DEMOS HELSINKI

Cleantech takes over consumer markets

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THIS IS A STUDY ABOUT THE POTENTIAL OF FINNISH CONSUMER CLEANTECH IN GLOBAL MARKETS.

The study is ordered by Tekes and conducted by Demos Helsinki in partnership with Solved.

Contents

Foreword:
a new age

In 2014, Google bought the smart home appliance company Nest for $3.2 Billion and the ride-sharing company Uber set a valuation record of $30 Billion. The flatsharing platform AirBnB reached a valuation at nearly $10 Billion, higher than Hyatt Hotels, and the energy software company Opower's shares soared in its initial public offering.

Global market conditions have changed radically in the past decades: the price of commodity production is low and emerging economies are gaining way quickly. The basic needs of the majority of consumers in the Western world have been met. As a result, economic growth has to be re-invented in post-industrial countries.

There is no need for panic, however. A wide range of new opportunities in the consumer market is opening up for both big and small businesses. The new opportunities lie in the intersection of an increasing scarcity of natural resources, growing energy prices, overarching digitalisation, and user-driven design. The growing market created by these drivers is called consumer cleantech. Consumer cleantech products and services save natural resources by creating new, more flexible, cheaper, and better forms of living, eating, and mobility.

One of the findings of this report is that competition in consumer cleantech is already fierce: new startups keep emerging and cluster development is booming in some areas of the world.

This report scans the global field as well as analyses Finland's particular strengths within it. The report suggests smart mobility and smart buildings as primary focus points for Finnish consumer cleantech. This is due to the fact that they are the core domains of consumer cleantech both in terms of their market size (wallet shares of housing and mobility) and resource intensity. More extensive justification for these focus and action points for state and municipality levels as well as for Team Finland are presented at the end of the report.

The growth potential of global consumer cleantech is almost limitless. In order to take a lead in highly competed sectors one needs to set a focus in good time. By taking the right actions, Finland can become a leading country in several consumer cleantech markets. The action points suggested in this report are the first steps on this road.

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The Head of Resource Smart Economy
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Customer-centric approach can elevate our cleantech sector

The big shift in cleantech does not only concern sharing, pooling, and circulation businesses. Energy efficiency companies are becoming as-a-service style businesses and cleanweb is gaining ground. Renewable-based technologies with digital business models opens opportunities for companies to swing from trading hardware to providing services. These kinds of capital light companies can scale extraordinarily fast.

By understanding and adapting the new innovative revenue and pay-cost models of emerging consumer cleantech businesses, even process industries can create new customer-centric value added services and fasten their go-to-market actions. With the closer attachment to businesses that are designed to address customer needs, our cleantech sector can identify new innovative and scalable revenue models that attract capital investors.

What are these new consumer-driven business models? How do they work? How can we adapt, deploy and create growth with them in Finland? These are the questions that we wanted to clarify with this report.

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1.

Introduction:
why is consumer cleantech gaining ground now?

Global markets are transforming fast. New dynamics are emerging, nontraditional markets are opening up, and many of the old ones are dying or switching to new locations. For many, it seems like it has become virtually impossible to keep track and see how functionable a certain product, service, or business model will be in the next turn. Collapses of lucrative companies and the sudden decline of seemingly everlasting industries have shown that one needs to be well informed of an ample amount of changes to be able to make the correct decisions.

The most common mistake for one is to think that the on-going change does not have anything to do with the field that one is operating on. This mistake has been done by many, for example in media, taxi, and hotel industries. Now the disruption is taking place in the financial sector (see Fortune, 2015). Chapter 5 elaborates why established Finnish companies should actively take part in the disruption and seriously plunge into consumer cleantech.

Shifts in the cleantech industry and the growing impact of consumer cleantech are best understood by looking at megatrends. Megatrends are global long-term forces of development that impact society, economy, environment, culture, and personal lives. Megatrends are continuously changing the dynamic landscape in which companies operate. They are going to take place under almost any circumstances. When it comes to megatrends, stability is actually found in the continuous transformation.

Although megatrends often appear as individual forces, in reality they are driven by many distinct ones: digitalisation is certainly taking place due to advances in processing technology, but also because of ever-cheaper sensors, new digital competition, and disruptive business models. Megatrends do have a considerable effect on the world and its pace of change, but they do not determine the future. Megatrends interact with each other and have impact in diverse contexts. As a result, megatrends convert and integrate into drivers, which have a more direct effect on society and its divisions.

Gradually, megatrends will penetrate virtually all industries and layers of societal everyday life. The effects will be manifested within different time frames in different contexts. Megatrends endure for a timespan of one generation or more, whereas drivers can alter or fade significantly faster.

Megatrends affect both the supply and demand for new solutions (see Picture 1, next page). In the context of cleantech, megatrends such as urbanisation and increasing competition over natural resources affect the demand for more effective use of space and sharing economy solutions, whereas digitalisation affects the supply side of smarter solutions. Traditionally cleantech markets have been perceived as something that is related to efficient industrial production processes, waste and water management systems, and technology development for renewable energy. Megatrends, however, are driving the sector towards new directions.

New cleantech opportunities mostly lie in domains that have not always been fully understood as relevant for cleantech: namely food, housing, and mobility.

PICTURE 1. Megatrends create demand for resource efficient solutions in housing, mobility and food.

MEGATRENDS	CHANGING POPULATION	SCARCE RESOURCES	GLOBAL ECONOMY	DIGITALISATION	THE AGE OF COMMUNITY-DRIVEN INDIVIDUALS
DEMAND BASED DRIVERS	Increased consumer demand for sustainable services		high rates of unemployment		the millenial generation: access over ownership
ENABLING DRIVERS	Breakthrought of BoP business models	Distributed Energy Systems and Off-Grid Opportunities	Smart City	Internet of Things	Emergence of as-a-service models · Growing anti-regulation attitudes

CONSUMER CLEANTECH RESOURCE EFFICIENCY MODELS

- UPCYCLING AND REFURBISHMENT
- DEMATERIALISATION AND SMART SUBSTITUTION
- OPTIMISATION
- SHARING

CONSUMER CLEANTECH VALUE CREATION HOTSPOTS

- HOUSING
- MOBILITY
- FOOD

New cleantech opportunities mostly lie in domains that have not always been fully understood as relevant for cleantech: namely food, housing, and mobility. These daily routines make up over 70 % of households' natural resource consumption (Statistics Finland, 2012). The same three domains also eat up the majority of households' income, with an average annual spending of 15 100 euros per household. Many of the new solutions related to these fields are described as consumer cleantech.

Through megatrends one can see how markets are likely to shift in the coming years and decades. Whereas short-term trends guide business, megatrends show where new markets are likely to emerge. In the case of cleantech, converging megatrends such as digitalisation, scarce resources, global economy, and a shifting population have paved the way for consumer cleantech. Consumer cleantech means products and services which save natural resources by creating new, more flexible, cheaper, and better forms of living.Consumer cleantech companies create value through four models: upcycling and refurbishment, dematerialisation and smart substitution, optimisation, and sharing. These models are further elaborated later in the report. Picture 1 demonstrates how megatrends integrate into drivers and create demand for resource efficient solutions, especially in housing, mobility, and food.

Those organisations which recognise global megatrends and take the changing world into account will be the market leaders of the future. In the following chapter, five megatrends shaping the world economy are introduced.

In short: how this report was done

- **15 experts interviewed including foreign top experts**
- **19 consumer cleantech entrepreneur interviews analysed**
- **280 consumer cleantech companies benchmarked**
- **40 documents relevant to consumer cleantech studied**

Read more extensive description of the process from Appendix 9.3.

1.2 Five megatrends that influence consumer cleantech

In this chapter, five megatrends that are shaping the world economy are introduced. These trends are:

1. *Scarce resources*

2. *Digitalisation*

3. *Changing population*

4. *Global economy*

5. *The age of community-driven individuals*

Out of over 1 000 interviewed CEOs only 32 percent thought that the global economy will be able to meet the needs of the developing nations and adjust to limited natural resources.

1.2.1 Scarce resources

Rapid growth in the planet's population and growth of new economies increase the demand for food, energy, and minerals. According to the UN, the demand for food will increase from the current level by 30 percent until 2030; and by a staggering 50 percent until 2050. In parallel, crop yield in agriculture grows at an ever-slowing rate, currently only 1 percent annually. Four decades ago the rate was twice as high (Alexandratos & Bruisma, 2012).

With demand outpacing production, prices are bound to soar and weaken the purchasing power of consumers. In a study by Accenture (2013), out of over 1 000 interviewed CEOs only 32 percent thought that the global economy will be able to meet the needs of the developing nations and adjust to limited natural resources. The unbearableness of the situation is not only identified in global risk reports (WEF, 2014; PWC, 2014; KPMG, 2014) but also the financial sector has started to digest that most of the fossil fuel of the planet cannot be burned due to alarming rates of global warming (see for example Guardian, 2014).

Housing, transportation, and food represent a lion's share of household energy consumption. Furthermore, these three factors also make up the majority of average household spending in Finland, adding up to 63 % of total spending. In monetary terms, this means over 15 000 euros per year (Statistics Finland, 2012). These figures show that consumer cleantech solutions have the possibility to tap into large markets while making a dramatic change where energy is used the most.

By 2020, 50 billion devices will be connected to the Internet

1.2.2 Digitalisation

Digitalisation refers both to the process of converting various forms of information into a computable form and to the integration of digital technologies in our everyday surroundings. It is one of the most significant and visible megatrends of our age. Digitalisation has all the potential to play a key role in solving growing problems bound to urbanisation, resource scarcity, population change, and many other domains.

The development of digitalisation is exponential. Digitalisation disrupts traditional business models, as digital models are global by default and not restricted by location. Starting from disrupting the media and banking sectors, the revolution is spreading to other sectors. It took 10 years for the Internet to become an integral part of daily life of billions of people around the world. Slightly later, the social media tool Google+ needed only 16 days to reach 10 million users. By 2020, 50 billion devices will be connected to the Internet (Ericsson, 2011). Rather than everything being digital or physical, the world is becoming something else.

Most physical services and goods such as housing, transportation, and mobility cannot be replaced by digital alternatives to the degree that communications and entertainment once were. Facebook, email, and other similar services can be said to have replaced postal services and media to a degree – AirBnB, however will never replace property and building services. People will always live in a physical location that needs to be heated and cooled. Interestingly, big opportunities lie in the intersection of digital and physical.

This ever-more speeding development of digitalisation will allow more and more disruptive innovations such as Uber, which can challenge the traditional businesses and their value chains faster than ever before. Soon all consumer products will be connected to the Internet.

1.2.3 Changing population

The global population is becoming more urban, wealthier, and more educated. By 2050, 20% will be over 60 years old, and 70 % will live in cities. According to the Brookings Institution, the global middle class will grow from the current 1.8 billion people to 3.2 billion by the end of the decade (BBC, 2013). The centre of education is also shifting as China and India are predicted to produce around 40 % of graduates in 2020 (ICEF Monitor, 2012).

The developing world is growing with the fastest pace: no less than 90 % of the population growth is expected to take place in Asia and Africa. This means that there are entire industries that need a better understanding of how to meet their customers' increasingly diverse and unique needs, while at the same time cutting down on their use of natural resources. It also means that new large consumer groups with distinct consuming habits, such as young urban Africans, are replacing the consumer paradigm of the Western working-age male.

Global environmental issues challenge all nations and urban centres also face their own local problems that are due to a growing population and thus growing emission rates. Deteriorating air quality, polluted water, and noise deficits are typical pains of urbanisation (UN, 2014). According to an OECD report (2014), the traffic congestion in U.S. cities of all sizes has created a USD 78 billion annual drain on the U.S. economy in the form of 4.2 billion lost

The developing world is growing with the fastest pace: no less than 90 % of the population growth is expected to take place in Asia and Africa.

hours and 2.9 billion gallons of wasted fuel. In Istanbul, Turkey, the CO2 emissions caused by transportation increased by a whopping 52.6 % in a decade (OECD, 2008). Despite their smaller size, European cities are facing similar challenges in terms of costs and CO2 emission.

These developments deteriorate the quality of life of billions around the world and put serious pressure on the management of big infrastructure systems, such as city traffic and energy usage. A growing demand for new types of smart and clean solutions drive the creation of smart city programs in cities across the world. The global superpowers with rapidly growing populations and large sustainability challenges recognise the need for clean solutions. In fact, investments in clean energy technologies in developing countries already outpaced that of developed countries in 2012. More commercial investment in clean energy technologies occurred in China than in any other country (National Science Foundation, 2014.)

The list of the top five countries in terms of GDP is projected to include newcomers Indonesia and Brazil next to China, India, and the US in 2050

1.2.4 Global economy

The most important driver for the the globalisation of the economy since the 1990's has been the lowered cost of transferring information and thus trading, mainly due to advances in ICT (OECD, 2013, 9). Scientific and technological advances have become central global value drivers at the same time as new markets have rapidly emerged.

Production chains are now global (Global Value Chains, or GVC): Even though Apple's products, for example, bear the text "Designed in California", the assembling of technological and other products as well as the gathering of raw materials most often takes place outside the Western world. The globalisation of production chains has pushed down the relative production price and consequently pushed post-industrial countries out of the manufacturing game.

Global Value Chains mean that local economies are increasingly inter-connected in the value chain and also that they are increasingly specialising in a particular link of the chain. (OECD 2013, 5). In Finland this has meant that jobs concentrate around high-expertise industries whereas traditional manufacturing industries diminish. Consequently, the global division of wealth is also shifting from the West and North to the East and South: the list of the top five countries in terms of GDP (PPP) is projected to include newcomers Indonesia and Brazil next to China, India, and the US in 2050 (Hawksworth & Chan, 2015). Especially the service sector is growing in relative size in the Western world. (Thornton, 2010). Due to this development and increasing resource scarcity, the role of low-carbon services will most likely play an increasingly significant role in Western economies.

1.2.5. The age of community-oriented individuals

Globally growing individualism means that more and more people around the world seek ways of getting their voices heard as well as symbols and products to express their identities. Individualism goes hand in hand with education: tertiary (higher) education is booming outside the Western world (Times Higher Education, 2015).

Individualism is growing towards a new direction in the 21st century. The late 20th century was the age of the rational consumer, who makes her own choices and to whom businesses cater endless options. An unforeseen wealth created immense markets in the Western world and the consuming individual was seen as a king. During the 20th century, products became increasingly individualised and thus a stronger connection between the consumer's identity and the product was formed. While individualisation is still going strong today, a new emergence of communities has appeared next to it during the last decades.

Collaborative consumption initiatives, social media, neighborhood activism, and crowdfunding are all examples of the shift from consuming as an individual towards acting in groups. They also reflect a shift in ways

Election turnouts are in decline throughout strong democracies with approximately a ten percent drop from the 1950s whereas digital community platforms have grown from zero to 2 billion users in 20 years

of participation: election turnouts are in decline throughout strong democracies with approximately a ten percent drop from the 1950s (Ferrini, 2012) whereas digital community platforms have grown from zero to 2 billion users in 20 years (Kemp, 2015). Individualism rules also in these social contexts, but they signal a new relationship to communities. Digital platforms have made it possible for more fluid communities to come about: people are for example able to fund an initiative together without ever meeting each other.

2.

Driving forces behind consumer cleantech

Context-specific drivers are often manifestations of megatrends and can be observed more directly. As an example, radical increase in renewable energy investments is a driver that is growingly affecting the energy market. Clearly, energy scarcity is a big megatrend behind this driver, but also digitalisation and changes in consumer attitudes have an effect on it. Further, this driver also has a plethora of consequences. Besides of challenging the traditional energy producers, it is turning consumers into producers ("prosumers"), creating new energy storage needs and application opportunities for smart grid, among many other implications.

Megatrends show new business opportunities and steer strategic planning: they act as guidelines for finding new areas. Drivers, however, need to be followed more hands-on as they cause market shifts within a two-three year cycle. Drivers immediately and directly affect things like production and distribution patterns and demand for specific types of products and services.

Drawing from expert interviews and desktop study, a list of nine drivers which have a particularly fierce impact on the emergence and development of consumer cleantech markets is introduced in this chapter.

In this report, drivers are divided in two: demand-based and enabling ones. The demand based drivers are based on different changes in market demand: in attitudes and behavioral patterns of consumers. Enabling drivers relate to changes and advancements in technologies, business models, policies, and other systems that facilitate the emergence of new business.

1. Increased consumer demand for sustainable services

Demand for sustainable products and services is experiencing a steady increase. 57 % of Finns report that they have changed their habits in the last 6 months to be more sustainable. Moreover, 70 % of Finnish consumers worry about climate change and 80 % believe that new sustainable services offered to the market will play an important or somewhat important role in tackling our climate problems. (Ilmastobarometri, 2015.)

Although awareness of scarce resources and willingness to select sustainable alternatives have increased, mere will does not explain all the increased demand. Unlike before, many sustainable products have now become the cheaper choice due to efficient use of resources. Customer segments for sustainable products have already emerged in the car industry (Toyota Prius, Nissan Leaf), in household appliances, and now also in the domain of energy. At the moment, consumer cleantech caters to individuals whose habits are in a flux. As more products and services with technological breakthroughs and customer-centric design enter the markets, the next big wave of increased consumer demand for sustainable solutions can be expected.

COMPANIES

Sustainable shopping incentive schemes: Bonsum, Nu Spaarpas

Crowdfunding platforms for solar energy: WeShareSolar, Bettervest

Leasing of clothes: Nurmi Clothing

p2p deliveries and neighbourhood help: Piggy Baggy

2. The millennial generation: access over ownership

The demands, needs, and aspirations of the millennial generation, born between 1980-2000, differ dramatically from those of the previous generations. This cohort has grown up in the digital world and has been empowered by rapid technological development. This generation wants to live creatively and efficiently, and mobile technology and peer-to-peer software provide the perfect tools for this. (Diamandis, 2015.) Moreover, an increasingly large part of them have been born to a thoroughly multicultural and rapidly changing environment, making them more exposed to different cultures and ideas.

This way of life also affects consumption desires. The Millennials value 'on demand' services - having access to goods immediately and conveniently. Combining this with dwindling resources creates a trend of 'access over ownership'. Rather than a car of their own, millennials need to be provided with great mobility (FastCompany, 2014). Rather than a house of their own, millennials need to be offered ways to live flexibly and conveniently.

