



**Circular economy
in the energy industry**

Summary of the final report
January 2018

Contents

Executive summary	3
What is circular economy in the energy industry?	4
How does circular economy occur in the energy industry?	6
Circular economy tactics of the energy industry	7
The future of circular economy in the energy industry	11
Summary	13



Executive summary

Circular economy enables new business opportunities for the Finnish energy industry

Finland strives for a global frontrunner position in circular economy. The energy industry is a significant player in creating a sustainable economic system: in addition to leading us towards a low-carbon energy system by replacing fossil-based fuels with renewable energy, the energy industry also plays a key role in enabling circular economy in other industries. Producing a new product from any recycled material requires energy, as does transportation, too.

The significance of circular economy is also worth considering from the energy industry's own perspective: the market situation for electricity and district heat spurs to search for new ways of creating profitable business. In addition to climate and business related issues, circular economy and the optimization of resources used in the energy system can be seen as a way to improve Finland's energy self sufficiency.

What is circular economy in the energy industry, then? This question can be approached as for any other industry by asking: for which material flows should closed loops be created in the energy industry? When looking at where the energy industry affects the use of renewable and non-renewable resources, three segments can be identified: 1) the use of natural resources related to primary energy production; 2) the use of excess resources by the energy industry as well as other industries, and 3) the use of energy by the end user.

How could the use of these resources then be optimized in the energy industry by means of circular economy? This study provides both Finnish and international examples of circular economy practices in the energy industry, and also seeks further inspiration from the circular economy tactics of other industries. The circular economy examples are examined with the help of two variables: firstly, it is defined whether the innovation in question is a product or a service. Secondly, it is defined whether the innovation has been created by a single company, in a partnership, or by a cluster formed by representatives of several industries. By comparing the placement of innovations on this fourfold table between Finland and other countries, as well as between the energy industry and other industries, we have discovered that the circular economy business potential for the Finnish energy industry lies particularly in the service business. Even though Finnish energy companies are not lagging behind in the amount or quality of circular economy innovations in comparison to companies outside of Finland, it can be noticed that foreign energy companies are more active in selling services for e.g. optimizing the use of energy. Instead, in Finland the long-term cooperation with different industries and municipalities in the form of CHP plants is evident.

To conclude, this report presents **four guidelines**, with which Finnish energy companies can actively promote circular economy and create new business:

1. The energy industry should use the **circular economy tactics presented in this report as an inspiration for developing new business**. Even if the term 'circular economy' would not be used, the megatrend it represents is true: the availability of natural resources is decreasing, and as a consequence, resources are becoming more expensive.
2. Energy companies could more actively **develop new circular economy solutions together with partners**. Partnerships between companies, or companies and customers, can help in creating e.g. new services.
3. As the roles in the energy market change, energy companies are encouraged to actively reflect on the **business opportunities from systemic challenges on a strategic level** – resource wisdom can be promoted simultaneously.
4. The **utilization potential of excess heat** could be increased by making reasonable solutions in city planning on the municipal level, or by designing new financing methods for the projects. Also developments in technology, such as heat pumps, enable more profitable excess heat utilization.

This study was funded by the Environmental Research Pool, coordinated by Finnish Energy

Sources: Interviews, workshop, Deloitte analysis

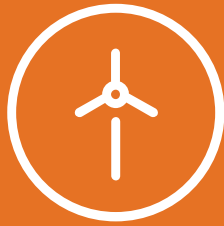
© 2018 Deloitte Oy, Group of Companies.

What is circular economy in the energy industry?

Circular economy in the energy system strives for the most efficient use of natural resources, end use energy as well as excess energy and side streams

What is optimized in the energy system from a circular economy perspective?

1. Use of energy sources



- Renewable and non-renewable natural resources used for energy production
- Natural resources used for the production of energy networks and energy production plants

2. Use of side streams and excess energy



- Side streams and flue gases generated by energy production plants
- Side streams generated by production units in other industries
- Excess heat generated in production units and properties

3. End use of energy



- Consumption of electricity, heat and cooling in companies and communities as well as by consumers
- Excess heat from end users of energy
- Use of energy grids

