Observing and innovating

Urban ecology

in the Baltic Sea region

Learners' Guide No. 8

The Baltic Sea Project

Švietimo ir mokslo ministerija

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ISBN 978-9986-528-14-2

Editor's note

This book has been produced within the UNESCO Associated Schools network „The Baltic Sea Project" as „Learners Guide No. 8" about Urban Ecology, Vilnius 2009. The previous titles can be seen and a number of them downloaded from BSP website www.bspinfo.lt

Further information about BSP on this website.

To the reader

This is basically a geography handbook in the sense that urban development and life mainly is regarded from the classical geographical point of view which tells that the cultivated landscape and first of all the towns and cities are man made. They are technological and social constructions, made by the humans who use nature as location, a workshop or a resource chamber.

Through a long history of the humans, this practice has changed the nature a lot, and consequently, the response from the nature is still growth of cities and still increasing use of natural resources, both of which are similar powerful changes of the natural balance.

They are known as climate changes, pollution, environmental problems, a wide range of which have been described and analysed for the sake of inspiration and education in the previously edited "Learners Guides" from this school network.

The purpose of this book No. 8 is to inspire the reader (teachers, students and pupils of the Baltic region) to use their already trained skills against the environmental problems caused by the growing cities.

These problems will not be minor in the future due to the perspective to have a doubled number of citizens in the World within the next 40 years. Solutions to the problems require more awareness and knowledge, which is the way to create more sustainable cities. Let us hope that the handbook will help stimulate this process.

Per Werge

Edition: August 2009.

Preface by the BSP International Coordinator 2009

Natural environment surrounding us is the base for existence and survival of humanity, particularly in the 21st century when a considerable part of our world surface is covered artificially. However, urbanization is picking up its speed towards its growth and sometimes it seems that to implement the future vision of sustainable development in such conditions is impossible. Fortunately, the requirements of the increasing world population have lately started to match the awareness of life harmony. The challenges of sustainable development have become the right way guide for urbanization, and research into urban ecology helps humanity realize their living environment as a living ecosystem with all nature valuables which is a safeguard for better quality of health and life.

A reasonable compromise to be reached between developing cities, people and nature is our basic mission and the reason for publishing the book "The Baltic Sea project Learners' Guide No. 8". Improved ecological knowledge amongst students and teachers from the Baltic Sea countries, also their close cooperation will lead to more awareness of the most sensitive issues of urbanization. Success of our future life depends on both all and each of us.

I would like to express my appreciation to the international editorial team for preparing BSP Learners' Guide No. 8, particularly Soren Levring, the author of "Urban ecology" core idea and the initiator of a guide edition, also Per Werge for his profound good-will input as an editor. I am thankful to Stanislav Babitch, a member of the editorial team, for his efforts in preparation of the guide, and also other authors for contributing to it with their informative articles. And finally I am grateful to Lithuanian Young Naturalist Centre, Lithuanian Ministry of Education and Science and Danish ASP-board for sponsoring this publication.

I deeply believe that all of you live to the principles of sustainability, therefore I wish you to spread sensible urban ideas among people around you. Good luck in practicing with the guide!

Miglė Simanavičienė
General and national coordinator of
the Baltic Sea Project within UNESCO ASPnet

Learners Guide 8: Urban ecology

Content

The panoramic view of Hong Kong

The "Turning Torso", Malmö, Sweden

Introduction

By Per Werge, Nykøbing Katedralskole, DK

Chapter 1. Why urban ecology?

Urban ecology is a strange concept or idea. Is a city by nature anything but the opposite of nature? Nevertheless urban ecology describes the cooperation between the natural and artificial environments of the city. Before the city or town was founded, the area had been pure nature. The city just transformed the nature. Instead of natural landscapes, we got cityscapes, or urban environment. Even so the cities are still exposed to the climate (now changed) and still partly fed by local resources (air, water, local products), but an important new condition is that still more resources are taken from the nature somewhere else, and still more non-used resources are, as waste, to be transported out of the city.

This is central: the natural input-output balance of energy and materials for the settlement, its metabolism, is out of natural balance. In addition to this the imbalance is growing: the urban areas are now home ground for half of all population on Earth. This causes a steady growing demand for supply to urbanisations from non-urbanised areas far from the cities.

The shown setting already gives us the two main components of "urban ecology": the natural and cultural environment.

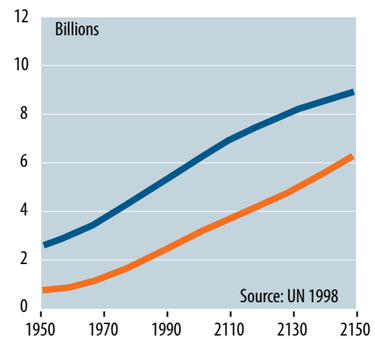


Figure 1.1. Big cities as part of the total World population 1950-2050

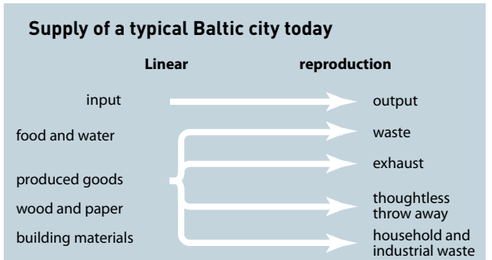


Figure 1.2. This model is often used to show the industrialised city as a parasite of the worlds environment (After "The Gaia Atlas of Cities" and Mellemfolkeligt Samvirke, Copenhagen 1993

The nature delivers naturally four, the culture the fifth environmental sphere:

1. The geosphere: landscape, soil and subsoil, hills, coasts, shores.
2. The hydrosphere: lakes, water streams, coastal water, soil water and ground water.
3. The atmosphere: the air, as a reservoir for radiation and other processes, the climate with its temperatures, precipitation or droughts.
4. The biosphere: the vegetation and animals and people (humans are the first primates!).
5. The antroposphere (or society) delivers all the cultural installations which transform the nature: buildings, roads, railroads, canals, water and sewage pipelines, power system, refuse removal, etc., and (again) population as cultural citizens with certain urban behaviour located in a complicated network infrastructure.

In this network all locations are not equal. Some of them are central and used by an immense number of people, others are peripheral.

The supply of a modern city (Hong Kong)

Tons per day	Input	Output Export	waste
Food	5.985	602	
Animal food	335		
Food waste			393
Soft water	1.068.000		
Ocean water	3.600.000		
Sewage			819.000
Sludge			6.301
Goods	18.000	8.154	
Liquid fuel	11.030	612	
Solid fuel	193	140	
Glass	270	65	152
Plastic	680	324	184
Concrete	3.572	11	
Wood	1.889	140	637
Iron and steel	1.878	140	65
Paper	1.015	97	691
Other waste			728
Oxygen	27.000		
CO			155
Greenhouse gasses:			
CO_2			26.000
CH_4			29
NOx			110
Particles			42

Figure 1.3. The input of world based resources to a big city is much higher than the output. (After Ken Newcombe et all 1978)

What happened when the city was built?

The roofs of the buildings cover the land surface
The traffic zones are treated with asphalt or concrete
Precipitation is lead into pipes, not to the soil or plants
The transport sector uses energy from abroad
The houses and households use energy from abroad
Food and resources come from outside
The domestic production is not consumed locally
Waste is only recycled partly, most is burned or deposited

Figure 1.4. The nature is partly set aside in a city

The uneven infrastructure causes uneven use of resources. In general a city uses resources from allover, from local gardens and fields in the surrounding area and local industry, but (as said) further more from production sites placed elsewhere or in other countries.

These resources are of all sorts: air, water, food, fuel, clothes, building materials, consumer goods, as the example from Hong Kong shows.

Most of them cause by consumption organic or chemical waste or exhaust, which influence the urban environment and make its balance unstable. Thus the balance is unstable on both sides: there will be extremes in the supply of resources as well as on the refuse side.

Urban ecology embraces all these processes, as they are elements of big natural bio-geochemical cycles i.e. the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle, etc. The perspective in this handbook will be to focus on the nature influence and its response to human urban activity, and conversely, to observe how much or little the environmental aspects are taken into account by urbanisation during the remarkable extension of the cities, that is going on right now and will continue worldwide.

The option is to determine a range of focus or research areas, which cover the headlines of urban ecology of today and create opportunities for further work and research for schools at our stage:

Urban housing
Urban traffic
Urban climate
Urban water runoff
Urban water supply
Urban energy supply
Urban waste and refuse removal and recycling
Urban planning
Urban wildlife and vegetation changes

Another general option is to create young citizens who will be aware of both the opportunities and the risk, as well as necessary solutions to be taken regarding city planning and development in the future, and are both willing to and capable to handle the development based on environmental knowledge and experience.

This perspective was already launched and expressed clearly in the Calcutta charter 1990:

The Charter of Calcutta

We are at a turning point in history.
Our planetary environment is severely damaged.
Desertification is spreading, the globe is warming.
Entire eco-systems are under threat.
And the city is at the centre of the storm of destruction.

But that is the key!
We must cease seeing the city as a problem.
We must see the city as the solution.
For the city is our home.
It is what we make it to be.
It is where we live.

If we fail to seize the future,
We will be consumed by the past.
The Future begins NOW!

Let the Charter of Calcutta be simple & clear,
To be heard by all,
And filled with hope & vision.

Why urban ecology should be subject for education, also along the coasts of the Baltic Sea?

First a focus on the population:

As mentioned: since 2007 half of the population on Earth live in urban areas, i.e. 3 billion people. The growth until 2050 is predicted to direct all newcomers in the world to towns and cities. This will double the urban population, while the rural population will remain the same.

By 2050 the UN prognosis tells about 6 billion citizens in urban areas. 6,000,000,000 people. Imagine how to build – before 2050, within 40 years – as much urbanisation as there already exists, built through 6,000 years!

In the Nordic and Baltic countries the urban growth is far from the drama going on in the developing countries, but here is regarded the same centralisation trend of migration from the outskirts and rural regions to the big cities and their suburbs.

The 20 largest cities of the nine BSP-countries grew from 1960 to 2008 from about 12 m to 20 m, suburbs included. Parallel to this a few new cross-boundary con-urbanisations have developed with shared labour and commercial markets in the region, as a consequence partly of political visions and

The location of Baltic cities

What will happen to these cities by the expected climatic and environmental changes?

Figure 1.5. Sea trade and transport placed most bigger cities at the coast of the Baltic Sea. By a raised sea level this position will be a threat. A solution could be a cooperation of building a huge dam with locks blocking the Danish Straits after the Dutch' model from the Rhine-Maas Delta. Here a series of dams and locks protect the hinterland from ocean floodings. The Baltic Sea will then turn into a freshwater lake as it was 8000 and 10.000 years ago.

planning, partly for economical and commercial reasons, e.g. the Over Torneå/Umeå (Finland/Sweden) and the Øresund region (Denmark/Sweden).

It is worth noticing that most big cities of the region are located along the coast, originally founded as seaports. The sea has been vital as their origin and lifeline.

Of the 20 biggest cities in the region only four are located in the hinterland, although at rivers: Warsaw and Krakow in Poland, Vilnius in Lithuania and Berlin in Germany, if we decide to include Berlin as a vital city for the Baltic region (though it according to hydrography belongs to the Elbe river system).

The changing climate makes the sea represent a future threat to all the coastal urban areas: if warmer climate melts the ice from the ice cap of Greenland and the Antarctic, the ocean level will rise between 1-2 meters by the year of 2100 depending on various factors.

With this scenery: how to avoid flooding of the city centres, all exposed to the sea?

british fit town - or eco town - combines fitness with sustainability

Figure 1.7. Fit towns is a new suburban concept launched in 2007 by the British government. It is meant to create suburbs where the citizens can only walk or cycle internally. By this the town can help curing two cultural diseases: The CO_2 emission from the traffic and the fat, unfit and unhealthy behaviour of the population

Will flooding barriers like The Thames Barrier east of London or The Delta Plan south of Rotterdam, be necessary elements of city planning in the future?

Must the Baltic countries in cooperation build long and tall dams across the Danish straits from island to island to block the rising Atlantic Ocean level? A project like this will make it possible to keep the recent sea level inside the Baltic Sea. This sea on its side will change to a fresh water lake when the saline ocean water is kept outside the barrier.

The future extension and reorganisation of the cities in the Baltic region thus ask the same questions and apply similar solutions as the main urban areas globally. Due to long traditions of the city development and planning, and due to (on a global scale) a good economical, political and technical standard as well as the tradition to involve a politically committed and skilled population, also through the periods of crisis, - the way the urban problems are solved may deliver potentially "good examples" and useful technology to other regions. The important part here is to be played by a well-educated and trained young generation with sufficient critical knowledge and sense of commitment.

Again: here is the reason for this handbook.

Sassi di Matera, Italy

Chapter 2. The state of urban ecology today worldwide: Global, local – or both?

By Per Werge

How is the strategy for urban ecology today in the shade of globalization of the market economy

About 1998
Global strategy
↓
Government and institutions
↓
Laws, rules and regulations for traffic, buildings, energy savings, recycling etc.

After a 2000
A strategy to activate the locals
↓
Sustainability as an urbanization process
↓
Use of local conditions i.e. local resources for sustainable livelihoods

Figure 2.1. An optional global strategy for urban ecology was put back by a strategy for liberalism and globalization at the turn of the 21st Century. Urban ecology development now depends on local projects, which may give it a new breath.

The focus on urban ecology as a cure against uncontrolled growth of unhealthy oversize cities worldwide possibly began in the 1960s. At this stage de-colonisation and political independence of the former colonial countries and re-vitalisation of the industrialised countries after World War II had led to an economic and demographic expansion of unseen dimensions. The Old World cities grew remarkably, but cities of the Third World grew even more, all of them connected to and stimulated by the creation of the liberalised world market economy or trade links to the expanding communist economy.

Trade and production within the market turned to be an attraction to migrants searching for work and improvement of their living, which in turn seemed to be the key generator of urban growth.

The dark side of this process was first seriously recognised and described during the 1970s, when the international oil crisis and recession dominated the liberal market economy. The crisis made it obvious that the mega-cities' extreme consumption of energy and other resources was unsustainable, and the supply and handling of waste had grown not only to ecologically irrational dimensions but also economically unrealistic size.

During the 1970s, a partly ecology and partly morality based trend picked up the discussion and advice on urban sustainability, both in an ecological and economical sense. Most advice was generalised and delivered standard methods for recycling of materials from the waste, energy conservation through better insulation standards for housing and processing, and rationalised use of materials in building and housing, optimised water household, and advice on reduced consumption of goods in general.

A romantic or anarchistic version of this trend was to stimulate young families to re-migrate to the countryside to build a subsistence economy on a small-scale farming and vegetable growing.

The political consensus by this resulted in a row of conferences and decisions on a global scale. Most known is The United Nations Conference on Environment and Development, at

Figure 2.2. Shibam in Yemen is one of a range of old originally isolated towns in the Middle East and the Mediterranean where draught and sparse natural resources forced the citizens to recycle and minimize consumption. (Illustrations and information about the cave dwellings and sustainable towns in the Mediterranean are mainly from the www.sassiweb.it and as source for Sassiweb: Pietro Laureano, the Ipogea Institute of Matera, Basilicata, Italy; website: www.laureano. it)

Rio de Janeiro from 3 to 14 June 1992, when regulations by both governments and municipalities according to general environmental standards were decided to be universal. The decisions were published as Agenda 21, telling how to handle the environment in the 21st Century.

Since 1992, local and state authorities in many countries followed the advice, also according to demands for urban standards, with more or less successful realisation. The need for economic growth, and the uneven booming or periodic regionally recessing World economy from about 1993 to 2008 made intelligent planning overtaken by "wild" urban growth upon a technological and political platform of "yesterday". All the advice from the conferences was referred to as too centralised, too general, and the legislative standards for urbanisation were – and are –in most regions too weak to avoid the power and will of both local and international financial or commercial, and entrepreneurial groups.

Only where strong local groups of inhabitants, planners, politicians – using the opportunities of politically well organised and democratic communities – worked for urban sustainable solutions optional in the specific local region or city, there happened to develop new towns or districts, or single buildings which add new urbanised and sustainable perspectives to the former, either through new use of technology, materials or planning.

Even in the Nordic countries with their long tradition of democratic, social and environmental commitment of the citizens, sustainable urbanisation has not been the main strategy. On the contrary the massive growth in welfare during the last 25 years has increased the consumption of resources extremely upon a non-sustainable basis of carbon exhausting technology (motor cars and carbon or oil burning power plants) and widespread settlements in suburbs and former villages, and in the open landscape to answer peoples' demand for "a house with a garden" and green non-polluted surroundings.

This housing pattern creates still more need for private transportation to the workplaces, which on their turn increasingly either are located along the main traffic arteries (motorways) and secondly, along railways outside the old town centres (especially production, distribution or service firms), while research, information and administration departments often settle in reclaimed former industrial districts or harbour areas in the city, near the universities with their source of researchers. A new urbanisation type is made: the highway-connected roadside city. Some of them are 100 km long. (See chapter 5) If these roadside cities and the urban sprawl should ever be sustainable, new transport systems and technology will be needed. For the city centre itself the technical solutions may be easier, but for all existing urbanisation the expenses of the change will be massive. For the future, urbanisation options for creation of new sustainable towns are necessary. Are they at hand?

The origin of the settlements on la Murgia - 8000-3000 years ago

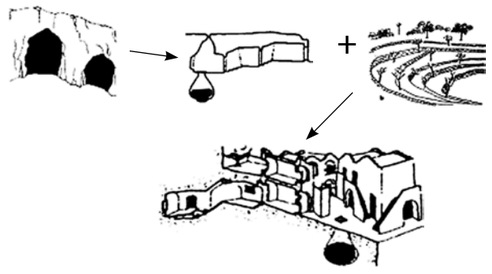


Figure 2.3. The natural caves in Basilicata in southern Italy's dry karstic landscape La Murgia were first used of hunters, later changed into agricultural cellars and housing.

Did sustainable cities ever exist?

This opens a simple question: Did sustainable cities ever exist?

A study of a city, which among similar towns was an example of full subsistence through thousands of years, may make it clear that sustainability through subsistence has no chance for cities based on trade and more or less regulated market economy.

Anyway, some of the principles for carrying out the former sustainable towns are interesting and still inspiring (and may be reused).

A case study of Sassi di Matera in Southern Italy, origins of which go back 12.000-8.000 years, shows an environmental adaptation to a steppe climate, cool and wet in winter, hot and dry in summer in combination with the use of natural (later extended) caves in the riffs of the chalk rocks for store of food and for housing.

By digging cisterns in the rock underneath the dwellings and leading the winter rain to them, the inhabitants were able to conserve fresh non-polluted water from winter to summer.

Though the town at its largest content might have been 10,000, it still grew most of its own food supply. Waste, waste water and manure were recycled, and the nearest gardens were on the roof of the lower cliff dwelling. The local chalk-sandstone named Tuffa was used as building material. New stones came when a cave was extended into the cliffs. Transportation was by all this reduced to a minimum.

Which environmental history is told by the Sassi example (UNESCO WHE 1996)

Though big - at its largest 18,000-20,000 citizens - Sassi was never more than a village with its self-sufficiency, its inhabitants consumed nearly all products. Through long periods, it took very little part in any network or relation to the "outer" world. First, the break of its isolation during the remarkable world trade revival of the 18th century did send - against its tradition - emigrants also to this remote region; and overpopulation of the caves started.

The intelligent water collection system was then broken by poor people who began to use cisterns as dwellings. The capacity of water conservation decreased while the consumption increased. The sustainable household ended.

Though Sassi di Matera was more a village than a town, what is then to learn from its example?

Figure 2.4. After having been the bad conscience of Italy in the 1950s due to the poor living conditions in the overpopulated Sassi cave dwellings, the Sassi was abandoned from 1960 to the 1990s. Then people like Pietro Laureano got aware of its former sustainability and adaptation to the local environment, and promoted a protection movement. In 1996 Sassi was declared a World Heritage Site by UNESCO.

Left: A model of Sassi, showing the recycling of most materials, i.e. water, manure from both people and animals for production of food on the roof terraces. Also, the building of fronts on the caves looking like real gables is shown - building stones came from inner extensions of the cave. The water management begins with collection of rainfall "Acque meteorique" led to the blue cisterns under the floor of every cave

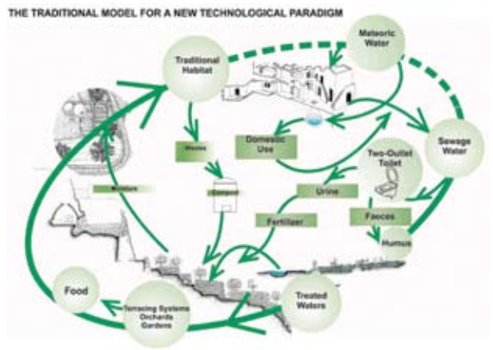


Figure 2.5. The Italian architect Pietro Laureano resumed the knowledge about urban ecology from his studies of sustainable cave dwellings and towns in the following schedule to underline the differences from modern urban and industrial development: (Compare the values with the planners values in Chapter 5)

Modern knowledge contra traditional knowledge

According to Pietro Laureano, the Ipogea Institute, Matera

Specific solution	**Multipurpose system**
Immediate efficacy	**Functionalism in the long run**
Specialization	**Holism**
Dominant powers	**Autonomy**
Separation	**Integration**
External resources	**Internal inputs**
Conflicts	**Symbiosis**
Monoculture	**Relationship and complexity**
Uniformity	**Diversity**
Severity	**Flexibility**
Expensive maintenance	**Self-regulation and work intensity**
Internationalization	**Contextualizing**
Waste	**Saving**
Technicism and rationalism	**Symbolism + wealth of meanings**
Dependence	**Autopoiesis (Independency)**

Recent policy and technology: Examples and visions of today

Let us resume:

The concept and the real function of a town and city is primarily to form the location and connections for production of knowledge and products, either in the city's workplaces or transported from other cities or the countryside. Secondarily, to function as a distribution network for the products to fulfil their purpose: to be used (consumed). Furthermore, the city houses homes for its producers and distributors as well as the cultural, political and social institutions and their employees necessary for the city's development and administration.

This concept creates a row of necessary demands for solid as well as immaterial resources to supply production of all kind, to build and preserve the physical infrastructure for housing, distribution, transport, consumption and recreation.

Expressed more simply, the city consists of buildings of many kinds, connected by networks of roads, water and sewage pipelines as well as of power and communication lines. The "eco-question" related to this construction and the use of it is also simple: Can it be done in a fully sustainable way?

The sustainable town of Matera from the past showed a balanced ecology based on low consumption of local resources and recycling. Almost no materials or food came from abroad, trade and transport was extremely limited to the surrounding agricultural land and based on land transport done by animals or people. This transport constituted at the same time the communication lines. Muscular power and wood for fire, oil for light were the scarce energy sources used. The town stayed literally unchanged and independent of external supply through hundreds of years, with very little growth in population.

Its decline as sustainable habitation came as told because of rapid immigration in a period (18th Century) of growing World trade.

During the last two centuries, neither the basic population nor the political powerful landowners, traders or governors wanted the sustainability and independency continued. They wanted to profit from the market.

On the contrary, Matera as well as all other cities, has been redefined as The Site of modern life, because of modernization, given through close connection to the growing world trade market for industrial products and resources.

After the unrolling of the communist planning economy nearly all regions and cities in the world are supplied according to the liberal market philosophy and hence built and expanded by use of materials, products and energy principally (and more or less) delivered through the world market.

WTO, The World Trade Organisation, has grown to the economically and legally most powerful international institution with supernational legislation and a status of a supernational Court according not only to the concept of "free trade", but also to "Trade-Related Aspects of Intellectual Property Rights, of patents, and of pharmaceuticals and public health".

Through the concept of free trade, very different regions of the world are brought in direct competition, what concerns the price of the final products as the consumer meets them in the supermarket and other retailers or importers.

The conditions for the production vary enormously from country to country and region to region: salary, local prices, living costs, technology, energy supply, infrastructure, legislation for nature protection and work environment, for safety and security in general, and "hidden" state support or corruption make together a setup totally opaque or impenetrable for anyone.

There are only few options for evaluation of products regarding their ecological, social or political sustainability. The market price and quality of the final product will generally be the only values to consider for the costumer, and they do not tell the full story.

As illustration: the concept of free trade meant still by year 2009 that the CO_2-emission from shipping and air transport was not counted as a part of any national emission, which means that even the real transportation costs are not included in the calculations for a product, neither economically nor environmentally.

Until the economic world crisis from 2008 and the shift in the international evaluation of the climate change most city planners or politicians (or just citizens) prefacing environmentally sustainable solutions in production, construction and consumption had little support from the leading political and economical nomenclature. The concept of free trade was stronger than environmental sustainability as a political leading concept.

Since the environmental warnings for the Globe of the 1960-70s from The Club of Rome 1968 and the internationally agreed headlines in the 1990s based on the UN Conference for the Environment in Rio 1992 there has been a turning in the promotion of urban ecology solutions from "the general" perspective to "the local". In many countries, planners and entrepreneurs have developed local urban technology, mostly green housing, zero energy buildings, electric transport systems, but also urban ecology projects for a full-scale towns or suburbs, though still local solutions.

This has happened due to the fact that the largest nations of the world like USA, China and Russia, never signed nor respected the Rio Declaration on Environment and Development, and still more powerful WTO had never argued for environmental solutions before free trade. The international crisis since 2008 and the renewed focus on the accelerating climate effects in symbiosis with new political structures first of all in America, may introduce urban ecology on a wider scale than the local, which will be welcomed and necessary in the light of the proposed building of new towns for 3 billion people within 40 years time.

Nevertheless local solutions have shown a variety of options, and the importance of using local ideas, resources and materials is inevitable. It is simply one of the fundamental components of urban ecology, as well as it is a strategy "to break through the barriers" for unsustainable urban development.

Let us make a giro, a round, to a range of innovations going on in the Baltic Sea region by the year 2009, when an International UN Climate Conference involving all the world's countries is being held in December in Copenhagen.

Map of the extent of Hansa about 1400, fragment

Carta marina, a wallmap of Scandinavia, by Olaus Magnus. The caption reads : A Marine map and Description of the Northern Lands and of their Marvels, most carefully drawn up at Venice in the year 1539 through the generous assistance of the Most Honourable Lord Hieronymo QuiriNo.

Chapter 3. The influence of historical and economical factors on urban development in the Baltic Sea region

Authors: Stanislav Babitch, Olga Gladkaya, Marina Petrova, Olga Verzhbitskaya, University of St. Petersburg

Résumé: This chapter describes the foundation and further development of the Baltic regional cities as centres for extraction and production and trading of raw materials and food. The trade established through the history the region as a transport corridor based mainly on shipping, connecting the cities in an urban network and connecting North-Eastern Europe with Central and Southern Europe. It is stated that the future role for the regional cities in the global economical geography will be to revive and extend the position as transport corridor. By creation of new transport technology i.e. intermodal terminals connecting sea- and land transport the cities will still be keeping and improve their role as transport knots. The chapter does not step into the discussion on how transport may obtain environmental sustainability. It delivers a basic knowledge on the conditions for the existence of the cities in the region, and hence represents a starting point for creation of a future sustainability.

Urbanisation factors

We want to consider the following factors that influence the process of forming urban networks and the structure of urban areas; natural resources and the economic-geographic position.

The main resources that influence economic development in the Baltic Sea region are:

- wood,
- fish (herring, sprat),
- amber,
- iron ore,
- non-ferrous metals.

During the definite period salt was a resource that influenced the main process.

Since the middle of the 20th century recreational resources have become a factor.

The second main factor is the economic-geographic position of the region (transit). This factor had its greatest influence in several periods:

- Viking Age,
- Hanseatic League times,
- Soviet times,
- Nowadays.

