphasis on the strategic decisions in selecting instruments, selecting customer groups, and making funding allocation decisions. Thus, in those case where programme impacts are evaluated, it is essential to both analyse the role of the programmes in relation to Tekes' strategy at the time of initiating the programmes and make a detailed analysis of participating companies.

Programme outcomes and direct impacts include project-level results (e.g. R&D activity, know-how and networking). Indirect impacts include growth, productivity, employment, new competence and innovations. Also interesting might be the results and impacts linked, for example, to competence development, new products or services, piloting and references, new business models, and new business or innovation ecosystems.

Larger societal indirect impacts are linked to the role of the participating companies in their own business ecosystems and other factors that are not linked to the Tekes activities.

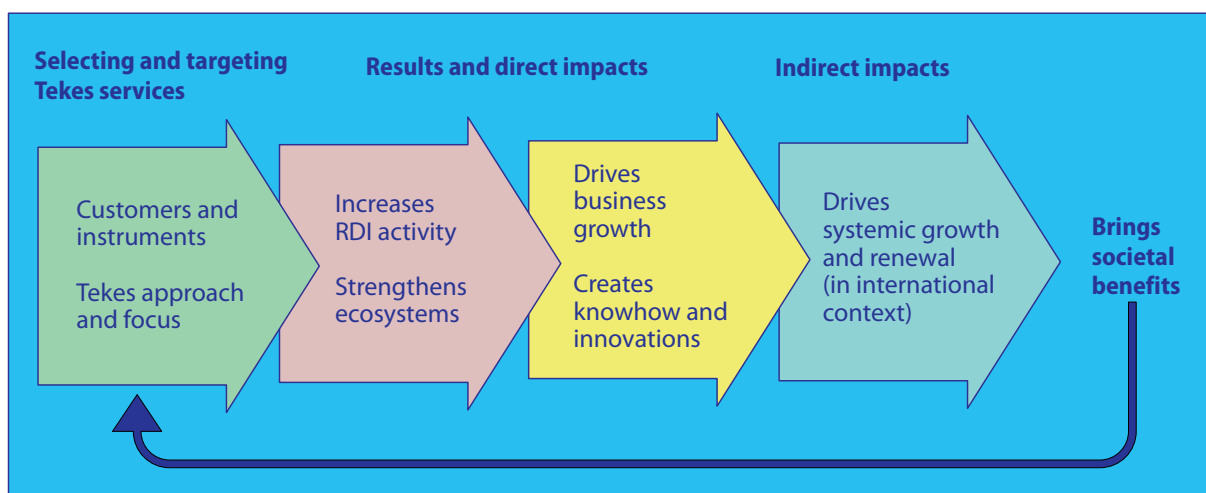
1.4 How was the evaluation made?

The final evaluation of the Green Growth, Green Mining, Groove and Electric Vehicle Systems (EVE) programmes focused on specific project results, programme relevance and programme efficiency. The ex-post-evaluation of the Climbus and Densy programmes focused on outcome impact, effectiveness and significance. The evaluation strives to understand specifically how Tekes cleantech programmes have benefitted Finnish business and global business growth. Thus the focus of the evaluation is on those company projects that were part of the programmes¹¹.

The assessment is based on programme reporting information; interviews of company participants, Steering Group members and Tekes staff; surveys of programme participants; data analysis; case studies; internal workshops; other related documentation; and evaluation team expert views. The case studies are an important part of the analysis and support understanding on the dynamics of the results and impacts. They point out, not only the impact of Tekes, but also the role of other Team Finland activities. Internal workshops were used to elaborate the material and results and for further analysis and drawing conclusions. In total, 42 interviews were made for the study (sources in the end of the report, Steering Group members and interviewees in Annex 2, case studies in corresponding chapters).

The evaluation methodology is described in more detail in Annex 2.

Figure 1.2. How Tekes creates results and impact.



¹⁰ Lähteenmäki-Smith et al. (2013)

¹¹ In addition to company projects the programmes that were evaluated included research projects driven by research organisations. These research projects were not analysed in detail in this evaluation.

2

Global cleantech market

2.1 Global drivers in cleantech

The cleantech sector is being shaped by several global drivers. As the most relevant for this assessment three of the most significant cleantech drivers are described in more detail below including: 1) Digitalisation, 2) Innovations in value creation, and 3) Planetary constraints.

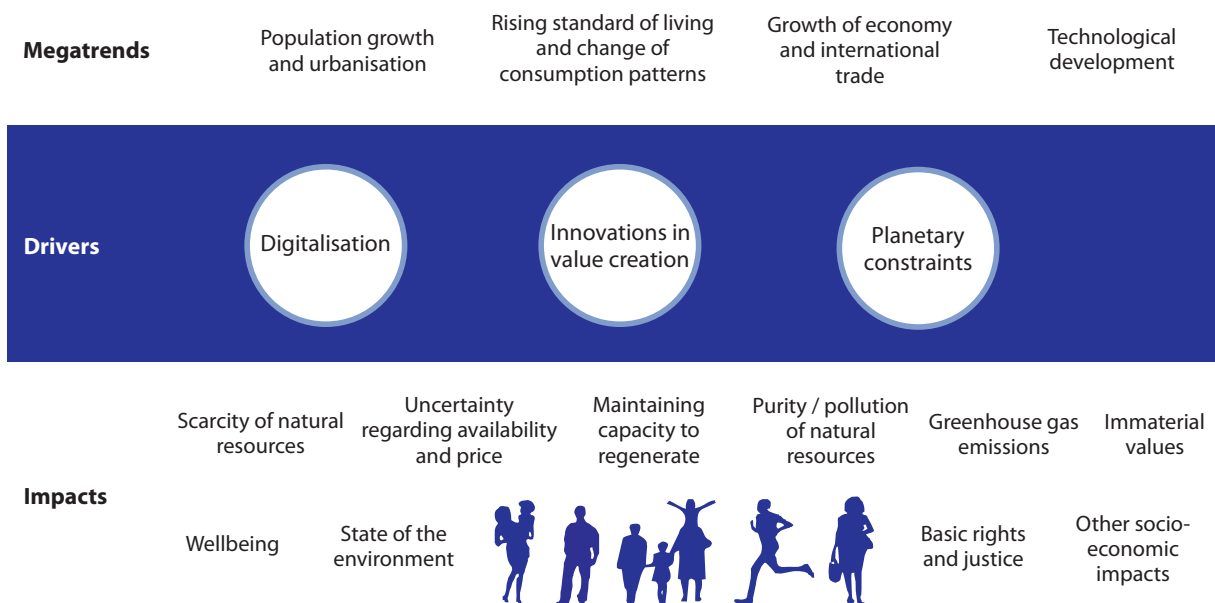
Digitalisation and the effective utilisation of its tools will be essential to future business value creation. Its integration in all business solutions is urgently needed. Encouraging the collaboration between cleantech and digitalisation companies can result in globally competitive business models and value creation. This could be one of the main objectives and additional value creation potential specifically for Finland in the future innovation programmes.

It is also necessary to understand the uncertainty associated with these drivers, and in particular their concrete effects on markets and business. In any case in a rapidly changing business environment, there is a growing impor-

tance of the resilience of innovation funding programmes and related business development. While more flexibility and responsiveness will be needed to take advantage of rapidly arising opportunities, these business development activities must also include a strong strategic component (including insight and trust on the future development), both in the design of the funding programmes and in the business itself.

Resource scarcity and resource efficiency related to planetary constraints are clearly defined business drivers as they directly affect the cost of doing business, the role taken by the public policy sector by ownership and governance as well as consumer preferences. For this reason, they continue to be a significant contributor to new market opportunities. However, a broader system-wide understanding is needed to develop radically new solutions and to launch and scale these solutions on the market. Figure 2.1 below illustrates the linkages between these drivers, their underlying mega-trends, and impacts.

Figure 2.1. Global cleantech drivers.



2.1.1 Digitalisation

Digitalisation is one of the key drivers affecting the development of cleantech and enabling disruptive innovations. New services and solutions are transforming value creation and redefining customer expectations. Cheaper and better digital solutions and technologies are becoming more accessible and different base technologies – such as mobile, cloud, sensors, analytics, the Internet of Things (IoT), big data, artificial intelligence and virtual reality - are increasingly combined, which accelerates the transformation.¹²

Companies are challenged to utilise digitalisation to create new business models and ensure the global scalability of their products and services. Global markets might be more easily accessible also for smaller companies using digital channels. Digital services bring businesses closer to their customers and consumers. Data can be used for designing better products and services and to lower transaction costs to improve market effectiveness and create new markets. Also distributed ledger technology, so called blockchain, promises to transform digital markets and improve their effectiveness¹³.

For example for energy sector, the digital transformation enabled the growth of distributed energy sources (such as small-scale rooftop solar panels), growth of demand-side energy management (activities that encourage consumers to reduce energy consumption) and digitalisation of energy infrastructure. In practice, digital solutions can be for example smart meters, energy management systems, automated demand response or microgrids which enable two-way communication between the consumers of energy and the producers of energy. Ideally, this leads to more uninterrupted, affordable energy supply (also referred to as energy security) and decreased energy consumption. For energy utilities, the digital transformation can imply redefining their role as system integrator of distributed energy resources and provider of energy services.¹⁴

Transportation and mobility are also being transformed by digital technology solutions. The automotive industry is adjusting to a sharing society where transportation is seen less as a product and more as a mobility service (also known as Mobility-as-a-Service, MaaS). For consumers, MaaS means for example mobile interfaces that provide access to public transportation, car sharing, rental cars, taxis and shared bicycles. The global market for shared vehicles and mobility offerings is predicted to grow by 25 % a year through 2020. The World Economic Forum has identified

three key themes in which the digital transformation will manifest itself within the automotive industry: connectivity of travelers, autonomous driving and digitising the ecosystem of the automotive industry.¹⁵

Finnish society and companies are undergoing a transition involving large structural reforms. Digitalisation is one of the key drivers for these changes. The accelerated deployment of digitalisation technologies is likely to change underlying value chains, ecosystems and market positions of Finnish companies both domestically and globally. Many consider benefit from the continued development and deployment of digitalisation technology^{16,17}, however there is a lot of untapped potential. The digital operational environment still needs to be updated to meet modern standards. This will require, among other things, the right kind of expertise, smart regulation for data protection, cyber safety, taxing and digital backbone industry¹⁸.

2.1.2 Innovations in value creation

Value creation for businesses, customers, the environment and society-at-large, is undergoing powerful, disruptive change. New technology transforms traditional ways of conducting business. At the same time, scarcity of resources is driving innovation in ways to fulfill the needs of a growing global population.

Seeking new ways of creating value is at the core of new business models. The following drivers are defining the process of value creation in the cleantech sector:

- Need to mitigate and adapt to climate change
- Resource scarcity and competition
- Need for clean energy production
- Population growth, urbanisation and rising standard of living
- Traceability of resources in global markets.

Continued value creation may involve, among others, replacing, sharing, optimising and looping material flows. Replacing existing material flows may involve replacing material product inputs and outputs with intangible products or services or replacing raw materials or products with more sustainable alternatives. Sharing material flows may create value through sharing resources, products or services (also co-ownership) and using products as a service. An electric car pool with shared cars or a service that rents household tools clients are some examples of sharing businesses.

¹² World Economic Forum (2017)

¹³ Blockchain means that data is distributed across all players instead of belonging to a central authority. Blockchain technologies can lower the transaction costs and enable transparency in the whole value chain.

¹⁴ Molinaroli (2016)

¹⁵ World Economic Forum (2016)

¹⁶ Ministry of Finance, Digitalisation webpage

¹⁷ Helsinki Smart Region (2016)

¹⁸ Technology Industries of Finland (2017)

Optimising and looping material flows may imply the more efficient use of resources or the performance of a product by extending the service life of a product or reducing the amount of waste generated in the value chain of product or service. An example could be a tool for ships to optimise the use of fuel. Intensifying material flows may comprise recycling or reuse of materials and products and segregating raw materials from waste streams.

Ellen MacArthur Foundation has identified a set of six actions that businesses and governments can take in order to transition to a circular economy which also reflect wider value creation opportunities in cleantech (Figure 2.2)¹⁹. In different ways, these actions all increase the utilisation of physical assets, prolong their life, and shift resource use from finite to renewable sources.

All of this is closely linked to digitalisation. The platform economy, for example, is connecting companies and clients more efficiently than ever before. Artificial intelligence is forecasted to, among others, optimise resource use and performance. Distributed ledger technology promises to transform business models that mediate transactions for example in the energy business.

Cleantech companies in Finland have the opportunity to create value using new business models competing

within a global business ecosystem. Although Finland has substantial valuable expertise, international cooperation and immigration to Finland may be key enablers to drive value creation in the future. One enabler – or hindrance – for new business models is regulation. Optimally regulation supports the establishment of new business models. Piloting and demonstration platforms are also crucial for the testing of new technologies. Other enablers for Finland include accessibility of open data, access to financing for risky investments, ability to react rapid to changes in the global markets and a nurturing a culture of collaboration between organisations.²¹

Also consumers are expected to play a key role in driving the development and deployment of new cleantech innovation. Sustainable consumer behavior can mean for example consumption of recyclable products or products that are made of recycled materials, consumption of renewable energy and overall lower consumption of materials. However, sustainable consumer behavior is highly dependent, for example, on the financial costs of greener choices, access to information about the life-cycle of products, general knowledge of the environmental impact of their consumption decisions and their level of commitment to supporting sustainable objectives.²²

Figure 2.2. Value Creation in circular economy.²⁰

Regenerate	Shift to renewable energy and materials Reclaim, retain and restore health of ecosystems Return recovered biological resources to the biosphere
Share	Share assets Reuse/secondhand Prolong the life through maintenance, design for durability, upgradability etc.
Optimise	Increase performance/efficiency of product Remove waste in production and supply chain Leverage big data, automation, remote sensing and steering
Loop	Remanufacture products or components Recycle materials Digest anaerobically Extract biochemicals from organic waste
Virtualise	Dematerialise directly Dematerialise indirectly
Exchange	Replace old with advanced non-renewable materials Apply new technologies Choose new product/service

¹⁹ The Ellen MacArthur Foundation (2015)

²⁰ The Ellen MacArthur Foundation (2015)

²¹ Luoma et al. (2017)

²² OECD, Green Growth and Consumer Behaviour webpage

2.1.3 Planetary constraints

Climate change, environmental pollution and resource scarcity are pressing planetary constraints driving the need for the development and deployment of new cleantech innovations. Stockholm Environment Institute²³ defines nine planetary boundaries: climate change, novel entities²⁴, stratospheric ozone depletion, atmospheric aerosol loading, ocean acidification, biogeochemical flows, fresh water use, land system change and biosphere integrity.

According to Stockholm Environment Institute²³, four of these planetary boundaries (climate change, biosphere integrity, biogeochemical flows and land system change) have already been crossed indicating a significant risk for societies. Pressure on these and other planetary boundaries is increasing, a result of several global megatrends including population growth, changing demographics, urbanisation, increased economic activity, and technological innovations²⁵.

Companies and other organisations are compelled to find ways of operating in an environment where natural resources are increasingly scarce. The need for mitigating and adapting to climate change is growing. Competition for scarce natural resources will continue to increase as businesses and states attempt to secure their ownership and access. Increased pressure on planetary boundaries and the consequently increasing competition over resources imply new business opportunities to the cleantech sector.

Innovations can be related to, for example, circular economy²⁶ and industrial symbiosis²⁷, resource efficiency, renewable energy as well as intangible and digital services. New resources are sought from side streams and waste. The scarcity of natural resources will lead to rising prices and growing competition, requiring the more effective use of existing resources and search for alternative resources more urgent.

Many Finnish companies have a solid track record of building their solutions in accordance with resource efficiency and circular economy principles. Good engineering skills have enabled many companies to develop solutions that attempt to tackle planetary constraints.

2.2 International best practices to support cleantech

In the following, international examples of best practices on cleantech RDI and international business growth are analysed. The aim is to gain insight on the successful tools, measures and instruments in use and to draw lessons for Finland.

The examples specifically cover three, partly overlapping, themes: 1) supporting customer-driven innovation and co-creation, 2) enabling international market access and growth as well as 3) strengthening business ecosystems. These themes are seen highly relevant for Finland and cover some of the most critical bottlenecks in the innovation system.

To select the most interesting examples for the analysis, potentially interesting activities and measures in selected countries including Austria, U.S. (California), Denmark, Netherlands, and Sweden were screened²⁸. These countries were selected for the screening based on their forerunner position on the cleantech as well as innovation and international business-related policies²⁹.

Better access to international markets is of high focus in all the benchmarked countries. Innovative instruments, measures and tools are developed to help the businesses to identify and meet potential customers and to support the market entry of the companies. Initiating joint innovation programmes, connecting innovative SMEs with established global industrial companies, as well as involvement of users of innovations and business advocacy groups are among the means to support companies' growth. Local presence to establish connections and identify potential partners on selected target markets and financing feasibility studies to enable businesses to assess the market potential of their idea and identify potential local clients and partners are in use.

Styria, Austria, and California, USA, have been successful in creating attractive locations for growth seeking companies. Facilitating private equity to support cleantech businesses is one of the success factors of California, as there are limitations to public sector programmes and it is seen that

²³ Keppner, Hoff & Kahlenborn (2017), Steffen et al. (2015)

²⁴ Novel entities include emissions of toxic compounds such as synthetic organic pollutants and radioactive materials, genetically modified organisms, nanomaterials, and micro-plastics. These can persist in the environment for a very long time, and their effects are potentially irreversible.

²⁵ UNEP (2012)

²⁶ A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times.

²⁷ Industrial symbiosis can be defined as the exchange of materials or waste streams between companies, so that one company's waste becomes another company's raw materials.

²⁸ The analysis is based on a literature review of publicly available information and publications.

²⁹ For example, all of the countries are highly positioned on the Global Cleantech Index (2014): 2. Finland, 3. USA, 4. Sweden, 5. Denmark, 11. Netherlands, and 16. Austria. Source: Cleantech Group (2014)

NGOs are often able to apply broadly-defined government innovation goals in a more flexible manner. In value-adding ecosystems, companies are encouraged by each other to innovate and internationalise. All the examples of successful business ecosystems show the need for the ecosystems to be closely linked internationally.

Supporting the whole innovation chain is seen critical in many cases. Targeted funding instruments for different sizes of companies in different stages of innovation process are in use. Easy application project with a preliminary quick scan or a voucher type of funding makes it easy for companies to benefit from these.

When mapped against the international benchmarks, the Finnish instruments, tools and activities do not differ that much, theoretically. However, the mindset that drives the instruments as well as the proactivity, scale and ambitiousness of the instruments, tools and activities vary to some extent. Table 2.1 compares the international benchmarks against the instruments, tools and activities in Finland. It highlights some of the main points brought up by this study.

Table 2.1. International benchmarks compared to the instruments, tools and activities in Finland.

	International benchmarks	In Finland
Supporting customer-driven innovation and co-creation	<p>International benchmarks demand for customer-driven innovation and cocreation</p> <p>Customers and end users are involved in creating and applying innovations</p> <p>Private venture capital, as part of the ecosystem, drives for attractive and scalable business models and concepts</p> <p>Focus is also on wider transformation including social and structural innovations</p>	<p>Focus on piloting and demonstration in the Finnish innovation policy in the past years, including public procurement, is only a limited approach to customer-driven innovation opportunities</p> <p>Domestic end-users have been included in the Tekes funded programmes and projects in varying degrees (for example in Green Mining programme)</p> <p>Less focus has been on committing international customers to cocreative innovation, which would be even more important for international business growth</p> <p>TeKes CleanWeb programme, in cooperation with Finpro, is a positive recent initiative on supporting companies to access to international networks, accelerators and consumers</p> <p>Through its contacts to potential international customers of the innovative solutions Finpro has the prerequisites to strengthen the customer-driven approach</p>
Enabling international market access and growth	<p>Better access to international markets is of high focus in all the benchmarked countries</p> <p>Innovative instruments, tools and activities are used and developed to help the businesses to identify and meet potential customers and to support the market entry of the companies</p> <p>Instruments are targeted for different sizes of companies in different stages of innovation process</p>	<p>Finland and Finnish business need to be smart in using their resources in conquering international markets as the competition is tough</p> <p>The resources required for international growth are multifold compared to RDI resources — the need of these resources might have had too little focus in the Finnish policy</p> <p>Finding the first international customers that open up the market is highly critical — this is where Finpro type of activities can be of support</p> <p>TeKes's and Finpro's joint knowledge of their customers should enable a more refined customer segmentation so that future programmes, instruments and services are better targeted to the needs of the companies</p> <p>Business Finland has an opportunity to bring together Finpro's practical business development approach and TeKes's longer-term risk taking RDI approach</p>
Strengthening business ecosystems	<p>International benchmarks have been successful in creating attractive ecosystems for growth seeking companies</p> <p>In value-adding ecosystems, companies are encouraged by each other to be ambitious in innovation and internationalisation</p> <p>Successful business ecosystems show the need for the ecosystems to be closely linked internationally</p>	<p>Focus rather on developing domestic ecosystems with often unclear view on the role and desired and expected value in the international context</p> <p>It seems important to facilitate concrete co-creation between the companies to create lasting impact</p> <p>TeKes has been supporting business spearheads and ecosystems in several recent calls introducing new practices on the area — their impact is to be seen in future years</p>

2.2.1 Supporting customer-driven innovation and co-creation

Supporting customer-driven innovation and co-creation are among the trends in developing attractive business models and concepts in a fast-changing world. Experimentation, piloting and demonstration are part of these

discussions and also of strong focus in the Finnish innovation policy. Thus, 5 examples of tools, measures and instruments in use were analysed to provide best practices on how to support customer-driven innovation and co-creation (Table 2.2). The examples are described in further detail in Annex 4.

Table 2.2. Examples of tools, measures and instruments to support customer-driven innovation and co-creation.

	Short description	Success factors and lessons learned
California Clean Energy Fund, California	The California venture finance ecosystem provides very strong support for customer-driven innovation and co-creation ³⁰ . Supporting this cleantech private venture capital ecosystem is a group of non-profit organisations that promote the rapid adoption of clean energy technology and encouragement of cleantech innovation through direct equity investment. The California Clean Energy Fund is an example of this critical element in the ecosystem.	<p>The California Clean Energy Fund provides a single point of contact for grant and loan funding applications. It maintains a network of public funding agencies and private investors.</p> <p>Partnerships with NGOs and the private sector can be used to expand cleantech start-up support and improve the chances of successful commercialisation.</p> <p>There are limitations to public sector programmes. NGOs are often able to apply broadly-defined government innovation goals in a more flexible manner. Platforms linking government funding to non-profit incubation and acceleration are critical elements improving the cleantech ecosystem.</p> <p>It works to ensure that support for incubator and accelerator programmes is flexible to meet rapidly changing needs. It does this by providing funding to multiple points within the cleantech ecosystem rather than focusing on a single programme or process.</p>
Cleantech Inn, Sweden	Swedish non-profit initiative that offers services with the objective to increase business between large international companies and innovative Cleantech SMEs.	<p>Connecting innovative SMEs with established global industrial companies and facilitating concrete business projects between SMEs and large industrial companies.</p> <p>SMEs in cleantech sector benefit from support to get connected with large industrial companies and get to learn from concrete business projects and interface to the large industrial companies (partner companies).</p> <p>Cleantech Inn organises regular international "Meet-the-Buyer" events.</p> <p>Close collaboration with cleantech clusters from other European countries.</p>
DRIP, Denmark	DRIP is a Danish Public-Private Partnership that aims at creating new export successes for Danish cleantech and improving the competitiveness of food industry by developing new sustainable water and production technology solutions that can reduce water consumption in industrial food production by 15-30 %.	<p>A public-private partnership including the end users of innovations who ultimately benefit from the new water saving solutions by improved competitiveness.</p> <p>The whole innovation process from new ideas to commercialisation supported.</p> <p>Out of eight work packages, three focus on development, testing, documenting and evaluating water-saving technologies and concepts.</p> <p>The last work packages concentrate in further development and testing of lighthouse projects and finally, their commercialisation and development of new business models.</p> <p>The partnership has been successful in attracting international interest and business delegation visits (organised in collaboration with State of Green).</p> <p>Inclusion of end-users of innovations in product development projects from start to end, including the provision of a demonstration possibility for innovations.</p> <p>Definition of national focus areas for innovation based on national industry needs.</p>

³⁰ California leads the world in venture capital investment in cleantech companies with 5.69B USD in 2014. Cleantech venture investment in the EU-28 was 1.03B USD over the same period. California is also in the global top 10 in energy efficiency, solar, energy storage, wind, clean transport, and other environmental intellectual property (IP).

...Table 2.2.

	Short description	Success factors and lessons learned
Open Innovation Strategy, Austria	A national Open Innovation Strategy was formed through an open, participatory process (including participation of businesses, research & public administration) aiming at making Austria an international pioneer in open innovation that can successfully compete in a global world.	<p>Austria is one of the very first countries in the world to have developed a national Open Innovation Strategy, all sectors, including citizens, were included in the strategy development process.</p> <p>As a result of the strategy process, three national action areas were defined: Culture & Competences, Networks & Cooperation and Resources & Framework Conditions.</p> <p>Targeted action areas and concrete measures/ tools to promote open innovation.</p> <p>Open, participatory process in strategy development, focus on citizens as key actors in innovation processes.</p>
Programme on Technologies for Sustainable Development, Austria	Austrian programme on Technologies for Sustainable Development initiates and supports trendsetting R&D and pilot projects in Austria such as generation of innovative approaches, fundamental research, applied R&D, networking and cooperation between projects, support of project implementation and pilot or demonstration projects.	<p>Strong national commitment and ambition level to catalysing a transformational change towards sustainable economy.</p> <p>Support and financing of pilot/ demonstration projects as part of the innovation process.</p> <p>In addition to technological innovations, focus also on social and structural innovations, for example, in Energy Systems of Tomorrow, this means e.g. changes in structure and systems and systems behavior (structural innovations); changes in user behavior dependent on knowledge, attitudes and lifestyle (social innovations); and developments in key areas of the entire spectrum from primary energy sources to energy services (technological innovations).</p> <p>Financing and encouraging the networking between individual research projects.</p>

2.2.2 Enabling international market access and growth

International market access and growth ensures the benefits of the innovation process to be captured. Thus, this theme is highly relevant not only in Finland, but also in

other countries, highly dependent on the international trade. Thus, four examples of tools, measures and instruments in use were analysed to provide best practices on how to enable international market access and growth of the companies (Table 2.3).

Table 2.3. Examples of tools, measures and instruments to enabling international market access and growth.

	Short description	Success factors and lessons learned
China Cleantech Trade Mission, California	The State of California is leveraging its global leadership in cleantech innovation to foster international growth for its cleantech products and services. One approach is to sponsor cleantech trade missions to other global markets. An example of how the State of California is supporting its cleantech industry is through a California-China Clean Tech Trade Mission.	<p>B2B commercial activities with consistent sponsorship of the State of California with employment growth and capital investment as key metrics.</p> <p>Direct, bi-lateral meetings between California and Chinese cleantech companies to generate B2B sales.</p> <p>Involvement of many California-based Asian business advocacy groups (e.g. CALASIAN Chamber) alongside State agencies.</p> <p>Example of a multi-tiered approach to global trade missions to leverage resources through large-scale B2B contact with a large cleantech market.</p> <p>Partnership between the Government and NGOs focused on specific cleantech geographic markets (e.g. China) to accelerate the “network effect” of B2B partnership development.</p> <p>Linking B2B events to support services to put in place sustainable global marketing platforms</p>



...Table 2.3.

	Short description	Success factors and lessons learned
Financing instruments of the Netherlands Enterprise Agency, Netherlands	Netherlands Enterprise Agency aims at encouraging entrepreneurs in sustainable, agrarian, innovative and international business, helping companies with grants, finding business partners, know-how and compliance with laws and regulations.	<p>Targeted funding instruments for different sizes of companies in different stages of innovation process.</p> <p>Financing young companies in a phase where an innovation is not yet generating returns and thus might not receive backing from private sector.</p> <p>Proof-of-Concept Funding enables start-ups and SMEs to find out whether their ideas have real market potential.</p> <p>Proof-of-Concept Funding has succeeded in supporting start-ups to commercialise ideas that now attract private investors and paid-up orders. This was the case for example with CTcue, a start-up company providing a tool for hospitals and doctors to quickly identify people who would make suitable subjects for clinical trials, which received Proof-of-Concept funding for commercialisation of their innovation.</p> <p>Application process for financing comprises a quick scan of eligibility, followed by a full application.</p>
New Ways to Export, Denmark	New ways to Export is a national programme and public-private partnership with the objective of increasing Danish exports and internationalisation of cleantech businesses, operating Cleantech hubs in New York and Shanghai.	<p>Financing a business oriented programme partly with public funding and partly with membership fees.</p> <p>Establishing local presence in countries that are considered as important, yet unexploited target markets, to establish connections and identify potential partners.</p> <p>The cleantech hubs provide the members with knowledge of the export opportunities to New York/ Shanghai markets and individual advice about business and engagement strategy.</p> <p>The cleantech hubs organise individual meetings for the members with local public and private partners as well as targeted activities such as seminars, workshops and roundtable discussions.</p> <p>Members have access to office and meeting facilities in New York and Shanghai.</p> <p>Focus on few selected target markets instead of a wider geographical scope.</p>
Demo Environment programme, Sweden	Demo Environment Programme is a Swedish national programme funding international clean technology transfers from Sweden to 14 countries in Africa, Asia, Latin America, Western Balkans and Eastern Europe.	<p>Financing local companies in target market countries facilitates the importation of new products and services (creating new business opportunities) and accelerates the transfer to green technologies.</p> <p>Financing feasibility studies enables businesses to assess the market potential of their idea and identify potential local clients and partners.</p> <p>Applications for funding are assessed based on impact; technical solution; market potential and commercial viability; partners; project plan, budget and risk; and additionality. Applications are processed within two months of the application deadline.</p> <p>Demonstration project funding is applied in two steps, of which first is voluntary: it includes submission of project idea and feedback to either develop the idea further or to explain if the idea does not fulfil the criteria of the programme. The second step is a mandatory full application process. Planning grants are applied in one step only.</p>

2.2.3 Strengthening business ecosystems

Strengthening business ecosystems is today of high interest in the public discussion and policy making in Finland. Thus, five examples of tools, measures and instruments in

use were analysed in detail to provide best practices on how to build up and strengthen growth driven regional, national and international business ecosystems (Table 2.4). The examples are described in further detail in Annex 4.

Table 2.4. Examples of tools, measures and instruments to strengthen business ecosystems.

	Short description	Success factors and lessons learned
Cleantech cluster CLEAN, Denmark	Cleantech cluster CLEAN is a Danish national cleantech cluster and a non-profit organisation that facilitates and creates collaboration between public and private sectors and research institutions internationally, gathering more than 170 Danish members from the cleantech sector.	<p>A non-profit organisation and cluster of cleantech actors as a central agent in developing and implementing projects and applying funding for the cleantech sector.</p> <p>Transboundary cooperation between cleantech clusters abroad increases connectivity and access to international markets and networks.</p> <p>Meet-the-Buyer events and professional expertise development programmes for innovators that focus on how to reach corporate buyers to support market entry.</p> <p>Several types of activities and financing to support members' international connectivity, such as a voucher system to finance international travel for market exploration and connecting with potential clients.</p>
Green Tech Cluster Styria GmbH, Austria	Green Tech Cluster Styria is Austria's Green Tech Valley for innovative energy and environmental technologies and growth businesses with 180 companies and research institutions and strong international networks.	<p>Attractive location for growth seeking companies. Since the cluster was created in 2005, the companies involved have grown at a rate of 14 % annually, 94 % of the output is exported in to global markets.</p> <p>Strong regional cluster attracts growth, and companies are encouraged by each other to innovate and internationalise.</p> <p>Actively initiating joint innovation projects. In 2015, the cluster organisation jointly initiated 24 innovation projects, generated 1158 ideas within companies and successfully brokered 1122 targeted B2B contacts.</p> <p>Access to international markets, proactive in the alliance of 15 global clusters in the International Cleantech Network benefits members.</p>
Los Angeles Cleantech Incubator (LACI)	LACI accelerates the commercialisation of cleantech by offering flexible office space, CEO coaching and mentoring, and access to a network of experts and capital. LACI is the business equivalent of baseball's farm system: it identifies local talent, nurtures it, and helps it get to market.	<p>Collaborative platforms enhance start-ups' abilities to research and develop their technologies by reducing costs and sharing risks. Reduces the risk to startups and smaller companies attempting to bring cleantech technologies to market.</p> <p>Good model of collaboration between a large city, universities and the private sector. Close interaction of all three parties (public, academic and private) within a same platform results in more mature technology solutions.</p> <p>A critical factor is the strong partnership with local companies and private venture capital investment community.</p> <p>LACI capital costs were reduced by using existing facilities in a brownfield development and securing corporate sponsorships for solar panels, equipment, and conference facilities.</p> <p>Demonstrated increases in local employment have led to continued funding from city and corporate sources.</p>



...Table 2.4.

	Short description	Success factors and lessons learned
State of Green, Denmark	State of Green is the official green brand for Denmark gathering leading players in the fields of energy, climate, water and environment, fostering relations with international stakeholders and concretising ambitious Danish plan to lead the transition to a green growth economy and independency of fossil fuels by 2050.	<p>Strong government commitment supports companies' efforts internationally: Denmark has decided to lead the transition to a green growth economy and aims to be independent of fossil fuels by 2050.</p> <p>Various proactive means of marketing in use to promote Danish cleantech and convincing and user-friendly online services for potential customers and partners: good online interface for finding solutions to specific needs, plenty of available material supporting the promotion of Danish cleantech.</p> <p>Active promotion of success: government commitment, business news and company visits all support the same story.</p>
Vinnväxt competition for regions, Sweden	Swedish Vinnväxt programme promotes sustainable regional growth by organising a competition where regions can apply for funding for long-term innovation initiatives.	<p>A competition with a significant award was effective in attracting a large number of regional applicants.</p> <p>Long time horizon of funding (10 years) to support the partners' commitment to the initiative and enable long-term business plans.</p> <p>Emphasis on innovation ecosystem development to catalyse a broader transformational change in the regions/ wider society.</p> <p>Regular evaluation of the results of the initiatives required for further funding ensures that the initiatives are well focused and create wanted impacts.</p>

3

Companies in the programmes

3.1 Company overview

In total about 400 companies participated in the evaluated programmes, covering a reasonable share of the cleantech companies in Finland. The companies are analysed in further detail in the programme specific chapters.

About 250 of the companies were SMEs³¹. The share of SMEs out of Tekes' funding in the programmes was 57 %. As a benchmark, the share of SMEs out of Tekes' funding in general was 77 % in year 2016 (70 % in 2015) (Table 3.1)³².

Table 3.1. Number of companies and SMEs in the evaluated programmes.

	Number of SMEs	Total number of companies	Share of Tekes funding to SMEs
Final evaluation: Green Growth	85	126	56 %
Final evaluation: Green Mining	30	46	53 %
Final evaluation: Groove	57	77	74 %
Final evaluation: EVE	36	79	52 %
Ex-post evaluation: Densy	35 ³³	59	63 %
Ex-post evaluation: Climbus	35 ³⁴	68	37 %

Companies in the programmes

400 companies* including 250 SMEs

20% of Finnish cleantech companies

25% also participating in Finpro's cleantech-related growth programmes

Total of 607 million euros, including 310 million euros Tekes funding

70% of Tekes funding to company projects, 57% of company funding to SMEs

3.2 Instrument overview

The evaluated programmes extended from 2003 to 2016 and totaled 607 million euros, of which 310 million euros was Tekes funding³⁵. About 70 percent of Tekes' funding was devoted to company projects and 30 % to research

projects (in total companies were funded with 219 million euros in the evaluated programmes)³⁶. Average Tekes' funding of company projects ranged from 0,3 million euros in EVE, Densy and Climbus to 0,6 million euros in Green Mining programme. Table 3.2 provides a comparison of essential programme data.

³¹ Small and medium-sized enterprises. In addition to the staff headcount ceiling (< 250), an enterprise qualifies as an SME if it meets either the turnover ceiling (≤ 50 million euros) or the balance sheet ceiling (≤ 43 million euros), but not necessarily both.

³² Tekes (2017b)

³³ Data regarding size distribution of the companies in Densy programme was incomplete and may cause small uncertainties to the amount of SMEs

³⁴ Data regarding size distribution of the companies in Climbus programme was incomplete and may cause small uncertainties to the amount of SMEs

³⁵ Source: Tekes' programme data

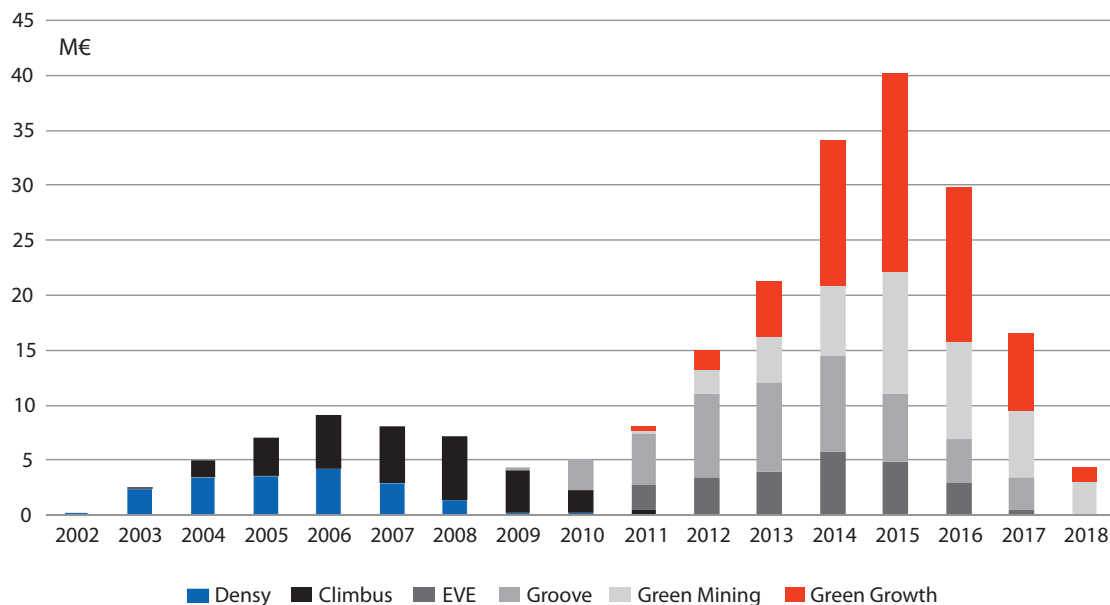
³⁶ As the evaluation aims to understand specifically how the programmes have created business growth the focus of this evaluation is on the company projects.

Table 3.2. Tekes funding in the evaluated programmes.³⁷

	Total volume (M€)*	Tekes funding (M€)*	Share of company funding out of Tekes funding	Average size of Tekes' funding in company projects (M€)	Number of companies (in company projects)
Final evaluation: Green Growth	160	81	75 %	0,4	126
Final evaluation: Green Mining	124	62	68 %	0,6	46
Final evaluation: Groove	101	53	85 %	0,5	77
Final evaluation: EVE	75	36	68 %	0,3	79
Ex-post evaluation: Densy	56	32	57 %	0,3	59
Ex-post evaluation: Climbus	91	45	61 %	0,3	68

* Including both company and reserch projects

Figure 3.1. Tekes funding of company projects in the evaluated programmes per year.³⁸



Specifically, in years 2014-2016 the Green Growth, Green Mining, Groove and EVE programmes constituted a significant share of the total Tekes funding. Tekes funding volume of company projects in the different programmes per year is shown in Figure 3.1.

As the focus of Tekes' innovation funding is currently being shifted from grants³⁹ to loans⁴⁰, the impact of different types of instruments needs more discussion. For this as-

essment, only the share of grants and loans were analysed, but not the differences in their impact. According to a 2015 study⁴¹ comparing the impact of Tekes' grants and loans, it was determined that grants have a greater impact on success of both company innovation activities and external co-operation and networking. Loan, in turn, had greater impact on innovation commercialisation. However, it was considered crucial that loans were preceded by other Tekes funding.

³⁷ Source: Tekes' programme data

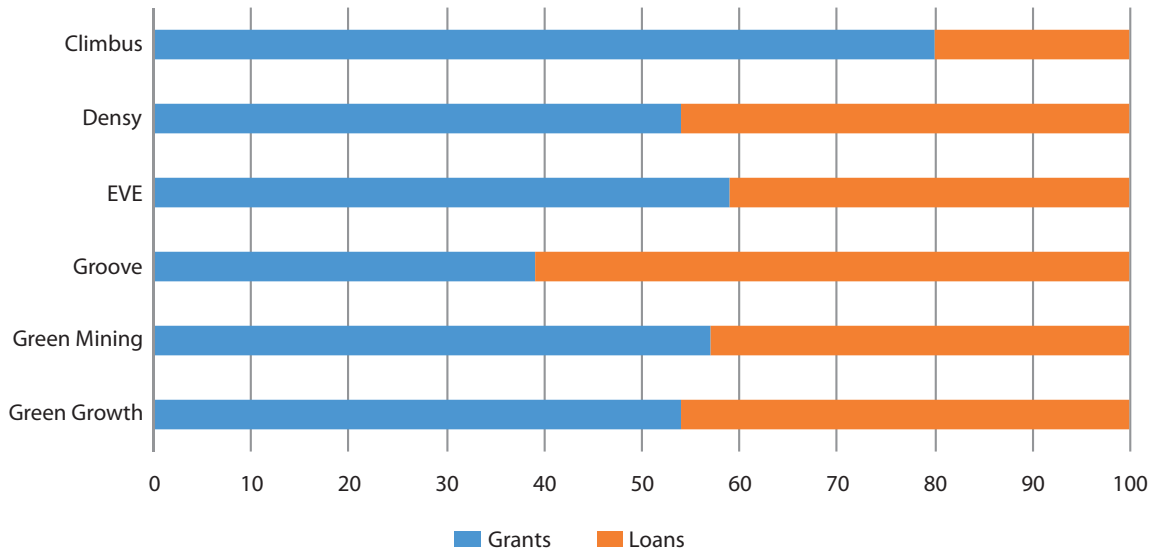
³⁸ Source: Tekes' programme data. The project funding for a specific project is divided evenly over the years of the project duration. Even though the programmes ended in 2016, some projects might be running until 2018.

³⁹ Tekes grants are intended for R&D by companies that generates new knowledge and competencies, but not a finished product or service at this stage. Tekes can award grants covering up to 50% of the total costs of SME research projects. For international joint projects, the funding can cover up to 65%. For mid cap and large companies the Tekes grant accounts for 40% of total project costs at a maximum. In addition, the large companies need to acquire services from SMEs or research organisations, or the project must be carried out as a genuine joint project with SMEs and research groups both in the case of grants and loans.

