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SUSTAINABLE URBAN TRANSPORTATION

Creating green liveable cities

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Urban transportation at Dronning Louises Bro in Copenhagen

Photo: State of Green

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EXECUTIVE SUMMARY

It is estimated that 9 billion people will inhabit the planet by 2050 – 70% of these will live in cities. The increasing urbanisation will be a challenge to cities all over the world and the demand for new innovative solutions within urban mobility is growing.

By integrating different modes of transportation, urban planning can address climate and environmental issues such as private car use and congestion, for instance through increased public transportation and facilitating greener alternatives, which saves both time and cost for people and society.

An integrated approach to mobility management

The key to successful mobility management is to incorporate several levels at the same time where collaboration between both public and private actors is necessary. Intermobility and a flexible transportation system enables people and goods to move around more easily by combining alternative modes of transport. Also, the large share of renewable energy in the Danish electricity system can play an important role through smart thinking and big data monitoring in an integrated system.

Green liveable cities

Cities must be built for people in order to be sustainable, healthy and liveable. Targeted policy-making to ensure that the residents of the city are invited to walk and bike as much as possible in connection with their daily activities is a strong reinforcement of these objectives. The key is to acknowledge the importance of city space and city life as an attractive, informal and democratic meeting place for the residents in the 21st century.

The world's best country for cyclists

Denmark has for many years been a frontrunner within urban mobility planning and we hold a strong tradition for people from all layers of society to bike and it has become an integral part of the Danish story. In fact, more than 60% of the people who live and work in Copenhagen commute by bike every day. The Danish companies and municipalities therefore have the perfect conditions for testing and developing state of the art bicycle infrastructure solutions.

This white paper provides insight into the solutions that Denmark has to offer within urban sustainable transportation. We hope you will be inspired.

SHARING SOLUTIONS FOR SUSTAINABLE URBAN TRANSPORTATION

Denmark's experience shows that integrated and sustainable transportation can reduce CO₂ emissions and be turned into an opportunity to create greener and more liveable cities.

Chair at the KR Foundation and former European Commissioner for Climate Action (2010 – 2014).



Our cities are growing and the need to focus on urban transportation is increasing. It enables trade, which is essential for societal growth and development. But according to the European Commission the transport sector accounts for almost a quarter of CO₂ emissions in the EU. Almost 95 % of the energy consumption in the transport sector derives from oil and oil-based products. Any country striving to reduce the CO₂ emissions must therefore prioritise sustainable transport in order to meet their goals.

Investing in green transport

Denmark has been able to decouple the transport sector emissions from the increase in the overall transport demand, but transformation of the transport sector will not happen overnight. New technologies

are introducing alternative fuels to the market, research is developing new ways to make transport more energy-efficient, thus saving costs, and a strong focus on urban mobility planning is enabling a decrease in congestion in the larger cities. In Danish urban areas, bicycles are now preferred, which carries a positive effect on public health.

However, investments in sustainable transportation has to be planned over long term. Decisions taken over the next few years will define the landscape for decades. Congestion costs Europe 1 % of its GDP, so investments that make better use of the infrastructure, create less congestion and ensure a better traffic flow will all contribute to reducing CO₂-emissions from transport.

Danish solutions to global challenges
The best examples on urban mobility projects succeed in solving more than one problem at the time. Such holistic solutions, however, often calls for close collaboration between the governments, regions, cities, private companies, and individuals. Denmark has a long tradition of such collaboration and we are eager to share our experiences and lessons learned with other countries.

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1. HISTORICAL PERSPECTIVE ON ALTERNATIVE GREEN TRANSPORTATION

Developing cities for people improve the quality of urban life

Klaus Bondam, CEO, Danish Cyclists' Federation

In the first half of the 1900s, Danish cities became cities of bicycles, but like the rest of the developed world, the cars slowly took over in the 1950s and 1960s. Areas in cities that are car-free today were characterised by dense traffic and car parks in the 1960s.

To an extent, the history of several Danish cities unfolded in parallel with the car-orientation found in many other western metropolises. But environmental movements and the oil crisis greatly helped to shake the dust off the cycling culture, which in the 1970s again began to appear in a positive light in Denmark.

Gradually it became clear to most people that the solution to the problems had to be found through city planning that gave space to bicycles, pedestrians and public transport. The Danish model, with its extended network of segregated cycle lanes along the roads, grew out of this realisation, which still continues to be further developed adding an extensive network of Super Cycle Highways. But another important factor made mobility and liveability

grow hand in hand in the cities of Denmark – the Danish tradition for urban planning. As early as 1947, a visionary urban plan for the region of Copenhagen was published; the so called 'Finger Plan'. The principles were that the distance between housing, jobs, and green areas should be as short as possible and reachable by public transport.

“History has proven that strategic and visionary urban planning has made the Danish cycling culture flourish along with public transport and road infrastructure in the second half of the 1900s. Today, Danish cities are among the most liveable in the world.”

Today, Danish cities are some of the most liveable and best planned cities in the world with a unique interaction between urban planners and politicians willing and courageous enough to make the necessary strategic choices. But also an efficient co-operation between the many private and

public stakeholders in the transport sector contributes to the ongoing development of a transport system fitted for safe, secure, and active mobility all over Denmark. So safe, that 50% of Danish school children use the bike every day.

Combinations of bicycle and public transport play a more and more crucial role in Denmark. Collaboration between various stakeholders helps secure smart and effective commuter behaviour, with intermodality not reliant on an individual car-culture, combining various modes of transportation for the greenest, fastest, and healthiest commute. This flexibility makes it easy to use the bike for the first or last mile of daily trips and as a result 50% of the cycled kilometres in Denmark are either to work or education. We call it 'everyday cycling'.