Economic-geographic position directly influences the foundation and location of towns. This economic-geographic position determines the attitude of places, districts or towns toward outside objects that play some economic role and also the presence of resources.

We indicated that main resources influenced the structure of the urban area and urban network in the Baltic Sea region (see Pic. 1).

Wood

The first factor that we picked out is a very important resource**—wood.** Wood satisfies various human needs. It is the base resource for the timber industry and woodworking and is one of the main elements used in recreational potential and human dwellings and it regulates and cleans surface runoff, prevents soil erosion, preserves and increases soil fertility, saves genetic biodiversity, enriches the atmosphere with oxygen and guards air from pollution, and takes part in the formation of the climate. The flora in wooded areas is a unique provider of wild fruits and berries, nuts and mushrooms, valuable species of herbs, and specific raw materials for different industrial branches.

Pict. 1. Map of the "factors" which influenced the development of the cities in the Baltic Sea region

Pic. 2. Pulp and paper mill in Segezha

Pic. 3. Pulp and paper mill in Svetogorsk

Because of these unique characteristics, this resource influences the process of settlement. Many towns are founded in the place of production forests and woodworking.

A sufficient amount of wood can be used for various purposes:

- primary wood processing,
- furniture,
- paper, cardboard (building of pulp and paper mill).

There are some good examples of such towns in Russia. Segezha is one of them. The pulp and paper mill in Segezha is the biggest hail growth enterprise.

One more example is Svetogorsk. At the end of the 19th century, a pulp factory started working at the place of the present settlement. It later developed into a cardboard and paper mill and even later to a pulp and paper mill. A dormitory grew around the factory and then became a town. The same process happened for many other towns in Sweden and Finland (Imatra, Kayaaani).

To found a pulp and paper mill two other factors, electricity and water resources, are needed. These factors are almost always joined together (hydroelectric station). Only one resource is not enough to develop a town; there is also the need for energy. For example, the Syassky pulp and paper mill has been the main enterprise in the town since 1928. It provides heat, drinking water, and hot water.

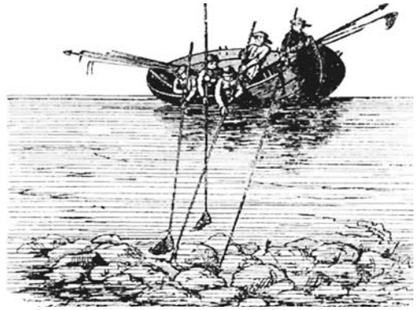
Pic. 4. Tampere paper mill

It is very important to mention the ecological factor that limits industrial development, also including the pulp and paper industry. This kind of industry pollutes the water and air. Many pulp and paper mills in the Baltic Sea region were built in the middle of the 20th century when the ecological factor was not so important as nowadays. That is why many pulp and paper mills were located inside the city limits, and this is important for city development.

An example is the Swedish company IKEA, which is the biggest furniture producer in Sweden. The small town Agunnaryd is famous for this company. IKEA has shops in 44 countries, and most of these shops belong to the IKEA Group. The main principle of the company is the compact transportation and storage of furniture and also the possibility to assemble the furniture oneself. For this reason, the finished products are exported to other countries.

Pic. 5. Catching of herrings in Oresund by Falsterbo by year 1200

Pic. 6. Commercial herring catch



Pic. 7. Amber hunters with harpoons and nets

Fish

Fish have always played an important role in the economic development of the region and influenced the formation of urban networks and structure of urban areas till the end of the 20th century, when fish resources were overfished.

The water of the Baltic Sea is recognized as not suitable for food fishing. The biggest exploitation of fishing resources occurred at the time of the Hanseatic League. At that time, towns like Lübeck in north-western Germany, towns in Skaane in Sweden, etc. experienced the most development.

Many experts considered the migration of herring to the coast of Holland to be one of the reasons for the Hansa's decline and an influence on the successful development of cities in Holland.

Amber

Amber is a mineral of many names: *jantar*, good stone, sacred stone, gold of the north, Baltic gold, and *electron*. Thanks to its own inner light and beauty, amber has always been a favourite stone used for adornment, especially in Europe. For example, the fashion of wearing amber bead necklaces began in the Middle Ages. Some people believed in both its mystical properties and its medical qualities. In any case, people have used amber with pleasure since the beginning of time

The Baltic Sea region has been the original source of amber since prehistoric times. The most common amber in Western Europe comes from Russia, Poland, Germany, Denmark and Lithuania. The major supply of Baltic amber comes from a 1,000-square-kilometer area of the Samland Peninsula, which is now known as the Kaliningrad Oblast. Towns were founded in this historic district as far back as the time of the Roman Empire. But in particular in the Middle Ages, when amber trading was occupied by the Hanseatic League, there was intensive development of a network of cities. But the trading of the Hansa trading monopoly was reorganized in 1255 after the Teutonic Order succeeded in overtaking the Baltic Samland with its rich locations for finding amber. Subsequently, the Teutonic Order made laws to organize sales and upgrading all amber findings exclusively in Lübeck (near Hamburg) and Bruges (near Antwerp). Exactly due to the Teutonic Order, Konigsberg (in future Kaliningrad) was founded in 1255. The Hansa trading monopoly ended in 1525, and any other amber trading routes to/from the Baltic States were virtually cut off from 1255 to 1525.

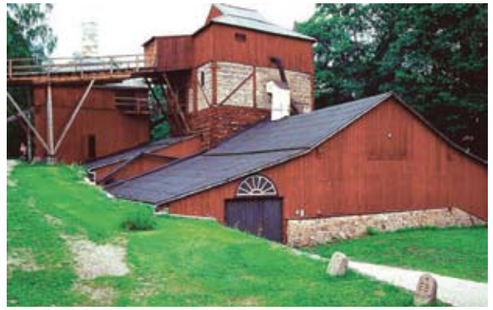
Lübeck may be considered the access to the Baltic Sea for Hamburg, and the towns on the direct route between Lübeck and Hamburg (which connected the towns ***Borndiek, Hamberge, Ammersbek, Berne***, and ***Hamburg***) may be seen as amber trading settlements. The names may have been given within the Hansa period (1255–1525). Therefore, some researchers suppose that the city of Antwerp (Spanish name: Amberes) may very well demonstrate the amber trading facilities at the time of the Hansa monopolies. Of course trading routes may have existed before 1255.

Nowadays amber mines in Kaliningrad supply 99 percent of the Baltic amber collected. Until the 19th century, amber was mined and gathered by hand from the sea. In the later part of the 19th century, mining operations became much more sophisticated as dredging and mining for amber began. Since then, millions of kilograms of Baltic amber have been mined. A small town in Kaliningrad Oblast has the world's largest amber mine.

Pic. 8. Amber museum in Kaliningrad

Pic. 9. One of the main amber products

At present amber is used in many fields. Amber acid was discovered to act as a biostimulant: it stimulates the nervous system, regulates the work of the kidneys and intestines, and is an anti-inflammatory and antitoxic agent. This ingredient is the basis for ointments and creams to treat rheumatic and asthmatic ailments, skin ulcerations and irritations, and bronchial, throat and thyroid conditions. The acid and oil obtained from amber are also used in the cosmetics industry since they destroy free radicals and bacteria, have disinfectant properties, and alleviate the effects of burns and insect bites. For these reasons, manufacturers have been trying to outdo each other by offering ever new ideas on how to use amber: you can buy mattresses and cushions, mats for pets filled with amber, insoles with amber fine, back and neck supports for drivers, amber incense sticks, and many other objects of this kind. Amber has antiseptic properties that protect the tree from various diseases.



Pic. 10. Engelsberg Ironworks

Iron

Ore deposits of the Swedish iron concern to be one of the richest in the World, both on concentration of stocks of ore, and under the maintenance in it of metal. The main iron-ore area in the country is above the polar circle, in Lapland. Other iron ore area - Bergslagen, which has been known since the Middle Ages—is located in Average Sweden. Among deposits of nonferrous metals, the most considerable are located in Norrland. This deposit of complex sulphidic ores in the Buliden-Kristineberg area contains copper, zinc, lead, gold, silver, and arsenic. A lead deposit (Lajsvall) and copper (Aitik).

The mining business in Sweden began and reached considerable lifting in the Vendel era (6th–8th centuries). The main role was played here by ore-bearing zones to the west and to the north of Lake Mälaren, especially extensive in the field of Dalarna. Operation of deposits of mountain both marsh ores and the control over the transportation of iron raw materials on waterways to Lake Mälaren and then through Helgyo and later through Birka created an economic basis for concentration of the political power of Swedish Konungs. Gotland was an important link during this process. The location of the island promoted its transformation into a reloading point for the export of iron from the area of Lake Mälaren and other places of continental Sweden to the east and the south on Russian rivers. On Gotland, metal could be worked into easily transported, partly finished products, mainly sword blades.

Iron, in comparison with furs, wax and slaves, which were earlier usually considered the basic articles of trade, was an item needed daily and it therefore represented the best subject of barter. Estimating the exact influence of the extension of the iron trade is difficult. While the majority of Swedish cities grew

or decreased less than 20 percent during the late Middle Ages, cities such as Stockholm and Arboga that to a large extent made a living from the iron trade grew more than 50 percent, and at cities Lidköping and Hedemora iron was probable so to explain their occurrence in the middle of the 15th century.

Herräng and the area rich with ores form Herrängsfältet which is the biggest area of a mining industry within the Stockholm County. Iron ore began to be extracted in Herräng at the end of the 16th century. The city was then known as Kuggvass, and one interpretation of the name is that Hansa ships moored in that place. Mines have been located at coast, without any source of hydraulic power to extort water from a deposit. The mining industry was therefore at a low level of development. In 1753 attention moved to Lappgruvan deposit and the mechanical device known as a *stånggång*. The mining industry in Herräng has been stopped for some time.

The company Herrängs Gruf AB was founded in 1889 by Natanael Fryoding, who advertised in several newspapers to get financial support. He even advertised in *the Times*, and in advertising he named Herräng the "new Dannemora".

Results were however not so good as Fryoding had hoped, and some mines were closed after 1 year of operation. The mining industry in Herräng gradually fell into decay to 1961. The metal works still operated, using ore from other mines, until 1969, when it was closed. The foundry is used today by another company, Roslagsgjuteriet.

The extracting area of central Sweden is often mentioned as Bergslagen. Bergslagen was important since the Middle Ages within the mountain and iron and steel industry. There are sites where iron has been received in 400 A.D., the Extracting area of the Central Sweden needs to be distinguished from Malmfälten, an extracting area of Northern Sweden, concentrated in cities of Kiruna and Malmberget which importance increased in the 20th century and especially during the Second World War.

Bergslagen covers the old landscapes of Västmanland, Dalarna (south) and Värmland (east). The main Cities of Bergslagen are Nora, Fagersta, Sala, Kristinehamn, Filipstad, Ludvika and Hedemora.

The northern extracting area of Sweden and the cities that were pioneers in the development of the iron ore industry are now in decline. Malmberget (Ore Mountain) is a miner's city in Gällivare Municipality, Norrbotten County, northern Sweden (Lappland). Malmberget is known as the main site for the extraction of iron ore from deep mines, which is done by the company LKAB. Gropen (Hole) has a deep deposit. Today Gropen is in decline as the underground mining industry undermines the area, and the seismic events caused by the mining industry regularly stir up Malmberget.

The first "Swedish" settlers arrived in the area of Kiruna from the southeast, nearby Masugnsbyn where the first iron ore mining industry opened in 1647. However the city has appeared only in 1900 when there has been begun a lining railway «the Ore Line» (has been opened per 1903). In connection with metallurgy decline, in this area tourism began to develop actively. The former industrial mines have improved and now best-selling excursions in the past of mining business of Sweden there are led.

With development of new technologies the Swedish cities – the centres of metallurgy not lost their value, but also could grasp the European leadership. The Berslagen area is the centre of an iron and steel industry, the largest in the EU. Sweden's share in the global iron market amounts to more than 1 percent. The Centres of qualitative metallurgy of Sandviken, Hufors, Fagersta, Avesta, Degerfos, Hagfors and others are concentrated in the old mining area Berrslagen on which share to have 2/3 steel melts, including 9/10 the qualitative. Large factories of a full metallurgical cycle are built in Burleng and in ore - export ports Luleå and Okselösund. Over 40% of all steel is melted in electric furnaces. The main centres of nonferrous metallurgy are Sheleftero (copper and lead), Sundsvall (aluminium), and Vesterås and Finspong (hire of nonferrous metals). The main centres of shipbuilding are located on the western and south-western coast of Sweden: Göteborg (Götawerken and Eriksberg), Malm (Kockums), Uddevalla, and Landskrona.

Salt

Salt has played a prominent part in the development of man's activities, trade, politics and culture since prehistoric times. Man's primary use of salt is as an essential dietary item for both him and his domestic animals. Salt has also been used since prehistoric times for flavouring, pickling, preserving, and curing meat and fish and for tanning. These features have made salt an important part of human culture and civilization. As one writer points out, "From the cells in our brains and bones to customs that spice our languages, salt penetrates every aspect of our existence".

Expressions such as *worth his salt*, *above the salt*, *old salt*, *loyal to one's salt*, *the salt of life*, and *salary*, are used every day. Different cultures have variously held salt as a symbol of divinity, purity,

Pict.11a: Salt is on the table for many purposes

Pic. 11b. Old salt storehouses in Luebeck

welcome, hospitality, wit or wisdom. In Sanskrit the word *lavanya*, which expresses grace, beauty and charm, is derived from the word for salt, *lavana*.

Salt has been equally important in trade and politics. Many earlier cultures used it as currency. Some primitive tribes gave its weight in gold to purchase salt. For almost 300 years, salt also influenced the development of trade and the cities of the Baltic Sea region. The Hanseatic League initially developed on the salt trade. The impetus for the formation of the Hanseatic League was trade along the Salt Road that ran between the German cities of Hamburg and Lübeck.

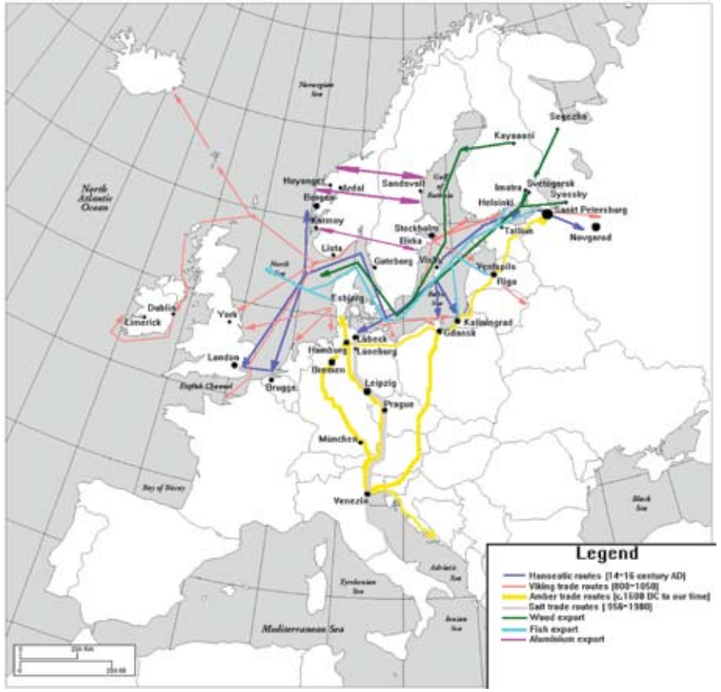
The salt, which was used to salt and dry meat and fish, making transport and distribution possible, was mined in Kiel and Lueneburg. The salt was sold in Eastern Europe, including Novgorod, so not only did Hansa cities develop, but also Russian cities like Novgorod and Pskov. In those cities, leather tanning flourished, and the leather trade developed. But as time went on, salt gradually lost its power. Nowadays one of the latest witnesses of salt might be the Lübeck-Elbe Canal, which was used as a waterway and trade route from the "salt city" of Lüneburg to the Hanseatic city of Lübeck. In certain periods, the development of the city was influenced by its economic-geographic position. That is why we will choose some periods.

The epoch of the Vikings

It is possible to define three basic stages of development of early urban centres in the Baltic region. The first stage (from the 8th century to the first half of the 9th century) is characterized by a gradual concentration of handicraftsmen and merchants in traditional places for ships to be docked and other central points on ways of messages and connected with the limited barter.

The most ancient Danish protocities (Dankirke, Southern Hedeby, Ribe) are obliged by the occurrence and development of international trade and the concentration connected with it of craft activity. Possibly, the new settlements which grow subsequently in the medieval period — Århus, Slagelse, Odenses, etc. - have same origins.

Pic.12. The Old Salt Route passing Lüneburger Heide



Pic.13. Trade routes of the Baltic Sea Region during the Hanseatic period

Some minor seaside trading places stopped at the first stage of development or because of an insufficient economic power of district or adverse communication-geographic conditions. In places where these sorts of adverse conditions were not present, at the second stage of development (9th–11th centuries) the old centres could be transformed into multiethnic early urban settlements (Ladoga, Rerik, Hedeby, Ralsvik); or new trading places were based near old settlements.

Paviken was a rich trading and crafts settlement on Gotland. Mentslin, at the mouth of the river to the Foam, was the same type of settlement. It soon, however, receded into the background and eventually drew back after Szczecin and Volin were founded in the second half of the 9th century. In Denmark Ribe and, apparently, Århus also rose gradually. In the east, Slavic earths not later than boundary IX-X centuries as the Slavic centre Novgorod advances to the forefront.

The third stage was connected with the consolidation of the domination of the feudal nobility and statehood in Poland, in the area of the Obodrits, in Denmark, Sweden and Russia. Basically it began in the second half of the 10th century. On the southern coast of Baltic Sea at this stage, there was Gdansk, Kolobrzeg, Szczecin, Usedom and Old Luebeck. In Denmark Hedeby, Ribe, and Århus were perhaps reconstructed. In Sweden, there was Sigtuna. On Gotland, origin of Visby, which replaced old Paviken.

The expansion of the network of sea communications in the 10th and 11th centuries, the increase of the tonnage of courts, and better arrangement of overland trading routes promoted that the network of the operating largest new centres early urban type appeared more rare, than during previous time. So, for example, the island of Rügen, before the boundary of the IX-X centuries - the important link in the trading message focused on coasting navigation, has appeared out of the basic

Pic. 14. Trade road through Russia in Vikings time

Pic. 15. Nicholas Roerich "Saint Nikolay"

trading routes and sea trade. In the 10th and 11th centuries, large vessels from the island Zealand got directly to the mouth of the Oder without coming to Rügen.

Århus rouse about year 900 on a cape in a river mouth. Protected by shaft and possessing a convenient waterway, it drew handicraftsmen and merchants whose interests were connected with the east and the north. Such early cities as Roskilde, Odense and Viborg rose simultaneously with Arhus, and at the same time in the second half of the 11th century Hedeby in southern Jutland gave way to a new city—Schlezvig. At the time of the Knut the Great (at the beginning of the 11th century, there was Lund, an important religious centre at a crossroads in Skåne, the southern extremity of the Scandinavian peninsula, which was under Danish control.

In the vicinity and territory of Visby, which later was an important centre of the Hanseatic League, traces of activity of trading communities from the Viking age, representing themselves an initial stage of development of this medieval centre, are opened. Trade as a leading employment was already being promoted during the Viking age.

Mining was one of the important factors for the development of cities in Sweden at this stage. Extracted in Sweden, iron was exported to Europe. Gotland was an important link in this process. The position of the island promoted its transformation into a reloading point for the export of iron from the area around Lake Mälaren and other places of continental Sweden to the east and the south on Russian rivers. On Gotland, metal could be worked into easily transported, partly finished products, mainly sword blades. It was the counter-response to the stream of silver that reached the islands from the east.

The formation of early cities in Russia

Connecting two lakes, Volkhov was a major part of the Varangian trading routes: Ladoga and Ilmen. However movement across Volkhov was at a loss set of thresholds, and near most difficult of them in the 8th century there was a settlement that now is known as Old Ladoga. The exact date of its foundation is unknown, but as archaeological excavations testify, it occurred not later than 753.

In the IX-XI centuries, Ladoga was a port city that served as a place of contact of various ethnic groups and cultures: Slavs, Finns and Scandinavians.

Approximately at the same time one more ancient city, Novgorod, was also founded. The reasons for its origin are very similar—since the most ancient times through Priilmene the international Baltijsko-Volga trading way which promoted formation at sources of Volkhov of the centre of political interaction of local Finno-Ugric tribes and come here in the 6th–8th centuries of Slavs came. Here in 859 year Novgorod also has arisen. At first, it was a small settlement with not numerous inhabitants. But with expansion of trade, Novgorod started to gain strength and soon became the capital of a rich state stretching from the Gulf of Finland to the Ural Mountains.

The ships ancient citizens of Novgorod went to New Land, Spitsbergen, Norway, Sweden, Denmark, Germany, and Poland.

The establishment of constant trade from the Varangian in Greeks promoted the development of Novgorod as a major point of transit trade. Finds of the treasures containing West European and east coins, and also nonferrous metals, precious fabrics, vessels testify to it for wine and olive oil from the Western Europe and Byzantium. At the same time, furs, honey, wax, flax and hemp from Novgorod were known all across Europe, including England.

By the end of the Viking age and immediately after it, in the 11th–13th centuries, almost all early proto-cities disappeared. In their place or near them, new, already actually medieval cities grew. Strengthening of commercial relations with Northern Europe in the 12th century increased the value of the cities that were on trading routes.

The example of Novgorod

The city of Novgorod did in this period not lose its value, but developed into one of the largest trade centres of Northern Europe. On the boundary of the 11th–12th centuries in Novgorod, its own merchants formed corporations (Ivansky hundred) and a foreign trading court yard: Gothic (belonging to inhabitants of the island Gotland), and German (Peterhof).

The inhabitants of Novgorod, in turn, made something similar in Visby (on Gotland).

The 13th–15th centuries were times of blossom for Novgorod. For its period it was a big city with a population of 25–30 thousand, comparable to Lübeck, Vienna and Prague. And Old Ladoga in the 12th century became one of the suburbs of Novgorod, a key link in the system of strengthening the protection of Novgorod from external enemies.

Pic.17. Burial mound near Novaya Ladoga

Pic.16. Nicholas Roerich "Volokut Volokom" showing how the Vikings pulled their vessels across the watersheds from river to river

And nevertheless loses the value as a considerable port city. Cities from the very beginning became centres of administration and supporters of the church. Their functions as centres of internal and external exchange are especially appreciable. And then, up to the end of the Middle Ages, in their economic activities of function of an exchange, trade, including transit, were economically leaders, they overtook concentration there crafts and crafts.

The city of Smolensk is such an example. Having arisen in 863 year as a city of the union of tribes, then it has developed in large transit point on a way from the Varangian in Greeks. In the 12th century, Smolensk was large point of trade and craft manufacture and a military fortress. Besides, thanks to the political activity of Smolensk princes, from Smolensk the Novgorod trade coped even. Smolensk became the first Russian city that is mentioned at the creation of the Hansa. With it in 1229 the society of German merchants concluded its first contract. It became a push for the formation of Hansa.

The Hanseatic League

By the end of the epoch of the Vikings and immediately after it, in the 11th–13th centuries, almost all the early Scandinavian cities disappeared. In their place or nearby them new, already actually medieval cities grew:

Pic. 18. Apollinari Vasnetsov "Novgorod Marketplace"

Uppsala, Skara, Linchyoping, Tele, and the Squid in Sweden; Ribe, Shlezvig, Roskilde, Viborg, Copenhagen (Zealand), Aarhus and Aalborg (Jutland), Odense (Fyn), and Lund and Malmo (Skåne) in Denmark; Nidaros-Tronheim, Bergen, Stavanger, Tønsberg and Oslo in Norway, and also smaller cities and towns.

Cities from the very beginning became centres of administration and taxes and supported in general royalty and the church. Their functions as centres of internal and external exchange are especially appreciable. And then, up to the end of the Middle Ages end, in their economic activities functions of exchange, trade, including transit, were economic leaders, they overtook concentration of crafts. The island of Gotland was famous. Almost the entire population of the island was involved in trade; it turned into a republic of trading bonds.

In the 13th century, German colonies were created in the main Sweden ports, including Abo (Turku) in Finland, and in all the major cities of Denmark and Norway. Bergen (present-day Norway) in general got under the power of the Hansa.

One century before Lübeck has received the first privileges in the north — the future head of Vends Hansa. In the 13th century and especially after the second half of the 14th century, great numbers of German burghers began to move to the Scandinavian cities. As a result, handicraftsmen, dealers, and ship owners from Hanseatic, primarily Vends, cities made up an appreciable part of the Scandinavian townspeople, especially their more well-founded layers. They took dominating economic and imperialistic positions not only in Stockholm, Copenhagen, Bergen where they had the offices, but also in less known city centres. They conducted Scandinavian naviga-

Pic.19. Map of Hanseatic Union

Pict.19a: Tapestry showing Hansa merchants standing i a map of the Hansa Union

tion closely connected with city trade. Already at a passing on a medieval map of Northern Europe rather non-uniform distribution of cities on this territory is found out.

Cities of Denmark and Norway are located close to the coasts. The Danish coast is covered with cities, but they are small, and more considerable centres are unique. In Sweden many cities were founded in remote places, but near big lakes and navigable rivers with convenient outlets to the sea. Here there are more appreciable cities, and between them there is a fierce struggle for the rights of active foreign trade, i.e. the possibility not only to import, but also to export. Stockholm, leaning against government support, used so-called trading compulsion method, compelling other cities to take out a number of the important export goods, in particular, metals, only through the port and as a result has sharply come off in the development other cities of the country.

Groups of Hanseatic cities

Hanseatic cities were located in the territories of the modern states of the Baltic region and the EU:

- In the territory of Germany: in Mecklenburg, Golshtejne, at the river mouth of the Elbe at the North Sea (Hamburg, Kiel, Lübeck), Brandenburg (Berlin, Brandenburg), former East and West Prussia (Torun [Torn], Königsberg, Gdansk [Danzig], Memel), present Westphalia and Lower Rhine (Dortmund, Muenster, Cologne), and present Lower Saxony to the south of the Elbe, partially present Saxony-Anhalt (Bremen, Magdebourg, Halle)
- In the territory of present Poland: present Pomorsky and Western-Pomorske land Poland (Szczecin [Stettin], Kolobrzeg [Kyolberg]).
- In the territory of present-day Baltic: Tallinn, Tartu, Riga, and Tsesin.
- In the territory of present-day Holland: Amsterdam and Kampen.
- In the territory of present-day Sweden: the island Gotland and part of the east coast of Sweden: the cities of Visby, the Squid.

In 1492, Ivan III founded Ivangorod. In German documents it was called Kontr-Narva. It carried out the functions of a post and often repulsed the attacks of Germans, Swedes and Poles. The original customs point which assessed with gathering the goods passing from Hansa to Russia was its one more function.

Soviet times

In these times, the inside links of the Baltic Sea region grew stronger. Many of the previously independent countries were absorbed by the Soviet Union. The formation of urban networks was planned with the government. In the 1970s, gas and oil were directed from the Soviet Union to Europe and pipelines were built. In such a way, new towns involved in petroleum processing and the chemical industry appeared (Mažeikiai, Lithuania; Polotsk, Belarus; Kirishi, Russian Federation). Oil ports were also built (Ventspils, Latvia; Vyborg, Russian Federation).

Town surveying and city architecture of the Soviet period was specific for the most part of the east countries of the Baltic Sea region (Poland, Latvia, Lithuania, the northern part of Germany). It was a time of optimization in usage of nuclear

Pic. 20. Typical architecture of the Hansa – from Stockholm

stations. Several nuclear stations were built and surrounding territories were settled (Sosnovy Bor, Russian Federation; Ignalina, Lithuania; Oskarhamn, Sweden; etc.).

