

# **Changing Human Behavior towards Energy Saving through Urban Planning**

***Creation of a new Planning Approach  
Lessons learned from Europe and North America***

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## **Executive summary**

Energy consumption (for everyday activities, lightning and heating/cooling of buildings, mobility, production of goods, etc.) has been and continues to be increasing all over the world. Generation and consumption of energy from both renewable and non-renewable sources cause negative environmental and social impacts. Therefore, this work describes energy consumption as a problem that can only be solved by saving energy and not by generating more energy. The goal of this work is to find a sustainable solution for the problem in the field of urban planning.

The aim is to create a new planning approach towards not only energy-efficient urban structures but an entire energy-efficient urban system that results in the change of people's behavior towards energy-efficient lifestyles. The idea is to combat the problem not by fighting the symptoms but by fighting its root causes.

Europe and North America (U.S. and Canada) are the investigation areas or research laboratory for this work. Problem-related research and the creation of a solution are related to these two continents only.

The expected result is a new planning approach that verifies the hypothesis that urban planning can change human behavior towards energy saving. Three main assumptions have led to this hypothesis:

1. Energy consumption strongly depends on human behavior and lifestyles.
2. Human behavior depends on the surrounding environments and the urban system.
3. Urban planning has a direct and an indirect influence on the urban system.

The planning approach is based on a holistic system approach that entails the entire urban system including the societal environment, the built environment, and the natural environment.

In a first step, an extensive problem analysis was conducted that included a general problem analysis in order to explain why energy consumption is a problem; a system-related problem analysis that described the technical causes, the root causes, and the motives of energy consumption; and a planning-related problem analysis that evaluated former planning approaches that led to the problem and current planning approaches that try to solve it.

The system-related problem analysis resulted in five categories of root causes (the five A's): Accessibility, affordability, availability, attractiveness, and awareness are the reasons why people decide for one or the other behavior.

The planning-related problem analysis showed that most past and current planning approaches do not address the root causes of the problem but only the problem itself and its technical causes. For instance, planners define the amount of energy consumption in single-family houses as the problem and determine the insulation of the building as a planning aim. However, they don't ask why people actually choose to live in these energy consuming building types.

Generally, planning approaches include four main components: problems, planning aims, the planning tools, and the background knowledge about the problems. Former planning approaches start at the problem and its technical causes, determine a planning aim according to the problem, and use existing planning tools.

The results of the three problem analyses of this work lead to two additional intermediate steps that are needed for a sustainable solution of the problem:

- First, the planning aims must be determined according to the root causes of the problem in order to achieve a sustainable solution of the problems. Therefore, multidisciplinary background knowledge about the problem, its technical causes, the motives, and the root causes is needed. Urban planning has an influence on the root causes (e.g., building awareness of public transit through attractive design of train stations). At the same time, the root causes have an influence on human behavior (e.g., the awareness of available public transit results in people using it). Therefore, the five A's or categories of root causes are the key factor between urban planning and human behavior.
- Second, the planning tools have to be adapted to the planning aims according to the five A's or five categories of root causes. Therefore, planning-related background knowledge and the interrelation of the planning tools and the five A's have to be analyzed. Former planning approaches only considered existing planning tools. They didn't consider changing or adapting them according to the new planning aims.

The main finding of this work and the key for the new planning approach are the five A's (accessibility, affordability, availability, attractiveness, and awareness) and the fact that they are the connector between urban planning and human behavior and therefore, the key to changing human behavior towards energy saving through urban planning. Both the planning aims as well as the planning tools have to be determined and

adapted accordingly. The alteration of the root causes of the problem result in a sustainable solution of the problem and not, as former planning approaches did, to a short-term solution of the symptoms.

An additional analysis of general policy issues and backgrounds (overall policy) on both sides of the Atlantic showed that the implementation of the new planning approach is possible and adaptable on both continents. The analysis outlines several synergies between the different approaches and planning cultures and gives additional recommendations of how planners can take the advantage of these synergies.



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# 1. Introduction and purpose of this work

The worldwide energy demand has been and continues to be increasing; prevailing developments don't predict a change in this trend. Unfortunately, at present, the predominantly used energy sources are not renewable. Consequently, within the next decades, a major lack of energy supply and increasing energy prices are expected. Apart from the environmental problems that are caused by energy generation and consumption (air pollution, green-house-gas emissions, etc.), the predicted lack of energy sources in the future makes increasing energy demand one of the main societal problems at present.

Various disciplines have already considered the increasing energy demand a serious problem not to be underestimated. Mainly mechanical engineers, process engineers and architects have tried to combat the problem in their work by finding ways to save energy through certain technologies or to generate additional energy by using renewable energy sources. Hence, the fuel efficiency of automobiles is improving, industrial processes have become more efficient, domestic appliances need less energy, and people start to generate their own electricity by installing solar panels on their roof tops and save energy for heating by insulating their houses. Also in the field of urban planning, experts try to find solutions to save energy through certain settlement structures and building codes.

Nevertheless, the energy demand is on a disproportionally high increase compared to the population increase. Due to the continuously growing number of available appliances and technical equipment, as well as changing values and lifestyles, in most households, positive efficiency developments haven't been able to compensate the energy demand.

Energy consumption per capita is increasing despite the more energy-efficient facilities and equipment.

However, most disciplines don't take into account that people don't consume energy just to consume energy, which is why they won't save energy just to save it. It is their activities, behavior, and lifestyles that require energy as an input factor. For instance, people need energy in order to watch TV, to drive from A to B, or to regulate the temperature in their houses. Therefore, in order to solve the problem of energy consumption, the aim must be to find substitutes for the energy consuming activities or substitutes for the way the activities are being executed.

Planners, as well as mechanical and civil engineers, focus too much on the technical background of energy consumption versus the behavioral aspect behind it. There are several causes within people's living environments that lead to the necessity of energy consumption.

The purpose of this work is to find solutions for saving energy through urban planning by considering these influencing causes and by changing the living environments accordingly. This work will soundly analyze the causes of energy consumption; furthermore, it will evaluate past planning decisions that have led to energy consuming environments and current planning approaches that try to combat the problem.

The aim of this work is to create a new planning approach towards not only energy-efficient settlement patterns but also energy-efficient living environments that result in the change of people's behavior towards energy efficient lifestyles. The idea is to solve the problem at its roots in order to achieve a sustainable solution.

The research about energy consumption, human behavior, and urban planning approaches focuses on Europe (EU) and North America (U.S. and Canada). This work provides an analysis and a comparison of the

developments and prevailing conditions of these two continents. It will transfer synergies, as well as lessons to be learned from both sides of the Atlantic, into a new planning approach.

## **2. Scientific approach**

This chapter describes the main assumptions that have led to the idea of solving the problem of energy consumption through urban planning. First, it will describe the key terms that are crucial for the understanding of the hypothesis, followed by the definition of the hypothesis and the scientific approach. Furthermore, it will outline the course of research as well as the applied methodology.

### **2.1 Definition of key terms**

#### **2.1.1 Urban system**

The term “urban system” stands for the entire system in which human activities take place including the built environment, the natural environment, and the societal environment as well as their interrelations (see Figure 1).

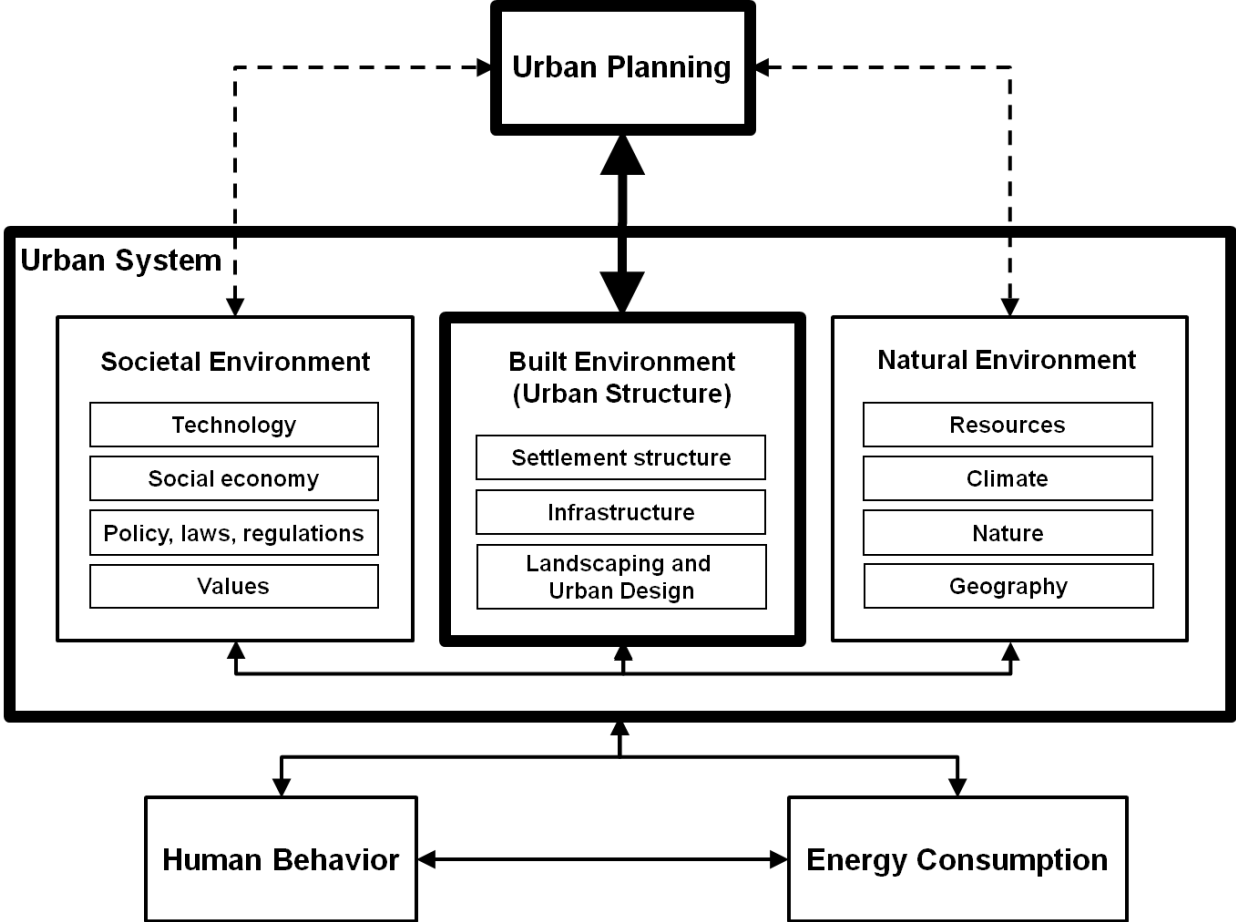
Available technologies, demographic and economic conditions, laws and regulations, as well as policies and values, are part of the societal environment. It's based on man-made decisions, prevailing paradigms, and the influence of the built and the natural environment.

The natural environment includes factors like existing natural resources, climate and weather conditions, fauna and flora, as well as geographical conditions (mountains, rivers, coasts, etc.). It's based on natural processes and developments. Alterations within the societal and the built environment can have impacts on the natural environment.

The built environment is completely man-made and includes settlements, infrastructure, and their design. The structure of these three components, further referred to as urban structure (see chapter 2.1.2), depends on

decisions made within the societal environment and conditions of the natural environment.

Figure 1: The urban system and its interrelations



Source: author

The three environments of the urban system are interrelated with each other. Furthermore, they can be influenced by urban planning and vice versa (see chapter 2.1.3). For example, the scarcity of natural resources (e.g., water) can result in new laws and regulations (e.g., water protection law) that influence planning decisions; the development of new technologies (e.g., automobile) results in planning and construction of new infrastructure (e.g., roads and highways) that leads to negative environmental impacts and so on.

The urban system is defined as the system in which human activities take place. Therefore, it is assumed that the urban system and its condition have an influence on human behavior and lifestyles. Human behavior and lifestyles depend on laws and regulations, available technologies, prevailing values, existing natural resources, available infrastructure, etc. For instance, if something is legally prohibited, most people don't do it. If I don't have the infrastructure or available technology to go from A to B, I can't go there, etc.

Assuming that energy consumption is a result of a certain behavior or a certain lifestyle, changing the urban system must lead to a change in the amount of energy consumed due to changing behavior.

### **2.1.2 Urban structure**

The “urban structure” is the main subject of urban planning. Its three components can be directly influenced by urban planning. It includes:

- Settlement structure (facilities and buildings): the place of activities
- Infrastructure (connection between facilities and buildings): the connection of activities
- Urban design and landscape (arrangement and design): support or restriction of activities

### **2.1.3 Urban Planning**

Urban planning is a multidisciplinary field that has an influence on the entire urban system and vice versa. Urban planning has a direct influence on the urban structure and an indirect influence on the societal



and the natural environment. The main task of urban planning though is the development of the built environment and its urban structure.

“Planners compose and offer advice on preparing for an uncertain future. Planners expect their advice to be heard and followed and to reap the intended results.”<sup>1</sup> Urban planning is about defining goals for future developments, and addressing prevailing problems (mainly collective problems “[...] that markets often create and cannot solve.”<sup>2</sup>) by analyzing the baseline conditions, developing and evaluating alternatives, and implementing them.

