

EGCA 2018, Umeå, Sweden

11. Energy performance

One of Umeå's strategic objectives is sustainable growth to 200,000 inhabitants by 2050. One implementation of this is the total energy use, which has remained constant since 1990, a de facto 22% city-wide reduction of energy use/capita, inspired by *EED-directive (2012/27/EU)*.

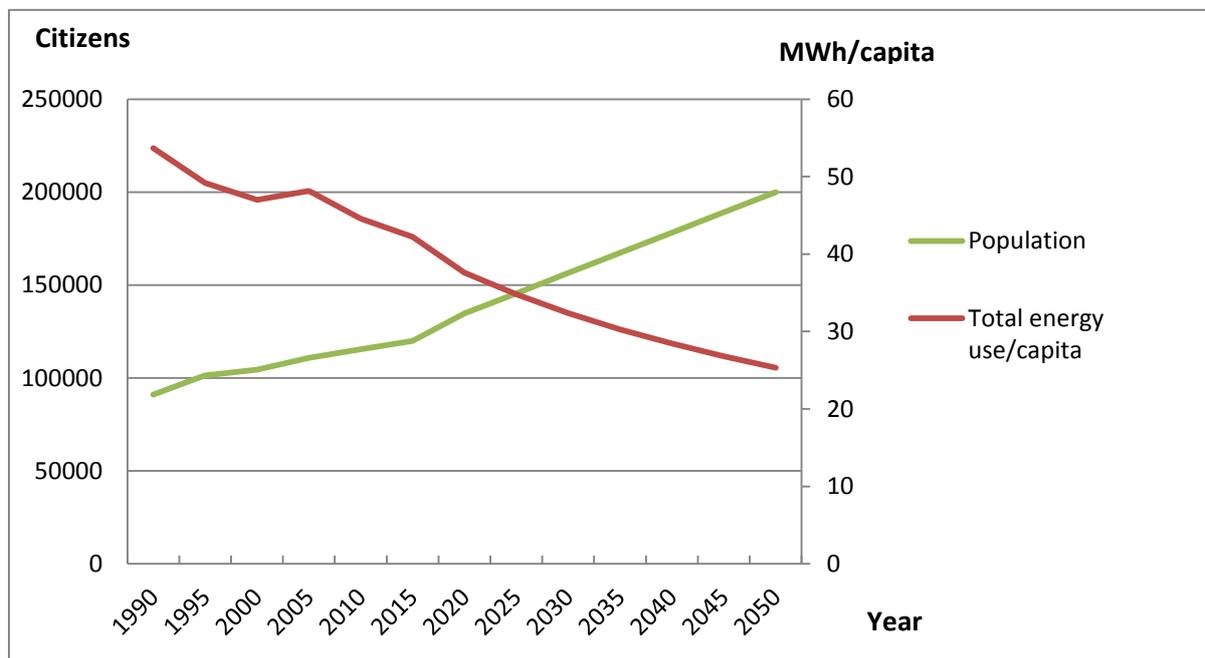


Figure 11A. Energy use/capita and population increase in Umeå 1990–2013, and 2050 projections.

11A Present situation

Indicator		Unit	Year of data
Final Energy Consumption	4988367	MWh	2013
Final Energy use/capita	42150	kWh/capita	2013
Final Energy usage /sector			
Ag & Fisheries	1,4	%	2013
Industry & Commercial	42,2		
Transport	19,2		
Domestic	21,3		
Services	15,9		
Other			
Total	100		

11A1 Present total final energy consumption by sectors.

As a fast growing city the majority of the building stock in Umeå dates after the 1960s. With a relatively cold climate, heating is a major part of the energy used in buildings.

Since the 1960s the city has made considerable investments in creating a city-wide district heating network. The comprehensive plan outlines the city's strategies to integrate new sustainable buildings in housing areas within existing infrastructures such as district heating, electricity and public transport networks. A complementary challenge to reach the EPB-Directive(2010/31/EU) is the transformation of existing buildings to become more energy-efficient.