In Denmark we have learned from the motor vehicle congestion suffocating cities throughout the world: The solution is not more room for cars, but less. Innovative and sustainable urban mobility planning will in time pay for itself tenfold – bigger highways do not.



Photo: Erik Petersen, Polfoto

One of the busiest shopping streets in Denmark, Strøget, has gone through significant changes in the past 60 years. Back in the 1950s cars dominated the street and pedestrians had to settle with narrow pavements. In 1962 the city council temporarily banned cars from the street causing an outcry from the local shop owners. However, despite of protests, the car free zone became a great success and was made permanent a few years later. Today, 50,000-80,000 people stroll Strøget every day.



Investing in cycling infrastructure

For the past 8 years the Danish Road Directorate has administered a subsidy scheme of DKK 1 billion known as the "Cycling Fund." The goal of the Cycling Fund is to facilitate projects that can improve conditions for cyclists so that the bicycle becomes a more attractive, widespread, and safe form of transport for both commuting and leisure all over the country. The national government can thereby stimulate and support local initiatives through the subsidy scheme. The fund has also fostered long term strategies and financing of cycle projects.

There has been a tremendous interest for the scheme; more than 1,000 applications have been submitted and 340 different cycling

projects have been co-funded by the scheme. As a result, the scheme has stimulated investments of more than DKK 2 billion on cycle-promotion as the Cycling Fund covers 40% of the total project costs. With support from the fund, the municipalities are able to make long-term planning and thereby facilitate the integration of new initiatives in planned projects in relation to the strategy.

Tentative evaluation results show that there has been a 24% increase in cyclists on the new cycle tracks funded by the scheme.

The Danish Road Directorate

2. POLICY MAKING FOR SUSTAINABLE MOBILITY

Heading for smart and comprehensive solutions

Morten Kabell, Mayor for Technical and Environmental Affairs, City of Copenhagen

Cities across the world experience more and more traffic, and everything indicates that it will continue to increase in the future. This means more congestion, limited space and, thereby, decreased mobility of goods and people. To combat these challenges and create sustainable liveable cities, synergies between political visions, plans and assessments are needed.

Ambitious goals with long perspectives

Policy making for sustainable mobility can play a key role in solving some of the current and future traffic challenges. In Denmark, transport planning takes place on national, regional and municipal levels, and on each level ambitious goals with long perspectives are essential.

As an example, the political goals are clear in the City of Copenhagen. Copenhagen strives to become a more liveable city to improve the quality of life for its citizens through pursuing the ambitious goal of becoming carbon neutral in 2025. The overall visions for Copenhagen are adopted by the politicians and pave the way for dedicated long term plans and strategies of how the goals can be complied with.

Integrated approach to planning

Enabling more liveable cities demands a smart and comprehensive approach to sustainable mobility with cooperation across various sectors, policy areas and levels of government as well as dialogue with citizens and other stakeholders.

Experience shows that when planning is combined with a continuous dialogue among the politicians, the administration and various private stakeholders in an iterative manner, a dynamic development of achieving the goals of the vision is facilitated.

In contrast to traditional transport planning, urban mobility planners are increasingly focusing on coordinating policies between several sectors such as land use, environment, social policy and transport. When sustainable mobility planning results in integrated solutions for urban areas, synergies between several sectors can be made.

Assessing the progress

To ensure the necessary progress towards achieving the goals, it is crucial to decide whether and when to allocate more

resources, to extend the time horizon and to adjust the goals accordingly. The City of Copenhagen applies green accounts to keep track on their progress. These tools facilitate a constructive dialogue and offer valuable knowledge for qualifying decisions. It allows an overview of the overall vision and understanding of the linkages between the goals.

“Political visions guide the city development by setting ambitious goals, followed by plans, strategies and assessments. In Copenhagen our vision is to be a liveable, responsible city with an edge.”

Creating liveable cities with sustainable urban mobility solutions depends on a combination of long-term visions, an integrated approach to planning and continuous assessments of the progress, where collaboration across multiple stakeholders, sectors and government levels is key.

COPENHAGEN GREEN MOBILITY GOALS FOR 2025

- **75%** of journeys in Copenhagen are done on foot, by bike or by public transport
- **50%** of all journeys to work or education in Copenhagen are done by bike
- **20%** more passengers using public transport compared to 2009
- **Public transport** is carbon neutral
- **20-30%** of all light vehicles use new fuels
- **30-40%** of all heavy vehicles use new fuels

Source: Copenhagen Carbon Neutral by 2025

Photo: Ursula Bach

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The Bicycle Account: Copenhagen - City of Cyclists

Since 1996 the Bicycle Account has been published biannually as it has become a very useful tool for citizens, politicians, the administration and the press. The Bicycle Account is an assessment of the cycling development in the City of Copenhagen. The Account systematically surveys the city's cycling initiatives, analyses Copenhageners' rating of Copenhagen as a bicycle-friendly city, and discusses other factors having impacts on the cycling development. The Bicycle Account relies on telephone interviews with approximately 1,000 randomly selected Copenhageners complemented with other figures and data from e.g. the transport habit studies carried out by the Technical University of Denmark.

The Bicycle Account serves as an important tool in the City of Copenhagen's efforts to make Copenhagen an even more bicycle-friendly city. It provides a clear indication of needs, demands and tendencies that strengthen policy-making, investments and green initiatives. A number of Danish cities are starting to develop similar accounts in order to measure the effects of investments over time.

City of Copenhagen

Company mobility plan leads to better transport habits

Mobility Management entails companies to be involved and affect the way employees travel during work time, to and from work and in their spare time.

The engineering and consulting company Rambøll work actively with mobility management.

