Application of Local Energy Indicators in Municipal Energy Planning: A New Approach Towards Sustainability

Farhad D. Rad, Lund University

ABSTRACT

This study aims at developing a methodology for using energy indicators in improving the quality of municipal energy planning in a more sustainable manner. The municipalities of Lund and Kristianstad from Sweden and Stavanger from Norway, with rather different energy systems, are selected for this study. The study consists of two major phases; first, identification of set of local energy and second, indicator validation. In the first phase, municipalities have contributed both by delivering the available data and by helping us in selecting the most appropriate indicators. In addition to municipalities, the local energy companies also contributed in data collection. In the second phase, the selected energy indicators are validated by analyzing their historical trends to justify whether they can demonstrate a clear picture of the facts within the local energy system. Regular planning meetings with the municipalities and their frequent feedbacks were helpful in the validation process. This study is carried out based on the available data and no new data is produced. Some of the identified indicators could not be assessed duo to lack of data, which resulted in identification of a small group of local energy indicators. We observed that energy indicators can be useful in monitoring the energy trends and evaluating energy policies. We also observed that energy indicators can assist to develop local energy systems through knowledge exchange and learning process between municipalities. The need for collecting energy-use data in various sectors of transportation, households and industries at local level is still very high.

Introduction

For a community, as an open system, there is no end-point for being sustainable. Sustainability is a continuous process of balancing the environmental, economic and social dimensions, related to our living environment (community) and their systematic improvements. Energy is among the important drivers to sustainable development regarding its necessity for improving the social welfare, its fundamental role in economic development and its environmental impacts. Urban areas, as centers of energy demand and carbon emissions, give important opportunities for initiating actions to promote the sustainability of community energy systems. Local authorities in most of the major cities such as New York, Paris, Tokyo and London with many other smaller-sized cities and towns have been developed a range of energy policies e.g. increasing the share of renewable energy resources in the community's energy supply system, carbon taxation or trade, waste and green procurement programs, increasing the efficiency of energy use in buildings and transportation (Corfee-Morlot et al., 2009). Energy as the core functional element of these policies is playing an important role in various initiatives taken by local and regional governments in reducing energy use and greenhouse gas emissions. Promoting the sustainability of the community energy system requires a system approach to energy in a diversity of disciplinary perspectives along with combining expertise from numerous fields in technology, natural and social sciences. To cope with the complexity of energy challenges, various energy planning methods have been and still are in use by most of local (municipal) authorities as a tool to assist the decision making procedure. Energy planning methodology may differ from place to place depend on the local circumstances e.g. geographical, socio-economic, political etc., however, methods of plan evaluation follows unique procedure i.e. assessing the effectiveness of the existing energy policies and the level of achievements to the planned goals. The overall objective of this study is to develop a methodology for monitoring the community energy trends, and assess its appropriateness in evaluating the sustainability of local (municipal) energy systems. This study is also attempts to examine how effective the energy indicators can be in evaluating both the energy plans and the sustainability of local energy systems.

Background and Motivation

The idea of developing a method for monitoring the energy trends have initiated throughout our previous research on sustainability of local energy planning in Sweden and its effectiveness on improving the community energy system in a sustainable manner. The research was carried out at the municipal level within the Swedish context, concluding that the existing energy planning methods are not sustainable (Rad, 2008). Various definitions and concepts of the term 'Sustainability' and its broad application in the field of energy planning were discussed in the research. It was argued that a better understanding of the sustainability of the energy system would assist to more effective goal settings in the energy planning procedure. In other words, the decision-makers can take more effective energy policies if they know how sustainable the energy system is. This vision has led us to think about developing a method for measuring and monitoring the energy trends at local level. This method should benefit from a set of measurable and understandable energy indicators in order to facilitate monitoring and evaluating the sustainability of energy system. Evaluation of an energy system from a sustainability point of view is not an easy job considering the conflictive sustainability dimensions of environmental, economic and social. Reducing these conflicts along with continuous balancing of the sustainability dimensions should be considered as a new approach to community energy planning (Rad, 2008). Developing methods for measuring the sustainability and monitoring the energy trends is not a new task. During last decades, several attempts have been done within the European Union (EU) to build up new methodologies for monitoring energy and sustainability trends. ODYSSEE is among the instances, which was a project that carried out in the EU context, aiming at evaluating trends in energy efficiency and discussing the pattern and the impact of policy measures between 1990 and 2004 in the new EU member countries and the EU-27. The purpose of ODYSSEE project was to monitor the energy efficiency of final consumers within the sectors of transportation, households, industries and services. Another instance is the PASTILLE[1] project, which was carried out from March 2000 to September 2002 through the selected cities of four European countries (England, France, Austria and Switzerland). PASTILLE was aiming at defining a range of local sustainability indicators and examining their impact and effectiveness in public policy decision-making development within each partner city. Although these projects had many things in common with our idea of monitoring the energy trends and sustainability at local level, they had some differences in their approaches to the subject. ODYSSEE has developed a method for monitoring the energy efficiency trends to apply

