Energy plan for Växjö Municipality

Växjö kommun
The Greenest City in Europe

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Foreword

Växjö is well on the way to becoming a fossil-fuel free municipality! Since 1996, when we were one of the first cities in the world to express this ambition, there has been a great number of positive developments in work on energy and climate-related issues in Växjö. In 2010 we declared our intention to ensure that the municipal authority and its organisations and companies become fossil-fuel free by 2020 at the latest, and that the municipality as a geographical area will achieve this goal no later than in 2030. Once again Växjö was one of the first local authorities in the world to specify these objectives.

Our goal for 2030 is for the energy used in our residential premises, in the business sector and to meet needs for transportation to be climate-neutral in terms of fossil carbon dioxide emissions. Since the Sandvik 3 CHP block commenced operations, all the heating, electricity and cooling is, under normal circumstances, produced without the use of fossil fuels. The construction of municipally owned residential properties and other premises is also a focus of attention, as we now have a Wood Building Strategy that prescribes an increase in the construction of timber-framed buildings.

The Energy Plan is a vital instrument for setting forth our high ambitions and deriving support for further bold decisions that lie ahead. It sustains us and guides us on our onward journey towards the high ambitions that we have set ourselves.

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Summary action list

The first digit indicates the strategic area, the second digit indicates the action number.

Renewable energy

Action	*Description*	*Responsibility*
1.1	Real estate companies will allocate 0.2% of total net annual sales to investments in renewable energy production, with priority given to small-scale local production.	VKAB (real estate companies)
1.2	Upgrades and environmental adaptations to hydropower plants owned by Växjö Municipality will continue to be made in order to maintain overall production capacity in the long term.	Technical Services Committee
1.3	The Technical Services Committee and the municipal real estate companies will become more self-sufficient in terms of renewable electricity.	Technical Services Committee and VKAB (real estate companies)
1.4	Växjö Energi AB will play a leading role in relation to renewable energy in the municipality and will prepare a forward strategy and an action plan. This strategy is based on a holistic approach and a system perspective which includes sustainable development, competitiveness and resource efficiency enhancement. Renewable energy means solar power, wind power, small-scale hydropower and biomass.	VKAB (Växjö Energi) and Technical Services Committee (for hydro-power)
1.5	As part of the dialogue it conducts with developers, Växjö Municipality will encourage investment in small-scale energy production.	Town and Country Planning Committee, Municipal Executive Committee and Technical Services Committee
1.6	Växjö Municipality and Växjö Energi will conduct a solar energy campaign directed at the private and corporate markets, with support for applications for subsidies, purchases and installation.	Municipal Executive Committee and Växjö Energi
1.7	Within the framework of its business development activities, Växjö Municipality will support and drive forward initiatives for renewable energy production.	Municipal Executive Committee
1.8	Växjö Municipality will work to supply as many areas and customers as possible with district heating. It will also conduct a dialogue to this effect with private district heating companies and local district heating companies.	Municipal Executive Committee and VKAB (Växjö Energi)
1.9	The district cooling network will be extended to serve more customers.	VKAB (Växjö Energi)
1.10	Environmental and Public Health Services will exercise day-to-day supervision to replace fossil oil with bio-oil or other fossil fuel-free energy.	Environmental and Public Health Services
1.11	Växjö Municipality will conduct an active dialogue with companies and local community associations to invest in large-scale wind power generation in accordance with the Wind Power Plan.	Municipal Executive Committee

Efficient energy use

Action	Description	Responsibility
2.1	When Växjö's municipal real estate companies build new-buildings, the energy demand must not exceed the following: Residential premises: 55 kWh/m^2 per annum. [1) 2)] For residential premises with electric heating: 30 kWh/m^2. Business premises: 50 kWh/m^2 [3)] per annum. For business premises with electric heating: 30 kWh/m^2. These limits may be achieved through the use of max. 5 kWh/m^2 of so-called "free-flowing energy sources" (sun, wind, hydropower, etc.), harvested either on site or locally.	VKAB (real estate companies)
2.2	Växjö's municipal real estate companies should endeavour to achieve the levels shown below in conjunction with all major renovations. In cases where these levels cannot be achieved, the reasons for this must be stated for each renovation project in connection with the annual follow-up of the Energy Plan. Residential premises: 75 kWh/m^2 per annum. For residential premises with electric heating: 40 kWh/m^2. Business premises: 70 kWh/m^2 [4)] per annum. For business premises with electric heating: 40 kWh/m^2. These limits may be achieved through the use of max. 5 kWh/m^2 of so-called "free-flowing energy sources" (sun, wind, free flowing water, etc.), harvested either on site or locally.	VKAB (real estate companies)
2.3	Växjö Municipality offers active energy and climate advice. Residents, companies, building owners, organisations and associations have access to advice and support in connection with their work to improve energy efficiency.	Municipal Executive Committee
2.4	When making investment decisions about new construction and renovation projects, Växjö's municipal real estate companies must include life-cycle costs in order to reduce energy use.	Municipal Executive Committee and VKAB (real estate companies)
2.5	Prior to new construction projects and major renovations/refurbishments, an analysis is to be made of possible flexible solutions such as shared use of the same premises for different activities.	Town and Country Planning Committee, Municipal Executive Committee and VKAB (real estate companies)
2.6	Building in compliance with passive house standards must always be considered as a possible option for new construction projects.	VKAB (real estate companies)
2.7	Wherever possible, functions are to be installed in each individual home to measure and clearly show the household's use of electricity and water. Electricity and water charges are to be linked to actual consumption.	VKAB (real estate companies)
2.8	Wherever possible, energy use in premises is linked to the respective user within the municipal organisation. Financial incentive models will be developed to support energy efficiency enhancement activities.	VKAB (real estate companies)
2.9	Växjö Municipality will regularly conduct new energy-saving campaigns based on positive experience from previous energy-saving projects.	Municipal Executive Committee and VKAB (Växjö Energi)
2.10	Växjö Municipality will investigate the possibilities of implementing development projects to supply even highly energy-efficient buildings with district heating. This may involve household appliances powered by district heating.	Municipal Executive Committee and VKAB (Växjö Energi)

[1)] As in the building regulations of the Swedish National Board of Housing, Building and Planning (BBR), there is a higher value for apartment blocks in which Atemp is 50 m2 or higher and which predominantly (>50% Atemp) contain apartments with a living area of no more than 35 m2 each. The Energy Plan's value that applies to this type of building is 62 kWh/m2 per annum. This follows the same percentage difference as in BBR.

[2)] When a building combines residential and business premises, the different target levels are weighted using the following formula:

$$\text{Weighted energy demand} = (\text{Energy demand for homes} \times (\frac{A_{temp} \text{ for all apartments}}{\text{Total } A_{temp}}) + (\text{Energy demand for premises} \times (\frac{A_{temp} \text{ for all apartments}}{\text{Total } A_{temp}})$$

[3) 4)] This does not include the supplement that may be made for reasons of increased hygiene that corresponds to 50% (new-builds) and 70% (total modernisation) respectively of the level specified in BFS 2015:3 BBR 22, Chapter 9 (Energy Management), Tables 9:23a and 9:23b.

2.11	We will strive to optimise the conditions for energy supply (including small-scale production) in one of our development areas through the use of smart networks. [5]	Municipal Executive Committee and VKAB (Växjö Energi)
2.12	Within the framework of its customer focus, Växjö Energi will maintain an active dialogue with customers about their energy consumption and will offer services that contribute to a reduction in energy use.	VKAB (Växjö Energi)
2.13	Environmental and Public Health Services will develop its supervision activities (for example checklists, projects, etc.). The purpose of this is to enhance the efficiency of energy use in activities and operations that are within the supervision of the municipality.	Environmental and Public Health Services

Renewable fuel and energy-efficient vehicles

Action	*Description*	*Responsibility*
3.1	A thorough investigation will be made to determine whether it is possible to supplement the Sandvik CHP plant with a biomass gasification plant to significantly improve electrical efficiency and increase the production of electricity from renewable sources. This electricity has the potential to make a substantial contribution towards achieving Växjö's goal of a fossil-free municipality, a genuinely neutral energy balance and the use and production of genuine renewable energy. It also paves the way to creating the right conditions for a functioning infrastructure for the efficient production of renewable fuel in the form of electricity available through a local network of charging stations, plus locally produced hydrogen gas for fuel cells in an adjacent integrated production plant.	VKAB (Växjö Energi)
3.2	Växjö Municipality will contribute to the development of the regional biogas market by working with different stakeholders and through municipal involvement in a range of projects.	Technical Services Committee
3.3	Växjö Municipality will work to further improve the infrastructure for renewable fuels and charging facilities for electric vehicles. All municipal workplaces will offer charging facilities.	Municipal Executive Committee, Technical Services Committee and VKAB (all companies)
3.4	Charging facilities for electric vehicles will always be installed where new municipal premises and residential premises are built.	VKAB (all companies)
3.5	There will be coordination between municipal players outside Växjö to improve the infrastructure for renewable fuel and electricity.	Respective committees and administrations
3.6	Demonstration projects will be implemented in order to investigate the potential for using renewable fuels or electricity in the municipality's service vehicles, machines and plant, as well as in public transport.	Municipal Executive Committee, Technical Services Committee and VKAB (all companies)
3.7	When negotiating procurement contracts for vehicles, we will aim to buy energy-efficient, climate-friendly vehicles. A green vehicle strategy/policy will be prepared.	Municipal Executive Committee

Åtgärd	*Beskrivning*	*Ansvar*
4.1	A strategy will be prepared to safeguard the delivery of district heating, electricity and district cooling at levels sufficient to meet customer needs, and to ensure that supplies of heating, cooling and electricity from renewable energy are sufficient to meet customer needs.	VKAB (Växjö Energi)
4.2	Measures specified in the risk and vulnerability analyses compiled by the municipality and municipal companies will be implemented with the aim of ensuring an adequate supply of electricity, heating, cooling and fibre optic provision in both urban and rural areas.	Respective committees and administrations

[5] This may comprise both electricity grids and energy-efficient smart solutions in the district heating network.

About the Energy Plan

The Swedish Municipal Energy Planning Act (SFS 1977:439) stipulates that every municipality must have an up-to-date plan for the supply, distribution and use of energy in the municipality. In addition to securing an adequate energy supply within the municipality, the plan (which is to be formally adopted by the Municipal Council) must also promote measures to save energy. In spring 2015, a proposal concerning updates to the Act was circulated for comment. The existing Act is obsolete and is based in part on conditions that prevailed before the deregulation of the energy markets. Nor has it been adapted to developments in terms of climate policy, or the major changes in energy policy, EU law and other national legislation that have occurred since its introduction. Compliance with the Act is also low and enforcement is often ineffective. However, at the time of writing, the details of what a new Act might entail remain unclear.

We have also to comply with Article 9 of the European Parliament's Directive on the Energy Performance of Buildings (2010/31/EU). This specifies that all EU member states "shall ensure that, after 31 December 2018, new-buildings occupied and owned by public authorities are nearly zero-energy buildings". The Swedish definition of a nearly zero-energy building is currently under discussion.

In addition to laws and directives, we have the Regional Development Strategy, "Green Kronoberg 2025" (RUS - Gröna Kronoberg 2025) and the County Administrative Board's regional environmental goals, both of which state that by 2050, Kronoberg County must be an "Energy-Plus" county. This means that the production of renewable energy and biofuels in the county must exceed the county's total energy use, thus rendering Kronoberg County self-sufficient in energy from renewable sources and providing the means for it to become a net exporter of renewable energy.