In connection with a relocation to a new headquarters in Ørestad in Copenhagen, transport options were decisive for the choice of location. The new location provides great accessibility, green transportation options and good cycling facilities.

In connection with the relocation, Rambøll developed a mobility plan with focus on motivating the employees to change their transportation habits and promote sustainable means of transportation.

Rambøll focused on internal communication with information about the different options in order to make them easy and accessible as it affects the choice of transportation.

More employees in Rambøll in Ørestad use bus, train and bike to work after the move than before. Although the average commuting distance was increased by six km, the overall CO₂ emissions remained unchanged as employees swapped their cars for public transport or cycling.

Working with mobility ensures the company to maintain focus on the employees' transportation habits in order to continuously improve and adapt to the needs of employees.

Rambøll



3. COLLABORATION FOR A TRANSITION TO SUSTAINABLE TRANSPORTATION

Creating synergies and exploiting opportunities through collaboration between different stakeholders

Claus Nickelsen, Head of Environment and Energy, City of Aarhus

When people travel, geographical borders are crossed and modes of transportation are often combined. Danish experience shows that collaboration across borders and between different stakeholders can create valuable synergies resulting in greener and more liveable cities. The Danish approach to collaboration with public and private parties is rooted in the Danish history where collaboration has been widespread within a number of sectors and across municipalities. The collaboration approach is challenged by the number of different stakeholders and interests, but has also given room for new solutions for better cycling conditions, such as the Cycle Superhighways that pass through more than one municipality. The collaboration ensures a common high quality standard for commuters passing through more than one municipality on their way to job or other daily businesses, making commuting by bike an easier choice.

More and more Danish cities have ambitious plans to be CO₂ neutral in the near future. To achieve the goals, the cities are focusing more and more on collaborations across the borders of the municipality as well as on extended public-private partnerships.

“Public-private climate partnerships are a win-win. The private partners make a profit and the City of Aarhus gets the benefits of a green demonstration project.”

In Denmark's second largest city, Aarhus, climate partnerships have been created within a variety of different themes: Fossil free energy, transportation, water & climate adaption, intelligent energy systems, buildings & housing, and export. At the moment, the city has teamed up with over 40 climate partners from a wide range of different areas and backgrounds.

The goal of these partnerships is to make it attractive and profitable for the private companies and big public organisations to get involved. In return they need to share knowledge and work together with each other and the city on demonstration projects where the return on investment is not here and now, but in the future.

Within transportation the city of Aarhus took the climate partnership to a new level in 2011 when they teamed up with 9 companies in an industrial area in Skejby in the North of the city and became facilitator for a network of companies, working together to find new ways to reduce congestion in and around the business area.

By applying cross-border collaboration and engaging in public-private partnerships, the municipalities, companies, and institutions were able to create synergies and exploit the different strengths of the partners at the same time.



Business Park Skejby

The business area in Skejby north of Aarhus houses 100 companies, academic institutions and a hospital with about 20,000 people working there every day. To reduce congestion in the area, the companies and institutions teamed up with the City of Aarhus.

First, the partners conducted a transportation survey among the employees to map the potential for reducing single car use and have people carpool, use public transportation or bike to work instead.

The initiative led to the establishment of “Business Park Skejby”,

which seeks to give the area an attractive green profile and happier, satisfied and healthy employees. When the light rail opens in 2017, the business park will offer an extensive network of cycling paths interlinked by bus stops and light rail stations, a bicycle library where employees can borrow different types of bicycles, an accreditation scheme as cyclist friendly company and distribution of a cycling promoting magazine. Other elements include easy access to information and short cuts for cyclist, as well as a cargo bike service for smaller deliveries.

City of Aarhus, Aros Kommunikation og Weinreich Mobility

The Cycle Superhighways

The Cycle Superhighways is an inter-municipal cooperation aimed at creating a strong net of bike paths across the Capital Region of Denmark. The goal is to provide better conditions for bike commuters and encourage people to choose to commute by bike through new and innovative solutions.

The Cycle Superhighways could potentially increase the number of bike commuters in the capital region by more than 30% compared to today, making the project a key factor in the overall development of sustainable mobility. We have already experienced a 52% increase in the number of bike commuters on the Farum route since the opening back in 2012.

Behind the project is a unique, inter-municipal partnership between the Capital Region of Denmark and 23 municipalities within the

region. A secretariat facilitates the coordination between the municipalities.

With a realisation of the 28 Cycle Superhighways there is a potential to reduce the number of sick days by 34,000 annually, and reduce car rides during rush hour by 1.4 million.

The Cycle Superhighways have a socio-economic return of 19% - far above the Ministry of Finance's requirement of a return of 5% for investments in projects on infrastructure. In comparison, the Danish Metro City Circle Line has a return of 3.1%. At full potential, the socio-economic surplus of the Cycle Superhighways is estimated to be EUR 978 million over a 50 year time plan from 2012.

Secretariat for Cycle Superhighways

52%
INCREASE IN BIKE
COMMUTERS
SINCE
2012



4. CREATING GREEN LIVEABLE CITIES

The human dimension in sustainable city planning

Jan Gehl, Birgitte Bundesen Svarre and Andreas Røhl, Gehl Architects

A common feature of almost all cities is that the people who use city space in great numbers have been increasingly poorly treated. Limited space, obstacles, noise, pollution, risk of accident and generally disgraceful conditions are typical for city dwellers in most of the world's cities - regardless of global location, economic viability and stage of development. This turn of events has not only reduced the opportunities for pedestrianism and cycling as a form of transport, but also placed the social and cultural functions of city space under siege. Fortunately, now more and more cities realise the value of putting humans first in order to create more liveable cities and hereby increase quality of life for the inhabitants.