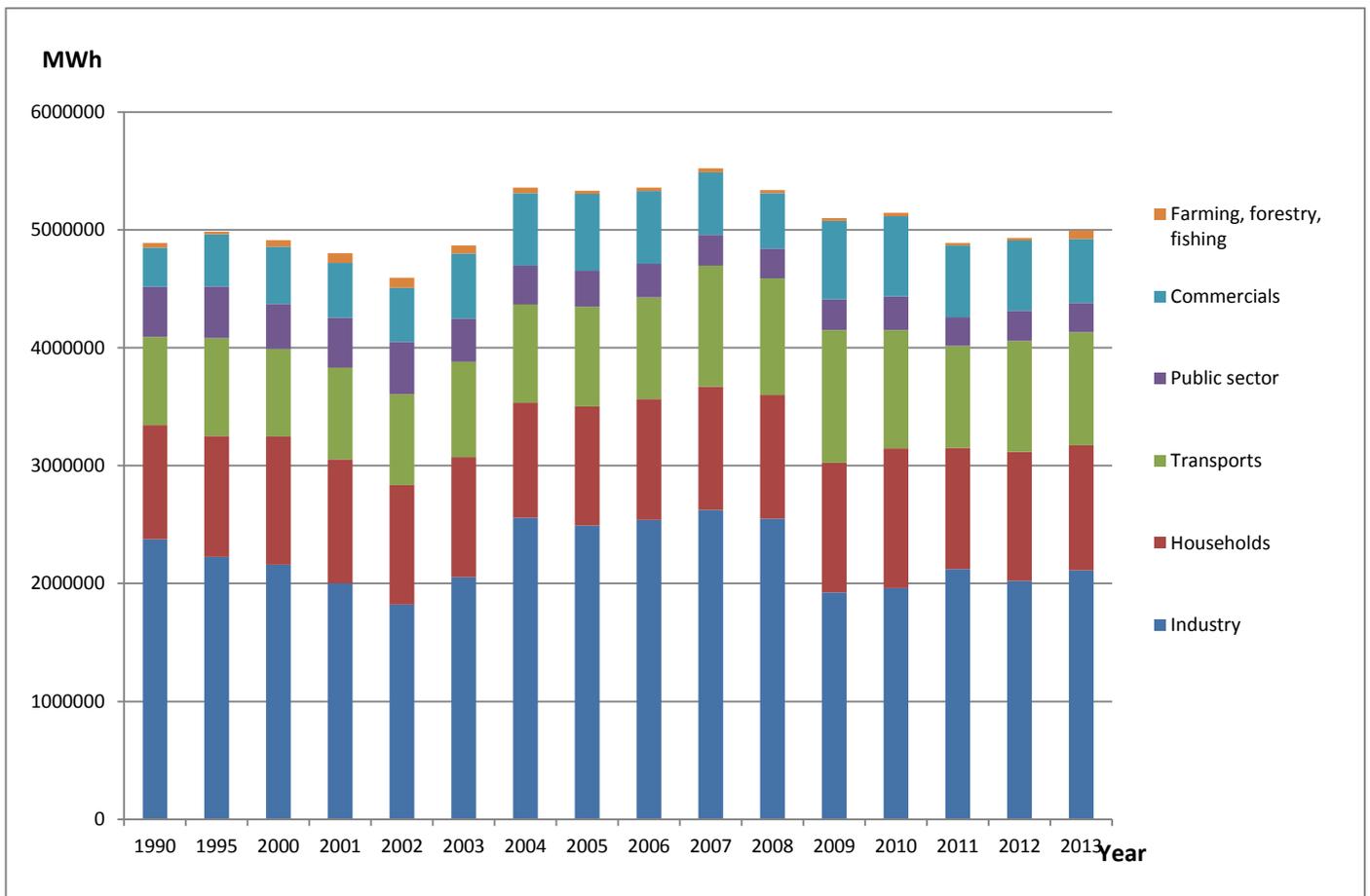


Figure11A1. Total energy use per sector. 1990–2013, data from Statistics Sweden.

11A2 Past development of energy consumption and current plan for future energy efficiency improvements and decreasing the use of energy

11A2a Energy performance of municipal buildings

Umeå was Sweden's first municipality to work systematically with an energy management system and is EN16001-certified. The municipality owns 700,000m² buildings. Energy use has been reduced by 20% since 2001; the city monitors energy performance in all municipal buildings.

Bostaden, the municipality owned housing company, manages 1,300,000m² rented apartments, 40% of all apartment buildings in the city. Bostaden targets 20% reductions in overall energy use by 2020 compared to 2007 with 8% decrease in 2014.

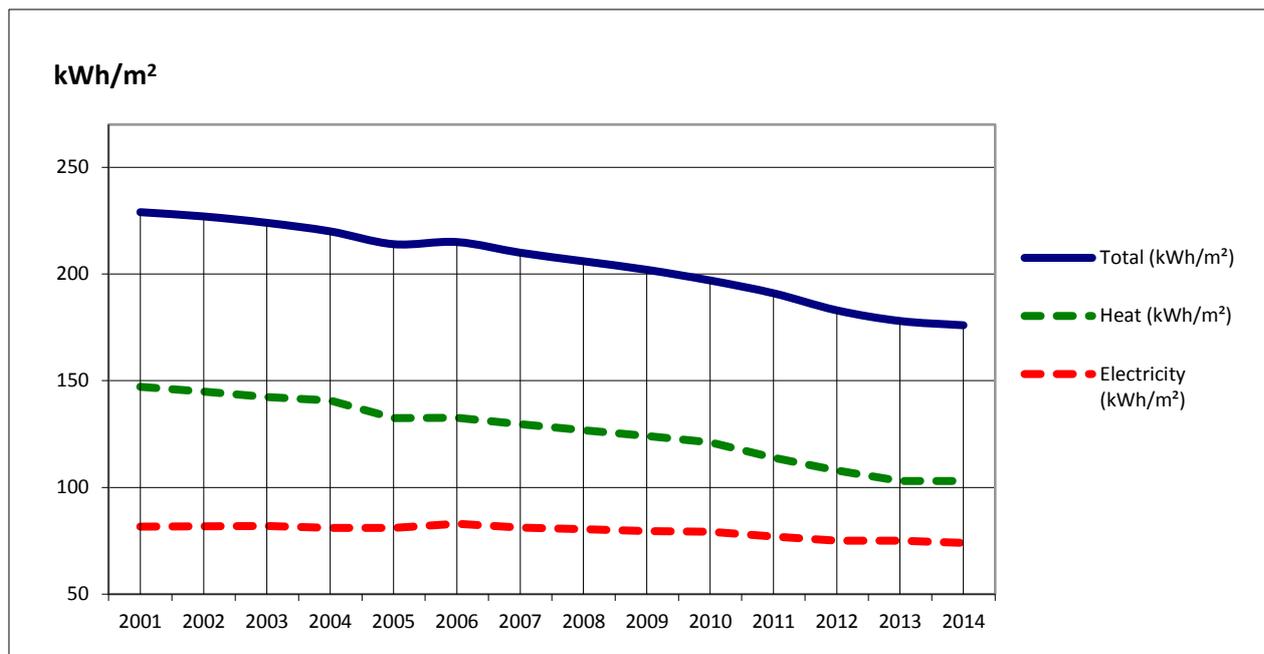


Figure 11A2. Energy use in municipal buildings 2001–2014 [kWh/m²/year]