Nowadays

In the present period, the formation of city networks is characterized by the intensification of the use of transit position in connection with the formation of the European policy of intermodal corridors. The increase in the transport of resources from Russia to Western Europe influences the formation of the city network and city structure.

In recent decades, the southern Baltic region has lost its industrial functions. Cities and industrial factories have fallen into decay. To give new life to this area, it is necessary to think of the main and unique resource which the Baltic region has—its economic-geographic position. Throughout history, the southern Baltic region has played the role of gateway to Scandinavia and the countries of continental Europe, and it also now provides access to emerging markets in Russia and Asia.

So, nowadays the policy of intermodal corridors can become a factor for the development of cities. The term *corridor* means the set of all types of transport in coordination, functioning in a defined direction and participating in the transportation of concrete cargo. The transport corridor is a consolidation in one strong European transport artery and the fruitful interaction of the following transport components: Rail, road, sea, river, pipeline, and air transport. It is also a consolidation of the accompanying infrastructural elements: IT and access roads, customs, border posts, warehouses, etc.

The idea of creating intermodal transport corridors is included in European transport policy. In compliance of this policy, ten corridors, with four passing through the Baltic region, have been developed. Regional transport hubs should be located on international or national transport corridors. The best variant is the interaction of all hubs.

In cities through which corridors will run, powerful transport hubs for maintenance of steady passenger and cargo transport between regional cities can be created. Ports can raise their competitiveness by creating ports hubs—ports intended for transfer of transit cargo. Besides, favourable to the cities which are on a way of corridors will develop the railway and automobile networks. In this case, they can become large transit centres on the road from Europe to Asia. A position

in the southern Baltic area is especially good in this case. In the southern Baltic region now, the volume of passenger and freight traffic is rapidly increasing. Insufficient development of existing infrastructure and transport systems, however, does not allow effective and rational administration of this growth to be exercised.

Now freight traffic between Asia and Europe is carried out mainly on water routes through the Pacific, Indian and Atlantic oceans. The transit time of freight traffic to Europe through the Suez Canal from Japan or South Korea takes 35–40 days. Transit time on the Trans-Siberian highway takes only 16–18 days. Thus, development of railway junctions in the southern Baltic region and north-west region of Russia will strengthen the economy of those areas, create new cities, and have a good effect on the transport system of the EU.

In regions through which transport corridors will pass, the markets of services, support branches, tourism infrastructure, and rest will develop. Adequate loading and development of a transport infrastructure will create additional stimulus for other branches of the economy—from power before retail trade. And this will have an effect not only along transport corridors. For example, a sharp increase in the volume of cargo transportation by rail will increase the requirement for rolling stock, and loading of whole our industry will increase. Assembly, metallurgical manufactures will receive real orders. There will be a real possibility to modernize industry, which is now not competitive and lead it to the necessary level. New industries—for example the manufacture railway-auto ferries—will be created. This type of transport will be one of the most demanded at formation of new intermodal system. By means of such ferries, it will be possible to deal with the problem of different track width in Europe and Russia.

A policy of carrying of intermodal corridors out in a life is just started. There have already been certain successes. In Russia new ports, which apply for becoming large transport hubs along the line goods traffics have been created. It is possible to give the example of Ust-Luga, a small settlement in Leningrad Oblast. Here a new port terminal which urged to become the largest on the Baltic Sea has been constructed. The purpose of building of port at Ust-Luga was to overcome the potential insufficiency of capacity of the port in St. Petersburg and to remove from a city zone cargoes causing pollution and transport problems.

The reason for a choice of this place is the unique natural features of Luga Bay. First, it is caused by possibility of year-round use of the port with the short period of the help of the ice breaker for courts. Second, a deep water of water area is combined with short channels of approach (3.7 km compared with 35 km for Port of St. Petersburg). There are no restrictions on the further expansion of territories to generate a customs warehouse and industrial zones in the port. Ust-Luga Port is actually located on the border of the Russian Federation and the European Union. It is in harmony with a network of transportation in the north-west area, which plays an essential role in the organization of shipments of transit within the European transport infrastructure.

Ust-Luga Port was designed to be a universal port. Multipurpose terminals and operational zones will render services of an overload and additional processing of more than 20 categories of cargo. Because of the use of modern technologies, the equipment terminals are able to present competitive terms of services. There are four terminals now working in the port: a coal terminal of an overload, the terminal of an overload of sulphur, a complex of the ferry of the motor railway, and the universal reloading complex. The port is involved in active construction of the multipurpose complex “Jug-2”, the container and terminals for bunkering, and complexes for the overload of general cargo, bulk cargo, liquefied gas, and other types of cargo.

The new oil port at Primorsk, the final point of the Baltic pipeline system, is also an important link in new transport system of the northwest. By results of work, in August 2008 the oil terminal at Primorsk passed 4.745 million tonnes of crude oil, 24 percent more than in August of the previous year.

The example of the city of Vysotsk, one of the smallest cities in Russia, is also interesting. Only 1719 inhabitants live there. Nevertheless, it is now one of the most important oil terminals in Russia. Throughout its history, Vysotsk was a seaport, a convenient and reliable harbour for the merchant marine and navy fleet. Now the port, which is located on an island, is connected to the continent with a new highway and a single-line railway. Since the middle of 1990 Vysotsk Port has experienced active development connected with the realization of some investments in civil engineering designs for new terminal complexes. By 2010, the turnover of goods in the port should reach 15 million tonnes a year (including general cargo).

So, it is obvious that the successfully realized factor of successful economic-geographic position together with the actively spent transport policy of the EU can become a starting point for the development of the Baltic Sea region.

Questionnaire for Chapter 3

The origin of the town

How was the historical resource-basis for the foundation of your town or city?

Research for its:

1. Natural resources
2. Production in and around the city
3. The city’s own trade
4. Transit trade, using the geographical position
5. The position in the regional infrastructure
6. Draw a map (a model) of these components

Describe and analyse the development till now

1. How has the resource-basis changed?
2. and the production of the city?
3. The trade internal
4. Trade for transit
5. The regional infrastructure
6. Draw an updated map

Predict the future urban development!

Try to make two scenarios:

1. A future development which is a simple prognosis (forecast) based on the present trend according to industrial and economic state and technology, administrative level, educational standard and composition of infrastructure.

2. Try to go in details with a scenario for the same urban parameters as above, if all CO_2-exhausting (producing) machinery is being forbidden and must be replaced by technology based on renewable energy supply

Future attraction of the Baltic region?

What has been the overall attractions for people concerning their living until now through the main periods?

What would you expect them to be in the future - state the reasons!

The regions biggest cities 2005

1. St. Petersburg (RS): 4.100.000
2. Berlin (D): 3.416.255
3. Warszawa (PL): 2.000.000
4. Hamburg (D): 1.743.627
5. København (DK): 1.230.607
6. Stockholm (S): 1.212.196
7. Gdynia, Sopot, Gdansk, (PL): 949.700
8. Kraków (PL): 756.267
9. Riga (LV): 720.000
10. Helsinki (SF): 559.046
11. Vilnius (LT): 550.000
12. Göteborg (S): 500.085
13. Kaliningrad (RS): 423.651
14. Szczecin (PL): 411.119
15. Tallinn (EE): 401.694
16. Novgorod (RS): 240.000
17. Lübeck (D): 211.825
18. Pskov (RS): 203.000
19. Rostock (D): 197.218
20. Klaipėda (LT): 194.400

Total a. 20 mio citizens

Chapter 4. What is "on" the agenda for urban ecology in the BSP-area

Résumé: This chapter presents a range of cases from the countries at the Baltic Sea, aimed to show a variety of local research and projects on urban ecology, based mainly on "green" technology, some of them at the same time new technologies.

Case 1. Research on the implications of the changed climate in big cities.

Urban climate – like climate on a steppe - dry, sometimes flooded, extreme temperatures and wind variations

The department of Geography at the Alexander Humboldt University in Berlin represents a long tradition of studying the urban climate and its influence on the health conditions for the living in cities. The purpose of these studies is naturally to analyse how the city may react to the consequences of extreme climate variations, not only directly when heat or cold conditions appear, but also the planning process for the city before it is built:

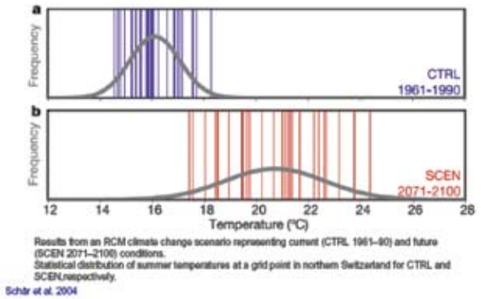
The focus is primarily on the planning, renovation and regeneration of the cities.

Based upon these studies professor Dr. Wilfried Endlicher in October 2007 at a symposium in Amsterdam about urban climate changes published the below referred demonstration of the Humboldt University study:

The basic point of the study is that global warming is inevitable

- Emission of green house gases will continue in the future.
- Increasing world population will emit probably even more green house gases.
- Global warming has started decades before and is in strong relation with the emission of green house gases.
- Following the IPCC, global warming will increase weather extremes.

16ºC is nearby the mean temperature also in the seaports of the Baltic Sea in July: Stockholm, Helsinki, St.Petersburg, Tallin, Riga, Klaipėda, Gdynia, Rostock and Copenhagen. Seaports though may be cooled by wind from the seaside and will not show the same increase in temperatures as inland cities.



Results from an RCM climate change scenario representing current (CTRL 1961–90) and future (SCEN 2071–2100) conditions.
Statistical distribution of summer temperatures at a grid point in northern Switzerland for CTRL and SCEN,respectively.

Schär et al. 2004

Figure 4.1. How temperatures will change in a Swiss city within the next 75 years - a rise of 4-5ºC within 100 years, from usually about 16ºC in the period 1961-90 to a level around 20-21ºC in the period 2071-2100.

The creation of the urban climate

Studies of urban climate have shown how temperatures and other climate components vary from the rural outskirts of the city to the centre as shown on the figure of the cross-section below (Figure 4.2). The geographers describe the variations as if there were islands of heat climate (UHI). The warmest and driest and most windy heat islands are located where most land is covered with asphalt or concrete, where the buildings are naked concrete or steel and glass buildings. The taller the buildings, the more radiation (reflection of heat and cold); the taller, the more wind-catching (creation of turbulence).

Infrared monitoring from satellites has contributed to the documentation of the complicated heat landscape of a city. The example of Berlin (Figure 4.3) shows clearly how much higher the re-radiation of the solar energy is in summer from the central business and government districts compared to the open fields around the city.

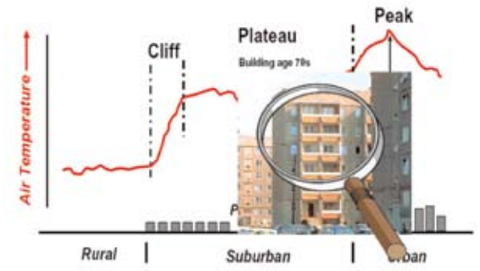


Figure 4.2. Generalised cross-section of typical urban heat island UHI

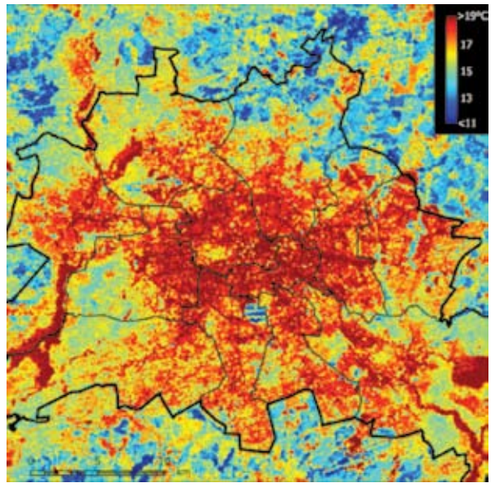


Figure 4.3. A summer days variation in temperatures in Berlin. Blue collars indicate cool micro climate, red warmer climate

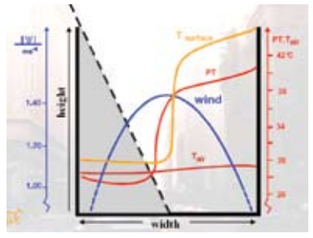


Figure 4.4. The street as canyon

The Figure 4.4 of the microclimate in the denser part of the city illustrates, how the street in the city functions as if it was a canyon.

Tall dark buildings of concrete, brick stone, glass and steel border the street and its pavement is usually dark asphalt upon a box of gravel and stones.

Most of these materials absorb and accumulate, due to their low heat density, radiation from the sun and reflect it soon as infrared radiation.

Only one side of the street is usually exposed to the sun, the other side is in the shade, causing great temperature differences between one side of the street canyon and the other, and between top and bottom of the canyon.

This causes again strong air movements between the colder parts of the street (where the cold air keeps a higher pressure) and the warmer parts, where the pressure is low.

The curves of wind and temperatures in the street canyon show a complicated relation between sun-heated surfaces and the cooler materials in the shadow:

The heating of the sunny side of the street tends to raise the temperature of the air on this side. The result is a strong wind in the centre of the street canyon attempting to equalize the temperature (and pressure) between the two canyon wings. Apart from these specific street conditions in the centre, there had been almost no wind.

This wind is an urban phenomenon, closely connected to the absorption of solar radiation in the city.

Implications of heat and cold on health

During a number of years the summer temperatures in Europe have reached a higher level than before, as a consequence of the global warming.

The Humboldt University describes the influence on health as shown in the model (Figure 4.5):

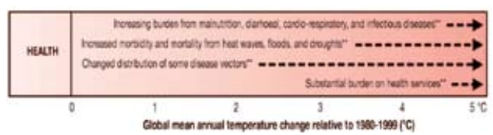


Figure 4.5. Health

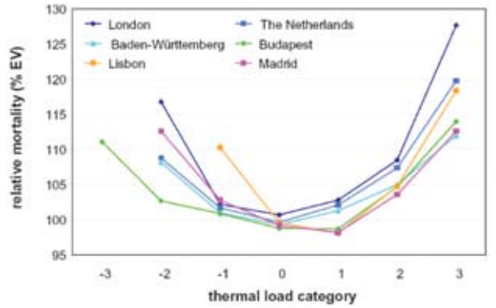


Figure 4.6: Heat and death correlation. Figure 4.6 left shows how closely changes in temperature were related to death during ten years, from 1986 to 1996, in different cities of Europe. London as the biggest city was influenced most by both cold and extreme heat.

Long-term adaptation

	Lead time necessary:
Reduction of outdoor **and** indoor thermal stress	**Urban planning** • Albedo • Ventilation; air flow • Green and open spaces; trees • Shadowing
Reduction of indoor thermal stress	**Building design** • Thermal capacity of the building • Position of the apartment • Control of solar irradiation • Passive cooling • Green walls and roofs

Figure 4.7. Changes to be made in the cities to avoid the worse effects of heat

As the figure shows, many people can feel aggravation of their diseases already by 2°C higher temperature than usual.

A serious 3°C increase in number of people dying of heat-related conditions has been observed lately.

With the temperatures higher than 4°C above the usual level, the situation will be out of control: the health care institutions will no longer cover medical service, there will be lack of drinking water and food on a bigger scale, a real possibility of infections and other illnesses due to bad sanitary conditions and hunger.

What is to be done within a short term and in the long run?

In the short run, Germany's example shows that mass media public warnings against heat must be provided first advising people in the cities to stay inside or in the shade, and to keep their habitation cool throughout the hot period.

More steps ought to be taken to prevent heat effect on population: specified health care service readiness, extended opening hours of cool shopping centres and other covered areas, swimming pools and public baths, adjustment of the working hours to the temperatures like siestas in „Mediterranean style" (i.e. from 1-4 pm).

The conclusion about the correlation of health and heat according to the Humboldt-University:

- Global and local warming are superimposed in cities.
- Heat waves are related to global warming and will become during the summer months more frequent in the future.
- Human beings are not only influenced by high temperatures; high direct solar radiation, an high air humidity as well as low wind speeds contribute to extremes of "Perceived Temperature" during heat waves.
- Mortality values and cardiovascular diseases show significant peaks in large cities heat waves (ex.g. European heat wave 2003).
- Heat waves have not to be considered as pure weather phenomena, but are closely related to human health, age, behaviour, social structures, housing conditions, medical care and so on.
- Urban planning has to take into account aspects of human bioclimatology.

How can urban planning reduce warmer climate?

To be helpful the researchers of the Humboldt University recommend the following (in the model figure 4.7) to develop better conditions in the cities in relation to the extreme urban climate.

The proposals for greener cities are followed by a number of examples of how to create lower temperatures: more green, shaded and ventilated spaces, also shadow systems in the parks and avenues, changed building methods, materials, colours of the buildings and roofs, use of green roofs and walls to improve the albedo (reflection of radiation „back into space").

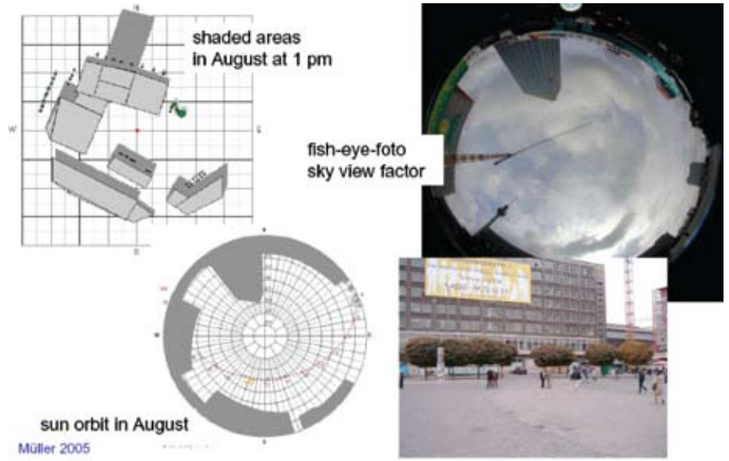
Figure 4.8. Green roof in Warsaw

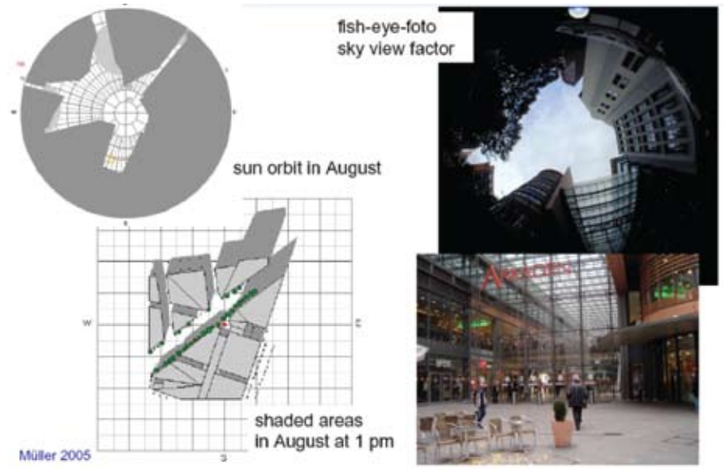
As the examples above show, there are already climate improvements around in the Baltic region: Warsaw, Berlin, Travemünde…. However, as the examples of heat illustrated, they are still only minor islands in the ocean of tall, dark concrete and glass buildings, which fill up the attractive central districts in the bigger cities.

(Ed: Per Werge, based on a web-published congress-presentation 2007 by the Humboldt-University of Berlin, with permission)

Figure 4.9. Green avenues, gardens, hanging walls and grass greens create different microclimates, cooler and more humid than open squares with pavement of concrete and asphalt

Figure 4.10. New housing in Travemünde protected from heat by "green walls" and hanging gardens but still surrounded by dark grey concrete pavement.





Figures 4.11. and 4.12. The sun orbit in two central squares in Berlin: The 60 year old Alexander Platz and the 2005 "reborn" Potsdamer Platz

The two examples above from Berlin show remarkable differences in solar energy input (sun orbit) corresponding to the form of the urban space or square:

The Berlin Alexander Platz is nearly fully exposed to the sun at mid-day, while the new Potsdamer Platz is planned to give maximum shadow and the pedestrian area is furthermore protected by reflective glass roofs. In suburbs like Dahlem the trees in the alleys protect the pedestrians most when the sun is at its peak. Besides, open spaces are half covered by the leaves of bushes and trees, keeping temperatures low and humidity high.

Questionnaire for Chapter 4.1

Practice: Climate measuring in a city

Aim: to observe, register and evaluate the local urban climate compared to the general climate of the region. Time of the year is equal.

Draw a simple map of your town, city or just a district. Or, simply print a section of a map of your town from the internet.

- Accentuate different urban components:
- A garden city area, inside a garden
- An approach road
- An open square in a suburb
- A court in a carreé of council housing (flats) A main street in the centre
- A big square in the centre
- A small square
- A park in the centre

Use a small portable weather station to measure the most significant climate parameters. If it is not available, a simple thermometer can be useful, combined with estimations of wind force according to Beaufort's scale:

- Temperature
- Pressure
- Wind force and wind chill
- Humidity
- Or, if it is raining or snowing, precipitation

Study the figures 4.2 and 4.4 and make your measurements close to buildings in the centre of streets, squares or gardens and, if possible at a height above streets and squares.

Register all the data of every place, also the precise spot where they were taken (altitude, in the shade, in the sun, asphalt road, green lawn or bushes)

If you began with an estimation (hypothesis) of what the climate ought to be, compare and evaluate all the data according to a generalized climate model (i.e. Köppen)

Questions:

How and where did you find differences from average standards of the season?

What explains the variations?

Is the degree of some variations as extreme as to require a special reaction from the city or health authorities?

Where do you find the most attractive and healthy climate in the town?

Are good and bad districts the same in all seasons?

What can be done to mediate extreme temperatures of urban climate in your town or district?

Influence on the planning process:

If you find your measuring remarkable, you can try to arrange a meeting with the local planning authorities to discuss the matter and the possible changes that can be made to improve the urban climate.

Reports to local media will possibly inspire them to take up the subject

Picture 1. The "Turning Torso" was built as a symbol for an urban planning exhibition in Malmö a.2000, placed as a new city district upon a former industrial polder at the coast, originally hosting car manufacturing and ship building. The Torso is now a symbol of the new spirit for green revitalisation of the city. The grassland between the buildings is the "banks" of an artificial stream leading runoff water to the coast. Before this happens, the rainwater is delayed by the passage and infiltration of many green roofs and artificial lakes and parks, located in many districts of Malmö.

Case 2: A project to naturalize the water runoff and prevent flooding in the city

The green roofs of Malmö

Green roofs: a way of bringing ecology into our urban areas?

Author: Jonas Oskarsson Swedish National coordinator Baltic Sea Project (BSP)

Growing plants on rooftops, or green roofs, has been a practice since ancient times and there have been many reasons for doing so. The rooftop is most of times free from shadows, thus making it easy to grow plants. In addition, it was convenient to have close access to herbs or flowers especially for people living in the city. Tall plants or trees on the rooftops could also give some shelter from the sun. Most of all, studies have shown that plants bring peace and harmony to the human mind.

In warmer countries, this was done on flat roofs whilst in the colder Nordic climate, the roofs had to be sloped due to snow during winter. The green roofs gave insulation during winter and cooled the house down during summer due to the evaporation from the plants. However, with modern architecture, urbanization, and economic growth, the green roofs became obsolete and equated with poverty.

Picture 2. An old fashion version of a green roof, well integrated in its surroundings. "Back Antes stuga" in Hästmahult Sweden. (Photo: Karin Gunnarsson)

What about today, is it possible that the green roofs will find their way back to our urban communities?

In the city of Malmö, in the very south of Sweden, there are ongoing pilot projects where large areas have been provided with green roofs and the effects are still being evaluated. The aim is to increase the green areas in the city.

Research and development of new materials have already brought a completely new spectrum of options to explore the possibility of bringing green roofs back to practice. There are two types of modern roofs, which have longer life spans than the conventional roofs.

One type, called the *extensive roof*, is fairly light and can be applied on most existing roofs even slightly sloped ones. This roof has a thin layer of vegetation, mainly based on mosses and sedum plants, and is not made for humans to walk on.

The other type, the *intensive roof*, has a deeper layer for the roots to grow in and therefore could provide more lush vegetation. Intensive roofs can carry trees and bushes and can even work as a green recreation area for urban dwellers. This, of course, comes with an added weight, which leads to the need of a

Picture 3. A view of an extensive green roof. Augustenborg, Malmö. (Photo: Karin Gunnarsson)

Picture 4. An intensive green roof with wild grapes, grass, and succulents. Augustenborg, Malmö. (Photo: Karin Gunnarsson)

strong construction. However, a great number of modern houses we find in the urban areas today already have strong concrete constructions with flat, lifeless and often dull roofs, which are of no other use but for keeping the rain out and the heat or cold from coming in.

The urban *heat island effect* causes a higher temperature in the cities compared to its surrounding areas. This is mainly a result of air-conditioning, traffic, and a more dense population. If the roofs were covered with vegetation, there would be a cooling effect due to the evaporation from the plants. A vegetated area also absorbs a lot less heat than an ordinary dark roof. Green roofs would provide a cooling effect on a structure; therefore, less energy would be used for cooling it during summer.

In winter, less energy would be required to heat up a building because of the improved insulation.

Picture 5. An intensive green roof, part of a recreational garden with wheel chair friendly floors Augustenborg, Malmö.

The air quality in urban areas often causes respiratory problems, mainly due to traffic releasing nitrous oxides, stirring up dust particles containing heavy metals such as cadmium and lead. The vegetation would absorb a lot of this. Green roofs would also significantly reduce noise pollution in the city.

Cities and urban areas are home for just a few species that have managed to adapt themselves to a sterile monoculture habitat. Green areas would serve as ecological islands and corridors, which are of great importance for creating new habitats promoting an increased biodiversity.

Aside from the ecological, energy saving and health promoting benefits of green roofs, we must not forget its aesthetical and holistic aspects. There have been studies made, asking people to describe a place they want to go to if they felt stressed or sad. The majority of respondents described a place in the middle of greenery and nature. It seems like nature has a good impact on our mental wellbeing. If we cannot move back to nature, we could do our best to bring nature closer to us.

Since this is an article in a Learner's Guide, how could environmental education in our schools make use of the concept of green roofs? Just introducing the idea would improve the knowledge and insights of students about green roofs and possibly, in the long run, other cities would follow the Malmö example. Many schools are already sterile boxlike buildings, so why not to use some of their areas for growing plants and involving students with hands-on education, where they can participate and develop new ideas, methods and get to learn more about ecology, energy efficiency, and sustainable development? It is a pity we are not doing much to make our urban life greener. Maybe through education and more awareness, we will see green roofs on our homes and buildings once again in the future.

Sources:

Gunnarsson, Karin. 2008. *En studie av fem kommuners inställning och attityder till gröna tak*. Dissertation Malmö University TBBUY-2008 BIBLKOD-XX

Obendorfer et al. 2007. *Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services.* BioScience, Volume 57, Issue 10 November 2007

Peck et al. 1999. *Greenbacks from green roofs: forging a new industry in Canada.* (http://www.greenroofs.org/pdf/Greenbacks.pdf)

Ottosson, Åsa & Mats. 2006. *Naturkraft, Om naturens lugnande, stärkande och läkande effekter.* Scand book Falun 2006 ISBN 91-46-21234-5

Case 3. Finnish school project on monitoring the urbanized life of birds and bats

Birds' adaptation to urbanization

Reprint of a PowerPoint demonstration of a school project in Kirkkonummi in Finland, now extended to a Commenius project on „outdoor activities" for three partner schools in Italy, Finland and Sweden.

Author: Tuovi Ronkainen, Finland's national BSP coordinator

From sparrow to barnacle goose

The world is urbanizing and this can be seen as the change in the species of living organisms.

