Multi-KETs pilot lines project

The goal of the Multi-KETs-PL project is to prepare and foster
a common understanding and consensus for future actions
in Europe focusing on Multi-KETs pilot lines

Multi-KETs-PL working document

Country report Finland

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- Netherlands organisation for Applied Scientific Research TNO
- Fraunhofer-Gesellschaft
- Commissariat à l'énergie atomique et aux énergies alternatives (CEA)
- Cambridge University-Cambridge enterprise
- VTT
- Tecnalia
- Technology Partners Foundation
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Content

1. Policy perspective

1.1. Country specific innovation system with emphasis on KET

In this section, we will focus on the Finnish KET innovation system. Finland is a sparsely populated country with 5.4 million inhabitants, a large land mass (the 8th largest country on the continent) and an isolated location in Northern Europe. In terms of R&D spending, Finland's gross domestic expenditure on R&D (GERD) represents 3.9% of GDP that is the highest figure in EU-27 (Eurostat 2010). Especially, the share of business expenditure on R&D (BERD) is considerable and business accounts for more than 70% of all R&D investments (Statistics Finland 2012). Despite the economic downturn, the total amount of R&D spending has remained on a stable level of c. 7 billion euros in 2008-2012 (Statistics Finland 2012).

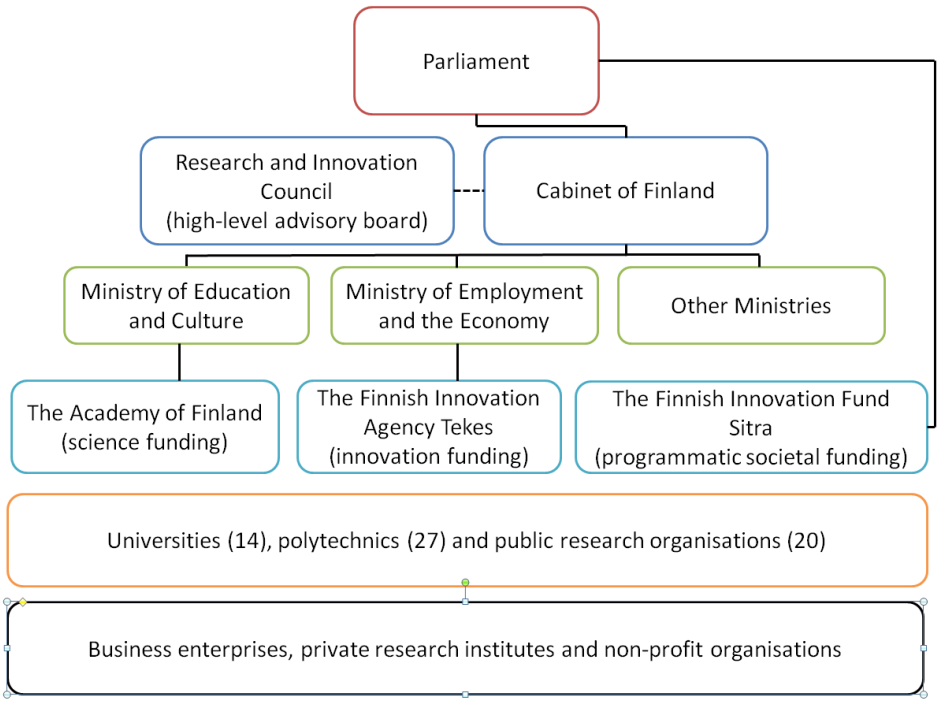

Figure 1. The Finnish innovation system. Source: research.fi (revised by authors)

In the Finnish innovation system, the Parliament and the Cabinet define the general outlines of innovation policy with assistance from a high-level advisory body, the Research and Innovation Council. Directed by the Cabinet, the Ministry of Education and the Ministry of Employment and the Economy account for over 80% of all government research and innovation funding. The Ministry of Education provides both basic funding of the higher education sector and competitive research funding through the Academy of Finland. TEKES, the Finnish Funding Agency for Technology and Innovation, operates under the auspices of the Ministry of Employment and the Economy and allocates money for business R&D projects and joint projects between the academia and companies. In 2012, TEKES funding accounted for c. €570m (TEKES 2012). There are several public research performers in Finland including 14 universities, 27 polytechnics and 20 public research organisations. The largest public research performers are University of Helsinki (€306m), Aalto University (€204m) and the VTT Technical Research Centre of Finland (€282m) (Statistics Finland 2012).

Key enabling technologies have been addressed by multiple programmes by both TEKES and the Academy of Finland. For instance, there is a successive chain of TEKES programmes that have supported industrial biotechnology and nanotechnology since the 1990s, such as the SymBio programme with the total funding

volume of €65m in 2006-2011 and the FinNano programme with the funding of €70m in 2005-2010. Also, the Strategic Centres for Science, Technology and Innovation (SHOKs), which are public-private partnerships launched in 2007-2009, have focused on key enabling technologies in the areas of energy & environment, bioeconomy and metal products & mechanical engineering.