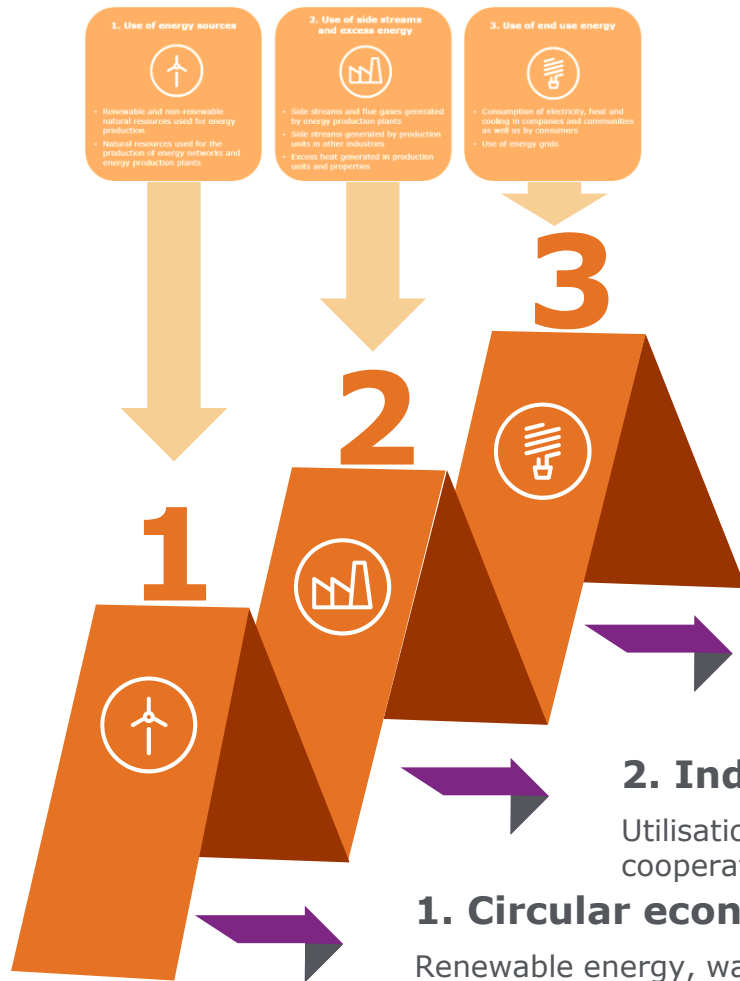
What is circular economy in the energy industry?
A definition for circular economy in the energy industry

Circular economy in the energy system consists of designs, processes and solutions that maximize the efficient use of natural resources for energy production, end use of energy, excess energy and side streams.

Energy is an essential part of a sustainable economic system, as it enables the re-use of materials. Circular economy in the energy industry is promoted by cooperation between industries and companies, as well as by services that decrease the overall consumption of energy.

How does circular economy occur in the energy industry?

From a circular economy perspective, the energy system can be optimized through 3 key tactics



How is the energy system optimized from a circular economy perspective?

Circular economy tactics of the energy industry

Circular economy in the energy industry can be categorized into the circular economy of energy production, circular economy established through cooperation with other actors and circular economy of the customer interface.

3. Circular economy in the customer interface

Demand response, two-way district heat, energy-as-a-service, energy efficiency of the end user