11A2b Important developments related to other end-use sectors besides the building sector

Umeå pioneers in including energy in its environmental inspections. Several projects for manufacturing companies have focused on energy efficiency and use of renewable energy. Over 75 companies have been supported. 2008–2014 surveys shows that the companies use of oil have decreased with 60% after the inspections.

Since 2005 public transport journeys has increased by 57%. Umeå is investing in fully-electric buses and by 2019 more than 70% of the bus fleet will be electric.

Norrmejerier, northern Swedens dairy co-operative owned by 530 local farmers, targets fossil free dairies in 2017 by investing in energy-efficient equipment and gradually switching to renewable energy.

11A3 Present situation, development and current plan for the energy supply mix

Umeå Energi, the municipal utilities company, offers 100% renewable electricity to its customers, with Guarantees of origin. Umeå is a **net exporter of renewable electricity**, with an annual production of 2300GWh, far exceeding the 1500GWh electricity used locally. Electricity production in Umeå comes mainly from Stornorrfor's hydropower plant (Sweden's largest, 25% city-owned), complemented by a dramatic expansion of CHP, wind power, and photo-voltaics in recent years.

The regional comprehensive plan for wind power suggests locations with a potential production of 620.000MWh/year. 14 wind turbines (28,6 MW) are running in Umeå today.

For DH-heating, the share of renewables have increased from 71% (2008) to 80% (2014).

This will improve further by increasing share of bio-fuels, changes in waste fraction composition.

Total Heating [GWh]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total energy, district heating	913	900	900	946	954	963	1000	1135	981	1049	995
Biofuels	74	45	78	72	78	79	91	110	107	103	99
Heating oil (excl. Industry)	118	90	125	122	70	57	103	91	53	24	35
Total energy heating	1105	1035	1103	1140	1102	1099	1194	1336	1141	1176	1129
Renewable energy, district heating	543	547	550	619	615	684	750	885	755	829	796
Biofuels	74	45	78	72	78	79	91	110	107	103	99
Total renewable energy, heating	617	592	629	691	692	763	841	995	862	932	895
Share of renewables	56%	57%	57%	61%	63%	69%	70%	74%	76%	79%	79%
Electricity [GWh]							2009	2010	2011	2012	2013
Total energy							2610	2668	2970	3249	2436
Renewables							2567	2595	2930	3192	2401
Share of renewables							98%	97%	99%	98%	99%
Municipal buildings [GWh] (Electricity and heating)							2009	2010	2011	2012	2013
Total energy							343	344	345	317	305
Renewables							279	288	297	272	265
Share of renewables							82%	84%	86%	86%	87%

Table 11A3: Energy supply mix, 10 year trend. Renewable/non-renewable mix for electricity and heating in municipal buildings vs total. Data from Statistics Sweden.

11A4 Current plan for integration and performance of renewable energy technology in municipal buildings and homes compared to total energy use

