



# NORDIC SOLUTIONS FOR SUSTAINABLE CITIES

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Copenhagen / Helsinki / Mariehamn / Nuuk / Oslo / Reykjavik / Stockholm / Tórshavn



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As Mayors of the Nordic capitals,  
we are proud to enjoy an international  
reputation for being 'green cities'.

## MAYORS OF THE NORDIC EIGHT



**Frank Jensen**  
Mayor of Copenhagen



**Jussi Pajunen**  
Mayor of Helsinki



**Edgar Vickström**  
Mayor of Mariehamn



**Asii Chemnitz Narup**  
Mayor of Nuuk



**Stian Berger Rosland**  
Mayor of Oslo



**Jon Gnarr**  
Mayor of Reykjavik



**Sten Nordin**  
Mayor of Stockholm



**Heðin Mortensen**  
Mayor of Tórshavn

## WELCOME

**In the Nordic region we take a long term view, considering sustainability and future benefits alongside more immediate pressures and opportunities. As city leaders, we have championed green growth, actively supporting innovations in products and services that could help to secure a more sustainable urban environment.**

The Nordic Eight cities comprise a mix of small and larger cities, each responding to challenges at a scale and in a manner most appropriate to them. Over the years, we have found great benefit in sharing knowledge between our eight cities, learning each other's lessons and collaborating, through both our formal channels of co-operation and our informal collaborations. We have been able to jointly fund projects, sharing the risk of experimentation and all benefiting from the results.

In an increasingly global community, we are more connected and integrated with other cities than ever before; sharing markets and resources across borders and continents in both real and virtual ways.

Although every city is unique in its totality, we all face the same generic challenges of climate change and resource depletion. Many of the solutions to those problems are transferable – we have certainly learned much from our engagement with other cities.

We have produced this catalogue together to outline some of the solutions we have found to creating more sustainable cities, in the hope that it may be useful or even inspiring for other cities outside the Nordic region.

The future of the world is increasingly urban - more than half of humanity now lives in cities. We want to work with other city leaders across the globe to make sure that our shared future is a sustainable one, improving quality of life and protecting our environment for future generations.

Here's to cities changing the world!



# MEET THE NORDIC EIGHT

The Nordic Eight are eight cities located in northern Europe around the Baltic Sea and Northern Atlantic Ocean.

The Nordic cities share many cultural traits. Globally they are renowned for their liberalism, strong sense of design, ecological ethic, high standards of education and abundant natural resources that have enabled them to enjoy relatively strong economies and a high quality of life.

Together they:

- represent 2.8 million people
- have 291bn US\$ of global GDP
- emit 10,752 thousand tCO<sub>2</sub>/year of global greenhouse gases

On a global stage, the Nordic cities all fall within the city size classes of less than 1 million inhabitants. 61% of today's global urban population live in settlements of this size (projected to reach 67% by 2025), with nearly 50% living in settlements of less than 0.5 million<sup>1</sup>. As such, the Nordic cities demonstrate that being a smaller city is not a barrier to committing to positive action for sustainability. If other cities of their size take action, a huge global shift towards sustainability can be achieved.

Equally, these are actions that can be universally shared between smaller and larger cities alike.

## Climate

Nordic city summers have long periods of daylight, whilst in winter they experience prolonged darkness. They mostly enjoy relatively mild, temperate climates throughout the year characterised by pleasant, warm summers of 15 - 30°C and frosty winters of around 0°C; although some of the cities such as Helsinki have been known to experience temperatures of as low as -20°C.

## Working together - Nordic Co-operation

Nordic Co-operation is one of the world's most extensive forms of regional collaboration; involving Denmark, Finland, Iceland, Norway, Sweden and the autonomous territories of the Faroe Islands, Greenland and Åland

It has firm traditions in politics, the economy, and culture; plays an important role in European and international collaboration; and aims at creating a strong Nordic community in a strong Europe.

Nordic Co-operation seeks to safeguard Nordic principles in the global community. Common Nordic values help the region solidify its position as one of the world's most innovative and competitive regions.

Through their Co-operation, the Nordic countries, and their cities, have created a strong community that plays an important role both in Europe and internationally.

Nuuk  
(Greenland)

1. World Urbanisation Prospects, the 2011 Revision,  
UN Department of Economic and Social Affairs, 2011

|   |  |
|---|--|
| <p><b>Copenhagen (Denmark)</b><br/> <b>Population</b> 539,542<br/> <b>GDP</b> 87,200 US \$/Capita<br/> <b>Carbon Emissions</b> 4.7 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> Carbon Neutral by 2025</p>   | <p><b>Oslo (Norway)</b><br/> <b>Population</b> 614,798<br/> <b>GDP</b> 123,794 US \$/Capita<br/> <b>Carbon Emissions</b> 2.0 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> 50% reduction by 2030 (1991 levels)</p>                                 |
| <p><b>Helsinki (Finland)</b><br/> <b>Population</b> 588,549<br/> <b>GDP</b> 64,262 US \$/Capita<br/> <b>Carbon Emissions</b> 5.2 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> 20% reduction by 2020 (1990 levels)</p>  | <p><b>Reykjavik (Iceland)</b><br/> <b>Population</b> 118,810<br/> <b>GDP</b> 36.8 US \$/Capita<br/> <b>Carbon Emissions</b> 2.69 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> 75% by 2050 (2007 levels)</p>                                       |
| <p><b>Mariehamn (Åland Islands)</b><br/> <b>Population</b> 11,232<br/> <b>GDP</b> 45,000 US \$/Capita (entire Åland Islands)<br/> <b>Carbon Emissions</b> 7.3 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> 25% reduction by 2020 (2002 levels)</p>   | <p><b>Stockholm (Sweden)</b><br/> <b>Population</b> 861,010<br/> <b>GDP</b> 143,767 US \$/Capita<br/> <b>Carbon Emissions</b> 3.8 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> Fossil fuel free by 2050</p>                                       |
| <p><b>Nuuk (Greenland)</b><br/> <b>Population</b> 15,522<br/> <b>GDP</b> 36,500 US \$/Capita (entire Greenland)<br/> <b>Carbon Emissions</b> 4.7 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> Currently calculating and discussing a target based on 2008 levels and made up of realistically achievable results</p> | <p><b>Tórshavn (Faroe Islands)</b><br/> <b>Population</b> 19,915<br/> <b>GDP</b> 44,074 US \$/Capita (entire Faroe Islands)<br/> <b>Carbon Emissions</b> 7.0 tCO<sub>2</sub>/Capita<br/> <b>Carbon Targets</b> 35% reduction by 2020 (1990 levels)</p> |

Reykjavik  
(Iceland)

Tórshavn  
(Faroe Islands)

Oslo  
(Norway)

Stockholm  
(Sweden)

Copenhagen  
(Denmark)

Mariehamn  
(Åland Islands)

Helsinki  
(Finland)



## Seven City Challenges

- » Urban Planning
- » Transport
- » Street Lighting
- » Energy
- » Water
- » Smart Information Management
- » Behaviour



# THE CHALLENGES CITIES FACE

Climate change, population growth, urbanisation and resource depletion; these are all major global challenges facing human civilisation today and nowhere more so than in our cities. They are particularly at risk and vulnerable. To survive in the 21st century, it is crucial that cities adapt to and address these challenges.

Cities are also major contributors to many of the problems we face. For example, 80% of global greenhouse gas emissions contributing to climate change are currently emitted by the world's cities.<sup>1</sup>

However, cities are also key to addressing these challenges for the following reasons:

actions are addressing seven of the challenges cities face today. They want to share their technical innovation, holistic systems approaches and methods of influencing behaviour change.

They hope their ideas and experiences are useful in the pursuit of a more sustainable urban future.

- » **The world's cities are currently home to 4 billion people**
- » **By 2050 this number is projected to reach 6 billion people; 70% of the human race**
- » **The top 600 cities alone, account for 22% of global population and more than half of global GDP<sup>2</sup>**

If cities can harness their enormous economic power and use their ability to influence their large populations and societal structures, they are well placed to take the lead in moving the world towards a more sustainable future.

Some cities have already started. Whilst international negotiations on addressing climate change have achieved mixed results, many cities are working together on taking the lead and inspiring each other to bring about change. With their global reputation for being forward thinking and sustainably aware societies, one such group of cities forging ahead with making positive changes are the Nordic Eight.

This brochure/catalogue has been prepared for you by them – eight Nordic Cities whose innovative

1. Urban World: Climate Change-Are cities really to blame? UN Habitat and UNEP, March 2009  
2. Urban World: Mapping the economic power of cities, McKinsey Global Institute, March 2011



# URBAN PLANNING: GROWING COMPACTLY AND EFFICIENTLY

Cities offer an environment in which people can be closer to the diverse amenities of modern life - key services, employment opportunities, entertainment, goods and transport.





## The challenge

City populations are growing and people are aspiring to an ever better quality of life. More and more resources are being used to support this trajectory but these resources can't keep pace with demand. Water, energy, land and food resources are not growing in absolute terms. In fact, many are depleting.

Land is a major issue. It provides the space for all living things to inhabit and survive. As populations continue to grow, cities can minimise land use through concentrating people and their activities. However, the challenge remains to provide citizens with a high standard of living, restrict resource consumption to sustainable levels and keep everything within a compact system - preventing urban sprawl and adverse impacts on the surrounding natural environment.

## The Nordic Eight Solutions

The Nordic Eight are addressing the urban planning challenge through a number of approaches:

- Regeneration within the existing city boundary to prevent urban sprawl
- Enhanced urban mobility through improved access and transport nodes
- Protection of resources as a key and central part of urban planning

## The benefits of these solutions

### *Environmental*

- By reducing car travel, the cities reduce air pollution, congestion and carbon emissions
- Through protecting green spaces, they encourage biodiversity
- More efficient use of resources reduces environmental impact

### *Social*

- Closer proximity to modern amenities enables a better quality of life
- Mobility is increased and travel delays reduced through better transport links
- More flexible lifestyles improves the work/life balance
- Access to more employment opportunities and key services increases social mobility

### *Economic*

- More efficient use of resources and city systems reduces the costs of doing business and providing resources
- Better transport links encourage economic investment from prospective businesses



# CASE STUDIES



## STOCKHOLM

### TURNING BROWNFIELD TO GREEN DISTRICT

With an ever-growing population, the City of Stockholm decided to develop a former brownfield site (an old industrial harbour area) into a modern eco neighbourhood: a district with high environmental standards and excellent quality of life.

#### The solution

From the outset Hammarby Sjöstad was designed to be a new city district with strict environmental standards and development requirements.

