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Lahti University of Applied Sciences

ENERGY SELF-SUFFICIENCY IN RESIDENTIAL PLANNING

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Marja Petäjä-Suvanto

Lahti University of Applied Sciences
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ABSTRACT

The European Union and Finland have set several targets for decreasing greenhouse gas emissions and consumption of energy, and also for using more renewable energy. Since a significant share of energy consumption is caused by buildings, it is justified to aim for energy self-sufficiency and usage of renewable energy also in residential areas.

The aim of this thesis was to disclose issues that give reasoning for planning and realizing energy self-sufficient residential areas in Finland. By studying case study sights in Finland and planning instructions made for energy efficient areas the target of the thesis is also to present functional ways for carrying out planning processes of energy self-sufficient residential areas in the future.

For achieving energy self-sufficiency, there are several options for the energy production, especially the heat. It is more challenging to produce electricity in cost-effective ways in residential areas in order to make them completely self-sufficient and off-grid from national networks. The co-operation with the collaborator fulfilling the energy production stood out as one of the most significant issues from the beginning of the planning process for reaching the self-sufficiency target. It is also important to examine different alternatives for the land use and solutions for energy production case by case.

Key words: residential planning, renewable energy, energy self-sufficiency, nearly zero energy building.

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TIIVISTELMÄ

Euroopan Unioni ja Suomi ovat asettaneet useita tavoitteita vähentääkseen kasvihuonepäästöjä ja energiankulutusta sekä kasvattaakseen uusiutuvan energian käyttöä. Koska merkittävä osuus energiankulutuksesta aiheutuu rakennuksista, on perusteltua tavoitella energiaomavaraisuutta ja uusiutuvan energian käyttöä myös asuinalueilla.

Tämän opinnäytetyön tavoitteena on tuoda esille perusteluja sille, miksi energiaomavaraisia asuinalueita tulisi suunnittella ja toteuttaa Suomessa. Tutkimalla suomalaisia esimerkkikohteita ja energiatehokkaiden asuinalueiden suunnitteluohjeita tavoitteena on myös esittää käytännöllisiä tapoja energiaomavaraisten asuinalueiden suunnitteluun tulevaisuudessa.

Omavaraisen energiantuotannon toteuttamiseen on useita vaihtoehtoja, etenkin lämmön osalta. Haastavampaa on tuottaa sähköenergiaa kustannustehokkaasti asuinalueilla niin, että ne olisivat täysin energiaomavaraisia ja irti kansallisesta sähköverkosta. Yhteistyö energian tuottajan kanssa on yksi merkittävimmistä asioista suunnitteluprosessin alusta saakka, jotta energiaomavaraisuustavoite voidaan saavuttaa. Tärkeää on myös tutkia vaihtoehtoisia suunnitteluratkaisuja ja energiantuotannon vaihtoehtoja tapauskohtaisesti.

Avainsanat: asuinalueiden suunnittelu, uusiutuva energia, energiaomavaraisuus, lähes nollaenergiarakentaminen.

SISÄLLYS

1 INTRODUCTION

1.1 Research topic, background and foreknowledge

This thesis deals with a planning process of new residential areas that aim at energy self-sufficiency by using renewable energy sources to produce the energy on spot. The thesis concentrates on energy solutions, not for example on technical issues of the buildings, although they also have positively conductive effects on reaching energy self-sufficiency. External issues such as traffic is not evaluated either. The thesis does not cover the planning of the existing settlement areas that aim at changing into self-sufficiency by renovations.

The topic of the thesis was chosen because of personal and professional interest in the energy self-sufficiency of residential areas but also as a result of the targets that the European Union and Finland have nationally set for decreasing emissions and increasing the usage of renewable energy and energy efficiency.

Using more renewable energy together with decreasing consumption of energy enables several targets and commitments to be fulfilled. These are, for example, the United Nation's general agreement considering climate change, commitments for keeping the temperature rise under 2 degrees, and lowering the greenhouse gas emissions by 20 percent by 2020 compared to the level in1990.

40 percent of total energy consumption is caused by buildings in the European Union. In Finland, in 2014, 25 percent of total energy consumption was used only by the heating of the buildings. To decrease the European Union's and Finland's energy dependence it is very important to reduce the consumption of energy in buildings, and use more renewable energy sources in construction business. This is one of the ways for increasing energy self-sufficiency, and decreasing greenhouse gas emissions. (Directive on the Energy Performance of Buildings 2010/31/EU, 1; Tilastokeskus: Energian loppukäyttö sektoreittain 2015.)

Especially the European Union's Directive 2010/31/EU on the Energy Performance of Buildings, with its requirement for the member states to make sure that by the end of year 2020 all the new buildings are nearly zero energy buildings, supported the topic's significance.

The theoretical part of the thesis elaborates the European Union's and Finland's national targets of energy consumption as well as the statistics of energy consumption in Finland. Furthermore, the legislation conserning energy is reviewed. Sources of renewable energy for residential areas are introduced as well.

The research part studies two residential areas in Finland that have already been built or are still at the planning phase, which have a target of energy self-sufficiency. By studying the experiences of these sites good practices and development targets can be found for the future projects.

1.2 Definitions and objective of the study

Definition of area's energy self-sufficiency:

> *"The area is energy self-sufficient when the same amount of energy from local renewable energy sources is produced in the area that it is consumed there."*
>
> *Timo Hyttinen, Levon-instituutti.* (Karesola 2012: translated by author.)

Definition of renewable energy:

> *"'Energy from renewable sources' means energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases"* (Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009).
>
> *"Renewable energy sources have in common that when they are exploited in a sustainable way these sources do not decrease in a long time span. Renewable sources of energy used in Finland are hydrothermal and wind power, solar power, geothermal and aerothermal power collected*

> *via heat pumps, bio gas, biodegradable parts of recycled fuels and waste fuels, fuels from wood and other fuels origin from plants and animals."* (Tilastokeskus: Käsitteet ja määritelmät: translated by author.)

The aim of this study will be the presentation of functional planning ways and policies to achieve self-sufficient residential areas in Finland that produce their own renewable energy. The energy sources taken into account will be geothermal heating, air-source heating, wind power, solar power and different kinds of bio energy sources.

This thesis aims at answering the following research questions:

1. How will the latest and upcoming directives and legislations affect the planning of residential areas concerning energy solutions in Finland?

2. What things should be paid attention to in the defferent stages of the planning process for achieving a self-sufficient residential area using renewable energy

    a. before the planning process: choosing the area and suitable energy solutions for it

    b. a planning process and co-operation with the stakeholders during the planning

    c. marketing and realization

    d. energy solutions (e.g. investments)

    e. future residents and their commitment

    f. monitoring

By answering these questions the thesis suggests good practises for the planning processes of self-sufficient residential areas.

2 ENERGY TARGETS AND CONSUMPTION

2.1 The European Union’s and Finland’s national targets for decreasing emissions and increasing usage of renewable energy and energy efficiency

The European Union has set a target of decreasing the greenhouse gas emissions by 40 percent from the level of 1990 by 2030. Obligatory goal for the European Union is also to reach higher level of using renewable energy: by year 2030 27 percent of total energy consumption should be produced from renewable sources. A normative goal for energy efficiency is to improve it at least by 27 percent, which goal must be put into perspective with the predictions concerning the future development of the use of energy based on the facts known today. (Eurooppaneuvosto 2014, 2, 5, 6.)

Nationally Finland has set its targets for 2020. Aim is to reach the European Union’s goal for 2020 by decreasing greenhouse gas emissions nationally by 20 percent. Moreover, a goal for energy efficiency is the same as the EU has set for year 2020: improving energy efficiency at least by 20 percent. As the EU has a target to increase usage of renewable energy from total energy consumption with 20 percent by 2020, Finland aims higher with decrease of 38 percent. (Kansallinen energia- ja ilmastostrategia 2013.)

2.2 The consumption of energy in Finland

The consumption of energy has risen rapidly as a result of the changes in the Finnish society. In 1974 the total consumption of energy in Finland was 18 676 ktoe and in fourty years’time it had risen in to 32 008 ktoe in 2014. In 2014 25 % of the total consumption of energy was used in heating of the buildings. (Tilastokeskus: Energian kokonaiskulutus energialähteittäin ja CO_2-päästöt 2015; Tilastokeskus: Energian loppukäyttö sektoreittain 2015.)

Figure 1 presents energy consumption in 2014 in Finland by the sources of energy. The figure shows that fossil fuels and unrenewable energy sources have a large share of the total energy consumption. Oil, nuclear power and peat are covering more than 50 percent of the total energy consumption.