Access to assets instead of ownership allows millennials to pursue the desired lifestyle of flexibility, individualism, and spontaneity which defines the generation. The consumer cleantech mindset settles well around this driver by placing the user in the centre and providing the smartest, most flexible, and easiest solutions to a variety of needs.
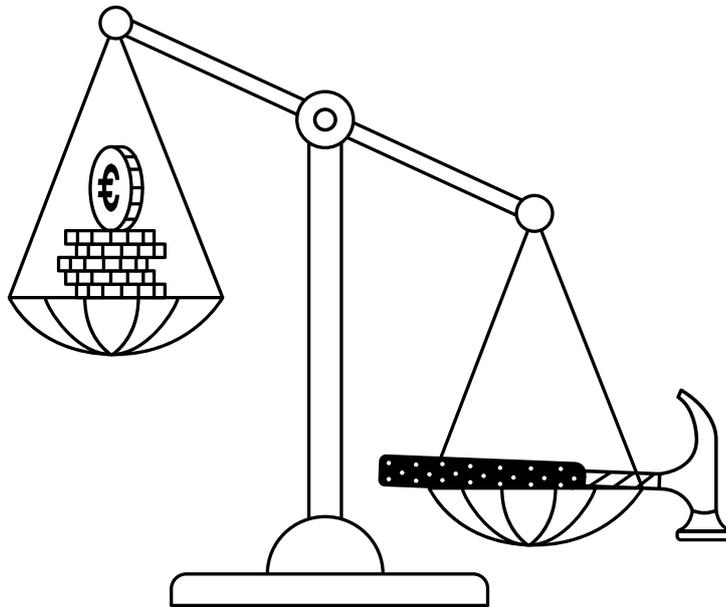
COMPANIES

Ride sharing: Uber, Taxify

Digital re-use retail: Huuto.net, Tori.fi, Ebay

Apartment sharing: AirBnB

3. High rates of unemployment

The Research Institute of the Finnish Economy predicts that, within the next 20 years, the professions of salesperson (104 219 positions), secretary (46 610), and bookkeeper (25 036) will be automated by a chance of 95 %. All in all, computerisation is suggested to replace one third of work positions in Finland (ETLA, 2014), making it challenging for many, especially those without education to become fully employed. As standards of living and average wealth are not dramatically decreasing, this means considerable systemic changes in society and how people make their living.

This development can function as a powerful boost for sharing economy. Renting assets that have traditionally been used by one household only – such as apartments, tools, and cars – can function as a source of extra income. With decentralised energy production, households can become energy sufficient and later energy providers through their own work and relatively small investments. As urbanisation accelerates in developing countries, the shared economy can open up new sources of income for millions of new urban dwellers. On the other hand, the demand side may also be boosted, as the use of the shared economy has been shown to benefit consumers with low incomes by giving them access to a variety of products too expensive for ownership (Financial Times, 2015). This can result in growing amount of microwork for instance in the fields of sustainable energy production (Tesla), gamified solving of scientific problems (foldit) and entrepreneurship in car-sharing (Uber), meaning more and more users for this kind of consumer cleantech companies.
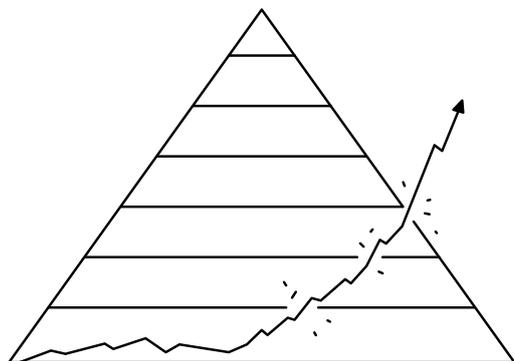
COMPANIES

Energy production: Energalis, M-Kopa Solar, d.light, SolarKiosk

Clean Water: Nanomaji

COMPANIES

Mobility-as-a-Service: Tuup

Housing-as-a-Service: The Collective

Living and sharing economy: Nifty Neighbor

4. Breakthrough of BoP (Bottom of the Pyramid) business models

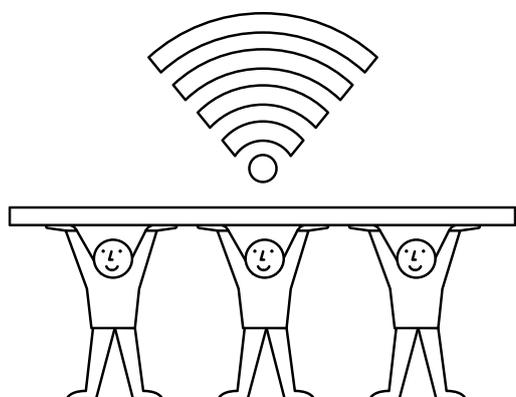Bottom of Pyramid market refers to the poorest 4 billion people in the world who earn less than 1500 dollars per year. For a decade now, companies have been pursuing BoP customers, hoping to capture the business potential in this vast market and looking to succeed in marrying profits with solutions for poverty. The demand for basic commodities such as clean water and power is massive, and companies are looking to provide these while creating consumption patterns that would not add an extra strain on our environment.

Due to economy becoming continuously more global, the $5 trillion BoP markets (WRI, 2007) are being opened. This is not only because of technological innovations, but combinations of them and new business models. The spending habits and abilities of the most economically disadvantaged differ radically from the advantaged: the disadvantaged do not have savings and they need to buy what they get – exactly when they need it. BoP markets are best tapped by getting closer to the customer and creating an ecosystem instead of pushing a narrow product (Prahalad & Hart, 2002). Micronizing goods and services and using ICT to connect the scattered market are examples of how to reach the BoP market.

5. Emergence of as-a-service business models

A shift from ownership to subscription is already a well recognised trend in the digital world, where software has increasingly moved from hard disks to the cloud. In short, X-as-a-Service business models (XaaS) offer us goods that were once bought in a new way: as demand-based services. At the moment, The XaaS model is expanding beyond software.

The XaaS model is trending towards convergence. In the field of mobility, for example, this means that several mobility solutions, such as taxis, buses, trams and shared cars are now accessed through one platform. Such mobility-as-a-service (MaaS) platforms are being developed around the world, in Finland by emerging startups such as Tuup and, on the other hand, a consortium of over 20 public and private partners (including Uber) are developing MaaS solutions (HSL, 2015).

The XaaS model is a form of consumer cleantech because it changes ownership and makes usage of different resources more demand-based and thus more effective. Most XaaS models are based on consumer interfaces: the consumer uses an interface that gives access to a given good or service. Taken further, the convergence trend means that a single platform could be used for mobility as well as housing and other services. This sort of development is in line with the rise of platform economy, which refers to an ever-more stronger position of the dominating platform providers such as Facebook, Amazon, Elance, and Uber.
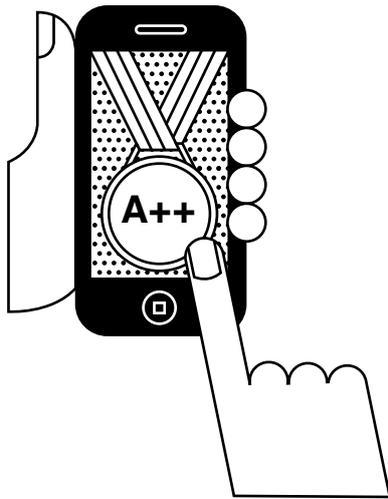
COMPANIES

IoT in housing: Fourdeg, Nest
IoT in cities: IoTSens
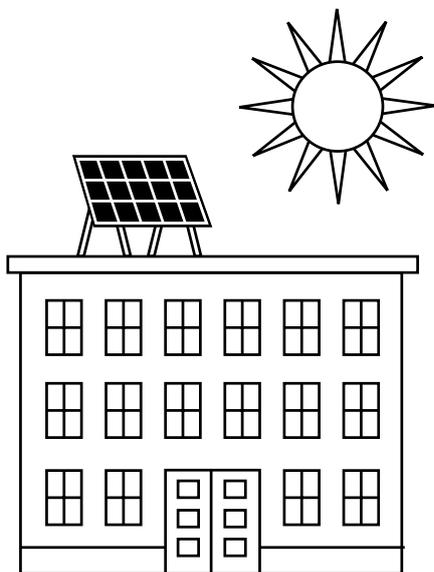
COMPANIES

Solar power as a service: Solar City, Oulun Energia
Geothermal energy / heat pumps: ST1, Eco2Energy
Small scale bio-energy transformers (biogas, CHP):
FarmiVirta, Volter

6. Internet of Things

Enabled by ever cheaper sensors, input devices and identifiers, big data and data transfer protocols, the Internet of Things (IoT) refers to a phenomenon in which objects and people are able to transfer data over a network without requiring a direct human-to-human or human-to-computer interaction. This creates a completely new electricity-like infrastructure layer for data. In the near future it is possible that most devices operating on electricity are also connected to the Internet. Ericsson (2011) estimates that around 50 billion devices will be connected by 2020. According to the estimate, the value of the IoT market stands at $14.4 trillion (Bradley et al., 2013.)

The Internet of Things has many names, such as the Programmable World, Connected Devices, Sensor Revolution, or Internet of Everything. One of the biggest applications of such technology lies in energy optimisation: sensors deployed across the electricity grid enable utilities to remotely monitor energy usage and adjust generation and distribution flows. However, the increased level of data collection will create a massive amount of opportunities in self-monitoring of health, home management, maintenance, and a great variety of other fields, many of them consumer-centred.

7. Distributed energy systems and off-grid opportunities

A continuing decline in the costs of clean consumer technology – particularly in solar but also in heat pumps, small scale bio energy, and most probably even wind micro-turbines – means that consumers' investments into their own energy production gets more and more profitable. In many locations, the cost of electricity from solar panels is lower than the cost of electricity bought from a local utility network. Further, the prices of heat pumps are declining and becoming very competitive with oil heating. This savings potential means that more and more people switch their heating source from oil to geothermal.

It is estimated that the heat pump market is 400 million euros only in Finland. The synergy between mobility transformation (EVs, V2G, car sharing, driverless cars) and energy transformation in terms of new energy sources (mostly solar energy and new energy storage capacity) will enable a fast and radical deployment of innovative solutions and models. The new energy generation will no more be locked to existing energy grids, as the new mobility services will provide a new infrastructure for energy distribution.

During the last few years, solar utility providers (i.e. Solnet.fi) have introduced solutions which include installation, maintenance, and other services beside the utilities, making installation of a micro power plant more approachable for the consumer. Better service packages combined with improved and cheaper technologies are likely to mainstream distributed energy production and radically disrupt traditional value chains.

8. Smart City

Smart Cities tackle difficult urban problems with new technological solutions. The management of growing cities is complicated due to intensifying problems like traffic, the high cost of upgrading infrastructure, growing emissions, and ever more complex administrative systems.

Smart City solutions use information technology to bring about new kinds of co-operation and to enable the interweaving of different city elements (energy, buildings, transportation, and users). In this way, existing infrastructure can be utilised better and by using fewer resources, and the growing needs of cities can be satisfied. This is crucial in Europe and especially in Finland where a major proportion of building stock dates back to 60's, 70's, and 80's. At the moment, these areas are far from energy efficient and have come to an age of renovation.

The smart city is one that adapts to both the environment and its citizens. From the service viewpoint, smart cities can offer citizens the services they need with a push of a button – or even without the button. As street lights, sewage systems, solar panels, thermostats, cars, trams, and ad screens become interconnected, a new wave of optimisation will sweep the urban environments. The connected city will enable radically different business models and businesses.

COMPANIES

Smart city as a service platform: IoTsens
Smart routing and mobility: Kutsuplus, BikeCitizens
Smart heat renovations: Thermondo
Smart waste collection: Enevo

9. Growing anti-regulation attitudes

Whether the conversation is about the efficacy of the public sector, opening hours of retail shops, or advertisement of alcoholic beverages, one can be sure about one thing: the regulation debate has most likely touched the issue. The rapid transformation of the world has proven to be a major challenge for the regulation system, also in Finland. The present regulation is partly planned to serve and support the traditional institutions and industries. While it is doing so, it is hampering the emergence of many of the most innovative new businesses.

Experiments and trials are one way for testing the effects of certain actions, for example the impacts of new laws or different forms of deregulation. Very recently, the idea of experimenting has mainstreamed in Finland. For instance, The Finnish Innovation Fund Sitra has conducted dozens of experiments in various contexts over the last years. Another indication of this is that fostering experimental culture and several specific experimental procedures were mentioned in 2015's government programme (Finnish Government, 2015).

Many highly valued disruptive companies such as Uber have been proclaimed illegal in Finland (see i.e. Yrittäjät, 2014) or are at least having problems operating in Finland due to regulation. Especially companies in the fields of sharing economy and distributed energy solutions often find it difficult to operate under the current regulation. Efficient and systematic testing protocols, introduction of deregulation areas, and well-planned adjustments in regulation could foster consumer cleantech innovations.
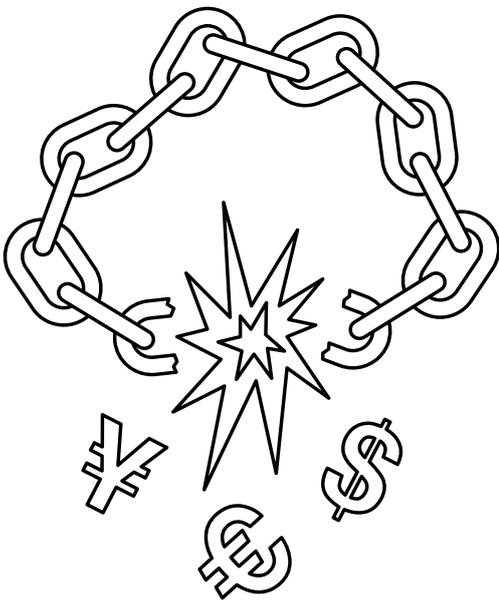
3.

Global consumer cleantech markets in 2015

Large-scale changes always unfold opportunities. The rise of platform economy, increasing consumer demand for sustainable services, and other drivers relevant for the development of consumer cleantech hold a great promise that is now materialising in a number of ways. For example, the rise of platform economy is visible in the emergence of the first mobility operators and possibilities of systematically sharing and selling goods that were earlier considered predominantly private or shared only with an inner circle. Similarly, the deregulation of energy markets combined with decreasing costs of renewable technologies is driving a global scale revolution of energy systems with households as important contributors.

The range of possibilities is wide, but all of the solutions come back to one denominator: they are solving inefficiencies in people's everyday use of natural resources. This is clearly visible in the data gathered for this survey. The data covers 280 consumer cleantech companies – most of them startups – from 21 different countries from Europe, North America, Asia, Africa, and Australia.

The majority of the scanned companies provide services and products that relate to three resource intensive lifestyle domains: housing, mobility, and food. These consumer cleantech hotspots are briefly introduced in Section 3.1. Moreover, the data shows that companies can be categorised according to four different resource efficiency models: 1) sharing, 2) optimisation, 3) upcycling and refurbishment, and 4) dematerialisation and smart substitutions. These are ways how consumer cleantech startups reallocate and save natural resources – or in other words – create or capture value.

This chapter introduces the gathered company data in terms of these domains and resource efficiency models. Resource efficiency models are explained and discussed in Section 3.2. Related business models are introduced in Section 3.3.

3.1 Consumer cleantech hotspots: mobility, housing, and food

The data gathered for this survey indicates that most consumer cleantech companies fall in one of the following domains: housing, mobility or food. For the ones that do not relate to previous categories, we have created a category of other smart services. The category of other smart services consists of companies operating in e.g. health or clothing markets.

This result is not surprising given that housing, food, and mobility account for the great majority of household energy consumption and CO_2 emissions. As shown in Picture 2, the shares of housing, food, and mobility represent some 30 %, 25 % and 15 % of households' total energy resource consumption, respectively (Ministry of the Environment, 2012).

What makes these three domains attractive for companies is that they make up over 60 % of total household spending in many industrialised countries. On average, households spend 678 euros on housing, 329 euros on mobility, and 251 euros on food each month (Statistics Finland, 2012), as shown in Picture 3. Comparing these amounts to the monthly spending on telecommunications provides a reference point to showcase the large market share available in the three large domains. The breakdown of households' wallet shares is examined in Picture 3.

Housing 30%

Food 25%

Mobility 15%

Other 30%
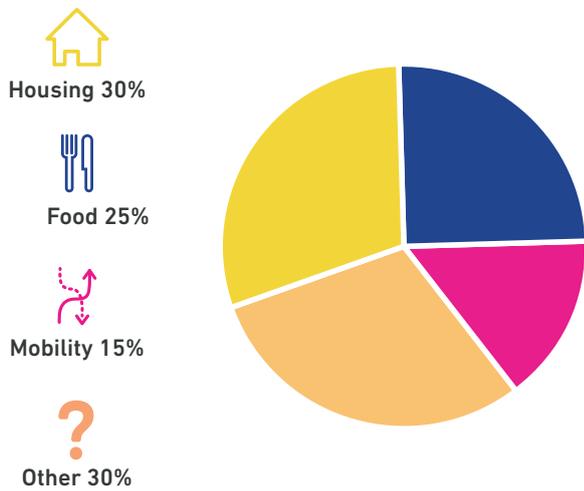
PICTURE 2. Shares of Finnish households' total energy resource consumption (Ministry of Environment, 2012).

800€
678
600€
400€   329
251
200€
49
Telecommunication
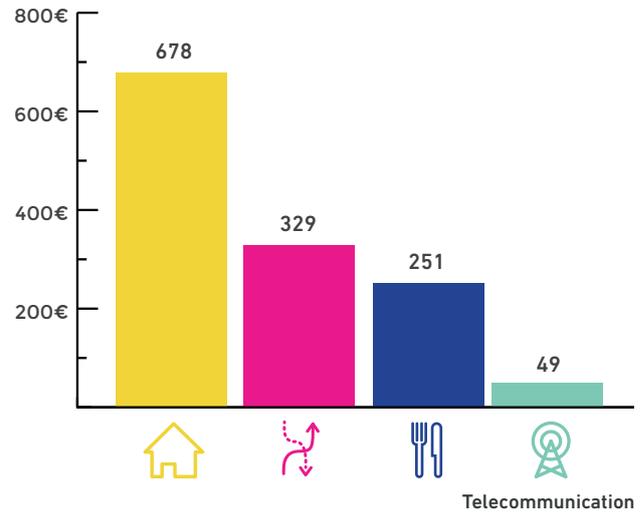
PICTURE 3. Shares of monthly household expenditure in Finland (Statistics Finland, 2012). Telecommunication used as a reference point.

3.2 Resource efficiency models

In addition to the three main consumer cleantech hotspots, the company data also reveals four main ways in which companies drive down consumers' dependency on natural resources. These four resource efficiency models were first identified in a workshop organised for 25 experts in context of the Smartup Summit held in August 2014. Now for this survey, the categorisation was validated based on the company data.

The resource efficiency models include sharing, optimisation, upcycling and refurbishment, and smart substitution. In more detail, the four categories that consumer cleantech companies use to leverage resources and create value are:

1. SHARING. Sharing simply means increasing the utilisation rate of physical resources by dividing and allocating their use more efficiently. This is a very typical and most commonly used model to improve resource smartness.