2. Industrial symbiosis and municipal-level circular economy cooperation

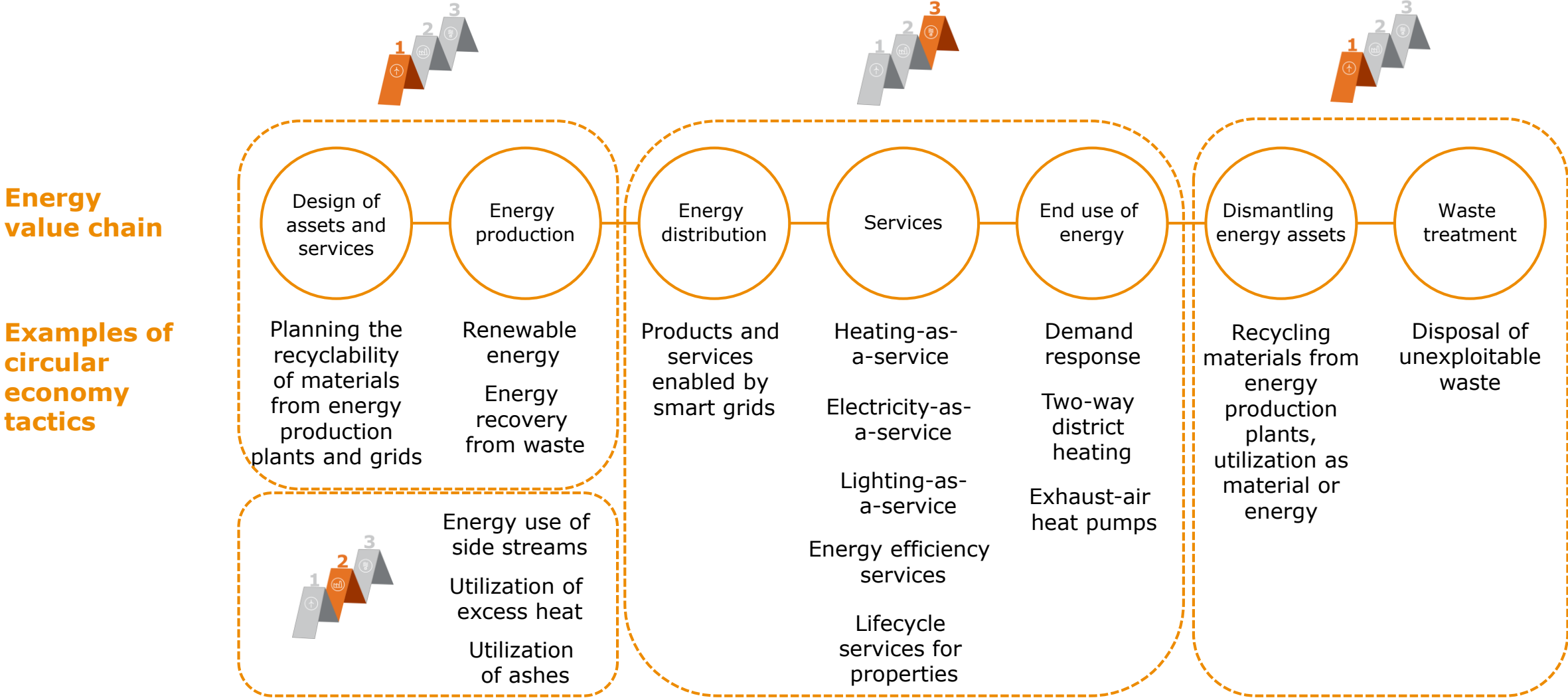
Utilisation of the energy industry's and other industries' excess energy and side streams, municipal and industrial cooperation

1. Circular economy of energy production

Renewable energy, waste-to-energy, recycling the materials from energy production plants

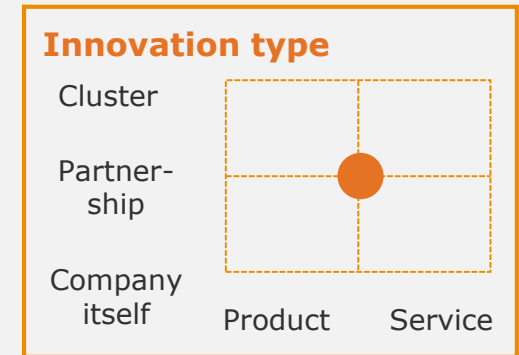
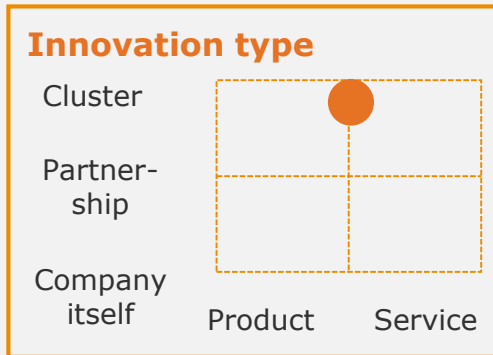
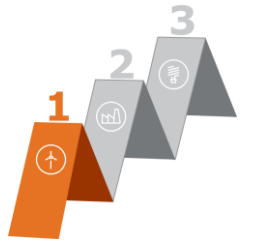
What is circular economy in the energy industry?

Circular economy tactics of the energy industry positioned along the energy value chain



How does circular economy occur in the energy industry? Circular economy tactics of the energy industry

Examples of circular economy in energy production



Circular economy action: Waste recycling and energy use

Fortum's Circular Economy Village

Fortum Waste Solutions' Circular Economy Village recycles materials separated from mixed household waste through the Ecorefinery, Finland's first Plastic Refinery and Gasum's biogas plant. The Circular Economy Village combines expertise from several industries.