The subjects of planning are not spaces or areas, but spatial interrelations and dependencies which make economic, social, technical, and ecological systems work. The interrelations of these components are continuously changing due to changes within the respective system itself. Urban planning is a multidisciplinary field; planning aims are defined through economic, social or ecological developments, trends, and aims.<sup>3</sup>

“Planners expect to act in powerful ways. As they work to identify and reduce collective uncertainty, planners participate in power relationships based on craft, coercion, and consent. Planners do not act as apolitical technicians or nontechnical politicians. Their actions necessarily draw on both political experience and technical knowledge.”<sup>4</sup>

Planners define locations for certain activities (e.g., zoning maps, settlement development plans, etc.). They make decisions about construction, maintenance, and decommissioning of the components of the urban structure (e.g., building codes, laws, etc.). They control and manage behavior (e.g., traffic rules, road pricing, definition of parking areas or pedestrian zones, public consultation, subsidies, taxes, etc.).

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<sup>1</sup> Hoch, C. (1994), p. 70

<sup>2</sup> Hoch, C. (1994), p. 8

<sup>3</sup> Schindegger, F. (1999)

<sup>4</sup> Hoch, C. (1994), p. 70

And they coordinate planning processes (e.g., permit application procedures, ordinance, law, competences, etc.).<sup>5</sup>

To sum up, urban planning is about defining aims about the future development of an entire urban system, improving bad conditions, maintaining good conditions, and solving existing problems. The main subject of urban planning is the urban structure.

Based on a definition of planning tools in Austria<sup>6</sup> and generalized for Europe and North America, planners have five types of planning tools:

- Laws and regulations (zoning laws, building codes, etc.)
- Monetary incentives (subsidies, fees, fines, etc.)
- Technology (construction materials, infrastructure technologies, etc.)
- Urban design and landscaping (public spaces, natural elements, colors, materials, ...)
- Promotion, education, and information

These tools can be used to either directly change the three components of the urban structure or to indirectly change all other components in the urban system through these changes.

#### **2.1.4 Human behavior and lifestyles**

This work defines human behavior as the range of activities people undertake and the way they do it; that is, watching TV, driving a car, reading a book, eating, sleeping, etc. Depending on what they do and

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<sup>5</sup> Schönwandt, W. (2002); Hübler, K.H. (2005)

<sup>6</sup> Blaas and Gutheil (2005)

how they do it, human behavior can be energy consuming or energy conserving.

Human behavior is not only the result of individual decisions and preferences but also the result of developments within the social structure, prevailing paradigms and surrounding environments<sup>7</sup>. The urban system and all its environments have an influence on the decision that lead to a certain behavior. For instance, existing infrastructure influences the decision on how to go from A to B. Prices influence the decision on buying product A or B etc.

The sum or combination of the activities a person carries out, that is the sum of their behavior, is defined as lifestyle. The lifestyles of people living in a city may differ from the lifestyle of people in the countryside; a child's lifestyle may differ from an adult's lifestyle. Depending on the sum of activities, a lifestyle can be energy consuming or energy conserving.

## **2.2 Main assumptions and definition of hypothesis**

This work deals with the problem of energy consumption and its connection to the field of urban planning. In particular, it focuses on the influence of the urban system and its urban structures on human behavior patterns that result in the demand for energy. The aim is to create a new planning approach that leads to a verification of the following hypothesis:

**Urban planning can change human behavior and lifestyles towards more energy efficiency.**

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<sup>7</sup> Wissenschaftlicher Beirat der Bundesregierung [ed.] (2003)

The following three main assumptions have led to this hypothesis:

**1. Energy consumption strongly depends on human behavior and lifestyles.**

People don't consume energy just because they want to consume energy. Furthermore, nobody would waste energy just to waste it. Energy is indirectly demanded when goods and services are consumed that can only be provided with the input factor energy (among others). To put it in other words, energy is being consumed in order to provide light when reading a book, or to have hot water when showering, or gas for cooking. Certain behavioral patterns lead to activities that require more energy as input factor than their substitutes (e.g., watching TV at home versus reading a book in the park, driving a car in order to get from A to B versus riding a bike or not going at all and staying in A). Therefore, human behavior and lifestyles have an influence on the amount of energy consumed.

It is “[...] ordinary people doing ordinary things”<sup>8</sup>. That is, individual activities influence the amount of energy consumed. A global problem of energy consumption can be addressed on an individual level by changing behavioral patterns and lifestyles. “It is argued that global environmental problems, such as greenhouse warming [or energy consumption], can be effectively tackled by alterations in the everyday lives of individual people.”<sup>9</sup>

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<sup>8</sup> Gardener, G.T. / Stern, P.C. (2002), p. 26

<sup>9</sup> Barr, S. (2007); p. 435

## **2. Human behavior depends on the surrounding environments and the urban system.**

The urban system has an influence on people's activities, behavior, and lifestyles. For example, activities can be limited or enabled by laws and regulations (societal environment), weather conditions (natural environment), available infrastructure (built environment), etc.

## **3. Urban planning has a direct and an indirect influence on the urban system.**

Urban planning designs and shapes the surrounding environments and therefore affects human activities that take place in these environments. On the one hand, urban planning can directly influence the amount of energy consumed by alteration of urban structures (buildings, infrastructure, and design), e.g., increase solar radiation in order to save electricity for light, decrease wind exposure in order to save gas for heating, etc. On the other hand, urban planning can influence human behavior and lifestyles by alteration of urban structures as part of an entire urban system. For example, mono-functional settlement structures or urban sprawl cause energy consuming lifestyles due to various technical causes. For instance, people who live in North American suburbs are forced to use their cars, as there is no public transit available and distances are too long for walking or biking.

Two types of causes of energy consumption can be identified:

- Direct causes (or technical causes) that are directly connected to the amount of energy consumed (e.g., an insulated building needs less energy for heating; a bike needs less energy than a car, etc.)

- Indirect causes (or root causes) that lead to energy consuming behavior due to certain motives (e.g., subsidies make insulation of buildings affordable and lead indirectly to more energy efficiency; availability and attractiveness of bike lanes make biking comfortable)

Planning approaches that focus on the direct influence on energy consumption, that is, the alteration of technical causes (from energy consuming urban structures to energy-efficient urban structures) don't consider the whole urban system. They affect the built environment but not behavioral patterns or the consciousness about energy consumption. A passive decrease of energy consumption is the result, without considering the root causes.

For example, a commuter from the suburb to the city drives with a new, more energy efficient car and therefore uses less energy than they used to with the old, energy-intensive car. However, the questions, why they actually have to commute from the suburb to the city and why they have to drive and don't use public transit, have only slightly been addressed. The change of the technical cause fights the symptoms but not the real causes, which can't be considered sustainable. As Owen D. puts it, a building or household appliance can't be sustainable; it's just "a single small element in a civilization wide network of deeply interdependent relationships."<sup>10</sup>

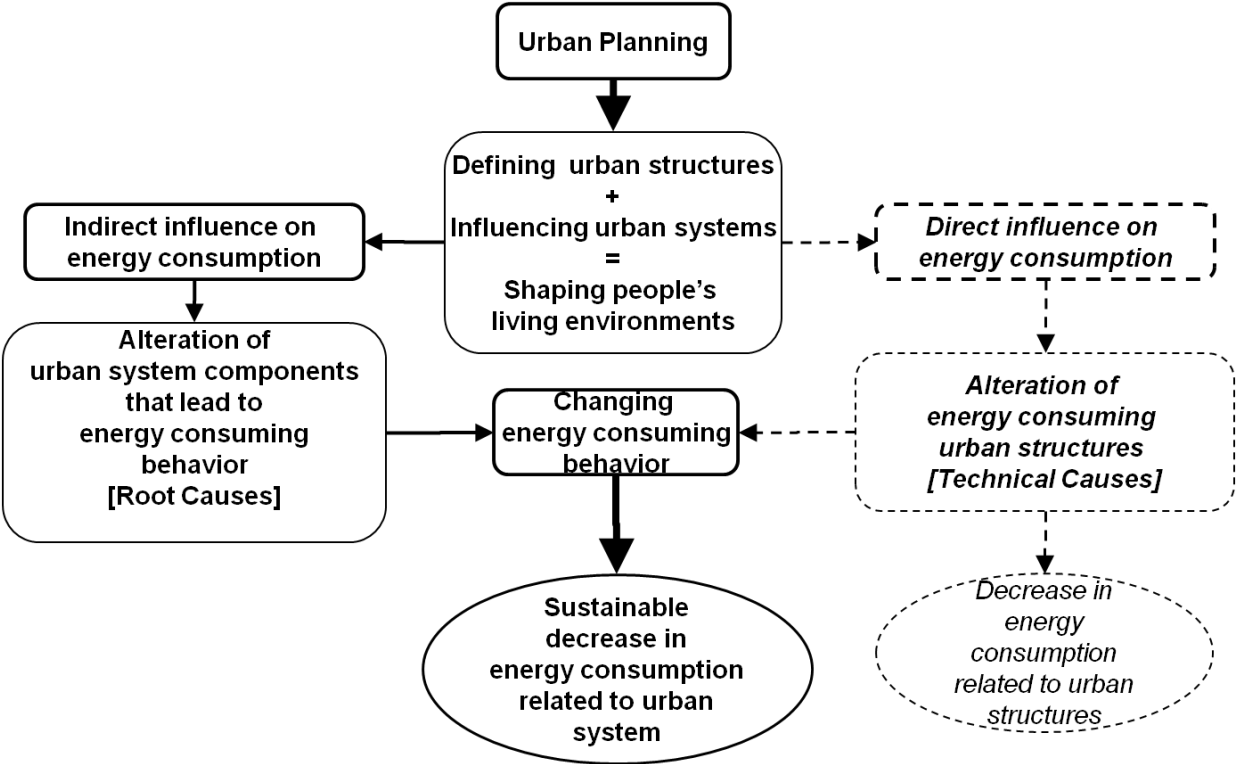
The main question should be about the root causes and the related motives that lead to energy consuming behavior. Therefore, the aim of this work is to create a new planning approach that focuses on the indirect influence of urban planning on energy consumption by taking the

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<sup>10</sup> Owen, D. (2009), p. 40

whole urban system into consideration. In other words, this indirect planning approach focuses on the alteration of those urban system components that lead to energy consuming behavior. It is a holistic system approach that affects people’s behavior and lifestyles and leads, therefore, to a sustainable decrease in energy consumption (see Figure 2).

Figure 2: Indirect planning approach or holistic system approach



Source: author

**2.3 Research design and methodology**

This chapter outlines the course of research and the applied methodologies. First, it gives a short overview of the structure of this work and describes all steps in detail. Second, it defines the investigation

area where research has been conducted and explains the expected results.

### **2.3.1 Course of research**

The course of research entails three main steps (see Figure 3). The first step has to be an extensive problem analysis. Schönwandt explains that planners often tend to define aims without knowing the problem, which is why he developed the so called “problems first” planning approach<sup>11</sup>. To put it in other words, a sound problem analysis has to be conducted in order to define the aims. It has to be proven that the problem really is a problem.

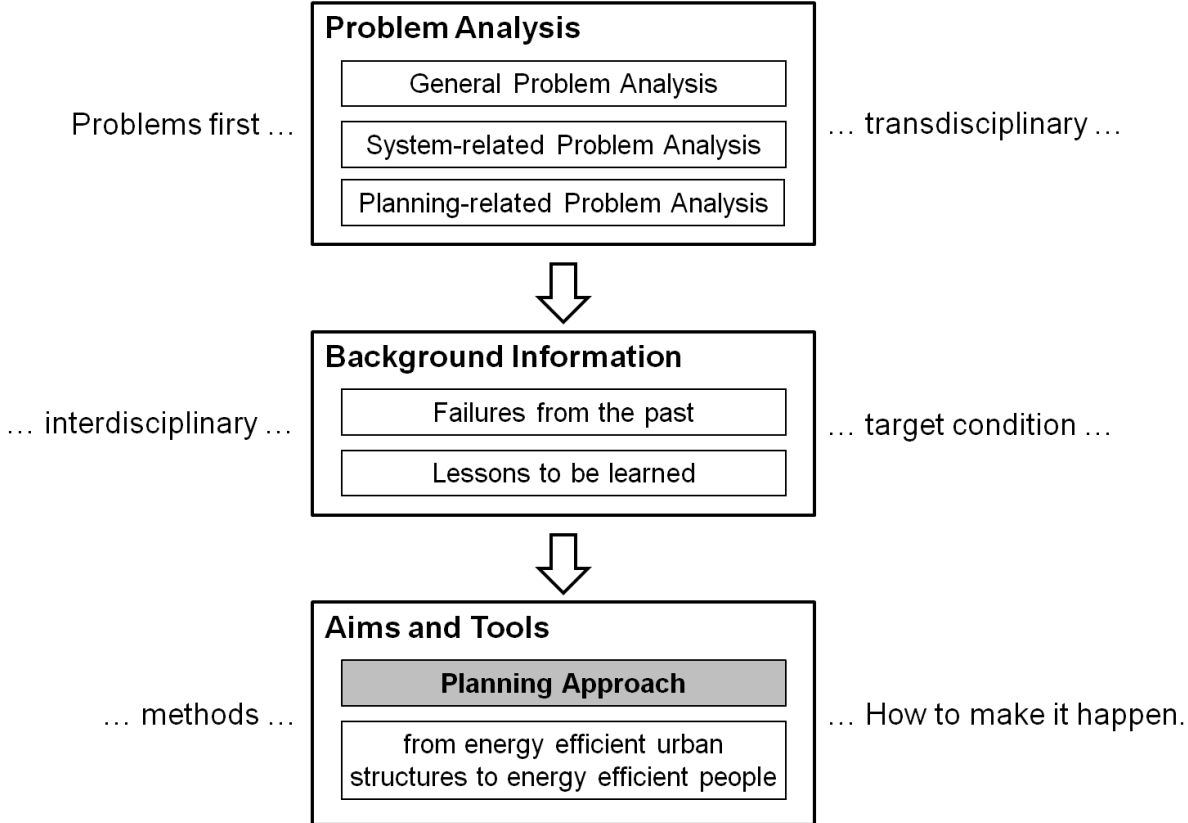
In a second step, the extensive problem analysis will lead to a conclusion about failure of the past and lessons to be learned in order to create a new planning approach. The third step is the determination of aims and tools for a new planning approach that leads to a sustainable decrease of energy consumption. The course of the problem analysis is outlined in more detail in chapter 2.3.2.

