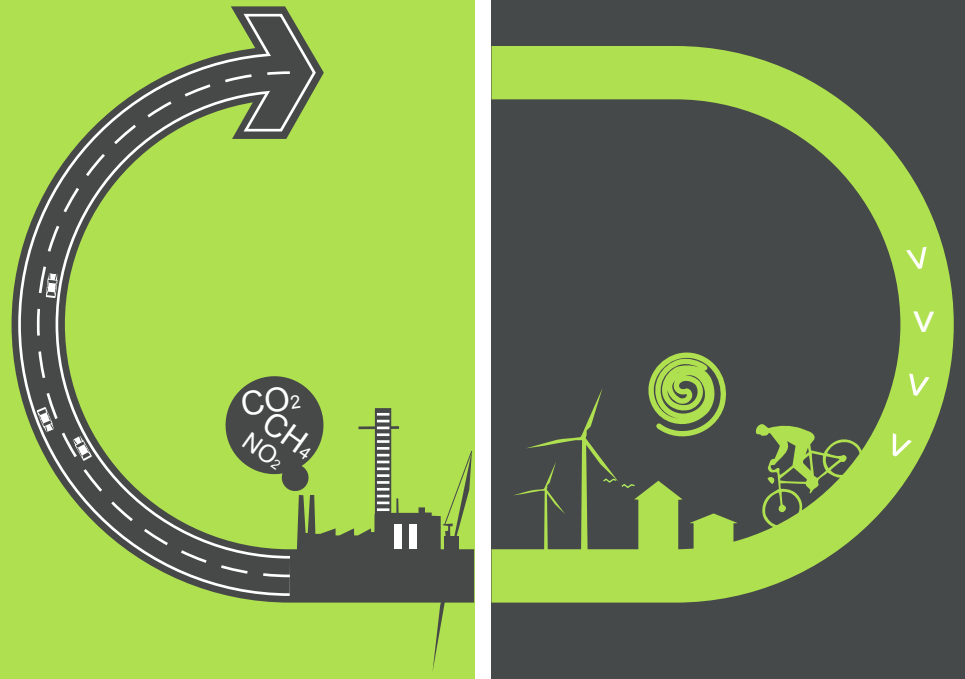
Efficient urban planning in new energy era

The ‘urban renewal planning’ guide for greenhouse gases reduction



Efficient urban planning in new energy era

The 'urban renewal planning' guide for GHG reduction

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Preface

In many countries, urban planning has been developed as one of the means to organize and to integrate limited resources and spaces. The procedure of urban planning includes consistent revisions, balancing social-economic development and many environmental issues. Having been manifested in the thought, 'sustainable development', it is becoming a main theme concerning the life of next generation.

Energy use is of particular importance among all the themes of sustainable developments. Firstly, advancement of energy use impulses every jump of civilization. For instance, the way that we use energy for cars and heating systems nowadays did not exist a hundred years ago. Gradually the pursuit of economic growth and a better quality of life is stimulating a permanent, increasing global energy demand. Secondly, energy production and consumption (including heat and electricity production, oil refining as well as use by households, services, industry and transport) cause considerable increasing pressures on the environment. These pressures include the constant emission of gases contributing to the greenhouse effect, waste generation, oil spills and other air pollutants. In a great degree, these contribute to climate change, damage of natural ecosystems and also the man-made environment. Moreover, these are the causes of adverse effects to human health. Worldwide studies have provided scientific evidence that the increase of greenhouse gas concentration in the atmosphere is largely of human origin. Furthermore, it has a direct bearing on the climate change. Human activities represent sources of greenhouse gas emissions mainly through conventional energy consumption, the burning of fossil fuels.

The more that energy and climate problems have become urgent, like two sides of the same coin, climate solutions have been studied in many different fields. It is logical that energy alternatives only come into existence with the understanding of how users consume energy. However, the pertinence of specializing technologies and measures based on "different horses for different courses" have been developed separately. As mentioned in European Council in March 2007, nowadays weaknesses in the energy research and innovation system are short of network connection, scattered and un-coordinated

market incentives, and scattered, fragmented and sub-critical research and innovation capacities. Thus a muti-sectoral strategy and set plans are crucial joints in which technical innovation and measurement can take place.

Scattered implementation in the realm of urban planning concerning energy and climate alleviation can also be found in many research studies. 'Means of saving energy' apply in a single target or a small scale. However, spatial strategies have not yet been integrated with energy demand, which is easily proven by current city plans from municipalities in the Netherlands. For example, the transit plan and displacement of urban functions account for accessibility rather than possible side-effects, both encourage car use. Since the Kyoto protocol world conference in 1997, traffic density in the Netherlands has raised 15% (2005); road networks increased 2,937 km from 2000 to 2004; and nearly 7 million cars were registered in the Netherlands in 2005, a 10 percent increase from 2000 (CBS, 2006). The problems of urban transportation cannot be explained by any single reason, but it is necessary to redefine spatial strategies especially when we are facing the terrific pressure to limit the rise of global temperature within 2°C. (the tipping point of a catastrophic climate.)

It appears that current reactions are too slow for the environmental enhancement. One of the bottle-necks which has existed in the initial planning levels is how to take care of mass sectors of urban environment and their affiliation to the systematic energy chain. This includes some rising questions:

—What kinds of spatial strategies can minimize their contribution to Green House Gas (GHG) emissions?
—What is the main task for the sustainable energy plan in urban planning level and what is not?

This guide was produced after eight-months research concerning spatial strategies and energy consumption. Through a master plan practice and relative research support, we hope to answer the questions above. The intention of this guide is not to cover every design possibility regarding energy related sectors in urban environments; nevertheless it is to denote how to use fewer sectors to create large-scale GHG reduction by the means of urban planning. The strategies included in this guide mainly focus on the housing and transport sectors which account for almost 50% of the energy consumption in the Netherlands. They are the essentials in every urban plan. The approach used for the housing sector is also applicable for buildings with other functions.

PART I
INTRODUCTION

Foundamental

This section introduces this guide book.

Why include the consideration of GHG reduction in urban renewal process?
Who should use the Guide?
What is the limitation of the Guide?



Why include the consideration of GHG reduction in urban renewal process?

>> Planning processes is of crucial importance

Many perspectives, charged for egregious price or immature technology, are mainly due to the fact that the idea of GHG reduction has not been applied widely yet. However, some evidences prove that it is not the only reason. A well-known, inexpensive and simple option such as double glazing and solar cells are sometimes not applied when houses are renovated. They are very expensive and have a long pay-back period, although this application is increasing in new housing estates. J.vd.Waals(2001) argued that *the adoption or non-adoption of options for CO_2-reduction in building and urban renewal projects cannot be explained solely by their technical and economic characteristics, because factors related to planning processes also play an important role.*

The decision-making process in large projects normally demonstrates complexity in nature, since many stakeholders are involved. It has to cooperate with relative politics, the competencies of actors, organization of the planning process, financial arrangements, obligation distribution and etc. To integrate the consideration of GHG reduction in planning process is a good starting point. And reducing amount of GHG emissions in planning level are related to information sources, treatment skill and instruments within limited money and time.

>> Potential in urban renewal

Generally, people who reside or work in new buildings consume less energy than those who live in old buildings. It is due to higher technical standards on new buildings achieved by progressive policy requirements and social demands. New housing developments have to comply with the energy performance standard, which was first introduced in 1995 in the Netherlands and further have been revised and amended several times for better efficiency. The policy affects large reduction of primary household energy consumption in new buildings. Housing built in 2000 consumes only half of the energy on heating and electricity than the housing built just after World War II.

However, housing built after 1995 only accounts for 11% out of 6.9 million dwellings in the Netherlands as of 2006. The annual housing replacement rate (including new development and old house replacement) is around 1%; and rest of 89 % of existing housing have to rely on the urban renewal process if a large-scale energy saving target is to be met.

However, little attention was paid to options for GHG reduction in the urban renewal projects before 2006. In 2006, a temporary subsidy for large-scale reduction of CO_2-emissions was issued for owners of existing dwellings and non-residential buildings. In 2008, more budgets of Spatial Planning and the Environment were assigned to built-up environment. This plan focuses on energy conservation in existing buildings and residential constructions. As a part of this plan, 500,000 buildings and residential constructions will be renovated in more energy-efficient way in 2011 (VROM, 2008). It draws daybreak of large-scale GHG reduction in household sectors. Thus urban renewal plan concerning energy saving is needed. First of all, it analyses social, spatial structure and energy performance in local level; secondly, it takes the lead to develop urban-energy integrated plan according to local demands. Many relative factors will be taken into account during planning process. More integration on earlier planning phase will result in less incoherent program and greater impact of energy saving.

Including the consideration of GHG reduction in urban renewal process is the premise of every further discussion. The proceedings may be how to approach and to realize this consideration. Diverse measures in sustainable development on the past have been devised for decision-making and planning process by different interests and goals. Many of measures are related with spatial planning and GHG reduction, although they are not sufficiently specialized thus arose confusion in initial phase of planning. Main objective of this Guide is to contribute to strategies and approaches for the urban (renewal) planning in the direction of GHG reduction. It also implies how planning process can contribute to GHG emissions and how different strategies are correlated to optimize this impact.

The Memorandum on Urban Renewal (Nota Stedelijke Vernieuwing, Ministerie van VROM, 1997a) and the Memorandum 'Housing in the 21st Century' (Ministerie van VROM, 2000) sketch the national policies toward physical improvements in existing cities. A central goal of urban renewal is to create a variety of housing stock and a population that also includes people with higher incomes. Physical improvements of existing city are expected in order to improve negative social and economic situation which was actually engendered by their development.

Who should use the Guide?

The purpose of this guide is to build up the relationship between spatial planning and energy consumption in order to clarify the crucial decisions in urban renewal concerning GHG emissions. Furthermore, it involves how to introduce possible approaches according to the principle 'less sectors, more integration ' in a practice site. This guide will review spatial strategies which **municipalities** used to follow and to establish parochial guideline for alleviation of global warming. On the other hand, especially for **urban planners** of **housing corporations**[1] and **housing association**, it provides integrated approaches with demonstrated cases which underline sustainable energy use. Moreover, it is aiming to derive balanced social and economic aspects to fulfill spatial transformation in limited time and space.

Similar intentions from this Guide are found in '*Meer met Minder plan'* in Energy Efficiency Action Plan (EEPA, 2007)' but have not yet been

1 Housing corporations play a major role in Dutch housing. About 500 corporations possess 35% of social sector renting houses in the Netherlands.

MmM-plan is a comprehensive collection of policy measures in EEAP 2007 to achieve considerable energy savings in the built environment. It will be implemented in covenants with the participating organizations. An MmM program board will be installed, which becomes responsible for the implementation of the plan.
The plan contains several components:
- Energy Central
- Remove barriers
- Change the housing assessment system for social housing
- To lead energy saving for homeowners and private landlords in combination with district approach.

Name	Meer met Minder (More with Less) plan
Category	Voluntary agreement with commercial and institutional Organizations
Regional application	The Netherlands
Target group	Energy companies, housing associations, private households, tertiary sector and construction sector
Action targeted	Stimulating both institutional and private home/building owners to take energy saving measures in existing buildings
Status of implementation and planning	Process of implementation not started yet

Source: Energy Efficiency Action Plan (EEPA, 2007)

specialized. This guide supports the idea of '*Meer met Minder* (More with Less) *plan*' in information organizing aspect, e.g., to combine energy saving with district approaches, to help decision-making on applying scale and adopting options, and to evaluate cost-effective investments with relative factors…etc.

The limitation of the Guide

This guide deals with the means for the climate change in the discipline of urban planning. Fossil fuel, as the conventional energy source, is located at the core of problem in global warming. This guide can be still functioning, unless no fundamental change is made or no substitution of energy, which can fit most demands from human activities without scarify environment balance is found.

This guide was written with the concept of sustainable development, which maintains a delicate balance between the human need to improve lifestyles and feeling of well-being on one hand, and preserving natural resources and ecosystems, on which we and future generations depend. Instead of widely covering every aspect in sustainable development or dealing with numerous urban problems, this **particularly deals with energy, transport and housing issues**. Some strategies which are offered in this guide may possibly disagree with other developing interest. How to compromise all issues in decision-making process is not dealt here. Yet the role of spatial planning in large-scale GHG reduction is partially introduced.

The awareness of urban planning in new energy era

This section discerns the role of urban planning by reviewed current energy policies and legislation.

2

Energy saving measures applied to energy use sectors are closely related to current policy system. Energy taxes and subsidy are the general instruments within central policy schemes to restrict energy use and to stress energy saving. However it is not enough for large-scale GHG reduction, if local authorities and involved parties as executants and receivers of central policy merely execute levy and adopt options without developing or optimizing their strategies. This type of multi-sector integration part was rather insufficient on current practice thus needs more incentive program from central government.

2.1 Know the climate change imperative in EU and Netherlands

There is almost unanimous agreement among scientists (also governments) that climate change is a fact. Geological records show that our climate has changed greatly over the time, but current concerns related to quickening, human-induced change are mainly due to burning fossil fuels. Fossil fuels as the conventional energy sources are the problem of global warming. Environmental concerns are not only linked with damage from energy supply system, e.g. oil slicks, nuclear accidents and methane leaks, but also from the inherent inefficiencies of the combustion systems. The general requirement for emergent reaction is based on the facts:

>> Economic and energy dependency on fossil fuels
Fossil fuels dominate more than 90% in the world's total commercial energy demands.

>> Tipping point of catastrophic climate
(a rise of 2 °C in global temperatures):
It is considered as the threshold for catastrophic climate change which will lead millions to drought, hunger and flooding. It was generally accepted two years ago that scientists predicted it would be as little as 10 years before this "tipping point", for global warming was reached, adding a rise of 0.8 degrees a year. But it had already been reached today.

Improving energy efficiency across sectors and throughout activities is a key factor and also a challenge towards sustainable energy use. As a response to energy problem

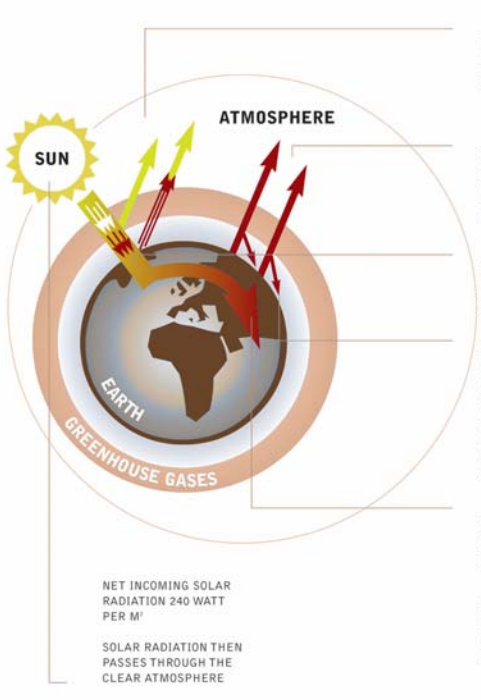
and climate change, the European Commission proposed 'An Energy Policy for Europe' in 2007, which described energy use objective. In the mean time, an action plan namely European Strategic Energy Technology Plan was further developed during 2007 and is being tested in 2008, in which EU promise to reduce its greenhouse gas emissions at least 20% unto 2020 compared to 1990 levels. In addition to that, according to the document 'Limiting Climate Change to 2°C - Policy Options for the EU and the World for 2020 and beyond', by 2050 global greenhouse gas emissions must be reduced by 50% compared to 1990 levels. Current core in EU energy policy can be classified into 4 emphases:

- >> **Reducing energy demand**
- >> **Efficient energy supply**
- >> **Renewable energy resource**
- >> **Muti-sectoral strategy**

Climate change

Above left: The greenhouse effect

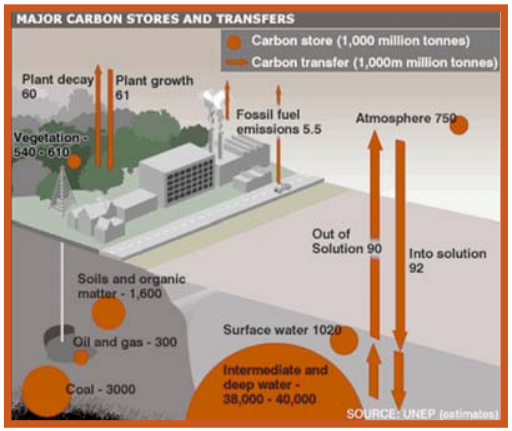
Above right: top 10 warmest years between 1850 and 2005



COMPARED TO MEAN GLOBAL TEMPERATURE 1880-2003

YEAR	GLOBAL TEMPERATURE ANOMALY	RANK
1998, 2005	+0.63°C	1
2003	+0.56°C	2 (tie)
2002	+0.56°C	2 (tie)
2004	+0.54°C	4
2001	+0.51°C	5
1997	+0.47°C	6
1995	+0.40°C	7 (tie)
1990	+0.40°C	7 (tie)
1999	+0.38°C	9
2000	+0.37°C	10

Source: EUROPEAN RENEWABLE ENERGY COUNCIL (EREC, 2007)



2.2 Policy background in Netherlands

The Netherlands' Energy Efficient Action Plan (EEAP) was published in September 2007, which is the implementation plan to meet the Directive[1] of April 2006. It described the measures toward energy end-user and energy services, and the indicative targets from 2010 to 2016 for energy saving. Corresponding with Energy mix fact sheet in Netherlands (2007), five main sectors were defined by energy end user: household (occupied 27% energy use), transport (23%), tertiary (18%), industry (24%) and agriculture (8%) sector, and at least 9% saving target was set. Unequal saving targets according to different sectors was introduced (Figure1). It is expected that the household sector will be the highest in energy saving on the level of 41% and 32% saving from transport, 18% from tertiary and only 2% from industry sector (EEAP 2007). It shows that household and transport sectors are highlighted in current energy efficient plan: for 9% energy saving target, household and transport sectors bear 6.7% energy saving as a whole before 2016.

>> Residential Sector

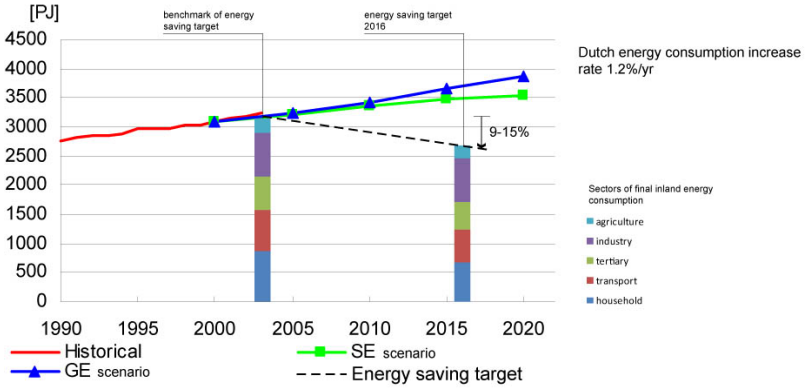
The energy policy (EEAP,2007) for households combines 13 policy instruments that are focused on increasing awareness of energy consumption (i, ii, iii, v), providing an insight into self-regulation (iii), stimulating households into taking measures (iii, iv, vi, vii, viii, ix, x, xi), and building up statutory measures for newly built housing (ii). The policy instruments are:

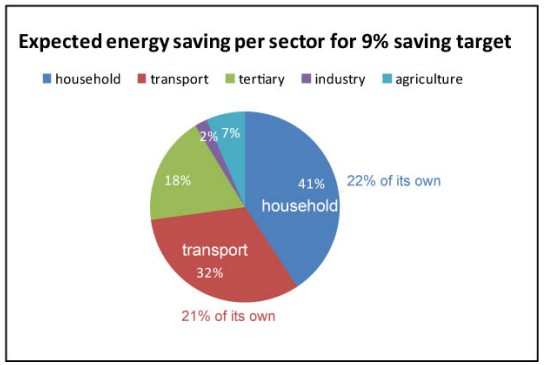
1 Directive is a legal instrument serving for European commission. It impulses Member States to cooperate with EU central plan. It asks Member States to tailor their own action plan to achieve the common goal. Member States are obligated to follow the Directive.

Figure 1

Dutch energy consumption trends and end users

Total inland consumption in PJ_{prim}, historical consumption including temperature correction





Source: ECN 2005, EEAP 2007

i. Energy Tax
ii. Building Decree and Energy Performance Standard (EPC)
iii. MilieuCentraal, COEN (Consumer & Energy) and HIER campaign
iv. TELI subsidy scheme
v. KOMPAS
vi. Temporary subsidy scheme Buildings and CO_2 reduction
vii. Green Funds Scheme (Groen Beleggen)
viii. Expand green investment arrangements
ix. Meer met Minder (More with Less) plan
x. Taskforce lighting
xi. Covenant housing corporations
xii. Heat distribution
xiii. Enhancing effects implementation of Eco-design directive

Energy performance requirement is an enforced energy saving instrument on newly built housings. Project developers and other parties of the project are obligated to take energy-saving measures in all new developments. The permitted Energy Performance Coefficient (EPC) for newly built housing has been tightened from 1.4 in 1995 to 0.8 at present. As a

result of these measures, newly built houses are able to save average of 30% in energy compared to previous building standard. Yet policy scheme on exiting housing has shown more incentive attitudes. Three financial schemes (iv,vi,viii) and one semi-enforced covenant (xi) focused on existing housing. They are aiming to encourage housing corporations, housing association, local authorities and private house owners to take energy saving measures. Existing building will be also assisted by MmM-plan, which will lead the role of advice, removing barriers and establishing approach for energy saving program.

>> Transport Sector

The following measures apply to the Transport sectors. They mainly deal with car user by levy, habit change education and speed limitation.