1.2. Organisation of Multi-KETs policy

The main actors for Multi-KETs match making activities are the Ministry of Employment and the Economy (hereafter referred to with TEM), VTT Technical Research Centre of Finland, Universities and SHOKs. SHOKs are strategic centres for science, technology and innovation representing networks of private and public players aiming at breakthrough innovation within focused fields, a unique characteristic of the Finnish innovation system. SHOKs have gained a lot of experience how to organise research between different partners and how to benefit from a combination of different technologies (see previous section).

- **The policy for Multi-KETs pilot lines has to be seen as a part of the broader pilot line policy.**

Currently there seem to be no specific policy measures available that aim at encouraging the combination of different key enabling technologies in the context of a pilot line. In Finland there is a trend to be more preoccupied with value creation (demand pull or market based) than with technology (technology push) as such. Clearly TEKES follows certain technology and industry trends when funding new projects. However, currently Multi-KETs do not appear as key funding criteria of TEKES and projects. Technology and the combination of technologies and its complexity should not be an aim as such. Very often one technology is the key technology in a pilot line while naturally other technologies may feed into those. This means that the multi dimension can be expected to be present in many pilot lines. The next section will therefore describe the policy instruments in the context of pilot lines as currently no specific political initiatives are heading for Multi-KETs explicitly. As a consequence it is still too early to measure and evaluate the success of Multi-KETs policy in Finland.

1.3. Main policies for Pilot Lines

The second focus of our study lay on Pilot lines. The following chapter deals with supporting structures for the implementation of technology based pilot lines. Historically pilot line activities have been around for decades in Finland. However, the appearance of investment intensive projects, or big scale projects, seems to be a new phenomenon. Albeit the recent work of the European Commission has put pilot lines back on the Finnish policy agenda currently no holistic Finnish policy approach for pilot lines exists.

- **A first observation on the Finnish perspective is that there is a lot of heterogeneity of how policy makers interpret pilot lines.**

An important distinction policy makers underlined is the one between small scale pilot lines and bigger scale pilot lines. The latter were referred to with the word “demonstrations” while the former or small scale projects were associated with “piloting activities”. Big projects were described as “demonstrations of industrial processes” while small scale projects were defined as “demonstrations of software”. This variation in interpretation of policy makers clearly originates from the heterogeneity in scale and the scope of pilot lines and from the current lack of a holistic Finnish policy approach towards pilot lines.

Table 1: Classification of Finnish policy measures and examples

A. Policies for knowledge base support	**B. Policies for commercialization support**
• Instruments to encourage applied research ➢ R&D subsidies for SMEs, big firms and research organizations ➢ R&D tax credits for SMEs supplement	• Risk loans for SME’s: TEKES loans are specifically intended for projects that result in a marketable product or service or a new business concept

R&D subsidies and can be obtained during the period 2013-2014 after which the scheme will be evaluated. ➢ Public funding ➢ Tax incentive for business angels investing in SMEs. ➢ Asymmetric returns in Venture Capital funds: where the public investor(s) only require certain level of return on investment (under discussion)[1] ➢ Vigo Accelerator program: which prepares promising companies for international venture funding[2] ➢ IPR box which would imply a lower corporate tax rate for revenues from IPRs (under discussion) • Instruments for strengthening co-operation among stakeholders and disciplines ➢ SHOKs: Strategic Centres for Science Technology and Innovation: carry out long-term cooperation in fields most crucial for the future[3] ➢ National R&D programs: TEKES and Academy of Finland ➢ FiDiPro (Finland distinguished Professor Programme): to foster long-term cooperation with top international experts ➢ Team Finland: coordinates public internationalization support both separately and in coordination with the Growth Track service ➢ Finnish public research institutes such as VTT	• Instruments to encourage the collaboration between public and industrial research. ➢ OSKE (Centre of Expertise program, 2007-2013): public program that promotes commercialization of knowledge and know-how that generates new products and services. ➢ SHOKS: Strategic Centre's for Science Technology and Innovation: carry out long-term cooperation in fields most crucial for the future cooperation[4]
C. Demand oriented polices • Finland has accelerated the use of **public procurement** and has set targets for certain sectors (1% for Cleantech)[5]. • Application of public procurement in the context of pilot lines (under discussion) • Finnish subsidies for renewable energy • Standardisation[6]	**D. Legislation** • Finland has accelerated the use of **public procurement** and has set targets for certain sectors (1% for Cleantech)[7]. The instrument is being discussed in the context of pilot lines.