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[1] Promoting Action for Sustainability through Indicators at the Local Level in Europe (PASTILLE), funded by the European Commission under its 5th Framework Research Program.

at national and international levels, while our focus is to use them at local level. PASTILLE had a local perspective; however, it was aiming at monitoring sustainable development in general, while our research is aiming at monitoring the local energy trends and their relation (or impacts, influence) to sustainable development. The initial work on energy indicators carried out by the International Atomic Energy Agency (IAEA) with contributions from United Nations Department of Economic and Social Affairs (UNDESA), the International Energy Agency (IEA) and some other international and national organizations was presented at the 9th session of the Commission on Sustainable Development (CSD-9) in 2001. The final set of energy indicators, under the name 'Energy Indicators for Sustainable Development', has been designed to observe and measure the current energy related trends at the national level. In this study, we benefited from the IAEA's guideline to take our approach and methodology of measuring and monitoring the energy-use trends within the municipal energy system.

Why Energy Indicators

The application of indicators for implementing sustainable development is suggested in chapter 40 of Agenda 21. In this chapter, articles 40.5 and 40.6 are emphasizing at collection and use of multisectoral information in decision making processes at local, provincial, national and international levels as well as developing the concept of indicators for sustainable development. Sustainability indicators can be used to monitor the status and trends of the planet's ecosystem, natural resource, pollution and socio-economic variables. They also can assist planners and decision-makers to set sustainable development policy goals. Energy plays an important role in sustainable development; therefore, it is important to develop methods for measuring and monitoring energy trends.

Methodology

The design and implementation of this research project is based on two main phases. The first phase consists of structuring the framework of research by choosing what types of energy indicators should be selected. Energy indicators should be identified in such a way that they can link energy related issues to the communities' environmental, economic and social aspects. In this study, the term community refers to the local (municipal) level. Three municipalities (Lund and Kristianstad from Sweden and Stavanger from Norway) with different energy system are chosen in order to get a better selection of energy indicators. One important feature of this research is to involve the municipal staff in project design by getting their ideas, interests and comments from the beginning of the project and continuously to the end. The scientific approach of the IAEA's energy indicator methodology and categorization is chosen for identification of energy indicators. In this study two factors are considered in selecting energy indicators, the interest/need of the municipalities and the availability of data. Collecting the corresponding data is also the task of the first phase. The third stage is to collect available data and information, which is an important and time consuming stage. It is important because it plays a key role in indicator validation. Indicator validation is the purpose of the second phase. The validation process consists of analyzing the historical trends and justification of whether energy indicators can demonstrate a reasonable picture of energy trends the local energy system. The study is planned to be implemented in 6 months (Table 1).

Table 1: Research Schedule

	2009			2010		
	October	November	December	January	February	March
Planning meetings						
Data collection						
Data filtering						
Data processing						
Indicator validation						
Final report						

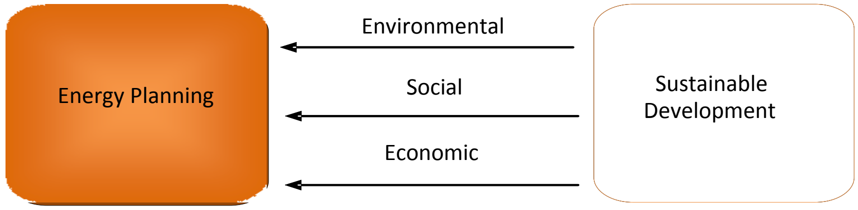
Research Limitations

Implementation of this research was restricted with two major limitations; first, short period of six months for implementing a project in this scale, and second, data inconsistency. The necessary data was scattered among different statistical entities e.g. various departments of municipalities, local energy supply and distribution companies, regional authorities, national statistical center, environmental organizations. Differences in both data collection methods and data units imposed to a time consuming task of data filtering and processing, which consequently resulted in a provision of a more limited database.