The aim was that the district should be twice as environmentally friendly as an average area built in the early 1990s. Integral to achieving this was the implementation of a unique eco-cycle - the Hammarby Model (see Fig.2)

#### The outcome

- Hammarby Sjöstad consists of 11,000 apartments, 10,000 office places and is visited by approximately 10,000 visitors each year
- Water consumption has reduced from 200 litres/day to 150 litres/day, with the aim of achieving 100 litres/day
- No bins are used, instead 'refuse chutes' carry waste to a central collection station using vacuum suction and a network of underground tunnels
- District heating and cooling is used throughout the neighbourhood, with the aim that 50% of the energy will be supplied through harnessing their own wastewater and combustible solid waste as resources
- In a study of 5,000 Hammarby apartments, combined modal share of public transport, walking and cycling has risen to 82% of all journeys made: reducing transport CO<sub>2</sub> emissions by 52% (2,373 tCO<sub>2</sub>/year)
- 10% of residents belong to a carpool scheme where 75% of the cars are bi-fuelled<sup>1</sup>

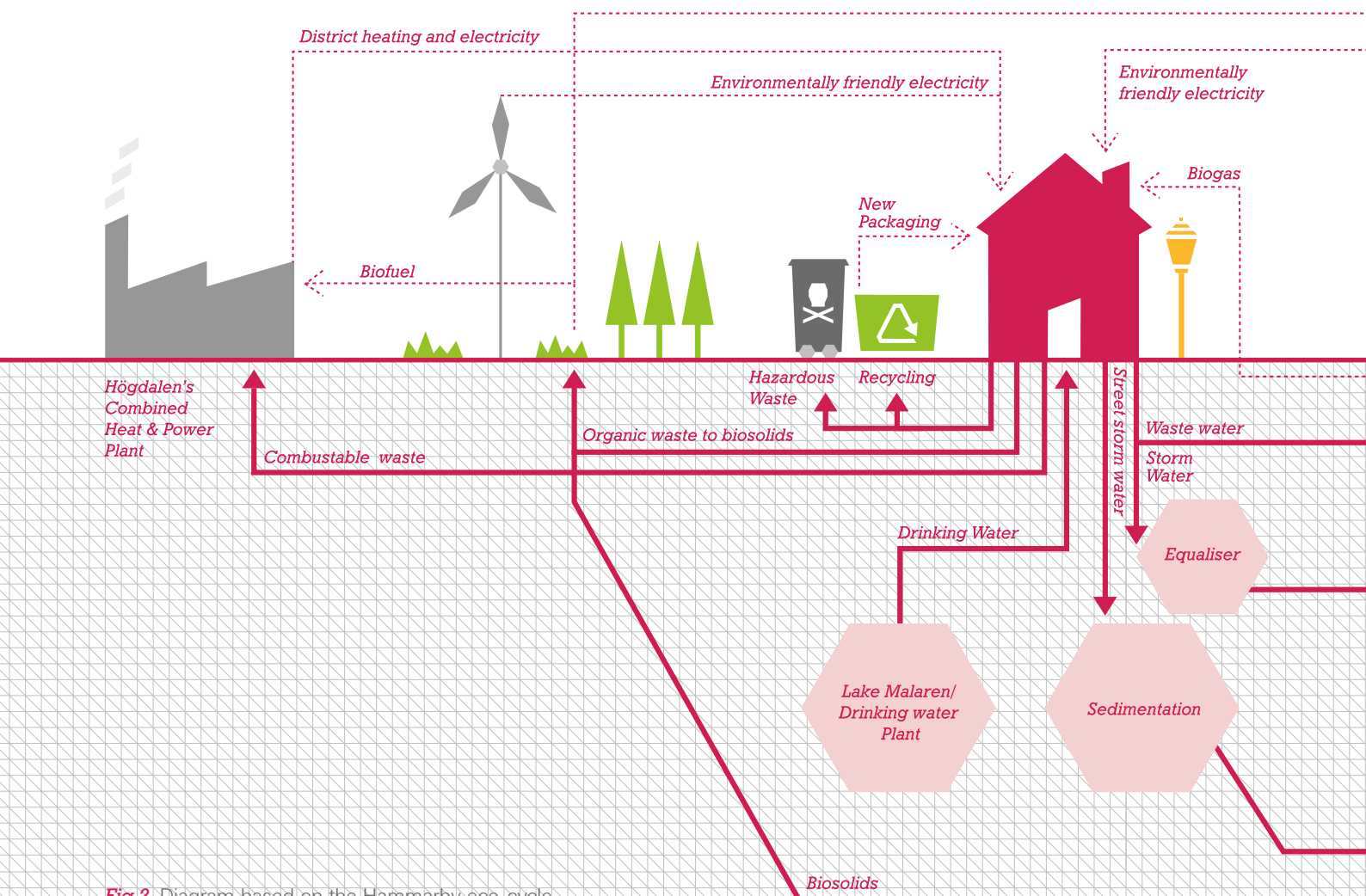


Fig.2 Diagram based on the Hammarby eco-cycle





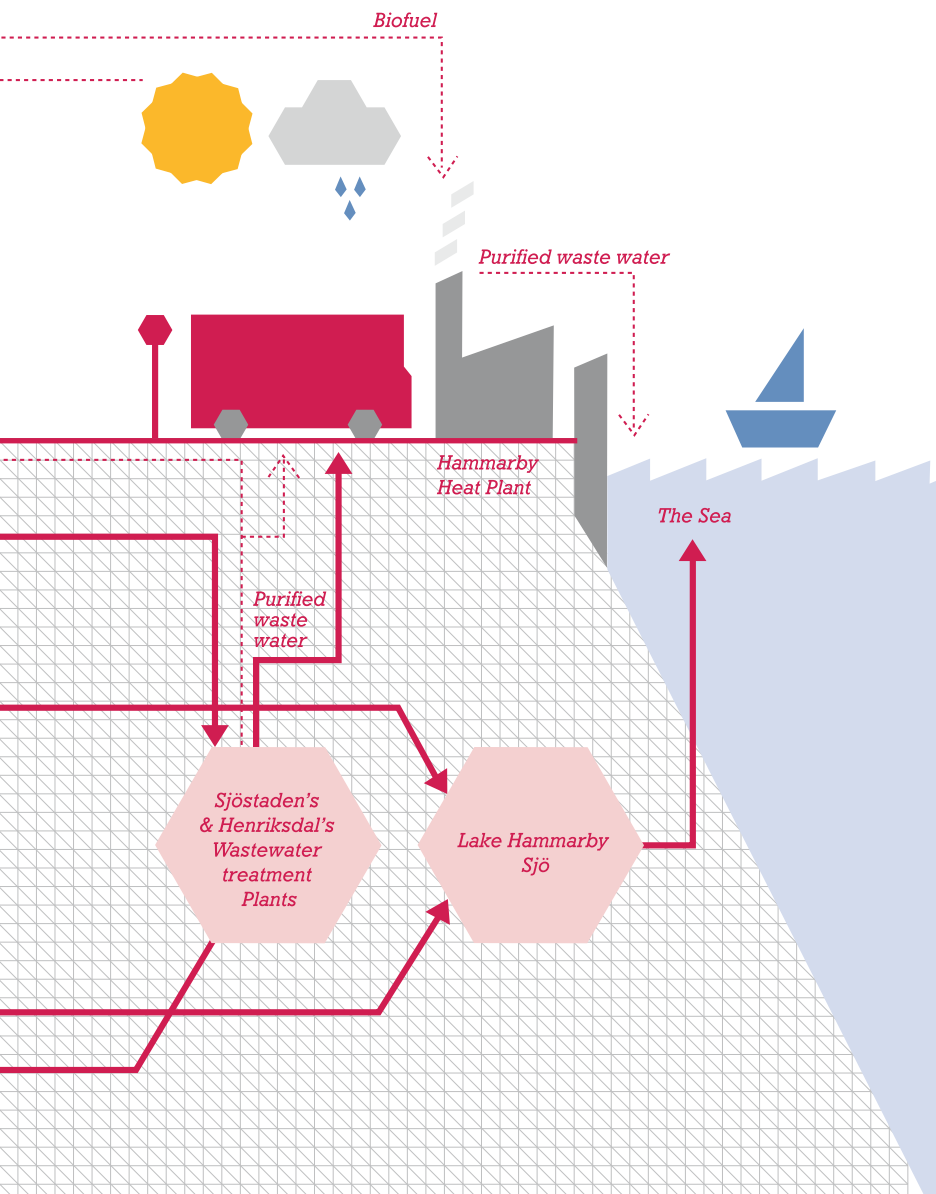
» Hammarby Sjöstad

39%

Total emissions into air soil & water is up to 39% less than 1990



Hammarby Sjöstad has no wheeled bins, 'refuse chutes' carry waste to a central collection station



## NUUK

### PLANNING BETTER USE OF ENERGY RESOURCES

Nuuk is almost totally dependant on hydropower for its electricity and heat. However, it is an expensive energy resource to harness in comparison to generation from fossil fuels. Whilst there is more than enough supply to meet existing demands, the city is keen to encourage new energy intensive industries to invest in the city; diversifying the city's economy and enabling those industries to make use of green energy resources.

#### The solution

To provide the extra capacity for these energy intensive industries, and maintain a green resource, the City of Nuuk is planning to promote more efficient use of their existing energy resource.

They are going to do this through intensifying the coordination of energy planning throughout the city. They will encourage all new developments to make more efficient use of the heat and power infrastructure, for example, through connection to the district heating network. When existing buildings need to renew their boiler, they will also be obliged to switch to district heating where feasible.

#### The expected outcome

- Avoidance of using fossil fuels to provide the extra energy capacity; saving having to import fuel, CO<sub>2</sub> emissions, air and noise pollution
- Moving energy intensive industries to the area, improving the city's economy and allowing the industries to make use of green energy

1 <http://www.hammarbysjostad.se/>



## COMPACT URBAN GROWTH

To accommodate a growing urban population, the City of Oslo has adopted a compact growth strategy; focusing growth within the city boundary rather than allowing the city to grow outwards.

### The solution

- The city boundary was determined by special legislation as the point at which the city meets the surrounding forest
- New developments are now focused on a strategy of strengthening the multifunctional city; developing a diverse mixture of commercial and industrial activity, cultural institutions, services and housing with good public transport access and links
- The strategy also places importance on providing every citizen with access to green space for wellbeing and to promote biodiversity

### The outcome

- The fjords, green landscapes and waterways are all protected from the impacts of human activity
- There has continued to be strong commercial development in the Oslo region
- Development has also occurred underground; road tunnels in the central area have freed land above ground for future urban development
- In the inner city there is an average of 30m<sup>2</sup> of green space per person and 56m<sup>2</sup> per person in the outer city, compared to the World Health Organisation's 9m<sup>2</sup> (see Fig.3)



» Compact urban growth in Oslo



» Residential area of Tórshavn



» A traditional 'sod roof' or green roof in the Faroe Islands

## TÓRSHAVN

### GREEN ROOFS

Tórshavn is based in the Faroe Islands, an isolated island group in the North Atlantic Ocean. The climate is harsh, so strong insulation is needed to protect the Faroese people from the elements. Unfortunately conventional building materials such as wood, stone and copper are scarce and expensive materials to acquire.