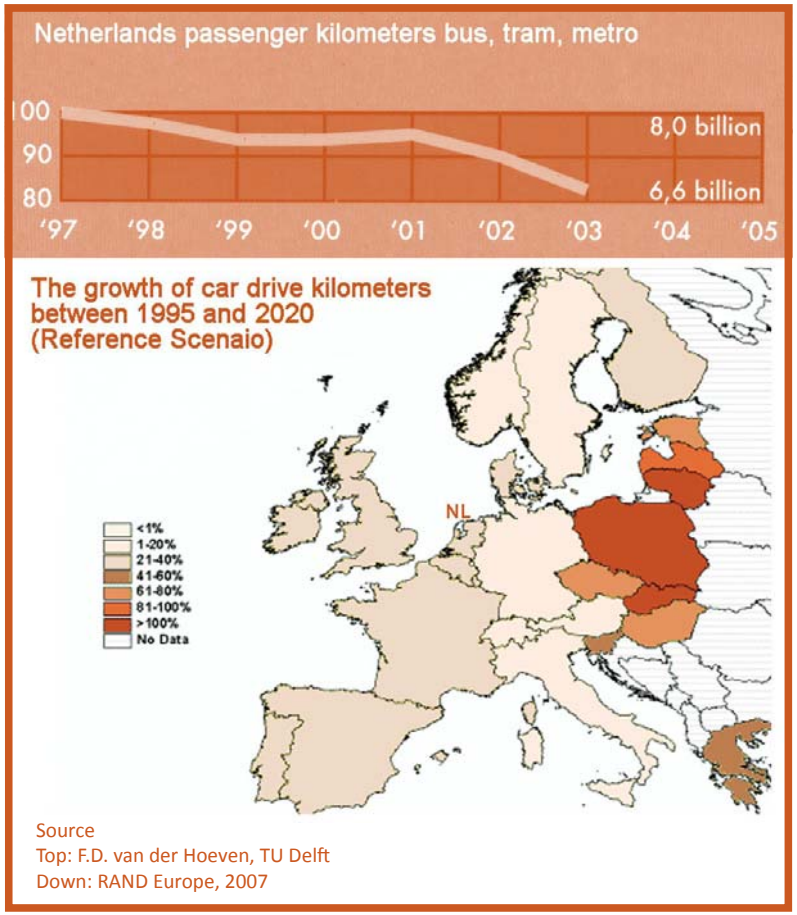
i. Energy Tax
ii. Energy Investment Deduction
iii. Long-term Agreements
iv. Taxes: fuel taxes, motor vehicle tax (Dutch: MRB) and private motor vehicle and motorcycle tax (Dutch: BPM), surcharge levy per kilometer, CO2-differentiation BPM
v. Limiting maximum speed
vi. Energy labeling of cars
vii. 'Eco-Driving' programme
viii. Subsidy scheme CO2 reduction transport
ix. Longer and heavier lorries
x. European car standards

Expected average annual natural gas consumption (space heating and hot water) of a new single-family house (VROM,1995)

Year	*EPC*	*Natural gas consumption (m^3/ year)*
1992	1.65	1650
1996	1.4	1400
1998	1.2	1200
2000	1.0	1000

xi. Distance-based levy for transporters of goods
xii. Additional taxation of motor fuels which are harmful to the environment
xiii. Discount on tax for most efficient leased cars

Vehicles burning oil, as one of main GHG emissions source should be held down without any doubt. Hence, increasing traffic density and car owners (CBS, 2006) in recent years cannot prove the effect of tight taxes. However, the mobility, one of the critical social demands has not been satisfied. Some remarks are brought forth from reviewing of energy policy structure on housing and transport sectors. Spatial planning should not exclude Energy efficiency and GHG reduction. Many urban land-use plans, for example in Rotterdam (Stadsvisie 2030, 2007), still gave priority to car movement which can be seen as one of contrary strategies between economic ambition and its environmentally friendly slogan. **Urban planning in new energy era ought to aware that energy adaptation be counted as separated items of spatial transformation. Proper urban plan or urban renewal plan can provide favorable environments to optimize energy saving measures. And in instrument package, integrated programs concerning spatial planning and energy saving should be included.**



Source
Top: F.D. van der Hoeven, TU Delft
Down: RAND Europe, 2007

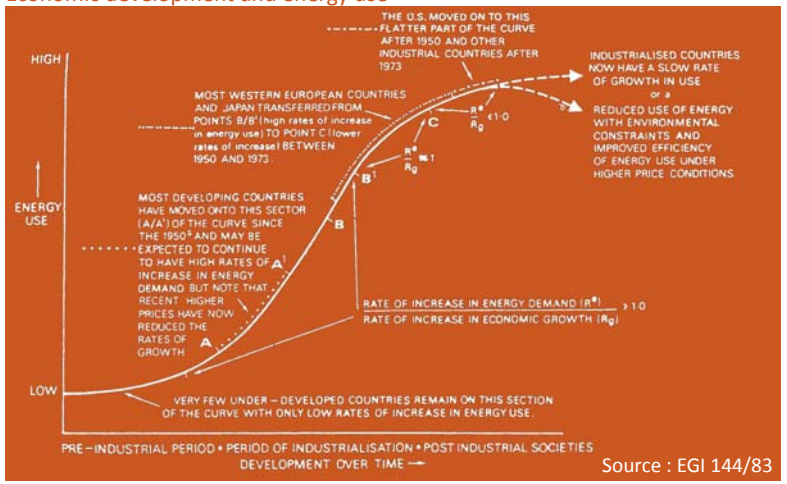
2.3 Create spatial development strategy for sustainable energy

City is the most intensive energy consuming aggregation. There is direct relation between economic development and energy use over time. As shown on Figure 2, energy use in industrialized countries rather slow in growth. One of the challenges to those who are responsible for future city plan may be “How to make economic growth in energy-sustainable way?” The crucial point for sustainable use of energy is waste control.

Energy waste takes large portion of total energy consumption. For example, huge wastage inheres in our centralized electricity system. Because we generate electricity in large power stations far from our cities, in which almost two-thirds of primary energy inputs to the system are wasted-partly from the wires that transmit the electricity around the country, but mostly in the form of waste heat from the power stations themselves. It would be sufficient amount enough to meet the entire space and water heating needs of every building in the country if this loss can be totally saved. Wastage also comes from building. Heating demand of current new houses is three times more than passive houses which have excellent insulation and heat recovery system. For old houses, they consume almost six times energy for heating than passive houses do. Furthermore, urban land-use plan also generates energy waste. Land use is one of the relative factors in travel patterns, related to variable rate of car use. D. Banister (2005) claims that land-use factors explain 20-30% of car use in determining travel demand and mode choice.

Large-scale GHG reduction needs extensive energy waste control which includes energy saving and efficient use. It will be further supported by widely adopted renewable energy techniques. Single-case adoption may be easily achieved. However, improving

Figure 2
Economic development and energy use



Source : EGI 144/83

energy use pattern in broad scale for sustainable energy use in urban level needs integrated strategies.

Complex energy chain reveals the need of integrated planning (Figure 3). Many good practices in city level have proven that spatial development strategy and proper planning can bring the city energy sustainability. Austria ’s famed quasi-autonomous energy township and regional networks of renewable-energy based villages feature bio-fuel and solar electricity. Scandinavian renewable energy cooperatives notably in Denmark are good examples which actually started from 1990’ s. Hannover Kronsberg (Figure 4) in Germany, which was introduced as a model case in EXPO 2000 is one of the most famous places for well undertaking its ecological optimization from a very early stage. They have testified that the idea of sustainability can be broadly applied only through a differentiated planning procedure and integrated quality standards for all planning measures.

Figure 3

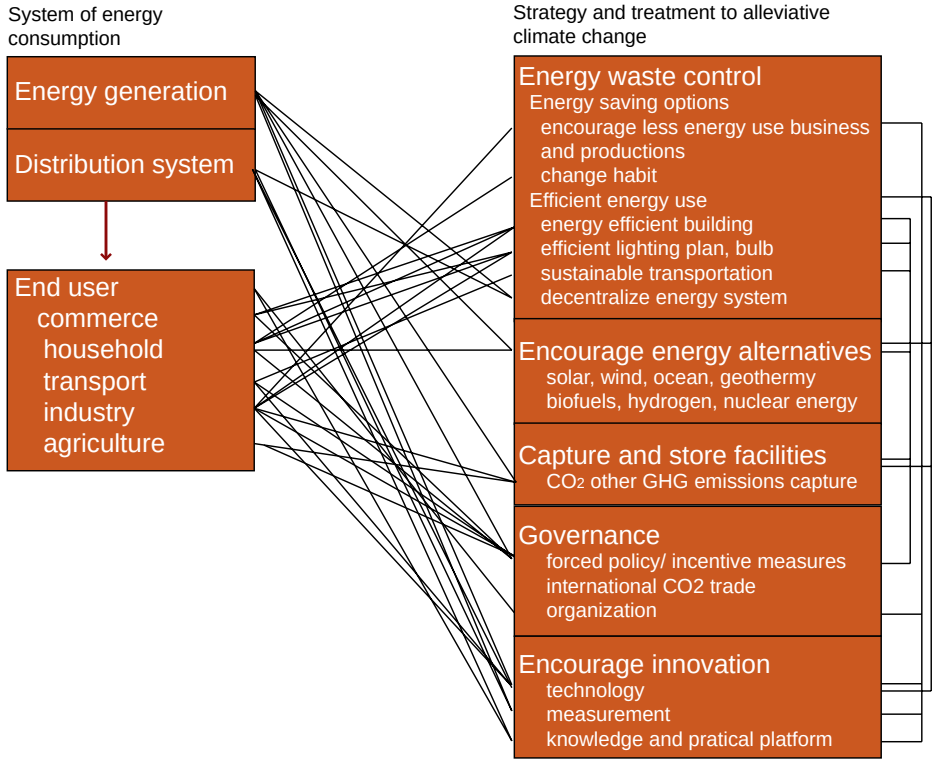
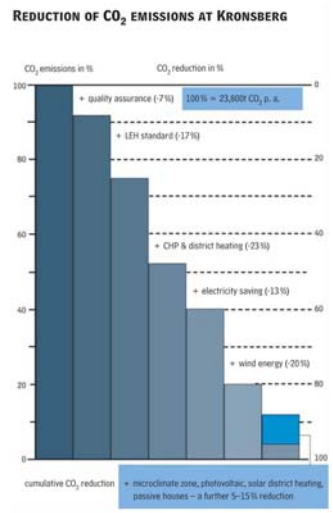
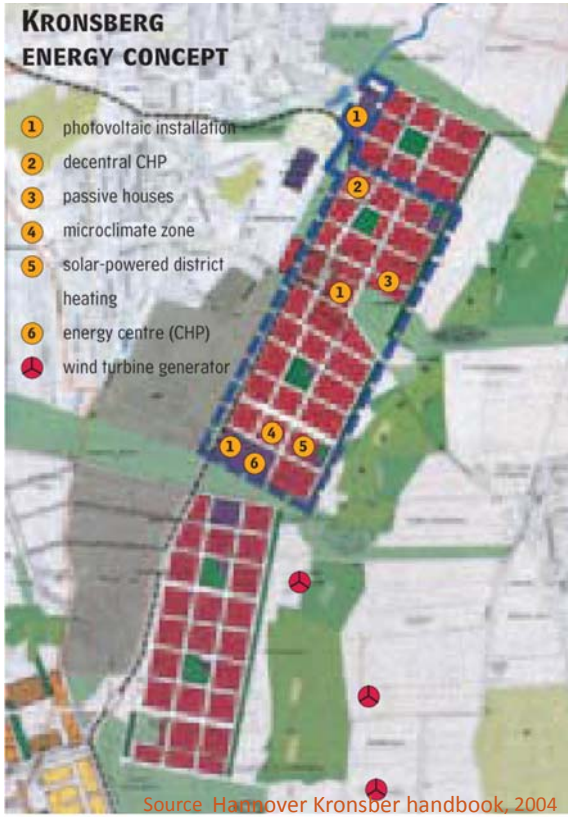


Figure 4







Source Hannover Kronsber handbook, 2004

Figure 3
Energy chain vs. strategies and treatments

Figure 4
Hannover Kronsberg, sustainable urban development solutions at the Urban Planning Level

2.4 Emphasis on urban renewal and spatial transformation

Many new urban areas in Western countries have adopted the concept of sustainable urban development in GHG reduction. In the Netherlands, ' compact city' as the guiding principle on policy level of urban sustainable development has been widely accepted. Hopefully, the compact city may result in reduction of car traffic, and hence reduction of GHG emissions. Nowadays it is still experiencing many debates[1]. However, in some urban planning clear intentions of GHG reduction are recognized.

Not only new plans, but also existing urban areas deserve additional attentions. Old housing stocks, regardless of the conditions of energy conservation or energy facilities, were not enabled to meet the requirements of up-to-date Dutch energy policy. Both short- and longer-term changes are needed. The change can be gradually achieved from adaptation of a single item (e.g. wall insulation, solar panel) on building level to the transformation of energy system (e.g. CHP[2] system) as a whole on community level. Options adopted in old building normally cost more and face shortage of flexibility compared to newly developed ones. Renewal urban projects usually embroil much more actors and variables in renewal processes than new developments due to the fact that existing patterns and facilities have to be compromised. On the other hand, large sum investment and rather a small portion of new development[3] cannot perform the task of GHG reduction alone within expected timeline. Even energy and material, consumed by new constructions can be offset by its higher energy performance in their lifetime; adaptation of old building still offers the advantage of short-term alteration and more cost-effective in most cases. More evidence can be found in the illustrative case in Part 2. It includes some comparisons between old building renovation and new building development in terms of cost and time.

Confronting complex urban renewal process, we have to select some strategies. Instead of developing many new schemes in different directions, strongly integrated and decisive strategy can avoid inefficient disorder induced by decentralization. **In management level complex energy chain should be sorted out in such ways that corresponding strategies are simple, efficient, applicable and influential in large scale.**

1 This assumption is experiencing amendment by several studies (J. vd. Waals, 2001), which show that compact urbanization is unlikely to drastically reduce car mobility within a period of twenty years. The debates mainly focus on oversimplifying model and exclude the role of public transportations.
2 Combined heating and power system
3 Annual housing replacement rate is 1% in the Netherlands

PART II
DIMENSION AND TOOLS OF PLANNING

Identify integrated plan strategies

This section describes the GHG reduction measures in spatial level and their relations with decision-making process .

3.1 Categorize GHG reduction options on housing and transport
3.2 Six spatial values and three plan strategies

3

3.1 Categorize GHG reduction options on housing and transport

In this chapter some design strategies by categorizing the options for GHG reduction are discussed. Options can be classified according to their position in energy chain. The energy chain consists of fuel production (e.g. gas extraction), energy conversion (e.g. electricity plants, electrical devices), distribution (electricity grid/gas grid), and energy functions (e.g. lighting, heat). Based on the concept of energy chain, the options for GHG reduction can differ in some levels:

>> Reducing energy demand (Avoid unnecessary use)
>> Using renewable energy sources
>> Improving efficiency of conversion and distribution (Use limited sources carefully)

The diagram in figure 3 concludes energy system and the current options concerning sustainable energy. The options for GHG reduction can also be categorized in spatial scales, since they are influenced by location and development scale as per different approaches and technologies.

J. vd. Waals (CO_2-reduction in housing, 2001, p.37) suggested the following options in spatial scales for the implementation of GHG reduction.

>> Construction measures
>> Options related to installations in houses
>> Options related to the spatial structure of an urban area
>> Options related to the energy infrastructure in an urban area

The emphasis on this guide is to inspire decision-making process and to offer spatial strategies in urban planning level. It can be seen as the extension and supplement of the third type: options related to the spatial structure and urban area. However, different types are interrelated with other levels due to their affiliation in energy chain. The following sections give brief introductions of each type as a knowledge base and rational premise for the selection of strategies and the proposal of integrated plan at the final stage.

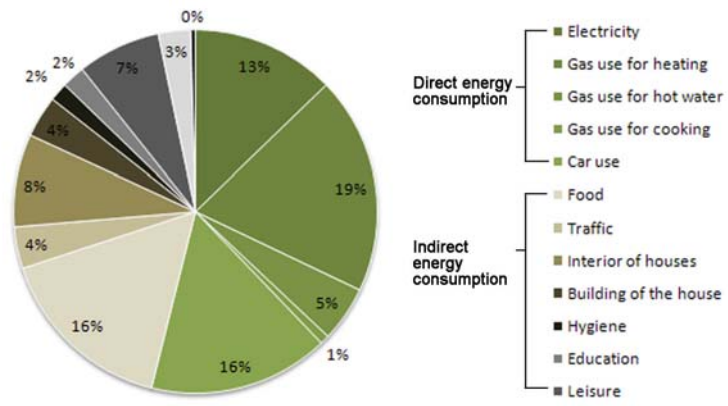
3.1.1 Construction measures

Household activities contribute to GHG emissions by both direct and indirect energy consumption. Direct energy consumption refers to the activities directly related to the burning of fossil fuel for electricity, heating, car uses. (Figure 5). Indirect energy consumption refers to energy use related to the purchased goods and services. The survey of 1997 indicates that the direct energy consumption per household occupied 54% of average total (direct plus indirect) energy requirement (J. vd. Waals, 2001). Energy saving plan of household takes direct energy consumption as the control parameter and the base of Dutch energy policy. It is because direct energy demand can be efficiently reduced by physical improvement of building.

The construction measures focus on reducing primary energy demands. Heat loss through a building's fabric has a major impact on its energy efficiency. It points out possible origins which cause primary energy waste from imperfect construction work such as cavity in wall, floor and roof. According to Cairns (1993), the approximate percentages of heat losses from an uninsulated dwelling are as follows:

- 25% escapes through the roof (8% after insulation);
- 35% escapes through the walls (10-12% after insulation);
- 15% escapes in air leakage through the doors (9% after

Figure 5
Directly energy consumption is the contorl parameter of policy.



Source
J. vd. Waals, 2001

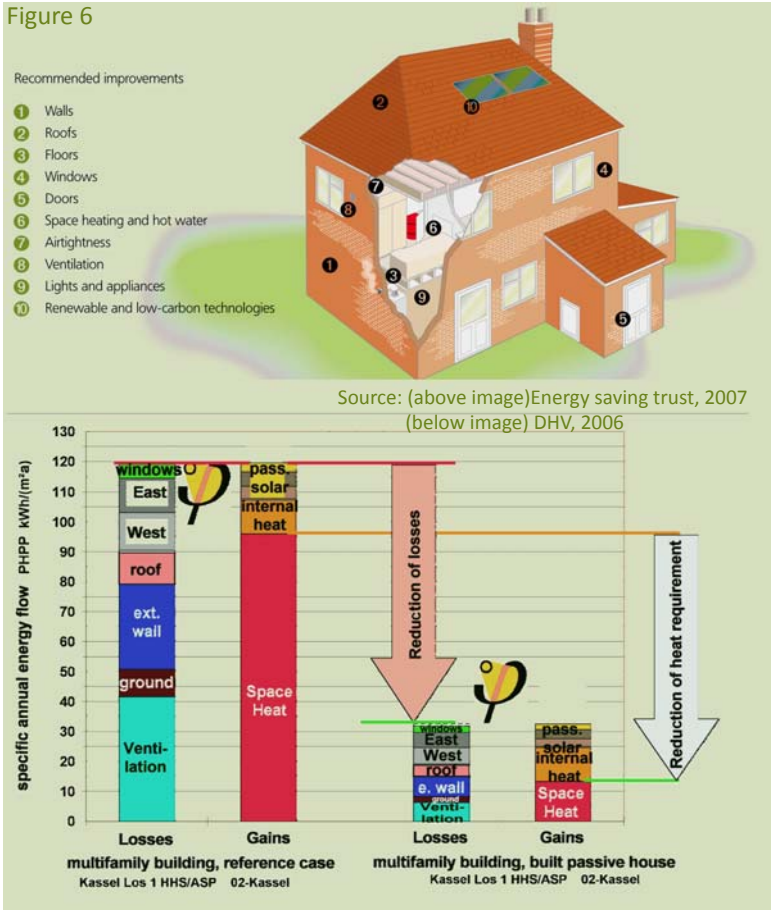
insulation);
- 15% escapes through the ground floor (9% after insulation);
- 10% escapes through the windows (5% after insulation).

Adopting insulation options can result in significant energy saving (up to 60% by great insulation). Energy efficiency goals in existing buildings can be attained in a refurbishment scheme by:

- Achieving good levels of thermal insulation in the external fabric;
- Conserving water use in buildings;
- Using energy efficient lightings;
- Providing an efficient heating and hot water system;
- Substituting controlled ventilation for exiting (uncontrolled draughts).

(J. Douglas, 2006)

Figure 6



Source: (above image)Energy saving trust, 2007
(below image) DHV, 2006

Figure 6
Various construction measures for energy reduction.

3.1.2 New Installations

New installation of renewable energy adaptor is able to reduce the dependency of conventional energy sources. Some of them can also reduce energy waste within system in the mean time. They include solar domestic hot water system, PV, heat pump and micro-CHP. Figure 7 denotes the cost comparisons and CO_2[1]reduction in seven wide approved energy techniques. They include ' combined heat and power (CHP)', 'large wind turbine', 'small wind turbine', 'photovoltaic solar energy (PV)', 'solar thermal collectors' , 'ground sources heat pumps(GHSP)', and ' biomass and biofuel'. More information can be found in annex.

Figure 7

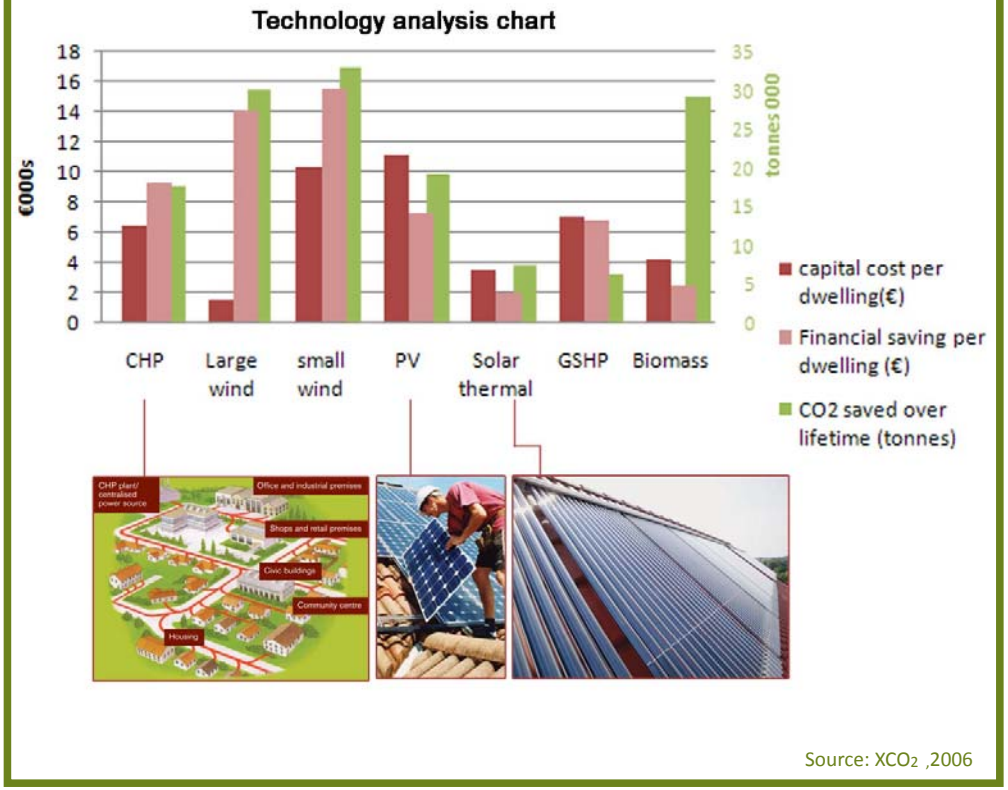


Figure 7
Cost and effect study of renewable and low-carbon technologies.

1 CO_2 is the main component in green-house gas which comes from burning of fossil fuel.

3.1.3 Urban planning measures

Urban planning measures can be described by two development scales: neighborhood/city scale and street/block scale. Urban planning deals with a full range of land uses on neighborhood/city scale. They require master plan or energy plan according to respective opportunities by means of integrated networks management plus the consideration of the cost effect. The new and growing focus on reducing GHG emissions in built environment requires a set of approach from the initial and conceptual design stage to the implementation and long-term management.

In street/block scale, importance of urban planning lies on creating favorable conditions to adopt particular options and to support green movement. Orientation of housing, densities, mix of housing type, mixed use of functions and transport provision are its main contents. Orientation of housing and density influence the solar-related options. Mix of housing type and density plus entrance design influence gain and loss of heat in building and microclimate in outside of building. Mixed-use of functions and transport provision are related with the preference of transport mode. Enough density and population are decisive conditions for economic sustainability in selection of energy system and public transportation. This scale may vary in different sizes: from an individual block to a large estate. More detailed reference standards are illustrated in chapter 3.2.2. and information concerning density, housing type, and solar-influenced design applying example can be found in the case studies of chapter 4.

3.1.4 Energy infrastructure

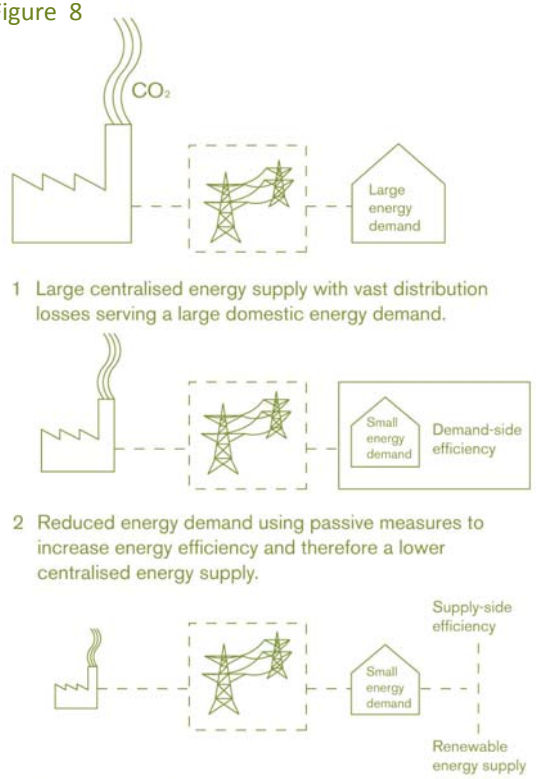
Energy infrastructure of urban area is mainly categorized in 3 groups.