- **A second observation is that in Finland many actors are involved with pilot lines but there is no clear ownership over the topic and its policy, hence the lack of coordination and holistic approach.**

To curb this situation TEM (Ministry of Employment and the Economy) has recently appointed a person in charge of coordinating the actions of the different players as a starting point to a holistic Finnish policy

[1] For a report that discusses a selection of the latest policy trends and tools to renew the Finnish economy see Nordic Innovation (2012), p.51-52.
[2] For more info on the VIGO program see http://www.vigo.fi/frontpage.
[3] For more information on the SHOKS see http://www.shok.fi/en/
[4] For more information on the SHOKS see http://www.shok.fi/en/
[5] For the latest national Finnish legislation on procurement see: https://www.tem.fi/index.phtml?l=en&s=2007
[6] For the latest standardization activities in Finland see http://www.sfs.fi/en
[7] For the latest national Finnish legislation on procurement see: https://www.tem.fi/index.phtml?l=en&s=2007

approach of bigger scale pilots. In addition a specific budget has been proposed by TEM to the Finnish government for the set-up and expansion of pilot lines. However, the status of this proposal is currently on hold.

- **A third observation is that Finnish pilots are mainly concentrated on the industries of forest and chemicals, energy, raw materials and metal. In addition a pilot line has emerged in the field of printed intelligence.**

EU structural funds have been important for setting up pilot lines in Finland both for private and public projects. Big investments in pilot lines that cost between 10 and 100 million Euros are dependent on EU funding. In the case of such huge investments small countries depend even more heavily on EU funding than the bigger EU member states. For financing pilot lines, the dependence on European funding has existed for several years. Applying for EU support can be time and resource consuming. In some cases, regional funding has flown to pilot line activities that had to be shut down as EU funding dried up. However, policy makers and other stakeholders built their competences during those experiences.

Table 1 lists and categorizes the army of national policy instruments available to the Finnish economy. The national support of pilot lines currently mainly happens through **loans of TEKES** that are specifically developed for the set-up and development of demonstrations and pilot lines. In addition it has been underlined that as part of the Finnish industrial policy actions **public procurement** could be an important instrument for allocating policy attention to pilot lines. Certain sectors (recycling waste, construction, transport) have received special attention in the form of earmarked targets within the innovation budget. An overarching field of activity that has obtained such a position is cleantech, for which 1% (or about 300 million Euros) of the procurement budget has been allocated as a target. The Finnish trend towards more public procurement is not only characterised by quantity but also by quality. TEKES has recently launched a programme on Smart Procurement (2013-2016) to speed up the introduction of innovations through procurement excellence and the development of markets. The programme focuses on those sectors which are addressing the major societal challenges, and where the public sector has a significant role in the market development. Private strategic procurement also holds an important position.

In addition **Public Private Partnerships (PPP)** where the public sector and municipalities and regions provide platforms for companies to pilot and demonstrate their solutions can be seen as a broad policy instrument that could be applicable. Platforms can be understood in terms of infrastructure, transport and public health services. The notion of shared platforms has for example been used in the INKA programme that will focus on innovative cities in next years.[8]

- **TEKES is the main public financer for R&D activities in Finland and pays increasing attention to value networks and allocation of support between SMEs and large companies (see table 2)**

TEKES R&D funding for large and very large enterprises

For larger enterprises TEKES funding is available for R&D projects that foster the renewal of an enterprise's business operations. TEKES encourages large enterprises to internationalise their R&D efforts and to work

[8] For more information on the INKA programme see http://www.tem.fi/?106266_m=110123&l=en&s=4712 .

Table 2 An overview of the all R&D funding instruments of TEKES

Maximum funding for SMEs (as a percentage of project costs)		
Nature of the project	**Grant, %**	**Loan, %**
International joint projects and their preparation	65	
Research-intensive and challenging development projects	50	
Challenging development projects of products, business operations, methods and services	35 or 25 and	70 25
Productisation, pilots, demonstrations, test production and validation		70
Aid for innovation advisory services	75	
Work organisation development	50	

Maximum funding for enterprises/groups with a maximum of 2,000 employees (as a percentage of development project costs)	
Nature of the project	**Grant, %**
Research-intensive, long-term, challenging development projects involving a large network • 100% of the project must be research, level of challenge: at least demanding international level, 20% outsourced or a joint project*	50
Actual international joint projects • a minimum of 80% research • level of challenge: at least demanding international level	50
Challenging projects to develop products, business operations, methods and services • at minimum 60% research • level of challenge: at least national top level	35
Project preparation and preliminary studies • granted exceptionally, in particular for indirect impacts	50
* Subcontracting or a joint project.	

Maximum funding for enterprises/groups with over 2,000 employees (as a percentage of development project costs)	
Nature of the project	**Grant, %**
Research-intensive, long-term and challenging development projects involving a wide network • 100% of the project must be research, level of challenge: at least international top level, 30% outsourced or a joint project*	50
Challenging development projects in a network • 80% of the project must be research, level of challenge: at least demanding international level, 20% outsourced or a joint project*	35
Challenging projects to develop products, business operations, methods and services • at minimum 60% must be research, level of challenge: at least national top level	25
Project preparation and preliminary studies • granted exceptionally in particular for indirect impacts	50
* Outsourcing or a joint project/international cooperation, for example JTI, Art 169 programme or Eureka; in research based projects, also public dissemination of results	

Source: TEKES

together with SMEs and research organisations. TEKES programmes offer excellent opportunities for cooperation and networking. With TEKES innovation funding, an enterprise can research and develop:

- products and techniques
- services and new business concepts
- trial production and demonstrations
- organization and management practices of the workplace.