#### The solution

Since the age of the Vikings, green roofs (or 'sod roofs' as they are locally known) have been used in Tórshavn to provide a local, readily available, natural roofing material. These types of roofs are very good at providing insulation, require little maintenance and are also good at retaining rainfall; helping to manage flood risk. They also help to encourage biodiversity within the city.

#### The outcome

- On modern developments, the use of green roofs is still popular. 5% of the buildings in Tórshavn have green roofs; including hotels, the Nordic House, the Faroese Fisheries Laboratory and government buildings
- The carbon emissions associated with producing and transporting other roofing materials are saved
- The ecological footprint of the building is reduced by relocating the green area to the roof
- A green roof will typically intercept the first 5mm and more of rainfall providing interception storage, the amount of which will be dependent on the depth and type of substrate in the green roof system
- A green roof can typically retain between 70% - 80% of rainwater runoff in summer
- Temperature fluctuations are stabilised; studies have shown that green roofs reduce fluctuations from 32°C to 12°C
- Energy demand has been seen to be reduced by up to 20%<sup>2</sup>

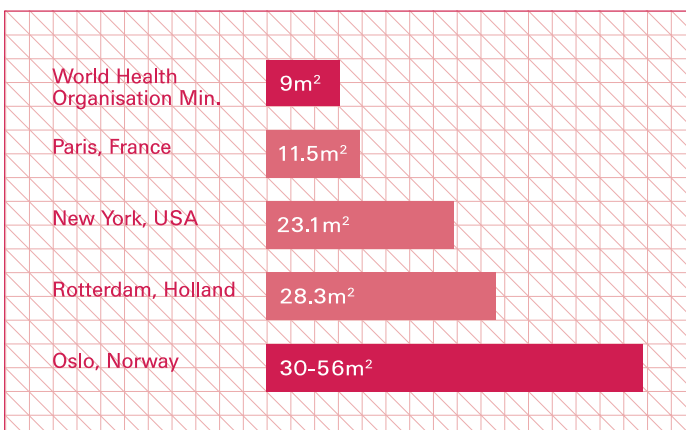


Fig.3 Amount of green space available per person<sup>1</sup>

<sup>1</sup> How much green space does your city have?  
Sustainable Cities Network, July 13 2011

<sup>2</sup> [www.livingroofs.org](http://www.livingroofs.org)



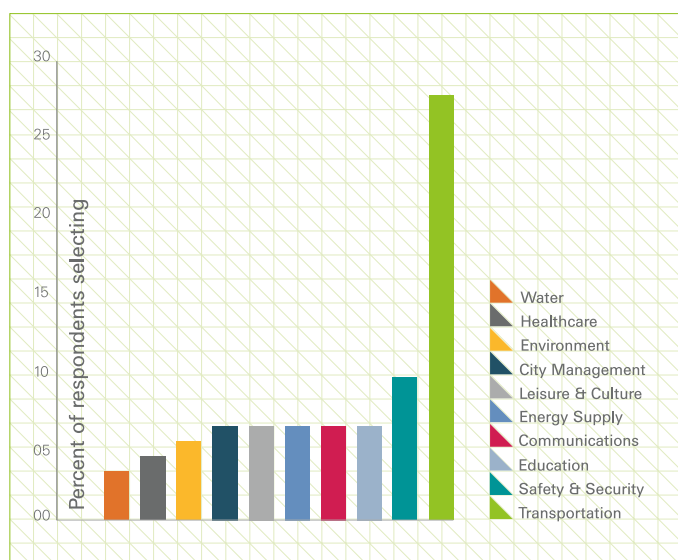






# TRANSPORT: KEEPING CITIES MOVING FORWARD

As cities grow, their transport infrastructures become more important in keeping people, services and goods moving. What's more, a good transport system is vital in encouraging further investment in the city. Globally, transport is the single most important factor when it comes to businesses deciding on a suitable location.



**Fig.4** Most important infrastructure area in attracting economic investment<sup>1</sup>

<sup>1</sup> Slim Cities: Urban Mobility, WEF and Arup, 2009

## The challenge

Urban mobility is restricted by a number of interrelated factors; land available for transport infrastructure, the cost of travel, the amount of time people are willing to travel and the convenience and accessibility of the transport mode. Without suitable alternatives, people often choose to travel by conventional cars for convenience reasons; status also has a part to play. This results in expensive infrastructure, heavily congested roads, air pollution, high carbon emissions and further pressure on fuel provision.

The challenge for cities today is to integrate sustainable transport into their urban plans and development so that people can traverse their cities easily and cheaply, but with lower environmental impacts.

## The Nordic Eight solutions

The Nordic Eight address the challenge of providing sustainable transport in cities through:

- Improving urban planning to incentivise walking, cycling, and public transport
- Improving public transport facilities to encourage increased use
- 'Greening' vehicles through encouraging ownership of more environmentally friendly cars and by procuring environmentally friendly public transport
- Discouraging the use of private cars

## The benefits of these solutions

### Environmental

- Reduced carbon emissions and air pollution
- Increased importance of green spaces to encourage walking and cycling - helping to protect biodiversity

### Social

- Better access to transport, increasing access to key services and amenities
- Increased walking and cycling promotes wellbeing and reduces healthcare costs

### Economic

- Reduction of time spent in traffic increases economic productivity
- Reduced use of road systems reduces associated maintenance costs



# CASE STUDIES



**COPENHAGEN  
& STOCKHOLM**

INVESTING IN PEDAL POWER

The Nordic Eight have made concerted efforts to incentivise walking, cycling and the use of public transport. In particular they have done this through incorporating these factors into their city planning, as seen in the Urban Planning section. Copenhagen and Stockholm have both made notable moves to increase the modal share of cycling within their cities.

## *The solution*

- Redesigning existing city streets to accommodate cycle lanes and including them into the design of new developments
- Integrating cycling with the wider transport network by allowing bicycles to be taken onto public transport, or parked safely near the stop
- Improving routing and implementing priority lighting; a 'Greenwave', so that a cyclist's journey into the city has almost no stops
- In Stockholm air pump stations have been installed along popular cycling routes for inflating bicycle tyres
- In Copenhagen 42km of 'Greenways' have been installed in suburban areas to provide safer, more direct neighbourhood routes away from main roads and through parks and recreational spaces
- A new system at traffic lights, warning vehicles of cyclists in their blind spots using LED lights, is also being trialled in Copenhagen to improve cycling safety



### The outcome

- Better journey times for bicycle commuters and increased safety
- Bicycle commuters enjoy better health
- Healthcare costs are reduced at an estimated rate of US\$1 per km cycled
- Reduced costs of transport for bicycle commuters
- Lower noise and pollution levels in the city

109,586  
TONNES

*The amount of CO<sub>2</sub> saved in Copenhagen through reduced car use (1995 - 2010)*

36%

*The total proportion of people going to work by bicycle in Copenhagen*

76%

*The percentage that cycling has increased in Stockholm*

20%

*The percentage that car traffic has decreased in Stockholm*



## TÓRSHAVN

### GETTING MORE PEOPLE ONTO BUSES

Traditionally the only means of public transport on the Faroe Islands has been bus or ferry. However, the bus service was rarely used due to an infrequent and low standard of service – a service that people were unwilling to pay for.

People preferred to be in their cars, which made for a heavily congested town centre and premium parking spaces.

### The solution

- After a successful one year pilot in 2008, the City Council decided to permanently implement a free public city bus service
- In 2010, they decided to increase the frequency of trips to every 20 minutes
- In 2011, they replaced the old buses with new, smaller models
- The location of the buses is tracked using GPS, allowing passengers to view the real time location of their bus online, or via an SMS request text service
- The investment and the operation of the city bus system has been outsourced to private operators for a period of seven years, with an option for the City Council to extend the contract period for another two years

- The City Council pays a fixed price per hour of effective operation of the buses. This price is made up from the operator's investment and operating costs
- The City Council fully funds this project through the City Council's annual budget

### The expected outcome

- Cost of journeys for the passenger is reduced by 100%; increasing the number of journeys taken by bus
- Reduced road maintenance costs due to reduced traffic
- Less investment required to provide parking facilities
- Reduced air pollution and CO<sub>2</sub> emissions

ONLY  
0.5%

CAR SALES  
GROWTH  
IN 2012

*The annual growth rate in private car sales has declined from 6.8% in 2008 to 0.5% in 2012*



» The new, smaller, free public city buses deployed in Tórshavn



» Copenhagen Metro



## COPENHAGEN

INTEGRATED PUBLIC TRANSPORT

Without a practical alternative, people who can afford a car will often choose to drive it. Between 1970 and 2010 the number of daily car trips across the Copenhagen municipality border rose from 392,000 to 535,000. Without concerted action, Copenhagen could have faced the traffic congestion and pollution problems that have blighted many other cities.

*The solution*

Copenhagen focused on developing physical and virtual integration between the bus, train and metro services to enable passengers to move seamlessly between different transport modes.

To do this:

- Legislation was introduced to stop competitive public transport operators charging different prices
- One ticket is now valid on the bus, train and metro across all three transport operators
- Passengers can buy their ticket via SMS, paying fares through their telephone bills
- Transport nodes where buses, trains and metro routes intersect have been built to make passenger journeys easier
- Bicycle parking facilities have been introduced in each metro and train station. Bicycles can be taken on the trains themselves
- An online Journey Planner maps commuters' routes across all transport modes. Real time information is provided by traffic control to increase accuracy

*The outcome*

- 60% of tickets are now bought via SMS; reducing queues, cutting operational costs, speeding up journey times and reducing paper usage
- Fast, reliable journey times and good transport connections make Copenhagen an attractive place to do business, as well as visit
- Traffic congestion has significantly reduced, cutting the number of hours lost per day and fuel wasted

83%



Every person who uses the metro instead of travelling alone by car, reduces their travel CO<sub>2</sub> emissions by 83%.





» Stockholm's integrated transport system



## OSLO, REYKJAVIK & STOCKHOLM

### GREENER CARS

Despite efforts to discourage the use of private cars and improve public transport, cars still dominate transport modal share and are likely to be a transport mode of choice for years to come. With greenhouse gas emissions from the transport sector contributing significantly to global emissions, moving towards cleaner low/zero emissions cars is a must. However, the alternatives are often expensive.