>> A gas grid in combination with mains electricity;
>> A combined heat and power (CHP) system (district heating or small-scale CHP) in combination with mains electricity;
>> Only electricity (all-electric)

Energy infrastructure is usually determined prior to the initial construction phase. Once the construction work is completed, it is hard or very costly to adjust or amend the infrastructure , especially in old types of building. But in large restructured urban areas, it may be relatively easy to adapt a new system in existing housing estate.

The dominant energy infrastructure for housing in the Netherlands is gas grid (94%). Probably, it is one of the possible advantages for adapting some specific techniques, such as micro-CHP and gas driven heat pumps which need a gas grid for their

Figure 8



Sustainable energy

The diagram left shows the steps to be taken to achieve a decentralised, more efficient and flexible energy infrastructure over the coming decades. Reducing energy demand through passive efficiency measures, such as better insulation or low energy lighting, is usually the most cost-effective strategy.It should be considered as the crucial first step towards reducing GHG emissions. Efficient and renewable supply of energy from a range of complementary low- and zerocarbon technologies reduces further the energy required from the inefficient national grid.

No generating plant operates 100% of the time.A system that relies on its energy from more than one source inherently has more stability of supply, regardless of the fact that the individual technologies within the system are intermittent. These steps are explained in greater detail in Section 4 of this guide.

Source: XCO_2 ,2006

operation. Compared to conventional gas grids, application of CHP system usually leads to CO_2 reduction about 10-13% (J. vd. Waals, 2001), although it involves higher cost for the installation. In case of small scaled projects (20 dwelling are involved), CO_2 reduction by using this technique is neither markedly achieved nor cost-effective.

'Only electricity' can be used for hot water and heating. Some renewable energy techniques such as PV, electrical heat pumps and windmills can partially support it. However this is not the conventional mode in the Netherlands.

3.2 Six spatial values and three plan strategies

Large scale GHG reduction would not be fulfilled without optimal process of initial program, action plan, measures and their implementation. Initial program and action plan can only be realized with the support or the performance of government power. Evaluation and implementation measures in general are given by different stakeholders in one project with different intentions. Evaluation measures are made for monitoring and administration purposes; they evaluate direct effects after the planning stage or completion of the project. For example, most of sustainable indicators which minister evaluating process for government have strong characteristics of monitoring. Implementing measures means the method to execute plans in practice. This kind of measures, relying on thematic assessment mainly deal with local conditions and project demands. Urban renewal normally takes place under neighborhood scale. The focus on this section is to reveal what the efficient implementing measures are, concerning GHG reduction in urban renewal process.

Corresponding to global warming, sustainable energy measures in urban planning level, especially when they meet existing urban context, can be related to six spatial values in housing and transport sectors. Three of them as below influence the choice of transport modes, and transport modes present different levels of GHG emissions.

- >> **Framework of movement**
- >> **Provision of transport alternatives**
- >> **Land-use characteristics**

Another three values deal with energy consumption in housing renewal plan:

- >> **Proportion of different types of building**
- >> **Tendency & point of improvement**
- >> **Design urban structure with high climatic quality**

They guide the process of (renewal) master plan to partake, to assist and to optimize GHG reduction in accordance with their range of application. They will be explained respectively with regard to representing spatial level and energy saving mode in the following section.

3.2.1 Spatial planning promotes transport mode

The influence of transport modes and given transport system on GHG emissions is quite significant. It can be enhanced by set of road system, non-motorized movement, public passenger transport, and goods transit. In this guide the last (goods transit) will not be dealt with. Regarding daily movement of people, figure 9 clearly presents the relation between transport mode and GHG emissions of from ecological point of view.

The preference of transport modes for daily movement is shaped by the conditions of accessibility on transport modes, reasonable traveling hour, transport habit, and transport motive. The role of spatial planning which normally deals with arranging movement framework, land-use characteristics and transport alternatives provision, can directly have an effect on accessibility and traveling hour, as well as indirect influence on transport habit.

>> Framework of movement

There is a close relationship between the placement of urban functions and urban mobility. The movement framework is responsible for the accessibility and the efficiency of connecting people to diverse urban functions. In respect of good practices of movement framework, the design notion was 'efficient transportation' which focused on accessibility and efficient

Figure 9
Comparison of various transport modes from the ecological viewpoint with a private car for an identical journey with the same number of people/km.
Base = 100 (private car without catalytic converter)

Space consumption	**100**	100	10	**8**	1	6
Primary energy consumption	**100**	100	30	**0**	405	34
CO_2	**100**	100	29	**0**	420	30
Nitrogen oxides	**100**	15	9	**0**	290	4
Hydrocarbons	**100**	15	8	**0**	140	2
CO	**100**	15	2	**0**	93	1
Total atmospheric pollution	**100**	15	9	**0**	250	3
Risk of accidents	**100**	100	9	**2**	12	3

* = **Car plus catalytic converter** It should be remembered that the catalytic converter is only effective when the engine has warmed up. For short distances undertaken in towns, there is no real anti-pollution benefit.

Source: UPI Report, Heidelberg, 1989, quoted by the German Ministry for Transport.

travel hour for car movement in the past, while 'sustainable transportation' accounting environmental effect is accentuated nowadays. Reduction of unnecessary car use is one of the crucial tasks in sustainable urban development and almost all measures stress excessive burning of fossil fuels. The confine in future would not be released, unless technological breakthrough on new energy source or new transport modes is realized.

The movement framework reflects urban transport strategy. Highway enlargement and expansion plan in Port city Rotterdam in ' stadsvisie 2030' focused on 'accessibility for vehicle' and 'efficient transport time' to relax increasing traffic bottle-neck in ring road (Figure 10). Economic growth accompanies bigger and faster transport due to the effect of globalization. It has been struggling with the demand of environmental balance. Even port area has gradually parted from city by moving toward west, inner city roads are still predominated by vehicles. Car reachable shopping center became one of pride of Rotterdam, where 40% of traffic mode in city center came from private cars (Rotterdammers overhet verkeer 2006). As shown on the contour map of NOx[1] concentration, measured NOx emissions spread along main motorized traffic roads (and rivers) and have very high concentration in city center (Figure 11). This is a typical example which shows how urban transport strategy can influence shaping of movement framework and also resulting car use rate and the amount of GHG emissions.

Urban strategies can encourage green movement and reduce car use by means of spatial arrangement. Through combining measures to promote cycling and public transport, lowering of car use rate can be achieved. As discussed In the following, in the cities where the 'green movement ' is activated, car use rate is much lower than the cities where there is little movement.

1 NOx is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. NOx causes a wide variety of health and environmental impacts because of various compounds and derivatives in the family of nitrogen oxides. The primary sources of NOx are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.

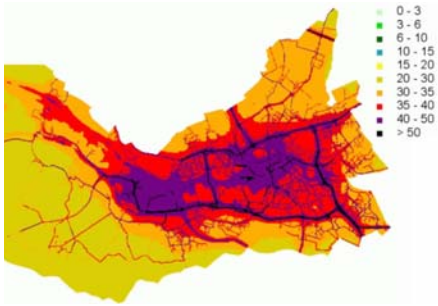
Figure 10
Transport plan in *Stadsvisie Rotterdam 2030*

Infrastructure, existing and new

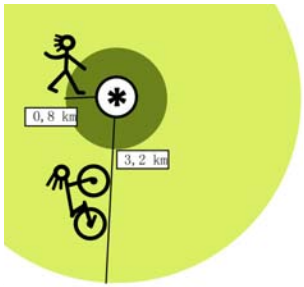


Existing motorway
Broaden motorway
New motorway
Study new motorway
Existing city highway
New city highway
Undergroud city highway
Light rail / Metro
New light rail
HSL / Betuwe line
To increase capacity of national track t.b.v stedenbaan and HSL
Study new IC station
Study new stedenbaa station
Study third city bridge
P&R (park and travel) location 1000 +
Centre-landscape (existing + new) bicycle routes
Centre boulevard (existing + new)
City boulevard (existing + new)

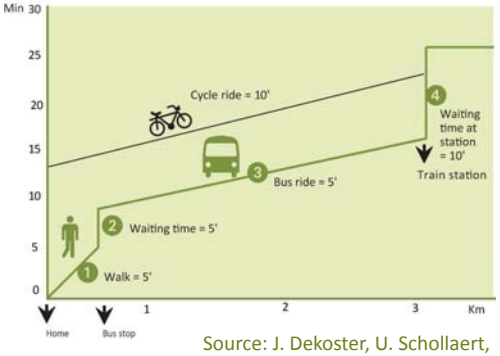
Figure 11
Concentration of NOx in Rotterdam, 2005



Source:
Left: Gemeente Rotterdam, 2007
Right: URBIS, 2005



Having to change bus/tram or train is a distinct disadvantage for public transport passengers (waste of time, discomfort of waiting). Bicycles are an effective answer to this problem. Cyclists may gain a quarter of an hour compared with a bus over the same distance to reach a rapid form of transport (railway station, underground station, etc.).



Source: J. Dekoster, U. Schollaert, European Communities, 1999

>> Provision of transport alternatives

Successful movement framework requires strategies in different levels with regard to travel distance and public motivation. It should be capable of vitalizing travel demand, reinforcing community and discouraging car uses. In this framework, walking, cycling and using public transportations are far easier and more attractive than driving private cars. It can be realized by arranging optimum routes which fit this purpose.

Recent studies on trips of short distances, financed by the European Union found that majority of journeys are taken by cars nowadays. It also underlines that there would not be any significant differences in traveling hour(door to door) even if car uses are replaced by other transport modes(Walcyng, 1997).

The potential of cycling should not be ignored in daily life such as trips to school, to work place (which account for 40 % of all journeys made) or for other reasons (60 % of journeys made are to do with shopping, services, leisure pursuits, social activities, etc.). More than 30 % of trips taken by car may easily be replaced by bicycles. Another survey reveals that cyclists themselves are eager for cycling facilities such as bicycle route, parking space and etc. to be improved. In Figure 12 the factors encouraging people to purchase bicycle or use it more often are listed; 58 % state that they would cycle more often if the facilities were improved; 70% state that cycling facilities, access facilities, shortcuts, diversions for cyclists are the reasons of discouraging bicycle use. In every city/neighborhood level, short distance trip can be ‘greener’ by arranging successful local movement

framework.
The scheme can be extended for long distance trip. In energy saving point of view, Even 83% of daily movements take place within the distance of 14 km (56% within 5 km), still more than half of energy consumption is taken by long distance trip (distance over 15km) for instance, the transport pattern in Rotterdam. Public transportation is the main alternatives to replace private car uses in long distance trip. Public transport consumes three times less primary energy (and emits three times less GHG) than private cars(Figure 7). Especially in rush hours, public transportation is approx. 10 times more beneficial than private cars. The public transport sector no doubt contributes to the improvement of energy efficiency and reduction of GHG emissions. Whereas some debates claimed that there is no obvious evident supporting the idea that travel habit would change by depressing prices or by increasing provision of public transportations. In UITP European Union Committee (2006), it was defined that the development of high quality public transportation is still crucial measures which can offer a real alternative to private car uses.

Developing high quality public transport needs combining measures. Public transport system must go along with land use plan. On the system planning side, to connect urban functions by seamless transfer, to cover residential area by enough public transport provisions and assortment with reasonable walking range, to improve parking facilities and to lower price of public transportations would encourage people to use them as transport alternatives.

Figure12

Reasons which encourage people to purchase a bicycle or use it more often

- Cycling facilities, access facilities/shortcuts/diversions for cyclists . . . . . **70 %**
- Restrictions to car traffic . . . . . **28 %**
- Supervised bicycle parking areas . . . **21 %**
- Promotion campaigns . . . . . **11 %**
- Hire or lease of bicycles . . . . . **8 %**

Source: J. Dekoster, U. Schollaert, European Communities, 1999

>> Land-use characteristics

The starting point of spatial planning for any public transport network is the pattern of land use. It strongly influences the potential traffic. The pattern can be distinguished by six different categories for its activities:

- The size of settlement
- The intensity of land use and activities
- The mixing of land uses
- Location (the decentralization of activities)
- Local accessibility to transport infrastructure
- Parking provision

Many researches have shown different level of database, approach and benchmark due to different opinion, debates and assumptions. For example, there is a dispute on the opinion that population density can impact travel distance and energy consumption.

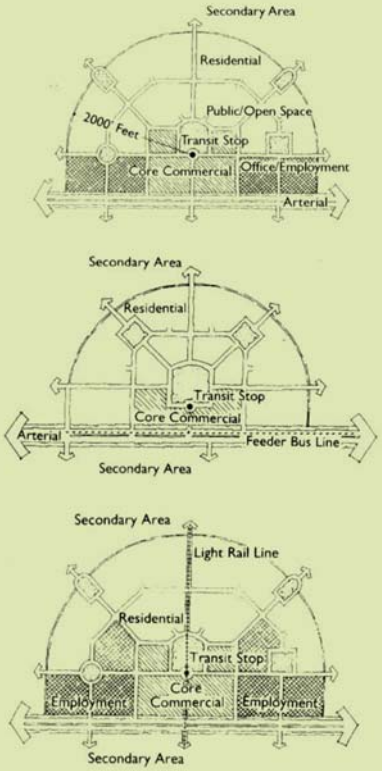
Different modal choices can result in various conclusions. For instance, there can be 3 different conclusions derived from the modes 'compact cities', 'decentralized concentration'and 'low density suburban spread'

D. Banister (2005) claimed that land use patterns influence the trip length, speed and mode choices; yet it is less impact on the frequency of travel. His conclusion on spatial planning is:

- New development location, especially housing, should offers ample size of population and locates close to or within existing settlements. At least 25,000 populations in total, favoring if it achieves 50,000. The transport provision of local facilities and services should be phased accordingly encouraging the development of local travel pattern.
- According to the data in survey, car use in the high density location is half that in the lowest density location.
- The larger size of settlement, the shorter distance of trips and the greater proportion of trips by public transport.
- Mixed use developments could reduce trip lengths and car dependence.
- The development should be located near to public transport network thus good accessibility can be guaranteed.
- Available parking place as a key factor influences decision making from driver side of whether a car is used or not.

Land use factors can influence 20-30% variation of travel demand and transport mode choice.

Land use model—TNDs & TOD



>> Good land use models provide a comprehensive response to the requisites of urban design; its techniques optimize urban density and financial return without neglecting function and liveabilitycan. TOD, Transit Oriented Development is one of them.

Land use mode in TOD focus around transit lines. It supports regional commercial and public facilities by incorporate feeder bus routes and light rail. The characteristics establish that:

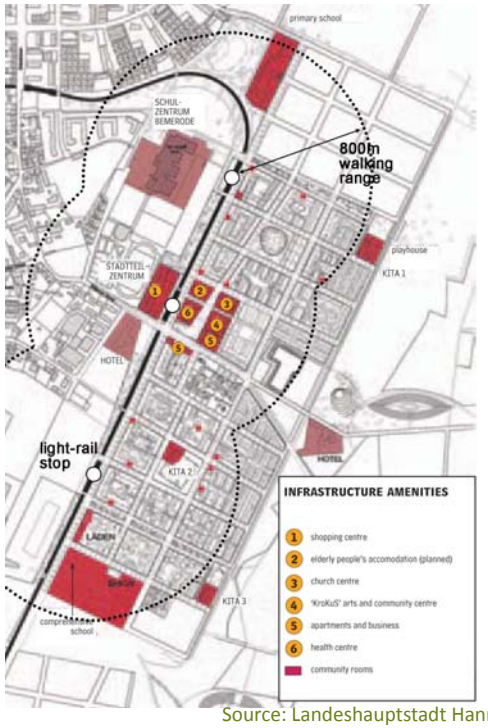
- the size of each neighbourhood: supported a walking distance of up to 10 minutes from the core commercial area and transit stop.

- integrated public transit structure at a regional scale with the elements of specific neighbourhoods.

- higher density housing and key retail, institutional and social facilities are placed at the stations of the transit network.

Source: P. Neal, 2003

>> **Hannover Kronsberg** in Germany is a well-known eco-project for sustainable urban development. Kronsberg can settle 6000 inhabitants after finish. They are provided exellent transport connections to the city.



Source: Landeshauptstadt Hannover, 2004

3.2.2 Deal with energy consumption in housing renewal plan

Housing stock in the Netherlands has achieved nearly 7 million until 2006, but nevertheless 2.2 million properties are over 50 years old and there is much talk about the house of the future. With current demolition rates the average house will have to last for 300 years before it is replaced. It is vital therefore to make improvement in the environmental performance of our old housing stock with priority.

One of the problems that local authorities, regional development agencies and private developers face on urban renewal is to refurbish or to rebuild existing housing. The issues they need to consider are broad ranged and complex. Restoring or demolishing considerable Dutch housing stock poses decision-makers with a range of technical, economic, environmental and social issues to grapple with. The following section discusses the essential consideration for urban renewal plan considering energy efficiency on housing sector with the aim of 40% energy reduction from EEPA.

>> Proportion of different types of building

Key parameter of energy performance in community level is the ages of the buildings. Construction date of the building denotes general building standard, policy regulation and architectural technology in its age. Some references about dwelling-related energy consumption as per building ages are needed.

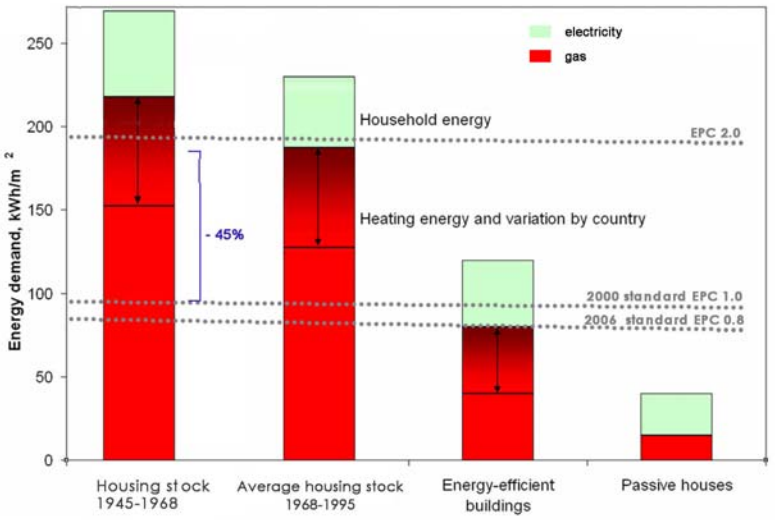
Figure13
Average dwelling-related energy consumption per dwelling in 1995 in the Netherlands.

	Gas consumption (m3)	Electricity consumption (kWh)	Primary energy(GJ)
Social rented sector	1472	440	57
Private rented sector	1751	677	69
Owner-occupied sector	2472	590	93
Housing stock < 1945	2603	615	98
Housing stock 1945-1968	2030	556	77
Housing stock > 1968	1628	498	63
Total housing stock	1992	545	76

Source: Slot et al., 1998, p.27

Another parameter is whether renovations were made for existing houses in the past. Dwelling which belong to private household has higher adapting rate in energy related renovation (mainly by insulation and solar energy gaining options) than social rental houses in the Netherlands. Various adapting options would introduce different level of energy efficiency. The precise energy performance in each building needs to be thoroughly examined by means of accurate survey. It accelerates decision-making process if assessment of energy performance for building has been prepared. However, accurate surveys have not yet been established on most of old buildings in the Netherlands. And some energy monitoring programs started not long ago in the big cities. On the condition of missing well assessment howbeit confronting urban renewal decision, the ages of the buildings present rough assumption of local housing energy performance. It can be assumed by rough calculation on composing of building ages corresponding with benchmark of dwelling-related energy consumption by building type. Figure 13 shows dwelling-related energy consumption in the Netherlands which was categorized by building ages and building ownership. Figure 14 compares housing energy demands in the past with current Dutch housing policy regulation (EPC) and proposals of houses types. In urban renewal planning, the survey of building ages in planned community and the abovementioned research base are the essential preparations for decision-making.

Figure14
Energy demands vs. housing types



Reference: PHI,Passive House Institute, 2005

>> Tendency & point of improvement

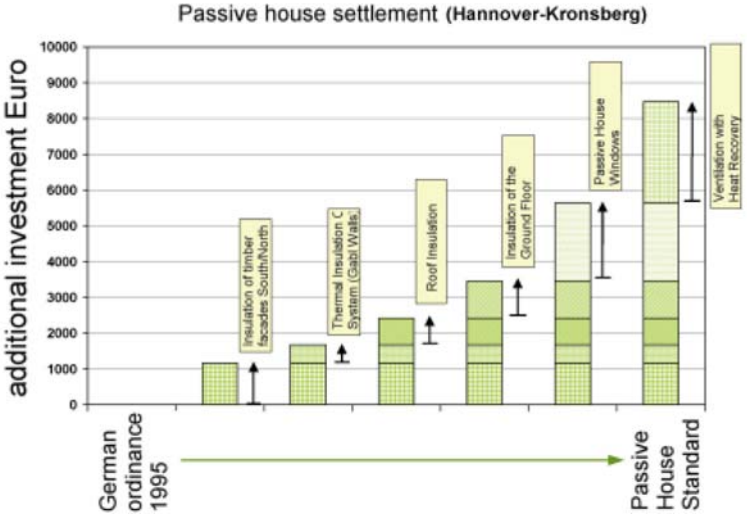
Upon developing new scenarios, they should be examined in many aspects: technologies and tendency of policy, feasibility, time schedule of commencement, applying range and sorts of adaptation options…etc. Different scenarios would be the base of different packages of measures and options. For example, according to the announcement of VROM (2008), Dutch policy tool Energy Efficiency Requirements (EPC) will keep tightening the standard for new building in close future (VROM, 2008). It indicates that additional cost for energy efficiency will increase construction investment of new housing to influence cost-effective new development in future to probably amplify the interest and motivation of old housing renovation. The tendency of policy is also an influential factor on decision-making process in the regard that it gives the range of housing redevelopment or renovation.

Decision-making is a complex process concerning not only the energy requirement, but also many other factors from different point of view. Fourteen factors were summarized by J. Douglas (Building adaptation, 2006) regarding the influences on adaptation versus redevelopment. They are namely alternatives, location of existing building, value of the existing site, building condition and morphology, operational factors, occupiers' requirements, adaptation potential of building, constructability, political influences, statutory controls, cost and time considerations, accommodation, design life, design process. The determination according to different interest per project resulted in diverse integration.

Another approach to set up proper measures is cases studies. Precedents of practical cases provide lessons and experiences. They also offer the database to predict planning project by comparison and analysis of the previous cases. Cases studies in Chapter 4 visualize the concept of energy reduction, investment, payback period, market value, and corresponding options of adaptation are in this research.



Figure15
Examples of policy and market factors related to decision-making process of ueban redevelopment





>> Cost-effective
€ for 1kWh heat reduction
Old : New= 1: 2.5

Surce: J. Douglas, Building adaptation, 2006

>> Policy trendency —low or zero-carbon building
Energy efficiency requirements(EPC) to new building
2006 EPC 0.8
2011 EPC 0.6
2015 EPC 0.4
2020 EPC 0

Source: VROM, 2008

>> Design urban structure with high climatic quality

Urban areas without a high climatic quality use much more energy for air conditioning in summer and for heating in winter and more electricity for lighting. The urban thermal island effect can cause temperature differences of up to 5-15°C between city center and its surroundings. The follow-on is amplified energy demand for cooling. Many new developments did not take climate issue into account. Normally they use reflected glass to cut out solar gain and daylight, air condition results in extra thermal emissions to the surroundings, and bulky buildings to create unfriendly local wind effects and overshadowing adjacent building. The consequence is a malignant circle of aggravating exterior environment and escalating energy costs.