Energy Planning and Sustainable Development

In general, energy planning can be defined as “the matter of assessing the supply and demand for energy and attempting to balance them now and in the future” (Kahen, 1995). The procedure of energy planning consists of setting energy related goals and policies, gathering and evaluating information, developing alternatives for future actions based on the evaluated information and policies and finally, proposing the best energy plan. Energy plans are used to sketch the roadmap for provision, transmission/distribution and use of energy in national, regional and local levels within a defined time range. Although, the implementation of energy planning procedure is different depending on the economic, political, social and environmental characteristics of the communities, it is often conducted using integrated approaches that consider both the provision of energy supplies for meeting the energy needs as well as reducing energy consumption by using energy more efficiently. In 1980s, when the term “sustainable development” came into the global consideration, with no doubt, energy became the key element for the community development regarding the three main topics, environment, economy and social equity. Adequate and affordable energy supplies have been playing an important role in economic development and the transition towards modern industrial and service-oriented societies. Energy is a key element for improving social and economic well-being, and is vital to most industrial and commercial wealth generation. It is necessary for improving human welfare and living standards. Both the energy exploitation from natural resources and energy use can affect our living environment. It is obvious that energy has a strong relationship with sustainable development. The theoretical framework of this research is formed based on the relationship between energy and the environmental, social, economic and institutional principles of sustainable development through the planning process (Figure 1). This platform will be used as the pattern for selecting the group of energy indicators for sustainable development.

Figure 1: Schematic of the Theoretical Concept



Case Studies

This section gives some information about the partner municipalities to provide a general picture of their similarities and differences in e.g. social structure, geography, energy system etc.

Table 2: Total Energy Use in 2006 (MWh)

	Lund	Kristianstad	Stavanger
Coke			200
Petrol (Gasoline, kerosene)	481 714	443 610	352 300
Diesel (Diesel, gas and light fuel oil, special distillate)	183 213	381 663	517 000
Fuel oil (Heavy fuel oil, waste oil)	75 436	322 076	45 900
Natural Gas	89 290		157 500
Wood Fuels	18 626		89 500
District Heating	784 000	296 807	
Total Fuel	1 637 264	1 755 335	1 162 400
Electricity	855 394	908 313	1 685 900
Total Energy	2 492 658	2 663 648	2 848 300

Lund

The city of Lund is located in south-west of Skåne (Scania) County, in Sweden (55° 42’ 0” N, 13° 12’ 0” E). With the total area of 431 km2 and 109147 inhabitants (Statistics Sweden, 2009), Lund is among the oldest cities in Sweden that is believed to be founded around 990[2]. The climate is relatively mild compared to the other locations with similar latitude mainly because of being close to the Gulf Stream. The average temperature in summer time is between 14°C and 22°C, while in winter time is between -1°C and 3°C. Because of its latitude, daylights last around 17 hours in midsummer and 7 hours in midwinter. Approximately 170 days of the year have light to moderate rainfall. Sparingly snowfall occurs normally between December and March. The main industries of the city are including Alfa Laval (heat exchanger and separator), Tetra Pack (Food packing), Gambro and Astra Zeneca (Medical and Pharmaceutical), high-tech companies such as Sony Ericsson and Ericsson Mobile Platforms. Lund’s district heating system is covering around 90% of the buildings in the city. The fuel mix of the district heating system is illustrated in Figure 4 (Lund Energy AB, 2009).