A necessary new planning dimension

After years of neglect of the human dimension, here at the beginning of the 21st century we have an urgent need and growing willingness to once again create cities for people. New global challenges underscore the importance of far more targeted concern for the human dimension. Urban planning with a human dimension focuses on the needs of the people who use cities. The vision of ensuring more lively, safe, sustainable and

healthy cities has become a general and urgent desire. All these four objectives can be strengthened immeasurably by increasing the concern for pedestrians, cyclists and city life in general. A unified citywide political intervention to ensure that the residents of the city are invited to walk and bike as much as possible in connection with their daily activities is a strong reinforcement of the objectives.

“For decades the human dimension has been an overlooked and haphazardly addressed urban planning topic in most cities. Fortunately, more and more cities now realise the value of putting humans first in order to create more lively, safe, sustainable and healthy cities.”

Cities must therefore urge urban planners and architects to reinforce pedestrianism and cycling as an integrated city policy to develop liveable and healthy cities. It is equally urgent to strengthen the social function of city space as a meeting place

that fulfills the aims of social sustainability and an open and democratic society.

Cities by people and for people

What is remarkable about the development in Denmark the last decades as well as cities such as New York City in recent years is that it reflects a growing understanding that cities must be designed to invite city life. These cities want people to walk in city space, they recognise the importance of pedestrian traffic and bicyclists for sustainability and health in society, and they acknowledge the importance of city space and city life as an attractive, informal and democratic meeting place for their residents in the 21st century.

Planning with human beings as the point of departure - and not the number of cars, the number of square meters or technical specifications of different transport systems - can create more sustainable cities, environmentally as well as economically and socially.

The text is adapted from the book Jan Gehl, Cities for People (2010), Washington DC: Island Press.



Photo: Gehl Architects

Photo: Ole Malling



The new Nørreport Station - a busy urban plaza

By putting cyclists and pedestrians first, conditions for all 250,000 daily visitors to Denmark's busiest transport hub have been improved dramatically. The transformation has turned the once cramped and untidy station area into an open, liveable and multi-functional urban plaza.

The design is inspired by the studies of people-flows across the square and has resulted in an open, safe and legible urban space - without a traditional station building or main entrance. Instead, the new station area boasts a number of clearly designated station functions, evenly distributed across the square to serve peoples'

needs at the most convenient place and to create an inviting and coherent urban space.

The new station buildings feature curved, glazed facades and green roofs with PV solar panels while the 2,100 bicycle parking spaces are set 40 cm below the surrounding paving. In this way, bikes are kept accessible and visible while ensuring unobstructed views across the square.

Gottlieb Paludan Architects, Cobe Architects, Sweco, Bartenbach Lichtlabor

The City Bridge - Reconnecting the city

In Odense a new bridge has improved mobility for cyclists and train passengers; stitching together two separated urban areas, and creating two new squares as well as a new landmark for the city. The railway lines running through the city have long served as a barrier between the harbour and the city centre, so in 2015 a bridge was established over the track area.

The bridge is a piece of very functional design, intended to simply extend Odense's large network of cycle lanes, catering to cyclists' demands. Thus the bridge was really designed as two bridges:

A bicycle bridge, based on cyclists' movements, gradients and curves - and a footbridge, optimised for pedestrians with wide stairs and direct access to station platforms. Above the tracks the two bridges come together as one, while they split in two at the abutments, providing the best possible 'landing' for the two types of users - creating a more connected and accessible city for the inhabitants.

Gottlieb Paludan Architects, NIRAS, ES Consult, Bartenbach Lichtlabor, Artist Anita Jørgensen



5. INTEGRATED TRANSPORTATION SYSTEMS

Combining modes of transportation can lead to more flexible and cost-efficient transportation systems

Michael Svane, CEO, Danish Transport Federation

Urbanisation causes increasing problems with traffic congestion leading to reduced mobility and rising CO₂ emissions from road traffic.

Congestion in one street can often be measured throughout a city's transportation network, and even slight changes in overall travel time can result in massive socioeconomic surpluses or deficits due to its effect on businesses' productivity.

8% of trips in the Greater Copenhagen Area are integrated transport trips, where the traveller uses a combination of bus, rail, car, or bicycle. The fact that many Danes in urban areas use a combination of train and bicycle is very visible near most stations, where the number of parked bicycles far exceeds the capacity for bicycle parking.

Focus on intermobility

In Denmark, one of the solutions to the challenges of congestion has been a focus on intermobility through an integrated transportation system where people and freights are moved effectively. Today, commuters choose between different modes of transport and are no longer viewed individually as a single type of commuter - be it cyclists, pedestrians, drivers, or users of public transportation. Goods are often

transported by both truck, train, ship and vans before reaching its final destination. Commuting and transportation of freights needs to be effective, flexible, cheap, and environmentally sustainable.

Planning for the future is about planning for intermobility, combining the best qualities of various modes of transportation in the different parts of the cities. Building a convenient and time-saving transport system makes it possible for people to move seamlessly between bike, bus, train, car, and metro services. When planning mobility, focus should therefore be on the first and last mile of the journey, as much as on the main choice of transportation.

Facilities for bikes and cars

Railway stations in the big cities in Denmark allow great accessibility and easy transfer by providing both bikes and cars with parking facilities. When leaving the car at the station and reaching their stop in the city, commuters have the possibility to change to one of the many modes of transportation available to them - including electric city bikes with GPS navigation, reliable and recurrent bus routes, rentable electric cars, or simply bringing your bike on the train and taking the final part of your journey by bike. An integrated payment

system allows free transfer between each mode and increasing the convenience for the users. Delivering post and parcels to the last destination is often done by bicycle.