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<sup>11</sup> Schönwandt, W. (2007)



Figure 3: Course of research



Source: author

**2.3.2 Problem analysis**

This work focuses on the indirect influence of urban planning on energy consumption. However, in order to identify the root causes of energy consumption, the technical causes and their direct influence have to be analyzed in a first step.

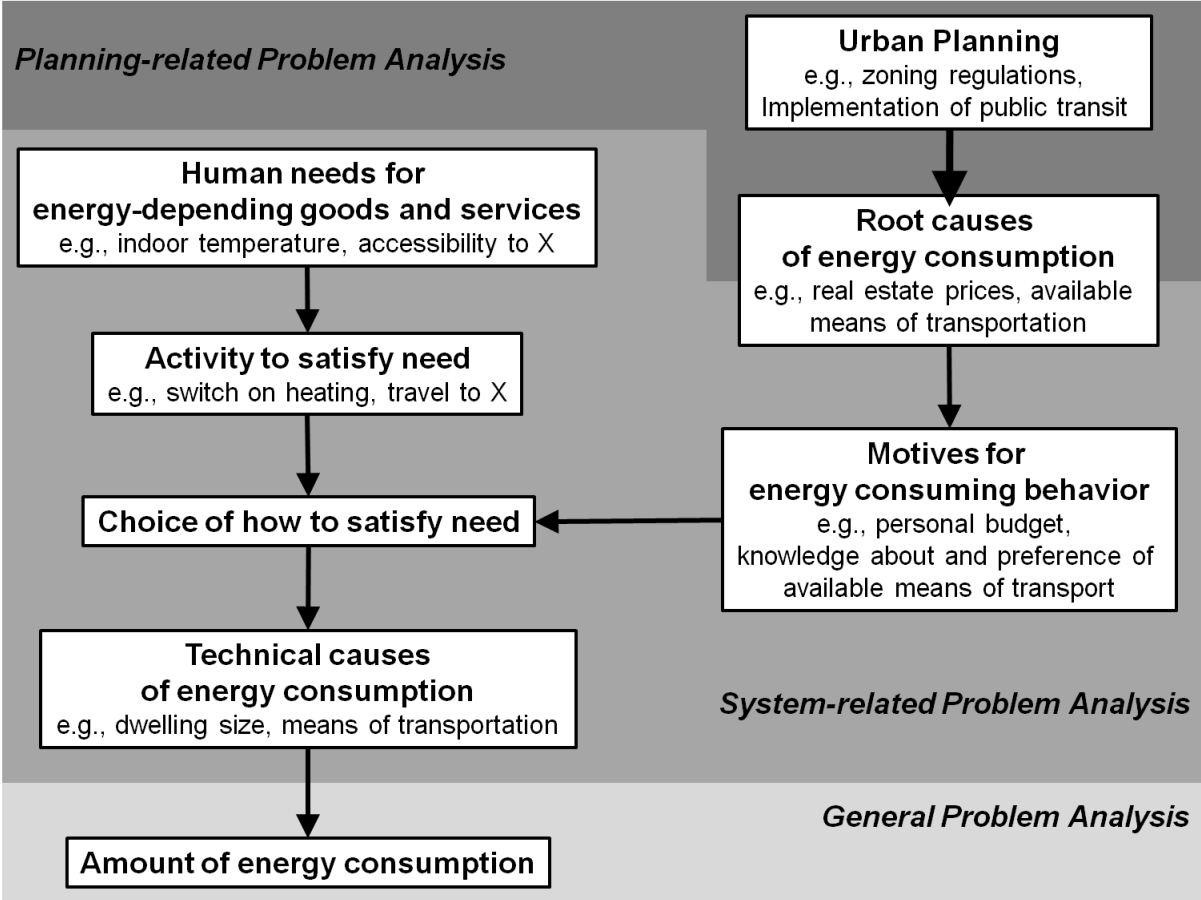
Generally, the cause of energy consumption can be found in the demand for energy-dependent goods and services (see Figure 4). Depending on the type of goods or services, the respective technical causes have a direct influence on the amount of energy consumed. However, the choice of how this demand can be satisfied depends on several root causes which influence the respective motives of choice. Furthermore, these root causes may result from former planning approaches. Due to these

complex interrelations of causes and motives that lead to the problem, the problem analysis has been conducted in three steps:

- General problem analysis that analyzes the amount of energy consumed, its development, and its impacts – why is the problem a problem?
- System-related problem analysis that analyzes the technical causes, the root causes, and the related motives – what makes us consume energy?
- Planning-related problem analysis that analyzes former planning approaches that have led to the problem and current planning approaches that try to antagonize the problem – which plans have led to the problem?

The three steps of the problem analysis are outlined in Figure 4. It also shows the interrelations between technical causes, motives, root causes, and their connection to urban planning.

Figure 4: Three steps of problem analysis



Source: author

To better understand the three steps of the problem analysis, this will be described in the following example (see also Table 1).

The demand for energy results from a certain human need (e.g., the need for food from the grocery store) that can only be satisfied by the consumption of energy-dependent goods and services (transportation service to get to the grocery store). The need can be satisfied through various activities depending on what the person chooses (walk, bike, drive, take public transit to the grocery store; choice of grocery store).

The choice of how to satisfy the need depends on root causes (means of transportation, type and location of grocery store, etc.) that influence the

motives for a decision (walk versus drive, grocery store in the neighborhood versus grocery store far away).

Depending on the choice of how to satisfy the need for food from the grocery store, the amount of energy consumed varies, e.g., driving to the grocery store in the suburb is much more energy consuming than walking to the grocery store in my neighborhood.

Table 1: Example of technical causes, root causes, and motives for energy consumption

Human need	Food from the grocery store
Activity to satisfy need	Go to the grocery store
Root cause of energy consumption	Availability of means of transportation, quality of available means of transportation, distance to grocery store, quality of available grocery stores, etc.
Motives of energy consuming behavior	Preference of grocery store, preference regarding means of transportation, time available, awareness of options, etc.
Choice of how to satisfy need	Drive to far away grocery store, walk to grocery store in neighborhood, etc.
Technical causes of energy consumption	Means of transportation, distance to be traveled, etc.

Source: author

### **General problem analysis**

The general problem analysis deals with statistics about the amount of energy consumption in Europe and North America, its development in

the past, its current situation, and an outlook for the future. Furthermore, it outlines the impacts of energy generation and consumption.

Methodology: Literature research | online research | statistical data analysis

Conclusion: Why is the problem a problem?

### **System-related problem analysis**

The system-related problem analysis entails two steps: First, the analysis of the technical causes of energy consumption within certain fields of energy consumption and their influencing factors. Second, the root causes and motives for energy consuming behavior.

Methodology: Literature research | online research | on-site investigations | statistical data analysis | expert interviews and meetings with urban planners, decision makers, and academics in this field | talks with local people

Conclusion: What makes us consume energy?

### **Planning-related analysis**

The aim of the planning-related analysis is to identify the planning approaches of the past that have led to the current conditions in Europe and North America, planning failures and lessons to be learned. It provides an analysis of the planning history of North America and Europe, their different historic backgrounds, and the respective planning approaches. Furthermore, it analyzes current planning approaches and the way North America and Europe already try to antagonize the problem. As planning is very complex and differs not only between the two continents but also from state to state in America and from country to country Europe, this analysis focuses on the general developments that are obviously connected to the defined problem of energy consumption.

In order to provide examples of planning approaches, it will describe detailed information about specific planning approaches from interviews that were conducted with city planners in several cities. However, the list of detailed planning backgrounds won't be exhaustive.

Methodology: Literature research | online research | on-site investigations | statistical data analysis | expert interviews and meetings with urban planners, decision makers, and academics in this field | talks with local people

Conclusion: Which plans have led to the current condition? How is it being addressed now?

### **2.3.3 Creation of a new planning approach**

The aim of this work is to define a new planning approach that shifts emphasis from energy-efficient settlements towards energy-efficient people. The problem analysis outlines the interrelations between urban planning, the urban system, and energy consumption. A generalization of the therewith identified root causes and motives of energy consuming behavior transfers the actual causes of the problem into theoretical factors of the new planning approach. Furthermore, planning failure of the past, lessons to be learned, and synergies from both sides of the Atlantic define the structure of the new, more sustainable planning approach.

Methodology: Generalization of actual influencing factors to theoretical categories of influencing factors | conversion of practice results into a theoretical framework and structure

Conclusion: How to change human behavior towards energy-saving through urban planning

### **2.3.4 Investigation area**

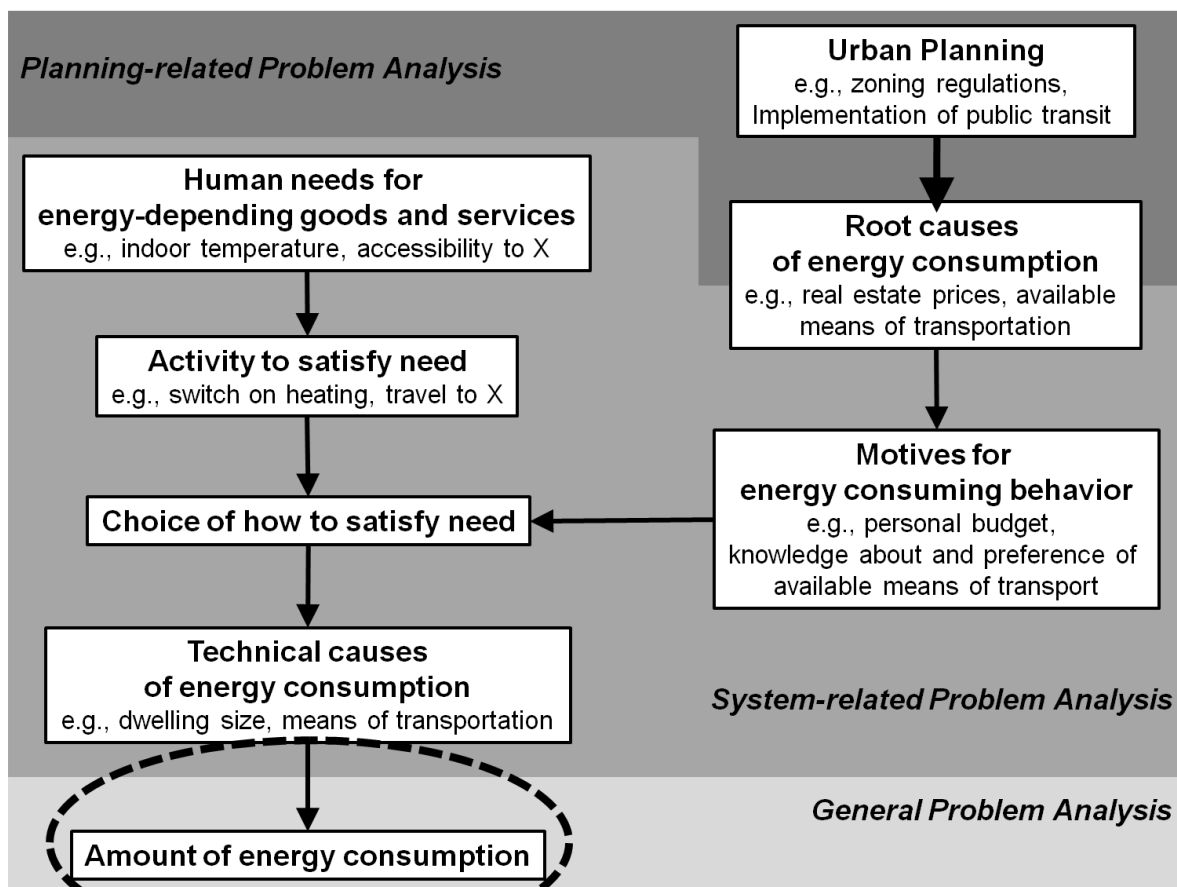
Europe (mainly the EU) and North America (U.S. and Canada) serve as investigation areas for this work. Both continents contain well developed countries with similar living conditions and well developed economies, education systems, etc.

The research did not focus on one city or one part of a city in particular. The aim was to find a general solution of the problem by identifying synergies of planning approaches in all cities that were investigated. In order to understand human behavior and the relation between certain behavior and the urban system, it was crucial to investigate these aspects on site. Cultural and behavioral aspects can only be understood by experiencing them.

### 3. General problem analysis – the problem of increasing energy consumption

The general problem analysis explains why energy consumption is a problem and how it should be solved. It outlines statistics about the development of energy consumption in Europe and North America in the past, as well as a predicted forecast for the future. Furthermore, it explains the impact that results from energy generation and consumption. It will give a short overview of the energy situation in Europe and North America and to explain why energy consumption, as it is now and predicted for the future, is a problem.