In addition to the measures described in the Energy Plan, Växjö Municipality has identified a number of general action areas that are already leading its operations in the right direction:

- The municipality's procurement of goods, services and contracts is designed to reduce energy use and minimise environmental impact
- The municipality works with various players to generate commitment to energy issues and the environment
- The municipality works actively to influence national and international energy and climate policies

This Energy Plan was adopted by the Municipal Council on 18 October 2016 and replaces the previous plan, adopted on 20 December 2011.

Goals

The Energy Plan is a tool to achieve the targets in Växjö Municipality's Environmental Programme. One of the programme's key focus areas is "Fossil-Free Växjö", where the goal is to achieve the following objectives by 2030:

- Växjö will be a fossil-free municipality

- All heating, power, cooling and vehicle fuels will be produced from renewable energy sources
- Energy will be used efficiently and effectively
- Buildings will be heated using methods that require the lowest possible primary energy consumption
- All new-buildings will be energy-efficient and built using materials from renewable sources, primarily wood

The goals have subsequently been broken down into targets for 2020:

- By 2020 fossil carbon dioxide emissions will have decreased by at least 65% per resident when compared with emissions levels in 1993. The municipality of Växjö will be fossil fuel-free by 2030 at the latest.
- By 2020 Växjö Municipality (the municipal council organisation and municipal companies) will be fossil fuel-free.
- By 2020 50% of all new municipal construction in Växjö will be timber-based.
- By 2020 energy use per resident will have fallen by 20% when compared with 2008 levels.
- By 2020 total energy use per square metre in the premises and residential premises used and owned by the municipal companies will have fallen by 20% when compared with 2010 levels.
- By 2020 municipal electricity generation from solar power, wind power and hydropower will be at least 4,500 MWh.

Cornerstones of Växjö Municipality's energy policy

Based on the above goals for 2030 and the targets for 2020, we have identified the following cornerstones on which to base our work with Växjö Municipality's energy policy:

Focus on combined heat and power

- All areas designated for new development will be connected to the district heating network. District cooling will always be installed where there is an adjacent network.

→ The greater the demand for our biofuel-based district heating and cooling, the greater the opportunities to generate green electricity.

- Develop the uses to which district heating can be put in order to replace demands for other types of energy.
- Reduce the return temperature in the district heating network. This presents opportunities for generation of more green electricity.

Focus on energy-efficient and climate-efficient fuels for the transport sector

- Biogas
- Electrification of the transport sector
- More energy-efficient vehicles

Focus on using electricity in more energy-efficient ways for other users and applications, in addition to buildings in Växjö

- Improve the energy efficiency of companies
- Develop district cooling
- Smart grids

Focus on energy-efficient buildings, both new-buildings and renovated buildings

- Improved climate shell
- Demand-controlled ventilation
- Energy-efficient electricity use
  - Very energy-efficient household appliances
  - Enhanced primary energy efficiency
  - Less waste heat in residential apartments
  - Increased demand for heating from VEAB.

→ Generation of more green electricity
- Reduced demand for cooling

- Improve the efficiency of premises and business electricity consumption

Scope, limits and follow-up

The Energy Plan covers the municipality of Växjö as a geographical area. In addition to the municipal council and municipal companies, the scope of the plan includes municipal residents, the business community and other public sector operations. The Energy Plan is adopted by the Municipal Council, so the measures it contains extend only to activities carried out by the municipality's own departments and companies. However, some measures relate to how the municipality should act in relation to other stakeholders; as a result, these measures contribute to a reduction in energy use and climate impact on behalf of residents, companies and others. The Energy Plan is based on the targets in the City of Växjö's Environmental Programme and, as such, includes strategies and measures for achieving the overall goals of the environmental programme. Växjö Municipality also has a Transport Plan, which includes measures and strategies for how to create a sustainable transport infrastructure in the municipality. In order to avoid any overlap between these documents, the Energy Plan's focus on transport has been limited to energy-efficient, green vehicles and the production of and access to renewable fuels.

The strategies and measures in the Energy Plan are therefore a breakdown of the energy and climate targets in the municipal environmental programme which, in turn, is managed and followed up in accordance with the municipality's operational management system. Consequently, the strategies and measures in this document form part of the content of the relevant sections in the operational management system's focus area "Environment, Energy and Transport" for the respective committees and boards. This means that these strategies and measures are to be followed up annually, while responsibility for managing them in order to achieve the overall objectives and ambitions of the Energy Plan is incorporated in the municipality's operational management system. The Energy Plan should be revised once during every term of office, so that strategies and measures can be reviewed and possibly supplemented based on the prevailing situation.

In addition to its links to the Environmental Programme and the Transport Plan, the Energy Plan also contains strategies and measures relating to land-use planning. Consequently, this document is an important tool, both for those working with strategic planning and those working with detailed local development plans, for land engineers and land development engineers, and for local government officers processing applications for building permits for new residential housing and commercial developments. New guidelines have also been adopted for dealing with land allocations, options and development agreements in the municipality of Växjö. These state that environmental issues are key when making assessments with regard to land allocations. Växjö Municipality's Environmental Programme and the documentation on which it is based form the basis for evaluation. In addition to meeting requirements, developers are encouraged to demonstrate how they intend to exceed requirements. There is, therefore, some overlap between the Energy Plan and these guidelines in relation to the energy-efficient construction of new properties. However, while the Energy Plan can only indicate target levels for the municipality's own companies (i.e. companies over which the municipality has full control), it is hoped that the guidelines will also stimulate private developers to give due consideration to energy efficiency issues when expressing an interest in building on land owned by the municipality. As a result, it may be said that these two policies complement each other.

Training and attitudes

In "The Greenest City in Europe" it is important that politicians, municipal employees and school pupils are well informed on energy issues. To meet this challenge, Växjö Municipality aims to offer politicians, municipal employees and pupils training in energy and climate issues that will reinforce our brand as "The Greenest City in Europe". Parallel with this initiative, energy-saving projects should also be implemented to encourage a change in behaviour among residents in municipal housing and all those who use premises that are owned by the municipality.

Networks and exchange of experience

Växjö Municipality is actively involved in several different types of network. The municipality has strong connec-

tions with various local and regional networks, with other stakeholders – Expansive Växjö, Sustainable Småland, the County Administrative Board's Environmental Goals Network, the Energy Agency for Southeast Sweden, etc. – and with a number of industry networks. We also participate in national and international networks such as Climate Municipalities (Klimatkommunerna), Energy Cities and ICLEI. In addition, there is an established partnership between the municipality and Linnaeus University with whom we regularly collaborate to conduct joint projects. These networks help to ensure that we are fully aware of and able to respond to what is taking place at local, regional, national and international level. This feeds important knowledge into our own municipal energy planning activities, while providing us with the opportunity to act as a driving force for developments in the networks. For further information about our various networks, please see Chapter 5.

Calculation bases and definitions
The thresholds specified for energy use apply to heating, hot water and property electricity (i.e. electricity used for shared functions within a building), but not business electricity or domestic electricity. Comfort cooling is also included. Where this is provided via separate chillers, the electricity consumed by these cooling units must also be included.

The factor used is A_{temp} (the area of premises heated to more than 10°C).

For dimensioning parameters, please see the information provided by the respective developer.

The definition of a passive house that has been adopted by Växjö Municipality is a house built in accordance with existing Swedish FEBY passive house criteria. This does not mean that there are not also passive houses that are built in accordance with the international standard.

Situation analysis

Växjö Municipality prepares an annual energy "balance sheet" that documents energy supply and energy use in the geographical area covered by the municipality. This information is also used as the basis for monitoring carbon dioxide emissions in the municipality. The statistics that the energy balance sheet provides are a good indicator of progress and show where measures need to be taken to achieve the various targets.
The statistics comprise data obtained both from Statistics Sweden (SCB) and other agencies, together with information from energy and real estate companies, all of which is further supplemented with a number of reliable estimates. The statistics are also mentioned in the various chapters of the Energy Plan. A summary of the outcome for 2014 is provided below.
A similar annual inventory is also carried out for the municipal organisation.

Energy supply
A total of 2,336 GWh of energy were supplied in 2014. Despite a growing population, the total energy supply remained steady and even fell slightly during the period 2002–2014. Energy from renewable sources accounted for 60% of the total (renewable district heating 27%, renewable electricity 19%, renewable fuels 5%, other 9%), while the proportion of energy from non-renewable sources was 40% (fossil fuel 27%, non-renewable electricity 10%, other 3%). In Växjö there is a clear trend towards an increased proportion of renewable sources in the energy mix. By way of comparison, the proportion of energy from renewable sources in 1993 was 33%.

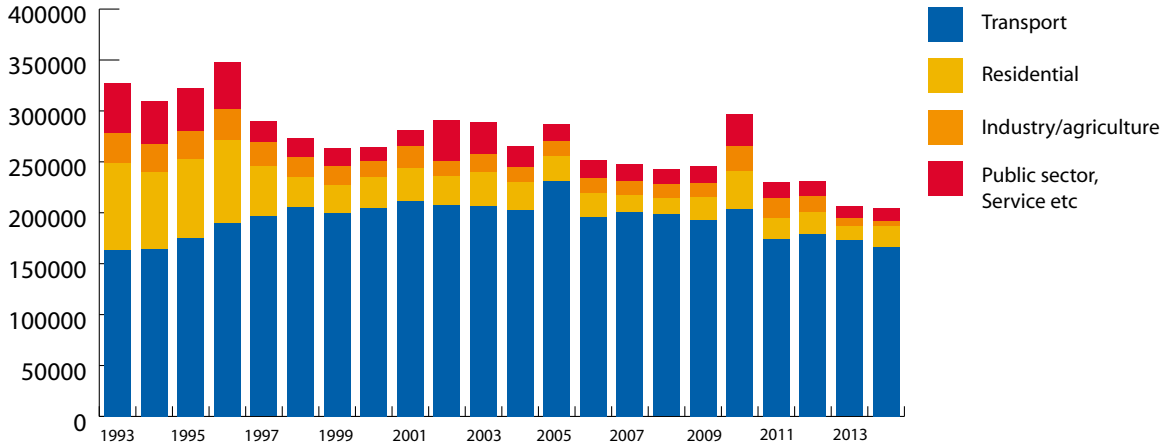
Energy distribution/energy conversion
Växjö Municipality has one combined heat and power (CHP) plant, which generates heating, cooling and electricity, and four local district heating plants, which generate heating. These local district heating plants are primarily wood-fired (chips, pellets, briquettes). The CHP plant is also primarily wood-fired, with the addition of a small quantity of peat.

The CHP plant generated 128 GWh of electricity in 2014. This corresponds to approximately 19% of the entire municipality's electricity consumption of 674 GWh. Electricity is also generated locally from water, wind, sunlight and biogas. However, net imports of electricity totalled 532 GWh in 2014.

Energy use
Data for 2014 show that 32% of energy was used for transport and machinery, 35% for residential sector, 8% for industry and 25% for public sector activities, commerce, etc. The housing sector used the largest proportion of renewable energy (85%), while the transport sector used the smallest proportion of renewable energy (15%).

Carbon dioxide emissions
The overall objective for Växjö is for the municipality to be fossil fuel-free. In 2014, emissions were 2,373 kg per resident, a reduction of 48% on the figure for 1993. Växjö has a low level of emissions compared with the rest of Sweden. A closer analysis of the distribution of emissions by sector reveals that 81% derive from

Fossil carbon dioxide emissions in Växjö municipality, tonnes



transport and machinery, 10% from residential, 2% from industry and 7% from public sector activities, commerce, etc.