#### The solution

Oslo, Stockholm and Reykjavik have all influenced their own national government to implement 'greener' policies that support cleaner, low/zero emissions cars:

- Enabling congestion charging
- Enforcing the delivery of alternative fuels
- Lowering taxation on cleaner, low/zero emissions vehicles

However, the cities themselves have gone even further than the national legislation to encourage uptake of these vehicles. They have introduced a series of strong incentives for low carbon vehicles:

- Free parking for low carbon vehicles
- Free passage through congestion zones
- Further tax reduction incentives
- Allocating city funds to provide and encourage the infrastructure required to fuel these vehicles, such as electric charging points and fuel pumps at service stations

#### The outcome

- Oslo now has around 3,500 electric cars in the Oslo urban area. Whilst this is only 1% of the total, numbers have risen by 50% in the last 12 months and continue to do so

- Oslo has installed 400 charging stations for electric vehicles in the city, with a target to install 100 further charging stations every year
- 98% of Stockholm's own vehicle fleet and 40% of all new car sales are clean vehicles
- The fuels for Stockholm's clean vehicles are now cheaper than petrol
- In Reykjavik, 66 City cars (48% of the City's total fleet) and all their waste collection trucks now run on bio-methane only
- Reykjavik has made a saving of 1,400 tCO<sub>2</sub> in 2010 and 600,000 litres of gasoline that would have otherwise been imported

#### The technologies

- In Norway (Oslo) the power supply is nearly 100% renewable owing to the vast amounts of hydropower available, making it ideal for them to decarbonise their transport by encouraging electric vehicles
- In Sweden (Stockholm) they are encouraging 'clean vehicles'; cars which run all or partially on electricity, biofuels and biogas
- In Iceland (Reykjavik) they are using the gas from landfill to make bio-methane available for use in vehicles
- 950 cars in total in Reykjavik are running on bio-methane and the number is growing

50%

*Methane is 50%  
cheaper than petrol  
in Reykjavik*



» City of Oslo Electric Car

## OSLO & STOCKHOLM

### CLIMATE NEUTRAL PUBLIC TRANSPORT



» Biogas buses in Oslo

Oslo & Stockholm are also working hard to introduce more green vehicles into their public transport fleets. 60% of both cities' transport is through subways, trams and trains that run on electricity. The remaining public transport service is delivered through buses, traditionally run on diesel and petrol.

#### The solution

To reduce emissions, Oslo and Stockholm have focused on ensuring their electricity comes from renewable resources. They've also decarbonised their bus services by using diverse fuel sources.

#### Oslo

- Introduced 21 bioethanol buses (95% bioethanol) and 223 biodiesel buses (a mixture of 30% and 100% biodiesel vehicles)
- The city is carrying out a pilot with five fuel cell buses
- Focusing on fuelling a large part of the remaining buses with methane from food residues and wastewater sludge

#### Stockholm

- In Stockholm, where their national grid is from mixed resources, the electricity for these transport services has been certified as 100% renewable
- Introduced both biogas and ethanol buses and are focusing on increasing the number of these buses, whilst reducing the number of traditional buses

#### The outcome

#### Oslo

- 60% of the energy used for public transport in Oslo is entirely renewable, with a growing proportion of the remaining 40% becoming low/zero emission

#### Stockholm

- 65% of Stockholm's public transport system is classed as low emission:
  - » all its electrically run services are 100% renewable
  - » all the buses and waste lorries operating in inner city Stockholm run on biogas/ethanol
  - » 40% of taxis are also biofuelled or hybrid electric vehicles (HEV)



## OSLO & STOCKHOLM

PRIVATE CARS GET THE RED LIGHT

To address their growing congestion problems, both Oslo and Stockholm are trying to discourage the use of private cars, whilst incentivising and investing in more sustainable transport means.

### The solution

Oslo and Stockholm have both implemented a form of charge for using a car within the city.

#### Stockholm

- In Stockholm, this charge has been called a congestion tax
- It is a charge on motor vehicles entering and leaving the inner city
- The charge varies depending on the time of day, and day of the week
- New legislation was required by the Swedish Parliament to enable the implementation of the city-scale congestion tax
- The funds raised are reinvested in further improvements in the traffic system

#### Oslo

- In Oslo, this charge is called a car toll
- It is a charge on motor vehicles travelling into the city and is the same throughout the day
- The charge is around 4US\$ with an additional charge of approx 3US\$ if you are travelling in from the west of the city
- The car toll is primarily to raise funds for roads and public transport investments

#### Both cities

- Both systems are automated using control stations positioned at the entrance points of the charge zones
- These stations are fitted with cameras that photograph passing vehicles, recording vehicle registration numbers
- Matching this data to the national vehicle registration database, a monthly bill can be sent to the vehicle owner
- Certain vehicles, including green vehicles, buses, motorcycles, emergency services and vehicles used by disabled people are exempt

### The outcome

#### Stockholm

- The Stockholm charging system covers a 24 km<sup>2</sup> area of the inner city and is the largest system of its kind in Europe

10 to 14%

*Reduction in emissions of pollutants and greenhouse gases from traffic within the charging zone*

18%

*Reduction in inner city traffic*

87m US\$

*Net revenues per year generated*

#### Oslo

- In Oslo, traffic congestion has significantly reduced and the following benefits seen:

15%

*Reduction in CO<sub>2</sub> emissions from road transport (2000 - 2009)*

64%

*Total proportion of all trips taken by public transport, cycling or walking*

6.5bn US\$

*Anticipated net revenues from car toll 2008 - 2027*



» Clean vehicles are exempt from congestion tax in Stockholm









# STREET LIGHTING: SWITCHING TO INTELLIGENT TECHNOLOGIES

Street lighting plays an integral part in creating a safe environment for people to carry on with their lives at night and so contributes to social wellbeing and economic growth. Globally, street lighting is responsible for 3% of electricity demand<sup>1</sup>; about the same amount as is consumed by Germany every year.

## The challenge

Street lighting is often inefficiently employed - generally switched on full beam throughout the entire night, rather than when and how it is needed. As a result, cities suffer from severe light pollution - causing adverse effects on health, welfare and nocturnal biodiversity.

In addition, the majority of street lighting found in cities is of the old, inefficient tungsten variety so it is energy-intensive and expensive.

It is estimated that substantial energy savings of at least 60% can be achieved through implementing intelligent, adaptive street lighting measures<sup>2</sup>. However, a change from traditional systems requires strong coordination and capital.

## The Nordic Eight solutions

To achieve intelligent, adaptive street lighting, the Nordic Cities follow these key approaches:

- Improve the efficiency of the light bulbs employed by switching to Light Emitting Diodes (LEDs); bulbs that can reduce energy consumption and associated costs by up to 90%<sup>3</sup>
- Use the lights more effectively through enhanced control and individual operation

## The benefits of these solutions

### Environmental

- Reduced energy consumption and the associated carbon emissions
- Reduced light pollution, revealing the night sky and improving habitat for nocturnal species

### Social

- Safer feeling city through targeted and effective lighting
- Reduced light pollution and effects on human welfare

### Economic

- Reduced energy bills
- Improved ability to maintain street lights, reducing costs and increasing light bulb lifetime

1 Answers in energy efficient lighting!, Responding to Climate Change 2010, Philips, 2012

2 Project Report; Energy Efficiency, Intelligent Energy-Europe Programme, July 2008

3 LED Energy-saving lamps, Philips, <http://www.philips.co.uk>

## CASE STUDIES



The three cities of Oslo, Tórshavn and Copenhagen are at differing stages of piloting and rolling out improved, more efficient street lighting to benefit from savings of electricity and the associated financial costs.

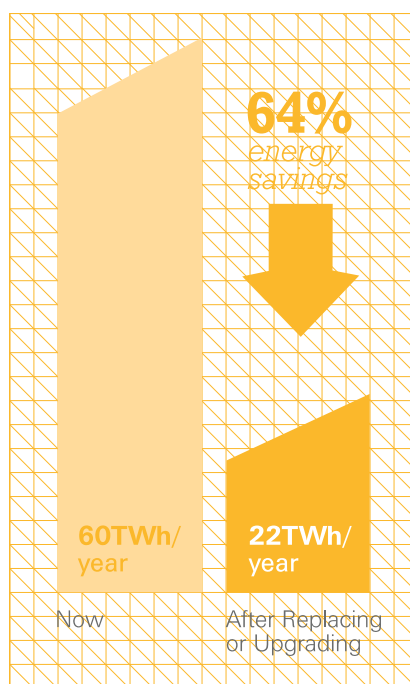
In the winter all three cities experience long hours of darkness, so street lighting is also extremely important to keep the city active and promoting a feeling of safety.

For Tórshavn in particular, making electricity savings is important. Being an isolated, small island community with no electrical connection to an external grid for support, they are currently heavily reliant on diesel generators for their supply. This makes the city very vulnerable to supply issues and price shocks.

### The solution

The solution is based on wirelessly linking a central control unit with the individual street lamps around the city.

- Lamps can be turned on and off or dimmed individually
- Real time information about the weather and traffic is linked to the central control unit, allowing lamps to be adjusted according to the ambient light levels from natural and artificial sources, for example, when it snows, up to 80% less light is needed
- Replacing the traditional lamps with LEDs alone accounts for approx 37% energy savings



**Fig.5** Estimated annual energy savings in European street lighting through intelligent improvements<sup>1</sup>

<sup>1</sup> Project Report; Energy Efficiency, Intelligent Energy-Europe Programme, July 2008