Climate friendly strategy on neighborhood scale can give opportunity to efficient energy infrastructure through decision-making and density design. Proper design of urban layout and guideline can create favorable condition to adopt low energy options and generate new life style. It realized on street and block level can provide adequate access to solar heat gain and day lighting, active solar gain installations and passive cooling in warmer climates. When adopting options, one should also count for existing building condition, tendency of development and market interest. In general, concentrative re-development area would create compact urban structure which may reduce network energy losses. It will also offer potential to larger re-layout by integrating with climate friendly design and transport mode. Scattered mode of re-development and renovation also can be a developing strategy, yet it would limit adapting options mostly in building level such as insulation



Credit: Greenpeace / Breeze

work or solar panel installation, which can be individually accomplished without interaction with other factors when they are implemented.

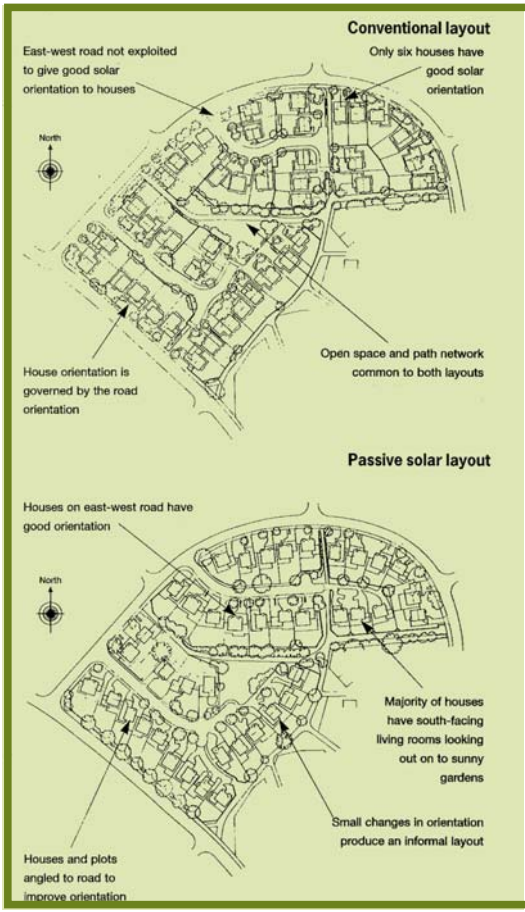
Climatic friendly design in street and block level highly agrees with the theories of solar-orientation design and bio-climate design as described below:

> Building and site orientation

- In an urban region, solar orientation, sky conditions (cloudy/clear), and are all interrelated to each other. The altitude of the sun is determined by the latitude and time. Site-clearing and planting strategies, which partially influence solar access, are influenced by those requirements.

- The building should be oriented to take advantage of shade and airflows for cooling in summer, and of passive solar energy for heating and wind protection in winter. If solar collectors or photovoltaic systems are proposed, orientation should allow maximum access to sunlight.

- Minimize overshadowing. Landscaped areas, open spaces, parking, and septic fields should be aggregated to provide the least solar shadow for southern orientations of the



Building layout

In the conventional layout (top) only six of the houses have good solar orientation. Realigning the roads enables two-thirds of the homes to face within 30° of due south and only four face due east or west

Source: BTP Architects for Lovell Homes

building and adjacent buildings. Calculating total site shadow can prevent the solar voids and cold-air-drainage dams. This is especially of significant importance in cold-temperate area.

- Provide a north-wall design that minimizes heat loss. Provide entrances with airlocks, and limit glass to prevent heat loss from the inside of the building. Large buildings in cold temperate require air-handling system to balance the interior building pressure with the exterior.

- Design access roads, landscaping, and auxiliary structures for wind channel in main buildings for cooling purposes or vice versa.(block them to reduce heat loss)

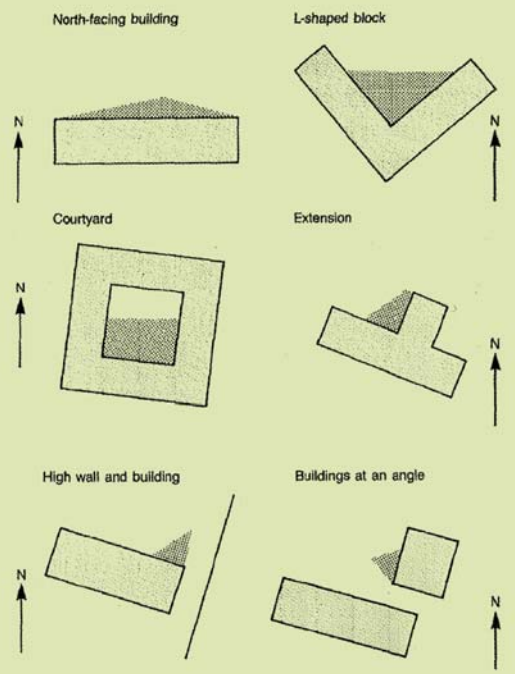
> Building shape and density

- A south-facing surface receives most solar radiation during the heating season, and is easier to provide shade in summer

- In the Netherlands, the prevailing winds come from a south-west direction. To reduce air infiltration and heat loss to a building it is recommended that the long faces of the building be oriented parallel to the prevailing wind.

- Density and detailed shape of a building can have an impact on

Sun shade for different layout



Examples of problem layouts where poor sunlighting on the ground can occur. The shaded areas will receive no sun at all for six months of the year

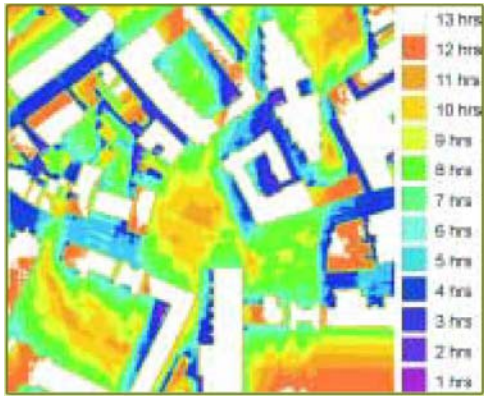
Source: P J Littlefair, 2000

surrounding site microclimate as well as on the solar access to the surrounding buildings. The example in box 5 denotes the relationship between the building form and its wind sensitivity. Solar access of building block can be evaluated by some simulation processes.

- The shape of a building and the surface volume ratio are of importance and both of them have a great influence on the energy efficiency of a building. (see the example in box 6)

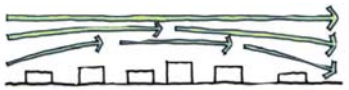
- Multi-story development limits heat losses because the exterior surface area per dwelling is relatively low. Van der Waals et al.(1999) claimed that energy use for heating and hot water in an existing flat was approximately two-thirds

Sun-hours Map
Each colour corresponds to the average hours of sunlight each area of the site receives.

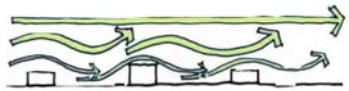


Source: RUROS, 2004

Work with the wind



A highly integrated street pattern encourages high levels of air movement. Winds are 'smoothed' over low, densely built areas.



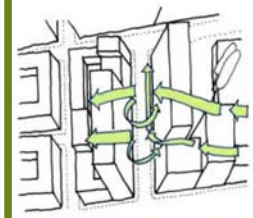
With greater spacing winds are forced down to make open spaces potentially uncomfortable



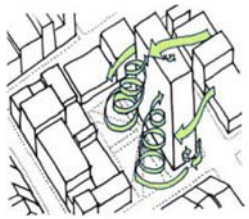
This is intensified by tall freestanding buildings, creating eddies that also result in building heat loss (adapted from Gehl, 1987)

ı the summer mild breezes
entilate buildings and
nprove comfort whereas
ı the winter winds increase
eat loss. The potential
f the wind for natural
entilation and as a possible
nergy source. Design and
osition buildings to minimise
unnelling and the creation of
ncomfortable microclimates.

Source : Urban design compendium, 2007



Building form can also affect the quality of public space by channelling wind along streets . . .



. . . or creating vortexes in plazas in front of tall buildings (from Lang, 1994)

3.2.3 Three-step-strategy and extension

Corresponding to six spatial values, the measures for systematic improvement can be deduced from an environmental balance design theory 'Trias Ecologica: three-step-strategy' (K. Duijvestein). Trias Ecologica described our built environment as a black box with energy, water and material flows (figure 16). The resources flow in the black box to be consumed and flow out of it as wastes, which are necessary for functioning. As slow as the flow speed is within the black box, the sustainable use of natural resources will be. The three-step-strategy dealing with flows in and out are under the principle of:

- avoiding unnecessary use,
- using renewable sources, and
- using limited sources carefully.

Three-step-strategy can be deduced to the strategies for sustainable mobility as:

- to reduce transport demand
- to use endless resource (muscle)
- to minimize motorized transport mode

And for the housing sector, the three-step-strategy as the base should further stress large-scale application at the urban planning level. Additional consideration has to be included as follows:

- maximized impact within limited money and time,
- good market value
- high climatic quality both indoor and public space

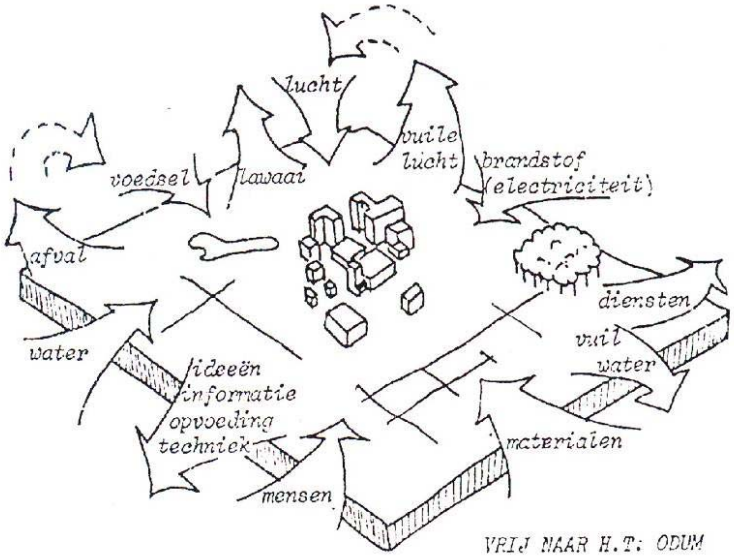
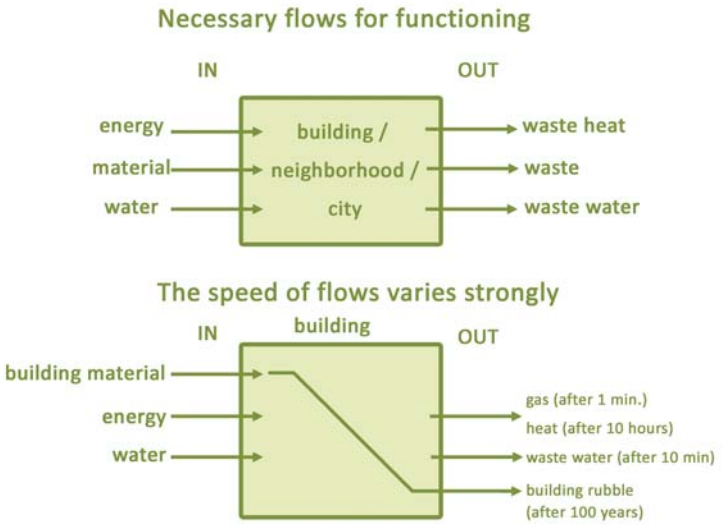


Figure16
Black box and necessary flows for functioning, 3-step-strategies is to slow down the flows within black box



Source: K. Duijvestein

PART III
CASE STUDIES

Formulate master plan

This section illustrates a planning approach which adopts the six strategies to an actual urban renewal site in Rotterdam.

4

4.1 GHG emissions in Rotterdam

Rotterdam is the second city of the Netherlands, the biggest port in Europe, the economic, social and cultural center of the Rijnmond ('Rhine Estuary') region and the industrial heart of the Netherlands. On the one hand, a year by year expansion plan of Rotterdam port successfully guaranteed economic growth; on the other hand, industrial cluster has resulted in a great amount of GHG emissions. Rijnmond region has become one of the highest NO_2 and CO_2 concentrated area in Europe as a result of maritime and road transport, energy production, import of energy carriers and industrial activities (Figure 17).

Energy use in Rijnmond is significant, amounting to approximately one seventh of the total energy use in the Netherlands. Around 70% of this is due to industry and power stations in the port area of Rotterdam; the rest goes to housing (10%), business services and small and medium-sized enterprises (10%), and traffic and greenhouse horticulture (10%). Rotterdam port releases three times more CO_2 than city area based on the data in 2005. It was assumed the port emission would increase more than 80% CO_2 by 2025, and the city would rise to 30% more, if there is no proper control (Figure 17). The energy generated by sun, wind and biomass provided less than one percent of the total primary energy use in Rijnmond in 2002. If all the energy from waste is counted as sustainable energy, then 2% of the energy came from sustainable sources. In Rijnmond in 2002 approximately 432 petaJoules of energy were deployed.

The 2006 ‘Rotterdamse Energy-Programma ’ (REP, Rotterdam Energy Programme) and the ROM -Rijnmond/R3 programme give Rotterdam a head start in the management of energy and climate concerns. The mission includes utilization of industrial excess heat for residences, driving a leading project of energy saving and energy innovations, and approaching large-scale energy saving measures. In 2007, Rotterdam Energy and Climate Programme has set the ambition to further develop Rotterdam into a CO_2-free city and first-rate energy port: ‘the world capital of CO_2 free energy’. This ambition is expressed in the target of a 50% reduction in CO_2 by 2025, relative to 1990, for the city as well as for the port.

Within the programme, ‘CO_2 capture, utilization and storage’ is recognized a strong and cost-effective approach for the Rotterdam port. Relative infrastructure will be installed in power stations, refineries and chemical sources for capturing CO_2 intensively, and transferring it to

greenhouse industry use or storing it in aquifers as well as empty gas and oil fields.

Cutting CO_2 emission in half is the target that was also set for city region. The ambition is to achieve energy-neutral development through a drastic reduction of energy consumption for heating, cooling and equipment in building construction. The spearhead focuses on a large-restructuring area in south Rotterdam to extend the surplus heat network on the one hand, to apply energy saving measures in existing buildings on the other. New construction will face tighter regulations of energy efficient building. Sustainable mobility is also part of the program. It plans to cut CO_2 and other toxic substances in half in 2025 through the use of alternative fuels, engines and radical optimization of traffic behavior. The scheme includes clean up for transportation of cargo as well as for travel. Use of bicycles and public transportation will be promoted.

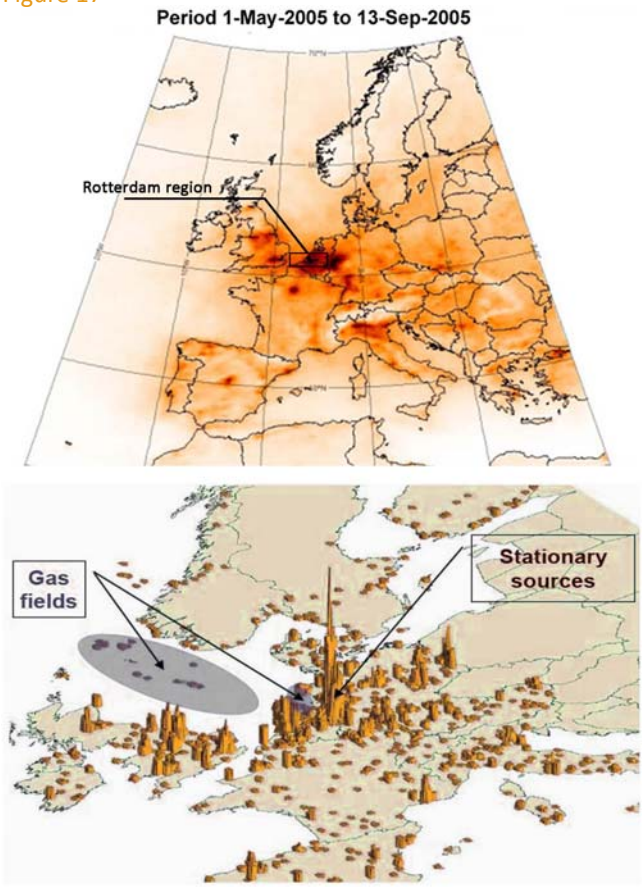
It is a great challenge for the Rotterdam region concerning GHG reduction because of it's important role in transporting gate and energy carriers to all of Europe. However Rotterdam Energy and Climate Program has shown the reaction and determination at the municipality level to deal with energy

Figure17

The map above presence of nitrogen dioxide, an important precursor in the production of ground-level ozone.Rotterdam region produced great NO_2 and CO_2 (map below) emissions.

Source: KNMI/FMI/NIVR/Nasa, 2005

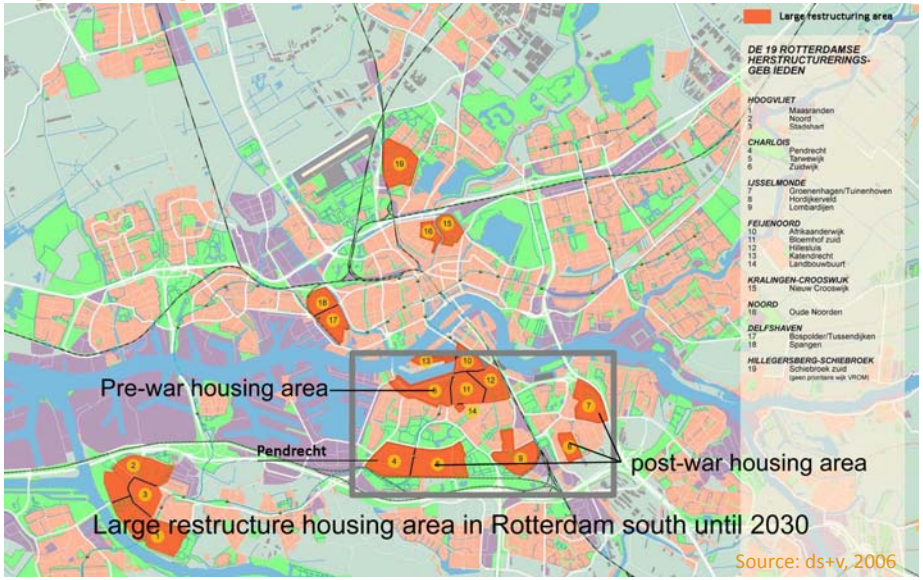
Figure 17



correlated problems. There is a need for embodiment of solutions upon different disciplines which can be developed and integrated in detail for fulfillment of the set target. Hereby this project can be also seen as a follow up, especially at the urban planning level.

4.2 Problems and potential of Pendrecht

Figure 18
Large restructuring area in Rotterdam south.



The Energy and Climate Program has to be realized locally and applied in good sequence. The large restructuring sites normally inherit certain urban problems which have been concluded in the evaluation process. These problem sites have gained the opportunity to change in large scale physically. They also have good potential to be included in the energy and climate program, which means to integrate with more environmental thinking in initial planning phase. Pendrecht which is one of the large restructuring areas in the plan was chosen as the illustrated site in this project (figure 18). The choice was narrowed down by local energy use pattern in the transport and housing sector. Site analysis concerning the energy use pattern in Pendrecht can be summarized in two points:

- Rotterdam is the one of low bicycle use rate municipalities in the Netherlands. Its transport mode, especially in short distance movement (<5km), has potential to be improved greatly. Pendrecht does not have sufficient public transportation provision, and very low bicycle use, therefore substantiating

the necessity for improvement.
- Postwar social housing, without updating, consumes two times more energy for heating compared to the housing which was built in 2000. Pendrecht, as a well-known postwar social housing area, could be a prime candidate to adopt housing renovation options, with cost-effective strategies. It would allow Rotterdam to explore the possibility of large scale energy savings in the housing sector.

4.2.1 Brief history of Pendrecht

Pendrecht belongs to sub-municipality Charlois and is a six thousand dwelling neighborhood on the south edge of Rotterdam. It is bordered by highway A15, cargo railway Betuwelijn, Waalhaven, and Zuiderpark (the biggest city park in Rotterdam). After the bombing of the inner city of Rotterdam in 1940, Pendrecht was assigned by the municipality of Rotterdam to relieve the housing shortage. In 1947, the design for the new residential district Pendrecht was created by urban architecture Charlotte Ida Anna Beese. The concept was to create an ideal society, an inseparable entity, meaning a well-functioning community. Pendrecht was designed to fulfill necessary living demands for inhabitants: shops, schools, churches, a community hall, etc. The plan was composed of stamp pattern housing blocks, one commercial and social core and a quadrant canal system (figure 19). For a certain period, the time which pursued a modernized version, international style and new life in

Figure 19

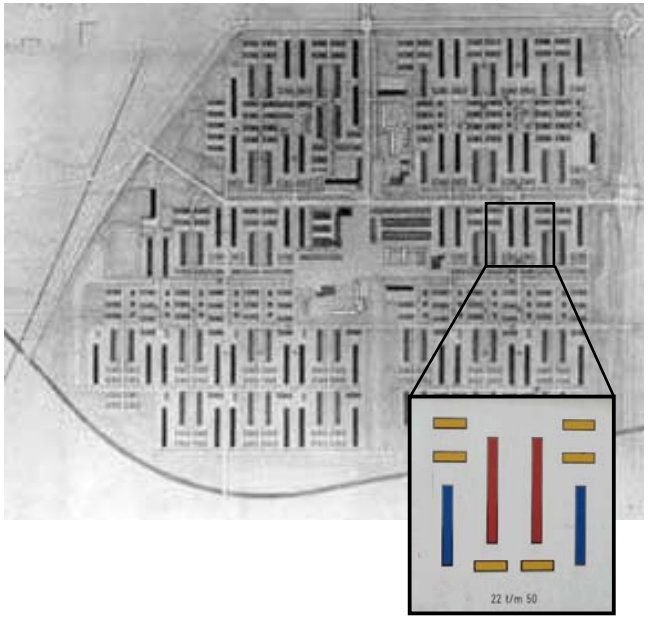


Figure 19
The plan in 1950 showed the stamp pattern housing blocks in Pendrecht, the commercial core is in the center of the district.

Source: http://www.mario-bosch.nl/pendrecht-introductie.htm

suburbia, Pendrecht was a model district in the Netherlands and even internationally. It was called Lotte Stam-Beese style.

After 1964, increasing unemployment and decreasing population in Rotterdam occurred as a result of the transfer of industry composition and social change. Confronting the tide of emigration and competition from new built area, Pendrencht gradually lost its crown of the housing market. Decreasing district population resulted in housing vacancies and local economy degradation. Large and empty semi-public courtyards, isolated district position, unconnected road layouts furthered the problem of social security. Pendrencht home values dropped dramatically so it became the area for low income migration. In Sep 2004, the 'Vital Pendrecht' program was offered as a solution to resist the downward reputation of Pendrecht through education and local upgrades. In ' Rotterdam Implementation Plan of Urban Project' (Uitvoeringsplan Stedelijke Projecten, 2003), Pendrecht also was approved for a large restructuring plan to take place from 2006 to 2010 to improve the physical living quality.

Figure 20

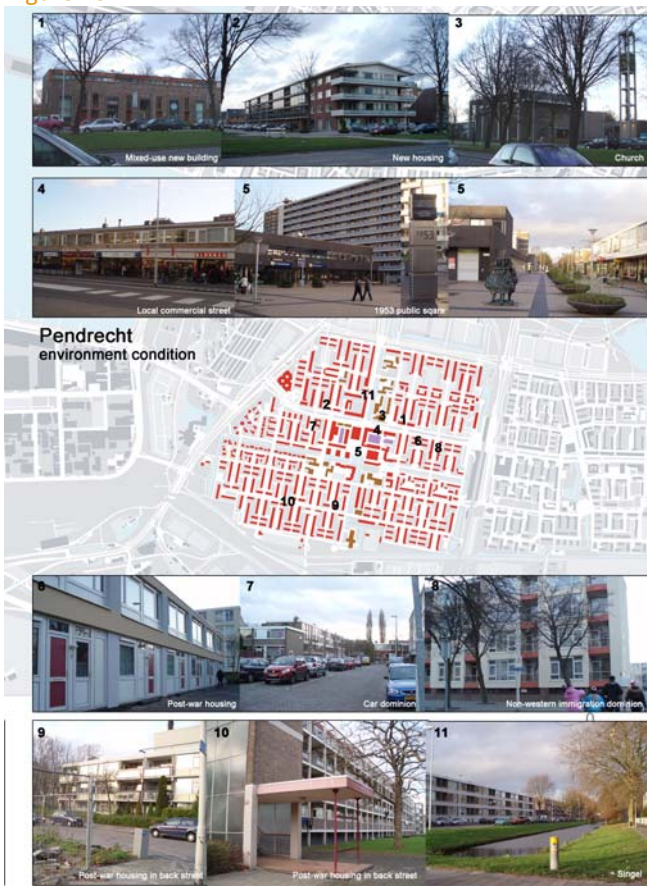


Figure 20
Pendrecht 2007. The central sqare and some housing have been rebuilt (photo above). Postwar social housing is still dominant housing povision in Pendrecht, their condition as photo below.