⁴⁰ Loan funding from Tekes is advantageous for companies. At the moment, the interest rate is one per cent, and no collateral is required in most cases. If the project fails or its results cannot be commercially exploited, the loan may be partially converted into a grant. For SMEs' development and piloting projects, Tekes grants a loan covering 50% or 70% of the project's total costs. For mid cap and large companies the Tekes loan accounts for 50% of total project costs at a maximum.

⁴¹ Valtakari (2015)

Figure 3.2. Share of grants and loans in company funding.⁴²



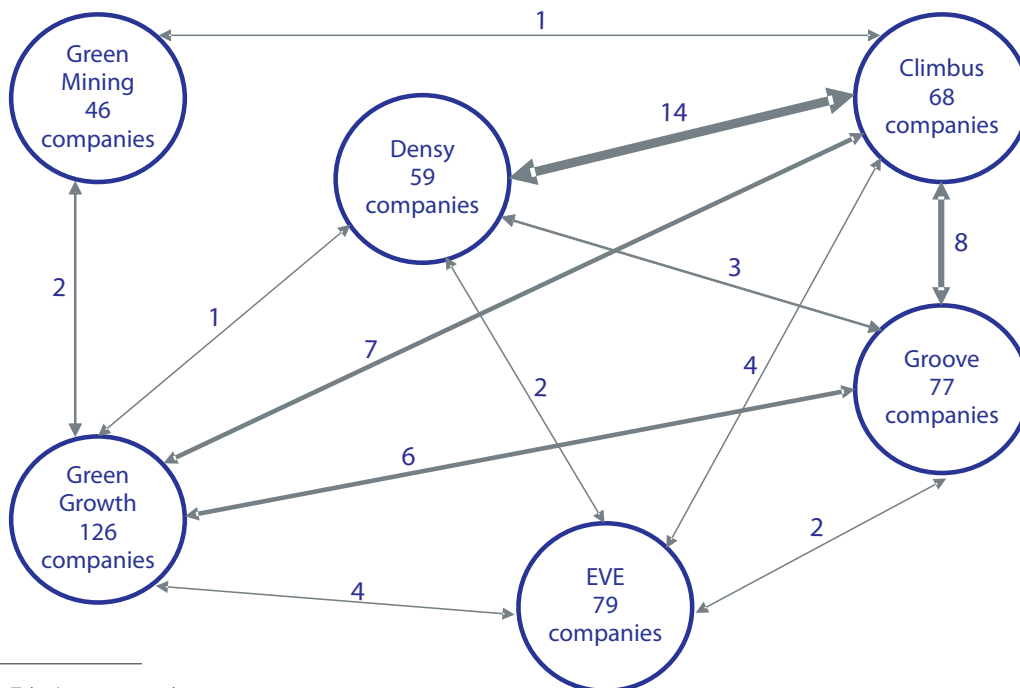
In the company funding of the evaluated programmes the share of Tekes' funding grants varied from 39 % in the Groove programme to 80 % in the Climbus programme (one of the earlier programmes). The share of Tekes programme grants and loans to companies is presented in Figure 3.2.

Further discussion of the funding instruments can be found later in the programme specific chapters later in this report.

3.3 Synergies within and outside the programmes

The programmes were partly overlapping in mission and company participation. The Densy, EVE and Groove programmes were strongly linked to the energy issues. Climbus had a slightly wider scope in climate business but was natu-

Figure 3.3. Number of companies participating in the programmes. The number above the arrow indicates the number of companies that participated in both of the programmes.⁴³



⁴² Source: Tekes' programme data

⁴³ Source: Tekes' programme data

rally also linked to energy. Green Growth continued developing business with a far broader scope and extended also to energy and mining topics. Thus it is evident that several companies participated in more than one of the evaluated programmes. Links between the programmes regarding the participating companies can be seen in Figure 3.3.

The same companies that participated in the evaluated programmes participated also in other Tekes' programmes

(the companies received 216 million euros of Tekes funding from 63 other Tekes programmes). In a detailed analysis of 11 cleantech companies in 2016, it was found that these companies participated in 23 Tekes programmes in total.

In total, 98 of the companies that participated in the evaluated programmes were also participating Team Finland's growth programmes⁴⁴. Out of these companies 67 were SMEs (Table 3.3).

Table 3.3. Tekes programme participants in Finpro's growth programmes.

	Number of companies that participated both Tekes and Finpro's programmes	Share of companies out of all Tekes programme participants that participated also Finpro programmes
Final evaluation: Green Growth	49	39 %
Final evaluation: Green Mining	19	41 %
Final evaluation: Groove	32	42 %
Final evaluation: EVE	16	20 %
Ex-post evaluation: Densy	19	32 %
Ex-post evaluation: Climbus	23	34 %

3.4 Customer views on programme benefits

As part of this evaluation, companies participating in the Green Growth, Green Mining, Groove and EVE programmes were surveyed as to perceived benefits of the programmes. Altogether, 48 respondents answered the questionnaire, of which 21 were Green Growth programme participants⁴⁵. The survey results concluded that the programmes have been successful in advancing companies' innovations and providing new strategic insight into related business opportunities. In addition, the survey indicated that the programmes enhanced efforts to find relevant partnerships and create business networks. However, the survey also showed that the programmes had only a minor impact on the level of ambitiousness of company projects and introducing new business practices.

The survey indicated that the programmes seem to have had a significant effect on innovation and business development that was continued after the programmes and projects. However, it should be noted that the sample of respondents was small and focused on the Green Growth programme. Typically, research, development and innovation (RDI) projects enabled companies to take additional steps towards piloting and testing right after the conclusion

of the project. Almost half of the respondents indicated that immediately after the programme they were prepared to put RDI results into practice through piloting and testing, i.e. the stage of innovation shifted from RDI to testing as a direct result of the programme project.

About third of the respondents were at testing stage as of this writing (2017), but it should be noted that some of the projects have been concluded quite recently. The survey results indicate that companies have taken the results ahead after the programme. At the moment, about 1/3 of the respondents report that their companies have launched the developed service or product to the market, whereas only about 1/5 were at this stage right after the RDI activities. A positive result is that about 1/4 of respondents indicated that the business is currently growing internationally.

According to the survey, programme funding and services had increased RDI investments and resources and also enabled customer-oriented piloting and demonstrations (Figure 3.4). The programmes have strengthened the expertise and strategic insight of the companies as well as enabled new strategic partnerships (Figure 3.5). However, the creation of new larger business ecosystems was not seen as a relevant programme outcome (although strategic partnerships can be seen as a part of valuable ecosystems).

⁴⁴ Including Team Finland's Beautiful Beijing, Cleantech Finland, Innovative bioproducts, Kehittyvät markkinat, Green Mining Growth Programmes, W2E and Bioenergy. Data source: Tekes and Finpro

⁴⁵ In total 48 respondents (12% of the companies participating in the programmes) replied to the survey: 21 from Green Growth, 8 from Green Mining, 7 from Groove and 12 from EVE programmes.

Figure 3.4. Effect of programme funding and services on companies' RDI activities.

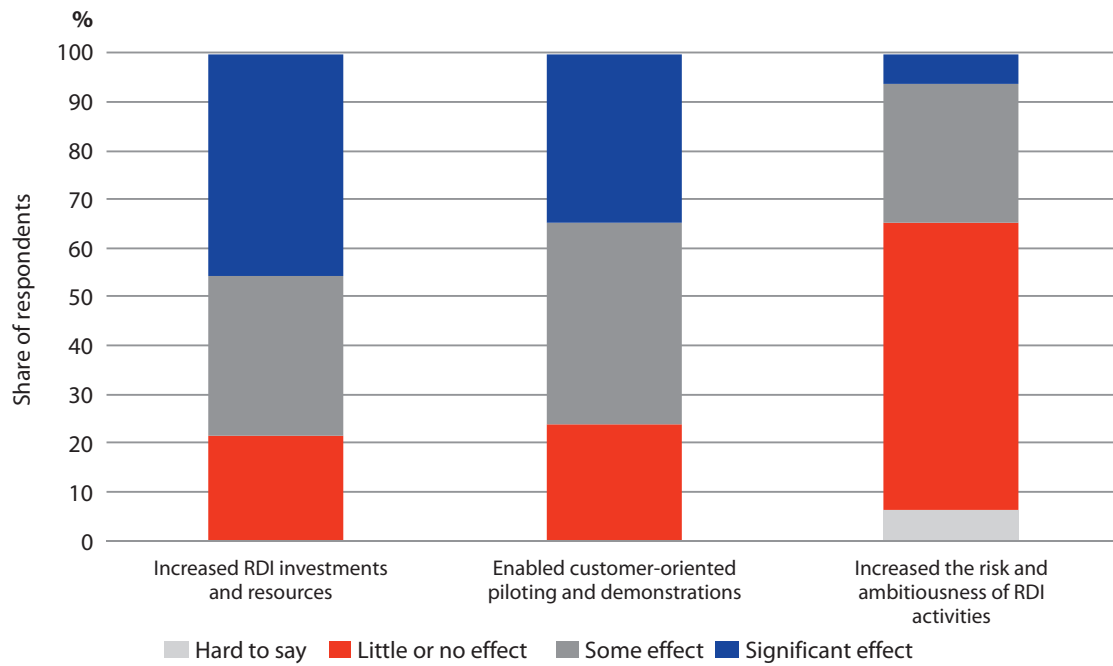
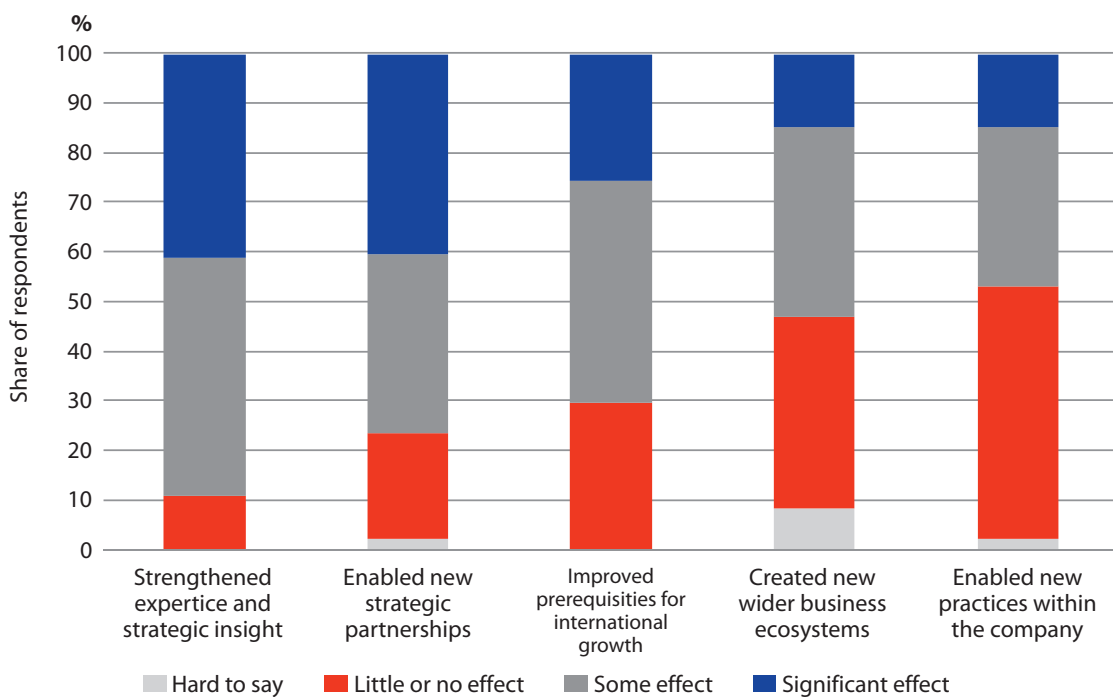


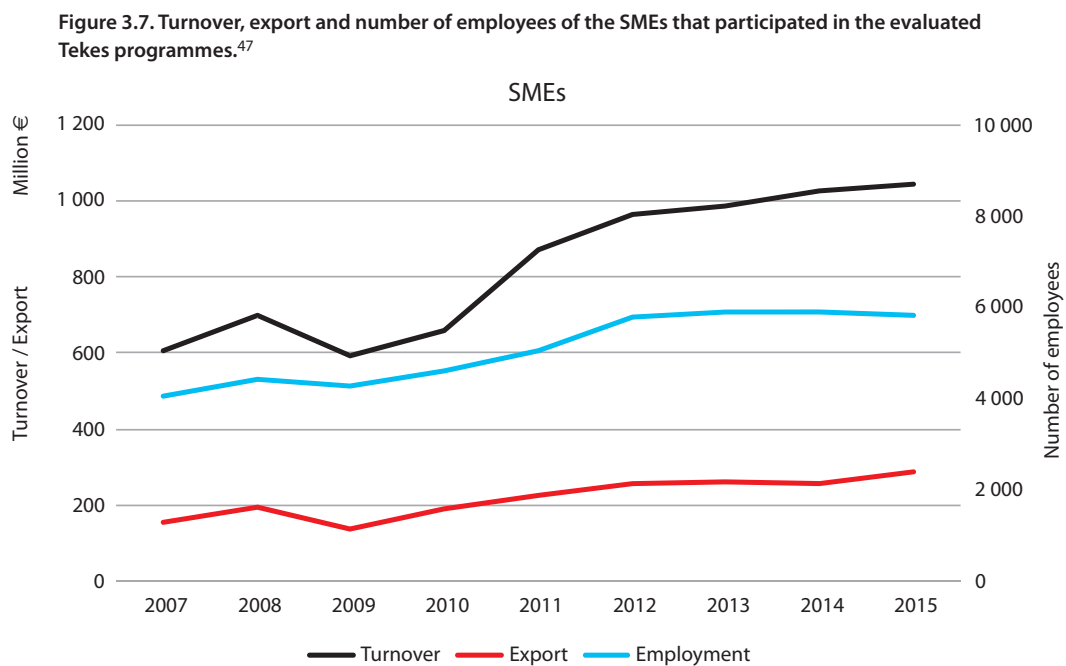
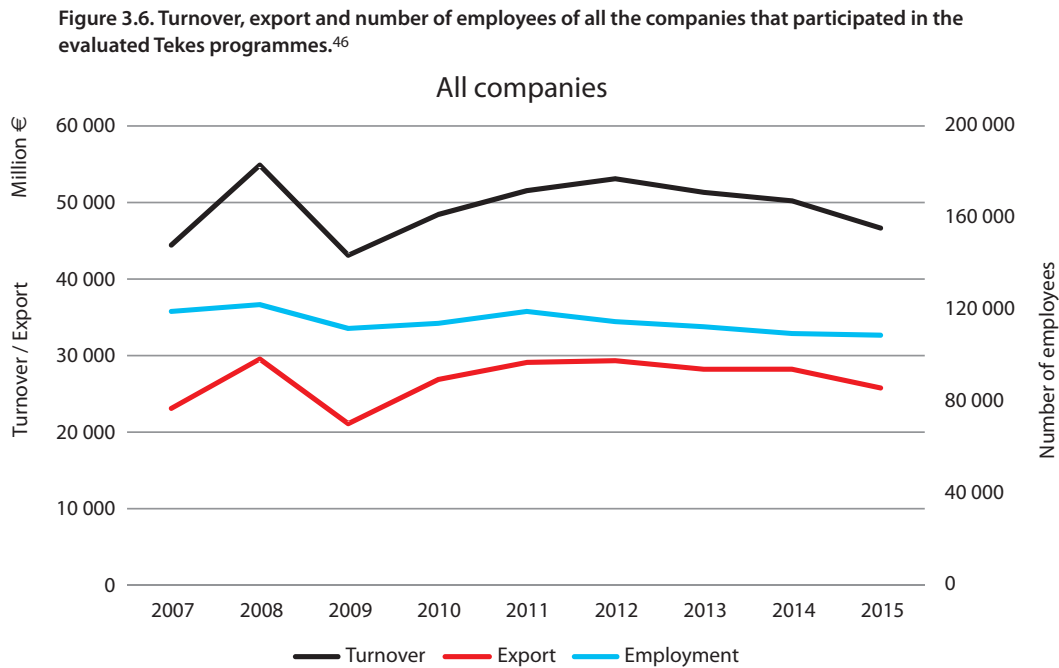
Figure 3.5. Effect of programme funding and services on companies' know-how and networks.



3.5 Growth of the customers

Business growth is a central expected outcome of Tekes programmes and activities. A summary of the turnover, export and number of employees of those companies that participated in programme projects is shown in Figure 3.6 (all companies) and Figure 3.7 (only SMEs).

The turnover of the companies is dominated by large companies. The effect of the 2008-2009 depression is clearly in evidence. This period was followed by a few positive years, however, the past few years show negative trends in both revenue and export volumes. The detailed reasons for this current trend were not analysed for this study, but it should be noted that these statistics do not include business activity outside of Finland (other than export).



⁴⁶ Source: Tekes' databases

⁴⁷ Source: Tekes' databases

There has been positive development in the SMEs business. However in 2015, SMEs represented only about 2 % of the total company revenue, 1 % of exports and 5 % of employment of all the companies participating in the evaluated programmes. Still their role as an important part of the renewal and growth of cleantech shouldn't be underestimated.

The turnover of the SMEs in all the evaluated programmes, with the exception of Densy programme, show a similar path (Figure 3.8). The SMEs of the Green Growth, Green Mining, Groove and EVE programmes show a significant growth in the turnover specifically from year 2010 to 2011.

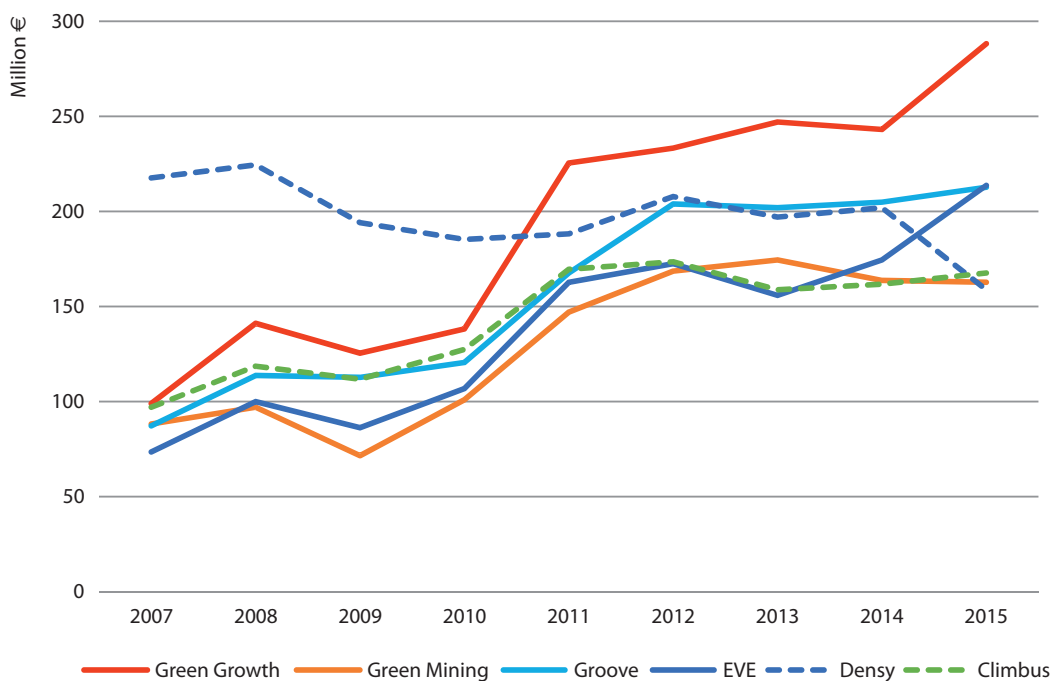
Between 2007 and 2015, growth figures for SMEs in the evaluated programmes are 72 % increase in turnover, 84 % in export and 43 % in employment. If all companies in the evaluated programmes are included in this analysis, the corresponding averages are 5 %, 11 % and 9 %. It may be concluded that, especially in the case of large companies, company level data does not indicate the renewal and growth of new business (as this is often offset decreasing businesses).

Figure 3.9 shows the turnover and export of the SMEs that participated in the evaluated programmes and those SMEs that participated also in Team Finland's growth programmes.

However, this data alone is not enough to understand the role of Tekes and the evaluated programmes on the growth of the businesses as the growth is a result of many company and market related factors. However, in the case of SMEs it appears likely that Tekes support is having a significant role in the company growth than in the case of large companies. In addition, for large companies the connection between Tekes-funded RDI projects and changes in annual turnover is difficult to prove.

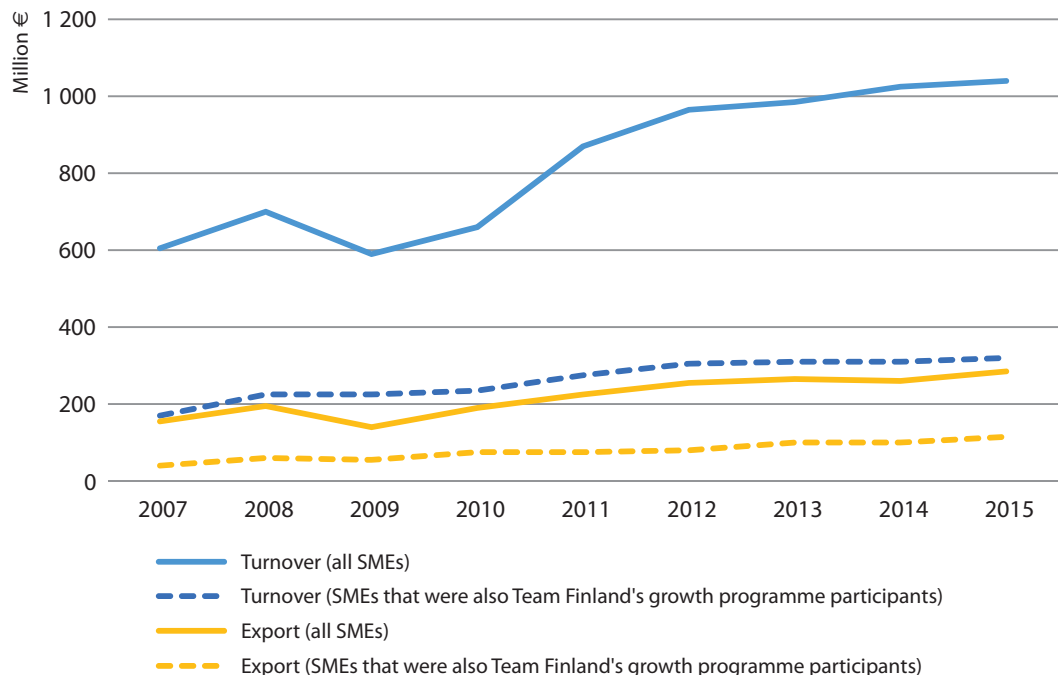
To further understand the impact of Tekes funding programmes on corporate growth and success, further insight into specific business areas affected by RDI (Research, Development and Innovation) activities is required. In addition to expected and realised company turnover, export and employment performance, it may be relevant to assess the RDI specific business development in further detail. This analysis could also include, for example, understanding the investments made both in tangible and intangible assets that support the commercialisation of RDI results and international growth of the companies. This insight is needed to ensure that renewal and the emergence of new business stands out from decreasing business, and to see the potential of creating new business in the future.

Figure 3.8. Turnover of the SMEs that participated in different programmes.⁴⁸



⁴⁸ Source: Tekes' databases. Some companies were part of several of the evaluated programmes. In this figure, the turnover of these companies is included in all the programmes that the companies were part of. This is the reason that the some of the programme specific turnover data in this figure is larger than the total turnover in previous figures.

Figure 3.9. Turnover and export of the SMEs that participated in the evaluated programmes and those SMEs that participated also in Team Finland's growth programmes.⁴⁹



⁴⁹ Source: Tekes and Finpro's databases

Final evaluation of the Green Growth, Green Mining, Groove and Electric Vehicle Systems programme

4

Results of the Green Growth programme

4.1 Overview of the programme

The goal of the 2010-2015 Green Growth programme was to identify and support potential new growth areas within the sustainable economy based on low energy consumption and sustainable use of natural resources⁵⁰. According to detailed data collected by Tekes and made available for this assessment, the total project volume was 160 million

euros, of which 129 million euros funded company projects and 31 million euros funded public research projects⁵¹. Of the total programme value, Tekes funding was 81 million euros. Note that the project funding statistics used later in this chapter include both Tekes funding and company funding. Table 4.1 summarises programme essential facts and data.

Table 4.1. Summary of the Green Growth programme 2010-2015.⁵²

Objectives	<ul style="list-style-type: none"> To identify potential new growth areas for sustainable economy business that were based on lower energy consumption and sustainable use of natural resources A leap forward in energy and material efficiency of production and service chains over the entire life span of products
Focus areas	<ul style="list-style-type: none"> Energy and material efficiency Bioeconomy and biomaterials Recycling, recovery of raw materials and waste processing Business models, service concepts and comprehensive solutions
Total volume	<p>Total volume of the programme 160 M€ (out of which Tekes 129 M€) Volume of company projects 129 M€ (out of which Tekes 61 M€) Volume of research projects 31 M€ (out of which Tekes 20 M€)</p>
Projects	<p>149 company projects (with 126 companies) 70 research projects (with 23 public organisations)</p>
Target customers	<p>Companies seeking growth or renewal of their business in the face of changing energy and raw material prices and the field of laws and regulations</p>
Participating companies and research organisations	<p>41 large companies 11 medium-sized companies 19 small companies 55 micro companies 23 public organisation</p>

⁵⁰ Tekes, Green Growth webpage, Tekes, Green Growth, The Green Growth programme's key figures webpage
⁵¹ Source: Tekes' programme data
⁵² Source: Tekes' programme data

4.2 Targeting the programme

4.2.1 Focus and objectives

The Green Growth programme sought to encourage innovations that would significantly improve energy and material efficiency and fund companies and value networks with growth potential in a resource-efficient and sustainable economy. The objective was to identify new potential growth areas for sustainable business defined by lower energy consumption and sustainable use of natural resources, and to enable dramatic increases in energy efficiency and material efficiency in production and service chains over the entire life span of products.⁵³

According to the programme preparation material, the rationale for the programme was based on global changes in markets and operating environments that are challenging Finnish companies and other actors to renew their business (including re-evaluating resource and energy efficiency benefits and identify new service sector opportunities). Many realised that these changes created new information needs, especially in SMEs, to proactively understand ongoing and expected future business developments. Renewing the structures of cooperation was seen as critical to future success, and new business opportunities were arising on the borders of traditional business sectors. The programme was originally planned with the name Climate Economy, to follow up earlier Tekes programmes like Climbus and Climech.⁵⁴

The programme was planned to run in phases. In the first phase, scenario and foresight projects, strategic research projects and market research was to be conducted to create foresight knowledge and detect signals. In the second phase, new business opportunities were to be identified supported by signal sessions, value network workshops and strategy projects for businesses and SME-targeted programme services. In the third phase, opportunities were to be refined into development projects by developing communities⁵⁵ and pilot projects for new value networks, as well as developing of new product, service and management innovations.⁵⁶

According to interviews conducted as part of this evaluation and a review of programme material, after programme launch this plan was refined in response to internal and external input to put significantly more emphasis

on business-driven development and projects. Although service business models, digitalisation, and value networks were embedded in the original programme plan, they attracted more interest during subsequent innovation policy and public discussions conducted during the programme. These concepts evolved further during and after the programme, an example being the CleanWeb programme for digital cleantech.

Programme themes had links to many other activities in Finland at the time. These included energy, climate and natural resources policy activities of research organisations and funding organisations, ministry activities, and others. According to the programme material, the programme has engaged in close cooperation with the Confederation of Finnish Industries EK, the Strategic Centres for Science, Technology and Innovation (SHOK), the Academy of Finland, the Finnish Innovation Fund Sitra and different ministries. In spite of different national activities, Tekes saw the need for an innovation programme with a specific green growth focus, high level of ambition, crosscutting nature, and foresight approach⁵⁷. In the planning phase, the programme was even viewed as a possible umbrella linking all the other national activities together.

The type of wider systemic approach and mindset in planning and implementing the Green Growth programme hasn't fit the typical Tekes programme model. According to the programme preparation material and interviews, this has apparently led to some confusion both inside and outside of Tekes, and questions have been raised as to specific programme objectives and roles in the national landscape.

4.2.2 Programme funding

Target programme customers were SMEs seeking growth or business renewal in the face of changing energy and raw material prices, laws and regulation. Target customers also included research institutions producing foresight knowledge and new areas of expertise as well as public bodies and third sector organisations that wanted to create new models of an eco-efficient society. The number of participating micro-sized companies⁵⁸ was relatively high, but the number of participating SMEs was relatively low. By the end of the programme, it appeared that a strong emphasis was put on identifying and recruiting highly innovative growth-seeking companies.

⁵³ Tekes (2015)

⁵⁴ Source: Programme preparation material

⁵⁵ The meaning of developing communities was seen pretty close to the term business ecosystems widely used nowadays.

⁵⁶ Suortti (2011)

⁵⁷ Source: Programme preparation material

⁵⁸ In addition to the staff headcount ceiling (< 10), an enterprise qualifies as an micro-sized company if it meets either the turnover ceiling (≤ 2 million euros) or the balance sheet ceiling (≤ 2 million euros), but not necessarily both.

Total programme funding was 160 million euros, of which 81 million euros came from Tekes. The programme was comprised of 149 company and 70 research projects⁵⁹, covering thematic fields of energy efficiency, material efficiency, bioeconomy and biomaterials, recycling, raw materials recovery, waste handling, new business models and innovative service concepts.⁶⁰

A total of 126 companies owned programme projects, of which 67 % were SMEs (including micro-sized companies). Of the 126 companies, 49 were also participating in the Team Finland growth programmes (Cleantech Finland, W2E and Bioenergy, Innovative Bioproducts, and Mining

growth programmes). This shows the strong international business development focus of participating Green Growth programme companies.

The volume of funded Green Growth programme projects differentiated by company size is illustrated in Figure 4.1.

Average Tekes' funding in company projects was 0,4 million euros. The largest programme beneficiaries were St1 Biofuels, Skaala Production, Savaterra, Enevo, UPM-Kymmene, Valmet Technologies, Aidon, Envor Protech, Coctio and Plantui (Figure 4.2).

Figure 4.1. Volume of the projects funded in Green Growth programme according to the size of the company.

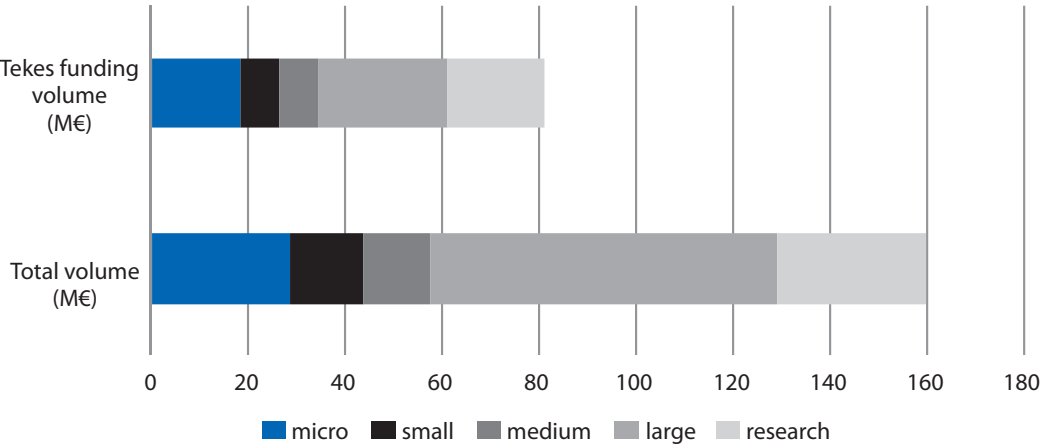
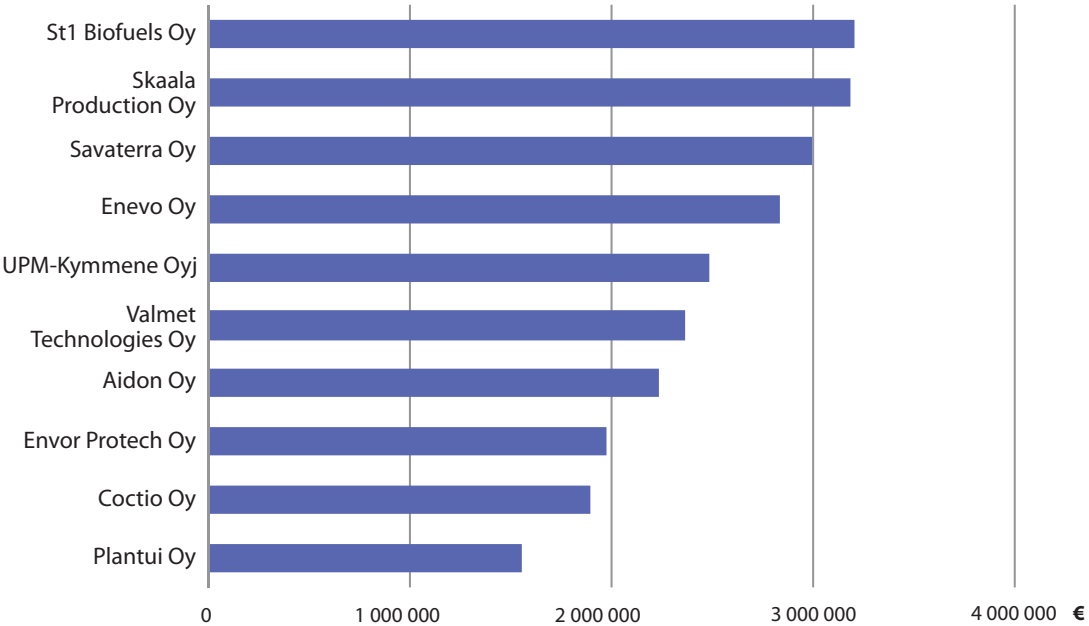


Figure 4.2. Companies with the most Tekes funding in the Green Growth programme.



⁵⁹ Consortia projects allocated per company.
⁶⁰ Source: Tekes' programme data, Green Growth result report webpage

The programme included a variety of interesting company participants, and based on the interviews proactive screening and activation of SMEs, specifically growth companies, was made by the Tekes' Programme Managers during the programme⁶¹. The focus appeared to have been finding growth-seeking innovative companies. The criteria for the funded projects included the following: delivery of a radical resource-efficient technology or service innovation; consideration of a whole life cycle perspective; and support the development of a new value network or testbed⁶². In addition, the business to be developed needed to have the ability to grow⁶³.

Active screening of growth companies resulted in a varied group of programme customers including not only the "usual-suspects" but also new type of entrepreneurial taking advantage of digitalisation and building up business that could be scaled up fast (comparable to companies in the digital and ICT sectors with lean service design). According to the evaluation material, this internal screening process led to the identification and recruitment of many interesting companies and projects.

Examples of the companies involved in the Green Growth programme are shown in Table 4.2.⁶⁴

4.2.3 Programme services and activities

The Green Growth programme included several innovative services and activities. In addition, the programme created valuable business connections between stakeholders both

domestically and internationally through active interactions and communications. The management and execution of the Green Growth programme was driven by three different Project Managers, resulting in slightly different focusing of the programme and its services and activities during the programme. This programme seems to have had a lot interaction to other activities both inside and outside Tekes, which might be due to the dynamism that the different Project Managers brought to the programme. However, this issue was not analysed in further detail. Programme coordination was outsourced to Spinverse, an innovation consultancy, which, based on the interviews, seems to have been working well.

Companies and other actors participating in the project were provided funding for R&D projects, networking events, workshops, sessions, breakfast events, study trips, market and forecast information, expertise in resource efficiency innovation, as well as business model and internationalisation coaching for SMEs. The programme had a lot of interaction with other activities inside and outside Tekes, and active interaction and communication was on high focus.

Based on the evaluation material, the companies seem to be relatively satisfied with the programme services and activities although specific benefits varied depending on funding and other factors. The Steering Group appeared to add considerable value to the programme.

Short description of the selected programme services and activities is presented in Table 4.3.

Table 4.2. Examples of companies in the Green Growth programme.

	Examples of companies
Energy and material efficiency	<ul style="list-style-type: none"> • LED lightning revolution (examples of companies Greenled, Valtavalo) • Energy saving potential in buildings (LeaseGreen, Fourdeg, Arealtec) • Distributed and sustainable power generation (Convion, Oilon)
Bioeconomy and biomaterials	<ul style="list-style-type: none"> • New business from the forests and fields (Valio, Raisio) • Developing renewable transportation fuels (Valmet, St1) • Innovative SMEs (Inray, Spectral Engines, Jarmat)
Recycling, recovery of raw materials, waste handling	<ul style="list-style-type: none"> • Capturing raw materials from waste flows (Ekokem, Jyväskylä Energy Group, CrisolteQ) • Smart solutions for waste handling (BMH Technology, Enevo, ZenRobotics) • Added value products from waste (Destamatic, Suomen erityisjäte)
New business models and innovative service concepts	<ul style="list-style-type: none"> • The rise of the sharing economy (Coreorient, Repack) • Creating green growth through digitalisation (Futuremark, Solved) • Sustainability as a source of innovation (GreenStream, EERA)

⁶¹ The programme manager screened the Tekes' project and customer portfolio actively with other Tekes's staff to identify relevant participants for the programme.

⁶² Source: Programme background material (in Finnish) 17.2.2012

⁶³ How this was determined was unclear.

⁶⁴ Source: Tekes, Green Growth result report webpage

Table 4.3. Selected activities of the Green Growth programme.⁶⁵

Interaction and communication	During the programme, large seminars of over 600 participants from Finland and abroad, small thematic workshops offering concrete help to companies, and delegation visits were organised to bring together the green growth community in Finland to share ideas, learn from other and find new partners. Continuous collaboration and exchange of information with the media has resulted in press releases, articles, editorials, company success stories, research results and the creation of green growth community ⁶⁶ . In addition, the monthly Green Growth newsletter (over 2500 subscriptions), news and current events in Green Growth website, and event materials disseminated through the website have been pivotal in the communication activities.
International cooperation	Green Growth programme promoted international collaboration by helping organisations to recognise potential partners, providing foresight information about international markets, and supporting the participation of small and medium sized companies in EU's Horizon 2020. The programme had specific links to China.
Business sparring	During 2013 and 2014, the Green Growth programme offered participating SMEs sparring from experienced professionals that aimed to support the companies in the challenges of growth, internationalisation and the business models of sustainable development.
Value network projects	The programme encouraged the creation of value network projects and example being the development of energy efficiency solution business concept for the Chinese industrial market. However, according to the evaluation material these type of projects didn't realise in larger scale.
Promise process	In addition, a "promise process" and a road map work were started with the Ministry of Employment and the Economy supporting its cleantech activities. However, this process didn't result in to any roadmap.
Cooperation with Berkeley	The programme cooperated with Berkeley on a MBA team assignment is to search and suggest key, high impact, areas for Tekes to invest through new Tekes programmes. Team will do secondary and primary research in the space of natural resources and resource efficiency including e.g. cleantech and bioeconomy.

International activities were a substantial part of the programme. For instance, Green Growth and Groove programmes were undertaken in cooperation with China Jiangsu and Zhejiang provinces as part of the Team Finland outreach activities. Tekes, Groove programme participants, and Jiangsu province organised a joint call in 2013. In 2014, Tekes and China's MOST (Ministry of Science and Technology) launched a joint call for cleantech. In 2014, the Green Growth and Groove programmes organised delegation visits both in Finland and in China. The Green Growth programme also supported Tekes' cooperation with the Brazilian Agency for Innovation (a Finnish-Brazilian joint call launched in 2014). Also, the programme supported Tekes' cooperation with India (delegation visit to India, Indian Renewable Energy Expo, in 2012). In 2013, Tekes initiated a foresight study of the Russian municipal solid waste management market as a Team Finland Future Watch Process. To support this effort, the Green Growth programme helped to build Finnish-Russian cooperation on waste management organising a workshop

in 2013 and helping to assemble the Finnish delegation to a delegation visit to the Komi Republic in Russia in 2014 organised by Team Finland. According to the evaluation material, specific companies have been able to take advantage of these international activities, specifically in China.

In addition, 40 % of the programme companies were also part of Team Finland growth programmes. However, their turnover growth hasn't been specifically strong raising the question on 1) which companies are attracted as growth programme customers and 2) how much the companies use other means than export to grow internationally. Company case studies give further insight on the benefit and synergies of public innovation and internationalisation support to companies.

As a sum up, the programme and its services and administration met the needs of the participants relatively well, although the companies pointed out the need for the public support to be flexible and specific in different phases of the development and international growth.

⁶⁵ Source: Tekes, Green Growth result report webpage

⁶⁶ For example, Mediajutut 2015: 19 media publications etc. Uusiouutiset, Tekniikka & Talous, Talouselämä, Kemia-lehti, Kauppalehti, Materia-lehti, Iltalehti, Programme final report (GG digiraportti), Publication on Green Growth Day 1/2015, Monthly newsletters to about 2700 recipients, Source: Presentation Green Growth -ohjelman johtoryhmän kokous 3 / 2015 (in Finnish), 5.10.2015

4.3 Results and direct impacts

The Green Growth programme successfully accelerated the market entry of many participating companies⁶⁷. This was mainly due to funding, but also international activities and business coaching as programme services are likely to have supported some companies. According to company participants (based on the result reporting of the programme⁶⁸), the development of business and solutions was faster than it would have been without the programme funding. Also by sharing development risks, programme funding enabled more risk-taking in both projects and business development (although the survey material of this study didn't emphasize this aspect strongly).

A survey of the programme's company participants (21 respondents representing 17% of the participating companies) shows that programme funding and services contributed to the companies own RDI activities, in particular, by increasing RDI investments and resources, and enabling customer-driven pilots and demonstrations. Regarding the expertise and networking, the programme funding and services contributed in strengthening business expertise and strategic insight as well as enabling new strategic partnerships. To some extent, the programme was also seen to have clarified companies' requirements for international growth, enabled the introduction of new internal business practices, and created new, more broadly defined business ecosystems.

According to the evaluation material, the focus of the programme on developing business models seems to be one reason for the high share of market acceleration. In addition, piloting, demonstration and business scale-up were a focus, supporting the commercialisation of developed solutions and businesses. One of the significant benefits of the programme participation was the increased credibility towards the customers and potential funders, as many companies were looking funding for their growth.

Inside the companies, programme-funded projects, and possibly also the events where business intelligence was shared, enabled deeper insight to the developed areas than would otherwise been possible⁶⁹. However, there is no clear evidence that companies could have specifically used the foresight studies done in the beginning of the programme. The events organised by the programme together with other actors reached hundreds of companies, and are likely to have had networking and business intelligence benefits.

