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# Carbon Neutral Aarhus

City Performance Tool – May 2016

Global Center of Competence Cities

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# Executive Summary

The City of Aarhus has the ambition to become carbon neutral by 2030, and the work delivered by Siemens using its in-house City Performance Tool has shown that this target is realistic. While it is realistic, it will certainly not be easy as the city will need to further electrify its transport and entice the private sector to do the same. Aarhus' local co-generation of heat and electricity is a key part of their plan to reach carbon neutrality, and because of this efficient and relatively clean local energy it is less clear what carbon focused actions the city should take or incentivize for its buildings. One option would be to focus only on transport and leave buildings as they are; however, because cities are comprised of buildings, and buildings consume a vast majority of energy in a city, therefore they cannot be ignored. This becomes even more important as buildings, transport and energy together are expected to become smarter over the next 15 years, and achieving the full benefits of a smart city requires upgrades in all three sectors.

The most impactful technologies for reducing carbon in Aarhus are those that increase the scope of public transport and electrify existing services. Building improvements will deliver energy savings, but the carbon savings are less clear because of the local energy mix. However, there are many reasons other than carbon to improve buildings such as operational cost savings, reduced demand on the electricity grid and possibly reducing the need for additional energy generation. If the city does want to improve its buildings then implementing the less invasive automation technologies becomes attractive because these technologies can deliver significant energy reductions without incurring the large costs associated with full building retrofit.

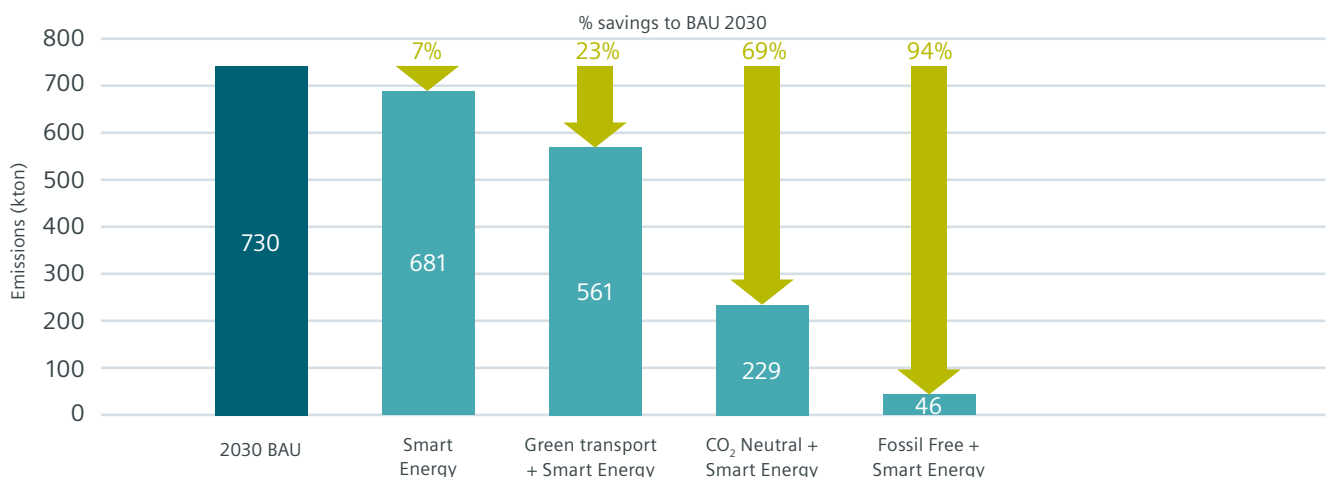
Siemens has partnered with the City of Aarhus to identify not only which technologies would make the most significant

carbon reduction, but also to identify the scale at which they would need to be implemented. Siemens has first considered the expected changes to the local heat mix, and the implementation of other key technologies by 2030 that have already been funded in its Business As Usual (BAU) reference case. All of the scenarios will calculate additional carbon reductions from the BAU. The scenarios considered will test varying take-up rates of technologies in both the public and private sectors ranging from Smart Energy (building technologies), to Green Transport, CO<sub>2</sub> Neutral and Fossil Free. Out of the tested scenarios, one of the most ambitious scenarios could deliver carbon reductions of up to 94% – here are some of the key numbers to come out of the Siemens analysis.