2. OPTIMISATION. Optimisation refers to improving energy efficiency through e.g. data management, smart home and metering applications.

3. UPCYCLING AND REFURBISHMENT. This category refers to improving the efficiency of physical assets by implementing energy efficiency solutions for homes and vehicles, as well as various circular economy applications in other domains.

4. DEMATERIALISATION AND SMART SUBSTITUTION. Companies in this category replace resource intensive practices with new solutions. Examples include teleconferencing and virtual reality applications and companies replacing energy intensive animal proteins from the food system with something that takes fewer resources to produce (e.g. insect and vegetable proteins).

Interestingly most of the companies explored for this survey leverage hybrid business models, meaning that their businesses are based on more than one of these models. The hybrid models are elaborated in detail in the following chapter.

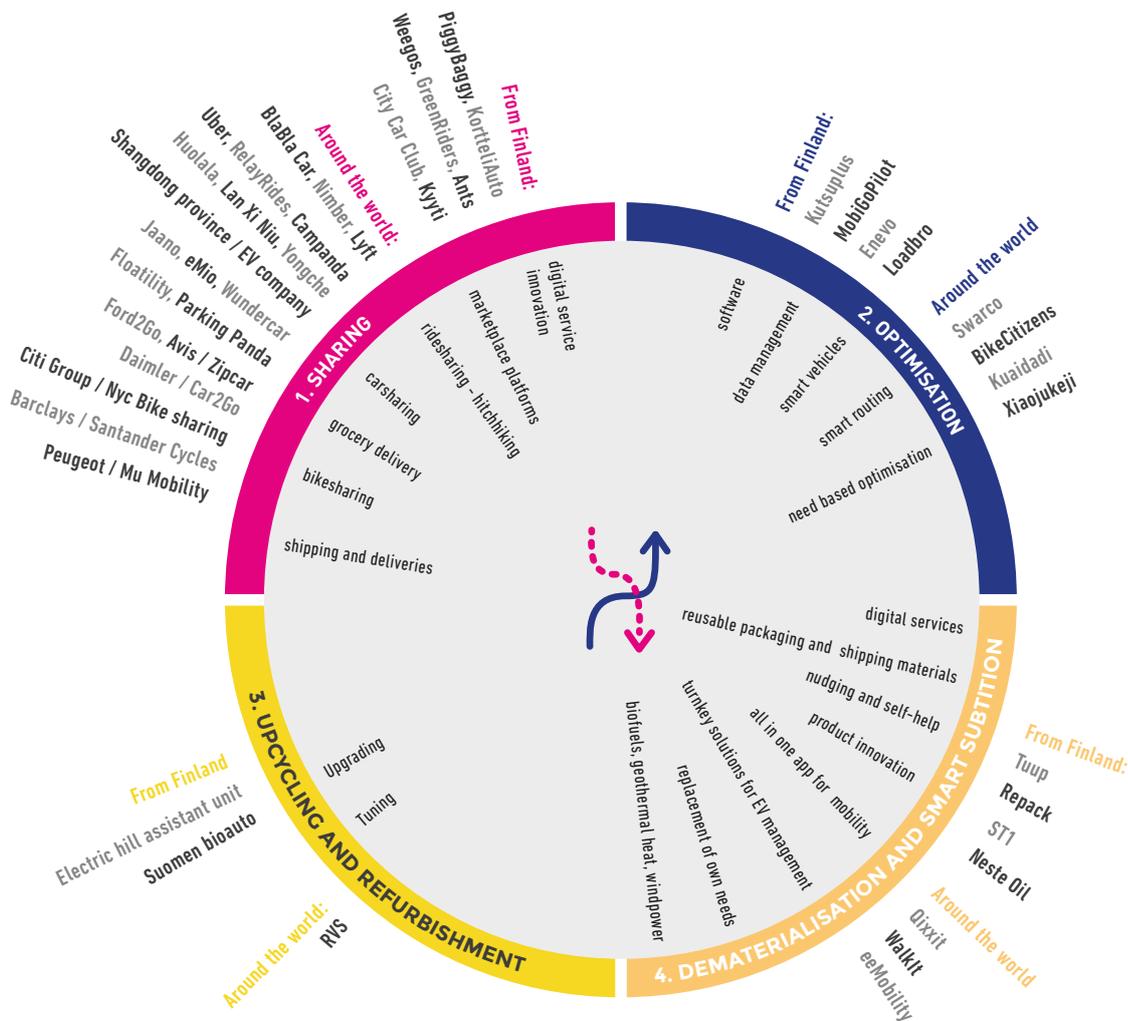# 3.3 Business models in today's consumer cleantech

In addition to leveraging natural resources in more efficient ways, consumer cleantech companies must be inherently smart: accessible, easy, and attractive to use. According to a famous estimation by Hart, Heskett, and Sasser (1990), a new service or practice must be approximately five times more functional and better to take over its predecessor in our daily life – in other words, to take over the markets.

This demand for smart solutions can be seen in consumer cleantech companies strong drive towards top level usability. Moreover, consumer cleantech companies often use innovative business models. AirBnB, Nest, and OPower among others are pioneers in leveraging various models that transform the ways people live and move about. In the following demonstrations, consumer cleantech companies – startups and more established ones – are categorised according to their respective domain and resource efficiency model. Furthermore, the dominating features of their business models are placed on the inner side of the graphs. These features indicate how consumer cleantech companies re-allocate natural resources – or in other words – create and capture value. The most dominant business models of the moment are elaborated in contexts of mobility, housing, food and other smart services. Additional business model descriptions can be found from many of the descriptions of Appendix 9.1. Moreover, the dominant features of consumer cleantech business models are also listed and categorised in Table 1.

TABLE 1. The most frequently appearing features in consumer cleantech companies' business models.

SHARING	OPTIMISATION	UPCYCLING AND REFURBISHMENT	DEMATRIALISATION AND SMART SUBSTITUTION
Marketplace platforms	Software	Upgrading	Cloud mobile services
Cooperative farming	Data management	Tuning	Fundraising platforms
Sharing goods	Smart products	Recycling technologies	Incentive schemes for shopping
Charity marketplace platforms	Data collection & analysis	Repairing	Health optimisation
Lending	IoT	Smart metering	Virtual services
Ridesharing – hitchhiking	Smart systems for growing food	Technical innovation	Gamification
Carsharing	Ingredient optimisation	Turnkey solutions	Nudging & self help
Grocery delivery	Need based optimisation	Recycling nutrients	Product innovation
Swapping	No waste cooking	Product innovation	Substitution of ingredients
P2P task sharing / outsourcing	Smart homes & smart cities	Circular economy solutions	Digital services
Bikesharing	Gamification	Water cleaning solutions	Online food shopping
Shipping and deliveries	Source based optimisation	Accessories from recycled materials	Aquaponics
Digital service innovation	Digital services	Leasing	Environmentally friendly packaging
Crowdfunding	Smart vehicles	Modular consumer electronics	Technical product innovation
Urban farming	Smart routing	Waste management	Virtual services for product development
Co-creation platforms	Smart metering	Consulting	Energy source substitution
Space use optimisation	Energy management	Return and buyback incentives	Turnkey solutions
Space rentals	Carbon management		Natural & bio gas
Workspace sharing	Home automation		Biofuels
Digital marketplace platforms	Turnkey solutions		Solar energy production
Social cooking			Decentralized energy
			Project financing
			Reusable packaging and shipping materials
			Nudging and self-help
			All in one app for mobility
			Turnkey solutions for EV management
			Replacement of own needs
			Biofuels, geothermal heat, windpower

Circular diagram with four sectors:

1. SHARING
- digital service innovation
- marketplace platforms
- ridesharing - hitchhiking
- carsharing
- grocery delivery
- bikesharing
- shipping and deliveries

From Finland:
PiggyBaggy, KortteliAuto
Weegos, GreenRiders, Ants
City Car Club, Kyyti

Around the world:
BlaBla Car, Nimber, Lyft
Uber, RelayRides, Campanda
Huolala, Lan Xi Niu, Yongche
Shangdong province / EV company
Jaano, eMio, Wundercar
Floatility, Parking Panda
Ford2Go, Avis / Zipcar
Daimler / Car2Go
Citi Group / Nyc Bike sharing
Barclays / Santander Cycles
Peugeot / Mu Mobility

2. OPTIMISATION
- software
- data management
- smart vehicles
- smart routing
- need based optimisation

From Finland:
Kutsuplus
MobiGoPilot
Enevo
Loadbro

Around world
Swarco
BikeCitizens
Kuaidadi
Xiaojukeji

3. UPCYCLING AND REFURBISHMENT
- Upgrading
- Tuning

From Finland
Electric hill assistant unit
Suomen bioauto

Around the world:
RVS

4. DEMATERIALISATION AND SMART SUBTITION
- digital services
- reusable packaging and shipping materials
- nudging and self-help
- product innovation
- all in one app for mobility
- turnkey solutions for EV management
- replacement of own needs
- biofuels, geothermal heat, windpower

From Finland:
Tuup
Repack
ST1
Neste Oil

Around the world
Qixxit
WalkIt
eeMobility

3.3.1 Business models in mobility

Everyone knows Uber, but despite it being the most well-known mobility provider that uses a ridesharing model combined with digital services, it certainly is not the only one. Business models based on sharing of rides, cars, shipping, deliveries, bikes, and other vehicles combined with digital service platforms have become a norm in urban environments around the world and are adopted especially in the big metropolises of the world.

In consumers' eyes, mobility is becoming a service, and not owning a vehicle often liberates resources to other uses and offers flexibility not achieved otherwise. In fact, the emerging players and traditional car companies adopting business models of sharing are now in a highly competed field that leaves little room for additional newcomers. Thus, the next development that has begun is the emergence of platform level players, i.e. service platforms connecting various mobility services in one application.

Thus, mobility as-a-service is becoming the norm and the ecosystem has already developed enough to offer new services that build on top of the current ecosystem. Interestingly enough, upgrading and tuning in addition to replacing traditional vehicles with bio or electric vehicles has not seen similar success yet.

1. SHARING

From Finland:
Venuu, Hukkatila, Collaplan, Kliffa

Around the world:
AirBnB, Xiaozhu, Tujia, Coffice, Hoffice, Box at Work, Bettervest, Homeaway, W Hotels / DesksNearMe, Hyatt Hotels / OneFineStay, Cemex / Patrimonio Hoy

digital marketplace platforms, workspace sharing, space rentals, space use optimisation, co-creation platforms, crowdfunding

2. OPTIMISATION

From Finland:
Salusfin, EnergyUp, There Corporatio, Naturvention, OptiWatti, RYM Oy

Around the world:
Ferroamp, Greenpocket, Watty, Opower, Viva, Mapdwell, Wattime, Open Utility, 2andgo, 720, Capacity Energy Storage, Ethera, Ice Gateway, CoolingInno
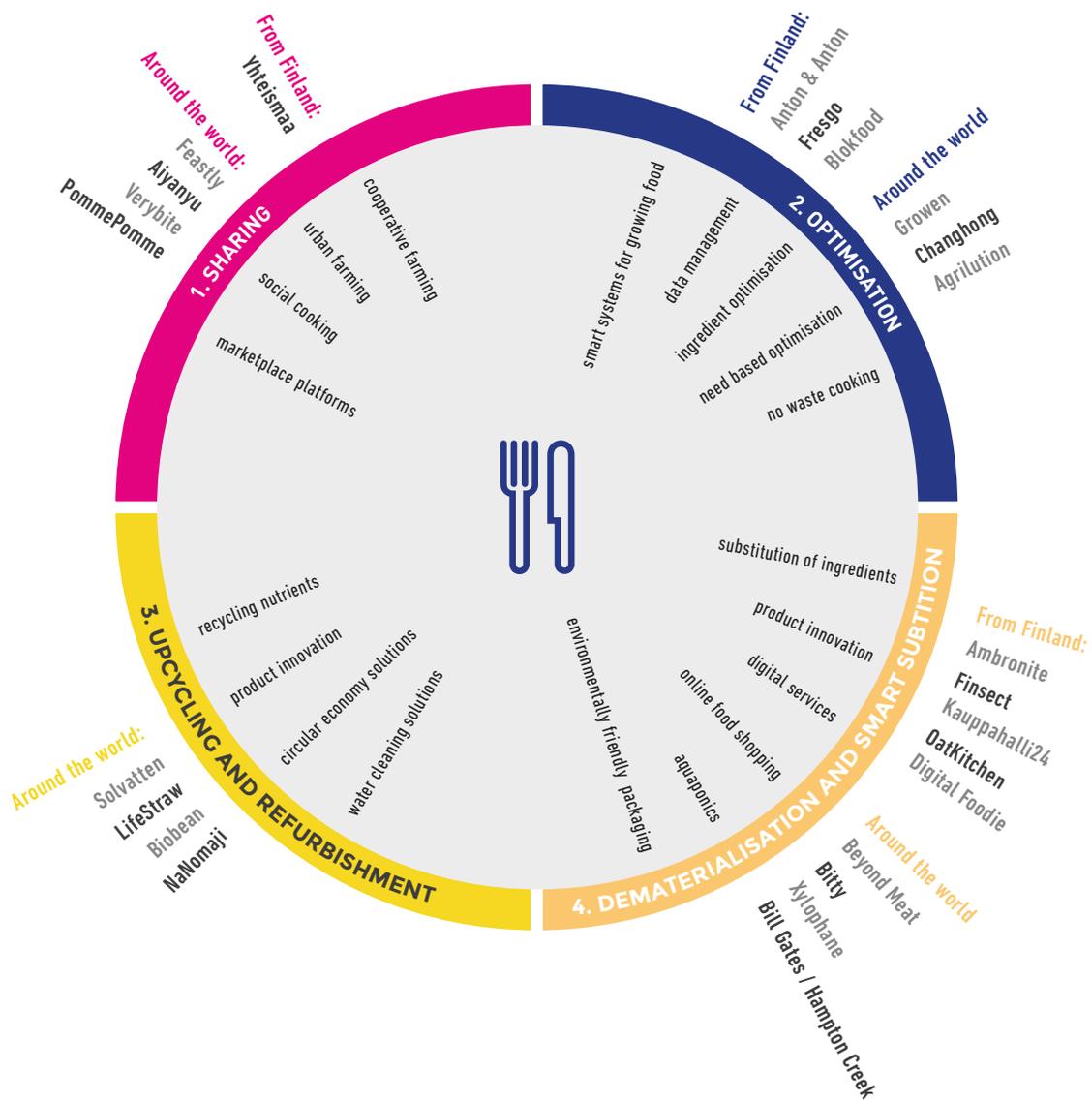
turnkey solutions, home automation, carbon management, energy management, smart metering, digital services, source based optimisation, gamification, smart homes & smart cities, technical product innovation

3. UPCYCLING AND REFURBISHMENT

From Finland
Fourdeg, Lassila & Tikanoja, Ouman, One1, Enefix

Around the world:
Helix, Yetu, Ferroamp, Thermondo, Ikea Secondhand Campaign

recycling technologies, repairing, smart metering, technical innovation, turnkey solutions

4. DEMATERIALISATION AND SMART SUBTITION

From Finland:
Caverion, Cubicasa, Fira, Fortum, Eneron, Ensto, Gasum, Granlund, Greenlux, Halton Group, Helen, Hydrocell, Masar, Motiva, Oilon, Oras, OurNeighbourhood, Savo Solar, SRV, Termopanels Oy, Solnet, Vallavalo, Vantaan Energia

Around the world
Ikea Solar, GreenGoEnergy, Washit, WeShareSolar, CrowdPowerPlant, GreenEnergetic, Rettig ICC, SunRun

virtual services for project development, energy source substitution, turnkey solutions, natural & bio gas, biofuels, solar energy production, decentralized energy, project financing

3.3.2 Business models in housing

In housing, the sharing economy has followed similar development as in mobility. Digital services have made it possible for consumers to create platforms for better use of space making sharing and space use optimisation popular business models in this value creation hotspot. Rentals, home and workspace sharing are trending and show no signs of slowing down.

Smart energy systems and smart homes, with easy-to-adopt technological development in energy management, have made it possible for companies to create business models around optimisation, upcycling, and smart substitution. These businesses are attractive to consumers for many reasons, immediate generation of savings being among the most important ones. The future potential of the business models that combine smart metering, repairing, upcycling, home automation, gamification, and energy source substitution is important. Similarly to mo-

bility, platform level players are gaining ground particularly in the areas of energy usage and home optimisation. In this regard, various services are now being developed by the same companies who offer turnkey solutions for renewable energy.
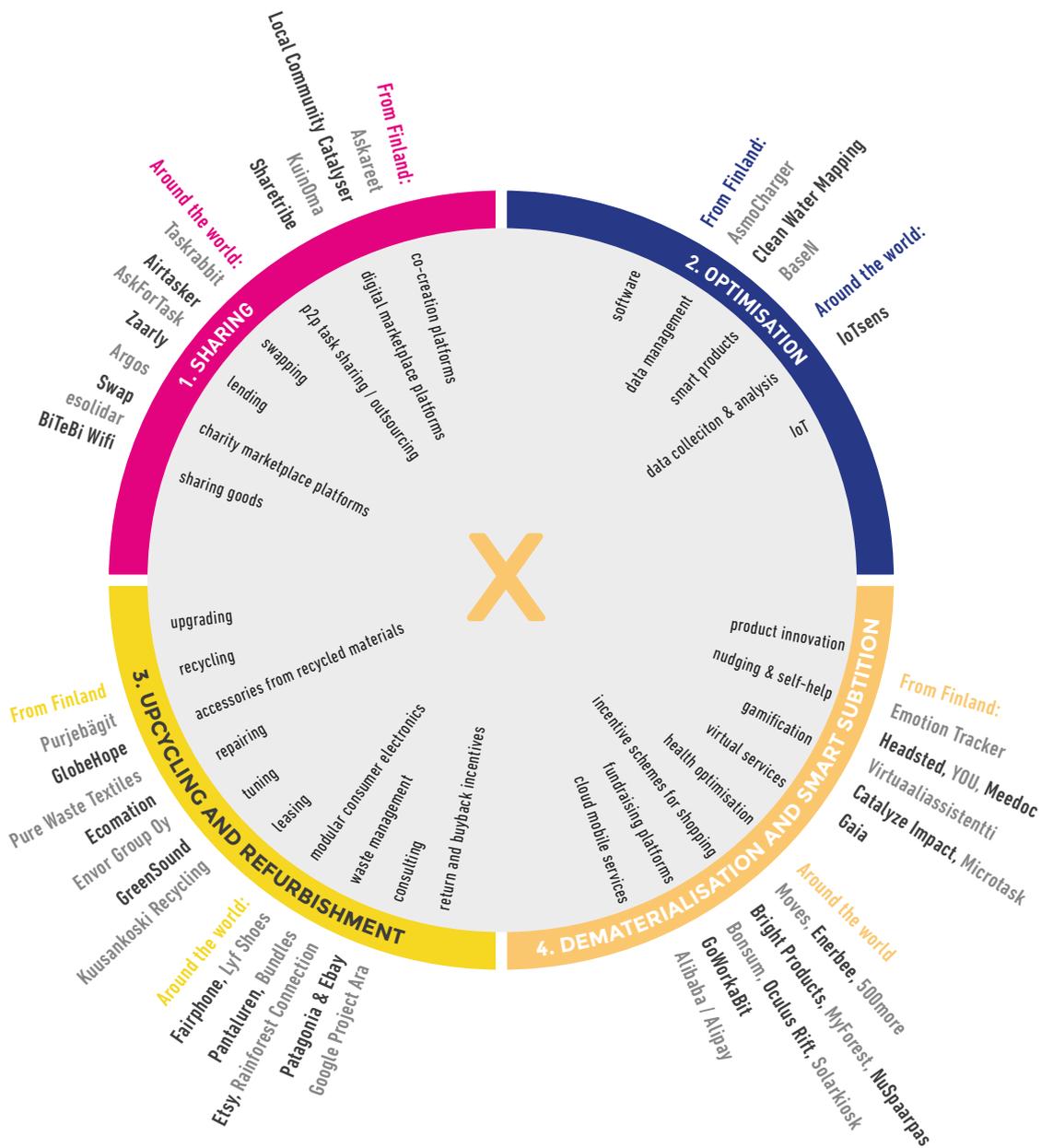
Businesses leveraging innovative ownership models are gaining popularity in housing. This is particularly the case with the household-level investments for renewables. Namely, a number of households prefer buying solar as members of a co-operative. It makes perfectly sense as this is a cost-effective way for households to make these investments. Group investments seem also attractive because buying and negotiating with peers potentially decreases the feelings of uncertainty. The already existing crowdfunding and crowdsourcing platforms for collective energy projects are among the most interesting companies working in this area.