TEKES experts will examine the project plan, targeted business activities and the enterprise as a whole. The experts will evaluate the market need, novelty value, competitive situation and customer benefits of the innovation proposed by the customer and the effectiveness of TEKES funding in the case in question. Innovation funding cannot be granted for ordinary business (or: business as usual) activities or their continuous development.

Enterprises based in Finland are eligible for innovation funding for projects that aim to develop products, services, production methods or business concepts. As a part of an R&D project, an enterprise may also develop its skills and operating methods.

The share of funding provided by TEKES depends on the research focus and novelty value of the project and the extent of cooperation. Funding granted for the projects of large enterprises may cover 25%, 35% or 50% of the costs, depending on the nature of the project.

Pilot and demonstration projects may be implemented by a company to prove the performance, usability and financial lucrativeness of new technologies and techniques on a commercial scale. Funding for these projects is usually granted as a loan, and it can be jointly funded by TEKES and other funding agencies.

Enterprises may also apply for TEKES funding for innovative projects that seek to develop the operating methods of the workplace. The changes improve both productivity and working life quality. The management and staff engage in development efforts together. TEKES may approve innovation funding for reasonable and justified costs arising from research and development efforts, including salaries, indirect personnel costs, overheads, travel costs, materials and supplies, hardware costs and outsourcing of services.

TEKES R&D funding for SMEs

For SMEs, TEKES will fund a part of the project's costs. The greater the novelty value of the innovation and the longer the period before anticipated commercialisation, the larger the investment TEKES may provide. The enterprise must always prove that it has the capacity to cover its own funding share of the project. Project funding may not include any other public aid. In TEKES innovation funding for SMEs, 35% or 50% of project costs may typically be covered by a grant, or 70% by a loan. The loans are specifically intended for projects that result in a marketable product or service or a new business concept. The loan is a risk loan granted without a security. The funding can also be granted as a combination of a loan and a grant. Funding for SMEs intended for preparing R&D projects is available from Centres for Economic Development, Transport and the Environment (ELY keskus). TEKES may approve funding for reasonable and justified costs arising from development efforts, including salaries, indirect personnel costs, overheads, travel costs, materials and supplies, cost of equipment, outsourcing of services.

Box 1 The major national public funding for pilot line activities in Finland comes from the Finnish Funding Agency for Technology and Innovation (TEKES).

TEKES funding for trial production and demonstrations embrace all kinds of pilot line activities, 'irrespective' of the associated technologies. The choice of TEKES instrument and extent of financial involvement that can be used for pilot line activities varies by the size of the company. The table below summarizes the key TEKES instruments for the targeted support of pilot line investments.

In the majority of the cases big industry players establish pilot lines for own use. Industry makes use of public funding where available or may develop projects fully based on private funding, too. Pilot lines involve considerable investments. Consequently, most SMEs do not have access to pilot lines either because of the lack of open access or the lack of funding.

For SME activities (firms up to 249 employees) related to productization, pilots, demonstrations and test production and validation, TEKES can give out loans for a maximum of 70% of the project costs. The loans are risk loans that do not require any guarantees. In practice risk loans imply that the loan can exceptionally be forgiven in case if the project does not generate any income that allows the paying back.

For big firms, the support of TEKES for investments in pilot lines and their operational costs also happens via loans. However, smaller maximum shares are applied and in practice TEKES finances between 25% and 40% of the total project cost. Naturally for very big projects (for example 20 million EURO projects) TEKES applies smaller shares of financing.

Table 3 TEKES specific instruments for financing demonstrations and pilots

TEKES funding anno 2013	Grant	Loan
SME[a]	*Costs of using public shared facilities	*Pilot line investments and operational costs are finance by risk loans
	can be booked as overheads in R&D projects	*maximum 70% of the project cost
Big firms	*Laboratory work related to pilot lines can be	*Pilot line investments and operational costs are finance by risk loans
	financed with grants in seperate R&D projects	*Case by case evaluation: usually 25% to 40% of te project cost
		*For very big projects Tekes applies smaller shares

Notes: [a]The SME rules tabulates apply for activities related to productisation, pilots, demonstartions, test production and validation.

In addition to policy instruments that support direct investments in pilot lines TEKES also offers standard instruments supporting R&D activities. In practice firms can obtain grants for laboratory costs that are related to pilot line activities but this involves additional R&D project applications. In the overheads of supported R&D projects SMEs can also include costs of using public shared facilities such as pilot lines. For public research institutes TEKES does not directly pay investments in equipment but these costs can be covered via the overheads of R&D projects.

At the national level specific energy related pilot line projects can obtain public support from the energy programs at TEM (Ministry of Employment and the Economy).

At the local and municipal level no particular instruments for pilot line investment exist. Evaluations and decisions are done case-by-case and ELY centres have investment subsidies that may be used for commercial production projects. There is, however, a lot of variation over regions.