Figure 5: Objective of the general problem analysis



Source: author



### 3.1 The increase in energy consumption and its backgrounds

The energy consumption is on the increase all over the world, which is not surprising as the population and the economy are growing as well. Table 2 shows that for both the U.S. and Europe the energy consumption was on a very high increase until 2005 (1990 – 2005: more than 10 percent in the EU and more than 18 percent in the U.S.) and has started to slightly decline since then. However, energy consumption is still on a higher level than it was in 1990.

From the 1970s to the turn of the millennium, energy consumption grew faster than the population and the economy in both North America and Europe. That is, the energy consumption per capita has been constantly increasing and is still on a very high level (in the U.S. more than in Europe). In 2009, people in the U.S. consumed more than three times the amount of energy per capita (7,761 kg-oe/capita)<sup>12</sup> than people in the EU-27 (2,230 kg-oe/capita)<sup>13</sup>.

Table 2: Increase in energy consumption EU-27, USA, 1990 - 2009

	Increase in final energy consumption	
	EU-27	U.S.
<b>1990 – 2009</b>	3.25%	11.76%
<b>1990 – 2005</b>	10.56%	18.66%
<b>2005 – 2009</b>	-6.61%	-5.81%

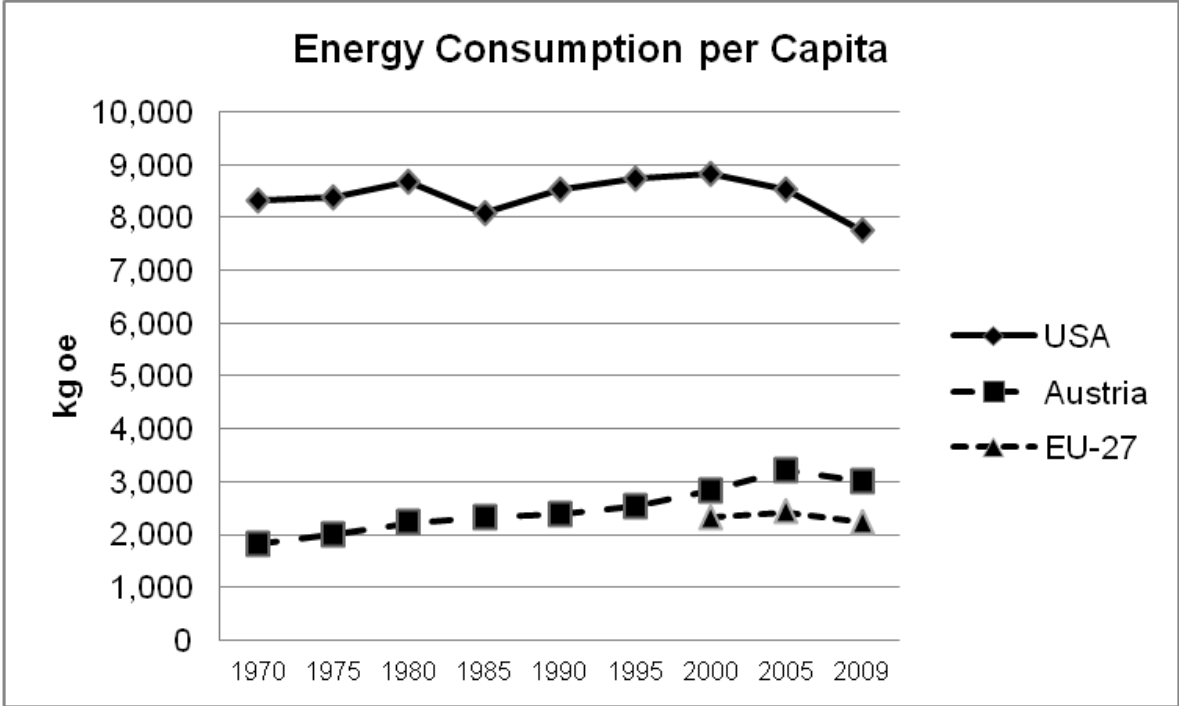
Source EU-27: [http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables) (11/30/2011)

Source USA: U.S. Energy Information Administration, EIA (2011)

<sup>12</sup> [http://www.eia.gov/state/seds/sep\\_sum/html/pdf/rank\\_use\\_per\\_cap.pdf](http://www.eia.gov/state/seds/sep_sum/html/pdf/rank_use_per_cap.pdf) (11/28/2011)

<sup>13</sup> <http://www.wko.at/statistik/eu/europa-energieverbrauch.pdf> (08/30/2011)

Figure 6: Energy consumption/capita U.S., Aut., EU-27, 1970 – 2009



Source: Population data USA: 1970 - 1999: <http://www.census.gov/popest/archives/1990s/popclockest.txt> (11/30/2011), 2000 - 2009: <http://www.census.gov/popest/states/NST-ann-est.html> (11/30/2011); Population data Austria: [www.statistik.at](http://www.statistik.at) (11/30/2011); Population data EU-27: [http://epp.eurostat.ec.europa.eu/portal/page/portal/population/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/population/data/main_tables) (11/30/2011); Energy data USA: U.S. Energy Information Administration, EIA (2011); Energy data Austria: [www.statistik.at](http://www.statistik.at) (11/30/2011); Energy data EU-27: [http://epp.eurostat.ec.europa.eu/portal/page/portal/population/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/population/data/main_tables) (11/30/2011)

There are various reasons for the tremendous difference between Europe and America. Energy has always been cheaper in the U.S. than in Europe, which is why no financial incentives were given to Americans to save energy. Another reason is the so called “American Dream” mindset, which is still prevailing within Americans’ minds. The desire for independence, privacy, mobility, ownership, and flexibility led to much higher automobile dependence, unstoppable sprawl of suburban settlements with large housing units, a much higher degree of equipment ownership, and a much stronger consumer society than in Europe.

Moreover, building standards in the U.S. are worse than in Europe. That is, the insulation of houses and windows, as well as the implementation of heat pumps and similar energy efficient heating solutions in the U.S., is not comparable to Europe. Although energy standards have been adopted over the last few years, “[...] the size of the average American house appears to be increasing more quickly, canceling out any efficiency savings.”<sup>14</sup>

The large amount of available, open land in the U.S. makes it hard for decision makers to limit settlement developments and house sizes. However, in Europe, land is very limited due to geographical constraints and the fact that the continent is already very densely populated, which justifies growth boundaries.

In addition, Americans are a much more mobile society. Always looking for better job opportunities, Americans constantly move from city to city, which is why they are not willing to invest in energy efficient building materials that would pay off after ten to twenty years. In comparison, in Europe, people are more settled and often stay in the same town for a lifetime, which makes it more efficient to make these investments.

In addition, European cities have very well developed public transit systems and are much more walkable than American cities, which is why the share of public transit, walking, and biking within the modal split is much higher in Europe than in America.

Obviously, technological improvements such as increasing vehicle fuel efficiency, energy efficient building, and increasing energy efficiency of electrical appliances couldn't compensate “our appetite for petroleum, electricity, mobility, indoor living space, and material goods [...]”<sup>15</sup> in Europe as well as in North America. However, during the past few years,

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<sup>14</sup> Farr, D. (2008), p. 25

<sup>15</sup> Farr, D. (2008), p. 21

the per capita energy consumption has decreased slightly due to the economic crisis which resulted in less production and consumption of goods and services.

Improvements in terms of energy efficiency vary between the four sectors (residential, industrial, commercial, and transportation). Most improvements could be achieved within the service sector. The per capita consumption of private households increased. Reasons for that are the increase in dwelling size and number, as well as the increase of ownership of electrical appliances.

Table 3: Share of energy consumption between sectors

	Residential	Commercial	Industrial	Transportation
EU-27 (2005)	27%	11%	31%	31%
Austria (2008)	25%	10%	31%	34%
USA (2009)	22%	19%	30%	29%
California (2009)	19%	20%	22%	39%

Source: EU-27: <http://www.eea.europa.eu/> (07/13/2011)

Austria: [www.statistik.at](http://www.statistik.at) (11/28/2011)

USA: [http://www.eia.gov/totalenergy/data/annual/pdf/sec2\\_4.pdf](http://www.eia.gov/totalenergy/data/annual/pdf/sec2_4.pdf) (11/28/2011)

California: <http://www.eia.gov/state/> (11/28/2011)

Energy consumption, within the industry and the service sector, is mainly dependent on economic growth. However, “structural changes of the economy such as a shift from industries towards services and within industry to less energy-intensive industries, as well as improvements in end-use energy efficiency, such as lower energy consuming appliances or use of insulation in buildings” have led to a decrease of energy intensity in those sectors.<sup>16</sup>

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<sup>16</sup> <http://www.eea.europa.eu/data-and-maps/indicators/en21-final-energy-consumption-intensity/en21-final-energy-consumption-intensity> (11/01/2011)

Concerning the transport sector, a tremendous increase in road transportation “led to a rapid increase in energy consumption despite some improvements in the fuel efficiency of cars. For example, the average fuel efficiency of a new car in the EU has fallen by 12 percent between 1995 and 2004 (European Commission, 2006). [...] Passenger transport continues to grow, particularly in aviation and cars. Increased car usage and a reduced number of passengers per car negate the improvements gained from improvements in vehicle efficiency. [...] Although improvements have been made in the energy efficiency of various transport modes and non-fossil fuels have been introduced, increased transport demand is outweighing these benefits (EEA, 2008).”<sup>17</sup>

Table 4: Increase in final energy consumption by sector, EU-27 & USA, 1990 - 2009

Energy Consumption	Residential	Commercial	Industrial	Transportation	Total
1990 - 2009 EU-27	7.98%	29.75%	-26.96%	30.58%	3.25%
1990 - 2009 USA	24.31%	34.52%	-10.38%	20.27%	11.76%

Source: Source USA: U.S. Energy Information Administration, EIA (2011)  
 EU-27: [http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables)  
 (11/30/2011)

The share of energy consumption between the four sectors is very similar in the U.S. compared to Europe. The transportation sector is the strongest energy consuming sector, followed by industry and households.

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<sup>17</sup><http://www.eea.europa.eu/data-and-maps/indicators/en21-final-energy-consumption-intensity/en21-final-energy-consumption-intensity> (11/01/2011)

From 1990 to 2009, in the U.S., the fastest growing sector in terms of energy consumption was the commercial sector followed by the residential and the transportation sector. Energy consumption in the industry sector has decreased since 1990. In the EU-27, the fastest growing sector was the transportation sector with more than a 30 percent increase, followed by the commercial sector. Compared to the U.S., the residential energy consumption increased slightly in the EU, whereas the industrial energy consumption already started to decrease in the EU between 1990 and 2005.

In terms of transportation, the European Environment Agency argues that “improvements in fuel efficiency were offset by increases in passenger and freight transport demand. Higher transport demand has resulted from increased ownership of private cars, particularly in the new EU Member States, growing settlement and urban sprawl with longer distances and changes in lifestyle. [...] By 2005, transport became the largest consumer of final energy in the EU.”<sup>18</sup>

Higher living standards, such as the increase in comfort levels and in ownership of domestic appliances, as well as rising incomes, have led to an increase in final energy consumption in the residential sector. The increase of energy consumption in the commercial sector “was due to the continued increase in the demand for electrical appliances, in particular, information and communication technology (such as computers and photocopiers), and also for other energy-intensive technologies such as air-conditioning.”<sup>19</sup> The decrease of energy consumption in the industrial sector was mainly the result of “a shift towards less energy-intensive

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<sup>18</sup> <http://www.eea.europa.eu/data-and-maps/indicators/en16-final-energy-consumption-by-sector/en16-final-energy-consumption-by-sector> (11/01/2011)

<sup>19</sup> <http://www.eea.europa.eu/data-and-maps/indicators/en16-final-energy-consumption-by-sector/en16-final-energy-consumption-by-sector> (11/01/2011)

manufacturing industries, as well as the continuing transition to a more service oriented economy.”<sup>18</sup>

### **3.2 Impacts from energy generation and consumption and strategies against them**

Energy generation and consumption, in general, lead to negative impacts on the environment. It doesn't matter if energy from fossil fuels or renewable resources is being generated. For all types of energy generation a certain amount of land is needed (land for power plants, refineries, transmission lines, mining operations, etc.). The construction and operation of hydropower plants has major impacts on rivers and their ecological condition. The operation of nuclear power stations leads to the problem of nuclear waste disposal and storage. The operation of coal-fired power plants and the use of oil and gas cause air pollution and green-house-gas emissions (GHG emissions). The operation of wind power plants causes comparatively major land take given their energetic output, etc.<sup>20</sup> This list is by far not exhaustive but it shows no matter how energy is being generated, it always results in negative impacts on the surrounding environments.

It is the common understanding that most negative impacts, or rather the more polluting and damaging impacts, come from energy generation and consumption from fossil fuels that are actually the main energy sources for both the U.S. and the EU-27 by now (see Table 5).