- Fossil fuel free approach – 94% CO<sub>2</sub>e reduction compared to 2030 BAU
- CO<sub>2</sub> Neutrality – 69% CO<sub>2</sub>e reduction compared to 2030 BAU

These scenarios demonstrate that it is possible for the City of Aarhus to reach carbon neutrality and possibly even to exceed it. However, out of the scenarios tested in the study, none actually reduced carbon emissions to zero. These residual carbon emissions are linked to electricity imports, but they are very minor given the scale of the carbon reduction successes.

The tested scenarios also identify an electricity gap between what will be demanded by the public in 2030 and what the City of Aarhus' municipal heat and electricity generation can provide. Today the gap is very small between local production and overall demand; however, in the future, there is a general expectation that electricity demand will increase due





to further electrification of transport, for example more take-up of electric cars. Reducing this gap will require the city to increase its local renewable generation, significantly reduce electricity use in all buildings or purchases carbon offsets. Actions taken by the City of Aarhus to reduce electricity demand in its buildings will help to reduce the demand for clean electricity that the national government will need to provide.

The key result of the CyPT analysis is the identification of the best performing technologies for the City of Aarhus irrespective of when or how much is actually implemented. The most significant results would come from actually changing energy generation away from combustion technologies to renewables such as wind and solar. The next most impactful technologies are those that will reduce the most carbon. These technologies may be those that are simply more energy efficient or switch fuel sources, such as electric cars (e-cars) if the local electricity mix is cleaner than burning petrol. The following points highlight the best performing technologies for Aarhus.

## Most impactful carbon reduction technologies

### Buildings

#### Non-residential:

- Building performance optimization

- Building remote monitoring
- Demand oriented lighting

#### Residential:

- Home automation
- Efficient lighting

*See appendix III for technology descriptions.*

Due to how the City of Aarhus creates its heat and electricity and how it counts its carbon emissions, building technologies that significantly reduce heat loss actually increase carbon emissions as 'dirtier' electricity from the grid must be imported.

### Transport

- City tolling
- Electric buses
- Plug-in hybrid cars
- New tram lines

Overall the most impactful technologies are transport related because of the assumed carbon neutrality of building heat and the associated additional carbon coming from electricity imports.



If we shift our focus away from the most carbon reducing technologies to those that save the most energy (heat and electricity) then these technologies are the best performing.

## Most energy savings technologies

### Buildings

#### Non-residential:

- Building performance optimization
- Building remote monitoring
- Building management systems BACS B
- Demand oriented lighting

#### Residential:

- Building envelope (glazing and insulation)
- Home automation

It is technically possible for the City of Aarhus to achieve real carbon neutrality by 2030 should acceptance and take-up of key technologies happen fast enough. Additionally, the cost of meeting this objective will be shared by both the public and private sectors. The city implementing some aspects of road pricing, provision of charging points for e-cars and the further expansion of electricity based public transport and

building owners increasing the degree of automation in their buildings. The shared burden of building improvement would require that all non-residential building owners upgrade building lighting and many of those owners would also need to engage in some form of building monitoring or optimization. All residential owners would need to upgrade lighting and just less than half would need to automate their homes and/or make some improvement to the exterior of their homes (glazing and insulation). Achieving 100% of all owners is an ambitious target, but for the lighting technologies which are for the most part inexpensive bulb upgrades and some sensors the economic case is strong over the next 15 years some people will make this change as part of their home maintenance work and others will require more education and encouragement.

Timings of technology implementation should be based upon where the city has the authority to directly implement change and those in which it must partner with other organizations or levels of government. Those technologies where the city has more direct authority could reasonably be delivered in the coming 3 to 7 years and the other technologies may need far longer lead times stretching to the 2030 target year.

A good climate strategy, smart use of technologies and view to partnership with the national government and other Danish cities, will all be required for Aarhus to deliver zero carbon emissions.