"Focusing on sustainable integrated transportation systems allows for a reduction in traffic congestion in the cities, secures more reliable travel times for the passengers and decreases valuable time lost when commuting, benefitting both the environment and the society."

Interconnected public transportation optimises the use of urban space in a very effective way. Focusing on moving commuters from single use of cars into other more sustainable modes of transportation thereby allows for a reduction in traffic congestion in the city, secures more reliable travel times for the passengers, and decreases valuable time lost in commuting time.

Bringing the bike along for the commute

The Danish State Railways (DSB) offer commuters the possibility to bring bikes on the trains in Copenhagen for free. By redesigning the carriages with a one-way system for easy entry and exit with bikes, DSB have created a very popular mode of daily commuting.

Making room for bikes did not take place at the expense of the other passengers, as the red Copenhagen trains transported a record 114 million customers and has not affected the timeliness, which was 99 percent in 2015.

One of the reasons for this is that the trains have been designed to accommodate the bikes and that the customers have become used to making room for the bikes and showing consideration.

The flexibility in being able to bring your bike with you when taking the train enables commuters to avoid using the car when travelling over longer distances, causing less congestion in the city and easier and faster transit for the travellers.

DSB



Photo: Ursula Bach

New Urban e-Mobility

Bycyklen in Copenhagen and Frederiksberg is the world's first electric smart bike-share system. It is the new generation of transport for the urban traveler combining state-of-the-art mobility, touch-screen-computing and GPS navigation.

Bycyklen is the "fourth leg" in the public transport, which complements the already extensive infrastructure in the Danish capital, allowing users to travel by rail, metro and bus hassle-free.

Furthermore, it saves CO₂ emissions and gives commuters and tourists the opportunity to connect the first and last mile to their journey.

Most of the Bycyklen stations are located close to a train, metro or bus station to facilitate easy use and journey integration.

Through a partnership with City of Copenhagen, Frederiksberg and DSB, Bycyklen has been able to implement a solution designed to suit different types of users with a flexible pricing model dependent on the type of use, through an easy-to-use solution.

City and Commuter Bike Foundation

Køge Nord Station - A landmark for green mobility

In Køge, south of Copenhagen, Banedanmark, Køge Municipality, and DSB are building Køge Nord Station. The station will be a new gateway to Copenhagen for the more than 100,000 people passing through the area daily, and a significant step on the commute for the expected 8,000 daily users of Køge Nord Station. The station will function as a hot spot for the entire Copenhagen region and a transport hub for people travelling by car, bus, train, and bicycle. The project consists of a 225 meter long pedestrian bridge, a new train station and an associated park and ride facility. The station is a part of a new electrified high speed railway line running from Copenhagen to Ringsted via Køge. The line will

contribute significantly to meeting the transport requirements of the future by significantly improving the timetable with more frequent departures and by reducing the travel time to and from Copenhagen considerably.

The station will stand as a characteristic landmark for green mobility and strengthen Køge's position as a regional business development hub.

Banedanmark, Køge Municipality, DSB, COBE, DISSING + WEITLING, COWI



Photo: COBE & DISSING+WEITLING

6. ALTERNATIVE MODES OF TRANSPORTATION CREATE SOCIO-ECONOMIC BENEFITS

Measuring the socio-economic benefits of alternative modes of transportation

Lars Green Lauridsen, Senior Vice President, COWI

Choosing mode of transportation has significant socio-economic impact for societies all over the world. Nowadays commuters are increasingly making a choice between different kinds of transportation in order to arrive at their destination in the most efficient way. Therefore, there is a need for more advanced socio-economic tools to calculate the benefits of these initiatives.

In Denmark there are well developed standards measuring the benefits of transport infrastructure projects to identify the socio-economic value. These assessments include various variables such as construction and maintenance costs, travel time, accidents, public health, and of course environmental effects such as air quality and CO₂ emissions.

Promoting active and environmentally friendly mobility has socio-economic benefits that can be quite substantial. The potential benefits are perhaps most significant when changing mobility patterns

to commuting by bike instead of by car. For example, for every kilometre commuted by bike instead of by car, society saves around 1 EUR per km. In a city like Copenhagen, people use their bike so much that it compares to 31 times around the world every single day. Cities with less developed cycling infrastructure can potentially save an even greater amount on costs, if they manage to change mobility patterns of even a small percentage of the citizens.

The socio-economic effect of these initiatives leads directly to an improved productivity because less time is spent on the daily commute.

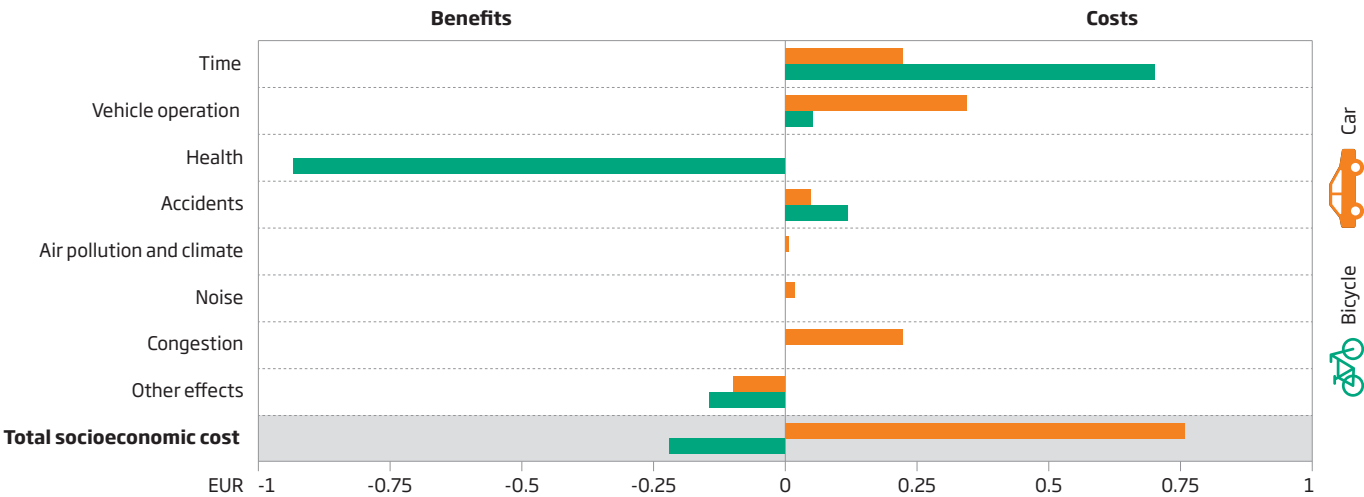
The single most expensive part about traditional car based mobility is the expenses used by municipalities, regions and the state, on maintaining and providing infrastructure for an extremely ineffective mobility choice. As a result, promoting alternative mobility and intermodality can cause significant socio-economic benefits such as less congestion, pollution and healthier