Green Growth programme company participants, especially the large players, viewed the enabling of cooperation between large companies and SMEs and between companies and research organisations⁷⁰ to support the creation of ecosystems as the primary programme benefit. Sharing examples of success stories and growth opportunities at various programme events seems to have catalysed the development of business ecosystems and building of confidence in the ability of the Finnish business ecosystem to produce globally marketable technology and business solutions. This is an important message for national policy makers, and helps to raise international awareness in Finnish expertise. However, the continued development of wider systematic outcomes, organisational impacts, cooperation and innovation platforms, and business ecosystems are difficult to identify and track.

There are several examples of business innovations that can be traced back to specific projects funded by the programme⁷¹. However, it needs to be noted that many other factors also affect the outcome of these business cases. Among the 126 participating companies, there exist several interesting examples of significant future growth potential. Examples include MSc Electronics, Soil Scout and St1. In the programme MSc Electronics developed energy storage, and is now well positioned to take advantage of the smart grids and other related developments in the energy sector. The company has also been part of the earlier Densy programme. Soil Scout developed permanent buried wireless soil moisture monitors and monitoring systems. It now has international patents and is growing globally. St1 developed production of bioethanol from lignocellulose, and today produces bioethanol from sawdust in Kajaani in a joint venture with SOK. Sawdust is provided by Pölkky Oy and the excess lignin is used in energy production by Kainuun Voima⁷², thus creating a local ecosystem.

According to the survey of the programme's company participants, the funded projects have helped companies to create new innovations and businesses to be commercialised. Typically at the conclusion of the funded projects, the feasibility and attractiveness of the new innovation and/or business was tested (52 % of the companies in this stage). At the time of the survey, however, a significant share (43 %) of survey respondents have launched the service or product to the market (as compared to 24 % in the end of the projects). In 50 % of the cases, the growth has

⁶⁷ In the area of energy and material efficiency, biomaterials, recycling, recovery of raw materials, waste handling as well as new business models and innovative service concepts.

⁶⁸ Tekes (2016a), see also <http://finlandinnovation.fi/greengrowth/>

⁶⁹ Through in-depth research for example.

⁷⁰ Tekes (2016a), see also <http://finlandinnovation.fi/greengrowth/>

⁷¹ Tekes (2016a)

⁷² Source: St1 (2016), Kinnunen (2015)

been either completely or almost completely consistent with the expectations.

Although the programme succeeded in identifying and supporting potential new growth businesses, the preliminary idea⁷³ to identify specific growth areas to be focused didn't work. As business innovations and growth opportunities should be driven rather bottom-up by the business itself, this is also a challenging approach.

Beyond specific programme objectives, an important programme outcome is the active interaction between a variety of green growth actors in Finland and internationally to find synergies between different technologies and service activities⁷⁴. Also the encouragement that businesses have provided to one another, other companies, and policy makers seems to have played a role.

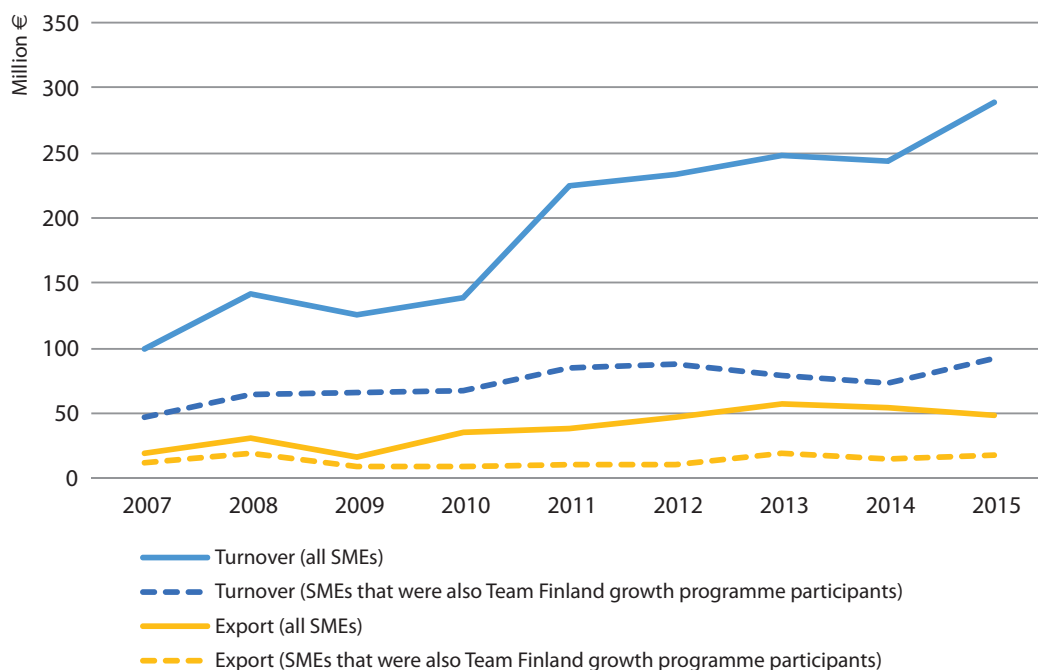
The growth of participating SMEs is presented in Figure 4.3. It shows a strong growth in turnover, specifically from year 2010 to 2011. Increase in exports, however, has been more moderate. The companies may have used other means to expand their international operations such as foreign subsidiaries.

4.4 Indirect impacts

The Green Growth programme sought to catalyse a leap forward in the energy and material efficiency of production and service chains over the entire life span of products⁷⁶. By including companies with interesting business models and growth prospects, it was expected that some would outperform the average. Many of the solutions developed as part of the programme have remarkable energy and material efficiency benefits. For example, Greenled's lightning technology as a service application has shown energy savings up to 90 % compared to traditional mercury technology in the case of street lighting change in the City of Helsinki⁷⁷. Many other companies can prove similar impressive energy and material efficiency benefits in a variety of application areas.

By actively soliciting companies from Tekes' portfolio and elsewhere, many interesting growth seeking companies were recruited into the programme. By focusing on business development and internationalisation in funded project definition, it is expected that many will realise increased revenue.

Figure 4.3. Revenue of the SMEs that participated in the Green Growth programme.⁷⁵



⁷³ A strong focus in the beginning of the programme was on research and creating a national roadmap. This would lead to more concrete company projects, and in the end creation of strong value networks and ecosystems.

⁷⁴ However, it is hard to see how systematic this has been

⁷⁵ Source: Tekes and Finpro's databases. Some of the companies might be part of several of the evaluated programmes and thus the sum of programme specific turnovers is larger than the sum up turnover represented in Chapter 3.

⁷⁶ Source: Programme preparation material

⁷⁷ Source: Greenlead, References, The city of Helsinki, Street lighting, webpage

Many of the programme company participants are introducing new ways of thinking to traditional sectors and processes, and have the potential to radically improve productivity, growth and renewal. However, the companies typically are SMEs with limited history and resources of bringing products and services to the market, thus limiting the speed and power to reach and change markets. Although business competence, including international business, has been high on the programme agenda, a lack of (international) business skills can in some cases limit business growth.

Indirect and future impacts will be highly dependent on the scalability of the businesses. Many of the projects focused on scalability through the application of digital technologies or modular solutions. Thus it can be hoped that international growth within this group of companies will be relatively strong (however, these companies are likely struggling with the same issues as any other growing company in Finland).

In spite of several big success stories, the value chains, potential partnerships and encouragement to other companies and policy makers, it is difficult to isolate and measure the benefits of systemic business ecosystems in Finland that may have occurred as a result of the programme (in addition to subcontracting and piloting and demonstration). It still seems to be far easier for the companies to develop solutions by themselves than create wider concepts and solutions with other companies, although some promising examples exist.

The programme has been successful in defining future needs (digitalisation, further focus on business models, consumer cleantech) that are further elaborated in the current Tekes programmes.

Based on the preparation material, the programme added value by creating new knowledge in a dynamic business environment and creating a Finnish competence base for future success in green growth through research, business renewal, business opportunities, and support for national energy-, climate and natural resources policies. These expected impacts are expected to be seen and evaluated in the future.

4.5 Summary and conclusions

The objectives of the Green Growth programme were relevant and challenging including crosscutting traditional sectors, creating new value networks and supporting business renewal. This despite tensions which built up both inside and outside Tekes through the questioning of the status quo. The programme was timed well, and the objectives supported the implementation of the strategic choices of Finland and Tekes as well as other activities in the field including energy, climate and natural resources policies. Green Growth, although different terms might be used, is still relevant and driving the development in global markets. Thus, programme has been forward-looking and resilient over time.

There are several examples of business innovation that can be traced back to the programme. The programme accelerated market entry of participating companies due to funding, but possibly also due to international activities and business coaching. It increased RDI resources speeding up the market entry of technologies and business solutions, which is crucial on the fast-changing cleantech market. However, also many other factors, including regulatory development, have contributed to the development.

Focus on customer selection and attractive business models has been a significant factor to the success. Also interaction between a variety of green growth actors in Finland and internationally is notable, although it is hard to say how systematic this has been. International collaboration was a significant part of the programme⁷⁸. 2/5 of the companies were also part of Team Finland growth programmes, but this synergy hasn't been used systematically or better than average business growth regarding turnover and export.

Many of the solutions developed have remarkable material and energy efficiency benefits. However, to track these as programme impacts would demand for more in-depth analysis and systematic emphasis on these impacts when selecting customers and projects to be funded.

The programme built confidence in the ability of Finnish business ecosystem, also SMEs, to produce globally marketable cleantech solutions. Also the encouragement that businesses provided each other is significant. However, the continued development of wider systemic outcomes, organisational impacts, cooperation and innovation platforms, and business ecosystems are difficult to identify and track.

⁷⁸ Green Growth programme promoted international collaboration by helping organisations to recognise potential partners, providing foresight information about international markets, and supporting the participation of small and medium sized companies in EU's Horizon 2020. The programme had specific links to China.

Summary of the Green Growth programme

- Timed well to take advantage of the global drivers and to support the strategic choices of Finland and Tekes
- Hand-picking of potential businesses and projects inside Tekes portfolio and elsewhere as well as activation of companies brought in customers with interesting business models and growth prospects
- There are several examples of business innovation that can be traced back to the programme, their potential for international growth is to be seen in future years
- Many of the solutions developed have remarkable material and energy efficiency benefit potential
- However, also many other factors, including regulatory development, have contributed to the development
- Increased RDI resources specifically speeded up the market entry, which is crucial on the fast-changing market
- Interaction between a variety of green growth actors in Finland and internationally
- Defined future needs (such as digital cleantech) that were elaborated to further Tekes' activities
- Built confidence in the ability of Finnish business ecosystem, also SMEs, to produce globally marketable cleantech solutions
- However, the concrete synergy between companies and projects in the programme as well as the systematics to link to other national activities could have been improved
- The continued development of wider systemic outcomes, organisational impacts, cooperation and innovation platforms, and business ecosystems are difficult to identify and track

4.6 Company case studies

4.6.1 LeaseGreen Group

Part of Green Growth programme

LeaseGreen Group Oy provides real-estate specific efficiency improvement solutions and implements projects so that the customer only pays for the achieved energy efficiency savings. Thus, LeaseGreen improves its customers' profitability and environmental performance. Company has over 100 reference projects in Finland and is aiming to develop their business globally. It is targeting for global presence with total project volume of more than one billion euros by the year 2020.⁷⁹

LeaseGreen has received Tekes funding since its founding. First, the company received funding for the business concept development. During the years 2013-2015, the company participated in Green Growth programme to develop, test and launch a new service concept and financing instrument that sought to provide an opportunity for property investors to invest in a decentralised energy efficiency portfolio. As a result of the project, a new financial instrument was introduced. During the years 2013-2016 the company received Tekes funding through the Green Growth programme to internationalise their business operations. Tekes and Team Finland contribution to this company case can be seen in Figure 4.4.

Key success factors:

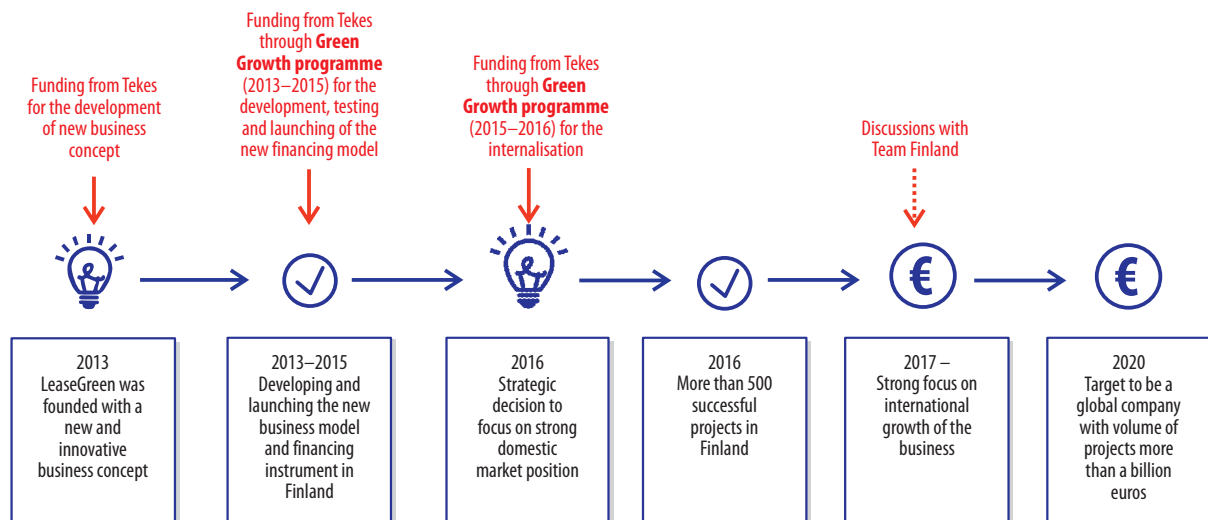
- Understanding possibilities of the market and customers' needs together with a strong vision have enabled the development of an innovative business model which offers acquisition model based on monthly fees instead of capital investments.
- Ability to provide a new and innovative service model for energy efficiency improvement projects, which is attractive for property owners because the monthly fees are lower than savings achieved through the energy efficient improvements.
- Independence and customer-oriented approach. Each customer case is evaluated separately so that the optimal technological solutions and partners can be applied for the specific needs.
- Develop and execute a strategy to postpone the globalisation and first concentrate on strengthening company's position in the domestic market.

Lessons learned:

- International markets were targeted since the beginning. Even though globalisation was not initiated as scheduled, the earlier work will be useful when these efforts move forward.
- Tekes' financial support has been essential for the development of company's business and has enabled the development of a flexible and scalable business concept enabling rapid growth.

⁷⁹ This case is based on following sources: LeaseGreen company's website, Rönni (2017), LeaseGreen (2016), Lappalainen (2016), Junttila (2014) and LeaseGreen Group Oy (2014)

Figure 4.4. Business growth and Tekes contribution in the case of LeaseGreen Group.



- Tekes funding has been an integral part of the company's business development through its life cycle. Tekes projects have resulted in more accurate project planning and has enabled the company to undertake a systematic approach to business development.
- Human resources have been in central role for the company and its growth. Tekes funding has provided possibility for the key resources to concentrate their expertise and know-how on the development of business instead.

4.6.2 TamTurbo

Part of the Green Growth programme Part of Finpro's Cleantech Finland and Beautiful Beijing growth programmes

Tamturbo Oy develops, manufactures and markets energy-efficient air turbo compressors, which are used in for example in chemical, pharmaceuticals, food, drink, electronic and pulp and paper industries to produce compressed air. Company's solution provides 10-20 percent savings in customers' energy costs. Since 2010, the company has invested in product development and is now ready to expand and scale its business globally with international partners. At the moment, the company is pursuing the turnover of 100 million euros by the end of the year 2022, 98 % of which is forecasted to come from international customers.⁸⁰

As part of the Green Growth programme, Tamturbo developed an international growth plan and identified optimal and accessible international markets. Also through the

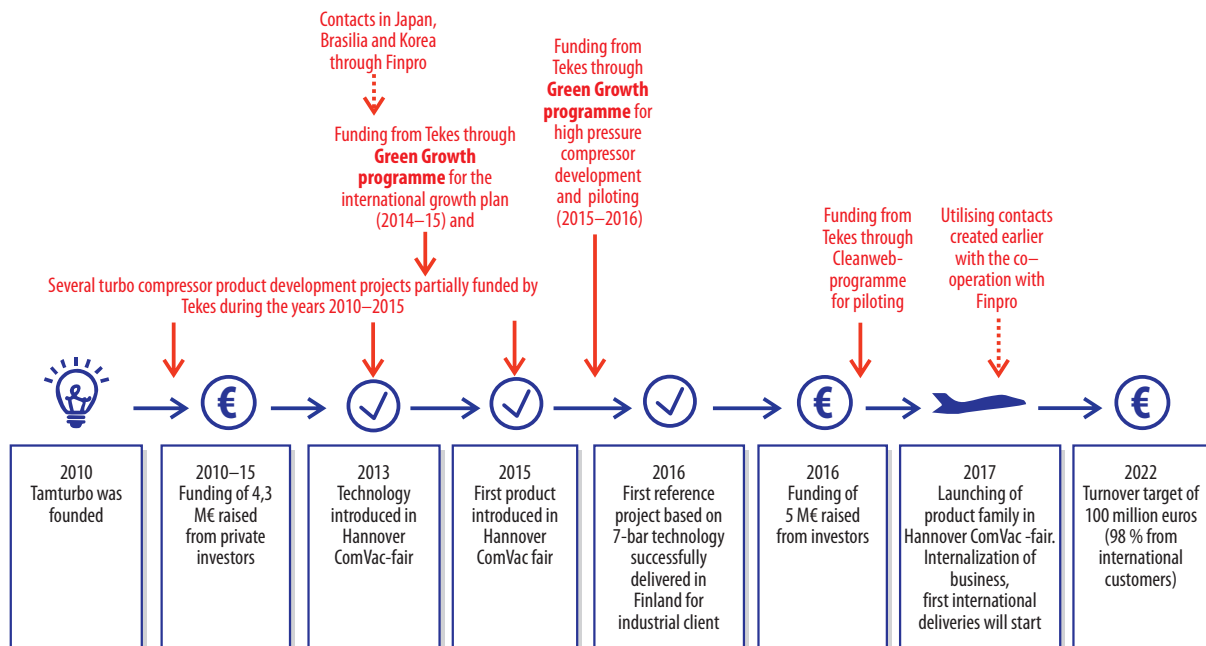
Green Growth programme, the company continued to develop their technology in order to configure and pilot 7 bar turbo compressor technology for industrial applications. As a result of the project, Tamturbo achieved the first industrial customer reference project in Finland. During the years 2010-2015, the company undertook several other product development projects partially funded by Tekes. The company is continuing to invest in product development and they have an on-going development and piloting project funded in-part by the Cleanweb programme. Tekes and other Team Finland contributions to this company case can be seen in Figure 4.5.

Key success factors:

- Advanced technology is the key success factor for the company. The company's oil-free turbo compressor decrease customer's energy cost by 10- 20 percent. Service and maintenance costs are up to 80 % less than traditional oil-free screw technology. Total life cycle cost savings are 20-30 %. Tamturbo is one of the two companies globally and only company in Europe focusing on the development of turbo compressors with high speed technology in this size category.
- Financial support from Tekes has been crucial for the company and its existence and has enabled full-scale product piloting in real industrial environment. The first piloting installation have given credibility and reference for Tamturbo's technological solution. Domestic references have been vital in order to be able to expand operations abroad.

⁸⁰ This case is based on the following sources: Tamturbo company website, Pulkki (2017), Tamturbo (2014), Nousiainen (2016), Tamturbo (2016), Peltonen (2016), Tekes (2014b)

Figure 4.5. Business growth and Tekes contribution in the case of TamTurbo.



- International markets were targeted since the beginning. Tekes funding for internationalisation has also been essential in order to identify potential international markets.
- Co-operation with Finpro has helped to create contacts and find partners in target markets.
- Unique expertise. Successful recruitments of top experts to the company has been crucial for the company's success.

Lessons learned:

- Time is needed to verify the reliability of the new technology with customers. Validation of reliability of the new technology is a key element in building trust with new customers and investors. Pilot projects and references are essential for success.
- Good cooperation with Tekes has been essential and has enabled the product development. It has been extremely important with the technology that requires long term product development.
- It has been really important to receive strong market signals in order to be able to convince private investors, funding instruments, partners and clients.

4.6.3 Enevo

Part of Green Growth programme

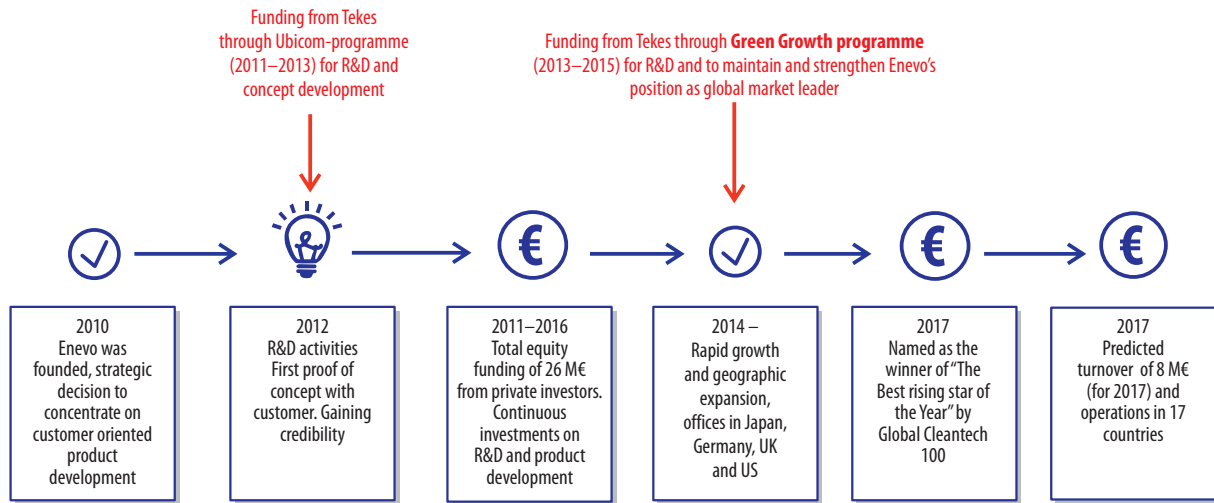
Part of Finpro's Cleantech Finland growth programme

Enevo Oy is a global industry leader in the field of dynamic waste collection optimisation. It provides solutions for more intelligent waste management. The wireless sensor technology collects and analyses data from refuse containers and optimises waste collection routes to reduce waste management costs. Enevo was founded in 2010 and operates now in 17 countries and is seeking growth especially in international markets.⁸¹

During 2011–2013 Enevo received funding from Tekes through the Ubicom-programme for R&D practices and business concept development. After successful piloting, the company secured Tekes funding through the Green Growth programme during the years 2013 – 2015 for further product development, to scale their business concept globally, and to ensure the operational reliability of their product in a business-critical environment. The contribution of Tekes along Enevo's development history can be seen in Figure 4.6.

⁸¹ This case is based on the following sources: Enevo company website, Engström (2017), Forsell (2014), Nikula (2017), Leino (2015) and Koskinen (2016)

Figure 4.6. Business growth and Tekes contribution in the case of Enevo.



Key success factors:

- Enevo has been able to create a new, innovative technology on the market and bring digitalisation to the very traditional waste handling and collection industry. This new way of thinking has enabled Enevo's position as a global market leader in the field of dynamic waste collection optimisation.
- Another success factor has been its customer-oriented approach. It is important to understand customers' needs and problems and provide solutions that bring true and validated value. Furthermore, digitalisation and the ability to scale the solution and adjust it to different operational environments have enabled rapid growth in international markets.
- Support from Tekes has been essential. It has enabled the development of technologies and business concepts which have international demand and which appeal to private investors. The financial support of both Tekes and private investors has enabled agile product development and rapid international growth.
- Enevo has set ambitious goals from the beginning to internationalise their business. These goals have been pursued consistently and hard work and expertise have been required in order to achieve them. Ambitious goals and internationalisation has also been really important for the private investors.

Lessons learned:

- Competition is intense and therefore it has been important to have the capacity to grow rapidly and respond quickly to customers' demands in order to maintain market position.
- It is important to secure sufficient funding that enables rapid development and growth.
- In a dynamic market environment, the company needs to be flexible and correspond rapidly to different market signals. It is also important that the company's internal processes support agile development and management practices.

4.6.4 BioGTS

Part of Green Growth programme

Part of Finpro's Cleantech Finland and Waste to Energy growth programmes

BioGTS provides modular, scalable biorefinery solutions for the treatment of organic waste from municipalities, industries and agriculture. Even materials that are difficult to treat in traditional biogas processes are converted into renewable energy, biofuels, fertilisers and chemicals. The company was established in 2011 and today employs about 40 people and an additional 50 through its subcontracting network in Finland. It had a turnover of 11 million euros in 2016 and the turnover goal for 2018 is 40 million euros. BioGTS has an ambitious growth strategy and invests heavily in developing its international resales network. The company has distribution agreements with 44 countries with a special focus on Asia and Latin-America.⁸²

Tekes' main contribution to the development of BioGTS has been Green Growth programme loans to develop the modular product solution and enable better solutions for using sludge as a biorefinery feedstock. As a by-product, the growth has led to the emergence and growth of subcontractors in the Central Finland region and has contributed to the emergence of a budding service industry built around the biogas production value chain subcontractor network which enables the rapid growth of the company. BioGTS has used different funding instruments at different stages of the development of the company. The "NIY funding" is considered a useful instrument because of the flexibility that it provides and lighter bureaucracy, which is especially suitable for a company such as BioGTS that is in a rapid development phase. Bio GTS has also participated in other Team Finland activities, such as Finpro's Waste-to-Energy project and a market research project on the Chinese

market together with Finpro and Fudan University. Tekes and other Team Finland contributions to this company case can be seen in Figure 4.7.

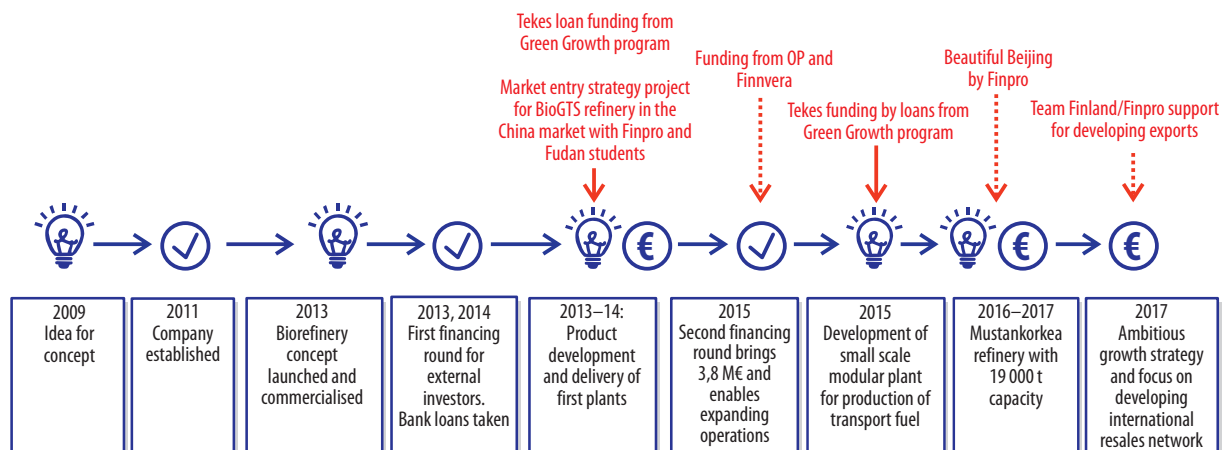
Key success factors:

- Financing has been possible to obtain in critical development phases. The sk. angel financing rounds have brought needed injection of funds that has enabled growth.
- Reference clients and pilot installations have been critical in demonstrating the solution and in building trust, both in financiers as well as potential new clients and resellers.
- The technological solution is based on standardised modular solutions. This is key for rapid payback time as well as enabling exporting the solution.
- The technological solution is cost-efficient, efficient with high energy output and scalable and it can be used to treat materials that are otherwise difficult to handle.
- Building and using a good subcontracting network has enabled rapid growth of the company.

Lessons learned:

- Successful retaining and recruiting of key expertise is essential. The recruiting has worked well through personal networks and more recently through professional recruiters.
- Tekes loans have been very useful in financing the development. The other more traditional Tekes instruments have been found to be unnecessarily difficult to manage and are not always suitable in a rapidly changing business environment.
- Cooperation with Finpro in internationalisation has worked well – the specific activities and support with the practicalities of establishing an export business have given good added value.

Figure 4.7. Business growth and Tekes contribution in the case of BioGTS.



⁸² This case is based on the following sources: BioGTS website, Lehtomäki (2017), Hietanen (2016), Tekes (2011c) and Saarinen (2014)

5

Results of the Green Mining programme

5.1 Overview of the programme

The main goal of the Green Mining programme, executed in 2011-2016, was to support the strategic objective set in the national Minerals Strategy⁸³ to make Finland a global forerunner of the responsible minerals economy by 2020, develop new business around traditional extraction activities, activate the SME sector, create international connections, and enhance the level of industry related education and expertise in research.⁸⁴

According to the detailed data collected by Tekes and provided for this assessment, the total project volume was 124 million euros, of which 95 million euros were company projects and 29 million euros public research projects⁸⁵.

Out of the total programme value, Tekes funding was 62 million euros. Note that the volumes used later in this chapter cover the total volume of the projects including both Tekes funding and company funding. Table 5.1 summarises the essential facts and data on the programme.

5.2 Targeting the programme

5.2.1 Focus and objectives

The Green Mining programme was an industry sector specific programme of Tekes. It was launched in June 2011 as a 5-year-programme ending in June 2016. The initiative came from Finland's mineral strategy, launched by the Ministry of Employment and the Economics in 2010⁸⁸. The programme

Table 5.1. Summary of the Green Mining programme 2011-2016.⁸⁶

Objectives	<ul style="list-style-type: none"> To make Finland a global leader of sustainable mineral industry by 2020 To increase the number of SMEs targeting the export market in the mineral cluster. To achieve global leader status for the research in selected sectors
Focus areas	<ul style="list-style-type: none"> Intelligent and minimum-impact mines New mineral resources
Total volume	Total volume of the programme 124 M€ (out of which Tekes 62 M€) Volume of company projects 95 M€ (out of which Tekes 42 M€) Volume of research projects 29 M€ (out of which Tekes 20 M€)
Projects	65 company projects (with 46 companies) ⁸⁷ 84 research projects (with 21 public organisations)
Target customers	Companies and research organisations operating in mining and mineral industries as well as industries related such as chemistry and engineering. SMEs seeking growth and export.
Participating companies and research organisations	16 large companies 9 medium-sized companies To network the actors operating in mining field and create more dynamic ecosystem 7 small companies 14 micro companies 21 public organisations

⁸³ Ministry of Employment and Economy and Geological Survey of Finland (2010)

⁸⁴ Source: Tekes, Description of Green Mining Programme webpage

⁸⁵ Source: Tekes' programme data

⁸⁶ Source: Tekes' programme data

⁸⁷ Consortia projects allocated per company

⁸⁸ Ministry of Employment and Economy and Geological Survey of Finland (2010)

has been implemented in close connection with the Action Plan "Making Finland a Leader in Extractive Industry"⁸⁹ and it had a close connection also with European Network on the Industrial Handling of Raw Materials for European Industries (Era-Min).⁹⁰

Together with the global megatrend of natural resources depletion, based on the Minerals Strategy and the programme preparation materials, one reason behind initiating the programme was to address the increasing domestic demand for minerals in a sustainable manner. There was also a need to ensure high quality of research and development activities related to mining industry and to increase the amount of relevant education among companies and research organisations, both of which, to a comprehensive extent, were included in the preparation process of the Green Mining programme.⁹¹

The Green Mining programme was supporting Tekes' own strategy by focusing on research and development of process technological solutions as well as solutions to explore, invent and assess the extractability of ore deposits. Also, process technical, chemical and biological know-how related to energy efficient treatment and recycling of minerals and water was the focus of the programme. Moreover, the programme was divided in two more specific focus areas: intelligent and minimum-impact mines and new mineral resources.

Besides the main objective of the Green Mining programme, making Finland a global leader of sustainable mineral industry by 2020, the objectives of the programme were to create business that requires new, specialised expertise alongside the growing field of traditional mining. In addition, an important goal was to increase the actual number of SMEs reaching for the export market in the mineral cluster and make the mining cluster an open innovation system. The Green Mining programme aimed to help Finnish mines to become global leaders in production and energy efficiency and the whole Finnish mineral industry to reach global leader position in the selected sectors. Also, safety at work and organisational practices were to be improved in mining sector through the programme.

According to the interviews, during the times Green Mining was being established in 2011, the mining industry was under pressure by the general public and green activities within mining industry was considered as "green wash". Thus, setting up the Green Mining programme, one

objective was to raise awareness and increase reputation on the industry and greenness was highlighted to mean enhancement of material and resource efficiency in minerals' production, to explore new raw material reserves and come up with sustainable solutions to utilise the reserves, to minimise negative impacts of mining activities on environment and society throughout the supply chain, to improve safety and working conditions in the field, and to reconstitute the mining areas after operational phase.⁹²

5.2.2 Programme funding

The sector specific programme targeted mainly on companies and research organisations operating in the field of mining industry. The purpose was also to include companies from other industries relevant to mining and mineral cluster into the collaborative and demanding R&D projects initiated in different focus areas of the Green Mining programme. The programme was seeking to initiate cross-sectoral and multi-disciplinary projects combining environmental friendliness, energy and material efficiency and operational profitability. The added value of the programme was seen to arise from mining and mineral cluster related consortium projects that could, in addition to mining companies, include machine engineering companies and SMEs with specialised know-how.⁹³

Total funding of the Green Mining programme was 124 million euros, out of which 61,9 million euros came from Tekes. According to the preparation material of the programme, the planned budget was ca. 60 million euros⁹⁴. The budget doubled during the programme volume of company projects being 95 million euros while research projects were funded with 29 million euros. The funded projects covered the thematic fields of water processing and management, mineral processing, waste processing and management, measuring technology, exploration, social aspects and machinery and maintenance.⁹⁵ In Green Mining programme, 65 company projects (with 46 companies) and 84 research projects (with 21 research organisations) were funded, out of which approximately 60% was grant and 40% loan.⁹⁶

Volume of the projects funded in Green Mining programme can be seen in Figure 5.1.

The 10 largest programme benefitters can be seen in Figure 5.2.

Based on the data provided by Tekes, the programme included altogether 46 company participants ranging from

⁸⁹ Ministry of Employment and the Economy, Strategic Programme for Cleantech (2013)

⁹⁰ European Commission (2017b)

⁹¹ Tekes (2011b)

⁹² Source: Tekes (2011a)

⁹³ Source: Tekes (2011b)

⁹⁴ Source: Tekes (2011a)

⁹⁵ Source: Green Mining (2016)

⁹⁶ Source: Green Mining (2016)

Figure 5.1. Volume of the projects funded in Green Mining programme according to the size and type of the company.

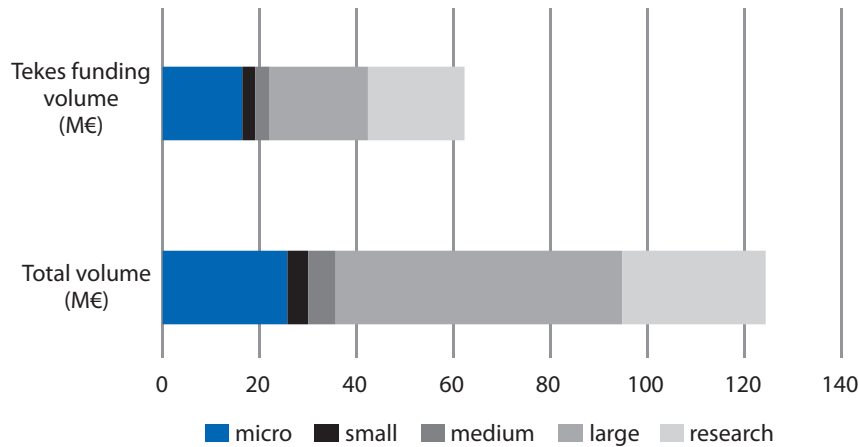
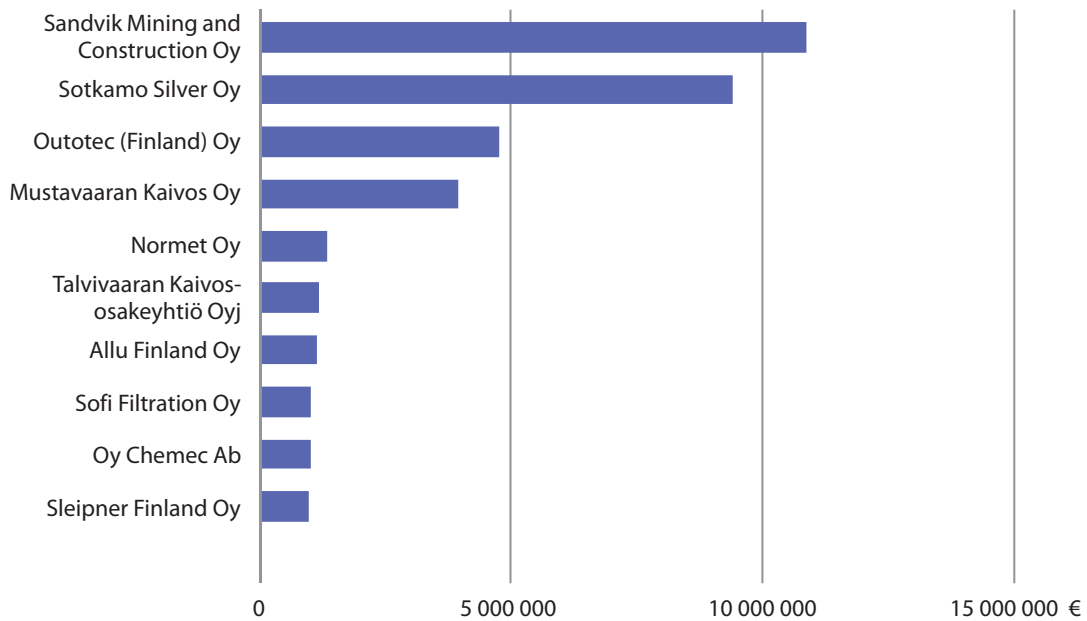


Figure 5.2. Companies with the largest Tekes funding from the Green Mining programme.



micro (30%) to large companies (35%). One purpose of the programme was to form collaborative projects consisting of both large and SME companies in order to boost SME companies' access to the industry international markets.

According to the interviews, one selection criteria was an SME company's willingness to do international business. Due to the relatively small number of companies, especially SMEs, operating in the mining industry in Finland and dominance of large companies, the programme set requirements for large companies to put up R&D&I partnerships and consortium projects that would include also SMEs and cross-sectoral companies with relevant

substance operating outside the industry. Thus, the role of large companies was also to create possibilities for SMEs to enter the market and, especially, get demonstration and piloting opportunities with the mining companies. When it comes to public research projects, the Green Mining programme set goals for research organisations to conduct collaborative projects also with top level international research organisations, encouraged to exchange of researchers across borders and supported inclusion of FiDiPro level professionals.⁹⁷

Examples of the companies involved in the Green Mining programme are shown in Table 5.2.⁹⁸

⁹⁷ Source: Tekes (2011d)

⁹⁸ Source: Tekes' database

Table 5.2. Examples of companies in the Green Mining programme.

	Examples of companies
Mineral, water and waste processing and management	<ul style="list-style-type: none"> Water treatment solutions (examples of companies, Chemec, Modumine) Sustainable mineral processing (Keliber, Metso Minerals) Energy and material efficiency (Outotec, Tulikivi, St1 Deepheat)
Measuring technology	<ul style="list-style-type: none"> Solutions for mineral analysis (Fenno-Aurum, IMA Engineering) Utilising digitalisation (Sillman digital, Empower IN) Innovative SMEs (Advacam, Sofi Filtration)
Exploration and social aspects	<ul style="list-style-type: none"> Mining companies as piloting platforms (Agnico Eagle Finland, Endomines) Sustainable exploration systems and technologies (Geosto, Miilux, Yara) Safety solutions (Heat-It, Nordic Mines)
Machinery and maintenance	<ul style="list-style-type: none"> Machine and equipment operating efficiency (Herrmans, Levanto) Ecosystems for mining innovations (Sandvik)

5.2.3 Programme services and activities

The management and execution of the Green Mining programme, in addition to the Programme Director, Programme Manager and Programme Coordinator, was guided by a comprehensive steering group including mining and mineral professionals from fields of technology, research and business. As internationalisation of SMEs was one of the programme's objectives, a representative of Finpro was also included in the steering group.

According to the interviews, the Green Mining programme was a traditional Tekes programme for an established industrial sector. In addition to funding for R&D projects, the programme offered services including a wide range of networking events, workshops, annual seminars, international seminars, road shows, delegation trips, market and forecast information.

The programme had a lot of interaction with other public activities inside and outside Tekes. For example, co-operation and coordination was made with SHOKs (Fimecc, CLEEN), Tekes Green Growth, EVE, Water and Arctic Seas programmes and different ministries.

A short description of selected programme services and activities is presented in Table 5.3.

Globally active interaction, e.g. with European Union through EIT Raw Materials KIC, and communication were on high focus. Global interaction focused geographically in Australia, Canada, South Africa, Chile and Sweden where the world's leading expertise in Green Mining practices could be found. For example, in Sweden Tekes had close co-operation with Vinnova considering Green Mining activities through the programme. In addition, the Chinese mining industry and market was of interest due to rapidly growing market and business potential for Finnish companies.¹⁰⁰

Table 5.3. Selected activities of the Green Mining programme.⁹⁹

Interaction and communication	During the programme awareness was raised through organising traditional networking events, where also international mining industry influencers were having presentations. As part of the programme also road-shows to attract SME sector were organised.
International cooperation	Delegations and business trips were organised to important mining countries such as Canada, Australia and Russia in order to highlight Finnish know-how. International mining companies operating in Finland, such as Agnico Eagle, participated in the programme.
Piloting and demonstration	One objective of Green Mining programme was to put forward piloting and demonstration projects in the mines.
Industry sector focused programme	Green mining was the last initiated industry sector focused programme of Tekes. Purpose of focusing on mining industry was to
Large companies as door openers for SMEs	The programme encouraged large companies to include SMEs especially in piloting and demonstration projects.

⁹⁹ Source: Green Mining. Intelligent and minimum impact mines. Results of the Tekes Programme 2011–2016, website.