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<sup>20</sup> European Environment Agency EEA [ed.] (2008)

Table 5: Gross energy consumption by fuel, U.S. and EU-27

	Solid Fuels	Petroleum	Natural gas	Nuclear	Renewable
EU-27 (2006)	17.8 %	36.9 %	24.0 %	14.0 %	7.1 %
USA (2009)	20.9%	37.5%	24.7%	8.9%	8.0%

Source: EU-27: European Commission [ed.] (2009), p. 27  
 USA: <http://www.eia.gov/state/> (11/28/2011)

A reduction of energy-related CO<sub>2</sub>- and other GHG emissions are listed as goals of today's political agendas. Thus, from 1990 to 2005, the EU-27 reduced its energy-related CO<sub>2</sub> emissions by about 3 percent, while CO<sub>2</sub> emissions increased by 20 percent in the U.S. In the same period of time, the energy-related per capita CO<sub>2</sub> emissions decreased by 6.7 percent in the EU-27. The per capita CO<sub>2</sub> emissions of the U.S. are more than double of that of the EU-27.<sup>21</sup>

In Chicago, IL, the amount of GHG emissions per capita is six times higher than in Copenhagen, Denmark. Cities like Vancouver, Canada; Seattle, WA, and New York City come close to the amount of GHG emissions in European cities.

According to the U.S. Department of Energy, 39 percent of CO<sub>2</sub> emissions are caused by the energy consumption in buildings.<sup>22</sup> In New York City, almost 80 percent of GHG emissions result from energy consumption in buildings<sup>23</sup>, about 70 percent in Chicago.<sup>24</sup> In Europe, 33 percent of GHG emissions result from energy generation, 27 percent from energy use, 19 percent from transport, and 18 percent from industry and agriculture.<sup>25</sup> In Stockholm, Sweden, around 66 percent of GHG

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<sup>21</sup> European Environment Agency EEA [ed.] (2008)

<sup>22</sup> <http://energy.gov/> (02/03/2012)

<sup>23</sup> The City of New York [ed.] (2011)

<sup>24</sup> <http://www.chicagoclimateaction.org/> (01/23/2012)

<sup>25</sup> European Environment Agency, EEA [ed.] (2011)



emissions result from heating and use of electricity; 31 percent result from transport.<sup>26</sup>

Table 6: GHG emissions in American and European cities (metric tons CO2 / capita)

Copenhagen, Denmark	2.1
Stockholm, Sweden	4
Vancouver, Canada	4.6
London, GB	6.2
New York City, New York	6.4
Seattle, Washington	7.1
Montreal, Canada	7.2
Portland, Oregon	11.9
Chicago, Illinois	12.7

Source:[http://vancouver.ca/sustainability/documents/ClimateLeadershipBrochure\\_final.pdf](http://vancouver.ca/sustainability/documents/ClimateLeadershipBrochure_final.pdf) (9/13/2011)

The general problem analysis identified two different strategies against the problem of increasing energy consumption. One of them focuses on the satisfaction of the demand for energy and solutions for additional energy generation. The other one focuses on solutions for minimizing the energy consumption. In the following, they will be described as supply strategy and saving strategy.

### **Supply strategy**

The aim of the supply strategy is to guarantee energy supply for the next generations taking into account that the currently mainly used fossil sources of energy are scarce and will be over within the next some decades. At the same time, the demand for energy continues to

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<sup>26</sup> City of Stockholm (2003)

increase. Simultaneously, the environmental impacts of energy generation and consumption shall be reduced. The supply strategy supports a shift from fossil fuels to renewable energy sources and the search for alternative energy sources.

However, the question is, if renewable energies can replace fossil fuels completely. Most renewable energy generation is highly dependent on weather conditions and climate (wind, sun, water current, etc.). Furthermore, the development of those technologies is much too slow in terms of efficiency, cost-effectiveness, and the adaption in permitting processes.

In addition, non-renewable energy sources are scarce. An estimate about the remaining time, in a business as usual scenario, says that coal will remain 146 to 169 years, brown coal 155 to 227 years, natural gas up to 65 years, mineral oil up to 42 years, and uranium 47 to 68 years.<sup>27</sup> Those estimates vary a lot depending on the authors and their interests. In parallel, research is being conducted for fossil fuels like oil sand in Canada or natural gas in the Antarctica. However, people are aware of the fact that with a current share of energy consumption from non-renewable sources of more than 80 percent, an alternative or substitute has to be found. Otherwise, the world's energy-dependent society will suffer from a major lack in energy supply in the future. This will have major impacts on economic production as well as the regular everyday life. Rising energy prices would affect everything else like prices of everyday products, travel costs, transportation costs, etc. A lack of energy would finally lead to an increase in social disturbance and inequity. Current and past examples show that, again and again, the

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<sup>27</sup> Verband Region Rhein-Neckar [eds.] (2007), p. 19

question of energy resources causes political conflicts and even wars on a global level.

Other than that, resources like crude oil serve as input factors for the production of certain goods (e.g., plastic). A lack of oil will therefore not only affect the energy market but also other markets.

“The environmental problems that have to be faced at this time result from the abundance of oil in the 20th century. However, problems that are expected for the future will result from oil’s scarcity and cost in the 21st century.”<sup>28</sup>

The European target (EU 2020), in terms of renewable energies, is to generate 20 percent of its gross final energy consumption from renewable sources by 2020. In 2009, the EU-27 had reached an 11.6 percent share (of gross inland consumption). However, the status and targets differ between the 27 EU-member states: Austria (2009: 29.2 percent renewable energy, 2020 target: 34 percent), Sweden (2009: 50.2 percent, 2020 target: 49 percent), Germany (2009: 9.7 percent, 2020 target: 18 percent).<sup>29</sup>

Neither Canada, nor the U.S., has national targets for renewable energy generation. Most regulations in terms of energy efficiency come from state and local governments in the U.S. About 30 states and 6 Canadian provinces developed their own targets (partially mandatory, partially voluntary). The strictest regulations in North America can be found in California.<sup>30</sup> Apart from the energy generation from renewable sources, the U.S. and Canada see their energy future in the extraction of oil sand

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<sup>28</sup> Owen, D. (2009), p. 49

<sup>29</sup> [http://ec.europa.eu/energy/renewables/targets\\_en.htm](http://ec.europa.eu/energy/renewables/targets_en.htm) (08/10/2011)

<sup>30</sup> [http://en.wikipedia.org/wiki/Mandatory\\_renewable\\_energy\\_target](http://en.wikipedia.org/wiki/Mandatory_renewable_energy_target) (08/21/2011)

and fracking of shale gas, a procedure with major environmental impacts and CO<sub>2</sub> emissions.<sup>31</sup>

Any type of energy generation (from fossil and renewable sources) causes environmental impacts. The supply strategy can therefore only be a small part of an overall concept. In other words, the supply strategy leads to a by-passing of the problem by increasing the generation from alternative energy sources as a substitute to fossil fuels. “Swapping one energy source for another does nothing to solve our underlying energy dilemma. [...]”<sup>32</sup>

### **Saving strategy**

The aim of the saving strategy is to avoid and antagonize the problem of increasing energy consumption by implementing technologies and supporting behavior that lead to minor energy demand. Apart from solving the energy dilemma, this strategy also results in a decrease in consumption of resources for energy generation. In addition, it leads to a mitigation of environmental and social impacts from energy consumption and generation.

A lot of cities and metropolitan areas in Europe and the U.S. defined goals of how to reduce energy consumptions. In Vienna, Austria, an urban energy efficiency program was issued in 2006 (“Städtisches Energieeffizienz-Programm”). It aims to reduce energy consumption through technical and behavior changing measures<sup>33</sup>. In New York City, the PlaNYC contains various aims and strategies to support a decrease in energy consumption<sup>34</sup>. The Climate Action Plan of Chicago aims to

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<sup>31</sup> World Energy Congress, Montreal (2010)

<sup>32</sup> Owen, D. (2009), p. 247

<sup>33</sup> <http://www.wien.gv.at/stadtentwicklung/energieplanung/sep/> (06/24/2011)

<sup>34</sup> <http://www.nyc.gov/html/planyc2030/html/theplan/energy.shtml> (08/23/2011)

fight climate change by reducing green-house-gas emissions and defines targets for the reduction of energy consumption in Chicago.<sup>35</sup>

These climate protection and energy saving programs are very similar in Europe and North America. It wouldn't make a difference if you look at the program from Berlin, Germany, Chicago, IL Vienna, Austria, Stockholm, Sweden, or Los Angeles, CA. The list of aims would be the same. Public transit, bike lanes, and the walkability of cities shall be improved. Buildings shall be more energy efficient. New sources for energy generation like waste heat from industrial processes or waste-to-energy cogeneration technologies shall be implemented. Green infrastructure, such as green roofs, shall help to regulate a moderate microclimate within the city, etc.

### **3.3 Conclusion – Why is the problem a problem and how should it be solved?**

To sum up, energy generation and consumption cause severe environmental damages as well as social, economic, and political conflicts. Hence, negative impacts of energy generation and consumption affect the entire urban system.

The demand for energy is on the increase due to growing numbers of population as well as growing prosperity that leads to more energy consuming lifestyles. That is, our society is highly dependent on energy. Various political goals and technical innovations didn't lead to a positive result in trying to solve this problem. The use of renewable energy sources versus fossil fuels won't solve the problem either, as most technologies do not yet meet the required capacity in order to satisfy the

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<sup>35</sup> <http://www.chicagoclimataction.org/> (03/08/2012)

entire energy demand. Furthermore, energy generation from renewable energy sources also causes environmental damages and other negative impacts.

Therefore, the current development in terms of energy consumption must be seen as a real problem which can only be solved in finding solutions to minimize the energy demand. The goal must be to consume less energy. “The power we don’t use is more important than the power we do.”<sup>36</sup>

The general problem analysis shows that all four economic sectors (residential, industrial, commercial, and transportation) require energy. The share between the four sectors is similar in America and Europe but the amount differs tremendously.

In order to find adequate ways to minimize the energy consumption on both sides of the Atlantic, an analysis of all four sectors, their specific energy demand, and their interrelations has to be conducted. It is a whole system of influencing factors and causes that lead to certain energy consuming activities with all sorts of stakeholders that are interrelated to each other. The system-related problem analysis will describe these interrelations and the connection to urban planning.

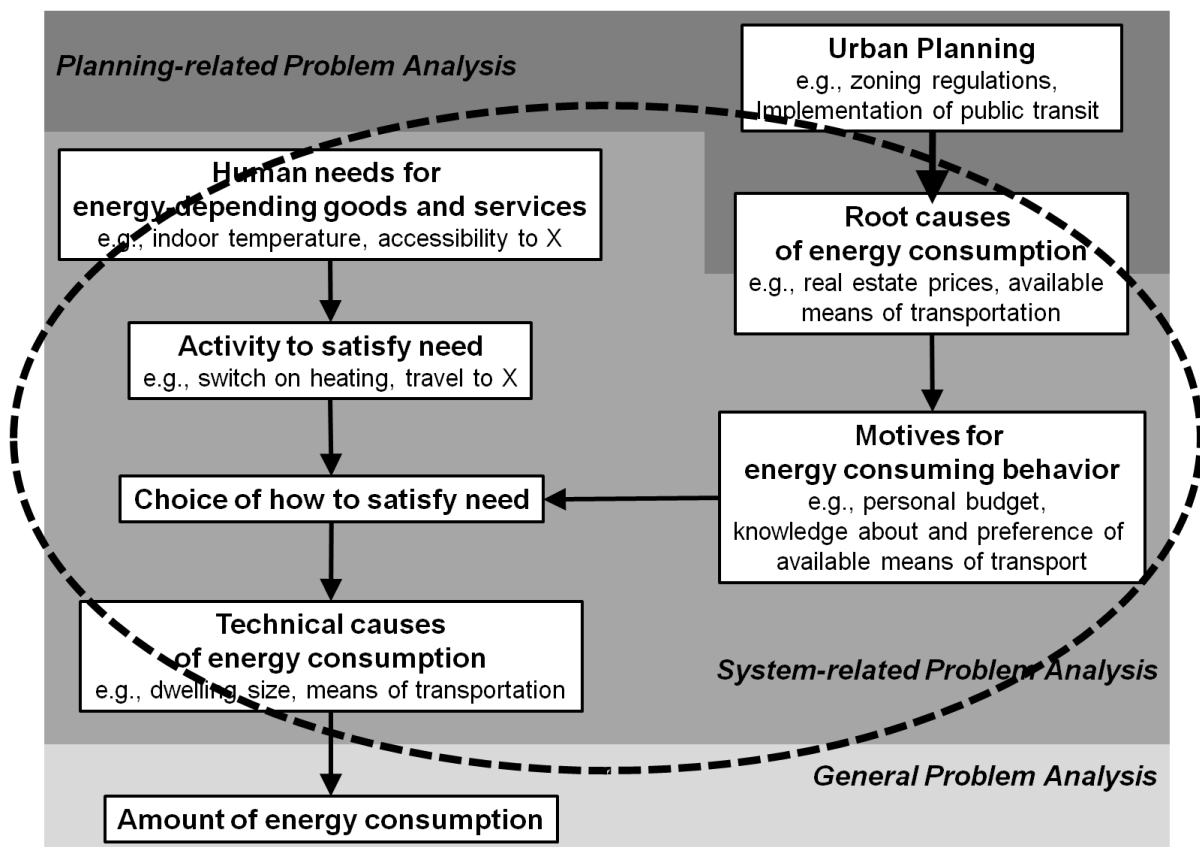
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<sup>36</sup> Owen, D. (2009), p. 247

## 4. System-related problem analysis – causes and motives

The system-related problem analysis explains which root causes of the problem are the results from urban planning decisions. It analyzes the causes and motives for energy demand that are influenced by the urban system. For this analysis, fields of energy consumption will be defined according to the results of the general problem analysis. Furthermore, it will outline the technical causes, motives, and root causes for energy consumption. The list of causes won't be exhaustive but shall give an overview and a general idea of why people consume energy. In a second step, the results will be clustered in categories of root causes and motives.