Of the incoming municipal waste approximately 30 percent of biowaste, 4 percent of plastics, 3 percent of metals and also 50 percent of waste-based fuel suitable for industrial use are separated at the Ecorefinery. The remainder of the waste is incinerated in the waste-to-energy plant

The biogas plant of the Village produces biogas for transportation from biowaste. In addition to the plastics from the municipal waste, also separately collected household plastic packaging is brought to the plastic refinery. Producing recycled plastic uses approximately 15 percent of the energy that would be required to produce new plastic.

[Read more on Fortum's Circular Economy Village](#)

Circular economy action: Recycling a power plant

Dismantling and recycling of a wind farm

Delete Finland completed the dismantling of Finland's oldest wind farm, which was owned by VS Tuulivoima. The 26-year-old, first to be built Finnish wind farm reached the end of its lifecycle. The expected lifespan of wind farms is usually approximately 20-25 years, and several repairs and part replacements had already been done to this wind farm over the years.

According to Delete, approximately 85 percent of the demolition waste is recycled. The recyclable material mainly consists of metal, which will be used as raw material for new products. Other recyclable parts are electric motors, cables, gears and gear oils. The gearboxes were left intact during the dismantling phase in order to facilitate the recycling of the oils inside them.

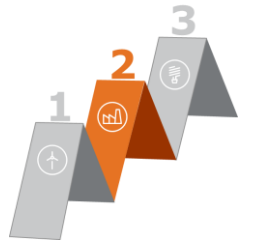
Glass fibre is the most challenging material to recycle in wind power plants. Parts of it can nonetheless be utilized as energy.

[Video of the wind farms dismantling](#)

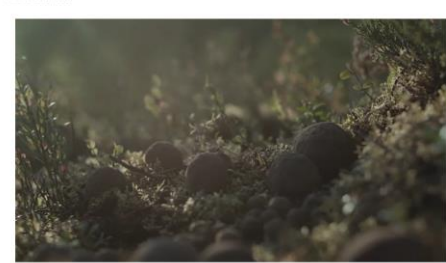
Sources: Fortum, Delete Finland, Deloitte analysis
 Pictures: screenshots from Fortum's ja Delete's webpages

How does circular economy occur in the energy industry? Circular economy tactics of the energy industry

Examples of industrial symbioses and municipal-level circular economy cooperation

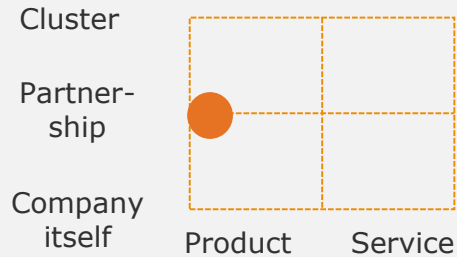


NATURLAN



Naturalan Metsärae -tuhkalannoite – kannattava ratkaisu

Innovation type



Circular economy action: Utilization of ash

Naturalan ashgrain fertilizer by Napapiirin Energia ja Vesi

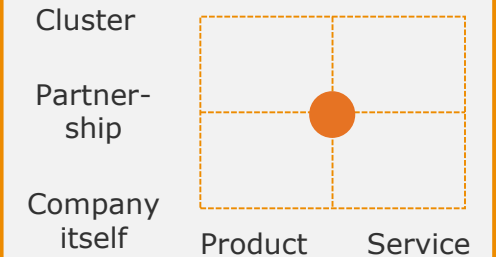
Napapiirin Energia ja Vesi (Neve) produces forest fertilizers from the ash created in the incineration process of its CHP plant. Neve has enabled the sales of the Naturalan ash fertilizer product by creating a process for handling the ash, and in cooperation with local transport and sales companies. The ash comes from Rovaniemi, where wood and peat are burned in the Suosiola power plant and water boiler. The Naturalan fertilizer returns the nutrients of the ash derived from burning wood and peat back into the forest.

According to Neve, the tax on waste, introduced in 2011, accelerated the search for new uses of ash deriving from energy production. In 2012 the registration of ash into the Finnish Food Safety Authority's control register allowed the use of ash as a forest fertilizer.