¹⁰⁰ Source: Tekes (2011b)

5.3 Results and direct impacts

According to the evaluation material the Green Mining programme managed to activate export-seeking companies operating in the field and facilitate their access to global markets through collaborative projects with large companies. According to the interviews, the number of companies with export capabilities grew from under 10 to approximately 30 during the programme. However, the goal to boost SME internationalisation and export was not achieved as planned, partly due to the changes in global economy and lack of willingness for Finnish companies to make investments. The programme enhanced the holistic participation of inter-disciplinary companies in the national mining ecosystem, such as automation, measurement and chemistry. The programme enabled piloting, demonstration of new technologies, and solutions in actual mines. However, piloting and demonstration activities could have played an even greater role during the programme. According to the interviews the piloting activities were hindered by the absence of international mining companies from the programme or lack of motivation to enable testing and piloting for SMEs in the mines.

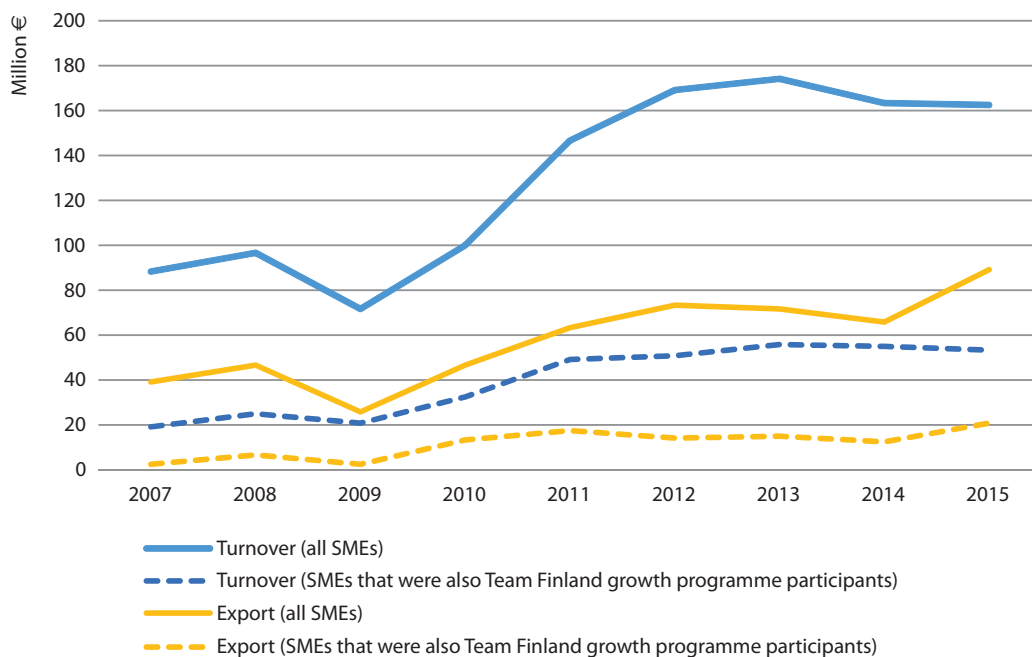
During the Green Mining programme a couple of new startups were founded. Public funding through the Green Mining programme was critical to the entry of start-ups to the market through consortium projects and piloting. In addition, the overall amount of participating companies' fund-

ing doubled during the programme due to an increase in demand for company projects.

The programme succeeded in promoting networking within the industry nationally and also globally to some extent. Prior to the programme, the industry was dispersed and dominated by the large technology companies and mining companies and the ecosystem beyond that was rather poorly defined. The Green Mining programme united the industry by bringing both public and private organisations to the same table. The network for sustainable mining was introduced and promoted during the programme and the ecosystem is still evolving since the programme's completion. However, the preliminary goal to introduce growth and export-seeking SMEs through demonstrations and piloting did not work as planned. There could have been more piloting activities during the programme to boost SME business opportunities. It is assumed that the slow-growth of global economy hindered these demonstrations and value chain projects on a wider scale.

The programme also aimed to increase the level of national education related to mining industry. As a result, new possibilities to academic level education was established in the university of Oulu and 48 academic degrees related to mining and minerals industry accomplished. Also 2 patents and 4 invention disclosures were submitted. Public and company R&D activities had been strong prior to the programme. The programme goal was to reinforce the national know-how in research, and this succeeded to some extent.

Figure 5.3. Revenue of the SMEs that participated in the Green Mining programme.¹⁰¹



¹⁰¹ Source: Tekes and Finpro databases

EIT Raw Materials KIC collaboration was initiated and one of its co-location centers was located in Finland. Simultaneously, 97 reviewed publications, including submitted manuscripts and 171 other publications and reports were published.

One objective of the programme was to raise awareness and improve the rather poor reputation of the industry, especially in Finland. The programme managed to raise international awareness on Finnish mineral cluster's know-how through interactive international collaboration, international seminars and delegation trips, for example, to Canada and Australia. The road shows also served to raise awareness nationally. It is not clear, however, whether the programme improved the overall reputation of the industry in the eyes of the general public. According to the interviews conducted for this evaluation, the Talvivaara case has had some negative impact on the industry's reputation.

The growth of the SMEs that participated the programme can be seen in Figure 5.3. It shows that during the programme the SMEs have gained growth both in turnover and export. Export of all SMEs has increased especially from 2014 onwards. However, growth for companies participating also Team Finland growth programmes has been rather moderate.

5.4 Indirect impacts

The indirect impacts of the Green Mining programme, including strengthening economic growth and productivity in the society, are difficult to assess so soon after the programme termination in 2016.

Many of the programme company participants are introducing new ways of thinking to the traditional sectors and processes and have the potential to radically improve productivity, growth and renewal in a sustainable manner. Particularly, process water treatment and digitalisation solutions have been gaining ground within the Finnish mining ecosystem both during and after the programme. However, the successful companies typically are large with international connections and resources to bring new products and services to the market. In the mining industry, SMEs entry to market is difficult due to dominance of the large companies.

The Green Mining programme ended in 2016, but its results are already in evidence. Results, such as the network of mining industry, facelift of the sector and enhanced level of education for the future needs of the industry give a solid basis for future development. In accordance with the digitalisation "megatrend", solutions which were demonstrated and partially adopted during the programme are likely to positively affect the mining industry in the future.

5.5 Summary and conclusions

The objectives of the Green Mining Programme were relevant, yet ambitious when taking into account the starting point before the programme. Two of the most challenging targets to achieve were improving the reputation of the industry and boosting SMEs business in the field dominated by large companies. The programme managed to raise international awareness on Finnish know-how, pulled the industry together and reinforced the level of research in the field.

The programme's objectives directly supported the objectives of the Mineral strategy and other national activities and goals. They were in line with Tekes own strategic alignments by supporting activities in the field including energy, climate and natural resources policies. A strong focus throughout the programme was on research and creating and introducing internationally top-level know-how in the industry. This is expected to lead to company projects with solid foundations, and in the end create strong value networks and ecosystems.

Green Mining, and sustainability in the mining industry in general, is always relevant as far as non-renewable natural resources are used and new mines established. Need for sustainability, by means of social, environmental and economical sustainability, drives the development of cleantech solutions on the global markets as well. Thus, it can be seen that the programme objectives have been resilient in time.

During the programme, the Finnish Network of Sustainable Mining was established and it is still in operation. Ecosystems related to research and education can be recognised as new academic education has been introduced and global cooperation and networks related to natural resource research and development exists. The programme was a traditional programme in a traditional industry. The Tekes funding model served both research objectives and large companies' needs.

For startups and small companies, it is, in general, important to get R&D funding and share risks in order to initiate operations. The basic funding model worked well in this regard. Joint demonstration projects sought to support inclusion of SMEs in the field. However, the motivation for mining companies and large companies to include SMEs in substantial projects did not always occur. The programme did not manage to boost SMEs business in partnership with large companies on value chain projects as planned. It is estimated that reasons were related to insecurity of the global economic situation, lack of motivation and incentives for large companies to include SMEs and some companies own unwillingness to internationalise their business. However, it is positive that during the programme micro companies

were activated and new startups were established in the industry.

In a relatively short timeframe, the programme managed to strengthen the network of Finnish mining and minerals industry efficiently. Partly it was due to large amount of companies own funding, but within the scope of the programme a lot of new partnerships were created.

One year after the programme Finland has received invest-in activities in relation to ore exploring (e.g. Sakatti). It is not clear which part of these activities is directly due to the Green Mining programme, but it could be assumed that the increase in international awareness might have had an impact on initiating the activities.

Summary of Green Mining programme

- Initiating the programme directly supported the strategic objectives of Finland, and it was also in line with Tekes' own strategic alignments
- Initial objectives were rather ambitious and the relative starting point of the whole sector was considered demanding. At least during the programme, Green Mining did not meet all of its targets, for example boosting international business growth of SMEs in the sector traditionally dominated by large companies.
- The programme's clear focus pulled the Finnish mining industry together through joint demonstrations led by large companies.
- The programme enhanced the level research and education activities in the mining sector (e.g. new possibilities for mining education were established at the University of Oulu).
- General awareness of the mining industry within Finland was heightened due to communications efforts. International connections were established to significant mining countries.
- It may be assumed that the programme helped to create networks within the Finnish mining sector (e.g. the Finnish Network for Sustainable Mining).

5.6 Company case studies

5.6.1 Sofi Filtration

Part of Green Mining programme

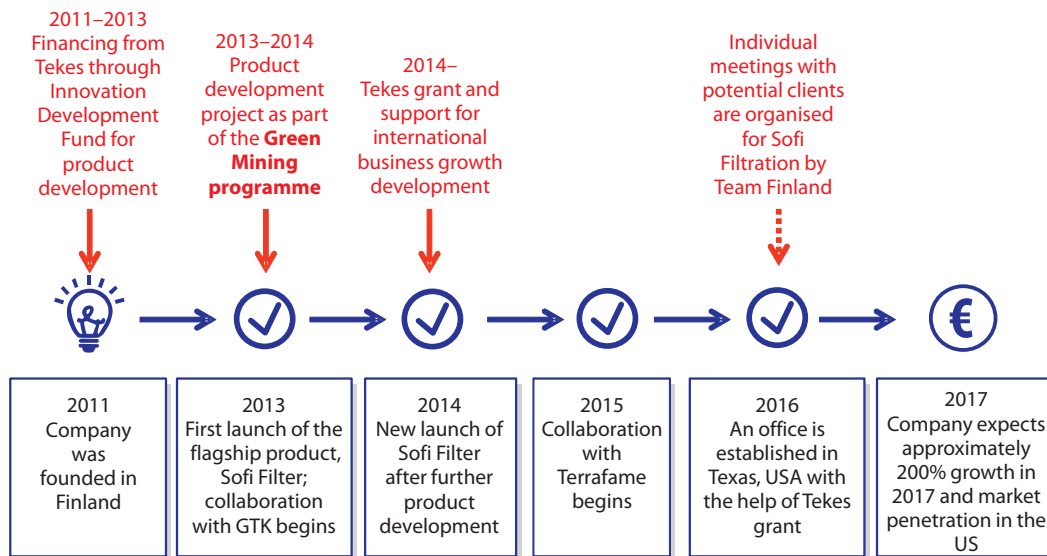
Part of Finpro's Cleantech Finland growth programme

Sofi Filtration is a Finnish provider of water filtration technology for industries like mineral processing, oil & gas and power generation. Sofi Filtration provides microfiltration solutions that reduce the need for fresh water and the amount of wastewater generated by increasing water recirculation rate. The flagship product of Sofi Filtration is "Sofi Filter", a high-capacity polishing filter with patented self-cleaning technology that was launched in winter 2013-2014. The company was founded in 2011 and it currently employs 7 people. In 2016, the turnover of the company was approximately 0.5 million euros and the company aims at reaching a 1.5 million euros turnover in 2017. The key markets of the company are the Finland, US, Canada and the EU.¹⁰²

Sofi Filtration received Tekes funding starting from its founding in 2011. First, a two-year long product development project was conducted in 2011-2013 with the goal of developing a functioning product. The goal of the next project was to create a solution that is more suitable for market entry. The project also included large scale in-situ testing of the prototype solution at actual mining and metallurgical industry sites. The third collaboration with Tekes and Team Finland focused on international market entry. A project focused on business growth and in particular international growth was commenced in 2014 and is still ongoing. As part of the project, Sofi Filtration has received a grant from Tekes that has been used for market entry in the U.S. Tekes and other Team Finland contributions to this company case can be seen in Figure 5.4.

¹⁰² This case is based on the following sources: Aho (2017), Cleantech Finland (2017), Niemelä (2012), Sofi Filtration (2017), Sofi Filtration (2014a), Sofi Filtration (2014b), Holopainen (2014)

Figure 5.4. Business growth and Tekes contribution in the case of Sofi Filtration.



Success factors:

- A pioneering, functioning microfiltration solution with patented self-cleaning technology
- Without Tekes funding, the company indicates that it would not have been able to put so much emphasis on product development and research.
- Financial support from Tekes for international market entry and business growth enabled Sofi Filtration to establish an office in Texas. Local presence in the US has been a key success factor in creating promising contacts with potential clients.
- Events and workshops organised in the Green Mining programme have brought Sofi Filtration new partnerships and clients. For example, since 2013 Sofi Filtration has collaborated with GTK on new product development and testing at mining sites (such as Yara site in Siilinjärvi and Polar Mining site in Orivesi, Finland). In addition, a collaboration with Terrafame since 2015 has originated from the Green Mining programme.
- Team Finland services have benefited Sofi Filtration in its US market entry and expansion. Team Finland organised meetings between Sofi Filtration and potential clients. Similar matchmaking services would benefit the company in other countries as well.
- Product development based on clients' needs: not only providing a functioning product but a comprehensive solution.

Lessons learned:

- Seeking opportunities to share business risk across several industries. Sofi Filtration first targeted only mining and metallurgical industry, which were hit by recession when Sofi Filter was launched. Thanks to continued Tekes funding, Sofi Filtration was able to continue product development and search for potential clients from other industry sectors. Today, the power generation industry is an important client segment for Sofi Filtration, and the company continues to search for new potential target industries.
- A good technological innovation as such may not be sufficient for market entry: clients are looking for turnkey solutions to meet their specific needs. Sofi Filtration learned this after the first launch, which was successful in generating sales leads but its solutions were not complete enough to close the deals. Product development with Tekes was continued to create a more comprehensive solution for clients' needs (although being based on the same technological innovation).

5.6.2 Sandvik

Part of Green Mining programme

Sandvik is a global engineering group in mining and rock excavation, metal-cutting and materials technology. The group has approximately 45,000 employees and the turnover was approximately 8.5 billion euros in 2015. In Finland, Sandvik Mining and Construction Oy operates manufacturing facilities in Tampere (including a test mine), Turku and Lahti. In 2013, a global recession in the mining industry sector put pressure to cut down Sandvik operations in Finland and forced the mining sector in Finland to look for ways to find competitive advantage. Facility closures were eventually avoided, and since 2016 the Group has announced significant investments to the manufacturing facilities of Turku and Tampere.¹⁰³

Sandvik participated in the Green Mining programme with a project called “Ideal Rock Factory” (IRF). As part of the programme, Sandvik made a concept development project in 2012 followed by three consecutive one-year-long sprints in 2013-2016. In the concept development project and the sprints, the company focused on: 1) assessing the current innovation ecosystem and its capacity to generate new innovations around Sandvik and 2) take a step to the next level in the mining industry expertise in Finland by creating new innovations and implementing them at mining sites. Special emphasis was put to the capacity building of the innovation ecosystem around Sandvik (including research institutions and SMEs). The activities in the IRF project were divided to five sub-projects: Ecosystem development, Mine

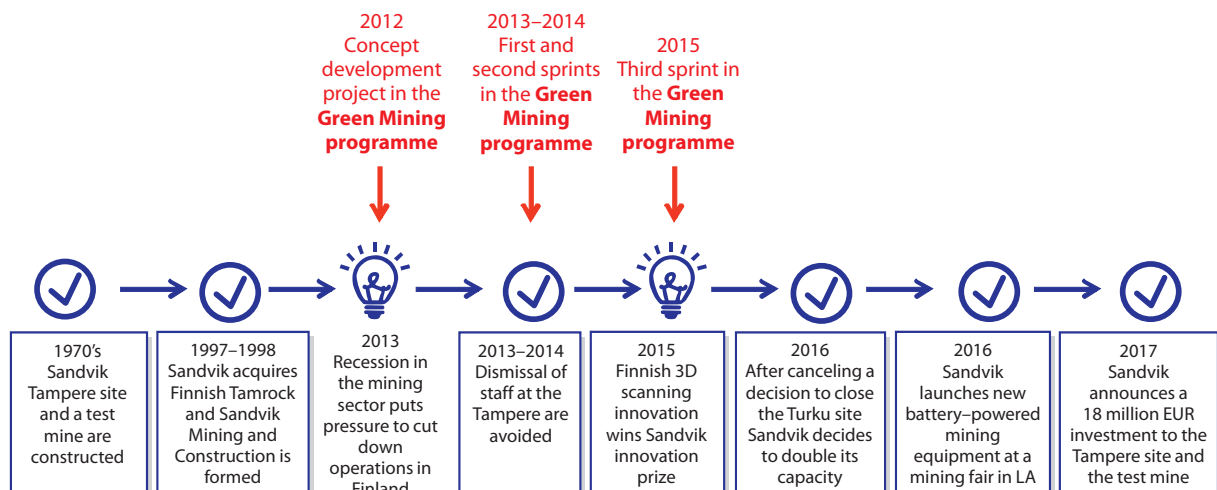
as a factory, All-electric mine, Technological solutions of a rock factory, and From value creation to business models. The IRF project also supported new product launches – such as recently launched battery-powered mining equipment¹⁰⁴ - and new innovations that are now in commercialisation phase (such as 3D mine scanning equipment). Tekes contribution to this company case can be seen in Figure 5.5.

Success factors:

- A concept development phase undertaken prior to the development sprints encouraged the setting of a high ambition level for the development of a large project requiring significant investments and resources both from the company itself and Tekes.
- Test mine in Tampere enabled Sandvik and other actors in the ecosystem to easily test and demonstrate new innovations. This accelerated the commercialisation of new innovations. The test mine was widely exploited in the Green Mining projects.
- Development of technology platforms for future commercialisation of new innovations through a modularisation strategy in which interfaces are developed to fit to current product platform.

The concept development phase and the first sprint enabled Sandvik to demonstrate the expertise of the Finnish mining industry sector and the potential of the innovation ecosystem to the Sandvik Group, which made it possible to avoid closures of the Finnish facilities and staff reductions.

Figure 5.5. Business growth and Tekes contribution in the case of Sandvik.



¹⁰³ This case is based on the following sources: Julkunen (2017), Juvonen (2015), Sandvik (2017), Melender (2013), Keränen (2017), Tekes (2017a), Keränen (2016) and Törmänen (2016)

¹⁰⁴ In 2016, Sandvik launched new battery-powered mining equipment at Minexpo in LA. The equipment were developed in the All-electric mine -project.

Lessons learned:

- Focus on the capacity of the ecosystem (research institutions and other companies) around the company to innovate is crucial for a continuous growth and competitive advantage.
- During recession, a significant financial support for research, development and innovation projects can be groundbreaking and even help a company avoid cut-backs of operations, at the same time preparing the company to develop new innovations and competitiveness for the time after recession.
- Running the development in concept development phase and three consecutive sprints enabled Sandvik and other actors in the innovation ecosystem to commit to the development and create lasting impact in form of capacity development of the innovation ecosystem.

Ecosystem impacts

A large global company as a central operator that distributed financing for smaller companies was seen by Sandvik as a key success factor for the development of the innovation ecosystem around Sandvik as a whole. The key actors in the innovation ecosystem include, among others, several Finnish engineering and software houses (Kilosoft, Bitwise, Symbio, Wapice, Comatec, Etteplan, Elomatic), research institutions (VTT, TUT, Aalto), automotive industry companies (Bosch Rexroth and TUT), several specialised SME's (Creanex, Leadin, Synocus, Lehti Group) and a global research hub Mining3. All core companies in the ecosystem have strengthened their growth. Although it is hard to assess how much of the growth has been generated by the Ideal Rock Factory project, Sandvik impact to the ecosystem as buyer has increased in form of external purchases by 13 % during 2014-2016 despite the recession in mining industry. New forecast for 2017 is between 400 to 500 million euros to Finnish suppliers directly and indirectly.

The Green Mining programme included targets concerning energy, fuel and rock moving cost savings, to which the Ideal Rock Factory also contributed to by new automation, sensor technology and digitalisation development. These technologies developed in the IRF project are currently in commercialisation phase. The improved capacity of the mining industry ecosystem to create new innovations is expected to lead to new innovations in the future as well, creating a long-lasting impact.

5.6.3 IMA Engineering

Part of Green Mining programme

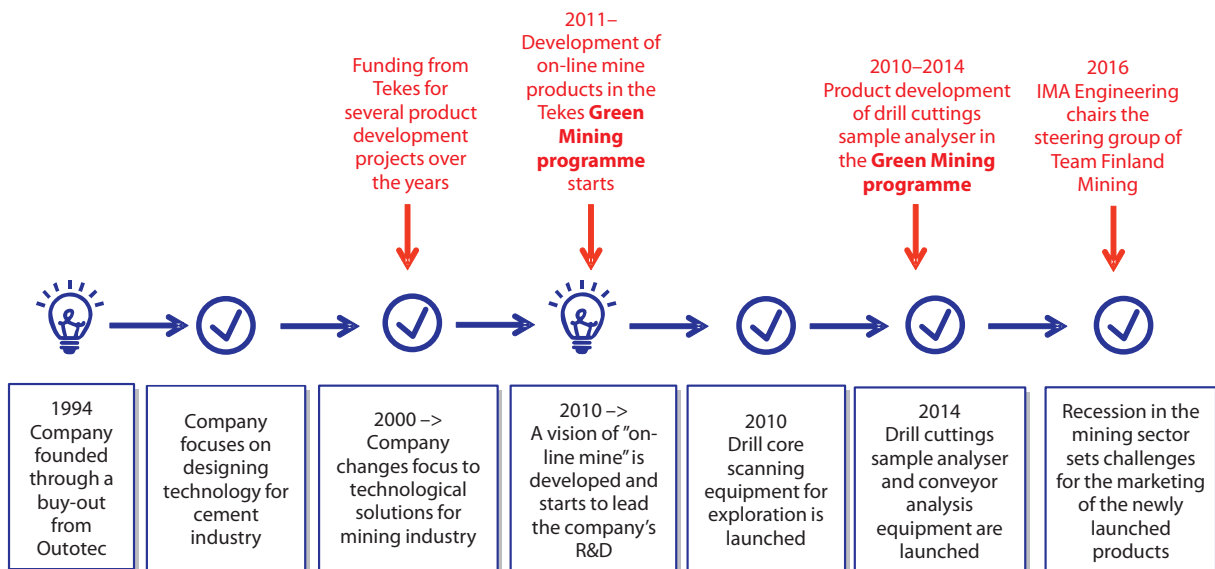
Part of Finpro's Mining growth programme

IMA Engineering is a manufacturer of on-line mineral sampling and analysis technology for mining and exploration companies. The company is located in Finland but has clients world-wide. The company has outsourced the manufacturing to a contract manufacturer, and has always used software and other technology partners during and after product development. The products of IMA Engineering include, among others, drill core scanning equipment for exploration and a drill cuttings sample analyser. From the beginning, the vision of an "On-Line Mine" has guided the company's research and product development. The turnover is approximately 1 million euros, and the company employs 4-10 people. The company was founded in 1994 through a buy-out from Outokumpu Mintec (today Outotec).¹⁰⁵

IMA Engineering received Tekes funding for the development of all key products and participated in the Green Mining programme since the beginning in 2011. The main goal for the company in the programme was to further develop its "On-Line Mine" innovations to products. The main focus was on a product called Drill Cuttings Sampler-Analyser, which is used to measure element and mineral levels in ore in real time and transmit the data wirelessly. When the Green Mining programme started, the company had a prototype of the product. The company succeeded in finalising the development of the prototype into a final product during the programme, but the product was launched during a recession in the mining industry in 2014. The market situation has been challenging for the company despite a promising product. IMA Engineering is currently active in the Team Finland Mining network. The network provides new contacts for the company and a platform to exchange knowledge of recent developments in the mining sector.

¹⁰⁵ This case is based on the following sources: Raatikainen (2017), IMA Engineering (2017), Tekes Green Mining case examples

Figure 5.6. Business growth and Tekes contribution in the case of IMA Engineering.



Tekes contribution to this company case can be seen in Figure 5.6.

Success factors:

- Ongoing collaboration with and financing from Tekes enabled a small spin-off company to develop new products. The market-entry of the products is an on-going process, for which a global recession in the mining industry sector has set challenges.
- Collaboration and networking with other actors in the mining industry through Tekes activities provided the company with better access to and knowledge of recent technological developments and ongoing research and innovation projects. For example, the Green Mining programme brought together IMA Engineering and FQML Kevitsa Mine in an on-going business relationship. The Drill Cuttings Sampler-Analyser was first tested in Kevitsa. As a follow-up to this, IMA has worked successfully in cooperation with Outotec and some Finnish and international research entities to apply for EU funding after the Green Mining programme. Two EU-funded projects with IMA Engineering as a partner (Integrated mineral technologies for more sustainable raw material supply, ITERAMS; and Metalintelligence) will kick-off in June 2017.

- Access to actual mines for product testing and demonstrations as part of the programme activities accelerated the commercialisation of new products. The Drill Cuttings Sampler-Analyser product prototype testing was done in Kevitsa (2011 and 2012) and earlier at Agnico Eagle Kittilä Mine. Other previous testing locations include Sweden (Boliden), Australia (RioTinto) and South-Africa (Anglo American).

Lessons learned:

- Good timing of new product launching is a key success factor for the market entry. With the Drill Cuttings Sampler-Analyser, IMA worked closely with Atlas Copco. When recession hit the mining industry, the cooperation was not a high priority due to a need for risk investment in market penetration. New agreements with Atlas Copco have been drafted since then.
- Research and product development should be based on actual needs of the target sector; in this case mining industry sector. For IMA Engineering, this meant cooperation in product development with a technology partner (Atlas Copco) and large and medium-sized mining companies.

6

Results of the Groove programme

6.1 Overview of the programme

The Groove programme (Growth from Renewables) was implemented between 2010-2014 as a follow-up to Tekes' international climate business-focused ClimBus programme (2004-2009). It was the first Tekes programme targeted to small and medium-sized companies. Groove was strongly focused on internationalisation and enhancing business opportunities of SMEs with mature solutions and willingness to reach for global growth.¹⁰⁶

According to detailed data collected by Tekes and provided for this assessment, the total project volume was 101 million euros, of which 89 million euros were company projects and 12 million euros were public research projects¹⁰⁷. Of the total programme, Tekes funding was 53 million euros. The funding amounts reported later in this chapter include both Tekes and company funding components. Table 6.1 summarises the essential facts and data on the programme.

6.2 Targeting the programme

6.2.1 Focus and objectives

The Groove programme was the first Tekes programme targeted mainly for small and medium-sized enterprises. Approximately 75% of the participating companies were SMEs, including micro companies. Activation of research organisations was also included in the programme to some extent. However, the main objective of the programme was to enhance Finnish SMEs competitiveness and international growth in renewable energy related business. The means to achieve the objective were to put effort in international networking, creating contacts and improving know-how on renewable energy solutions through R&D and piloting, for instance.¹¹¹

The programme's focus was derived from the global need to tackle climate change through renewable energy and related cleantech business. According to the pro-

Table 6.1 Summary of the Groove programme 2010-2014.¹⁰⁸

Objectives	<ul style="list-style-type: none"> To improve the business capabilities of target companies (SMEs) by improving their international competitiveness by means of developing business skills and networking, with a strong emphasis on international networks
Focus areas	<ul style="list-style-type: none"> Renewable energy solutions (technologies and services) Small and medium-sized enterprises International growth
Total volume	Total volume of the programme 101 M€ (out of which Tekes 53 M€) Volume of company projects 89 M€ (out of which Tekes 46 M€) Volume of research projects 12 M€ (out of which Tekes 8 M€)
Projects	91 company projects (with 77 companies ¹⁰⁹) ¹¹⁰ 41 research projects (with 19 public organisations)
Target customers	Small and medium-sized enterprises willing for growth in renewable energy business.
Participating companies and research organisations	20 large companies 4 medium-sized companies 19 small companies. 34 micro companies 19 research organisation

¹⁰⁶ Source: Tekes, Green Growth, webpage

¹⁰⁷ Source: Tekes' programme data

¹⁰⁸ Source: Tekes' programme data

¹⁰⁹ One public association is classified as a company.

¹¹⁰ Consortia projects allocated per company.

¹¹¹ Source: Tekes (2010)

gramme material, the reasoning of the programme was rapid growth of cleantech business especially in China, the U.S. and Europe and, on the other hand, vast cleantech expertise and know-how based in Finnish companies.¹¹²

Groove, like its predecessor, was based on EU level regulation and strategic climate and energy targets to produce 20% of the consumed energy from renewable sources by 2020. In Finland, the target was set to 38%. EU targets include also to reduce carbon emissions 20% by 2020 and increase energy efficiency 27% by 2030¹¹³. National and international climate and energy politics enabled the development and markets for renewable energy and cleantech business solutions. At the same time, by supporting SME sector the Groove programme was in line with Tekes' own strategy which was for the first time more focused in SMEs.

According to programme interviews and documentation, Groove was a dynamic programme adapting to the development of participating companies and changes in business environment. At its inception, wind and bioenergy solutions seemed to have stronger emphasis, while towards the programme end solar energy solutions were emphasised. The spectrum of participating companies representing different business sectors was rather wide – for example, the programme had companies participating from healthcare and ICT sectors as well.

From its inception, the main focus of the Groove programme was SMEs and their opportunities to expand renewable energy business internationally. Key target markets included China, Germany and the U.S. due to on-going activities and strong need for cleantech solutions. Early on, there were many U.S. initiatives and activities, but soon participating companies began to view U.S. markets as not very tempting and more focus was put in China and Germany activities.¹¹⁴ Tekes also had intentions to introduce Finnish cleantech companies to emerging markets in India and Brazil, but it turned out that the companies did not, at that time, have suitable solutions for the Brazilian market, and due to low interest for Indian markets no significant activities were launched.

6.2.2 Programme funding

The target customers of the programme were small and medium-sized companies seeking international growth and business opportunities for their solutions in the renewable energy field. There was a wide variety of participating companies and projects, including ICT and healthcare. A

programme strategy was to gather together companies with similar solutions in order to find synergies for export instead of introducing single products to target markets.

Total funding in the Groove programme was 101 million euros, out of which 53 million euros came from Tekes. In the programme altogether 92 company projects (with 77 companies) and 41 research projects (with 19 public organisations)¹¹⁵ were funded, of which approximately 46% were grants and 54% loans¹¹⁶. Funding was more loan-based because the programme projects were closer to companies' business. Being closer to companies' business was one of the programme's objectives as well.¹¹⁷ The funded projects covered the thematic fields of solar power, wind power, bio energy, wave energy and smart grids.

Volume of the projects funded in Groove programme can be seen in Figure 6.1.

The 10 largest programme beneficiaries can be seen in Figure 6.2.

The programme was primarily seeking companies and solutions working in renewable energy technologies, services and research. There was a lot of interest in the programme from SMEs and Tekes received a lot of applications from international growth seeking companies working in bio, wave, wind and solar energy solutions. Also, applications were received from sectors outside of renewable energy, notably ICT and smart grid technology companies. For example CyberLightning, an ICT company providing "Internet of Things" solutions, was seeking access to Chinese markets and received programme funding for its market study.

Many of the larger companies participating in the Groove programme, such as Aidon, Fortum GreenStream Network and Oilon for example, had previously participated in the ClimBus programme as well. In addition, the existing Tekes' project and customer portfolio was actively screened against the target market needs with a steering group serving to identify potential technologies and participants in the programme.

Aside from the economic rationale and sound target market business concepts, a main reason to select small- and medium-sized companies to participate in the programme was those companies' willingness to seek international growth in the programme's primary target markets. According to interviews conducted for this evaluation, the programme also tried to compile groups of supplemental companies operating in the same solution area and, thus, boost the export of entities instead of single products,

¹¹² Source: Tekes' programme material

¹¹³ Source: Ministry of the Environment (2013)

¹¹⁴ Source: Tekes (2014a)

¹¹⁵ Source: Tekes' programme data

¹¹⁶ According to Tekes programme data the share of loans was more than 60%

¹¹⁷ Source: Tekes (2014a)

Figure 6.1. Volume of projects funded by the Groove programme according to size and type of the company.

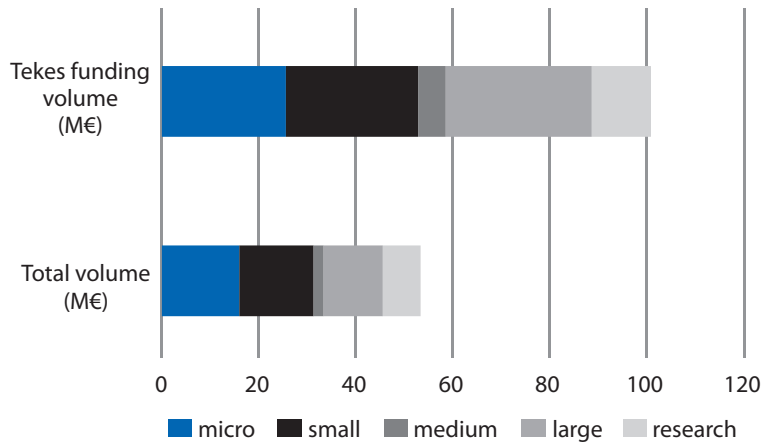
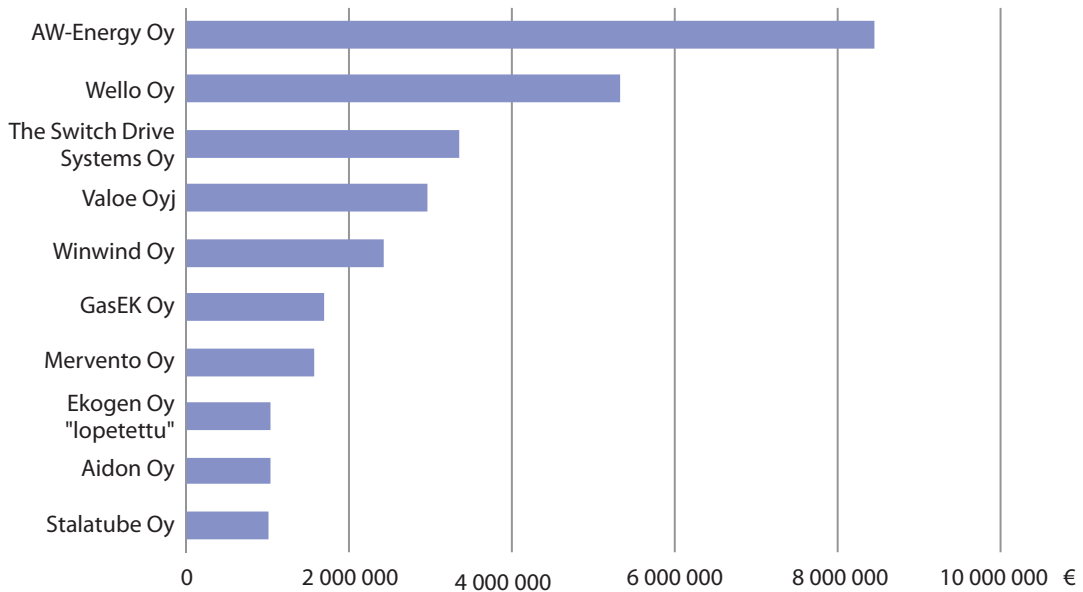


Figure 6.2. Companies with the largest Tekes Groove programme funding.



which was seen to be a successful strategy for entering the selected target markets.

According to the evaluation material, the Groove programme appears to have succeeded in reaching a good number of the most important target customer groups - growth seeking SMEs - to participate in the programme. The programme developed active communication and interaction with different forums, which helped it to reach an even larger audience and inform SMEs about programme oppor-

tunities. Groove received a greater number of SME project applications than expected. According to the interviews, however, the quality of many applications was deficient, particular among research project applications. It may be assumed that the reason for this may be due to either the novelty of the programme to SMEs or the prerequisites of the application process.

Examples of the companies involved in the Groove programme are shown in Table 6.2.

Table 6.2. Examples of companies in the Groove programme.

	Examples of companies
Energy production technologies	<ul style="list-style-type: none"> • Solar panels and equipment (SolarWheeler, Savo Solar, Areva Solar) • Wind power and turbines (WinWind, Norse Power) • Wave energy production technologies (Wello, AW-Energy, Ecowave)
Energy efficiency	<ul style="list-style-type: none"> • Energy efficiency in power generation (Merus Power Dynamics, Doranova Oy) • Energy efficiency systems and services (TM System Finland, Oilon)
Bio-based materials research and energy technology	<ul style="list-style-type: none"> • Bioenergy production solutions (Ekogen, AP Industry Engineering Service, GasEK) • Bio-based materials research (UPM-Kymmene) • Bio-based fuels development (Sybimar, MetGen)
Services and software	<ul style="list-style-type: none"> • 3D Internet of Things solutions (CyberLightning) • Smart metering (Gurux, Aidon) • Supportive energy systems (Nocart, The Switch)

6.2.3 Programme services and activities

As in many Tekes' programmes, the executive management of the Groove programme consisted of programme director, programme manager and programme coordinators. In addition, the programme had a collaborative and business oriented steering group including members of the academic sector, large and SME companies, public sector, and investor community. According to the interviews, it was considered as a valuable asset that the steering group could provide multi-disciplinary insight to the market potential of certain solutions' and companies' possibilities to succeed in international markets. These steering group sessions were called "steering group analysis".

Groove programme fulfilled the renewed strategic vision of Tekes by focusing on activities targeted for SMEs. In addition to funding projects targeting international business development, the programme offered services including networking events, workshops, annual seminars, international seminars, delegation trips and market information. Groove introduced business sparring, investor meetings

and pitching sessions for SMEs, previously quite rare among Tekes programmes.

The programme had some interaction with other public activities related to SME business internationalisation. For example, there was some interaction with the Tekes Green Growth programme including joint delegation trips to China. Groove also coordinated with the Ministry of Economic Affairs and Employment and Ministry of Foreign Affairs on high profile delegation trips to China. According to programme interviews, Groove operations were quite similar to Finpro by supplementing the internationalisation services offered by Team Finland as whole. Particularly on delegation trips to China, Finpro and Tekes worked closely together.

A short description of select programme services and activities is presented in Table 6.3.

According to the evaluation material, in addition to having Finnish representatives located in China, the Groove programme cooperated closely with the Chinese Ministry of Science and Technology (MOST) to create additional op-

Table 6.3. Selected activities of the Groove programme.¹¹⁸

Investor Advisory Board, investor relations and pitching	Networks of SMEs and investors were created by organising investor events at which SMEs had the opportunity to pitch their business plans to investors and get advisory feedback. Tekes invited investors with different business perspectives to participate in the events.
International cooperation	Delegation trips were organised throughout the programme. The target markets included especially China, Germany and the U.S., where programme cooperated closely with local public sector.
Focused market research	International Business Development students from the University of California Berkeley Haas Business School were hired to do market research on business opportunities in North America and China for Finnish companies.
Business sparring	In order to improve international business opportunities of the SMEs, Tekes hired two business coaches to organise sparring sessions with participating SMEs developing their business models and ideas.

¹¹⁸ Source: Green Mining. Intelligent and minimum impact mines. Results of the Tekes Programme 2011–2016, website.

opportunities for Finnish companies to meet Chinese companies and to acquire credibility in Chinese domestic markets. Tekes had cooperation agreements with science and municipal technology departments of Beijing, Shanghai, Jiangsu and Zhejiang. Groove introduced Finnish companies also in the World Expo of Shanghai 2010.

The Groove programme maintained cooperation and joint activities with Germany, another Groove programme target market. These activities included business delegation trips focusing on solar and bioenergy projects. In the U.S., International Business Development students from the University of California Berkeley Haas Business School were hired to conduct market research in North America and China markets for Groove programme Finnish companies.

Based on programme interviews, in addition to project funding Groove programme participants seem to have been satisfied with other programme services and activities. Investor meetings and business sparring, in particular, received positive feedback.

6.3 Results and direct impacts

According to the evaluation material, the Groove programme managed to activate international growth-seeking SMEs operating in the field of renewable energy. The programme facilitated their preparedness and access to the market (especially in China and Germany) by offering extensive programme services, including business sparring and investor meetings. According to surveys conducted during the programme, participating companies indicated that they made direct contact with potential global customers, and that the delegation trips were a good way to enhance their international growth opportunities. However, the level of activation was not as good as planned before the programme. According to the interviews, programme's global growth expectations were too high for some companies, especially in the bioenergy sector. Further, some companies were not ready to seek global growth. In addition, no specific programme sub-targets were defined to boost international growth and capabilities of SMEs. Based on the evaluation material Groove did also not define quantitative targets.

Business sparring offered by Groove enabled growth seeking companies to refine their business model and strategy in alignment with target markets. Especially for the smaller companies, business sparring appeared to be a good first step toward internationalisation. Some of the companies continued taking business sparring sessions also after the programme. According to the interviews, toward the end of the programme, operations become somewhat inefficient likely due to the large number of participating companies and new projects.

During the programme, four investor event days were organised to bring cleantech companies and mainly Finnish investors together under the same roof. Over 80 Finnish companies and about 20 public and private sector investors participated in these events. Over 200 bi-lateral investor meetings were conducted during these events. There were also some international investors attending these events, but according to the interviews, this number could have been higher, resulting in even more international business opportunities. During the investor events, companies had the opportunity to pitch their solutions to the investors and get valuable feedback. According to the evaluation material, the companies were satisfied with these events and after the programme's conclusion investor meetings were continued in Tekes' Cleanweb programme to some extent.

However, due to a lack of detailed information, it is not clear how much funding companies ultimately received as a direct result of the investor events. Further, there is no clear evidence whether the programme succeeded in building ecosystems among Finnish companies or increased the revenue of participating companies. At a minimum, Groove succeeded in boosting the overall knowledge of selected target markets for participating companies.