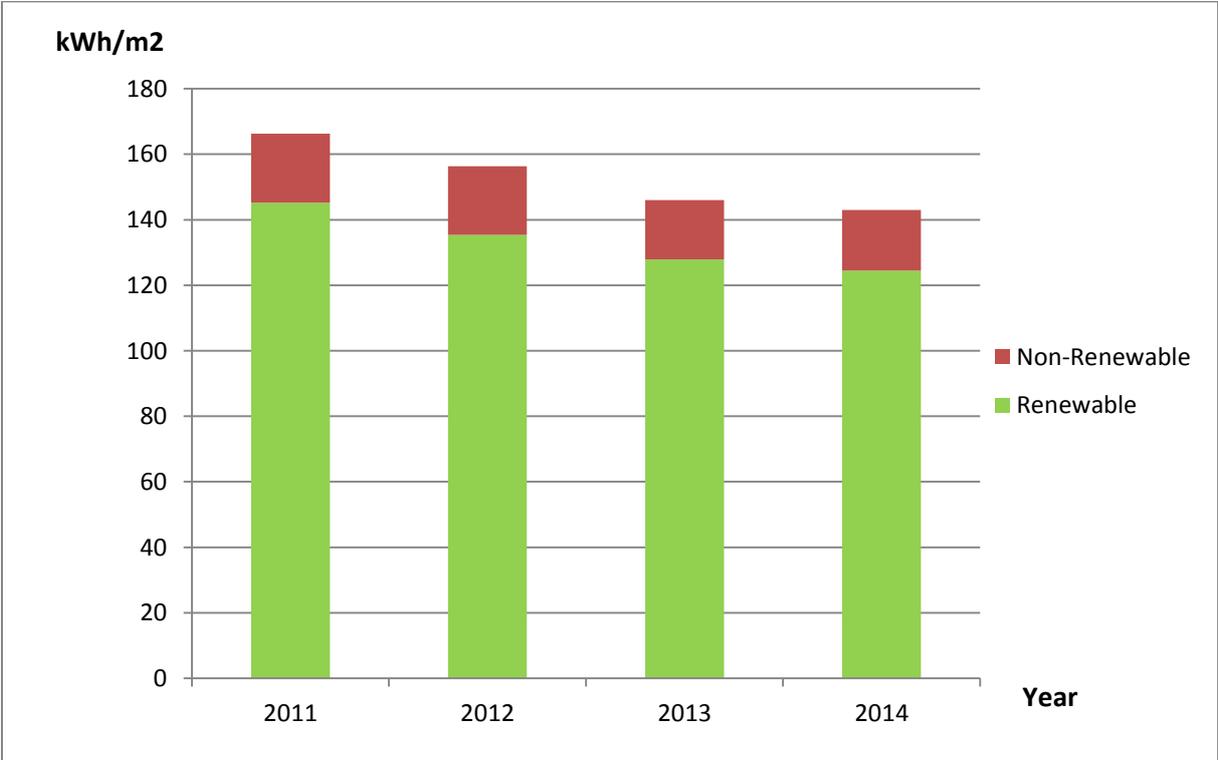


Figure 11A4. Energy use in municipal buildings and homes 2011–2014. Renewable energy use [kWh/m²] compared to Non-Renewable energy use [kWh/m²]. Umeå’s energy system far exceeds national targets in Renewable Energy Directive(2009/28/EU).

Bostaden purchases all electricity used for property management from renewable sources, including five self-owned wind power plants, and is highly connected to the district heating network.

Current renewable approaches involve cutting oil use for district heating (1% today), using a peak load management scheme and gradually switching to bio-based oil.

11A5 Development and plan for integrated district heating energy compared to total energy use

For DH-heating, total production is about 1000GWh/year or 30% of Umeå’s total energy use.

Today 80% of the buildings in Umeå are connected and nearly all municipal buildings are connected to district heating, buildings located outside the network use bioenergy or heat pumps. One of the challenges ahead is strategies for connecting areas of low-energy housing needing less heating to the network.

11A6 Application of innovative technologies

The city is changing old public lighting to more efficient, in line with the EDD-directive (2009/125/EC). The stock today consist of 75%high pressure sodium, 11%metal halide, 6%LED, 5%mercury vapor and 2%fluorescent. During 2015 all mercury-vapor lamps will be phased out.

Bostaden is changing to LED-technology and induction lamps. This initiative has saved more than 1GWh since 2011.

11B Past performance

11B1 Attempts to improve the energy performance above national requirements

The municipality and Bostaden have both decided that energy use in new buildings shall not exceed 65kWh/m²/year, compared to national guidelines for northern Sweden 130kWh/m²/year, as contributions to *EPB Directive (2010/31/EU)*.

Sweden's largest EPC project

In 2008, an Energy Performance Contracting project was adopted. One of Sweden's largest energy efficiency projects in existing buildings, in order for Umeå to reach the EED (2012/27/EU) target. The project includes 130 properties and 425,000m² floor areas, 50%+ of total area of the municipality owned buildings. Total investment is 140MSEK. The project has a calculated energy reduction of 20% and decreases CO₂-emission by 5,800ton/year.

Unique pre-school passive house with gender equality education

The newly built Hedlunda pre-school is the world's northern-most and northern Sweden's first certified public passive house. The building goes way above national standards on energy use, using less than 15kWh/m²/year for heating. It is certified according to BREEAM and the national standard *Miljöbyggnad*, using environmentally friendly building materials and building process. Sustainability is the focus area also in the education with a special gender equality direction.

Sustainable Ålidhem – Award winning neighborhood

Sustainable Ålidhem is a national pilot project focusing on large-scale sustainable renovation of 1960s and 1970s buildings, side-by-side with new low-energy buildings. The overall objective is to transform Ålidhem into a more sustainable neighborhood by halving the energy use in the area with sustained rent levels. About 400 kW of photo-voltaic cells have been installed, which will supply the area with a third of the building electricity, northern Swedens largest PV-installation. The project is a co-operation between Bostaden, Umeå Energi, and the municipality. Umeå University coordinates an integrated research and monitoring project using open data from the project partners. The project won the *Sustainable Energy Europe award* in 2013.