From Finland:
Yhteismaa

Around the world:
Feastly
Aiyanyu
Verybite
PommePomme

1. SHARING
- cooperative farming
- urban farming
- social cooking
- marketplace platforms

From Finland:
Anton & Anton
Fresgo
Blokfood

Around the world
Growen
Changhong
Agrilution

2. OPTIMISATION
- smart systems for growing food
- data management
- ingredient optimisation
- need based optimisation
- no waste cooking

From Finland:
Ambronite
Finsect
Kauppahalli24
OatKitchen
Digital Foodie

Around the world
Beyond Meat
Bitty
Xylophane
Bill Gates / Hampton Creek

4. DEMATERIALISATION AND SMART SUBTITION
- substitution of ingredients
- product innovation
- digital services
- online food shopping
- aquaponics
- environmentally friendly packaging

Around the world:
Solvatten
LifeStraw
Biobean
NaNomaji

3. UPCYCLING AND REFURBISHMENT
- recycling nutrients
- product innovation
- circular economy solutions
- water cleaning solutions

3.3.3 Business models in food

Consumer cleantech businesses do not seem to have a clear, big global breakthrough in the food domain like Uber and AirBnB have been for mobility and housing. The business models of food include cooperative farming, social cooking, smart systems for growing food, no waste cooking, recycling of nutrients, and substitution of ingredients to name few. The most developed and competed sectors seems to be ingredient substitution, in most cases replacing animal proteins with vegetable sources. More competition is coming to this specific field with the introduction of different insect-based sources of protein, and even if eating insects involves some cultural acceptability issues, it has already been made legal in some European countries with expectations that the rest will follow in the next few years.

Figure labels (clockwise around the wheel):

1. SHARING
From Finland: Askareet, KuinOma, Sharetribe, Local Community Catalyser
Around the world: Taskrabbit, Airtasker, AskForTask, Zaarly, Argos, Swap, esolidar, BiTeBi Wifi

Inner segments: co-creation platforms, digital marketplace platforms, p2p task sharing / outsourcing, swapping, lending, charity marketplace platforms, sharing goods

2. OPTIMISATION
From Finland: AsmoCharger, Clean Water Mapping, BaseN
Around the world: IoTsens

Inner segments: software, data management, smart products, data collection & analysis, IoT

3. UPCYCLING AND REFURBISHMENT
From Finland: Purjebägit, GlobeHope, Pure Waste Textiles, Ecomation, Envor Group Oy, GreenSound, Kuusankoski Recycling
Around the world: Fairphone, Lyf Shoes, Pantaluren, Bundles, Etsy, Rainforest Connection, Patagonia & Ebay, Google Project Ara

Inner segments: upgrading, recycling, accessories from recycled materials, repairing, tuning, leasing, modular consumer electronics, waste management, consulting, return and buyback incentives

4. DEMATERIALISATION AND SMART SUBTITION
From Finland: Emotion Tracker, Headsted, YOU, Meedoc, Virtuaaliassistentti, Catalyze Impact, Microtask, Gaia
Around the world: Moves, Enerbee, 500more, Bright Products, MyForest, NuSpaarpas, Bonsum, Oculus Rift, GoWorkaBit, Alibaba / Alipay, Solarkiosk

Inner segments: product innovation, nudging & self-help, gamification, virtual services, health optimisation, incentive schemes for shopping, fundraising platforms, cloud mobile services

3.3.4. Other smart services and their business models

Looking at consumer cleantech business models that do not directly relate to mobility, housing, or food, four business models seem to be widely used: microwork platforms, sharing of goods, upcycling of goods and materials, and virtual services that replace resource intensive practices.

As an example of the changing work culture, microworking has become more popular as consumers look for extra income and as the digital platforms have made it easy to connect the people with skills and time with the needs of other people. These platforms work especially well in large and dense cities, where the mere quantity of population makes it likely that the needs will be met fast enough.

Another value creation model gaining popularity is the emergence of different sharing platforms for a variety of consumer goods. Upcycling and refurbishment of goods is also trending in the fields of clothing and related materials as well as modular consumer electronics. Virtual services replacing the need to travel are being developed e.g. for doctors, dieticians, personal trainers, and personal assistants. Online availability of their services make them easily accessible to anyone with a smartphone and Internet connection.

4.

Emerging business: benchmarking consumer cleantech

In this section, the most interesting startups and established companies adopting new business models are introduced.

The companies were picked to be a representative cross-section of the most potential business areas of consumer cleantech based on expert interviews as well as benchmarking of companies and their business and value creation models. The aim was to highlight startups and companies from fields that have developed fast and offer clear market opportunities in addition to a few companies that are disrupting the market with something totally new.

Since competition is already tough at the consumer cleantech markets, the chosen examples might not be the ones that are actually able to scale up globally. Thus, included in each company introduction are examples of firms with similar business models that we recommend readers also took a look at. In any case, the chosen companies provide an idea of the kind of businesses and value creation models that seem most promising at the moment and that can be expected to become the next big things in cleantech.

One of the most interesting and important things that should be paid attention to is how multiple value creation models are combined and thus hybrid business models created. For more comprehensive listing of companies, please take a look at Appendix 9.1

4.1 Examples of top Consumer Cleantech SME's

4.1.1 Mobility

NAME: Suomen Bioauto

FIELD: mobility

RESOURCE EFFICIENCY MODEL(S): upcycling and refurbishment, smart substitution and dematerialisation

FROM: Finland

WHAT do they do: consulting, assisting consumers and spreading information on how to change bikes to electric bikes and cars to biocars.

WHY is it promising: promoting new ways to upgrade current vehicle base and expand their lifespan. Requires small material input compared to making new electric vehicles or biocars from scratch, in addition to offering a possibility to decrease dependency on gasoline and use less resource intensive fuels. Revenue from consulting services. Example of increased demand for sustainable services.

COMPANIES with similarities in the business model: RVS (UK)
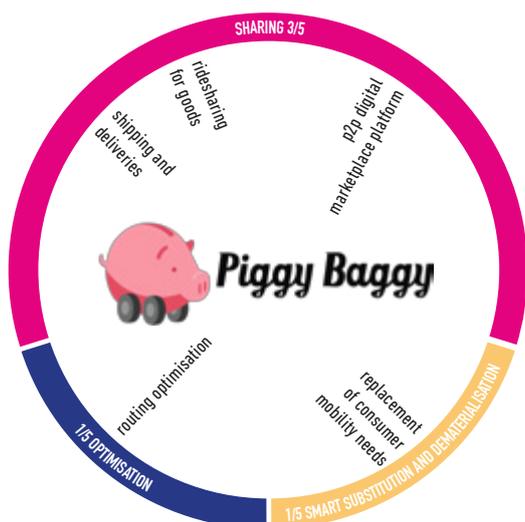
NAME: Piggy Baggy

FIELD: mobility

RESOURCE EFFICIENCY MODEL(S): sharing, smart substitution and dematerialisation, optimisation

FROM: Finland

WHAT do they do: P2P ridesharing for goods through marketplace platform

WHY is it promising: Piggy Baggy connects consumers to collaborate in deliveries and shipping. Thus, it acts as an incentive to not own a vehicle yourself as well as providing and defining new ways of working and generating income. In addition, Piggy Baggy offers a way for route optimisation through combining more deliveries to one gig. Piggy Baggy's main revenue is based on small transaction fees. Good example of a business spawning from increasing demand for sustainable services and the emergence of microworking patterns.

COMPANIES with similarities in the business model: Box At Work (Germany), Huolala (China)
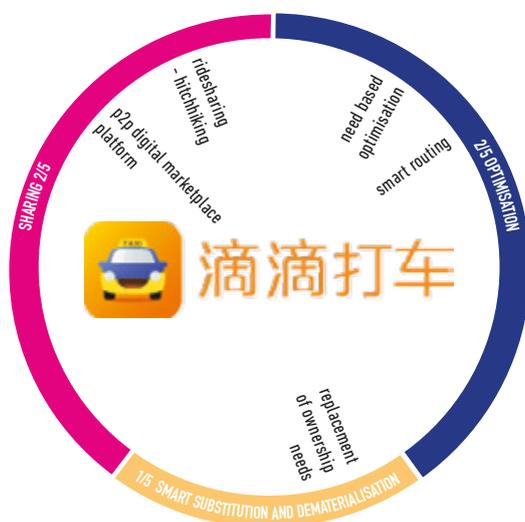
NAME: Xiaojukeji

FIELD: mobility

RESOURCE EFFICIENCY MODEL(S): optimisation, sharing, smart substitution and dematerialisation

FROM: China

WHAT do they do: P2P hitchhiking service and P2P & B2B car rentals

WHY is it promising: Xiaojukeji does P2P optimisation to find people with same mobility needs in real time and connecting them to share rides in addition to both P2P and B2B car rentals. They have recently partnered up with WeChat ecosystem to connect users effectively. Regarding WeChat's 355m user base and Chinese cities' sizes and densities, the service holds large potential. The service reduces need to own a vehicle, offers extra income for those who own one, and reduces resource need by more efficient usage of current resources. Main revenue source is small transaction fees. Example of microworking patterns and access over ownership.

COMPANIES with similarities in the business model: GreenRiders (Finland), BlaBlaCar (France)

NAME: Shangdong Province & local electric vehicle company
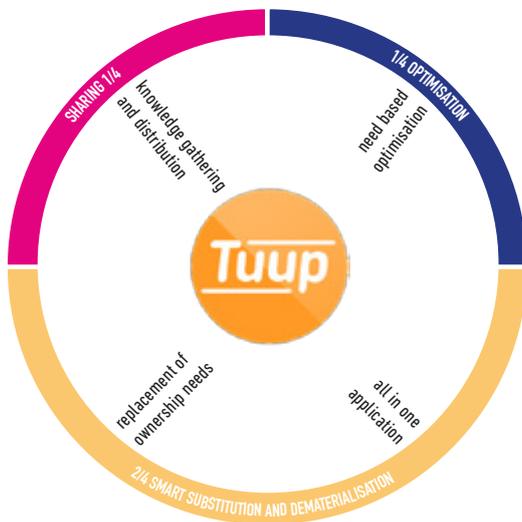
FIELD: mobility

RESOURCE EFFICIENCY MODEL(S): sharing, optimisation, smart substitution and dematerialisation

FROM: China

WHAT do they do: Membership-based mobility as a service electric vehicle project, enabling users to use a vehicle through a free-floating service: pick up from point one and drop off to point two.

WHY is it promising: The approach introduces a new way of looking at mobility by serving it to consumers in many ways and by on-demand principle. Sharing of resources, optimising the need for the amount of vehicles needed as well as reducing the need for individual ownership. Later bikes, e-bikes, taxi, and bus network will be integrated into the system. The most important drivers include access over ownership, growing need for as-a-service -models in addition to growing demand for sustainable services.

COMPANIES with similarities in the business model: Easy Ride

NAME: Tuup

FIELD: mobility

RESOURCE EFFICIENCY MODEL(S): sharing, optimisation, smart substitution and dematerialisation

FROM: Finland

WHAT do they do: Gathers all services for mobility under one platform, all in one solution for mobility

WHY is it promising: offers a platform level view to mobility as a service, combining different services such as parking, public transport, taxi, rental cars, rental bikes, and carsharing. Offers the user a possibility to sort from different options to find the fastest, cheapest, or the most responsible choice possible, offering comparability between different mobility services. For consumers, reduces material usage, helps out in choosing the best mobility service, and makes it easier to compare between services uncomparable before. Current development is at prototype testing level. Great example showing how internet of things is driving superoptimisation and enabling as-a-service business models.

COMPANIES with similarities in the business model: Qixxit (Germany)

4.1.2 Housing

NAME: There Corporation

FIELD: housing

RESOURCE EFFICIENCY MODEL(S): optimisation, upcycling, and refurbishment

FROM: Finland

WHAT do they do: Smart energy control systems that are adapted to existing systems to achieve better energy management and price optimisation.

WHY is it promising: There Corporation offers an easy and fast way to adapt smart energy control systems with a user-friendly digital service and a clear track record of improvements. Typically There Corporation's model offers 15-40 % energy cost savings and installation to existing systems only takes 1-3 hours. Main source of revenue is consulting services. Intriguing example of how buildings get smart upgrades, how the demand for sustainable services is increasing, how the Internet is driving optimisation, and how energy efficiency is seen as an as-a-service business model.

COMPANIES with similarities in the business model: Greenpocket (Germany), Fourdeg (Finland)

NAME: GreenEnergetic

FIELD: housing

RESOURCE EFFICIENCY MODEL(S): smart substitution and dematerialisation, optimisation

FROM: Germany

WHAT do they do: Enabling decentralisation of energy system by providing one-stop-shop for homeowners to plan, purchase, and finance residential photovoltaic systems online.

WHY is it promising: Makes adopting photovoltaic energy systems easy for homeowners by providing homeowners full service and thus decreasing the barriers to adapt solar energy systems. Various revenue streams including consulting, deployment, installation, and repairs. Shapes the image of solar panels to appear more like a typical consumer good resulting from increased demand for sustainable services. Also, typified example how energy can be seen as-a-service and how the energy systems are becoming more distributed.

COMPANIES with similarities in the business model: GreenGoEnergy (Denmark), Savo Solar (residential applications - Finland)

NAME: Bettervest

FIELD: housing

RESOURCE EFFICIENCY MODEL(S): sharing, upcycling and refurbishment

FROM: Germany

WHAT do they do: Crowdfunding platform that makes it possible for anyone to invest in energy efficiency projects and benefit from the savings.

WHY is it promising: Offers a different approach to promoting energy efficiency through crowdfunding. Makes it easier for organisations and individuals to collaborate in energy efficiency projects. Especially for citizens it is an easier and more efficient way to encourage energy efficiency through investing in projects that matter to them. After crowdfunding, Bettervest supports the development by consulting the projects to get them done. This is where their main revenue comes from. Trends supporting their business are increased demand for sustainable services and distributed energy systems as well as access over ownership becoming more important for consumers.

COMPANIES with similarities in the business model: We Share Solar (crowdfunding for solar energy projects - Netherlands)

NAME: Ferroamp

FIELD: housing

RESOURCE EFFICIENCY MODEL(S): optimisation, smart substitution and dematerialisation

FROM: Sweden

WHAT do they do: Ferroamp makes modular solar and storage solutions through an EnergyHub system, with a powerwall in the heart of the system that allows energy storage, bidirectional energy flows, savings on grid fees, and faster electric vehicle charging.

WHY is it promising: Creates energy savings through smart system and innovative powerwall development, making it easier for consumers to adopt solar energy as well as energy efficiency to their homes. Interesting, already-in-business competitor for more famous Tesla Powerwall. Main source of revenue from installations and product sales. Ferroamp is supporting the transition to more distributed energy systems and answering to the growing demand for sustainable services as well as demand for energy storage.

COMPANIES with similarities in the business model: Tesla Powerwall (USA)

4.1.3 Food
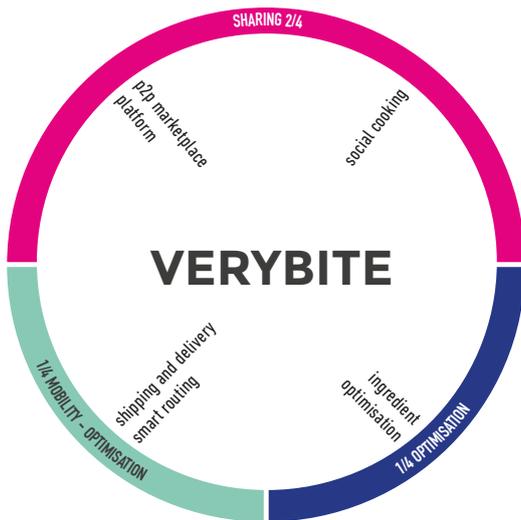
NAME: Verybite

FIELD: food

RESOURCE EFFICIENCY MODEL(S): sharing, optimisation, mobility - optimisation

FROM: China

WHAT do they do: P2P marketplace for homemade food and delivery service

WHY is it promising: Combines local people and resources as well as different aspects of cleantech by sharing resources, increasing social connections, optimising deliveries, and supporting users to cook larger batches at a time to generate income and plan the usage of ingredients better. Main revenue stream for Verybite comes from delivery services. Example of microworking patterns and increased demand for sustainable services.

COMPANIES with similarities in the business model: Feastly (USA)

NAME: OatKitchen

FIELD: food

RESOURCE EFFICIENCY MODEL(S): smart substitution and dematerialisation, optimisation

FROM: Finland

WHAT do they do: Substitution of animal proteins for vegetable sources by creating new, delicious foods and ingredients based on vegetable proteins.

WHY is it promising: OatKitchen answers to the growing need for more sustainable protein sources in food consumption by replacing animal proteins by more ecologically, economically, and environmentally friendly vegetable proteins. Benefits of their product development answer to larger customer need. OatKitchen's main revenue comes from selling their products and is an example of growing demand for sustainable services.