One final policy dimension that has come under our attention is that the competition for pilot lines is played at a global level. Important industry players get many offers from around the globe to make investments in infrastructure. Attracting bigger scale pilot lines are a clear target for nations as they may be the very beginning of a whole new cluster and market to be developed. In the case of EU funding and Finnish national funding, their overall relationship is characterised by complementarity. However, single EU member states may be competing with other EU member states backed up by EU funding. The focus of the EU should however not be on competing EU countries but rather on trying to set-up strategically important pilot lines in Europe as to make them as competitive as possible on a global scale.

2. Business perspective

2.1. Implementation of Multi-KETs pilot lines

The views of the industrial players interviewed are summarized below:

- For industry demand pull is more important than technology push. Listening to the markets and the trends is crucial. Setting up of pilot lines always happens in connection to the market needs. The main message of the industry is that everything that is done should have a commercial purpose.

- There are three different models of pilot lines:

    1. In the first model, an industry player builds a pilot line in cooperation with the client. Pilot lines are only built if needed, preferably on a small scale. Larger scale pilot lines are set up if it looks promising. For industry, this is by far the most important model of operation.
    2. In the second model, there is a publicly-owned pilot line where all kinds of players from around the globe buy testing time.
    3. In the third model, there is a real consortium between universities, RTOs, industry players and public bodies, and ownership is shared.

It can be expected that the implementation and operation of the pilot line differs between each of the above models.

- There are different success factors for implementing a Multi-KETs pilot line, the following three are key:

    - Existence of a clear market need
    - Cooperation with existing industry and financial commitment from industry (risk sharing)
    - Setting up start-up companies around the pilot line with the aim at making those companies your customers one day.

- The main channels for “inter-technological” communication are running via the use of advanced materials, components and machinery in the pilot line.

- The pilot lines should be built so that they cover all stages in the value chain. Advanced materials could be in upstream of the value chain, advanced manufacturing technologies of the manufacturing firms in the middle and the end users and applications in downstream.

- The ultimate aim of Multi-KETs pilot lines should be to work with the best players in the relevant field on the planet, also when these players are not Finnish or European. To capture value for Europe should happen via setting up start-ups that feed into and grow through the global networks and know-how of these players. But to benefit the Finnish/European economy one needs to link in Finnish/European networks too. However this global and most ambitious approach may lead to the fact that the access to national and even European funding is cut off. This means that the market for pilot line funding is actually global.

- The selection of other KET-suppliers is fully based on excellence. Once again this is a global game.

- Combining two technologies is already pretty complex, and in case of more than two one may lose control.

- Multi-KETs paradox: it is difficult to get industry aboard of shared pilot lines that are by nature advanced in technology and manufacturing readiness. One of the main rules or barriers for the implementation of

Multi-KETs pilot lines is that industry players want to own all the IPR in their core strategic field. This means that cooperation is only possible in case when core technology is not shared. This also explains the fact that industry is reluctant to cooperate when the commercialisation stage is approaching. Interesting to not here is that in some cases a client can get a temporary monopoly on the licence use of a patent after which it is opened up and the client can get royalties from that.

- Overall, Multi-KETs pilot lines are rather a business of public players than that of industry. They can be important to build up capacity and human resources in the long term but companies basically think very short term as results have to be obtained to the market as fast as possible.

2.2. Evaluation of KET policies/KET innovation eco-System

- The main instrument fostering a Multi-KETs know-how network is the creation of new markets.
- In Finland there are two main drivers for the set-up of Multi-KETs pilot lines.

    1. Companies see the pilot line activities involvement as a way to open up new markets. These can be e.g. suppliers of materials or machinery. Companies do also get involved in pilot lines to be able to have future access to the best knowledge creation and human capital.

    2. Multi-KETs projects are instrumental for competence building in universities and RTO's. In Finland VTT has been a key player in Multi-KETs activities.

- The location of the set–up of pilot lines are influenced by regional politics.
- Industrial policy influences the field in which pilot lines are supported. Currently Finland focuses very much on the overlapping fields of cleantech, energy and mining.
- The main barriers in implementing Multi-KETs based business is the fact that very often markets don't exist yet. This means that technology and markets have to be developed at the same time.
- A more focused policy is needed, the danger is that too many projects receive too little funding. The scale and scope of activities is often highly important.
- As subsidies for pilot line activities often dry up, it is important that the activities can become viable over time independent of subsidies. Once again there is a need for a clear strategy and purpose for investments that are made in pilot lines.
- Pilot line activities are very expensive and too often this leaves out the smaller players and newcomers. By default, pilot line activities easily remain as a big player's game, unless mechanisms are built to change this.
- Not only should the initial investments in pilot lines be supported. Also the updating and maintenance of the facilities requires national and EU funding.
- For recent pilot line activities the use of policy instruments has been mainly TEKES loans and grants and FP7 funding. For industry, the good thing about FP7 has been that it pays half of the R&D costs while the downside is the request to include many partners in the consortia. In general applying for EU funding involves a lot of administration and uncertainty. This often excludes the smaller players to invest their limited resources to this process. According to industry, the downside of the national TEKES funding is the fact that it only covers 25% to 35% of the costs of industry while other players get greater shares.