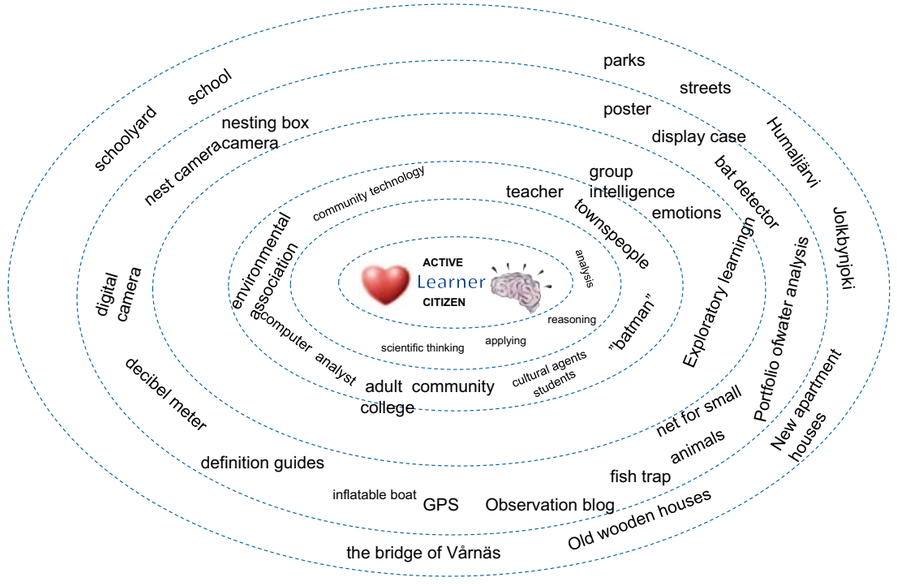
The town is a versatile and valuable habitat.

The study of urbanization gives students a chance to genuine cooperation with other agents.

Information and communication technology serves the study of urbanization very well.

The students will get active to have an influence on their own environment.

Diagram of the learning environment



Old and new

Pigeons nest under every eaves of the school all the year round.

1. Detecting the need for research

The centre of Kirkkonummi is changing now more than it has in a hundred years, from a village into a town. Now it is the last chance to survey the current species and valuable areas and to start follow-up research.

The project started as a school-specific advanced high school biology course in spring 2008.

2. How can urbanization be studied?

The birds, mammals and bats of the town centre were chosen as the indicator species.

Everyone can see the changes in the bird species, especially the reproduction of pigeons and jackdaws.

Bats haven't been studied very much. They are a typical species for old wooden houses and stone buildings.

3. Man and water in the town

The River Jolkbynjoki flows in the middle of the area that is under construction and its channel will be moved in 2009.

The river group studied the species of the river (plants, fishes, water invertebrates), the quality of the water (nitrates, phosphates, pH, oxygen level) and the river's suitability for recreational use.

The River Jolkbynjoki turned out to be a bad boating route.

4. Creating the research plan

The students planned their research: the observation routes and the observation times (for three weeks, three times a week).

The students followed the nesting and other behaviour of the birds with the help of the cameras in the nesting box and in the nest under the eaves.

The film of the nesting of a great tit recorded by the camera in the nesting box was shown in the corridor of the school.

The poster of the project

The bat detector in use

5. Bat study

A bat expert gave a lecture and led the first night trip to the woods.

With the help of the school's computer analyst and the expertise of the Museum of Natural History the school acquired a bat detector of its own.

The bat group planned and took night trips.

6. Recruiting participants and getting publicity for the project

To get observations, an observation blog was set up (http://muuttuva-porkkala.blogspot.com).

The local newspaper wrote a story about the project and encouraged the towns people to use the blog.

The information on the aims of the project and its expected impact with some illustrative material was placed in the display case located in the school corridor.

Batmen and batwomen

7. Many agents are involved

The head of the town's cultural services told the students about the history of the town centre and took part in the trips.

The adult community college and the environmental association also participated in the project and took the bat-observation trips as a part of their own program.

The humble surroundings of Porkkala High School revealed an interesting spectrum of bird species.

Outdoor activities

8. The first part was ready in spring 2008

The bird group, the bat group and the water group published their studies. The bat group became interested in continuing the research on their own during the summer and the fall.

The project continues with a follow-up study in the same area in spring 2009 and it will extend outside the town centre in spring 2010.

9. Expanding the project

The experiences gained from the project have been taken into a guidebook on urban ecology of the Baltic Sea Project of The Finnish National Board of Education.

The project gave a lot of material to Porkkala High School's COMENIUS Project (Finland, Sweden, Italy) called "Outdoor Activities". http://comoutdoorscience.com

From sparrow to barnacle goose

- The most important pedagogical method of the project is exploratory learning. It accentuates:
- Making reliable observations about the environment, scientific thinking.
- Using group intelligence, the school, the town, the university and the third sector.
- The analysis and application of the results, sharing the information.

Figure 1. Summer in the Murckowski Forest reserve (Photo Michał Mackiewicz)

Case 4. Ecology of the city

Katowice – an industrial desert or a green city? Wooded areas as the green lungs of the city

dr Beata Węgrzynek – Silesian University, Katowice, the Faculty of Biology and Environmentalism,
Lidia Janas and dr Jolanta Mol with students of II Konopnicka Grammar School, Katowice.
Translated by Magdalena Kubica – II Konopnicka Grammar School, Katowice

Introduction

Regardless of the future climate change on Earth, forests are undoubtedly one of the most important factors influencing the level of carbon dioxide in the atmosphere. While looking for some solutions in order to struggle with global warming, we must not forget about the role of this ecosystem as one of the most vital factors moderating climate change.

Forests and other wooded areas are a crucial part of the city's greenery and their history is as long as the history of cities themselves. An urban forest is a notion, which is much broader than the one used in traditional forestry, as it concerns not only 'typical' forests but also small wooded areas like parks, gardens and separate trees. Wooded areas in big cities have varied functions: they are the habitats for numerous plants and animals, conservation areas for nature and landscape, absorbers of air, water and soil pollution, they also regulate the climate, thus positively influencing the inhabitants' health, they also function as ecological education centres and the places where people can rest and relax. They produce large amounts of oxygen and phytoncides; they serve as air ionizators, noise reducers and microclimate modifiers.

The more intense the urbanisation becomes, the more intense the industry is, and the denser the population is, the more valuable each wooded area should be for the inhabitants of the city. Katowice is an example of an industrial and densely populated city.

Figure 2. A saprothropic *Calocera viscosa* in the Murckowski Forest (Photo Michał Siwek)

Katowice – the most densely wooded city in the voivodeship

Katowice is situated in the largest Polish industrial area – Upper Silesian Industry Area (*Górnośląski Okręg Przemysłowy*). It is the capital city of the most urbanised agglomeration in the country and one of the most heavily populated regions in Europe (4 million inhabitants). This is the reason why Katowice is perceived as an environmentally degraded area, simply an ecological desert. The data concerning the natural resources of the city contradict this view. 28% of the city area is covered by forests (the average forestation of Poland is 28.7%).

Additionally, Silesian Culture and Recreation Park, created in the 1960s on the post-industrial wasteland, functions as the 'green lungs' of the region. It is one of the largest urban parks in Europe (600 ha), situated on the border between Katowice and Chorzow. We should not forget about the role of other parks, squares and cemeteries where old trees grow.

Urban forests are situated mainly in the southern part of Katowice, where the most precious wooded areas were designated as two nature reserves. The 'Murckowski Forest' nature reserve, which takes more than 102 ha, was created to preserve the temperate mixed forest, which is the remains of the Old Growth Silesian Forest. In the reserve, there are numerous endangered and rare species of plants, fungi and animals as well as a 150-year-old beech forest. In the smaller 'Ochojec' reserve situated in the valley of the Slepiotka River (25 ha) there is a relict population of the mountain plant Clasping Twistedstalk *(Streptopus amplexifolius)*. Some enclaves of 'wild nature' can also be found in the city centre. Besides the above mentioned natural reserves, there are 40 areas which are valuable from the biological point of view. A variety of endangered and rare species has been found in those areas (Tokarska-Guzik and others 2002). They play a very important ecological role, for example, amphibians breed and birds nest there. Those areas also serve as wildlife corridors. They play the educational and recreational role for the inhabitants of the region as well.

Ideas for ecological classes

Teenagers can develop their ecological awareness and sensitivity by taking part in outdoor classes in a natural 'laboratory' – a forest situated in the city where they live. It enables them to learn in an attractive way about the ecosystem and the phenomena taking place in it.

Young people can also develop the feeling of responsibility for the activities done in the natural environment. The classes of this kind help to show students the links between the elements of ecosystems, the mechanisms and consequences of negative changes caused by human activity, they should also encourage students to plan and conduct their own research, gather and work on the data, and monitor the decisions of the City Council which affect the natural environment.

Figure 3. A parasitic *Inonotus obliquus* growing on a tree in the Panewnicki Forest (Photo Michał Prażanowski)

Figure 4. A common brackenfern (*Pteridium aquilinum*) and a common male fern (*Dryopteris filix-mas*) growing at one of the stops on the didactic path (Photo Bartosz Piekaruś)

The aims of outdoor classes may be:

- recognising common and rare or endangered species of plants and animals
- biodiversity of organisms and their habitats
- diversity of animal activities (e.g. breeding activity)
- monitoring phenological phenomena
- analysis of the density and the age structure of the forest
- monitoring the anthropogenic changes in the ecosystem (e.g. illegal dumps)
- comparing the climatic conditions in the forest and outside it
- analysis of the occurrence of bioindicators
- finding and drawing food webs
- watching the secondary succession of the ecosystem
- learning about the rules of forest industry (e.g. a lesson with a forester)
- comparing forests with different levels of anthropogenic changes
- planning/organising activities to improve the condition of the natural environment in the neighbourhood

Research concerning natural resources of Katowice

The important quality of urban forests is their size, but the variation of their life forms (biodiversity) is also vital. Young people attending II Konopnicka Secondary School in Katowice conduct varied forms of research concerning the natural environment in their city. Long-term research and theses based on this research are often connected with the forest ecosystem or urban forests. Teenagers create ecological didactic paths in chosen areas in Katowice and at the same time learn some information about the environment, practise some scientific research methods and realise extracurricular activities. Such outdoor classes are aimed at young people living near wooded areas in their city.

The thesis entitled 'A didactic path along the Slepiotka River' deals with the results of the research concerning plants growing along the banks of the Slepiotka River flowing through one of districts of Katowice. The thesis was based on the analysis of aquatic and reed plants and some chemical elements of the water and soil from the river banks. The author describes the didactic path, characterising plant associations that can be found there: a riparian forest, bog plants, reed plants and plants typical of temperate coniferous forests of mixed forests.

Figure 5. A meadow horsetail *(Equisetum pratense)* growing at one of the stops on the didactic path (Photo Bartosz Piekaruś)

The thesis entitled 'A didactic path in Katowice-Ligota' is an interesting work based on the research conducted in one of the districts of Katowice. The path is divided into five sections related to various habitats, which enables the visitor to watch various species of animals and plants, typical of each habitat. The author of the thesis mentions species of trees growing in the described area, which are rare species in Poland: the Caucasian wingnut *(Pteryocarya fraxinifolia)* and the Japanese larch *(Larix kaempferi)*.

The thesis entitled '*Polystichum* species – an ecological cycle path in Katowice' is a work concerning various *polystichum* species, which are not very well known, but quite interesting. The author focuses the reader's attention on two conservation reliant species: the great horsetail *(Equisetum telmateia)* and the stiff clubmoss *(Lycopodium annotinum)*.

Figure 6. The Slepiotka River in Katowice-Ligota (Photo Hanna Palowska)

The thesis entitled „The composition dendroflora of chosen complexes in Katowice with the special emphasis on foreign species' represents another kind of research work. The research was concentrated on listing the dominant species of trees and bushes, the level of anthropogenic change and the level of hazard to biodiversity, the source of which is foreign invasive species. The prunus serotina *(Prunus serotina)* and the northern red oak *(Quercus rubra)* turned out to be the most dangerous for Polish tree species.

The author of the thesis entitled 'The comparative study of the species composition of vascular plants growing on pavements in Katowice' describes the species of plants growing between pavement tiles in the city centre. The results of the research show that the plants growing in such places are anemogamic heliofits, hemicryptophytes, many of which are thought to be medicinal plants.

The thesis entitled 'Mycological biodiversity of the chosen area in the Murckowski Forest' enables the readers to get to know 51 species of fungi found by the author in the chosen area. During the research the author found in the forest two rare species of fungi: the parasol mushroom *(Macrolepiota procera)* and the oak oyster mushroom *(Pleurotus dryinus)*. The phenomenon of the migration of forest species to cities, e.g. to parks and cemeteries, is also described in the thesis.

The author of the thesis entitled 'Biodiversity of trees and bushes in chosen cemeteries in Katowice' conducted the research in three cemeteries, the result of which was identifying 38 species of dendroflora. The author emphasises the mass occurrence of a decorative foreign species of the common box *(Buxus sempervirens)*, which is rare in other parts of the city, and the thuja occidentalis *(Thuja occidentalis)*.

Conclusion

The answer to the question asked at the beginning is the statement that contrary to a popular belief that Katowice is a grey city deprived of greenery, it turns out to be a very attractive city from the biological point of view. Some wooded areas may be called the sanctuaries of natural life in our voivodeship.

The fact that we notice biodiversity in our surroundings is very important. Being aware of how much we can lose due to our half-baked activities, we will be ready to undertake some activities preventing the devastation of our surroundings – wooded areas in the city where we live.

Forests both help people to shape their living conditions and enable the regeneration of the natural environment. Our existence was, is and will be dependent on the condition of woodlands on Earth.

Bibliography:

Geszprych M. 2006. *Lasy miejskie w Polsce*. Aura 10: 9-10.

Gil W. 2009. *Las a zmiana klimatu*. Echa leśne 1: 7-9.

Tokarska-Guzik B., Rostański A., Kupka R. 2002. *Katowice. Przyroda miasta. Nature in the city.* Publisher "Kubajak". Krzeszowice.

Wika S. *Rola lasu w życiu człowieka i regeneracji środowiska przyrodniczego. Problemy środowiska i jego ochrony.* Katowice. 1994.

Wika S. (red.) 1999. *Lasy województwa śląskiego.* Publisher "Kubajak". Krzeszowice.

Questionnaire 4.2

Check the water runoff in your city:

1. Compare two maps of your city or district, an old and a new one, where the locations and the beds of rivers, streams and brooks are visible. Where and how are the streams now: open water, pipes? Have lakes been reclaimed?

2. How much runoff is brought to the sea through impermeable pipes compared to the entire rain- and snowfall (precipitation)? Try to get this information from the water supply and runoff authorities.

3. Which (former) streams, lakes and ponds will be possible to restore and re-open?

4. Find opportunities for creating new lakes and ponds and slow streams in order to reduce the thread of flooding of low streets and downtown areas during torrential rain.

5. Make a research on which cities in the Baltic region are at highest risk for flooding? What has been planned to avoid flooding?

Check the sewage system and capacity

1. Find (if possible) through the municipality or regional authorities (i.e. internet pages) a map of the sewage system of the town and information of its capacity. Compare this with the potential surface runoff of water, led to the pipes. Is the capacity of the system sufficient to adapt heavy rainfall?

2. Which solutions could be made to avoid runoff water into the pipes (and thus flooding of the sewage treatment plants) in your city: Green roofs and more parks, separate pipes for runoff, new ponds or underground containers?

Questionnaire 4.3

How un-natural is your environment?

1. Register the most typical species of plants and wild animals in your surrounding urban landscape to be aware of its biodiversity.

2. Compare this with a list of typical species for the natural landscape that would have existed if the town had not occupied the area.

3. Explain the special demand for the species of a certain biotope, which makes it impossible for some species to stay in a city-scape and favourable for others to arrive.

4. What can be done to re-enclose missing species in your district?

Questionnaire 4.4

Has your town any green belts or spots?

What can you do to make it more green?

1. Copy a local map and highlight the green areas, parks and woods.

2. How much of the area is covered with woods? (In percent). Compare green zones and areas of Katowice to other cities.

3. What happened to former green areas, i.e. forests, military training grounds, green commons, demolished industrial areas?

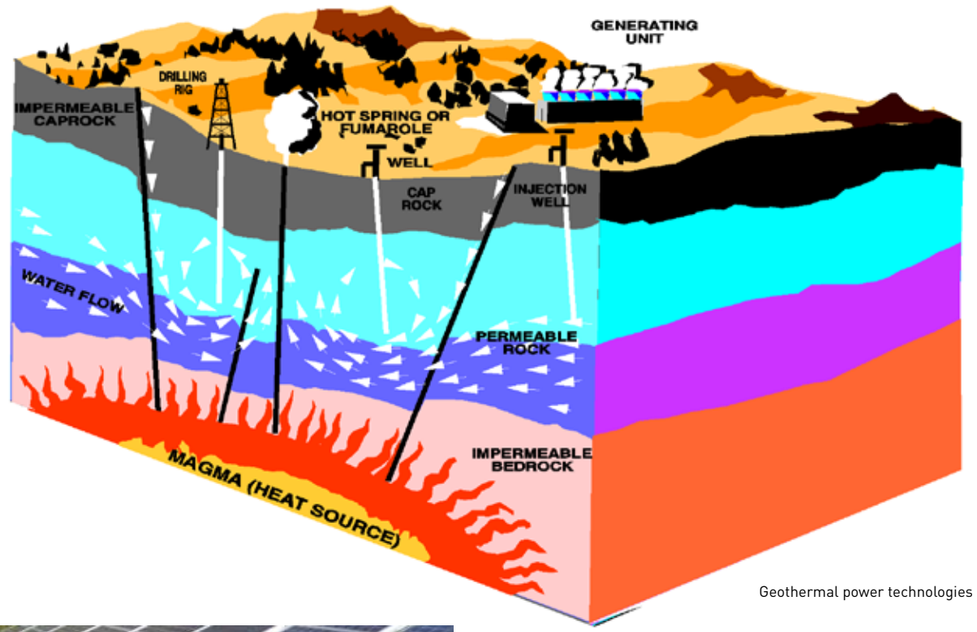
4. Check the local plans for new green areas it is often possible to find this info on the local authorities' internet pages. Check what is going to be planted in and around new urban areas and suburbs too.

5. Measure the air quality and micro climate (temperature, humidity, wind, etc.) inside green city belts and outside (in the streets). See also chapter 4.1 about urban climate. Compare the measurements.

6. Analyse where optional new green belts might bring fresher air to densely polluted city districts.

7. Publish your results in reports and send them to the city government and local media.

Sønderborg



Geothermal power technologies

A solar panel in Marla, Cirque de Mafate, Réunion

Case 5. A project to neutralize the city's CO_2 emission

Zero-energy cities

Sønderborg among other Danish cities launched 2007 a plan for independence of carbon hydrates (gas and oil) by use of geothermal energy and zero energy housing combined with a strategy for teaching the citizens "sustainable practice"

Author: Morten Menné, The Climate Section, Sønderborg Municipality, Denmark

ProjectZero in Sønderborg CO_2-neutral in 2029

Background

Before the last reform by year 2007, the Danish State administration was organized on the regional level through 14 counties (amter), and on the local level through 225 municipalities. Sønderjyllands Amt was the southernmost county bordering Germany. A survey few years earlier had shown that:

- the educational level in the county was the lowest in Denmark.
- the income was among the lowest of all counties
- the average age increased - the younger generations moved to more central places in Denmark

These perspectives inspired a range of tradesmen to form a think tank named Futura South. In the lead was Jørgen Mads Clausen, CEO for Danfoss, Denmark's largest industrial group. Danfoss is owned by the Clausen-family and located in the municipality, but operating all over the world.

The think tank produced different visions over the years; most visionary was probably the ProjectZero of 2007. ProjectZero is both the name of the vision and the name of the organisation, made to realise the vision.

The Vision

Sønderborg Kommune is the geographical area, which still after the reform represents the municipality of Sønderborg. The area is around 500 km² with 77,000 inhabitants. 20,000 live in the countryside, the main part in the city – of these 30,000 inside Sønderborg, where the 752-year-old core is surrounded by modern districts of garden city and industrial areas.

To reach the target of CO_2-neutrality it is necessary to make intensive efforts within all areas of the modern society: housing, transport, behaviour, industry, public service, etc.

Many other cities have ambitious aims for reducing their CO_2-emission, but only few aim for total CO_2-neutrality. None of these made exact plans on how to reach the goal, and on the global level, there are no experiences to learn from.

Upon this ProjectZero decided to reach the goal through a reduction of the consumption of energy. More cities - among them Danish - reduced the CO_2-emission remarkably by relaying their energy supply from fossil fuel to sustainable energy, primarily within district heating and electricity. These cities though did not reduce the total consumption of energy.

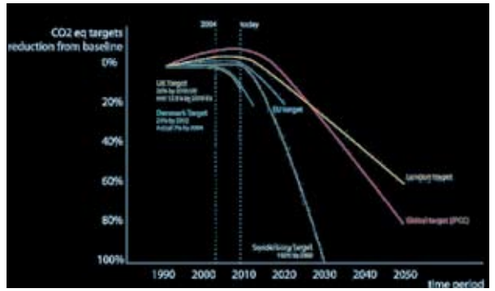


Figure 4.4.2. The CO_2 - emission targets for Sønderborg compared to London, EU, and the World

ProjectZero should be an example for the World of the possibility to proceed with the existing lifestyle based on continuous growth even though the energy consumption has been the half. This halved energy supply must naturally remain CO_2-free.

The last target reminds of the birth of ProjectZero as an industrial project. The introduction to this article hence underlines that the motive power behind ProjectZero and all connected innovations together is an exercise for the population (as a humoristic storyteller - and a liar - Munchausen did) to lift itself by the hair.

The negative trend must be changed into a positive spiral made from economic growth, increasing employment and population, but also a reduced consumption of energy and reduced impact on the climate.

The Sønderborg districts industry has both national and international strength positions, especially within heating technology: cooling, light, process control, motion controls, water treatment, district heating, fuel cells and solar panels.

Sønderborg municipality's total CO_2 emission is measured as 875,750 tons in 2007, or about 11,4 ton per inhabitant (according to international standards). The value is a bit higher than average in the country. The Sønderborg area hosts both the largest Danish industrial concern (Danfoss), and the largest bacon factory. These conditions will irresistibly pull the CO_2-emission and counteract the positive effect of a great district heating network mostly based on waste incineration.

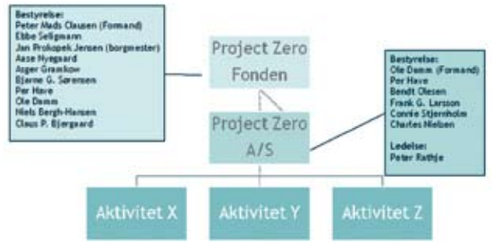
The organisation

ProjectZero is a public-private-partnership of

- Danfoss A/S
- SYD ENERGI A/S
- DONG Energy A/S
- Nordea Danmark Foundation
- Sønderborg municipality

ProjectZero has at the moment 5 employees. There is no intention of building the organisation bigger. It is the society that must cooperate, not a single organisation.

ProjectZero's websites are www.projectzero.dk and www.brightgreenbusiness.com.



One of the biggest tasks for ProjectZero is to produce a timetable versus 2029 by involving active people, consultants and partners.

Activating the citizens

As mentioned an important element in the timetable is to make as many people involved as possible. This work runs parallel to the work with the timetable. All 77,000 inhabitants will not be active ProjectZero ambassadors, for sure, but less can do it, though the behaviour and traditions of use of energy has to be changed for the wider part of the population through campaigns for new behaviour. Broad groups may be let out of sight, out of range, though.

This creates the necessity for industrial development of products with much lower energy consumption, which automatically will reduce the need of energy.

As in all campaigns with the aim of changing attitudes, it seems easier to influence children than adults. Thus, the schools in Sønderborg are important co-operators, which through the time will teach children already on the nursery school level. Little children learn to save water easily.

Example 1

As an example it is optional to ask people to cycle instead of using the car. 20-25% of all car drives are shorter than 3 km. To improve the consciousness on cycling an idea could be to inspire the bakers to sell a new roll or bread named a "cycle helmet", sold for two prices:

- Ordinary price for cycling costumers.
- Raised CO_2-price for costumers by car.

Commitment of people through the Bright Green Youth Climate conference

In spring 2009, 250 CO_2-intelligent families are pointed out as hosts for ca. 500 youngsters from all over, who in August 2009 will join the BGY – "*Bright Green Youth*" – youth climate conference in Sønderborg. BGY is held before the COP15 UN Climate Conference in Copenhagen in December 2009. The Bright Green Youth programme will learn from exact experiences with the climate change by youngsters as the next step creates "young solutions" of the challenges. The BGY is developed and done in close cooperation between ProjectZero and Danfoss Universe, supported by Sønderborg municipality among others. The conference is expected to attract great international media supervision, but will be used for activation of the local citizens as well.

Look for more information on www.brightgreenyouth.org

The staff of the municipality as role models for the citizens

Sønderborg municipality employs about 7,700 people. This corresponds to 10 per cent of the inhabitants, though not all of them live in the district. The education board decided to support the ProjectZero vision; but how can 7,700 people in the staff contribute to the CO_2-neutrality for the municipality not later than 2029?

Example 2

Sønderborg Municipality participates in the international campaign for turning off the light. This was first launched as a cultural event, but is at the same time reminding people on energy-saving

Example 3

I may 2008 ProjectZero in cooperation with the 21 village guilds of the district and a number of its consulting and engeneering firms organized 4 Energy Roadshows with focus on the most energy-and CO_2-efficient renovation an saving and supply. Nearly 400 households joined the meetings in the evenings. The concept supposes to be copied through the next years in combination with proper courses

Example 4

ProjectZero has among the interested families selected 100 families as ProjectZero role-models. They will be trained educationally in order to optimise the use of energy within own household and work.

ProjectZero helps from January 2009 to January 2010 117 enthusiastic families with reduction of their CO_2 emission. The ZEROfamilies will show the Sønderborg districts other households how to join the vision of making Sønderborg CO_2 neutral not later than 2029.

The families will through the Learning period get knowledge and experience on how to spend less energy in the daily run - both according to the household itself and the practice in the traffic and on work this might be everything from boiling eggs to driving the car with a minimum of energy consumption.

ProjectZero cooperates with the Education Centre South and the company Southern Energy on the project. The ZEROfamilies will get invitation to training, sparring and to use tools, which match their own ambitions and wishes for change of use of electricity, water, heat, petrol etc. - the ZEROfamily project should be driven by the intention of changing behaviour in the society.

The ZEROfamily is a project too to involve the children and youth of the families to make it more fun and good learning for the entire family. The ProjectZero arranges five great theme days for the families during the year, to learn them smarter behaviour in the home, in the traffic, during the cooking, but they will also get to know about handing of and recycling waste. All together there are 208 children in the 117 families of them 60 teenagers.

The families are invited to a family day at Danfoss Universe to learn about climate and energy. Besides they may compete through "The Challenge of the Month" for a prize. On the homepage the families may place a profile 'MY ZERO', where they in own words tell about their family and daily life as pioneers for the lifestyle of the future.

The staff of the municipality gets different roles:

- At their daily work they may contribute to minor energy consumption.
- Nearly all colleagues are in touch with the citizens during a day. The staff thus got a unique opportunity to act as a role model and to spread the awareness in the population.
- The staff deals with family and friends in their leisure time, where awareness is spread too.

The municipality appointed a secretary for the climate to work for 20 pct lower energy consumption in the municipality buildings in 2009 than 2007:

- The municipality's service managers got a 3½ day AMU course on EUC South – together with service managers from the housing organisations, invited by the municipality.
- All municipal buildings have energy saving systems.
- An Energy foundation is made to finance the municipality's own energy optimising innovations, based on a pay back period of 10 years.
- Energy advisors are engaged to advise the institutions about energy saving.
- An energy consultant shall support 56 institutions for children with energy reductions. Only few of them may have own service managers.