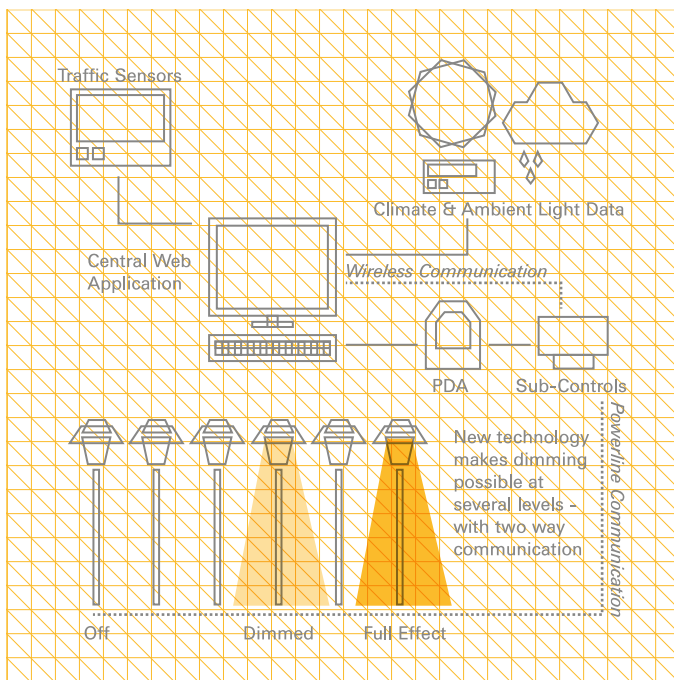


Fig.6 Design of intelligent street lighting<sup>1</sup>

### The outcome

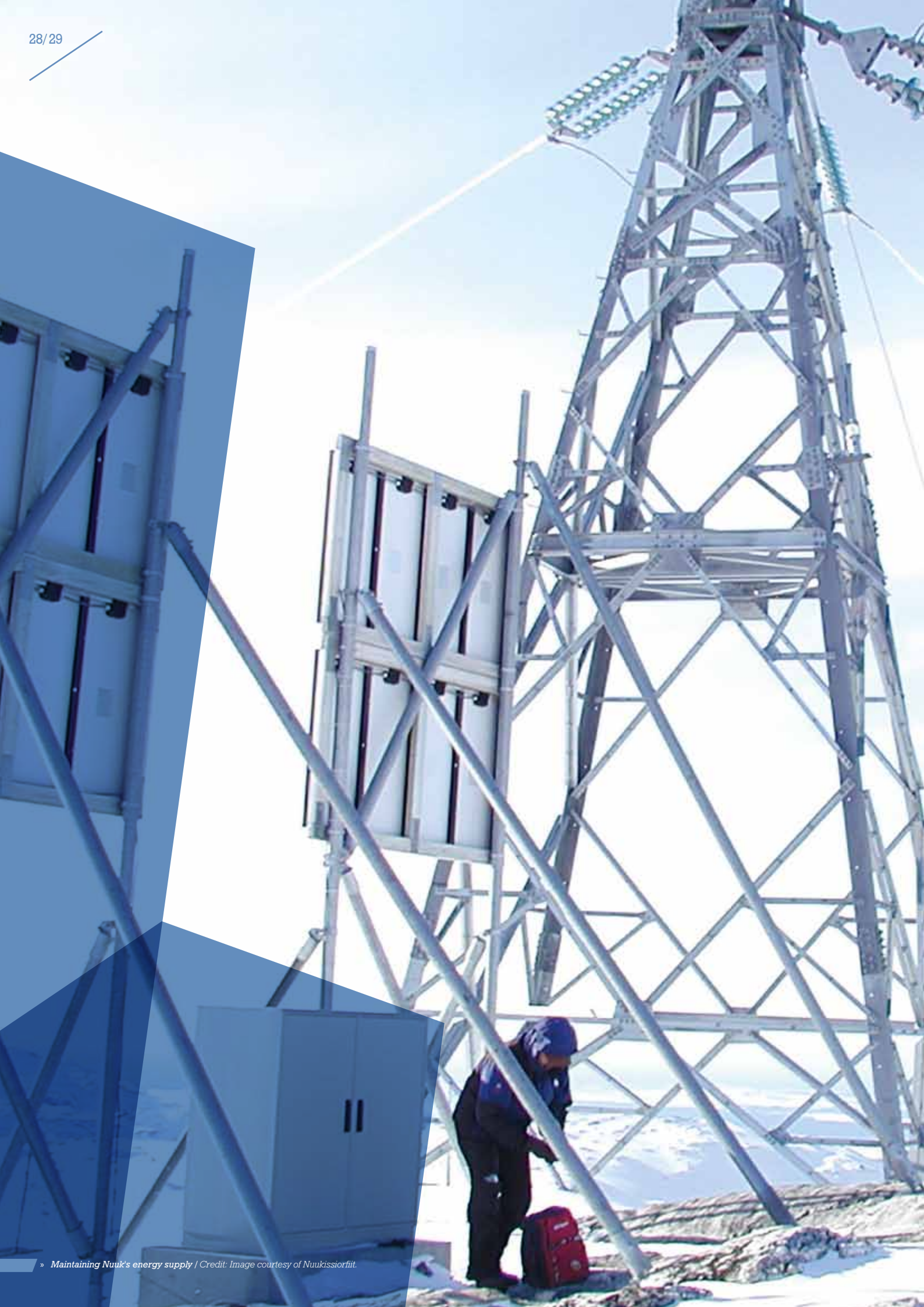
Successful pilots and attractive energy and cost savings are driving the cities towards full implementation:

- Tórshavn aim to replace 100% of all street lights with intelligent street lighting units over the next 3 - 5 years. 15% have already been replaced in the last year. Based on the costs for the control systems, the payback on investment is approximately 2.5 years
- Oslo have now installed 10% of the total street lighting units required throughout the city and have already experienced savings of between 52 - 62% from the replaced units
- Copenhagen plan to start replacing their entire fleet of street lights, about 20,000 units, from 2013 at a cost of 60million US\$



The payback  
on investment  
in smart street  
lighting in  
Tórshavn is only  
2.5 years.







# ENERGY: MOVING ON FROM FOSSIL FUELS

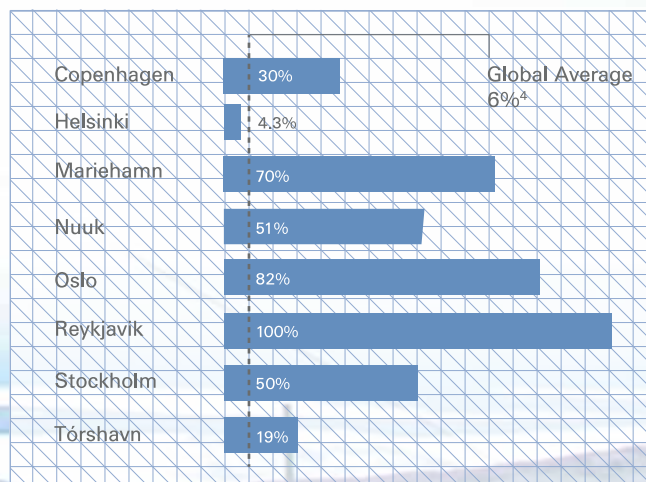
Cities consume 75% of global energy<sup>1</sup>. Energy fuels many of the functions and systems that a city, its residents and organisations perform on a daily basis; from heating the space we occupy to charging our phones; fuelling the transport we move around on to powering the networks and equipment we work with.

## The challenge

Globally, the demand for energy is predicted to increase a third by 2035 (from 2010)<sup>2</sup>. The vast majority of which will be in our growing cities. This, of course, has an enormous impact on the carbon cities emit, and so, on climate change.

There are also major issues with the security of continuing to supply traditional fossil fuels. Resources are diminishing, becoming harder to extract and laced with geopolitical concerns. Access differs among regions, countries and throughout cities, affecting the alleviation of fuel poverty and continued socio-economic development. At present, a third of the world's population has no access to modern energy services<sup>3</sup>.

As a result of these factors, many countries around the world have ambitious targets for increasing the renewable energy they use, becoming more energy efficient and committing to reducing carbon emissions. To meet these targets significant change is needed, requiring a challenging combination of political will, legislation, behavioural change, creative finance and technological innovation.



**Fig.7** Percentage of renewable energy in heat and electricity energy mix

1 The Global Innovation Index 2011, INSEAD and WIPO, 2011  
2 World Energy Outlook, International Energy Agency, 2011  
3 Poor People's Energy Outlook, Practical Action, 2012  
4 Renewables 2011: Global Status Report, REN21, 2011



## The Nordic Eight solutions

The Nordic Cities are widely recognised to be renewable energy leaders. Finland and Sweden achieved their renewable energy targets for 2020 in 2009, due in no small part to the leadership shown by their own cities.<sup>1</sup>

The Nordic City approach involves:

- Looking to local, innovative, low carbon/renewable energy resources
- Improving the efficiency of supply and distribution through installing district energy networks

## The benefits of these solutions

### Environmental

- Reduced carbon emissions and impact on climate change through decarbonisation
- Reduced pressure on resources

### Social

- Increased access and resilience of supply
- Reduced fuel poverty

### Economic

- Stabilised energy prices
- Reduced reliance on imports



» Reykjavik: Transporting geothermal heat from the source to the city.



» Tórshavn: Lighthouse

- ① Seawater as energy source
- ② Seawater well with pumps and heat exchanger
- ③ Brine is pumped between the well and the consumer
- ④ Heat pump system
- ⑤ The consumer Boðanesheimið (senior citizens' home)

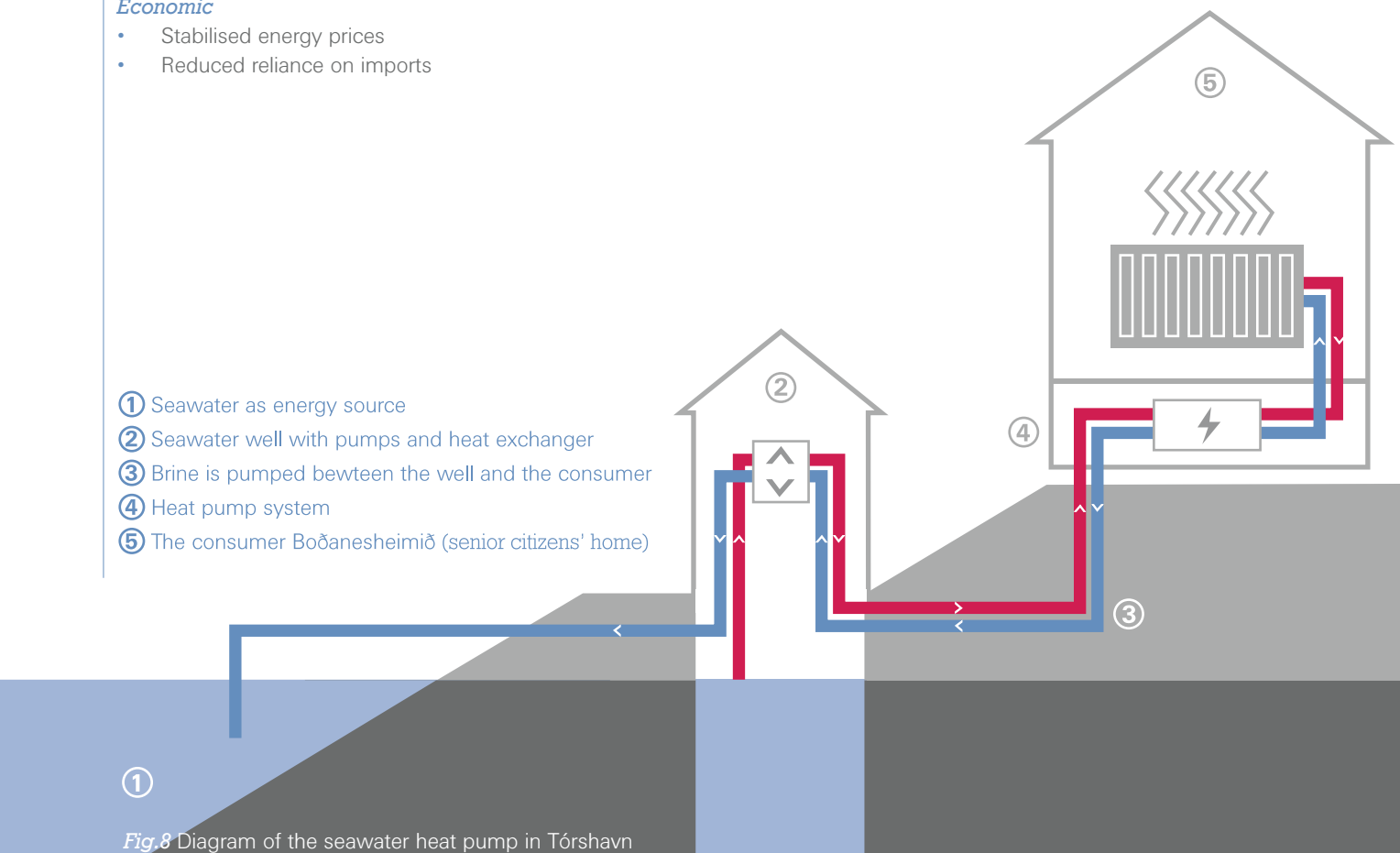


Fig.8 Diagram of the seawater heat pump in Tórshavn



# CASE STUDIES

## *Making the most of local resources*

The Nordic cities have been particularly innovative when it comes to addressing their energy supply issues. They have done this by using local solutions. Wind, energy from waste, biogas from sewage, biomass to heat are all highlighted in this brochure. Here, we present some of the other approaches where they have looked to their local vicinity for inspiration.



