SIBBESBORG MASTER PLAN

Eco-efficiency work package:

Concepts for Sustainable Technical Systems

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WSP sipoo sibbo

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TIIVISTELMÄ

Sibbesborg on suuren luokan aluekehityshanke, jossa yhdyskuntarakenteessa tapahtuva merkittävä muutos toteutetaan huomioimalla kestävän yhdyskunnan periaatteet kaikessa suunnittelussa. Sibbesborgin suunnittelun taustalla vaikuttavat Sipoon yleiskaava 2025 sekä Uudenmaan liiton alueelliset suunnitelmat Helsingin seudun kehityksestä. Näiden sekä vuonna 2011 pidetyn kansainvälisen kestävän yhdyskunnan suunnittelukilpailun pohjalta on laadittu Sibbesborgin kehityskuva ja kestävyyskriteeristö. Vuonna 2008 hyväksytyn yleiskaavan yhteydessä hyväksyttiin voimakkaan kasvun strategia, jossa itäisen kehityskäytävän osalta tavoitellaan huomattavaa asukasmäärän kasvua Helsingin ja Porvoon välille. Sibbesborg tarjoaa luontevan ja houkuttelevan paikan metropolialueen kehitystä tukevalle kaupunkirakenteen täydentämiselle itämetron jatkeeseen tukeutuen.

Sibbesborgin kestävyysnäkökulma tulee esille myös teknisten järjestelmien suunnittelussa. Vesi-, energia- ja jätehuollon järjestäminen määräävät pitkälti ne rajat, joiden varaan syntyvän yhdyskuntarakenteen toimivuus ja kestävyys rakentuu. Ekotehokkuus-työpaketin alla laadittu selvitys kattaa vesihuollon järjestelmät sisältäen talousveden jakelun ja jätevesien viemäröinnin sekä hulevesien hallinnan konseptin, energiakonseptin sisältäen sekä tuotannon että loppukulutuksen vaihtoehtojen arvioinnin, sekä jätemäärän vähentämiseen ja kierrätykseen tähtäävän jätehuollon konseptin sekä kotitalous- että rakennusjätteille. Myös liikennettä sivutaan erityisesti energiatarpeen näkökulmasta, johon vaikuttaa mm. joukkoliikenteen järjestäminen ja yksityisautoilun tarve. Näistä hulevesien hallinnan konsepti on laadittu tiiviissä yhteistyössä maankäytön suunnittelun kanssa, ja julkaistaan erillisenä raporttina.

Suunnittelun tueksi on jo varhaisessa vaiheessa pyritty tunnistamaan alueen ominaispiirteet huomioivia mahdollisuuksia ja rajapintoja, jotka tukevat ekotehokkaan ja kestävän aluerakenteen näkökulmaa. Sibbesborgissa teknisten järjestelmien tärkeänä periaatteena on pyrkimys suljettuun kiertoon, mikäli se on mahdollista. Konseptityön osalta tämä tarkoittaa tiivistä vuorovaikutusta teknisen huollon eri toimijoiden kesken, jolloin järjestelmien teknisten ominaisuuksien ohella pyritään tunnistamaan rajapintoja ja mahdollisuuksia hyödyntää materiaali- ja energiavirtoja ensisijaisesti alueen sisällä. Kestäviä teknisiä ratkaisuja jätehuollon, vesihuollon ja energiajärjestelmien osalta on jo laajasti käytössä, mutta järjestelmäkohtaisessa tarkastelussa saatetaan päätyä osa-optimointiin, jolloin synergiaedut jäävät huomaamatta. Tämä pyritään välttämään lisäämällä vuorovaikutusta jo konseptisuunnittelun tasolta lähtien.

Vesi- ja jätehuollon järjestelmien suunnittelu nojaa pitkälti hyviin suunnittelukäytäntöihin, mutta energiakonsepti tarjoaa useita mahdollisuuksia alueelliseen energiantuotantoon, joka pohjautuu useista eri lähteistä saatavien energiavirtojen hyödyntämiseen energiatehokkuuden edistämisen ohella. Energiakonseptissa keskeisenä periaatteena on matala energiankulutus ja hukan minimoiminen kaikissa ketjun vaiheissa. Esimerkkejä vuorovaikutteisen tarkastelun myötä käsiteltävistä mahdollisuuksista ovat esimerkiksi lämpöenergian talteenotto jätevesiverkostosta ja talteen otetun energian hyödyntäminen edelleen lämpimän käyttöveden lämmityksessä. Esiin on noussut myös orgaanisen jätteen hyödyntämisen tehostaminen biokaasun tuotannossa, jota voidaan myös hyödyntää polttoaineena. Alueella on lisäksi mahdollisuus hyödyntää uusiutuvaa energiaa mm. aurinkoenergian, maalämmön sekä biopolttoaineilla tuotetun kaukolämmön kautta.

Kestävyysnäkökulma on huomioitu läpäisyperiaatteella teknisten järjestelmien suunnittelussa. Tarkastelu perustuu kahteen vaiheeseen, jossa lähdetään liikkeelle 30 000 asukkaan ja 5 000 työpaikan välitavoitteesta. Toinen vaihe, joka kuvaa alueen erittäin pitkän tähtäimen tavoitetta, on arviolta 60 000 asukasta ja 22 000 työpaikkaa. Tavoitteet perustuvat Sibbesborgin kehityskuvassa asetettuihin tavoitteisiin sekä Sipoon kunnan näkemykseen alueen kehityksestä.

VESIHUOLTOJÄRJESTELMÄT

Kestävä vesihuoltojärjestelmä on ennen kaikkea toimintavarma ja energiatehokas. Vesihuollon osalta tarkastellaan vedenjakelun ja viemäröinnin nykytilaa, sekä esitellään alustava esisuunnitelma vesihuollon järjestämiseksi alueen lähtiessä rakentumaan. Luotettavuuden takaamiseksi on tärkeää, että vesihuolto toimii kaikissa tilanteis-

sa, myös mahdollisen putkirikon yhteydessä. Tämä edellyttää veden johtamista alueelle useiden runkolinjojen välityksellä, sekä riittävän vesitornin hyödyntämistä vedenjakelun huippukulutuksen aikana. Jätevesiverkostossa toimintavarmuutta voidaan kasvattaa hyödyntämällä gravitaatiota mahdollisimman kattavasti sekä tarkkailemalla verkon toimintaa ja puuttumalla häiriöihin mahdollisimman aikaisessa vaiheessa. Energiatehokkuutta voidaan puolestaan edistää varmistamalla optimaaliset paineolosuhteet vedenjakeluverkostossa sekä minimoimalla jäteveden pumppaamoiden lukupumpatun jäteveden määrä. Toisaalta energiatehokkuuden kannalta on myös perusteltua pyrkiä matalaan vuotoveden määrään molempien verkostojen osalta. Tällöin sekä vedenjakeluverkostosta vuotavan veden määrää että viemäriin johtuvan huleveden määrää seurataan ja niihin puututaan aikaisessa vaiheessa. Nykyistä teknologiaa ja mittaustekniikkaa hyödyntäen voidaan tunnistaa verkoston häiriötekijöitä kohtuullisen helposti ja näin hallita etenkin uusien verkostojen kuntoa tehokkaasti.

ENERGIA

Energiakonseptissa on lähdetty liikkeelle energiantarpeen vähentämisestä energiatehokkaiden rakennusten ja järjestelmien myötä, sekä pyrkimyksestä hyödyntää alueen sisäisiä energiavirtoja ja uusiutuvia energiavarantoja pyrkien energian ja materiaalin suljettuun kiertoon. Tavoite energiaomavaraisuudesta on 75 %. Alueella on jo Keravan Energian kaukolämpöverkko, ja suunnitelmissa on uuden biopolttoaineilla toimivan lämpökeskuksen rakentaminen. Nyt suunnitellun puuhakkeen käytön ohella alueella saattaisi olla potentiaalia esimerkiksi maatalouden ja kotitalouksien orgaanisen jätteen mädätyksestä saatavan biokaasun hyödyntämiselle. Alueellisen lämpökeskuksen koko ja tuotannon tehokkuus vaikuttavat myös olennaisesti siihen, miten bioperäinen kaukolämpö tukee alueen kestävän energiantuotannon imagoa. Kaukolämpöverkon rinnalla alueella on potentiaalia myös pienemmän mittakaavan hajautetulle energiantuotannolle, jossa voidaan hyödyntää maalämpöä erityisesti kallioperäisillä alueilla, sekä aurinkoenergiaa, jota voidaan hyödyntää sekä sähkön että lämmön tuotannossa. Aiemmin mainittu lämmön talteenotto jätevesiverkostosta tarjoaa myös mahdollisuuden alueen sisäisten energiavirtojen hyödyntämiseen. Myös tuulivoima nähdään kustannustehokkaana uusiutuvan sähköenergian lähteenä, mutta tuotannon sijoittuminen Sibbesborgin alueelle ei välttämättä ole tarkoituksenmukaista mm. tuuliolosuhteiden puolesta.

MATERIAALIEN KIERTO JA JÄTEHUOLTO

Sibbesborgissa tavoitteena on olla edelläkävijä jätteen määrän vähentämisessä, materiaalien hyödyntämisessä ja kierrätyksessä. Tavoitteeseen pääseminen edellyttää, että perinteisesti jätteeksi mielletyt materiaalit nähdään mahdollisuutena, ja mietitään myös, miten materiaalien kulutusta voidaan vähentää ja toisaalta tehostaa lajittelua, jolloin hyödynnettäväksi kelpaava materiaali saadaan talteen. Käsittelykeskuksissa tulisi huomioida teolliset symbioosimahdollisuudet eri jätemateriaaleista ja sivuvirroista. Materiaalien kierrossa tulisi huomioida sekä kotitalouksissa että rakentamisessa syntyvät materiaali- ja jätevirrat. Lajittelemalla rakentamisesta syntyviä jätevirtoja, luodaan mahdollisuus uusille innovaatioille ja tehostetaan materiaalihyödyntämistä. Jätehuollon järjestämisessä tulisi lisäksi selvittää energiatehokkaiden keräysjärjestelmien, kuten imukeräyksen mahdollisuutta. Pitkällä tähtäimellä myös orgaanisen jätteen hyödyntäminen esim. biokaasuksi voisi olla mahdollista.

SUOSITUKSET JATKOSUUNNITTELUN POHJAKSI

Teknisten järjestelmien suunnittelussa ollaan pitkälti vielä konseptitasolla, mutta tunnistetut mahdollisuudet antavat arvokasta lähtötietoa jatkosuunnittelun pohjaksi. Työssä on tunnistettu järjestelmien tilavaraustarpeita sekä muita alueelliseen rakenteeseen vaikuttavia tekijöitä, jotka tulisi huomioida aluesuunnittelussa. Selvitysraportti myös antaa hyvän yleiskuvan teknisten järjestelmien jatkosuunnittelun vaatimista selvityksistä ja alueen erityispiirteistä sekä Sibbesborgin ekotehokkaiden teknisten järjestelmien suunnitteluun vaikuttavista keskeisistä tekijöistä.

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1. SUSTAINABLE TECHNICAL SOLUTIONS FOR URBAN DEVELOPMENT

1.1 Overview of Sibbesborg regional plans and strategies

Sibbesborg development policy is based on Sipoo community master plan (2009) and regional plans of Uusimaa Regional Council, the regional authority of the Helsinki metropolitan area. Sibbesborg is a large-scale area development project which aims to respond to the needs of the growing metropolitan region, and also to help establish a goal-oriented and sustainable pattern for the growth of community structure. It represents a drastic change both in community structure and planning practice, for the project is seeking to develop the urban design practice in a wider scope.

The area development project is based on the results of the open international planning competition for sustainable community, organized in 2011 by Sipoo Municipality (http://www.sibbesborg.net/), as well as several regional strategies and plans. During 2012, a Development Policy for Sibbesborg, sustainability criteria of Sibbesborg and a preliminary study of the eastern extension of metro were conducted on the basis of the competition winning entry.

The Development Policy summarises environmental and local strengths and identity factors. It connects visions to regional plans and strategies. Sustainability criteria gathered views on land use factors affecting sustainability, and customized them into criteria. The criteria functions as a tool for evaluating the plans and for setting guidelines for new solutions. A set of indicators for monitoring compliance with the criteria are also defined. These instruments allow evaluation of the planning projects on different levels, and they also allow exploring whether they do indeed lead to a new, sustainable community in Sipoo. Master plan for Sibbesborg continues the process by combining the premises with developing planning practices and the methods of interaction and communication within planning.

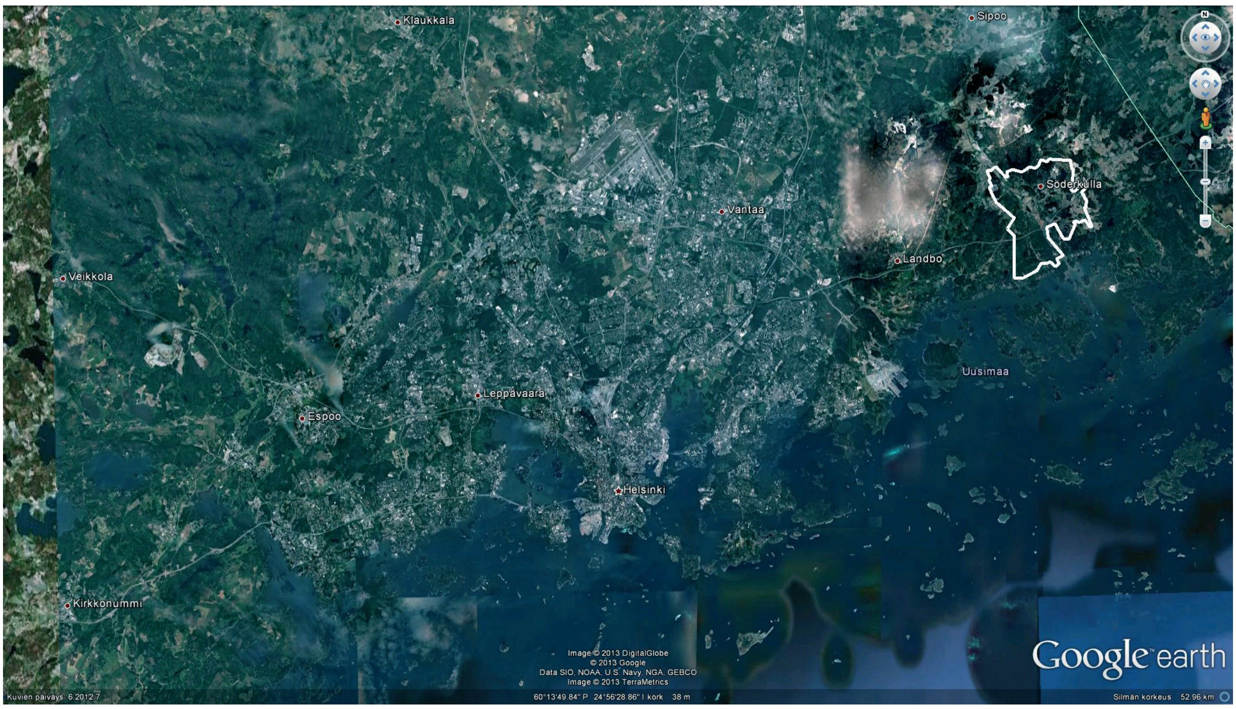

Figure 1. Project area of ”Sibbesborg” in white 20 km east of Helsinki.

Planning phase of the Sibbesborg master plan process started in 2010. Actual master planning section consists of three stages through which the previously described process materializes for precise guidance for urban design and construction.

1. Work packages / creating information needed for concrete plans by carrying out studies parallel to and in interaction with each other
2. Co-design / including planning officials, landowners, enterprises, residents and other stakeholders in the process.
3. Key projects / concretizing co-design efforts into actual plans to be executed. Key projects will be designated on master plan map and instructed with guidelines.

This report provides information on the technical services concepts – work package, which is associated with the first stage of the Sibbesborg master planning. General aim is to identify and utilize interlinkages and synergies between waste management, energy system and water management.

Eco-efficiency work package contains:

- analysis of current energy and water supply, and their future demand in Sibbesborg
- definition of energy and water management strategies based on closed eco loops
- definition of waste management concept for future growth
- designs for storm water management
- workshops with representatives of local authorities and technical personnel

1.2 What is sustainable planning?

In Sibbesborg sustainability is the common ground for all planning. Setting a clear standard in the beginning provides all parties involved in the planning process with a clear mind-set, and enables creative thinking of how best to address the challenges associated with creating a sustainable community structure. The planning process is carried out in close cooperation with all relevant stakeholders, and technical solutions and systems are considered together throughout the process, with the aim of identifying possibilities for realizing co-benefits of integrated design.

Sustainable solutions for water management and services, energy systems and waste management already exist, and many of the solutions are in fact widely used in areal development projects. However, it is still common to consider each individual component of the technical system separately, which may lead to sub-optimisation and overlooking possibilities for synergies between different functions. Consideration of the various interconnections between the systems in the early stages of the planning process enables realizing smart solutions that will result in a more sustainable areal development. Sibbesborg is a large-scale development project, which utilizes a new, integrated urban planning process. The overall goal for the Sibbesborg area is to enable more sustainable, low-carbon lifestyle through environmentally, socially and economically sustainable community structure. Technical solutions create a cornerstone towards such development.

1.3 Key components of the technical solutions

1.3.1 SUSTAINABLE WATER ENGINEERING

A sustainable water system is, above all, highly reliable and energy efficient. In order to achieve a reliable water supply system, there is a need to ensure that the water demand in the planning area is met under all circumstances, even in case of a pipeline break. It is therefore a prerequisite that water is conveyed to the Sibbesborg area through several connections, and that inside the area, the network forms an interconnected structure consisting of several connections. A water tower is also an important feature when planning a reliable water supply system because it continues to operate in case of a power failure. An energy efficiency water supply is created by controlling the amount of leakage water and by ensuring optimal pressure circumstances. In an efficient water supply network, leakage water is less than five per cent of the water demand. The basic techniques for controlling the amount of leakage water are based on careful construction and correctly timed rehabilitation of the network. Modern smart solutions provide data for water network management and offer means to control the water supply network and detect disturbances in their early phases. Such solutions consist of strategically located metering as part of the water network, as well as metering of the customers with significant water demand through automated reading devices. Basic meter types include flow and pressure meters, but water quality meters are also available. With strategically located meters, water supply network disturbance detection can be enhanced. Optimal pressure conditions are achieved by dividing the network into pressure zones according to the pressure needs. These needs can be influenced by land use planning.