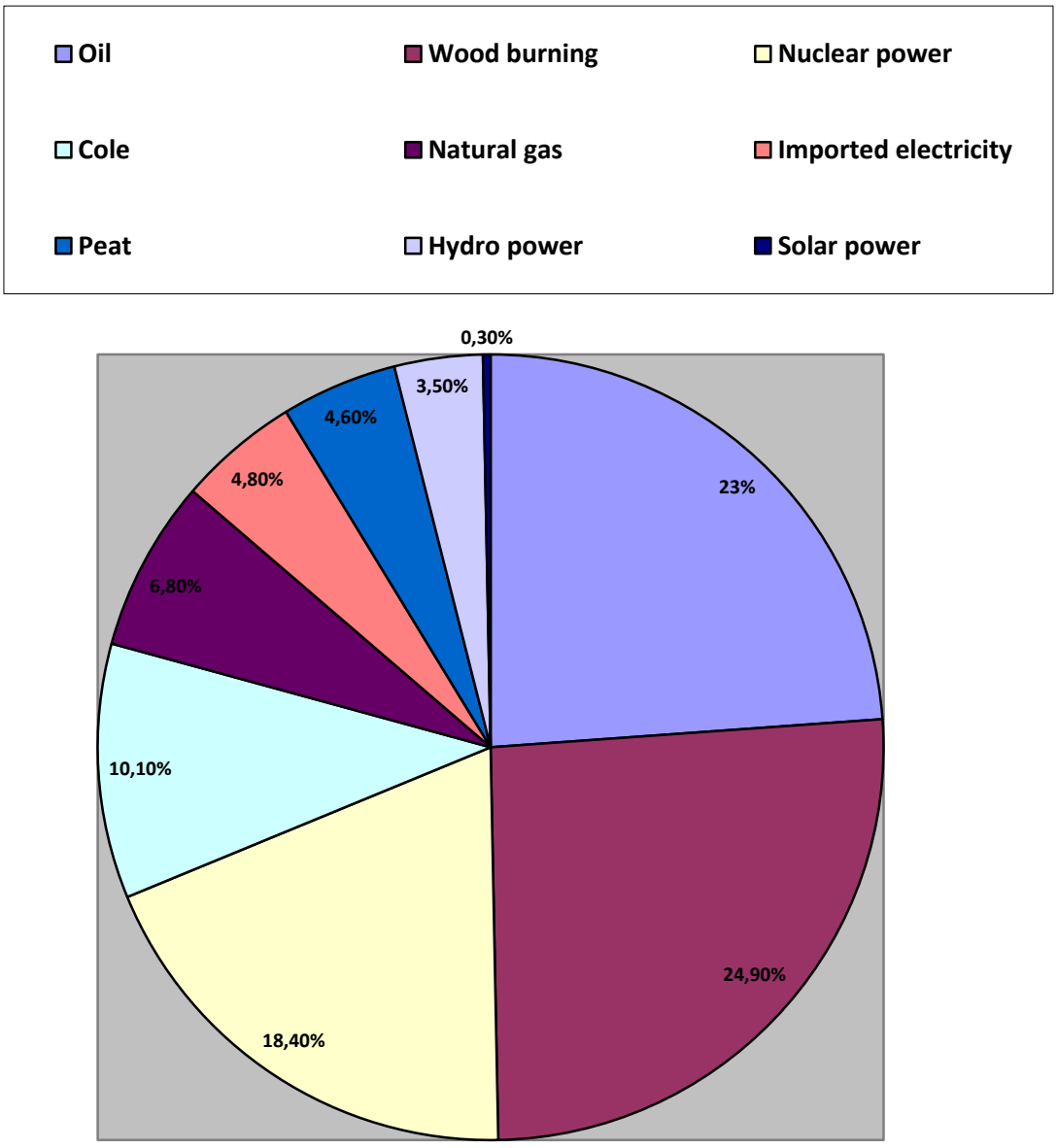

FIGURE 1. Sources of energy from total energy consuption in Finland 2014 (Tilastokeskus: Energian kokonaiskulutus energialähteittäin ja Co2-päästöt 2015).

2.3 Energy self-sufficiency in Finland

At the moment Finland is importing 70 % of the energy that it is using. The financial value of that imported energy was over 12.3 million euros in 2014. (Ahola 2012; Tilastokeskus: Energian tuonti ja vienti alkuperämaittain 2015.)

In report ”Kasvua ja työllisyyttä uudella energiapolitiikalla” made by a group of professors, it has been claimed that Finland has a potential and possibility to become self-sufficient of energy by 2050. This would require a new definition of energy policy and new solutions should be found from renewable energy and energy effectiveness. By giving up imported energy there would be more investments that would create tens of thousands of new jobs in Finland. Inventing new technologies to the energy field would also increase exports. Many other countries in Europe, for example Sweden, Germany, Dennmark and Austria, have seen the demands concerning emissions set by the European Union as a possibility. These countries have set even stricter goals for decreasing the emissions, and production of energy nationally is increasing. According to the report, Finland has a different attitude, where requirements of the European Union are considered negative and as an adverse factor for traditional energy policy. (Niemiläinen 2014.)

In Finland there has been a rising interest among municipalities, planners, companies, constructors and consumers in the energy self-sufficiency. Despite the fact investments for using renewable energy have been minor compared to for example Germany, Denmark, Sweden and Spain. Finland has many conventions, policies and practices that make using renewable energy complicated, for example permission procedures and costs of joining the power networks. Thus, new alingments of policy are necessary to make processes easier and more profitable to all parties. (Lielahti 2012.)

3 THE EFFECT OF THE LEGISLATION ON THE ENERGY SOLUTIONS IN RESIDENTIAL AREAS

There are multiple directives and standards regulating energy efficiency of building within the European Union.

3.1 Energy Performance of Buildings Directive

Buildings are causing 40 percent of the European Unions total energy consumption. The energy consumption is growing together with the growth of the construction business as a whole. Hence, it is very important to reduce the consumption of energy and use more renewable energy sources in construction business for decreasing the European Union's energy dependence and greenhouse gas emissions.

Using more renewable energy together with decreasing consumption of energy enables several targets and commitments to be fulfilled. These are, for instance, the United Nation's general agreement considering climate change, commitments for keeping the temperature rise under 2 degrees and lowering greenhouse gas emissions by 20 percent by 2020 compared to level in 1990.

Actions are needed for increasing the number of buildings that are even more energy efficient than the minimum demands call for. For this reason all the member states of the EU shall make national plans for increasing the number of nearly zero energy buildings. (Directive on Energy performance of Buildings 2010/31/EU, article 9.)

3.1.1 Nearly zero energy buildings

Definition of 'Nearly zero-energy building' in the Directive 2010/31/EU on the Energy Performance of Buildings article 2:

> *"'Nearly zero energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very*

> *significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;" (Directive on Energy performance of Buildings 2010/31/EU, article 2.)*

Definition of nZEB (nearly zero energy buildings) has also been implemented into the National Building Code of Finland in the same way as in the directive (Ministry of the Environment a 2015, 1).

EPBD's (Energy Performance of Buildings Directive 2010/31/EU) article 9 deals with nZEB. It instructs the member states to make sure that by the end of year 2020 all the new buildings are nearly zero energy buildings. The buildings owned and occupied by public authorities should achieve it two years earlier, by the end of year 2018.

Like other member states of the European Union, Finland also has to make national plans for increasing the number of nZEB's and also develop policies and set targets to speed up buildings under renovations to become nearly zero energy buildings too. (Directive of Energy Performance of Buildings 2010/31/EU, article 9.)

3.1.2 National plans in Finland

Ministry of the Environment has set a project to prepare new legislation for nearly zero energy buildings in Finland. The goal of this project is to prepare legislation and indications for transferring to nearly zero energy building in new constructions. The project will be running until the end of year 2016 and the government of Finland is aiming for giving its proposal to the Finnish Parliament in autumn 2016. Work done for implementation of RES-directive (Promotion of the use of energy from renewable sources directive 2009) and the results of national development projects concerning nearly zero energy buildings, such as FInZEB-project will be exploited in preparation work. (Ministry of Environment b 2015.)

Rakennusteollisuus RT ry, Talotekniikkateollisuus ry and Ministry of Environment had a project called FInZEb with a target to create a base for national interpretation for definition of nearly zero energy buildings (nZEB).

The project outlined a proposal about attributes that nZEB should fulfill. The review of nearly zero energy will be done in phases and some of the attributes must be proven to be fulfilled already when building permit is applied for. The rest of the demands must be realized by the revision of initialization. (Rakennusteollisuus RT ry, Talotekniikkateollisuus ry, Ministry of the Environment 2015.)

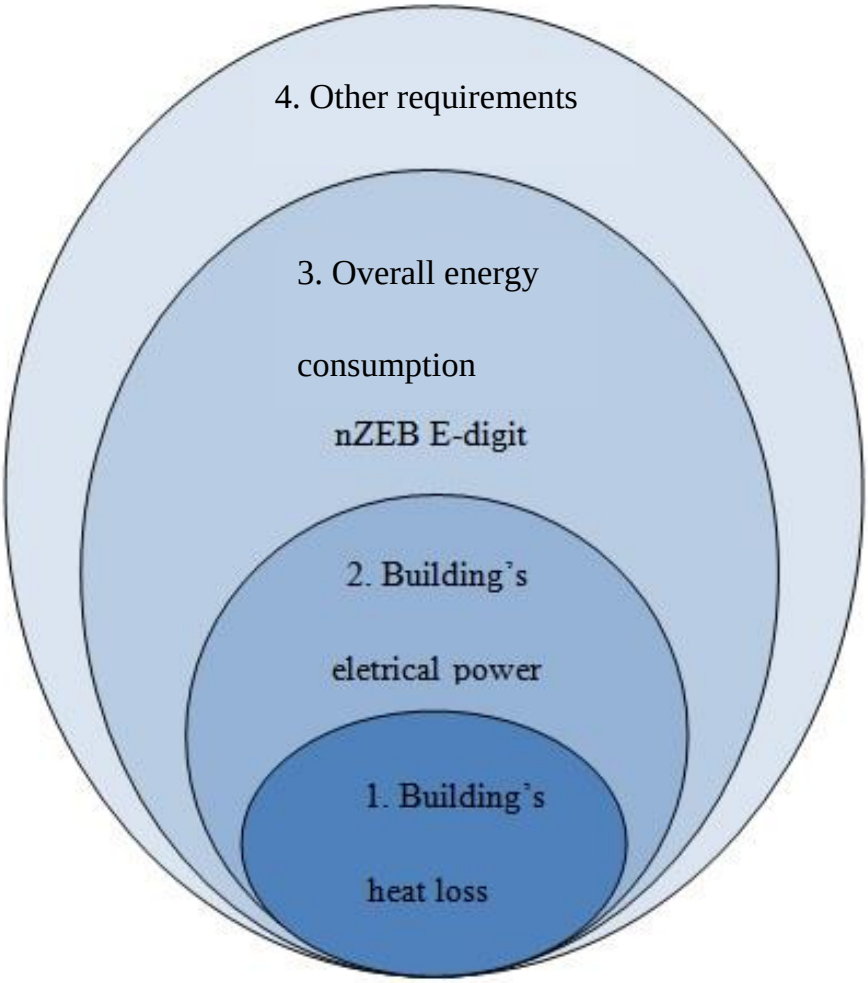

FIGURE 2. Phases of nearly zero energy building's requirement review (Rakennusteollisuus RT ry et al. 2015).