## TÓRSHAVN

### ENERGY FROM THE SEA

Tórshavn is an isolated island community, heavily reliant on fossil fuels to provide both heat and power. The cost of this dependency is becoming increasingly expensive, leaving the city vulnerable to supply insecurity.

#### The solution

- Tórshavn decided to pilot the use of seawater as an energy resource
- The seawater is between 8 - 11°C
- A 240kW seawater heat pump will provide heat to a new 5,000 m<sup>2</sup> senior citizens' home, that would otherwise have been heated using traditional heating with fossil fuels
- The low grade heat, coupled with under floor heating, will provide comfortable room temperatures
- The system has been specially designed to cope with the extreme weather conditions of the North Atlantic Ocean
- Tórshavn Municipality hopes to inspire the Faroese government and others to follow the same path

#### The expected outcome

- The system will be in operation by October 2012
- CO<sub>2</sub> emissions will be reduced by almost 100%
- It is expected to achieve a coefficient of performance of 3.5 to 4
- Although expensive to install, the running costs are significantly lower; at current fossil fuel prices, the system is expected to return the investment made within 15 - 20 years



## REYKJAVIK

### USING ITS GEOTHERMAL POWER

Historically, Reykjavik's homes were heated by burning coal. It was common to see a black cloud of smoke hanging over the city. For the last 50 years, the city has been reducing its dependence on fossil fuels and making use of naturally occurring geothermal energy.

#### The solution

The city has harnessed locally available geothermal energy in the following ways:

- To generate electric power
- Through direct use for thermal energy
- Through indirect use by ground source heat pumps
- To melt snow on pavements when there is excess heat

Small amounts of greenhouse gases that were dissolved in the steam are released as part of the geothermal process releases. Reykjavik now plans to completely decarbonise the process and are piloting a project known as 'CarbFix'. This is a process of capturing and sequestering CO<sub>2</sub>. The CO<sub>2</sub> is captured at source, dissolved in water and injected into the basalt strata where it should remain for thousands of years.

#### The outcome

- Reykjavik now provides all of its heating and the majority of its power by harnessing geothermal energy
- The need for imported coal and oil is significantly reduced, saving money and improving energy security
- Air quality is much improved as there is no longer any smoke emitted
- The CarbFix pilot can currently safely inject 2000 tonnes of CO<sub>2</sub> per year

280,000  
TONNES

*Amount of CO<sub>2</sub>  
saved per year  
(100% reduction)*

# CASE STUDIES



CHP 95% efficient (in general)



Separate heat & power generation: 30 - 40% efficient (in general)



## NORDIC EIGHT

DISTRICT ENERGY NETWORKS

Traditional, centralised generation of energy is often inefficient, wasting 60% or more of fuel – in particular, the generation of electrical power using fossil fuels or nuclear simultaneously produces large quantities of heat energy that, with nowhere to go, is discarded.

### The solution

- In response, over the last 100 years, the Nordic cities have championed decentralised, district energy networks; systems that can generate energy at fairly large scales, but close to where the demand is
- This has enabled them to make use of waste heat from the power generation process through 'combined heat and power' (CHP) using it to heat (or cool) homes and workplaces
- The Nordic cities started off using coal and gas to generate heat for their networks but now are striving to decarbonise and make use of diverse energy resources. These currently include energy from

waste, wastewater sludge and biomass. Fig.10 shows how far the Nordic Cities have come in implementing, and then decarbonising, these networks

District energy systems are ideal for cities with high density energy demands and diverse energy resources in close proximity.

### The outcome

- Nordic cities are much less affected by changing international fuel prices due to higher level of energy security
- They have lower per capita CO<sub>2</sub> emissions
- Through the combined generation of power and heat, overall efficiency is increased, reducing the fuel required, associated carbon emissions and financial costs. E.g Copenhagen estimates cost savings of 56% compared to natural gas for a home of 130m<sup>2</sup>
- District energy systems are technology and resource agnostic, meaning that there is always the flexibility to change in the future should more efficient technology or lower carbon fuel resources become available



Average city wide penetration



Average percentage of renewable heat generation

| CITY       | NUMBER OF CONNECTED CUSTOMERS / BUILDINGS | CITY-WIDE PENETRATION (% OF TOTAL BUILDINGS CONNECTED TO NETWORK) | AVERAGE % OF RENEWABLE HEAT GENERATION |
|------------|---|---|--|
| Copenhagen | 31,000                                    | 98%   | 33%                                    |
| Helsinki   | 14,000                                    | 93%   | 2%                                     |
| Mariehamn  | 710                                       | 21%   | 75% (woodwaste)                        |
| Nuuk       | 156                                       | 75% (includes electric heating)                                   | 98.5% (hydropower)                     |
| Oslo       | 54,000                                    | 17%   | 79%                                    |
| Reykjavik  | 19,738                                    | 100%  | 100% (geothermal)                      |
| Stockholm  | 12,000                                    | 80%   | 80%                                    |
| Tórshavn   | 945                                       | 20%   | 50%                                    |

Fig.10 Nordic city district heating networks



» Katri Vala heating and cooling plant

## COPENHAGEN & HELSINKI

MAKING USE OF EVERY  
LAST BIT OF ENERGY

Both Helsinki and Copenhagen have used district heat networks for nearly 80 years. In recent years, summer demand for cooling (air conditioning) has risen. Simultaneously, in hot weather the heat network has a lot of spare heat.

### The solution

- The two cities have evolved their district energy networks to include cooling using complementary technologies
- In the winter, any cooling required is provided using seawater
- In the summer, surplus heat is used to meet most of the demand for cooling through 'absorption chillers'; a chiller that is able to use heat to provide cooling
- Any additional cooling is produced by electrical compression chillers
- Any heat absorbed in the district cooling network is recovered using heat pumps and directed into the district heating network

### The outcome

- Helsinki currently has 100MW of cooling capacity, whilst Copenhagen has 15MW
- The use of district cooling rather than conventional cooling methods reduces associated electricity consumption and CO<sub>2</sub>

- By displacing the conventional cooling method, the release of harmful HCFC (hydrochlorofluorocarbon) compounds often used as cooling agents are significantly reduced, for example, sulphur dioxide by 62% and nitrogen oxide by 69%



*Electricity saving  
compared to  
using conventional  
methods*



*CO<sub>2</sub> saving  
compared to  
using conventional  
methods*

## HELSINKI

DECARBONISING DATA  
CENTRE COOLING

Data centres require vast amounts of cooling to protect equipment from overheating and becoming damaged; an energy, and often carbon, intensive process. As demand for better, faster and safer information flow grows, this cooling demand is going to increase.

### The solution

The complementary district heating and cooling system in Helsinki has enabled them to encourage data centres to make use of their lower carbon cooling, and save energy, through connection to the district cooling network.

### The outcome

- Two large, recently connected IT customers, each requiring around 1MW of electrical energy for their IT equipment, are saving 3000MWh of primary energy and 600 tCO<sub>2</sub> in comparison to conventional electrical cooling
- The cooling source is 'unlimited' compared to the alternative, which would have been designed to meet a specific demand
- This project won the 2010 Uptime Institute Enterprise IT Award



» Data centre, Helsinki





# WATER: PROTECTING OUR MOST IMPORTANT RESOURCE

Water is a fundamental to all human life. Cities rely on water for their drinking, washing and sewage systems. It's also a vital resource for industrial processes, transport and food provision.



## The challenge

Cities have a huge impact on water resources. High demands reduce local supplies and water scarcity is already an issue in many parts of the world. The problem will only get worse as city populations grow and lifestyles continue to be more water-intensive. Every year 250 - 500million m<sup>3</sup> of drinking water is lost in megacities due to leakage. This is enough to provide an additional 10 - 20 million people with drinking water<sup>1</sup>.

City processes, such as sewage and industrial waste, are huge contributors to the pollution of water ecosystems.

Every day, 2 million tonnes of sewage and other effluents pour into the world's waters<sup>2</sup>. This not only means that cities have to work harder to supply a sanitary resource, but aquatic life (also used as a source of food) disappears.

Many cities face the increased risk of flash flooding due to climate change. This is exacerbated by paved, non-permeable surfaces forcing the resultant run-off rainwater to enter city drainage systems, containing sewage and contaminants. This very often overloads the system, and with limited alternatives, the effluence overflows into local water resources.

## The Nordic Eight solutions

The Nordic Eight have taken a holistic approach to tackling this challenge, involving:

- Improving the management of rainwater and storm water to prevent overloading of urban drainage systems
- Cleaning and protecting natural water resources to encourage use by city residents and aquatic life
- Improving the use and reuse of water by reducing leaks and utilising rainwater for non-sanitary processes

## The benefits of these solutions

Adopting a water efficiency approach, rather than seeking to increase water supply, can achieve the following benefits:

### *Environmental*

- Reduced demand on water resources - which are also used by flora and fauna
- The re-establishment of aquatic life

### *Social*

- People can enjoy safe and sanitary rivers, lakes and seas for recreation (blue) spaces
- Reduced risk of flooding and related disasters

### *Economic*

- Reduced cost of water treatment
- Reduced risk of flooding and associated costs
- Increased real estate prices through regeneration of water side properties

<sup>1</sup> Water and Cities: Facts and Figures, UN, 2010

<sup>2</sup> Human development report, UNDP, 2006

# CASE STUDIES



COPENHAGEN,  
HELSINKI & OSLO

HOLISTIC WATER MANAGEMENT

Water is continuously flowing and moving through its natural cycle. As such, any attempt to improve the way we use and benefit from it cannot be limited to one solution.