3. Conclusions

3.1. Summary of policy perspective

- To put Multi-KETs on the national agenda is a long process. Therefore it may not come as a surprise that the Finnish awareness about the importance and potential benefits of Multi-KETs is still limited.
    - Although the Finnish government indicated in 2012 that KETs are an integral part of TEKES funding the awareness of Multi-KETs is still very limited in Finland and our project has been raising the awareness of the potential of the Multi-KETs funding for global competitiveness. In past, the Ministry of Employment and the Economy used to follow technologies more closely but nowadays takes a more general approach. However, in Finland it is TEKES that pays close attention to the evolution of technologies. Recently it was stated that certain TEKES programs do not address the higher readiness levels and policy makers started to address this issue. In addition some experts at RTOs and universities are following the issue very closely and their expertise can be an important input during the preparations of a new policy approach towards Multi-KETs pilot lines.
- Although pilot lines are not new to policy makers, a holistic policy approach towards pilot lines in general and Multi-KETs pilot lines in particular does not exist yet but is being prepared.
    - The issue is complex as there are many players in the field but no clear ownership. In Finland, there may currently be a considerable chunk of public support available for pilot line activities, but due to a grey zone in responsibilities companies and research organisations may have difficulties in finding out where to apply for it. In a healthy holistic approach policies for pilot lines should be interacting at different levels.
- The key question is how Europe can benefit from pilot lines?
    - As Finland is a small EU country it is of utmost importance that it has access to European funds enabling unwinding of pilot line projects which are investment intensive. European funding has to be used for really big projects with European relevance and added value. National and EU funding should therefore be complementary. It is important to stress that European funding of pilot lines should be benefiting the EU as a whole so that it adds strategic long term value and increases EU's global competitiveness.
- The main policy instruments to support pilot line activities in Finland are:
    - Risk loans from TEKES
    - R&D subsidies from TEKES
    - Public procurement: setting innovation budget targets for investments in pilot lines has been under discussion in Finland. Public procurement policy seems to be promising in encouraging the private sector to co-invest in expensive pilot lines. The parliament recently voted on minimum quota of subsidies going to Cleantech. This fits in the broader agenda of tackling grand challenges such as climate change. Connection between Multi-KETs and grand challenges is crucial.
    - National and EU regulation: setting climate targets is a strong enabler for bioenergy investments and investments for resource efficiency.
    - FP funding: It was mentioned that the fact that FP7 requires cooperation limits industry cooperation in consortia mainly to upstream development activities. Private players want to do closer-to-market activities on their own.

- Structural funding

- Smart specialisation agenda intertwines with Key Enabling Technology agenda: Regional policy perspective is very important as regions are encouraged to specialize in the technologies at which they are good. As such, the Multi-KETs agenda goes hand in hand with the regional policy.

- If the investment is not in Finland, Finnish subsidies are out of the scope, the same holds for the European perspective. Global competition for attracting pilot lines is very high.

3.2. Summary of business perspective

- The awareness of the potential benefits of Multi-KETs pilot lines in Finnish industry is still limited but rising. There exists an accelerating Finnish industry commitment in the field of Bioeconomy, Cleantech, Sustainable Mining, and Electronics (Printed Intelligence).

- For industry, setting up pilot lines is always based on market trends. This demand pull view contrasts with the technology push view of many RTOs and universities. Multi-KETs pilot activities should not be done because they get funding but they should be done because somebody is eventually willing to buy the products and services they develop. Mapping the needs is the first thing that should be done. Willingness to pay is a good proxy for needs. Shared facilities should always be based on industry commitment, and never be accessible for free. Life cycle of pilot lines is important, if not needed anymore one has to drive down the pilot line or rearrange things. It is also important to distinguish between small scale-pilot lines (experiments) and big-scale pilot lines (industry commitment needed from the start).

- Finnish companies should be more aware of EU funding. Only big players can devote resources to screening EU funding opportunities. This typically leaves out the SMEs. It is also important to note that EU funding is often seen as cumbersome to apply for by industry players. An important indirect effect of EU funding is that it may give you the visibility you need for your new technologies.

- The existence of what we define as a *KETs-paradox* is problematic: companies only bring strategic knowledge to the table at the research stage. Close to the market cooperation becomes more difficult as companies typically want a monopoly on IPR or market share. Therefore very often the pilot line is owned by the private player and their clients in the value chain. Private players want to own all the patents. However, clients sometimes obtain a temporary monopoly on the licence use of a patent after it can be opened up and the client can get royalties from that. If a pilot line is owned by a private sector, it very often happens that no other players come into the scope. This means that many pilot lines do not involve any public players although they may nevertheless have enjoyed subsidies.

- Regulation in the form of targets enables people to cooperate and share risk in the context of pilot lines.

- There is a lot of international competition for attracting the establishment of pilot lines. This is true within Europe but increasingly the game is being played at the global scale. Subsidies may sometimes play a crucial role here, in parallel with the markets and human capital available.

