ANALYSIS OF URBAN ENERGY IN THE NORDIC REGION
- OPTIONS FOR CARBON NEUTRALITY

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Overview

The urban energy supply and demand and related greenhouse gas (GHG) emissions will be critical in reaching the global 2 degree target. In 2013 energy demand in urban areas accounted for 55 % of global and 85% of the Nordic energy demand. The share of urban energy will be increasing due to urbanization and increased welfare of cities both on a global and Nordic level. It is important that the urban planning and development of energy systems in cities support the national emission reduction targets.
Urban energy supply and demand have unique characteristics as higher density of population enables new low carbon and smart technologies and solutions for energy supply and more efficient energy end use, especially in buildings and mobility. Nordic countries have, for example, developed extensive district heating networks and increasingly also district cooling networks and invested in public transportation and bicycle infrastructure.
All Nordic capitals have a target to become carbon neutral by 2025 or 2050. In total, over 100 Nordic cities have joined the Covenant of Mayors movement which encourages cities to increase energy efficiency and use of renewable energy [1]. A large proportion of these cities have submitted an individually designed action plan to reduce their energy consumption and GHG emissions. These cities have made an inventory of the energy consumption and GHG emissions and set targets for the future, as well as included suggestions of measures for reaching their targets.

Methodology

Despite the importance of the urban energy and a big number of city-level programs and targets, there has not been a study of all urban areas in the Nordic countries. This paper focuses on the Nordic aspects of the urban energy systems and climate change mitigation in urban areas. The work is part of the project “Nordic Energy Technology Perspectives 2016 (NETP 2016)” which is carried out in collaboration between Nordic research organisations, Nordic Energy Research and the International Energy Agency (IEA), and is building on the experience from the NETP 2013.

The IEA has analysed urban and non-urban areas in the Nordic countries within their global Energy Technology Perspectives (ETP) model [3], with respect to options for carbon dioxide (CO_2) emission reductions and energy efficiency.

Two more detailed case studies have been carried out, one for the Metropolitan region of Finland, and one for the city of Oslo (Norway). The two urban areas have been modelled with TIMES; the metropolitan region of Finland within the TIMES-VTT model [4] as one of the regions, closely connected to the rest of Finland, and the city of Oslo is modelled as a region in the TIMES-Norway model [5], [6].

Results

Low carbon urban areas are an essential part of sustainable low carbon pathways in the Nordic region. Urban areas have higher population density and shorter distances which enable more technology solutions to increase energy efficiency and reduce emissions, such as district heating, electric vehicles and effective public transportation. Many technologies are easier to adopt first in the urban areas.

The drivers for a change of urban energy consumption are political, technical and behavioural. In addition, increased population and GDP changes the urban energy patterns. Urban population is expected to increase due to urbanisation of Nordic countries but also due to global demographic changes. The policy level includes the decisions of individual cities and international and national policies affecting the cities. Technological development both changes the competitiveness of existing technologies and brings in new services and solutions. Behavioural and societal drivers shape the consumer choices and define trends for the standards of living.

The development of the urban energy systems has been studied with a carbon neutral scenario (CNS), reaching a 85% reduction in CO_2 emissions by 2050 (relative to 1990), and compared with a base line (reference) scenario.

The transport sector is the end use sector that must undergo the hugest changes in order to meet the target for 2050. In order to reduce or eliminate the dependence of fossil fuels in road freight, deployment of alternative technologies like plug-in hybrids and electric vehicles, advanced biofuels, natural gas or hydrogen fuel cell are needed. Electric vehicles fuelled by hydrogen or non-fossil electricity is the only of these alternatives that have the potential to totally eliminate the fossil fuels dependence. In the analysis of the CNS for Oslo we observe a high utilisation of new fuels and technologies, but also a need to change to other transport modes.

Conclusions

All Nordic capitals are aiming for carbon neutrality. The level of ambition is high, and efforts are needed especially in the deep retrofits of existing buildings and decarbonisation of transportation. In total, over 100 Nordic cities have emission reduction targets. Even though Oslo is a small city in a global context, the city wants to focus on how cities can take responsibility for the development of sustainable energy systems for the future, and to show how cities can take the leadership in the green change and contribute with innovative ideas and solutions.

Larger cities have more technology options available to mitigate climate change. Larger population and higher density of population gives bigger cities options to utilize more efficient technologies in all end-use sectors. The energy demand of buildings and transport is 30% less per person in the Nordic urban areas than in the Nordic rural areas. Nordic capitals can be 30% more efficient than average Nordic urban areas.

In urban areas, an up to 75% of the energy consumed in buildings and transport could be delivered through smart electricity and district heating and cooling systems. Increasing share of electricity and heat gives good opportunities to decarbonize the urban energy systems. Increased share of energy delivered through grids and networks increase the importance of system flexibility and management.

Building energy efficiency measures can decrease heating, cooling, and electricity demand per capita in urban areas by 40 % by 2050. Low energy codes for new buildings and deep retrofits of existing building stock have potential to decrease total final energy consumption in urban areas despite the increasing population in cities, rising standards of living and increasing floor area.

Electric cars, buses, bicycles and other electric vehicles are adopted first in urban areas where driven distances are shorter and charging station infrastructure is more compact to build. By 2050 electric vehicles could cover above 50% of urban final energy for transport. Biofuels are needed to decarbonize the remaining transport. The availability and sustainability of biofuels are critical issues. The Nordic region has, however, good possibilities to produce 2nd generation biofuels from wood raw materials and biowaste.

Under strict climate policy targets, the role of district heating will increase, but the role of combined heat and power (CHP) might become less important. The amount of district heat increases 20% in the urban areas in the CNS despite the increasing energy efficiency. The CHP production has to compete with biomass supply for biorefineries while large-scale heat pumps can balance the variable electricity production. The amount of CHP production decreases 40% in Nordic urban areas in the CNS.

References

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