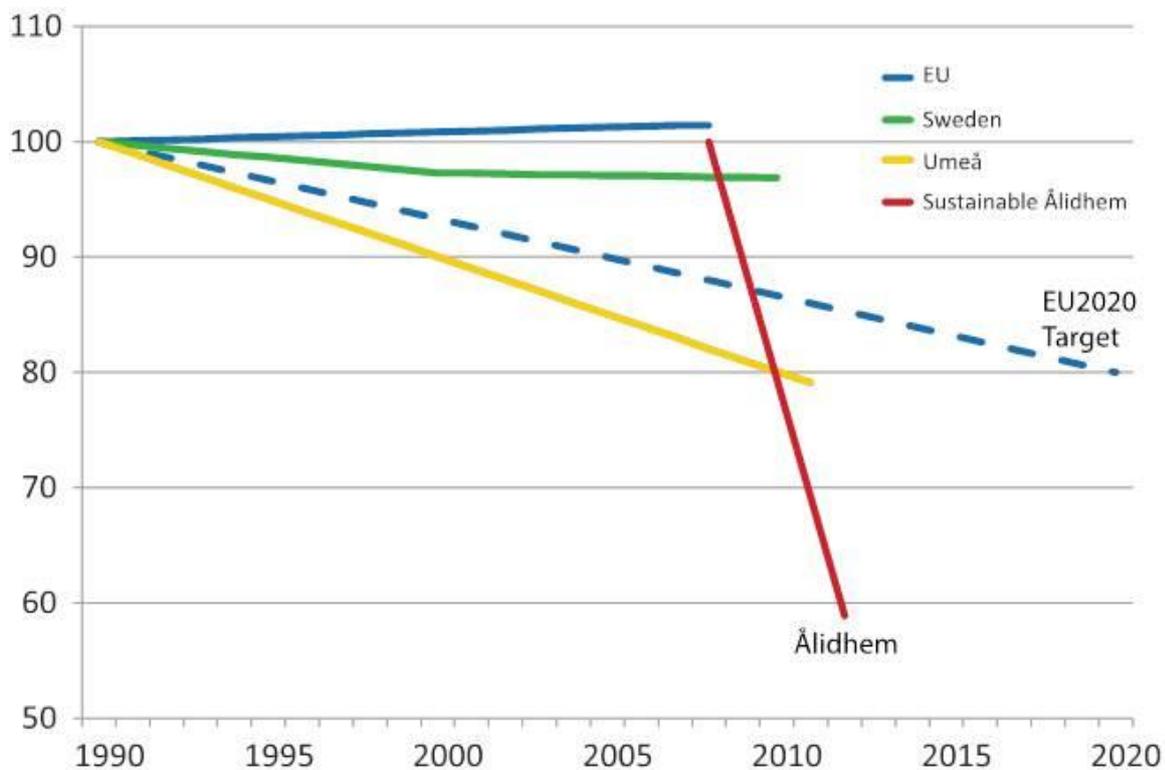


Figure 11B1. Energy use per capita. Comparison between index trends for EU, Sweden, Umeå and the Sustainable Ålidhem project that accomplishes a more than 40% reduction in energy use in just five years.



Figure 11B2. Students are building the northern-most single family houses certified to passive house standard. To meet future energy regulations it's important to educate craftsmen with the know-how and workmanship needed to go the extra mile.

High school students learn future building techniques

Students from the Dragonskolan high school construction program are learning to build low energy and passive standard houses. These are the first passive house villas in Sweden to become environmentally certified, the students will construct six passive houses in the project.

On-line map for solar energy potential

Despite the dark winter time, the preconditions for solar energy in Umeå are good (950kWh/m²). The municipality and Umeå Energi has created an online map for solar energy potential of every building in the city area, a way for house owners to visualize the potential for producing own energy from the sun.

Umeå Energi also offers solar PV-packages for both small houses and larger residential buildings.

11B2. Maximizing and prioritizing use of renewable energy technology in municipal buildings & homes

Strategy / action plan	Area	Adopted
Strategy for energy and climate for Västerbotten	Regional	2012
Action plan for decreasing greenhouse gases in the municipality’s own buildings and transports	Local	2009
Energy plan for sustainable development	Local	2003

Table 11B2. The city’s three relevant city-wide strategy documents for renewable energy

The action plan for decreasing greenhouse gases contains 28 different actions in areas like building, energy efficiency, waste, transports and planning. In 2011 Umeå also signed the Covenant of mayors to underline its ambitions to reduce energy use.

Astonishing 99.8% of the municipal buildings and homes are connected to district heating or heated by other renewable energy sources. One core strategy for improvement of renewable energy use in municipal buildings is therefore made on the system level by increasing renewables in the district heating of Umeå, thereby making an impact on city level.



Figure 11B3. The drastic change in the city “chimney-line“ from the 1960s until today with the expansion of a city-wide district heating network.



Figure 11B4. Dåva 2 Biofuel combined heat and power plant, opened in 2010.

In 2010 a new CHP plant was opened using biofuels such as logging residues, wood chips, bark, sawdust and peat. The facility dramatically reduces the amount of oil in Umeå Energi's fuel mix down to 1% (2014). Biofuels suppliers have to follow sustainable criterias, regarding both ecological and social development.

Bostaden is securing its supply of renewable electricity by purchasing five wind power plants and building the largest PV-plant in northern Sweden, together supplying 59% of the electricity used in buildings.

11B3. Measures to facilitate integrated district systems and a more sophisticated city wide control

The district heating grid is monitored and controlled by a central control unit which also can control and start auxiliary heat units on the grid. Umeå Energi has started a peak load management project to cut system-oriented peaks in oil use in the district heating system, occurring at extreme cold temperatures during the year.

11B4. Measures to improve the city's overall energy demand performance

- A network for sustainable construction and real estate management in cold climate includes companies, organizations and the public sector in a joint effort to create markets for sustainable buildings in northern Sweden. The network started in 2009 and is an important force for a more sustainable Umeå region.

- The municipality provides free energy and climate advice for companies, organizations and citizens. The main purpose is to raise awareness on climate change and give personalized advice on how to switch to more sustainable lifestyles.
- Bostaden, UMEVA and Umeå Energi collaborate with Umeå University to jointly develop conditions for research on sustainable city development. This collaboration has also secured funding for a professorship dedicated to energy efficiency.

11C Future Plans

11C1 City strategy to achieve 2030 and 2050 goals (energy efficiency and % renewable energy share of total energy supply)

	1990	2013	2050 projection
Energy use buildings, equipments/facilities& industries (MWh)	4141381	4029832	3732257
Energy use Subtotal transport (MWh)	748118	958535	1272758
Total energy use (MWh)	4889499	4988367	5005015
Population	91085	117294	200000
Total energy use (kWh)/capita	53681	42149	25025

Table 11C1. Umeå energy consumption 1990–2013, and 2050 population projections, connected to Umeå's sustainable growth objective.