- Several pilot lines have been failures. However, stakeholders have acquired lots of valuable knowledge during these endeavours.

3.3. Recommendations to support pilot lines

- The support of pilot lines should be based on a holistic approach that coordinates the actors of the regional, national and European level. All pilot line activities should contribute beyond the national level so that it enables Europe to be a respected competitor on the global scene.

- A challenge is that it is difficult to know formally, if a pilot line is Multi-KETs or not. If there is a tendency to call all pilot lines Multi-KETs then the usefulness of the terminology is hollowed out. On the other hand, if only very few sectors can fall under Multi-KETs then Multi-KETs policy equals industrial policy.

- Pilot lines should be based on a triangle of players: (1) You need the company that delivers the technology, (2) you need the client that trusts in you to build the technology on a commercial scale and (3) you need public support to bear risk and make it work, either money or regulations or both. Money speeds up the pilot-line activities considerably. Industry has always to be involved, even if it is only by delivering raw materials or energy, there needs to be an industry commitment. In general, however, companies are reluctant to enter long term projects that are too far from the market.

- It has to be underlined that economic impact should be the target of Multi-KETs pilot lines while multi-technology is one way to reach that target. On average the Multi-KETs approach is still very much a technology push story. KETs are mainly pushed by research organisations and the risk is that it stays too much research-oriented and lacks commercial use. Europe has to prove that these pilot lines actually can lead to commercialisation and things don't get stuck at the level of research.

- Based on previous pilot line experience, certain minimum conditions are required to guarantee the success of a pilot line. Indeed, setting up and running pilot lines involve lots of economic uncertainty. At minimum, the following four conditions are required to guarantee continuity of the core activities if subsidies dry up over time:

    1. The dependence on subsidies is of timely nature
    2. Market players show clear and stable commitment to the pilot line activities. There has to be a clear need from industry for the set-up of new pilot lines. Ideally end users should be involved in pilot lines from the beginning.
    3. Modularity and flexibility of the pilot line
    4. The pilot line activities will address grand challenges and will have long term societal impact in addition to mid-term economic impact.

- Considering the size of the pilot lines is important. Most players should have small pilot lines, and in case when modelling can be used, it should always be preferred to piloting or at least both should be combined. Also the use of sophisticated instrumentation is crucial.

- Long term finance planning: There needs to be a clear long-term business plan for the pilot line and its financing. Next to the set-up and operation, the financing of the maintenance and updating of pilot lines has to be taken into account.

- Very often the players involved in pilot lines are large enterprises. SMEs should have access to pilot lines but very often they lack the money to buy time. Specific subsidies could be a solution here.

- Connection between public support and shared IPR can be problematic. Some want public funding but do not want to share IPR or vice versa. On the upside, "non-strategic" knowledge can create some really new outcomes.

- Cooperation in the context of pilot lines has to take the following aspects into account if it is wanted to function well:
    - Timing of stepping into a pilot line matters a lot.
    - Heterogeneity of the network is crucial.
    - Feedback is a key measure to set-up cooperation. Financial commitment of current and new members is the perfect measure for feedback.
    - Pilot line activities need to be based on trust but also on real rules.

- The potential power of pilot lines in educating people and forming human capital for future industry needs cannot be underestimated and should be fostered.

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4.2. Interviews

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5. Annexes

5.1. List of pilot lines in Finland (existing ones and under planning)

Raw materials:

- Establishing a new urban mining pilot plant in Rajamäki: The purpose of the pilot plant is to develop selective, clean and affordable technologies for waste processing. The plant will increase the recycling rate of critical and valuable metals through a) selective pre-treatment methods and b) a hybrid combination of biological and chemical leaching and other recovery technologies. The pilot is located in Rajamäki where VTT already has several pilot activities, and owned by VTT an Aalto University. External actors, especially SMEs and universities, are offered to provide with raw materials and processes to be tested at TRL levels 4-6. Investment costs for the pilot are roughly estimated at 25 million €.

- Hydro-Copper, Harjavalta, Outotec Oyj: Analysis of different metals leaching processes; the metals can be reduced to metal.

- Heap leaching, Sotkamo, Talvivaara Oyj: Examination and measurement of a number of phenomena related to the heap leaching of metals.

- Enrichment pilot, Oulu University: The study of different aspects of pre-treatment flotation, including grindings, flotation processes and automation development (Schindler Electrics and Outotec and Metso minerals involved).

- EU pilot: ULCOS, blast furnace pilot application, total cost amounting to several hundreds of million Euros. A blast furnace is envisaged from which the majority of the formation of CO2 is recovered (CCS). Finland is represented by Rautaruukki. Pilots in Sweden and France.