Sustainable energy supply

As told, it is important that energy supply be based on sustainable energy sources. This is the reason why the municipality works with a row of sustainable energy technologies.

Solar energy

In 2008, Sønderborg District Heating Company built the first part of a sun collector of 3,000 m^2. Fully built it will cover 11,000 m^2, delivering hot water to 1,200 homes. The collector is designed as a recreational public park, where people will get the opportunity of looking at remnants of a very early Viking Age house from the year 800 AD.

Example 5

Since the 1st of January 2008 Sønderborg town council has passed a number of regulations for new building concerning the level of energy consumption, which as minimum must be "Class 1", two levels higher than the minimum standard for low energy housing

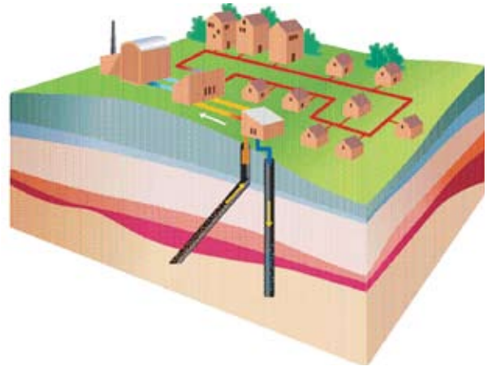
Geothermal energy

Not only in Iceland may you collect unpolluted hot water from the underground. This is possible in Denmark too, where geothermal installations are built in Thisted and Copenhagen.

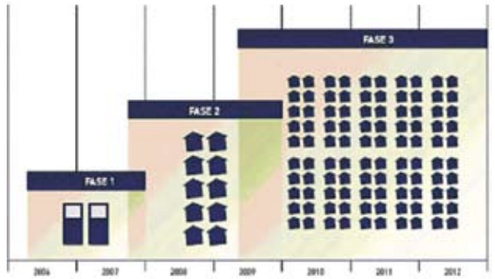
Studies show that there are layers of underground heat and water aquifers of sandstone at many locations of Denmark.

While many countries like Sweden and Norway are located upon hard and impermeable rock, Denmark is placed in a geological basin of easy permeable layers. Here the crystalline rock is typically deeper than two kilometres and overlaid by thick layers of sandstone, clay and chalk, of which sandstone is especially suitable for adoption and drawing of water, pumped down though drilled pipes. DONG Energy and Sønderborg District Heating cooperate on building a geothermal plant to heat 5,000 households within few years. The entire investments will be about 21 m Euros.

Since there is 70°C hot water in the underground below many locations in Denmark, it presents a great potential of a CO_2 -free supplement to the existing district heating networks. Geothermal heat is not only sustainable and without CO_2-emission, but will ensure a stable energy price for 30 years. There will be a borehole 1 - 2½ km deep, where the sandstone is layered, and from there geothermal water 30-80°C is pumped to the surface. The deeper the drilling, the warmer the layers - in Denmark the temperature usually increases 25-30°C pr. km.



A model of the geothermal district heating system in construction in Sønderborg and Copenhagen and already in function in Thisted, DK. Below the city is recognized a thick layer of sandstone or other water permeable rock, which in the depth of 2 km is capable to heat water up till 70°C. Through an exchanger the heat is transmitted to the circulating water in the already existing district heating pipelines



The model shows the extension of Zero energy homes in three steps within the project period: First the fuel cell plants, then ten detached houses connected and finally 100 before 2012

In the geothermal plant, the heat is extracted by means of heat pumps and exchangers. The heat is pumped as hot water from the underground to the district heating plant and is through the exchanger transmitted to the district heating water, which circulates in a closed system of pipes passing all the connected residents and homes. After use, the cooler geothermal water is re-circulated to the underground through the second borehole, just ten meters from the first hole on the surface. The second hole though is not vertical, but returns the water to a place 1½ km from the drawing pipe mouth in order not to cool the hot sandstone layers.

Geothermal heat in combination with bio fuel, electricity and heat from the waste incineration plant and solar energy is expected to cover Sønderborg city and partly its surrounding area completely with sustainable and CO_2 -neutral energy from 2013.

Within the Hydrogen technology Sønderborg Municipality takes part in a project run by Danfoss "*Danish micro power and heating based on fuel cells*" and with 8 Danish firms as participants. The aim is to develop hydrogen fuel cells for family homes. The installations based on natural gas are tested in Sønderborg, and the hydrogen installations in Lolland (see the next case study on the Lolland H_2 Society.) Connected to this project another project named "Application of bio-energy in micro power and heating" is conducted with the aim of showing how bio-energy can be used in fuel cells.

The technology in short:

- Micro power and heating plants produce energy by the technology of fuel cells.
- In combination with oxygen fuel cells transform hydrogen or natural gas to electricity and heat through a chemical process without proper combustion.
- In the micro power and heating plant many fuel cells are connected in "stacks" to build adequate electric voltage.
- All hydrogen or natural gas will not be transformed to electricity of the fuel cell. The loss is converted into useful heat.

The Danish Micro Power and Heating Project tests the technology where the fuel cells receive either hydrogen or natural gas.

In the micro power and heating plant for natural gas there is an initial process converting gas to useful fuel. The project runs six years from 2006 to 2012, in three steps.

Denmark's first Energy+ Home

The SIB Zero+ Building (www.sibzero.dk) comprises the construction of Denmark's first detached house which is not just a house of high energy standard (the passive house standard), but is self-sufficient of all necessary energy for high comfort: climate and ventilation, all electric equipment and floor heating, etc. The energy is produced by a 46 m^2 PV (photovoltaic) installation on the roof, using the electric grid as a buffer. A surplus of produced electricity is delivered to the grid.

The home has been inhabited since 1st of February 2009 by a family, who was trained in energy-saving behaviour. The building and its concept of reaching the standard of CO_2-neutrality as just a single household has especially recalled interest of citizens from the city itself and from foreign countries. Hence, the SIB Zero+ building project has already established a role model for energy neutral new building. During the next years schools, housing, sports centres, public institutions and firms will be built the same way with the energy supply integrated in the construction. The development is possible through a close cooperation between the involved architects, engineers and the educational centre EUC South.

The Zero+ Home - a modern building of brickstones and concrete with a 46 m^2 PV (photovoltaic) solar panel on the roof

Questionnaire 4.5

How the +energy house is made

The construction of a zero-energy consuming house, both for industry and private homes, has involved architects and companies in many countries through a number of years; many countries claimed that they were "The First" to make it: Austria, Germany, Sweden, Finland, Denmark, etc.

The Zero+ Home is simple in terms of construction:

1. Thick walls with 500 mm insulation under the floor, in the walls and roof.
2. Specialized energy glass in all windows.
3. Solar cells on the roof to produce electricity.
4. Heat rewinding ventilation.

This zero-energy building named the EnergyFlexHouse is ready for demonstration for the COP 15, the UN climate conference in Copenhagen Dec. 2009

Installations in a Zero energy building

According to Technology Denmark - a group of independent technical institutes. Source: EnergyFlexLab

Photovoltaics
Solar heaters

Low energy windows
Minimised edge losses
Vacuum insulation
Building envelope as heat storage incl. PCM

Ventilation and heat system with heat pump
Energy effective hot water installation
Energy effective ventilation system
Heating systems for low energy building

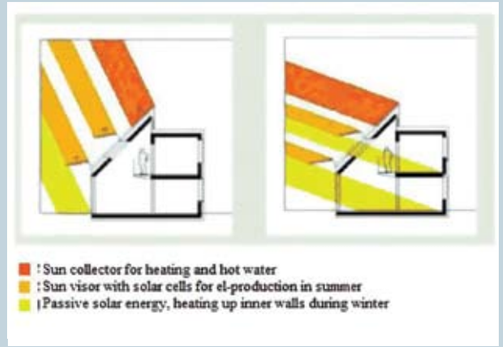
Replacing el-consumption with heat
Flexible el-consumption
Electric car and loading dock
Intelligent and interactive user interface
Lighting, LED, white goods etc.

Minimising electricity consumption for operation
Optimised control of energy consumption

Micro CHP from fuel cells
DH for low energy building

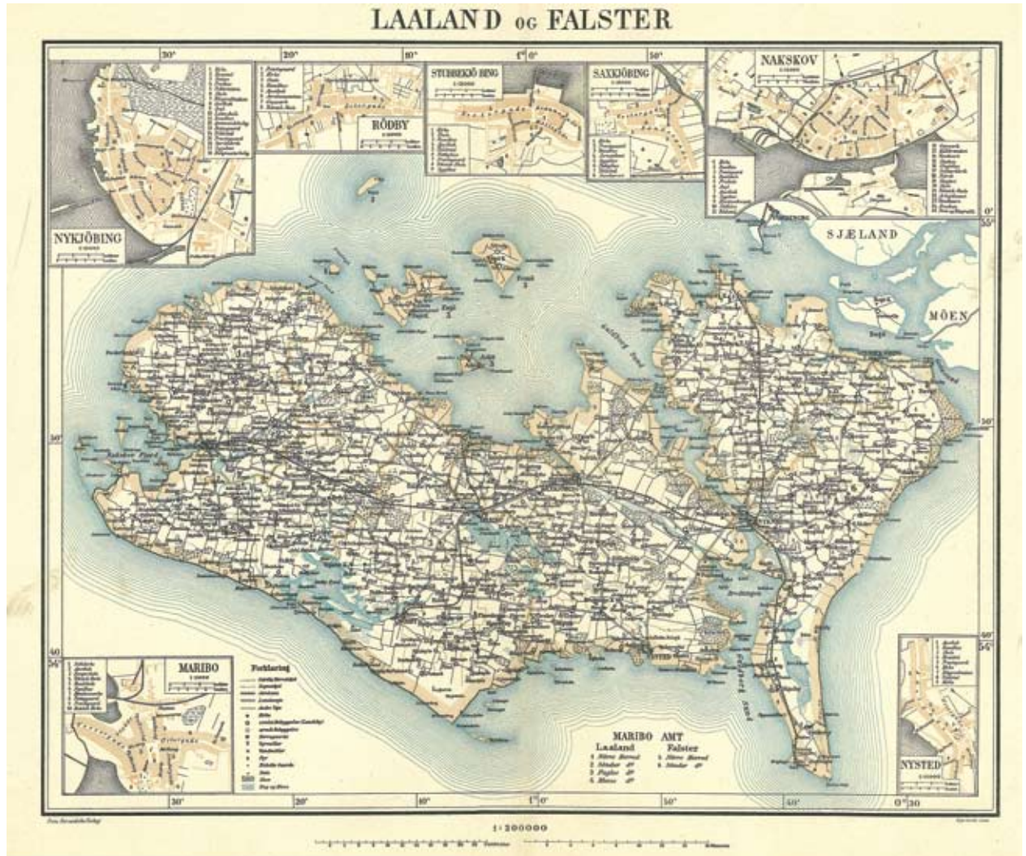
The installations above are all represented in the EnergyFlexHouse (left). How many of them are possible to install in an existing building?

How to optimise the use of solar energy in the Austrian Solar Active House



Energy balance - Solar Active House

Energy Demand	Heat loss	8.000 kWh
	Hot water	3.500 kWh
	Ventilation	500 kWh
	Solar+pump	1.100 kWh
	Total	13.100 kWh
Energy Saving and production	Solar+pump	5.500 kWh
	Heat rewind	4.000 kWh
	Passive sun	2.000 kWh
	Solar cells	1.600 kWh
	Total	13.100 kWh
Netto energy consumption		0 kWh



Map of Lolland and Falster in Denmark, ca. 1900

Case 6: A Danish project to build a sustainable region through reuse of all waste and sewage water and by building an over-capacity of wind- and wave-energy production

Creating H_2-community Lolland

The town Nakskov and the island Lolland try to pull themselves from 25 years of crisis and poverty to a balanced sustainable independence of oil, gas and coal.

The chapter was originally made as a PowerPoint presentation: Author: Per Werge, Nykøbing Katedralskole, Denmark

Turbulent Lolland

Is the island going to be one of the World's first all-round sustainable regions?

Nakskov, a city founded a. 1200, through most of the industrial era an important ship building site, ran into a deep crisis as part of the international crisis of the 1980s. Nakskov's vital shipyard and most manufacturing industry shut down.

Until 2000 Danisco Sugar was the only remaining big industry in Nakskov, and the entire island Lolland suffered through 12-14 years from unemployment rates up to 25% and replacement of many qualified people for social clients from the big cities.

From a. 2000 this view changed into its contrast: Lolland insists of being one of Europe's leading sustainable communities based on new energy- and recycling tools.

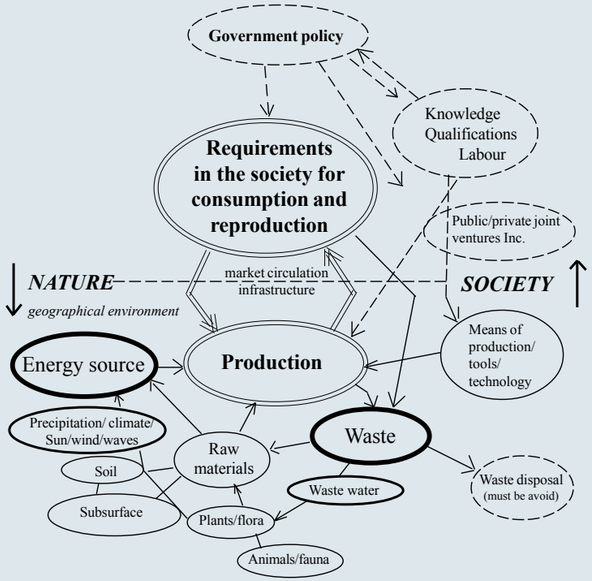
What is now on the shipyard?

First of all: The shipyard was demolished and the empty site opened for new use "from scratch"

Second: The knock-down state of flat Lolland applied for help from EU and the State – and invited wind power and recycling technology in the 1990es.

By 1999 Vestas Wind Power company built a wing production plant in Nakskov – and the municipality revised its development visions:

1. **Sustainable** production by use of **local resources** and **local energy**,
2. **Recycling** of waste to be used as **resources**.



The recycling site was an eye opener

Re-use sites are usually bad - hidden areas - far from the town centre Nakskov Miljø- og Genbrugsplads is far to south west, but not hidden

It's a park

Designed as a green park fully equipped with electric and electronic installations for concerts, meetings, outdoor exhibitions and open air theatre built amphitheatrical on top of and covering the recycle containers, under the open sky and with a view to Nakskov Fjord as natural wings.

A model of sustainable production and the role of recycling of energy and waste

Nature regarded as a resource base for sustainable use only

Per Werge 2009

A vision was found:

Lolland may better take the lead in showing cleaver treatment of local resources rather than to compete with the worlds core areas for sparse and expensive world market resources.

Local resources?

Available: Wind, sea waves, agri-industrial products, unemployed people

Shortage: Long educated people

CASE: Hydrogen society Lolland:

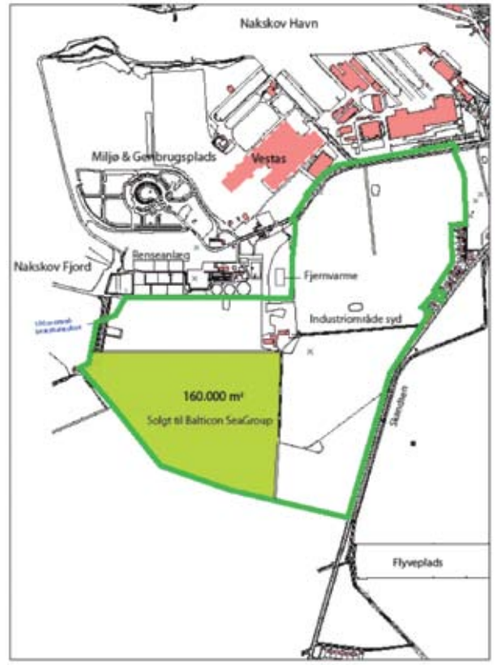
- Waste-treatment and recycling
- Waste water for gas, heat and electricity
- Biomass/manure for gas, heat and electricity
- Wind power for electricity
- Wave energy (type: Poseidon) for electricity
- Waste for heat and electricity (incineration)
- Electrical hydrolyse of water for hydrogen to use in fuel cells for heat and electricity
- Root zone to catch nutrients + heavy metals
- Algae basins to catch CO_2 for oil production

H_2-Lollands sub organisations:

- Bass, Baltic Sea Solutions (Holeby)
- LOKE (holding)

Partners:

- Universities in USA, DK
- Energy firms DONG, SEAS, NVE
- Energy techn. firms: Danfoss, Risø, IRD
- Nakskov Gymnasium, HTX og Celf (schools)
- Public support: EU, The Danish State, Lolland municipality



Nakskov Industri & Miljøpark Stensø

A vision in five green spectacles:

- Wave and wind power
- Hydrogen society
- Windpower Academy
- Rapsol – locally produced rape seed oil
- Biomass

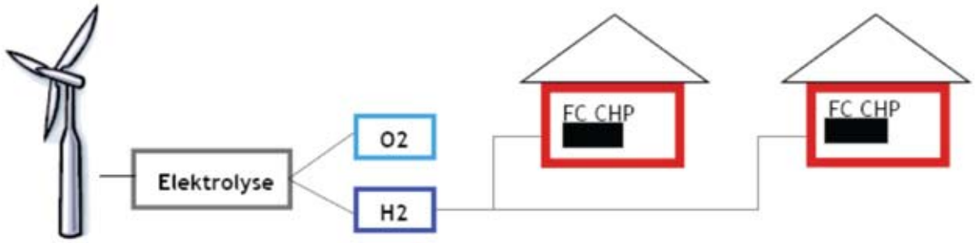
Nakskov's recycling park is now a design for industrial supply from local resources

Nakskov's former shipyard is now designed as the city's environmental base camp:

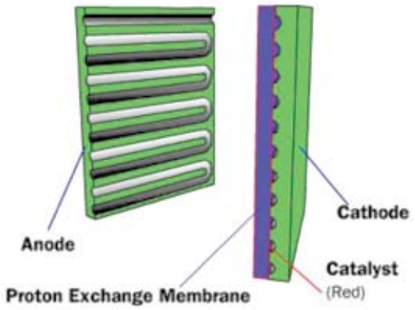
It is location for the recycling park for solid waste, for a sewage water treatment plant, a district heating plant in combination with a biomass (biogas) plant and wind generators, and next door lies Vestas Blades (building of generator wings).

The park includes an exhibition of new energy prototypes:

1. An electrolysis converter for water H_2O to H_2 and O_2
2. Hydrogen Fuel cells



How Fuel Cells work



The hydrogen community

By use of wind-generated electricity water H_2O is split into hydrogen H_2 and oxygen O_2

H_2 is from the electrolyser lead through pipes to nearby fuel cells FC CHP installed in ordinary houses in a village (Vestenskov)

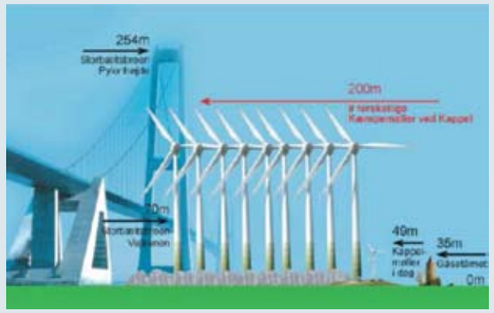
H_2 functions as fuel and creates either heat or electricity or both

Chemistry of a Fuel Cell

Anode side: $2H_2 => 4H+ + 4e-$

Cathode side: $O_2 + 4H+ + 4e- => 2H_2O$

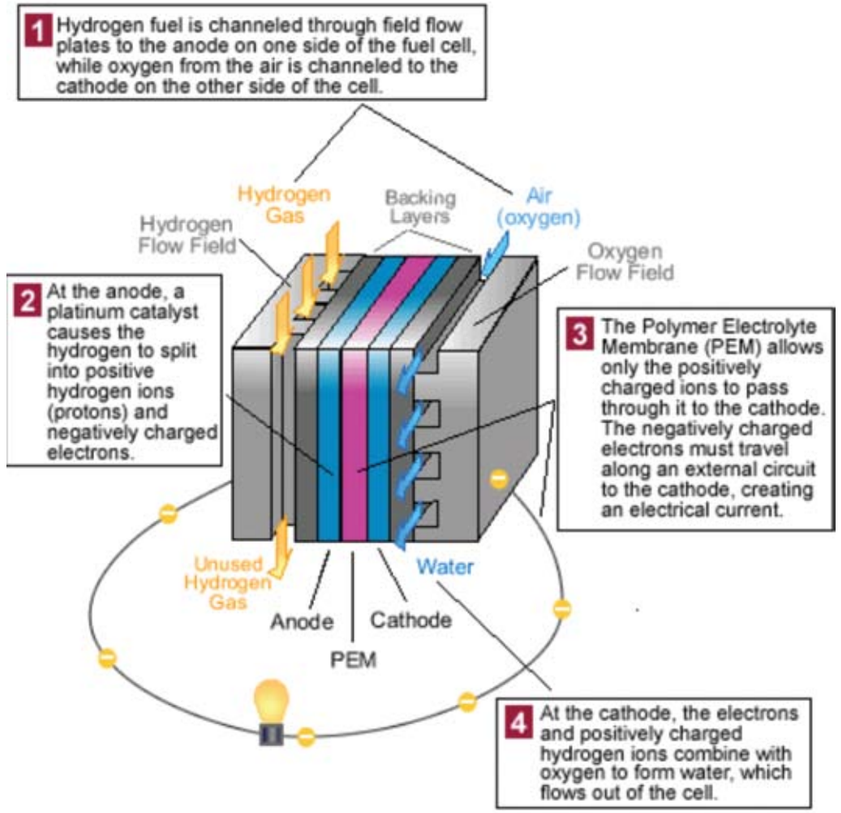
Net reaction: $2H_2 + O_2 => 2H_2O$



Wave and wind power

Around Lolland-Falster 500 wind generators already produce 1 million kWh per year – more than 150% of the consumption. Offshore Nysted is planned a second wind farm adding 50% to this production. Besides, the small old generators will be substituted by taller ones, up to 200 meter.

Northwest of Lolland is located a test wave engine connected to wind engines – a promising technology due to the steady movements of ocean waves



The fuel cell

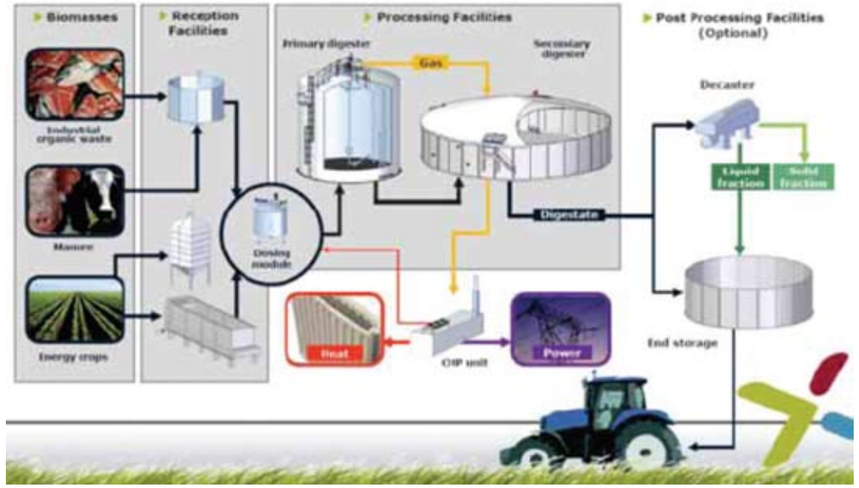
The fuel cell works similar to a battery; though the solid materials (anode and cathode) are not consumed through the process.

Instead the hydrogen gas H_2 is “used”, decomposed at the anode into protons (H+) and neutrons (e-).

The protons passes through a membrane to meet oxygen (O_2) at the cathode, creating water (H_2O), but only if the electrons move through an electric consumer to the cathode.

This moving of electrons is named “electricity”

The Basics of Biogas Plant



Biomass

Organic waste is in Denmark produced in a large scale by the agri-industrial sector:

The projected Biogas Plant in Nakskov shall process dried liquid manure and crops (straw) and deliver biogas to a new plant for production of electricity or district heating.

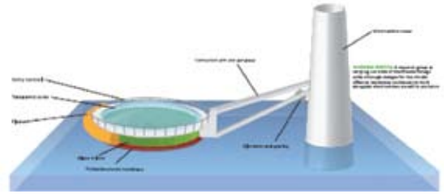
Waste from the process, fibres, is either incinerated or used as manure again.

Rapsol – rape seed oil

40% of the buildings in open landscape are still heated by small oil burners. The rape seed oil company Rapsol in Bandholm was established 2007 to deliver local and sustainable fuel to these decentralized small oil-burners.

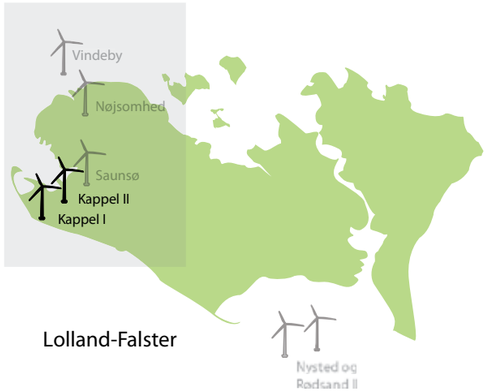
The seed covers 4000 ha on Lolland-Falster-Møn producing 5000 ton oil /year

Another use might be as CO_2-neutral fuel for vehicles - a hot issue at the moment - or as a local food ingredient



Source: www.rechargenews.com

Notice also questionnaire 4.6.2



By Per Werge. Sources: Bass, Lolland municipality, "How stuff works", Wikipedia

Offshore algae farms for energy production?

A group of scientists, led by Jonathan Trent, NASA, 2009 is exploring the ambitious idea of wiring up the 11 turbine towers at the veteran Vindeby offshore wind farm in the Baltic Sea to large-scale floating membrane enclosures (named Omega) housing high-yield algae cultures.

The Omega enclosures are covered by glass or V-resistant polyethylene. An underside of a NASA-devised membrane uses the process of forward osmosis to take seawater contaminated by chemical fertiliser run-off and desalinate it, while also super-charging the contained algae culture with the nutrients and water it needs before flushing surplus fresh water into the sea.

Brought to the shore the harvested algae can be squeezed out for oil, and the remains will make perfectly good fertiliser.

Windpower Academy

The vision of IWAL – an International Windpower Academy on Lolland – is connected to the intention of creating a windpower research institute direct linked to the 350 MW Nysted/Redsand Wind Parks and to the project of 11 giant 200 m tall test wind towers in Kappel, Lolland. IWAL's planned "House of Energy" is meant to be both a science adventure park and a centre for research and education. If succeeded the centre may attract the qualified people that Lolland lacks.

Lolland looks still turbulent – but in a constructive sense

Lolland municipality's energy policy of 2007 says that by year 2015 90% of all buildings shall be heated by sustainable sources. By year 2020 consumption of electricity has to be reduced by 25% of the 2004-level.

The overall policy for Lolland

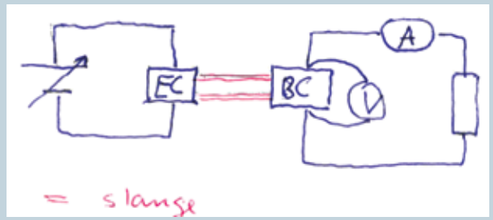
By this is to create new development based on sustainable energy production- and energy saving technology thus creating new educations, new combined research – and production firms. Lolland call this policy concept CTF, Community Testing Facilities, which informs on the intention of being Europe's practical test centre No. 1 for several renewable energy technologies.

Questionnaire 4.6.1: Perpetuum mobile?