COMPANIES with similarities in the business model: BeyondMeat (USA)

4.1.4 Other
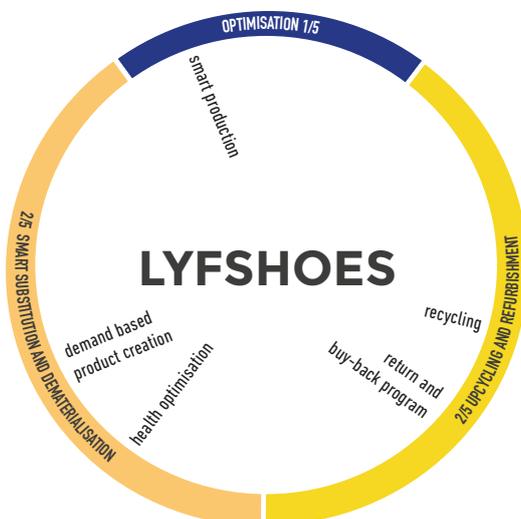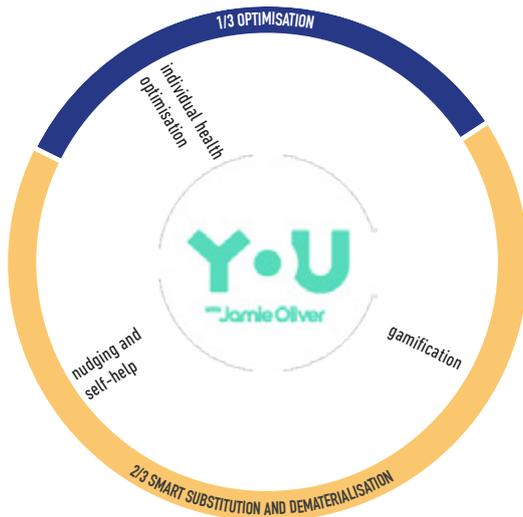

NAME: Lyf Shoes

FIELD: other

RESOURCE EFFICIENCY MODEL(S): upcycling and refurbishment, smart substitution and dematerialisation, optimisation

FROM: USA

WHAT do they do: developing a perfect shoe that combines shoe-making on demand, buy-back program to recycle the materials, design made without glue, and a microchip that collects data to custom-design user's next shoe better.

WHY is it promising: combination of different aspects and approaching a consumer good - shoes - holistically to create a product that brings value for the user, Lyf Shoes, and the environment. Breaks the typical business model of shoe-making by inventing a better product, including service, and promoting your health through a shoe that learns and can be custom-designed. Development of the shoe is on prototype level. Trends behind Lyf Shoes are increasing demand for sustainable services, as-a-service business models as well as optimisation driven by internet of things.

NAME: YOU

FIELD: other

RESOURCE EFFICIENCY MODEL(S): smart substitution and dematerialisation, optimisation

FROM: Finland

WHAT do they do: health application made to promote users' personal health by nudging to the right direction

WHY is it promising: taking healthcare to the hands of individuals by a user-oriented approach, combining tools that digitalisation and smart phones offer to the knowledge about behavior, gamification, nudging, and self-help. Can supplement traditional healthcare services as well as optimise individual health for greater wellbeing and productivity. YOU is at early stage development. Trend behind combination of demand for more sustainable services.

COMPANIES with similarities in the business model: Moves (Finland/USA), Meedoc (Finland)

NAME: Askareet

FIELD: other

RESOURCE EFFICIENCY MODEL(S): sharing

FROM: Finland

WHAT do they do: P2P collaborative marketplace platform to sharing work and skills in the neighbourhood

WHY is it promising: platform provides a way to use resources and skills better, creates microtasks that can function as additional employment, enhances social contacts in the neighbourhood, and replaces the need to search for help from traditional commercial companies in addition to connecting needs and services or skills locally. Main revenue from small transaction fees. Example of microworking patterns and increasing demand for sustainable services.

COMPANIES with similarities in the business model: Taskrabbit (USA), Airtasker (Australia), AskForTask (Canada), Microtask (Finland)
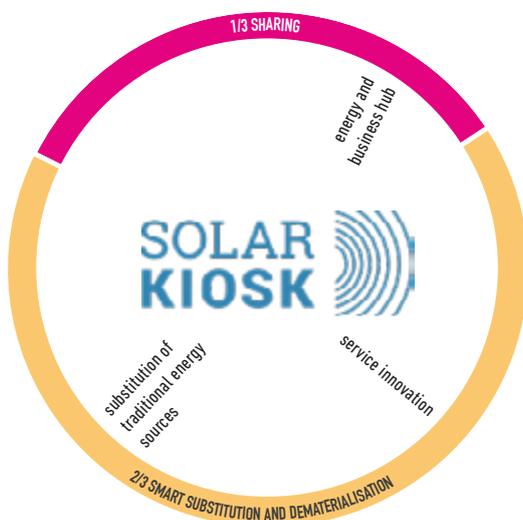

NAME: Solarkiosk

FIELD: other

RESOURCE EFFICIENCY MODEL(S): smart substitution and dematerialisation, sharing

FROM: Germany

WHAT do they do: Solarkiosks serve as an energy and business hub for solar products, fast moving consumer goods and energy services in base of pyramid markets.

WHY is it promising: Kiosks enable new business opportunities that are powered by solar energy and transforms BoP communities into self-sustainable and evolving clean energy centres that can organically grow along with the local economic development. New service for large market in the BoP, which offers potential for growth and is an example of technology deployment in BoP markets. In addition, SolarKiosks are an example how distributed energy systems and off-grid opportunities are becoming available and how there is increasing demand for sustainable services.

4.2 Selected Examples of Major Companies with Top Consumer Cleantech Solutions
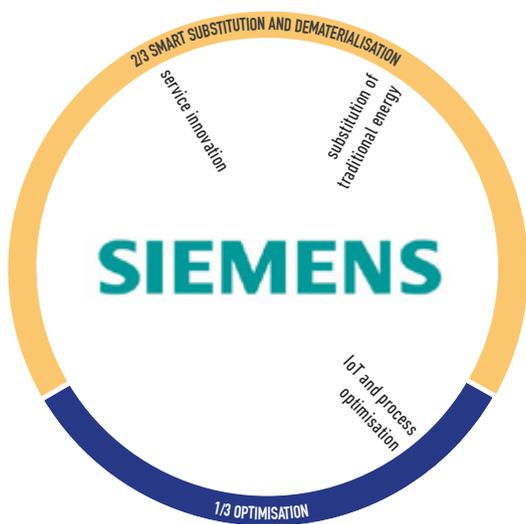

NAME: Siemens

FIELD: housing

RESOURCE EFFICIENCY MODEL(S): smart substitution and dematerialisation, optimisation

FROM: Germany

WHAT they do: Siemens has a dominating presence in renewable energy (leading position in off-shore wind), lighting (OSRAM), green building solutions, and energy transmission and distribution. The company has also made great leaps in for example the fields of high-speed railways and new generation high voltage DC electricity transmission.

COMPETITIVE EDGE: Today, Siemens is one of the world's biggest cleantech companies, reporting EUR 28 billion in its environmental portfolio. The company has definite technological and incumbent advantages despite great competition in the sector. The focus on emerging markets like India and China should yield decent growth for the company.
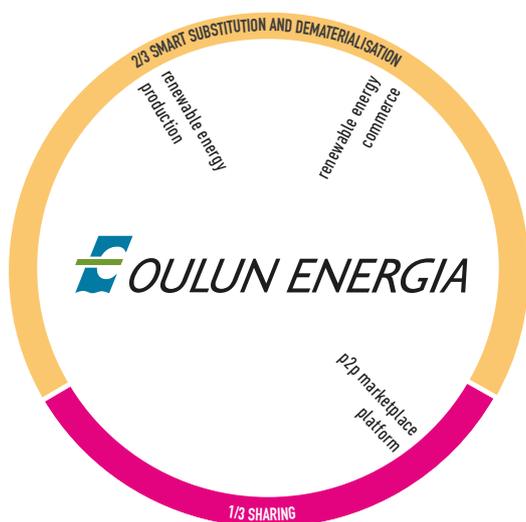
NAME: Oulun Energia, Oulun Sähkönmyynti Oy's Farmivirta

FIELD: housing

RESOURCE EFFICIENCY MODEL(S): smart substitution and dematerialisation, sharing

FROM: Finland

WHAT they do: Farmivirta is a P2P clean energy electricity product; a consumer can buy electricity produced by another consumer in a market-based manner while Oulun Sähkönmyynti handles practicalities such as marketing, contracts, billing, and balance settlement.

COMPETITIVE EDGE: Energy is produced at micro and small power stations with fully renewable power sources such as hydro, wind, solar, and biomass, and practically any household can become a producer. If preferred and to avoid shortages in demand, the producers may also access the Nordic power market with the help of Farmivirta and sell all their production at the Nordpool SPOT-price to the common electricity market.

NAME: Alibaba

FIELD: other

RESOURCE EFFICIENCY MODEL(S): Dematerialisation and smart substitution

FROM: China

WHAT they do: Alibaba is a Chinese e-commerce company that provides C2C, B2C, and B2B sales services and electronic payment services via several web portals. Alibaba has developed an entire e-commerce ecosystem around local, Chinese needs.

COMPETITIVE EDGE: Alibaba first set their focus on B2B markets by connecting Chinese manufacturers and exporters to foreign companies looking to buy Chinese products. Unlike eBay, Alibaba lets people list for free, but charges for advertising. This is crucial for attracting Chinese companies and consumers to start selling their goods online. A growing amount of digital services including taxi and restaurant reservations and ordering queue numbers are easily accessible through Alibaba's ecosystem and mobile application, making Alibaba a big actor in consumer cleantech.
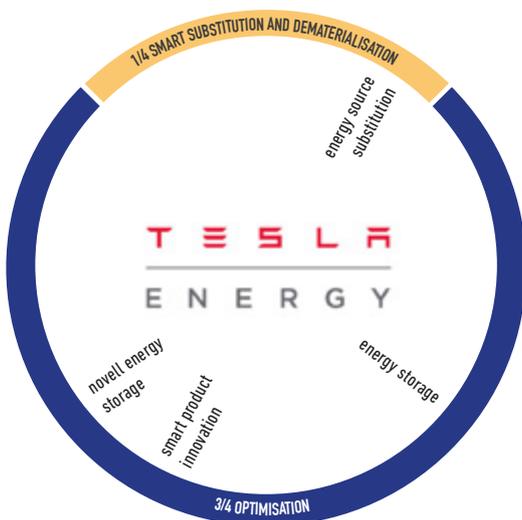
NAME: Tesla Energy, Tesla Motors and Solar City

FIELD: mobility, housing

RESOURCE EFFICIENCY MODEL(S): dematerialisation and smart substitution

FROM: USA

WHAT they do: Tesla's vision is to make all energy generation, infrastructure, and mobility services carbon neutral.

COMPETITIVE EDGE: Tesla has the opportunity to be a true pioneer in the global transformation towards a carbon neutral economy. Their concepts are unique and ready for market deployment in a way that leaves them with no comparable competition at the current time.

NAME: Nest (Google)

FIELD: housing

RESOURCE EFFICIENCY MODEL(S): optimisation

FROM: USA

WHAT they do: Nest – a s startup acquired by Google in 2014 – produces home automation devices with user-friendly interfaces. The devices enable fast energy conservation and have a high ROI for the user.

COMPETITIVE EDGE: Nest places special attention to the UX of the products, which makes them intuitive and easy to install and use. Competing metering companies have not put as much effort as Nest has to UX in home automation.

5.

Why should a Finnish corporation get involved with consumer cleantech?

"We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction."

Bill Gates

Tech giants Alibaba, Baidu, and Xiaomi have all stepped into the financial sector by opening online banks and and announcing money market funds. Thus they have started challenging China's four gigantic state-owned banks. Just recently, the online company Tencent Ltd decided to turn its social media platform into a massive online retail shop: it allowed users to establish in-app stores to sell goods to their friends in WeChat, an app covering 355 million users, many of them instantly engaged with the new mode of selling and buying goods. Needles to say, the hotel and taxi industries have had to face unforeseen difficulties because of the likes of AirBnB and Uber.

What is common to these cases is that bold newcomers have found gaps between the consumer and the product or service. They have come up with smarter and a more resource effective ways to respond to user needs than incumbent companies. In the coming years, the digital disruption will threaten to radically transform virtually every business – also in Finland. This is where a large part of consumer cleantech opportunities emerge.
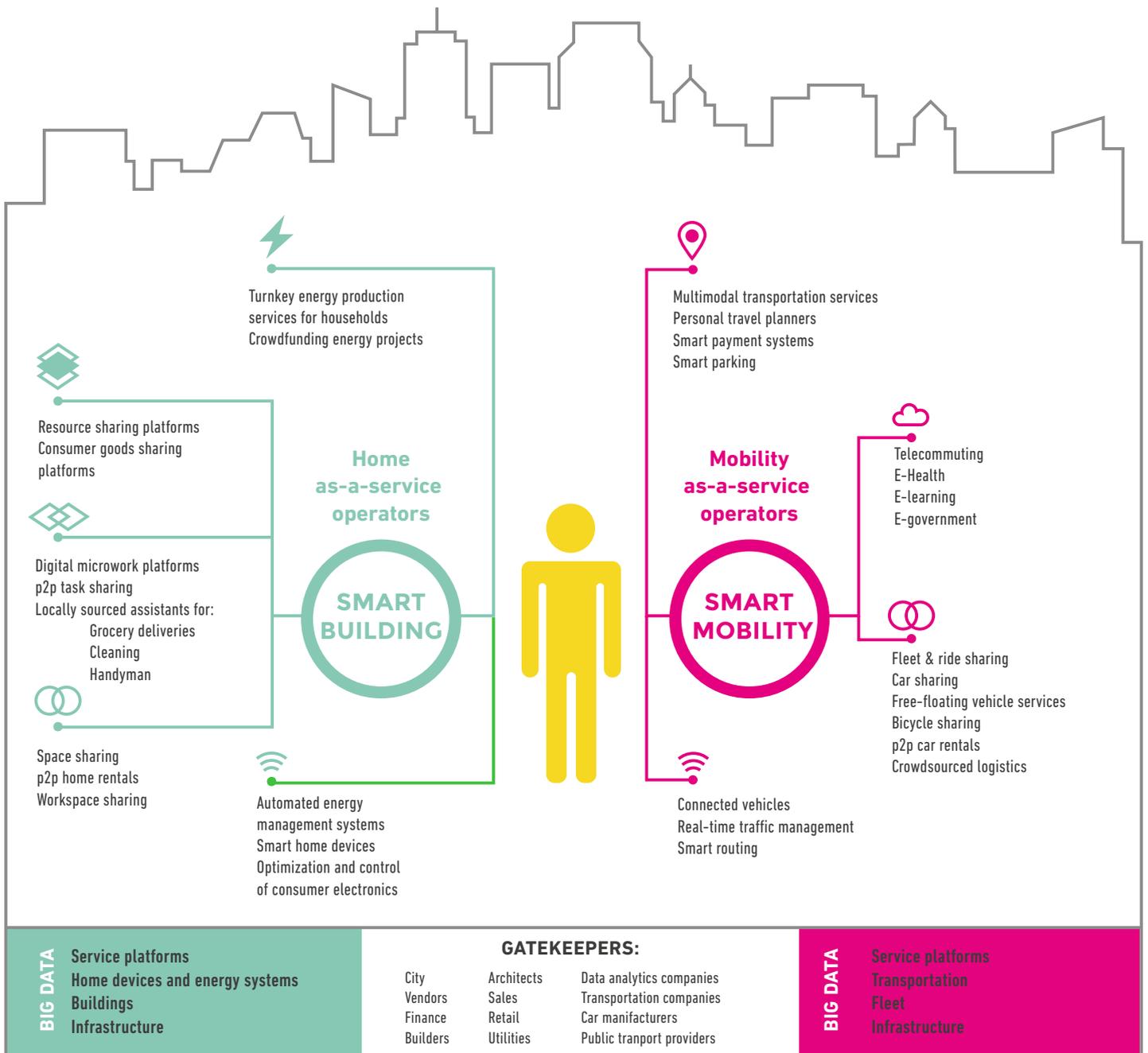
How can Kesko, Enso, Wärtsilä – among other traditional Finnish companies – protect themselves from being disrupted? The old way for staying on track has been to keep developing one's core business and building core

competencies. But increasing research, development, and training does not seem to be the trick any more. The design space has become almost boundless. Building all the capabilities that would ensure future success inside the company has become virtually impossible.

This is due to the fact that many of the solutions that we are now surrounded with are going to be replaced by something very different. Fridges are not going to be replaced by more advanced fridges, but for instance by a home delivery services agile enough to deliver fresh food instantly when needed. Cars are not replaced by cars but a seamless access to flexible mobility. Offices can be partly replaced by not better offices but by mixed and more optimised use of existing spaces.

This is why Konecranes has introduced its famous Industry Hack and why Fortum has its own corporate venturing program. And this is also why Elisa has its own IoT competition. Large corporations might know a great deal about the current markets. Nevertheless, even the largest actor on the field cannot know everything about the user needs related to the field. The mentioned programs are still small compared to these companies' sizes, however, but they are a start.

PICTURE 4. Smart city as a service

Turnkey energy production
services for households
Crowdfunding energy projects

Multimodal transportation services
Personal travel planners
Smart payment systems
Smart parking

Resource sharing platforms
Consumer goods sharing
platforms

**Home
as-a-service
operators**

**Mobility
as-a-service
operators**

Telecommuting
E-Health
E-learning
E-government

Digital microwork platforms
p2p task sharing
Locally sourced assistants for:
　　Grocery deliveries
　　Cleaning
　　Handyman

**SMART
BUILDING**

**SMART
MOBILITY**

Fleet & ride sharing
Car sharing
Free-floating vehicle services
Bicycle sharing
p2p car rentals
Crowdsourced logistics

Space sharing
p2p home rentals
Workspace sharing

Automated energy
management systems
Smart home devices
Optimization and control
of consumer electronics

Connected vehicles
Real-time traffic management
Smart routing

BIG DATA

**Service platforms
Home devices and energy systems
Buildings
Infrastructure**

GATEKEEPERS:

City	Architects	Data analytics companies
Vendors	Sales	Transportation companies
Finance	Retail	Car manifacturers
Builders	Utilities	Public tranport providers

BIG DATA

**Service platforms
Transportation
Fleet
Infrastructure**

As can be seen, many of the services and products separated today are quite likely to become integrated. As this happens, it is not yet determined which actors will take over new business areas.

Corporate venturing allows traditional actors to protect their businesses by sweeping the whole ecosystem. In case of disruption, it is possible for market leaders to do aggressive early stage buy-outs. Further, it enables them to better understand the business environment. Following startups helps getting a good grasp of what kind of solutions work and what do not. Thirdly, it helps in creating new growth opportunities. Via startup-derived growth and learning from startups, innovative corporations can cannibalise their businesses themselves in a controlled way.