Figure 7: Objective of the system-related problem analysis



Source: author

## 4.1 Fields of energy consumption

People consume energy indirectly as a production factor when consuming goods and services (energy was used for the manufacturing processes of goods or for providing the service), and directly as a comfort factor when switching on the heating, turning on the light or driving the car.<sup>37</sup> The comfort factor includes any activity that requires energy directly for the satisfaction of a need. For example, purchasing a TV, and the energy used for the manufacturing of it, relates to the production factor. Sitting at home and watching TV is direct energy consumption for the satisfaction of the need to watch the news or a TV-show and therefore relates to the comfort factor. Different types of comfort will be described in the following chapter.

Thus, the amount of energy needed as a production factor depends on the production process, the demand for goods and services, and the distance between producer and consumer (freight transportation). This can be summarized as the production field of energy consumption. The amount of energy consumed as a comfort factor can be divided into two fields of energy consumption: comfort at home or the residential field of energy consumption (for housing, living, and recreation) and comfortable interconnection between goods and services or the mobility field of energy consumption (passenger transportation).

Consequently, three fields of energy consumption can be defined:

- The residential field: type of living and housing
- The production field: production, delivery, and selling of goods and services
- The mobility field: ways we go and modes of travel

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<sup>37</sup> Priewasser, R. (2003)



The amount of energy consumed within the residential field is equivalent to the numbers within the residential sector outlined in the general problem analysis. The production field corresponds to the energy consumed within the industrial sector, the commercial sector, and the freight transportation related share of the transportation sector. The mobility field corresponds to the passenger transportation related share of the transportation sector.

The following chapters analyze the backgrounds of energy consumption within these three fields in North America and Europe. The following results from the general problem analysis are important to keep in mind:

- Americans consume three times more the amount of energy per capita than Europeans
- The share between the fields of energy demand is almost the same in the U.S. and Europe

## **4.2 The residential field**

The human need that has to be satisfied through energy consuming goods and services within the residential field is comfort.

### **4.2.1 The need for comfort**

Four types of comfort have been identified:

- General indoor comfort in terms of livable atmosphere (heating, cooling, lightning)

- Comfort in terms of ability to easily provide goods and conditions indispensable for life (cooking, warm water for personal hygiene)
- Comfort in terms of convenience in housekeeping by using household appliances (washing machine, dryer, stove, microwave, etc.)
- Comfort in terms of recreation and entertainment by using several electric devices (TV, computer, video games, etc.).

In the following, the share of energy consumption between those four types of comfort will be outlined for the U.S. and Europe (EU-15). It is important to keep in mind that the subject of this comparison is the share of energy consumed within the residential field in the respective amount of total energy consumed. This comparison aims to give a general overview of what are the activities which consume most energy within the residential field and what are the differences between America and Europe. In 2009, people in the U.S. consumed about 1,709 kg-oe per capita in the residential sector<sup>38</sup>. In the same year, people in the EU-27 consumed 589 kg-oe per capita<sup>39</sup> which is approximately a third of the U.S. per capita consumption.

With a share of about 40 percent of the total residential energy consumption, the bigger part of energy consumed is needed for “indoor comfort” in both the U.S. and Europe (EU-15). Besides the fact that Americans consume three times more energy for indoor comfort than Europeans, they use 11 percent of this energy for air conditioning, whereas Europeans only use 1 percent for air conditioning.<sup>40</sup>

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<sup>38</sup> [http://www.eia.gov/state/seds/sep\\_use/notes/use\\_print2009.pdf](http://www.eia.gov/state/seds/sep_use/notes/use_print2009.pdf)

<sup>39</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables)

<sup>40</sup> Weizsäcker, E.U. von et al. (2010)

Other than climatic aspects, a reason for the tremendous difference in terms of energy used for cooling between the U.S. and Europe might be cultural aspects. From a climatic point of view, the U.S. covers a larger area where cooling is needed more than heating which is vice versa in Europe. Additionally, air conditioning usage started much later in Europe than in the U.S. Even today, air conditioned homes are rare in Europe compared to the U.S.

However, from a cultural point of view, people in Europe, and especially people in the southern parts of Europe where air conditioning may be needed due to climate conditions, have a much stronger connection to outdoor environments and fresh air (e.g., piazza in Italian cities, Spanish courtyards, etc.). It seems that for European people, it is still more convenient to open the window instead of turning on the air conditioner. “We in Italy are proud about our connection to street life and public spaces. If we want to have air circulation inside, we can open our windows. I don’t want to live in a house where I can’t open the windows. [...]”<sup>41</sup>

Even the American architect Doug Farr argues the way Americans use their air conditioners is “beyond good and evil”<sup>42</sup> and could be improved easily. However, looking at the statistical data it becomes clear that “[...] a significant amount of energy consumed by the average building is used to circulate oxygenated air, formerly the work of open windows.”

Within the other three types of comfort, energy is mainly used to operate certain appliances that are needed for activities essential for life, for housekeeping, and for recreation. Around 9 to 11 percent of the total residential energy consumption is consumed for water heating in the U.S.

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<sup>41</sup> Attendee at the International Forum (Vienna, Austria; 2009)

<sup>42</sup> Farr, D. (2008), p. 21

and Europe.<sup>43</sup> Around 30 % of the total residential energy is consumed for domestic appliances and other things needed for entertainment, housekeeping, etc.

#### **4.2.2 Causes and motives for residential energy consumption**

As already mentioned in chapter 3.1, the average American consumes three times more energy than the average European. Furthermore, the residential energy consumption is on the increase on both continents, in total and per capita. The amount of energy consumed for residential comfort depends on the following technical causes. This list is not exhaustive but outlines the most significant and obvious factors.

- Constant causes (can't be influenced or changed)
- Climate and outside temperature
- Available resources
- Variable causes
- Dwelling size (m<sup>2</sup> / capita) and number of household members
- Type of dwelling (apartment, single-family house, etc.)
- Quality of buildings (Insulation and building material, passive house technology, etc.)
- Location of building in urban context
- Equipment ownership
- Personal causes
- Personal sense of comfort

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<sup>43</sup> Weizsäcker, E.U. von et al. (2010)

- Health, disabilities

Constant causes like climate or availability of resources won't be a topic of this work. They are a matter of location of the entire urban settlement (where are the needed resources available? which climate is less energy consuming?). The focus of this work is to find solutions for existing settlements but not to resettle them. Personal root causes like a personal sense of comfort (sensation of cold and warmth or health conditions) can be hardly influenced and won't be a topic of this work either.

In the following, the variable technical causes and their backgrounds (root causes and motives for energy consuming behavior) will be analyzed. Each of them has a direct connection to the amount of energy consumed. However, the change and development of their backgrounds influences the amount of energy consumed indirectly.

### **Dwelling size per capita**

The bigger a house or apartment, the more energy is needed for indoor comfort. There is a direct connection between the amount of energy consumed and the size of a dwelling.

The average dwelling size has been on the increase for years on both continents. In Germany, for example, the average dwelling size per capita increased from 34.8 m<sup>2</sup>/capita in 1990 to 41.2 m<sup>2</sup>/capita in 2005<sup>44</sup>, which is an increase of more than 18 percent within 15 years. In the U.S., the average dwelling size per capita has always been larger than in Europe due to more available land. In 2006, the average U.S. dwelling size per capita was more than 80 m<sup>2</sup>/capita.<sup>45</sup>

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<sup>44</sup> <http://www.ifs-staedtebauinstitut.de/> (10/20/2011)

<sup>45</sup> <http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml> (3/30/2013)

In Austria, the total settlement area has doubled between 1950 and 2010, while the population grew by 20 percent.<sup>46</sup> The average area for a typical American single-family house increased from 130 m<sup>2</sup> in 1970 to 200 m<sup>2</sup> in 2000, which is an increase of more than a 54 percent.<sup>47</sup>

While the dwelling size is on the increase, the number of household members decreases. In the EU-27, the average household size is about 2.4 people per household.<sup>48</sup> In Austria, the average household size has decreased from 2.7 people per household in 1984 to 2.3 people per household in 2010. In 2010, 36 percent of all households were single-person households, which is a 15.8 percent of the population.<sup>49</sup> In the U.S., the average household size shrank from 3.14 in 1970 to 2.62 people in 2000; 27 percent of all households are single-person households.<sup>50</sup> In San Francisco's district 1, 35 percent of households are single-person households; the average household size is 2.5 people per household.<sup>51</sup>

A small number of household members results in inefficient lifestyles in terms of energy consumption. That is, although a single-person apartment might be smaller than an apartment for a family, there still needs to be a bathroom, a kitchen, and various appliances.

Additionally, people use more and more electric devices such as TV, hi-fi, computers, microwave etc. Nowadays, they are affordable for everyone. A TV used to be a luxury product in the 1960s, a microwave started to be affordable in the 1970s, and computers became common in

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<sup>46</sup> Umweltbundesamt, UBA [ed.] (2008)

<sup>47</sup> Farr, D. (2008), p. 21

<sup>48</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/publications/eurostat\\_yearbook\\_2010](http://epp.eurostat.ec.europa.eu/portal/page/portal/publications/eurostat_yearbook_2010) (10/18/2011)

<sup>49</sup> <http://www.statistik.at>: Census data Austria (10/18/2011)

<sup>50</sup> <http://factfinder2.census.gov>: Census USA 2010 (10/18/2011)

<sup>51</sup> San Francisco Planning Department, 2005 - 2009 American Community Survey, May 2011

the 1980s and 1990s. In addition, nearly everybody owns their own freezer, washing machine, and dryer and operates them at home. Although the number of household members decreases, the number of equipment per dwelling increases. In Vienna, for example, the electricity consumption for domestic appliances increased by about 34 per cent between 1993 and 2003 due to an increase in domestic appliances per household.<sup>52</sup>

Rising prosperity, the increase in single-family houses (that are usually larger than apartments), and changing lifestyles towards one-person households are the main root causes for the increase in dwelling sizes and the therewith related increase in energy consumption; that is, the affordability of larger dwellings and a larger amount of electric devices, the availability and accessibility of residential building areas outside the city, the missing attractiveness of living in the city and sharing dwellings, and the missing awareness of the inefficiency of that kind of lifestyle.

### **Type of building**

In terms of energy consumption, the type of building also plays an important role. “Single-family detached houses usually have a larger floor area than apartments and row houses.”<sup>53</sup> To put it in other words, an increase in single-family houses leads to an increase in the average dwelling size and is directly connected to the amount of residential energy consumption. Furthermore, detached buildings consume more energy for indoor comfort than attached buildings due to their “larger surface area of external walls and roofs per square meter floor area. Moreover, the need for technical infrastructure (including roads, sewers,

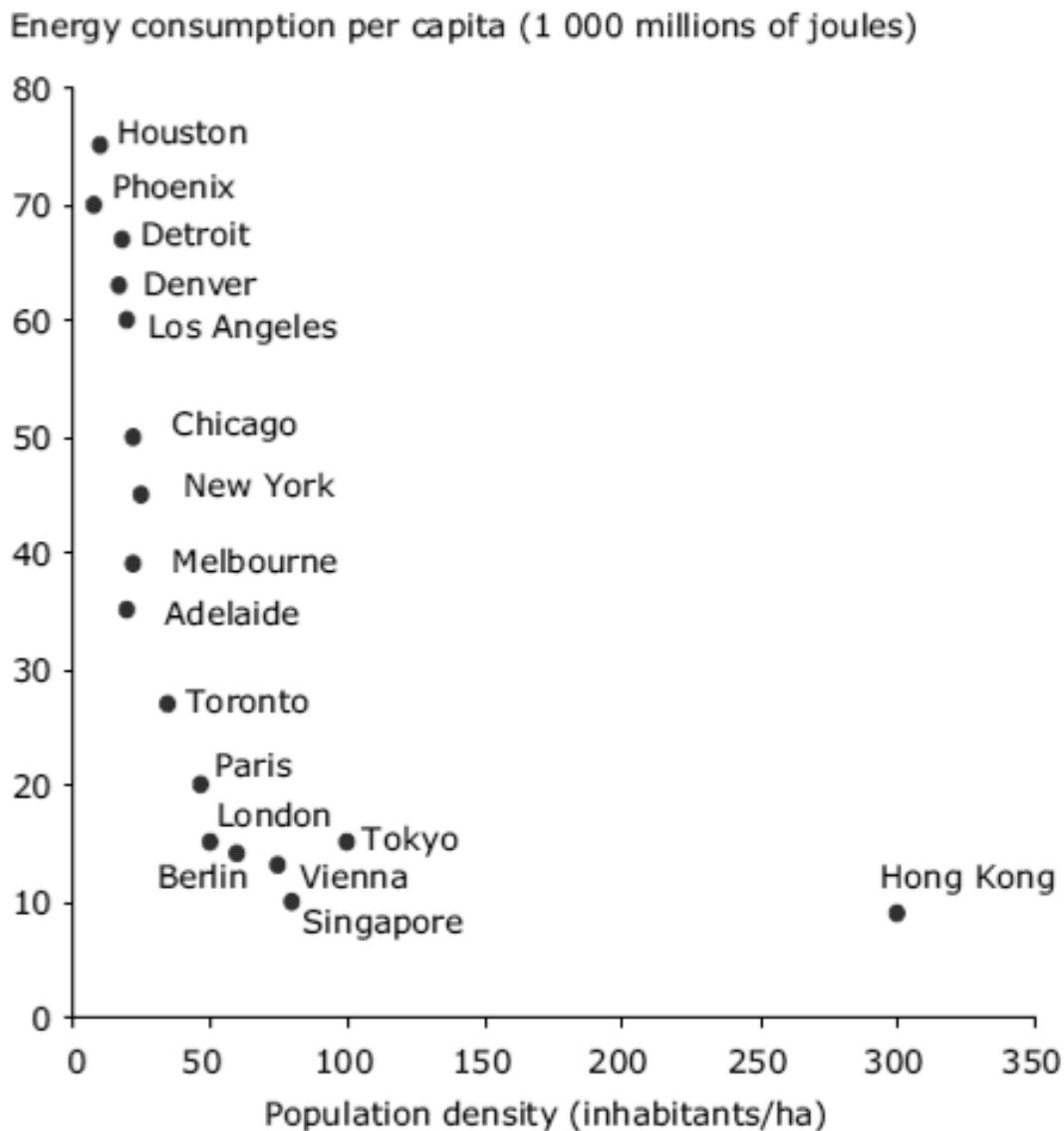
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<sup>52</sup> City of Vienna (2006)