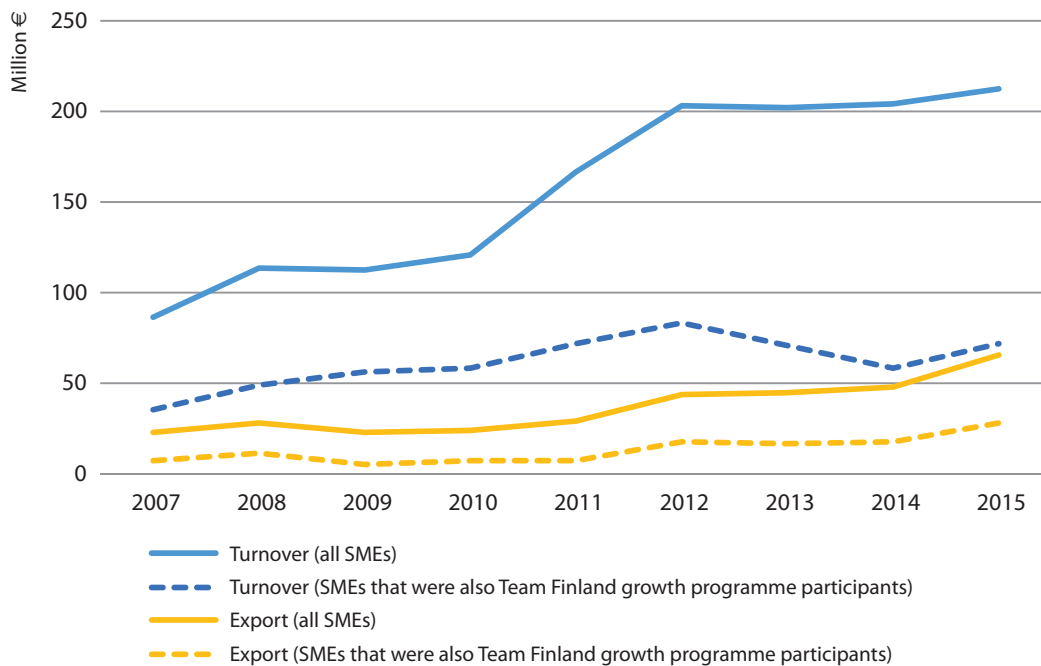
One of the most important results of the programme has been the maintaining and deepening of cooperation with Chinese actors; companies, investors and the public sector. As evident in interviews of companies seeking international growth, the best way to gain growth is to be present in the target market. The programme managed to create contacts for Finnish companies in Germany as well, but most of the effort was put into Chinese markets.

China-related activities were vivid during the programme. Two calls for funding applications were organised for Finnish-Chinese joint ventures, through which 22 projects were funded. Four delegation trips to China involving a total of 50 companies were organised and about 40 Chinese companies and public administration representatives visited Finland, during which over 200 meetings between Chinese and Finnish companies took place.¹¹⁹ After Groove, these China-related activities continued as part of the Green Growth programme. During Groove, calls for joint funding applications were also organised in 2012 together with Germany, resulting in seven funded consortia projects involving a total of over 15 companies and research institutions. This cooperation between Finland and Germany established the "Berlin Model", which is a form of cooperation for two or more EU countries wherein multi-national project funding comes from national funding institutions. Following the Groove programme, the Berlin Model has been utilised between other EU countries as well.¹²⁰

¹¹⁹ Tekes (2014a)

¹²⁰ Tekes (2014a)

Figure 6.3. Revenue of SMEs that participated in the Groove programme.¹²¹



The growth of the SMEs that participated the programme can be seen in Figure 6.3. SMEs participating in Tekes programmes have gained strong growth in turnover especially in 2010-2012. During the programme, on average, export of the companies has doubled for all Tekes programme and Finpro growth programme participants.

6.4 Indirect impacts

Indirect impacts of the Groove programme, such as strengthening economic growth and productivity in society, are difficult to detect so soon after the programme's conclusion in 2014. However, the close and continuous interaction with target market actors, particularly China, is expected to reap economic benefits in the future. For some participating companies, such as Norsepower, the programme is expected to lead to future enhanced opportunities to operate in international markets, business development, and widened domestic and international networks. Many programme participants are still operating in the main programme target markets, China and Germany.

The Groove programme ended just a few years ago, but its results still prevail. According to the interviews, joint ventures within EU countries through the Groove based Berlin Model have occurred since the programme's conclusion, helping to catalyse multi-national development projects for Finnish companies as well. In addition, the coop-

eration model for funding joint ventures between Chinese and Finnish companies still exists. Though not directly due to the Groove programme but as part of many initiatives related to enhancing economic cooperation between Finland and China, the foundations for deeper cooperation between are in evidence already. The latest significant advance was the visit of the President of China, Xi Jinping, to Finland in 2017, raising the status of international relations to a new level and boosting bilateral trade, including cleantech.¹²²

At this point, three years after the programme's end, the programme's indirect impacts on society, such as increased well-being of citizens and environment, are difficult to evaluate. According to evaluation material and expert interviews, broader indirect impacts will likely be realised in the future if development of companies and public activities continues.

It is evident that global objectives to mitigate climate change would have taken place without the programme and that these efforts will likely continue in the future. However, the companies that expanded their businesses internationally during Groove may have had impacts on the well-being of target markets. For example, the air pollution in China caused by energy production may have begun to diminish due to cooperation with Finnish cleantech companies. Broader indirect impacts of such cooperation will likely be seen in the future.

¹²¹ Source: Tekes and Finpro's databases

¹²² Koivula-Olstad (2017)

6.5 Summary and conclusions

The goal of the Groove programme was to enhance Finnish SMEs' competitiveness and international growth in the renewable energy sector through international networking, improved know-how, and by providing tools for companies to develop their business. This goal was consistent with Tekes' own strategy. Continuing the agenda taken forward in the Climbus programme, Groove was a relevant programme through its years of execution. The programme's main theme, renewable energy technologies and related business, has continued after the programme's conclusion in other Tekes' programmes and operations.

After the financial crisis (2007-2009) the world economy started to grow, but the business environment in Finland was not improving accordingly. This affected Groove as well. However, due to its broadly-defined goals, the programme adapted to global changes. Global market demand for renewable energy technologies and services has been growing for decades. International mandates to mitigate climate change by reducing emissions has also been a main driver in the development and implementation of renewable energy solutions in various industries. Thus, the Groove programme has been resilient in time.

As a programme, Groove was dynamic and the emphasis of the focus areas changed throughout the programme enabling rather wide scope of different projects, including projects taking advantage of ICT as well. On the other hand, according to the interviews, the lack of more specific targets and including wide range of projects and companies into the programme has been seen causing inefficiency in programme execution. Still, the programme managed to enhance Finnish SMEs' preparedness to access international markets and, due to vast international efforts, to create business networks and local contacts to markets especially in China and Germany that somewhat prevail to date as well. However, there is no evidence to what extend

these business networks and contacts have been realised to concrete business growth and revenue for participating companies in target markets or nationally. The Groove programme failed to meet its targets for internationalisation with some SMEs, especially in the focus area of bioenergy, due to unwillingness and immaturity of some companies to seek for global growth. The results arouse speculation whether the pre-screening of projects included in the programme has been efficient or not.

As being very internationally cooperative and business orientated, the Groove programme managed to include several relevant actors from the field of renewable energy to operations especially in China and Germany, including the public sector. The programme managed to deepen understanding and knowledge on the Chinese and German markets. The programme also reinforced the foundations for international cooperation within the sector of renewable energy related business and enhanced bilateral cooperation with Chinese and German public sectors as well. When it comes to U.S., the Groove programme did not manage to meet its targets to introduce Finnish SMEs or raise interest on providing cleantech solutions to the U.S. markets. Due to its heavily emphasised international networking activities, the programme has been seen operating a lot like Finpro, and it was kind of a new experiment for Tekes at that time.

The programme was creating opportunities for participant companies to develop and demonstrate their solutions and export holistic entities of solutions instead of single products to some extent. The programme services, such as market studies, business sparring, pitching sessions and investor meetings have been useful for participating SMEs, enabling refining of business concepts and getting valuable insight near the market. As a good internal working practice, the Groove introduced steering group analysis on potential business themes, that, on its part, improved the possibility to select relevant companies and projects into the programme.

Summary of Groove Programme

- The programme did not fully reach its targets to boost the internationalisation of SMEs as expected partly due to their lack of preparedness to expand into global markets.
- As the focus areas changed slightly during the programme period it enabled a rather wide range of projects (e.g. ICT). On the other hand, including wide range of projects and companies and lacking specific targets seems to have caused inefficiency in programme execution.
- Programme included good practices such as multi-disciplinary steering group, company sparring, contacts to investors and international match-making, which were later adopted by certain other Tekes activities.
- A wide range of international connections were established and some of these continued after the programme. The programme deepened the understanding of the Chinese and German markets and enhanced bilateral cooperation between the countries' public sector actors. However, there is no evidence of specific increases in sales revenue due to the programme.
- Due to its heavily emphasised international networking activities, the programme has been seen operating a lot like Finpro, and it was kind of a new experiment for Tekes at that time.

6.6 Company case studies

6.6.1 Merus Power Dynamics

Part of Groove programme

Part of Finpro's Cleantech Finland and Mining growth programmes

Merus Power Dynamics designs, manufactures and markets various power quality solutions for commercial buildings and both light and heavy industries, including mining operations and renewable energy sectors. Their product portfolio includes active harmonic filters, STATCOMs, SVCs and UPQ energy storage solutions, and other equipment. Company's solutions enable improved power quality technologies for their customers providing energy savings, increased productivity, reliability as well as improved environmental performance. Currently, the company's key markets are China, Africa and Southeast Asia. In 2016, turnover was 4,7 million euros and they have 25 employees in Finland.¹²³

Participation in the Groove programme has had an essential impact on the company's product development. First, the company had an R&D project funded by the Groove programme from 2010 – 2012 to further develop their product and product family. The project was a foundation for the company's product offerings and enabled the development of higher capacity products. Second, the company further improved its product offerings to meet international customer demand through a Groove-funded project in 2014–2016. This project enabled the development of a new energy storage system technology. The company delivered several systems in Africa and South- Korea. The company's

contribution to product development and technology has been recognised and awarded internationally, e.g. by Frost & Sullivan, who predicted that Merus Power Dynamics is rapidly gaining a good reputation in the market due to their geographical market coverage, expertise, quality of products and technical services.

Tekes contribution to this company case can be seen in Figure 6.4.

Key success factors:

- Investments and funding for product development has been integral part of the company's operation and have enabled the existing product offerings. It is expected that these investments will have long-term impacts and increase future cash flows.
- The company's flexible, customised solutions with an international partner network is a distinct competitive advantage.
- Good references have been crucial for company's success.

Lessons learned:

- Investments in product development create long-term cash flow, but it takes time to get products to market.
- It has been more difficult to get domestic than international clients, but international references have increased interest of domestic markets.
- The economic well-being of a customer segment influences that segment's willingness to invest in their operations. Therefore, it is important to actively seek out new customer segments and expand product offerings into those segments.

Figure 6.4. Business growth and Tekes contribution in the case of Merus Power Dynamics.



¹²³ The case was compiled from the following sources: Tuomala (2017), Merus Power website, Inventure (2015), Vanhanen (2015), Landon (2014), Good News From Finland (2016)

6.6.2 Gurux

Part of Groove programme

Gurux was established in 1998 and offers automatic meter reading software products. The product makes it possible to read DLMS compatible water, gas or electricity meters and enable up to real-time meter communications via an automatic meter reading system (AMR or AMI). The solution enables savings as meter reading becomes efficient and electricity consuming devices become easy to detect. The solution is based on an open source solution which means that it is free for all users who accept the license terms (GPL2).¹²⁴

In 2009 Gurux received Tekes funding for a project through which Gurux evaluated its open source strategy. Based on that evaluation the decision was made to adopt an open source model. This decision involved some risk. Gurux also participated in a 2012 Tekes initiative which sought to develop sales in China. Gurux took part in a business delegation visit to China organised by Tekes. This visit was important for Gurux, because it provided access to local contacts and enabled meetings with the Chinese energy companies. China is no longer a main focus area of Gurux partly because of the concentrated market with two large energy utilities and because China has chosen a different standardisation path. Nevertheless, the visit was considered a success because allowed the company to get to know the Chinese market. Gurux with its open source meter reading code has been instrumental in the promotion of the DLMS standard in the EU area as well as internationally. Tekes and other Team Finland contributions to this company case can be seen in Figure 6.5.

Key success factors:

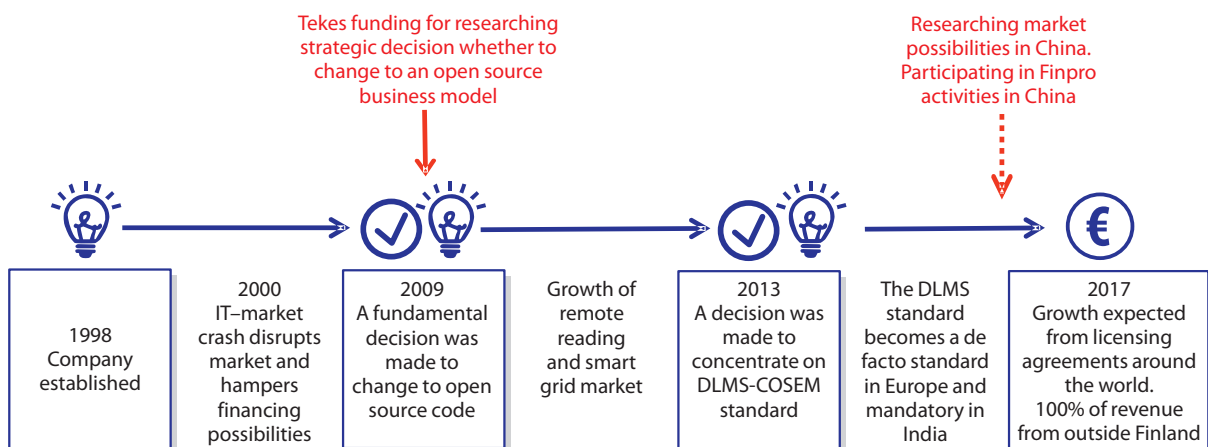
- In order to be successful in licensing you need a very good, high-demand product.

- Focus on a specific market niche where it is possible to develop a good product that is important to clients.
- A business model combining open source code with licensing.
- Picking the right standard. Choosing to concentrate on the DLMS/COSEM standard turned out to be the de-facto standard in Europe. It is also the only allowed standard in India for electrical meters.
- Developing a licensing scheme and a pricing system that takes into account the economic realities and business environment in each country. This has been especially important in developing countries where an European pricing structure may not be competitive.

Lessons learned:

- When international sales are the target in the software business, there is a need to concentrate on a clear niche with sufficient demand potential. It is not possible to compete in multiple areas in a business environment where competition is tough and where the cost structure in other countries with competitors can be much lower.
- Tailoring solutions to the needs of different customers can be unprofitable for software business because of the cost structure in Finland. It is difficult to make a profit by tailoring software services for individual customers. Gurux has many clients in developing countries and this is causing price pressure.
- When working with certain developing countries there is a need to have different types of licensing agreements tailored to the needs of the target country. The business culture can be different. This has been new lesson learned for many Finnish companies.
- Getting international visibility and doing international marketing requires effort and is challenging in a market with extensive competition.

Figure 6.5. Business development and Tekes contribution in the case of Gurux.



¹²⁴ This case is based on the following sources: Kurunsaari (2017), Gurux website

7

Results of the Electric Vehicle Systems programme

7.1 Overview of the programme

Tekes Electric Vehicle Systems (EVE) programme from in 2011-2015 sought to increase the Finnish electric vehicles and machinery sector from 200 million euros in 2010 to approximately 2 billion euros by 2020.¹²⁵ According to detailed data collected by Tekes and provided for this assessment, total project funding was 75 million euros, of which 57 million euros were company projects and 18 million euros were public research projects¹²⁶. Of the total programme value, Tekes funding was 36 million euros. The total funding amounts reported in this chapter include both Tekes funding and company funding. Table 7.1 summarises essential programme facts and data.

7.2 Targeting the programme

7.2.1 Focus and objectives

From the beginning, the EVE programme had a clear focus on electric vehicle systems, infrastructure and networks, which included passenger cars and services, testing services for automotive industry and electrification of public transportation and heavy-duty vehicles. Based on interviews, the focus areas were chosen based on the companies, technology and know-how already existing in Finland. It was a strategic decision to exclude electric passenger car manufacturing from the programme, since that sector was already under intense competition and dominated by global car manufacturers. It was not considered an existing national strength to manufacture electric passenger vehicles.

Table 7.1 Summary of the Electric Vehicle Systems programme 2011-2015.¹²⁷

Objectives	<ul style="list-style-type: none"> to increase the amount of business related to electric vehicles and machinery from the 2010 figure of 200 M€ to approximately 2 B€ by 2020 to create a community of electric vehicle and support system developers with close contacts to international research and business networks to develop test environments and standards for the industry
Focus areas	<ul style="list-style-type: none"> passenger cars services testing services for automotive industry electrification of public transportation and heavy duty vehicles
Total volume	Total volume of the programme 75 M€ (out of which Tekes 36 M€) Volume of company projects 57 M€ (out of which Tekes 24 M€) Volume of research projects 18 M€ (out of which Tekes 11 M€)
Projects	93 company projects (with 79 companies ¹²⁸) ¹²⁹ 34 research projects (with 15 public organisations)
Target customers	Companies and research institutes working with electric vehicles and machinery as well as with the components and systems used in them.
Participating companies and research organisations	43 large companies 6 medium-sized companies 13 small companies 17 micro companies 15 public organisations

¹²⁵ Source: Tekes, Description of Electric Vehicle Systems (EVE) programme

¹²⁶ Source: Tekes' programme data

¹²⁷ Source: Tekes' programme data

¹²⁸ Three cities and one federation of municipalities are classified as a company.

¹²⁹ Consortia projects allocated per company.

The main drivers behind the programme were international climate change mitigation objectives, which are to large extent related to decreasing the usage of fossil fuels in transportation and rapidly growing business opportunities in the EV related markets.¹³⁰ Before the programme started, several studies on global EV business and opportunities for Finnish companies had been made.^{131,132} It was estimated that by initiating the EVE programme the EV related research and development could be more focused and integrated, and new business opportunities could be created in the electric vehicle sector. It was thought that the programme would provide easier industry networking. It was hoped that operating jointly through a single programme would improve competitiveness of Finnish companies and a common national vision on development could be found. In addition, internationally competitive testing environments and piloting projects could be created, and accessing the international cooperation would be easier. It was assumed also that a programme would effectively involve public sector in the holistic development of the EV sector, including required infrastructure.¹³³

To include all relevant actors in the programme, planning was undertaken in close cooperation with EV companies and authorities, including the Ministry of Employment and the Economy and the Ministry of Transport and Communications. In order to boost electric vehicle business, a government subsidy instrument for energy investments related to electric vehicles¹³⁴ was launched simultaneously with the EVE programme in 2011. However, the main target of the programme was not to increase the EV business in Finland, but to boost internationalisation of Finnish companies in order to access high demand international EV markets.

In addition to the ambitious long-term objective to tenfold the EV sector by 2020, the main goal of the programme was to create an electric mobility ecosystem that could generate new knowledge and competence in EV related technologies and services.¹³⁵ In more detail, the objectives included developing a collaborative forum for electric vehicle developers, creating a testing environment, developing competitive technologies and services, establishing new business, and influencing the standardisation of the electric vehicles industry.¹³⁶

One goal of the programme was to create contacts with international programmes and other important business actors related to the EV industry. According to the programme preparation material, it was also recognised that collaboration within the value chain and with competitors, also internationally, developing networks between large companies and SMEs, centralised coordination of national projects and enhancing cooperation also with and between the authorities needed to be developed.¹³⁷ According to the interviews, as the programme was highly focused on international business, conducting academic research was not a main objective.

In the first two years after the programme's initiation in 2011, EVE consisted of five consortia. Eco Urban Living, EVELINA (National test environment for electric vehicles) and Electric Traffic were focused mainly on passenger cars and services. The WintEVE consortium (Winter operability for electric vehicles and electric vehicles go arctic) was active in testing services for automotive industry, and the Electric Commercial Vehicles (ECV) consortium was active in the electrification of public transportation and heavy-duty vehicles. In the latter part of the programme in 2014 and 2015, Electric Traffic, WintEVE and ECV continued as a part of the EVE programme while Eco Urban Living and EVELINA did not.¹³⁸

7.2.2 Programme funding

The EVE programme was seeking companies developing solutions related to: electrification of mobile machinery, intelligence in vehicles, charging points and network, special components to vehicles and infrastructure, development and piloting of concepts and testing environment and services especially in arctic conditions.¹³⁹ Over 50% of the companies participating in the EVE programme were large companies by EU standard definition.¹⁴⁰

The programme funding was divided in two periods first one taking place in 2011-2013 and the second in 2014-2015. The first of the periods was targeted to companies and research institutes working with electric vehicles and machinery as well as with the components and systems used in them. The latter period was mainly targeted for international business development of companies.

¹³⁰ Source: EVE preparation material, IEA (2017)

¹³¹ e.g. Biomeri Oy (2009)

¹³² e.g. SWOT Consulting (2010)

¹³³ Source: EVE preparation material, EVE presentation material

¹³⁴ Energiakokeilut.fi (2016)

¹³⁵ Source: EVE programme description

¹³⁶ Source: EVE presentation material

¹³⁷ Source: EVE preparation material

¹³⁸ Source: EVE programme final report

¹³⁹ Source: EVE programme final report

¹⁴⁰ European Commission (2017a)

The EVE programme funding was based on consortia funding. The funding was directed to five consortia, and based on pre-screening process made by the consortia leading companies and Tekes, the funds were allocated to specific projects that fit under the targeted scope of a consortium. The number of large companies participating in the programme was approximately 50 %.

Total funding was 74,8 million euros, of which 35,8 million euros came from Tekes. Altogether 93 company projects (with 79 companies) and 34 research projects (with 15 public

organisations) were funded. The funded projects were in the fields of testing and piloting environments for electric vehicle development, EV services, power generation systems and electrification of heavy duty vehicles and machinery.

Volume of projects funded by Electric Vehicle Systems programme are set forth in Figure 7.1.¹⁴¹

The 10 largest programme beneficiaries can be seen in Figure 7.2.¹⁴²

Examples of the companies involved in the EVE programme are shown in Table 7.2.¹⁴³

Figure 7.1. Volume of projects funded in Electric Vehicle Systems programme according to the size and type of the company.

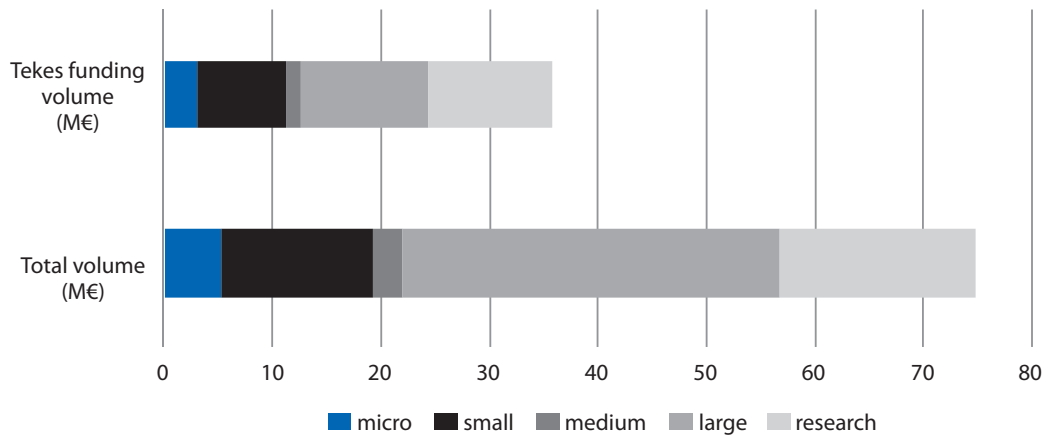
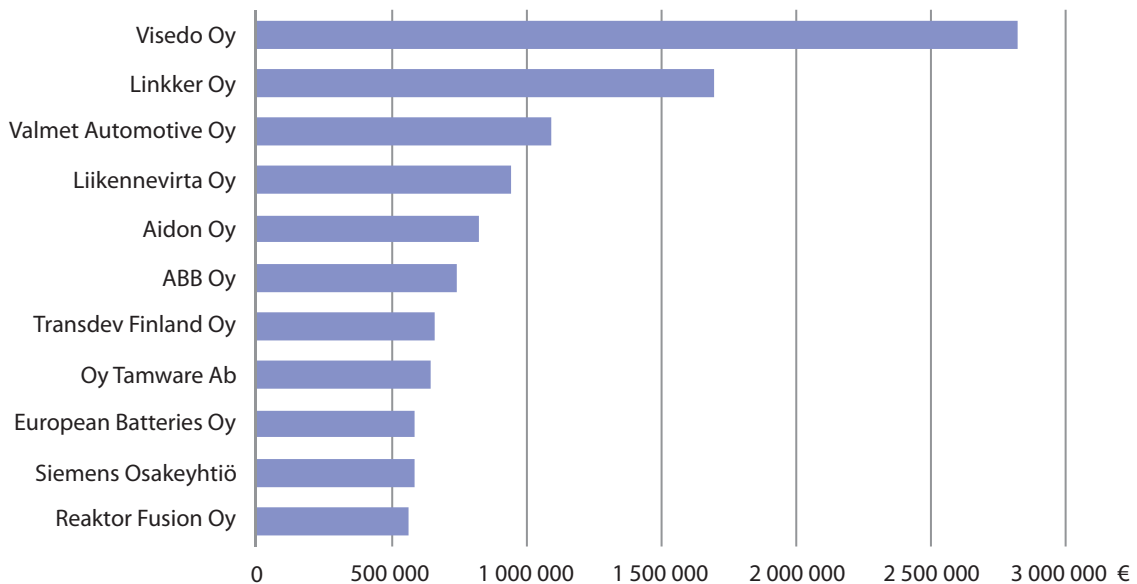


Figure 7.2. Companies with the biggest Tekes funding in EVE programme.



¹⁴¹ Source: Tekes' data

¹⁴² Source: Tekes' data

¹⁴³ Source: Tekes' data

Table 7.2. Examples of companies in the EVE programme.

	Examples of companies
Electrification of mobile machinery, heavy duty vehicles	<ul style="list-style-type: none"> • Drive solutions (examples of companies, ABB, Visedo, Toroidion Oy) • Heavy duty vehicles (Linkker, Jeti Industries Oy, Valmet Automotive)
Intelligence in vehicles, charging points and network	<ul style="list-style-type: none"> • Intelligence in vehicles (Hybria) • Intelligence in charging points (Kemppi, Liikennevirta) • Intelligence in network (Fingrid, Wapice)
Special components to vehicles and infrastructure	<ul style="list-style-type: none"> • Special components to EVs (European Batteries Oy) • Charging solutions (Ensto, PlugIT) • EV infrastructure (Fortum, Eltel Networks)
Development and piloting of concepts and testing environment and services	<ul style="list-style-type: none"> • Testing environments (Mobisoft, MeshWorks Wireless Oy, ABB) • Piloting concepts and local ecosystems (Aidon, BK Group Oy) • EV services for consumers (AC2SG Software Oy, Örum Oy Ab, Snuger Oy)

7.2.3 Programme services and activities

The programme was company-driven and strongly focused on international opportunities in EV business sector. Alongside with Programme Director, Programme Manager, the EVE programme had two coordinators, one of which was from Finpro dealing with international connections. The other coordinator was more focused on domestic markets and research. The programme was managed by a steering group, the members of which were mainly from private companies. The EVE programme consisted of five consortia, which were led by five companies. With the final approval from Tekes, and based on the focus area, these consortia leading companies selected other companies' and research organisations' projects to include in the EVE programme.

Tekes allocated funding to the consortia instead of single projects, which was unusual in context of previous Tekes programmes.

In addition to funding for R&D projects, the programme offered a wide range of networking events, sparring for pitching ideas, workshops, annual seminars, international seminars, delegation trips, market and forecast information. The programme had a lot of interaction with other public activities inside and outside Tekes. For example, there was coordination with Fimecc, Tekes Green Growth, Green Mining, and different ministries. Also, there was close cooperation with the Electric Mobility Branch Group of the Federation of Finnish Technology Industries.¹⁴⁴

Short description of the selected programme services and activities is presented in Table 7.3.

Table 7.3. Selected activities of the EVE programme.¹⁴⁵

Interaction and communication	The programme raised awareness through traditional networking events with international companies and possible partners making presentations. Programme participant companies were offered the opportunity to participate in international trade fairs and seminars. The programme maintained close communication and cooperation with national programmes and actors, including the mobility branch group of the Federation of Finnish Technology Industries.
International cooperation	Trade delegations were conducted in South Korea, Germany and USA among others. Finpro was involved in programme internationalisation activities. There was close cooperation with the Nordic countries and EU.
Testing and demonstration	One objective of the EVE programme was to develop testing and demonstration environments for EV solutions.
Sparring for pitching ideas	Participating companies were offered sparring services to practice pitching their products and services to potential customers.
International market information	The most of the business potential of EV sector exists outside the borders of Finland. The EVE programme provided valuable market information on local business environments and companies, for example, for the participating companies.

¹⁴⁴ Source: EVE programme final report

¹⁴⁵ Source: EVE programme final report

According to the final report and related interviews, the EVE programme was heavily focused on international markets, had vivid interaction with international organisations creating concrete business opportunities and networks and securing relevant market information. As one of the programme coordinators was from Finpro, the EVE programme maintained close cooperation with that organisation and also addressed Nordic cooperation. For example, a Nordic delegation of 14 enterprises took part in the South Korea Electric Vehicle Symposium in 2015 supported by the Nordic Energy Research. In addition to Asia, delegation trips were made to North America and Germany during which Finnish companies participated in trade shows and seminars.

7.3 Results and direct impacts

The programme created new business opportunities for both existing companies and those established during and after the programme. Examples of the companies include electric buses manufacturing company Linkker that was established as a spin-off of the EVE programme and has exported electric buses to Copenhagen. Based on the interviews, due to the operating model and efficient coordination, the programme succeeded to catalyse the SMEs in the EV sector.

The programme successfully integrated the national EV network, including both companies and public sector. The business ecosystem was energised by consortia projects, and included actors in research and development activities in joint testing environments. The programme also increased the interaction among companies and public sector actors including Tekes, Finpro, ministries and public industry representative organisations. The cooperation with Nordic actors was deepened. By boosting this network, the programme enabled companies to differentiate, to introduce holistic solutions to the market, and to strengthen synergies between actors. For example Ensto and Symbicon successfully integrated EV charging points and digital outdoor advertising.¹⁴⁶

Especially during its first period, EVE increased the level of research of EV technologies through testing and more importantly, focused the research activities through funding decisions so that the amount of overlapping research at least within the programme was minimised. According to the interviews, although research activities in many programmes is initially very broadly defined, the EVE programme should have selected research themes that were more business-oriented. For instance, there is no added ecosystem value if research organisations are all focused on developing their own electric car.

To some extent, programme results have enabled the future adoption of disruptive technologies including

digitalisation in smart mobility and joint development of complementary service concepts. Yet, the ambitious 2 billion Euro Finnish EV revenue 2020 goal will be difficult to meet, particularly when compared with the pace of global development of the EV sector. Further, programme results have not been as rapid as hoped making the 2020 goal even more difficult. Most of the large companies that participated in EVE are operating only partially in the EV sector (e.g. Valmet Automotive) and, thus, it is difficult to accurately estimate EV sector revenue development as a whole.

The programme focused on international business and generally succeeded in networking the industry nationally and, to some extent, internationally through joint delegation and fair trade trips. Participating companies have been successful in penetrating the international market, growing their international business, and expanding their offerings in EV business. For example, Virta (previously Liikennevirta), that was established during the programme, has exported EV charging solutions to Switzerland, and Visedo, another EVE participant, currently exports ca. 90% of its products to China and Europe with revenue of almost 7 million euros. The programme has raised the global credibility of the Finnish EV industry creating a basis for closer international cooperation opportunities.

Public funding and support through the EVE programme has been critical for start-ups attempting entry to the market, primarily through consortium projects and piloting, involvement of public actors, such as cities, acting as enablers to public transport test solutions for example. The programme enabled the development of testing environments and technology demonstrations on a much broader scale that would have been possible otherwise. For example, in Helsinki region (Espoo) there was a joint electric mobility project (electric buses) involving HSL, VTT and Veolia Transport.¹⁴⁷

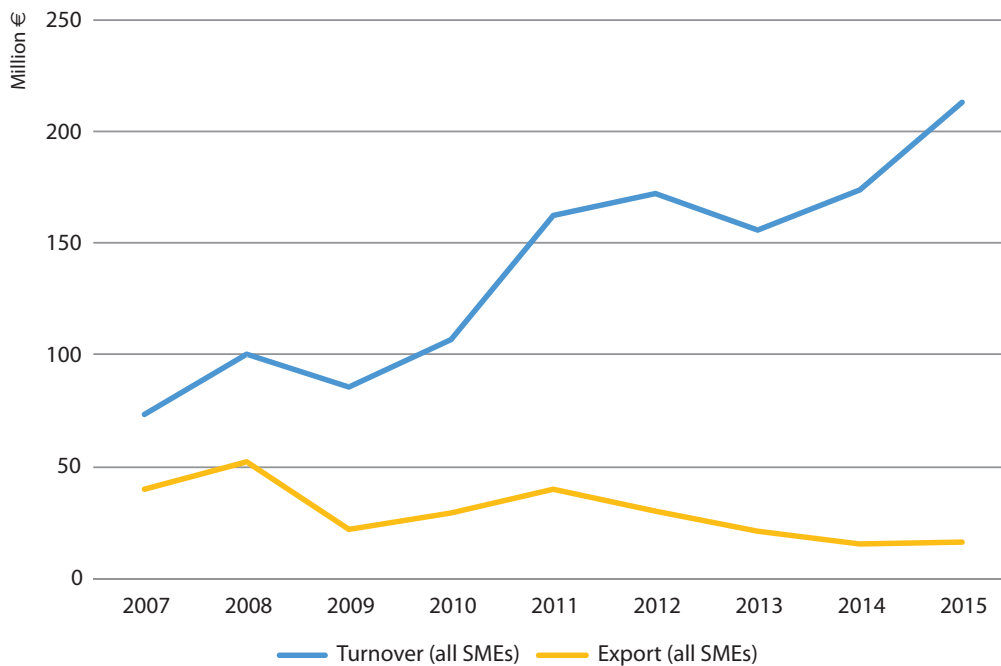
The programme goal to standardise EV business environment requirements was not achieved as planned. There is no evidence either domestically or internationally, and significant benefits have not yet been realised. One reason for failing to reach this goal may be that Finnish actors have little influence in international markets when compared with others.

The growth of the SMEs that participated in the programme can be seen in Figure 7.3. The figure shows that EVE participating SMEs have gained strong growth in turnover before and during the programme. However, the export of participating SMEs has declined between 2011-2015. It may be due to development activities in Finnish testing and demonstration environments and inputs in domestic EV infrastructure.

¹⁴⁶ Source: EVE programme final report

¹⁴⁷ Source: EVE programme final report

Figure 7.3. Revenue of the SMEs that participated in the EVE programme.¹⁴⁸



7.4 Indirect impacts

The EVE programme supported participating companies by providing global market information, thus increasing awareness and increasing the readiness to operate in international environments. During the programme, domestic market information was also disseminated to general public, the indirect impacts of which are hard to measure but viewed as possible motivation for consumers and businesses to adopt EV related technologies.

Possibly due in part to the programme, the national EV business and research ecosystem was established and improved. The programme encouraged participating companies to reinvent and test their existing businesses, especially in the heavy-duty vehicles sector, by means of electrification of production vehicles and machines and incorporating high value-added components into products. Innovations in digital charging technologies and measurements solutions, for example, occurred as part of the programme's consortia projects, forming a solid basis for further development in the digitalising world. The strengthened electric vehicle ecosystem now enables companies to offer holistic solutions instead of single products to the international market, fostering sector growth and innovation.

A central programme goal was to internationalise Finnish companies' businesses and achieve close coordination with national public sector partners such as Finpro and the Federation of Finnish Technology Industries. The programme developed global business connections, boosting future opportunities to enter new markets and get international partnerships. The programme enabled establishing startups and SMEs to access to international markets and to offer holistic solutions made possible through ecosystem synergies. For example, Virta was established during EVE by 17 Finnish companies.

The close cooperation in EV business environment development with public sector actors that had begun prior to the programme still exists to some extent (e.g. Finpro's smart mobility growth programme). National level strategies for energy and climate¹⁴⁹ are now taking into account electric mobility and related business environment development as one measure to mitigate climate change. In the beginning of 2017 the Ministry of Employment and the Economy granted 4,8 million euros of subsidies for developing the national charging infrastructure for electric vehicles as part of a cutting edge bioeconomy and clean solutions project.¹⁵⁰ It seems that more governmental support for non-fossil transportation will be available in the future.¹⁵¹ These public actions show commitment to develop the field further and is likely to catalyse business growth.

¹⁴⁸ Source: Tekes and Finpro's databases. Only three companies were also part of Team Finland growth programmes, and thus data on SMEs that participated both in the evaluated programmes and in Team Finland growth programmes is not presented.

¹⁴⁹ Ministry of the Economic Affairs and Employment (2016)

¹⁵⁰ Sähköinenliikenne.fi (2017). Spearhead projects are Government's top priority national projects.

¹⁵¹ Kauppalehti (2017)

7.5 Summary and conclusions

The long-term revenue growth objective of the EVE programme was very ambitious yet considered achievable. In short-term, creating new EV business and supporting internationalisation and business growth for SMEs based on existing expertise was widely viewed as realistic given the existing ecosystem and EV expertise. Including interaction among public sector actors was viewed as important to encourage EV testing and piloting infrastructure and a business environment driven by public sector enabling actions. The objectives of the EVE programme supported implementation of Finnish strategic climate policy decisions. The programme also followed Tekes' energy, climate and natural resources policies and strategies.

Electric vehicle related business has been a growing market globally already for a decade. International aims to tackle climate change by reducing emissions is the main driver for development and implementation of electric solutions in transportation. Thus, the EVE programme has been resilient in time leaning also on national strengths of the sector.

As being very focused and business orientated, the EVE programme pulled the EV related industry together and managed to include several relevant actors on the field, including public sector. It was creating opportunities for participant companies to develop and test solutions together and export holistic solutions instead of on certain technology. The synergies between companies and the value network were enhanced. Through the programme Finnish industry also managed to deepen cooperation in the Nordics and internationally.

Customers selected to the programme have seen the EVE programme as an asset to network with other players

in the field both nationally and internationally. However, in the consortia model led by companies, it needs to be ensured that the objectives that are set for the focus areas and consortia serve the whole sector, not only the companies involved or in charge. On the other hand, the company led consortia model brought agility into the operations and funding. The focused model itself with clear vision bring up possibilities to reinforce and develop the ecosystem further.

The EVE programme could be considered efficient by means of public resources used and results achieved. For example, as shown in figure 7.3, the turnover of EVE participating SMEs has strongly increased also during the programme. The programme has created and enforced still existing connections and operating network during 4 years' execution period. It is estimated that the efficient execution is due to clear vision and focus, global demand for EV related business, cooperation with public sector enablers and consortia based operating model, which all bring agility and direction to collaborative operations. Strong focus on business might have been one explaining factor as well. The impact of the programme on the EV companies' growth is hard to assess due to the many large participating companies, which only partly operate in the EV business and the growth facts related to those business areas are not available. In the beginning of the programme, EVE helped the research sector to focus research activities so that the amount of overlapping research was minimised.

The target to tenfold the revenue of Finnish companies operating in the field of EV business by 2020 has not yet been achieved, but global EV sector growth has been restrained as predicted before the programme and lets one suggest that the target will not be met.

Summary of the EVE programme

- The programme was proactive in recognising the global need for EV business and sought to boost Finnish EV related companies' internationalisation and EV in accord with both national core competencies and climate change mitigation goals.
- EVE was business driven, considered an asset and effective way to screen and select companies and projects fitting with its goals and objectives.
- Companies were founded as direct result of the programme, including Linkker and Virta. There are also examples of Finnish companies with international EV sector growth, but the role of the programme is not clear and wider impacts may be realised in the future.
- The programme integrated Finnish EV businesses and public sector enhancing cooperation within the sector nationally.
- However, beyond specific strategic partnerships, overall business ecosystem development domestically or internationally directly due to the programme is not in evidence.

7.6 Company case studies

7.6.1 Linkker

Part of Electric Vehicle Systems programme

Linkker, founded in 2014, provides solutions for emission free public transport. The company has developed an electric powertrain, lightweight chassis and electric bus system optimised for intensive public transport in cities. In addition, Linkker electric buses provide an enhanced travel experience for passengers and drivers. The key characteristics of the solutions are zero local emissions, low noise, high energy efficiency, long lifespan, and smooth and comfortable user experience. The Linkker solutions are the Linkker 12 and Linkker 13 electric buses, the LinkDrive drivetrain and the LinkLight chassis. In 2015 Linkker's turnover was approximately 1,3 million euros and it is estimated to grow rapidly in the near future while the demand for clean public transport is growing globally.¹⁵²

Before Linkker was established as a company, the light weight construction was first used in a diesel bus launched back in 2005. In addition, drive line development started in 2007 and was completed in several projects that casted the foundations for future development of Linkker solutions. The first electric prototype bus was developed and tested in the EVE programme's VTT led R&D project eBus 2011. The technology was developed as proof of concept level during the EVE programme already before the company was established. Linkker was founded as a spin-off of Tekes electric vehicles (EVE) programme in 2014. In 2015 Linkker put effort in product development resulting as two con-

verted vehicles and one whole new model. Production in Sastamala started quickly in summer 2016 in collaboration with Fortaco. The first electric buses delivered to Copenhagen, Helsinki and Turku in 2016-2017. The near future goal of Linkker is to reach 200-600 million euros revenue from the fast growing global electric vehicle market. Tekes and other Team Finland contribution to this company case can be seen in Figure 7.4.