Energy projects carried out as part of the previous Energy Plan

Since the previous Energy Plan was adopted there has been a significant number of positive energy-related developments in Växjö. Some of these are listed below (in no particular order of priority).

- Sandvik 3 CHP block commences operations, 100% biofuel (peat is now used only in Sandvik 2)
- Expansion of district cooling network
- Växjö's first dedicated filling station for hydrotreated vegetable oil (HVO) opens
- Energy-plus houses built and tested
- Car pool for electric vehicles established
- New construction in accordance with the limits laid down by the Energy Plan:
- Aspen, Passet, Minnet, etc.; timber-framed houses in Vallen and Teleborgsskogen; passive house concept for Södra Climate Arena, Gemla Sports Hall; timber construction for N Block on the university campus; passive house concept for Vikaholm Preschool; new energy-efficient apartments in Gemla
- Renovation of existing properties in accordance with the limits laid down by the Energy Plan: Körsbäret 1 (apartments), Norregård School, Alabastern (apartments)
- Tolg School and Gemla School (ground-source cooling with heat pumps)
- Green Data Center, efficient energy use
- Introduction of numerous EV charging stations, including Växjö's first quick charging station
- Collection of food waste for biogas production
- Bio-oil in local district heating plants
- Education for municipal companies in life-cycle cost (LCC) calculations
- Inauguration of the EU READY project
- City buses run on biogas, regional bus services run on rapeseed oil methyl esters (RME)
- Photovoltaics erected at Norregård School, Green Data Center, Vikaholm Preschool, Centre for Cultural Heritage, and private installations
- HVO blended in diesel fuel. (Although this is not a municipal initiative it does have a positive impact on local and regional energy and climate targets.)

- Lantmännen Räppe switches from fossil oil to bio-oil
- Wind power cooperative Karrydvind builds Växjö's second large wind turbine
- Sundet wastewater treatment plant starts to use pellets for heating
- Sundet initiates a thermal hydrolysis process to increase biogas production
- Companies in the Sustainable Småland environmental network develop a renewable energy certificate and challenge business community to increase the share of renewables in their energy mix
- Haulage contractors expand the use of renewable fuels in their vehicles
- A new risk and vulnerability analysis is produced, updated to reflect changes in climate

System perspective

All work on energy issues requires a decision to be made about which among a number of different systems should constitute the focus of the work. We apply two system boundaries, the municipality as an organisation and the municipality as a geographical area. The main thrust of our work in the Växjö Energy Plan is to improve energy efficiency and reduce the climate impact of activities undertaken by the municipal council and municipal companies. By doing so, we hope to set an example and lead the way for others to follow.

The Energy Plan also encompasses a larger system – namely, the municipality as a geographical area. This includes local companies, industries and businesses, municipal residents and numerous other stakeholders. When we carry out new projects, we adopt a primary energy perspective for calculating energy consumption and carbon dioxide emissions.

Finally, based on these different system perspectives, we aim to achieve flexible, smart system solutions that result in the total optimisation of energy use and reduced climate impact. Life-cycle cost (LCC) calculations are of great significance in this respect and should be used to provide a more objective view of the outcome by weighing the cost of investment against future savings.

With the primary energy concept and LCC calculations as the basis for decision-making, it is natural for the municipal council and municipal companies to focus on a building's entire energy needs instead of simply discussing purchased energy. This then leads to the logical progression of guaranteeing a low energy demand by ensuring that buildings are given a good climate shell. We then ensure that the energy used has the lowest possible primary energy factor.

Primary energy

Adopting a primary energy perspective involves considering the entire life cycle of energy use – from the energy resources taken from nature, through the processes of extraction and refining to transportation and the distribution of the energy source to the end user. Many people believe that this gives a more accurate description of the amount of energy resources (i.e. primary energy) that is needed to produce a unit of energy as consumed by the end user. There are energy losses in all of the different steps from source to end user, and the higher these losses are, the higher the primary energy use is. The primary energy factor (PEF) is a measure of how much primary energy is being used by an energy source. The PEF is defined as the total primary energy supplied divided by the end-use consumption. Usually, it is the system from cradle to gate at the energy plant that is most relevant. For example, the process of collecting biofuel in the form of branches and tops from the forest consumes primary energy from a variety of types of energy before the biofuel is chipped and ready for use in a CHP plant.

Taking vehicle fuel as an example, a primary energy perspective involves not only a consideration of the quantity of fuel put into a vehicle's tank, but also the energy consumed when the fuel was extracted, refined, transported and distributed to the filling station. The same applies to the use of electricity, where the primary energy is determined by the means of generation. Electricity generated in a European coal-fired condensing power plant with a low thermal efficiency has a higher primary energy factor than electricity generated in a bioenergy-fired Swedish CHP plant that is operating at a high level of thermal efficiency. This means that it is important to consider not only purchased energy, but also how the energy purchased has itself been produced.

An evaluation of new energy use or changes in energy use in the municipality must always be calculated on the basis of primary energy use. The decisions that are reached and the measures that are taken must lead to a reduction in primary energy use.

Which energy source has the lowest primary energy factor?

Some examples of the factors that are used are given below. What is indicated here is mainly the system from the energy source (for example, the forest or oil source) to the gate at the energy plant. This means that if, as here in Växjö, a district heating system uses large amounts of woodchips from residual forest products to generate heating and power, the total consumption of woodchips at, say, Växjö Energi must be multiplied by the primary energy factor for branches and tops/woodchips (0.03) in order to calculate the total primary energy resource. That figure is then divided by the quantity of energy produced to establish the efficiency of the CHP plant and calculate the primary energy factor for our district heating.

Coal = 1.15*
Oil = 1.11*
Branches and tops/woodchips = 0.03*
Peat = 1.01*
Electricity, marginal electricity, Nordic region = 2.5**
District heating = 0.215***

Things are not always what they appear to be. Primary energy use should be a key factor when choosing the most efficient source of energy:

Which of these buildings is most energy efficient?

Uppvärmning:	**District heating**	**Heat pump (Nordic marginal electricity)**
Purchased energy:	75 kWh/m² (actual requirements)	35 kWh/m²
Primary energy needs:	16 kWh/m²	88 kWh/m²

The example above is revealing. While the two houses are identical, because of the different forms of heating that they use, they are also each other's opposite. The house with district heating provides us with the conditions for being able to produce more green electricity *to* the system, whereas the house with the heat pump requires electricity *from* the system.

The high value of the electricity above is motivated by what electricity production looks like in a Nordic perspective, of which Sweden is a part. It constitutes the "marginal electricity" that is to be used when making decisions about new investments. There are often discussions about what value should be attached to electricity and the perspective that should be adopted. If the method of production is specified for the electricity that is purchased (for example, "Bra Miljöval" eco-labelled electricity), the primary energy factor is much lower. However, regardless of how "good" the electricity is, the fact remains that that electricity can be consumed elsewhere in the Nordic countries (or, indeed, elsewhere in Europe) where it may be able to make a greater difference. District heating in Växjö can only be used within the region's district heating network and, for that reason should be consumed there, whenever it is possible to do so.

From a primary energy perspective, it is more important to save electricity than to save district heating.

The right form of energy must be used in the right place.

Electricity should be used for purposes that electricity (alone) is well suited for. Examples include lighting, powering electric motors, computers, etc. Electricity should not be used to produce warm air. That represents a waste of primary energy!

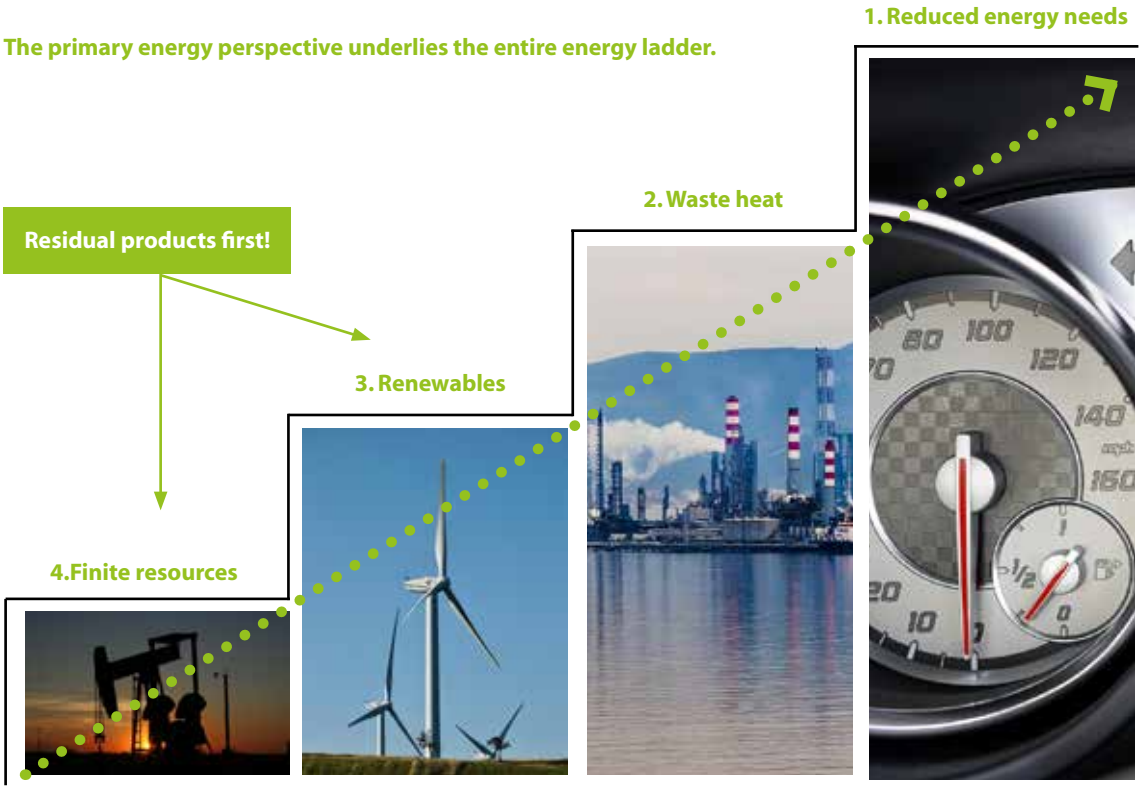
* Environmental Fact Book (Miljöfaktaboken) 2011 and Profu AB's Primary Energy Accounts 2015 for Växjö Energi.

** Addendum to the 2008 Interim Report of the Official Report on Energy Efficiency Enhancements

*** District heating from Växjö Energi AB 2015, http://www.veab.se/om-oss/miljo/miljovardering/

The energy ladder
A fundamental assumption that is made in the Energy Plan is that the best kilowatt hours are those that are saved.

One approach for how the municipality can work on energy use and energy production is to look at energy from a primary energy perspective. Figure 3 shows the energy ladder, which is to act as a guide to Växjö Municipality in all matters relating to the conversion and use of energy.



The Energy Ladder describes an approach that should guide municipal departments and companies in their operations and activities. Stage 1 is to be given priority over the subsequent stages.

What does the future hold?

The Swedish Energy Agency has prepared a long-term forecast that is designed to illustrate the development of the Swedish energy system up to 2030 [6] . The forecast, which is based on the policy instruments in force at the end of June 2010, gives a good indication of how future energy supply and use might look, if these policy instruments are applied throughout the forecast period.