In 2007 Umeå signed the Aalborg Commitments and in 2011 the Covenant of mayors to underline its ambitions to reduce energy use. The municipality is a part in the regional vision to be world leaders of sustainable construction and building maintenance in cold climate by 2020. The vision is developed together with relevant industrial practitioners, public sector and academia. Based on these objectives the city currently has two action plans in place, mentioned in 11B2.

In all new buildings Bostaden charge tenants individually for electricity, cold and hot water, visualizing their consumption on a display in the apartment. This gives the tenants incentives on energy savings.

Some key overarching strategies and objectives include:

Visions and objectives	
Umeå's growth is reached with social, ecological and economic sustainability aiming towards the vision of 200,000 citizens in 2050.	Local
Umeå – Target for energy reduction in municipal buildings updated to 20% reduction from 206kWh/m ² in 2008 to 165kWh/m ² by 2020	Local
All new buildings owned by the municipality and Bostaden shall not use more energy than 65kWh/m ² , compared with the national legislation guidelines of 130kWh/m ² .	Local
Umeå – CO ₂ -emissions from fossil fuels shall be reduced by 50% 2025 compared to 1990.	Local
Umeå energi – Climate neutral energy system in 2018	Local
Bostaden – reduction of energy use by 20% to 2020 compared to 2007	Local
Bostaden – all own-produced and purchased energy to be renewable by 2016.	Local
In 2011 Umeå signed the Covenant of mayors initiative to underline its ambitions with an aim to meet and exceed the European Union 20% CO ₂ reduction objective by 2020	European
<p>Swedish environmental objectives</p> <ul style="list-style-type: none"> ○ 20% reduction in energy use by 2020 compared to 2008. ○ 49% renewable energy of total energy by 2020. ○ 40% reduction in GHG emission by 2020 compared to 1990. ○ Net zero-emission of GHG on national level by 2050. ○ Fossil fuel independent vehicle fleet by 2030. 	National

Table 11C2. Visions and objectives for further energy efficiency and share of renewable energy in Umeå.

Planned electricity measures

Estimated theoretical wind power potential from the *Comprehensive plan for wind* for the Umeå region is 620.000MWh electricity/year (40% of electricity use in Umeå).

The potential for solar power for the city area has been calculated to 50 000 MWh or 350 000 m² roof area that's considered suited for future expansion of solar power.

Reduce the loss in the electric grid by 4% from 2012 to 2018.

Further adaption to future smart-grid solutions by installing meters with on-line communication at several powerline stations around the city.

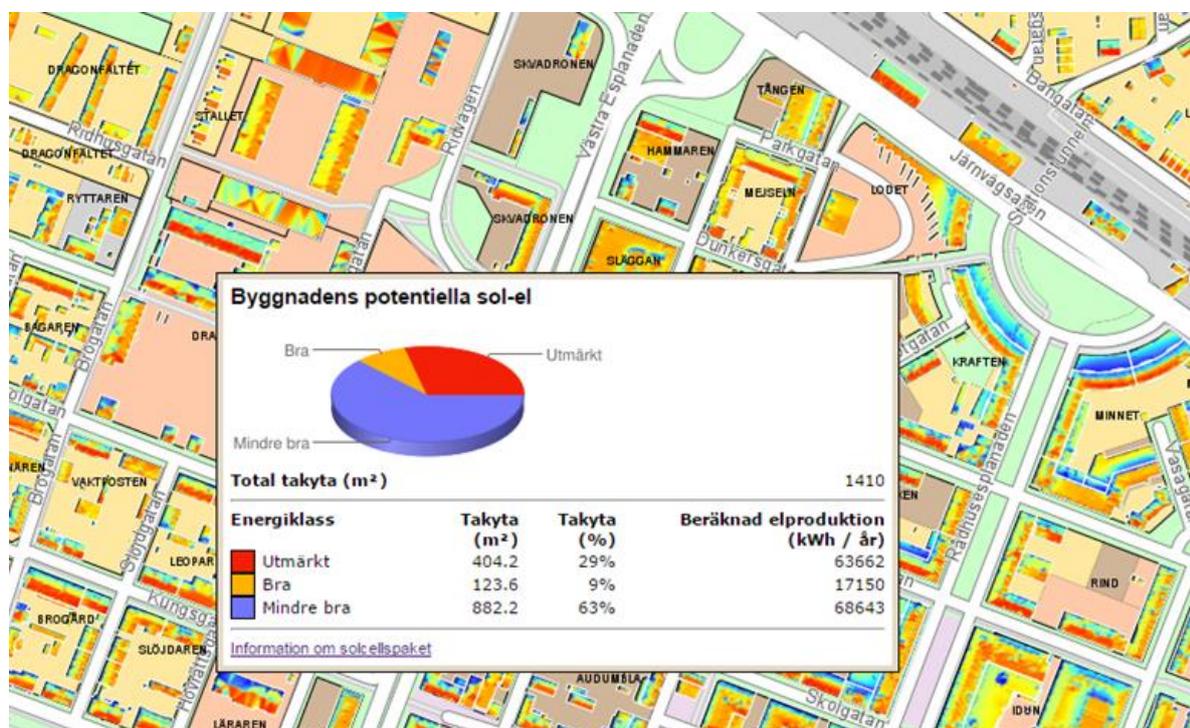


Figure 11C3. An online map for solar energy potential of every building in the city area shows the potential for solar power in the city.