By examining building's heat loss it will be ensured that structures, condensation and ventilation's reclaiming of heat are correct and meet the reference values. Some of the reference values can be still tightened. Building's electrical power including the electricity used for heating must be calculated and presented in the building permit. Furthermore, the overall energy consumption and nZEB E-digit is calculated and included in the building permit application. E-digit for nZEB means a new calculation system that has been developed from a current one, including E-credit calculation and emphasition of bought energy consumption with current energy source's factors. (Rakennusteollisuus RT ry et al. 2015.)

Building code will define limits for different building's nZEB E-digits. Other requirements include, for example, the electricity efficiency of ventilation systems and calculation of RER-credit. The code pays attention to the amount of renewable energy of bought energy, possible renewable energy produced on the spot and a preliminary energy certificate.

The project made a proposition for nZEB E-digits for nine different building types. Building types were categorized to small residential buildings, apartment buildings, offices, schools, day care centers, business buildings, sport centers, accommodation buildings and hospitals.

It was observed, that profitability of actions to save energy varied in different building types and cost-effective actions were different depending on the building type. The most profitable actions conserned are reclaiming of heat, ventilation and lightning. Also improvements in condensation of windows and in the whole building were found out to be profitable. The main conclusion was that the change of structures to passive energy level was unremunated. Additionally, the local production of renewable energy was not found to be cost-effective in most of the situations, but it was fould to being capable of lowering the need of bought energy and improving the E-digit value. Its economical efficiency should be estimated on a case-by-case basis. (Rakennusteollisuus RT ry et al. 2015.)

	E-credit value limit D3/2012	Proposition for nZEB-E-credit	Change from current
Small residential buildings	160…204	160…204	
Apartment buildings	130	116	-11 %
Offices	170	90	-47 %
Schools	170	104	-39 %
Day care centers	170	107	-37 %
Business buildings	240	143	-40 %
Sport centers	170	115	-32 %
Accommodation buildings	240	182	-24 %
Hospitals	450	418	-7 %

FIGURE 3. Propositions for nZEB-E-credit values in different building types (Rakennusteollisuus RT ry et al. 2015).

3.2 Renewable Energy Sources Directive

Increasing the usage of energy from renewable sources is an important issue for the reduction of the greenhouse gas emissions. It also creates opportunities for employment and regional development for rural ans isolated areas. Local and regional enterprises have a significant role in

production of energy from renewable sources giving them opportunities for growth and employment. Decentralized energy solutions have several positive aspects such as utilization of local energy sources, increased local security of energy supply, shorter transport distances and reduced energy transmission losses. It also advances community development and cohesion by bringing income to the community and creating work. (Directive on the promotion of the use of energy from renewable sources 2009/28/EC, 1.)

3.3 Energy Efficiency Directive

Directive on energy efficiency gives instructions for the member states for increasing energy efficiency to cut up primary energy consumption and decrease importing the energy. The goal is also to reduce green house gas emissions cost-effectivily and extenuate climate change. Becoming more energy-efficient escalates spreading of innovative technological solutions and upgrades industrial competitiveness in the European Union. (Directive on energy efficiency 2012/27/EU, 1.)

3.4 Land Use and Building Act

Finnish Land Use and Building Act aims at arranging land use and construction in such way that it creates conditions for good living environment and supports ecologically, financially, socially and culturally sustainable development.

The energy efficiency is addressed in chapter 17. Article 117 g § of the act. Accordingly, the energy efficiency must be taken into account at every phase of a construction project. Both at the drawing board and on the construction site the work must be carried out in such a way that the finished building consumes the least amount of energy and that the natural resources are spent in an efficient manner. The minimum demands of energy efficiency must be presented with calculations based on energy use, energy loss and energy sources used. When setting the factors for energy sources used in the building, raw natural energy’s consumption,

advancing usage of renewable energy and heating system’s effectiviness by general energy production are evaluated. Products and technical systems of the building must enable minor energy consumption and needs. It must be possible to monitor the energy consumption.

Article 117 h § deals with the evaluation of the heating system. If the heating system chosen for a building is not using multipolar energy based on renewable energy sources, heating system based on collaboration, district- or areal heating- or cooling systems or heat pumps even if some of these choices would be available and implemented cost-effectively, the chosen heating system’s viability must be evaluated technically, environmentally and financially. (Maankäyttö- ja rakennuslaki article 117 g, article 117 h.)

4 SOURCES OF RENEWABLE, SELF-SUFFICIENT ENERGY

Energy solutions are increasingly starting to have effects on areal planning. Interest in using multipolar, local and renewable energy has been growing thanks to the new solutions available, and also because of price advance of fossil fuels. (Pesola, Hoviniemi, Vehviläinen &Vanhanen 2010, 4.)

There are various ways to produce renewable energy for areas aiming to self-sufficiency. Choosing the energy source depends on the area and which solutions suit it. Here are some of the main sources for renewable energy suitable for residential area's energy production.

4.1 Geothermal energy

Geothermal energy exploits heat which is stored within the Earth. Geothermal energy is emitted from the core, mantle and crust with a great share of it originationing from nuclear reactions. Also warm groundwater tides and heat of the sun stored in the soil, rock and water are creating energy. The source and amount of geothermal energy is depending on the depth of the drilling, but also from geographic location and its circumstances. In the edges of tectonic plates and above hot-spots there are higher temperature gradients and therefore more energy available. (Armstrong & Blundell 2007, 35; Motiva Oy: Lämpöä omassa maassa 2012.)

The most common way for exploiting geothermal energy in residential areas is household specified, in which the small residential buildings collect their heat energy with heat pumps and use it for heating the building and their domestic water. Heat pumps can also be used for cooling of the building during summer times and all the pumping systems need electricity for their functions. The heat energy is produced by sun it can be collected from deep bore well, horizontal pipelines or from water if the plot is located by body of water. From these options the bore wells are the most commonly used.

The maximum depth for bore wells is usually from 200 to 250 meters depending on the amount of buildings heat needs and bore well's water production. If one bore well does not produce enough heat energy, several bore wells can bedrilled.

Horizontal pipelines for collecting geothermal energy require a fairly big plot because one building square meter needs from one to two meters of pipelines and one meter of pipe needs 1.5 square meters of land space. Horizontal pipes are installed approximately one meter below ground surface.

To collect heat energy from water, the shore depth should be at least two meters quite near the shoreline. Weights are used for sinking the pipes to the bottom of the water body. (Motiva Oy: Lämpöä omassa maassa 2012.)

Geothermal energy can also be utilized with centralized systems in residential areas. Centralized geothermal heating is a reasonable option in residential areas especially when the heat can be collected from a body of water and the houses are quite close to each other to minimize costs of the network. (Matikka 2009, 47.)

4.2 Aerothermal energy collected via heatpumps

Air source heat pumps utilize hydrothermal energy stored in the air. There are three kind of different solutions for air source heat pumps: air-to-air heat pumps, air-to-water heat pumps and axhaust heat pumps. From these, the air-to-air heat pump is an add-on solution, and it can be used only a side of another main heating system. It transfers the heat of the outside air directly into air blown inside the building. Air-to-water heat pumps can cover the heating needs of the building completely almost throughout a year. It works independently until -20°C temperatures. This system requires a heat distribution system which is based on the circulation of water, i.e. underfloor heating system or heaters. It also heats up the domestic water. Exhaust heat pumps can cover the heating needs 100 % because it transfers the heat from the air inside the building and

therefore it is not dependent on the temperature outside. (Motiva Oy: Lämpöä ilmassa 2012.)

4.3 Wind energy

In wind power the air flow's kinetic energy is transformed in to electricity by wind turbines. Wind turbines include a tower, rotor and a nacelle which contains the power converter. (Suomen tuulivoimayhdistys ry, 6; Armstrong & Blundell 2007, 71.)

Wind power is mainly produced in large wind power parks by industries but it can, and is utilized also in a smaller scale locally or in separate small wind turbines in the house holds. In these cases using wind power fits best to areas of dispersed settlement and it is a good option or supplement for solar electricity system. (Pesola et al. 2010, 19-20; 49.)

At the end of year 2013 Finland's wind power capacity was 447 MW produced by 209 wind turbines. Approximately 0.9 percent of Finland's electricity consumption was produced with wind power (VTT 2014). The goal for year 2020 in Finland is to increase the production in to 2500 MW per year which would cover seven percent of the electricity in Finland. To reach this goal there should be around 600 new wind turbines built. One of the problems in reaching the aforementioned goal seems to be the permission bureaucracy and complaints in different phases of processes in Finland caused by the public. Issues that concern the public are usually the emitted noise, the effect on birds and the visual distruption in the landscape. (Sipinen 2014; Armstrong & Blundell 2007, 77.)

4.4 Solar power

Solar power can be used for heating and electricity. It can be collected with different kind of solar panels and solar collectors. Solar panels are used for producing electricity and solar collectors for collecting heat from the sun. In both cases the energy is utilized with a surface receiving the radiance of the sun. For achieving the maximum benefits of the solar

power the placement and the angle of the system is in a significant role. Solar power can be a part of residential area's shared multipolar energy production or residents can collect it using systems of their own.

Active collecting of solar power is usually used as an addition to the main heating and / or electricity source. Solar power can be used also as a passive source of heat by optimizing the heating effect of insolation with architecture, layout of the building and structure solutions in the building. (Motiva Oy: Auringosta lämpöä ja sähköä 2012.)