4.2.2 Site analysis on energy use pattern and potential

Following is a site analysis based on six spatial values which were concluded in Chapter 3. The analysis of the transport sector uses a graphic map and data from the Rotterdam mobility report (COS, 2007) to provide evidence of the transport pattern in Pendrecht. Some data, for instance, the transport alternatives in Rotterdam and Amsterdam, were collected from different municipalities, which used different ways of classification and may influence the correctness of numbers to some extent. Transport alternatives data in the Rotterdam mobility report was limited to the sub-municipality level. Therefore, the conclusions of analysis should be counted as the result from indirect evidence.

The analysis of energy performance of housing in Pendrecht is calculated by respective building ages in the district with energy performance by building age. As the result, current energy performance became the benchmark of the scenarios. Furthermore, sun shadow analysis was given to current building blocks which reveal the problems of old building layouts concerning climatic quality.

i. Transport pattern from graphic map

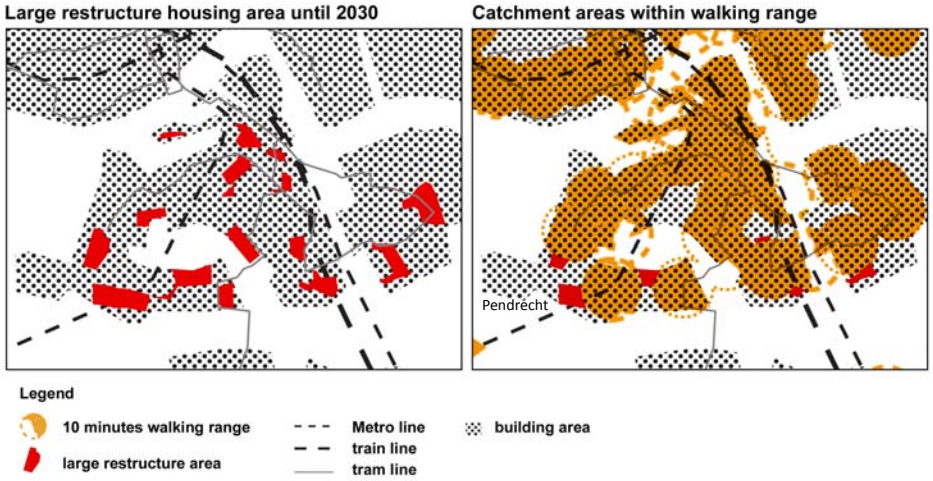
The graphic map divides framework of movement by three transport modes: public transportation, roads for the vehicles, and bicycle and pedestrian paths.

- Public transportation (figure 21)

The approbatory walking catchment area from a metro station is 800 meters, 10 minutes walking distance. Metro station Slinge was connected to Pendrecht

Figure 21

The large restructuring area and public transportation provision.



in 1970, which covers two-thirds of the area of Pendrecht. In 2009, Metro station Slinge will be directly connected to Den Haag by Randstad Rail, the terminal station in Rotterdam. Public transportation in the rest of area relies on bus service. The fact that bus use rate in Rotterdam in recent years is quite low should be kept in mind (Figure 22,23). The two nearest tram stops which are respectively 1km and 2km from the center of Pendrecht.

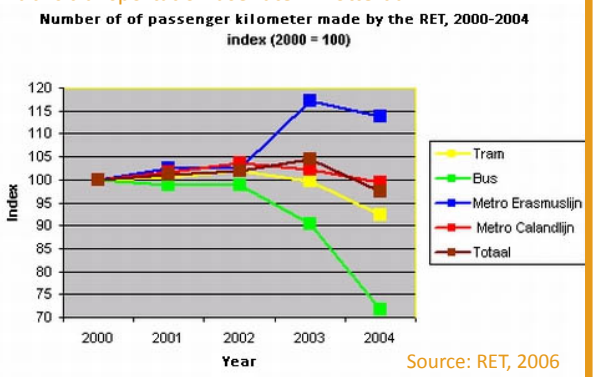
- Roads for vehicles

Pendrecht is surrounded by high speed city roads on the north and west sides with a four-lane road on the east side although the road stops at the border of Penfrecht (figure 24,26). The south side is fully blocked by the infrastructure cluster: metro track, cargo train track and motorway. Except the road on west side, which is the one of artery for the city, the others are just for local traffic yet have full scale of city road. Parking space is sufficiently arranged within every housing block and at the road sides. Pendrecht was purposely designed for an easy-car-use life style.

- Bicycle and pedestrian path (figure 25)

Bicycle and pedestrian paths were analyzed respectively by their catchment area within 10 minutes distance: 3.2km for bicycle, 800m for walking. The maps show current connections from Pendrecht to important surrounding urban functions by bike and by foot. From the center of Pendrecht, east and north are the main directions for local movement. No specialized bicycle paths or short of bicycle parking facilities are generally available in Pendrecht. Except for the square of the commercial center, there are no

Figure 22
Public transportation use rate in Rotterdam



Source: RET, 2006

Figure 23
Public transportation provision

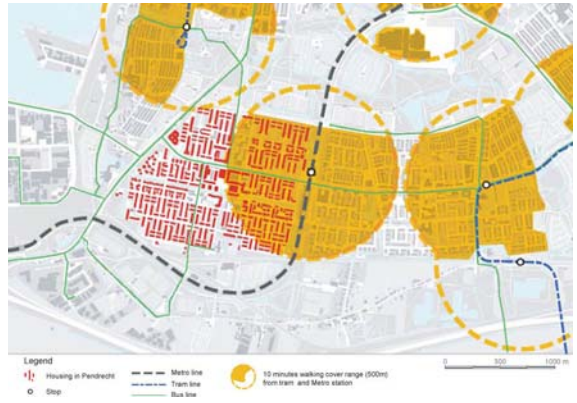


Figure 24

Road Oldegaarde is not an artery of city yet has 4 lines in width and high speed car flow which has become a barrier for crossing.

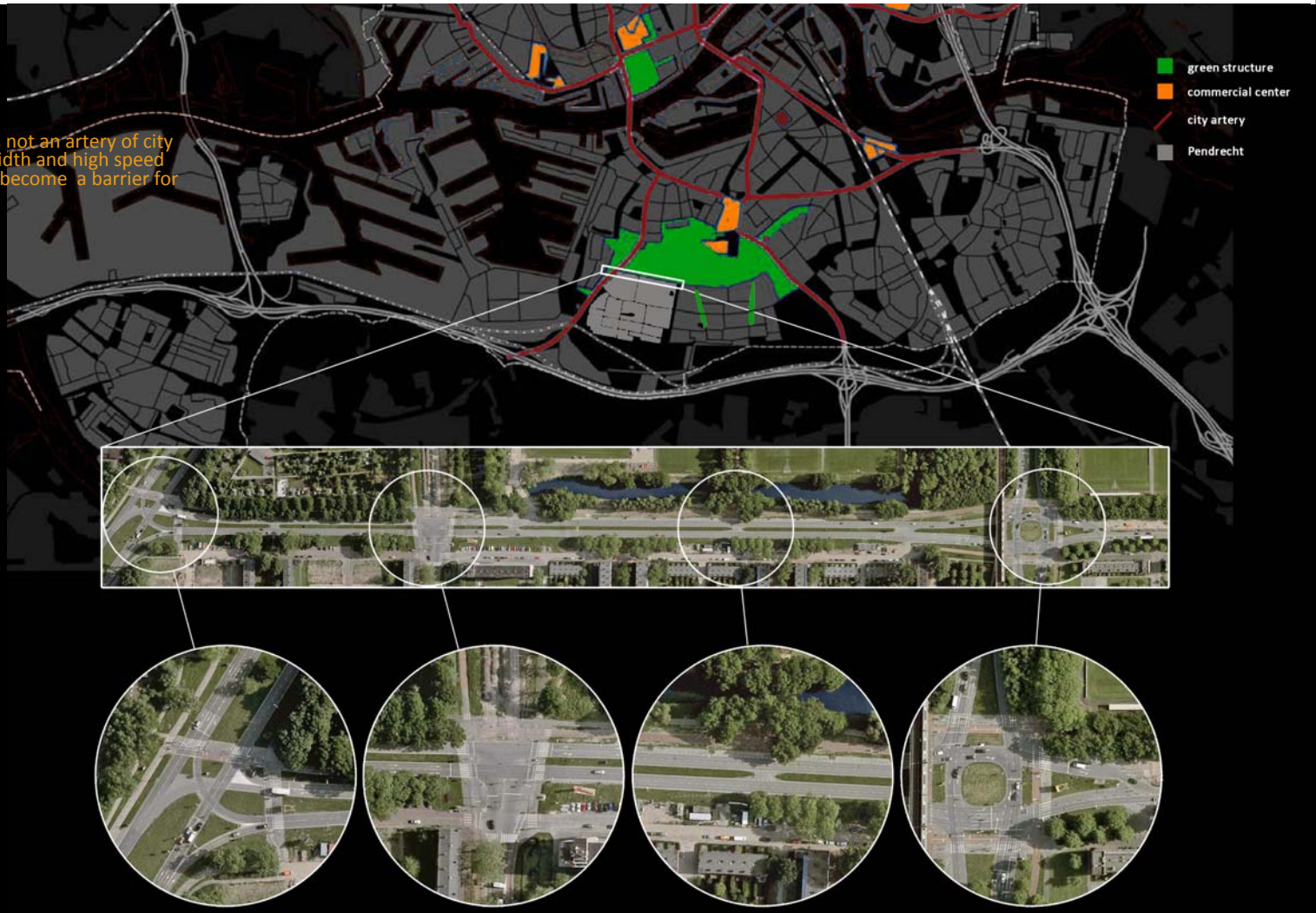


Figure 25
Walking and biking catchment area and connected urban function

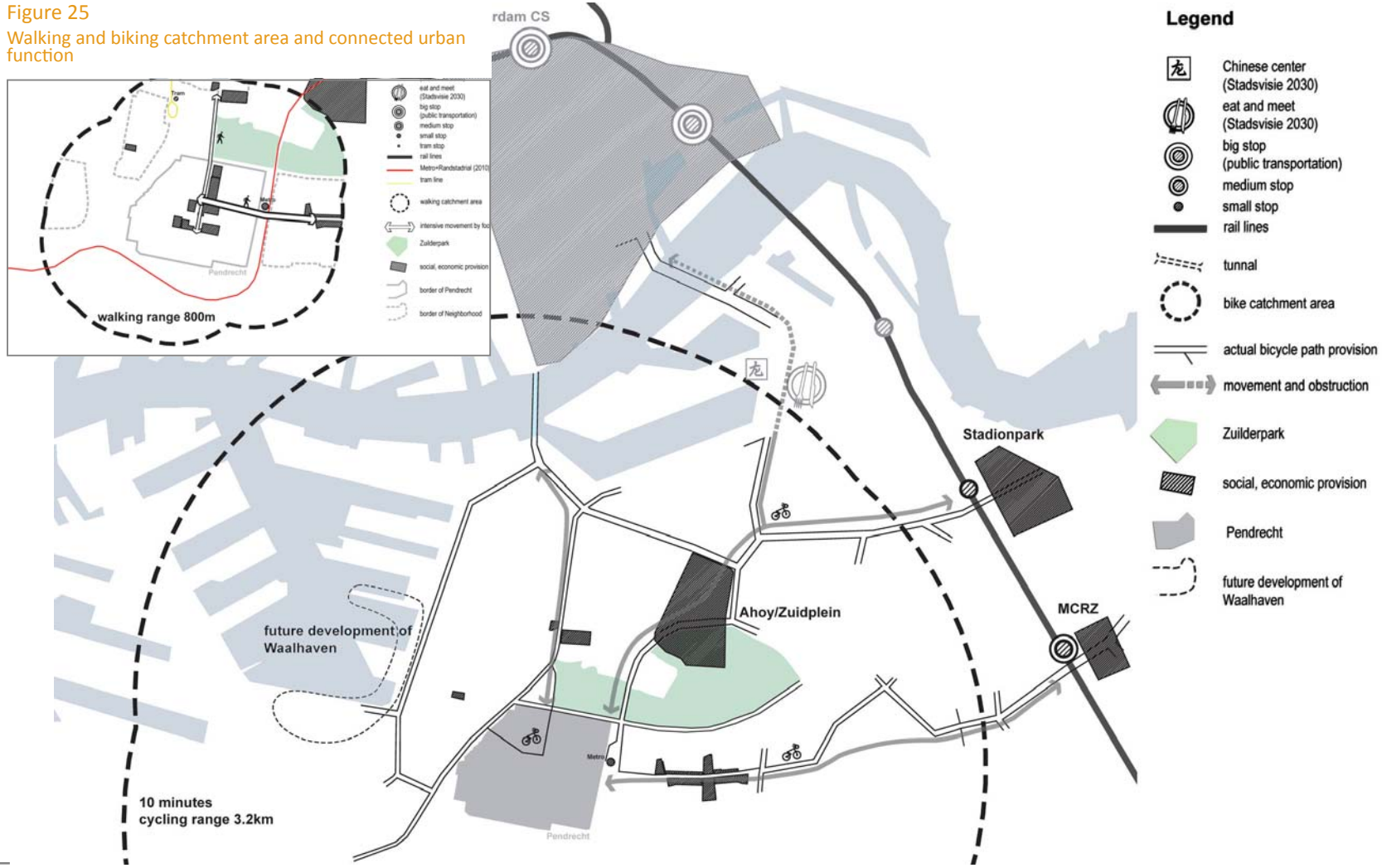




Figure 26

Road Slinge is in the middle of Pendrecht, has 3 lines for car but no specialized bicycle path.

Road Zuiderparkweg is under the metro line. It has 4 lines for car and is blocked on south.

attractive public spaces found along the main traffic areas. The square at the metro station Slinge is wide, dirty, and dark at night.

- Land use character (figure 27)

Main living functions were configured from north to south along the middle axis of Pendrencht. Metro station does not directly connect to core commercial areas according to a sustainable development land use model TOD (see chapter 3).

ii. Transport pattern from data collection

The data of daily personal transport alternatives (average number of displacements) reveals the proportion of transport modes which people choose for their daily movement. At the municipality level, the data of Rotterdam and Amsterdam show a large difference on bicycle and car use rate. 42% car use supports daily personal movement in Rotterdam, which is 14% higher than the average car use in Amsterdam. Amsterdam has 29% bicycle use rate, which is 10% higher than Rotterdam (figure28). The same survey for sub-municipalities in Rotterdam also shows diverse results on the choice of transport

Figure 27
Land use character in Pendrecht

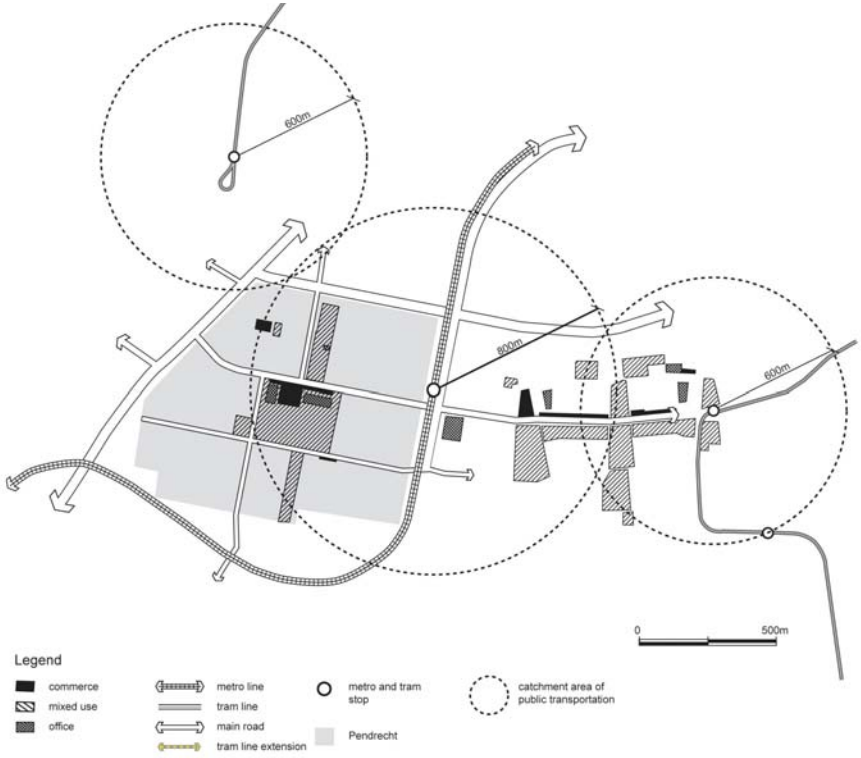
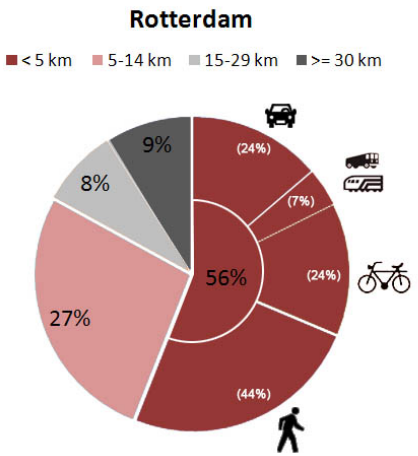


Figure 28



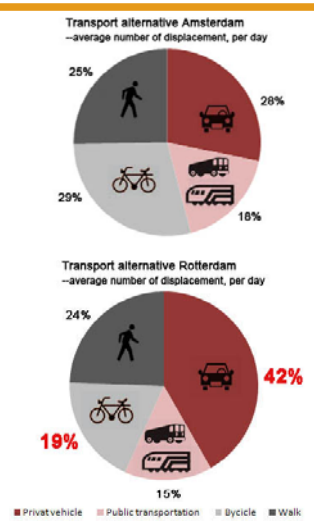


Figure 28

Distance of daily trip in Rotterdam (above lift) and comparing transport mode in Amsterdam and Rotterdam (above right)

Figure 29

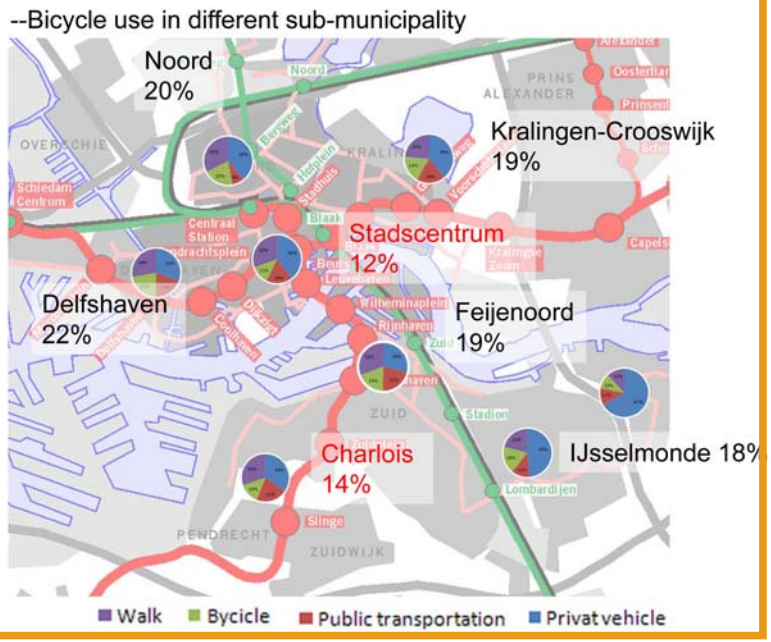


Figure 29

Charlois was one of the lowest bicycle use sub-municipalities (14%) within Rotterdam.

modes. Comparing seven core sub-municipalities within Rotterdam ring road, Stadscentrum as the city center has lowest bicycle use rate about 12%, and Charlois is the lowest bicycle use residential district, at 14% (figure29).

The data about travel distance for daily trips (to school or to work place) shows 56% daily movement within 5km, and only 17% daily movement over 15km in Rotterdam. The same survey also shows daily total moving distance per person in Charlois is 22.5km, and movement by car averages 12.7km, which indicates 56% of the travel was carried out by high energy consumption transport mode.

iii. Energy performance on housing—district level

There were 6018 dwellings in Pendrecht in 2006. The current proportion of building age in Pendrecht follows: 51% of the housing was built between 1954 to1960, 14% of new housing replacement was completed after 2000, 35% of old housing will be further replaced by new housing before 2010 (figure 30, 31). Energy performance of the housing which was built after 1996 has been regulated by the standard of policy tool EPC: EPC 1.0 after 2000 and EPC 0.8 after 2006. Energy performance of old housing was counted as EPC 2.0 based on the reference by J.F.M. van der Waals (2001).

iv. Potential and tendency analysis

This part of the analysis provides backup to decision making and strategies in the urban renewal project. It includes a feasibility study for two schemes of development: new housing replacement and old housing renovation. Several integrated issues such as comparison of energy related technology, adaptation options and policy tendency in the Netherlands are covered.

<u>Schemes of development I -- new housing replacement</u>

Figure 30
The change of housing occupation number through years and its assumption.

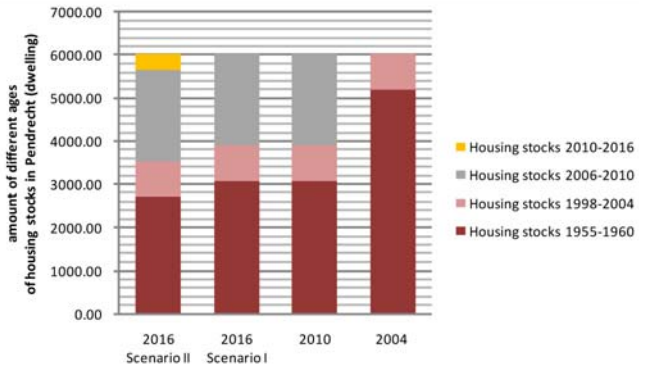


Figure 31
Current proportion of housing ages in Pendrecht, 2007



The cost of new building is expected to increase because of tighter standards for energy performance from policy trends in the Netherlands. The new housing in 2020 is expected to be CO_2 neutral (gross zero energy consumption). Energy efficient housing requires higher initial cost for construction (figure15). The Passive House in the case of Hannover-Kronsberg (Germany) needs additional investment of around 8500€ per dwelling. However, a Passive House has many economic benefits. The low power demand is beneficial for the energy infrastructure. Also, local energy production on the scale of an urban area becomes a feasible option because of the low energy demand. The escalating energy bill and the depreciation of energy technologies probably offset the additional investment in long term. The average energy bill in an average household has soared by over 75% since 2000. The price of natural gas has more than doubled and electricity is almost 50% more expensive (CBS, 2006).

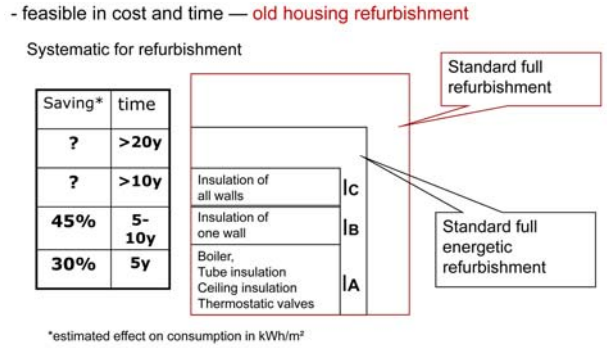
Minimizing energy demand increases economic viability of renewable energy. A Passive House has minimized heat losses, and thus a larger share of the building's heating energy can be covered economically by passive solar gains. The remaining energy demand can then be covered by active solar systems or other renewable sources.