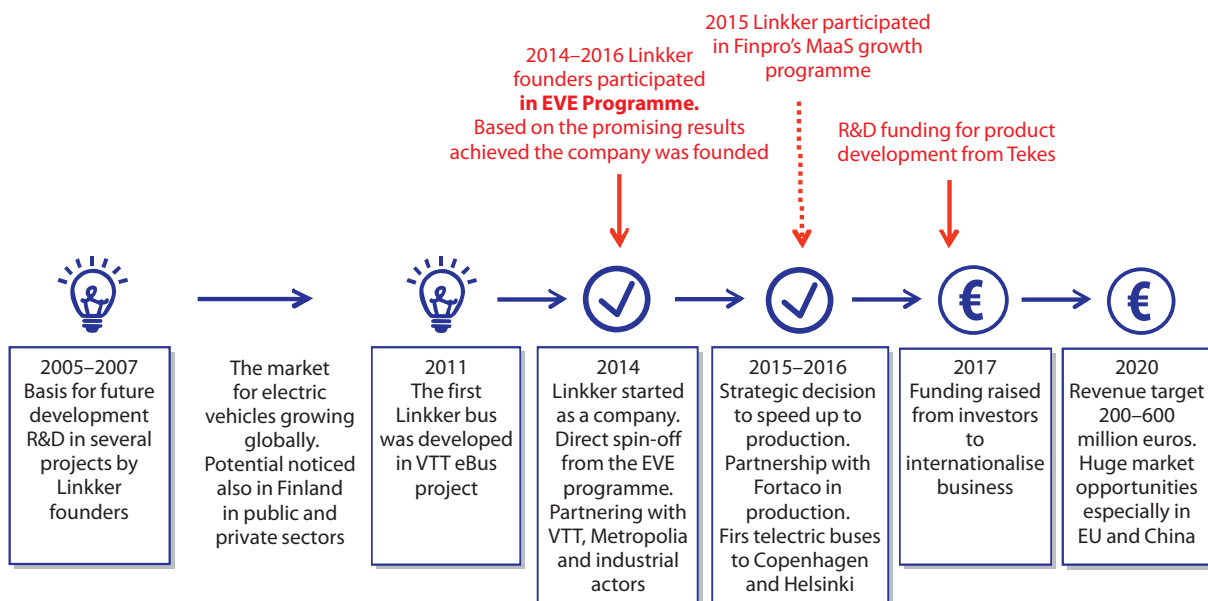
Success factors:

- Strong basis for product development made before founding the company in Tekes EVE programme.
- Without the EVE programme company would likely not exist. The founding team came together during the programme and several important partners were identified through the programme.
- National ecosystem that supports EV development as a whole (drivetrains, charging technology, transport operators, public sector etc.)
- Global growth for low carbon transport and electric vehicle development boosted product commercialisation.

Lessons learned:

- In an emerging field, it is important to have nationally holistic understanding on market development and opportunities for business also in public sector. The ecosystem works better and develops further, if all relevant parties are involved and committed to achieve common goals. If public sector actors (for example different ministries) have different goals for developing a certain sector, it could easily hinder the business growth of SMEs.

Figure 7.4. Business growth and Tekes contribution in the case of Linkker.



¹⁵² This case is based on the following sources: Erkkilä (2017), Linkker (2017), Tekniikka&Talous (2017)

- One question to consider is how to boost SMEs that have a product suitable for emerging market and willingness to scale business fast globally? Usually SMEs need support from public sector actors for rapid growth in form of risk sharing or guarantees for example.
- Having all relevant actors (research, business, public sector enablers) around the same table gives companies a huge advantage in grasping global market opportunities and rapidly develop the whole national ecosystem further

tion between companies should be more open and transparent. The state, cities and companies owned by them should open fair opportunities for smaller companies. Same applies for subsidies, which should be treated more transparently. Best practices could be sought from US, Singapore, Sweden, Netherlands etc. Even if political decisions have not favored EV market development, promising company examples are emerging. In 2016, the turnover of the company was 1,6 million euros and the company aims to accelerate growth both in Finland and internationally in the Nordic and Baltic countries as well as in Far East.¹⁵³

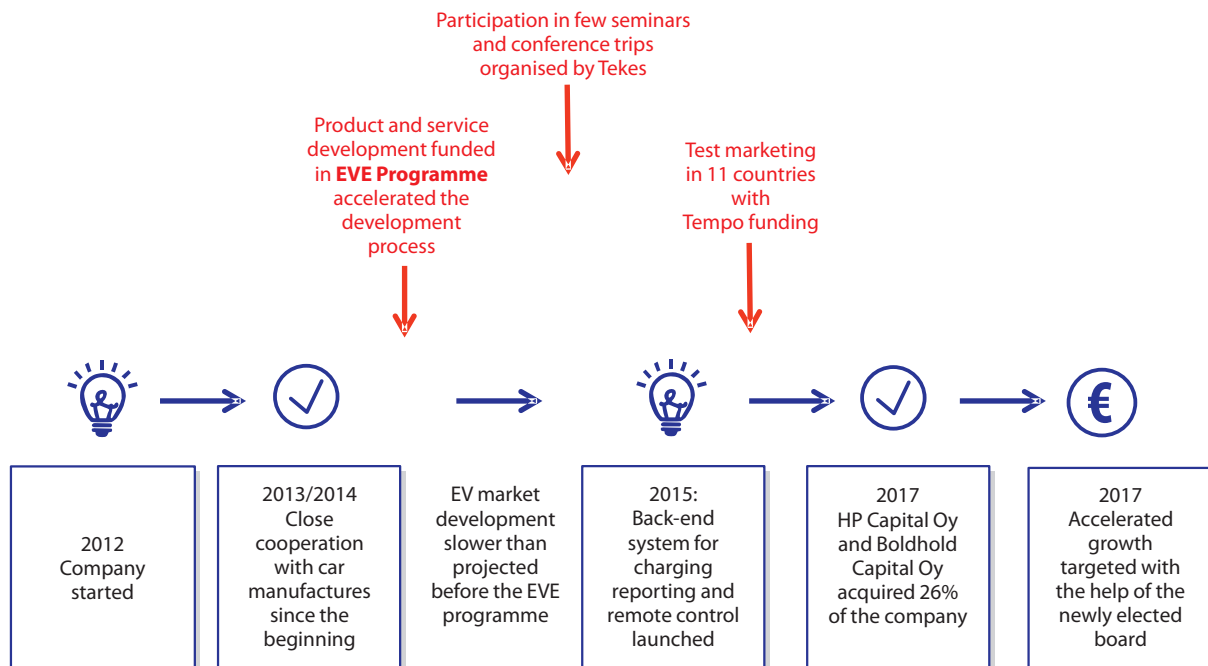
7.6.2 PlugIT

Part of Electric Vehicle Systems programme

PlugIT Finland supplies electric vehicle charging equipment and data control system as well as mapping, design, installation and maintenance related services for electric vehicle charging. The customers are housing and real estate companies, shopping centres, large enterprises, property management offices, and individual homes. By 2017, the company has supplied over 500 charging devices for different applications. However, the company growth has been hindered by weaker than anticipated development of the electric vehicle market in Finland. Finland has fallen behind in EV ecosystem development especially due to lack of attractive enough incentives for low emitting cars. Secondly, due to low risk taking and true venturing from established businesses and very limited public piloting. In order to create trust between parties, collabora-

As part of the EVE programme, PlugIT Finland developed first of a kind horizontal business platform for electric mobility industry. The developed solution enables fast deployment of charging services and system solutions in a market driven manner. In addition to the actual charging station, the development included cloud back-end systems providing summaries of the charging events and remote control possibilities. Also specialist services including charging system feasibility surveys and customer training were developed and piloted. The EVE programme provided a platform for speeding up the product development. More than 200 business customers are using the PlugIT charging solutions. The PlugIT charging solution have proven track record with 99,6% success rate for transactions in its charging network of more than 500 remotely managed, intelligent charging stations. Now the company is ready to enter global markets

Figure 7.5. Business growth and Tekes contribution in the case of PlugIT.



¹⁵³ This case is based on the following sources: Saarela (2017), PlugIT Finland (2017)

with the developed products. There was a lack of similar companies in the EVE programme so significant potential for EV ecosystem development did not exist. Plugit has not utilised Team Finland services to a great extent due to its own already existing, large global network of direct contacts to relevant international stakeholders. Tekes and other Team Finland contribution to this company case can be seen in Figure 7.5.

Success factors:

- Strong cooperation with the car manufactures and customers as well as market -driven development since the beginning. All of the company solution are developed for a specific need together with the customer.
- The EVE programme enabled development of an internationally scalable charging system solution in non-existent domestic EV market.
- In-house international contacts are seen as the greatest asset for international growth. All Plugit board members has extensive global network of key players as well 15-20 years international business experience.

Lessons learned:

- Policy decisions and regulation have not supported the development of electric vehicles and related businesses in Finland. The domestic EV market has developed weaker than projections anticipated in the beginning of the EVE programme.
- Presence of potential business partners in the seminars and conference trips organised by Tekes would have made them commercially more interesting. The focus should be on creating value adding ecosystems and building platforms with open interfaces. Without a true opportunity to contribute and grow within those context, it is better to be off and do it by yourself.
- All actors in the Ministry for Foreign Affairs and Team Finland should focus more on opening concrete leads for Finnish companies abroad by proactive marketing. Current way of working is too technology oriented and the delegation trips too general. Good benchmarks include Sweden, Germany and USA. A great exception on providing support and networking has been the Embassy of Finland in Singapore and their trade counsellor.

7.6.3 Visedo

Part of Electric Vehicle Systems programme

Visedo manufactures electric drivetrains for marine vessels, commercial vehicles and heavy-duty applications. The turnover of the company was around 6,7 million euros in 2016, and exports to Europe and Asia represent 90 percent of its sales. The company has ambitious growth targets (turnover target for 2020 is 50 million euros) and it is proactively developing commercial opportunities across Asia's rapidly developing electric vehicle markets. As an example, in 2017, Visedo signed a supply and purchase agreement with Asia's largest electric motor producer TECO Electric & Machinery Company.¹⁵⁴

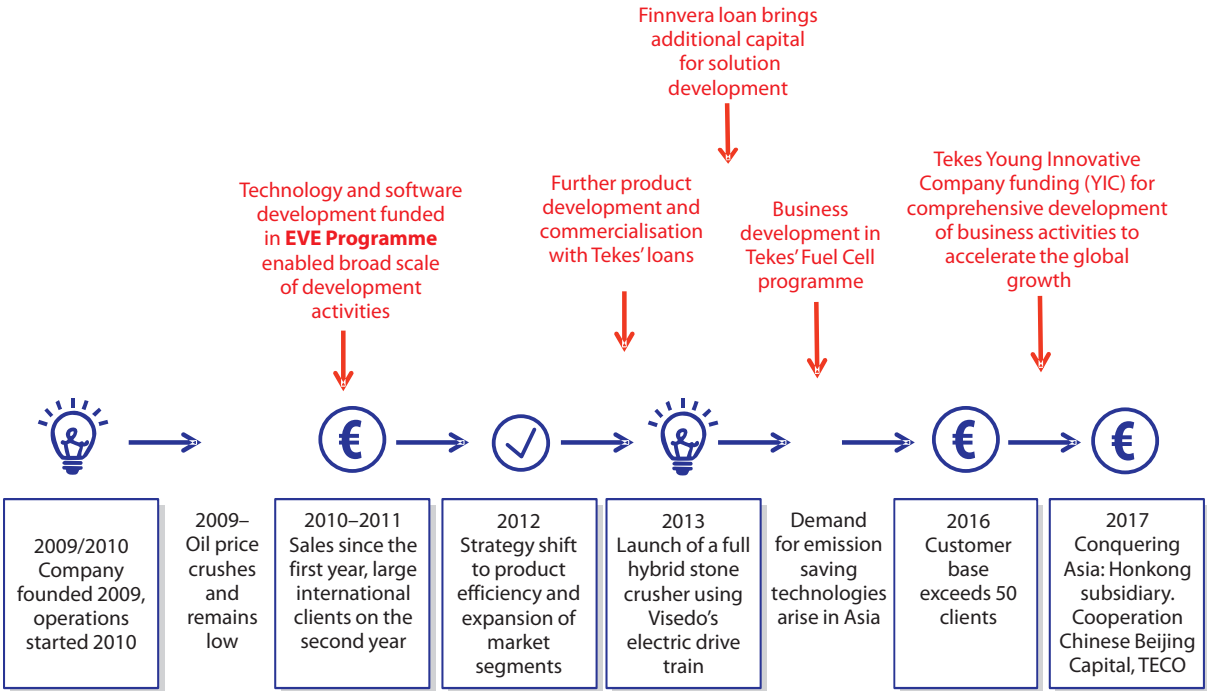
The core technology of the company's products was developed during the EVE programme. Visedo's representative also participated in the steering group of the programme. Through Visedo's history, Tekes has proactively suggested ongoing Tekes programmes and funding that match the company needs. In addition, Tekes has supported Visedo's product development and commercialisation with loans and other smaller programmes and funding such as Young Innovative Company funding (YIC). Since Visedo has so far mostly concentrated on technology development, it has not seen Team Finland services as crucial as cooperation with Tekes. Tekes and other Team Finland contribution to this company case can be seen in Figure 7.6.

Success factors:

- Courage to follow company's own vision and hard work have been essential for the company's success.
- International markets were targeted since the beginning. Domestic references have been vital for international expansion.
- The company's understanding about political, societal and market requirements increased during the programme.
- Tekes EVE programme enabled concrete technology solution development and testing in real life environment with other programme participants. Tekes funding has enabled the scale and magnitude of the core technology development. Visedo succeeded developing a software and system technology that matches the market demand. It also helped Visedo to network with relevant research partners and some business prospects.
- Without Tekes cleantech programme, Finland would have fallen behind from international rivals. The programme theme was innovative and encouraged companies for cleantech development. Domestic EV ecosystem development has been slow but is now emerging.

¹⁵⁴ This case is based on the following sources: Järveläinen (2017), Talouselämä (2017), Visedo Oy (2017)

Figure 7.6. Business growth and Tekes contribution in the case of Visedo.



Lessons learned:

- The company encountered several unexpected obstacles related to basic mechanics during the development process that led to increased knowledge base.
- To boost ecosystem development, the share of companies in the programmes could have been higher. Grasping business opportunities with other programme participants is dependent on the growth ambitions and courage of each company. Start-ups tend to be more agile than traditional industrial corporations. In the future, the programmes could encourage the more traditional industrial corporations to concrete actions.
- Ecosystem programmes have brought the few existing actors together in efficient way, and the Tekes funding has activated in concrete actions. In order to further develop, EV market requires political and societal support in addition to Tekes support.
- Events organised in Tekes programmes have been useful for networking and eased cooperation initiatives, however they could be more business oriented.
- Finpro support seems to be directed for more mature companies and the provided financial support is rather small compared to the cost structure of an industrial company. Information is not as easily available as from Tekes which proactively suggests new possibilities.
- Tekes and Team Finland could support Finnish companies in acquiring coverage/visibility in global markets. Also, providing country specific market data and international client contacts as well as organising events is seen as valuable.

Ex-post evaluation of the Densy and Climbus programmes

8

Impacts of Distributed Energy Systems (Densy) programme¹⁵⁵

8.1 Overview of the programme

The Densy programme was launched to create new knowledge and understanding in the area of distributed energy technologies¹⁵⁶ and to enable new business and export possibilities for Finnish enterprises¹⁵⁷. A motivation for this programme was the general belief that the global market for distributed generation was expanding (in early 2000). The market for distributed generation was thought to be increasing, and energy prices continue to rise. However, the development of this market has been different. Electricity prices are now low and are forecasted to remain low for the near term.

The overall energy market is becoming diversified and

the rapid growth of wind and solar power has led to increasing volatility. This growing volatility is a strong supporting argument for electric systems and ICT focus programme areas. On the other hand, the speed of technology development in distributed cogeneration and fuel cells focus areas have not been as expected.

It should be noted that Densy programme was followed by other similar Tekes programmes like Biorefine, Fuel Cell and Groove that many of the same companies participated in. Isolating the impact of the Densy programme from others is therefore not obvious. Tremendous growth of the heat pump sector was also not in evidence over the course of the programme. The summary of the Densy programme is presented in Table 8.1.

Table 8.1. Summary of the Densy programme 2003–2007.

Objectives	<ul style="list-style-type: none"> • To create new knowledge and understanding in the area of distributed energy technologies, and to enable new business and export possibilities for Finnish enterprises • The main objectives of the programme have been to assist this niche Finnish industry, especially SMEs in developing products and services for global markets, to increase global awareness of Finnish technology, to build a world-class innovative environment, and to produce commercial products for several niche markets by 2010
Focus areas ¹⁵⁸	<ul style="list-style-type: none"> • Electric systems • Heating, cooling and cogeneration • ICT • Business models • Manufacturing • Fuel cell and hydrogen systems
Total volume	57,5 M€, of which Tekes share 32,7 M€
Duration	2003-2007

¹⁵⁵ Distributed energy systems were defined as local small sized systems for energy conversion, production and storage as well as related services. This was an inclusive definition covering any energy production unit located in the distribution network as well as production of power, heat or cold and especially renewable energy sources. Independent or grid-connected as well as mobile solutions were accepted.

¹⁵⁶ Timonen, Kangasharju & von Hertzen (2008)

¹⁵⁷ Tekes (2007)

¹⁵⁸ The focus areas here are those themes that dominated the actual project portfolio.

8.2 Impacts on the programme focus areas

The long-term impacts of the Densy programme were analysed according to the focus areas of the programme including 1) electric systems, 2) heating, cooling and cogeneration systems, 3) ICT, 4) business models, 5) manufacturing, as well as 6) fuel cell and hydrogen systems.

8.2.1 Electric systems

At the core of the programme was the development of products and solutions for the integration of distributed energy generation to various energy systems such as integration to the electrical grid, to the district heating networks and to the end users on-site systems. RDI on electric systems covered both the systemic influence of distributed generation on the electricity network and the devices and systems used in the distributed generation.

This was a research-intensive part of the programme but had also a good amount of industrial activities. Most of the industrial participants were large companies like Fortum and ABB with well established businesses. However, also today very successful SMEs like MScElectronic Oy and Verteco Oy (today The Switch Oy owned by Japanese company) were part of the programme. It is interesting to note that also energy storage, which is of high interest today, was studied in the programme and was specifically encouraged by the steering group of programme.

This part of the programme seems to have supported further business development of the participating companies and related business in general. Electric systems is a very know-how intensive development area, and less capital intensive than many other areas in the programme, and thus fits well to Finnish cleantech targets.

8.2.2 Heating, cooling and cogeneration systems

Heating, cooling and cogeneration systems development in the programme focused on finding smaller cost-efficient solutions on the area where most technology has been developed for a larger scale. Further integration to, for example, waste management was considered and there was an interest to develop biopower solutions.

Mainly due to the market development only modest outcome on small scale heating, cooling and cogeneration systems can be seen. Several of the companies that participated in the programme don't do business on the area any more. Examples include Savonia Power Oy (does not exist anymore), Condens Ltd (has moved to other business areas away from gasification), Greenenvironment (bankrupt) and Wärtsilä Biopower (does not exist anymore, but technology is utilised by Valmet). It seems to be difficult even today to make market driven business out of solid biomass cogeneration because of low electricity price and high price of small scale cogeneration technology.

8.2.3 ICT

At the time of the programme, information and communication technology was increasingly seen to be used in the energy sector as instrumental in enabling cost-effective distributed energy generation. The combination of new hardware, communication, and software technologies was seen to create opportunities to achieve two-way interaction with all kinds of power network nodes, customers and customer equipment and to more autonomous, flexible self-managing system of networks. The list of new products developed included remote control and operation as well as optimisation and energy management of dispersed CHP-units.

Today, digitalisation is providing, in increasing scale, new opportunities to access the potential of energy efficiency, enabling impacts to be more accurately measured at a more granular level, and opening up new business models to take advantage of the multiple benefits that efficiency can provide. Need for related solutions is growing in the volatile electricity production and consumption systems. A remarkable share of this development is done at the customer and consumer surface.

At the time of the programme the scope and tools of ICT were far more limited. However, some of the programme participants have successfully managed to transform their business to take advantage of the digitalisation of energy systems. A good example is Netcontrol Oy, established in 1991, and providing energy network automation. The company has been growing since the 2010's and today has a turnover of about 10 million euros and employs 55 people.

8.2.4 Business models

The programme attempted to focus on the development of business models to promote distributed energy systems. Most of the business model development projects in the programme had a strong link to related technology development, and in the hindsight, might be seen more as technology development as business model development projects. However, in the face when the market for distributed generation systems was in its infancy, it is understandable that, for example, the value networks and revenue streams that enable the market access are of interest.

Since the programme's conclusion, wind and solar power have been growing rapidly and have overtaken solid biomass and other solutions. Today, new business models are far more creative in taking advantage of the opportunities of the digitalisation as well as, for example, sharing assets in new ways. Also, business models which overlap not only energy, but also other areas such as water and waste management are of interest.

8.2.5 Manufacturing technology

The outcome of this part of the programme was a limited number of research projects run by VTT on material and manufacturing technologies in small and medium sized boilers and advancing the competitiveness of distributed energy systems, and thus its impact can't be expected to be remarkable. The market development did not support the vision of a large number of small power plants which was the reasoning behind this focus areas.

8.2.6 Fuel cell and hydrogen systems

Fuel cell research was quite modest in Finland until the beginning of the 21st century when Wärtsilä Corporation started its development. This gave a strong boost the fuel cell activity in Finland. Fuel cell and hydrogen systems were included in the Densy programme from 2004 until eventually in 2007 a new Fuel cell technology programme was launched.

The development of fuel cell and hydrogen systems started from Wärtsilä's interest supported by VTT's high level competence. During the Fuel cell technology programme it became clear that market did not match with expectations and resources needed. This led Wärtsilä to spin the business off. This reflects well the development on the global market as well, where fuel cell and hydrogen systems haven't provided the business they once promised.

8.3 Impacts according to Tekes' impact model

8.3.1 Increases RDI activity

Since the programme's conclusion, energy related RDI has been increasing both in Finland and globally. In the EU, a major contribution to research and innovation is "Horizon 2020", with a budget of 70 billion euros for year 2014-2020. Energy research is about 10% of the total funding. Remarkable EU support is also available for demonstration projects. In Finland, public R&D funding on energy has been growing in relative and absolute terms indicating its role in the societal development and policy making. In general, on the field of energy Finnish RDI is well linked on the international level and increasingly participating in international projects especially within EU.

8.3.2 Strengthens ecosystems

The programme covered a wide scope of systems and services for small scale production, system integration and storage of energy. By the conclusion of the programme, it was reported to have improved collaboration and networking of distributed energy system research, both between research institutes and businesses. Today, it can be seen

that it might have contributed to building up ecosystems on specific technology areas of distributed energy.

By focusing also on demonstration, the programme launched a so-called multipower platform to be used as a testing, validation, optimisation and integration site for the components and generation units of distributed energy systems as well as a computer-based simulation environment. However, there is no evidence that this platform has contributed measurably to the strengthening of related ecosystems.

The realm of the market development has been negative on several of the programme's focus areas. Thus, the possible ecosystems initiated during the programme haven't been pushed further by strategic partnerships and other concrete business relations.

8.3.3 Drives growth

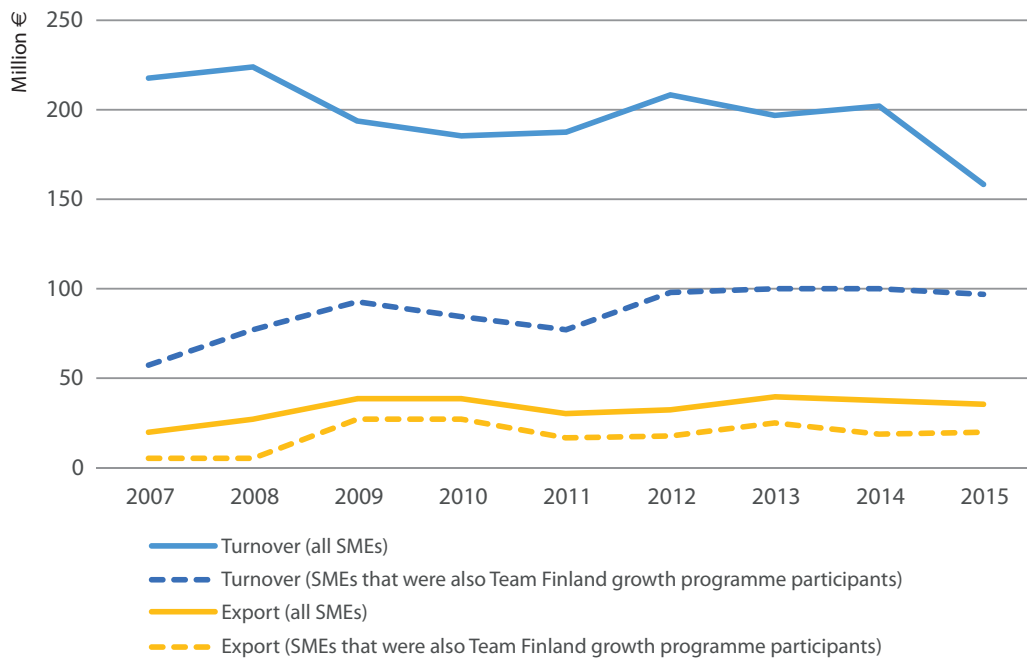
A primary programme goal was to generate new business and export possibilities for Finnish companies. However, only a few companies have been able to generate global business and significantly improve their position according to the expectations. The main reason being that the global market development haven't supported the commercialisation of distributed energy systems developed in the programme.

It is interesting to note that there has been very good business development for companies that did not join this programme. Examples are Volter Oy established 1997 and having solid 10 million euros turnover in 2016. Another good example is Nocart Oy, established 2010 and having over 10 million euros turnover in energy power units and management. On the other hand there are companies who did also not join this programme and are in a very tough situation like SavoSolar Oy.

The growth in the revenue of the SMEs that participated in the Densy programme can be seen in Figure 8.1. The revenue of the companies seems to have developed well until 2009. After that several of the companies have reduced or finished their activities on the field (which is totally opposite for example to the companies in EVE and Green Growth). This might be linked to the technology choices and market developments.

The growth of the SMEs that participated the programme can be seen in Figure 8.1. It shows a decreasing turnover of the participating SMEs. However, the turnover of those companies that also participated in the Team Finland growth programmes seems more positive, and in general the export of the SMEs has increased to some extent. However, as described above the fact is that many technologies developed during the programme couldn't be launched to market, and there has also been business disclosures.

Figure 8.1. Revenue of the SMEs that participated in the Densy programme.¹⁵⁹



8.3.4 Results in innovations and competence

Although programme new business volume objectives were not met, the programme can be seen to have contributed to the development of electric systems and some specific energy segments such as wind technology business and hosted some promising new innovations in other segments of distributed energy systems. However, as discussed above the commercialisation of many of the innovations has been hard due to the general market development and programme's focus to some non-winning distributed technologies (cogeneration and fuel cells) instead of winning technologies, such as solar power, heat pumps, energy storage as well as home automation and demand side management solutions, which had a smaller role in the programme.

In Finland, the domestic market has not stepped up to support the demonstration of solutions developed in the programme which would have been crucial especially for SMEs. This need for system demonstrations is especially important for system providers. Consequently, Finnish companies have tended to seek roles as component or add-on service providers.

8.3.5 Drives systemic renewal and brings societal benefits

The role of distributed energy has grown in the energy market during the past few years. Since the programme, the role of consumers has become more active in the market. Residential installations (e.g. solar panels) are also electricity producers selling excess electricity into the power grid. In the heating market, various kinds of heat pumps have become very popular. In addition, consumers are participating in demand side management and are shifting electricity consumption from high price hours to lower price hours. During the programme, the role of consumers was underestimated and the focus of the programme was more on production, how to connect distributed electricity into the grid, and how to manage the overall energy system.

¹⁵⁹ Source: Tekes and Finpro's databases

8.4 Summary and conclusions

As a motivation for this programme was a general belief at that time (early 2000) of increasing global market for distributed generation. Today, the overall cleantech market is becoming diversified. Wind and solar power are growing leading to increasing volatility on production side and consequently on the consumption side.

From today's perspective, overall programme results are modest. However, in the electric system and ICT focus areas, the programme successfully developed know-how that could be utilised in creating smart grids suitable for distributed energy systems. On the other hand, some programme focus technologies, such as small scale cogeneration and fuel cell solutions, did not achieve market maturity and are still too expensive for wider use.

It is interesting to note that there has been very good development in companies that did not participate in this programme. Examples are Volter Oy established 1997 and having solid 10 million euros turnover in 2016. Other good example is Nocart Oy established 2010 and having now over 10 million euros turnover. On the other hand there are companies who did not join this programme which are in a very tough situation like SavoSolar Oy.

Programme results vary among focus areas reflecting market and regulatory development. The Electric Systems sector was a very R&D intensive part of the programme but it exhibited good industrial collaboration in the subprojects. Most of the participating companies were large (e.g. Fortum, ABB) with well established businesses. But there were also some successful SME's (e.g. MScElectronic Oy, Verteco Oy).

The heating, cooling and cogeneration systems focus area generated only very modest outcomes, mainly due to the slow market development. ICT and automation are growing needs in the volatile electricity production and distribution systems. However, the ICT part of the programme was not too comprehensive. Regarding business models, wind power has been growing and overtaking other solutions, consumption driven focus has increased, and digitalisation has provided new tools and opportunities which were not seen during the programme. Fuel cell and hydrogen systems continued later with separate Fuel Cell programme, started from Wärtsilä's interest supported by VTT's high level competence. However, during the development time it became clear that market did not match with expectations and resources needed.

Summary of the Distributed Energy Systems (Densy) programme

- The programme was motivated by the increasing global distributed energy market, and indeed the market is becoming more diversified
- Systemic issues like volatility on production side and consequently on the consumption side are gaining more importance, but were not as strongly emphasised at the time of the programme which focused on technologies
- A wide scope of systems and services for small scale production, system integration and storage of energy were covered, however the results and impacts vary significantly among the focus areas reflecting differences in market and regulatory development
- Electric system and ICT related projects have evidently created knowledge to be utilised in creating smart grids for future distributed energy
- Some focus areas, such as small scale cogeneration and fuel cell solutions did not achieve market maturity and are still too expensive for wider use
- Finland has strong business ecosystems on energy, many significant factors have contributed to this during the years, Densy being part of these factors
- Regarding business models, wind power has been growing and overtaking other solutions, consumption driven focus has increased, and digitalisation has provided new tools and opportunities which were not seen during the programme
- It is interesting to note that there has been very good business development for companies that did not join this programme

8.5 Company case studies

8.5.1 AW Energy

Part of Densy and Groove programmes

Part of Finpro's Cleantech Finland growth programme

AW-Energy provides technology for generating electricity from ocean waves in the nearshore area with panels installed in the seabed. The solution has been developed since 2002. It has passed the proof of concept stage through marine testing and piloting in Portugal and Scotland and is now in a commercialisation stage where growth is sought from larger scale installations. The goal is to install solutions for a value of 100 million euros by 2020. The company has a research budget of 10 million euros and the turnover so far is around 500 000 euros. AW Energy employs 20 people.¹⁶⁰

Tekes has supported the development of the solution and the business in the different phases through the years 2003-2016. In the Densy programme the company developed pilot and testing facilities and research and measurement solutions for the wave roller. In the Groove programme it developed the wave roller technology further and established the Portuguese pilot site. In 2010-2012 installation of the wave energy power unit at sea in a safe and efficient way was developed, and supported by loan financing from the Groove programme. Team Finland and Finpro have supported the commercialisation of the solution by helping with contacts and arrangements locally in, among others, Chile and Mexico. In 2003 and 2007 angel investors invested in the company and in 2007 Fortum joined as a minority owner. Current investors include Aura Capital, Fortum, John Nurminen Oy and Sitra. Tekes and other Team Finland contributions to this company case can be seen in Figure 8.2.

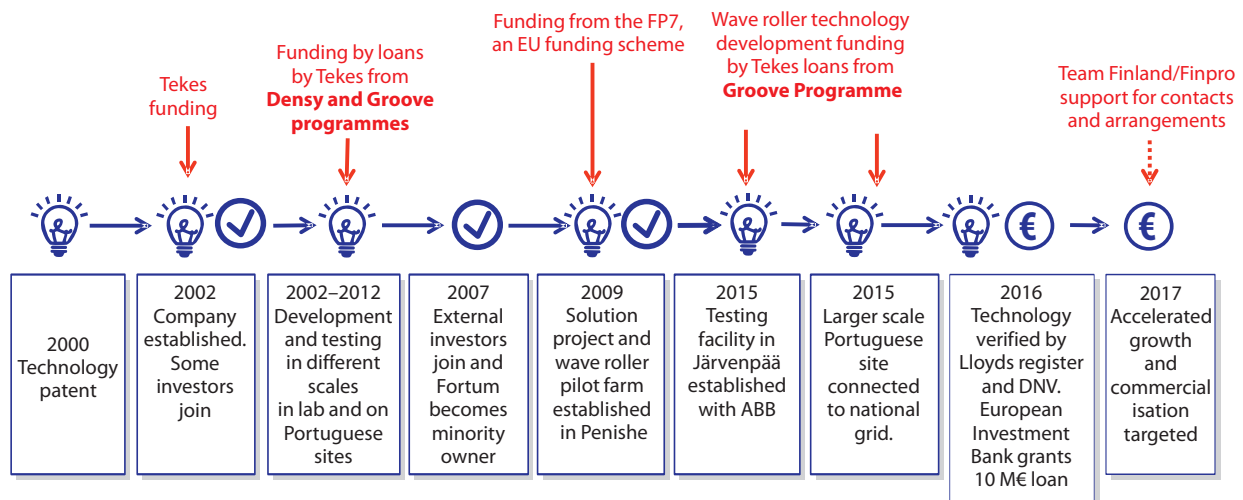
Key success factors:

- A viable technological innovation and good technological knowhow as well as the emergence of renewable technologies as a viable solution for fossil fuels and the surge of investments into renewable energy technologies.
- Pilot installations in coastal Portugal and Scotland have given credibility and references for the technological solution and built trust in the concept. They have also produced valuable information for wave technology research.
- Good networking capabilities have enabled developing pilot projects in different countries and setting up capabilities for commercial operations.
- In addition to reaching a commercially viable solution it is necessary to work on reaching potential customers and choosing potential sites and getting to know local operators.

Lessons learned:

- Tenacity and patience in developing a new innovative technology.
- Time is needed to verify the test and research results. Independent external validation of test results is a key element in building trust in new innovative technologies that need considerable investments.
- Not only money is needed, but also building the knowledge and experience needed to reach the commercialisation stage.
- Pilot projects and references are essential.
- Good cooperation with Tekes has been essential and has enabled long term work towards the goals. Risk loans in the right phases of the concept development have enabled continuing development work and commercialisation. Other investors have been necessary in order to receive Tekes support.

Figure 8.2. Business growth and Tekes contribution in the case of AW Energy.



¹⁶⁰ This case is based on the following sources: AW-Energy company website, Forssell & Burston-Marsteller (2014), Fortum (2007), Tidal Energy Today (2015), Järvinen (2017)

8.5.2 Wärtsilä

Densy and Climbus programmes

Part of Finpro's Cleantech Finland growth programme

Wärtsilä provides technologies and lifecycle solutions for the marine and energy markets aiming to maximise the environmental and economic performance of the vessels and power plants of its customers. In 2016, Wärtsilä's net sales totalled 4.8 billion euros. The company has operations in more than 70 countries around the world. Between years 2002 and 2013 Wärtsilä put effort on research, development and commercialisation of fuel cells related solutions and Wärtsilä also participated in Tekes' Densy programme in 2003-2007.¹⁶¹

The decision to begin development of fuel cells was made in early 2000, when several studies and market drivers triggered the growth in cleaner energy production. In the Densy programme Wärtsilä focused specifically on fuel cell solutions related to marine industry and electricity and heat production. The goal was to commercialise the product. The development of technology continued in Fuel Cells programme of Tekes (2007-2013). Due to a change of strategy in 2013, Wärtsilä decided to spinoff the fuel cells business. Based on acquired know-how, Wärtsilä personnel founded Convion Oy to continue fuel cells development. Tekes and other Team Finland contributions to this company case can be seen in Figure 8.3.

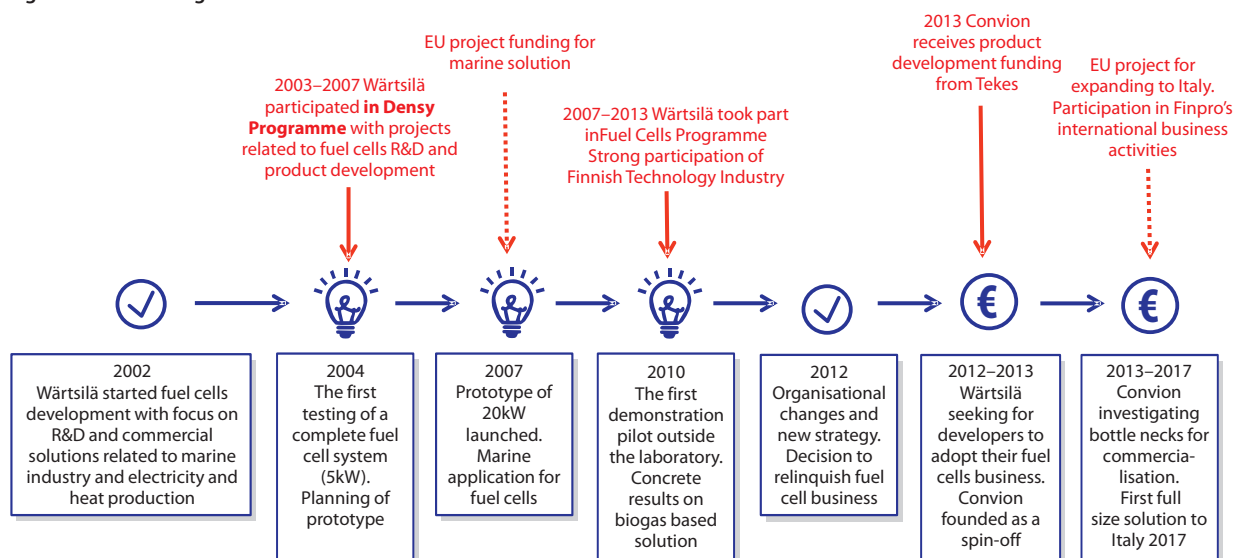
Success factors:

- Company and stakeholder commitment to developing process realised in good planning and resulted in rather quick concrete tests and piloting results.
- Close cooperation with Finnish research organisations and other companies operating in the same field formed a solid basis for further development of fuel cells nationally.
- Possibility to research, test and demonstrate a wide range of solutions has been directing the development process in the right way.

Lessons learned:

- Prototypes and demonstrations from the home market are important in order to reach for international growth. Added value of Tekes/Team Finland actors is to act as enablers of new business and networkers for and companies.
- Possibilities of continuity of public funding from research and development to commercialisation is often slight, but it would help companies to get their products and know-how to the market and thus taken into account in the future.
- In multi-stakeholder programmes and projects the roles and tasks of public actors (including Tekes and Team Finland) need to be well defined and consistent in order to help the companies and networks to achieve their goals more efficiently and have a wider acceptance on the matter.
- Without companies, there would not be programmes. It is important that the company is motivated, committed and courageous to further their agenda.

Figure 8.3. Business growth and Tekes contribution in the case of Wärtsilä.



¹⁶¹ This case is based on the following sources: Wärtsilä company webpage, Wärtsilä Finland Oy (2013), Kallio (2017), Convion company webpage, Fontell (2017)

Results of the Climbus programme

9.1 Overview of the programme

The Climbus programme was run by Tekes in 2004-2009 as an early climate business development programme¹⁶². At the beginning of the programme, the EU emissions trading scheme had been launched, and there was a clear need to create awareness of new climate-related business opportunities among Finnish companies.

The objective of the Climbus programme was to find and promote technological options to mitigate climate change. The short-term target was that the companies and research parties invest in technology and service development for climate change mitigation so that the turnover of the sector would increase by 60 % by year 2010 compared to the situation in the beginning of the programme. The long-term objective was to create new competences and globally strong research networks which would support established position of the Finnish companies in the global climate markets after year 2010.¹⁶³

The Climbus programme provided support to a total of 141 projects. Of these, 56 projects were carried out by research organisations and 85 by companies. The total vol-

ume of programme funding was 91 million euros, of which the share of Tekes was 45 million euros.

The summary of the Climbus programme is presented in Table 9.1.

9.2 Impacts on the programme focus areas

The long-term impacts of the Climbus programme are analysed according to the focus areas of the programme including: 1) energy efficiency of heavy duty transport systems, 2) measurement services, 3) scenario projects, 4) carbon capture and storage, 5) liquid biofuels as well as 6) recycled fuels and co-firing concepts¹⁶⁵.

9.2.1 Energy efficiency of heavy duty transport systems

The programme enabled the demonstration of some new heavy duty vehicle technologies in Finnish circumstances¹⁶⁶. It included a limited number of development projects of companies and public sector as well as a demonstration project of the city of Helsinki on gas engine heavy duty vehicles. In the longer perspective, the programme can be

Table 9.1 Summary of the Climbus programme 2004–2009.

Objectives	<ul style="list-style-type: none"> To develop technology and business concepts, products and services that are internationally top-class in cost-effectiveness to reduce greenhouse gas emissions To increase the turnover of the sector by 60 % from 4,7 billion euro (2004) to 7 billion euro by year 2010 To create new competence and globally strong research networks which support established position of the Finnish companies in the global climate markets after year 2010
Focus areas ¹⁶⁴	<ul style="list-style-type: none"> Energy efficiency of heavy duty transport systems Measurement services Scenario projects Carbon capture and storage Liquid biofuels Recycled fuels and co-firing concepts
Total volume	90,7 M€, of which 44,6 M€ from Tekes
Duration	2004-2009

¹⁶² Climbus programme was preceded by the Climech programme in 1999-2002.

¹⁶³ Source: Vanhanen et al. (2009)

¹⁶⁴ The focus areas here are those themes that dominated the actual project portfolio.

¹⁶⁵ These were the so-called microclusters analysed in the final evaluation of the programme. Source: Vanhanen et al. (2009)

¹⁶⁶ Vanhanen et al. (2009)

assessed to have helped to lay the cornerstones for energy efficiency and multi-fuel research and to help brake the paradigm of traffic based on fossil fuels. In general, during the programme a strong emphasis on both energy efficiency and the development of domestic biofuels in future activities was hoped for and this was realised later in the Tekes' BioRefine programme.

Even if most of the current energy efficiency of heavy traffic has been based on the efforts of large engine and truck manufacturers outside Finland, the programme can be seen to have laid the cornerstones of current fuel strategies in Finland (some of which are required by EU legislation) including 1) blending of biofuels (e.g. ethanol) to gasoline, 2) establishment of distribution network for natural gas for fuel (now increasingly converted to distribution of biogas as fuel by Gasum Oy) and 3) increasing use of biodiesel as a fuel (now available even in 100% biodiesel).

The buses in the Greater Helsinki area as well as vehicles and work machines in the City of Helsinki are currently changing to biofuels. During the 2010s, Gasum Oy has developed a well-functioning sourcing and distribution system around biogas business and expanded it through acquisitions to Nordic level. Current requirements on shipping in the Sulfur Emission Control Area ("SECA")¹⁶⁷ and the limits on nitrogen emissions are driving vessels to use more LNG as fuel. The first gas-fired vessels have been taken into use in ferry traffic, and the use of renewable liquefied biogas as vessel fuel is considered as next step. All of this shows the relevance of this development area, although many of the developments can't be linked to the Climbus programme.