Planned district heating measures

Cutting oil use for district heating (1% today) using a peak load management scheme and gradually switching to bio-based oil.

Future development in district heating: The municipality plan for Umeå with 200.000 inhabitants by year 2050. Planning to meet these new conditions is under progress.

11C2. The city strategy regarding renewable vs non-renewable energy mix, as well as of the renewable energy mix per se (the percentage of different renewable energy sources). Describe the dynamics of energy mixes for at least the coming two decades, preferably add diagrams to describe this dynamic development.

Twenty-year dynamics for energy-mix is not available, figure 11C2 show ten-year projections. The strategy for increased renewable use is to reach the objectives listed in Figure 11C2 by annual improvements.

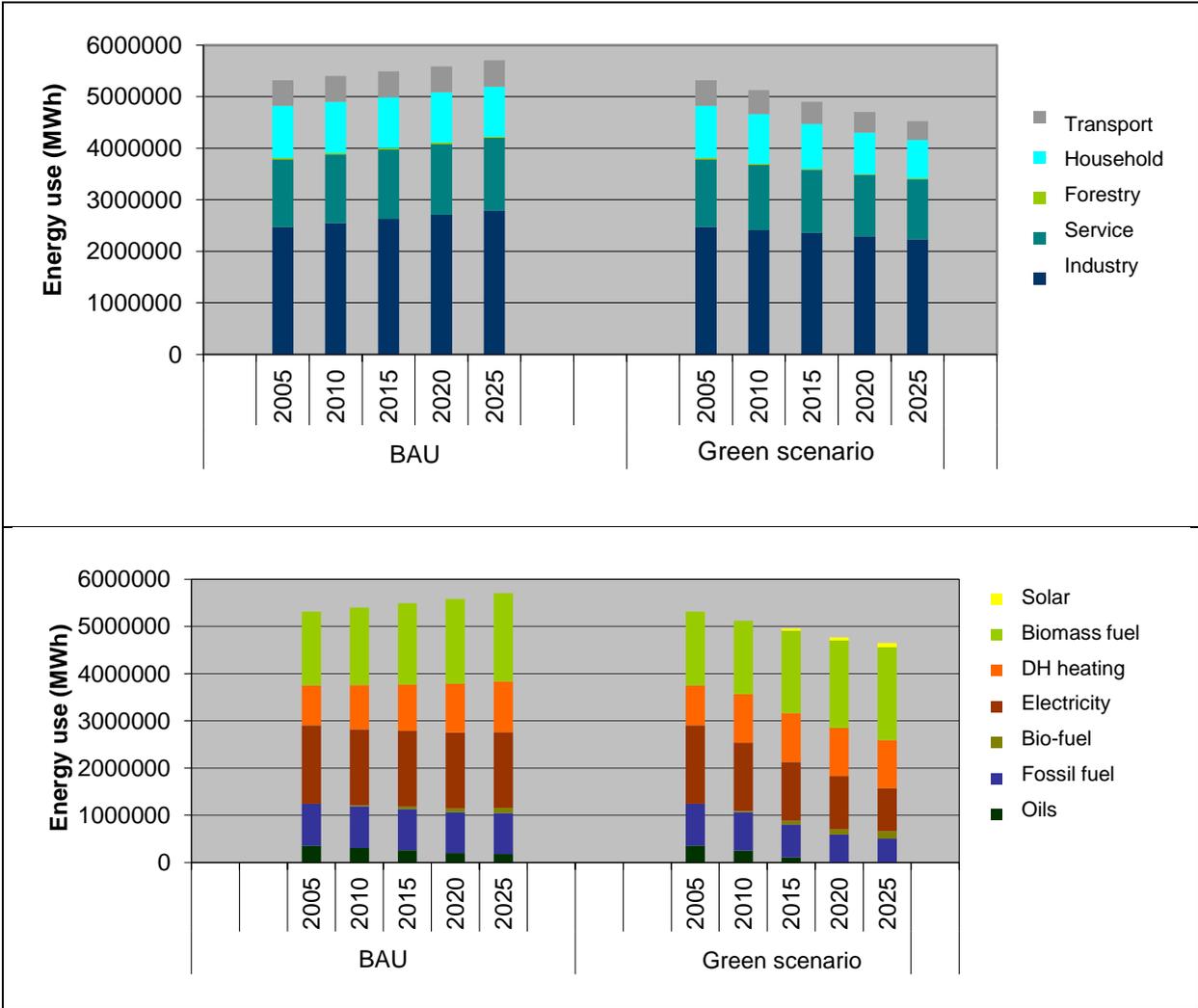


Figure 11C4. Two Umeå energy scenarios from 2005 to 2025 – Business as usual (BAU) compared to “Green scenario” Source: Nenet, the north Swedish energy office (in Swedish)

- a. Sector: Private transport, household, forestry, service, industry
- b. Source: Solar, biomass fuel, district heating, electricity, bio-fuel, fossil fuel, oils

11C3. Other measures affecting the total energy use in the city, e.g.

- urban morphology and import and export chains
- changes in transport and communication systems,
- industrial practices

The city comprehensive plan includes **transport and infrastructure**, outlines planned changes for the urban morphology with an outlook to 2050. The development strategies include growth in public transport corridors and a densification of the city within a five-kilometer city limit.



Figure 11C5. In 2016 nine new fully electric buses with ultra-fast charging technology will operate the public transport system of Umeå. In October of 2015, Umeå received the CIVITAS Award for Technical Innovation for the initiative.