[Read more about the solution](#) and [watch a video on Naturalan's ash fertilizer](#).



Innovation type



Circular economy action: Recovery of excess heat

Recovering excess heat from a data centre to the district heating network

The heat generated by the equipment of the Russian Yandex data centre in Mäntsälä is collected into the district heating network of Mäntsälä by Nivos Energia. Recovering the heat decreases both Yandex's maintenance costs as well as the need for fuels used in district heating. Thus the solution significantly also decreases the carbon dioxide emissions of district heat production. Calefa, a company focusing on the utilization of excess heat, delivered the equipment.

Every single second, the data centre produces the equivalent amount of heat of approximately 1000 sauna stoves. Nivos buys the heat energy of the data centre and can thereby get the heat energy required for heating 1000 houses.

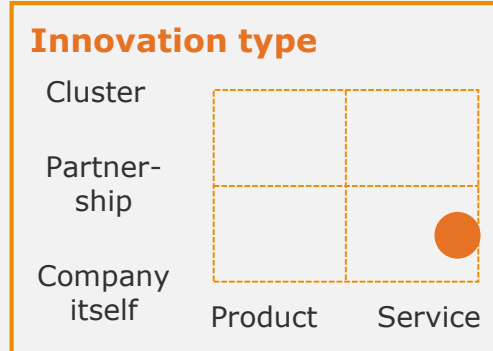
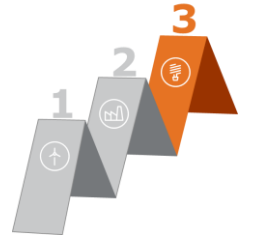
The solution would not have been born without the close cooperation between Yandex, Nivos and Calefa.

[Read more about the solution](#)

Sources: Interviews, Neve, Nivos, Deloitte analysis
Pictures: screenshots from Neve's ja Nivos' webpages

How does circular economy occur in the energy industry? Circular economy tactics of the energy industry

Circular economy innovations in the customer interface



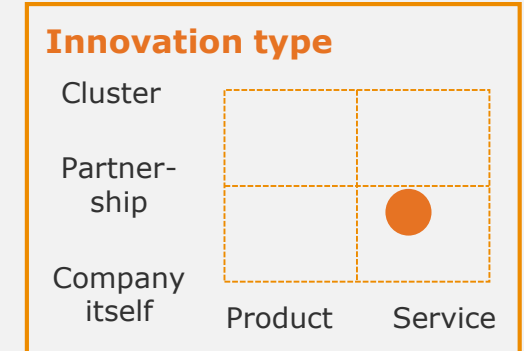
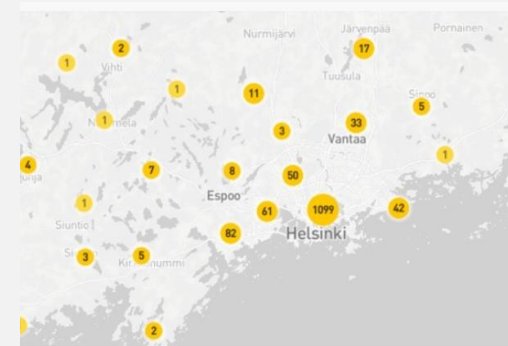
Circular economy action: Energy-as-a-service

Oulun Energia Urakointi Oy's Valoa

Oulun Energia offers lighting services to housing cooperatives, companies and public entities. The Valoa-service package consists of i.a. inventory of current lighting, mapping and documentation, designing, building and maintaining a new system.

Customers can for example have the design and implementation of large lighting projects done by Oulun Energia. The lighting service is paid according to a monthly fee for the contract period, during which Oulun Energia is also responsible for the maintenance and repairs. In a new lighting project, LED lights can save up to 50% in energy costs compared to traditional lights. In addition, night-timing and control systems can help to achieve additional savings.

[Read more on the Valoa-service package](#)



Circular economy action: Demand response

Helen's Heat Pledge

By taking part in Helen's Heat Pledge campaign, consumers promised to decrease their heat consumption at home during the points in time announced by Helen. The campaign sought to reduce the amount of fuel used in producing district heat and thereby also reduce the amount of emissions produced during winter peak consumption hours. During the peak hours in winter of 2016-2017, detailed instructions were sent to the consumers committed to the pledge.