The forecast predicts a rise of approximately 5% in total energy use in Sweden. This will be due primarily to greater conversion and distribution losses as a result of increases in the amount of power generated by nuclear power stations, but it is anticipated that there will also be a rise in the demand for energy from the industrial sector to keep pace with increases in production. Electricity production is also predicted to rise, due in part to the construction of new wind turbines. Electricity production will rise by approximately 7% in CHP plants, while the supply of biofuel will also increase. Homes and services will reduce their temperature-corrected energy use by making a transition from oil and electric heating to other heating methods, for example heat pumps and district heating. The use of domestic electricity and electricity end use in commercial and public buildings will be relatively stable, as the effect of energy efficiency enhancements resulting from the evolution of low-energy technologies (white goods, household appliances, electronics, etc.) will be counteracted by an increase in the volume of home electronics and peripheral equipment.

Finally, energy use for domestic and international transport is predicted to fall by just under one percent, while the use of petrol will decrease in favour of diesel and renewable fuels.

Local forecast for Växjö

The Sustainable Development section has prepared its own forecast for the development of energy supply, energy consumption and carbon dioxide emissions up to 2030 for the municipality of Växjö as a geographical area. The forecast is based partly on trends in the detailed historical energy statistics that the municipality has for the period between 1993 and 2014, partly on the imminent future implementation of measures already known to the municipality, and partly on information, forecasts and studies from sources such as the Swedish Energy Agency and Statistics Sweden. A number of assumptions – for example, with regard to anticipated developments in terms of "green" vehicles – have also been made in the forecast.

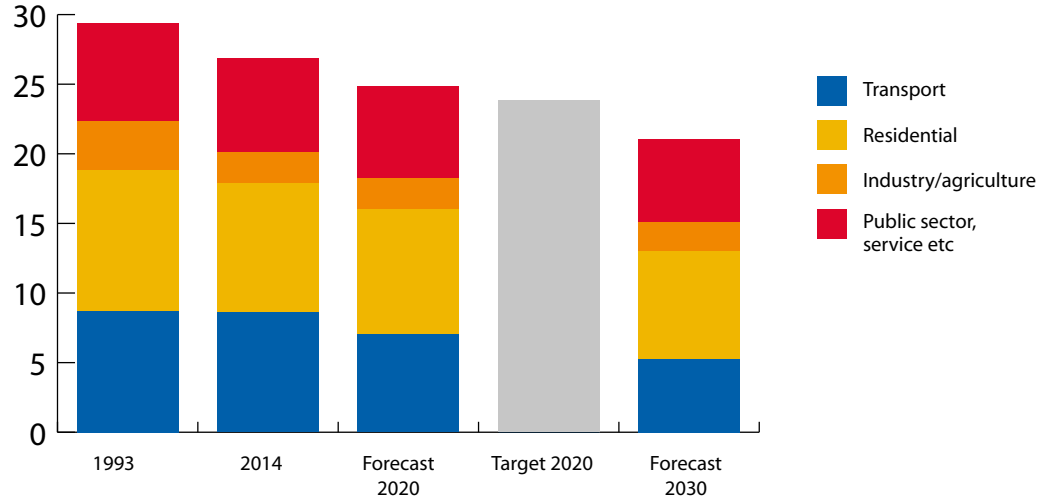
The forecast shows that, by 2030, energy consumption per resident will have fallen by 28% in comparison with the figure for 1993. The proportion of renewable energy will have risen to 90% and fossil carbon dioxide emissions per resident will have fallen by 90% compared with 1993. A comparison with the Environmental Programme's targets for 2020 reveals that energy use per resident is expected to fall by 18% between 2008 and 2020 (target is 20%) and that fossil carbon dioxide emis-

[6] "Energiförsörjning i Sverige år 2030. En konsekvensanalys av gällande styrmedel (ER 2011:03) ("Energy supply in Sweden in 2030. An impact analysis of existing policy instruments")

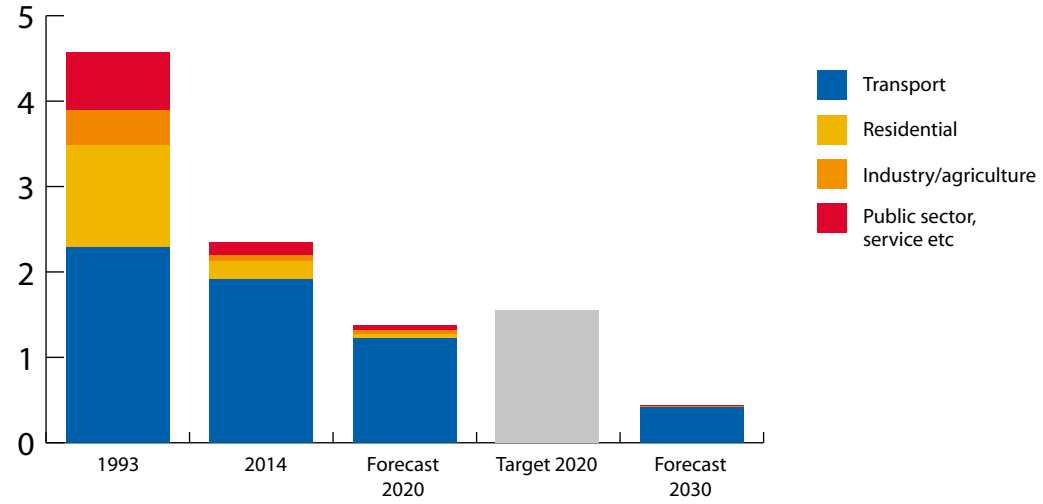
sions are expected to fall by 70% (target is 65%). The forecast shows, therefore, that while we can be expected to achieve our climate targets in the short term, we will not be fully successful in doing so in the long term. Notwithstanding this, a reduction in emissions of 90% to a level below 0.5 tonne per resident by 2030 must be considered to be a very good achievement. With regard to the goal of more efficient energy use, the Energy Plan will be a vitally important tool in helping to achieve the target for 2020.

The diagrams below show the forecast for energy use and carbon dioxide emissions in Växjö.

Energy use per capita in Växjö, MWh



CO2 emissions per capita in Växjö, tonnes



Renewable energy

Here in "The Greenest City in Europe" we are net producers of electricity and heating from renewable energy sources. We have a mix of small-scale and large-scale energy solutions and are committed to enabling all of our residents to contribute to increasing the proportion of electricity and heating that is produced from renewable sources. All the production of electricity and heating takes place through the sustainable use of natural resources.

In the Greenest City in Europe demand for heating is met primarily by biomass-fired district heating. In parts of the municipality where district heating is not a viable alternative, other solutions based on renewable energy sources are used.

Introduction and situation analysis

The trend in Växjö in terms of renewable energy remains positive. The main factor contributing to this success was the inauguration of the third cogeneration facility at the Sandvik energy plant in March 2015. Sandvik 3 will take care of base load production, thus making the production of electricity and heat at the plant 100% fossil fuel-free. Far-reaching initiatives are also having a positive impact in other areas. For example, photovoltaics have now begun to make a breakthrough as a result of falling prices and ongoing improvements in the thermal efficiency of photovoltaic technology. There has also been a national review of the regulations for feeding surplus electricity into the electricity grid; as long as the prime aim of micro-producers is to generate no more than what is required to cover their needs, the regulations that now apply are relatively straightforward. Many surfaces where there is potential for deploying photovoltaic arrays remain unutilised but, as the use of photovoltaics becomes more profitable, it is hoped that it will also be possible for municipal utilities to install photovoltaics in the future. We need to constantly seek out new cutting-edge projects; the challenge is to further quicken the pace of progress in this area while making use of good experiences.

There is some small-scale hydropower in Växjö. This has the potential to be upgraded in a way that will raise the output of existing facilities without impacting negatively on the natural surroundings or the watercourses themselves. Small-scale hydropower is an important resource in the total energy mix, especially in the south of Sweden (electricity area 4), where more energy is currently consumed than is produced. Better use can also be made of the heat generated by the sun, although in this case production is highest during those periods of the year when demand for district heating is lowest. The challenge today is to devise solutions for how to produce district heating/local district heating using a variety of small-scale renewable energy sources.

Now that the third CHP block at the Sandvik energy plant has come online, work on phasing out the use of peat as a fuel has begun in earnest in Växjö. However, while the Sandvik 3 cogeneration facility has been designed to run on wood fuel only, it may still be necessary to use a small amount of peat at Sandvik if there is a need to start the Sandvik 2 CHP block.

Växjö Municipality has designated certain areas as suitable for the development of large-scale wind power. There are currently plans to erect a number of wind turbines in the municipality. This is a positive development that deserves the support of the municipal authorities. The municipal authorities have an important role to play in demonstrating the commercial benefits of renewable energy and the positive impact that this has on local economic development, and in inspiring and stimulating the business community and private individuals alike to increase their commitment to renewable energy. The challenge here is to prevail upon private real estate owners to follow the good examples set by the municipal companies so that they, too, are willing to make similar investments in photovoltaics, wind power, etc.

In 2014 60% of the energy supplied in Växjö came from renewable energy sources. This corresponded to a total of 1,396 GWh, of which 1,282 GWh were used to produce electricity and heating, while just 113 GWh were used in the transport sector.

Biofuels

Växjö Energi has been supplying district heating since 1970 and currently has some 8,000 customers connected to its district heating network. District heating and electricity are produced at a number of units at the Sandvik energy plant. The main facilities are the Sandvik 3 cogeneration facility, Sandvik 2 and the Sandvik 1 heat recovery boiler, all of which use biofuels, chiefly in the form of wood chips, bark and shavings, but also residual forest products such as branches and tops. In addition to the main facilities, there are oil-fired reserve/back-up facilities which can be used to manage demand in extreme situations. In recent years the electricity produced here has been sufficient to meet approximately one fifth of the annual electricity consumption in the municipality. When operating at full capacity, the Sandvik energy plant can meet approximately two thirds of the maximum need for power in Växjö's electricity network.

In addition to Sandvik there are another four small, biofuel-powered local district heating plants that were built in the late 1990s at Ingelstad, Rottne, Braås (all owned by Växjö Energi) and Lammhult (owned by Solör Bioenergi).

The Sandvik plant also produces district cooling based on the same concept as district heating; instead of using numerous small chiller plants and air conditioning units that consume considerable amounts of electricity, demand for cooling is met by a single, centrally located and environmentally adapted district cooling plant. Work is currently under way to extend the supply of district cooling services to large industrial, commercial and municipal premises.

To achieve a closed ecological system, a large amount of the ash that remains after incineration is returned to the forest. The ashes contain plant nutrients and trace elements that perform a valuable service as fertilisers and also help to mitigate acidification. The municipal heating plants produce different types of ash. How this is used or disposed of depends on the chemical properties of the ash. Today around 50% of the ash is returned to the forest and 50% is used as construction material in landfill sites. The goal over time is to increase the proportion of ash that is returned to the forest to 80% of the total ash produced. Also, forest raw materials must be harvested in a sustainable way so that biological values are not compromised.

The five plants described above account for more than 90% of the wood fuel that is used in Växjö. The remainder is used in wood pellet boilers and wood burners, mostly in domestic properties in rural areas. Other biomass fuels, such as straw, are also used in Växjö, although only to a limited extent.

It is crucially important to be able to source biomass in the forests in a sustainable way while also contributing to meeting Sweden's national environmental objectives. For this reason, we monitor research in this area and contribute when we can.

Solar energy

Trials using small-scale district heating based on solar energy took place in Ingelstad in the 1980s. The Ingel-

stad plant was decommissioned in the early 1990s after a series of operational problems, but the solar collectors were salvaged and are now in use at Växjö's swimming centre, where they provide a valuable contribution to heating the water that is used for the showers. There are also numerous private solar energy installations and it is estimated that these produce a total of around 570 MWh per year.