Which fields should be interested in consumer cleantech? It could be safer to ask who should not. In the end of the 19th century dozens of manufacturers were developing better horse carriages, knowing that the best would win the race. Finally – now seemingly self-evidently – all of them lost, because of a paradigmatic change in mobility: cars.

To stay in the game, the big actors must actively join the disruptive forces – at best, start to disrupt. Consumer cleantech startups tend to do things with efficient resource use, efficient use of assets, and superior end-user focus. Therefore established companies should look for ways to work with, not against them.

Picture 4 illustrates the on-going convergence into two domains: smart mobility and smart buildings. As can be seen, many of the services and products separated today are quite likely to become integrated. As this happens, it is not yet determined which actors will take over new business areas. Established companies can find new fields of business and protect themselves from disruption by tapping into consumer cleantech fields.

Consumer cleantech companies (see Appendix 9.1) provide people with a wide variety of accessible services that are attractive to use. Together these services have the potential to revolutionise lifestyles, replacing previously resource-intensive practices with less intensive ones. Picture 4 demonstrates the interlinkages of the services in the overall ecosystem of smart cities.

As-a-service businesses play an important role as connectors in the big picture. Interestingly, they have a capacity to bring all different services in one platform making it easy for users to optimise their daily routines. As a result, the consumer cleantech hotspots can be expected to converge with a logic similar to depicted in Picture 4. Perhaps in the future people can buy a turnkey home that serves as an electric vehicle charging station, comes with bikes and a bikesharing storage room, creates its own electricity by solar panels, grows its food on the roof and inside with high-tech growing systems, and controls its energy usage automatically.

6.

Analysis: towards driving consumer cleantech in Finland

Most of the radical technologies that define our contemporary lifestyle owe their genesis to audacious risk-taking on the part of the State. The Internet is a paradigmatic case. Through mission oriented funding and a variety of policy instruments, the U.S. government sparked development of a technological infrastructure whose magnitude and influence stretches well beyond what was foreseeable in the 1950s (Mazzucato, 2013).

The award-winning economist Mariana Mazzucato (2013) argues that the "green revolution" can be as wide-ranging and disruptive as the revolution in information and communication technology if governments actively support the buildup of innovation ecosystems. Public sector investments to low-carbon society plays a role comparable to investing in technical infrastructure, such as roads and railroads, not to forget the basic research behind the development of the Internet. The State's role at its best is an enabler, which perceives and seizes crucial investment targets which are out of the reach of the commercial mechanism due to their prolonged payback time – and eventually benefits from the innovations that it came to enable.

Based on the consumer cleantech company profiles mapped for this survey across the world, it seems not at all far-fetched to say that the green revolution has already taken off. 15 experts were interviewed for this report, including experienced founders and organisers of top class cleantech events as well as startup and business hubs from Finland and abroad (see list of experts, Appendix 9.2). These experts were of the opinion that consumer cleantech will continue shaping the global markets tremendously. They viewed consumer cleantech certainly as an opportunity to create new business that radically reduces the use of natural resources.

For the survey we asked the experts what they considered the key characteristics of a functional innovation ecosystem enabling the formation of vibrant consumer cleantech markets. Based on the discussions, a framework that highlights critical functions of the innovation ecosystem in different levels (state, region/city, Tekes/Team Finland) as well as focus areas including access to markets, access to capital, and access to diverse ecosystems was developed. This framework works as a basis for the recommendations of this study. It is introduced more thoroughly in Section 6.2. Before this, the potential of Finnish consumer cleantech scene is investigated in Section 6.1.

6.1 The potential of Finnish consumer cleantech scene

In Finland, consumer cleantech has been steadily rising with new startups and business models in various domains, leveraging various resource efficiency models. Top Finnish companies in consumer cleantech include startups such as Enevo, Swap.com, There, Sharetribe, One1, and Fourdeg. The markets still lack a strong flagship company, a strong brand such as AirBnB.

Compared to the global consumer cleantech companies identified in this survey, Finnish consumer cleantech seems to have roots in the legacy of Nokia with the orientation of the companies in smart devices and mobile technologies. These characteristics are not, however, typical only to the Finnish consumer cleantech companies.

Similar business and resource efficiency models are being developed by a number of companies across the world. Mobility and data utilisation are at the core of the development of consumer cleantech markets. Further, the data gathered for this survey reveals that in some consumer cleantech domains companies based in Finland lag behind. This is the case for instance with models that are based on the sharing economy. This observation is supported by some recent smart city assessments. Finland gains top positions based on all indicators except for the sharing economy, which still leaves room for improvement (FastCompany, 2014b).

6.1.1. The potential by areas of business

SHARING ECONOMY: The global sharing economy market was valued at $26 billion in 2013 and some predict it will grow to become a $110 billion revenue market in the coming years, making it larger than the U.S. chain restaurant industry (HBR, 2014). Also the number of companies offering sharing services in Finland is expanding. Services like AirBnB, Hoffice, Xiaozhu, and Venuu have made it possible for consumers to share spaces when they are not in use. Also peer-to-peer marketplaces like swap.com and Huuto.net and a group of smaller car and ride sharing services have solidified their positions. The trendsetter AirBnB has been quite successful in reaching Finland as well, even if its adoption has not been as fast as in other Nordic countries (Helsingin Sanomat, 2015) - another hint about the market not being quick to adopt new business models even if they are largely popular around the world already.

SMART BUILDINGS: Another field that has been going through rapid change are services and products that one can refer as smart buildings or smart energy systems related to housing. Global market sizes in 2015-2020 are estimated to be 82.5 billion dollars for smart buildings and 183 billion for smart energy (Frost & Sullivan, 2014). Companies operating in the field of smart buildings combine different ways to do energy management from smart metering, digital services, gamification, and automation to optimisation. In Finland, companies such as There Corporation and Fourdeg are setting the trend and elsewhere companies like Opower, GreenEnergetic, and Watty provide similar services.

Housing and energy related business models are also on the rise in the solar industry. Business models including turnkey solutions that make it easy and much more attractive for consumers to change their energy usage to solar are paving the way, especially around the world but in Finland as well. Finnish companies SavoSolar and Solnet are good examples of this. Combined with smart energy management tools such solutions offer exciting prospects for future business development.

SMART MOBILITY: As-a-service business models enabled by platform level innovations will most probably represent the next big wave in consumer cleantech. These innovations are already emerging in the smart mobility domain as well as in smart housing markets. The Finnish early-stage startup Tuup and the US-based Qixxit are targeting the mobility markets with their business models, which bring different mobility options under one platform. These companies naturally do not erase the need for players specific to a certain area of mobility as a service (for example bike sharing). Quite the opposite, in order to function, the development of different, segment-focused models is a prerequisite for scaling up. During 2015-2020, smart transportation is estimated to grow into a business worth 138 billion dollars (Frost & Sullivan, 2014).

OTHER SMART SERVICES: Finnish companies are among the pioneers in combining digital services, healthcare, and mobile apps. From the cleantech viewpoint, digitalisation and virtual health services decrease the need to travel, thus using less resource intensive practices to make the services reach the consumer in addition to nudging users to make better and more sustainable choices in their everyday life. By 2020, healthcare costs will account for 11.1 % of GDP in a typical advanced economy, which is up from 6.3 % in 2010 (Frost & Sullivan, 2014). Finnish services including Meedoc, YOU, and Moves have realised the limitations of the market in Finland and have from the beginning aimed for global markets, all them being quite successful at it, creating business models that others follow. Next, interesting opportunities may well lie in optimisation enabled by the Internet of Things that links health with smart city structures and also optimises daily healthcare routines.

In order to create an innovation ecosystem that fosters Finnish cleantech know-how and supports the most promising companies and development projects, it is essential to

1. **identify the most promising companies and**

2. **recognise the different maturity levels of these companies.**

Some of the most interesting Finnish consumer cleantech companies are briefly introduced in Table 3 (p. 40). Moreover, their the maturity levels of these companies are displayed in Table 2.

	R&D	DEMONSTRATION	PRE-COMMERCIAL	SUPPORTED COMMERCIAL	COMMERCIAL
	Basic research Applied research	Prototypes Functioning technologies/products	First commercial applications	Commercial applications supported through tax benefits	Market viability
HOUSING		Solnet Meido	Fourdeg	Solar energy storage	There corporation Naturvention One1 Oilon Savosolar
MOBILITY	Algae fuel	Toroidon MaaS	Tuup	Suomen bioauto PiggyBaggy Kutsuplus	Enevo ST1 biofuels NEXTBTL
FOOD	OatKitchen	Entocube BlokFood Insects as protein source		Recycling nutrients Circular economy	Ambronite
OTHER	Ioncell		Askareet	Sharetribe	Re-Pack Swap.com Solved Moves

The different phases mapped here range from initial research and development all the way to commercial viability. When different financial instruments or growth programs are planned, they ought to be directed so that companies can fully utilise the support offered. It would be more beneficial to target companies according to a level or maturity and not for instance the field they operate in, or at least be very mindful of how the companies' needs vary depending on their maturity.

As we see from the Table 2, many of the most promising startups that have been mentioned earlier in this report are in very different stages of maturity. In order to fully capitalise on these startups' potential, they should be helped with the specific obstacles of their field (e.g. legislation) and the specific obstacles they have from moving to the next phase of maturity (financing/networking/marketing). As we can see, the most potential area is "housing" and companies in pre-commercial and commercial phases such as Fourdeg and There Corp. Mobility is the second most lucrative area, where Finland has competitive companies e.g. in biofuels and mobility-as-service business area. It is also worthwhile to take a careful look at the "other" sector and seek companies with really unique value proposition and business models that can be scaled up globally, e.g. Swap.com and Solved.fi. Difficulties faced by Finnish consumer cleantech entrepreneurs are summarised in Section 6.1.3.

TABLE 3.

SWAP.COM	Swapping and buying platform for secondhand consumer goods
ENEVO	Smart collection plans for waste collectors
THERE CORPORATION	Smart energy control systems that are adapted to existing systems
FOURDEG	Smart metering application for buildings and district heating networks
SHARETRIBE	Local digital marketplaces to sell and rent goods, spaces, or services
SAVOSOLAR	Residential solar energy applications and management systems that allow for prosumerism
SOLNET	Turnkey renewable energy solutions and energy management applications that allow for prosumerism
MEEDOC	Virtual healthcare service innovation
YOU	Health care solutions through an application that promotes microactions
SPLIT (AJELO)	Kutsuplus Digital automatic solution to allow for shared rides to be dispatched on the fly
TUUP	Gathers all services for mobility under one platform
REPACK	Reusable packing materials
MEIDO	Digital housing social network
OATKITCHEN	Substitution of animal proteins with vegetable sources
VENUU	AirBnB for event spaces

6.1.2. SWOT analysis

A pool of experts interviewed for this survey listed a number of strengths and weaknesses in the Finnish business environment relevant for the growth prospects of consumer cleantech companies. These observations are pulled together in a SWOT analysis presented below in Table 4.

TABLE 4. Strengths, weaknesses, opportunities and threats of Finnish business environment, recognised by experts.

STRENGTHS	WEAKNESSES
A lot of technical expertise, combined with connectivity and mobile know-how	Small market which is lacking mechanisms for scaling fast to international markets
Pioneering as-a-service business models for mobility	Lack of a big consumer brand building global visibility and awareness for Finnish companies
Emerging IoT initiatives by big companies	Cleantech markets are dominated by manufacturing companies
Cleantech is adopted as the most important export sector and is receiving large amounts of innovation funding	Corporate venturing programs are rare
Smart cities adopted as a development paradigm in a number of municipalities big and small	Rigid and difficult public sector and corporate financing instruments
Strong proliferation in cleantech including good rankings in international indices combined with strong country brand	Regulation that hinders the emergence of radical innovation and disruption
Solid consumer demand for sustainable products and services	Smart city programs and instruments lack mechanisms that help startups scale their services to global markets
Technically advanced infrastructure and good level of ICT utilisation	Lonely rider mentality and working in silos leads to overlooking of hybrid solutions (e.g. our cable for your electric car)
High level of education and prospects for exporting education	Finland is not present in the international circles of cleantech
Know-how in monitoring health and homes	Small volumes and a culture that promotes saving (frugality) instead of consuming
	Stiff decision-making processes in cities, which slow down business development
	Lack of sales and marketing skills, especially in terms of consumers; selling is undervalued in Finland
	Design know-how is not leveraged by cleantech companies
	Development projects run by the public sector lack transparency
	Narrow national capital markets: only of a handful of VC firms and business angels; companies have difficulties raising investments exceeding €1-2 million

OPPORTUNITIES	THREATS
Positive drive and spillover effects from the gaming industry; including access to capital	Climate targets are not taken seriously and viewed as an opportunity for new business by the government during times of economic downturn
Both the public and the private sector realise the potential of gathering and opening up big data	"Not invented here" mentality, doing your own thing without seeing what's happening elsewhere. Where is Finland's first "copycat accelerator"?
Climate change and scarcity of natural resources are seen as systemic challenges affecting both production and consumption	Companies can't be bothered to participate in Tekes' rigid financing procedures
Bioeconomy, clean technologies, and digitalisation emphasised in the new government program	Companies are not willing to cannibalise their own business; they prefer staying in their foxholes covering their backs when they should be innovating and taking risks
Experimentation culture (also well present in the government program) has the potential to shape public-private-people partnerships and provide new opportunities for testing and piloting	Venture capitalist market doesn't grow and the access to capital remains narrow
2015-2016 is the tipping point for solar technology and many other consumer cleantech technologies due to increased awareness and sinking production prices	
Several leading universities focus their strategy in tapping opportunities rising from climate change, resource scarcity, and other environmental challenges (e.g. UEF strategy)	
Shared benefits type of business models are increasing in number - e.g. ESCO type of saving model	
Willingness to streamline regulation can offer possibilities for new competing business models	
Leveraging Finland's good reputation abroad (e.g. many countries consider that a Finnish company could operate in their grid)	
Extending the strong B2B mindset to consumer markets	

6.1.3 Bottlenecks to growth reported by the Finnish consumer cleantech startups

In addition to the expert interviewees, a number of prototype level startups and larger companies that collaborated with startups reported the most serious bottlenecks that they find crucial in their journey to the global markets. Some similarities can be identified in the SWOT and the bottleneck analyses. In the future, a similar analysis would be valuable to carry out for established companies. Within the scope of this study, the analysis was mostly limited to startups. The answers are divided in three categories: those given by early-stage startups ("seed-level"), those given by early growth startups, and those who were at the stage of scaling their business to global markets.

SEED

THERE are a lot of good ideas of consumer products, but many people lack abilities or the right mentality to start working on their own ("no need to rush, there's plenty of time").

LACK of know-how on how to establish a company: practicalities related to establishing and running a business as well as consumer behaviour are not learned as part of basic education

LACK of consumer cleantech ecosystem's support and transfer of know-how and other support from peers.

UNAWARENESS of the lean method and design thinking methods, crucial to understanding the consumer and thus finding a functional business model

DOMINANT mindset is that one needs to grow big in Finnish consumer markets before going international.

EARLY GROWTH

STARTUPS are often driven by passion for solving climate problems or expertise related to certain technology, not business - more time and effort to marketing is needed.

DIFFICULTIES in identifying early adopters and getting into touch with them. This makes it hard to convince investors about the potential of the business model or product, especially when they lean on relatively new kind of behaviour such as in case of sharing economy applications

REGULATORY STIFFNESS prohibits prototype testing (specifically a problem with the sharing economy business models).

LACK OF ACCESS to city authorities as innovation partners – the interested city officials are often development managers or environment specialists, and without wider support it is slow to proceed with collaboration

THE ALMOST NON-EXISTING corporate venturing culture for consumer cleantech services

LACK OF COURAGE to take not-yet-ready prototypes (i.e.) MVPs under the eyes of early adopters. This is crucial for products that are aimed for consumer markets

NOT MANY BUSINESS ANGELS operate in the Finnish markets, making the group of consumer cleantech focused business angels even smaller
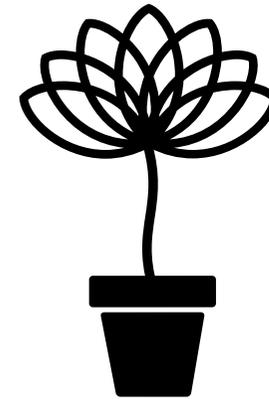
SCALING TO GLOBAL MARKET PLACE

THE WEAKNESS of Finnish financing markets: it is practically impossible to raise more than €1-2 million from venture capitalists. For example Enevo had to be able to attract multiple VCs from Finland and abroad to close its 6 million euro funding.

SHORTAGE OF CONNECTIONS to the global VC scene. Couple of promising events in Finland gather important investors, but there's no consumer cleantech scene to attract relevant investors.

NO PROPER PRESENCE in the most important global cleantech events, including Cleantech Open as well as EcoSummit.

6.2 Recommendations

Based on the interviews carried out for this survey, Finland has the potential to become a trailblazer in a number of consumer cleantech areas. In order to achieve this, however, much needs to be done.

The recommendations section of this report consists of three sections. In the first section Team Finland is recommended to choose smart buildings and smart mobility as thematic focus areas to enable smart growth in consumer cleantech. The focus areas are elaborated in Section 6.2.1. In the second section (6.2.2), we present 5 exceptionally promising business opportunities. These five topics differed from the other recommendations, since they coherently relate to specific themes. Due to their almost project-like form they are presented as a separate section. recommended for Team Finland to take these opportunities under investigation when planning the next cleantech program.

In the third section (6.2.3), concrete action points for building a strong consumer cleantech ecosystem as well as enhancing Finnish consumer cleantech startups access to capital and markets are given. These recommendations are concluded from expert interviews and the difficulties that were reported by consumer cleantech startups (see, Section 6.1.3). The recommendations are most importantly directed for Team Finland and players within it, due to Team Finland's important role as a promoter of international success of Finnish enterprises. Also state and municipality-level recommendations are done, however. While as a large amount of recommendations is presented in 6.2.3, the three most important recommendations are highlighted in the Conclusions chapter.

6.2.1 Consumer cleantech focus areas: smart buildings and smart mobility

Based on the interviews carried out for this survey, Finnish consumer cleantech has potential growth opportunities especially in two areas that are linked closely with smart city development: smart mobility and smart buildings. Therefore we recommend Team Finland to focus on these consumer cleantech hotspots.

Smart buildings and smart mobility hold great promise. In this survey they were chosen as recommended focus areas due to the fact that they are the core domains of consumer cleantech both in terms of their market size (wallet shares of housing and mobility) and resource intensity. Judging from the number of companies with various business models operating on these markets (see Section 3.3), there's a great potential for radical breakthroughs in housing and mobility.