people. The added health benefits can be measured on municipalities' bottom line, as less sick days in companies reduces production losses, in turn positively impacting the economic growth of cities.

“Denmark is known as one of the best cycling countries of the world, and our cycling infrastructure is among the finest in the world. Why do we do it? Because substantial benefits can be harvested and measured throughout the society when choosing alternative transportation.”

Policymaking promoting alternative mobility will be the correct path for cities throughout the world who wish to increase the quality of life for their citizens, while at the same time supporting projects directly beneficial to the city's economy.

1 km by car moved to bicycle = 1 EUR in socio-economic benefit



A cost-benefit analysis of a 1 km cycle journey at a speed of 16 km/h in Copenhagen rush hour shows a socioeconomic benefit of 0.22 EUR per km. In comparison, the socio-economic loss of a 1 km car journey at a speed of 50 km/h corresponds to 0.70 EUR. The total saving in cost therefore corresponds to EUR 1 per travelled km. (Source: Copenhagen Bicycle Account 2014)



Photo: Danish Cyclists' Federation

Encouraging children to bike through effective campaigns
The annual All Children Cycle campaign has been assessed by COWI and The Danish Cyclists' Federation using the socio-economic methodology and the unit costs developed for cycling projects. The campaign aims to make school children change their mode of transport to and from school from being driven by their parents to using their bike for a two week period.

The campaign costs are very low and achieve very high impacts. The number of participants are approximately 136,000 children, where a substantial part of these are 'new' bike users. This leads to more than 600,000 additional bike kilometers and a reduction of 340,000 km in the parents' car use.

The main benefits of the campaign are that more children are physically active giving positive health effects and a reduction in car use.

The socio-economic return is more than EUR 60,000 in net present value from an investment of EUR 330,000. This leads to a return on the campaign costs of 18%, which is more than twice the return on e.g. the fixed Fehmarnbelt tunnel return on investment.

COWI

The Cycle Serpent - a creative cycling solution that benefits the city and the people
The "Cycle Serpent" in Copenhagen is a great example of a costly yet effective cycling solution in Copenhagen. The project had a cost of EUR 5 million and was partly financed by national funds and by the City of Copenhagen. The new bridge was inaugurated in 2014 and made up the final link between Vesterbro and Islands Brygge. Before it was built, cyclists had to stop and haul their bicycle down two sets of stairs in order to reach the little older (from 2006) bicycle and pedestrian bridge "Bryggebroen". A 2014

count shows that there are more than 11,500 cycle journeys across the Cycle Serpent every day - 15% more than expected by the City of Copenhagen. The bridge makes up a missing link in the network of cycling routes in Copenhagen. Every cyclist saves 1 minute by not having to use the stairs, which amounts to almost EUR 2000 a day - more than EUR 0.7 million a year in socio-economic benefits. That gives a payback time of 7 years and is thereby a great benefit to society.

City of Copenhagen



Photo: Ursula Bach

7. SMART MOBILITY WITH CAR SHARING AND ELECTRIC VEHICLES

A smart approach to urban transportation with renewable energy

Lærke Flader, Managing Director, The Danish Electric Vehicle Alliance

As more and more people move to urban areas, commuting and transportation of goods will increasingly challenge the transport system and as a consequence increase congestion and emissions. At the same time politicians and citizens are asking for more "liveable cities" with greener spaces, cleaner air, biking lanes taking up space from roads, etc.

To many, the answer is Smart Mobility, where existing and future technology lead to more integrated and strategic ways of mobility management - including big data monitoring, sharing economy, self-driving cars and e-mobility. This changes how we get around and makes transportation more efficient, cleaner and less space demanding. These are not only visions for the future. Cities can take the first steps today.

Several municipalities in Denmark have, as part of their green city initiatives, embarked on different strategic intelligent traffic solutions. Advances in intelligent communication technologies and transport monitoring systems have for example made it possible to build traffic models based on large scale data gathering in order to reduce congestion, emissions and

increase safety for both vehicular traffic and bicycles.

Transportation in a sharing economy

By providing a wide range of different car sharing programs in combination with public transportation citizens' transportation needs are likely to be covered, without having to own a car. As a result, fewer cars will take up valuable space in the city for parking. Many car sharing programs depend on the municipalities reducing parking fees and/or creating dedicated parking lots, hereof also dedicated parking lots for electrical vehicles, which contributes to an improvement of air quality in the city.

The flexibility potential of electric vehicles

Electric vehicles also play a key role in the greening of the transportation sector. Not only do electric vehicles encourage smart mobility. They also enable the realisation of an intelligent energy system with increasing amounts of fluctuating power.