Many people ask if the fuel cell could be the furnace and motor of tomorrow. It is more flexible concerning energy output than a gas-, oil- or coal furnace or engine, and produces no CO_2; but how efficient is it?

Another question often raised is how much energy will be lost through the transformation of energy from i.e. wind power or wave power to hydrogen H_2, converted by electrolysis? Is the experiment on Lolland in reality an impossible dream of the "perpetuum mobile"?

The following exercise is done at DTU, The Danish Technical University, Copenhagen, by Ole Trinhammer, and open for reuse here: (with permission)



The fuel cell: Effect and efficiency

After this exercise, you will be able to tell, how the fuel cell will get its best performance in a power plant or car. It will increase your understanding of the exercise and make it easier to report if you first answer the question "before the practice" - before practicing.

Aim: Finding the average production of electric effect and determination of the efficiency.

Diagram: look at the model

Equipment: A fuel cell, decade-resistance, amperemeter, voltmeter, stopwatch, hydrogen from electrolysis, an electrolysis cell with energy supply of a. 2 V

Setup: Let hydrogen pass weakly through the cell for some minutes to "refresh" it before measuring. The hydrogen to be fed into the cell must be ready in a separate container of known volume. If the hydrogen is delivered from an electrolysis cell with measurable stores, the stores may be filled with oxygen and hydrogen, and the electrolysis is to stop when ready.

Tips on electrolysis:

Fill with demineralised water. Connect the electrolysis cell with energy supply of 2 V, i.e. from a solar panel. A limit for the current intensity may be respected.

Be patient: The cell may first work after some time if it has been out of use for a long time, i.e. caused by draught. Leave the cell with water. Be patient with the fuel cell too.

Tricks on operating the gas:

The gas has to be controlled by binding screws upon the tubes. This works quite simple. The two exhausts must be open while the fuel cell is "aired" by hydrogen. When ready for measuring, the input and output on the hydrogen side should be closed. Check that the hydrogen store is filled. Then stop the electrolysis. The exhaust on the hydrogen side must stay closed during the measuring - if not, you cannot control the amount of consumed hydrogen.

Now the supply can begin. Generally, it is necessary to exercise how to open correct for supply more times. It is important too that the cell produces electricity immediately after opening of the hydrogen supply. To ensure this you may start the measuring short after the cell has run under similar conditions as the new situation.

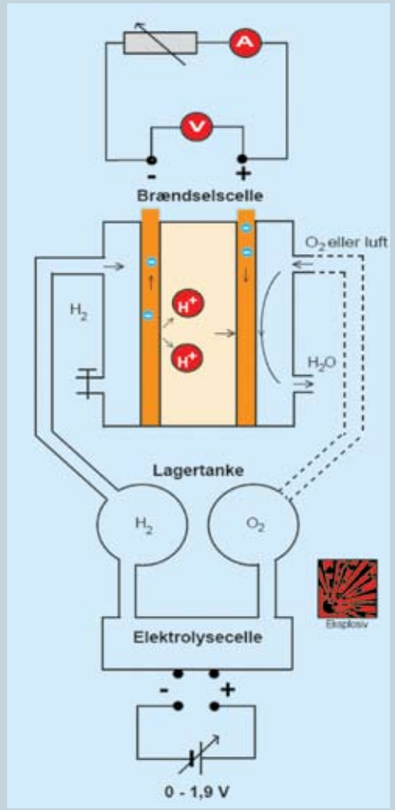
Measurements:

Current I and tension U at the fuel cell is noticed at a certain load, i.e. 2.0 ohm. Measure the time t for consume of the H_2 cubic content V

Tip: Start and stop the time measurement when the water surface passes a rule on the store. Think about what to do, if I and U change during the process. Repeat by another load, i.e. 0,5 ohm and a number more...

Data processing:

Calculate the average production of electric tension $P = U \cdot I$ and the total production of electric energy within the period of t.



Calculate the energy of the consumed volume of hydrogen

$E_{fuel} = HV. V,$

where HV is the heating value 12 J/mL by 25°C and 1 atm.

Calculate the efficiency.

The efficiency is measured in %. Measurements and results must be collected in a table as below:

$$n = \frac{E_{electric}}{E_{fuel}}$$

Conclusion:

Compare the effect and efficiency at different loads. Comment on them.

The resistance in the exercise is a demonstration of the load, which could be either of a motor in a car or the electric grid when connected to the power plant. Which load would be reasonable if we use the fuel cell in a sports car where the wish is a fast acceleration by a given stack of cells? Which load is reasonable for a fuel cell in a power plant, where the most efficient use of fuel is wanted?

Optional:

It might happen that hydrogen leak out during the practice. This risk is possible to check by filling the store with hydrogen, and then after some minutes to check the volume.

"Before the practice"

Effect and efficiency. A fuel cell delivers 208 mA by 0,695 V during 180 seconds by a consumption of 5,7 mL hydrogen at 25°C and 1 atm.

Calculate the effect P of the cell and the efficiency n

Answer:

R	V	t	U	I	P	$E_{electric}$	E_{fuel}	η
Ω	mL	s	V	A	W	J	J	%
2,0								
0.5								
.....								
.....								

Questionnaire 4.6.2. Are algae capable to deliver the future fuel to the world?

Why Algae?

Published by Bass, October 3, 2008

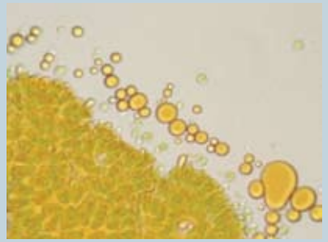


Figure 1. *Botryococcus braunii*

With the availability of petroleum diminishing, the largest world reserves of petroleum existing in politically unstable regions and, most importantly, the adverse effects of burning petroleum on global climate, there is a critical need to find alternative, sustainable, and carbon-neutral fuels. It is well known that some plants produce significant quantities of oil and since they use CO_2 from the atmosphere to synthesize this oil, burning this same oil as a fuel is carbon neutral.

It is clear from the scientific literature that micro algae, or at least some species of micro algae, have the potential to produce significant amounts of oil. Indeed, it is estimated that some fast-growing species that produce over 50% oil (by dry weight) could provide enough oil to replace petroleum diesel in the US if approximately 1% of the total land that is now dedicated to farming and grazing in the US (i.e. about 10 million acres) were transformed into algae farms. Algae, including micro algae, have been cultivated around the world for food, vitamins, nutraceuticals, edible oils, fertilizers, animal feed and other products.

Why then is so little bio fuel currently being produced from algae?

The short answer is that we do not know how to do it on a scale that would be economical and that would not adversely impact our environment.

From 1978 to 1996, the Office of Fuels Development at DOE funded a program under the National Renewable Energy Laboratory known as the „Aquatic Species Program“. The research began as a project looking into using algae to sequester CO_2 emitted by coal and natural gas power plants. When it was observed that some algae species produce significant quantities of oil, the project shifted its focus to growing oil-producing algae as a potential source of bio diesel. This research indicated that many species produce oil, but few species have what it would take for oil production. For production, the requirements include: significant oil content per cell, a usable fatty-acid profile, rapid growth rates, reasonable nutrient requirements and other growth conditions, hardiness to environmental fluctuations, and resistance to invasion from other species. All of these features can be manipulated by the appropriate selection of species and selective breeding. In fact, fast-growing algae have been studied extensively for not only oil (lipid), but also a variety of other valued products including biomass, hydrogen, hydrocarbons, vitamins, alcohols, carbohydrates, methane, and syngas.

Why Offshore?

Thought Experiment

It is argued that algae cultivation need not compete with agriculture, because the algae do not require fertile land, but only places with adequate sunlight and supplies of water (fresh or salt water), nutrients, and an infrastructure for harvesting and processing. Current efforts to produce algae in the US are all focused on land-based systems, either open ponds, referred to as „open raceways“, or closed bioreactors, consisting of arrays of clear tubing or flat panels.

The major costs associated with both of these systems involve:

- Land
- Water
- Open and/or closed photo bioreactors
- Electricity
- Nutrients, including CO_2
- Maintaining cultivation conditions
- Harvesting and dewatering algae biomass
- Processing biomass/oil

Raceways are considered the more economical systems at approx $40,000/acre, while the current designs of closed bioreactors on land are estimated to be close to $1,000,000/acre (Benemann 2007: Algae Biomass Summit; Seattle).

Some disadvantages of the open raceways however, are lower yields, evaporation, and intrusions of ‘weed’ species. There are no problems with closed bioreactors, but the current closed designs have problems with scaling to sufficient size for bio fuels production, temperature control, and bio fouling limiting light availability; all of which influence the economics of their use for algae production.

In both systems, water is going to be a major issue in the future. There are marine algae that produce oil and there are coastal lands or salt water aquifers in many areas of the US that could be used to cultivate algae. Pumping salt water from the ocean or from salty aquifers is energy intensive however, even in open systems the problem of evaporation remains; if the salt concentration gets too high, the algae die.

The question of where algae farms for biofuels should be located is an important one. In addition to the need for water (salt water for growth and freshwater for maintaining the right salinity), there is the need for adequate sunlight and a supply of essential nutrients, including CO_2. Both the freshwater and the nutrients can be supplied by municipal wastewater, but algae farms should not be too close to cities for the same reason as pig farms should not be too close to cities: they will smell bad. As the distance between the algae farm and the source of nutrients increases, the issue of plumbing and pumping or trucking affects the economics of the farms.

The growing need for oil and the potential productivity of algae are driving significant investments in addressing the challenges for their cultivation, but most of the current effort seems to be focused on perfecting some land-based system and there has been little discussion of moving algae cultivation offshore. Clearly, many of the problems with land-based systems disappear offshore (e.g. space, water mixing, temperature control, and nutrient availability). There are new problems with infrastructure, access, ship costs, tracking, marine traffic, environmental impact, durability, control, harvesting, processing, and so on, but are these and other imagined problems so formidable to eliminate offshore algae cultivation as a possibility?

It was the purpose of the Wind, Sea, and Algae Workshop in Lolland Denmark, April 20-22, 2009 to address the question:

Is it possible to produce algae-based carbon-neutral biofuels for the world offshore?

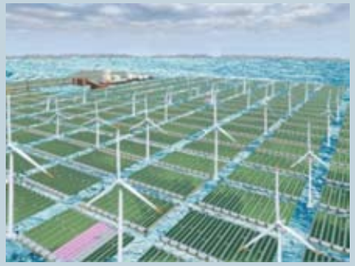


Figure 2. Model of a marine algae farm

A basic environmental question to this is:

Will the production of this kind decrease the total amount of CO_2-emission to the “greenhouse” atmosphere, if the algae are fed by emission from industrial and urban coal-, oil- and gas burning? This emission may be led by pipes straight to the raceways or “omegas”, or just to the atmosphere, from where the algae will digest it.

Ignalina RBMK reactor tube tops

Ignalina Nuclear Power Plant, Lithuania

Case 7: The history of the development of nuclear power based energy production worldwide and shut down of the Lithuanian nuclear power plant. The decision on the construction of the new plant has been made but the implementation of it has long horizons. 2016 is the earliest estimated operation start time

Focus on The Ignalina Nuclear Power Plant Challenges

Nuclear energy is used worldwide to generate large amounts of electricity reliably and without CO_2 production. Lithuania operating one nuclear power plant is a member of the nuclear industry world.

Author: Ona Beinoravičiūtė, Ministry of Economy of the Republic of Lithuania, Nuclear Energy and Radioactive Waste Management Department

This study focuses on the description of the function and conditions of the Lithuanian nuclear plant in Ignalina, where according to the agreement with the EU the last remaining reactor will be closed in 2009. The study does not discuss the role of nuclear power in the world facing increasing emission of greenhouse gasses from carbon and oil burning energy plants. Using objective figures it shows present stage of the nuclear sector, ongoing and planned expansion of nuclear energy production. It gives a detailed description of the problems concerning shut down of nuclear plants as well as handling of radioactive waste.

Nuclear Power in the World

Currently 32 countries operate 436 nuclear power reactors. (Picture 2). Five of them are in a long-term shutdown phase and 44 reactors producing a total 38 GW capacity (Picture 3). In 2009 two reactors in Japan (Hamaoka nuclear power plant (further in the text – NPP)) and one at Ignalina NPP will finally stop operation.

Currently 65 reactors are in operation and they are 24-25 years old and nine reactors – 40-42 years old.

First nuclear reactors were small, but now there is a great variety of sizes, ranging from the smallest four reactors of 12 MW of Bilibino NPP in Russia (Chukchi Autonomous Okrug) to the largest two reactors of 1560 MW of Chooz-B NPP in France (Ardennes).

The largest number of closed reactors is in the United Kingdom – 26 (they are also the oldest), United States – 28, Germany – 19, France – 11. These countries also have the largest experience in decommissioning works and could be good examples for other countries in gaining decommissioning knowledge.

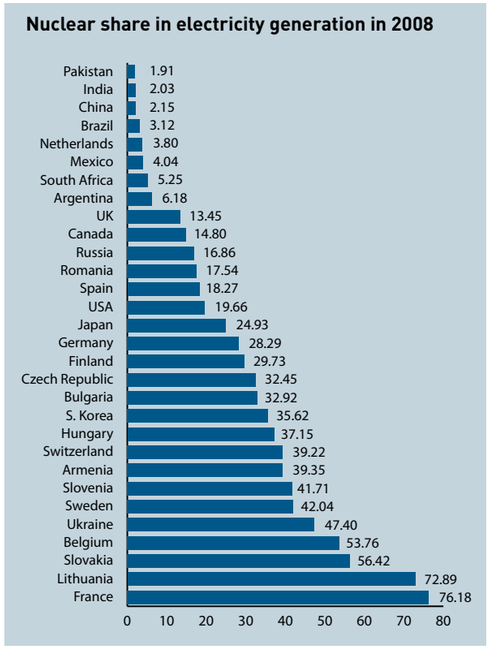
In the past 5 years many countries began building new reactors, others made decisions to start new units including such countries as Iran, Philippines, and United Arab Emirates, which have never had nuclear power reactors before. Russia's current ambitious goal is to put into operation 2 new reactors each year starting 2013.

Alongside power generating nuclear reactors, research reactors are in operation as well. **There are about 280 of such reactors operating, in 56 countries.** Some of those produce radioactive isotopes for medical purposes.

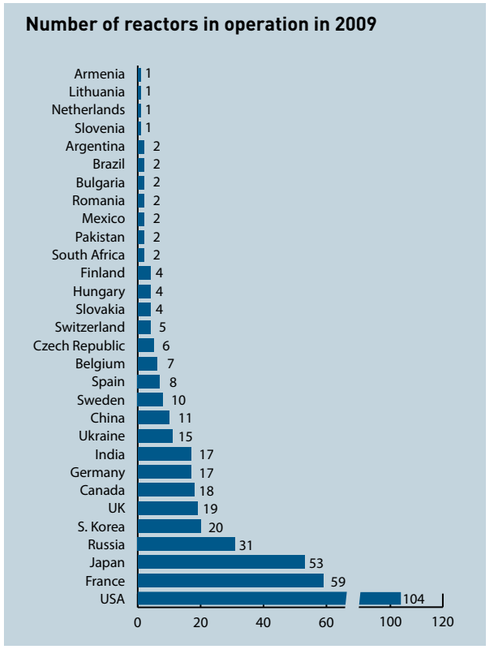
The History of Nuclear Power

Often scientists seeking one aim make use of their discoveries for other purposes. In the beginning all works related to nuclear fission were aimed at using nuclear power for weapon production.

With the start of the World War II in 1939 research of nuclear fission moved from Europe to the U.S., Such a research was carried out in great secrecy. In 1941 the Manhattan project was started and in 1942 the first nuclear „reactor" Chicago Pile 1 was constructed under the abandoned Alonzo Staggs Field



Picture 1. Nuclear share in electricity generation in 2008, IAEA.



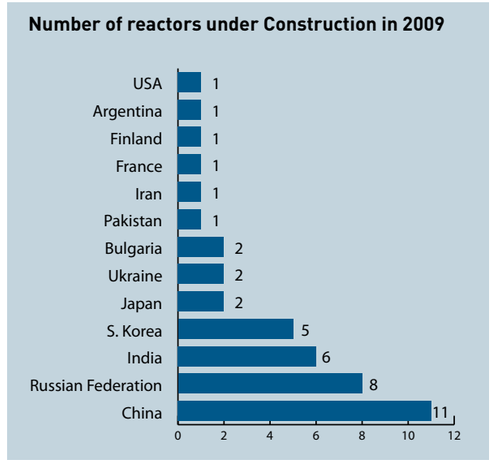
Picture 2. Number of nuclear reactors in operation in the world in 2009, IAEA.

stadium, at the University of Chicago. The reactor was made as a pile of graphite blocks with uranium (U235) pellets. The reaction was controlled by cadmium-coated rods that absorbed neutrons. Withdrawing the rods would increase neutron activity in the pile resulting in a self-sustainable chain reaction. Re-insertion of the rods would slow the reaction. The aim of the Manhattan project was to produce material for nuclear bombs, therefore 6 years later the bombs produced with the help of this reactor were dropped on the cities Hiroshima and Nagasaki in Japan.

The use of nuclear reactors to produce electricity started in 1954. On 26 June, in Obninsk (a city near Moscow (former USSR), the first semi-experimental 5 MW nuclear reactor Obninsk APS-1 (light water cooled graphite reactor) (Picture 4) was connected to the public electricity grid. From this time on nuclear science moved from strictly military to civilian applications. Although still for a long time, the primary purpose of nuclear reactors remained military.

Calder Hall (Sellafield, Cumbria, United Kingdom) was the world's first nuclear power station to produce electricity in commercial quantities. The first reactor was connected to the grid in 1956. The power plant had 4 Magnox reactors capable of generating 50 MW of power each and it was closed in 2003 after 47 years of operation.

Since then many countries started building nuclear power plants and they were generally built with high safety standards in mind. Nevertheless, there have been two serious accidents. The first (by INES scale level 5) occurred in 1979 at Three Mile Island NPP (Pennsylvania, USA) in a widely used PWR reactor type, resulting in serious reactor core damage, but without consequential environmental damage. The second (by INES scale level 7) occurred seven years later in Ukraine (former USSR) in 1986 at Chernobyl NPP (Picture 5) in a RMBK type reactor, resulting in serious and widespread environmental consequences.



Picture 3. Number of nuclear reactors under construction in the world in 2009, IAEA

Many lessons have been learned from these two events. Over the years a global nuclear safety culture has evolved through international collaborative efforts to strengthen safety worldwide. Binding international agreements, codes of practice, non-binding safety standards and guides along with international review and advisory services now exist. Agreements among countries on Early Notification of a Nuclear Accident (entered into force in 1986) and Assistance in the Case of a Nuclear Accident or Radiological Emergency (1986), Convention on Nuclear Safety (1996), Convention on Safety of Spent Fuel Management and Safety of Radioactive Waste Management (1997). International Atomic Energy Agency's (IAEA) inspectors can check a nuclear power plant's condition at any time and regularly organize safety missions in nuclear power plants.

Germany: Influenced by the Chernobyl accident several countries decided to stop their nuclear power plants. In 2000, the German Government officially announced its intention to phase out the use of nuclear power. The Minister of Environment, Nature Conservation and Nuclear Safety, reached an agreement with energy companies on the gradual shut down of the country's nineteen nuclear power plants and a cessation of civil usage of nuclear power by 2020.

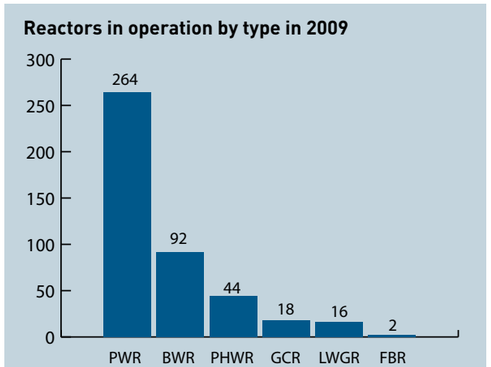
Picture 4. The Obninsk reactor near Moscow, IAEA

Picture 5. Chernobyl NPP Unit 3 Shelter.

Italy: In a referendum in 1987 following the Chernobyl accident, Italy decided to place a moratorium on nuclear power. The 5 years moratorium covered both power generation and construction of new nuclear power plants from 1988 to 1992. The construction of two new nuclear power plants was stopped, and in 1988 the Italian Government ended all nuclear constructions. The Caorso reactor, which was shut down in October 1986 for the annual refuelling remained shut down ever since. In 1990 the Trino NPP was closed. The remaining units of Garigliano and Latina had already been closed down in August 1978 and November 1986, respectively. At the same time the decision was made to close down a number of facilities relevant to the fuel cycle: enriched uranium extraction facility, fuel elements production factory, reprocessing of spend fuel and the plutonium plant. As a result, Italy is not currently active in the nuclear energy sector.

Spain: Spain passed a moratorium against nuclear power plants before others – in 1983. Spain had constructed but not started Lemoniz NPP, Valdecaballeros NPP Unit 2, and Trillo NPP Unit 2. This was an achievement by the communities living in the surroundings of nuclear plants. In 1994, definitive cessation was decided for the nuclear power plants under the moratorium. Present Law on Energy Sector does not include any nuclear power plants under construction, project or license application, and in the short term there are no known electric companies planning to build new nuclear power plants.

Nevertheless, many nuclear power plants and especially those in U.S., make renovations and ask nuclear safety regulatory bodies to prolong operation licence for minimum 20 years.



Picture 6. Nuclear reactors in operation by type in 2009, IAEA

Reactor types

Every reactor type has its own advantages and disadvantages from the point of view of safety and economics. This includes many details, e.g. type of coolant, moderator, fuel type and assemblies form, amount of radioactive waste generated during operation, decommissioning and etc.

PWR Pressurized Water Reactors

The most widely spread, used in 264 nuclear power plants, are the PWR type reactors (e.g. Ringhals NPP (Sweden), Biblis NPP (Germany) etc.) (Picture 7). Russian design PWR reactors are called VVER (e.g. Kozloduy NPP (Bulgaria), Bohunice NPP (Slovakia), Loviisa NPP (Finland), and Leningrad NPP (Russia)). Pressurized water reactors in which the heat generated by nuclear chain reaction from nuclear fuel is dissipated using highly pressurized (superheated, about 160 bar) water to achieve high temperature and avoid boiling within the core. The cooling water transfers its heat to the secondary system in a steam generator. Fuel used is 4% enriched uranium oxide, moderator – water, coolant – water as well. They were originally designed in the U.S. for use in nuclear submarines.

The most advanced PWR reactors are called European pressurized reactors (EPR) (produced by Areva). The construction of such reactors started in Olkiluoto NPP (Finland) and at Flamanville NPP (France), also in the nearest future construction works of EPR reactors are foreseen in France, China, United Arab Emirates, and India.

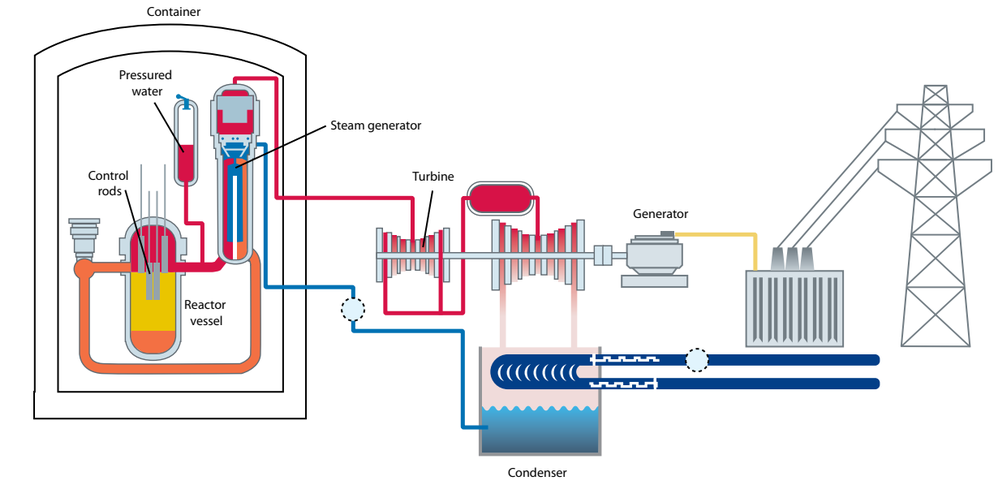
EPR design includes more safety measures, enhanced efficiency with the capacity of up to 1650 MW. It can use 5% enriched uranium oxide fuel.

BWR Boiling Water Reactors

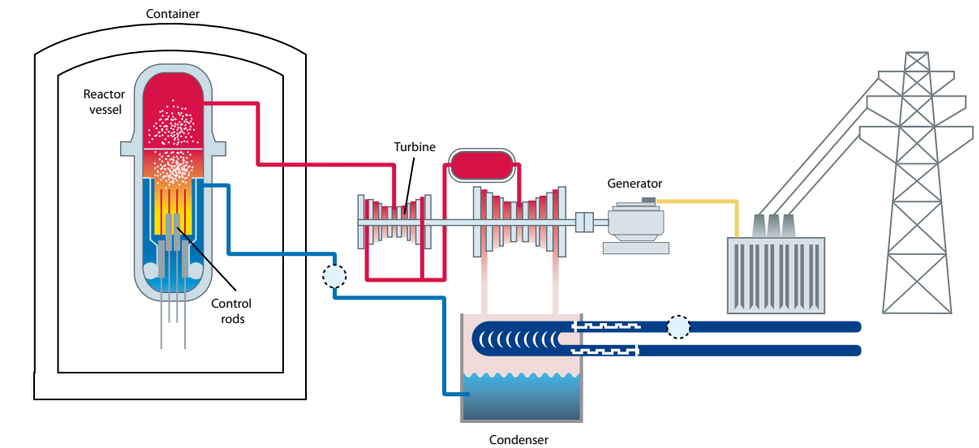
Another wide spread type of reactors is boiling water reactors (BWR) (Picture 8). There are 92 BWR reactors in operation in the world (e.g. Forsmark and Oskarsamn NPPs (Sweden), Gundremmingen NPP (Germany). The difference comparing with PWR reactor is that BWR has only 1 circuit of boiling water (primary loop) where steam produced goes straight to turbines. It also uses 4% enriched uranium oxide fuel, with water serving as both moderator and coolant.

PHWR Pressurized Heavy Water Reactor

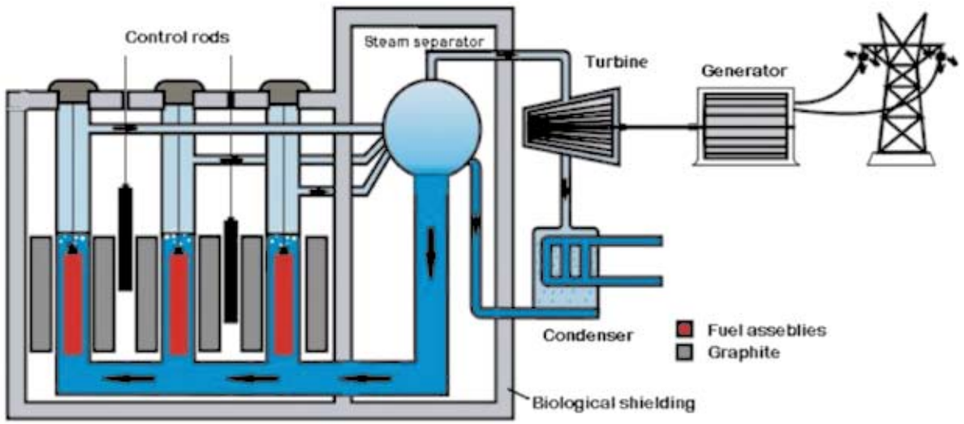
44 units of pressurized heavy water reactors are now in operation all over the world. A Canadian company made 42 of them and they are called CANDU reactors. These reactors use natural uranium oxide fuel (that allows reducing uranium enriching costs) and heavy water (D2O) as both coolant and moderator. (heavy water production costs a lot).