Finland has good potential to access and even take over the markets in smart mobility and smart buildings. As a forerunner in mobility-as-a-service thinking, the Finnish MaaS has already provoked international interest. Projects to make Finland the first country to implement MaaS have already been initiated. Smart buildings, on the other hand, refers to a range of features ranging from smart home devices to smart grid applications and distributed energy production solutions. Finland has solid know-how in mobile and platform solutions due to the Nokia background, but also fine energy expertise. Finland is often described as a country of abundant technical expertise and limited marketing know-how, and thus it is forgotten that it was indeed a Finnish company which produced the most popular consumer products in the mobile market for over a decade. This expertise shall be grasped and brought to the centre of smart home and smart buildings development.

However, in consumer cleantech focus is not only in the creation of new technologies, but also in serving people in smarter ways. As discussed in Chapter 1, the convergence of different industries means that one must understand, perhaps clearer than ever, one's own role besides competitors, gatekeeper industries, and other actors in order to align one's offering as smart as possible. These facts are underlined in the five business opportunities for Finnish cleantech companies, presented next.

6.2.2. Five best business opportunities for Finnish cleantech companies

Five business opportunities have been mapped with a focus on consumer cleantech and companies' scaling opportunities to markets with a lot of demand. These business opportunities are presented in this chapter. As estimated by Frost and Sullivan (2013), fields of smart buildings ($82.5B), smart energy ($183B), and smart transportation ($138B) hold massive potential for business. These numbers represent the entire smart solutions eco-system in each selected segments for both urban and non-urban panoramas.

1. **INTEGRATION OF FINNISH CLEANTECH SOLUTIONS FOR CONSUMERS IN HOME AUTOMATION BY COMPANIES SUCH AS GOOGLE AND APPLE.** In 2014 Google acquired the company Nest for $3.2 billion and a few months later, Nest purchased Dropcam. With the combination of Nest, Dropcam, and Revolv, Google is building a very competitive smart building hardware team. In turn, Samsung recently bought SmartThings to pursue a similar goal. Apple has also developed their technology called HomeKit, which is designed to streamline communications between Apple's gear and accessories like web security cameras, smart plugs, thermostats, and other pieces of the smart building ecosystem. Linking new cleantech solutions into these existing interfaces would be a profitable way of spreading Finnish smart building solutions. It is possible that consumer cleantech markets will be dominated by large corporates and their ecosystems. We suggest Finnish companies establish a strong link to these corporations and learn to collaborate with them.

There are several promising home automation companies in Finland such as There, Optiwatti, Fourdeg, and BaseN, which are already collaborating with major construction companies such as YIT and Skanska and energy companies such as Helen, Fortum, and Oulun Energia. Team Finland should facilitate collaboration between top Finnish home automation companies and global top players such as Google and Apple (and Chinese counterparts) by integrating Finnish know-how into their developments and by inviting them into interesting projects such as Smart Kalasatama in Finland.

Company examples: There, Optiwatti, Fourdeg, Ouman, One1, BaseN.

2. **SMART GRID SOLUTIONS AND USER INTERFACES.** According to Frost and Sullivan (2013), smart energy markets of 2015-2020 are going to be valued at 183 billion dollars. We recommend offering products for projects operated by potential strategic partners such as Tesla Energy, Tesla Motors, Solar City, Siemens, or GE. Joining forces with the big players can be a very lucrative way to tap into the smart grid development and decentralised energy production markets. For instance China's State Grid Corporation is the largest state-owned electric utilities company in the world and they are developing a super grid of ultra-high voltage transmission systems to connect far-off power sources with cities hungry for ele-

ctricity. SGCC wants to replace coal and oil heating with electric heating all over China to cut air pollution. UHV super grid would also allow integrating renewable energy production and other smart grid solutions at a large scale.

Likewise as in home automation, in smart grids Finland has been one of the forerunners in the world thanks to companies such as ABB, Fortum, and Tieto. Team Finland should 1) map out key Finnish companies and the touch-points and enablers for scalability in the smart grid ecosystem 2) spark co-creation with global top leading companies in USA, Germany, China, and South Korea with help of Team Finland players for fast market testing and new partnerships.

Company examples: Savosolar, Solnet, BaseN, Aidon, Ensto, Viola Systems, Gasum.

3. **MOBILITY AS A SERVICE (MAAS).** Finland has become known as the birthplace of innovative mobility concept MaaS and aims to build world's first Mobility as a Service ecosystem. The concept has evoked international interest ranging from the city of Palo Alto in California and Mexico City and companies such as award-winning global design firm Ideo. The novelty value needs to be utilised quickly through testing and developing concepts further with real life pilots. At this end, there is an ICT Finpro Growth program that together with Team Finland members, ITS Finland, and companies promotes the successful internationalisation of the concept. The MaaS paradigm should be taken as a focus in all Finnish cities. It is predictable that urbanisation will increase global demand for innovative mobility solutions and eventually become one of the key drivers.

Smart transportation is estimated to become a business worth 138 billion dollars during 2015-2020. Through Tekes and other Team Finland players (Sitra, Finpro), the new innovation solutions should be introduced to significant markets. We suggest bringing smaller startups such as Tuup and Ajelo together with bigger players such as Neste Oil, Gasum, Nokia HERE, and HSY. Furthermore seek ways to set up quick pilots in selected markets such as Palo Alto and Mexico city. City to city collaboration is needed and we recommend to invite the cities in Helsinki metropolitan area for joint development.

Company examples: Tuup, Ajelo, Reittiopas 2.0, Nokia HERE

4. **REAL ESTATE AND SMART CITY DEVELOPMENT PROJECTS.** There are numerous large real estate development projects and smart city enterprises that could be used to push Finnish cleantech solutions towards global markets. Getting products and services piloted in large scale brings enough money, interest, and visibility to aid in internationalisation. Smart city projects have been established all around Europe: for example TINA in Vienna and Forum Virium in Helsinki. In 2009 Korea founded a smart grid test bed in Jeju Island for national Smart Grid Project. The test bed aimed to become the largest smart grid community globally and allow the testing of the most advanced smart grid technologies and R&D results as well as the development of business models. It also serves as the foundation for the commercialisation and industrial export of smart grid technologies. The ongoing Beautiful Beijing project by Tekes and the Department of International Cooperation of the Ministry of Environmental Protection offers companies access to demonstrating and piloting projects and more importantly to commercial projects later on.

Finland's existing real estate and smart city development projects are world class and thus should be better utilised and aimed to claim their part of the 82.5 billion dollar global market related to smart buildings. More than half of smart cities of 2050 will be from Europe and North America. Moreover, more than 80 trillion dollars will be spent on core infrastructure in domains such as transportation (32 %, i. e. roads, rails, airports), water (32 %, i. e. dams, reservoirs, wastewater treatment), and power (14 %, i.e. generation, transmission). (Frost & Sullivan, 2014.)

Project developers such as Enevo should be guided to seek new innovative and scalable solutions to their projects. Team Finland players should support this by financing visionary project scoping together with a wide range of companies, for example Ramboll's activities in the Östersundom development project. Moreover, to establish testbeds in Finland, smart city and real estate testbeds should be supported with funding, training, and communications procedures. Relevant development projects in Scandinavia and Central Europe should be mapped out and made accessible for Finnish startups. Joint testbed programs with Finnish companies' participation to be formed in selected markets.

Company examples: Enevo, DigiEcoCity, YIT, Skanska.

5. **EDUCATIONAL ACTIVITIES,** support services, and applications for youth and consumers about environmental awareness in Asia (China, South East Asia, Indonesia). Finland has a strong name in education and developing innovative learning materials and environments. We also have plenty of skills in ICT, gaming, and software development industries. By combining these we could rise as a leader in environmental awareness and cleantech education.

Finland's reputation in education and efforts in education exports should be combined with goals to raise environmental awareness and consumer engagement. Team Finland should organise joint workshops on consumer cleantech, education, and gaming to map out new opportunities.

In addition, initiatives such as Rails Girls and MeHackit need to be picked up at an early phase and made into export products.

COMPANY EXAMPLES: Rails Girls, MeHackit, YOU

These five opportunities are wider opportunities for Finnish consumer cleantech excellence. The two most important notions here are that 1) consumer cleantech demand is vast and fast developing and 2) Finland has a relatively strong offering. Consumer cleantech shall be funded by various sources, Tekes' project funds being an important one.

6.2.3 Recommendations for Team Finland's next cleantech program

Based on the analysis in previous sub-chapters, a set of recommendations have been pulled together with an objective to make important changes to the Finnish innovation system. The recommendations are targeted to state, municipalities, and to Team Finland.

This report has chosen an approach in which multiple different actors will be brought together to develop consumer cleantech solutions. It is suggested that Team Finland will focus in thematic areas instead of choosing specific organisations or technologies to be supported over others. The suggested focus areas are smart buildings and smart mobility. Buildings and mobility are chosen not only due to large market shares related to them. Finland has strong capabilities and know-how in development of mobile solutions, platforms and energy solutions, as well as good amount of both smart buildings and smart mobility startups. As demonstrated in Chapter 5, the convergence of ecosystems ensure that a growing amount of services are connected to the user through smart mobility and buildings. The leading actors in these areass have the potential to be leaders in many business sectors.

Recommendations for facilitating Finnish consumer cleantech companies' access to markets, access to capital, and promoting related ecosystems is listed next. Three of the most repeated recommendations are highlighted in the Conclusions chapter.

RECOMMENDATIONS FOR TEAM FINLAND

ENABLING CONSUMER CLEANTECH COMPANIES' ACCESS TO MARKETS:

Partner with cities which are global edge markets in the contexts of smart buildings and smart mobility to create visibility and help Finnish companies test and scale their businesses in these environments.

Provide help in modifying procurement policies. Set an ambitious target that 10 per cent of the mobility and housing-related public procurements must be sustainable solutions. This is how consumer cleantech startups can get reference cases and more likely step into growth, which in return benefits the public sector.

Create a pool of mentors that consists of Finnish entrepreneurs in the target market. Link these mentors with the startups which are to enter the market or intent to internationalise.

Organise a training program and thus train city officials to make cities testbed areas and create local demand for new mobility and housing solutions, meanwhile push startups to internationalise and test their products on international markets at early stage.

ENABLING CONSUMER CLEANTECH ECOSYSTEMS:

Benchmark the most significant consumer cleantech accelerators globally. Create an exchange program with them to enable Finnish startups' presence in the target markets. Expand the Finnish companies' networks to reach the best professionals of their respective fields.

Organise regular bootcamps for startups in Silicon Valley and other relevant markets (i.e., 5 bootcamps for 20 startups each year). Bootcamps should consist of pitch events, meetups with contacts to get to know the local market (from lawyers to market experts), and one-on-one meetups with local VCs.

Organise bootcamps for the executives of Finnish companies in order to train them to conceptualise and lead Finnish corporate venturing programs. Focus on attracting the most interesting consumer cleantech startups globally to join the programs (i.e. best Silicon Valley startups to collaborate with Wärtsiltä etc). This is also how Vodaphone and Google are building their bridges to the startup world.

Create a program to attract the most important consumer cleantech startups globally to create their concepts in the local Finnish market. This increases competition in the local markets and drives the whole ecosystem forward. The benefits of attracting international startups can be clearly seen at the Dutch accelerator Rockstart, which has about 50 % of the startups coming from outside the Netherlands.

Initiate dialogue about corporate venture programs between the Finnish startups and the global corporates which are prominent market leaders in the fields of smart buildings and smart mobility (i.e. Samsung, Nokia, Google).

Connect Finnish traditional cleantech companies with consumer cleantech startups, so that consumer cleantech companies can benefit from traditional industrial cleantech expertise.

Organise training through which traditional construction and mobility actors learn to build early stage accelerators, to run challenge based programs and hackathons in order to support consumer cleantech startups and create partnerships.

ENABLING CONSUMER CLEANTECH COMPANIES' ACCESS TO CAPITAL:

Map the most important consumer cleantech VCs globally and establish linkages between companies in the relevant growth stage. Support development of venture capital scene in Finland. To begin with, introduce a yearly consumer cleantech event in Slush. Invite the most important consumer cleantech VCs globally as well as smart buildings and smart mobility investors to take part in the event, which will be profiled as the world's most significant consumer cleantech gathering.

Standardise Team Finland's funding requirements to steer startups toward building minimum viable products, testing them in contact with end-users continuously from early stage, building sufficient skills on user insight and creating user centric business models.

Map out the current crowdfunding actors at different scales - in Finland, in the Nordic region, in Europe and so forth; study the enablers and challenges in building up a vibrant crowdfunding system which will best foster the Finnish startup culture.

RECOMMENDATIONS FOR MUNICIPALITIES & STATE

	ENABLING CONSUMER CLEANTECH COMPANIES' ACCESS TO MARKETS:	ENABLING CONSUMER CLEANTECH ECOSYSTEMS:	ENABLING CONSUMER CLEANTECH COMPANIES' ACCESS TO CAPITAL:
MUNICIPALITIES	Integrate smart buildings and smart mobility projects to city-level development frameworks like HINKU and Resource Smart Jyväskylä to create a strong starting point for cities to kickstart their activities and create profiles as platforms for new consumer cleantech businesses. Set emission targets and strategies to support innovative public procurement especially for public housing, offices, and transportation service startups. Support distributed energy production by ensuring that it has to be considered in each level of city planning and different monitoring systems of built environment.	Encourage municipalities, teleoperators, energy companies, and other actors to collect and enable access to energy data especially in the domains of mobility and buildings. Open, reliable, and up-to-date market information helps consumer cleantech startups and SME's to better build their business plans. Using *kumppanikoodari* model as a reference, assign experts to visit city offices and assist in procuring for consumer cleantech solutions (i.e. an expert suggests new mobility innovations to be integrated in public transportation). Helsinki is currently hiring experts to procure for innovative solutions. Cities to accelerate facilitated corporate venturing schemes that bring start-ups, established companies, and cities themselves together. The focus is on finding common benefits and actively engage with end-users. The Oulu-Health and the Smart Retro projects are examples.	Taking Oulu's asymmetric fund as a reference, build asymmetric innovation funds for smart building and smart mobility contexts in large cities in order to attract private capital and provide public sector a new channel for funding consumer cleantech companies. Create collaboration networks with other cities in the domain of smart buildings and smart mobility to find related venture capitalists and to attract investments globally.
STATE	Adjust regulation by removing obstacles from building sharing economy and small scale energy production. Secondly, adjust regulations to better promote business operating in smart buildings and smart mobility. Create measures and provide political support to consumer cleantech services by shifting emphasis from production to consumption in measuring climate emissions.	Create minimum quota in public procurements for consumer cleantech solutions (i.e. 10% of procurements must be sustainable solutions). Make household level and other renewable energy production more feasible. This can be done either by a) removing VAT from self-produced energy; b) allowing citizens to buy shares from renewable energy that is produced by electricity company, while not collecting tax from the proportion that a citizen buys energy for her own use; c) reintroduce and broaden housing-related ARA fundings to cover home energy installations.	Establish a capital investment fund for consumer cleantech under Finnvera. Create financial instruments for energy savings and resource optimisation. Leverage government program's plan to build an Internet of Things programme to allocate research, development, and innovation funding to promote the growth of digital services in order to develop and test new consumer cleantech solutions.

7.

Conclusions: Finland's first steps

This study has investigated the potential of Finnish consumer cleantech. It is truthful to conclude that Finnish companies have all the potential to develop into market leaders in the vastly growing consumer cleantech markets. The market is still at developing phase, and there are not so many dominant actors on the playground. At the same time, the competition is already tough. A descriptive example of the market is a Finnish heat optimisation startup Optiwatti's situation: it has to compete with the likes of Google. It is entirely possible that some sectors of consumer cleantech are soon in the hands of giant data and internet conglomerates.

This doesn't mean that the markets couldn't be entered and taken over. This kind of manoeuvre, however, requires a strategy and focus. This report suggests smart homes and smart mobility as the thematic focus areas of Finnish consumer cleantech. These areas are both resource-intensive and large by their market size. Some of the greatest megatrends of our time, such as urbanisation and resource scarcity, ensure that there is a growing demand for solving problems related to mobility and built environment.

To help the Finnish consumer cleantech companies to succeed, at least the following three important actions are suggested to be taken by Team Finland:

1. **Create an exchange program with 2–3 best consumer cleantech accelerators in the world and hence regularly send Finnish companies to get in touch with their target markets, network, and learn from the best.**

2. **Introduce a yearly consumer cleantech event in Slush and profile it as the world's most significant consumer cleantech gathering. Invite the most important consumer cleantech VCs, smart buildings and smart mobility investors as well as startups.**

3. **Initiate a dialogue with the largest consumer cleantech corporations in the world in order to establish corporate venturing programs with them. Make sure to establish at least one program for smart buildings and smart mobility companies.**

These three action points were brought up by multiple interviewees. As such, they facilitate Finnish companies' access to markets and capital and also help building a world-scale startup ecosystem for consumer cleantech. It is highly recommended to invite and involve relevant international customers and partners (e.g Google, Apple, Samsung, GE, Siemens, Uber, etc.), key players in the markets, and Finnish consumer cleantech companies to co-create the winning models. In regards to mobility, Finland has already taken action to become a forerunner. Promisingly, Finnish mobility-as-a-service paradigm has provoked interest in US and Mexico. When it comes to mobile solutions, electronics and energy expertise, Finland still has a solid and respected reputation.

Finnish startups should be supported by resources sufficient enough for creating prototypes and test them. At the same time, they should be boldly sent to global markets at an early stage. It is important to note that while cleantech is almost thoroughly driven by energy scarcity and related cost savings, consumer cleantech is also largely influenced by many other factors, such as consumers' interests of the environment or experienced need to save money. In the field of consumer cleantech, the understanding of consumer behaviour is crucial and must be enhanced by continuous testing.

Team Finland can support Finnish growth stage startups expand internationally by both creating enabling structures as well as helping the companies individually.

This report suggests plenty of concrete action points to be taken in order to attract capital, create and broaden networks, and enable market entries in Finland and abroad.

8.

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8.1 Photo attributes

9.

Appendix

9.1 List of top 80 startups around the world

KAUPPAHALLI24, http://www.kauppahalli24.fi/ Finland
Food, Dematerialisation & Smart Substitution
Delivery service and a digital Service replacing grocery shopping

OATKITCHEN, Finland
Food, Dematerialisation & Smart Substitution
Ingredient substitution. Substitution of animal proteins sources with vegetable sources in different products.

XYLOPHANE, http://www.xylophane.com Sweden
Food, Dematerialisation & Smart Substitution
Environmentally friendly, biodegradable packaging for food.

BEYOND Meat, http://beyondmeat.com USA
Food, Dematerialisation & Smart Substitution
Ingredient substitution. Substitution of animal proteins sources with vegetable sources in different products.