The first municipal large-scale solar cell assembly was installed at the Teleborg Centrum School but the largest to date is at the Kungsmad School; this produces approximately 110 MWh of electricity a year. The municipal real estate management company Vöfab has played an important role in the expansion of solar power in the municipality with solar cell installations at Centrum School, the City Hall, Östra Lugnet School, Norregård School, the Centre for Cultural Heritage and Vikaholm Preschool. Växjö Energi has also installed photovoltaics on the sub-station beside the lake in central Växjö and on the Green Data Center. In 2014 photovoltaics in Växjö, half of which are located on municipal facilities, produced a total of 755 MWh of electricity.

In 2010 the KTH Royal Institute of Technology in Stockholm investigated the potential for producing electricity from wind power and solar power in Växjö. The KTH report asserted that, while on paper there is the technical potential to produce in excess of 500 GWh of electricity from photovoltaics in Växjö, the portion of this total that may be considered as being economically feasible to produce is very limited.

Wind power

In 2011 Växjö Municipality adopted a Wind Power Plan that constituted a thematic addition to the municipality's general land-use plan. This Wind Power Plan pinpoints areas where wind power can be given priority over other interests, but also indicates areas where it is not deemed appropriate to install wind turbines. The plan also lays down general guidelines for wind turbine installations in terms of location, distance, noise, design, lighting, shadow flicker and other concerns, and it sets out guidance for consultation and cooperation. The Wind Power Plan, the details of which still apply, serves as a basis for decision making and supports politicians and local government officers in issues relating to wind power.

In 2015 there were two privately owned wind turbines in the municipality, which together produce an annual total of approximately 2.6 GWh. There is also a small urban wind turbine at Teleborg that produces approximately 10 MWh a year.

More wind turbines are in the pipeline. At the time of writing, a total of 21 applications for wind turbine installations in Växjö, with an aggregate production potential approaching 180 GWh a year, are at various stages of the licensing process. However, it is important to remember that experience shows that, when the need for power from these sources is greatest – for example on cold winter days – only 10–11% of production capacity is available.

The KTH study mentioned above estimated that the technical potential for wind power in the municipality is almost 9,000 GWh. While most of this potential is economically viable, it is not necessarily practicable. As things stand today, the main obstacle to fully exploiting the potential of wind power is low profitability. What is needed to stimulate willingness to invest in wind power is not only higher electricity prices but also taller wind turbines that have the capacity to produce more energy.

To achieve the aims of the regional development strategy "Green Kronoberg 2025" and the County Administrative Board's regional environmental goals, both of which state that by 2050 Kronoberg County is to be an "Energy-Plus County", wind power is a source of energy that needs to be exploited to a greater extent. Clearly, all of the municipalities in Kronoberg County need to play their part in helping to achieve this goal.

Hydropower

Växjö Municipality owns four hydro-electric plants, three of which are currently in use. In all, there are 13 hydro-electric plants in the municipality with a total installed output of 2.6 MW and a normal production

level of between 8 and 17 GWh, depending on precipitation. Production during 2014 was estimated to be 10.5 GWh. There is potential for increasing the production of electricity from small hydropower plants by modernising and improving the efficiency of existing facilities. It is important, however, that this is done without exerting any negative impact on the natural surroundings or the watercourses themselves. Hydropower is also very valuable in terms of balancing other stochastic sources of renewable energy, such as solar power and wind power, at times when there is no direct sunshine and little wind. Växjö Municipality seeks to support small-scale hydropower plants – both private and municipally owned – while maintaining the right balance with other environmental goals.

Bio-oil

Bio-oil (pyrolysis oil) is now used as a reserve fuel in all three of Växjö Energi's small-scale local district heating plants, and studies are under way to investigate whether bio-oil can be used to replace fossil oil when the Sandvik CHP plant is re-started after a scheduled or unplanned production stop. Positive results following the use of bio-oil in an industrial facility also suggest that it should be possible to replace fossil oil with bio-oil in other privately owned oil-fired boilers in the municipality.

Heat from heat pumps

Approximately 200 applications a year are submitted in Växjö to install geothermal heating systems. In addition, increasing numbers of different types of air source heat pump are also being installed. In 2014 the energy contributed by heat pumps in Växjö was estimated to amount to 100 GWh.

Strategies and actions

Strategy A: Increase small-scale energy production from renewable sources

In the Greenest City in Europe we want to continuously increase the share of renewables in the energy mix. The municipal authority and its companies already have positive experiences of small-scale electricity production on their own properties. We are committed to continuing to test small-scale renewable energy solutions in municipally owned premises, while also encouraging and supporting other players to follow the same path.

Strategy B: Increased opportunities for business development

In the Greenest City in Europe we see renewable energy solutions as a key component in the development of local business community.

Strategy C: Combined heat and power and district heating/cooling

In the Greenest City in Europe large parts of the central urban area and surrounding communities are already served by district heating networks. We will continue to develop the district heating network while also expanding the district cooling network. As much of the heat load as possible is used as a basis for the production of electricity, which can also include local district heating plants.

Strategy D: Investment in wind power

In the Greenest City in Europe the municipal Wind Power Plan has designated certain areas that are suitable for the development of wind power. Wind power represents great potential in the municipality of Växjö, both in terms of the contribution it can make to an increased use of renewable energy and in the way it supports rural development. Urban wind power is also a possible solution.

Renewable energy

Action	*Description*	*Responsibility*
1.1	Real estate companies will allocate 0.2% of total net annual sales to investments in renewable energy production, with priority given to small-scale local production.	VKAB (real estate companies)
1.2	Upgrades and environmental adaptations to hydropower plants owned by Växjö Municipality will continue to be made in order to maintain overall production capacity in the long term.	Technical Services Committee
1.3	The Technical Services Committee and the municipal real estate companies will become more self-sufficient in terms of renewable electricity.	Technical Services Committee and VKAB (real estate companies)
1.4	Växjö Energi AB will play a leading role in relation to renewable energy in the municipality and will prepare a forward strategy and an action plan. This strategy is based on a holistic approach and a system perspective which includes sustainable development, competitiveness and resource efficiency enhancement. Renewable energy means solar power, wind power, small-scale hydropower and biomass.	VKAB (Växjö Energi) and Technical Services Committee (for hydropower)
1.5	As part of the dialogue it conducts with developers, Växjö Municipality will encourage investment in small-scale energy production.	Town and Country Planning Committee, Municipal Executive Committee and Technical Services Committee
1.6	Växjö Municipality and Växjö Energi will conduct a solar energy campaign directed at the private and corporate markets, with support for applications for subsidies, purchases and installation.	Municipal Executive Committee and Växjö Energi
1.7	Within the framework of its business development activities, Växjö Municipality will support and drive forward initiatives for renewable energy production.	Municipal Executive Committee
1.8	Växjö Municipality will work to supply as many areas and customers as possible with district heating. It will also conduct a dialogue to this effect with private district heating companies and local district heating companies.	Municipal Executive Committee and VKAB (Växjö Energi)
1.9	The district cooling network will be extended to serve more customers.	VKAB (Växjö Energi)
1.10	Environmental and Public Health Services will exercise day-to-day supervision to replace fossil oil with bio-oil or other fossil-free energy.	Environmental and Public Health Services
1.11	Växjö Municipality will conduct an active dialogue with companies and local community associations to invest in large-scale wind power generation in accordance with the Wind Power Plan.	Municipal Executive Committee

Efficient energy use

In the Greenest City in Europe residents live in energy-efficient, intelligent homes and have access to energy saving tools that enable them to make active choices so that they can combine a high standard of living with a low-energy lifestyle.

Introduction and situation analysis

Växjö Municipality's own real estate companies have continued their investment in the development of energy-efficient new construction. Early good examples in the form of the Green Building certified N Block (built by Videum on the university campus) and Portvakten (timber-framed, passive apartment blocks built by Växjöbostäder) have been followed by further energy-efficient building projects. These include the preschool at Vikaholm (a passive house construction built by Vöfab to the specifications of Sweden's Forum for Energy-Efficient Buildings, FEBY), the Vallen and Teleborgsskogen developments, (energy-efficient, timber-framed rental apartments built by Växjöbostäder) and Gemla Sports Hall (built by Vidingehem). In addition, Södra, the organisation that represents forest owners in southern Sweden, has built the Södra Climate Arena, an indoor tennis centre with multiple courts that meets international criteria for passive house constructions and is built using timber as a construction material.

The municipal authority's ambition in this area is expressed in the budget text that stipulates that new-builds are to be constructed in accordance with the Silver criteria of the Sweden Green Building Council (SGBC). However, since the Energy Plan sets stricter limits in terms of energy needs, in this respect construction must comply with the Energy Plan's criteria; in all other respects construction conforms to SGBC's Silver certification. The municipal authority has ambitions to impose even more stringent criteria to meet the requirements for Gold certification. However, as the SGBC certification programme is currently being comprehensively reviewed, a decision on this has been deferred until the details of what Gold certification involves have become clear. Meanwhile we are bound to respect the conditions laid down in Article 9 in the Directive 2010/31/EU on the Energy Performance of Buildings. This specifies that all EU member states shall ensure that by 31 December 2020 all new-buildings are "nearly zero-energy buildings", while new-builds occupied and owned by public authorities must set an example by meeting the same nearly zero-energy criteria by 31 December 2018. At the time of writing, the Swedish definition of a near zero-energy building (nZEB) is yet to be finalised. It remains to be seen whether the definition applies criteria that are stricter than those in Växjö Municipality's Energy Plan. If this is the case, it will, of course, be necessary for us to meet nZEB criteria by 31 December 2018 at the latest. In order to retain the title of the Greenest City in Europe, going forward we will need to make sure that all the buildings in the municipality – new and existing buildings alike – are even more energy-efficient. To gain acceptance for a possible increase in the cost of construction to meet these demands, we must start using life-cycle cost calculations as a basis for our decisions. These reflect the true costs more accurately, as future energy savings can be offset against the cost of the initial investment.

Passive houses are one of the alternatives to consider when planning and constructing energy-efficient buildings. Passive houses are air-tight, well insulated buildings where the heat generated by occupants, animals and home electronics is re-used to heat the house. It is important to maximise the effectiveness of the electricity that is used in a passive house, so that ventilation, white goods, lighting and pumps all require as little electricity as possible. The extra expense of sophisticated construction components such as better insulation, windows and heat-recovery ventilation can translate into a lower overall cost after only a few years. Returns on investment do vary, however, from project to project. There are many examples of other municipalities that have pioneered the way in this respect and already have a portfolio of profitable projects to show for their efforts. That issues an important challenge to the Greenest City in Europe to stimulate the construction of more passive houses. Careful planning in terms of where these are to be located can also benefit the district heating network; for example, choosing areas on the margins of the development area can reduce the costs for expanding district heating. But it is also possible to make significant energy savings simply by building "compact houses": i.e. houses that have a small external surface in relation to their heated volume.

Energy-plus houses are another interesting technical development that is worthy of mention in this context. In essence, this concept involves the use of sources of renewable energy such as solar collectors, photovoltaics and/or wind turbines linked to residential premises and other premises that ideally are built in accordance with passive house techniques. As a result, the building produces more energy over the course of the year than it uses, and is thus a net exporter of heat and/or electricity. As new technology evolves and the EU imposes ever stricter requirements, energy-plus houses will be even more important when developing and expanding built-up areas, especially on the rural-urban fringe, beyond the reach of district heating networks.

The Åsaliden Project in Växjö has now been terminated, but not before it demonstrated how a combination of photovoltaics and solar collectors can be used to produce more energy than a house needs. The surplus electricity and heating was fed into the electricity and district heating networks. The project also showed that district heating can be used for white goods, such as dishwashers, washing machines and tumble dryers.