Schemes of development II -- old housing renovation

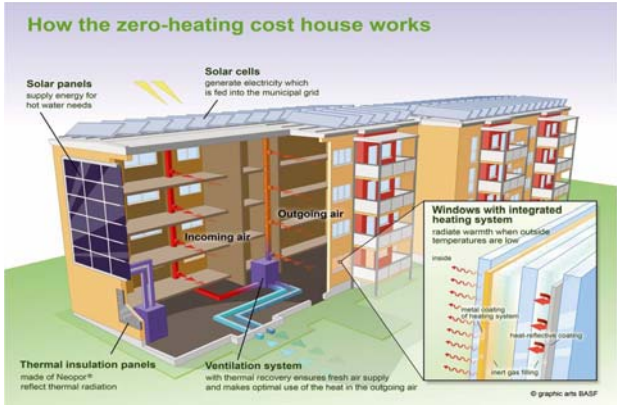
Old housing adaptation would be relatively inexpensive based on the total investment because of the concept of material reuse and life cycle extension versus new development. New housing can achieve great amount of CO_2

Figure 32

After refurbishing, life time and value of old housing will increase. Over 10 years pay-back period is general difficult realizated for social housing.



Source:CEBra, 2007



reduction and have higher market value in general, yet it might not be as cost-effective as old housing renovation related to large-scale energy savings. New construction takes 2.5 times the investment to save 1Kwh heat versus old housing renovation which averages a 40% energy saving, including the process of demolishment (J.Douglas,2006; J.F.M. van der Waals, 2001). From this point of view, the small amount of new development (current new housing development rate is 1% in NL) would not be as crucial as old housing renovation to carry out large-scale CO_2 reduction.

Case studies—costing and information among low- and zero-carbon technologies

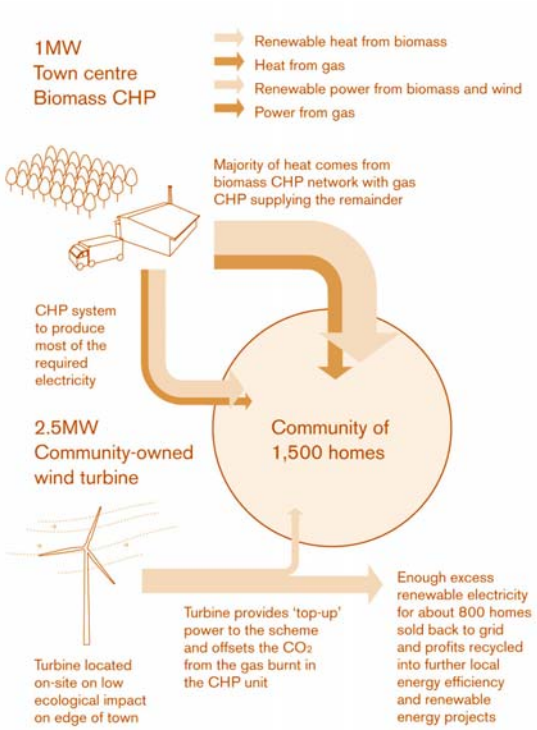
Available low- and zero-carbon technologies which can be applied to individual buildings or a group of building blocks are summarized below. For the comparison of costing and CO_2 reduction of the technologies see figure 7.

>> Combined heat and power (CHP)

In a CHP system, energy can be produced in the same way as conventional electricity, but the heat is retained for heating, hot water and cooling, and is distributed to customers via highly insulated pipes. This improves the overall efficiency of energy conversion to around 85%. CHP is applicable on a variety of scales, from city-wide development down to individual buildings. Micro-CHP refers to small scale CHP, which is most commonly used for individual buildings.

Summary: CHP

- Increases efficiency over conventional grid supply by up to 50%.
- Reduces CO_2 emissions by up to 40%.



A decentralised hybrid energy system supplying energy to a 1,500 home community and selling the excess electricity to the national grid

Source: XCO2

- Can be used at all scales but most efficient when used as part of a sustainable energy network.
- Lifespan of around 15 years.
- 2.6kg of CO_2 saved per € of capital cost

>> Wind turbines

Wind turbines convert the power in the wind into electrical energy using rotating wing-like blades which drive a generator. They can be connected to the national grid to export electricity, used directly for electricity or used to charge batteries for on-site use. Wind velocities are the key factor in the location of wind turbines.

The Netherlands has a huge potential wind resource. Sites of wind turbines normally were selected in wide open spaces such as onshore land and industrial sites. Urban turbines for urban environment do not have an implementation plan in the Netherlands yet.

Summary: wind turbines

- Care should be taken in choosing turbine types and location to take advantage of available wind, but also to avoid or minimize visual impact.
- Developments will normally require planning permission.
- Larger turbines require suitable infrastructure.
- Can be stand-alone or integrated into a network.
- Lifespan of around 25 years, or less if connected to a battery.

CHP plant



500kw turbines can generate 1.5MW per year in general and can cover energy demand from 300 houses.



CO_2 emissions offset and the number of homes powered by different sized turbines

These figures are based on standard assumptions and will vary depending on site-specific features.

Source: XCO_2

- 17.9kg of CO_2 saved per € of capital cost for big wind turbine, and 3kg of CO_2 saved per € for small wind turbine.

>> Biomass and biofuel

Biomass is a generic term that describes the use of organic matter to produce energy. Biomass heating is a simple and proven technology, widely used across mainland Europe. Biomass can be processed to produce either solid or liquid energy. Biomass fuels are virtually carbon-neutral. This is because the growing plant or tree absorbs CO_2 in its lifetime, and the same amount is released upon conversion to energy. Biomass can be used in space heating, for hot water and in CHP units.

Summary: biomass and biofuel

- Virtually carbon neutral (CO_2 emissions associated with transportation).
- Cost of fuel is comparative with conventional heating fuel, and will improve as fossil fuel prices increase.
- Can operate at a variety of scales.
- Storage of fuel and disposal of ash are considerations.
- Lifespan of biomass energy generation approximately 20 years.
- 6.5kg of CO_2 saved per € of capital cost

Biomass Gas / Electrical Power Generating System



>> Photovoltaic (PV) panels

Photovoltaics are materials capable of converting daylight into direct current electricity. In principle they are the ideal source of renewable energy as they use the most abundant source of energy on earth: the sun. They also produce electricity which is the most useful form of energy.
Currently efficiencies are only around 18% but recent advances in technologies and economies in the manufacturing process are likely to see efficiencies increase and prices fall.

Summary: PV

- Silent operation with no moving parts, leaving minimal operational or maintenance costs.
- Can be integrated into the building fabric, thereby offsetting costs such as solar shading, roofing or cladding.
- Does not require direct sunlight, though care must be taken to avoid overshadowing.
- May have implications for load capacity of the roof or structure of a building.
- Lifespan of at least 15–20 years.
- 2.4kg of CO_2 saved per € of capital cost

>> Solar thermal hot water collectors

Solar water heating harnesses the sun's rays to heat water that can then be used for either space heating or, more commonly, domestic hot water heating. The system consists of solar collectors that are often roof-mounted. Water or oil is passed through the collectors to a heat exchanger in the hot water cylinder, which will also have a top-up heat source from a conventional system.

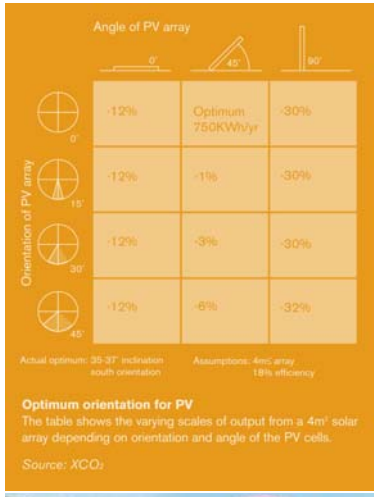
Summary: solar thermal

- Can be either flat plate (cheaper) or evacuated tube (more efficient) collectors.
- Does not require direct sunlight, though care must be taken to avoid overshadowing.
- Can be used with combination boilers.
- Lifespan of at least 20 to 25 years.
- 2kg of CO_2 saved per € of capital cost

>> Ground source heat pumps (GSHP)

Ground source heat pumps (GSHP) harness energy from the ground. Ambient air temperatures

A building-integrated roof tile PV system and a conventional roof-mounted PV array.





vary widely throughout the year, however ground temperature is stable.

Summary: ground source heat pumps
- Provide either heating or cooling.
- Trench systems require a large area.
- Borehole systems need access for drilling, a geological survey and possibly a permit from the Environment Agency.
- Life span for heat pump – around 15 years; for the coil system – around 30 years.
- A typical borehole system costs around €1,500 per kilowatt.
- Trench systems cost around €750–1050 per kilowatt.
- 0.87kg of CO2 saved per € of capital cost

(The technology study above were mainly quoted from TCPA, 2006)

Large wind turbine (90 diameters) which can save 17.9kg of CO_2 saved per € of capital cost is the most economical zero-carbon technologies.

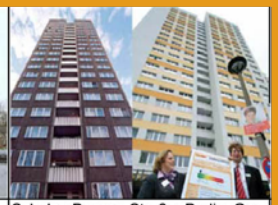
However, urban turbine has not been admitted for residential areas yet in the Netherlands. Biomass has good performance on 6.5kg of CO_2 saved, though recently it is challenged by the worry of insufficient world food supply. Costliness is still the obstacle to widely adopt photovoltaic and solar thermal. A new subsidy scheme for renewable energy (solar water heaters, heat pumps and solar panels) was just be introduced in 2008 from VROM, 100,000 existing housing will be able to take advantage of these renewable energy options.

Case studies— reasonable energy saving range for old housing refurbishment

Three to four layer flats are the main type of social housing in Pendrecht; but a small amount of apartments are over seven layers. Thus low rise and high rise flats are studied as the target group concerning energy saving in housing refurbishment. Five cases with diverse project scales were collected from four Europe countries (figure 33). They achieved 28% to over 50% energy reduction by adopting different energy saving schemes with reasonable pay-back period. They presented good practices in different aspects, which are economic feasibility and gain good market value after adaptation. The comparison proved that pay-back period has been shortened year by year because the increase of energy cost and depreciation of energy technologies.

Cost and value has to be distinguished concerning economic feasibility. Cost

Figure 33

Good practice of housing refurbishment					
Location	Tarweveld,Veenendaal,NL	Poptahof,Delft, NL	Cornwall Falmouth, UK	Rumburk, CZ	Schulze-Boysen-Straße, Berlin, Ger
Project	housing refurbishment	community-wide regeneration project	community-wide regeneration project	social housing refurbishment	social housing refurbishment
Time	2000-2002	2004-unknow	1995-2003	1997	2006-2007
Building type	high-rise flats	high-rise flats	terraced and semidetached houses and low-rise flats	housing and low-rise flats	high-rise twin flats
Dwellings	75 DW.x 2	converting old 200 flats to become 100 flats;new housing 96 flats.	900 dwells	2 houses and 66 flats	296flats
Floor area/DW.	95-100㎡	108㎡		60-80㎡	37㎡,111㎡,74㎡
Insulation	-	- building thermal modernization	-loft insulation, covering 300 DW. -cavity insulation, covering 300 DW. -external insulation,600 DW.	-roof insulation and remodeling -external insulation -doors and windows -floor insulation	-roof insulation -external wall insulation -floor insulation -triple insulation glazing
Installation	-condensing boilers -new piping and radiators -solar domestic hot water system -universal control unit	-Extending and upgrading of heat distribution system -10 kWp PV system	-central heating, covering 300 DW. -condensing combi boilers -over-bath showers	-	-highly efficient rotational heat exchanger -air feed and exhaust plant -controlled ventilation -integrating the new block heat power plant (BHPP)
	-balanced ventilation with heat				-water-saving taps
Heat demand before refurbishment	125kWh/m²	193kWh/m²	unknow	174kWh/m²	90.6 kWh/m²
Heat demand aftre refurbishment	90kWh/m²	target in old:95 kWh/m²; in new:51 kWh/m²	unknow	95kWh/m²	44.9 kWh/m²
Energy saving	28%	62%	30%	45%	50%
Total costs for the project	€ 1.24 million	unknow	€ 1.46 million	€ 300,000	€ 8 million
Cost/dw(excl. tax)	€ 8327 (excl. VAT about € 85/m2)	unknow	€ 1622	€ 4500	€16428 €49284 €32856
Subsidy	€ 1044/DW. (solar energy)	unknow	€ 1.46 million	€ 100,000	€ 4,400,800
Duration of construction work inside a single apartment	2days	unknow	unknow	unknow	1 year
Pay-back period(excl.subsidies)	7 years	unknow	5.5years	unknow	7 years
Remark		large-scale upgrading will take place during the next 10 years. The upgrading includes the public space, areas for water and greenery, the adherent shopping centre, roads for cycling and cars, parking areas etc. Renovation of 800 dwellings in 8 highrise apartment buildings is part	a number of knock-on effects were noted after physical improvements.Such as 50% drop in the numbers suffering from asthma;a dramatic reduction in crime; community spirit was improved.	Combination of house rehabilitation with building additional floor of flats under the roof gives very good economic results and can be recommended.	Europe's largest low-energy building

is the amount of money it takes to manufacture an artifact or asset, and includes any basic profit. Value is the worth of something in monetary terms, which is influenced by market forces.

A simple example involving the refurbishment of a building illustrates this point. For example, homeowners often have to be reminded that spending tens of thousands of euro extending or improving their dwelling does not always increase its value by the same quantity. It is the market that ultimately determines the value of property.

Some adaptations, however, are more likely to achieve added value to the building than other interventions. Installing double-glazing in a property will in itself not necessarily increase its open market value by the cost. The pay-back period for this type of adaptation may be over 10 years or more. Converting the loft of a detached/ semi-detached dwelling is a more effective way of increasing its value in the short time. The research from G. Wagener-Lohse (2007) gave a general concept about energy saving and pay-back period by systematic refurbishment measures (Figure 32).

v. Analysis climatic quality of urban structure

With good orientation the need for auxiliary heating and cooling is reduced, resulting in lower energy bills and reduced greenhouse gas emissions. Orientation for passive heating is about using the sun as a source of free home heating. Poor orientation can exclude winter sun, and cause overheating in summer by allowing low angle east or west sun to strike glass surfaces. Sites running N-S are ideal because they receive good access to southern sun with minimum potential for overshadowing by neighboring houses. In the summer, neighboring houses can provide protection from low east and west sun.

Most of the flats in Pendrecht are facing E-W with east or west facing glass area in each living unit. Configuring renovation for the interior space can increase market value but may not influence the solar access[1] or passive heating. Instead, re-configuring the layout of the building block has potential to decrease overshadowing area from neighboring building.

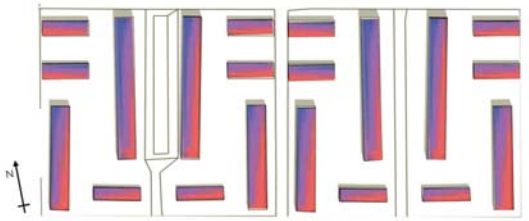
Sunlight also influences the quality and use of public space for outdoor activities. Semi-public court yards or public squares should not be placed on the north sides of building. The distance between the house and any building development to the south should be maximized. Building on the North boundary can be useful to increase the amount of south facing outdoor space. The will avoid compromising the solar access of neighbors by overshadowing. The public space within the building blocks

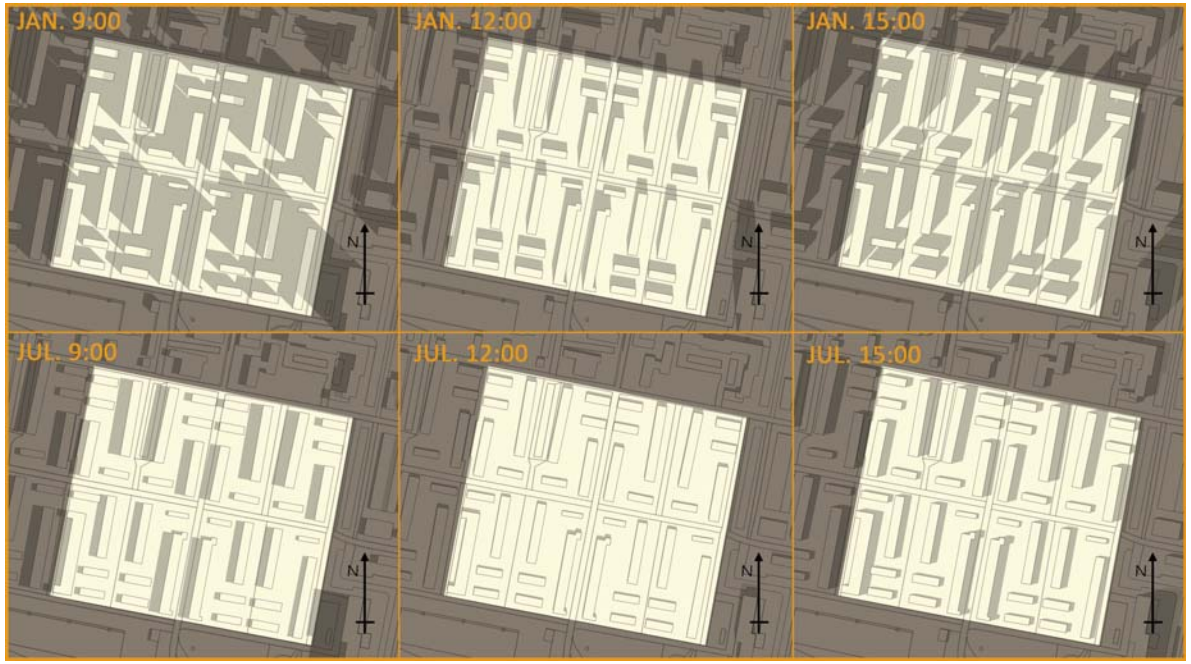
1 'Solar access' is the term used to describe the amount of useful sunshine reaching the living spaces of a home.

of Pendrecht has reasonable sun hours: 50% sunlight area for three hours in winter and seven hours in summer. The general problem of public space in postwar housing, alike in this case, is the unfinished character of the district: a lot of ideas and planned facilities, like stores and spaces for sport and recreation were not realized because of lack of finances (figure 34,35).

Figure 34 (right)
Indoor solar access was evaluated from solar hour map.

Figure 35 (below)
outdoor solar access was evaluated from solar shadow map.





4.3 Urban renewal master plan

With the premise of large-scale of GHG reduction, an urban renewal master plan has to widely adopt a 'Three-step-strategy' (chapter 3) to encourage and maximize a sustainable living style by:

>> avoiding unnecessary use,
>> using renewable sources, and
>> using limited sources carefully.

Daily travel can become more efficient by means of urban planning. The proposal for Pendrecht is first to remodel the local transport network by assigning priority to pedestrian and cyclists. Guaranteeing the safety of pedestrian and cyclists is a necessary prerequisite for promoting walking and cycling as a daily mode of transport. Roads are multifunctional spaces which have to be shared fairly among all users. The idea of moderating traffic is a necessary consequence of adapting car traffic to other road users, with crossing areas for pedestrians, commercial areas (shops, cafés), social spaces (playgrounds for children, pavements for people to stand around and chat) and above all a living space.

Moderating traffic has a marked impact on safety. Indeed, 65% of accidents occur in conglomerations. There is a link, moreover,



A piece of equipment with a double environmental effect.



Through road for cyclists, dead end for motorists.



Contraflow behind parked cars where car traffic is heavy.



'Cycles only street' with special access for busses.



Cyclists can ride on the pavement in order to save effort.

between speed on the one hand and the risk of an accident and its seriousness on the other: for the apparently insignificant speed difference between 30 km/h and 40 km/h, for instance, the braking distance rises from 13.5 m to 20 m.

The adult cyclist will instinctively choose his or her routes (major or secondary roads, cycle path or track, direct changes of direction or crossings on foot). Cyclists must therefore be enabled to circulate everywhere, on both secondary roads and major routes. Children are a different category. Less capable than adults of choosing their itinerary according to their skills, they need guidance and various facilities all along their route. Routes leading to schools merit particular attention.

Pedestrians and cyclists often find their place quite naturally. Wherever cars are no longer taking up all the space, bicycles pop up. When defining cycle routes, there are certain imperatives: they must be simultaneously intelligently chosen, direct and pleasant and any installations made on these routes must be simultaneously safe and comfortable. Indeed, the cycle routes appreciated by beginners are preferably separated from the major car traffic flows (criterion of comfort) which can thus follow more local roads, as long as the trip remains direct, without pointless or excessive detours.

As long as the cycle routes are following local roadways, the main measures taken can be those of moderating speed and, as far as possible, cutting down the volume of traffic. In cases such as this, there are few restrictions placed on car traffic and any opposition



Contraflow with occasional markings in local streets.



Cycle path ends smoothly where cyclists re-enter mixed trafic lanes.



Busses and cyclists share a wide contraflow lane.



A simple, efficient and inconspicuous cycle rack.



Cyclists going straight ahead are clearly separated from those turning right.

from the car lobby can easily be defused by a good information campaign and by encouraging the participation of motorists (J. Dekoster, U. Schollaert, 1999).

According to the design principle above, the traffic system in Pendrecht would have the following proposed changes (figure 37):

>> Local commercial core (shops, cafés) and social amenities (school, association) with projected safe and comfort access for pedestrians and cyclists. Attractive public spaces are planned along the artery (Road Slinge). Car traffic would be restricted to a feeder traffic lane.

>> Moderate car traffic speed by reducing width of road Oldegaarde, the road between Zuiderpark and Pendrecht, which is now dangerour to cross.

>> Install a new tram track to pass through two local commercial centers in Pendrecht and its neighbor district Zuidwijk along the road Slinge (figure 36). It will remedy the local shortage of public transportation on the one hand, and complete the public transport network of Rotterdam south on the other. (70% metro passengers come from tram system connected area, J. Westrik, 2008)

>> Build one new car traffic road to merge into the original infrastructure cluster in the south and connect to the road Zuiderparkweg. Thus an unhindered car course can be guaranteed.

Secondly, land use character which can influence a 20-30% variation of travel demand and transport mode choice (chapter 3) would be modified. Transit-oriented development (TOD) (p.39) was taken as a sustainable land use model for design. Land use character in Pendrecht would be tuned work with the transport framework, to reduce transport demand and increase market value. Two lots near a transit stop were included in the redeveloping plan strategy. The potential of three lots can be found by their location: the lot A and B near the metro station Slinge which will become the terminal of Randstad Rail in 2009 merit attention on regional level. Redeveloping old housing in lot A and B will attract regional housing buyers and will stimulate joint development of the surrounding area (figure 38). Timeworn metro square and facilities can be renovated at the same time for the sake of improving living quality and encouraging green movement.

The lot C close by the local commercial center also will profit from a new tram connection plan (figure 39). The location provides good market potential for the housing renewal plan and can be synergistically developed with a new tram stop, public space and bicycle path.