BITTY, http://bittyfoods.com USA
Food, Dematerialisation & Smart Substitution
Protein source substitution by cricket flour, as it is one of the most sustainable forms of protein on the planet. Products made in partnership with professional chefs to ensure good taste.

BLOKFOOD, Finland
Food, Optimisation
Combines greenhouse and fisheries, reduces water consumption in these activities by 90 percent. In design, prototype building phase.

AGRILUTION, http://agrilution.com Germany
Food, Optimisation
A device that grows herbs, salad, and berries fully automated in your home. Consumer empowerment through food growing solution

FRESGO, http://www.fresgo.fi/en/ Finland
Food, Optimisation
Service innovation: ordering food with smartphone app so it comes ready to be picked up or to be eaten when you arrive

CHANGHONG, http://slide.tech.sina.com.cn/elec/slide_5_42385_51818.html#p=2 China
Food, Optimisation
Smart Food Identification Refrigerator: sensors and camera let you know what's missing. Smart temperature adjustments. There's a larger company behind, which also makes smart kitchenware, heating, etc.

GROWEN, http://growen.me/app USA
Smart meter growing pots. Enables you to automatically grow houseplants using a smart plant pot with a mobile application as a remote control.

ANTON & Anton, http://www.antonanton.fi Finland
Food, Optimisation
Preordered groceries with ready made recipes = no waste cooking.

VERYBITE, http://www.verybite.com/ China
Food, Sharing
P2P marketplace for homemade food + delivery service.

AIYANYU, China
Food, Sharing
Brings people together to eat and share food.

YHTEISMAA ry, www.yhteismaa.fi Finland
Food, Sharing,
Co-creation & community building, cooperative farming, and different social innovations.

FEASTLY, https://eatfeastly.com Finland
Food, Sharing
Digital marketplace that connects not-professional chefs and everyone else to cook and eat together.

POMME Pomme, www.pommepomme.se Sweden
Food, Sharing
A mobile apple juice factory. Pomme Pomme visits peoples gardens and produces juice out of their fruit.

BIOBEAN, http://www.bio-bean.com USA
Food, Upcycling & Refurbishment
Green energy company that has industrialised the process of recycling waste coffee grounds into Advanced Biofuels.

LIFESTRAW, http://www.buylifestraw.com/en/ Denmark
Food, Upcycling & Refurbishment
Water cleaning through a straw that includes water filters. Possible to use in different markets, especially including BOP.

SOLVATTEN, http://www.solvatten.se Sweden
Food, Upcycling & Refurbishment
Combined water treatment and solar water heater system typically used in situations where water resources are scarce and prone to contamination. It enables children and their families living without safe water to improve their quality of life. BOP.

NANOMAJI, Finland
Food, Upcycling & Refurbishment
Technology-driven frugal water filter, that utilises an innovative filter material licensed by Ahlstrom, removing contaminants from the water and eliminating the need of treating it. This solution has potential to reduce the amount of charcoal used around the world for boiling water, being affordable for the BOP-markets.

GREEN Go Energy, http://www.greengoenergy.com Denmark
Housing, Dematerialisation & Smart Substitution
Creation of prosumers of energy. Energy company that delivers stable solar power to the markets with low electricity price, from the consumers' own roof.

GREEN Energetic, http://www.greenergetic.de Germany
Housing, Dematerialisation & Smart Substitution
Turnkey solution that offers a one-stop-shop for home owners to plan, purchase, and finance their residential photo-voltaic system online.

WESHARESOLAR, http://wesharesolar.com/ Netherlands
Housing, Dematerialisation & Smart Substitution
Creation of prosumers of energy. Crowdfunding of collective solar energy projects. Takes care of financing, contracting, administration, and management.

SUNRUN, http://www.sunrun.com USA
Housing, Dematerialisation & Smart Substitution,
Creation of prosumers of energy, residential solar financing.

MASAR, http://masar.io/ Netherlands
Housing, Dematerialisation & Smart Substitution
Turnkey solution that is the first distributed solar power-generating network in Egypt for homeowners. Possibility for BOP-markets as well.

THERE Corporation, http://www.therecorporation.com/ Finland
Housing, Optimisation
Holistic home energy management solutions.

COOLINGINNO, http://coolinginno.com Slovenia
Housing, Optimisation
Air-conditioning unit that works with almost no electricity. AIR Tower is a low energy cooling and ventilation system that creates a comfortable, fresh, and healthy indoor environment while reducing over 90 % of cooling costs!

FERROAMP, http://www.ferroamp.com Sweden
Housing, Optimisation
Powerwall that is developed offers modular solar and storage solution. The smart energy storage not only increases self-consumption of solar electricity, but it also reduces capacity peaks during the wintertime, thus reducing the need for fossil fueled power plants.

OPOWER, http://www.opower.com/ USA
Housing, Optimisation
Turnkey solution for energy optimisation. Energy efficiency, demand response, digital engagement, customer care, and gamification combined.

GREENPOCKET, http://www.greenpocket.de/en/ Germany
Housing, Optimisation
Smart home software enables the control of radio-controlled devices, which range from lighting and heating to surveillance and ventilation. Its integrated solution is designed to offer the user control over their household and transparency of energy consumption

XIAOZHU, http://www.xiaozhu.com/?utm_source=qdan.me#/ China
Housing, Sharing
Chinese AirBnB. Established in 2012. Got 10 million dollars of funding on first round. Subsidiaries in 13 cities, apartments in 130 cities."

VENUU, http://venuu.fi/ Finland
Housing, Sharing
Enables users to connect with each other and trade for spare resources, connecting the different spaces for events on to one platform.

BETTERVEST, https://www.bettervest.de/home Germany
Housing, Sharing
Crowdfunding platform for energy-efficiency projects of companies, NGOs, and local authorities that allows the crowd to participate with high returns in the cost savings.

BOX at Work, http://www.boxatwork.com Germany
Housing, Sharing
Innovative smart storage solution and sustainable moving boxes, pick-up and delivery service, and transport with an eco-friendly van that chooses efficient routes.

COFFICE, http://coffices.co USA
Housing, Sharing
Enables users to connect with each other and trade for spare spaces for more efficient usage of build environment.

FOURDEG, www.fourdeg.com Finland
Housing, Upcycling & Refurbishment
Housing and smart homes, smart metering application that offers energy efficiency in buildings and district heating network.

ONE1, http://www.one1.fi/index.php?mid=2 Finland
Housing, Upcycling & Refurbishment
Renewable energy and energy efficiency services and solutions for energy companies, municipalities, and communities as well as developers and property owners.

THERMONDO, www.thermondo.de Germany
Housing, Upcycling & Refurbishment
Turnkey solution for energy renovation. Online heating installation company that enables an automated proposal creation process for heating renovations. Based on 14 data points entered by the customer, the system proposes the most suitable heating system and its cost. The proposals include hardware of all major German heating manufacturers as well as installation consultation services.

YETU, www.yetu.com Germany
Housing,Upcycling & Refurbishment
Smart home and energy management, connects all devices in a household and lets users run their entire home through one simple online platform that works across all devices.

HELIIX, www.heliixinc.com Germany
Housing, Upcycling & Refurbishment
Waste heat recovery technology capable of harnessing low-grade waste heat at efficiency higher than state of the art technologies. First commercial application is the Phaethon, a domestic scale device that retrofits to SWHs and transforms them into cogeneration units capable of generating electricity in addition to hot water.

REPACK, http://www.originalrepack.com Finland
Mobility, Dematerialisation & Smart Substitution
Reusable packing materials.

TUUP, www.tuup.fi Finland
Mobility, Dematerialisation & Smart Substitution
Helps to manage the everyday time use and mobility by bringing all mobility options into one application (parking, public transport, taxi, car and bike sharing, etc.). With Tuup it is easy to compare and pay for the services. With Tuup the employer can offer employees a flexible mobility benefit, which puts climate friendly travel alternatives on an equal footing with car use.

EEMOBILITY, www.ee-mobility.com Germany
Mobility,Dematerialisation & Smart Substitution
Smart flat-rate eCar charging at home and everywhere. Turnkey solution with a full-service one-stop solution to EV drivers: a wallbox, installation service, and renewable energy supply for a home.

WALKIT, http://walkit.com/ UK
Mobility, Dematerialisation & Smart Substitution
Digital service that gives a route map between any two points, including journey time, calorie burn, step count, and carbon saving.

BIKECITIZENS, www.bikecitizens.net Austria
Mobility, Optimisation
Bike Citizens offers individually optimised services and products for cities and urban cyclists. App shows cycle paths and side streets and avoids busy main streets. The app utilises smart algorithms based on the know-how of bike couriers.

"URBAN electric vehicle sharing project", Shangdong province, http://cnews.chinadaily.com.cn/2015-04/01/content_19973851.htm China
Mobility, Sharing
Chinese MaaS project. Local people order a membership through an app. Using a EV is charged by minute (3snt/min). Free floating service: pick up points. Later, bikes, e-bikes, taxi, bus network will be integrated to the system. City in collaboration with a EV company.

XIAOJUKEJI, http://www.xiaojukeji.com/website/index.html China
Mobility, Optimisation
P2P hitchhiking service & P2P & B2B car. Mobility as a smart service connects people with same route and help them share mobility costs. Partnered up with WeChat ecosystem.

AJELO (acquired by SPLIT), www.ajelo.fi Finland
Mobility, Optimisation
Efficiency and cost reduction through digital automatic solution, which dispatches shared rides on the fly.

ENEVO Oy, http://www.enevo.com Finland
Mobility, Optimisation
Creation of smart collection plans for waste collectors. Uses wireless sensors to measure and forecast the fill-level of waste containers and generates smart collection plans using the most efficient schedules and routes. The solution provides up to 50 % in direct cost savings.

MOBIGOPILOT, http://mobigopilot.wordpress.com/ Finland
Mobility, Optimisation
Offers a comprehensive solution for employee mobility benefits and optimisation of mobility. Service that allows users can adjust mobility expenses to better match their needs.

QIXXIT, https://www.qixxit.de/ Germany
Mobility, Dematerialisation & Smart Substitution
MaaS operator that brings together different mobility services. Similar to Tuup.

PIGGYBAGGY, http://piggybaggy.com Finland
Mobility, Sharing
Shipping and deliveries digital service platform.

CAMPANDA, www.campanda.com Germany
Mobility, Sharing
P2P Motorhome sharing and renting in 32 countries. Travellers can rent motorhomes over Campanda, owners can rent out their campers & motorhome to make cash out of their unused resource.

JAANO, www.jaano.de Germany
Mobility, Sharing
Free-floating scooter sharing service. Parking, traffic, usage, gas included. MaaS platform.

FLOATILITY, http://floatility.com/ USA
Mobility,Sharing
Lightweight e-scooter renting/selling targeting the last mile problem. Maas operator.

PARKING Panda, https://www.parkingpanda.com USA
Mobility, Sharing
Parking space shared through digital service and marketplace platform.

RELAYRIDES, https://relayrides.com USA
Mobility, Sharing
Carsharing, digital service and marketplace platform

BLABLA Car, https://www.blablacar.com France
Mobility, Sharing
Ridesharing, digital service and marketplace platform

NIMBER, https://www.nimber.com USA
Mobility,Sharing
Sharing shipping and deliveries with people going the same direction.

ELECTRIC motor powered hill assistant unit for Heavy Good Vehicle, Finland
Mobility, Upcycling & Refurbishment
Install an electric motor and battery in the trailer of a truck. Assist hill climbing, regenerate power, and charge the battery when going downhill. Additional charging from a biogas based generator. The system is independent of the truck and uses location, pitch, speed, and altitude data to control the assistance. Reduce fuel consumption and particulate emissions.

SUOMEN Bioauto, http://www.suomenbioauto.fi Finland
Mobility, Upcycling & Refurbishment
Upcycling your vehicles, spreading information on how to change bikes to electric bikes, cars to biocars.

RVS, http://www.refusevehiclesolutions.co.uk UK
Mobility, Upcycling & Refurbishment
Tuning vehicles with 72-point check to correct all defects. Upcycling of old vehicles to usable vehicles.

YOU with Jamie Oliver, http://you-app.com Finland
Other, Dematerialisation & Smart Substitution
Digital service innovation, health care solutions through microactions. Nudging app.

MEEDOC Labs Oy, https://www.meedoc.com/suomeksi Finland Other, Dematerialisation & Smart Substitution
Virtual healthcare service innovation. Efficiency and cost reduction through digital healthcare service. Reducing primary care costs up to 50 % through its communications platform.

VIRTUAALIASSISTENTTI, http://www.v-assistentti.fi/ Finland
Other, Dematerialisation & Smart Substitution
Microworking service. Virtual assistant to ease the process of getting things done.

ENERBEE, http://market.ecosummit.net/c/EnerBee France
Other, Dematerialisation & Smart Substitution
EnerBee is an industrial startup developing motion-based energy-harvesting solutions to replace batteries in industrial and consumer connected objects.

NU SPAARPAS, http://www.prewaste.eu/index.php?option=com_k2&view=item&id=289&Itemid=101, Netherlands
Other, Dematerialisation & Smart Substitution
Sustainable incentive card scheme and loyalty program.

SOLAR Kiosk, http://solarkiosk.eu/ Germany
Other, Dematerialisation & Smart Substitution
Service innovation. BOP-market service kiosk running by solar power, serving different consumer needs.

ASMOCHARGER, http://www.asmocharger.com/en/ Finland
Other, Optimisation
Reducing electricity consumption. ASMO Charger is automatically working charger that does not waste any electricity on standby. It saves electricity and makes products more fire-safe.

ASKAREET, http://www.askareet.fi Finland
Other, Sharing
Microworking. Small tasks done by people who can do them better than you in your neighbourhood.

LOCAL COMMUNITY CATALYSER, Finland
Other, Sharing
24/7 smart container reinvigorates the local community by providing easily accessible facilities for local services and exchanges. This reduces the need for travel to city centres and for construction of business space. The service point is integrated with an online service platform as well as existing services and communities

SWAP, https://www.swap.com Finland
Other, Sharing
Secondhand consumer goods swapping and buying platform.

SHARETRIBE, https://www.sharetribe.com Finland
Other, Sharing
Local digital marketplaces to sell and rent goods, spaces, or services.

TASKRABBIT, https://www.taskrabbit.com USA
Other, Sharing
Microworking. Small tasks done by people who can do them better than you in your neighbourhood.

LYF Shoes, http://lyfshoes.com/lyf-story/ USA
Other, Upcycling & Refurbishment
Leasing of shoes, shoes are assembled on demand – an ideal for meeting consumer needs with the lowest carbon footprint possible. Buy-back program to recycle, microchip collecting data to make the new shoe better fit your feet.

PURE Waste Textiles, http://www.purewaste.org Finland
Other, Upcycling & Refurbishment
Textiles and clothes from recycled materials. Manufacturing, turning waste and recycled materials to premium products.

PURJEBÄGIT, http://purjebagit.tictail.com Finland
Other, Upcycling & Refurbishment
Textiles and clothes from recycled materials. Manufacturing, turning waste and recycled materials to premium products.

GLOBE Hope, https://www.globehope.com/en Finland
Other, Upcycling & Refurbishment
Textiles and clothes from recycled materials. Manufacturing, turning waste and recycled materials to premium products.

BUNDLES, www.bundles.nl Netherlands
Other, Upcycling & Refurbishment
Quality household appliances paid per use, leasing of household appliances. Takes away the investment hurdle and the worries for repairs and provides customers real-time support on using the appliance better.

FAIRPHONE, http://www.fairphone.com Netherlands
Other, Upcycling & Refurbishment
Modular phones offering individuality, reparability, to use less materials and save in costs.

9.2 List of the experts that provided insight for the report

KAROLIINA AUVINEN, Aalto University
BLAKE BURRIS, Cleanweb
MO EL-FATATRY, Masar
DANIEL GOLDFARB, Greenstart
SONJA HEIKKILÄ, Tekes
JAN HESS, Ecosummit
SAMPO HIETANEN, ITS Finland
PASI HURRI, BaseN
JUHA KOPONEN, Swap
JUHA KOSTIAINEN, YIT
BIGGE LIDGREN, Cleantech Scandinavia
IRENE ROMPA, Dutchbasecamp.org
TARJA TEPPO, Cleantech Invest
JOHANNES URPELAINEN, Columbia University
QIONGFANG ZHENG, EnterpriseHelsinki

9.3 How was this report done

This report was done in collaboration between Demos Helsinki and Solved for Team Finland, The Finnish Funding Agency for Innovation. The research included two phases: desktop study and horizon scanning. In the first stage, the desktop study of consumer cleantech related reports was conducted. As a basis of the desktop study, a list of megatrends was formed. The list was proofed and further developed with expert interviews. 15 experts were interviewed for this report, including experienced founders and organisers of top class cleantech events as well as startup and business hubs from Finland and abroad (see list of experts, Appendix 9.2). Next, drivers relevant for the development of consumer cleantech were identified as a result of the interviews. 15 experts were interviewed and the interviews were transcribed. See Appendix 9.2 for the list of experts. Transcriptions of 19 consumer cleantech startups' interviews (conducted by Demos Helsinki in 2014 and 2015) was analysed to recognize Finnish companies bottlenecks to growth (Section 6.1.3).

In addition, a comprehensive listing of consumer cleantech companies was outlined. Incubators and accelerators across the world were contacted for inquiry about consumer cleantech companies. Through interviews, desktop study, and professional contacts the list of consumer cleantech startups around the world was made.

The list of companies mostly includes startups, but also some more established companies and a few other kinds of organisations and projects that relate to consumer cleantech. In total, 235 startups and 45 larger organisations adopting smart business models or collaborating with smaller consumer cleantech companies were investigated. The startups came from 21 different countries on four different continents. Many of them are international companies that operate in multiple countries. The 45 larger companies adopting smart business models or collaborating with smaller consumer cleantech companies operate globally

The four subcategories – sharing, optimisation, upcycling and refurbishment, and dematerialisation and smart substitution – are based on earlier work accomplished by Demos Helsinki on Smartup Manifesto (2014). The four resourcesmart value creation models were concluded in a workshop with 25 experts. As seen throughout the report, many startups use different aspects of these value creation models, so the categorisation was based on the main value creation of each company. list of top 80 consumer cleantech startups around the world can be found in Appendix 9.1.

The analysis of Finnish cleantech field was done to shed light on the current situation in Finland compared to the development around the world. SWOT analysis was conducted to add depth to the research of the current state of consumer cleantech in Finland. The top 5 business opportunities for Finnish actors were identified as a short conclusion of the findings. Based on the Finnish context researched and benchmarked, recommendations for further actions to promote Finnish consumer cleantech was given to different actors: the state, the municipalities, and most importantly to Team Finland. The expert interviews were the main source of information for the recommendations and the analysis of the Finnish cleantech field.