Växjö now also has some good examples to show from the results of renovation projects. Two of the most recent successes are Växjöbostäder's work on the Nydalavägen 20 apartment block, which in principle meets the Energy Plan's limits for renovated premises, and Vöfab's project at Norregård School, which now has an energy performance significantly better than that specified in the Energy Plan. Work is also under way as part of the EU READY project to renovate apartments originally built as part of Sweden's Million Homes Programme in the 1960s and 70s. In this instance Växjöbostäder and CA Fastigheter are each contributing about half the total number of apartments.

If we are to achieve our municipal energy goals, we cannot afford to focus solely on new-builds; we must also continue to work on our existing building stock. In this respect, it is important for us to exchange and share experiences with real estate companies in the private sector. This not only provides us with insights that can be valuable for the municipal council and municipal companies, but it also gives us opportunities to share the knowledge we gain with others.

Today measuring energy use over time presents something of a challenge, as equipment (in buildings) and activities are constantly changing (for example, more technical aids, such as computers in schools). As it is rarely possible to establish an exact correlation between energy measurements and the corresponding organisational structures, it is difficult to effectively inform different users in shared premises of their individual energy use with the aim of encouraging a reduction. The challenge therefore is to improve the techniques and develop better technology for measuring and following up energy use linked to different administrative structures.

We are already familiar with several intelligent and flexible solutions relating to energy use in buildings/premises that it would be possible to implement. Vikaholm Preschool is an example of a preschool built as a multi-storey construction in order to reduce energy use. Another example would be the shared use of premises for various activities. Other municipalities also have some good examples from which we can learn, not least the use of returned district heating water to heat premises/private homes. As part of the EU READY project we will test reducing the supply flow temperature of the district heating to the 400 or so apartments that are to be renovated. Flexible energy solutions like these have the potential to result in significant energy savings; the challenge is to identify such solutions and to implement them.

Residential premises and other premises

In 2014 there were approximately 42,000 residential premises in the municipality of Växjö. In addition to this there are large numbers of other types of premises – public buildings and industrial, service and commercial premises. Since the life of a building is at least 50–100 years, the decisions that project leaders and builders make today will affect energy use for a long time to come. That said, given the relatively low level of new construction, the greatest potential for making more effective use of energy in the residential and property sector probably lies in the current building stock. Methods and technologies that can halve energy use are already available. Renovating properties that are more than 40 years old can be an expensive business, but if this is combined with measures to make the premises more energy efficient, not only can costs be recouped, but in the long term the investment may even prove to be a competitive advantage. All upgrades and renovation work can play their part in helping to achieve the energy goals of the Greenest City in Europe.

Our goals for new-builds in the current Energy Plan also set levels for electricity used for heating, for example through the use of heat pumps. If electricity is used for heating, it is important to bear in mind that energy consumption in a new-build should be seen from a marginal electricity perspective. This is because this consumption did not previously exist and, as such, it adds to the use of electricity within the geographical boundaries of the municipality. That is why district heating and energy from other renewable sources, such as biofuels and solar power, must be the first choice for heating residential premises and other premises in the Greenest City in Europe. In this sense, we can benefit from using the concept of "primary energy".

According to data compiled by Växjö Municipality, energy use in residential properties owned by the municipal parent company, VKAB, was 143 kWh/m2 in 2014. The figure for all VKAB premises in 2014 was 164 kWh/m2. In both instances the trend shows a reduction in energy use.

For the health of people and the wellbeing of the buildings that they occupy and use, it is important that energy-saving measures do not overlook the need for ventilation that complies with the prescribed norms.

Effecting changes in behaviour

It has been shown that it is possible to reduce energy consumption by around 20% by the simple expedient of making energy use visible in some way to the end user. This can be done by installing displays in apartments to indicate the consumption of hot water and electricity at a glance, or by itemising the use of energy for hot water and energy for heating separately on the user's energy bill. Displays that indicate energy consumption can already be found in many new apartments and have also been installed in certain older properties. Another useful innovation is Energikollen, an "Energy Check" tool that the municipal district heating and electricity company, VEAB, offers its customers and that provides easy-to-understand details of energy consumption. The municipal authority has an important part to play in motivating local government employees, private individuals and the business community to become involved in reducing energy use. The READY project includes the development of smart visual analytics tools. By presenting users with a pedagogic and easily intelligible way of monitoring their energy use via a smartphone or smart TV, these tools can help to motivate a highly positive change in behaviour.

Strategies and actions

Strategy A: Energy efficiency renovations of existing residential properties and other premises
In order to achieve the energy efficiency goals in the Environmental Programme, a comprehensive approach is required with regard to the existing building stock, as this accounts for by far the largest share of energy use in the residential and property sector. For this reason, the Greenest City in Europe will work to reduce energy use in existing residential properties and other premises.

Strategy B: Energy-efficient new-builds
In the Greenest City in Europe we endeavour to spearhead the development and implementation of energy-efficient construction techniques and to heat our properties with energy from renewable sources.

Strategy C: Effecting a change in behaviour
In the Greenest City in Europe we work to reduce the energy consumption of residents in domestic properties and the users of other premises.

Strategy D: Optimised energy use
In the Greenest City in Europe we understand the value of not only saving energy, but of saving energy at the right time. We also make every effort to match the energy carrier to the purpose for which it is used.

Efficient energy use

Action	*Description*	*Responsibility*
2.1	When Växjö's municipal property companies build new-buildings, the energy demand must not exceed the following: *Residential premises:* 55 kWh/m² per annum. [1) 2)] For residential premises with electric heating: 30 kWh/m² *Business premises:* 50 kWh/m² [2 3)] per annum. For business premises with electric heating: 30 kWh/m². These limits may be achieved through the use of max. 5 kWh/m² of so-called "free-flowing energy sources" (sun, wind, free flowing water, etc.), harvested either on site or locally.	VKAB (fastighetsbolagen)
2.2	Växjö's municipal property companies should endeavour to achieve the levels shown below in conjunction with all major renovations. In cases where these levels cannot be achieved, the reasons for this must be stated for each renovation project in connection with the annual follow-up of the Energy Plan. *Residential premises:* 75 kWh/m² per annum. For residential premises with electric heating: 40 kWh/ m². *Business premises:* 70 kWh/m² [4)] per annum. For business premises with electric heating. 40 kWh/m². These limits may be achieved through the use of max. 5 kWh/m² of so-called "free-flowing energy sources" (sun, wind, free flowing water, etc.), harvested either on site or locally.	Kommunstyrelsen
2.3	Växjö Municipality offers active energy and climate advice. Residents, companies, property owners, organisations and associations have access to advice and support in connection with their work to improve energy efficiency.	Kommunstyrelsen och VKAB (fastighetsbolagen)
2.4	When making investment decisions about new construction and renovation projects, Växjö's municipal property companies must include life-cycle costs in order to reduce energy use.	Byggnadsnämnden, kommunstyrelsen och VKAB (fastighetsbolagen)

[1)] As in the building regulations of the Swedish National Board of Housing, Building and Planning (BBR), there is a higher value for apartment blocks in which Atemp is 50 m2 or higher and which predominantly (>50% Atemp) contain apartments with a living area of no more than 35 m2 each. The Energy Plan's value that applies to this type of building is 62 kWh/m2 per annum. This follows the same percentage difference as in BBR.

[2)] When a building combines residential and business premises, the different target levels are weighted using the following formula:

$$\text{Weighted energy demand} = (\text{Energy demand for homes} \times (\frac{A_{temp} \text{ for all apartments}}{\text{Total } A_{temp}}) + (\text{Energy demand for premises} \times (\frac{A_{temp} \text{ for all apartments}}{\text{Total } A_{temp}})$$

[3) 4)] This does not include the supplement that may be made for reasons of increased hygiene that corresponds to 50% (new-builds) and 70% (total modernisation) respectively of the level specified in BFS 2015:3 BBR 22, Chapter 9 (Energy Management), Tables 9:23a and 9:23b.

2.5	Prior to new construction projects and major renovations/refurbishments, an analysis is to be made of possible flexible solutions such as shared use of the same premises for different activities.	Town and Country Planning Committee, Municipal Executive Committee and VKAB (property companies)
2.6	Building in compliance with passive house standards must always be considered as a possible option for new construction projects.	VKAB (property companies)
2.7	Wherever possible, functions are to be installed in each individual home to measure and clearly show the household's use of electricity and water. Electricity and water charges are to be linked to actual consumption.	VKAB (property companies)
2.8	Wherever possible, energy use in premises is linked to the respective user within the municipal organisation. Financial incentive models will be developed to support energy efficiency enhancement activities.	VKAB (property companies)
2.9	Växjö Municipality will regularly conduct new energy-saving campaigns based on positive experience from previous energy-saving projects.	Municipal Executive Committee and VKAB (Växjö Energi)
2.10	Växjö Municipality will investigate the possibilities of implementing development projects to supply even highly energy-efficient buildings with district heating. This may involve household appliances powered by district heating.	Municipal Executive Committee and VKAB (Växjö Energi)
2.11	We will strive to optimise the conditions for energy supply (including small-scale production) in one of our development areas through the use of smart networks. [5)]	Municipal Executive Committee and VKAB (Växjö Energi)
2.12	Within the framework of its customer focus, Växjö Energi will maintain an active dialogue with customers about their energy consumption and will offer services that contribute to a reduction in energy use.	VKAB (Växjö Energi)
2.13	Environmental and Public Health Services will develop its supervision activities (for example checklists, projects, etc.). The purpose of this is to enhance the efficiency of energy use in activities and operations that are within the supervision of the municipality.	Environmental and Public Health Services

[5] This may comprise both electricity grids and energy-efficient smart solutions in the district heating network.

Renewable fuels and energy-efficient vehicles

In the Greenest City in Europe we use energy-efficient vehicles that run on fuels from renewable energy sources.

Introduction and situation analysis

Sweden has entered a period in which a great deal is happening in terms of vehicles and fuels. The infrastructure for charging electric vehicles is being rapidly expanded throughout the country. Several fuel companies are offering diesel blends that contain more than 30% of renewables, and the airlines, too, are beginning to invest in fuels from renewable sources. There is a range of energy-efficient vehicles to choose from and electric vehicles are on the threshold of making a significant breakthrough. Nonetheless, there is a need for some major improvements in terms of the infrastructure for renewable fuels in Växjö. There are many filling stations for E85 ethanol-gasoline blends in the municipality, but most of these are located in the urban area of Växjö. There is only one filling station for biogas. As a result of investments made in 2014 in the infrastructure for electric vehicles in Växjö, there are now more than 40 charging stations open to the public. While this means that Växjö is among Sweden's leading municipalities in terms of charging infrastructure, once again most of the charging stations are to be found in the urban area.

Biogas in Växjö is currently produced from sewage sludge and food waste. Today 85% of all households and businesses contribute to the municipal food waste collection; the target for 2020 is 90%. There is further potential to increase the collection of food waste from multi-storey apartment blocks. The aim is also to obtain more substrates from neighbouring municipalities. As the Sundet wastewater treatment plant has sufficient capacity to process food waste from all of the municipalities in the county, it could potentially become a biogas producer for the region as a whole. If that is to become a reality, however, there needs to be a further expansion of the infrastructure for biogas filling stations in order to stimulate interest in the market for owning and using biogas-fuelled vehicles. Växjö Municipality has initiated a project with the other municipalities in Kronoberg County to organise a coordinated waste management system that may enable Växjö to make use of food waste that has been generated in other municipalities. A proposal for an appropriate solution is currently the subject of discussion.