9.2.2 Measurement services

New legislation on real time metering of electricity consumption of all households was a key driving force in metering service development in Finland at the time of the programme¹⁶⁸. This was expected to bring significant new business and demand for new technologies. Since the time of the programme, smart grids have been an increasing focus in the energy policy and digitalisation has brought a variety of new technologies to be used on that field. Smart electricity meters became mandatory after the programme and were installed by 2013, bringing along new electricity products, e.g. hourly based electricity price, to retail customers in Finland.

In hindsight, it can be concluded that smart meters and associated measurement services formed a basis for current trends of electric load leveling, smart grids and integrated

energy systems. (e.g. the Finnish subsidiary of Landis & Gyr, former Enermet Oy). Smart meters, used in conjunction with other digital solutions, will enable future digital electricity systems (e.g. distributed generation, smart appliances and eventually connecting electric vehicles smartly in the electricity system).

The programme provided an early impetus to the development of smart meters in Finland, and enabled it to fulfill the requirement of installing almost 100% of smart meters by 2013. After the modification of meters, small service companies have emerged to utilise the data provided by smart meters.

For example, the globally operating Landis & Gyr has kept significant product development and manufacturing in Finland after acquiring Enermet Oy in 2006. Also Aidon, which developed real-time electricity measuring in the programme, has been strong in this business, also internationally (see case description 9.5.1). There are also a significant number of Finnish start-ups established to analyse and utilise electricity measurement data. Generally, it can be said that the development of services for the utilisation of measurement data has been relatively slow until now, but improvement is expected within the next few years with the advance of digital technologies.

9.2.3 Scenario projects

The climate scenario work conducted within the programme was seen to have contributed to the identification of opportunities for Finnish climate technologies, but also highlighted the need for strategic choices, systematic investments and decisive policy measures to make Finnish technology providers competitive and successful in the rapidly growing but highly competitive international markets. The scenarios produced supporting material for Finnish policy making and in some cases directly contributed to the preparation of the national climate and energy strategy. During the programme especially energy efficiency and user side solutions were highlighted more than before.¹⁶⁹

Today the future energy scenarios for Finland serve as a most essential tool in policy making, and in drafting Finnish responses to EU initiatives and international climate treaties. The development of scenario tools initiated during the programme has been continued in Technical research Centre of Finland (VTT) and the Ministry of Employment and Economy (TEM). However, as the models are in the possession of VTT and TEM, and according to the Supreme Administrative Court (KHO) decision they are not public, their use and development is limited.

¹⁶⁷ International Maritime Organisation webpage

¹⁶⁸ Source: Vanhanen et al. (2009)

¹⁶⁹ Source: Vanhanen et al. (2009)

9.2.4 Carbon capture and storage

The programme formed a central source of funding for carbon capture and storage (CCS) projects in Finland. It was seen to have contributed to strengthening the cooperation of Finnish CCS stakeholders. While the projects focused primarily on R&D, feasibility studies and preliminary piloting, no direct turnover and employment benefits were identified or even expected at this stage. The SHOK (Strategic Centres for Science, Technology and Innovation) activities were expected to support the continuation of the Finnish CCS work.¹⁷⁰

The current low prices of EU emission allowances have weakened the prospects of CCS in Europe, and CCS is not among the most economical methods by marginal costs to reduce CO₂ emissions. This is to be compared with the international development of CCS which has been slower than many have expected. For example, no EU funded project under so called NER300 programme did materialise in the CCS field.

Today the technical and regulatory efforts to found CCS projects is centered in oil and natural gas producing countries where CO₂ gas can be used to drive hydrocarbons from existing oil and gas fields. As transport costs are decisive for the costs of CCS, current activities are based in countries where CO₂ can be transported through old oil and gas pipes to the field. Finland lacks suitable geological formations for CO₂ storage and applying CCS here would require liquefaction and shipping of CO₂ to the nearest suitable storage locations, probably to the North Sea. Accordingly, no significant resources are dedicated to further CCS research in Finland for the time being.

9.2.5 Liquid biofuels

According to the final evaluation, the role of the programme was mainly considered as a financing instrument which accelerated the start and implementation of certain projects and subprojects on liquid biofuels. Tekes' BioRefine programme continued this development, and also SHOKs (Strategic Centre for Science, Technology and Innovation) on energy and environment, CLEEN Ltd, and forest cluster, Forestcluster Ltd acted as a platform for future development.¹⁷¹

During the programme, the motive to study liquid biofuels was strengthened by the first EU biofuel directive from 2003, and later updates of the directive. In 2008, the EU required that that traffic fuels are mixed with 10% bio-component by the year 2020. As part of its so-called "winter package" from November 2016, EU proposed a new renewable energy directive¹⁷². Expected to become imple-

mented in respective national legislations by January 2021, this directive proposal seeks to address the uncertainties related to liquid biofuels, e.g. issues related to the sustainability of biofuels. Thus, the landscape and market drivers on biofuels are changing.

The current knowledge base in biofuels in Finland is largely based on the research carried out under Climbus and following Tekes' programmes, especially by Neste and St1. A long tradition in the manufacture of wood-based pulp and paper has provided an excellent knowledge base and network of companies in the area of biomass production and utilisation of biomass as liquid biofuels. More recently the application of this knowledge in the manufacturing of liquid biofuels from waste materials, as e.g. both Neste and St1 do, has become more attractive. Since the programme, the complexities around liquid biofuels have increased manifold, and e.g. alternative solutions to mobility (electric cars, advanced trains etc.) have gained ground.

From the perspective of business strategies, the programme seems to have had an excellent timing in encouraging the first efforts to change the nature of a profitable existing business to a more environmentally friendly approach, such as enabling Neste to acquire a global first mover advantage in the biodiesel production.

9.2.6 Recycled fuels and co-firing concepts

The projects under this area concentrated on developing and testing technical concepts for co-firing power plants, especially those using solid recovered fuel (SRF), to reduce the share of fossil fuels and to take advantage of waste fuels. The main emphasis was in the R&D projects co-ordinated by boiler manufacturers in Finland, most of them manufacturers of fluidised bed boilers, complemented with demonstration, pilot and modelling projects by universities and research institutes. Some projects also studied the boiler materials required by co-firing.¹⁷³

The research consortia in this area were very inclusive, and most of relevant Finnish manufacturers and research institutes had an opportunity to network within the framework set by the programme. However, the projects funded were initial development projects, and the long-term and large-scale testing of the concepts and materials were outside the programme.

Nowadays, multi-fuel capability is highly valued by investors in new boilers, despite the obviously higher price in comparison to single fuel boilers. Even boilers allowing the use of 100% of two or three different fuels are not uncommon, and co-firing capability is appreciated for the

¹⁷⁰ Source: Vanhanen et al. (2009)

¹⁷¹ Source: Vanhanen et al. (2009)

¹⁷² COM (2016) 767 final of 30.11.2016

¹⁷³ Source: Vanhanen et al. (2009)

flexibility to take advantage of short-lived fuel price and availability variations.

Today, multi-fuel capability and ability to combust waste fuels can be considered to have thoroughly penetrated the Finnish energy industry and boiler manufacturing companies. Especially Foster Wheeler (now part of Sumitomo Group) and Metso (now demerged to Valmet) benefitted from the programme, and it helped the companies to secure their positions in the circulating fluidised bed (CFB) boiler markets. In addition to manufacturers of large high-pressure boilers, Finland has now a network of companies manufacturing smaller boilers with multi-fuel capability, e.g. KPA Unicon.

9.3 Impacts according to Tekes' impact model

9.3.1 Increases RDI activity

The focus and timing of the programme can be considered to have been highly relevant to raise companies' interest to invest in climate business development and related RDI activities. Qualitative impacts of the programme on the companies' RDI activities are described above in relation to the programme's focus areas. Due to the wide scope of the participating companies no statistical data can be easily found to follow up the amount of RDI activities in quantitative terms.

During the programme, industry driven research activities in Finland were reorganised into Strategic Centres for Science, Technology and Innovation (SHOK). The programme accentuated the importance of climate issues and these issues were also incorporated in the established SHOKs, including the predecessors of current Clic Ltd and Dimecc Ltd.

After the programme, more focus in innovation activities have been put globally on finding solutions on global challenges including not only climate change but also, for example, clean water and sanitation, affordable and clean energy as well as sustainable communities and cities¹⁷⁴.

9.3.2 Strengthens ecosystems

As a result of the programme, networking of companies and research organisations was seen to have increased and become more cross-disciplinary and a national climate cluster has strengthened¹⁷⁵. The programme seems to have had a relevant role on the focus areas as a catalyst for networking and competence development.

Today, the climate and cleantech business sectors are considered strong in Finland. Cleantech Finland¹⁷⁶ which is

marketing Finnish cleantech internationally has some 1600 participating companies, out of which a large share works with clean energy. Furthermore, several global companies are having their crucial energy and energy efficiency business and development units in Finland, giving evidence of a strong competence base.

Demonstration projects and piloting of novel technology for climate change mitigation in Finnish circumstances was considered as an important part of the programme. In the end of the programme, the companies were satisfied especially in projects with emphasis on concept demonstration. They considered that such projects created specific value added and networking benefits¹⁷⁷.

The programme must be seen in a continuum of developing strong competence base, including both business and research, specifically on clean energy and industrial energy-efficiency in Finland. This development has been supported by Climbus programme and several earlier as well as later Tekes programmes. However, it can be argued that the highly established energy and industrial ecosystems have been too closed and exclusive to encourage dynamic development of new ideas and businesses.

9.3.3 Drives growth

The programme helped the companies realise climate change as a business opportunity. There are many examples of Finnish companies, which also were part of the programme, actively pursuing today the business opportunities developed during the programme. The most successful examples include St1 (decentralised bioethanol production), Foster Wheeler (now Amec Foster Wheeler) etc. (multi-fuel concepts) and Neste (biodiesel technologies).

The key driving force for development of new technology and business on the climate related business has been legislation, like EU Renewables Directive¹⁷⁸ and national legislation on real-time metering of electricity consumption¹⁷⁹. The strongest market impacts were realised in technology areas where EU directives or national legislation, e.g. the EU 20/20/10 by 2020 policy, drove market development in the areas of these regulatory changes (real-time measurement of electricity, biofuels for traffic, and fuels from recycling). At the time when the programme was initiated in 2004, it could not be anticipated how quickly the climate related technology market ultimately would evolve.

Emission trading did not end up being as a strong force in the market, especially in comparison with the policy

¹⁷⁴ Source: United Nations, Sustainable Development Goals webpage

¹⁷⁵ Source: Vanhanen et al. (2009)

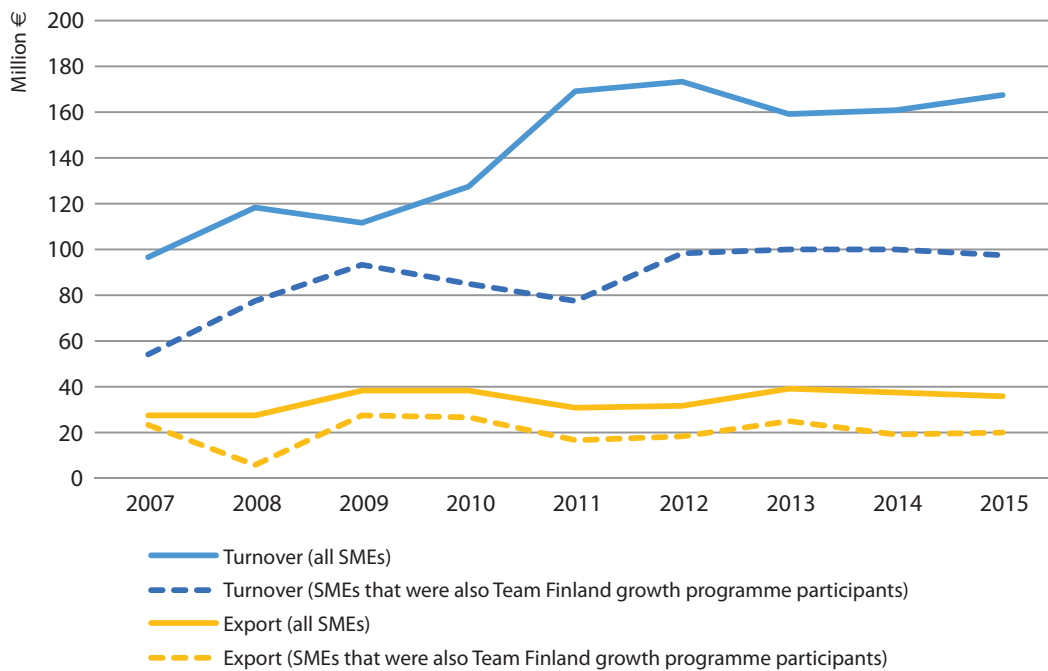
¹⁷⁶ Cleantech Finland website

¹⁷⁷ Proposal by Vanhanen (2006)

¹⁷⁸ EU Directives regulating renewable energies, 2001/77/EC, 2003/30/EC, 2009/28/EC, and latest draft to amend 2016/0382 (COD)

¹⁷⁹ Valtioneuvoston asetus sähköntoimitusten selvityksestä ja mittauksesta (66/2009) 5.2.2009

Figure 9.1. Revenue of SMEs participating in the Climbus programme.¹⁸⁰



measures on promoting renewables or energy efficiency. Thus, radically changing the business landscape for some of the companies, and raising up the question of the resiliency of the chosen business strategies.

Initially, the target of the programme was that the turnover of the climate business would increase by 60 % by year 2010 compared to the situation in the beginning of the programme, i.e. from 4,5 billion euros to 7 billion euros. However, there has not been a systematic follow up of the programme targets (the global economic downturn of 2008 affected the turnover of Finnish technology companies in 2009-2011, and thus the time frame for the target can also be considered to have been problematic).

The growth of participating SMEs is illustrated in Figure 9.1. Turnover and export volumes have been growing. However, the last couple of years have been rather stagnant. From year 2010 to year 2014 the growth in the turnover of the SMEs was 26 %.

9.3.4 Results in innovations and competence

Long-term innovations and competence benefits have been described in chapter 9.2 for the various programme focus areas.

In addition to the focus areas, service business was planned to have a stronger focus in the programme, but the share of service business related projects was low and the programme was, in fact, highly technology-oriented.

The role of service business development, and business development in general, has gained further interest on the markets and public discussion since the programme and the preconditions for service business development have advanced with remote data transmission, IoT and management of large scale data.

Both small and large scale solutions were included and created in the programme. However, when the results of the programme were summed up in the end of the programme large companies have been able to exploit the growing climate market faster than small and medium-sized enterprises¹⁸¹. In many projects, the existing competitive and well established businesses of larger companies were scrutinised for the first time in the light of emissions and future climate change. With the uncertainty about the aspects of climate change that prevailed at the time, the programme can be seen as the crucial source of early financing and networking that assisted the first steps to examine and modify the existing businesses to take into consideration the opportunities of the climate business.

In the programme, energy efficiency and technological solutions of the end user sector were brought up with the more traditional production side solutions. In spite of the activation, still the focus was in the production side and the end use sector remained under-developed. Since that more and more focus is given to the energy use and demand, and this is also likely to change the ecosystems.

¹⁸⁰ Source: Tekes and Finpro's databases

¹⁸¹ Source: Proposal by Saarnivaara (2009)

9.3.5 Drives systemic renewal and brings societal benefits

Since the 2004-09 programme period, discussion and business opportunities in climate change have developed significantly. The effects of climate change have been increasingly recognised and climate change mitigation and resiliency have gained much more political, economic and technological interest. Climate related policy decisions, regulation and legislation have had a huge impact on the market development guiding the investments and funding.

Emissions trading did not end up being as a strong force in the development, especially in comparison with the policy measures on promoting renewables or energy efficiency. However, climate change remains a strong global driving force especially on the markets related to energy and natural resources, and the role of climate change on policy decisions on this market is remarkable.

The scenario projects mapped and promoted technological possibilities for cutting down the greenhouse gas emissions. This work was initiated in the Climtech programme and continued in the Climbus programme. This has supported the work on national climate and energy policies.

The Climbus programme was successful in initiating energy efficiency as a national research theme, but the projects on this area were only few, especially in the energy end use sector. Developing the efficiency of residential energy use in Finland was relatively slow at the time, but this was later tackled by the energy efficiency programme of Sitra in 2008-2012. Since the Climbus programme, energy efficiency has been high on the agenda in many companies, primarily for the cost-saving opportunities, as well as in public policies. Many businesses and markets, from maritime sector to process and retail industry, are interested to take up energy efficiency solutions, and in many products manufactured for the international markets, energy efficiency has been carefully considered during product design.

In global benchmarks, Denmark, Finland and Sweden are the world's best at clean technology innovation. Finland is recognised as a cleantech pioneer. It ranks particularly highly when it comes to patents and venture capital invested in new cleantech innovation. But there are some weak points, including a low level of cleantech imports/exports, renewable energy investments and early-stage startup activity.¹⁸²

Specific solutions developed during the programme aimed at reducing carbon emissions through a variety of measures. Thus, for example the impact of specific energy

efficiency solutions could be measured in reduced emissions. However, the companies have not at least systematically used this as a marketing argument but rather pointed out the related cost-savings.

9.4 Summary and conclusions

The programme helped companies to see climate change as a business opportunity. This mindset is still valid and many companies take advantage of these opportunities. The timing of the programme can still be considered excellent for initiating the development of climate related business and solutions. Today, many Finnish companies are strategically positioned to provide climate solutions on the market for a variety of (mainly industrial) customers.

However, the carbon market did not develop as expected, pointing out the resiliency of business needed to adapt to the fast-changing business environment and take advantage of new business openings such as end-user energy efficiency and electricity elasticity. The programme partly helped to shift the focus from energy production to energy efficiency, although further pressure was needed to take this more seriously. Today, many Finnish companies are strategically focused to provide energy-efficient solutions, and also their international growth has been based on related competitive advantage.

The programme supported the development of national climate and energy policy, specifically the scenario projects were seen to support this development. Today scenarios still are in a relevant role in the national policy making but they haven't been opened extensively to discussion which might result into looking alternatives too narrowly and fixed.

The programme linked companies and research organisations, and enabled growing expertise and experts on the sector. The programme already raised the need for market-stimulating policy measures but at the EU level the biofuels market especially is developing to much lower targets than our national policy is setting. Also, demonstration projects were seen relevant at the time.

The programme was part of a continuum of several other related Tekes' programmes, and also had, through the participating companies, links to the Cleantech Finland. There are many examples of companies pursuing today the business opportunities developed during the programme. The strongest market impacts were realised in the areas where EU directives or national legislation drove market development (real-time measurement of electricity, biofuels for traffic, and fuels from recycling).

¹⁸² Swarder, Salge & Van Soest (2017)

The impacts of the programme vary a lot between the focus areas depending on the market and regulatory development:

- Even if most of the current energy efficiency of heavy traffic has been based on the efforts of large engine and truck manufacturers outside Finland, the programme laid the cornerstones of current development in Finland.
- The programme provided an early impetus to the development of smart meters in Finland, and enabled the country to fulfill the requirement on smart meters.
- The current low prices of EU emission allowances have weakened the prospects of carbon capture and storage (CCS) in Europe, and CCS is not among the most economical methods by marginal costs to reduce CO₂ emissions.
- The programme had a good timing in encouraging the first efforts towards biofuels, continued in Tekes' Biorefine programme and SHOKs.
- Today, multi-fuel capability and ability to combust waste fuels can be considered to have thoroughly penetrated the Finnish energy industry and boiler manufacturing companies.

Summary of Climbus Programme

- Encouraged companies to view climate change as a business opportunity and supported the development of national climate and energy policy
- Today, many Finnish companies are strategically positioned to provide climate and energy-efficient solutions globally
- The strongest market impacts were realised in the areas where EU directives or national legislation drove market development
- As the carbon market did not develop as expected, the resiliency of business to adapt to the fast-changing business environment has been crucial
- Tried to help shift the focus from energy production to energy efficiency, but further pressure was needed to take this more seriously
- The business impacts vary a lot between the focus areas depending on the market and regulatory development
- Raised the need for market-stimulating policy measures at the side of RDI, and was part of a continuum of several other Tekes programmes

9.5 Company case studies

9.5.1 Aidon

Part of Climbus, Groove, EVE and Green Growth programmes

Part of Finpro's Cleantech Finland growth programme

Aidon was founded in 2004 and supplies smart energy metering systems and smart grid applications. This helps energy distribution companies to ensure faultless delivery of electricity to end users. Aidon is the leading supplier of smart energy metering systems and smart grid applications in the Nordics serving more than 1.5 million metering points. The turnover of the company in 2017 was 86 million euros and there are 60 employees. Aidon's subcontractors employ about 150 people mostly in Finland but also in other countries.¹⁸³

Cooperation with Tekes and Finnvera has been continuous throughout the history of the company. In the last 10 years, there have been many technological changes and some paradigm shifts that have necessitated focusing on R&D. From the onset Aidon has participated in multiple Tekes programmes and the participation and especially the available funding has been a key element for Aidon's success and almost unprecedentedly rapid growth.

As part of the Climbus programme Aidon has researched technical solutions and market opportunities, developed smart grid solutions for network management and real-time meter reading solutions as well as new generation open architecture solutions for real time meter reading. In addition, in the Green Growth programme Aidon has researched megatrends and opportunities for Aidon's future growth. In the Groove programme Aidon studied how to create value from

international business as well as from smart grid services and internationalisation activities. A project in collaboration with Tekes on logistics and production chain management has been especially important for Aidon and the results are still in use. Aidon has been a catalyst for the establishment of several subcontractors and partners. Tekes contribution to this company case can be seen in Figure 9.2.

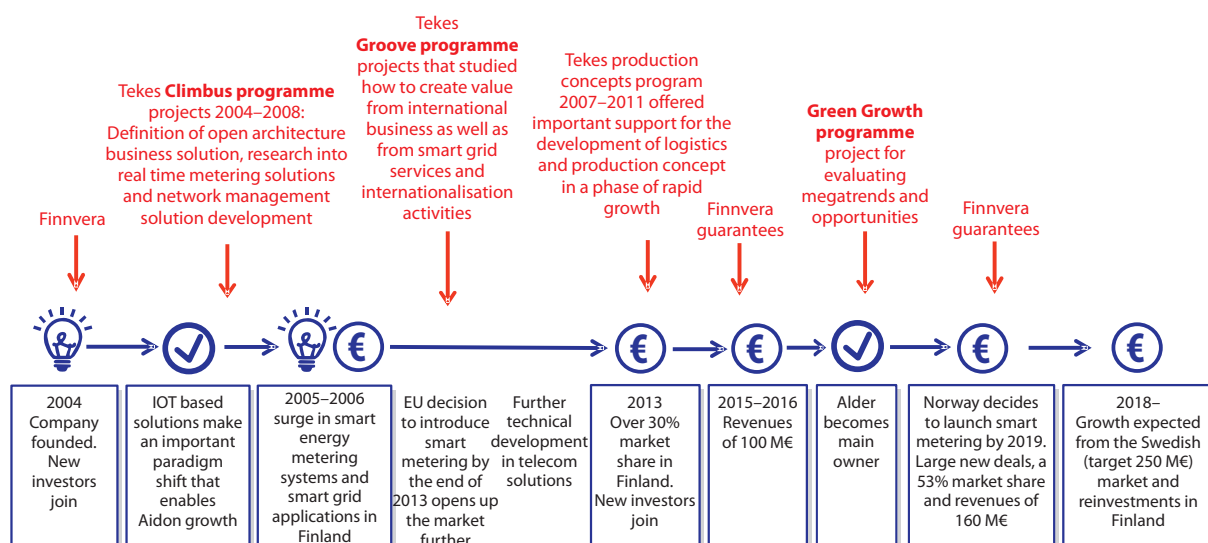
Success factors:

- Personnel competence and a good business idea. The "package" has been believable from the onset, even at the stage when the company was only a startup. This has enabled developing the company in the right direction and helped get the necessary financing without any problems.
- Getting financing at the right times.
- Developing a solution based on real time access to data and multiple uses for the collected data instead of only collecting meter readings was a paradigm shift that helped develop the business and drive rapid sales growth.
- Data-driven supply and demand of energy is rapidly changing the energy sector. Aidon has been active in creating new services on real time monitoring of electricity.
- Aidon has benefited from the smart metering regulation that has driven growth of the sector in the Nordic countries and lately elsewhere.

Lessons learned:

- The programmes themselves may not be important but they enable getting funding and the necessary support for developing the business.
- Customers choose partners because of the people that are involved and high quality technological solutions.

Figure 9.2. Business growth and Tekes contribution in the case of Aidon.



¹⁸³ This case is based on the following sources: Chrons (2017), Aidon webpage, Lehmusvirta (2016)

9.5.2 GreenStream Network

Part of the Climbus, Groove and Green Growth programmes

Part of Finpro's Cleantech Finland, Developing Markets and Beautiful Beijing programmes

GreenStream Network Ltd supplies energy efficiency solutions to the industry. It is planning projects, looking for appropriate equipment suppliers, financing the project and taking care of the implementation. The company used to be the most successful intermediary in the green electricity markets, and has been focusing on international markets from the start. The rapid changes in the markets have forced the company to re-create the business concept several times during the years. Since 2006 the role of China has steadily grown in company's business. Altogether, GreenStream has been involved in over 200 emissions reduction projects globally. The turnover of the GreenStream Group is around 4 million euros.¹⁸⁴

As part of the Climbus programme, GreenStream developed its business model for fund management and CO₂ and green certificates. In the Groove programme the company was focusing on rethinking the business model to take advantage of emission reduction business in China. The development of the business concept on energy efficiency business in China was carried further in the Green Growth programme focusing on creating a platform for wider cooperation of Finnish technology companies. Tekes and other Team Finland contribution to this company case can be seen in Figure 9.3.

By networking Finnish technology companies into its international investments GreenStream's business model creates ecosystem benefits in Finland. It gathers specific technologies into comprehensive customer-driven solutions. It provides customer contacts and references for Finnish companies on the Chinese market opening doors for further sales leads. Strong partnerships within the ecosystem are crucial as the success of the GreenStream's business depends on the energy savings and reliability of the solutions.

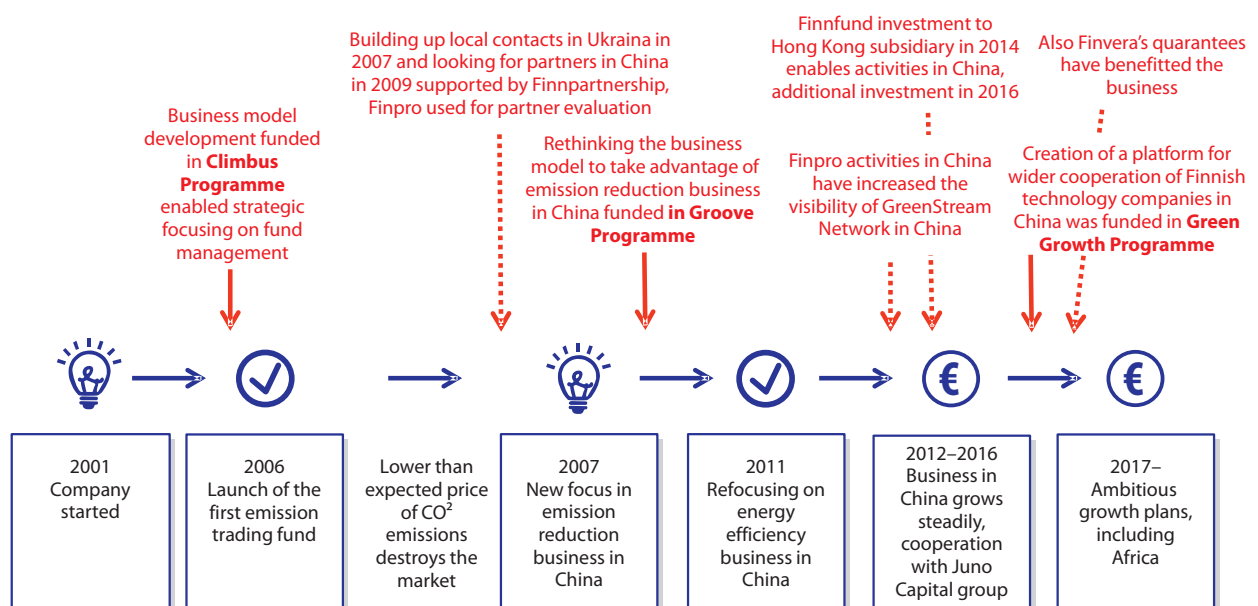
Success factors:

- Capability of developing new, ground-breaking business concepts and implementing those as the market has changed, being a frontrunner also includes risks
- Ability to create and take advantage of strong networks, especially crucial for a small company in a big market like China
- Innovative business model based on financing investments in return for a share of the value of energy savings, technology transfer from Nordic countries an integral part of the concept

Lessons learned:

- Businesses, especially forerunners with ground-breaking business concepts, need to be ready for rapid changes in the market (especially policy driven markets) and ready to continuously re-create and transform business concepts based on the needs.

Figure 9.3. Business growth and Tekes contribution in the case of GreenStream Network.



¹⁸⁴ This case is based on the following source: GreenStream Network (2017), Finfund (2017), Nykänen (2017)

- Public support, especially Tekes funding, have enabled GreenStream's strategic transition from broker to fund manager and further to energy efficiency company.
- In the different stages of business development and international growth different public support is needed, GreenStream case shows a good synergy between different Team Finland actors and measures.
- As a small Finnish company on a non-traditional business sector getting growth financing is hard, domestic growth financing for growth companies is crucial as an alternative for buy-out by large international companies.

9.5.3 St1 Biofuels

**Part of Climbus and Green Growth programmes
Part of Finpro's Cleantech Finland and W2E & Bioenergy programmes**

St1 Biofuels Oy was established in 2006¹⁸⁵ to create a bioethanol production concept that could be utilised widely in waste-based bioethanol production. The expertise of company lies within biochemical processes, technology development, engineering, and project delivery. The core idea is to replace fossil fuels in a profitable and sustainable way. Throughout the last 10 years, the company has been participating in several Tekes programmes in order to develop bio-based fuels' production processes, expand the research on new raw materials and mapping market opportunities globally.¹⁸⁶

Research and development of production technologies towards smaller scale distributed bioethanol production took place in Tekes Climbus programme in 2006-2008, while the raw material base and processes for producing bioethanol were examined in Tekes Biorefine programme (2007-2012). Raw material base was researched in more detail related to saw dust in Green Growth programme in 2014-2016. As one result of the development projects, St1 Biofuels has relinquished small scale distributed production and is nowadays focused on more profitable large scale production facilities with enhanced technologies. Commercialisation and possibilities for internationalisation, especially in Asia, were examined simultaneously ending up on constructing a production facility in Thailand in 2017. In the 2010's the

global market for bio-based fuels has been growing rapidly in general and also the ecosystem of companies operating in the field of bio-based fuels has been pulled together nationally resulting as export of system level solutions with services more than just single products. Tekes and other Team Finland contribution to this company case can be seen in Figure 9.4.

Success factors:

- Possibility to share financial risks in collaborative, Tekes funded projects.
- Thorough planning of R&D activities and focused execution of the most potential solutions. At the same time actively raising company's awareness on the global markets (also through services provided by Team Finland actors).
- One of the main success factors in St1 Biofuels' case was that the company and teams working on the projects were of suitable background, motivated and courageous enough to further projects towards the set goals.
- Finding the right partners and concrete customer cases from Finnish and global biofuels ecosystem.

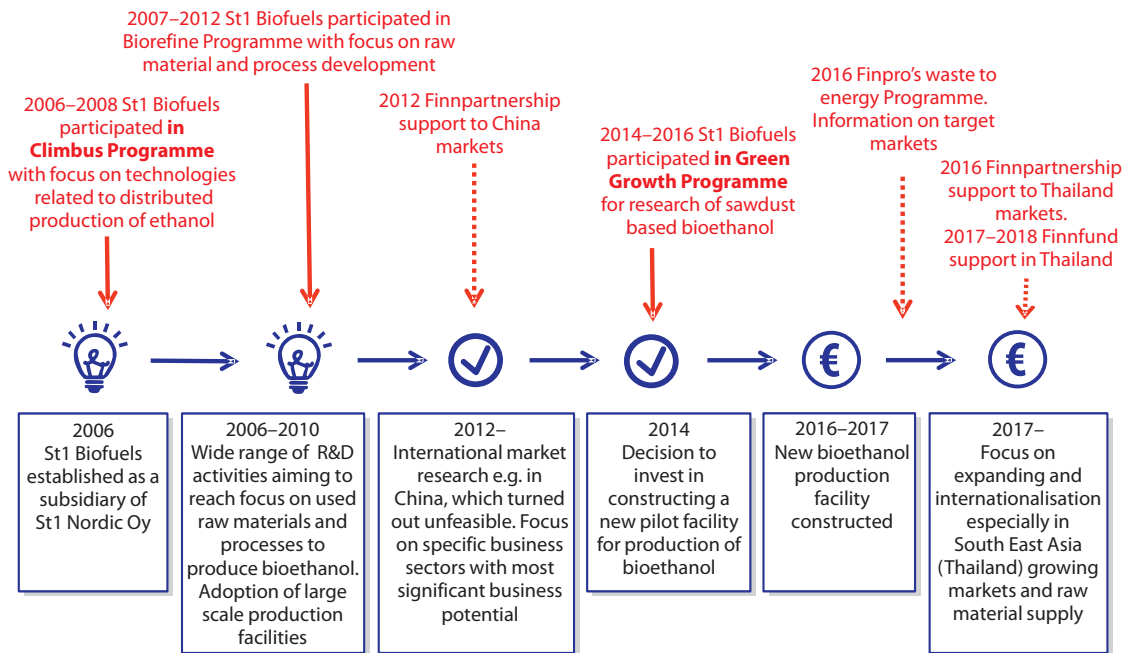
Lessons learned:

- As a lesson learned, furthering projects with a clear focus is one of the key elements of R&D and especially commercialisation. On the other hand, financial risk sharing enabled widening the research base.
- Finding a suitable customer case already in the development phase of a product/service is important. Anyhow, sometimes finding the case is one of the most challenging tasks and it might take a lot time and resources. In some cases, through networks, events and different programmes it might be easier. Company has to have clear focus on the customer case when it is available and other development paths need to be terminated.
- It is important to do R&D broadly and share information and work openly together with relevant partners, such as other companies, public sector and research organisations. For example, Tekes programmes enable this kind of actions, if well planned and right parties participate. Exporting system level solutions instead of single products is the key.

¹⁸⁵ As a subsidiary of the Nordic energy company, St1 Nordic Oy

¹⁸⁶ This case is based on the following sources: St1 Biofuels company webpage, Pitkänen & Granström (2017)

Figure 9.4. Business growth and Tekes contribution in the case of St1 Biofuels.



10

Conclusions and recommendations

10.1 Discussion and conclusions

For many years, Tekes has been the most important public cleantech funder in Finland. It is estimated that the programmes evaluated for this report provided funding to about 20 % of the Finnish cleantech companies¹⁸⁷. These programmes together with other Tekes activities have thus played a key role in shaping Finnish cleantech innovation. Tekes' public investment role has been important, not only for business growth and renewal, but also in Finland's contribution to solving global development challenges and realising future environmental benefits.

In addition to Tekes, new actors are taking an active role in facilitating and funding cleantech development. For example, in the clean water sector, various foundations are funding research, demonstrations and the commercialisation of new solutions. Cities, such as the Helsinki Metropolitan Area, are serving as test beds for smart cleantech solutions. Private investors are also shaping the cleantech landscape by making targeted investments, for example, in smart energy.

The cleantech innovation landscape is becoming more agile and versatile. The consumer's role as a primary cleantech driver and enabler is changing and opening up markets for new solutions and business models. Digitalisation companies are finding attractive growth opportunities in cleantech and are radically challenging traditional cleantech business models. However, regulatory development remains a critical factor in the development of the cleantech sector. Its role to constrain and/or accelerate the cleantech sector needs to be better understood and innovation investments and activities modified accordingly. All these changes in the cleantech innovation landscape will continue to challenge also the way Tekes cooperates and positions itself in this new landscape in the future.

This evaluation was conducted using Tekes new impact model. It was slightly simplified for the needs of programme evaluation. For each programme, the companies participating, services offered, direct and indirect results, and other impacts were assessed. The overall effectiveness of the new model is also discussed. In this evaluation, the synergy between Tekes and Finpro was of specific focus

since they will soon be merged into a new organisation: Business Finland. In total, about 25 percent of the participating companies included in this evaluation, mostly SMEs, also participated in Team Finland's growth programmes administered by Finpro. Although some companies benefitted from Finpro's services, the cooperation between the programmes was not consistent. Finpro's role has also evolved during the evaluated years. The intention for synergy between these two actors has been growing during and after the evaluated period.

10.1.1 Programmes' focus areas and impacts vary

The evaluated programmes identified future cleantech needs, defined market opportunities, and resulted in several interesting results and market openings for participating companies. Measurable programme business results and focus area impacts vary significantly depending on market sector, and regulatory environment, and companies readiness to undertake international business.

This evaluation demonstrates that market access timing is a critical success factor, especially as cleantech regulatory constraints often play an important role. In many of the case studies analysed for this evaluation, achieving market access, introducing products, and developing and testing new business models took longer than planned. Market timing of new services and solutions was a key success factor, and first-mover companies often need to also invest time and money to create the market. The question is, how to speed up the market access and, on the other hand, make sure good ideas don't die before they get to the market (since revenue is often realised later than expected).

This evaluation concludes that these programmes and projects have increased the strategic understanding of participating companies, not only in technology and business options but also with respect to customers, markets and cleantech's political and societal context. This is critical to understanding the key supporting role policy plays in the development and market launch of new cleantech innovations.

The timing of the programmes and their themes has been overall successful. The evaluated programmes demonstrate the difficulty of designing public programmes and other public measures to push business development be-

¹⁸⁷ In 2014 the amount of cleantech companies in Finland was estimated to be around 2000 companies (Source: Ministry of Economic Affairs and Employment (2014)). The evaluated programmes covered about 400 companies.

yond the readiness of the Finnish businesses (such as the readiness to test new business models and digitalisation) and the market (such as fuel cell and hydrogen systems and carbon capture and storage). The programmes analysed for this evaluation have, for example, emphasised the importance of business models, as well as digitalisation, but participating companies haven't necessarily been attracted to these themes.

As was pointed out in similar earlier Tekes programme evaluations, the opportunity to mitigate risks through public funding seems to achieve desired benefits and results in RDI activities that are more broadly-defined, more thorough, and more rapidly implemented than without public support. Advocating for some risk taking in RDI and business development is deeply rooted in the Tekes' mission and funding criteria.

10.1.2 Different paths for international growth

Programme business growth and jobs impacts are highly dependent on the participating companies. Some of the evaluated programmes focused on finding and integrating potential participants even though some of those companies may not view themselves as cleantech companies. The Finnish cleantech sector is generally dominated by large companies and although SMEs have been the target of many of the evaluated programmes, the SME funding share was still lower than the share of Tekes's funding to SMEs generally during the last years.

The capacity of participating companies to capitalise on their innovations and generate international business varied significantly both within and between the programmes. The companies also varied in their ability and mindset to apply and benefit from public support and tools, including Tekes programmes and Finpro's growth programmes. Those companies that had a clear strategic insight, vision and plan to grow internationally seem to be able integrate public support and tools into their business plans. Only those with a very clear strategy were able to successfully identify and benefit from the synergy between different Team Finland actors and measures.

The cases analysed in this evaluation highlighted the fact that cleantech companies often have very different paths to international expansion and growth. The resources required for international growth are multifold compared to RDI resource needs. For example, some cleantech companies came to the conclusion that a merger or acquisition is the best path to take these next steps. Many companies were also able to expand their business with the help of private investors. Although Finnish business is attracting

international investments in increasing scale, domestic growth financing is viewed as a critical alternative. Public RDI funding can also play a significant role in strengthening the credibility of the companies when they are seeking external funding.

10.1.3 Environmental benefits complicated to track

Anticipated environmental benefits are at the core of the cleantech sector and should be understood within the wider sustainable development context. From a business perspective, it is highly relevant to understand how cleantech solutions create value, not only to the customer but also to society as a whole. This often provides crucial insights in understanding market development and the building of a sustainable competitive advantage.

Although a specific environmental benefit, e.g. reduced CO₂-emissions, can be claimed and measured for a specific product or service and extrapolated to its use as and sector a whole, such environmental attributes are also driven by many factors outside Tekes. To be systematic in claiming these environmental benefits, Tekes should also be more systematic in setting them as programme objectives and criteria for customer selection and project definition. What defines the cleantech sector will likely change over time, and there is a need to ensure that public RDI investments are in line with other policy decisions and objectives which, for example, shape the operating environment of companies in Finland.

10.1.4 Supporting innovative international growth

In general, cleantech companies face the same growth and innovation opportunities and challenges as do companies in other sectors¹⁸⁸. Tekes activities and services face similar opportunities and challenges. Public support programmes need to be flexible to address innovation and international growth business requirements that vary throughout the business and product development life cycle. The prerequisites for international growth vary significantly from company to company, and public measures should support the companies in their specific needs.

The growth of Finnish cleantech companies is not so much limited by the size of the global markets as the competitiveness and attractiveness of their solutions, and the degree to which Finnish companies can access international ecosystems. If a company targets growth in international markets at the inception of RDI activities, all the work is driven by that objective. This approach often does not preclude domestic market growth, but focuses the RDI goals and objectives with an international mindset. Today,

¹⁸⁸ Also a recent study made for the Ministry of Economic Affairs and Employment (MEAE) on the dynamism of growth and jobs on the bioeconomy, cleantech and circular economy in Finland proved that growing cleantech companies do not differ from other cleantech companies regarding the substance or sector where they operate. Instead the success is explained by other factors. Probable success factors are, for example, strong strategic insight and excellent resources for international growth.

innovation activities do not precede customer interaction linearly, but rather need to be undertaken side-by-side with customer interaction. This emphasises the close synergy between innovation and internationalisation activities.

With respect to international cooperation and international market access, there was some overlap between Tekes' and Finpro's programmes. For instance: delegation and business trips (see for example Groove programme) and specific activities in China (Tekes' activities in Groove and Green Growth programmes and Team Finland's growth programmes). In addition, there were some programme-specific links to Finpro (e.g. Programme Coordinator staffing, Steering Group members). Also Team Finland was an active partner throughout those years included in this evaluation.

Strong synergy is needed between innovation and internationalisation, both in business and in policies and public measures. For example service design, co-creation and experiments with international customers can help to integrate Finnish companies into global ecosystems early in the RDI phase. This market presence generates interest in Finnish know-how and ensures that future customer needs are understood and monitored.

Expertise in international sales and marketing is now critical for companies that seek to grow internationally. Strong target market and customer know-how, expertise to run international projects, and the ability to operate in international ecosystems are particularly important skill sets¹⁸⁹. In order to strengthen internationalisation skills, companies should be supported in the recruitment of international experts and relocation to Finland. Business Finland could, for example, help companies to develop sufficient commercial expertise in building international business.