With waste water collection, reliability and energy efficiency is achieved by utilizing gravity in the conveying network. This minimizes the number of waste water pumping stations and in particular minimizes the total volume of pumped waste water. Also the optimal sizing of the network is a prerequisite. Further, it is important to control the leakage storm water that is flowing into the sewer network. With regards to the means for controlling the amount of leakage water in a sewer network, there is a need for careful construction of the network and correctly timed rehabilitation, as well as a need for the utilization of smart solutions for detecting problems and controlling the network. Thermal energy recovery from waste water and sludge is also important, and this process should be emphasized when planning and operating the pumping stations and waste water treatment plants in particular.

1.3.2 SUSTAINABLE ENERGY SYSTEM

A sustainable energy system is a prerequisite when developing sustainable communities. Sustainability is achieved through careful consideration of the possibilities to enhance efficiency throughout the supply chain and end use, including through striving for low-energy demand in housing and infrastructure.

The following corner stones are the basis of the suggested sustainable energy system concept for Sibbesborg:

1. Efficient energy end use
2. Efficiency in all parts of the energy supply chain
3. Closed eco loops; and
4. Local production of renewable energy.

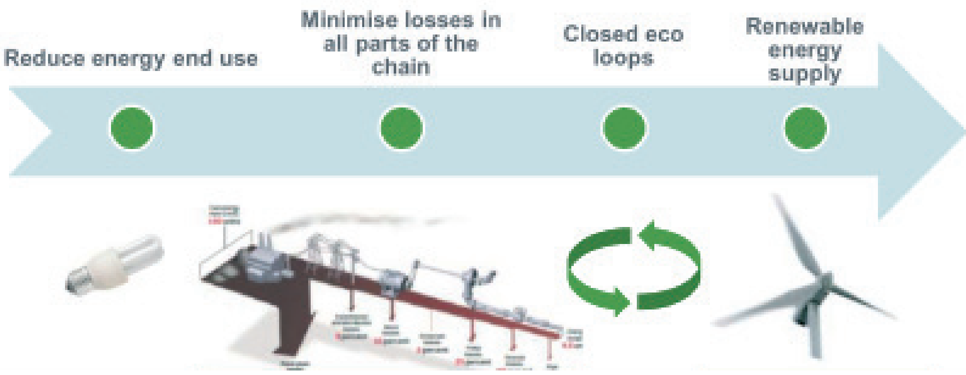

Figure 2: Schematic illustration of the sustainable energy system concept suggested for Sibbesborg.

The planning principles for Sibbesborg aim for creating a building stock consisting of low- and zero energy buildings, and this aim is also well in line with the first prerequisite for a sustainable energy concept with regard to efficient end use of energy. There is also potential for utilizing renewable energy in the area, including the plans of the local energy company to provide bioenergy-based district heating. Several opportunities for utilizing other sustainable energy sources have also been identified. Examples include production of biogas from organic waste fractions and by-products, and recovery of thermal energy from waste water.

1.3.3 SUSTAINABLE WASTE MANAGEMENT SYSTEM

In 2012 (1.5.2012), the regional authority for waste management, Itä-Uudenmaan Jätehuolto (IUJ) published its municipal waste management strategy, according to which it strives to be "the best municipal waste management company and active partner in the field of waste management". The strategy is based on the new waste law in Finland. Currently, IUJ waste management operation area includes 52 000 inhabitants and over 10 000 summer cottages.

IUJ has met most of their early goals of the 2009-2011 strategy, but diverting each extra percentage of the municipal waste from landfill becomes progressively more challenging. Landfill has traditionally been seen as the cheapest and easiest option for waste disposal, but in order to achieve the reductions in waste de-posited to landfill, there is a need to change the way municipal waste is collected and managed. Otherwise, there will be environmental and financial consequences. The waste management authorities as well as present and future households in the area all need to contribute towards realizing the aim of diverting municipal waste from landfill, building on the results achieved to date.
A sustainable waste management concept is built on the well-known hierarchy of waste management, listing the priorities starting with reduction of the amount of waste

produced. Disposal to landfills is only the final option, after all re-usable and recyclable material is separated. In Sibbesborg, the waste management concept follows the waste management strategy of IUJ as well as national guidelines for waste management, with the aim of re-using or recycling 90 per cent of the municipal waste produced, with maximum 10 per cent to be landfilled. For construction waste, the aim for material utilization and recycling is 70 %.

WASTE HIERARCHY
1 Reduce
2 Re-use
3 Recycle & compost
4 Recover energy
5 Dispose in landfills

2. SETTING THE SCOPE

The project area is approximately 2 000 hectares, and there are currently approximately 3 400 inhabitants in the area according to the statistics of the municipality of Sipoo. The landscape is rural, dominated by agricultural fields and small farms. Sipoo river valley and the marine landscape with rocky outcrops along the bay of Sipoo are also typical landscape features defining the area. The area contains many valuable nature sites. The local centre Söderkulla has a more urban structure, with some apartment buildings and detached housing areas. Most of the services and work places in the area are found in Söderkulla. Towards the coastline, there is a large concentration of summer houses. There are currently less than 1 000 workplaces in the area.

The vision for the next 50+ years is to achieve sustainable growth towards an urban area providing housing for approximately 60 000 new inhabitants. The scale and phasing of the growth envisaged is still under scrutiny and will be more clearly defined as the co-design process proceeds. For purposes of this study, the development is divided into two phases. The first phase, which corresponds to approximately 30 000 inhabitants and 5 000 workplaces, reflects the intermediate step in the development of the area, where the new area structure has started to take form, and the second phase, corresponding to approximately 60 000 inhabitants and 22 000 workplaces, reflects the mature stage of development in a more distant future. The municipality has considered an annual population growth rate of 3.5 % to be close to the highest possible rate that can be achieved sustainably, ensuring the provision of all necessary services.

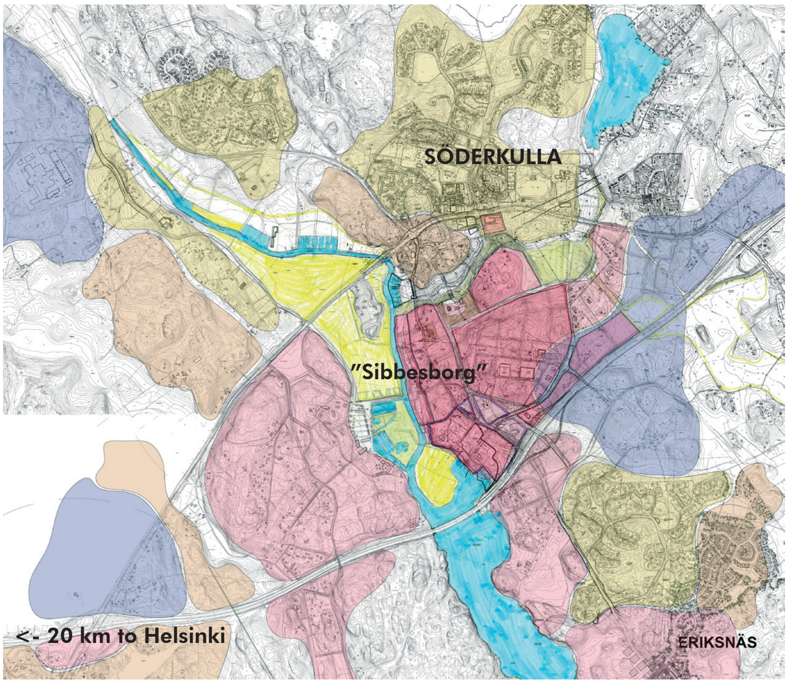

Figure 3. Draft of "vision map" illustrating potential areas for "key projects" (based on competition phase)

The work carried out this far includes creating a development policy and sustainability criteria to the new development taking place in the Sibbesborg area. When considering sustainable technical solutions, striving for closed loop systems and realizing co-benefits to be achieved through innovative solutions are at focus.

In the next section, we will look at the technical requirements, opportunities and challenges with regard to the energy infrastructure and water and waste management and services. This chapter aims to provide an overview of the current status-quo, feeding to the possibilities and understanding of the site-specific issues to be addressed.

2.1 Technical systems at present

2.1.1 WATER MANAGEMENT AND SERVICES

2.1.1.1 Water supply

At present, the water demand in the municipality of Sipoo is about 3 000 m3/d. The municipality of Sipoo is a stakeholder in a regional joint authority for water management, Tuusulan seudun vesilaitoskuntayhtymä (TSV), which is responsible for water supply to the municipality of Sipoo. TSV has reserved 570 l/s of the lake water conveyed through the Päijänne tunnel, from which one quarter (about 13 000 m3/d) is reserved to cover the demand of the municipality of Sipoo. In addition to the artificial groundwater made from lake water of Päijänne, TSV also operates two groundwater plants in Sipoo, in Paippinen and in Marjamäki, where the wells of Nygård are used. The existing groundwater intake in Söderkulla is not in use at present. The permitted water supply capacity is 1 200 m3/d for Paippinen, 900 m3/d for Marjamäki (Nygård wells), and 600 m3/d for Söderkulla. The use of Söderkulla groundwater is limited due to water quality problems and pollution caused by commercial activities in the nearby area. In addition, Arla Ingman Foods operates the Nikukälla groundwater intake that is located in Söderkulla, where the permitted water supply of groundwater is 800 m3/d. Sipoo also purchases small amounts water from the adjacent regional joint authority Helsingin Seudun Ympäristöpalvelut (HSY). In addition, several unutilized groundwater areas are located in Sipoo. In 2007, water demand in the municipality of Sipoo was 214 liters/inhabitant/day. The total length of the water supply network is about 300 km and the average age of its parts is 17 years.

The Sibbesborg area belongs to the Söderkulla pressure zone, which comprises the southern part of Sipoo. Water supply to the Söderkulla pressure area comes from two directions, from Nikkilä in the north and from Landbo in the west. Water coming to the Sibbesborg area from the north flows through skeletal PVC pipe that is 280 mm in diameter (constructed in 1991), and the Broböle pressure increase station (owned and operated by TSV) that has a maximum capacity of 120 m3/hour at the moment. The volume of the Söderkulla water tower is 770 m3, with the lower level of the water table at +62.50 m and the upper level at +68.10 m. This defines the pressure in the area. Water demand in the Söderkulla pressure zone is on average over 1 700 m3/d based on the measurements of the Broböle pressure increase station. This includes the water demands of the Arla Ingman food factory (900 m3/d on average). The water flow to Sipoo from the west comes through a 160 mm PVC pipe that was constructed in 1991, and is only about 250 m3/day. The water supply network is presented in Figure 4.

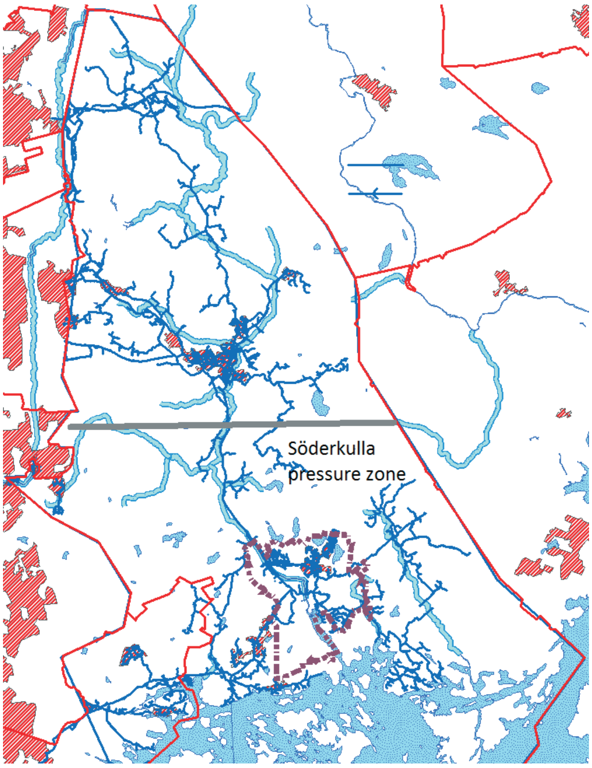

Figure 4. Water supply network in Sipoo at present.

2.1.1.2 Sewerage

At present, all waste water from Sipoo is pumped to the Viikinmäki waste water treatment plant owned mainly by HSY. The municipality of Sipoo has reserved 1.5% of the waste water treatment capacity of Viikinmäki. The total amount of waste water pumped to Viikinmäki in 2007 was about 3 600 m3/d, of which about 2 800 m3/d was invoiced, so on average the amount of leakage water into the sewer network was about 23 % of the total waste water amount. The total length of the sewer network is about 280 km and the average age of its parts is 18 years.

From northern Sipoo, waste water is led to Viikinmäki through the KUVES sea sewer tunnel. From southern Sipoo, waste water is led directly to the HSY sewer network. The northern sewer network is separate from the sewer network in the southern part of Sipoo. The network is presented in Figure 5. In the southern part, the skeletal plastic pressure pipe, constructed in 1991, conveying sewerage to the HSY network consists mainly of PE pipe that is 400 mm in diameter.

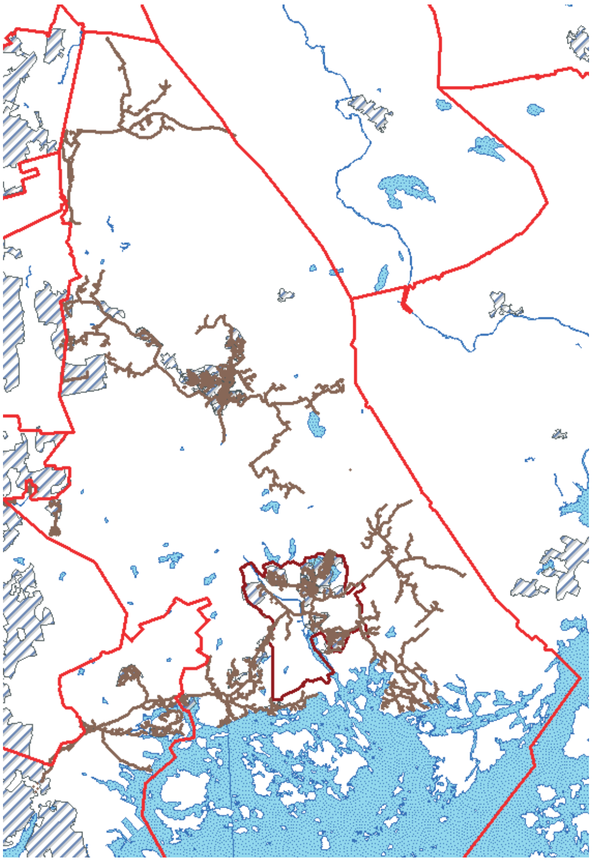

Figure 5. Sewer network in Sipoo at present.

2.1.2 ENERGY

2.1.2.1 Current situation

At present, the project area has a district heating network in Söderkulla, provided by Kerava Energy Ltd, a municipally-owned energy sale, production and distribution company, of which Sipoo owns 3.5 per cent. Their network in Sibbesborg reaches approximately 900 households. There are currently two heating stations in the area, one in Söderkulla (5 MW) and one close to K.Hartwall industrial area south of Söderkulla (9.5 MW). The skeleton of the Söderkulla district heating network at present is shown in Figure 6. The heating energy demand, divided by different household types, is shown in table 1.

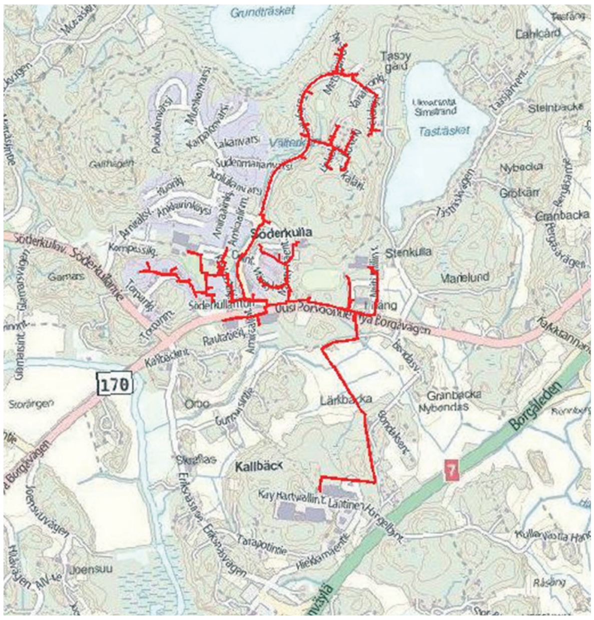

Figure 6. Skeleton of the Söderkulla district heating network.

Table 1. Current energy demand for heating and hot water in Söderkulla. (Source: Keravan Energia Oy)

Type of building	Number of connections	Number of households	Energy provided [MWh/year]
Detached	27	27	563
Multifamily buildings	20	60	4 834
Town houses	12	240	2 057
Other residential build-ings	3	30	761
Homes for elderly	1		959
Municipality offices	1		1 324
Private offices	2		950
Day care centers	3		714
Schools	1		1 796
Sport	2		1 843
Commercial buildings	2		409
Metal industry	1		5 290
Total			21 500

In 2012 the energy demand of existing building stock was 16.2 GWh district heating and an estimated use of 9 GWh electricity. The same year the existing metal industry's district heating demand was 5.3 GWh and an estimate of its use of electricity is 5 GWh. The current energy demand for transport has been calculated to 26 GWh/year. Energy demand for infrastructure (water treatment, street lighting etc.) should be added; infrastructure energy demand has been estimated to be approximately 1 GWh/year (based on experience values from other cities). This adds up to a total energy demand of 62 GWh/year.

Energy demand for travelling has been calculated by using estimated distances travelled by use of different travel modes in the Helsinki region and adjacent areas. These estimates have been gathered from a report by the Finnish Environmental Institute.

Using the classification outlined in the above mentioned report, the Söderkulla area at present could be considered to be a populated community outside a more central populated area with less than 5 000 inhabitants within the greater Helsinki region. The estimated division between transport modes in such a case is shown in Table 2.

Table 2. Estimated average travelling distance for populated areas with less than 5 000 inhabitants and breakdown between different transport modes.

	Transportation mode (% of all travel)						
	on foot	by bike	by car	by bus	by metro	by train	Distance travelled by car (km/person/day)
Populated community outside a more central populated area (<5 000 inhab.)	16%	10%	62%	5 %	0%	2%	44,3

Source: The Finnish Environmental Institute

For comparison, division of transportation mode in an area within Helsinki region, categorized as public transportation zone, is shown in Table 3.

Table 3. Estimated average travelling distance and breakdown between transport modes for Public transportation zone in Helsinki region.

	Transportation mode (% of all travel)						
	on foot	by bike	by car	by bus	by metro	by train	Distance travelled by car (km/person/day)
Public transportation zone, Helsinki region	26%	7%	45%	11%	5%	4%	20,5

Source: The Finnish Environmental Institute

It can be seen, that there is a significant difference in the estimated distance travelled by car (44.3 km/person for Söderkulla at present, compared to 20.5 km per person per day in the public transportation zone). The definition for public transportation zone is as follows:

- Distance from city center over 2 km
- Good or excellent level of service by public transportation
- Frequency of public transportation departures during rush hour is 4-6 departures per hour
- Distance from residential and work areas to closest public transport stop is less than 400 m.