According to Helen, when 10 000 people momentarily reduce the heating of their home, emissions are reduced by the equivalent amount of approximately 10 000 oil litres. During the winter of 2016-2017, more than 2800 pledgers saved 2200 oil litres together.

Helen wanted to test the flexibility of the energy system with the campaign, as well as the willingness of consumers to take part in demand response.

[Watch a video about the Heat Pledge](#)

Sources: Oulun Energia, Helen, Deloitte analysis
Pictures: screenshots from Oulun Energia ja Helen's webpages

The future of circular economy in the energy industry

The transformation of the energy market brings about solutions that promote circular economy

New players in the energy market



- **The role of consumers** in the energy system is increasing. Decentralized energy production increases as different small-scale production solutions become more economical. Also the energy industry offers ready-made packages, such as solar power plants, as turnkey projects for customers.



- **Decentralized energy production** can not directly be seen as a sub-tactic of circular economy, as material efficiency differs between individual cases:
 - Does a solar panel purchased for a summer cottage for example replace the need to be connected to the grid? Is the electricity that the solar panel is replacing produced by which energy source? Lifecycle assessments need to take **alternative methods of production** into consideration.
 - On the other hand, district heating networks enable **small-scale heat generation**, such as the efficient utilization of solar thermal collectors, which then requires less fuel to heat water in other parts of the network.



- **Energy production by consumers can be seen as both replacing and increasing the need of fossil-based fuels:**
 - The more decentralized renewable energy production there is in the whole energy system, the less need there is for fossil-based production solutions.
 - On the other hand, the need for electricity and heat in Finland is the largest when the sun does not shine. Fossil-based energy is still used during peak hours of electricity and heat consumption.



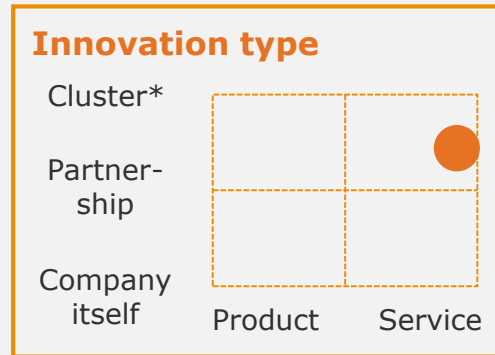
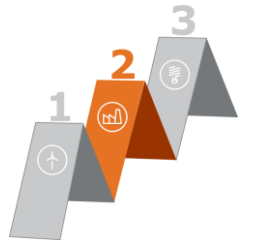
- **The role of energy storage solutions** will be significant in the future energy system with large amounts of variable renewable energy production.



- With increasing decentralized energy production, also the current **roles of the counterparts in the energy system** will change and **services** will gain new kind of demand:
 - For example a new operator type has already emerged between electricity producers and end users, which carries out **electricity demand response as a service**.
 - These **aggregators** are the operators of demand response for electricity - they compile the scattered flexible electricity loads of end users so that the compiled load can be sold in the electricity markets. Aggregated demand response is utilized to **balancing electricity consumption peaks**.
 - In the future, electricity users will have an opportunity to offer their electricity response potential directly to an electricity retailer or to a third party – this is how a virtual power plant is operated.
 - Also the **peak consumption of district heating** can be balanced with demand response services.

The future of circular economy in the energy industry

Examples of the future of circular economy in the energy industry



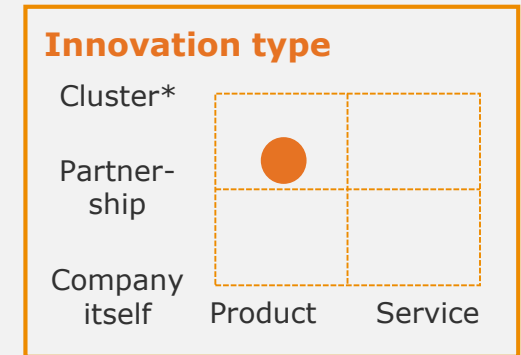
Circular economy action: Virtual power plant

The virtual power plant of Savon Voima and Energy2market

Savon Voima is building a virtual power plant for the Finnish balancing and reserve markets together with a German company Energy2market (e2m). The solution provides a reliable and easy way for companies to take part in the balancing market. According to Savon Voima, companies and communities that consume a lot of electricity can be incorporated into the virtual power plant

The solution enables increasing amounts of players to participate in the balancing and reserve market maintained by Fingrid. Energy2market (e2m) has experience from various similar solutions in Germany, Poland, Austria and Italy.