Figure 36

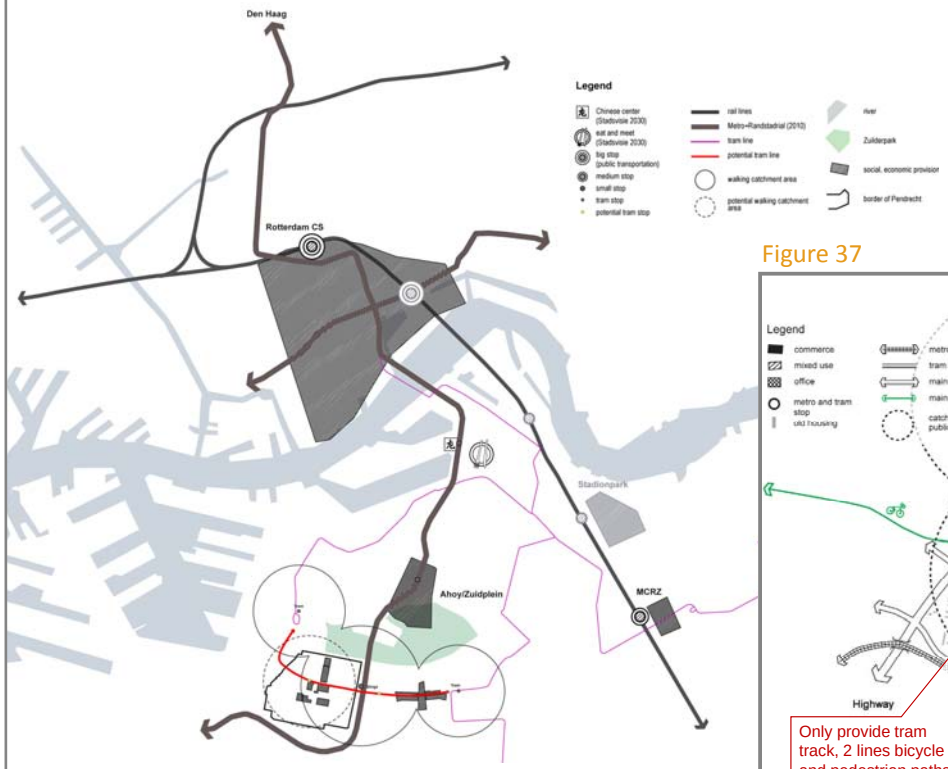


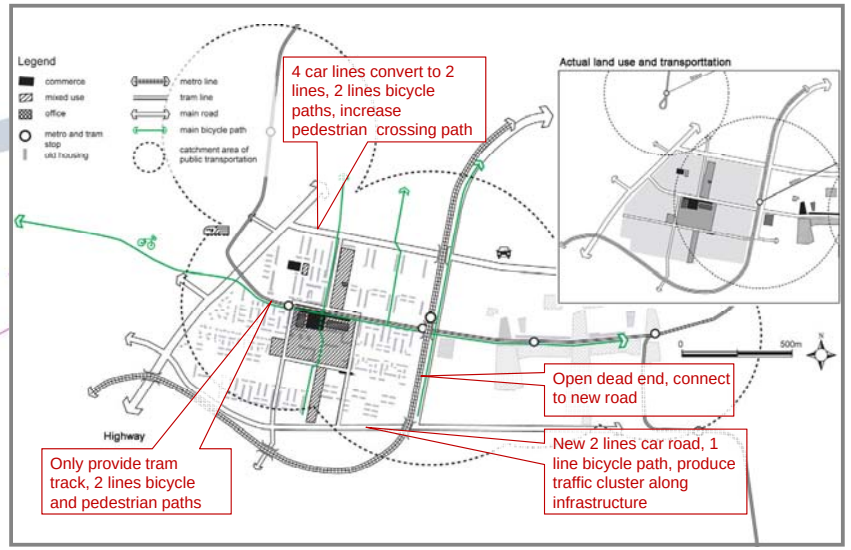
Figure 36

New extension of tram track benifit Pendrecht on the one hand, complete transport network of south Rotterdam on the other.

Figure 37

New proposal of local transport network.

Figure 37



Mixed use of housing types and functions can properly be added to these two lots. Restaurants and cafés which would provide a meeting and resting point for transit population can be a proposal for lot A. Personal working studio which mixed with living function is an profitable housing type both for lot A, B and C.

Two existing high rise buildings which are located at the gate way of Pendrecht as landmarks in the past can be converted to office use. They will be the showcase for Pendrecht to turn over the bad image of the past and advocate current sustainable urban renewal development. Two new office lots are placed close to the north and south border. They are easy reached from Waalhaven (city port and will gradually be converted to office agglomeration after 2011), and located within walking distance from public transportation. One sport amenity is planned on south to provide integrative services for the existing sport fields on the south border.

Thirdly, three large redevelopment lots will be adopted for energy saving measures as renovation sites according to their potential. Two scenarios were established, according to site analysis in section 4.2.2 which concluded that GHG reduction will largely rely on old housing

Figure 38
Integrating regional transport network with land use development

Figure 39
Integrating local transport network with land use development

Figure 38

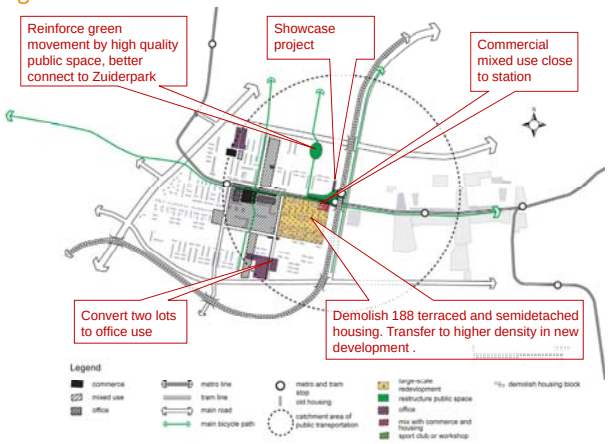
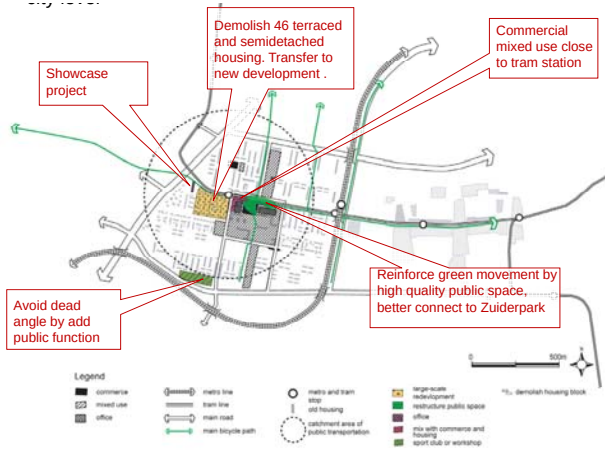


Figure 39

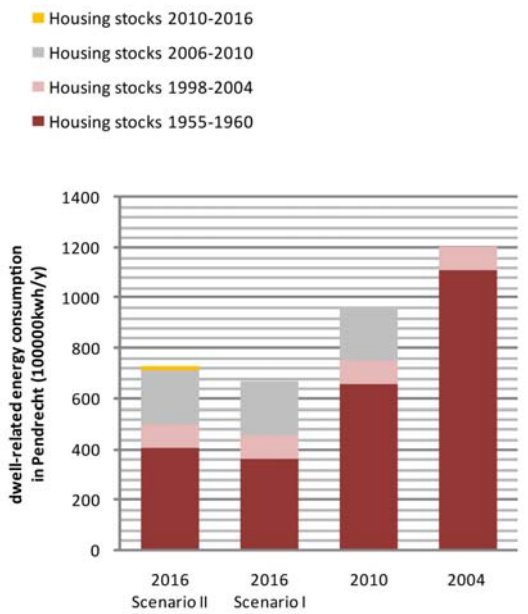


refurbishment.

The period chosen for these scenarios is from 2010 to 2016 (the target year of EEAP). To meet the target from The Netherlands Energy Efficient Action Plan (EEPA, 2007), household sectors should reduce energy consumption by 22% by 2016. The planned new housing, which will be completed before 2010, occupies 35% of available housing stock in Pendrecht and will carry out 23% energy savings as a result of the EPC requirement, which fulfill the set target already. However, the project pursued potential scheme with high and realizable energy savings target according to the practical data. 45% energy saving can be achieved with 5-10 years pay-back period for per old dwelling (not counting other purpose of refurbishment). In Scenario I, it was assumed that there is no further new housing replacement after 2010. Just by renovating existing housing a 23% energy saving for Pendrecht can be achieved with a 5-10 year pay-back period. Thus Scenario I will bring a total of a 46% (23% plus 23%) energy saving for housing in Pendrecht. (figure 40)

However, market value is an inescapable factor concerning housing development. Only adopting energy saving measures may not satisfy market demand, especially when the bad image of the living environment of Pendrecht has been rooted in public opinion. There is a need for a brand-new image of visual and energy efficiency renewal. The case study (next section) shows that even a small portion of housing replacement can activate old housing renovation through integration to shape a holistic renewal of building blocks. Scenario II thus was established with the idea of an annual replacement 1% of existing housing from 2010 to 2016. 360

Figure 40
Dwell-related energy consumption in Pendrecht as a whole: comparing current condirion and after adopting energy saving packages by scenarios.



old dwellings can be replaced by passive housing with the EPC standard in average 0.4, which can reduce 5% of the energy consumption for Pendrecht. The rest of the 2710 old dwellings can be assigned reasonable refurbishing costs (assuming a 10 year pay-back period) by combining 30% energy saving measures (with a 5 year pay-back period) plus other market-oriented refurbishing measures. Together, the changes will total a 40% energy saving in the housing sector in Pendrecnt with the advantage of improved living conditions and market values. Concerning the proportion of housing demolishment and replacement, the detail plans for lot A, B and C in the next section is one illustration based on the Scenario II, projecting a positive and reachable future.

Energy saving measures for old housing refurbishment should be tailored respectively by diverse types with consideration to the condition of building. Further solution packages would not be included in this case related to the project level. More fieldwork, survey and engineering analysis have to be prepared in order to determine a feasible implementation. Nevertheless, old dwellings which are in the large-restructuring area (three lots) are expected to share larger energy reduction because of more integrated measures that can be made.

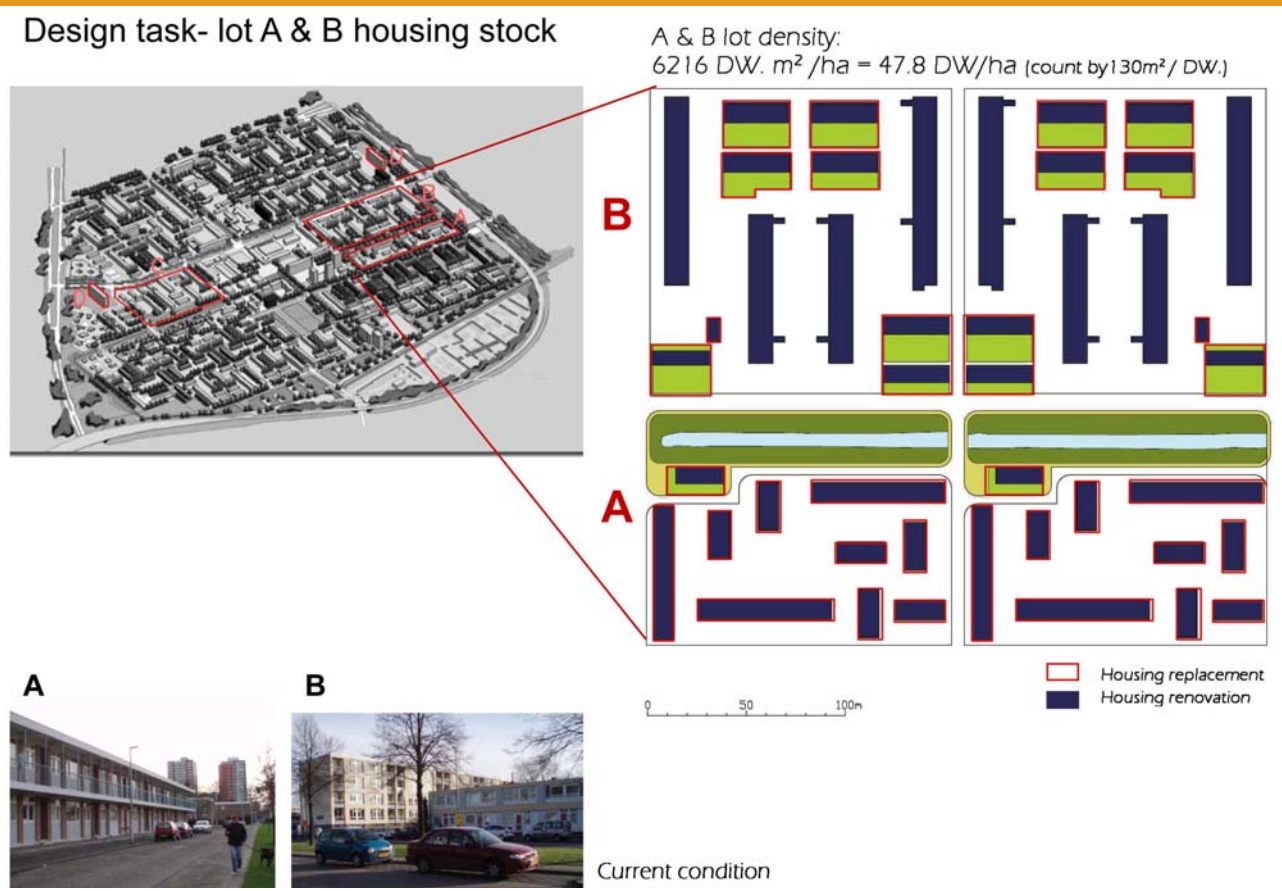
4.4 Density, housing block and climatic design

Proposed density and housing typology of the three lots mainly came from current good practices which were chosen according to similarity and current market taste.

Two different schemes were given to lot A and B. Original housing in lot A is composed of 188 postwar-type terraced and semidetached houses with relative small floor area. The plan is to all replace all of them with passive houses. BedZED, the largest carbon-neutral eco-community in the UK, has gained an impressive reputation and is used as the referenced case for lot A. With a similar site size, BedZED was shaped by a high density but mixed-use, mixed-tenure scheme and employed innovative approaches to energy conservation and environmental sustainability. Restructuring lot A, using the housing pattern of BedZED, will increase the living space more than 4100 m2 per hectare (or an increase 32 dwellings per hectare if divided by 130 m^2/DW) with good commercial value and high living quality (figure 41, 42).

Lot B will have 8 four-layer flats (mainly social housing) and several semidetached houses with similar appearance.

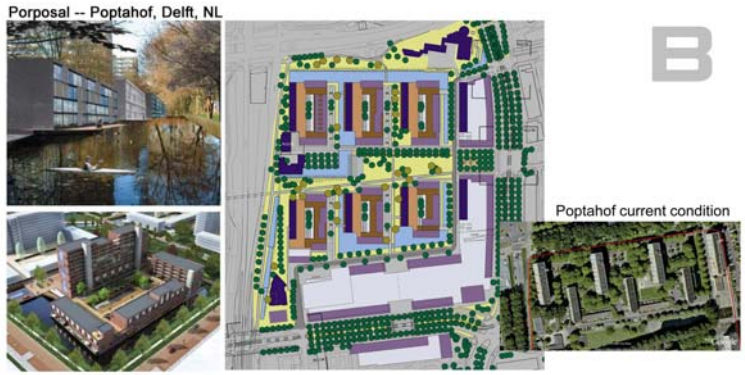
Figure 41
Current condition of lot A and B



Density after completion: 9351 DW.m2/ha = **71 DW/ha** (count by 130㎡/DW)
Housing standard: energy saving: **62 %**

Density after completion: 6546 DW.m2/ha = **50 DW/ha** (count by 130㎡/DW)
(9419) (73)
Housing standard: **Zero CO_2 emission**

Figure 42
Comparable case for lot A and lot B



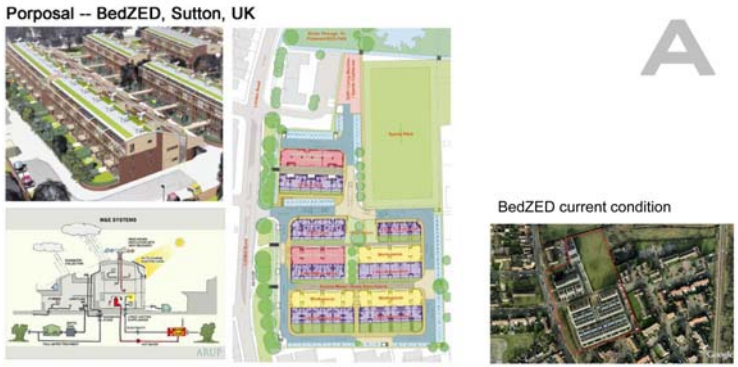
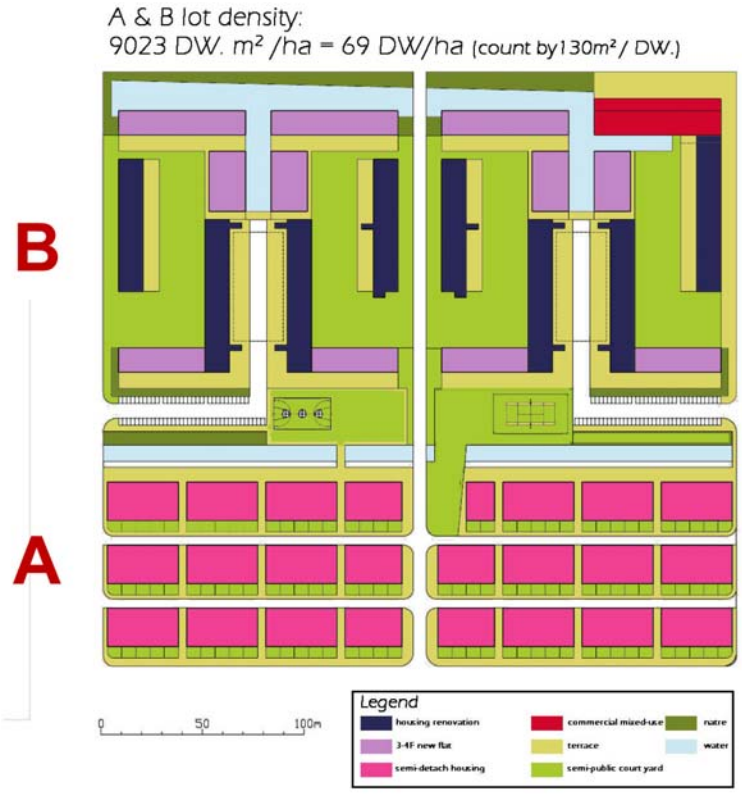


Figure 43

Design proposal: passive houses replacement in lot A and configuring refurbishment in lot B.



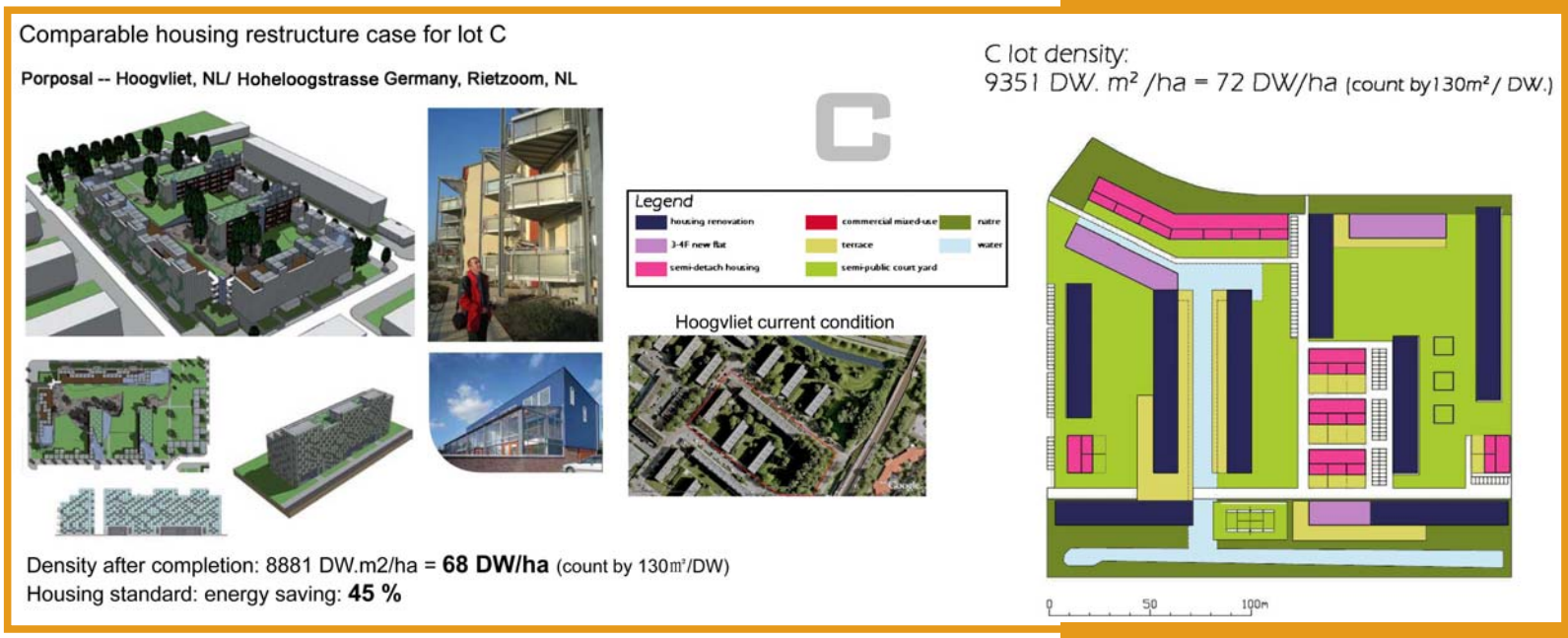
Restructuring plans call for demolishing semidetached houses with replacement by new dwellings with co-development of the old flats' configuration, public space and façade. Eco-building in Poptahof, Delft (NL) is a representative case. Poptahof is an ongoing project which started from 2004 and will continue during the next 10 years. The plan is to renovate 800 dwellings in 8 high rise apartment buildings with the upgraded features. The renovation includes energy saving equipment in the building structure, and measures to stimulate energy-saving behavior. 46 energy efficient new dwellings will replace medium rise buildings and single-family dwellings with respect to the old flat renovation to shape a holistic building block. Restructuring lot B using the model of Poptahof will increase living space more than 2600 m2 per hectare (or increase 20 dwellings per hectare if divided by 130 m2/DW) with good commercial value and high living quality (Figure24). Mixed-use and mixed-tenure schemes are expected to be built-in. To sum up the new density design and proposal scheme for lot A and B, please see figure 43.

Original lot C possessed similar buildings as lot B yet with higher density. If the buildings which have been or will be connected to different levels of transport networks can be developed respectively in diverse housing types, the result will be a proposal of higher merit concerning various market demands. Some alternatives are given for reference (figure 44, 45):

Figure 44
Current condition of lot C.



Figure 45
Design proposal for lot C



- (No) Flat Future: postwar housing renewal in Hoogvliet, Rotterdam

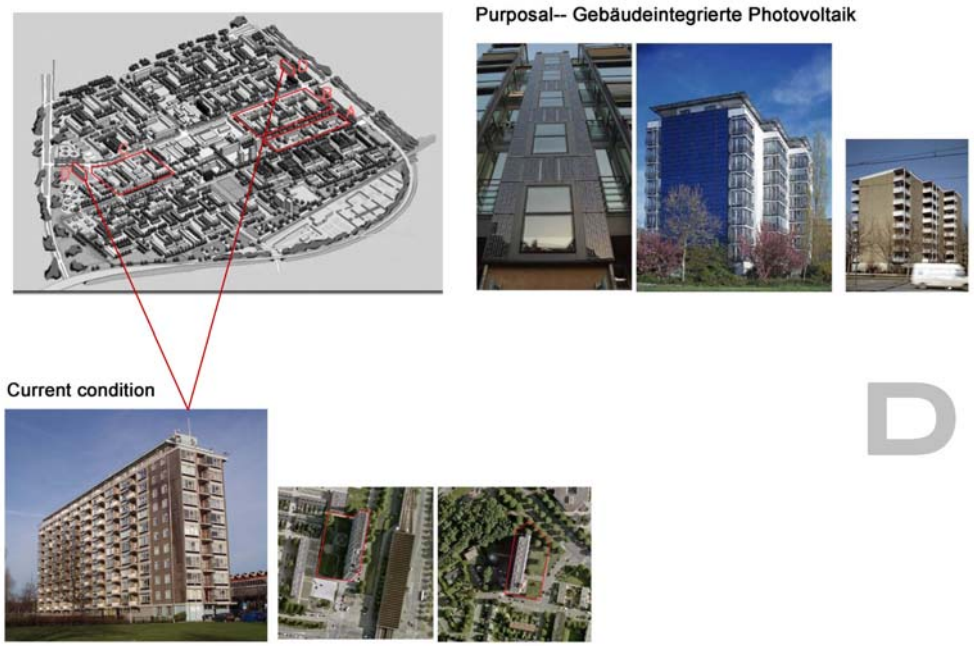
4, five-layered flats within a same lot were planned to be refurbished. An innovative idea has been developed through this project. For instance, a renewable energy scheme is merged into the façade design: solar thermal water tanks are embedded into exterior frame to become part of the appearance of the building. The roof will be covered by green space with a conservatory cover. Good insulation and energy efficient ventilation will be also adopted to achieve a 45% energy reduction after renovation.