2.1.3 WASTE MANAGEMENT

There are approximately 93 000 inhabitants in the five communities in which Itä-Uudenmaan Jätehuolto Oy (IUJ) operates, namely Porvoo, Sipoo, Loviisa, Askola and Pornainen. In 2011, the households in the IUJ's area of operation produced a total of 80,000 tonnes of waste. Approximately 30,000 tonnes were re-used, and a further 20,000 tonnes were utilized as a fuel for energy production. The remaining 30,000 tonnes were landfilled. Landfilling is increasingly more expensive option for waste disposal, and the reception costs for unsorted waste are generally high compared to sorted recyclable waste fractions. Thus, reduction of un-sorted waste disposed at landfills also creates considerable savings in addition to environmental benefits.

[1] http://www.ymparisto.fi/download.asp?contentid=89856&lan=fi

IUJ as a waste collection authority is responsible for collecting household waste from permanent residents and part-time households (summer cottages). IUJ must also arrange collection of commercial packacing waste commonly known as 'plastic waste'. IUJ is further responsible for organizing recycling and disposal of household waste not collected from households. For this purpose, the waste management company operates household waste recycling centres. Finally, arranging the disposal of the collected waste is also the responsibility of the waste management company.

The waste collected by IUJ is deposited or stored for further treatment at Domargård's waste and recycling centre, which also includes a landfill site for municipal waste. In Sipoo, Mömossen waste and recycling centre receives recyclable household waste, hazardous waste and small amounts of unsorted waste from households. In Mömossen, there is also an industrial landfill, which is used for depositing industrial waste from Kilpilahti industrial area. There are plans to establish a new waste treatment centre in Kilpilahti, which should be in operation earliest in 2016. Part of unsorted waste from IUJ's area of operation is collected and transported to Kotka Energia's waste utilization power plant, which produces district heat, electricity and industrial steam.

At present, there are approximately 1 000 households and 100 summer cottages in Söderkulla served by IUJ. Assuming that there are currently approximately 3 000 inhabitants in Söderkulla, and on average, one person generates 500 kg household waste and 280 kg construction waste, the total amount of household waste generated is approximately 1 500 tons, and the amount of construction waste approximately 840 tons annually. Table 4 below illustrates the current share of recycled and landfilled waste, assuming that approximately 63 per cent of the waste produced is currently recycled or utilized as energy.

Table 4. Calculations of present waste streams in Sibbesborg area for municipal and construction waste.

Inhabitants	Municipal waste [kg/cap,a]	Municipal waste [tot t/a]	Recyclables [t/a]	To landfill [t/a]
3 000	500	1500	945	555
Inhabitants	Construction waste [kg/cap,a]	Construction waste [tot t/a]	Recyclables [t/a]	To landfill [t/a]
3 000	280	840	529	311

At the moment, renovation is the most significant source of construction waste in Sipoo, but the amount of new construction waste is going to be significantly higher once the construction of new detatched housing areas will commence. These estimates utilize outcomes of a study on construction waste conducted in Oulu region in 2007.

3. TECHNICAL SYSTEMS AND ECO-EFFICIENCY MASTER PLAN

3.1 Opportunities for integrated systems

The scale of the planned development in Sibbesborg sets a demand for major up-scaling of the current technical systems. Along with sustainability, smart systems and use of local resources can also create cost benefits. In a major development, careful consideration needs to be given to feasibility of the solutions from technical, financial and environmental point of view. Cost-efficiency throughout the lifecycle is an important factor to be considered when planning innovative and sustainable solutions, as the initial investment costs can be higher for more advanced systems, but benefits accumulate over the lifecycle, often resulting in overall savings in a long term.

Current best practices for many technical systems include striving towards closed-loop systems. They can be conceptualized as a sustainable approach to managing the entire process or production chain so that all material produced as a co-product in the process, or material not entirely used, will be seen as assets and be used as an input into the same or other processes. Thus, material that would generally be considered as waste or by-products can be utilized, simultaneously resulting in cost savings and reduced environmental impact. The cost savings could e.g. be achieved through reduced material costs, transport and energy savings and reduced quantities of waste. Environmental benefits are also achieved through reduced use of primary materials.

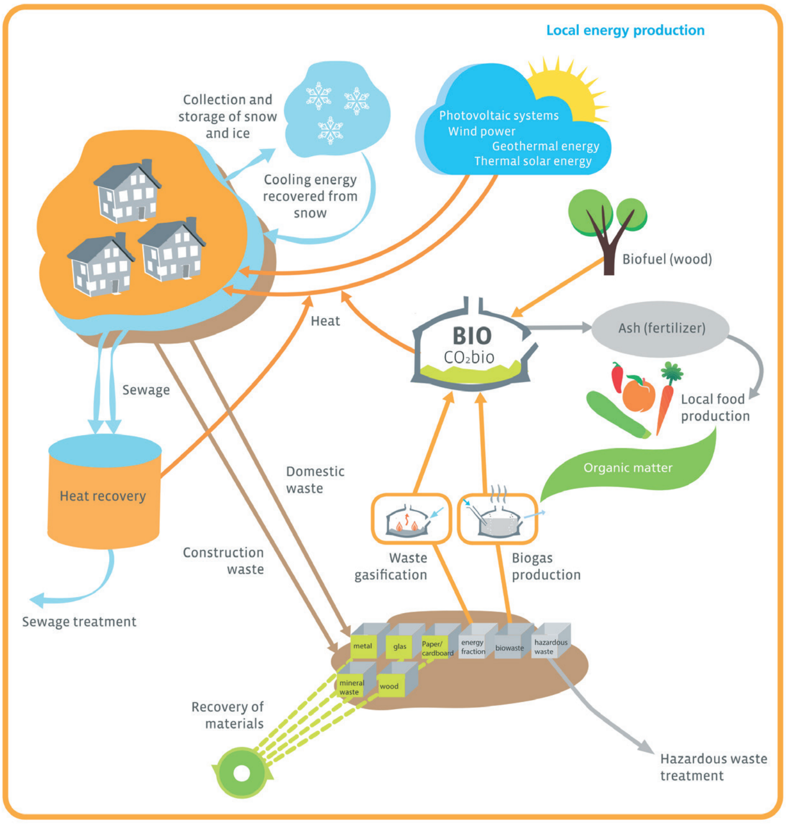

Figure 7. Possibilities for closing the loops and realizing synergies in water management, material circulation and energy production in Sibbesborg.

[2] http://www.ouka.fi/documents/64417/3fec1ade-9298-422f-b7eb-4f30388d26cb

As shown in the figure, several opportunities exist in Sibbesborg for utilizing local by-products and energy resources, supporting the aim of low-carbon society with closed eco-loops. Opportunities exist in particular with regard to sustainable energy management.

3.1.1 BIOGAS PRODUCTION FROM AGRICULTURAL AND DOMESTIC BIO WASTE

Biogas can be produced from biological material through a fermentation process. Technologies for producing biogas are well known and widely used, and biogas can be easily used to replace primary fuels. Furthermore, in addition to avoided greenhouse gas emissions associated with non-renewable primary fuels, a controlled fermentation process of biological material and use of the biogas as an energy source also reduces the amount of methane released to the atmosphere, reducing the global warming potential associated with methane considerably.

In order to estimate the potential for biogas production, a further study of possible sources and estimated volumes of biological material suitable for biogas production could be carried out. Further, the location of such facility should be considered early in the planning process, as there are area requirements associated with such facility. When considering possible locations, the utilization of biogas should also be considered. Possibilities include utilization in energy production, e.g. in production of district heat, in which case the ideal location would be in close proximity to such energy facility.

3.1.2 WASTE WATER HEAT RECOVERY

There are considerable energy saving opportunities associated with recovering thermal energy from waste water. In Finland, the typical thermal energy leak to the sewer is estimated to be 21-24 %, which makes it equal to or higher than the energy flow through the windows (typically 15-25 %) or exterior walls (17-21 %) . Waste water heat recovery can take place within the property, from the sewer network before the treatment or after the treatment in the waste water treatment facility. In Switzerland, specific maps have been produced in several cities indicating areas where utilizing thermal energy of waste water could be economically feasible. In Finland, several waste water treatment facilities recover heat after the treatment, but there are no systems in place yet utilizing heat from the network prior to the treatment. The regional authority for Helsinki Region, Helsingin seudun ympäristöpalvelut (HSY) has commissioned feasibility studies on utilizing heat from the network for example in Marja-Vantaa area.

In Sibbesborg area, one possible location for waste water heat recovery could be in Massby, where majority of the Sibbesborg's waste water will pass through as it proceeds towards the waste water treatment plant according to the current plans for waste water management. In addition to waste water from households, large quantities of waste water from Arla Ingmann production process will also pass through Massby pumping station. The current district heating network in Söderkulla does not reach the planned detached housing areas in Massby, and an alternative local district heating network could be feasible. Such local solution could be recommended in particular if the development would strive for low energy or passive house-standards with regard to their energy consumption. If the heating energy demand in the area is low, it might not be economically feasible to expand the district heating network to the area, and a local low temperature network, utilizing heat pumps to recover heat from waste water and possibly also combined with geothermal energy, could be a more suitable option.

The rough estimate for theoretical potential for heat recovery from waste water at Massby pumping station calculated for the current alternatives for conducting waste water is shown in Table 5. below. In alternative A, all waste water from the Sibbesborg area will pass through Massby pumping station and in alternative B, part of the waste water is conducted via Hitå pumping station. The respective dimensioning flow at Massby pumping station is 320 l/s for alternative A, and 210 l/s for alternative B. Both options include approximately 23 l/s waste water flow from Arla Ingmann. Due to warmer waste water input from Arla Ingmann, the average temperature of waste water has been estimated to be 15 °C. Based on the dimensioning flow and approximation of fluctuations in waste water flow throughout the day, the average flow was estimated to be 168 l/s for alternative A, and 110 l/s for alternative B.

Theoretical potential for recovery of heat was calculated using the following equation:

$$Q = m \cdot c_p \cdot \Delta T$$

where

Q=energy, kJ/a;

m=mass of the waste water, kg/a;

cp= specific heat capacity of waste water, kJ/kg°C;

ΔT= temperature difference (cooling potential), °C

[3] Tekes 2013. Lämpöenergiaa jätevedestä-katsaus nykytilanteeseen ja mahdollisuuksiin. http://www.tekes.fi/fi/gateway/PTARGS_0_201_403_994_2095_43/http%3b/tekes-ali2%3b7087/publishedcontent/publish/programmes/vesi/documents/130210_katsaus_lampoenergiaa_jatevedesta.pdf

[4] Tekes 2013. Lämpöenergiaa jätevedestä-katsaus nykytilanteeseen ja mahdollisuuksiin. See page 31.

Table 5. Estimated theoretical potential for heat recovery at Massby pumping station, if the estimated dimensioning flows are 320l/s for alternative A, and 210 l/s for alternative B. The cooling potential was estimated to be 5°C.

	Alternative A	Alternative B
Average flow [l/s] at Massby pumping station based on typical fluctuation in waste water flow	168	110
Mass of the waste water [kg/a]	5298048000	3468960000
Specific heat capacity, water [kJ/kg°C]	4,19	4,19
Estimated temperature of waste water [°C]	15	15
Heat recovery (cooling potential Δ°T) [°C]	5	5
Potential for recovered heat [MJ/a]	110994105,6	72674712
3,6 MJ=1 kWh; conversion factor [MWh/MJ]	0,000277778	0,000277778
Theoretical potential for recovered heat energy [MWh/a]	30831,696	20187,42

The estimate shows that there is a significant theoretical potential for heat recovery from waste water at Massby pumping station. However, there are several factors which influence the actual heat recovery, including large fluctuations in the flow of waste water. The operating efficiency would also depend for example on the technology used for heat recovery. Waste water network heat recovery systems in networks with similar flow of waste water have already been implemented e.g. in Austria and Germany, utilizing systems comprising of heat exchangers and heat pumps connected to the heat distribution pipeline. The typical payback times for these systems have been in the range of 2-6 years. Even with estimated operating efficiency of 10 % with respect to the theoretical potential, the recovered heat from Massby could cover the annual heat energy demand of 200 -300 detached housing units. Further feasibility study on the possibility for heat energy recovery is therefore strongly recommended, including consideration of possible technical solutions for local heating network for Massby area.

3.1.3 STORED SNOW AND ICE FOR SUMMER COOLING

Cooling and air conditioning has become common in office buildings. New buildings should include careful design with passive building measures to avoid too high indoor temperatures. This is even more important in the future with expected rise of summer temperatures due to climate change. If this isn't done there is a risk that a need for summer cooling will increase also in residential buildings.

Along with district heating networks, district cooling is already provided e.g. in Helsinki, where a heat pump plant produces both cooling and heating in the same process, utilizing purified waste water and sea water. Similarly, snow and ice can be used as a source of cooling energy distributed through district cooling networks. Use of district cooling offers a range of advantages, including:

- Improved energy efficiency from larger systems
- Lower greenhouse gas emissions and no need for ozone-depleting HCFC gasses
- Elimination of noise pollution and esthetics and spatial gains as condensers are not needed
- Improved reliability with more centralized maintenance requirements
- Cost savings through lower investment needs in cooling equipment and lower cost of cooling energy
- Ability to adjust cooling energy provision to meet the changes in demand

Additional benefits are reached through making use of snow removed from streets by the municipality, which is normally stored at separate snow dumping sites or deposited in the sea.

3.2 Description of the concepts

3.2.1 WATER MANAGEMENT AND SERVICES

3.2.1.1 Capacity of the water supply at present

At present, the maximum water conveying capacity to southern Sipoo is about 3 100 m3/day. As there is only one connection with enough capacity to convey water to the customers, any disturbance in water supply exceeding the storage capacity of the water tower will lead to water shortage in the area. Therefore one of the most important priorities in the near future is to increase the water supply to the Sibbesborg area through a new pipeline (Figure 8).

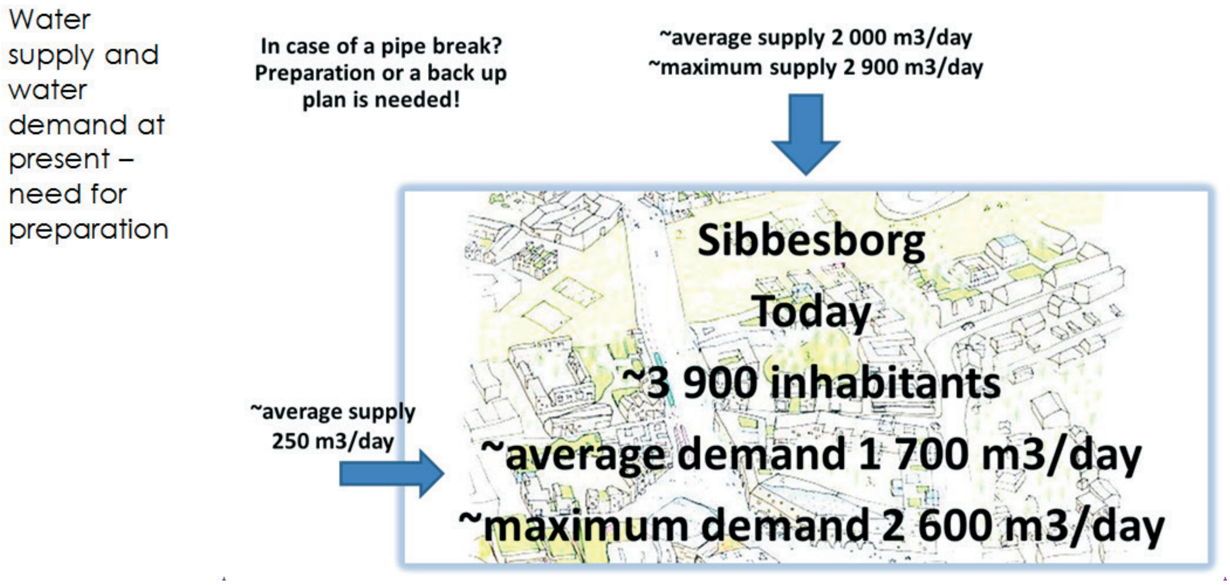

Figure 8. A backup plan is needed to prepare for a possible pipeline break

The largest water demand in the area originates from Arla Ingman and K. Hartwall: their combined water demand is about 1 400 m3/day. If the company-based water demand stays at this level without having demand peaks, the existing water supply capacity would be enough to serve a maximum of 6 000 inhabitants (Table 6). Yet, depending on the diurnal demand pattern and on the level of the water tower, there is a possibility that decreased pressure will be experienced.

Table 6. Water supply and water demand in southern Sipoo

Water supply and water demand in southern Sipoo	
Water demand per day	3 100 m3
Water demand per day - Arla Ingman and K. Hartwall - characteristic water demand per inhabitant per day (includes water demand from public services) - water demand for 6 000 inhabitants per day on average	 1 400 m3 180 l 1100 m3
- coefficient for the maximum day demand (cdmax) - leakage water 10% Total water demand on a maximum demand day	1,5 ~ 100 m3 3 100 m3

3.2.1.2 Capacity of the sewerage at present

The current practice of conveying waste water to the Viikinmäki treatment facility will continue in the future. The dimensioned flow capacity of the sewer pipeline that is connected to the Kallbäck pumping station is about 115 l/s and it will be one of the first limiting factors with regard to conveying waste water from the eastern side of the Sipoonjoki towards Viikinmäki. Waste water conveyed to the Kallbäck pumping station from the eastern side of the Sipoonjoki includes, in addition to the waste water from the planning area, waste water from the Metsäpirtti composting area, and in the near future, waste water from the Kilpilahti waste treatment facility as well as household waste water from the Box and Eriksnäs areas. Assuming that both the overall and peak water demand of the business activity does not increase, the service capacity of the sewer from the Kallbäck pumping station can serve a maximum of 9 000 inhabitants (table 7). Therefore, one of the most important priorities in the near future is to increase the sewerage capacity from the eastern side of the Sibbesborg area, while also taking into consideration the developing neighboring areas.