- EU pilot: GTK, bio leaching pilot, EU-application

Additive manufacturing:

- Further development of PrintoCent, Oulu. PrintoCent is printed intelligence and optical measurements world class innovation centre, whose customers are globally leading companies. PrintoCent is jointly operated by VTT, University of Oulu and Oulu University of Applied Sciences and Business. PrintoCent Innovation Centre commercializes research results of Printed Intelligence and Optical Measurement The goal is to get 1% of the forecast 250 billion € printed electronics market in 2030 to Finland and to Oulu, creating jobs for more than 10 000 employees. Majority of funding comes from public sources, including EU and regional funding. The project portfolio is 15 Million Euro, with company funding of 2 Million Euro for joint projects and 9 start-ups. PrintoCent Community has over 180 person working years per annum and five installed manufacturing lines.

Bio-economy:

- Establishing new bioeconomy infrastructure, Espoo and Rajamäki, VTT and Aalto University: The pilot aims to develop and demonstrate processes and process concepts for industry based on renewable raw materials. The pilot plant infrastructure for bioeconomy is located in the Otaniemi campus in Espoo and in Rajamäki, and is built around the existing biomanufacturing and chemistry pilot facilities

of VTT and Aalto University which today offer excellent tools for development and demonstration of novel bio-based solutions. The bioeconomy pilots are supported by several other pilot units of VTT targeted for application development and demonstration, such as (bio) plastic converting and testing, fibre web manufacturing, and roll-to-roll coating.

- **KCL pilot** (Otaniemi): KCL offers unique pilot services located in a centralized site for the paper- and packing value chain.

- Waste gasification plant

- Biomass gasifier

- **TESTAA concept** for SME's. VTT's research environments for paper making (Jyväskylä Innovation Ltd. and VTT). First phase in 2010-2011, second phase as from 2011. VTT offers its papermaking research environment for SMEs to develop papermaking processes potentially together with research institutes and large-sized enterprises (TESTAA-concept). SME's can cover their testing costs partly with TEKES funding. New ideas can be evaluated for their industrial potential in an early stage and developed further. This co-operation between research centres, universities, large-sized enterprises and small and medium-sized enterprises will increase business opportunities in the forest industry. The research environments are free of cost for the participating SMEs, so they will only have to cover their own costs. Each company can independently decide how much of the project results they want to publish or share with the other companies. The project will help SMEs in their business by sharing some of their R&D risks.

- **BioVerno biodiesel** (UPM, Lappeenranta): 150 million Euro. Completed in 2014.

- **NSE Biofuels BtL Demonstration Plant (stopped projects)**: NSE Biofuels Oy - a joint venture between Neste Oil and Stora Enso operated a BtL demonstration plant at Stora Enso's Varkaus Mill in Finland. The output was 656 t/a from a 12 MW gasifier. As well as providing test data and operating experience, the plant also reduced greenhouse gas emissions as wood-based gas from the plant replaced oil in the pulp mill's lime kiln, making the Varkaus integrate virtually fossil fuel free. NSE Biofuels (in partnership with Foster Wheeler and VTT) planned to develop a commercial production plant at one of Stora Enso's mills (Porvoo or Imatra) with a projected output capacity of 100000 t/a and a potential launch date of 2016. However, in August 2012 Neste Oil and Stora Enso announced that they had decided not to progress with their plans to build a biodiesel plant, for which the two companies had applied for funding under the EC's NER 300 programme. Although the technology has worked well at the demonstration plant (above), the project was not among those listed [in the NER300 intermin report] as scheduled to receive funding. Even with public funding, significant investment would also have been required for the commercial plant (Neste Oil).

- **Ajos BTL**: It was also announced that the AJos BtL project, Finland, has been selected to receive counterpart funding of €88.5m under the first call for proposals of the NER300 funding programme for innovative low-carbon technologies. The Project concerns the design, construction and operation of a biofuel-to-liquid (BtL) plant in northern Finland, with a gasification capacity of 320 MW and an annual output of 115000 t/y of biofuel using close to 950000 t/y of woody feedstock and 31000 t/y of tall oil. The technical solution is based on the following main components: biomass pre-treatment, gasification island (comprising two gasification lines of 160 MW each and an air separation unit), gas cleaning and compression, gas-to-liquid conversion (Fischer-Tropsch) including refining, processing and storage of products. The Project will produce and sell biodiesel and bionaphta in the Baltic Sea area, with a focus on Finland and Sweden. Principal off-takers are expected to be diesel and petrol retailers. [Source: SWD(2012) 224 final: NER300 - Moving towards a low carbon economy and boosting innovation, growth and employment across the EU]. The preparation work in the project has been carried out by the Forest BtL Project established by Metsäliitto and Vapo.

Biochemical technologies

Chempolis Ltd (Oulu) uses non-wood and non-food lignocellulosic biomass such as straw, reed, empty fruit bunch, bagasse, corn stalks, as well as wood residues to produce ethanol and various chemicals with an output of 5000 megawatt (operational).

Chemical Technologies

Neste Oil (Porvoo) uses oils and fats to produce diesel-type hydrocarbons with an output of 190000 megawatt (operational)

Neste Oil (Porvoo) uses palm oil, rapeseed oil and animal fat to produce diesel-type hydrocarbons with an output of 190000 megawatt (operational)

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