## The solution

Copenhagen, Oslo and Helsinki have all employed a number of techniques to manage water more effectively, including:

### Protecting green space

Oslo have legislated to stop the city spreading and taking up more green space. Green space acts as attenuation basins storing rainfall during extreme rainfall events; reducing pressure on the drainage system.

### Green roofs

Copenhagen have promoted green roofs to retain rainfall and help manage rainwater more efficiently.

### Rainwater soakaways

Oslo have opened up their covered rivers. Combined with the external landscape and sustainable urban drainage, their capacity to cope with rainfall has significantly increased.

### Fluvial and pluvial flood prevention

Both Oslo and Copenhagen have implemented a combination of stormwater retention, rainwater harvesting and sustainable urban drainage to reduce the entry of excess fluvial and/or pluvial water into the municipal water treatment pipelines. This reduces the pressure on the drainage system and the likelihood of the overflow of polluted water into valuable water resources.

### Better planning

Copenhagen have introduced new planning regulations requiring new developments to implement a three-tiered system; one for rainwater, one for storm water and one for black wastewater. This has already proved very effective against flooding.

### Reducing water lost in pipework

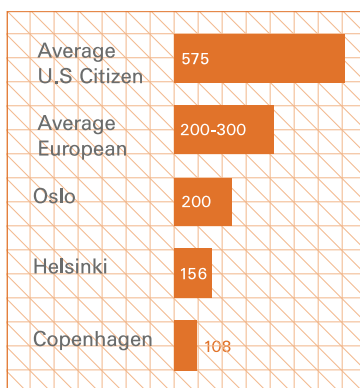
Copenhagen have implemented leak detection and pressure regulation to reduce the loss of water in pipework. They now lose as little as 6%, compared to as much as 40 - 50% in some other cities.

### Smart water management

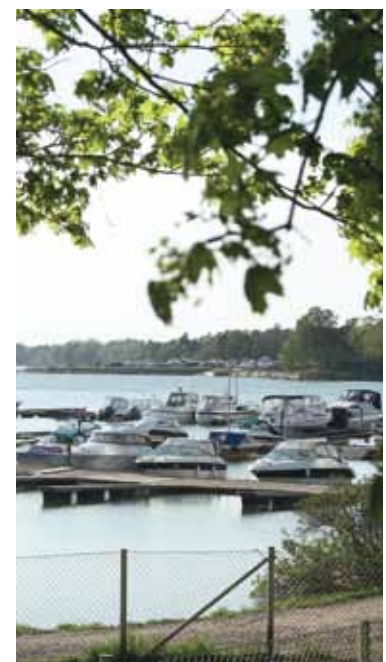
Copenhagen undertook a 3D mapping exercise of the city's hydrological cycle. They now use this, along with weather forecasts, and leak detection equipment, to monitor and manage their water resources.

### Protecting water resources

Helsinki have joined forces with another Finnish city to protect the Baltic Sea. The 'Baltic Sea Challenge' is a collaborative commitment to implement actions, such as better storm water management, reducing the impact of agricultural fertilisers and encouraging cruise ships to leave their wastewater on shore for proper treatment. Through working together, the cities support each other's actions, share expertise and benefit from the improvements in their shared water resource.



**Fig.11** Average daily consumption of water in Nordic Cities is much lower than other cities (litres per person)<sup>1</sup>



» Recreational water use in Helsinki

<sup>1</sup> Human Development Report, UNDP, 2006





## COPENHAGEN

### HARBOUR BATHS: REGENERATING A DISUSED HARBOUR

The water around Copenhagen's harbour was badly polluted from the city's old sewage system and local industry. The whole area was increasingly neglected and run down.

#### The solution

Copenhagen regenerated the disused harbour into a public harbour bath - creating a recreational space, improving the water quality and increasing the price of property in the area. They did this through:

- Removal of heavy metals from riverbed to clean it
- Modernising the sewage system and improving treatment with physical, biological and chemical cleaning, gasification of sludge and incineration processes to remove nutrient salts
- The closure of 55 overflow channels to prevent sewage discharge into the harbour waters
- Better rainwater management to reduce pressure on drainage system
- Use of a automatic warning system for bacteria levels in the harbour, identifying when it is safe to swim

#### The outcome

- Real estate prices have significantly improved, by 50 -100% in the direct harbour area and 10% adjacent to the harbour area
- The amount of sewage and rainwater discharged into the Port of Copenhagen has reduced by almost 50%

## MARIEHAMN

### WASTE WATER TREATMENT

Mariehamn is the Capital of the Alandian Archipelago in the middle of the Baltic Sea. The Town is surrounded by sea water with tourism and recreation as high priority interests. As such, protection of the natural water system is very important to the people of Mariehamn and in 1993 Town Council decided to make Mariehamn an Eco City.

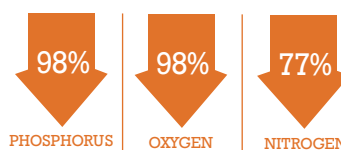
#### The solution

In 2004, work started on improving the waste water treatment plant to meet this aspiration and it is now one of the highest quality plants along the Baltic Sea.

- The plant has capacity to treat the waste water of 30,000 people
- All the basins and treatment facilities have been built underground, close to the port, with only a small administration building above the ground surface

#### The outcome

- The waste water treatment plant is close to where the waste water is collected, yet does not provide an eye sore in the centre of the city
- The plant's capacity is much more than the population of Mariehamn, enabling the city to treat the waste water from ships entering the port and preventing it from being dumped in the Baltic Sea
- The plant's output into the natural water system is much better for the environment



*Reduced levels as a result of the plant's output*



» Mariehamn's waste water treatment plant: only the entrance building is visible, the treatment plant is hidden underground out of sight



# SMART INFORMATION MANAGEMENT: STREAMLINING DECISION MAKING

Good information enables people and systems to make decisions that improve, enhance and facilitate city processes, livelihoods and lifestyles. It can help us effectively address the challenges we face and move beyond our current thinking and behaviours.



## The challenge

Smart technology could play a substantial role in creating the sustainable cities of the future through increased empowerment, better decision making and streamlining action.

The Climate Group estimates that 15% of global CO<sub>2</sub> emissions could be reduced through employing smart technology. 'Smart' includes everything from household appliances which can turn themselves on or off in response to changing electricity prices, to electric vehicles providing storage for the electricity grid or city wide management systems.<sup>1</sup>

However, the true benefits of smart technologies are only realised when they work within well-integrated and holistic systems. In essence, 'smart cities' use a combination of data and technology to become more efficient. This requires a detailed understanding of city systems and coordination between all the relevant stakeholders - some of which may not have the incentives in place to change.

As such, few cities have fully grasped the possibility of becoming a 'smart city'.

## The Nordic Eight solutions

The Nordic cities have generally been among the first to collectively adopt new technologies, and the move towards becoming smart is no exception. They have followed these key strategies:

- Investing in information technology infrastructure
- Exploring smart-enabled efficiencies through both bottom-up behaviour change empowerment and top-down management improvements
- Introducing flexibility into people's work-life balance

## The benefits of these solutions

### Environmental

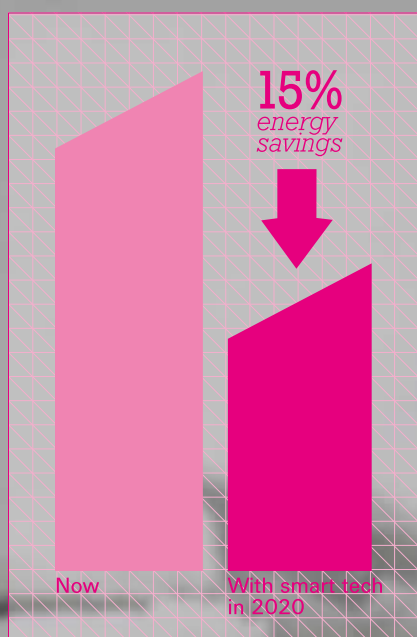
- Reduced consumption of primary resources, such as energy and water

### Social

- People are able to perform daily tasks more effectively and enjoy a better quality of life
- People can work from home and achieve a more flexible work/life balance

### Economic

- Increased efficiencies reduce associated costs



**Fig.12** Estimated annual energy savings through implementing smart technologies in cities<sup>1</sup>

<sup>1</sup> Smart 2020, The Climate Group, 2008



# CASE STUDIES

**STOCKHOLM****GREEN ICT**

Stockholm has a comprehensive green ICT (Information Computer Technology) strategy that sits within the city's environmental strategy. Stockholmers themselves are generally early adopters of new technology, making the city a popular test bed for companies and organisations with high demands on the ICT infrastructure.

## *The solution*

Key to delivering this strategy was upgrading the underlying physical infrastructure so that it is easy to develop new smart products and services within the city. As a result, Stockholm now has a large, city-wide, open, fibre-optic communications network - its length is equal to 30 times the circumference of the globe.

The network has been designed to be highly competitive and offer its users diversity and freedom of choice. It also facilitates large amounts of data to be sent across the city quickly and efficiently.

## *The outcome*

- More than 20,500 ICT companies now reside there, which combined employ a total of 95,000 people (11% of Stockholm's population)
- In 2012, 400,000 households will be able to connect to the network; 90% of the total homes in the city
- People can work from home remotely, via video conferencing and exchange of digital information

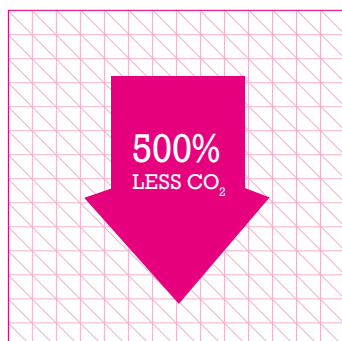


- Real-time information about traffic and public transport services is available; enabling people to make informed decisions about their journeys
- The city can implement information intensive systems, such as the automated congestion charging scheme
- Traditional paper intensive processes can be digitised



*Improvements to the mobile network will reduce CO<sub>2</sub> consumption by 20%*

- One telephone conference, using Stockholm's new smart infrastructure and regardless of the number of attendees, produces at least 500 times less CO<sub>2</sub> than more traditional meetings.



**Fig.13** The telephone conference in Stockholm has an environmental impact of 20gCO<sub>2</sub>. As a comparison, if four people went to a meeting 3km away, each travelling in an eco-friendly Toyota Prius (Auris HSD at 89gCO<sub>2</sub>/km) this would have an environmental impact of 1068kgCO<sub>2</sub>; 500 times more.

## HELSINKI & NUUK

### GET SMART WITH METERS

In Nuuk and Helsinki, they recognise that to cut CO<sub>2</sub> and reduce their environmental impact, their energy and water resources need to be used more efficiently, and be paid for by the consumers more fairly.

#### The solution

In Nuuk and Helsinki, they have been rolling out the installation of smart meters into people's homes.