Table 7. Waste water to Kallbäck pumping station from the eastern side of the Sipoonjoki

Waste water from Kallbäck pumping station through 400 PEH-6 pressure pipe with a flow of 1,1 - 1,2 m/s capacity:	115 l/s
Waste water from households, water demand 180 l/inhabitant/day (includes the water demand from public services) - Box (about 60 m3/day including leakage water into the sewer) - Eriksnäs (town plan for 1 600 inhabitants – about 400 m3/day including leakage water into the sewer) - Planning area (including Söderkulla, altogether 7 400 inhabitants – about 1 800 m3/day including leakage water into the sewer) All households together - about 2 200 m3/day	~ 25 l/s
Waste water from business	3 l/s
- K. Hartwall (90 m3/day, expected 8 to 9 working hours)	23 l/s (max 35 l/s)
- Metsäpirtti (83 m3/hour)	8 l/s
- Kilpilahti (29 m3/hour in the near future)	
Coefficient for the maximum day demand (cdmax), used for household water demand only	1,5
Coefficient for the maximum hour demand (chmax), used for household water demand only	2,1
Total waste water flow to Kallbäck pumping station at maximum hour	~105 l/s (max ~117 l/s)

At present, the Massby pumping station receives all of the waste water from the eastern side of the Sipoonjoki. It also receives waste water from about 500 inhabitants from the neighboring area and from the Arla Ingman food factory. The capacity of the 400 PVC-6 and 400 PVC-10 pressure pipes carrying water forward from Massby to Västerskog is about 130 - 135 l/s (flow about 1,3 m/s). If the number of inhabitants in the Massby area stays near today's number and the waste water flow from Arla Ingman is a maximum of 23 l/s in the day time, the waste water put through the Massby pumping station is about 133 l/s. This amount comes from the following equation: 105 l/s (from the Kallbäck pumping station) + max 5 l/s (from the households at Massby area) + 23 l/s (from Arla Ingman Oy during the day). So, the dimensioned flow is barely enough to serve the projected growth at the eastern side of the Sipoonjoki, where the number of inhabitants is expected to reach 9 000. If the number of inhabitants grows further, the capacity from Massby to Västerskog should also be increased, or other connections for conveying waste water from the eastern side of the Sipoonjoki to Västerskog should be considered.

From Västerskog to Östersundom, the capacity of the 400 PVC-10 pressure pipe is 120 l/s. This figure comes from a 2007 pressure stroke study done by Suunnittelukeskus Oy. If this is still the maximum capacity forward from Västerskog, and if the number of inhabitants in the Västerskog area stays at the present modest level, it will limit the growth at the eastern side of the Sipoonjoki to a maximum of 8 000 inhabitants. To meet the network capacity needs beyond Västerskog, it is recommended that the information on the land use planning in Majvik and Östersundom is checked, but this is outside of the scope of this study.

3.2.1.3 Scenario for water demand and waste water amounts in the Sibbesborg area

The development of the Sibbesborg area is a long process that will take several decades. Figure 9. shows the water demand and waste water growth with the increasing number of inhabitants and business activity. Water demand for households is expected to be 180 l/inhabitant/day including water demand from public services.

As the Sibbesborg area reaches approximately 30 000 inhabitants and 5 000 workplaces, the corresponding water demand will be on average about 9 000 m3 per day, and on a maximum demand day it might be as high as 13 000 m3. The volume of waste water will be on average about 11 000 m3 per day and could be as high as 15 000 m3 on a maximum use day. If the area reaches 40 000 inhabitants, the water demand will be on average 11 000 m3 per day and the amount of waste water will be about 13 000 m3 per day. Due to population growth, there is also a need to increase Sipoo's share of the water from lake Päijänne and/or increase the utilization of ground water resources.

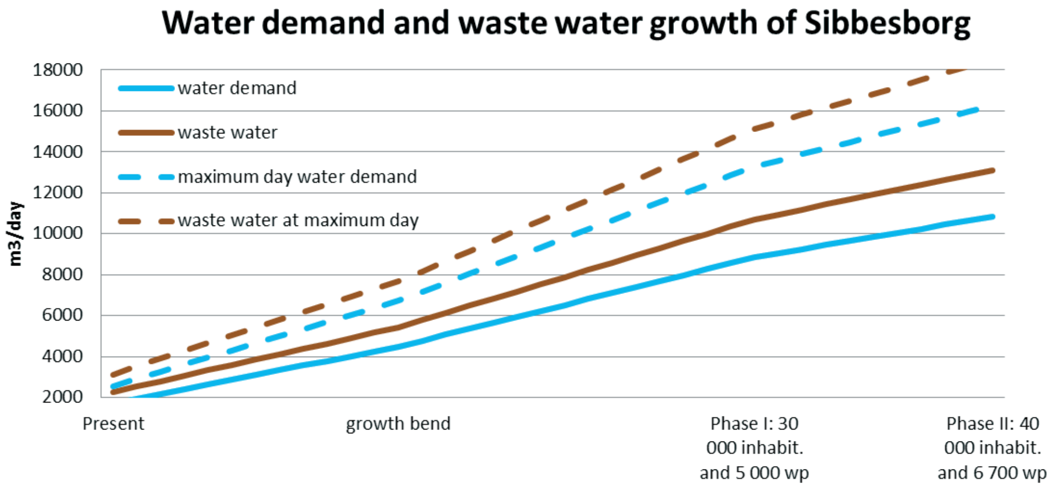

Figure 9. The estimated growth in water demand and waste water in Sibbesborg.

3.2.1.4 Scenario for water demand and waste water amount in the neighboring areas

Together with the development of Sibbesborg, growth is also happening in both the Eriksnäs and Majvik areas. In particular, the Eriksnäs development should be taken into account when planning the technical systems of Sibbesborg, as water to Eriksnäs and waste water from Eriksnäs flow through Sibbesborg. Water use in Majvik has an impact on the final sewer connection conveying waste water to Viikinmäki. In the future, it is likely that most of Majvik's water demand will be covered by the HSY connection.

In Eriksnäs, the current town plan is for 1 600 inhabitants. The Eriksnäs area is to be further developed in the future, and the number of inhabitants in the master plan is estimated to be between 10 000 and 13 000. In Majvik, the plan is for about 10 000 inhabitants and 2 000 workplaces.

3.2.1.5 Possibilities for increasing the capacity for water supply and sewerage

From a preparation or backup plan point of view, it is recommended that water supply capacity is increased. This means that in the future, water is conveyed to the southern Sipoo through at least two or three separate pipelines to secure sufficient water supply. Separate connections should ensure that the water demand is met on an average day, even if there is a break in, or other interruption to, one of the supply lines. There are three separately surveyed possibilities for increasing water supply to the Sibbesborg area and its neighborhoods (Figure 10). Two of these are related to water supply to Porvoo.

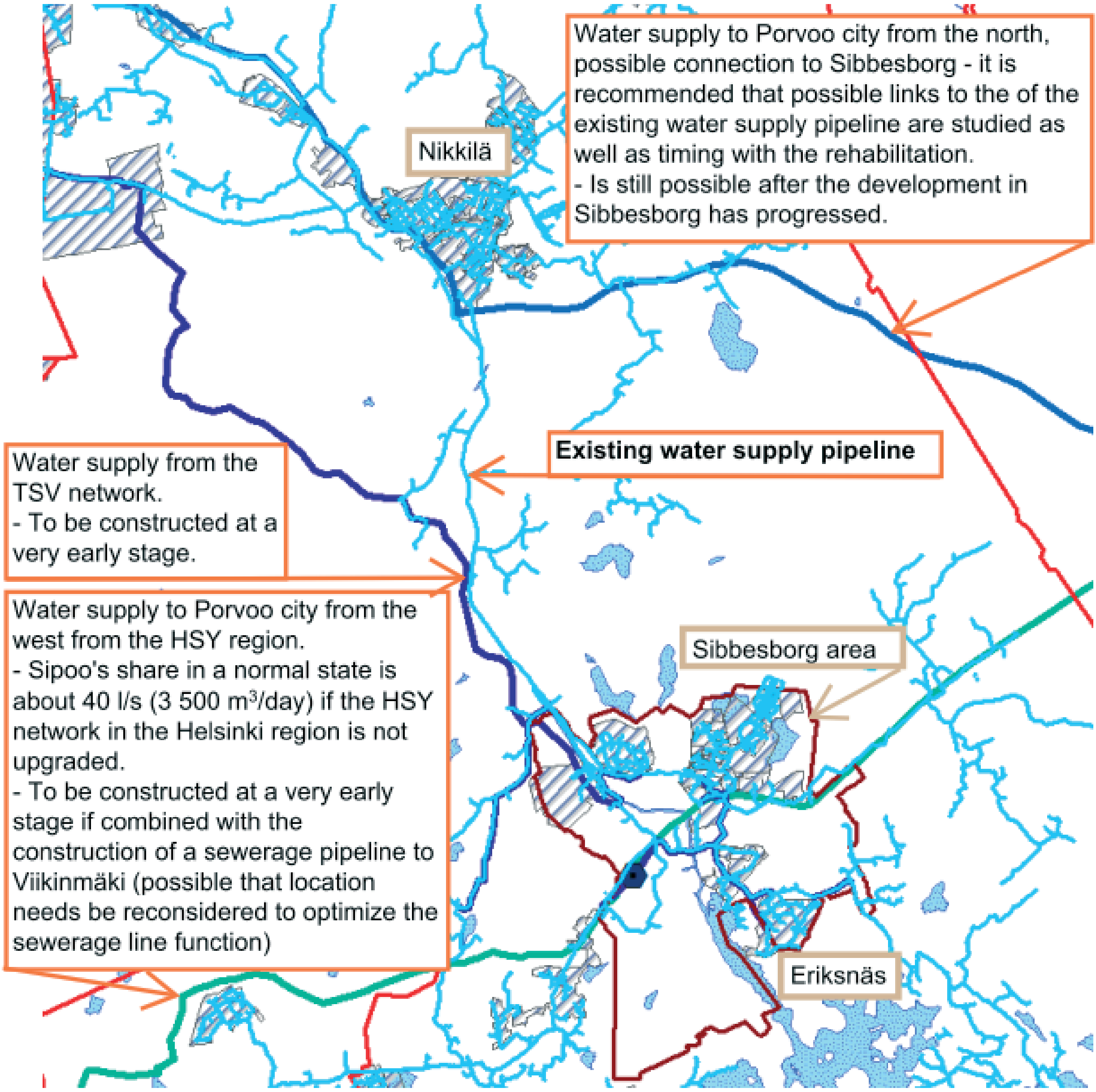

Figure 10. Water supply possibilities to the Sibbesborg area.

The construction of different pipelines is phased in with the growth of the city. At present, there is no alternative pipeline connection to the Sibbesborg area. In case of a break in the pipeline conveying water from the Broböle pressure increase station, water shortage will be experienced after the water stored in the water tower (maximum volume of water 770 m3) is consumed. Thus, the construction of a water supply connection to the area is recommended to be carried out as an upfront investment. As Sipoo is a stakeholder in TSV, it is natural to implement a water supply pipeline from the TSV network. Also, water provided by TSV is low-priced. Two other possibilities are to construct a new water supply pipeline from the HSY network or upgrade the capacity of the existing water supply connection. The study "Vedenhankinnan turvaaminen Helsinki-Porvoo siirtovesijohdolla (24.5.2013)/Pöyry Finland", ordered by Porvoon Vesi, concluded that in normal operation, water supply to Sipoo is 40 l/s (about 3 500 m3/day) without having to upgrade the water supply network in the HSY region. From Sipoo's point of view, it is natural to link this investment with the construction of skeleton sewer pipeline to the HSY region because it is most cost efficient to only excavate one route to the HSY region. Possibilities include using the existing route to add capacity, building new sewerage in an entirely different location, or a combination of both. Because the water supply from the HSY region is limited, and because the price of the water is significantly higher compared to the price of water produced by TSV, a connection to the TSV network is necessary despite the decision made with regard to a new connection to HSY. If water supply is linked to the waste water conveyance, both of these connections should be working before the number of inhabitants reaches 8 000 - 9 000 in the area of Sibbesborg and the neighboring areas of Eriksnäs and Box (Figure 11).

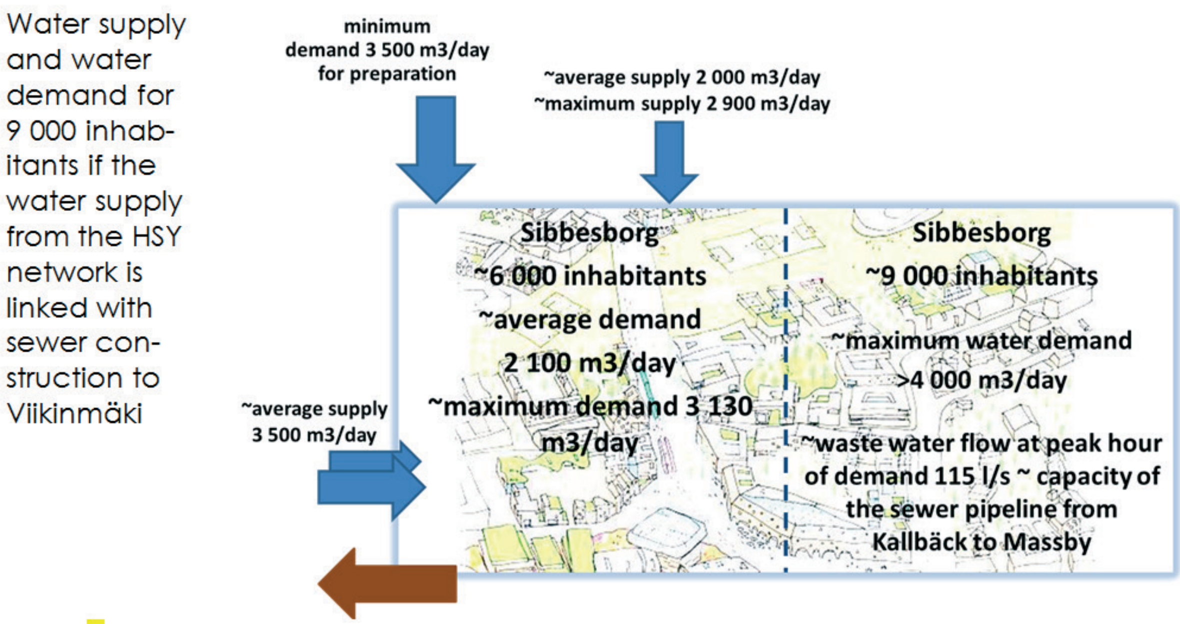

Figure 11. Water supply and sewerage as the number of inhabitants reaches 9 000 in southern Sipoo.

If it is possible to construct both the water supply and the sewerage pipelines at the same time, it would most likely be advantageous from Sipoo's point of view to be part of the water supply line to Porvoo from the west. However, if it is not possible to construct both the water supply and sewerage lines at the same time, it would be advantageous for Sipoo to be part of the water supply line to Porvoo from the north. This is because the northern alignment better serves the entire municipality of Sipoo and because the areas of Nikkilä and Talma are expected to grow in the future. As the number of inhabitants in Sibbesborg grows to 30 000 and the number of workplaces grows to 5 000, water supply from the north needs to be increased further. At some point, it might also be worthwhile considering rehabilitating the existing low capacity pipeline. Construction to the water supply network and rehabilitation of the existing pipeline conveying water to the Söderkulla pressure zone (Figure 12) could be done together.

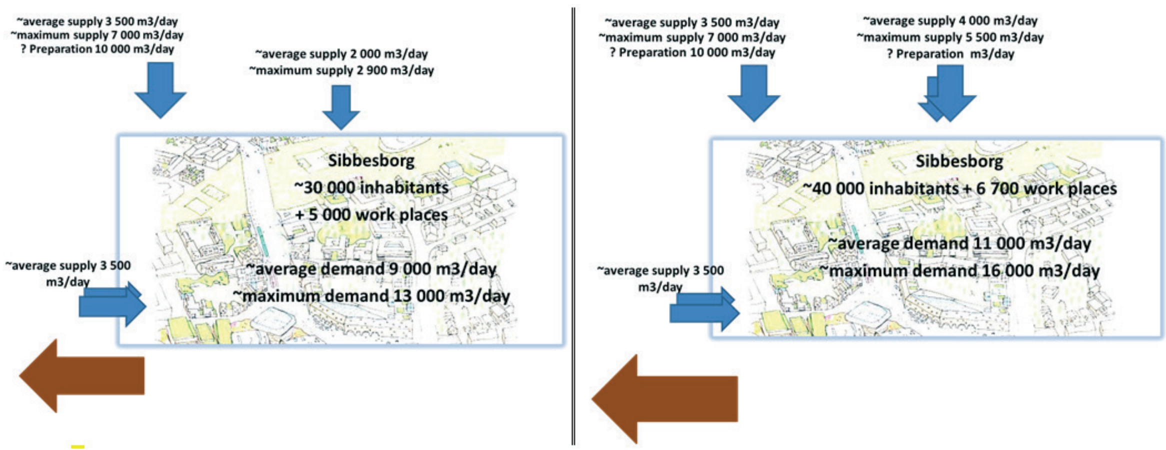

Figure 12. Example of water supply and sewerage in the future with the growing number of inhabitants and business activity.

3.2.1.6 Water supply solutions in the Sibbesborg area

A preliminary skeleton for the water supply network is presented in Figure 13. A reliable water supply is secured through a web-like design of the network. Each separate sub-area is fed from at least two directions. A water tower is needed to accommodate peak demand situations, and it is to be constructed according to pressure needs in the future. As pressure needs come from the height and location of the buildings, as well as from the location of water demand, the dimensioning of the water supply network with a new water tower is recommended after land use planning has proceeded.