Today, wind power accounts for more than 40% of the Danish power generation and Denmark therefore has a strong focus on enhancing flexibility on the demand-side

of electricity. Electrical vehicles play a key role in providing flexibility to an energy system with even larger shares of renewable energy, since charging the electrical vehicle can be moved outside of peak hours, without reducing the comfort of the consumer. This brings several socio-economic benefits due to a cheaper electricity production and energy savings for the end consumer.

"Danish municipalities have taken their first steps into the future of smart mobility with a variety of sustainable mobility management initiatives causing less congestion and easier accessibility through the city."

With a smart approach to urban transportation where renewable energy is part of the solution, the future challenges can be met.



CITS - Copenhagen Intelligent Traffic Solutions

The CITS project is an innovative smart city project to improve traffic flow, reduce emissions and increase safety for the citizens by using big data. The objective is to enable city officials to both monitor traffic conditions in real-time and run a variety of simulations.

The CITS platform draws data from a network of wifi access points that have the capability of geo-locating wifi enabled devices on the streets without compromising privacy. The data is aggregated, anonymised and then fed back into a cloud based software dashboard.

The dashboard can help categorise traffic, look for patterns and identify long term behavioural tendencies amongst the road users. The data can be explored and analysed historically, presented in real-time or serve as a basis for a variety of simulations that can predict future traffic behaviour. The system makes it possible to plan and test new traffic scenarios for city planners, build cause-effect relationship, optimise traffic light timings and much more. CITS bring depth and richness to traffic data like never before.

Leapcraft, Citelum, Technical University of Denmark, Cisco, City of Copenhagen

Fully electrified car sharing

Copenhagen serves as a test platform for technologies and innovative business models. This has been proved many times before. DriveNow, in Copenhagen, is the first fully electric free floating car sharing scheme in the world, to be integrated with public transportation. This is indeed also a test platform to measure how electric cars can affect the patterns and behaviour of the passengers last mile, from bus stop to their door steps. The system conducts information about the usage and utilisation of the cars, compared with public transportation and where people live and work. Details

about weather, events and the "rhythm" of the city is compiled into data, which are used to identify hotspots and positioning of the infrastructure needed for charging. All in all to make a public infrastructure suitable for use for both the car sharing scheme and the daily use of private owned electric cars. The electric car assists as a modern platform, by integrating to an online travel planner and providing the possibility of using the nationwide travel card as key for entering the system. This will change the intermobility of Copenhagen.

Arriva Danmark & DriveNow



8. INNOVATIVE SOLUTIONS IN URBAN TRANSPORTATION

Developing new solutions to solve multiple challenges

Niels Hoé, CEO, HOE360 Consulting

If we want the cities worldwide to adapt to a future with increasing urbanisation causing massive problems with both congestion and decreasing air quality, alternative modes of transportation is required and getting people to adapt to these alternatives is necessary.

Political courage and a more holistic approach to innovative solutions are required to create the necessary momentum and efficiency to keep up with future needs. This involves both public and private stakeholders as well as knowledge institutions to be able to create truly innovative and meaningful smart urban solutions.

Live test and demonstration in the city

The city is the perfect demonstration site to test new innovations to meet the needs of the growing cities and at the same time support the citizens in adapting to new modes of transportation. The innovative projects are often developed in collaboration between private companies and the municipalities creating both local growth

and city development and at the same time involving the local citizens in creating a more liveable city.

“Innovation in an urban context is key to create sustainable cities of the future, involving both city development, local growth and citizen involvement.”

Existing solutions can be used to test new technology, such as the public transportation that is an ideal opportunity to test alternative fuels. Also, implementation of sensors creating real-time data on congestions and air quality can help to foresee and solve concrete challenges. Even small everyday-innovations can support the people in the city to make the smarter and more sustainable choice in regards to transportation.

Using familiar solutions in new contexts

Implementing new features around the city

that cater for the cyclists' needs is another example of using familiar solutions, but in a new context. Green waves have been used in order to make the traffic flow more easily, but now, specific bicycle friendly “green light waves” have been implemented to follow the flow from cyclists, not cars, thereby increasing the effectiveness when travelling by bike. Innovations in urban mobility does not always have to be technical and complicated, often small simple new elements can have a large effect.

Cycling is an element in creating the smart city and with the many years' knowledge and experience gathered from a long tradition for cycling, the Danish companies are able to develop new innovative solutions that can be integrated in different contexts and solve multiple challenges. When innovating for urban mobility, it is important to maintain a holistic view, considering the environment and purposes of the city in general.



Photo: Troels Heien



Photo: Mikkel Østergaard

Small innovations to show the city cares

In Copenhagen, a special effort has been made towards making the cyclists feel welcome in the city by offering them “a little extra”. Small innovative solutions that make the bicycle ride more enjoyable and prove that your city cares have been implemented city-wide, such as footrests at intersections that makes waiting at red-light easy, tilted litterbins made cycling friendly, by facing the cyclist making it easy to get rid of your empty coffee cup without stopping, and green waves that fits the speed of cyclists and makes the traffic flow more easily are just a few examples.

By counting people who ride bicycles and showing it on a bicycle counter display, the city sends a signal that “every cyclist counts”, thereby encouraging the choice of transport. In central Copenhagen, the yearly count accumulates to the equivalent of the Danish population passing by twice.

HOE360 Consulting, City of Copenhagen

Technical experiments mature the industry and accelerate the green transition

In an attempt to ensure environmental sustainability and the green transition in the public transport industry, Movia has facilitated test with new technology and green solutions for busses for many years. There is a need for public transport authorities to take an active role by facilitating technical tests in order to support the maturing of the industry and to help uncovering risks and costs. The knowledge gained through tests is shared with the private operators, enabling them to offer environmentally sound solutions at a more reasonable price than otherwise possible.