According to the benchmarking conducted for this evaluation, better access to international markets is a primary focus in all benchmarked countries. Innovative instruments, measures and tools are being developed to help the businesses to identify and meet potential customers and to support global market entry. Initiating joint innovation programmes, connecting innovative SMEs with established global industrial companies, involving customers of cleantech innovations and business advocacy groups are among the means to support companies' growth. Local presence to establish connections and identify potential partners in selected target markets and financing feasibility studies to enable businesses to assess the market potential of their idea and identify potential local clients and partners are in common practice.

10.1.5 Strengthening ecosystems

Often, exciting business growth opportunities are found in the gray areas between solutions and actor core competencies. For instance, the application of digitalisation to enable energy consumption and production, mobility, and resource sharing and optimisation services. This evaluation as well as a recent study for the Ministry of Economic Affairs and Employment (MEAE) on the dynamism of growth and jobs in the Finnish bioeconomy, cleantech and circular economy indicated that exploitation of these interfaces could be important growth opportunities.

Strengthening ecosystems has been discussed a lot recently in Finland, and this could be seen as a forum to exploit these synergies. However, the definition and value of business ecosystems are often left unexplored. Ecosystems can be defined as any system or network of interconnecting and interacting parts. The deeper idea is that each ecosystem actor is affected by the others, creating a constantly evolving relationship in which each actor must be flexible and adaptable to survive. There needs to be a shift in ecosystem development from light networking and debates, and only generic development of research and business cooperation to ambitious and goal-oriented strategic partnerships, customer-driven joint development, joint service offerings including commercialisation and scale-up.

The ability to create and exploit these strong networks, or ecosystems, is especially crucial for small companies that often lack internal resources. Most measurable ecosystem impacts are realised when a specific company has an interest to find (commercial) synergies between the companies. This can result in strong strategic win-win-partnerships. Focus on the capacity of the ecosystem (research institutions and other companies) around the company to innovate could be one way to support ecosystems with concrete outcomes. For some companies, it has been more difficult to secure domestic than international customers, but international references have also increased interest in domestic markets thus emphasising links to international ecosystems.

Rather than domestic ecosystems, the focus should be on how Finnish cleantech companies can strengthen their role in international ecosystems. Growing cleantech companies need networks to reach potential customers and partners, identify local operators, and choose international markets. These networks lead to pilot projects in different countries and developing capabilities for global commercial operations. Public actors can and should support these activities. Business Finland has an opportunity to open up existing international networks and encourage business

¹⁸⁹ MEAE 2017, Study for the Ministry of Economic Affairs and Employment (MEAE) on the dynamism of growth and jobs on the bioeconomy, cleantech and circular economy in Finland. To be published in October 2017.

connections in international business and innovation ecosystems.

The importance of domestic markets in the growth of international business varies from company to company. Domestic research facilities and RDI including testbeds, and public procurement are tools for opening up markets for innovative solutions and making Finnish know-how more attractive internationally. However, their relevance is company and solution-specific and not always the only missing link to international success. The domestic market references and demonstrations may be important in some cases but often equally important is to experiment directly in targeted global markets.

10.1.6 Agile development in cleantech needed

Cleantech businesses, especially pioneers and first movers with ground-breaking solutions and business concepts, need to be prepared for rapid market change and to continuously re-create and transform business concepts. On the other hand, patience in developing innovative solutions is deemed to be key as time is needed to verify the results and scale up technologies.

Competition is intense in the global cleantech market and it is important to be able to grow rapidly and respond quickly to customers' needs and demand in order to gain and maintain market position. In such a dynamic market environment, companies need to be flexible and respond rapidly to different market signals. A critical success factor is that a company's internal processes support agile development and management practices.

How cleantech innovation is driven is in flux. Innovation activities are increasingly spread more broadly within organisations, not only RDI but also business strategy, development, sales, and production¹⁹⁰. For Tekes, it is not enough to understand the logic of RDI and innovation, but also understand the logic of business development. If wider societal and economic impacts are aimed for this understanding should be expanded further to cover also the dynamic development that occurs in the Finnish and international business ecosystems.

10.1.7 Future programme concept

As more programme agility is required, feasible future programme concepts may be quite different from those programmes included in this evaluation. For instance, future innovation activities may be structured as a collection of instruments and services to best fit specific defined objectives. Attractive Business Finland service packages would be defined out of the existing Tekes' and Finpro's services

and developed further. A programme could act as a campaign to facilitate companies' innovation activities in specific markets, focusing on specific market opportunities, customer segments, solution areas or themes. This approach demands for a strong strategic insight on how these activities work together and with other programmes and instruments, and serve Tekes' and Business Finland's objectives in the best possible way.

To address different company needs, Business Finland has significant opportunity to target services more efficiently to different types of companies at different business development stages. Tekes's and Finpro's joint knowledge of their customers should enable a more refined customer segmentation so that future programmes, instruments and services are better targeted to the needs of the companies.

In order to develop the services offered to target companies, Business Finland has an opportunity to bring together Finpro's practical business development approach and Tekes's longer-term risk taking RDI approach. This may help to develop service packages for future programmes that may be more appealing to companies and which address their most pressing needs.

Finding a feasible programme thematic focus is not easy. The evaluated programmes varied in their scoping. Electric Vehicles Systems and Green Mining programmes had a clear business area focus and a relatively clear set of target customers. On the other hand, the scope of Green Growth and Climbus were only broadly defined. There is no clear answer as to whether a narrow or broad focus is better. Some of the key questions to define the scope are the following.

- Does the programme scope allow targeted companies to be easily identified, or are they hard to identify with fewer clear existing synergies? Are new surprising connections between companies likely to be created or does the programme emphasise only existing links and ecosystems?
- Is the aim to create and exploit only easily-identified business impacts, or allow for broader, possibly unforecasted opportunities to materialise over a longer time perspective?
- How does the programme's defined scope affect the types of innovation that may occur and types of risks to be mitigated? Will there be, for example, potentially very expensive demonstrations or relatively low cost digital experiments?

The significant elements of the future programme concept are presented in Table 10.1.

¹⁹⁰ Source: Tekes (2016b)

Table 10.1. Elements of the future programme concept.

	Reasoning	What to do
Reflects agility to react to market opportunities but is based on a longer-term strategic insight	<p>Cleantech businesses, especially first movers, need to be prepared for rapid market changes and to continuously re-create and transform business concepts</p> <p>Companies' innovation activities as well need to be flexible to respond more rapidly to different market developments and support business concept transformation</p>	<p>To be more agile, future innovation programmes may be structured as a collection of instruments and services to best fit specific objectives — they could be seen as agile “campaigns” to facilitate companies' innovation activities in specific markets, customer segments, solution areas, challenges or themes</p> <p>This approach demands for a strong strategic insight on how these activities work together and with other programmes and instruments to serve Tekes' and Business Finland's objectives in the best possible way —the long-term objectives of Business Finland need to be very clear and carry over the long term vision across more agile and perhaps shorter programmes</p>
Designs attractive and innovative service packages for different needs of the companies	<p>Cleantech companies have very different paths to international expansion and growth</p> <p>Business Finland has the opportunity to target a broader set of services more efficiently to different types of companies at different business development stages</p>	<p>Attractive Business Finland service packages should be defined out of the existing Tekes' and Finpro's services and developed further</p> <p>Tekes' and Finpro's joint insight on the needs of their customers should enable a more refined customer segmentation so that future programmes, instruments and services are better targeted to the needs of the companies</p> <p>When designing future programmes and services it is not enough to understand their likely impact on RDI, innovation, and business development in targeted companies — it is also crucial to understand how the services might support wider dynamic developments in the Finnish and international business ecosystems, for example, by encouraging cooperation</p>
Finds a feasible scope and focus for the activities	<p>Finding a feasible content focus and target participants (including thematic focus) for a programme is not easy, and the evaluated programmes varied significantly in this sense</p> <p>A tight and obvious content focus seems not to be as fruitful for unexpected and disruptive results and impacts as a wider and more surprising focus</p> <p>However, a tight focus may lead to more evident short term impacts (e.g. increased export)</p> <p>The decision on the focus depends on the strategic objectives set for the programme</p>	<p>Key questions in scoping innovation programmes:</p> <p>Does the programme scope allow targeted companies to be easily identified, or are they hard to identify with fewer clear existing synergies? Are new surprising connections between companies likely to be created or does the programme emphasise only existing links and ecosystems?</p> <p>Is the aim to create and exploit only easily-identified business impacts, or allow for broader, possibly unforecasted opportunities to materialise over a longer time perspective?</p> <p>How does the programme's defined scope affect the types of innovation that may occur and types of risks to be mitigated? Will there be, for example, potentially very expensive demonstrations or relatively low cost digital experiments?</p>

10.1.8 Feasibility of Tekes impact model

This evaluation utilised the new Tekes impact model by adapting it slightly to be suitable for a programme rather than project evaluation. In this section, the suitability of the new impact model is discussed within the wider context of anticipated Business Finland activities.

Selecting and targeting customers and instruments is highly relevant in defining Tekes and Business Finland potential outcomes and impacts. This is also well defined in the new impact model. At the time of the evaluated programmes the focus was rather on selecting projects. Current programme data management practices do not fully support customer-driven approach and follow-up activities. Monitoring of project statistics does not provide a way to measure specific business results. This is especially the case with larger companies operating in several business areas or when the aim is to measure business renewal results. Company-level information is often too generic when attempting to understand growth and assess the impacts of Tekes funding to achieve this growth. Instead, business-area specific or other detailed quantitative and qualitative information should be utilised to make these measurements.

From a customer's perspective, a programme may be seen as a service package comprised of different instruments that together advance specific programme objectives. The new impact model provides a good basis for examining the programme service package as a whole. It is important to note that it is not only instruments, but also approaches and practices, that affect the value and relevance of service packages to companies. Business Finland should be able to design attractive service packages out of the instruments in use based on understanding what companies need in different phases of innovation and internationalisation.

In the cleantech sector, the regulatory environment is a strong market driver. Thus the scale and focus of business opportunities, the investments driving growth, Tekes' impact on achieving these objectives, is highly dependent on the regulatory development. Also other drivers, such as raw materials prices, specifically oil, have a huge impact on the markets. The ability of Tekes to catalyse increases in revenue and international growth cannot be assessed without understanding the dynamics in the wider business environment.

The new impact model generates some overlap between direct and indirect impacts. The elements in the model are well applicable when the impacts of RDI funding are looked at, but some parts are unclear or difficult to interpret when other types of programme services are examined. A good example is internationalisation services including delegation or study visits abroad, bilateral funding agreements, and partner search. In this case a direct impact might include first access and first customers abroad, but an indirect impact might be international growth realised only over longer time and more difficult to assess. Thus specific impact pathways need to be understood.

Tekes' public investment role is important, not only for business growth and renewal, but also in Finland's contribution to solving global development challenges and realising future environmental benefits. These are also the most relevant market drivers on cleantech. Thus the international context of these objectives needs to be embedded in understanding and targeting cleantech innovation activities and business development.

10.2 Recommendations

Figure 10.1 sums up the recommendations of this study for Tekes and Business Finland as well as for research, development and innovation (RDI) policy and activities in general. The recommendations are described in more detail below.

Figure 10.1. Sum up of the recommendations.

<p>Look for customer-driven business development</p>	<ol style="list-style-type: none"> 1. Focus on new ways of creating value 2. Support innovation partnerships and co-creation 3. Target international markets at the inception of RDI 4. Find new funding instruments to open global markets 5. Find feasible ways to coach companies, especially SMEs 6. Put focus on market access
<p>Facilitate interfaces</p>	<ol style="list-style-type: none"> 1. Highlight cooperative innovation projects 2. Demand for agile and open innovation practices in cleantech 3. Facilitate business out of the boundaries of know-how and actors
<p>Promote renewal</p>	<ol style="list-style-type: none"> 1. Understand the critical success factors of cleantech companies 2. View programme customer selection as significant strategic choice 2. Design attractive service packages 4. Work to increase the dynamism in the Finnish cleantech ecosystem 5. Advertise the accomplishments of successful companies to encourage others

10.2.1 Look for customer-driven business development

- Focus on new ways of creating value.** Tekes and Business Finland should, together with companies and other actors including research and other innovation funders, focus on new ways of creating value (both customer value and wider societal value). The key to growth for cleantech companies is to create new business models and shareholder value. Opportunities are emerging through services, for example, intangible value creation and resource sharing. Business models also play an important role in what kind of resources international growth requires.
- Support innovation partnerships and co-creation.** Tekes and Business Finland should support companies to co-create with their customers in cleantech innovation partnerships, projects and programmes. To involve companies' customers, including international customers and public bodies, in the publicly supported RDI projects should be straightforward and recommended. This is particularly important in the cleantech sector where solutions often demand customers and other actors on the ecosystems to change their mindset and approach.
- Target international markets at the inception of RDI.** Tekes and Business Finland should ensure that cleantech companies target international markets at the inception of RDI activities. In this case, RDI work is driven by that objective and builds the basis for future international growth. This approach does not ignore the domestic market, but focuses the work with the right mindset. Innovation activities should not precede customer interaction linearly, but rather they should be undertaken in parallel. This emphasises a close synergy between innovation and internationalisation.
- Find new funding instruments to open global markets.** The Ministry of Employment and the Economy, together with Business Finland and other ministries, should analyse the use of potential new funding instruments to create opportunities for Finnish companies to make first global customer contacts and to identify and enter global markets. These instruments may include different funds, impact investments and others. The aim is to strengthen the position of Finnish companies in international ecosystems.

- **Find feasible ways to coach companies, especially SMEs.** Drawing from their past experience, Tekes and Business Finland should identify the most feasible ways to coach companies, especially SMEs, in international growth and business model development.
- **Put focus on market access.** Tekes and Business Finland should, together with companies, focus on those effective company activities that provide global market access, and how public measures could support them. Cleantech innovation platforms (e.g. piloting environments and testbeds) continue to play a central role in demonstrating the viability of new solutions, providing references, and opening up global markets, and the existing platforms should be used effectively.

10.2.2 Facilitate interfaces

- **Highlight cooperative innovation projects.** Tekes should highlight ways in which cooperative cleantech innovation projects are more attractive than company specific development. Cooperative cleantech innovation projects should be made more attractive than company specific development. It can accomplish this, for example, by creating funding incentives that reward cooperative RDI projects.
- **Demand for agile and open innovation practices in cleantech.** Tekes should encourage the development and experimentation of innovative and more open innovation practices in cleantech. Today new knowledge is often not a result of academic research but rather hands-on experiments. Lean product and service design might provide some tools to accelerate this experimentation and the commercialisation of promising new technologies. The concept development phase undertaken prior to development sprints could be used to set high goals for the development and ecosystem partner commitment.
- **Facilitate business out of the boundaries of know-how and actors.** Tekes and Business Finland should facilitate internationally competitive, innovative and scalable business achievable at different boundaries and interfaces. They need to push for integration of different know-how and actors. The goal is to renew cleantech ecosystems and businesses and to develop internationally competitive, innovative and scalable business out of these interfaces. Tools for this integration are already in place, for example, the joint project facilitation in Tekes' Arctic Seas programme and the Demobooster run by Dimecc, one of the SHOKs. Furthermore, the focus should be on how the Finnish cleantech companies strengthen their role in international ecosystems rather than in domestic markets alone.

10.2.3 Promote renewal

- **Understand the critical success factors of cleantech companies.** Tekes and Business Finland should develop better tools and approaches to understand and follow up the growth and renewal of cleantech companies. Specific quantitative and qualitative information should be available for companies and cleantech sectors. Use this know-how to identify potential Business Finland customers and select the right instruments for them.
- **View programme customer selection as significant strategic choices.** Tekes and Business Finland should view customer selection as a critical success factor, one with significant strategic implications. To identify fast-growing international business, select those companies that meet necessary prerequisites for international growth. However, other opportunities to encourage business renewal may be missed in the process.
- **Design attractive service packages.** To address different company needs, Business Finland has significant opportunity to target services more efficiently to different types of companies at different business development stages. Tekes's and Finpro's joint knowledge of their customers should enable a more refined customer segmentation so that future programmes, instruments and services are better targeted to the needs of the companies. In order to develop the services offered to target companies, Business Finland has an opportunity to bring together Finpro's practical business development approach and Tekes's longer-term risk taking RDI approach.
- **Work to increase the dynamism in the Finnish cleantech ecosystem.** Tekes and Business Finland should work with private investors, advocate for start-ups interested in cleantech, and encourage mergers and acquisitions as tools for international growth.
- **Advertise the accomplishments of successful companies to encourage others.** Tekes, Business Finland and other public actors should proudly point to successful companies to encourage for others. This will increase the number of business growth opportunities and encourage all of Finnish business to grow. It is important to emphasise the importance of growth companies in many sectors and to create opportunities to exchange experiences and conduct peer learning with other international growth companies.

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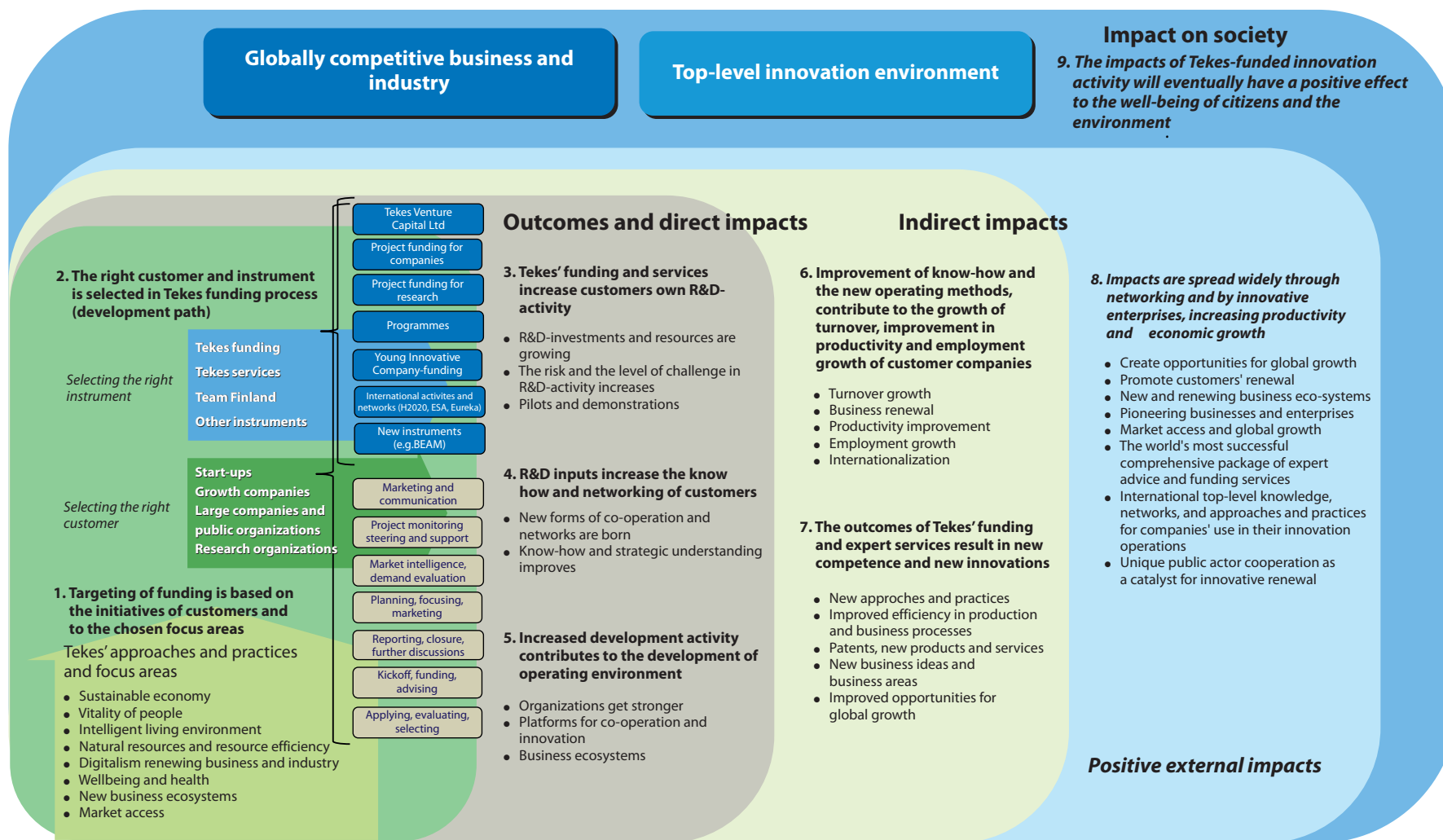
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Annex 1. Tekes impact model



Annex 2. Steering Group members and interviews

Steering Group members

Jarmo Heinonen, Tekes
 Risto Huhta-Koivisto, Finpro
 Christopher Palmberg, Tekes
 Teppo Tuomikoski, Tekes

Interviews

Programme	Name	Organisation
ClimBus	Jukka Leskelä	Energy Industry
	Jussi Nykänen	GreenStream
	Martti Äijälä	Tekes
	Patrick Pitkänen	St1 Biofuels
	Teija Lahti-Nuuttila	Tekes
	Timo Chrons	Aidon
	Tom Granström	St1 Biofuels
Densy	Arvo Järvinen	AW-Energy
	Erkko Fontell	Wärtsilä/Convion
	Ilari Kallio	Wärtsilä
	Juha Vanhanen	Gaia Consulting
	Jukka Leskelä	Energy Industry
	Martti Korkiakoski	Tekes
EVE	Martti Äijälä	Tekes
	Elias Pöyry	Eera
	Jussi Palola	Virta Oy (Liikennevirta Oy)
	Kimmo Erkkilä	Linkker
	Kimmo Rauma	Visedo
	Markku Antikainen	Wirebit Oy
	Martti Korkiakoski	Tekes
	Mikko Koskue	Finpro
	Mikko Pihlatie	VTT
	Tommi Saarela	PlugIt
Green Growth	Annimari Lehtomäki	BioGTS
	Fredrik Kekäläinen	Enevo
	Juho Rönni	LeaseGreen
	Jussi Nykänen	GreenStream
	Jyri Arponen	Tekes
	Kari Herlevi	Sitra
	Kirsi Sormunen	Member of Board at Neste, DNA and Sitra
	Teija Lahti-Nuuttila	Tekes
	Timo Pulkki	TamTurbo
Tuomo Suortti	Tekes	

Programme	Name	Organisation
Green Mining	Harry Sandström	GTK
	Jari Riihilahti	Metso Minerals
	Jukka Raatikainen	IMA Engineering
	Kari Keskinen	Tekes
	Pasi Julkunen	Sandvik
	Pekka Nurmi	GTK
	Simo Aho	Sofi Filtration
	Teija Lahti-Nuuttila	Tekes
Groove	Jarmo Saaranen	VNT Management
	Jussi Nykänen	GreenStream
	Kari Tuomala	Merus Power Dynamics
	Leena-Kaisa Piekkari	Pöyry
	Mikko Huumo	Pöyry
	Mikko Kurunsaari	Gurux
	Pekka Grönlund	Ministry of Economic Affairs and Employment
	Pia Salokoski	Tekes
	Teija Lahti-Nuuttila	Tekes

Annex 3. Evaluation methodology

The evaluation of Tekes cleantech programmes was executed between March-October 2017. The evaluation consisted of two ex-post (ClimBus and Densy) and four final (EVE, Green Growth, Green Mining, Groove) evaluations of Tekes' cleantech related programmes. Evaluation material was gathered from various sources in order to get wide insight from different angles on the results and impacts of the very programmes. The main evaluation material included specific programme data received from Tekes databases. In addition, company data from Finpro and relevant public sources were utilised. As part of the programme evaluation 16 company case studies were conducted. In addition, literature review on global cleantech megatrends and benchmark study on innovation-driven cleantech business were conducted in order to get insight and widen the understanding on the context of the evaluation as a whole. For the four final evaluations, a questionnaire for company participants on programme benefits and results was made. Figure A3 summarises the evaluation methodology.

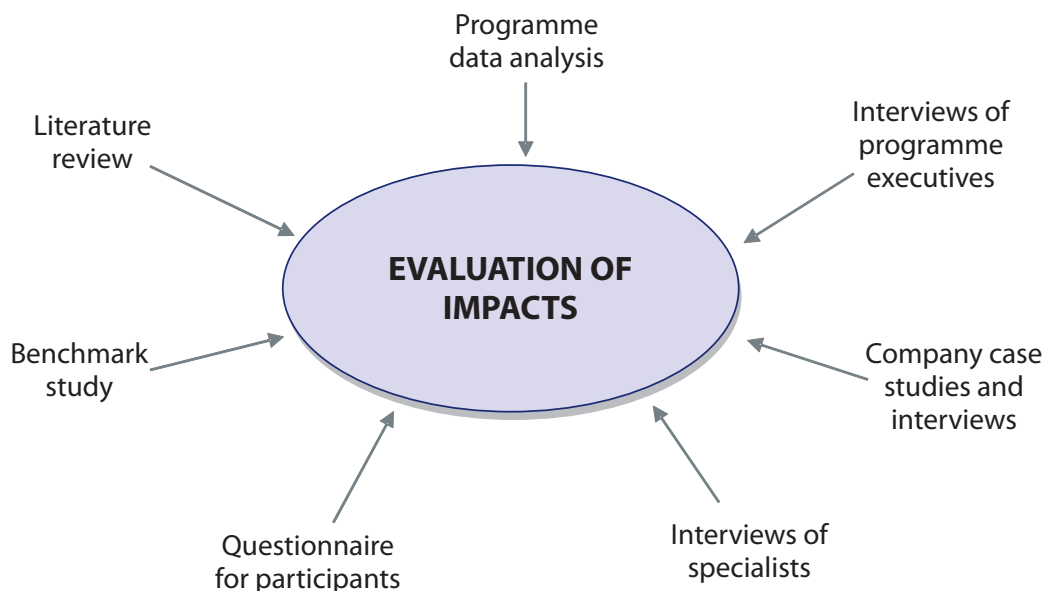
Cleantech megatrends and their impact on Finland

In this task, the megatrends affecting cleantech were identified and their impacts on Finland analysed. An in-depth review was made on the relevant literature to understand the major global trends and drivers related to and impacting in development of cleantech related business. This is supported by Gaia's expertise on this field to filter and select the most relevant material. This task also takes into account the major differences among the various industries and business areas the programmes have covered.

Best practices on making international business out of innovation-driven cleantech

International examples of best practices on cleantech RDI and international business growth were analysed to gain insight on the successful tools, measures and instruments in use and to draw lessons learned for Finland. To select the most interesting examples for the analysis, potentially

Figure A3.1. How the evaluation was made.



interesting activities and measures in selected countries including Austria, California, Denmark, Netherlands, and Sweden were screened. These countries were selected for the screening based on their forerunner position in the cleantech sector as well as innovation and international business-related policies¹⁹¹. The analysis is based on a literature review of publicly available information and publications.

Programme evaluation

The evaluation of Tekes cleantech programmes was conducted using the renewed evaluation framework of Tekes, which is focusing on results and direct impacts as well as on indirect impacts of the programmes. The core evaluation material, an excessive amount of programme related data, was received from Tekes for the evaluation. The data included information on programme participating companies, company projects and funding of the projects across all programmes under evaluation as well as data on the expected results and impacts such as expected turnover and export. The data was analysed per programme and also summary analyses on the programmes as a whole were drawn. In addition to results and impacts, on each programme their focus and objectives (including the reasoning of the programme), programme funding (including customer selection) and programme services (including programme management and execution) were gathered from the evaluation material and analysed.

In order to support the quantitative analysis based on the received data and other evaluation material, 31 programme specific interviews¹⁹² were conducted for the programme management and specialists during the evaluation. The target persons of the interviews were programme

directors, programme managers, programme coordinators, selected steering group members and other specialists with specific substance knowledge on the programmes' theme areas.

As part of the final evaluations of EVE, Green Growth, Green Mining and Groove a questionnaire on results of the programmes was sent to company participants of each programme. 48 answers were received and analysed in more detail. The results of the questionnaire contributed to the assessment of benefits derived from the programmes by the companies, which, on its part, gave valuable insight on the utility of the programme services and funding in general.

Case studies

Altogether 16 company case studies were conducted as part of the evaluation. For every of the six programmes evaluated, at least two company case studies were conducted utilising the impact pathway analysis. The analysis aims to show the main contribution of Tekes programmes, alongside with other public interventions, to development of company's possible success. Also other relevant internal or external changes impacting in the success of the company, such as strategic decisions to focus on cleantech, strategic partnerships, or technological break throughs for example, were taken into account in case studies. As a result contributing to the evaluation, key success factors and lessons learned were highlighted. Case studies were selected partly based on Gaia Consulting's expert work and partly together with Tekes. Case studies are based on publicly available information on the companies and altogether 19 interviews with company representatives involved in the programme under evaluation.

¹⁹¹ For example, all of the countries are highly positioned on the Global Cleantech Index (2014): 2. Finland, 3. USA, 4. Sweden, 5. Denmark, 11. Netherlands, and 16. Austria. Source: Cleantech Group (2014)

¹⁹² Some interviewees were interviewed considering several programmes. The total number of programme specific interviewees was 23.

Annex 4. Best practices on making international business out of innovation-driven cleantech

Supporting customer-driven innovation and co-creation

California Clean Energy Fund, California

California Sustainable Energy Entrepreneur Development Initiative (CalSEED) is a funding and professional development programme for innovators and entrepreneurs working to bring early-stage clean energy concepts to market. It plans to provide \$24M in early stage funding across an estimated 100 entrepreneurs over the next five years. A key component of CalSEED will be the development of an Equity programme supporting underrepresented applicants and communities. This social mission is a key aspect of the programme —striving to bring cleantech innovation to communities of color and disadvantaged local economies. CalSEED is a funding initiative of the California Energy Commission, a State of California agency.

CalCharge is an innovative public-private partnership working to accelerate the development, commercialisation, and adoption of new energy storage technologies for the consumer, transportation, and grid markets. CalCharge brings together emerging and established companies, academic and research institutions, government agencies, and other key stakeholders to spur advanced manufacturing and increase the growth of the energy storage sector. It does this through joint activities, conducting competitive funding tenders, and promoting public and private networking activities.

New Energy Nexus is a global network of clean energy incubators and accelerators. It facilitates collaboration and innovation between startups, accelerators, industry and investors around the world that are transforming tomorrow's energy systems. Its goal is to build a local and global community of entrepreneurs and support systems to incubate and accelerate 100,000 clean energy startups worldwide. It is attempting to do this by building a global platform for collaboration, research, and networking.

Free Electrons is a global energy startup accelerator programme that connects the world's most promising startups with leading utility companies to co-create innovative customer solutions and the future of energy. The

programme is an opportunity for later stage energy startups to gain access to the utility partners that can help them scale and expand into new markets around the world. Free Electrons takes a unique approach by working directly with energy utility companies to introduce them to promising startups.

Cleantech Inn, Sweden

Cleantech Inn has an Industrial Partner programme which brings together global industrial companies with innovative SMEs in cleantech sector. The programme aims at developing business opportunities between these companies. Cleantech Inn continuously recruits new suitable SMEs and facilitates the cooperation between the existing programme members. The industrial partners include E.ON, Siemens and Alfa Laval.¹⁹³

DRIP, Denmark

The partnership supports the development of new technologies and the testing of technologies in pilot or full-scale under production conditions. DRIP receives 50 % of funding from Innovation fund Denmark and 50 % from other Danish project partners that include 13 companies, three universities, two research and technology organisations. DRIP was launched in 2015 under the INNO+ societal partnership framework (as part of Danish government's innovation strategy, the INNO+ identified particularly promising areas of innovation for Denmark).¹⁹⁴

Open Innovation Strategy, Austria

The main goals of the Open Innovation Strategy are (1) opening and further developing the Austrian innovation system and strengthening the networking capability of Austrian organisations, (2) increasing the involvement of citizens in generating innovations, and (3) increasing the efficiency and orientation results of the Austrian innovation system by, for example, implementing innovative forms of knowledge transfer. The outcome was a strategy paper with an extensive catalogue of measures concerning e.g. creating a culture of open innovation, forming innovation networks, strengthening public involvement in research

¹⁹³ Cleantech Inn Sweden, initiative website

¹⁹⁴ DRIP, Company website

programmes, as well as questions of open access and fair compensation models for crowd work. Also, a national vision open innovation for 2025 was developed.¹⁹⁵

Programme on Technologies for Sustainable Development, Austria

The programme aims at supporting a sustainable economy with future-oriented innovations and developments and consolidating Austria's position in the field of technology. This is done by strengthening Austria's R&D competence (initiating and supporting R&D and piloting projects), interdisciplinarity and networking as well as diffusion and application of R&D results. The programme is based on an idea that sustainability must be a constituent element of future-oriented research and development, and that research plays a key role in this. The programme also underlines social and structural innovation in addition to technological innovations. By supporting R&D projects, the programme ultimately aims at creating demonstration projects and regions for new innovations. It has three subprogrammes: Building of Tomorrow, Energy Systems of Tomorrow and Factory of Tomorrow. Under these subprogrammes, new projects and pilots are initiated and funded through tendering. The programme was initiated by the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT).¹⁹⁶

Enabling international market access and growth

China Cleantech Trade Mission, California

The California-China Clean Tech Trade Mission was co-sponsored by the California Governor's Office of Business Development (GO-Biz) and the California Energy Commission. The Trade Mission provided an opportunity for California firms to explore business prospects and exchange information on clean energy technologies, strategies, and policies that are being explored and implemented in China. The mission was defined by an extensive set of events, competitions, networking exercises, and tours of company sites. The involvement of California-based Asian business advocacy groups to the mission activities was strong. Participants included California companies in the following fields: 1) re-

newable energy generation; 2) renewable energy storage; 3) Electric Vehicles (EV) and Fuel Cell Electric Vehicle (FCEV) companies; 4) energy efficient product manufacturing, distribution, construction, installation and maintenance; 5) natural and sustainable product manufacturing; 6) insulation technology; and 7) recycling of existing materials.

Financing instruments of the Netherlands Enterprise Agency, Netherlands

The Netherlands Enterprise Agency has several financing tools for innovations, including Proof of concept -funding and Innovation credit. Proof-of-concept -funding is targeted for innovative start-up enterprises (5 years old or less) as well as existing SME businesses that are creating and verifying new commercial concepts, identifying suitable markets and developing the right patents (IPs). The funding aims at supporting the shift from planning phase to start-up phase. The funding scheme was initiated by the Dutch Ministry of Economic Affairs and is implemented by the Netherlands Enterprise Agency and the Technology Foundation STW. The funding is a loan that must be paid back with an interest. The total volume of funding was 9.5 million euros in 2016.¹⁹⁷

Innovation credit is a funding instrument for risky innovation projects of SMEs. To be eligible for funding, projects must be technologically innovative and unique to the Netherlands, Bonaire, St. Eustatius or Saba. The technical feasibility needs to be established in the application of the fund, and all activities up to and including the testing of prototypes must be able to be supported. Funding is granted as a direct loan.¹⁹⁸

New Ways to Export, Denmark

The programme has two target markets: New York and Shanghai, where it has established a local presence at cleantech hubs. These markets are estimated to have significant unexploited business potential for Danish cleantech businesses. The members of the partnership pay a fee for the activities and services of the cleantech hubs. The partnership comprises the Danish Industry Foundation, State of Green and the University of Southern Denmark. Members of the partnership include companies, research institutions and regional bodies. The programme was kicked off in 2016 and will run for two years.¹⁹⁹

¹⁹⁵ Federal Ministry of Science, Research and Economy (bmwfw) of Austria (2017)

¹⁹⁶ Nachhaltigwirtschaften, Technologies for Sustainable Development, webpage

¹⁹⁷ Netherlands Enterprise Agency (2017a)

¹⁹⁸ Netherlands Enterprise Agency (2017b)

¹⁹⁹ Confederation of Danish Industry (2017)

Demo Environment Programme, Sweden

The Demo Environment programme focuses on cleantech products, systems, processes and services related to water, sanitation, ecosystem services, energy and urban development. The programme has different financing instruments for international technology transfers. It grants a “Planning grant” for companies to explore new markets and research the technology’s impact on the environment and poverty reduction. Secondly, it provides financing for local actors in demonstration projects (“Demonstration Project grant”) to help them import technologies that offer solutions to local environmental challenges. The grants are awarded on a competitive basis. The Seller in a partnership can apply for a Planning Grant, and the Buyer can apply for a Demonstration Project grant. All payments are made retrospectively based on actual costs. The Demo Environment programme is financed by The Swedish Agency for Development Cooperation (Sida) and managed by The Swedish Agency for Economic and Regional Growth (Tillväxtverket).²⁰⁰

Strengthening business ecosystems

Cleantech cluster CLEAN, Denmark

CLEAN has a strong international focus and a mission to accelerate the green and sustainable transition and growth of the Danish cleantech sector. It develops and operates projects that are focused in, among others, network activities, technology development, strategic platforms etc. All projects are developed and implemented together with CLEAN’s members. The project financing comes from the EU (i.e. Horizon 2020 funds), public funding schemes (national, regional, local), philanthropic foundations and in a few cases participation fees. The projects fall within CLEAN’s four focus areas; Smart Energy, Environment, Smart City and Internationalisation. CLEAN has also good international networks, and some of the projects are implemented as an international collaboration.²⁰¹

Scale-Up is an example of a collaboration project between CLEAN and other European cleantech clusters: Cambridge Cleantech (UK), Clean Tech Delta (Netherlands), i-Cleantech Vlaanderen (Belgium) and Cleantech Inn (Sweden). The project is co-funded by the European Union. In Scale-Up, CLEAN has a goal of catalysing the international uptake of 25 novel green products and services by large corporate buyers. The project emphasises connectivity between the clusters in order to speed up the market introduction of innovative cleantech products and services.

The concrete goals of the project are: 5 established clusters connected; 50 transnational match-making events; up to 250 innovators financially supported in transnational business development; and 300 innovators provided with skills to serve industrial markets.²⁰²

Green Tech Cluster Styria GmbH, Austria

Green Tech Cluster Styria is an example of a strong regional ecosystem focusing on growth on green innovation. It is home to 180 companies and research organisations, and owned and funded by both private and public, mainly regional governmental, actors. Founded in 2005, it provides support for RDI project development, assessment of technology trends and market opportunities as well establishing global contacts. It aims to launch 100 new innovation projects over 5 years and actively drive the development of the Green Tech location. Cluster partners have tripled their sales and doubled the number of employees in the ten years the cluster has been in place. In return of an annual fee for the partnership of the cluster, partner organisations are offered access to international networks as well as different activities and services such as business-to-business meetings, open innovation tools, strategy consultancy as well as providing market information and access to international networks. Other services include among other Green Tech Innovators Club, Green Tech Radar magazine, and Green Tech Circles. It is financed by the contributions of the cluster partners, project revenues and funding of the proprietors and the European Union. Annual fees for companies vary from 750 to 5 900 euros. Start-ups are encouraged to be part of the ecosystem with highly attractive fees: 1st year 1 euro per month, 2nd year 1 euro per week and 3rd year 1 euro per day.²⁰³

Los Angeles Cleantech Incubator (LACI)²⁰⁴

LACI was founded in 2011 as a cluster-driven economic development initiative supported by the City of Los Angeles, The Los Angeles Department of Water and Power (LADWP) and the Community Redevelopment Agency of Los Angeles. Recognised as one of the most innovative business incubators in the world by UBI, LACI identifies local entrepreneurs across multiple cleantech business sectors. Since its inception, LACI has helped 67 companies raise \$134M in funding, created 1,500 jobs, and delivered more than \$335M in long term economic value for the City of Los Angeles. LACI operates out of the La Kretz Innovation Campus, with satellite offices at California State University,

²⁰⁰ Swedish Agency for Economic and Regional Growth (2017)

²⁰¹ CLEAN company website

²⁰² CLEAN (2017)

²⁰³ Green Tech Cluster webpage

²⁰⁴ It should be noted that the Cleantech Ministerial Mission to Los Angeles led by Secretary General of Ministry of (TEM) Mr Gustafsson and accompanied by 20 Finnish companies in the fall of 2016 included a series of meetings at LACI.

Northridge and Silicon Valley. It is the organiser of an annual Cleantech Global Showcase and founder of the Network for Global Innovation (NGIN).

LACI has a centralised, downtown physical location where entrepreneurs, engineers, environmental organisations and policymakers can collaborate, promote and support the development of clean technologies. In addition to being home to LACI and an ecosystem of thought leaders, the Campus has 30,000 sq.ft. of office and event space along with the region's most sophisticated Advanced Prototyping Center where members can design, build, test, certify and manufacture products all under one roof. Features include an electronics lab, chemistry lab, cell lab, CNC center, water jet center, welding shop, 3D printing shop, premium CAD workstations, laser cutters, woodworking, an assembly bay, and training centers.

State of Green, Denmark

State of Green has a strong international focus, aiming at attracting foreign partnerships and trade. As one gateway to Danish cleantech expertise, it provides an easy way for potential partners and customers to explore Danish cleantech sectors, find solutions and connect with Danish expertise. Their internet pages include an active news section. In its Green Toolbox, it has gathered materials to promote Denmark's green solutions abroad including white papers, brochures and leaflets as well as infographics to be used, for example, in speaking engagements and delegation visits. It also organises tours to green sites in Denmark for visitors. It is a Public-Private Partnership founded by the Danish Gov-

ernment, the Confederation of Danish Industry, the Danish Energy Association, the Danish Agriculture & Food Council and the Danish Wind Industry Association.²⁰⁵

Vinnväxt competition for regions, Sweden

The Vinnväxt programme aims to develop internationally competitive research and innovation milieus in specific growth fields in Sweden and catalysing a broader transformational change in society, towards innovation-driven sustainable growth. In the competition, a national call for proposals is announced. Based on the proposals, the best regional innovation systems to be supported are selected. The winning proposals must contribute to the Agenda2030 goals and Swedish priority areas within it, which are: smart cities, transportation, industrial symbiosis, materials, health and circular economy. The winners are granted an annual 0.2-0.8 million euros funding for ten years. After 1, 3, 6 and 12 years from the beginning of funding, the supported initiatives are evaluated. Further funding is dependent on the evaluation outcome. Financed initiatives are also required to apply for funding from other sources and make plans with a long-time perspective. During the period of financing, the initiatives must develop new patterns of regional, national and international cooperation that lead to more efficient innovation processes. Cooperation must include businesses, research and public sector. To date, some 200 initiatives have applied for funding under Vinnväxt's five calls for proposals. Of these, 17 regions have been declared as winners and have received funding.²⁰⁶

²⁰⁵ State of Green, About State of Green webpage.

²⁰⁶ Vinnova, Om Vinnväxt (in Swedish) webpage

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