In a growing city, added pressure is put on the transport system. With Umeå's well-developed renewable electricity network, opportunities for electric vehicle transport solutions are excellent. Existing and planned development initiatives include:

- Designated semi-quick charging places for PEVs are scattered in car parks and other strategic locations, a dozen more will be operating in the coming year. By 2016, municipal energy company Umeå Energi in cooperation with fuel company OKQ8, will have three quick-charging stations installed. Umeå Energi is also developing a product for those who want to provide the opportunity for their customers to recharge vehicles (e.g. supermarkets, hotels).

- Umeå is investing in fully-electric buses and ultra-fast charging stations for the local bus system. In the beginning of 2016, a total of nine fully-electric buses will be operating. By 2019, 24 additional buses will be implemented, for a total of 33, or more than 70% of the bus fleet.

Since 2010, Umeå has a new stronger rail connection for cargo and passengers via the new Bothnia railway, which cuts hours off rail-transport to southern Sweden and enables rail-commuting in the region. The northern extension of the Bothnia railway to Haparanda is at an advanced planning stage. Umeå also invests heavily in other regional renewables infrastructure: biogas-production and distribution through the BioFuel region initiative. A novel environmentally friendly natural gas-ferry connecting to Vasa in Finland plans to be in operation in a couple of years.

A public-private partner initiative to develop the university campus area as a low carbon zone (today 3,700 inhabitants) with focus on sustainable mobility, integrated infrastructures and low-energy built environment is underway, and scheduled for implementation 2016–2020. These initiatives further builds on previously agreed political objectives – to establish Umeå as a northern hub for clean-tech and sustainable city solutions. To this end an agreement of collaboration on sustainable urban development and cleantech has been signed with Umeå University, and is now further developed, along with other interested stakeholders.

New innovative demonstration and research facilities

- At Dåva CHP algae is mass-produced in a unique pilot facility from sewer water and CO₂ from the CHP flue-gases. The algae can for example be used to produce biodiesel. The project is run by Swedish University of Agricultural Sciences and co-financed by Umeå Energi.
- 3D-printing of sustainable buildings, a constellation of industrial and academic partners are about to start a three year journey to build a wooden house using additive manufacturing, a process led by Umeå University. In 2018 a 3D printed house will be unveiled.
- University startup BioEndev, co-financed by Umeå Energi, has developed an innovative torrefying technology for production of black pellets. Black pellets resemble fossil coal in many ways but is renewable, carbon neutral and has up to 50% higher energy density than white pellets. A pilot plant is in operation, an Industrial Demonstrations Unit is under construction, and the first full-scale commercial unit opens 2015.

11D References

Regional strategy for energy and climate for Västerbotten (adopted 2012, in Swedish)

<http://www.lansstyrelsen.se/vasterbotten/SiteCollectionDocuments/Sv/miljo-och-klimat/klimat-och-energi/Klimat-%20och%20energistrategi.pdf>

Action plan for decreasing greenhouse gases in the municipality's own buildings and transports (adopted 2009, in Swedish)

<http://www.umea.se/download/18.3343915a13c39d421191d98/1361887844923/%C3%85tg%C3%A4rdsplan+f%C3%B6r+minskade+utsl%C3%A4pp.pdf>

Energy plan for sustainable development (adopted 2003, in Swedish)

<http://www.umea.se/download/18.63ee7a0812b10f3e0f18000836/1361887585570/Energi-programmet.pdf>

Energy performance contracting in Umeå (in Swedish)

<http://www.umea.se/umeakommun/kommunochpolitik/planerochstyrdokument/utveckling-ochplanering/projekt/pagaendeprojekt/byggaboochmiljo/energiprojektet.html>

Sustainable Ålidhem

National pilot project national focusing on large-scale sustainable renovation of 1960s and 1970s buildings, side-by-side with new low-energy buildings. The overall objective is halving the energy use in the area with sustained rent levels. Awarded the *Sustainable Energy Europe award* in 2013.

<http://www.bostaden.umea.se/sustainable-alidhem/>

Umeå comprehensive plan (2011, in Swedish)

<http://www.umea.se/umeakommun/kommunochpolitik/planerochstyrdokument/utveckling-ochplanering/stadsplaneringochbyggande/oversiktsplan.4.bbd1b101a585d7048000168114.html>

Bostaden Environment focus 2016 program:

<http://www.bostaden.umea.se/about-bostaden/environment-focus-2016>

Umeå Energi renewable energy production (in Swedish),

<http://www.umeaenergi.se/om-oss/produktion/fornybar-energiproduktion>

BioFuel region

A regional network for the transition to renewable energy by increasing production and infrastructure for biofuels in Northern Sweden. Focusing specially on transport and sustainable fuels based on raw material from forestry(in Swedish).

<http://www.biofuelregion.se/index.cfm>

On-line map for solar energy

https://secure.app.umea.se/mapserver2015/fusion/templates/mapguide/Small_template/index.html?ApplicationDefinition=Library%3a%2f%2fUmeaEnergi%2fSolkarta_sma2.ApplicationDefinition

+project, 3d printing of houses

<http://www.sliperiet.umu.se/en/making-and-thinking-start/plusproject/>

Comprehensive plan for wind power (in Swedish)

http://www.umearegionen.se/download/18.1a5fea8a1437b3e6e52889e/1390483495150/fop_vindraft_lagupplost.pdf