Picture 7. Structural scheme of PWR reactor



Picture 8. Structural scheme of BWR reactor



Picture 9. Structural scheme of a RBMK reactor

GCR Gas Cooled Reactors

There are two types of gas cooled reactors (GCR) – Magnox in United Kingdom and UNGG (Uranium Naturel Graphite Gaz) in France. Currently 18 such reactors are in operation. In these reactors natural uranium metal with magnox cladding is used as a fuel, graphite serves as moderator and pressurized CO_2 as coolant.

FBR Fast Breeder Reactor

The fast breeder reactor (FBR) is a fast neutron reactor designed to breed fuel by producing more fissile material than it consumes. Fuel in such reactors is uranium/plutonium oxide, no moderator and liquid sodium serves as coolant. Only 2 FBR reactors are now in operation - Beloyarsky NPP Unit 3 (Russia) and Phenix NPP (France). Most of FBR reactors are old and in decommissioning stage (e.g. Dounrey NPP in Scotland). One FBR reactor is under construction in India. Fast breeder reactors are now under discussion in the nuclear community due to the possibility of reduction of spent fuel storage and disposal costs.

LWGR (RBMK) Light Water Graphite moderated Reactors (Chernobyl type)

Light water cooled graphite moderated reactors or RBMK (a Russian acronym for „channelized large power reactor“) needs more attention because of the Chernobyl NPP Unit 3 accident (totally there are 4 Units at Chernobyl NPP, 3 of them are in decommissioning stage) and the Ignalina NPP in Lithuania (the most advanced RBMK). RBMK reactors were built only in former Soviet Union and now 16 of them are in operation (including very small reactors of Bilibino NPP). Eight of them are being decommissioned and one under construction (Kursk NPP Unit 5, Russia).

RBMK reactor (Picture 9) has two cooling loops, a direct cycle. Fuel assemblies are loaded into individual channels which allow refuelling of the plant without putting it off line. All other types of reactors have to be stopped, used fuel removed and fresh fuel loaded into a reactor. Massive graphite blocks are used as moderator, water as coolant and 3.6% enriched uranium oxide as fuel. The difference from other types of reactors is the absence of containment (as in VVER reactors). Containment as „safety factor“ is mostly used when describing RBMK reactors' safety drawbacks. Containment is made of very thick reinforced

Picture 10a and 10b. The Ignalina nuclear Power Plant at the shore of Lake Drukšiai

sealed concrete and includes all the cooling circuit and is meant to avoid discharge of radioactive materials in case of an accident in a reactor core.

Nevertheless RBMK reactors are equipped with a biological shielding, which is similar to containment, but is made of a number of compartments but still does not cover all of the cooling circuit. There are many other kinds of safety measures in RBMK reactors, such as automatic security and control systems, accidental reactor cooling system, accident localization system, fuel assemblies sealing system in reactor core and many others. Graphite stack is located in a sealed cavity and entire reactor is filled with helium and nitrogen mixture, which prevents graphite oxidation and improves heat transfer from graphite to fuel channels.

Totally 2,052 channels penetrate the reactor's graphite stack. 1,661 channels are used for fuel loading and others are needed for rod control, accommodate sensors, temperature instrumentation, make gas sampling etc. In case of incidents or accidents, even those not related directly to the reactor, the Ignalina's RBMK can be stopped in a couple of seconds automatically.

As in all nuclear power plants – here safety is first. A well-trained personnel is prepared for normal and extreme situations. Possible incidents and accidents (e.g. technological, human, from inside and outside, including airplane crash) are calculated and safety measures are continuously improved. The personnel are due to continuous training in handling of all possible risk elements.

The Ignalina Nuclear Power Plant faces decommissioning

Ignalina NPP (Picture 10) was built to supply electricity for the North Western part of Soviet Union (Lithuania, Latvia, Belarus, Kaliningrad region). Lithuania at that time already had many thermal power plants and was well connected by electricity networks with surrounding regions. After geological research the location was chosen at the bank of the big lake Drukšiai, which needed to be used as a coolant for the nuclear power plant. Preparation works began in 1974 and in 1983 the Unit 1 of Ignalina NPP started producing electricity, in 1987 Unit 2 began operation. It was foreseen to build 4 units, but in 1989 it was decided to stop construction works of the third unit, which at that time was almost 60% complete. After the collapse of the Soviet Union the Ignalina NPP was overtaken by Lithuania and is located just ~ 7 km from Latvia and Belarus borders.

So far the Ignalina NPP has been working without any major incidents. But following international pressure based on „unsafety of RBMK“ the Lithuanian Government in 1991 signed a Grant Agreement on Nuclear Safety stating that the country commits not to change fuel channels in first reactor in 2005 as was required by the technology. This meant that the reactor could not continue operation. In 2000 Lithuania adopted the Law on Ignalina NPP Unit 1 Decommissioning and country's preparation for final shut down of the plant started. During many years of negotiations on joining European Union one of the conditions was closing of Ignalina NPP. Therefore in the Protocol No 4 of the Treaty on Accession to European Union it was stated that Lithuania *„has committed to close Unit 1 of the Ignalina Nuclear Power Plant before 2005 and Unit 2 by 2009“* and on other side European Union

Picture 11. Bohunice NPP, Slovakia

„Recognizing that the decommissioning of the Ignalina Nuclear Power Plant is of a long-term nature and represents for Lithuania an exceptional financial burden not commensurate with its size and economic strength, the Union shall, in solidarity with Lithuania, provide adequate additional Community assistance to the decommissioning effort beyond 2006". Similar commitments were made for Kozloduy NPP (Bulgaria) and Bohunice NPP (Slovakia) (Picture 11), which have Russian type VVER reactors.

Financing the shut down of a nuclear plant

Decommissioning of nuclear plant is one other stage of their life cycle, which was not in consideration for many years. Only during the last 15 years, when many nuclear power plants and nuclear facilities were shut down, decommissioning became an important problematic issue.

After final shut down of a nuclear plant it becomes an object, which needs to be removed. It creates different kinds of waste. Nevertheless, such an object needs special safety attention because of the presence of spent nuclear fuel, radioactive waste, hazardous waste and enormous amounts of concrete and metal waste.

First question may arise how much all works will cost and how much time the process will take. In theory every nuclear power plant had to have a special fund for its decommissioning and waste management. In the early stage funds were accumulated only for very few nuclear power plants. For example, for Ignalina NPP the Decommissioning Fund was not established until 1995. Ignalina NPP pays 6% to the fund from the income it gets from sold electricity. At present only 60 million Euros are collected in the fund. Therefore European Union gives financial support to Lithuania for decommissioning of Ignalina NPP. It is calculated that the whole decommissioning process of Ignalina NPP will take around 30 years and will cost around 2.4 billion Euros, excluding spend fuel disposal.

Decommissioning strategy

For decommissioning process a strategy needs to be developed. The ways of how the plant will be dismantled and what will be left on the site need to be decided. Possible options include immediate dismantling when everything including the reactor is dismantled a step at a time, defer dismantling when all buildings surrounding reactor are removed and the reactor building left to decrease radioactivity for 30-80 years. This method allows increasing of decommissioning fund by interest rate and it is suitable when a power plant has more units in operation. Entombment when everything is dismantled and removed, except for the reactor itself, which would be stabilized with concrete and left covered for ever. This method now is chosen only for some small research nuclear reactors but for a big nuclear reactor it is impossible to make long-term safety assessment.

For Ignalina NPP Lithuania has chosen the immediate dismantling strategy. This decision was influenced by many factors:

1) Personnel. Immediate dismantling strategy allows using the operational personnel of the plant for decommissioning works, and hence causes minor social problems in the region. The Ignalina NPP is the biggest job-suggesting place in the region and redundant workers could not find jobs neither in the region nor in Lithuania. There are no other nuclear facilities in the country which would need nuclear specialists. Also, as most of the personnel are Russian speakers their integration in the labour market in other regions of Lithuania would be complicated. In addition, if the plant is not dismantled immediately there will not be any nuclear specialists left in the country. Later decommissioning works will demand hiring of foreign specialists.

2) Technology. Existing techniques, equipment, technologies in the world already allow decontamination and dismantling of nuclear facilities safely. Safe management of waste technologies also exists. Other proposed option - safe enclosure for 30 years would not have substantial influence on radioactivity decreasing of the reactor core of Ignalina NPP.

3) Infrastructure. Exiting infrastructure such as roads, equipment, buildings, water, and electricity and heating systems would need renovation after 30 years.

4) Finance. Ignalina NPP Decommissioning Fund is not sufficient to cover all decommissioning and radioactive waste management costs. The European Union is supporting decommissioning of Ignalina NPP, but nobody could guarantee that Lithuania would get support after 30 years.

Construction works

IAEA had prepared recommendations and requirements for dismantling of big nuclear facilities. Following those recommendations Ignalina NPP prepared The Final Decommissioning Plan that includes detailed description of the entire decommissioning period of the plant, including, safety issues, possible dismantling techniques, radiation protection programme, environment protection programme, waste management programme, site restoration etc.

Before the start of decommissioning new projects have to be implemented. The pre-decommissioning period of Ignalina NPP began in 2000. From then there have been several facilities at Ignalina NPP site commissioned. The main requirement for the Lithuanian nuclear regulatory body (State Atomic Energy Safety Inspectorate) was to built heat and steam boilers near the Ignalina NPP. During operation the nuclear power plant produces not only electricity, but also steam, heat and hot water for its own needs as well as for district heating of the nearby Visaginas town. After the final shut down of Unit 1 the possibility of an incidental stop of the only remaining Unit 2 in a cold winter would cause a catastrophic lack of district heating for the plant and for Visaginas people. To prevent this there were new boilers built and 108 km of gas pipeline from Pabradė to Visaginas constructed to assure gas supplies for those boilers.

Another new building appeared near the plant – technical documentation archive. Information maintaining, storage is another very important issue arising in the course of nuclear facilities decommissioning. In many other countries, which started decommissioning of nuclear facilities, it appeared that many documents we either missing, or it became impossible to read older electronic documents because computer technology fast development and nobody was able to read files recorded using old technologies. At Ignalina NPP old archive was not capable to accommodate all documents; many documents were kept just at offices at plant departments. The new archive meets all modern document maintenance and record keeping international requirements and it is meant for minimum of 100 years which is not very much for nuclear industry, having in mind radioactive waste storage time needs.

Removing of such big electricity source from all electricity networks also requires special attention. JSC „Lithuanian Energy" asked to build 330 kV compensating reactor (special transformer) that would be used after the shut down of both Ignalina NPP Units.

In the mean time Ignalina NPP built a liquid radioactive waste cementation facility that will allow stabilizing and packing all operational and decommissioning liquid radioactive waste in a safe manner into 2,00 l metal drums (Picture 12a, 12b). Metal drums (4 of them) are put into concrete containers and stored until final disposal repository will be available.

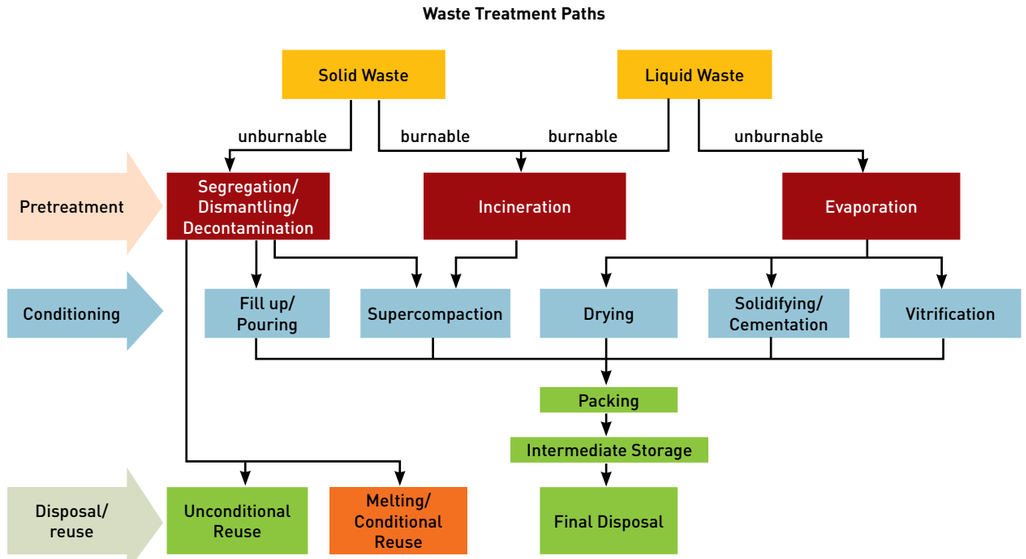
Radioactive waste

General radioactive waste treatment paths are presented in Picture 13.

Radioactive waste final treatment technologies also have a short history. In most cases in many nuclear facilities radioactive waste was just segregated by activities and kept in temporary storages or in earlier times just filled in excavated trenches around a nuclear facility. Such cases can be found in many countries (e.g. Port Hope town in Canada, having uranium enrichment plant now realized that 6 areas are contaminated of very low level radioactive waste, La Manche storage in France, many points in Russia including a sunken nuclear submarines reactors in the Barents sea, Swedish radioactive waste in the Baltic sea). Many programmes of restoration of territories, of removal of radioactive waste and management them by modern technologies have been now started.

Solid radioactive waste at Ignalina NPP was kept in concrete bunkers (Picture 14) separated only by activity. In 2008 all those bunkers were opened to check the condition of waste and to take examples. It was found that the waste is a mix of concrete, metals, woods (Picture 15). There is an ongoing project on building solid radioactive waste treatment and storage facilities. All waste from present storages will be removed, sorted, characterized, treated, conditioned, packed, stored and later disposed.

The facility will include incinerator for burnable waste, super compactor, packaging equipment, and storage area for long-active radioactive waste.



Picture 13. Classical scheme of radioactive waste treatment paths

Radioactive metal waste melting technologies exist and are successfully used in Sweden, Germany for example. Technologies for recycling of metals currently allow around 97% recycling level. Slightly radioactive metals can be reused for production of drums for radioactive waste storage. Swedish incineration and melting facility in Studsvik propose radioactive waste treatment services for other countries, because it is not always economically reasonable to have such facilities in every country.

Radioactive waste classification system in Ignalina NPP represents disposal options for separate groups of the waste (Table).

The Ignalina NPP decommissioning includes projects of building very low-level waste repository – landfill (Picture 17) and near surface repository for low and intermediate short-live radioactive waste (Picture 19). They will be built close to the nuclear power plant too.

In 2008 materials free release facility was constructed (Picture 21). This facility is necessary to remove materials from radiological control after decontamination. Afterwards materials can be reused as waste disposed in conventional landfills. That allows decreasing of radioactive waste disposal costs. For Ignalina NPP landfill repository the calculated disposal cost is 240 euro/m^3, for near surface repository – 2,400 euro/m^3, temporary storage – 500 Euro/m^3.

Spent nuclear fuel

Spent nuclear fuel is removed from reactors and stored in water pools, adjusted to reactors, for cooling. After min 5 years it can be moved to long-term spent fuel storage. From 1995 Ignalina NPP is operating dry spent nuclear fuel storage that now contains 20 CONSTOR and 108 CASTOR metal-concrete dual-purpose (storage and transportation) containers (Picture 22) produced by a German company GNB in the Czech factory „Škoda“. This type of container can accommodate 51 fuel

Picture 14. Ignalina NPP solid radioactive waste storage bunkers

Picture 15. Mixed operational radioactive waste

Picture 17. Landfill repository model

Waste Group	Definition	Surface dose rate	Conditioning	Disposal method
0	Exempt waste		Not required	Management and disposal as conventional waste
Short-lived low and intermediate level waste				
A	Very low level waste (VLLW)	≤0.5 mSv/h	Not required	Very low level waste repository (Landfill Facility)
B	Low level waste (LLW-SL)	0.5-2 mSv/h	Required	Near surface repository
C	Intermediate level waste (ILW-SL)	>2 mSv/h	Required	Near surface repository
Long-lived low and intermediate level waste				
D	Low level waste (LLW-LL)	≤10 mSv/h	Required	Near surface repository (cavities at intermediate depth)
E	Intermediate level waste (ILW-LL)	>10 mSv/h	Required	Deep geological repository
Spent sealed sources				
F	(SSS)		Required	Near surface or deep geological repository

assembly or 102 bundles. Nuclear fuel assembly in Ignalina NPP reactors is 7 m length (Picture 23). By technology it is specially prepared to cut into 2 pieces and after cutting it can be stored. Nevertheless it is not enough space in this storage facility to accommodate all spent nuclear fuel which is in water pools near reactors and will be produced during operation of the plant. This problem arises not only in Ignalina NPP but also in Kozloduy NPP, Chernobyl NPP and many other nuclear power plants. Primarily, when Lithuania was part of Soviet Union, it was planned that spent nuclear fuel would be transported back to Russia. However, not a single fuel assembly was transported since Russia did not start reprocessing of RBMK fuel (due to low enrichment of RBMK fuel it is not economically worthy to reprocess). It is calculated that after closing of Ignalina NPP Unit 2 there will be a need for storage of approximately 18000

Picture 21. Ignalina NPP free-release facility construction finishing

fuel assemblies. This need has created an ongoing project for building new dry spent nuclear fuel storage. There fuel will be stored in a new type 190 containers with max of 91 fuel assemblies (182 fuel bundles); also specialized containers for damaged fuel assemblies are created. Totally in both the facilities there will be around 22 000 fuel assemblies. For both storages safety assessment is done for a 50 year storage term.

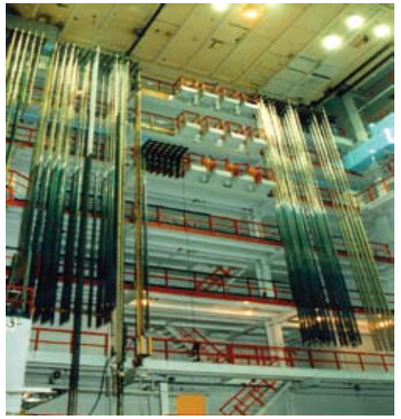
The Lithuanian Radioactive Waste

Management Strategy foresees that spent nuclear fuel could be transported to other countries which have facilities for reprocessing or disposal (at the moment not existing), to use European initiative of European regional repository or, if no other solutions will be possible, to start research works for deep geological (in 500 m) disposal repository in Lithuania. Preliminary studies show, that Lithuanian ground is not very suitable for a deep underground repository.

At present after rejecting ideas and theories about sending spent nuclear fuel into space or sinking it in the world's oceans, the only safe disposal option remaining is underground repository. There are no such repositories in the world. The most advance research works on this matter are done only in Finland, Sweden and the U.S.

On the other hand, with intensive use of natural sources, in the future spent nuclear fuel can be a source of many radionuclides and other materials, therefore the Japanese model of a deep geological repository includes retrievability option.

Picture 22. Ignalina NPP dry spent fuel storage



Picture 23. Ignalina RBMK fresh fuel assemblies hanging in the reactor hall

Reprocessing of spent nuclear fuel is done for research reactors, VVER reactors, and PWR reactors. France, UK, Russia, USA, and Japan have such facilities. After reprocessing high level radioactive waste is vitrified and is send back to the country of origin.

The lack of a solution for the final treatment and storage of spent nuclear fuel in reality stops the development of nuclear industry. IAEA has initiated several working groups of experts to find the solution of this problem.

Further the projects for the Ignalina NPP include: preparation of decontamination and dismantling engineering documents for every building and facility that have to be removed, full technical and radiological characterization of the plant, removal of spent nuclear fuel from reactors (till 2015), removal of unnecessary equipment, decontamination, dismantling of buildings (Picture 24).

The final site restoration is foreseen at the level of "brown field", as the radioactive waste repositories, spent nuclear fuel storage will stay in place for many years.

Lithuania has made the decision to build a new nuclear power plant (Visaginas NPP) on the same site using existing infrastructure, but presently only environmental impact assessment study has been prepared.

Editorial note: According to the magazine „Lithuania in the World" Nov-Dec 2008 this plant, build by either French, Canadian or American companies, and with financial support from the EU, won't be in operation before 2016, even in case of most optimistic scenario.

Used information sources:

1. http://www.iaea.org

2. B. Barre, P.R. Bauquis. *Understanding the Future Nuclear Power*. Editions Hirle, 2007.

Questionnaire 4.7

The Chernobyl accident has caused a long discussion of the safety and economic reason by using nuclear power plants. Here are some of the main questions and answers:

How serious was the accident?

UNSCEAR, The United Nations Scientific Committee on the Effects of Atomic Radiation in 2002 stated that the Chernobyl nuclear reactor accident April 26, 1986 was the most serious accident ever to occur in the nuclear power industry. The reactor was destroyed during the accident and considerable amounts of radioactive materials were released to the environment. The accident caused the deaths of 56 workers and children and radiation injuries to over a hundred others."

What is the accident damage estimate?

It is estimated by the IAEA Chernobyl Forum 2005, that 4,000 people got sick with thyroid cancer. 336,000 people were relocated from the accident zone. The damage caused by the accident is estimated several hundred billions US dollars.

What happened to the Chernobyl reactor? Was it an accidental disaster or experiment?

UNSCEAR notices further: "The accident at the Chernobyl reactor happened during an experimental test of the electrical control system as the reactor was being shut down for routine maintenance. The operators, in violation of safety regulations, had switched off important control systems and allowed the reactor to reach unstable, low-power conditions. A sudden power surge caused a steam explosion that ruptured the reactor vessel, allowing further violent fuel-steam interactions that destroyed the reactor core and severely damaged the reactor building. Subsequently, an intense graphite fire burned for 10 days. Under those conditions, large releases of radioactive materials took place."

This explanation indicates that the nuclear plant as such was safe, but that the operators were too young, inexperienced and unaware of the risk they took with the experiment.

Why should Chernobyl be unsafe?

It is noticed, that design features (such as a positive void coefficient type of reactor, use of graphite in construction, and lack of a containment building) are generally cited as the causes of the accident.

Further information and discussions are to find on the internet, for example from IAEA:

http://www.iaea.org/NewsCentre/Focus/Chernobyl/index.html (incl. many links)

How to count on the period of radioactive decay?

Storage of radioactive wastes is to allow them to decay to lower radioactivity levels; either while awaiting processing for reuse as fuel; or to temporarily store them awaiting disposal. For spent nuclear fuel, the „storage for decay" period may be many hundreds of thousands of years.

Until now the storage problem is not solved for more than a shorter period by deposition in former coal or underground salt mines or deep in rocky underground stores, and the final expenses for storage is not known.

Activities:

Make a research on the actual state for storage of nuclear waste.

Compare prices for nuclear fuel to oil, coal and bio fuel.

Find and consider the amount of uranium in the World. Which countries will be the new strategic energy-suppliers of a possible leading energy sector? Which countries will be dependant on their supply?

Figure 5.1. Bogota in Colombia is a 8 m inhabitants city which politics for sustainable development is a composition of physical and socio-economical planning and democratic will: In the downtown area, the government demolished 20 HA of buildings that had been taken over by drug dealers and gangs in order to create more space for public parks and green areas. A country club is now a park too. Cycle lanes are made across the city to reduce cars.

Chapter 5. How can the city be the solution for over-consuming cities?

Cycling, insulation and renewable energy make a sustainable urbanisation possible. Democratic urban planning may be the tool for it, if the citizens go for influence.

By Per Werge, Geographer at Nykøbing Katedralskole, Denmark

"Cities in the developing world are expanding, populations grow, and we need more housing. Over the next 40 years, more cities will be built in the third world than exist today in total.

In societies like ours, we never had the money to follow the 20th century city model – which is now widely regarded as a mistake. So now is the time to build different and better cities.

We need a model that provides higher density rather than suburbs, with pedestrian streets only, so that no children grow up more than three blocks away from a park. We need a city where everybody can walk, and where people are able to buy groceries without using the car. We should create cities with networks of bicycle and pedestrian lanes not only in the city centre but all over the city."

"Protected cycle paths and pavements are very strong symbols of democracy. They show that a citizen on a 30-dollar bicycle is equally important as the one in a 30,000-dollar car."

"To create a more inclusive city, where people feel equal, we need to invest a lot more in public spaces. Providing adequate leisure activities for the less wealthy citizens is very important. While other people go to restaurants, go on vacation or stay at home in their gardens during their leisure time, poor families can only afford to stay at home in small 40 m^2 homes – sometimes even smaller. Public spaces like sport facilities, parks and pavements offer an alternative. At the very least, a democratic environment should include public spaces."

Enrique Peñalosa interviewed in "Monday Morning", Copenhagen 2007

If we face the words above of Bogotá's city mayor from 1998, Enrique Peñalosa, we must consider, that no society up till now has created a city without geographical and social disparities such as social ghettos for the different economic and social classes, and subcultural enclaves for various "cultures".

Though this setup is vital for innovations and change of production and living conditions, it means in many periods - often economic febrile times with groups of new rich people surrounded by growing poverty- that the build-in social tension gets up to the city's surface, visible as social rebellion and disorder, as we have seen in the city centres and suburbs of Paris, London, Athens, Copenhagen, Los Angeles, Mexico City and many other big cities during the last decades.

The concept of sustainable cities hence requires wider government than physical infrastructure solutions and sustainable energy supply alone.

It requires a balanced cooperation and involvement of both "rich and poor", families and singles, youngsters and elderly, firms and private people in changing the city's old central district to areas with access to lots of public places. The suburbs are also to be planned and built as mixed and complex urban structures with the same intention.

We have seen how rapidly even old quarters can change - old harbour docklands home for prostitution and drunk seamen are being gentrified - taken over by well off people and companies - and old working class districts changed into "downtown" recreational and displaying environments with fancy cafés, restaurants, theatres and cinemas, clubs and exhibitions.

On the contrary we have also seen nearly new architectural designed housing and offices and commercial buildings being derelict sites - all together within one or two decades.

Bad government, no long-range or far-sighted democratic will or influence from the citizens - and thus an open gate for short-sighted speculative investors and entrepreneurs.

From a sustainable point of view, economically, socially and environmentally, this is a disastrous way of urbanisation.

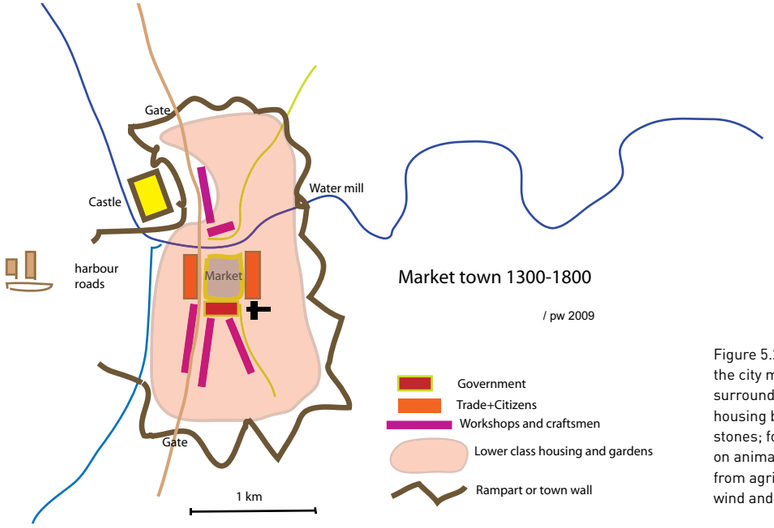


Figure 5.2. During its initial centuries the city mainly belonged to its surrounding resources: heating and housing based on wood and clay or local stones; food, work and transport based on animal and human power i.e. food from agricultural production and finally wind and water power.

Let us take a look to how the cities developed in northern Europe through the main historical periods of growth reflecting the key factors such as production and trading sites, housing districts for the main social groups (historical classes), government districts and the traffic network that links these functions together.