[2] Touchdowns in the history of Lund, retrieved on 2010-02-18 from www.lund.se

Kristianstad

The municipality of Kristianstad with 1346 km2 and 78788 inhabitants (Statistics Sweden, 2009), is located in south-east of Skåne (Scania) County, in Sweden (56° 1' 46" N, 14° 9' 24" E). The city was founded in 1614 by King Christian IV of Denmark as Christiansstad. Kristianstad is 2.41 meters below mean sea level; therefore, a part of city has to be protected from flooding by a system of levees and water pumps. Agriculture and foodstuffs are building the core for the city's industry and commerce with some ancillary businesses. In 1999, the Kristianstad municipality decided to declare that they will be a fossil fuel free municipality. A climate strategy including measures for transport and agriculture was adopted by the municipality in 2005. Kristianstad enjoys a bio fuel powered combined heating and power plant (Allöverket CHP) with the capacity of 60 MWth plus 15MWel (C4 Energy AB, 2009). Total production of Allöverket CHP in 2008 was 300 GWhth and 70 GWhel. In 2009, waste from forestry, which is taken from within a radius of 100 km together with biogas from landfill and from the biogas production plant (Karpalund) were providing 99% of the fuel needed in Allöverket CHP plant.

Stavanger

The city of Stavanger is located in Rogaland County, south west coast of Norway (58° 57' 48" N, 5° 43' 8" E). The city is located on a peninsula with the area of 71 km2 and total population of 121610 (SSB, 2010). Stavanger was fulfilling an urban role from the time the Stavanger bishopric was established in 1120s. Shipping and ship building with fish canning industries were among the important industries for long periods of time before 1969 when oil was discovered in the North Sea. Today, Stavanger is referred as the petroleum capital of Norway. The city is significantly influenced by the foreign oil companies and related businesses. The University of Stavanger with around 8300 students established in 2005 and has strong linkages with oil industry and related R&Ds. Stavanger enjoys a maritime and rather windy climate with the average precipitation of 1200 mm/year. The energy supply resources of Stavanger's stationary energy system are rather different from the two previous cities and mostly are based on hydro power. Electricity is providing more than 95% of the city's stationary energy needs particularly in households. In 2007, electricity use, with 1915 GWh out of the total (stationary + mobile) 3129 GWh that was consisting more than 61% of Stavanger's energy use. A waste fueled combined heat and power plant called Forus with the capacity of 86 GWh transforms 38000 tons of waste to energy annually. This CHP plant also supplies the city's small district heating system.

Identifying Energy Indicators

To select a set of energy indicators, those relate energy use to various dimensions of sustainable development; we benefited from the methodology sheets of the International Atomic Energy Agency (IAEA) and its categorization of energy indicators for sustainable development. This categorization divides energy indicators into three groups of environmental, economic and social with a comprehensive description of the type of data needed, their relevancy to sustainable development, their units as well as methodology for data gathering and calculations. Several planning meetings were arranged with the municipal staff in order to identify what energy indicators could be useful to apply at the local level. Since the duration of implementing our research project was limited into 6 months, it is decided to work on the indicators which have available data in municipalities. For this purpose, the municipalities have been asked to highlight the indicators based on data availability. The result was three short lists with almost similar types of indicators. A combination of these short lists is shown in appendix 1. Most of common indicators were the environmental ones such as GHG emissions from the energy use. Some municipalities had a more detail information for an item compared to the others depend on their advantages and interests; for instance, the city of Lund had a complete data sheet of energy used in district heating system while Stavanger had a detailed information of the energy use in the transportation sector. To get better results, it is decided to focus on energy indicators that have available data and are in common between all the three municipalities.

Data Collection

Adequate and reliable database is fundamental to using energy indicators. Most energy related analyses depend upon examining past trends, whether they are energy intensity, economic activities, markets or consumption (Gold R. & Elliott, 2010). After selecting the set of energy indicators, the partner municipalities have been asked to send the corresponding data for each indicator. The data sheets we received from the municipalities were rather different. Many of the energy use items were collected through different methods depend on the local circumstances; as an instance, different categorization of the municipal waste which is driven from different methods of waste collection and incineration. One important problem that appeared in this stage was the time gaps among most of the data sheets. Complete time series are important for analyzing the energy trends. Almost all municipalities had several time gaps in their collected data. In attempt to complete our database, we searched for data through other resources such as the local energy companies, the national statistical center, environmental organizations and NGOs. Although we got some more energy related data, they couldn’t fill all the niches we had in our database; meanwhile, they had different units driven from different methods of data collection. Data collection from all these sources was resulted in creation of a database consisting of more than 75 Excel sheets. This database was containing various energy related information e.g. energy use by type of energy source in households, transportation and industries, emissions from the local energy system, municipal waste production and incineration etc.