Plug-in electric vehicles still account for only a small proportion of the total number of vehicles in Växjö, but their share of the market is increasing rapidly year after year. Interest in plug-in vehicles will rise as consumers are gradually able to choose from a wider range of models and charging stations become more numerous and more widespread within the municipality.

Finally, fuels from renewable sources are not only of relevance to climate issues; their availability is also a matter of security of supply. As the prices of petrol and diesel rise, the increase in cost will inevitably begin to impact on municipal activities such as healthcare, other care and welfare activities, and technical services. This means that, over time, energy-efficient vehicles and vehicles that run on renewable fuels will assume even greater importance. The development of renewable diesel, HVO, has paved the way for the use of biofuels in plant and machinery.

Biogas

In 2014 a total of just under 12 GWh of biogas was used in Växjö. The majority of this gas was produced in the Sundet facility from sorted food waste and sewage sludge. All the gas produced here is upgraded to vehicle gas, but retains the ability to produce heat. At the time of writing, Växjö has just one filling station for biogas that is open to private individuals, companies and public sector operations. Most of the biogas produced in the Sundet facility is used to drive buses operating on urban routes. In 2015 the biogas plant was complemented with a facility for thermal hydrolysis; in addition to increasing biogas production, this also produces digested sludge, a hygenisated residual material that can be spread on agricultural land.

Ethanol

The steady rise in the use of ethanol in Växjö since 2000 is a consequence of the increase in the number of flexible-fuel vehicles. Approximately 7.5% of all cars in Växjö can run on ethanol-based fuel. In 2014 20 GWh of ethanol were used in Växjö. Just under half of the ethanol is used in low-ethanol blends, and as we are seeing a steep decline in demand for petrol, this means that the use of ethanol is also beginning to fall.

FAME and HVO

Fatty acid methyl esters (FAME) and hydrotreated vegetable oil (HVO) can be considered to constitute two types of biodiesel. However, in principle, HVO has the same physical and chemical properties as fossil diesel and is used either as a high-blend component in fossil diesel, or as it is in existing diesel engines. HVO is the fastest growing biofuel in Sweden as all major fuel companies use HVO in their diesel blends.

50 GWh of FAME were used in Växjö in 2014. Previously virtually all FAME was used as a low-blend component in diesel, but this use currently accounts for only around one third of FAME consumption. Two thirds are now used as pure FAME, for example in buses operating on regional routes, in waste collection vehicles and by several road haulage companies. 29 GWh of HVO were used in petroleum diesel blends in 2014. Växjö's first filling station for pure HVO opened early in 2015.

Electricity

It is estimated that almost 4 GWh of electricity were used in 2014 for transport purposes in Växjö, chiefly to power trains. However, as interest in plug-in vehicles increases, the transport sector's use of electricity will rise. Several new charging stations were unveiled in Växjö in 2015, including the city's first quick charger.

Sustainable transport

Creating more attractive urban environments with less traffic can benefit both businesses and residents. Smart IT solutions – video conferencing is one example – are also important tools for reducing, for example, public sector travel. As more and more people choose to cycle or travel on public transport, public health will improve and sickness absence will fall. Fewer cars also lead to better air quality in our cities, towns and built-up areas. In the Greenest City in Europe community planning work on sustainable transport recognises the following hierarchy:

1. In the first instance there should be no need for transport
2. In the second instance the choice should be between walking or cycling
3. In the third instance public transport should be used
4. In the fourth instance a form of "green" vehicle should be used
5. Only in the last instance should other vehicles be used.

Växjö Municipality's current Transport Plan deals primarily with the first three stages above. The Energy

Plan focuses instead on creating conditions to stimulate the use of energy-efficient vehicles that run on renewable fuels.

Fossil fuel-free cars

At the end of 2014 there were just over 41,000 cars registered in Växjö: 8% of these (3,110 ethanol cars, 133 gas cars and 42 electric cars and plug-in hybrids) were equipped to run on electricity or renewable fuels. This puts Växjö in the front rank among Swedish municipalities.

Strategies and actions

Strategy A: Improved availability of renewable fuels

In the Greenest City in Europe renewable fuels must be readily available. Växjö Municipality is therefore working actively to initiate and support projects that increase and improve accessibility. The strategy includes the production and distribution of renewable fuels.

Strategy B: Increased proportion of "green" vehicles

Energy-efficient, climate-friendly vehicles are an important step towards making the Greenest City in Europe fossil fuel-free. This means that we give priority to activities to increase the proportion of vehicles that can run on renewable fuels or electricity.

Renewable fuel and energy-efficient vehicles

Action	*Beskrivning*	*Ansvar*
3.1	A thorough investigation will be made to determine whether it is possible to supplement the Sandvik CHP plant with a biomass gasification plant to significantly improve electrical efficiency and increase the production of electricity from renewable sources. This electricity has the potential to make a substantial contribution towards achieving Växjö's goal of a fossil-free municipality, a genuinely neutral energy balance and the use and production of genuine renewable energy. It also paves the way to creating the right conditions for a functioning infrastructure for the efficient production of renewable fuel in the form of electricity available through a local network of charging stations, plus locally produced hydrogen gas for fuel cells in an adjacent integrated production plant.	VKAB (Växjö Energi)
3.2	Växjö Municipality will contribute to the development of the regional biogas market by working with different stakeholders and through municipal involvement in a range of projects.	Technical Services Committee
3.3	Växjö Municipality will work to further improve the infrastructure for renewable fuels and charging facilities for electric vehicles. All municipal workplaces will offer charging facilities.	Municipal Executive Committee, Technical Services Committee and VKAB (all companies)
3.4	Charging facilities for electric vehicles will always be installed where new municipal premises and residential premises are built.	VKAB (all companies)
3.5	There will be coordination between municipal players outside Växjö to improve the infrastructure for renewable fuel and electricity.	Respective committees and administrations
3.6	Demonstration projects will be implemented in order to investigate the potential for using renewable fuels or electricity in the municipality's service vehicles, machines and plant, as well as in public transport.	Municipal Executive Committee, Technical Services Committee and VKAB (all companies)
3.7	When negotiating procurement contracts for vehicles, we will aim to buy energy-efficient, climate-friendly vehicles. A green vehicle strategy/policy will be prepared.	Municipal Executive Committee

Security of supply

In the Greenest City in Europe renewable fuels and electricity/heating produced from renewable energy sources are readily available and distributed to residents with good security of supply.

Introduction and situation analysis

The Municipal Energy Planning Act (SFS 1977:439) states that local authorities are to work for the provision of a secure and adequate energy supply. A "secure energy supply" means that the municipality must have a strategy for how to minimise risk of disruption to the energy supply. Today energy supplies are largely governed by market forces, and most of the deliberations about energy supply are made at national political level. There are, however, several areas where local authorities have an interest in and can exert an influence over issues related to energy supplies. Examples include an assessment of the effectiveness of the measures that are in place locally to avoid and overcome any disruptions in the electricity grid, the production and supply of district heating and supplies of renewable fuels.

The references the act makes to an "adequate energy supply" have their origin in the oil crises of the 1970s and may therefore seem out of date today. However, some municipalities are working towards the goal of being more or less self-sufficient in energy – for example, by taking a proactive approach to the production of cogenerated heating and power, wind power and biogas. It is extremely difficult to compile a comprehensive picture of all the risks relating to energy supply. Key question such as "which system perspective?" illustrate the problems. Is the focus solely on the municipal organisation itself, on the municipality as a geographical area, or on the municipality in the context of the wider region? War and unrest in oil-producing countries can have severe consequences for Växjö, yet the municipal authorities are powerless to exert any influence in such situations. That is why it is important to identify certain key areas and to focus on these in order to determine what action the municipal authorities can reasonably take.

All Sweden's municipalities are now also required to work with an emergency planning system for electric power, known as the Styrel – or "directed electricity" – system. This is to be implemented in the event of a shortfall in output so that supplies can be prioritised to electricity users whose access to power is critical from a societal perspective. Växjö Municipality has been working to develop its own Styrel plan.

Planning and preparation are essential in order to be able to respond well to a crisis situation. This means that there is a continuous need to analyse the risks and vulnerabilities in the municipality. In the municipal Risk and Vulnerability Analysis from 2015 each of the departments and companies in the municipal organisation analysed the risks and vulnerabilities within its own individual sphere of operations. The results were then compiled for the municipal organisation as a whole, and a risk assessment was made of events that can lead to severe disruption in the local community.

This study revealed one area of particular vulnerability as regards energy; namely, adequate access to and distribution (transportation) of suitable fuels for emergency operation in the event of disruption to or cessation of supplies. Certain of the vital societal functions for which the municipality is responsible – kitchens, senior citizens' homes and IT-based activities – do not have access to reserve power.

The Energy Plan includes strategies designed to safeguard the distribution of large-scale energy supplies (in other words, the functionality of infrastructure systems for electricity, heating and vehicle fuels), to ensure that energy supplies are always adequate, to guarantee the diversity of energy sources, etc. The Energy Plan does not, however, list what measures are to be implemented in the event that the infrastructure for supplying and distributing energy ceases to function, or what action is to be taken if energy supplies are no longer adequate. This is dealt with in other documents, such as the Risk and Vulnerability Analysis.

The production and supply of renewable energy is not only a climate issue, but also a matter of cost. Renewable energy means that the impact on the climate is reduced at the same time as we make ourselves less vulnerable to future rises in the price of fossil fuels. It should be recognised that work to optimise the use of resources plays an important part in reducing the costs that result from fossil fuels, and therefore, by extension, maximises the resources available for the municipality's core activities. Climate change and rising average temperatures increase the risk of weather-related events that can cause severe disruption to vital societal functions. The consequences of climate change and the effect this has on the operations and activities of Växjö Municipality have been analysed and compiled in a Climate Adaptation Plan. One of the areas analysed is "technical supply systems/ infrastructure", and one of the factors here that has been identified as being of particular importance is the increased need for cooling during the summer months.

Secure supply of adequate quantities of electricity, district heating and district cooling

In 1887 Växjö was the first local authority in Sweden to start to build a municipal electricity grid. Today Växjö Energi's electricity network comprises 300 kilometres of high-voltage cables and 950 kilometres of low-voltage cables. Most of the cables are subterranean. Växjö Energi serves more than 30,000 customers and the grid is an important component in the municipal infrastructure on which everyone relies. Reliability is very high – namely 99.99% – and work is taking place continuously to maintain and expand the network. Cable-mapping and surveillance in connection with tree-felling operations are two important aspects of preventive work but, despite everyone's best efforts, occasional misjudgements can result in power outages. In the winter months the possibility of shortfalls in output is a question that needs to be addressed. Responsibility for the electrical network in and around the urban area of Växjö lies with Växjö Energi Elnät AB, a wholly owned subsidiary of Växjö Energi. Växjö Energi Elnät AB is responsible for operating, maintaining, upgrading and expanding the network. Municipal residents outside the area covered by this electricity grid are connected to the E.ON grid.

Växjö Energi produces district heating, district cooling and electricity at a number of units at the Sandvik plant. Most of the production takes place in the Sandvik 3 cogeneration block and Sandvik 2, and in a heat recovery boiler in Sandvik 1, all three of which use biofuels. In addition, there is a reserve facility at the Sandvik site in the form of an oil-fired heat recovery boiler for meeting peak load demands. To safeguard the supply of heating, additional back-up plants are located at strategic points throughout the district heating network. These are not normally in use but are brought online only in the event of a fault at the Sandvik plant or somewhere along the intermediate district heating pipes. District cooling is produced at the Sandvik plant with the aid of district heating and at the Västra Mark plant. There are also back-up plants for district cooling at several locations in the district cooling network. In the event of a total electricity outage which leaves the entire municipality without power, electricity can still be supplied to certain

urban areas in Växjö by using the Sandvik plant as a new point of origin. How these deliveries are allocated depends on the decisions made by Svenska Kraftnät, the authority responsible for the safety and security of Sweden's electricity transmission system. When operating at full capacity the Sandvik plant can meet approximately two thirds of the maximum power demand from Växjö's electricity network.