- Waterrandwoningen Rietzoom, Zoetermeer

Another good practice of energy efficient houses: good insulation and renewable energy scheme (PV, energy efficient ventilation and water boiler) were adopted to achieve EPC standard 0.7 for new houses. Five houses were connected

Figure 46

Showcase project: two high-rise flats are proposeed to be renovated with renewable energy technology and transfer to office use.



together as a unit to share one common garden.

Two high-rise buildings (10 and 11 layers) which are located on the gateway of Pendrecht can be a visual landmark to offer a showcase effect. A photovoltaics panel can be merged into the façade design like the case in Germany (figure 46). It will result in higher construction costs which can possibly be covered by higher commercial activities, for example transferring the buildings to office use.

The proposal for the three lots, especially on the new housing plan, mainly followed the principle of solar-oriented design. New development proposals include low-rise buildings (not over four-layers is preferred) with good climatic layout which can avoid large over-shading and unpleasing wind tunnel on the surrounding ground. The solar assessments of three lots are simulated as figure 51. Final transport network and renewal public space please see figure 47-50.

Figure 47
The public space will be remodeled with the integration of three redeveloping areas and with proposed transport network.



Figure 48

New public space (light green area) will strengthen the oringinal green structure (dark green area) and will provide better green connection from Pendrecht to Zuiderpark.







Figure 49
The perspective of three lots

Figure 50
The proposal of transportation framework and provisions

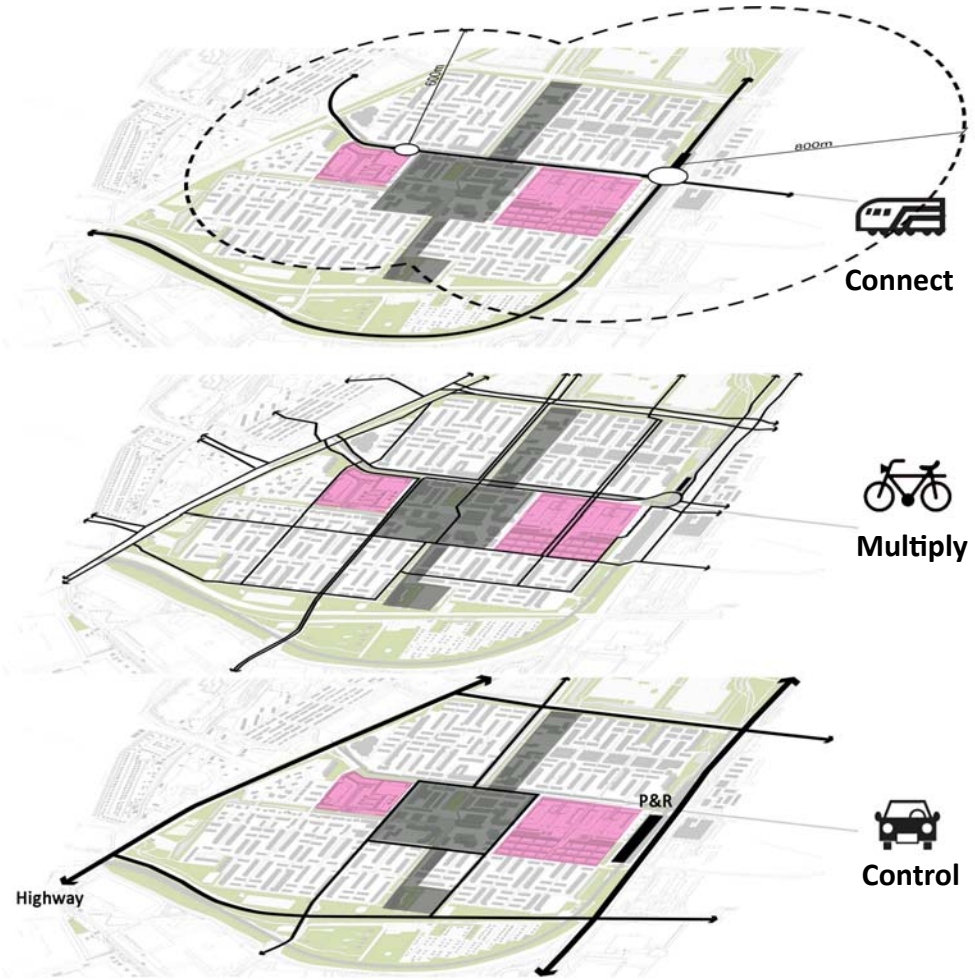


Figure 51

Solar assessment for public space. Reference time : 9am, 12am, 3pm on 15 Jan. and Jul.

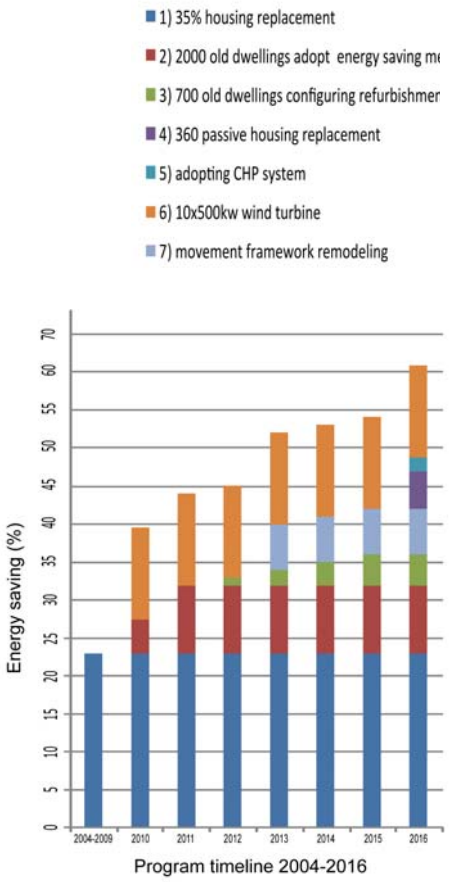


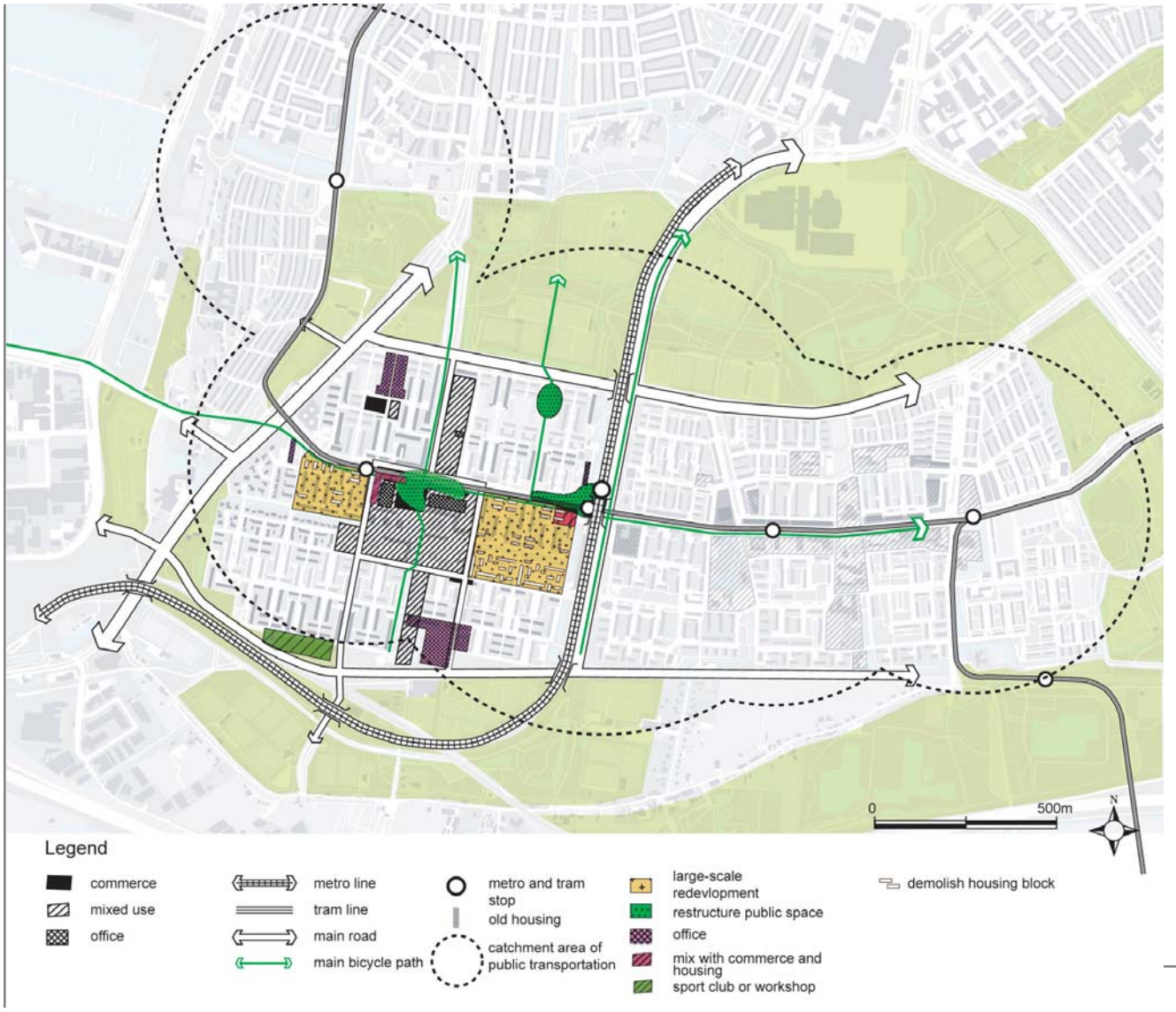
4.5 Progressive GHG reduction

Progressive GHG reduction

Sectors	Program	Energy reduction	Timeline
			2004-2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016
Housing	1) 35% housing replacement according to current plan	23%	
	2) 2000 old dwellings adopt 25-30% energy saving measures	9%	
	3) 700 old dwellings configuring refurbishment with 45% energy saving package	3-5%	
	4) 360 passive housing replacement(EPC 0.4)	5%	
Energy infrastructure	5) 10% reduction by adopting CHP system in three lots(1060dw)	1.80%	
	6) 10x500kw wind turbine on Pendrecht border	12.45%	
Sum		54-56%	
Transport	7) new car road in south border and connect to Zuiderparkweg	>6% (5% replace car use by bicycle from short distance trip, 1% replace car use by public transportation,did not count the influence from land use remodeling)	
	shrink road Oldegaarde		
	remodeling road Slinge for tram		
	public space		
	multiplying bicycle and foot path,improving facilities		
Sum		>6%	

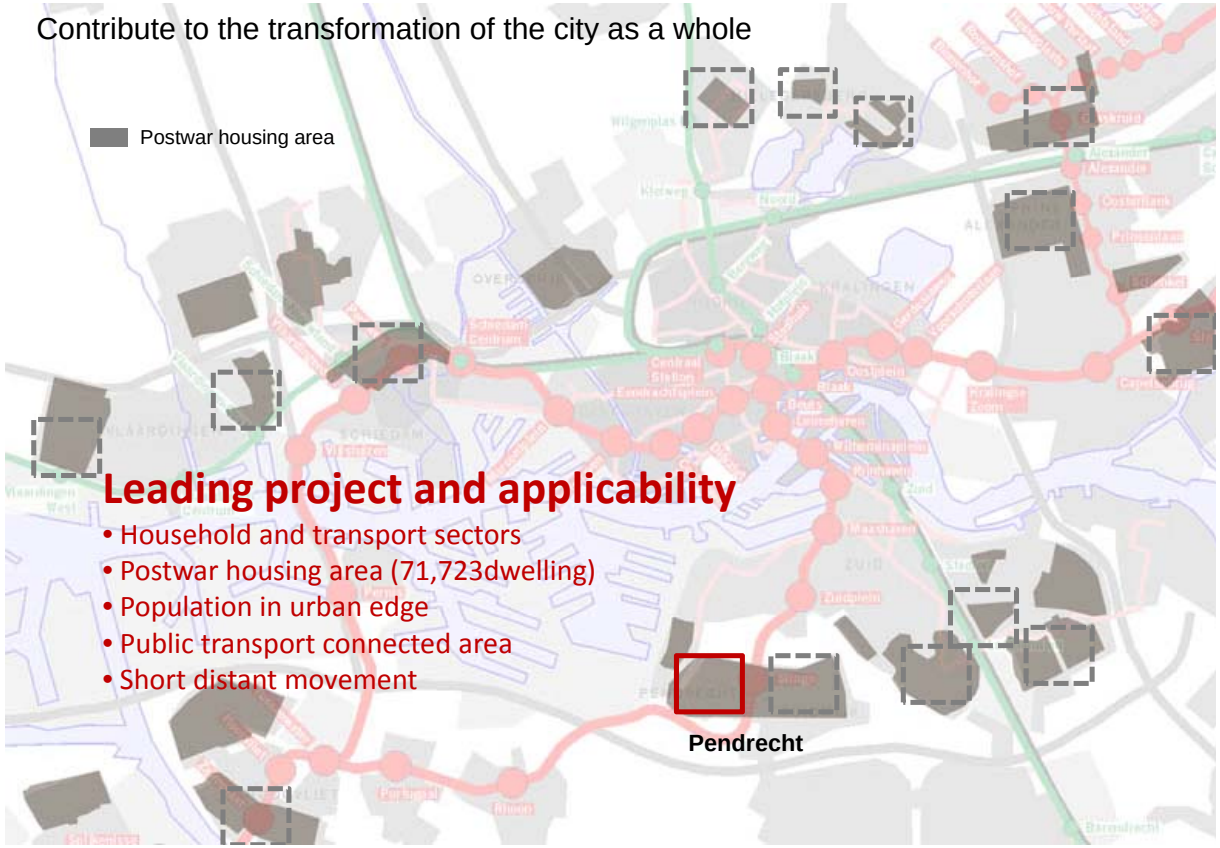
note: short distance trip is the trip <14km




0
500m
N
Legend
commerce
mixed use
office
metro line
tram line
main road
main bicycle path
metro and tram stop
old housing
catchment area of public transportation
large-scale redevlopment
restructure public space
office
mix with commerce and housing
sport club or workshop
demolish housing block

Project extension

Contribute to the transformation of the city as a whole



Summary

Introduction

There is almost unanimous agreement among scientists that climate change is a fact. Burning fossil fuels as the conventional energy sources are the problem of global warming. Nowadays energy and climate are like two coin sides' problems, are confronting knotty conditions especially lying on economic dependency on fossil fuels and imminent catastrophic climate from the reason of global warming.

The purpose of this guide is to build up the relationship between spatial planning and energy consumption in order to clarify the crucial decisions in urban renewal concerning greenhouse gas (GHG) emissions. It contributes strategies and approaches for the urban (renewal) planning in the direction of GHG reduction.

Reduce GHG emissions through integrated plan

Planning process can contribute to GHG emissions; through different strategies the correlated impact can be optimized. Urban renewal plan concerning energy saving is needed. First of all, it analyses social, spatial structure and energy performance in local level; secondly, it takes the lead to develop urban-energy integrated plan according to local demands. Many relative factors will be taken into account during planning process. More integration on earlier planning phase will result in less incoherent program and greater impact of energy saving. Large scale GHG reduction would not be fulfilled without optimal process of initial program, action plan, measures and their implementations.

The role of urban planning regarding GHG reduction

Urban planning in new energy era ought to aware that energy adaptation be counted as separated items of spatial transformation. Proper urban plan or urban renewal plan can provide favorable environments to optimize energy saving measures. And in instrument package, integrated programs concerning spatial planning and energy saving should be included.

Single-case adoption may be easily achieved. However, improving energy use pattern in broad scale for sustainable energy use in urban level needs integrated strategies. Spatial development strategy and proper planning can bring the city energy sustainability.

Policy target in EU and NL

'An Energy Policy for Europe 2007' from European Commission has described energy use objective: 20% GHG reduction unto 2020 and 50% by 2050 compared to 1990 levels. 'Energy Efficient

Action Plan' (EEAP, 2007) in the Netherlands set the scheme for at least 9% energy reduction unto 2016 compared to 2004 level. The target respectively laid on five main energy end use sectors: household, transport, tertiary, industry and agriculture. The household and transport sectors are expected to share biggest energy saving on the level of 22% and 21% from its own.

Implementing strategies: Less sectors, more integration, strong impact

Confronting complex urban renewal process, we have to select some strategies. Instead of developing many new schemes in different directions, strongly integrated and decisive strategy can avoid inefficient disorder induced by decentralization. In management level, complex energy chain should be sorted out in such ways that corresponding strategies are simple, efficient, applicable and influential in large scale.

The strategies included in this guide mainly focus on housing and transport sectors which occupied almost 50% energy consumption in the Netherlands and they are the essentials in every urban plan.

Energy waste control is crucial important among every measures

Energy waste takes large portion of total energy consumption. Large-scale GHG reduction needs extensive energy waste control which includes energy saving and efficient use.

Four categories of the GHG reduction measures by spatial scales

The options for GHG reduction can be categorized in spatial scales, since they are influenced by location and development scale as per different approaches and technologies.

>> Construction measures
Adopting insulation options can result in significant energy saving (up to 60% by great insulation).

>> Options related to installations in houses
New installation of renewable energy adaptor is able to reduce the dependency of conventional energy sources. Some of them can also reduce energy waste within system in the mean time.

>> Options related to the spatial structure of an urban area
Urban planning deals with a full range of land uses on neighborhood/city scale. They require master plan or energy plan according to respective opportunities.

Reducing GHG emissions in built environment requires a set of approach from the initial design stage to the long-term management through proper implementation. In street/block scale, importance of urban planning lies on creating favorable conditions to adopt particular options and to support green movement. Orientation of housing, densities, mix of housing type, mixed use of functions and transport provision are its main contents.

>> Options related to the energy infrastructure in an urban area
Energy infrastructure is usually determined prior to the initial construction phase. But in large restructured urban areas, it may be relatively easy to adapt a new system in existing housing estate.

Six spatial values related to GHG emissions

Corresponding to global warming, sustainable energy measures in urban planning level, especially when they meet existing urban context, can be related to six spatial values in housing and transport sectors. Three of them influence the choice of transport modes, and transport modes present different levels of GHG emissions. Another three values deal with energy consumption in housing renewal plan

>> Framework of movement
Successful movement framework requires strategies in different levels with regard to travel distance and public motivation. It should be capable of vitalizing travel demand, reinforcing community and discouraging car uses. In this framework, walking, cycling and using public transportations are far easier and more attractive than driving private cars. It can be realized by arranging optimum routes which fit this purpose. Urban transport strategy can influence shaping of movement framework and also resulting car use rate and the amount of GHG emissions.

>> Land-use characteristics
The movement framework is responsible for the accessibility and the efficiency of connecting people to diverse urban functions. The placement of urban functions relies on land use plan as the result of master plan and strategies. The research showed that Land use factors can influence 20-30% variation of travel demand and transport mode choice.

>> Provision of transport alternatives
Different traffic systems should be well integrated together so as to provide convenient transferring alternatives for local. On the system planning side, to connect urban functions by seamless transfer, to cover residential area by enough public

transport provisions and assortment with reasonable walking range, to improve parking facilities and to lower price of public transportations would encourage people to use them as transport alternatives.

>> Proportion of different types of building
The survey of building ages and building energy performance in planned community are the essential preparations for decision-making for energy related urban renewal.

>> Tendency & point of improvement
Decision-making is a complex process concerning not only the energy requirement, but also many other factors from different point of view. The determination according to different interest per project resulted in diverse integration. Precedents of practical cases can provide lessons and experiences. They also offer the database to predict planning project by comparison and analysis of the previous cases.

>> Design urban structure with high climatic quality
Urban areas without a high climatic quality use much more energy for air conditioning in summer and for heating in winter and more electricity for lighting. Climatic friendly design in street and block level highly agrees with the theories of solar-orientation design and bio-climate design. The crucial factors within are orientation and density. Good insulation can large diminish the impact from building types concerning energy consumption.

Trias Ecologica: three-step-strategy
Corresponding to six spatial values, the measures for systematic improvement can be deduced from an environmental balance design theory 'Trias Ecologica: three-step-strategy'. Three-steps-strategy dealing with energy (and other sources) flows in and out under the principle of:

>> avoiding unnecessary use,
>> using renewable sources, and
>> using limited sources carefully.

Three-steps-strategy can be deduced to the strategies for sustainable mobility as:

>> To reduce transport demand
>> To use endless resource (muscle)
>> To minimize motorized transport mode

And for housing sector, three-step-strategy, the basis of sustainable energy, is extended to large-scale application in urban planning level, in which additional considerations have

to be included:

>> Maximized impact within limited money and time,

>> Good market value

>> High climatic quality both indoor and public space

Learning experience from precedent and case study in Pendrecht

Financial and social aspects vs. energy issues

>> Postwar housing replaced by new and energy efficient housing (if EPC0.8) can reduce half of energy consumption with 3 to 5 years planning and construction process. The same amount of energy saving can also be achieved by old housing refurbishment: 60% energy reduction by full insulation measures without considerable amount of material waste.

>> Good practice in Tarweveld of Netherlands used only 2 interior working days per dwelling for new boiler installation. It means that no occupant is needed to move out in adaptation period. After the set of installation, it achieved 28% energy reduction.

>> Good practice in Cornwall Falmouth of UK showed that 30% energy saving measures with proper physical improvements brought in positive social effects: 50% drop in the numbers, suffering from asthma and a dramatic reduction in crime. It has been done within very limited financial support.

>> Good practice of old housing in Rumburk of Czech achieved 45% energy reduction after insulation measures combined with configuring refurbishment which built additional floor under the roof. It gives very good economic results on local housing market.

>> New housing replacement cost 2.5 times more than old housing refurbishment for 1kwh heat reduction (average cost for 40% energy saving package).

Transportation vs. energy issues

>> Improving bicycle use environment can replace more than 10% of car use for daily trip.

>> The main reason for declining bicycle user is the absence (or disappearance) of facilities for cyclists (70% from questionnaire survey). The concern that bicycles will be stolen is also a deterrent factor.

>> Car parking provision is a decisive factor for car driver to use car visiting indispensable social amenities and places.

Elucidating density, orientation, building typologies and mixed-use vs. energy issues

>> Higher density can create financial advantage for adopting new energy and transport infrastructure.

>> To maximize density regarding under four layers building block (would not create huge shadow and strong wind in outdoor), sufficient distance in-between (sufficient solar access indoor and outdoor) and market-oriented configuration, plus sufficient transportation alternatives will provide sustainable aspects for new development.

>> building shape, width/depth ratio, window area and indoor configuration can influence air and thermal lost in buildings. It also influences the passive solar gain in daytime. However, in the case of excellent insulation, no evident different has shown from research between various building appearances for gas consumption.

>> Building orientation, height, roof shape and distances between buildings affected solar access to public space and to room, which are related to spatial and living quality.

>> The abovementioned 4 aspects are also related to outdoor microclimate and outdoor comfort for pedestrians and cyclists.

>> The potential and efficiency of solar energy installation is decided by solar access hour on chosen places of installation.

>> No clear evidence which mixed-use strategy has directly reduced travel demand has been found. However, diverse and mixed-use types can generate positive social and market values.

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