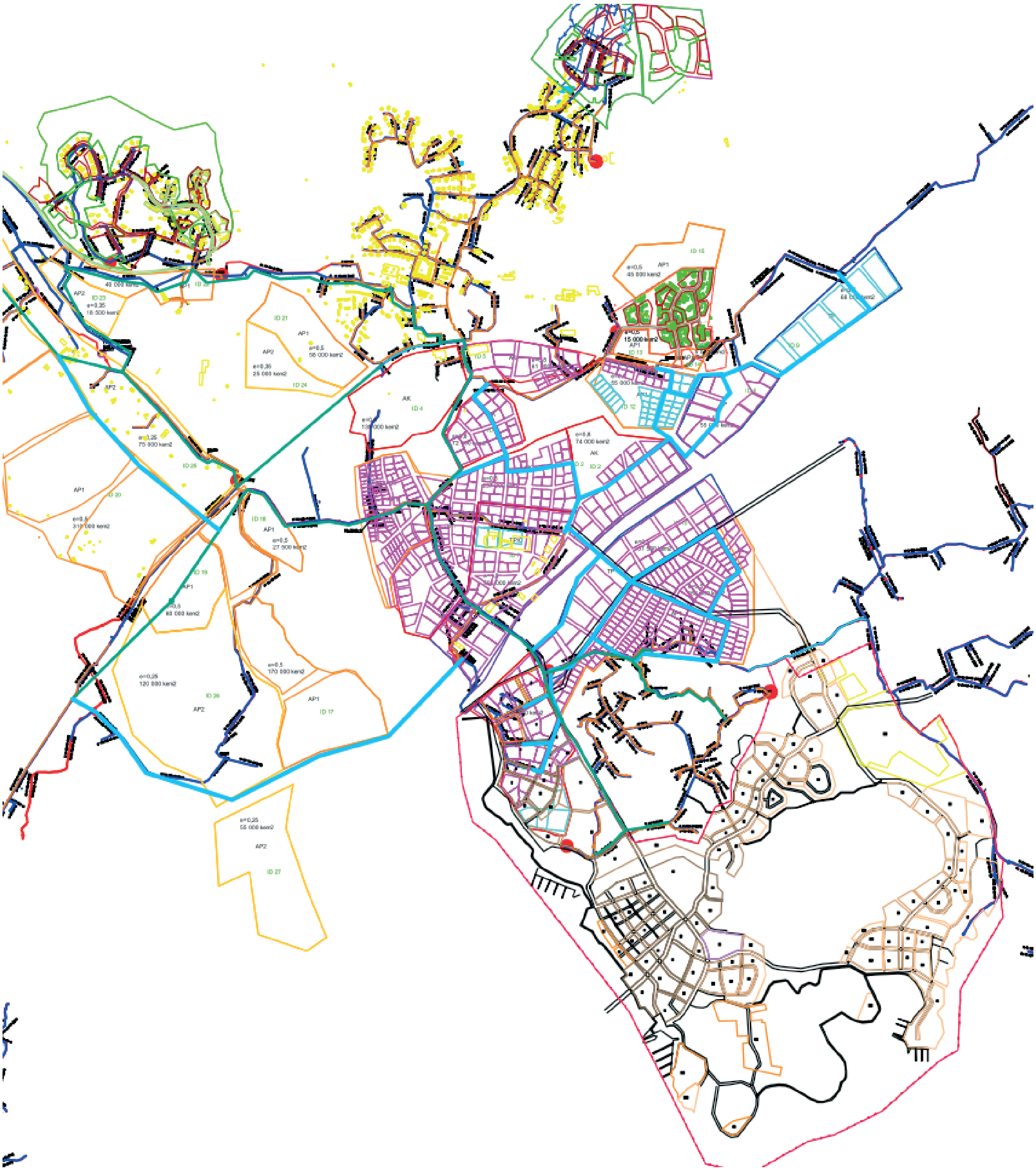

Figure 13. The skeleton layout of the water supply network in Sibbesborg: the blue lines are the existing water supply network, the green lines are TSV plans to enhance the water supply in their part of the network and the light blue lines are recommended skeleton lines to ensure reliable water supply in the future.

3.2.1.7 Sewerage solutions in the Sibbesborg area

Because the aim is to design an energy efficient and reliable sewerage network by minimizing the volume of pumped waste water and the number of waste water pumping stations (by using gravity), the most important parameter to take into account is the topography of the area. Other parameters to consider are soil characteristics and the fit with land use, together with minimizing the length of the network.

At present, all waste water from the eastern side of the Sipoonjoki is pumped through the Kallbäck pumping station across the Sipoonjoki to the western side to the Massby pumping station. In the future, one possibility is to continue to utilize the Kallbäck pumping station to pump all of the waste water from the eastern side of the Sipoonjoki. In this case it would mean that the dimensioning flow could be as high as 240 l/s (Table 8). At the end of Phase II, the number of inhabitants on the eastern side of the Sipoonjoki in Sibbesborg will be about 23 000 and the number of workplaces will be about 6 700, plus the existing inhabitants in the Söderkulla area and the inhabitants in the four new town plan areas in Söderkulla. Waste water from the Sibbesborg area would be on average about 7 300 m3/day in addition to the existing waste water flow and waste water from the new town plan areas. Also, there would be waste water flows outside the Sibbesborg area from Box, Eriksnäs, Metsäpirtti and Kilpilahti.

Table 8. Option I – all waste water is pumped from Kallbäck across the Sipoonjoki through one pressure pipe

Option I – all waste water from Kallbäck pumping station to Massby through one pressure pipe	
Waste water to Kallbäck pumping station	
- number of inhabitants on the eastern side of the Sipoonjoki in the Sibbesborg area is about 28 000 and the number of work places is about 6 700 (including leakage water into sewer)	~ 100 l/s*
- Eriksnäs (town plan for 1 600 inhabitants – about 400 m3/day including leakage water into the sewer) and Box (about 60 m3/day including leakage water into the sewer)	5 l/s
- Metsäpirtti (83 m3/hour) and Kilpilahti (29 m3/hour in the near future)	31 l/s (max 43 l/s)
- Coefficient for the maximum day demand (cdmax)	1,3
- Coefficient for the maximum hour demand (chmax)	1,6
Dimensioning flow	~ 240 l/s*
Total length of the sewer pipe line (approximately)	750 m
Roughly estimated pressure pipe size	630 PE-10*
Roughly estimated lifting height (depth of the Sipoonjoki is not included)	5 m*
Waste water from Massby to Västerskog	
- dimensioning flow from the eastern side of the Sipoonjoki	~ 240 l/s
- number of inhabitants in the Massby sewerage area - 11 200 (includ-ing leakage water into the sewer)	~ 30 l/s
- Arla Ingman food factory with a water demand of 1 300 m3/day, and maximum day time waste water flow of 23 l/s	23 l/s
- Coefficient for the maximum day demand (cdmax)	1,3
- Coefficient for the maximum hour demand (chmax)	1,6
Dimensioning flow	~ 320 l/s*
Total length of the sewer pipe line (approximately)	4 200 m
Roughly estimated pressure pipe size	710 PE-10*
Roughly estimated lifting height	25 m*

*Needs to be recalculated with pressure stroke analysis as the land use planning proceeds and grade levels are measured.

There are also other possibilities to consider. To avoid premature rehabilitation and to create prerequisites for a more reliable network, it is recommended that as the development of the eastern side of the Sipoonjoki proceeds, waste water will be pumped across the Sipoonjoki by two pumping stations. In this scenario, the Kallbäck pumping station continues to operate serving northern parts of the Sibbesborg area, Box, Metsäpirtti and Kilpilahti. In this scenario, waste water flow to the Kallbäck pumping station would increase on average by about 1 800 m3/day in addition to the waste water at present and the four new town plan areas in Söderkulla. According to the land use planning, the Kallbäck pumping station would serve a total of about 12 300 inhabitants and some work places (about 7 300 new inhabitants in the Sibbesborg area as well as approximately 5 000 of the existing inhabitants and the inhabitants in the four town plan areas.

Waste water from the southern parts of Sibbesborg and Eriksnäs would be conveyed to the Sipoonlahti pumping station in the corner of Sipoonlahti and Porvoonväylä and from there, further on across the Sipoonjoki. In this case, this existing Sipoonlahti pumping station is upgraded to pump waste water from the southern parts of the area across the Sipoonjoki, instead of to Kallbäck. With rehabilitation, the relocation of the Sipoonjoki pumping station is also needed according to the development of the neighboring blocks. An upgrade of the pumping station and the existing pipes conveying waste water to the Sipoonjoki pumping station are needed anyway as the growth of Sibbesborg and Eriksnäs continues. So this solution would not increase rehabilitation costs or the number of pumping stations, and more importantly it would decrease the volume of pumped waste water. The waste water amount that would be conveyed to the Sipoonjoki pumping station would be on average about 5 500 m3/day as it would serve approximately 15 700 inhabitants and 6 700 work places in the Sibbesborg area, plus inhabitants in the Eriksnäs area.

Also, the role of the Massby pumping station is to be reconsidered. Will it serve Sibbesborg and the areas behind Sibbesborg altogether or should there also be another pumping station? Waste water from the Sipoonjoki pumping station can either be pumped to the Massby pumping station (Table 9) or to the west to a new Hitå pumping station by the Porvoo motorway (Table 10 and 11). From Hitå, there are two options for conveying waste water to Västerskog. In option III, southern alignment is presented and in option IV, alignment besides the Porvoo motorway is presented (Figure 14). In this scenario, the Hitå pumping station would increase the number of main pumping stations, but it would also enable the flow of waste water from the residential areas of Hitå by gravity and thus the total number of pumping stations would not increase. In the case where the Massby pumping station would be the main pumping station, waste water from Hitå area needs to be pumped there nearly completely. In both scenarios, the receiving pumping station could be the Västerskog station, as is expected in this study. From a sustainability point of view, heat recovery from waste water is strongly recommended. One location to execute heat recovery is the pumping stations. Furthermore, the implementation of heat recovery in the Massby station is ideal because Arla's waste water contains even more heat than waste water from households. If heat recovery is done at Massby, it would be a good choice to convey waste water from the Sipoonjoki pumping station because this would maximize the energy recovery. It is also possible for heat recovery to be done at both Massby and Hitå.

Table 9. Option II – waste water from Kallbäck and Sipoonjoki pumping stations is pumped to Massby

Option II – waste water from Kallbäck and Sipoonlahti pumping stations to the western side of the Sipoonjoki to Massby pumping station	
Waste water from the Kallbäck pumping station to Massby	
- number of inhabitants on the eastern side of the Sipoonjoki in the northern area of Sibbesborg	~ 35 l/s*
- about 12 300, and some work places (including leakage water into sewer)	1 l/s
- Box (about 60 m3/day including leakage water into the sewer)	31 l/s (max 43 l/s)
- Metsäpirtti (83 m3/hour) and Kilpilahti (29 m3/hour in the near future)	1,5
- Coefficient for the maximum day demand (cdmax), used for household water demand only	1,9
Dimensioning flow	~ 130 l/s*
Total length of the sewer pipe line (approximately)	750 m
Roughly estimated pressure pipe size	450 PE-10*
Roughly estimated lifting height (depth of the Sipoonjoki is not included)	5 m*
Waste water from Sipoonlahti pumping station to Massby	
- number of inhabitants on the eastern side of the Sipoonjoki in northern area of Sibbesborg - about 15 700, and about 6 700 work places (including leakage water into the sewer)	~ 65 l/s*
- Eriksnäs (town plan for 1 600 inhabitants - about 400 m3/day including leakage water into sewer)	4 l/s
- Coefficient for the maximum day demand (cdmax)	1,5
- Coefficient for the maximum hour demand (chmax)	2,0
Dimensioning flow	~ 170 l/s*
Total length of the sewer pipe line (approximately)	1 600 m*
Roughly estimated pressure pipe size	500 PE-10*
Roughly estimated lifting height (depth of the Sipoonjoki is not included)	10 m*
Waste water from Massby to Västerskog as in option I	

*Needs to be recalculated with pressure stroke analysis as the land use planning proceeds and grade levels are measured.

Table 10. Option III – waste water from Kallbäck and Sipoonjoki pumping stations is pumped to Massby and Hitå

Option III – waste water from Kallbäck and Sipoonlahti pumping stations to the western side of the Sipoonjoki to Massby and Hitå pumping stations	
Waste water from Kallbäck pumping station to Massby as in option II	
Waste water from Sipoonlahti pumping station to Hitå Dimensioning flow (as in option II) Total length of the sewer pipe line (approximately) Roughly estimated pressure pipe size Roughly estimated lifting height (depth of the Sipoonjoki is not included)	 ~ 170 l/s* 1 300 m* 500 PE-10* 15 m*
Waste water from Massby to Västerskog - dimensioning flow from the eastern side of the Sipoonjoki (as in op-tion II) - number of inhabitants in the Massby area - 9 700 (including leakage water into the sewer)	 ~ 120 l/s ~ 27 l/s
- Arla Ingman food factory with a water demand of 1 300 m3/day, and a maximum day time waste water flow of 23 l/s - Coefficient for the maximum day demand (cdmax) - Coefficient for the maximum hour demand (chmax) Dimensioning flow Total length of the sewer pipe line (approximately) Roughly estimated pressure pipe size Roughly estimated lifting height	23 l/s 1,5 1,9 ~ 210 l/s* 4 200 m* 560 PE-10* 25 m*
Waste water from Hitå to Västerskog - dimensioning flow from the eastern side of the Sipoonjoki (as in op-tion II) - number of inhabitants in the Hitå area - 1 500 (including leakage wa-ter into the sewer) - Coefficient for the maximum day demand (cdmax) - Coefficient for the maximum hour demand (chmax) Dimensioning flow Total length of the sewer pipe line (approximately) Roughly estimated pressure pipe size Roughly estimated lifting height	 170 l/s ~ 4 l/s 1,5 2,0 ~ 180 l/s* 3 300 m* 500 PE-10* 25 m*

*Needs to be recalculated with pressure stroke analysis as the land use planning proceeds and grade levels are measured

Table 11. Option IV – waste water from Kallbäck and Sipoonjoki pumping stations is pumped to Massby and Hitå with a joining sewer to Västerskog

Option III – waste water from Kallbäck and Sipoonlahti pumping stations to the western side of the Sipoonjoki to Massby and Hitå pumping stations	
Waste water from Kallbäck pumping station to Massby as in option II	
Waste water from Sipoonlahti pumping station to Hitå as in option III	
Waste water from Massby to the Porvoo motorway crossing - dimensioning flow from the eastern side of the Sipoonjoki (as in op-tion II) - number of inhabitants in the Massby area - 9 700 (including leakage water into the sewer) - Arla Ingman food factory with a water demand of 1 300 m3/day, and a maximum day time waste water flow of 23 l/s - Coefficient for the maximum day demand (cdmax) - Coefficient for the maximum hour demand (chmax)	 ~ 120 l/s ~ 27 l/s 23 l/s 1,5 1,9 ~ 210 l/s*
Dimensioning flow Total length of the sewer pipe line (approximately) Roughly estimated pressure pipe size Roughly estimated lifting height	 2 200 m* 560 PE-10* 25 m*

Waste water from Hitå to the Porvoo motorway crossing - dimensioning flow from the eastern side of the Sipoonjoki (as in op-tion II) - number of inhabitants in the Hitå area - 1 500 (including leakage wa-ter into the sewer) - Coefficient for the maximum day demand (cdmax) - Coefficient for the maximum hour demand (chmax) Dimensioning flow Total length of the sewer pipe line (approximately) Roughly estimated pressure pipe size Roughly estimated lifting height	 ~ 170 l/s ~ 4 l/s 1,5 2,0 ~ 180 l/s* 1 300 m* 500 PE-10* 35 m*
Waste water from the Porvoo motorway crossing to Västerskog Dimensioning flow (as in option I) Total length of the sewer pipe line (approximately) Roughly estimated pipe size Roughly estimated lifting height	 320 l/s* 2 000 m* 710 PE-10** gravity

*Needs to be recalculated with pressure stroke analysis as the land use planning proceeds and grade levels are measured
** Needs to be recalculated with gradient information, expected 3 ‰

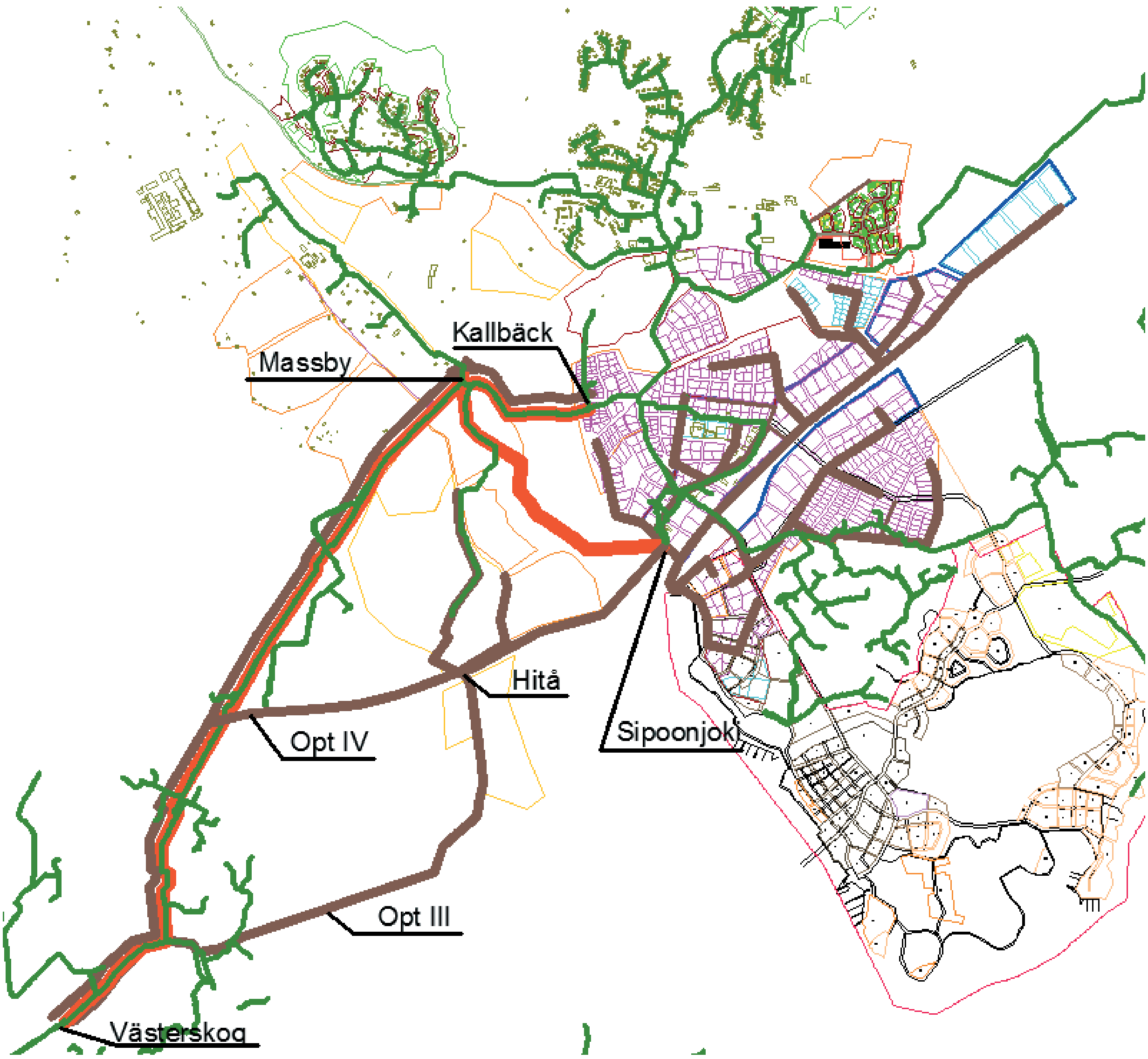

Figure 14. Sewerage in the future for the area of Sibbesborg: green lines are existing sewerage, the red lines are the skeleton sewer pipe-lines in option II, and the dark brown lines are the skeleton sewerage in option III and IV.

COMPARISON OF DIFFERENT SEWERAGE OPTIONS

As planning is more on a preliminary level at this stage, the most important issue is to make approximate decisions which fit in with the operational principles of the municipality. The length and reliability of the network, the volume of pumped waste water, the number of pumping stations, the soil characteristics and the investment and operating costs can be used to compare benefits of different solutions.