Data Filtering and Categorization

In this research, we categorized the collected data into two main groups of energy related data and environmental data. Energy related data were consisting of information about energy supply and use in different sectors of households, transportation and industries by fuel and energy carrier. Environmental data were including various emissions driven from the local energy use in all sectors. Different municipalities use different data categorizations and units; therefore, data filtering is necessary to get fruitful results from comparative studies. Table 3 shows an example of differences in categorization among municipalities. In this study the filtering procedure is done by unifying the energy units and re-categorization of energy related data.

Data Analysis

For an indicator to be measurable, a combination of two or more data elements is needed. Both values and units of the data elements should be normalized for further use within multiple tables. In order to measure trends of the selected indicators we benefited from the IAEA's methodology sheets. Each methodology sheet consists of a brief definition of the indicator, its unit and measuring methods. For some of the indicators we changed the methodological measurements and/or the measurement units depend on the local circumstances. Since municipalities have different energy systems, geography and population, the value of a given energy indicator might not mean the same thing in another municipality. Hence, using them for comparison studies should be done carefully.

Table 3: Categorization for Emissions Driven from Energy Use in Different Sectors

Lund and Kristianstad	Stavanger
Transportation	
Cars Light trucks Heavy-duty trucks and buses Mopeds and motorcycles Domestic commercial vessels Domestic air traffic Other transport	Light vehicles, petrol Heavy vehicles, petrol Light vehicles, diesel Heavy vehicles, diesel Motorcycles, mopeds Domestic air traffic Domestic Ships and boats International sea traffic International air traffic Others
Industrial	
Energy use via the electricity and heating plants Fugitive emissions from fuel handling Boiler Refineries Industrial Processes Mineral industry Chemical Industry Metal industries	Stationary combustion: Oil and gas extraction Stationary combustion: Mining and manufacturing Stationary combustion: Other industries Process emissions: Oil and gas extraction Process emissions: Mining and manufacturing Process emissions: Landfill gas Process emissions: Other
Households	
Space heating (no electricity or district heating)	Stationary combustion: Private households

Indicator Selection

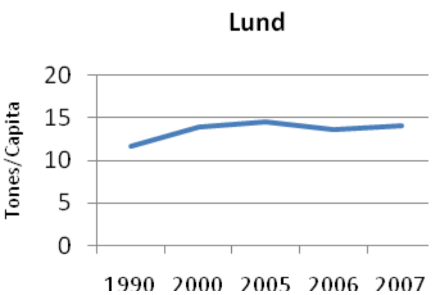
Indicator selection, in this study, is done based on data availability in all three municipalities. Most of the identified energy indicators are covering the environmental and economic dimensions of sustainable development. Social energy indicators such as share of household spent on fuel and electricity or household energy use for each income group and corresponding fuel mix could not be used duo to lack of relevant information (Appendix 1).

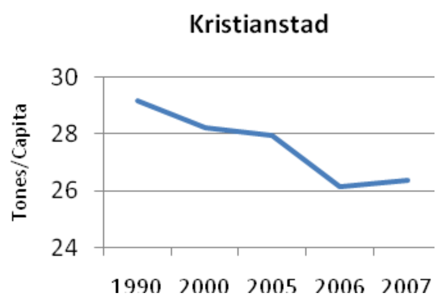
Indicator Validation

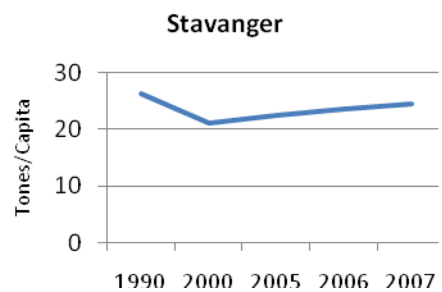
In this study, the methodology used for indicator validation is subjected to analytical assessment of the historical trends and justification of their capacity in demonstration of a clear picture of the facts within the local energy system. In other words, the usefulness of energy indicators is examined by comparing the trends shown by the indicators with the existing historical information from the energy system. This assessment is done on the selected indicators which have acceptable time series. Availability of data is also very important since the data gaps within time series cannot be manipulated. The energy indicators that had the minimum requirements of data availability and acceptable time serine were selected for validation analysis as follow:

ENV1, Per Capita Emission

This indicator measures the total, per capita emissions of the three main GHGs including carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4) from energy use. The measurement unit is annual GHG emission in tones per capita. Emissions of CH4 and N2O are converted to CO2 equivalents using the 100-year global warming potentials (GWPs) provided in the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (1995). Kristianstad's GHG reduction is because of development of district heating system powered by Allöverket CHP and fueling the city buses with biogas produced by Karpalund waste to energy plant. Increase in Stavanger's GHG is mainly is driven from the transportation sector.

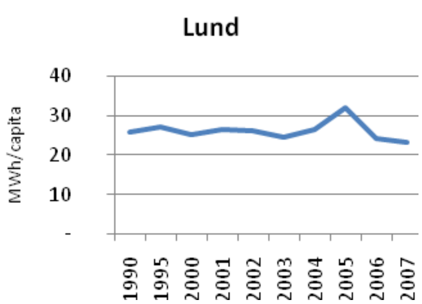


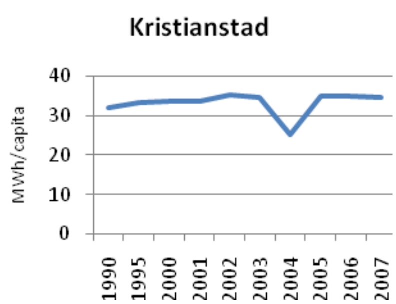


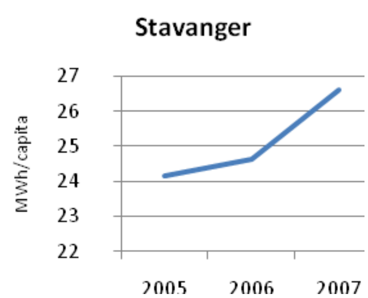


ECO1, Energy Use per Capita

A per capita basis for measuring energy use gives the pattern of aggregated energy intensity within a society. The term 'energy use' refers to total final consumption and final electricity use per capita. The unit used in this study is MWh per capita.

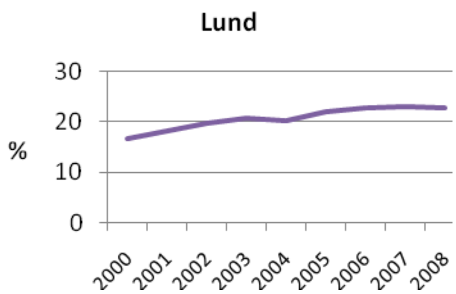


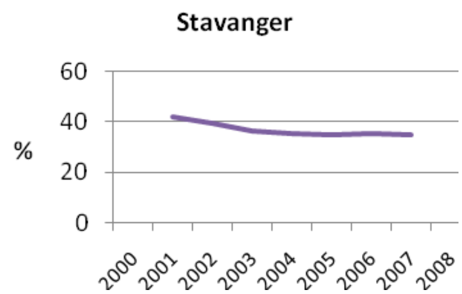




ENV7, Solid Waste to Energy

The main purpose of this indicator is to provide information on the ratio of solid waste used to generate energy through incineration and landfill process. The unit is percentage. Raise in percentage of energy produced from waste in Lund is because of increasing the capacity of