[Read more about the solution](#)



Circular economy action: Solar collectors in district heat generation

Etelä-Savon Energia's hybrid heating system

Etelä-Savon Energia (ESE) implemented a pilot project for Ristiina's district heating system, where the load of the bioenergy plant is cut during the summer with the help of solar heat. The solar heating system for the pilot was provided by Savosolar.

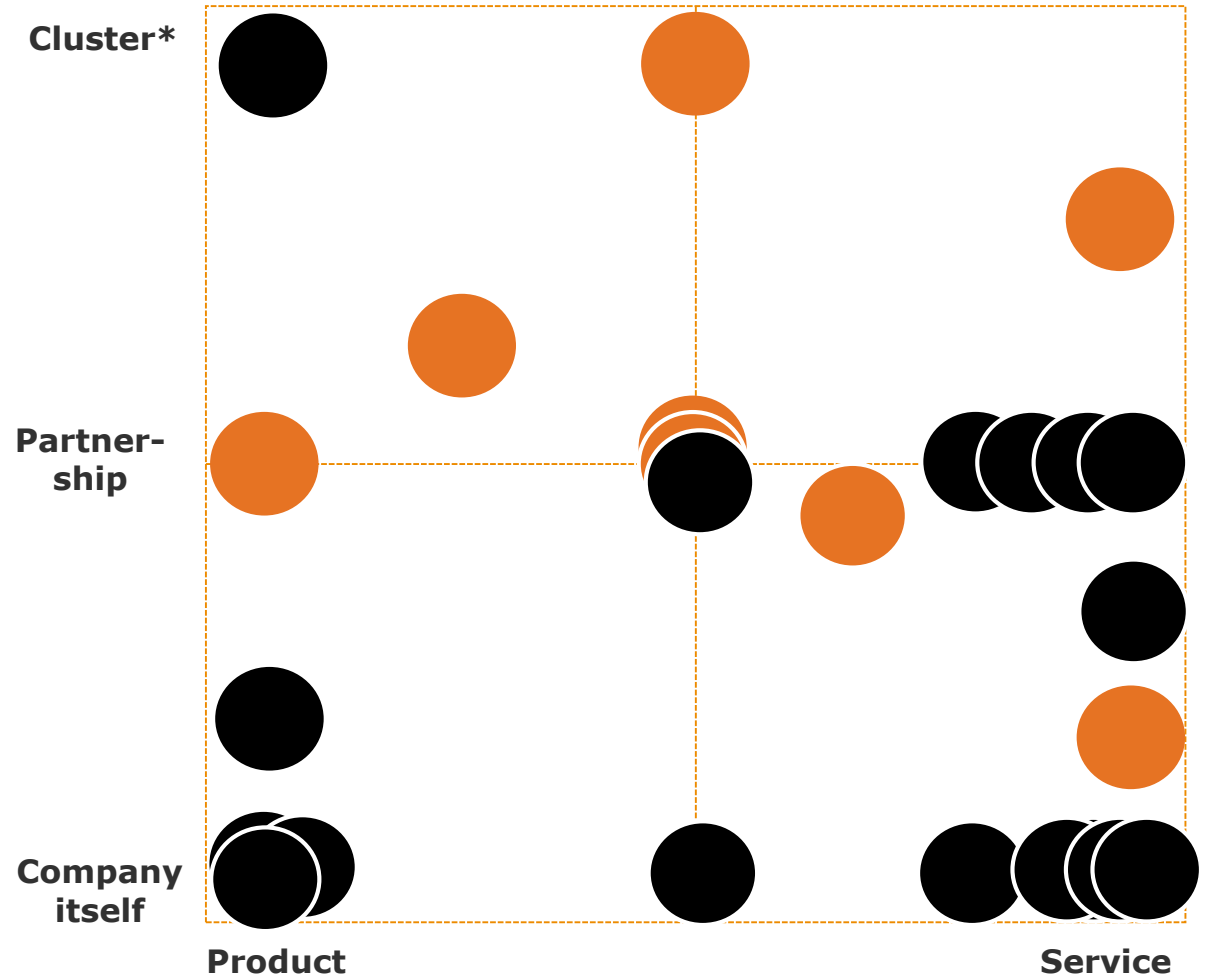
The collected solar energy is transferred to a bioenergy plant with the help of heat transfer fluid. A 300 litre water tank, pumping unit and control centre are situated at the bioenergy plant. Thanks to the accumulator, solar heat can be transferred into the district heating network when needed. Excess heat can be discharged into the network in a similar way as a battery.