The soil characteristics vary from rock and moraine to clay and sludge. The skeleton sewer pipelines are presented on top of a soil map in figure 15. In general, the soil is very similar in all alignments based on the general soil map. It is recommended that detailed soil studies that include drilling and boring be done in connection with the planning. The estimated lengths of the new pipelines in different options are presented in table 12. The investment costs of the skeletal sewer pipelines based on the preliminary information are also presented. The calculated costs are only part of what should be considered because it is more important to minimize the volume of waste water pumped. In particular, pumping the same waste water several times should be avoided because with more pumping, operating costs increase rapidly and the savings in investment costs are lost.

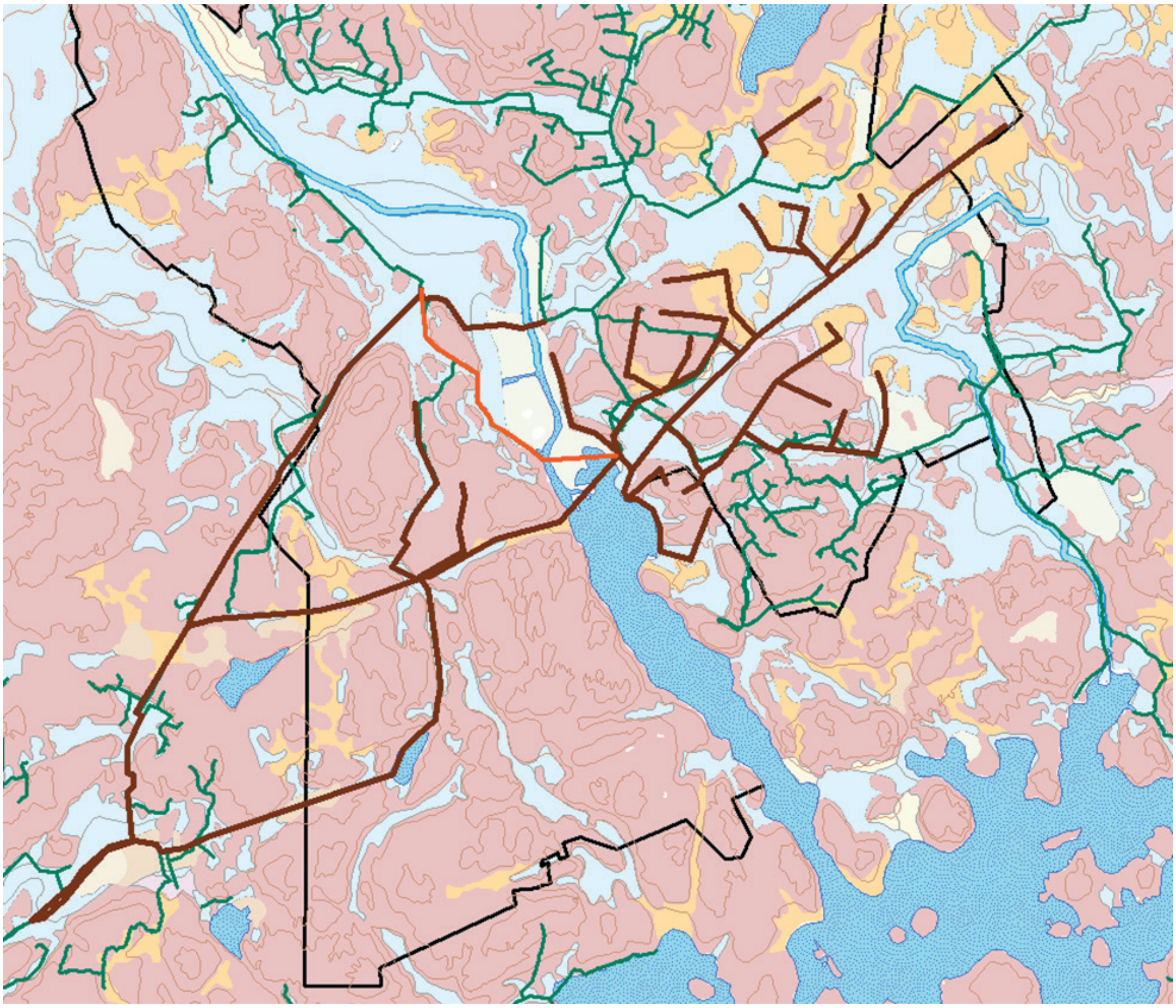

Figure 15. Skeleton sewerage network and related soil types.

Table 12. Preliminary estimated lengths and investment costs of skeleton sewer lines for different options.

Option	total length, m	Pipe sizes, mm and lengths, m	investment costs of skeletal sewer pipelines, milj. eur
Option I	5 000	630 PE - 800 m (subaqua) 710 PE - 4 200 m	4,2
Option II	6 600	450 PE - 800 m (subaqua) 500 PE – 1 600 m (subaqua) 710 PE – 4 200 m	4,9
Option III	9 600	450 PE - 800 m (subaqua) 500 PE – 1 300 m (subaqua) 500 PE – 3 300 m 560 PE – 4 200 m	5,5
Option IV	7 600	450 PE - 800 m (subaqua) 500 PE – 1 300 m (subaqua) 500 PE – 1 300 m 560 PE – 2 200 m 710 PE – 2 000 m	4,8

3.2.2 ENERGY CONCEPT

3.2.2.1 Efficient energy end use

The first priority of a sustainable energy system is a low energy demand. This is a prerequisite, and needs to be based on an efficient energy end-use in buildings, transport and infrastructure. In order to achieve this, buildings, transport and infrastructure need an efficient approach in several ways - design, technology as well as behaviour.

The first step in the work plan is to estimate the future energy demand. For new buildings it is important to produce only high performance buildings with a minimal energy demand. Measures such as very high level of insulation, efficient ventilation systems with high performance heat recovery, and passive design measures for avoiding high indoor air summer temperatures due to insolation are important to implement. It is also important to implement measures for higher energy efficiency when retrofitting the existing buildings.

The industrial sectors energy demand needs to be analysed and measures for an energy-efficient end use needs to be implemented. It is also of utmost importance to reduce the transport sector’s energy demand, both with respect to travelling and transport of goods. A number of measures for improved mobility with reduced need for fossil fuelled transport need to be implemented. Examples include improved bicycle and walking possibilities, improved public transport and car pools.

3.2.2.2 Future Energy demand

The future energy demand of Sibbesborg has been calculated in two scenarios, and for two phases. The first scenario is a baseline scenario (Business as usual) and the other scenario is an ambitious energy efficiency scenario. In phase 1 we have assumed 30 000 inhabitants and 5 000 work places, while in phase 2 we have assumed 60 000 inhabitants and 22 000 work places.

According to the goals for the Sibbesborg one of the planning principles is:

“All buildings are nearly zero energy and use wood as a material, restricting building height to eight floors. “
Thus we have chosen one of the scenarios to be aiming at ambitious energy efficiency. A number of assumptions have had to be made in the calculations. These assumptions are presented in Table 13 next.

Table 13: Assumptions for the energy demand calculations in this project.

	Baseline scenario	Energy efficient scenario
Inhabitants and work places	2013: 3 400 inhabitants and 1 000 working places Phase 1: 30 000 inhabitants and 5000 working places Phase 2: 60 000 inhabitants and 22 000 working places	
Buildings		
Existing buildings	2013: Electricity demand in existing residen-tial buildings has been estimated to be 50 % of the energy demand for heating and tap water. For non-residential buildings the electricity demand has been estimat-ed to be 60 % of the energy demand for heating and tap water. Between phases 1 and 2: The energy demand for heating will be 20 % more efficient when entering phase 2than the current situation. EU directives, introduction of new technologies undertaking a share of the profitable energy-efficiency measures while major renovations are carried out, and changed heating demand due to the ongoing climate changes are assumed to be the drivers. (10 % phase 1 and 20 % phase 2). Electricity demand is assumed increase with 10 % during the period. (no assumed change by 2020, 2 % increase by 2025	2013: As baseline scenario Between phases 1 and 2: Heating demand de-creases by 30 %, electricity demand is maintained at 2013 level throughout the period.
New buildings	Phase 1: New residential buildings are as-sumed to have a total energy demand of 150 kWh/m2 and year, of this 30 kWh/m2 is ex-pected to be electricity. Built area: 50 m2/capita New non-residential buildings are assumed to have a total energy demand of 140 kWh/m2 and year, whereof electricity is expected to stand for 40 kWh/m2 and year. Built area:20 m2/capita Phase 2: New residential buildings are as-sumed to have a total energy demand of 120 kWh/m2 and year, of this 30 kWh/m2 is ex-pected to be electricity. Built area between 2025 and 2050: 25 m2/capita New non-residential buildings are assumed to have a total energy demand of 120 kWh/m2 and year, whereof electricity is expected to stand for 40 kWh/m2 and year. Built area between 2025 and 2050: 6 m2/capita	Between phases 1 and 2: Passive houses and smaller working place area per capita com-pared to baseline scenario. Phase 1: New residential buildings are assumed to have a total energy demand of 45 kWh/m2 and year, of this 20 kWh/m2 is expected to be electricity. Built area: 50 m2/capita New non-residential buildings are assumed to have a total energy demand of 50 kWh/m2 and year, whereof electricity is expected to stand for 20 kWh/m2 and year. Built area:12 m2/capita Phase 2: New residential buildings are assumed to have a total energy demand of 30 kWh/m2 and year, of this 15 kWh/m2 is expected to be electricity. Built area between 2025 and 2050: 25 m2/capita
Transport		Transports 20 % more energy efficient in phase 2. Efficiency increases throughout period. 2013: Same as baseline scenario Phase 1: 10 % more efficient than baseline 2013 calculated transport energy demand Phase 2: 20 % more efficient than baseline
		2013 calculated transport energy demand

Industry	Throughout the whole period from current situation to phase 1; Electricity demand has been estimated to be of the same order as energy demand for heating and tap water. Industrial energy demand is assumed to be maintained at the same level throughout the whole period	Industrial energy demand 20 % more energy efficient by phase 2. Efficiency increases throughout period. 2013: Same as baseline scenario Phase 1: 10 % more efficient than baseline 2013 industrial energy demand Phase 2: 20 % more efficient than baseline 2013 industrial energy demand
Infrastructure	Based on experience values from similar areas. 2013: 1 GWh/year Phase 1: 12 GWh/year Phase 2: 18 Wh/year	Increasingly energy efficient (compared to baseline) throughout the period. 2013: 1 GWh/year Phase 1: 7 GWh/year Phase 2: 9 Wh/year

The results of the calculated energy demand for Sibbesborg are presented in Tables 14 and 15. It is also shown in Figures 16 and 17.

In the baseline scenario the total energy demand is expected to increase rapidly throughout the whole period. The total energy demand for phase 2 has been calculated to 597 GWh in the baseline scenario. Energy demand for buildings will increase significantly over the period. Transport energy demand is expected to be seen to initially grow dramatically, but then grow slower towards the end of the period. This slower development is due to assumed change in travelling patterns (due to the larger size of a city district by the end of the period). Industrial energy demand is in this scenario expected to maintain at the same level, and energy demand for infrastructure will grow in proportion to the increased population.

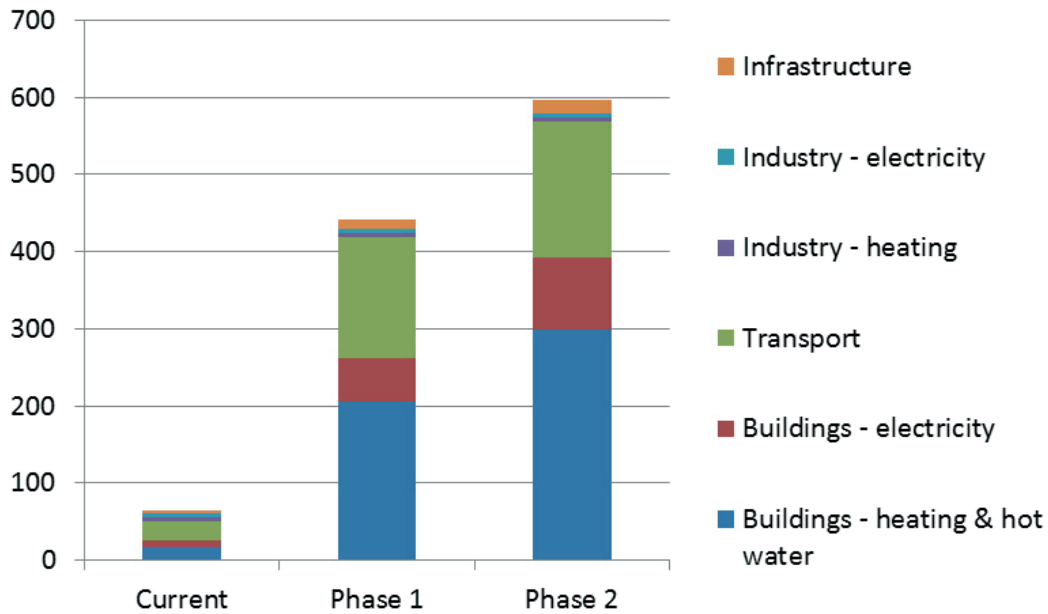

Figure 16: Estimated energy demand in the baseline scenario for Sibbesborg.

In scenario 2, the ambitious energy efficiency scenario, the total energy demand is calculated to be 285 GWh in phase 2. This is approximately half the energy demand of the baseline scenario.

Energy demand in buildings is assumed to grow, but at a moderate pace compared to the baseline scenario. This moderate energy demand growth is thanks to energy efficiency measures in the existing building stock and the implementation of passive house standard for the new buildings. Transport energy demand is expected to be growing faster than the buildings' energy demand, and is of significant importance for the energy system as a whole. The decrease in transport energy demand towards the later period is expected to occur due to changes in transportation needs linked to size of town (from small community to large town) , better mobility management with improved public transport, more energy efficienct vehicles, individual choices of transport modes etc. Industrial energy demand is expected to decrease, and the infrastructure's energy demand is expected to moderately grow.

It should be noted, that the calculated total energy demand for phase 2 in this scenario is merely 13 per cent larger than the calculated phase 1 total energy demand. The primary reason for this is that the increasing building energy demand is lower than the decreasing transport sector energy demand in this scenario.

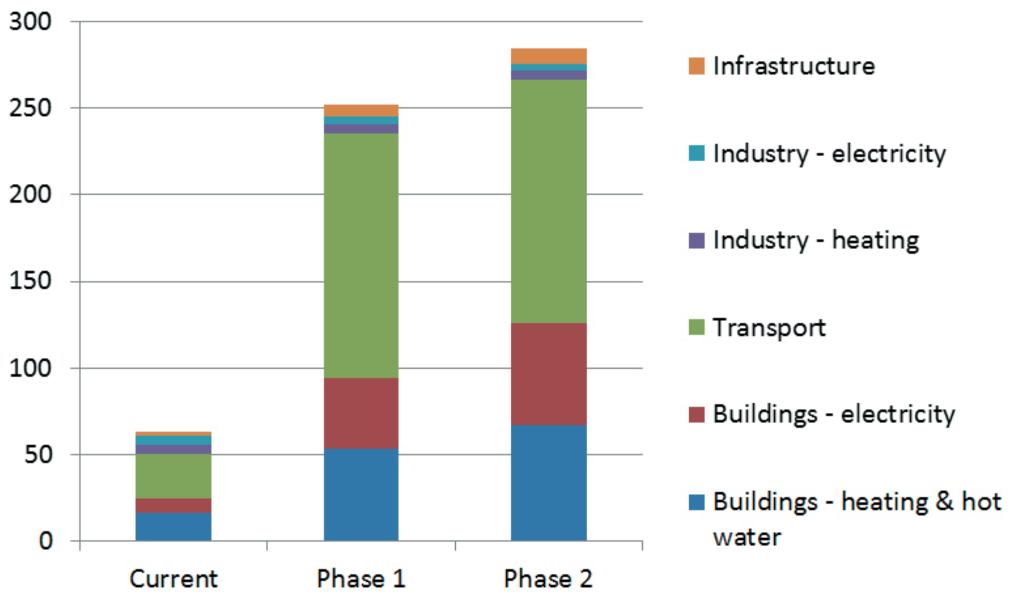

Figure 17: Calculated energy demand – ambitious energy-efficiency scenario - for Sibbesborg.

Table 14; Calculated energy demand – baseline scenario - for Sibbesborg.

Scenario 1	Current	Phase 1	Phase 2
Buildings - heating & hot water	16,2	204,6	298,0
Buildings - electricity	8,7	57,9	95,0
Transport	25,7	157	175,1
Industry - heating	5,3	5,3	5,3
Industry - electricity	5,3	5,3	5,3
Infrastructure	1,0	12,0	18,0
Total energy demand	62,2	442,1	596,6

Table 15: Calculated energy demand – ambitious energy-efficiency scenario - for Sibbesborg.

Scenario 2	Current	Phase 1	Phase 2
Buildings - heating & hot water	16,2	53,3	66,9
Buildings - electricity	8,7	40,7	59,3
Transport	25,7	141,3	140,08
Industry - heating	5,3	5,3	5,3
Industry - electricity	5,3	4,77	4,24
Infrastructure	1,0	7,0	9,0
Total energy demand	62,2	252,3	284,8

[5] See typology in the Finnish Environmental Agencies assumptions for transport needs an modes due to city size.

3.2.2.3 Energy demand and primary energy

It is also important to analyse the primary energy demand, not only the energy end use. Consideration of primary energy also takes into account the natural resources used in production of energy. The 2012 instalment of the national building code of Finland is a first performance-based code that requires a mandatory energy frame calculation resulting in the expected monthly final energy consumption. The established E-factor (E-luku) is an energy weighted factor, which also takes into account the source of the purchased energy through an energy factor which also reflects the relevant primary energy factors specific to Finland, although other factors have also influenced the values set for different sources of energy.

The Finnish energy carrier factors are weighted against the energy carrier factor of fossil fuels, which is set to be 1. The current energy carrier factors used for determining the allowable energy consumption of the buildings are 0.5 for use of renewables, 0.7 for district heating, 0.4 for district cooling, and 1.7 for electricity . The allowable final energy frame of a building is set to kWh/m2/pa and depends on the type of the building. Primary energy-based calculation of the weighted energy performance was chosen, as it was seen to be a more efficient way to support energy efficiency improvements than for example a CO2-based performance factor. There are some deviations in use of primary energy, for example typical European primary energy factor for electricity production is approximately 2.5, but in Finland, the value is lower due to the efficiency of energy production, influenced for example by a higher share of cogeneration of electricity and heat when compared with the European average. Further, energy carrier factors are only used for energy purchased, so the factors are not used for energy produced using building-based solutions such as solar-driven electricity production using photo voltaics.