In the past five years, Movia has commenced tests with hybrid busses, gas busses, lightweight busses, midi-busses, eco-driving, different forms of biofuel for example 100% synthetic biodiesel

based on slaughterhouse waste, and both 7 and 12 meter nightly charged electric busses. Currently, Movia is planning tests with 12-meter electric busses charged in the urban area in 2016. Overall, these technologies reduce harmful pollutants such as CO₂, NOx, particles and noise among others.

And tests make a difference. Many of the tested technologies are in operation today, e.g. numerous lightweight busses, eco-driving and busses using CO₂-free slaughterhouse waste. The many tests and trials enable a faster transition from fossil to renewable fuel to the benefit of passengers, citizens living along the routes and the environment as such.

Movia



THE CYCLING EMBASSY OF DENMARK

The Cycling Embassy of Denmark (CED) is a comprehensive network of cycling professionals from private companies, local authorities, and non-governmental organizations working together since 2009 to promote cycling and communicate cycling solutions and know-how. The members of CED represents the latest knowledge of all areas related to cycling be it planning bicycle and people-friendly cities, creating synergy between cycling and public transport, building safe infrastructure for cyclists like cycle tracks and bicycle bridges, developing successful campaigns and municipal policies that motivate people of all age groups to cycle, designing urban furniture like bicycle pumps, bike counters, and bicycle parking facilities, and much more.

The goal of CED is to encourage cycling throughout the world and share the know-how that have made Denmark one of the most cycling friendly nations in the world.

The expertise of the CED is extremely wide-spread as the CED include members in public administration (on both a local, regional and national scale), some of the world's most renown architecture firms, innovative NGOs, and possibly the world's best consultants in the field of everyday bicycling.

Our activities

CED assists with the coordination of masterclasses, study tours, lectures, and guided bike tours in various Danish cities. Our services target professional planners in public administrations and private companies, local and national policy makers, researchers, and civil society organisations. CED receives over 100 foreign delegations every year - who come to Denmark to study cycle infrastructure and planning solutions in leading Danish cities. The members constantly work to share their knowledge and know-how internationally - through the

mentioned activities in Denmark but they can also be found all over the world giving lectures and consulting to a wide range of professionals.

In addition the CED awards the Leadership Award for Cycling Promotion each year, to an individual or organization in acknowledgement of their work to promote cycling. The award has previous been given to Mayors, CEO's and cycling advocates from all over the world.

All in all the over 40 organisations in CED are all working together to create more liveable and bikeable cities around the world.

For more information about the Cycling Embassy of Denmark, please visit www.cycling-embassy.dk

Photo: Mikkel Østergaard

DENMARK - THE STATE OF GREEN

Denmark has a long tradition for cycling and alternative transportation modes in the cities. In order to meet the challenges of an increased urbanisation, sustainable transportation must be an integrated part of city planning. A flexible and smart approach to commuting and transportation of goods is necessary to meet the ambitions of Denmark becoming independent of fossil fuels by 2050.

Denmark knows smart and sustainable urban transportation

In Denmark we believe that knowledge is power. To ensure that the transition to a greener economy is a good investment, renewable energy resources must be intelligently integrated into the energy system and used as alternative fuels. This requires more flexibility in the system and integrated in the urban planning.

Since the 70s, Danish governments have addressed the country's limited natural resources, concentrating on using them wisely, pushing energy efficiency measures. As a nation we are known for our ability to collaborate and our expertise is in

helping customers and stakeholders reach highly efficient and 'smart' solutions, while in turn developing their ability to profit from that knowledge. We see great opportunity for mutual benefits in the transfer of knowledge, spurring growth in both partners' businesses - holistically, with healthy respect for different perspectives and agendas, as well as for the environment.

Explore, learn and connect online

State of Green gathers all the leading players within sustainable transportation in Denmark. Stateofgreen.com is the official platform for Denmark's green solutions and knowhow. The web portal is an online entry point for all relevant information about Danish companies and institutions and their expertise within Denmark's ten green strongholds.

Come visit us in House of Green

House of Green is an interactive visitors' and exhibition centre located in the heart of Copenhagen. House of Green uses a combination of guided storytelling and self-exploration to showcase green Danish integrated solutions and scenarios, as

well as an overview of the combined Danish story within energy, climate, water and resources. Danish representatives act as hosts that both inspire and inform delegations before they move on to on-site visits. For more information about House of Green, please visit houseofgreen.dk

Experience implemented green solutions - live!

A cornerstone of the Danish vision is to inspire others and demonstrate how a green society is both possible and profitable - and we invite people to come see for themselves. Through State of Green Tours we offer commercial and political decision makers and journalists from around the world a chance to take advantage of the lessons learned by leading Danish companies and institutions within the fields of energy, water, climate adaptation and environment, and to experience Danish green solutions - live. For more information about State of Green Tours, please visit stateofgreen.com/tours

About State of Green

State of Green is a public-private partnership founded by the Danish Government, the Confederation of Danish Industry, the Danish Energy Association, the Danish Agriculture & Food Council and the Danish Wind Industry Association. H.R.H. Crown Prince Frederik of Denmark is patron of State of Green.

As the official green brand for Denmark, State of Green gathers all leading players in the fields of energy, climate, water, and environment and fosters relations with international stakeholders interested in learning from the Danish experience. Connect through: www.stateofgreen.com



Learn more about Danish solutions in sustainable transportation, find more cases from around the world and connect with Danish expertise at:

www.stateofgreen.com/sustainable-transportation

State of Green is a non-profit, public-private partnership founded by:



Confederation of Danish Industry



DANISH
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