4.5 Biofuels

Biofuels are fuels produced from biomass. In Finland the most significant sources of biofuels are wood and peat. However, since peat is a slowly renewalbe source, it is not considered as a renewable energy source in energy politics. Even if it is not a fossil fuel, in climate politics it is handled the same way – it's seen as a fuel that increases emissions of green house gases to the atmosphere. The most notable and voluminous source for biofuels in Finland is wood in its different forms. It can be used as raw wood, pellets, wood chips, felling waste and wood stumps. It has high energy content and it is a great heat source. (Bioenergianouvoja.fi; Energiateollisuus ry.)

Biogas is also one form of biofuel, produced from bio masses such as bio waste, animal waste and waste waters. Methane gas produced from biogas can be used for electricity and heating of the residential areas. One form of biofuels is a agricultural biomass i.e. plants grown for energy purposes. These biomasses can be burned or processed into solid or liquid biofuels.

One of the future's potential for biofuel production is horse manure. It has a great energy value, but the legislations in Finland are yet making it hard to utilize horse manure as an energy source. (Bioenergianouvoja.fi.)

5 FINNISH RESIDENTIAL AREAS WITH A TARGET OF SELF-SUFFICIENT ENERGY PRODUCTION

Finland has a lot of residential areas that are aiming on energy efficiency. There is still a quite small amout of newly built residential areas done or in a planning phase that are, or that aim on energy self-sufficiency.

In this thesis two different areas were chosen for closer research and interviews were done to find out more about these areas. The reason for choosing Eco village in Kempele and Taivaanranta in Nastola was that both of them had a target of energy self-sufficiency in the beginning of the planning phase. Yet, there are also many differences to be found between these two projects.

Eco village is already built and Taivaanranta is in a construction phase. Eco village is the first energy self-sufficient residential area in Finland and it is a fairly small area with ten houses. Taivaanranta in Nastola is going to be a quite large area with 145 building lots. Eco village reached the energy self-sufficiency target when it was built, but the area of Taivaanranta will not be reaching its original target of being a self-sufficient area.

5.1 Interviews

Interviewing is a flexible research method and especially when it is carried out orally it gives opportunities for interaction and directing the data collecting. It enables a chance for repeating guestions if necessary, correcting possible missunderstandings and making conversation with the interviewee openly. (Hirsjärvi & Hurme 2000, 34-37, 73.)

For researching the case study sights, interviews were chosen as a method for collecting information about the areas and for finding out how the planning processes were carried out. The reason for choosing interviews as a method was that researching only the planning materials available did not give a complete picture of the decision making and the planning processes as a whole.

To carry out the interviews there was a form including the questions made to make sure, that the same themes and matters were covered conserning both case study sights.

In case Eco Village the other interviewee wanted to answer the questions literally. Some issues were completed with extra questions via e-mail. His answers were supplemented by another person interviewed via telephone conversation. In case Taivaanranta the interview was carried out face to face.

The interviewed persons were not able to answer all of the questions presented in chapter 5.1.1. The reason for the incomplete answers stems from the lack of information, i.e. the interviewees' home organizations had not collected the relevant information or researched the subject at all. The responses for the questions are written openly and presented more closely in Finnish in the appendix 1 and anppendix 2.

5.1.1 Interview questions

The interviews for the areas of Eco village in Kempele and Taivaanranta in Nastola included the following questions:

BASIC INFORMATION ABOUT THE AREA

1. The name and the location of the area
2. Amount of households in the area building types
    a. detached houses
    b. semi-detached houses
    c. row houses
    d. high-rise apartment houses
3. Actual situation of the area
    a. in a planning phase, in what kind of situation?

b. in a construction phase, when it will be finished?

c. completed, when?

ENERGY SOLUTIONS

1. The level of the area's self-sufficiency of energy

    a. the area is 100 % self-sufficient and off-grid from national energy networks

    b. the area is partly self-sufficient, but connected also to national energy networks

    c. the area will not be energy self-sufficient

2. The area's ways of energy production?

CO-OPERATORS AND STAKEHOLDERS

1. Land ownership of the area in the beginning of the process

    a. private land owner

    b. municipality

    c. other, who?

2. What kind of stakeholders were involved in the process, and in what kind of roles?

    a. in the starting phase

    b. in the planning phase

    c. in the construction phase

    d. in the monitoring phase

THE PLANNING OF THE AREA FROM ENERGY SELF-SUFFICIENCY POINT OF VIEW

1. Did the solutions for energy production have an effect on the location of the area or vice versa? How?
2. How were the targets of energy self-sufficiency taken into account during the planning process?
    a. in the pre-investigation, how?
    b. in the plan symbols and orders, what kind?
    c. in the building code, how?
3. If you see that the planning how has guided the energy self-sufficiency target more effectivily, how it could have been done?

COMMITMENT OF THE RESIDENTS

1. How was the marketing of the area carried out for the future constructors?
2. Did the target of energy self-sufficiency have effects on finding the constructors and the marketing of the area positively or negatively?
3. Was the finding of the constructors
    a. easy
    b. relatively easy
    c. quite difficult
    d. difficult
4. In which ways were the future residents committed in to energy self-sufficiency?

REALIZATION OF THE TARGETS AND MONITORING

1. Did / will the targets set on energy self-sufficiency be fulfilled?
    a. If not, how will they be un-fulfilled and why?
2. How is the energy production going to be monitored?
3. Are the inhabitants satisfied with the ways of energy production?
4. Have the ways of producing energy found to be economically profitable or unprofitable?

5.2 Eco village in Kempele

Eco village of ten houses in Kempele is the first energy self-sufficient residential area in Finland. The area accomplished the target of being completely independent and out of touch from the national power grid when it was built. It was awarded as the most significant building site in Finland year 2010 by Suomen Rakennusinsinöörien Liitto (RIL). The area has a wind turbine of its own own and a power plant that produces electricity and heating power for ten small houses by burning woodchips. All the households belong to areal energy co-operative. (Volter Oy 2014; Pesola, et al. 2010, 36-38.)

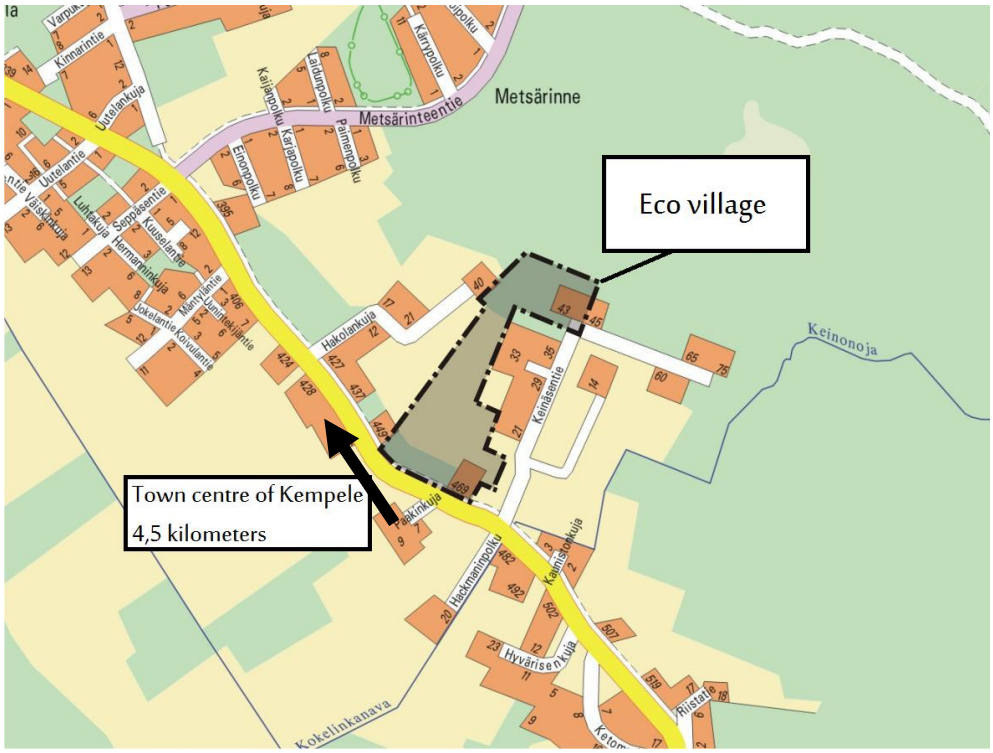

FIGURE 4. Location of the area. Municipality of Kempele 2008.

FIGURE 5. Observation image of the Eco village. Municipality of Kempele & Airix Ympäristö 2008.

Pekka Salmela, who worked as a planning engineer in the municipality of Kempele during the planning process of Eco village answered to interview questions literally in autumn 2015. Representive of Volter Oy, managing director Jarno Haapakoski was interviewed by telephone in November to get information about technical issues. The following information is based on these materials.

Information about the area

Eco village in Kempele (Kempeleen ekokylä) is located in built-up, town plan area of Kempele municipality.

The area consists of ten detached houses and the building phase has been completed in year 2009.

The aim of the project was to create a testing- and product development environment for Volter Oy's technical systems producing the heat energy and electricity. Eco village was a suitable area to become a pilot sight.

When Eco village was built it was 100 % energy self-sufficient and out of touch from national power grid. There was also a backup generator in case of a disruption in the system.

In the beginning of the planning phase the land was owned by Juha Sipilä who is also the founder of Volter Oy. Municipality of Kempele made a contract about the land use with the land owner. According to the contract the municipality paid a raw land price from the lands for lot areas, street areas and park areas. Ownership of the land for the power plant remained in the private land owner. A contract on Volter Oy taking a responsibility of energy production and maintenance of the power plant for five following years was also made.

Stakeholders during the whole project were the municipality of Kempele, the private land owner and Volter Oy.

Planning the area from the viewpoint of energy self-sufficiency

The planning process got started from suggestion of the land owner and Volter Oy.