Furthermore it is important that all chains in the energy supply chain are efficient – from extraction of fuels, to heat and electricity generation and distribution. Careful design is necessary for the detailed planning of all these parts of the energy system.

3.2.2.4 Closing the eco loops

Closing the eco loops is the third step in a sustainable energy system. One example of the closed eco loops principle is using organic waste for biogas production; another example is heat and power generation using gasified waste, which is produced from energy waste fraction that is not suitable for material recycling. Gasification technology is in use for example in Lahti Energy's new Kymijärvi II combined heat and power production plant, which uses gasified and purified ecogas produced from solid recovered fuel (energy waste). The purified ecogas is suitable for combustion in an ordinary natural gas boiler. The utilization of energy waste has enabled increasing the regional waste company Päijät-Häme Waste Management's utilisation range of municipal solid waste to 88 per cent in 2010 .

With regard to waste water treatment for the Sibbesborg area, Sipoo municipality is planning to continue using Viikki's capacity in Helsinki instead of establishing a new waste water treatment plant in Sipoo. Therefore waste water sludge is not available for biogas production. Nevertheless, it is recommended to consider the possibilities and feasibility for biogas production using available organic material, including bio waste and organic material from households, industries and nearby farms. Biogas is also suitable to be utilized in combined heat and power production, or it can be further refined and used as a fuel, for example to power gas-powered buses used for public transportation.

3.2.2.5 Renewable energy supply

A scenario of energy supply possibilities is the fourth step of the sustainable energy system analysis. Renewable energy sources that can be used in Sibbesborg are e.g. biomass, photo voltaics (PV), CPV, geothermal energy and wind power. In a longer term perspective electricity generation from algae, fuel cells and tidal waves can also be part of the Sibbesborg sustainable energy system. A careful analysis is necessary when designing the energy supply part of the energy system, and it is not possible to design it at this early project phase. But it may be assumed that the major renewable energy sources for the Sibbesborg sustainable energy system will be thermal solar energy, solar electricity production and district heating.

► Thermal solar energy

Thermal solar energy can be recommended for Sibbesborg. But due to the low heat demand during spring, summer and autumn the profitability will probably vary. It may be better to assume that thermal solar energy can cover 50 % of the energy end use for hot water.

► Geothermal energy

Geothermal energy can be described as solar energy stored in the bedrock. As the Sibbesborg area has several outcrops of bedrock, the potential to utilize geothermal energy through an areal heating network may be explored as an alternative or addition to the regional district heating network in areas where the potential is sufficient to meet the demand.

[6] http://paviljonki.fi/sahko2012/Jyvaskyla2.2.2012.pdf
[7] http://www.slideshare.net/cleantechfinland/sustainable-waste-management-in-the-lahti-region-cleantech-lahti-lahti-science-and-business-park-ltd

► PV and CPV

Electricity production from PV (Photovoltaic systems) is recommended for Sibbesborg. Depending on what system boundaries are chosen for the energy system, the total electricity production from PV can vary. If the aim is an energy positive system on an annual basis, where a surplus of electricity can be produced during summer and less electricity during winter, the system will be less costly than if we are aiming for a system which is energy positive at any time. In the following calculations it has been assumed that 20 per cent of Sibbesborg's total electricity demand can be covered by PV.

Concentrated photovoltaic systems (CPV) may be an interesting solution for Sibbesborg in a later phase of the development. Currently this is not a common product on the market, but demonstration projects may show interesting results also for locations in Nordic countries.

► Wind power

Wind power is probably one of the most cost-efficient ways to produce additional renewable electricity. We foresee a significant share of the Sibbesborg energy demand to be covered by new wind power. However, this too includes a system boundary matter to be discussed. Does the new wind power generation have to be placed within the Sibbesborg municipality? Or could it be placed elsewhere but seen as allocated to Sibbesborg as long as it is invested in thanks to Sibbesborg investments?

► District heating

District heating based on renewable energy sources (biomass for example) is recommended for Sibbesborg. A high share of CHP is preferable, as it would increase the electricity production in the area while at the same time cover the heating demand. Definition of a renewable energy source varies between countries, but in Finland wood is considered to be a renewable and carbon neutral energy source. Wood can therefore be recommended as an energy source when aiming at a low carbon society. Of other nationally sourced fuels, peat is not a preferred option, as it is not considered to be a renewable energy source according to the Finnish energy policy, and it also has a very high CO2 emission factor.

Regarding the heat energy demand in scenario 2, it may be an issue that the total heat demand (67 GWh/year) may be too low for a large and efficient CHP. One solution could be that during the establishment of Sibbesborg the CHP could produce heat and electricity for the neighbouring areas as well. This is also a system boundary question which needs to be further analysed in the next project phase.

District heating could of course be chosen even if the CHP option not is used. Should a "traditional" district heating system be chosen, it is strongly recommended to be based on bio energy. By adding another boiler, it's possible to step-wise scale up the current district heat production. It is of importance to design the distribution system taking into account the long-term perspective even if the production system is developed step by step.

3.2.2.6 Sustainable energy production outline for Sibbesborg

Since new energy production is cost intensive, has negative environmental impacts and often needs large land allocations, it is important to keep the energy demand as low as possible. Low energy demand is also the best measure for securing the energy supply, and the most cost-efficient measure to achieve reduced CO2-emissions. It also helps to avoid future risks of increasing energy costs.

Based on the above presented energy demand calculations and discussion on energy supply options a sustainable energy production for Sibbeborg could be as shown in the scenarios outlined here:

SCENARIO 1 – BASELINE

2017:
- Heat demand – Geothermal energy
- Electricity demand
  - 20 % PV
  - 80 % Electricity produced by wind, from the grid

Phase 1:
- Heat demand
  - 80 % district heating based on renewables
  - 20 % Geothermal energy
- Electricity demand
  - 20 % PV
  - 60 % CHP
  - 20 % Electricity produced by wind, from the grid

Phase 2
- Heat demand
  - 80%district heating based on renewables
  - 20 % Geothermal energy
- Electricity demand
  - 20 % PV
  - 60 % CHP
  - 10 % Algaes
  - 10% Fuel cells

SCENARIO 2 - SUSTAINABLE ENERGY SYSTEM
2017:

- Heat demand – Geothermal energy
- Electricity demand
  - o 20 % PV
  - o 80 % Electricity produced by wind, from the grid

Phase 1:
- Heat demand
  - o 70 % district heating based on renewables
  - o 30 % Geothermal energy
- Electricity demand
  - o 30 % PV
  - o 40 % CHP
  - o 30 % Electricity produced by wind, from the grid

Phase 2:
- Heat demand
  - o 80 %district heating based on renewables
  - o 20 % Geothermal energy
- Electricity demand
  - o 30 % PV
  - o 40 % CHP
  - o 10 % Algaes
  - o 20 % Fuel cells

3.2.2.7 Large share of self sufficiency

The aim is that Sibbesborg should be energy self-sufficient to 75 %. When analysing how to achieve this goal it is important to discuss where to put the system boundary. The system boundary choice will have a major impact on cost efficiency, necessary energy demand requirements and choice of renewable energy supply and eco system integration.

3.2.3 WASTE MANAGEMENT CONCEPT

The aim for Sibbesborg is to be at the forefront of waste management innovation and practice. A local waste management target, entitled ”A Greener Strategy for a Greener Future”, sets a challenging goal to reduce waste growth and increase recycling and composting. Achieving these targets would put the regional authority for waste management, Itä-Uudenmaan Jätehuolto (IUJ), and its local partners at the forefront of waste management performance in Finland.

The new waste management strategy for the Sibbesborg area covers the period from 2008 to 2050. Entitled ”from Waste to Resources”, it looks to build on new actions under the IUJ partnership by identifying possible future pathways and by setting even more challenging targets. It represents a paradigm shift in how Sibbesborg as a society should come to view waste as a resource to be valued and used and not simply something to be thrown away. ”From Waste to Resources” will act as a framework for establishing the policies that will guide the development of sustainable waste management in the Sibbesborg area. It presents objectives and actions for waste collection, treatment and disposal that will apply across Sibbesborg, and sets the targets that will be measured.

This strategy remains firmly focused on the municipal waste streams. Work will continue to explore how to establish a link between this strategy and actions to wider waste network (commercial, industrial and construction waste streams).

As regards construction waste, Finland is officially aiming for 70 % material utilization, as set out in EU’s waste directive. The aim for material recycling is to large extent directed at wood-based waste fractions. At the same time, the national energy strategy is aiming to increase forest- and other biomass utilization in energy production. This constitutes a major controversy.

Achieving the targets set by the strategy will also require co-operation with areal planning, if we are to achieve the targets set for reducing the amount of waste through recycling. The strategy identifies what the inhabitants, the public, businesses, schools and others can expect to see with regard to waste management service provision, in order to realize the targets.

Further factors influencing the design on the waste management concept include collection of used packaging, which will become the responsibility of the producers on 1 May 2014. The need for collection points, including their areal density, will be determined in the upcoming regulation. In addition, complementary collection of plastics will be required starting from 1 May 2014. IUJ has also set an aim that by 2016, the deposition of biodegradable waste to landfills is stopped.

3.2.3.1 Main Drivers for Change

Landfilling unsorted and untreated waste represents a missed opportunity. In the waste we send to landfill at present, there are great quantities of valuable materials, many of which are being used up because of society’s over-exploitation, which can be difficult or environmentally damaging to extract in the first place. Over one-third of our municipal waste is still sent to landfill. One third of this amount contains recyclable materials, mainly paper and card, glass, plastics and metals. Organic materials, mostly food waste and also green garden waste, account for another third or more.

European and national waste management legislation is driving forward actions to address these priorities and change our approach to dealing with waste. The key message is to deliver waste management in the most sustainable manner, in line with the waste hierarchy.
This strategy explains our current performance against the levels of the hierarchy and the action needed in the future if we are to meet European, national and regional targets and hopefully exceed them.

► Landfill Directive

One of the main drivers for change for Local Authorities in their management of waste has been the introduction of The European Landfill Directive which places restrictions on the type and quantities of waste that can be landfilled. Specifically it sets limits on the quantities of biodegradable municipal waste (BMW), such as food, card, paper and textiles that can be landfilled.

► National Waste Strategy

The National waste strategy focuses primarily on the management of municipal waste and issues surrounding compliance with the landfill directive.

► Landfill Tax

The tax is charged in addition to the actual cost that landfill operators charge for every ton of waste disposed of to landfill. The rate of landfill tax for municipal waste in 2013 stands at 50 euros per ton.

► Regional Waste Strategy

The Regional Waste Strategy sets out the strategy for managing waste in the Eastern Uusimaa region. It states that the following changes are needed:

- Decrease of landfill gas;
- Increased recycling of construction waste; and
- Increased information related to waste management.

3.2.3.2 Sibbesborg vision and objectives for municipal waste management

Sibbesborg philosophy to drive actions and underpin Sibbesborg's targets for the future is aiming to promote a culture whereby waste is recognized as a resource and there is acceptance of responsibility for minimizing its production and maximizing its recovery. This vision is essential if the partnership area is to maximize the amount of waste that it recycles, composts and recovers and in turn diverts away from landfill.

In order to achieve this vision, the following is needed:

- Recognizing municipal waste as a resource;
- Minimizing the amount of municipal waste produced;
- maximizing the recovery of organic and non-organic resources;
- Dealing with waste as near to where it is produced as possible;
- Minimizing contamination of the residual waste stream;
- Minimizing the amount of waste going for disposal to landfill;
- If landfilling of waste is unavoidable, minimizing its' biodegradable content;
- Effectively managing all municipal waste within the wider waste context;
- Developing local markets and manufacturing for recovered materials;
- Achieve sustainable waste management;
- Developing strong partnerships between local authorities, community groups and the private sector;
- Ensuring services are accessible to all residents.

3.2.3.3 Sibbesborg vision and objectives for construction waste management

With regard to construction waste, Sibbesborg philosophy to drive actions and underpin Sibbesborg's target for the future is aiming to promote a culture whereby:

- Waste is recognized as resource
- Sorting is promoted
- Statistical information from construction waste is improved
- New innovations and concepts to reuse wood-based waste fractions are promoted.

According to an on-going study on construction waste and recycled fractions in Oulu, it can be assumed that out of the construction waste deposited to landfill, insulation materials constitute 28 %, and gypsum 17 %. Both of these fractions could be utilized, if they were separately collected.

Using the conventional sorting model, approximately 57 % of the materials can be reused. In advanced sorting model, the fraction of the construction waste to be deposited to landfill would be 7 %, that is, the recovery rate would be over 90 %.

The optimal recycling model for construction waste would therefore include separate collection of insulation materials, in addition to the fractions listed in §15 of the Waste Act. Separate collection of gypsum has not proven feasible to date, except for gypsum waste originating from construction of new buildings.

In order to achieve the goal set by waste regulations, the wood waste fraction to be utilized as material should be approximately 60 %, which is seemingly impossible at present. To support the statistical information on construction waste, estimated waste amounts and share of recovered fractions, more specific estimates of waste generated in construction of residential buildings and their recovery and utilization rates are needed.

Using the current information on waste fractions as a basis for recycling estimates would require a significant shift from utilization of wood-based waste in energy production towards material recovery and reuse. In order to realize such shift, new innovations and concepts are needed.

In order to achieve this vision, the following is needed:

- Recognizing construction waste as a resource;
- Minimizing the amount of construction waste produced;
- Maximizing recovery of gypsum and insulation materials;
- Dealing with waste as near to where it is possible to reuse;
- Minimizing contamination of the residual waste stream;
- Minimizing the amount of waste going for disposal to landfill;
- If landfilling of construction waste in unavoidable, minimizing its wood content;
- Developing local markets and manufacturing for recovered materials;
- Achieving sustainable construction waste management;
- Developing strong partnerships between local authorities, community groups and the private sector;
- Ensuring services are accessible to all residents.

3.2.3.4 Waste fractions and recyclable materials

As the Sibbesborg area is developing, the need for areal collection points and recycling points, which enable reducing the amount of waste disposed to landfills, are needed within short distances from housing areas. Usually, local collection points for recyclable materials including glass, metals, textiles, cardboard, paper and packaging waste are located adjacent to grocery stores or other facilities which allow for easy access. The general rule is, that one such collection point should be available per every 1 000 inhabitants.

To support recycling also in one-family houses, IUJ is promoting the use of segregated containers which allow collection of four waste fractions. Currently, segregated containers are used for collection of glass, metals, bio waste and combustible waste. IUJ's plans are that by 2020, more than 50 per cent of the properties are served by these four-stream containers, increasing to 70 per cent by 2025. In addition, adhering to the principle of one areal collection point per 1 000 inhabitants, in intermediate development phase (phase 1, 30 000 inhabitants), there is a need for 30 such collection points which have a possibility to segregate seven waste streams. By phase 2 (60 000 inhabitants), there should be 60 areal collection points scattered throughout the area. The collected fractions at these collection points are: cardboard, paper, glass, metals, textiles, packaging, and combustible waste.

In addition, to support efficient recycling, there is a need to establish one new collection and recycling point for bulky household and construction waste, receiving wood, garden waste and other organic waste, furniture, metals and plastics. There is also a need for a material recycling center, receiving lightning, batteries, tires, waste oil and electronic waste. To enable efficient recycling of construction waste, a recycling point is also required for mineral waste (concrete, bricks, stones, gravel, sand and soil).

In table 16 are estimated amounts for municipal waste and construction waste produced by the inhabitants, including estimates based on the strategy with regard to the amount of recycled and re-used amount of waste produced (the goals for phase 1 and phase 2 being 90 % for municipal waste and 70 % for construction waste), as well as the remaining fraction. The possibilities to utilize also the remaining unsorted fraction e.g. as energy and avoid landfilling altogether should be further studied.

Growth of the amount of waste as the area develops is shown in figure 18 for municipal waste and figure 19 for construction waste.

Table 16. Estimated amounts of municipal waste and construction waste. Phase 1 corresponds to 30 000 inhabitants and phase 2 to 60 000 inhabitants.

	Present	Phase 1	Phase 2
Municipal waste [tot t/a]	1500	15 000	30 000
Recyclables [t/a]	945	13 500	27 000
To landfill [t/a]	555	1500	3000
	Present	Phase 1	Phase 2
Construction waste [tot t/a]	840	8400	16 800
Recyclables [t/a]	529	5880	11 760
To landfill [t/a]	311	2520	5040

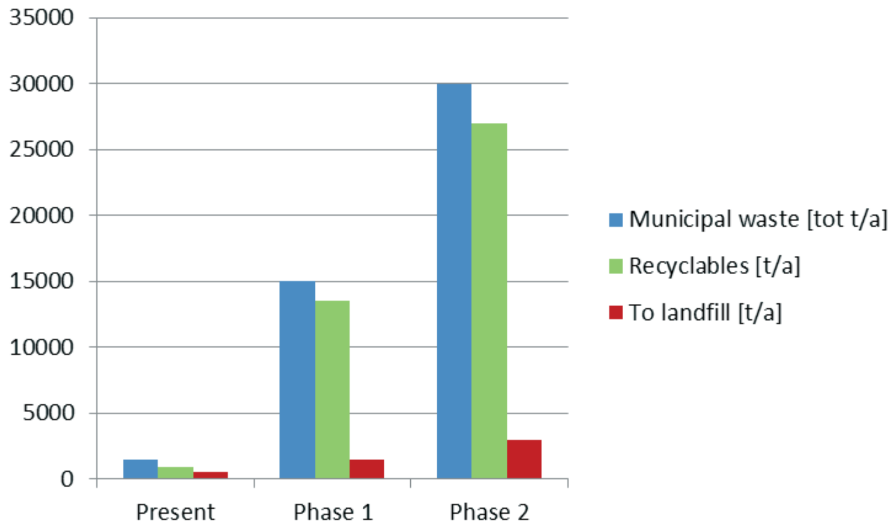

Figure 18: Growth of the amount of municipal waste as the Sibbesborg area develops. Phase 1 corresponds to waste produced by 30 000 inhabitants, and phase 2 indicates waste produced by 60 000 inhabitants, if the average amount of waste produced is 500 kg/ person,pa.