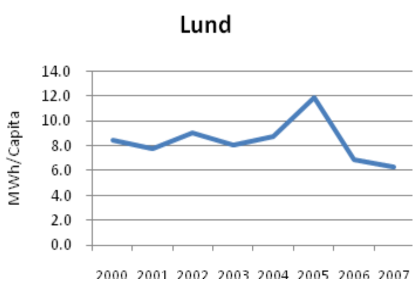


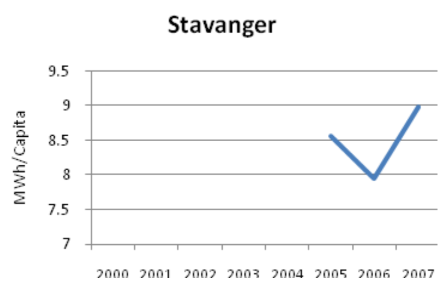


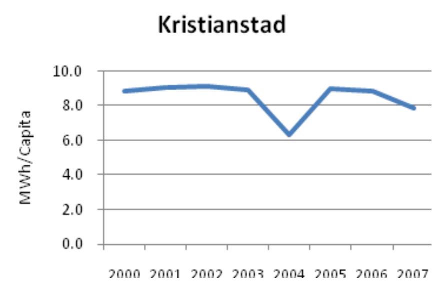
SYSAV waste to energy plant in the neighboring city of Malmö. Reduction in Stavanger is due to limited capacity of the Forus waste to energy plant in respond to increasing waste production. Data from Kristianstad had too anomaly to be used.

ECO9, Household Energy Intensity

This indicator is for monitoring energy use in the household sector. The unit is KWh per capita. Data for Stavanger before 2005 was not available and the municipal is trying to develop a method for data collection in energy use of household sector. Increase of household energy intensity in Lund in 2005 was because of cold winter in that year which caused to run an extensive isolation program for buildings in the next years. The reason for anomaly in Kristianstad is not clear.

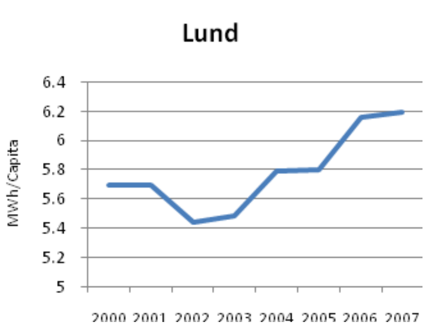


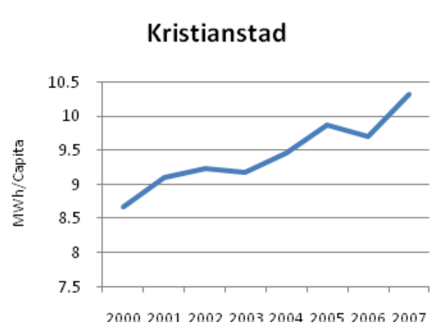


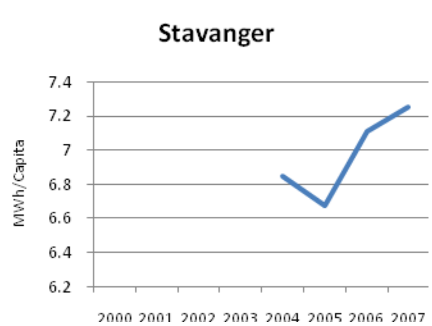


ECO10, Transport Energy Intensity

This indicator is used to monitor energy use in the transportation sector for both goods and people. Transport as a major consumer of fossil fuels is an important source of air pollutions within the community energy system. The unit used in this study is MWh per capita. All the three municipalities show increase in energy use in the transportation sector. Local authorities believe that it is mainly because of increasing the numbers of passenger cars.







Conclusion Results

This study is carried out to improve the quality of municipal energy planning by developing a methodology for measuring and monitoring local energy trends. We tried to select a group of energy indicators which can link the energy use trends to sustainable development. The identified energy indicators in this study can be useful for monitoring some of the environmental and economic dimensions of sustainable development. Social energy indicators could hardly be applied duo to lack of data. Lacking of data is identified as the most important challenge throughout our study. Time gaps were also a limitation to make adequate comparative analysis in our study. The need for collecting energy related information at local level is still very high. One suggestion for the municipalities could be collection of more detailed energy use data on a regular basis (annually) not only by themselves but from the local energy companies and the other related entities. Most of the existing data among the partner municipalities and the other related entities are collected in different units and categorization, which restricts the application of energy indicators in comparative studies. Although, regarding the differences in the cities' geography, socio-economic structures etc., using energy indicators for comparison studies should be done carefully, we observed that energy indicators can assist to develop local energy systems through knowledge exchange and learning process.