All this connected to the perspective of searching for a future more sustainable - possibly fully sustainable - urban development.

Pre-industrial towns until a.1800

During the pre-industrial periods all work was man made, i.e. hand made craft, most resources came from the local district except special raw materials (logs, iron and other metals) or products (cloth, amber, fine food, weapons, spices) as described in chapter 3. Transport was based on animal or human power with the wind as supplement for boats and ships.

This means that energy consumption was fully delivered by renewable resources (wood), the only machines were powered by wind (the sun) or streaming waters (the gravity).

The town or city was rarely larger than 1-2 km x 2-3 km. Everyone could move all over the area just by walking - longer distances by sailing, riding, or in a horse carriage.

Industrial towns a.1850-1950

During the industrial period these old cities were surrounded by new urban layers of manufacturing industry based first on steam machines, later diesel and electric engines. New railway lines and greater harbours for steam ships went straight to the gate of the old city, which in turn changed to be CBD centre of a big city (Central Business District), filled with finance, trade of all scales and small crafts and industrial backyard firms. Still graded housing for various classes like before.

New growing classes of industrial workers settled in the next urban layer or "ring" around the industrial city, while new rich industrialists or tradesmen as a new "gentry" built countryside or seaside villas outside the city, after all forming new districts of garden cities. A growing middle class of tradesmen and leading people from the public and private administration and the education as well as information and science sector settled in detached housing or better apartments than the workers in a ring next to the workers circle.

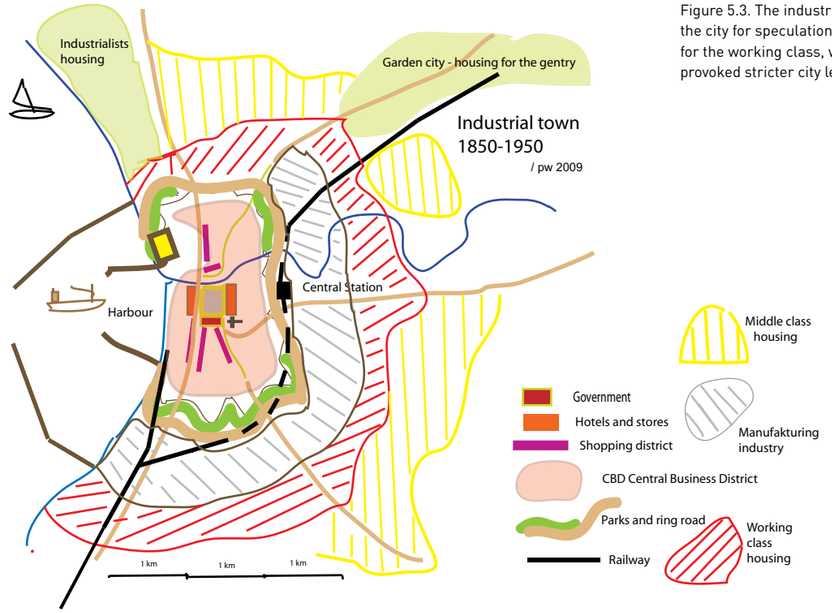


Figure 5.3. The industrial era opened the city for speculation in poor housing for the working class, what later provoked stricter city legislation.

The infrastructure during this century expanded to most corners of the world: already before the year 1900, most mountain chains were penetrated with tunnels for railways. The railways crossed all continents, later supplied by a widespread extension of asphalt roads for motor vehicles and by harbour facilities.

Inside the centre many cities got underground railways and electric tramways in the streets. After a.1920, still more private cars occurred bringing the new rich people from the garden cities to the centre. Commuting was at this period a privilege for better-off people.

Regarding the consumption of resources, the industrial town belonged by far to the local region anymore. Raw materials, energy, building materials, some components and semi-manufacture, a lot of food, luxury and many daily products and even specialised manpower were imported by ship, train, and later in the period on a limited scale by truck, flight - all consuming first coal, later besides coal using diesel, petrol or electricity (mostly produced by coal).

Post-industrial cities 1950-2010

This was the period of globalization of the market economy, first through de-colonization of the former European overseas colonies and their change to independent developing countries, from 1990 through change of most communist planning economies to market economies.

The open borders for finance, trade and manpower caused the widest and most penetrating reorganisation of the production and migration of people ever in history. For the city, the globalization meant a similar reorganisation.

As still more of the manufacturing industry moved to the developing countries and former planning economies due to their lower salaries and weak labour and environmental protection, the size of the industrial working class diminished in the former industrial countries. Instead, the sector for all kind of services grew: from basic maintenance, from retail to financial and commercial service, both private and public, and for information, education and research.

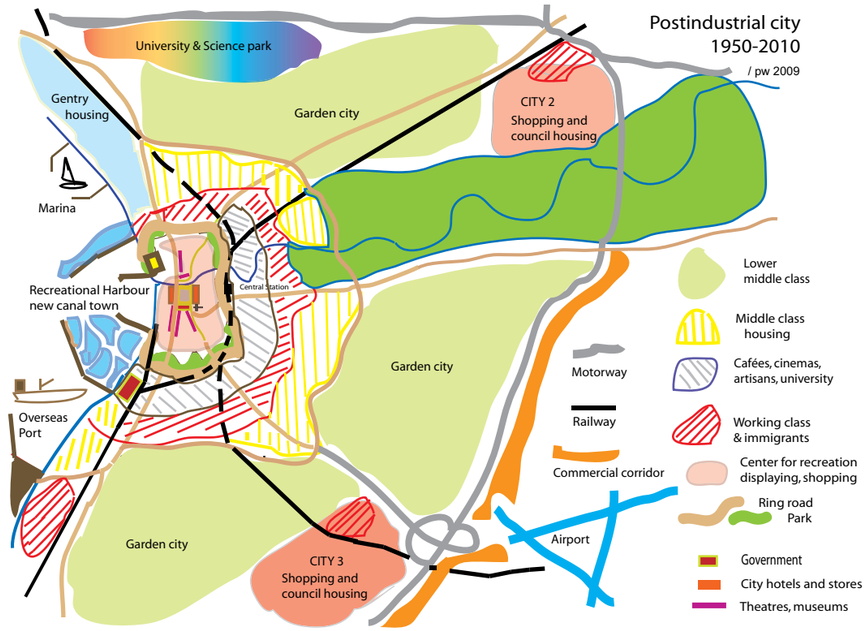


Figure 5.4. The motorization has since the 1950-70s changed the size and composition of the city dramatically. It will be crucial for obtaining sustainability to get rid of the oil-based motor technology. Notice the commercial corridors growth along the motorways. It is here the citizens by car catch their large consumer goods, causing traffic jams and massive long lasting CO2-emission every evening and weekend.

While immigrants together with the lower middle class and educational youth took over the old working class districts, the fast growing middle class from the service sector moved out of town to new built suburbs or garden cities, or to next provincial town. After all, this caused general urbanization even of the countryside especially for villages located near motorways and railways.

The new rich "gentry" from trade, high tech, IT and finance settled in new recreational seaside residential areas in the old harbour or property along the coast. The city centre was transformed to a recreational shopping and cultural area with museums and theatres. In connection to this, new quarters for bars, cafés, experimental theatres, music stages and cinemas aroused from the improved former industrial district.

In most cities the old centre has restrictions for cars. Pedestrians, cyclists, buses and metros make the transport. However, around the centre the physical transport is mainly motor cars and trucks. Many suburbs, in particular garden cities, are badly served by public transport. Besides, the retail of goods and even grocery stores have moved out of town to satellite sub-cities with commercial centres and to roadside commercial corridors, built along the motorways with easy access for cars, vans and trucks, but with no access by bus or train - and long distances for bicycles.

This way of location of the commercial service sector will link future city development to motoring for long and make lower greenhouse gas-emission nearly impossible as long as the engines of the cars burn petrol and oil.

How to make the city sustainable?

The question on how to change the over-consuming and exhausting city in an environmentally friendly direction has in the light of climate changes and urban expansion been in focus for discussion at many international conferences and meetings for urban planners and environmentalists through the last decade.

Let us take one of them, a congress about "The future of cities" held in Copenhagen September 2007 for 700 planners, politicians, researchers and students from 40 countries.

They passed a common "Copenhagen Agenda for Sustainable Cities" of 10 principles:

The basic statement was, that since the challenges for the cities derive from the city itself, the solutions must be developed there.

Another statement was, that cities by nature ought to be environmentally-friendly because they concentrate population and thus should reduce heating and transport.

Both statements sound visionary, but can never cover the reality that most citizens originally moved from the country to the city or back to urbanized villages due to bad living conditions. In the city or the urban sprawl they had just to use existing technology for heating and transport and to take the jobs and products available from the globalized market. Alone they had no chance to break this pattern of dependency between the globalized city and the World market.

Nevertheless, the Copenhagen City Agenda brought good visions for sustainable city governance, and promises to deliver "specific issues" about "healthy future for global cities" at the UN Global Climate Summit in Copenhagen December 2009.

The 10 principles in the City Agenda were:

1. Re-discover the city
2. Re-define city values
3. Involve every day experts
4. Break down "silos" (adm. structures)
5. Re-distribute urban decision-making
6. De-design urban planning
7. Promote corporate urban responsibility
8. Go global - for environmental technology
9. Embrace chaos, crisis and change
10. Encourage passion in urban leadership

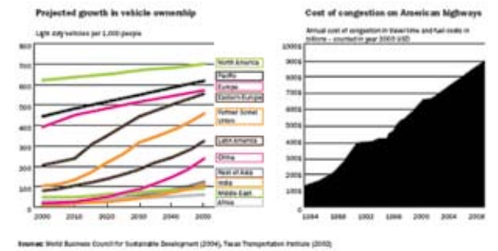


Figure 5.5. In 2009, many governments such as in the USA and the Nordic countries predicted a farewell to the motor car within 15 or 20 years. But will people give up individual transport or will other cars occur out side city?

These principles are all democratic i.e. human and political objectives. They do not pinpoint how and by which means and technology the future city exactly may develop in a sustainable direction.

However, among the contributions to the conference the concrete pieces of advice were numerous: urban density is fundamental for reduction of energy consumption, both to transport and heating, that has been ignored in Europe and USA, but will not be in China (prof. Richard Burdett, London)

He also calls for strong and visionary urban leadership to force private companies and investors to be interested in participating in the development of cities.

Democratic leadership is also fundamental for Joel Kotkin, the author of „The City".

"The concept of the city is driven by two equally important visions: (1) Do we care about what happens to our city? This is highly dependent on governmental institutions.

(2) On a lower scale, these feelings must be brought down to the local neighbourhood to help engage people locally and strengthen their feelings towards the city."

Many contributors mentioned the infrastructure as well as building standard as crucial for sustainability. The former mayor of Bogota Enrique Peñalosa thinks that people in cities like Amsterdam and Copenhagen underestimate the importance of cycling.

Cycling and walking are beside energy-saving also instruments for keeping the population healthy simply because they get motion. As for the British fit towns, this strategy is seen as

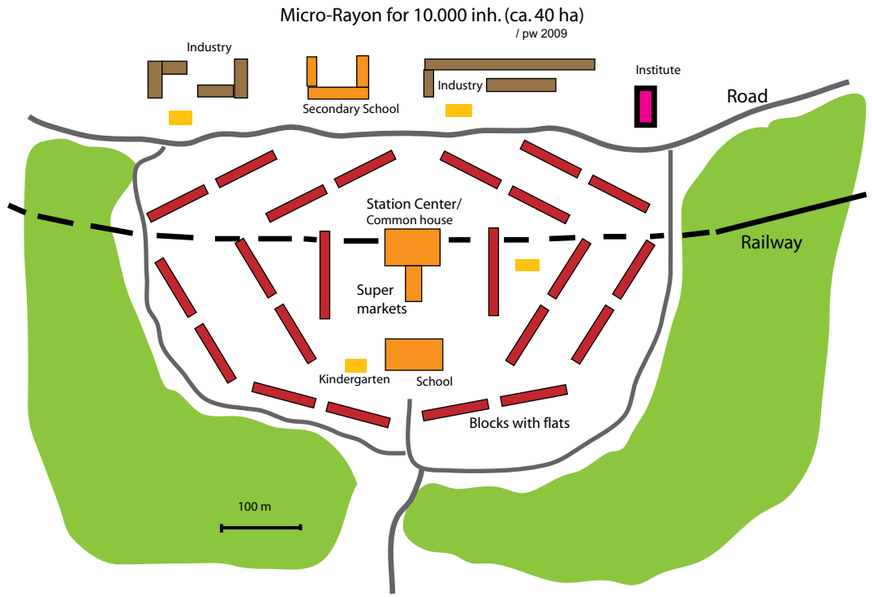


Figure 5.6. During the communist era the planners in Eastern Europe realised a model for suburbs, which is actual again due to the need for Zero consuming cities: the unit of a suburb was home for 5-15,000 people in flats, of which none had longer walking distance than 8 minutes to all central facilities: shops, transport, work, kindergartens and schools, sports and leisure areas.

"medicine" against the global obesity epidemic of fat people. Urban planning may reduce lifestyle obesity and diabetes, and make a farewell to car driving in towns easier.

Figure 5.5 shows how common private cars have become, without any sign of decreasing demand for private cars. If car driving is going to be restricted inside cities, there will be a need for a new quality of flexible and cheap public transport, either light rails or simply electric busses in separate bus lanes like in Bogota and Brasilia, where a bus system with high frequency move 500,000 citizens as fast as a metro for a tenth of the cost of a subway.

A similar view of the importance of the good infrastructure of a "healthy" city was given by Anthony Capon, Australia:

HEALTHY CITY CHECKLIST

- less than 500 m to a bus, train or tram stop with regular services (min. every 30 min)
- less than 500 m to shops
- less than 500 m to parks
- less than 30 min to education, employment, social and cultural opportunities
- safe walking and cycling paths to a primary and secondary school
- mix of housing types and prices, suitable for various life phases
- housing built or adapted using environmental principles
- good outdoor and indoor air quality
- sense of community in the neighbourhood
- tolerant and safe environment

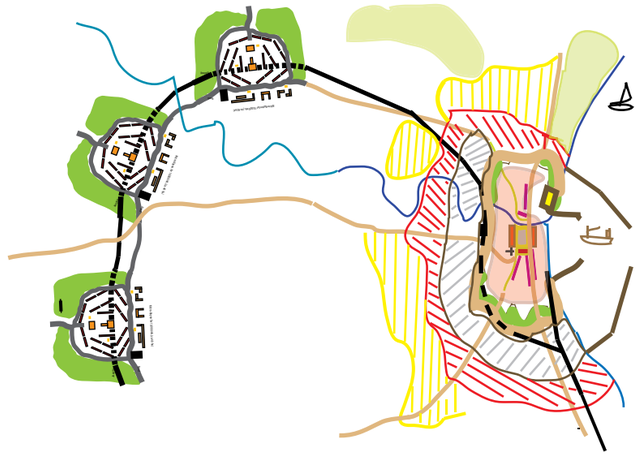


Figure 5.7. By location of a row of suburbs, the city grew without losing the composition of local democratic governing units. Fast busses, trains and cycle paths connected the "rayon" with both work and education places, and the old city centre with its recreational, historical and cultural institutions.

Among the other contributions to the creation of a sustainable city were instructions for green housing, i.e. energy saving, well insulated but ventilated buildings as demonstrated in the example of Sønderborg's zero housing.

How the power for electricity and heating is produced is another core question for the future sustainable city. The example of Sønderborg shows how a local solution based on geothermal energy reduces the need for fuel. Another local solution used biogas or biogas generated by wind power. Housing in huge districts may be heated these ways, or by solar energy. The technology is at hand, investments, planning and good democratic governance is what will be needed!

Hence, as for inhabitants in the cities of the future, it is up to the citizens to take part - take "the other part" - in a democratic partnership with the government for sustainable urbanization!

Questionnaire 5: How to check the planning of your own city - make it future-ready!

What to do for BSP-schools. Research schedule:

An idea-sketch on how to implement and push more sustainable development and technology in the local, regional or national urbanisation process.

Research schedule (proposal) for any town and city.

Check the urban development since 1991 (Rio) for its sustainability:

How did the Rio-convention affect the planning of urban areas according to sustainability?

Check by use of maps and other documents which new districts and constructions have been made.

Check all parts of the city: the town centre, harbour, suburbs, other districts.

Check the plans for the future extension of the city, among them for suburbs.

Ask the local administration of the municipality for information and plans.

Search internet homepages.

Traffic

To what degree are principles of sustainability integrated in the traffic planning now and for the future?

Check by observations and use of maps the infrastructure, i.e. roads, cycle paths, pedestrian areas (footpaths, pedestrian streets, pavements, squares); rail- and tramways; waterways, canals, harbours, airports. Draw a map of the infrastructure.

What are the priorities of transport forms now: walking, cycling, scooter, bus, automobile, train?

Are there plans for alternative transport or roads: windbreaks for cycle paths, light rails or trams, bus lanes, pedestrian streets and districts, electric cars, airship zeppelin?

Energy account

Register the energy production and use, type, limits. Try to get information from local authorities, energy plants, energy and environmental organisations.

Buildings

Check insulation, energy efficiency, design – how does law give the statutory standards?

How far are they from zero-energy standard?

Materials – to what extent are building materials local? Global (imported)?

Consumption and use of materials. Treatment of waste

How is the collection/sorting of waste?

To what extent is waste reused or recycled?

How is environmental scrap treated?

Green surroundings as climate zones

Draw simple mapping sketches of green networks, belts or lonely spots. Parks and urban forests. Sports grounds. Green courtyards. River, lake, coast promenades.

What happens to former harbour and docklands? Deserted or gentrified?

Water household

Is the supply from the surface or ground water, or both?

Does the community feed the groundwater or let the runoff run?

What happens to runoff of surface water?

How is waste water and sewage water treated? Visit the local waste water treatment plant.

Draw a map on how the treatment plants cover the city's need.

Planning

Draw a simple plan for the future development of your city as a healthy city.

Send your proposals and plans for a better city to the government and local newspapers!

A view into the future of the city - what is on its way to be realised?

Urban greenhouse

American scientist have already long talked about skyscrapers as greenhouses for growing of vegetables for the cities. The Swedish food company Plantagon is may be going to build them soon.

The main argument is that though humans originally lived in the wild nature as well as plants and animals, most people now live in towns. Since modern farming is still more critical for the nature due to its use of chemistry it will be more environmental friendly if basic food is produced in tall greenhouses separated from the nature:

Water and organic waste can be reused, the growing is independent of the weather. It will not occupy agricultural land, which is a limited resource, transport to the consumer is short.

(More sources: among them "www.squidoo.com" and "Ingeniøren", Copenhagen 2009)

Will the shipping emission be solved by new high tech vessels ?

As the supply of the cities for 90% rely on transport of goods, this sectors energy consumption is crucial for the efforts to developing sustainable cities.

The BP Oil Co, which runs 50 super tankers estimated 2007 that the global fleet of 70,000 ships uses approximately 200m tonnes of fuel a year and this is expected to grow to 350m tonnes a year by 2020. Carbon dioxide emissions from shipping will then be 4% of the global total. Aviation counts for 2%.

Without action the International Maritime Organization predicts that by 2020, emissions from ships would increase up to 72%.

(Source: The Guardian 3 march 2007)

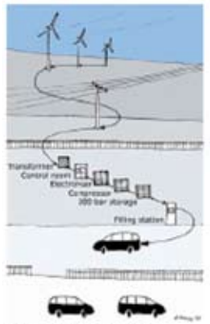
Either shipping nor air transport is covered by the Kyoto accord. How then to solve the problem of the growing CO_2 emission from this sector?

The Japanese shipyard CoNippon Yusen KK (NYK) is going to try. The company plans to complete the development of a future container ship by year 2030, 353 m long and mainly powered by fuel cells of 40 megawatts using liquefied natural gas as hydrogen source.

The aim is to reduce the CO_2-emission per ton-mile by 69% by this technological innovation. Besides the fuel cell engine the "super eco ship" from NYK will use a sort of high tech lamels as sails to use when the wind is useful, supplied by energy from solar cells.

Involved in the project is the NYK-owned Maritime Techology Institute in cooperation with the Finnish consulting company Elomatic and the Italian ship design company Garroni Progetti. (Source NYK Lines April 2009)

Private transport to the city - do electric vehicles make the future?



Examples of wind-hydrogen-transportation supply chain with production of electricity, electrolysis plant, storage and filling station.

Which one of these electric vehicles will be the future means of transport in the city and outside it? The electric BYD car from China or the German bicycle with an electric motor built-in on the front wheel, the battery is on the back (Manufacturers photos)

Many researchers and manufacturers try these years to conquer the future market for individual sustainable vehicles to use both inside and outside the cities. Bicycles have a great future, no doubt, inside and between suburbs. Transport to and from the settlements in the countryside - the urban sprawl - and for travelling as individual tourists will for long keep millions of people heading for a private non-polluting car.

Does it exist?

One vision deals with the promotion of the fuel cell as engine in cars and trucks shown at the left. This concept is based on a production of hydrogen by converting wind or solar power to electricity and further on by electrolysis to H_2.

Another vision ask why electricity can't be used straight as it is in cars with electric engines. Until now the limitation for this concept has been the low capacity of the battery, but manufacturers are working to solve the problem. One of them is the Chinese manufacturer of accumulators BYOD, which through a number of years also produced electric cars, named BYD (Buy Your Dream). The next years will show which trend is the strongest.

Are the cities' "downtowns" to rescue from flooding?

After a serious flooding of 15.000 hectares in 1953, Holland built a huge flooding protection system of the delta area for the Rhine, Maas and Schelde rivers between Rotterdam and Antwerpen. Gates can be locked for the ocean during storm and sluises let the ships pass the locks at normal tide.

Photos by Deltawerken.com

One of the greatest environmental threats to the cities in the future is flooding caused by a still warmer climate, both due to rising sea level and to higher precipitation. Considering the shape of the Baltic Sea there are only two or three relatively slim and shallow (7-11 m) water straits or gates from the Baltic Sea to the ocean, which during westerly storm carry big quantities of water to the Baltic basin.

A rise of just ½ m (expected within 50 years) will cause severe flooding in the low centres - the crowded downtowns - of most coastal cities in the region. But the regions geomorphological development points out a solution: A barrier of the Danish Straights, similar to the Deltaplan in Holland. Here a sensible very low delta zone has been protected from both ocean flooding and flooding from rain brought by the rivers.

Literature and references, links etc.

Most used sources are mentioned directly in connection to or inside each chapter. Further links are:

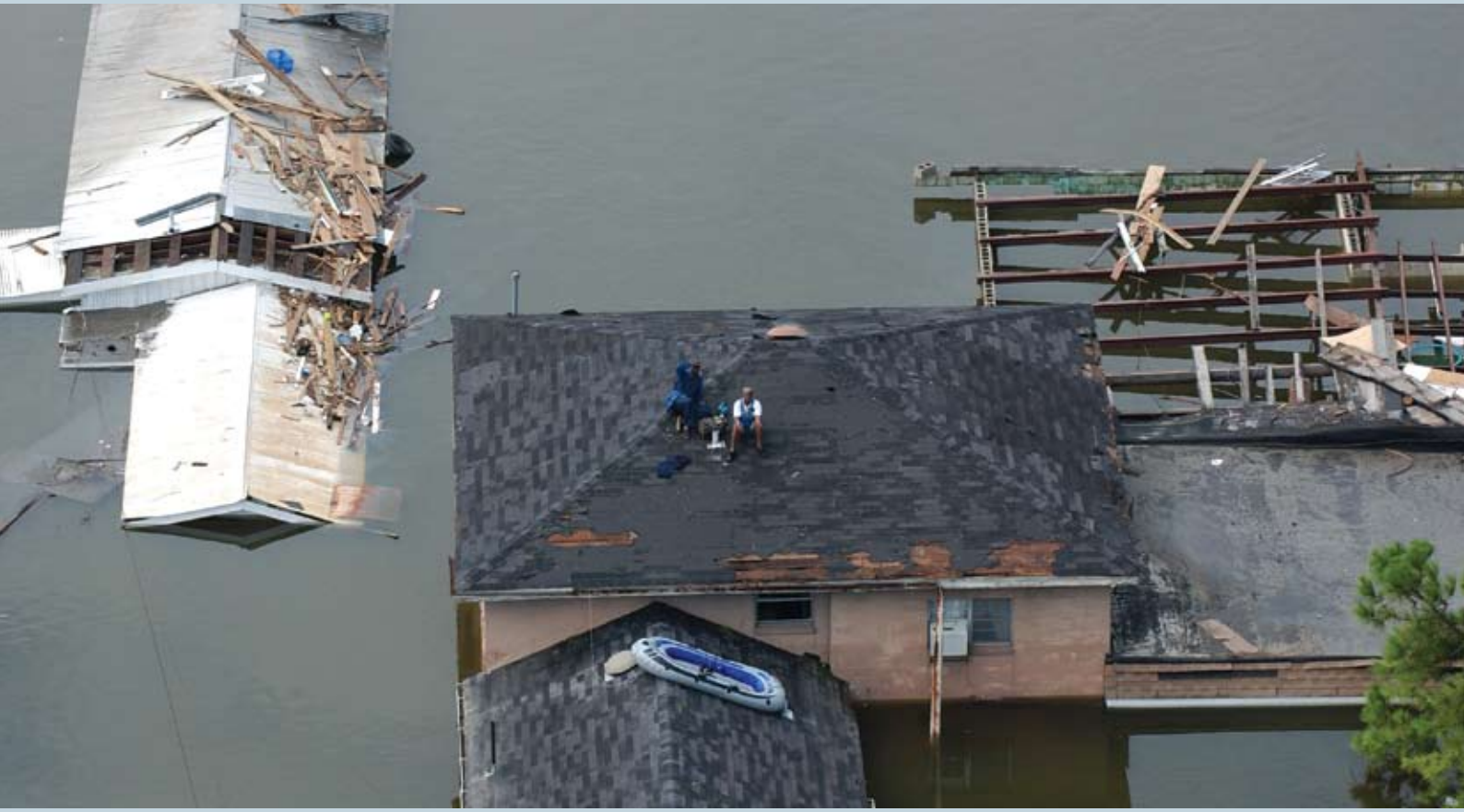
Links

http://www.iclei.org	search system for urban ecology websites
http://www.nweurope.org/page/projetIdea.php?p=&id=241	EU-project for urban development
http://auto.howstuffworks.com/	How stuff works: Very instructive website on all sorts of technologies and their function, even the newest: fuel cells and solar cells
http://www.iisd.ca/	Canadian International Institute for Sustainable Development
http://www2.wupperinst.org	German Institute for Sustainable Development
http://www.dcue.dk	Danish centre for urban ecology
http://www.urbanecology.net/	The Urban Ecology Centre, Montreal, Quebec, Canada
http://www.urbanecology.org.au/	Australian Research Centre for Urban Ecology. Royal Botanic Gardens, Melbourne
http://www.earthcharter.org/youth/	The youth group of Earth Charter;
http://www.users.on.net/	Australian website on sustainability
http://www.worldwatch.org.	The World Watch Institute
http://www.environment.fi/	Finlands ministery for Environment
http://www.mappeonline.com/unesco/atlas/	The Ipogea Institute of Matera (Research institute for traditional knowledge on sustainable development in the Mediterranean and Middle East)
www.greenroof.se	a Swedish firm producing green roofs

Further readings:

Urban Ecology: An International Perspective on the Interaction Between Humans and Nature. *By John M. Marzluff. Contributions of Eric Shulenberger, Wilfried Endlicher, Marina Alberti, Gordon Bradley, Clare Ryan*. Springer Verlag 2008. ISBN 0387734112, 9780387734118

The UNESCO Associated Schools Project



Hurricane Katrina aftermath in New Orleans, 2005

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