The aim of energy self-sufficiency was taken in to account in the planning process by sizing of the area for the small power plant. In the beginning of the planning process the option of guiding the energy self-sufficiency in the actual plan was considered. It was excogitated that the plan would have been too un-flexible in case of changes in the situations such as transformation of the technical solutions.

The area could have been planned to be denser to minimaze the lengths for the pipelines in the area.

To attract builders to the area, the plots were planned to be relatively big compared to typical plot sizes offered by the municipality, 2000 m^2. Prizes of the plots were set lower than other plots offered by municipality because the buyers had to join the energy co-operative and pay 10 000 euros for it. This was taken in to account in pricing of the lots.

Main point in the marketing was that costs of energy would be 30 percent lower than in a normal houses heated with electricity. The marketing was done by internet and advertising in papers. Both the municipality and the private land owner did marketing. Energy self-sufficiency was seen as a positive aspect in the area and it increased interest among potential residents. Since the area had only ten lots it was easy to find the builders.

The plot buyers were commited in to energy self-sufficiency by making them join in to areal energy co-operative when the plot was handed off. They had to pay 10 000 euros for joining. The building's energy saving issues were included in the terms of plot release.

FIGURE 6. Eco village in Kempele when houses were still under construction. Volter Oy.

FIGURE 7. Residential buildings in Eco village. Volter Oy.

Reaching the goals and monitoring

The area was energy self-sufficient for 5.5 years from 2009 to end of year 2014. In the beginning of year 2015 the area was connected in to the national energy net work. The reason for this decision was, that during the monitoring it was discovered that is was not productive enough to run the energy production in the area completely off grid. Price development of energy and heat had an impact on unprofitability. The option of having a

one electricity connection to national network for the power plant was considered. This would have enabled the selling of the spare electricity in the winter time to the network and buy electricity in the summer time when the power plant's needs for the heat energy are lower. The law on the energy market became strained in year 2014 preventing a possibility to sell the electricity if there is a connection to national network. The possibility of having crossing power grids in the area and exploiting spare heat in the summer time and spare electricity in the winter time form the area's power plant was prevented. For this reason the only option was to have electricity connections for each household separately. The area is now getting its electricity from the electricity network and the heat from the heat network. The electricity and the heat produced from the power plant are sold to the electricity net work and to the heat network.

For Volter Oy the project has been a significant reference and proof of technical know-how. After Eco village company's solutions have been exported abroad for example to England, Canada and Australia. According to Volter Oy's managing director, in Finland the present legislation is making it difficult and unprofitable to carry out self-sufficient areas with areal production of electricity. Heat energy can be procuced communally but electricity should be produced in each building separately, if the goals of energy self-sufficiency wish to be reached.

5.3 Taivaanranta Nastola

In Päijät-Häme, municipality of Nastola the land-owner and the municipality in co-operation have planned a residential area of Taivaanranta, overall with 260 apartments in the future. In the planning process the aim was to plan an energy self-sufficient and communal area with internet-based service platform, where inhabitants can keep track and control of their household's energy consumption. The goal was that Taivaanranta becomes example area of cleantech following operation recommendations of ERA17- programme started by the Ministry of

Environment. Aim of this programme is to make Finland the leading country in energy wisdom.

One1 participated in energy solutions and delivery of energy models in the area. The original plan was to use eco-friendly energy solutions like solar power, geothermal heating and bioenergy. (Taivaanranta asunnot Oy 2014; Ladec Oy 2014.)

FIGURE 8. Location of the area. Google maps 2015.

FIGURE 9. Observation image of area of Taivaanranta. Arkkitehtitoimisto Ajak Oy 2014.

Taivaanranta's land owner Pär-Gustaf Relander was interviewed in autumn of 2015. The following information is based on the interview.

Information about the area

Taivaanranta area is located in Nastola by lakes Kymijärvi and Kärkjärvi. Distance to the centre of Nastola is 7 kilometers and city centre of Lahti 13 kilometers.

Amount of lots in the area is in total 145 and 132 of them is for single houses and 13 for small residential buildings. Amount of households in the future will be approximately 260 in 160 lots. It is estimated that there will be around 800 inhabitants living in the area.

The planning phase has been finalized in summer 2014. The project is now continuing in 3 different areal phases. First phase is called Kannas, second Sylialue and third Niemi. The first phase is now started with selling the lots. Eleven lots have been reserved or sold from total 51 lots. The

building of the area will start in spring 2016. The target is that by 2017 70 percent of Kannas area will be under construction.

FIGURE 10. Observation image from the Kannas area. Arkkitehtitoimisto Ajak 2014.

The original plan was to build a centralized geothermal heating system to the area and all three areas would have had their own center for heat distribution. Drilling for the geothermal heat was planned to be done in the parks, fields and also in to the lake. Energy companies experienced that the solution would have been too expensive to keep the costs in a profitable level and for that reason there was no operator found to execute the plan. Also an option of co-operative was found impossible to carry out because of expenses. At the moment the first area, Kannas has a temporary environmental permission of five years for an oil burner. Plan modification for a woodchip burning plant is in the making. Supplier of the plant will be Lahti Energia. This plant is going to produce all the heating energy needed in the area. Before the plant is built it is required that also Sylialue area starts build up.

All the plot buyers are required to commit in to the district heating contract and to pay the energy development payment. Nevertheless they are not obligated to join the areal network and it is possible that some of the builders will have their own geothermal heating. Plot buyers are encouraged to produce electricity from solar power and the building code also has reservation and guidance for solar panels. It is also possible have the electricity from Lahti Energy's network, so self-sufficiency is not required.

Planning process

The area of Taivaanranta is owned by a private person, so the planning process was also launched and subscribed by the land owner. There was an invite competition organized for five different architect offices from which three provided an idea for the area. All the plans were bought by the land owner and the planner for the area was chosen based on the competition materials. Architect office Ajak was chosen to do the planning.

Municipality of Nastola was involved in the process for the whole time. Engineer office Poutanen also took part in the process.

Ladec has been participating in to the process and co-operating with the land owner and municipality of Nastola in developing the plan. It has also been participating in funding the planning of cleantec to the area. The solutions of energy production were made by a company called One1.

Some construction companies and real estate agencies have been involved as personal advisors of the land owner.

It was noticed that it would have been important to get the possible suppliers of energy to participate in to the process in early stage. In Taivaanranta project they were searched in a point where plans were mainly done already. Since there was no supplier found for the original idea of producing the heat energy by geothermal heating, plans needed to be changed for the bio burning plant.

From the beginning the major idea for the area has been the sense of community. From that point of view a co-operative for energy would have been a positive aspect. It would have helped to achieve and increase the sence of community for the inhabitants of the area.

As a private person the land owner sees that there would have been no better ways for influencing to the self-sufficiency of energy by planning. If the municipality would have been in charge of the planning, there would have been better possibilities for guiding self-sufficiency.

The marketing of the area has not been based on the energy solutions since the geothermal heating was not fulfilled. The main marketing arguments have been the nature, communality, lakes and landscapes. The energy production has created a positive addition to the marketing. Finding builders and inhabitants to the area has been fairly easy so far and the selling process is in the schedule.

The target is that expenses of heating energy from bio energy power plant will be cheaper than private geothermal heating after seven years of consumption. Aim is to reach a solution that is profitable for consumers and for the supplier. The area will also have a district heating but its purpose is only to ensure the heating for very cold periods.

5.3.1 Summary and results of the interviews

What kind of things should be paid attention to in different stages of the planning process of the project for achieving a self-sufficient residential area using renewable energy?

Choosing the area and suitable energy solutions for it

In these cases, the geographic location of the planning area was decided berofe the solutions of energy production. The suitable solutions for energy production were chosen afterwards. The main way of energy production in both cases is a power plant that burns woodchips so it not dependent in the location. If the original plan of heat production by

geothermal heating in Taivaanranta would have been fulfilled, it would have utilized the areas location by drillings to unbuilt areas and the lakes.

Planning process and co-operation with stakeholders during the planning

Co-operation with stake holders was found to be very important. For accomplishing the energy self-sufficiency targets one of the most significant stakeholders is the collaborator who carries out the energy production. For this reason energy companies or other operators should be participating in the process in the early stage. If the operator for the energy solution chosen is not found, targets are not accomplished and plans need to be changed. Therefore, the operator should be found before the final plans are made. The solution has to be profitable for all parties and energy companies make investments only if they find the solutions cost-effective enough.

Future residents and their commitment

Either of the plans included ways for committing future builders or residents for energy self-sufficiency. Energy self-suffiency was guided in the actual plan material only by the reservations for energy production facilities. In Taivaanranta guidance for using renewable, self-sufficient energy was included in the building code but not as a compulsory matter.

In case Eco village energy self-sufficiency was guided by compulsory joining in to the energy co-operative for the plot byers. Instructions of building's energy saving issues were included in the terms of plot release. This was seen as a better way than burdening the plan orders.

In case Taivaanranta plot byers have to pay the energy developmet payment and they are also required to commit in to the district heating contract. Nevertheless they are not obligated to join the areal network.

Marketing and realization

In a case Eco Village marketing of the area was based on energy savings. It was easy to find the byers for the plots. In the marketing of Taivaanranta

area, energy issues are not in an important role. This is partly a result from the original plans about the energy production not actualizing. Nevertheless using renewable energy produced on the spot for the heating of the area has been seen as a positive aspect. During the selling process potential byers are encouraged for solar power solutions.

FIGURE 11. Example of the housing in Taivaanranta. Arkkitehtitoimisto Ajak 2014.

6 PLANNING PROCESS OF ENERGY SELF-SUFFICIENT RESIDENTIAL AREAS

To achieve residential areas with self-sufficiency on energy, there must be other things than energy technology and energy solutions observed too. Using multipolar energy production has a strong connection with planning, regional climate goals and advancing and testing of new technologies. Energy self-sufficiency can also work as an arttaction and create local business to the area. To enable local energy production and self-suffiency it has to be observed in the planning prosess right from the beginning.