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Appendix 1: List of Energy Indicators that has been Sent to the Municipalities. The Orange Color Indicates the Availability of Data Component in Municipality

Theme	Sub-theme		Energy indicator	Components	Lund	Kristianstad	Stavanger
Atmosphere	Climate Change	ENV1	GHG emissions from energy production and use per capita	– GHG emissions from energy production and use – Population			
	Air Quality	ENV2	Ambient concentrations of air pollutants in urban areas	– Concentrations of pollutants in air			
		ENV3	Air pollutant emissions from energy systems	– Air pollutant emissions			
Water	Water Quality	ENV4	Contaminant discharges in liquid effluents from energy systems including oil discharges	– Contaminant discharges in liquid effluents			
Land	Soil Quality	ENV5	Soil area where acidification exceeds critical load	– Affected soil area – Critical load			
	Forest	ENV6	Rate of deforestation attributed to energy use	– Forest area at two different times – Biomass utilization			
	Solid Waste Generation and Management	ENV7	Ratio of solid waste generation to units of energy produced	– Amount of solid waste – Energy produced			
		ENV8	Ratio of solid waste properly disposed of to total generated solid waste	– Amount of solid waste properly disposed of – Total amount of solid waste			
		ENV9	Ratio of solid radioactive waste to units of energy produced	– Amount of radioactive waste (cumulative for a selected period of time) – Energy produced			
Use and Production Patterns	Overall Use	ECO1	Energy use per capita	– Energy use (total primary energy supply, total final consumption and electricity use) – Population			
	Overall Production	ECO2	Energy production by the local energy company	– Energy production(Electricity, district heating and cooling) in MWh			
	Supply Efficiency	ECO3	Efficiency of energy conversion and distribution	– Losses in transformation systems including losses in electricity generation, transmission &distribution			
	Production	ECO4	Reserves-to-production ratio	– Proven recoverable reserves – Total energy production			
		ECO5	Resources-to-production ratio	– Total estimated resources – Total energy production			
	End Use	ECO6	Industrial energy intensities	– Energy use in industrial sector and by manufacturing branch – Corresponding value added			
		ECO7	Agricultural energy intensities	– Energy use in agricultural sector – Corresponding value added			
		ECO8	Service/commercial energy intensities	– Energy use in service/ commercial sector – Corresponding value added			
		ECO9	Household energy intensities	– Energy use in households – Number of households, floor area, persons per household, appliance ownership			
		ECO10	Transport energy intensities	– Energy use in passenger travel and freight sectors – Passenger-km travel and tone/km freight			
	Diversification (Fuel Mix)	ECO11	Fuel shares in energy and electricity	– Primary energy supply and final consumption, electricity generation and generating capacity by fuel type – Total primary energy supply, total final consumption, total electricity generation and total generating capacity			
		ECO12	Non-carbon energy share in energy and electricity	– Primary supply, electricity generation and generating capacity by non-carbon energy – Total primary energy supply, total electricity generation and total generating capacity			
		ECO13	Renewable energy share in energy and electricity	– Primary energy supply, final consumption and electricity generation and generating capacity by renewable energy – Total primary energy supply, total final consumption, total electricity generation and total generating capacity			
	Prices	ECO14	End-use energy prices by fuel and by sector	– Energy prices (with and without tax/subsidy)			
Security	Imports	ECO15	Net energy import dependency	– Energy imports – Total primary energy supply			
	Strategic Fuel Stocks	ECO16	Stocks of critical fuels per corresponding fuel consumption	– Stocks of critical fuel e.g. oil, gas etc. – Critical fuel consumption			
Equity	Accessibility	SOC1	Share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy	– Households (or population) without electricity or commercial energy, or heavily dependent on noncommercial energy – Total number of households or population			
	Affordability	SOC2	Share of household income spent on fuel and electricity	– Household income spent on fuel and electricity – Household income (total and poorest 20% of population)			
	Disparities	SOC3	Household energy use for each income group and corresponding fuel mix	– Energy use per household for each income group (quintiles) – Household income for each income group (quintiles) – Corresponding fuel mix for each income group (quintiles)			
Health	Safety	SOC4	Accident fatalities per energy produced by fuel chain	– Annual fatalities by fuel chain – Annual energy produced			