[Read more about the solution](#)

Summary

The circular economy oriented business potential for the Finnish energy industry lies within services

- In this study, circular economy solutions of the energy industry from both Finland and other countries have been reviewed with the help of the innovation framework displayed on the right-hand side. The examples presented in this study have been placed accordingly:
 - Business example from the Finnish energy industry
 - Business example from the global energy industry
- The Finnish energy companies' circular economy initiatives are not lagging behind when comparing with initiatives from other countries.
- Finnish examples are mainly positioned on the partnership level, which indicates that the industry has already taken steps towards promoting systemic changes.
- However, Finnish companies seem to offer less services when compared to the foreign companies. This indicates that the Finnish energy industry has potential to develop its service offering from a circular economy perspective.
- Especially service business models based on novel profit models have not been extensively developed in Finnish energy companies. In other countries, energy companies have developed e.g. new financing solutions for energy efficiency investments.



Sources: Interviews, workshop, Deloitte analysis

© 2018 Deloitte Oy, Group of Companies.

* A cluster of many different industries

Summary

The Finnish energy industry has already implemented some circular economy tactics, but systemic change requires innovations that exceed industry boundaries

Guidelines for promoting circular economy business practices in the energy industry

1. Detachment from the fossil economy is a target for both climate change mitigation and circular economy in the energy industry. Climate policy guides the choices regarding sources of energy, but the energy industry should use **circular economy as a source of inspiration for developing new business opportunities** in order to be prepared for the decrease in the availability of raw materials and the increase in their prices.
2. Circular economy requires a systemic change, where useless industry silos need to be torn down. The energy industry is not yet actively searching for new opportunities for circular economy partnerships and clusters between industries – companies still rely on their own, familiar products. In some cases, business skills may also not be sufficient enough for creating novel solutions. Companies within the energy industry should be **more active in creating new circular economy solutions together with partners**. Partnerships between companies or between companies and customers can generate e.g. new services and financing solutions.
3. The energy market is changing rapidly: the amount of e.g. decentralized renewable energy generation is growing, which increases the need for demand-side management. The roles of industry operators may change in the future, and the industry may soon also have new kinds of players. **Energy companies are advised to become active and to consider the business opportunities from future systemic challenges on a strategic level** – resource efficiency can be enhanced simultaneously.
4. Currently, recovering excess heat is often not financially feasible in Finland. Obstacles to utilizing excess heat include the fact that industrial plants usually reside outside residential areas and district heating networks, temperature levels of the excess heat and the required payback periods for corporate investments. **The utilization potential of excess heat could be increased by making reasonable solutions in city planning on the municipal level or by designing new financing methods for the projects**. Also developments in technology, such as heat pumps, enable a more profitable utilization of excess heat.

Businesses should be braver pioneers and provide novel solutions to their customers. In order to enable this, companies need to be equipped with functions or teams that have time for strategic and innovative thinking.

- Expert from a global circular economy company



Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee (“DTTL”), its network of member firms, and their related entities. DTTL and each of its member firms are legally separate and independent entities. DTTL (also referred to as “Deloitte Global”) does not provide services to clients. Please see www.deloitte.com/about for a more detailed description of DTTL and its member firms.

In Finland, Deloitte Oy is the Finnish affiliate of Deloitte NWE LLP, a member firm of Deloitte Touche Tohmatsu Limited (“DTTL”), and services are provided by Deloitte Oy and its subsidiaries. In Finland Deloitte is among the nation’s leading professional services firms, providing audit, tax, legal, consulting, and financial advisory services through 450 people in 3 cities. Known as an employer of choice for innovative human resources programs, Deloitte is dedicated to helping its clients and its people excel. For more information, please visit our website at www.deloitte.fi.

This communication contains general information only, and none of Deloitte Touche Tohmatsu Limited, its member firms, or their related entities (collectively, the “Deloitte Network”) is, by means of this communication, rendering professional advice or services. No entity in the Deloitte network shall be responsible for any loss whatsoever sustained by any person who relies on this communication.