6.1 Different areas

Areas are always individual and that is why the way of producing energy should be chosen regionally. One of the main things creating differences is the location and population density of the area in the future.

During the planning process it is important to research and compare all the different options for energy production. Many of the solutions with their emission and cost effects are dependent on the location so the solutions have to be considered case-by-case. It is also notable that different options for energy production and the profitability compared to each others can change rapidly, so the solutions should not be done a lot earlier than the building phase actually begins. (Rajala, P., Hirvonen, H., Perttula, S., Lähde, E., Pulkka, P., Jarmala, L., Laukkanen, J., Patronen, J., Jokinen, M., Rintala, T., Rajakallio, K., Kauppinen, T. & Pöyry 2010, 146, 145.)

In compact residential areas there are usually more options for profitable renewable energy. When there is enough consuption in the area it is cost-effective to build an areal heat network based on local energy sources. Ways to produce the energy locally depends on the natural conditions of the area. Solution can be a combination of different local sources.

In areas of dispersed settlements real estates are often located so far from each other, that it is more difficult to make areal shared energy solutions profitable. When planning new settlements to these areas it is possible

and also benefical to create groups of buildings that can share their production of energy. In country side there are different kinds of sources for renewable energy compared to population centres. For example biogas produced from organic waste in farms can offer a solution for using local renewable energy. Single households in areas of dispersed settlements have the same multipolar solutions that compact residential areas have, for example wind turbines and solar power. In the residential areas located outside the urban area off-grid solutions are often more attractive and profitable than in the areas that have better connections to national networks available. (Pesola et al. 2010, 44, 45.)

6.2 Planning

Local master plans and detail plans can be tools for affecting the carbon footprints of residential areas. It is important to have cooperation between all stakeholders from the beginning of the prosess. There have been good experiences of prosesses where for example planners of the area, traffic planners and energy companies have worked together.

Planning prosess can be made so, that it emphasizes aspects of energy production and consumption. Figure 12 expresses an example of how this kind of planning prosess can be made. This model of planning prosess was created during the planning of Skaftkärr- project in Porvoo. (Pesola et al. 2010, 44-46.)

Planning of alternative land use models

- examination of areas internal structure and it's association to city's urban structure

⇩

Research of alternative solutions for energy production

- observing multipolar, local and renewable energy solutions
- cooperation with local energy companies is important

⇩

Evaluating effects of alternatives

- evaluating for example effects on traffic and self-suffiency and substainability of energy production
- aggregating effects conserning energy effectivity, self-suffiency and carbon dioxide emission

⇩

Defining of different land use models energy consumption and carbon dioxide emission by using variables of local energy effectivity

⇩

Combining impacts of local energy effectivity, self-suffiency and emissions with solutions of energy production and energy effectivity level of buildings

- Energy effectivity profiles of variables and comparing them

⇩

Conclusions of appropriate solutions made based on calculations and a sketch of the plan

- examination continues when the solutions of the plan become more precise

FIGURE 12. Paying attention to energy production and consumption in planning process (Pesola et al. 2010, 46).

It is noticable that planning solutions can have also effects on increasing the attraction of the new residential area and the whole municipality. Eco-friendly approach can boost city's or municipality's profile in a positive way and tempt new inhabitants and also new business in to the area.

Even if energy self-suffciency and using renewable energy can work as an attraction it self, also other planning solutions can be made to expand the attraction even more. For example in Ecovillage of Kempele building lots were planned to be bigger than usual. (Pesola et al. 2010, 49.)

7 CONCLUSIONS

Energy self-sufficiency by producing all the energy from renewable sources on the spot in a residential area is an issue that has several variable aspects.

Buildings are causing a large share of Finland's energy consumption and for this reason increasing usage of renewable energy sources in buildings, including residential buildings plays significant role in lowering the greenhouse gas emissions and also increasing the national independence on energy market. The amount of imported energy to Finland is massive, being 70 percent of the total consumption in 2012, even if the there is potential and possibilities for being nationally energy self-sufficient. Finland has set a goal for renewable energy usage being 38 percent of total energy consumption by 2020.

The European Union has set several directives and standards that support energy efficiency, usage of renewable energy and making construction business, including the residential areas, self-sufficient on energy production. One of the most significant and topical directives is the Energy Performance of Buildings Directive which includes demands for the state members to make national plans for increasing the number of nearly zero energy buildings. According to the directive, all the new buildings built after the end of 2020 should be nZEB. This means that buildings should have a very high energy performance and that the low amount of energy needed should be covered with renewable energy, including energy produced on-site or nearby. This directive supports highly planning and building energy self-sufficient residential areas. Legislation for nZEB buildings in Finland is in a preparation phase, so the details ultimate solutions of national plans are not yet available. Assuming that plans made in the preparation phase of the national legislation and indicators are fulfilled, the building's electrical power and heating power have to be presented in the building permit application. The new E-credit calculation will evaluate the amount of renewable energy from energy purchased from elsewhere and from energy produced on the spot.

For achieving energy self-sufficiency in residential areas there are several options for the energy production. Especially for generation of heat energy the options are quite easily realized in a profitable way. The most common way for local heat production is a power plant utilizing biofuels such as burning wood in its different forms. Also geothermal energy is being utilized with centralized systems. For house hold specified systems there are more options used, such as aerothermal energy and solar power. It is more challenging to produce electricity in a cost-effective ways in to residential areas to become completely self-sufficient and off-grid from national networks. It seems to be, that the present laws and regulations are making it difficult to realize areal electricity production in a cost-effective way. The more profitable way is to produce the heat energy regionally but have the electricity produced separately in each household.

The co-operation with the collaborator fulfilling the energy production stood out as one of the most significant issues from the beginning of the planning process for reaching the self-sufficiency target. Without finding a suitable operator it is not possible to carry out the process successfully. In the study cases the actual plans did not include very much guidance for the energy issues expect for the land reservations for energy production facilities. Guidance was done in other phases: in the terms of plot release and in the building code. Commitments were done also with payments. In both cases energy issues were seen as a positive aspect in the marketing phase. The planning process of a self-sufficient residential area can be carried out by following the steps of figure 12: Paying attention to energy production and consumption in planning process. It is important to examine different alternatives for the land use and solutions for energy production case by case.

As a final conclusion, the opportunities and possibilities for achieving energy self-sufficient residential areas using renewable energy sources are available for the future, and in the future these options must be taken in to consideration and put in to use more. Finland has to act on changing its legislation so, that they give better possibilities and conditions for realization of self-sufficient areas.

LIST OF REFERENCES

Ahola, J. 2012. Tavoitteena energiaomavaraisuuden nostaminen – miksi, milloin ja miten? Lappeenranta University of Tecnology. [Retrieved 7 November 2014] Available from LUT website: http://www.lut.fi/green-campus/asiantuntijat-aanessa/energiamurros-energiaomavaraisuus

Armstrong, F. & Blundell K. 2007. Energy… Beyond Oil. Oxford University Press.

Bioenergianeuvoja.fi. 2015. Biopolttoaineet. [Retrieved 24 November 2015] Available at: http://www.bioenergianeuvoja.fi/biopolttoaineet/

Directive 2009/28/EC of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources

Directive 2010/31/EU of the European Parliament and of the Council of May 2010 on the energy performance of buildings

Directive 2012/27/EU of the European Parliament and of the Counsil on energy efficiency

Ekotuki- toimintamalli työpaikan ekoarkeen. [Retrieved 9 March 2015] Available at Ekotuki websites: http://www.ekotuki.fi/toiminta/

Energiateollisuus ry. Energialähteet: Turve. [Retrieved 24 November 2015] Available at: http://energia.fi/energia-ja-ymparisto/energialahteet/turve

Energy Vaasa. 2014. Energiaomavarainen asuinalue. [Retrieved 10 November 2014] Available at Energy Vaasa website: http://www.energyvaasa.fi/fi/home_fi/caset_fi/new-energy---energiaomavarainen-asuinalue_fi

Eurooppaneuvosto, 2014. Eurooppa-neuvoston päätelmät ilmasto- ja energiapolitiikan puitteista 2030. Bryssel October 23th 2014. Available at: [http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/fi/ec/145365.pdf]

Hirsjärvi,S. & Hurme, H. 2000. Tutkimushaastattelu. Teemahaastattelun teoria ja käytäntö. Helsinki: Yliopistopaino.

Kansallinen energia- ja ilmastostrategia. Valtioneuvoston selonteko eduskunnalle 20.päivänä maaliskuuta 2013. Ministry of Employment and the Economy Publications. Energy and climate 8/2013. Edita Publishing Oy

Karesola, I. Suupohja energiaomavaraiseksi - presentation. 2012. Kauhajoen seudun KOKO- ohjelma. Energiaomavarainen seutu ja kestävä kehitys. Retrieved [11 March 2015] Available at: http://sek.suupohja.fi/tiedostot/SUUPOHJA_ENERGIAOMAVARAISEKSIkalvot.pdf

Lielahti, M. 2012. Energiaomavaraisuus on nouseva trendi. Suomen itsenäisyyden juhlarahasto Sitra. [Retrieved 9 November 2014] Available at Sitra website: http://www.sitra.fi/artikkelit/lahienergia/energiaomavaraisuus-nouseva-trendi

Maankäyttö- ja rakennuslaki 5.2.1999/132.