Over the next few years Växjö Energi will continue to expand its network for supplying district cooling to companies and large properties.

Supply of vehicle fuels
Guaranteed secure access to vehicle fuels is an absolute necessity for a significant number of vital societal functions, including the fire service, police, ambulance and home care service. The resources that Växjö Municipality has through the Technical Services Department are sufficient to cover only a small portion of these needs. Another aspect of the supply of vehicle fuel is how to supply all the reserve power plants with fuel in the event of an emergency or a sudden shortfall in output. In this connection, it is worth mentioning that we currently have only one public filling station for biogas in Växjö. Consequently the need for more biogas filling stations should be borne in mind in the ongoing work of securing supplies.

Strategies and actions

Strategy A: Adequate access to renewable energy
Competition for renewable energy is accelerating as global demand rises. The long-term consequences for the Greenest City in Europe can be reduced access to energy sources and higher energy prices. By taking measures to combine the effective use of renewable energy with an increase in local energy production, we are reducing our vulnerability to the negative consequences of increased competition.

Strategy B: Securing energy supplies
In the Greenest City in Europe we secure supplies of energy to end users.

Security of supply

Åtgärd	*Beskrivning*	*Ansvar*
4.1	A strategy will be prepared to safeguard the delivery of district heating, electricity and district cooling at levels sufficient to meet customer needs, and to ensure that supplies of heating, cooling and electricity from renewable energy are sufficient to meet customer needs.	VKAB (Växjö Energi)
4.2	Measures specified in the risk and vulnerability analyses compiled by the municipality and municipal companies will be implemented with the aim of ensuring an adequate supply of electricity, heating, cooling and fibre optic provision in both urban and rural areas.	Respective committees and administrations


Lännen

Collaboration within and beyond the borders of Växjö Municipality

Växjö Municipality uses its connections with business community as a way of actively supporting companies' efforts to make more effective use of energy. This is one of the factors that contribute to the fact that Växjö also has Europe's Greenest Business Community.

Växjö Municipality needs help from the world around it in order to achieve its environmental goals. Chapter 5 shows that the work that Växjö Municipality carries out in energy issues is part of a larger context of both local, regional, national and international networks.

The EU Energy Roadmap 2050 aims to cut carbon dioxide emissions by 80% by compelling all sectors to change their carbon dioxide footprint. Sweden goes even further and aims for zero emissions of greenhouse gases by the same deadline. This political agenda creates great pressure. A great deal of work and a fundamental change in behaviour across the whole of society are essential in order to succeed.

Local and regional networks

Sustainable Småland

Sustainable Småland is a cooperative association and business network, whose members include companies and stakeholders in academia and the public sector, all of whom are actively committed to sustainable development. Members from different industries and sectors of society are motivated by many different factors and are able to contribute different insights. The network is active in the fields of sustainable energy supply, sustainable buildings and homes, and sustainable transport solutions. The network exists to strengthen and share members' environmental expertise and to develop sustainability projects in the region. The association is involved in a handful of ongoing projects in these core areas. Close and effective cooperation between members lays the foundation for and contributes to the region's development towards a fossil-free society.

Linnaeus University

Linnaeus University is a relatively recent newcomer among Sweden's higher education institutions. The university has campuses in both Växjö and Kalmar, where approximately 31,000 students are studying a total of 150 degree programmes and 2,000 single-subject courses. The prime role of the university is to provide general basic knowledge in specialist disciplines such as labour market policy, energy technology, welfare issues

and entrepreneurship, bioscience and aquatic ecology. The university also possesses cutting-edge expertise in fields such as local district heating systems, property heating, and fuel and energy logistics – all of which generate knowledge that is highly useful in helping Växjö Municipality to achieve its goals.

In addition, the university offers in-service training both for local government officers and planners, and for maintenance and operations staff in municipal companies. This training aims to help those concerned to make the most effective use of energy and to reduce environmental emissions from municipal activities.

The Växjö Declaration
The Växjö Declaration has been produced and endorsed by the Sustainable Småland business network, Linnaeus University and Växjö Municipality. It is addressed to the Swedish government and European local authorities. Business community and the public sector in Växjö stand fast by the high ambitions they have in terms of the environment and climate. Växjö aims to be a fossil fuel-free municipality by 2030. To achieve that aim, however, Växjö needs help from other quarters. We have identified the Swedish government as a key player in this, but also other local authorities in Europe, so that we can together be a positive driving force for tackling climate issues throughout Europe.

Bioenergy Group
Since it was founded in 1996 the Bioenergy Group in Växjö has worked to develop bioenergy in the south of Sweden. Today the Group comprises a handful of members active in bioenergy consulting and in the manufacture, distribution and supply of bioenergy.

Since 1996 the Bioenergy Group's work has focused on supporting progress in the field of bioenergy by conducting research, stimulating development and education in technical bioenergy issues and working closely with Linnaeus University and regional business community.

GodaHus
This organisation ("Good Houses") was founded in 2009 and aims to support work to develop more energy-efficient buildings in south-eastern Sweden. The approach that the organisation has chosen is to initiate research and development projects in accordance with the Triple Helix model, together with Linnaeus University and public and private sector stakeholders in the region. The organisation acts as the hub for this work.

GodaHus has a vision of establishing a reputation for south-eastern Sweden as a centre for energy-efficient buildings.

GreenCharge Sydost
GreenCharge Sydost is a research and demonstration project which entered Phase 2 at the end of 2015. The project brings together Miljöfordon Syd (the regional association for green vehicles in the south of Sweden) with researchers at Blekinge Institute of Technology (BTH), 26 local authorities, three county councils, four regional administrations, four county administrative boards and a large number of companies in south-eastern Sweden. The aim of the project is to increase knowledge about and pave the way for a sustainable introduction of electric plug-in vehicles and the accompanying charging infrastructure in south-eastern Sweden (Småland, Blekinge, Öland and northern Skåne).

The focus is on the customer benefits of plug-in vehicles (simplicity, availability, cost-effectiveness). The project seeks to identify success factors and remove obstacles in order to make investing in electric vehicles a more natural choice for ever larger groups of consumers. With the support of the local authorities and the implementation process described above, it is hoped to create a regional network that will provide opportunities to exchange experiences and conduct analyses and field tests of the financial, technical and environmental consequences for electric vehicles and transport systems if, for example, half of all private cars in the south-east region were to be replaced by electric vehicles by 2030.

Bo-IT
The municipal Elderly and Disabled Care Services, Wexnet (broadband network), Region Kronoberg and

possibly some of the municipal companies are working to create an open, widely available IT infrastructure that offers a broad spectrum of services for tomorrow's homes. Bo-IT focuses on the introduction of sustainable technology across a broad front to make it easier for patients discharged from hospital to recuperate at home, thus avoiding the need for them to be taken into care homes. Bo-connect is a new branch on the Bo-IT tree that liaises on the development of services designed to make everyday life easier for municipal residents, to enable them to enjoy greater independence and to remain in their own homes longer than they are able to do so today.

National networks

Climate Municipalities

Climate Municipalities (Klimatkommunerna) is a network for municipalities, county councils and regions that work actively with climate issues at their respective local level. The association's 35 members are leading the way in climate work in Sweden and worldwide with tough climate and energy targets and ambitious programmes of measures.

The overarching aim of Climate Municipalities is to reduce greenhouse gas emissions in Sweden by exchanging experiences, sharing good examples and lobbying at national level. The network is a proactive participant in national climate work, highlighting the opportunities that exist, the obstacles to be overcome and the driving forces that are essential to achieve the desired results. Since the association was founded in 2003 it has grown to now represent more than 3,500,000 of Sweden's inhabitants.

Swedenergy

Swedenergy (Energiföretagen Sverige) is an industry association formed by the coalition of Svensk Energi and the Swedish District Heating Association (Svensk Fjärrvärme). Its members produce, distribute, trade and store electricity, heating and cooling. The association's main aim is to secure good commercial conditions for its members, whose activities seek to promote sustainable, resource-efficient energy systems. Swedenergy is active at local and national levels, as well as internationally. An important part of the association's activities is to offer service to members in the form of specialist support, business intelligence, technical development, education, conferences, etc., in order to develop competence within the industry and meet the challenges ahead.

Regional Energi

Regional Energi is a network of 19 municipally owned energy companies that works to promote regional collaboration, investments, employment opportunities and sustainable development. The long-term clarity and predictability of the regulatory framework is essential to provide a stable foundation for energy operations, and the network therefore works to raise these issues on the national political agenda.

Fossil Free Sweden

Fossil Free Sweden is a Swedish government initiative that aims to help Sweden to become of one the world's first fossil-free welfare countries – not only because this is a moral obligation we have to future generations, but also because it makes sound economic sense. To achieve this aim, however, all aspects of society need to work together to reduce emissions. Through the Fossil Free Sweden initiative, the government seeks to mobilise the whole of Swedish society to become committed to climate work, while also giving the business sector, municipalities and organisations the opportunity to showcase the contributions that they are making to climate change work.

International networks

Energy Cities

Energy Cities is a thematic network for European cities that are working with energy issues, renewable energy, energy efficiency programmes and the planning of sustainable energy systems. Växjö is an active member of the network and has a seat on the board.

ICLEI

Local Governments for Sustainability (founded in 1990 as the International Council for Local Environmental

Initiatives, ICLEI) is an international environmental organisation with 500 member cities worldwide. ICLEI represents the world's municipalities at UN negotiations on environmental issues. There are various thematic networks, such as the Network for Energy Procurement that local government officers from Växjö participate in.

Covenant of Mayors
Växjö Municipality became a signatory to the Covenant of Mayors in 2008. This is a commitment that goes further than the EU's climate goals in terms of reducing fossil carbon dioxide emissions through energy efficiency improvements and cleaner energy production techniques. Some 50 Swedish municipalities and many thousands of cities throughout the EU have now committed to the Covenant of Mayors.

Mayors Adapt
Mayors Adapt is a European Commission initiative from 2014 that seeks to emphasise the importance of municipal commitments in making the EU better adapted to climate change. Växjö joined this collaboration on 28 August 2014. Växjö Municipality adopted a Climate Adaptation Plan in April 2013.

Union of the Baltic Cities (UBC)
This network of some 100 member cities in the Baltic Sea region seeks to create a dynamic region where sustainable development is at the forefront on all levels. Work is carried out through seven commissions, and energy issues are dealt with in the UBC Sustainable Cities Commission. Växjö is one of 18 member cities from Sweden and represents other Swedish member cities on the board.

Plats för egna anteckningar

Never before has humanity used as much energy as we do today. And yet we know that supplying and consuming energy impacts on the natural environment and our health in many different ways.

The only sustainable solution is to use renewable energy and to reduce our energy consumption so that renewable sources are sufficient to meet everyone's needs.

That's why energy efficiency – employing better technology or adopting other methods that use less energy to achieve the same result – is so important.

One key principle in all of this is that every kilowatt hour that is not used will be both cheaper for the consumer and kinder to the planet!

The Energy Plan for Växjö Municipality explains the municipal organisation's strategy for dealing with this issues.

Växjö kommun

The Greenest City in Europe

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