<sup>53</sup> Naess, p. (2006), p. 250

water pipes and electricity cables) are usually higher in single-family house areas.”<sup>54</sup>

Figure 8: Population density and energy consumption, selected cities



Source: EEA (2006), p. 30

Due to the area that single-family houses occupy and the large backyards that are usually attached, single-family house areas have a much lesser population density than urban settlements with apartment

<sup>54</sup> Naess, p. (2006), p. 250



buildings. According to the EEA, there is a direct interrelation between the population density in one area and its energy consumption.<sup>55</sup>

The number of single-family houses is on the increase in both North America and Europe. In the U.S., 61.4 percent of housing units are single-family houses.<sup>56</sup> In comparison, in Austria, 47 percent of all housing units are single-family or semidetached houses.<sup>57</sup> Between 1981 and 2003, in Vienna, the increase in single-family houses (35 percent) was higher than the increase in multi-family houses (7 percent). In 2001, 59 percent of all residential buildings were single-family houses whereas only 41 percent were multi-family houses.<sup>58</sup>

The development of suburban, single-family house areas and the phenomenon of the so called urban sprawl was driven “by a desire to live in the countryside the sprawl destroys, by a widely held belief that low-density garden city or garden suburb living is good for us, and by a retreat from community into individualism.”<sup>59</sup> Urban sprawl is not only a U.S. phenomenon, but also in Europe, urban sprawl has been on the increase since the early 20th century.

People want to live in their independent, detached, self-designed single-family houses outside the city, close to nature and within a quiet environment. Other than that, incentives given from the real estate market and the governments also influence the choice of building type. They make the single-family house outside the city not only affordable but much cheaper than an apartment within the city and accessible through an increasing amount of roads that allow people to drive to their suburban houses.

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<sup>55</sup> EEA (2006), p. 30

<sup>56</sup> <http://factfinder2.census.gov>: Census USA 2010 (10/18/2011)

<sup>57</sup> <http://www.statistik.at> (12/16/2011)

<sup>58</sup> City of Vienna (2006)

<sup>59</sup> Reeds, J. (2011), p. 9

Figure 9: Suburban single-family house area: Glenview, IL



Source: Google Maps (03/08/2012)

Figure 10: Suburban single-family house area: Germering, Germany



Source: Google Maps (03/08/2012)

Actually, the single-family house in the suburb, surrounded by nature, should be a luxury good and the city apartment should be the affordable place to live. Matthew Roddis, a city planner in the city of Vancouver, Canada, sees “the main problem of suburbanization in the costs of living in the city. People move into the suburbs because living costs are much cheaper there than in dense urban areas.”<sup>60</sup>

In Phoenix, AZ, the land use map, as part of the General Plan for urban development, is based on a survey about what people want. Additionally, according to Jacob Zonn, urban planner at the City of Phoenix, the hands of urban planners are tied due to property rights. “The city can’t forbid people to build single-family houses on their own property.”<sup>61</sup> This leads to missing growth boundaries and extensive urban sprawl. In comparison, in European countries, laws and regulations determine which land can be used as a building area and which land can’t.

### **Quality of buildings**

Building standards and the quality of buildings in terms of insulation, type of windows, etc., have a huge influence on the amount of residential energy consumption. A lot of energy can be saved through better building qualities. In general, buildings in North America have much poorer quality than the average Middle European building stock and the rest of Europe. There are various reasons for that.

First, most European countries have very strict building codes which require certain wall thickness, building materials, and insulation standards. Since the EU Directive 2002/91/EG (EPBD Energy Performance of Buildings Directive) was transformed into national laws (e.g., the “Energieausweis” in Austria in 2006) the energy performance of

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<sup>60</sup> Interview with Matthew Roddis (Vancouver, Canada; 09/13/2011)

<sup>61</sup> Interview with Jacob Zonn (Phoenix, AZ; 11/23/2011)

any newly built building in Europe is regulated through these laws and has to meet certain requirements.

Also in the U.S. and Canada, building certifications like LEED (Leadership in Energy and Environmental Design) were developed during the 1990s but in most cases those standards are not required by law. Some U.S. and Canadian cities and states require certain LEED certifications for public buildings (e.g., Los Angeles, CA, Chicago, IL, Atlanta, GA, and Vancouver, Canada). However, the private sector is only regulated where governmental funding is involved. Washington, D.C. and Santa Monica, CA are the first cities where energy efficiency standards are also required for the private sector.

In Phoenix, AZ, people don't have to pay for the permit procedure if their buildings or certain appliances meet specific energy efficiency standards. However, if they don't apply to certain energy efficiency, nothing happens (no fines and the building can still be built). "We can't tell the people that they have to meet LEED gold standards."<sup>62</sup> In comparison, in Austria, people won't get a construction permit for their house if it doesn't meet the energy efficiency requirements.

Second, "[m]ost buildings in the U.S. were built [...] during a time when fossil fuels were cheap and abundant. Americans are a mobile society, constantly moving to be closer to better paying jobs, school or neighborhoods, so there was no immediate incentive to invest in building more efficient, higher quality buildings."<sup>63</sup> Furthermore, in the late twentieth century, in the U.S., a "home became less a shelter than a tradable asset [...].Owning a house was like running a small business that had to be sold every so often, [...]. By the end of the millennium, the average American homeowner sold that business every seven years. In

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<sup>62</sup> Interview with Jacob Zonn (Phoenix, AZ; 11/23/2011)

<sup>63</sup> Tahan, N. (2010), p. 6

real estate hot zones like Phoenix, the turnover was much more rapid, and so the population was in a constant churn.”<sup>64</sup>

Additionally, in North America and Europe, in the past, governmental funding was available for the construction sector in general without consideration of energy efficiency, location or size of building (e.g., “Wohnbauförderung” in Austria). In the last few years, most European countries, some U.S. states and cities, and several cities in Canada have adapted their laws and regulations towards more energy-efficient buildings. Nowadays, subsidies for construction in California require certain LEED certifications, and the so called “Wohnbauförderung” in Austria requires energy efficiency standards according to the “Energieausweis”.

To sum up, the reasons for less energy efficiency in American buildings compared to European buildings are, on the one hand, stricter laws and regulations in Europe, and on the other hand, cheaper energy prices in North America that result in longer pay-off for energy improvements, which contravenes the short-term housing attitude of Americans.

### **Location of building in urban context**

The location of a building within the urban context influences the amount of energy consumed in various ways. First, depending on the surrounding facilities, public transit, and accessibility to goods and services, the location of a building influences the amount of energy consumed for mobility needs tremendously (see also 4.4).

Second, an attached building located within a dense urban area can save a lot of energy due to its smaller surface area of external walls. Furthermore, the orientation of a building and its solar radiation or wind

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<sup>64</sup> Ross, A. (2011), p. 32f.

exposure can influence the amount of energy consumed for light, heating, and cooling.

Third, dense, urban patterns result in more efficient operation of infrastructure (public transit, sewers, etc.). Moreover, in dense settlement areas more efficient heating systems such as district heating can be implemented.

Last, but not least, the availability and accessibility of natural areas close to one's home have an influence on the amount of outdoor versus indoor activities, and travel by bike or foot, versus using the car. The phenomenon called biophilia tries to explain the effect of nature on human beings. It used to refer to stress reduction and other emotional reactions as effects of nature.<sup>65</sup> “[E.O.] Wilson popularized the term biophilia two decades ago to describe the extent to which humans are hardwired to need connection with nature and other forms of life. More specifically, Wilson describes it this way: ‘Biophilia ... is the innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature.’”<sup>66</sup> People who live close to parks, a beach, or other forms of natural environments tend to spend more time outdoors and do sports, relax in the sun, etc. instead of playing video games or watching TV. Furthermore, it is scientifically proven that “green features correlate with decisions to walk or bike to work. Schantz refers to these green urban features as “pull factors for physical activity””.<sup>67</sup>

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<sup>65</sup> Ulrich, R. (1993)

<sup>66</sup> Beatley, T. (2011), p. 3

<sup>67</sup> Beatley, T. (2011), p. 6

### 4.3 The production field

The production field summarizes the need for consumer goods and services. It contains basic needs like food and beverages, as well as luxury goods and services such as hairdresser, etc. that lead to energy consumption. The production field and its backgrounds are much more complex than the residential field. Energy serves as input factor for the following three activities:

- Production (production processes, type of industry, etc.)
- Delivery (freight transportation)
- Selling of goods and services (type of product, circumstances of storage (e.g., cooling), quality of building, etc.)

The amount of energy consumed depends on the demand of goods and services to be produced, delivered and sold. That is to say, the direct consumers of energy are companies within the industrial, commercial, agricultural, and freight transportation sectors. The energy efficiency of the production process can be influenced by laws and regulations (e.g., a law that requires the installation of heat-recovery systems for certain industries, energy efficiency standards for machinery, etc.). Furthermore, building standards for commercial and industrial buildings may result in a decrease in energy consumed.

The energy consumption for the delivery process depends on the location of the production and the selling place, as well as the means of transportation. The choice of location can be influenced by zoning regulations, subsidies, etc. The choice of means of transportation can be influenced by the availability of different types of means of transportation, their attractiveness, and affordability.

However, the very root causes of energy demand in the production field are changes within our society that led to an increase in the demand for goods and services. Growing economies and the growing demand for goods and services all over the world have led to an increase in production, delivery, and selling of goods and services. Furthermore, globalization has led to international exchange of goods and services which induces more freight transport.

In order to analyze the root causes of energy consumption in the production field, a much more extensive analysis of socio-economic and political developments outside the urban system would have to be conducted. Such an analysis won't be part of this work, as the aim of this work is to find solutions within the urban system by means of urban planning.

#### **4.4 The mobility field**

Mobility is not a matter of sitting in a car and driving around or taking the train and watching the landscape pass by. Mobility is a matter of accessibility. In other words, within the mobility field, energy is consumed to provide accessibility to certain locations, facilities, and activities. Mobility “is determined by the ability to reach a great number of destinations within the shortest possible time while covering the shortest possible distance. [...], mobility should be defined as the number of destinations that can be reached within a certain time.”<sup>68</sup>

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<sup>68</sup>Schriefl, E. / Schubert, U. / Skala, F. / Stöglehner, G. (2008), p. 2



#### **4.4.1 The need for accessibility**

In 2009, the U.S. consumed 2,192 kg-oe per capita for transportation.<sup>69</sup> In comparison, people in the EU-27 consumed 734 kg-oe per capita<sup>70</sup> in the same year, approximately a third of the U.S. consumption. Reasons for this tremendous difference can be found in the two main technical causes for energy consumption in the mobility field: the average distance traveled and the mode share. Americans are a much more mobile society than Europeans; they are more willing to accept much longer daily commutes than Europeans.<sup>71</sup> The average passenger-km traveled in the U.S. in 2008 was 24,319 km per capita and year (air, water, and non-motorized traffic excluded); 23,232 km per capita were traveled by car, which is a share of 95.5 percent.<sup>72</sup> In the EU-27 the average European traveled 11,517 km per capita (air, water, and non-motorized traffic excluded) in the same year; 9,431 km per capita were traveled by car, which is a share of approximately 82 percent.

#### **4.4.2 Causes and motives of mobility-related energy consumption**

The amount of energy consumed for mobility depends on the following two technical causes:

- Distance traveled (depending on the density and proximity of the urban structure)
- Means of transportation

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<sup>69</sup> [http://www.eia.gov/state/seds/sep\\_use/notes/use\\_print2009.pdf](http://www.eia.gov/state/seds/sep_use/notes/use_print2009.pdf)

<sup>70</sup> [http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables)

<sup>71</sup> Florida, R. (2008), p. 150

<sup>72</sup> European Commission [ed.] (2010)

Americans consume three times the amount of energy for transportation than Europeans. Reasons for this are, on the one hand, much longer average distances traveled, and on the other hand, a higher rate of more energy consuming means of transportation (automobile) within the mode share.