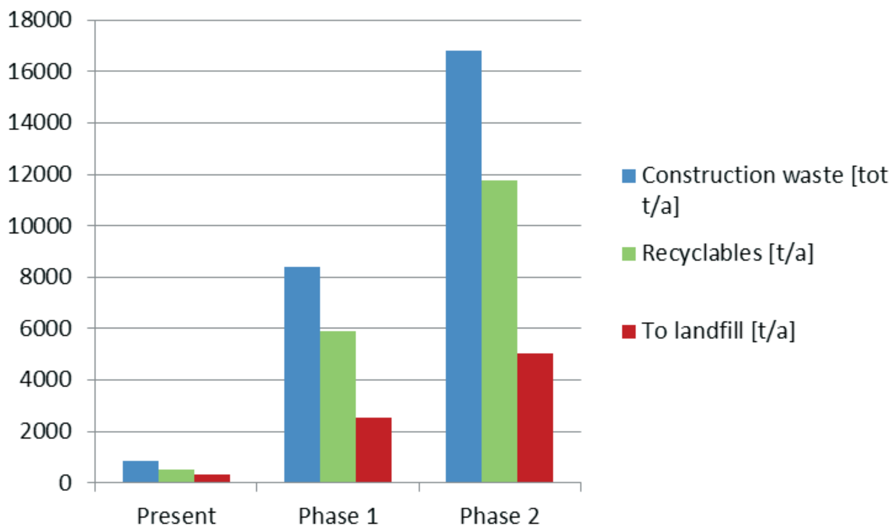

Figure 19: Growth of the amount of construction waste through the development of Sibbesborg area. The average amount of construction waste is assumed to be 280 kg/person, pa.

Table 17.Origin of construction waste produced by private persons for Phase 1 and Phase 2.

Case Sibbesborg

Phase 1				
			Construction waste [kg/person, a]	Total [t/a]
Inhabitants		30 000	280	8400
Demolition	21 %			1764
Renovation	40 %			3360
New buildings	39 %			3276

Phase 2				
			Construction waste [kg/person, a]	Total [t/a]
Inhabitants		60 000	280	16800
Demolition	21 %			3528
Renovation	67 %			11256
New buildings	12 %			2016

According to national statistics, renovation counts for approximately 67 per cent of the total construction waste produced in Finland, excluding mineral waste, while demolition accounts for 21 per cent and new construction for 12 per cent. The case presented in Table 17 shows, that the amount of construction waste from construction of new buildings in Sibbesborg is estimated to be higher during Phase 1, as the construction of new detached housing areas is peaking.

For the estimation of share of recyclable fractions shown in Figures 20 and 21, the information from a study on construction waste conducted in Oulu region in 2007 was used.

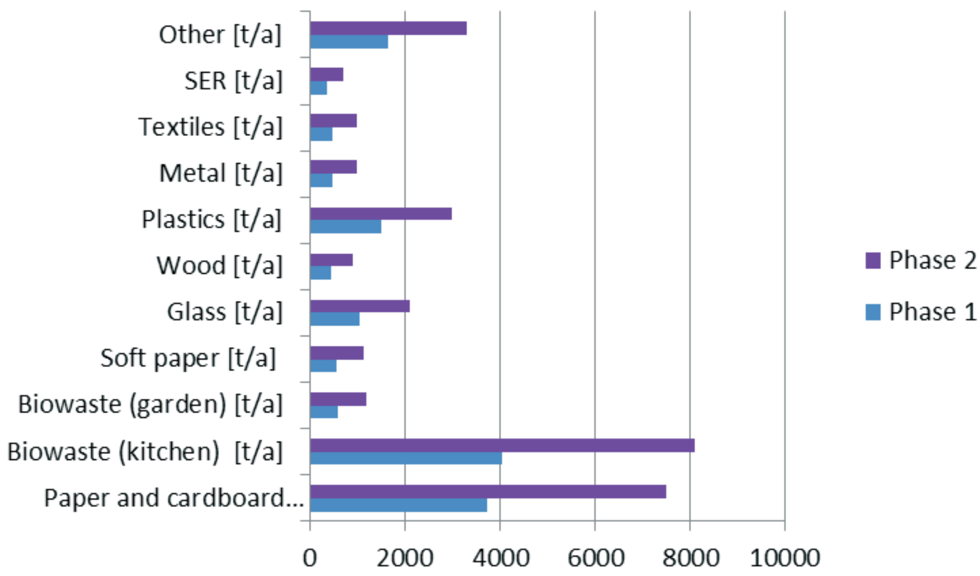

Figure 20: Estimated municipal waste fractions for Phase 1 and Phase 2.

[8] [Reference to study on construction waste carried out in Oulu in 2007]

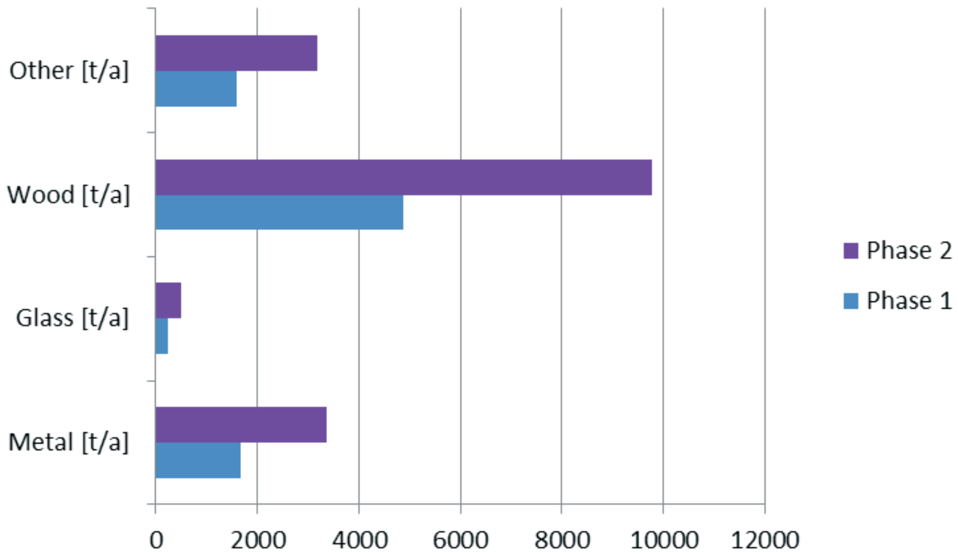

Figure 21: Estimated construction waste fractions for Phase 1 and Phase 2.

3.2.3.5 Possible solutions to enhance sustainable waste management

The local waste management company IUJ has set ambitious targets for increasing sorting of the waste and recycling. It is also aiming to reduce the environmental impact of the waste collection centers as well as the old landfills. It further aims to stop deposition of biodegradable waste at landfills by 2016. The means, as set out in IUJ's strategy up to 2016, include deployment of new, economically efficient low-emission solutions for collecting sorted materials from households.

Material recycling, including utilization of biodegradable waste, requires efficient source-separation of waste fractions. Enhancing the awareness among the inhabitants on how the waste produced in Sibbesborg is sorted and recycled, and showcasing the advantages of recycling through concrete examples, is recommended as part of the sustainable waste management concept. By prioritizing waste reduction and re-use when raising public awareness, the actual amount of waste to be handled can be decreased, generating both economic and environmental benefits also to the inhabitants.

Efficient and low emission technologies for improving source-separation and collection of recyclable materials include for example a suction collection system, which could be an alternative to traditional waste management and collection practices especially in areas with efficient land use, as it allows energy efficient collection of waste e.g. through avoided traffic, as waste can be collected from one collection point, whereas traditional waste collection requires waste collection from each housing unit or facility separately. Further advantages of suction collection system include more efficient use of common space, as areas usually required for waste collection sheds can be used for other purposes. In addition, there is no long-term storage of waste at the premises.

One suction collection network can service between 2 000 - 3 000 up to 10 000 - 11 000 inhabitants [9]. With the present systems, there is a possibility to collect 3-4 different waste fractions. Challenges in Sibbesborg include the topographical variation in the area. Further, most of the investments for a suction collection system are made upfront as the network is constructed, and cooperation would be needed between the municipal authorities, construction of other infrastructure and infrastructure operators, area developers and construction companies and the waste management company.

Deep waste collection containers, which are installed partly underground and enable collection of waste and recyclable fractions from several housing units through to larger storage capacity enable a centralized waste collection in areas where a suction collection network is not a feasible option, but alternatives are required for traditional waste collection. It could be suitable in areas, where a centralized collection can be arranged without compromising the easy access to and closeness of the collection points by the inhabitants in the area.

IUJ's plans also include increasing the capacity to enable energy utilization of all remaining unsorted municipal waste. No matter how efficient recycling and sorting of the waste is, there still remains a fraction that cannot be reused as material. A sustainable treatment option for this fraction is utilization in energy production, and modern technology, such as waste gasification or

[9] Simo Isoaho, TTY: http://www.pirkanmaan-jatehuolto.fi/japo/imukerays_isoaho.pdf

thermal treatment with efficient filtering of combustion gases, allows an environmentally friendly treatment of substances contained in such unsorted waste. Further benefits of thermal treatment of waste include the possibility to recover metals, which would otherwise be lost if the waste was landfilled. In terms of closing the loops through recycling, waste-to-energy plants, when used as part of a holistic sustainable waste management concept which takes into account all steps of the waste hierarchy, are essential, and in case of Sibbesborg, would also enable waste treatment that would not include landfilling.

4. ENABLING SUSTAINABLE SIBBESBORG

4.1 Key objectives and reflections on the technical systems, recommendations for further planning

4.1.1 WATER MANAGEMENT AND SERVICES

Ensuring both sufficient water supply to the Sibbesborg area and sufficient sewerage capacity from the area are the most important prerequisites that enable development in general. In this study, several options are presented for water supply and sewerage. When choosing between different options, it is recommended that the sustainability of the solution is evaluated as a whole. For example, the water supply from the water source (all the way to the Sibbeborg area), the sewerage system with the total pumped volume of waste water (maximizing the utilization of gravity) should be considered.

In the Sibbesborg area, step wise development of water supply and sewerage can be accomplished. It is possible to develop the area in a way that some of the investments can replace rehabilitation of the present networks. Also, flexibility of the water supply can be achieved if there is enough good quality ground water ready to be pumped into the water supply network during the peak demand hours. With modern automation algorithms, the integration of small scale ground water stations can be combined with the water supply network. This is desirable if most of the water needs to be conveyed to Sibbesborg.

The Sustainability of water services in Sibbesborg is related to the objectives for how the water supply and sewerage systems work. In a sustainable water supply network, the pressure circumstances are well managed and no low or unnecessarily high pressures occur. From this point of view, the location and the height of the buildings needs to be considered together in connection with planning and the formation of meaningful pressure areas should be the goal. With modern automated meter reading solutions in the properties as well as the strategically located hydraulic metering of the network, the water supply network can be managed to keep the amount of leakage water under five percent of the total water demand. With sewerage, reliability and energy efficiency are taken for granted. These objectives are achieved by optimizing the size of the network together with well-placed pumping stations. In particular, energy efficiency is achieved through heat recovery, and it is highly recommended that heat recovery is implemented in the large pumping stations. This is particularly important for stations where flows are significant and that are located near heat exploiting buildings. Also it is important to be able to utilize metering and automation to observe waste water volumes, to locate storm water that is leaking into the network, to minimize the pumping energy, and to maximize the benefits of heat recovery.

4.1.2 REFLECTIONS ON THE ENERGY SYSTEM

As the planning process is moving forward, further feasibility analysis should be carried out to determine the best solutions for the planned community structure in terms of source and location of local energy production. Further measures that also support the overall energy efficiency, such as the energy performance of the buildings, and solutions to support sustainable travel, such as safe bike storage at public transportation stops, should be considered in sync with the specific planning of areal functions. Several eco-efficiency measures relevant to efficient use of energy can also be addressed through real estate conveyance protocol and guidelines for construction.

Promising opportunities that would require further analysis include utilization of heat recovered from waste water to cover part of the heat demand in detached low-energy and passive housing areas, which may have too low heat energy demand for traditional district heating solutions. Although there are plans to cover the energy demand in Sibbesborg by using renewable fuel such as wood chips, prior consideration should be given to energy streams that already exist in the area, and would otherwise be left unutilized. The figure 22 shows a summary of the recommendations that relate to further planning of Sibbesborg area.

Strict requirements on low energy demand in new buildings and industry, and on good mobility management solutions are prerequisites for a sustainable development in Sibbesborg. Low energy losses in all chains of the energy supply are also a necessity when striving to achieve a sustainable society. Furthermore, closing the eco loops and renewable energy supply is a prerequisite.

► Advantages and disadvantages of large scale energy production

District heating has many advantages. Among other things it is an efficient means to supply heat, it can be used for simultaneous production of heat, electricity and cooling, it can significantly contribute to decreased CO2 emissions, NOx, SOx, particulate matter and other environmental hazards. But it also has disadvantages. The most commonly mentioned are that there is a need to allocate land for the district heating production plant, both the production plant and the distribution system is investment heavy and district heat is an oligopoly market with a limited degree of flexibility once investments are made. On the other hand, this latter disadvantage of limited flexibility also goes for e.g. heat pumps, geothermal energy, and large scale electricity production. From a holistic perspective bioenergy based district heating must be seen as a good solution.

► Energy system flexibility and possibilities to a step wise development

The energy, heating as well as electricity, demand is low in the initial phase (2017). The energy demand is expected to increase significantly during phase 1 and phase 2 in both scenarios, although at a very moderate pace in the sustainable energy scenario compared to the business as usual scenario. The optimal choice of energy supply system is depending on how large the increase in energy demand will be. Neither of the scenarios have a large enough energy demand to justify a bioenergy based combined heat and power production plant in the initial phase (Phase 1A).

There are clear thresholds to be dealt with when designing an energy system. One example is that the heating demand is estimated large enough at first by the end of phase 1. For this reason a geothermal energy system for heating is seen as a more likely solution during the first part of the development, then followed by a bioenergy based CHP for the latter part of the development. This means that the major part of the Sibbesborg electricity demand will be supplied from the existing grid during the first phase of the area development. Another example of energy system thresholds is local biogas production. This needs to be looked into further if the municipality decides to use the biogas production possibilities.

► Integration of large scale and decentralized electricity production

There are several advantages with combining decentralized (small scale) energy production with smart grids. Such a combination decreases both peak power demand and large scale power supply need. Decentralized PV installations also decrease the necessary large scale grid distribution, and it can enable an easier production control and lower peak load. A system based on several types of energy production would also enable a more flexible system that allows a scaled up production to meet the increasing demand.

► Spatial needs for energy production

The spatial needs for implementing a sustainable energy system in Sibbesborg depend on what scenario is chosen. The most important factor in this respect is what requirements are put on energy demand. The land need for energy production is significantly larger in the business as usual scenario than in the sustainable energy system scenario. The sustainable energy system's scenario has a limited land need for some size installations, for combined heat and power production, Wind power, fuel cells, algae energy production, and possibly solar cells and/or solar thermal energy production. However, these spatial needs are minor in comparison with the spatial need of the business as usual scenario. Parts of the energy production will also be distributed, e.g. PV located on the roofs and facades of the buildings. This also decreases the spatial needs in the sustainable energy scenario.

The spatial need is also significantly smaller in the sustainable energy scenario due to lower share of travelling with private cars. However, in order to achieve this there is a need for a high performance public transport which sets a number of requirement on commuter trains, buses, walking friendly infrastructure, a good bicycle road network, etc.

4.1.3 ACHIEVING THE TARGETS FOR SUSTAINABLE WASTE MANAGEMENT

The waste hierarchy, as defined by the waste framework directive of the EU, is a good tool to guide waste management, and it is also reflected in the strategy of the waste management company Itä-Uudenmaan Jätehuolto Oy. The growth envisaged to Sibbesborg area will create both a challenge and an opportunity for realizing the aims set for improving recycling and sustainable treatment of waste. Investments to new efficient technology and increase of capacity are needed, and economically and environmentally sustainable solutions that support a holistic approach towards a closed-loop waste management system should be prioritized. Raising awareness on the benefits attained through efficient sorting and recycling should also be showcased to the general public, together with encouraging reduction of the amount of waste altogether.

In order to achieve the goals for a sustainable waste management and closing the loops, the whole chain from the origin of the waste to collection and finally recycling and utilizing the collected fractions needs to be considered carefully. Reducing the amount of waste is a high priority, and depending on the success in realizing this aim, the estimates for amount of waste produced over the long term can differ significantly. In addition to reducing the overall amount of waste, collection of recyclable and reusable materials should be made easy.

A more centralized collection compared to the traditional waste collection model could enable collection of several reusable fractions within a short distance from households, and at the same time contribute to other sustainability goals e.g. through reducing the traffic associated with each building having separate waste collection units.

Finally, efficient storage and handling of recovered and recycled materials and treatment of waste streams, including utilization of waste in energy production and treatment of bio waste, requires also anticipation of possible land use reservations to meet the spatial needs for collection and handling of different waste fractions.

Ecoefficient technical systems in Sibbesborg – recommendations for planning

SIBBESBORG

Sector	Water management	Buildings	Energy systems	Transport	Waste management
Solutions	Highly reliable and energy efficient water system	High performance buildings with minimal energy demand Use of wood Passive design measures	Low energy demand through energy efficiency Use of local renewable energy resources District heating using renewables	Efficient public transportation and walking / biking infrastructure Reduced need to travel; services and jobs are available locally, within walking /biking distance	Easily accessible recycling points (for both municipal and construction waste) Use of energy efficient collection of waste (e.g. suction collection systems)
Planning requisites	Ensuring reliable water supply system through conveying water through several connections to the area, and through utilizing gravity in conveying sewerage when possible. Energy efficiency measures include also controlling leakage using modern technology.	Real estate conveyancing protocol (tontinluovutusehdot) Guidelines for construction (rakennustapaohje) Property-owned solutions (e.g. solar energy)	Efficient land use Reservation for local energy production Renewable energy potential mapping	Efficient land use Area requirements for efficient public transportation Easy access to public transportation Attractive walking and biking route Alternative parking norms (e.g. priority parking for low-CO2 vehicles, promotion of car clubs etc)	Efficient land use Reservations for collection points and relevant collection system (e.g. underground suction collection system)

Primary parametres for a sustainable Sibbesborg

Optimal area efficiency - Use of local energy resources - Striving for closed-loop systems - Local energy resources - Smart and efficient technologies - Minimal energy demand - Reduced need to travel and high quality public transportation - Efficient recycling - Resource efficient and reliable infrastructure - Functioning green infrastructure and use of ecosystem services

Needs for further analysis

Further feasibility analysis with regard to potential and solutions for closed-loop systems, e.g. defining the energy potential of local energy sources - Energy efficiency analysis and life cycle comparison studies to be carried out with regard to selection of technologies to be implemented - Seeking innovative concepts for cooperation with the energy provider and other technical operators, as well as for decentralized energy production contributing to the energy mix - Cooperations with relevant actors - Planning flexibility to the system enabling accommodation of new measures and technologies as the area evolves - Energy requirements for buildings - System boundaries

Figure 22.Recommendations for further planning

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Sibbesborg technical meeting, 21 May 2013 at Sipoon municipality

Sibbesborg technical meeting, 12 June 2013 at Sipoon municipality

Sibbesborg seminar, 12 June 2013 at Gumbostrand Konst&Form

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