Matikka, V. 2009. Maalämpöprojektin loppuraportti. Maalämmön soveltuvuus keskitettyyn lämmöntuotantoon kaukolämpöverkostojen ulkopuolisilla alueilla-projekti. Savonia Ammattikorkeakoulu. Available at Savonia University of Applied Sciences web pages: http://portal.savonia.fi/img/amk/sisalto/teknologia_ja_ymparisto/ymparistotekniikka/Loppuraportti_MAALAMPO.pdf

Ministry of the Environment a. Lainsäädäntöhanke lähes nollaenergiarakentamiseen siirtymiseksi. YM036:00/2014. 13.1.2015. [Retrieved 16 March 2015] Available at Ministry of the Environment sites: http://www.ym.fi/download/noname/%7B2A4F3E27-BB1E-43D2-9DA7-97DB144D5452%7D/106497

Ministry of the Environment b. Lähes nollaenergiarakentamisen lainsäädäntötyö käyntiin. 20.1.2015. [Retrieved 15 March 2015] Available

at Ministry of the Environment sites: http://www.ym.fi/fi-FI/Ajankohtaista/Tiedotteet/Lahes_nollaenergiarakentamisen_lainsaada%2832508%29

Motiva Oy. 2012. Auringosta lämpöä ja sähköä – aurinkoenergia. Motiva Oy julkaisut.

Motiva Oy. 2012. Lämpöä ilmassa – ilmalämpöpumput. Motiva Oy julkaisut.

Motiva Oy. 2012. Lämpöä omasta maasta – Maalämpöpumput. Motiva Oy julkaisut.

Niemiläinen, J. 2014. Kova ehdotus: Suomi energiaomavaraiseksi vuoteen 2050 mennessä. Taloussanomat. [Retrieved 13 November 2014] Available at taloussanomat website: http://www.taloussanomat.fi/energia/2014/02/26/kova-ehdotus-suomi-energiaomavaraiseksi-vuoteen-2050-mennessa/20142823/12

Pesola, A., Hoviniemi, A., Vehviläinen, I., Vanhanen, J. Selvitys hajautetusta ja paikallisesta energiantuotannosta erilaisilla asuinalueilla. Loppuraportti 12/2010. 2010. Motiva Oy.

Rajala, P., Hirvonen, H., Perttula, S., Lähde, E., Pulkka, P., Jarmala, L., Laukkanen, J., Patronen, J., Jokinen, M., Rintala, T., Rajakallio, K., Kauppinen, T. & Pöyry. 2010. Energiatehokkuus kaavoituksessa. Skaftskärr Porvoo. Kaavarunkovaiheen loppuraportti. Sirtan selvityksiä 41. Sirta, Helsinki.

Rakennusteollisuus RT ry, Talotekniikkateollisuus ry, Ministry of the Environment. FInZEB-hankkeen keskeiset johtopäätökset. 5.2.2015. [Retrieved 28 March 2015] Available at FInZEB project sites: http://finzeb.fi/wp-content/uploads/2015/02/FInZEB_yhteenveto_final.pdf

Sipinen, M. 2014. Tuulivoimatavoite jäämässä haaveeksi – syynä valitukset ja paperisota. MTV Internet. [Retrieved 16 December 2014]. Available at:

http://www.mtv.fi/uutiset/kotimaa/artikkeli/tuulivoimatavoite-jaamassa-haaveeksi---syyna-valitukset-ja-paperisota/2817522

Suomen Tuulivoimayhdistys ry. Hyvän tuulen paikka!- esite. JS Suomi Oy. Available at: http://www.esitteemme.fi/tuulivoimayhdistys/WebView/

Taivaanranta asunnot Oy. 2014.Tervetuloa Taivaanrantaan. [Retrieved 11 November 2014] Available at Taivaanranta website: http://www.taivaanranta-asunnot.fi/

Tilastokeskus. Energian kokonaiskulutus energialähteittäin ja Co2-päästöt. Updated 21.9.2015. Helsinki: Tilastokeskus. [Retrieved 23 September 2015] Available at Tilastokeskus PX-Web database: http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__ene__ehk/010_ehk_tau_101_fi.px/?rxid=49c9987d-bd82-4d73-b416-1dff372a588a

Tilastokeskus. Energian loppukäyttö sektoreittain. Updated 23.3.2015. Helsinki: Tilastokeskus. [Retrieved 2 September 2015] Available at Tilastokeskus PX-Web database: http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__ene__ehk/080_ehk_tau_118.px/?rxid=49c9987d-bd82-4d73-b416-1dff372a588a

Tilastokeskus. Energian tuonti ja vienti alkuperämaittain. Updated 21.9.2015. Helsinki: Tilastokeskus. [Retrieved 23 September 2015] Available at Tilastokeskus PX-Web database: http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__ene__ehk/030_ehk_tau_103_fi.px/?rxid=49c9987d-bd82-4d73-b416-1dff372a588a

Tilastokeskus. Käsitteet ja määritelmät. Uusiutuvat energianlähteet. [Retrieved 29 September 2015] Available at Tilastokeskus website: http://www.stat.fi/meta/kas/uusiutuvat_ener.html

Volter Oy. 2014. Volter references. Volter Oy. [Retrieved 9 November 2014] Available at Volter website: http://www.volter.fi/referenssi

APPENDICES

Appendix 1

KYSELYLOMAKE ENERGIAOMAVARAISTEN ASUINALUEIDEN SUUNNITTELUSTA

MARJA PETÄJÄ-SUVANTO

LAHDEN AMMATTIKORKEAKOULU

LAHTI UNIVERSITY OF APPLIED SCIENCES

Master of Engineering

Master Degree Programme in Sustainable Urban Planning and Climate Change

Haastateltava: Pekka Salmela, kaavoitusinsinööri, Kempeleen kunta

ALUEEN PERUSTIEDOT

1. Alueen nimi ja sijainti:

   Kempeleen Ekokylä, Kempeleen kunta, taajaman asemakaava-alue

2. Alueen kotitalouksien määrä asuntotyypeittäin

   a. omakotitalot *10 kpl*
   b. paritalot / kytketyt omakotitalot
   c. rivitalot
   d. luhtitalot / kerrostalot

3. Alueen ajankohtainen tilanne
   a. suunnitteluvaiheessa, millaisessa?
   b. rakennusvaiheessa, milloin valmistuu?
   c. rakennettu, milloin? *Valmistunut v. 2009*

ENERGIARATKAISUT

1. Alueen energiaomavaraisuuden aste
    a. alue on 100 % energiaomavarainen ja irti valtakunnan sähköverkosta
    Alue on omavarainen ja siellä on varavoimala systeemin häiriöitä varten. Käsittääkseni myöhemmin se on liitetty myös valtakunnan sähköverkkoon.

    b. alue on osittain energiaomavarainen, mutta on valtakunnan sähköverkossa

2. Alueen energiantuotantotavat (ei vastattu lomakkeessa)

ALUEEN YHTEISTYÖTAHOT JA SIDOSRYHMÄT

1. Alueen maanomistus suunnitteluvaiheen alkaessa
    a. yksityinen maanomistaja *Juha Sipilä*
    b. kunta
    c. muu, mikä?

2. Millaisia sidosryhmiä hankkeessa on ollut mukana, ja missä rooleissa?
    a. käynnistämisvaiheessa *maanomistaja*
    b. suunnitteluvaiheessa *Volter Oy*
    c. rakentamisvaiheessa *Volter Oy*
    d. monitorointivaiheessa *Volter Oy*

ALUEEN KAAVOITUS ENERGIAOMAVARAISUUDEN NÄKÖKULMASTA

1. Vaikuttivatko alueen energiantuotantotapojen valinnat alueen sijaintiin tai päinvastoin? Miten?
    Suunnittelu lähti liikkeelle maanomistajan aloitteestaan hänen omistamalleen maa-alueelle

2. Kuinka kaavoitusprosessissa otettiin huomioon alueen tavoitteet energiaomavaraisuudesta?
    a. esiselvitysvaiheessa, miten? *Mitoituksessa; aluevaraus pienvoimalaa varten*
    b. kaavamerkinnöissä- ja määräyksissä, millaisin merkinnöin? *Pienvoimalaa koskeva tontti merkintöineen*
    c. rakentamistapaohjeissa, miten? –

3. Jos kokemuksenne mukaan kaavoituksella olisi voinut ohjata paremmin alueen energiaomavaraisuustavoitetta, millä tavoin? *Kaavoituksella olisi pitänyt saada aikaan tiiviimpi rakenne putkivetojen minimoimiseksi*

ASUKKAIDEN SITOUTTAMINEN

1. Millä tavoin aluetta markkinoitiin tuleville rakentajille? *Lehti- ja nettimainonta sekä kunnan että maanomistajan toimesta.*

2. Vaikuttiko energiaomavaraisuus rakentajien löytymiseen ja markkinointiin positiivisesti vai negatiivisesti? *Positiivisesti sillä kyselijöitä oli paljon.*

3. Koetteko, että rakentajien löytyminen alueelle oli
   a. helppoa *rakentajia piti löytää vain kymmenen ja se oli helppoa*
   b. kohtuullisen helppoa
   c. melko vaikeaa
   d. vaikeaa

4. Millä tavoin tulevat asukkaat sitoutettiin energiaomavaraisuuteen?
   Alueelle perustettiin energiaosuuskunta johon tontinluovutuksen yhteydessä piti liittyä ja maksaa liittymismaksu.

TAVOITTEIDEN TÄYTTYMINEN JA SEURANTA

Näistä asioista minulla ei ole tietoa; suosittelen yhteydenottoa Volter Oy:n vastuuhenkilöihin

1. Ovatko / tulevatko alueelle asetetut energiaomavaraisuuden tavoitteet toteutumaan?
   a. jos eivät, millä tavoin tavoitteet jäivät saavuttamatta ja miksi?