Smart meters:

- Send hourly readings of consumption to the services companies so that more accurate bills can be issued
- Can compare consumption data of similar buildings. So it's simple to identify the buildings where energy efficiency improvements are needed
- Enable consumers to see their real time consumption, empowering them to change their behaviour and reduce their consumption

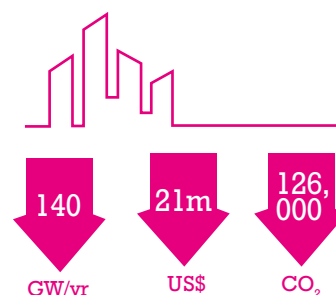
In Nuuk, they have installed smart power, heat and water meters throughout the entire city for each individual consumer, as part of a national programme. There is one parastatal (government owned) company that deals with the collection of this data and the issuing of bills.

In Helsinki, they're aiming to have 350,000 smart power meters and 14,000 smart heat meters in service by 2013, 60% of these have already been installed. The old meters are

being collected and recycled. The roll out has been financed through the city's energy services provider, Helsingin Energia, who expect to make back their investment through the savings made.

#### The outcome

- In Helsinki, 20,000 consumers already use the real-time consumption service to monitor their consumption and change their behaviour, resulting in up to 10% savings in their energy consumption
- If all households in Helsinki took action, that would be the equivalent of saving at least 140GWh per year, a total cost saving of 21m US\$. This would be equivalent to emissions savings of 126,000 tCO<sub>2</sub>



*The above graphic shows what Helsinki would save if the whole city used smart meters.*





» Residents come together in City Square in Tórshavn.





# BEHAVIOUR: CHANGING ATTITUDES AND ACTIONS FOR A BETTER FUTURE

City governments and technology are important when it comes to addressing the challenges facing cities in the 21st century.

However, ultimately it is the way that individual people and companies act that dictates resource demands, consumption patterns and our impact on the natural surroundings. To truly address the challenges of climate change, resource depletion and population growth, human behaviour must change. Acting sustainably must become 'normal'.

## The challenge

Changing behaviour, habits, societal structures and business models requires increasing awareness and promoting action. Cities are highly complex systems, comprising hundreds of thousands, even millions, of individual decision makers; people. Societal change, on a scale to affect whole cities, is unlikely to happen spontaneously.

## The Nordic Eight solutions

The Nordic cities have looked at this challenge through the eyes of the stakeholders involved:

- City government
- Private business
- General public

As a result, they've adopted new strategies to make change easier:

- Setting the example by encouraging positive action and implementing standardised Environmental Management Systems in city government

- Certifying sustainable businesses, so that they are more visible, and provide the infrastructure to 'green' business
- Raising awareness of the issues and educating the public

## The benefits of these solutions

### Environmental

- Increased awareness of environmental impact, positively influencing decision making
- Changed behaviours reducing pressure of environmental systems

### Social

- People empowered to change for the better
- Increased awareness in decision making

### Economic

- Better management of the natural systems that all our services and operations rely on, reducing costs resulting from degraded systems and protecting future socio-economic development

"Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has"<sup>1</sup>

1. Margaret Mead, American cultural anthropologist, 1901 - 1978

## STAKEHOLDER: CITY GOVERNMENTS

### HELSINKI

#### A CITY GOVERNMENT LEADING BY EXAMPLE

The city of Helsinki has taken positive action with all its stakeholders involved, and lead by example in changing its behaviour.

#### The solution

In 2006 Helsinki launched the Eco-support programme promoting environmental awareness and environmentally responsible working habits within the city government. The programme supports individuals, known as 'Eco-supporters', within government departments to implement actions within the 10 organisational aims through training, advice and collaboration.

The programme aims to:

- Commit the government department to be environmentally responsible
- Make efficient use of the resources they use
- Promote sustainability and ecoprocurement
- Support individuals and other organisations to do likewise

#### The outcome

900

*The number of Eco-supporters that have already been trained to guide and motivate their colleagues to change their work habits and make environmentally-friendly choices*

14

*Helsinki has also trained 14 other cities in Finland*

3

*Helsinki has also trained three other cities in Estonia*

### MARIEHAMN

#### IMPLEMENTING AN ENVIRONMENTAL MANAGEMENT SYSTEM

Mariehamn has set itself the goal of continuously improving overall environmental performance, reducing its environmental impact and raising awareness amongst citizens.

#### The solution

- Mariehamn have implemented an environmental management system that is certified to ISO14001; an internationally accepted standard that sets out how to address the delicate balance between maintaining profitability while still reducing environmental impact
- The system is used in all the municipal bodies, as well as organisations contracted by the city
- Being small, the city achieved this high standard with few resources by developing specialised environmental management tools and methods, using their own advanced computer communication software
- This computerised system also allows the city to inform the public online about Mariehamn's environmental impacts per inhabitant, such as CO<sub>2</sub> emissions, energy use and cost, nitrogen and phosphorus discharges
- This improves the public's awareness of their individual impact

#### The outcome

- Drive towards improving energy efficiency of public buildings
- Increased levels of procuring ecologically friendly food at schools and in geriatric care
- Mariehamn's citizens are encouraged to be more environmentally friendly to reduce their impact
- Environmental objectives have also been incorporated into the budgeting process of all departments



» The Public Baths of Mariehamn is located at the east shore close to town centre. Indoor swimming baths offer through wall sized windows a magnificent view of the bay outside the building



## STAKEHOLDER: PRIVATE ORGANISATIONS



### ECOCOMPASS - IDENTIFYING GREEN BUSINESS

As part of its holistic approach, Helsinki has been championing a way for businesses to identify themselves as environmentally responsible.

This identification enables the public and other organisations to make their decisions about goods and businesses they buy into, based on a company's environmental track record.

#### The solution

Helsinki has introduced a certification process for businesses - EcoCompass, which enables companies to:

- Show their environmental performance
- Improve awareness and transparency of information
- Deliver environmental benefits such as: reductions in energy, waste, water and chemical use
- Encourage improvements in driving

Companies follow a process where they are analysed and evaluated before an environmental management programme is outlined.

If, after 6 - 12 months, the company passes an audit against their programme objectives, they receive an EcoCompass certificate which is valid for three years.

#### The outcome

- EcoCompass environmental management system is recognised in the public procurement process of participating cities

46

*46 companies are going through the process*

26

*26 companies have received the EcoCompass certificate*

20

*20 business advisors have been trained to include environmental issues in their advisory work*

200

*200 entrepreneurs have been trained on environmental issues*



### GREEN STEPS

In order to make the operations of the municipality to more environmentally friendly, Reykjavik launched their own environmental management system. The system is used within City government workplaces but is available for the private sector as well. It is known as Green Steps.

#### The solution

- There are four green steps that organisations can volunteer to take, based on the Harvard Green Office Project
- The steps are focused on reducing environmental impacts, enhancing the well-being of employees and reducing the cost of operating in the city
- Workplaces then receive recognition for their work on environmental issues
- Workplaces can implement actions in different ways depending on the size and nature of their operations

#### The outcome

- The first workplace signed up at the end of October 2011
- At the end of April 2012, a total of 36 workplaces are participating covering about 1,000 employees of Reykjavik City (13%)
- Knowledge and encouragement is shared through digital media such as Facebook and Twitter

1,000

EMPLOYEES

*By April 2012, 36 workplaces were participating in the scheme covering around 13% of Reykjavik City's employees*



» Reykjavik's Green Steps programme



» Composting in Reykjavik



## STAKEHOLDER: THE WIDER PUBLIC

### COPENHAGEN

#### GETTING PUBLIC SUPPORT FOR WIND

Denmark wanted to significantly change the landscape of its energy mix. It took advantage of its natural resource- wind. Today, it produces 22% of its electricity through wind power and has developed a globally recognised wind industry.

However, public support for this was slow. People had concerns about landscape, noise and the capability of the grid to cope with the intermittent source. The city of Copenhagen took the lead in changing the public attitude.

#### The solution

Copenhagen implemented a public awareness campaign, taking members of the public on demonstration tours of on-shore wind farms to show them that there would be none or minimal noise impact.

The city further encouraged support for wind power by creating a Wind Turbine Cooperative alongside the first wind farm.

- This was half-owned by the city utility company
- The other half sold in shares to 8,650 members of the local community
- Each share represented 1000kWh/year and was worth 809 US\$

#### The outcome

- There is now wide-spread support for wind turbines in the city
- The city now plans to build more than 100 new on and offshore wind turbines before 2025
- Local residents can invest in these through locally based cooperatives
- By creating strong local demand, the Danish wind industry has grown into a multi-billion dollar industry, achieving growth rates of over 30% per year and almost half of the world's wind turbines are now produced by Danish manufacturers

### HELSINKI

#### RAISING AWARENESS AND PROVIDING EDUCATION

Helsinki is very active in engaging the public on the question of sustainability. The city has adopted two solutions to raise awareness and provide in-depth education on the issues of sustainable living.

#### The solution

##### Raising Awareness – Climateinfo

- Climateinfo is an organisation that aims to empower individuals to make the necessary change towards more ecological lifestyles
- It raises public awareness around four key themes: living, transport, food and consumption
- These themes are made visible through various events, discussions and workshops as well as in the social media
- Climateinfo works together with various city departments, companies, as well as clubs and associations to deliver its message and education
- Climateinfo believes that the most effective way to influence people's behaviour is to go where people make their choices (at home, in shops and restaurants etc.). The best results are achieved through activities, which combine economic and social benefits with environmental benefits

#### The outcome

16,000

16,000 people were directly engaged in Climateinfo's activities

16,000

9,500 people visited its website during 2011

#### The solution

##### Providing education: The Harakka Nature Centre

- The Harakka Nature Centre is a demonstration centre of energy efficiency and renewable energy measures. Its aim is to raise awareness of these measures so that the citizens of Helsinki feel more confident in investing in them
- It's located on an island in front of Helsinki, and is maintained by the City of Helsinki Environment Centre
- The centre also:
  - » functions as exhibition space
  - » has an energy nature trail
  - » delivers a school programme on nature
  - » has a website, where visitors and others can learn about energy efficiency and renewable energy technologies
- The centre itself has reduced its own carbon footprint by 60% through improving its own energy efficiency and employing renewable technologies

#### The outcome

10,000

The Harakka Nature Centre has approximately 10,000 visitors every year.



## Seven City Challenges Behaviour





# LOOKING TO THE FUTURE: JOIN US

Cities are where the majority of the world lives and where the challenges of the 21st century need to be resolved.

Each city's journey towards sustainability is an individual story.

We, the Nordic Eight, hope that you have found our stories useful and thought provoking.

We invite you to contact us to learn more about any of the case studies in this catalogue.

Through sharing our experiences we look forward to the opportunity to learn from your innovative, sustainable city solutions.







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