2. Millä tavoin alueen energiantuotantoa tullaan seuraamaan?

3. Ovatko asukkaat olleet tyytyväisiä energiantuotantotapoihin?

4. Ovatko energiantuotantotavat havaittu taloudellisesti kannattaviksi vai kannattamattomiksi?

Appendix 2

KYSELYLOMAKE ENERGIAOMAVARAISTEN ASUINALUEIDEN SUUNNITTELUSTA

MARJA PETÄJÄ-SUVANTO

LAHDEN AMMATTIKORKEAKOULU

LAHTI UNIVERSITY OF APPLIED SCIENCES

Master of Engineering

Master Degree Programme in Sustainable Urban Planning and Climate Change

Haastateltava: Taivaanrannan alueen maanomistaja Pär-Gustaf Relander (22.10.2015)

Kirjattu suullisen haastattelun pohjalta.

ALUEEN PERUSTIEDOT

4. **Alueen nimi ja sijainti:**

   TAIVAANRANTA, NASTOLA.

5. **Alueen kotitalouksien määrä asuntotyypeittäin**

   Kotitalouksia alueella yhteensä n. 260, 160 tonttia. keskimäärin 260 rakennuspaikkaa. Asukkaita alueelle tulossa arviolta 800 – tosiasia 4+ per talous.

   a. omakotitalot *132 tonttia erillispientaloille, lisäksi 13 asuinpientalotonttia (laskettu kaavasta)*
   b. paritalot / kytketyt omakotitalot
   c. rivitalot
   d. luhtitalot / kerrostalot

6. Alueen ajankohtainen tilanne / suunniteltu

a. suunnitteluvaiheessa, millaisessa? *Kaavoitus valmis, kaava hyväksytty 9.6.14 / vahvistettu 17.7.14.*

b. rakennusvaiheessa, milloin valmistuu?

vaihe 1: Kannas 2014–2017 – tavoitteena että 2017 yli 70 % rakentamisen alla --- Tilanne nyt: 11 tonttia myyty/varauksen alla. Kauppoja on tehty. Rakentaminen alkaa keväällä 2015.Kunnallistekniikkaa rakennetaan parhaillaan.
vaihe 2 : Sylialue: 2017-. Vaihe 3: Niemi 2020- .

c. rakennettu, milloin?

ENERGIARATKAISUT

3. Alueen energiaomavaraisuuden aste (SÄHKÖ JA LÄMPÖ)

a. alue on / tulee olemaan 100 % energiaomavarainen sekä lämmön että käyttösähkön tuotannoltaan ja irti valtakunnan sähkö- ja lämpöverkosta

b. alue on / tulee olemaan osittain energiaomavarainen, mutta on valtakunnan sähkö- ja / tai lämpöverkossa

c. alue ei ole energiaomavarainen

Alkuperäinen tavoite oli tehdä keskitetty maalämpö ja kaikille alueille oma lämmönjakokeskus. Poraukset oli suunnitteilla toteuttaa alueen puistoihin, pellolle ja Niemen alueen osalta järveen. One1 etsi toimijoita toimittamaan maalämpöä. Kustannukset havaittiin liian kalliiksi. Pohdittiin myös osuuskunnan perustamista. Alkupääoman sijoittaminen teki ideasta toteuttamiskelvottoman. Tällä hetkellä kannaksen alueella on öljypoltin viiden vuoden väliaikaisella ympäristöluvalla. Hakelaitoksen kaavamuutos on tekeillä, toimittajana Lahti energia. Laitos tuottaisi koko alueen lämmmöntuotannon. Muutaman megawatin tuotto. Laitoksen rakentaminen edellyttää, että myös Sylialue alkaa rakentumaan. Alueellinen kaukolämpö on hinnoiteltu niin, että se on kilpailukykyinen maalämmön kanssa.

Kaikkien tontinostajien on sitouduttava kaukolämpösopimukseen. Energiakehitysmaksu maksettava. Jotkut rakentajat haluavat silti ottaa maalämmön. Ei ole velvoitettu liittymään alueen lämpöverkkoon. Sähkö joko omalla aurinkoenergialla tai Rakennustapaohjeissa on aurinkokeräimille varaus / ohjeistus. Tontinostajia kannustetaan kovasti aurinkoenergian käyttöön.

4. **Alueen energiantuotantotavat**

Alueen lämpöenergia tuotetaan aluksi öljypolttimolla. Alueelle on tulossa aluelämpölaitos, joka polttaa haketta ja mahdollisesti pellettiä tuottaakseen lämpöä alueen kotitalouksille. Aurinkoenergialla sähkön tuottaminen on asukkaille valinnanvarainen vaihtoehto, johon kannustetaan. Sähköenergia tulee mahdollista aurinkoenergiaa lukuun ottamatta verkosta.

ALUEEN YHTEISTYÖTAHOT JA SIDOSRYHMÄT

3. **Alueen maanomistus suunnitteluvaiheen alkaessa**
    a. yksityinen maanomistaja
    b. kunta
    c. muu, mikä?

Millaisia sidosryhmiä hankkeessa on ollut mukana, ja missä rooleissa?

    d. käynnistämisvaiheessa
    e. suunnitteluvaiheessa
    f. rakentamisvaiheessa
    g. monitorointivaiheessa

Nastolan kunta ollut mukana – mutta ei kaavoittajana. Rakennusvalvonta osasto oli mukana lahden kaupungilta. Ladec (Lahden seudun kehitys) clean tec- puolen maksajana puoliksi. One1 on ollut hankkeessa mukana alusta saakka suunnittelemassa energiantuotantoa. Insinööritoimisto Poutanen on ollut myös mukana suunnittelutyössä. Energiaratkaisujen toteuttamisen mahdollistamiseksi tulisi ottaa energian toimittajat mukaan jo heti kaavan suunnitteluvaiheessa mukaan. Tässä hankkeessa niitä ryhdyttiin etsimään vasta kun etsittiin rahoittajia energiaratkaisujen toimittamiseksi. Rakennuttajapuolen edustajia on ollut mukana henkilökohtaisina sparraajana maanomistajalle, samoin kiinteistövälittäjiä. Alueelle järjestettiin maksettu kutsukilpailu viidelle arkkitehtitoimistolle, joista kolme toimittivat omat ajatuksensa ja sen perusteella valittiin suunnittelija.. Ajak valittiin tekemään kokonaissuunnitelma.

ALUEEN KAAVOITUS ENERGIAOMAVARAISUUDEN NÄKÖKULMASTA

4. **Vaikuttivatko alueen energiantuotantotapojen valinnat alueen sijaintiin tai päinvastoin? Miten?**

Eivät. Oma visio ja halu energiatuotantotapojen kehittämiseen on mukana alusta saakka.

5. **Kuinka kaavoitusprosessissa otettiin huomioon alueen tavoitteet energiaomavaraisuudesta?**

a. esiselvitysvaiheessa, miten?
b. kaavamerkinnöissä - ja määräyksissä, millaisin merkinnöin? *Varauksella maalämmöntuotantoon kaavassa. Kaavamuutoksessa lämpölaitoksen aluevaraus tekeillä.*
c. rakentamistapaohjeissa, miten?

Yhteisöllisyys ollut kantava ajatus alusta saakka. Osuuskunta-ajatus olisi luonut yhteisöllisyyttä alueelle. Osuuskunta-ajatus kaatui siihen, että kukaan energiayhtiöistä ei halunnut investoida siihen.

6. **Jos kokemuksenne mukaan kaavoituksella olisi voinut ohjata paremmin alueen energiaomavaraisuustavoitetta, millä tavoin?**
Yksityisenä kaavoittajana ei, jos kunta olisi ollut kaavoittajana, siihen olisi ollut mahdollisuuksia enemmän.

ASUKKAIDEN SITOUTTAMINEN

5. **Millä tavoin aluetta markkinoitiin tuleville rakentajille? Kuinka voimakkaasti energia-omavaraisuuden tavoite on ollut osana markkinointia?** *Tällä hetkellä aluetta ei markkinoida energiantuotannollisilla tavoilla, koska alueellinen maalämpö ei toteutunut. Myyntiargumentteina ovat luonnonläheisyys, yhteisöllisyys, järvi ja näkymät.*

6. **Vaikuttiko energiaomavaraisuus rakentajien löytymiseen ja markkinointiin positiivisesti vai negatiivisesti? (tämänhetkiset kokemukset)** *Potentiaaliset rakentajat ovat tiedustelleet asiaa, se ei ole ollut kriteerinä mutta positiivinen lisä.*

7. **Koetteko, että rakentajien löytyminen alueelle oli / tulee olemaan**
   a. helppoa
   b. kohtuullisen helppoa *Asetetut tavoitteet ovat aikataulussaan.*
   c. melko vaikeaa
   d. vaikeaa

8. **Millä tavoin tulevat asukkaat sitoutetaan energiaomavaraisuuteen?** *Ei sitouteta. Energiaverkon kehitysmaksu edellytetään kaikilta.*

TAVOITTEIDEN TÄYTTYMINEN JA SEURANTA

ALUE ON VIELÄ TOTEUTUMATON JOTEN SEURANTAA EI OLE TEHTY.

5. **Ovatko / tulevatko alueelle asetetut energiaomavaraisuuden tavoitteet toteutumaan?**
Tällä hetkellä toiveena on, että alueellinen lämpölaitos toteutuu.

   a. **jos eivät, millä tavoin tavoitteet jäivät saavuttamatta ja miksi?**

6. **Millä tavoin alueen energiantuotantoa tullaan seuraamaan?**
   Lahti Energia tekee omaa seurantaansa tulevaisuudessa.

7. **Ovatko asukkaat olleet tyytyväisiä energiantuotantotapoihin? –**

8. **Ovatko energiantuotantotavat havaittu taloudellisesti kannattaviksi vai kannattamattomiksi?**
   Tavoite lämpölaitokselle on ollut siinä, että hinnoittelu on seitsemän vuoden pitoajalla kuluttajalle edullisempi kuin maalämpö. Eli tavoitellaan kaikille kannattavaa ratkaisua. Tavoite on, että kaikki tarvittava lämpö tuotetaan laitoksessa. Kaukolämpö on vain buffina kylmemmille kausille.