### **Distance traveled**

The longer the distance of travel, the more energy is needed. The average distance traveled per capita and year has always been on the increase, influenced by the technological progress of means of transportation. The average time a person spends to move around has always been more or less constant. That is, through the invention of faster and more convenient means of transportation, people were able to travel longer distances by spending the same time. This is the so called Marchetti Constant. "Cities have always been one hour wide depending on the means of transportation."<sup>73</sup>

Cities developed from walkable cities to public transit cities and ultimately to automobile cities. They grew with the respective speed of transportation.<sup>74</sup> "Cars don't just use energy themselves; they also raise energy consumption in all forms and in all categories [...] by enabling people to live in ways that are unavoidably inefficient."<sup>75</sup> In particular, in the 20th century, when most of today's common means of transportation were invented or rather made affordable for everyone, the average passenger-kilometers per year and person were growing tremendously. And still, the distances traveled are growing. Between 1995 and 2008 the

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<sup>73</sup> Kenworthy, J. at the Eco-City World Summit in Montreal (2011)

<sup>74</sup> Newman, P. / Kenworthy, J. (1999)

<sup>75</sup> Owen, D. (2009), p. 102

passenger-kilometers traveled grew by a 22.5 percent in the EU-27 and by a 28 percent in the U.S.<sup>76</sup>

Geographically, the distance traveled depends on the compactness and the density of a settlement, as they influence the proximity of goods and services. Additionally, the attractiveness of the available goods and services plays an important role. That is, the choice of the facility or the location where one's needs shall be satisfied depends on the distance that has to be traveled and the attractiveness of the facilities (gravitation model).<sup>77</sup> However, the influence of the attractiveness of a facility is much more important for the decision of where to go. People are more willing to travel longer distances to satisfy their needs and "[...] emphasize the possibility of choosing among facilities rather than proximity."<sup>78</sup> Especially, with the invention of the automobile, proximity became less important. This is the case for almost all types of facilities (work places, education, stores, entertainment, leisure activities, etc.).

Besides any facility preferences, people who live in less dense settlement structures (e.g., peripheral, rural areas, suburbs) have to travel much longer distances to reach the goods and services they need. This results in a larger amount of energy consumed for transportation. For example, the average rural or exurban Atlanta area resident drives nearly eight times more each day (forty miles) than the average central-city Atlanta resident (five miles).<sup>79</sup>

Although the main population growth of the U.S. is registered in the metropolitan areas that usually show much higher densities than rural areas (an 83 percent of the U.S. population lives in urban metropolitan

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<sup>76</sup> European Commission [ed.] (2010)

<sup>77</sup> Giffinger, R. (2002)

<sup>78</sup> Naess, P. (2006), p. 220

<sup>79</sup> Farr, D. (2008), p. 24

areas<sup>80</sup>), urban density is on the decrease. American cities, or rather metropolitan areas, grow outside the city. Urban growth is mainly a phenomenon of the suburbs and the tremendous increase in single-family houses along the fringes of the cities.

Most European cities are much more compact and denser than American cities. Furthermore, European cities and their metropolitan regions are much smaller. For example, in San Francisco metropolitan area, only a 19 percent of the population lives in San Francisco. The urban density of San Francisco is rather high with 6,600 people per km<sup>2</sup>, whereas the density of the metropolitan area amounts to 470 people per km<sup>2</sup>. Vancouver's urban density is about 5,250 people per km<sup>2</sup>, whereas the metro density is 800 people per km<sup>2</sup>. In Chicago, it is even worse with an urban density of about 4,450 people per km<sup>2</sup> and a metro density of 336 people per km<sup>2</sup>. In comparison, in the Vienna region, a 71 percent of the population lives in the city. Its urban density is about 4,100 people per km<sup>2</sup>, which differs only slightly from its metro density.<sup>81</sup>

Benet Haller, the director for urban design and planning at the City of Chicago, sees two main problems in Chicago's planning approaches towards density. First, on the one hand, plans like the Chicago Climate Action Plan define general aims towards more sustainability but on the other hand they are "not spatially specific". And second, planning regulations allow "to develop density but developers don't do it", as regulations don't forbid the development of non-dense settlement areas.<sup>82</sup>

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<sup>80</sup> Stieninger, P. (2011)

<sup>81</sup> <http://www.wikipedia.org> (7/13/2012)

<sup>82</sup> Interview with Benet Haller (Chicago, IL; 10/18/2011)

Figure 11: Downtown density in Chicago



Source: author (08/05/2011)

Figure 12: Low density area north of Downtown Chicago



Source: Google Earth (03/08/2012)

Figure 13: Dense city center of Barcelona, Spain



Source: Google Earth (03/08/2012)

Between 1950 and 1990 in Phoenix, AZ, the population increased by more than 800 percent whereas the urban density decreased by about 60 percent.<sup>83</sup> The city center of Phoenix couldn't even be identified as a city center if the city map didn't say "downtown Phoenix". There are four-to six-lane streets, convention centers, car repair garages, and other huge buildings that are usually located somewhere outside the city center. The size of the buildings and the size of parking places between them make downtown Phoenix unwalkable. "We are the biggest city which has no city center."<sup>84</sup>

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<sup>83</sup> Owen, D. (2009)

<sup>84</sup> Kimber Lanning, arts and small business advocate, in Ross, A. (2011), p. 75

Figure 14: Downtown Phoenix



Source: author (11/22/2011)

Furthermore, the distance that has to be traveled to reach certain facilities influences the choice of means of transportation. Short distances are more likely to be walked or traveled by bike, whereas for longer distances public transit (if available) or the automobile may be used. According to Naess, who conducted a survey about traffic behavior and urban density in Copenhagen, Denmark, “[...] living in a dense area close to central Copenhagen contributes to less travel, a lower share of car driving and more trips by bike or on foot. Conversely, living in the peripheral parts of the metropolitan area contributes to a higher amount of transport and a lower share of travel by non-motorized modes.”<sup>85</sup>

Moreover, the density of a settlement not only influences the choice of means of transportation, but also the possibility of providing certain means of transportation. That is, public transit can't be operated economically in low density areas due to missing demand and a lack of passengers. An urban density of about 3,500 people per km<sup>2</sup> is needed

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<sup>85</sup> Naess, P. (2006), p. 178

for an efficient operation of public transit.<sup>86</sup> In Los Angeles, CA, „in some areas, up to 70 per cent of the land area is covered with roads and parking; [...]“<sup>87</sup>, which results in an urban density that is too low for the economic operation of public transit.

Therefore, a lot of U.S. and Canadian cities started the so called transit-oriented development planning (TOD), a planning approach that shall increase the density around public transit stations in order to make public transit economically feasible. However, Americans are used to low densities and don't want to live in dense areas as Europeans do. Furthermore, the main question that remains is “the debate of what comes first, density or public transit”?<sup>88</sup>

With their planning director Brent Toderian, Vancouver wanted to become a “Five Minute City”<sup>89</sup> where everything is available within a five minute walk. Toderian is a strong supporter of the TOD planning approach and is aware of the fact that “good planning is not a popularity contest.”<sup>90</sup> Vancouver improved and extended their public transit system for the Olympic Games in 2010. After the Games, they had to find additional transit users to make the system cost-effective. However, the people who live in Vancouver were not satisfied with his planning approach. Although Vancouver is known as a “green” city, people were not willing to live in denser areas just to make public transit possible, which resulted in Toderian's contract “being ended “without cause.””<sup>91</sup>.

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<sup>86</sup> Kenworthy, J. at Eco-City World Summit in Montreal, 2011

<sup>87</sup> Schiller, P. / Brunn, E.C. / Kenworthy, J.R. (2010), p. 8.

<sup>88</sup> Interview with Matthew Roddis (Vancouver, 09/13/2011)

<sup>89</sup> Interview with Matthew Roddis (Vancouver, 09/13/2011)

<sup>90</sup> <http://www.theglobeandmail.com/news/british-columbia/vancouver-planning-chief-toderian-given-the-axe/article554571/> (11/11/2012)

<sup>91</sup> <http://www.theglobeandmail.com/news/british-columbia/vancouver-planning-chief-toderian-given-the-axe/article554571/> (11/11/2012)



Settlement density is always a question of availability of land. San Francisco and Manhattan are dense because they were built on peninsulas. European cities are dense due to geographical restrictions and a general higher density of population in a smaller area. Why should Chicago stop growing on its fringes as long as the automobile allows people to access these areas? Besides Lake Michigan, no geographical issue limits the ability to grow.

Furthermore, it's also a question of the real estate market and the economic development of a region. Phoenix, AZ also started a TOD program along a 22 mile light rail track including bike lanes, sidewalks, and landscaping. The economic crisis resulted in a 22 mile corridor from the northwest to southeast of the city with nothing attached to it and no one using it. When the corridor was finished, the collapse of the real estate market made it impossible to develop housing or commercial real estate along the corridor.

### **Means of transportation:**

Different types of means of transportation consume different amounts of energy. The energy consumption per passenger-kilometer of busses amounts to less than 30 percent of the energy an automobile consumes. Commuter rails and light rail systems consume less than 20 percent of the amount of the automobile.<sup>92</sup> Thus, the automobile is the most energy consuming means of transportation. Unfortunately, it is also the most used means of transportation in both the U.S. and in Europe.

With 23,232 km per capita and year, Americans use their cars 2.5 times more than Europeans. The amount of public transit usage per capita in Europe is more than double the amount of the U.S. Although private

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<sup>92</sup> Priewasser, R. (2003)

transportation in the U.S. increased by about 26 percent from 1995 to 2008, the use of public transit increased tremendously too: 11 percent increase in passenger-km by bus and 43 percent increase in passenger-km by rail (see Table 7).

Table 7: Passenger transport, comparison EU-27 and U.S. [psg.-km/capita]

Passenger-km / capita	EU-27 2008	EU-27 %	EU-27	USA	USA %	USA
			1995 - 2008	2008		1995 - 2008
<b>Automobile</b>	9,431	81.89%	+ 21.40%	23,232	95.99%	+ 26%
<b>Bus, trolley-bus</b>	1,092	9.48%	+ 9.40%	784	3.24%	+ 11%
<b>Railway, tram, metro</b>	994	8.63%	+ 18%	187	0.77%	+ 43%
<b>Total</b>	<b>11,517</b>	<b>100.00%</b>	<b>+ 22.50%</b>	<b>24,203</b>	<b>100.00%</b>	<b>+ 28%</b>

Data Source: European Commission [ed.] (2010); calculated by author

### Automobile:

Since 1988, the U.S. has experienced a steady 2.5 percent annual increase in kilometers driven.<sup>93</sup> Similar numbers have been registered in Austria and all over Europe.<sup>94</sup> However, the motorization of the U.S. is much higher than in the EU-27. In the U.S., 780 out of 1,000 people own a car. In Europe, 467 out of 1.000 people own a car.<sup>95</sup>

The number of automobiles in the U.S. exceeded the number of driver's licenses in 2001.<sup>96</sup> The U.S. population amounts to a 4 percent of the world's population; simultaneously, Americans own one third of the

<sup>93</sup> Farr, D. (2008), p. 25

<sup>94</sup> Statistik Austria, Eurostat

<sup>95</sup> European Commission (2010)

<sup>96</sup> Owen, D. (2009), p. 102

planet's automobiles.<sup>97</sup> The ownership of a car is the most influential factor for the choice of means of transportation, independent of any economic reason or time considerations. That is, people who own a car are more likely to not use public transit or their bike. Not only that, they do not even think about these options.<sup>98</sup>

In addition to the fact that Americans drive more than Europeans, the fuel efficiency of operating cars in the U.S. is much poorer than that of European cars. Due to stricter regulations, the average European car consumes 4 to 5 liters per 100 km. The average U.S. car consumes 7 to 9 liters per 100 km. In California, stricter state regulations have led to a slight improvement of fuel efficiency (see **Error! Reference source not found.**). Although fuel efficiencies are generally improving, the improvements have been overcompensated by the increase in vehicle miles traveled.

### Public Transit

Usually, the share of public transit usage is higher in metropolitan regions and large cities because of the better quality and more extensive public transit systems. However, the generally lacking supply of public transit in America leads to the fact that Americans use public transit less frequently than Europeans, even though more than 80 percent of the U.S. population lives in metropolitan areas<sup>99</sup> and more than 25 percent lives in large cities with a population of more than 5 million people. In Europe, only 7 percent of the population lives in large cities<sup>100</sup>.

In 1990, the per capita transit use in American cities was around 80 times per year whereas in European cities, public transit was used more

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<sup>97</sup> Schiller, P. / Brunn, E.C. / Kenworthy, J.R. (2010)

<sup>98</sup> Franzen, A. (1996)

<sup>99</sup> Stieninger, P. (2012)

<sup>100</sup> Commission of the European Communities [ed.] (2008)

than 300 times a year.<sup>101</sup> Today, only 4 percent of passenger-km per capita is being executed in public transit in the U.S. In comparison, in Europe, the share of public transit is about 18 percent (see Table 7). The main reason for this tremendous difference is the fact that most American cities were built, or rather recorded their highest growth rates, in times when the automobile had already been invented and was affordable for most people (see chapter 5).

In 2006, almost 60 percent of Vancouver’s population drove to work. Two years later, only 31 percent of the Berlin population used their cars and almost the same number of people walked to work. Copenhagen is known for its large amount of cyclists. In 2004, already 36 percent of the population used their bikes to go to work (see Table 8).

Table 8: Mode share of trips to work in U.S. and European cities

Mode	San Francisco (2009) <sup>102</sup>	New York City (2009) <sup>103</sup>	Vancouver (2006) <sup>104</sup>	Vienna (2010) <sup>105</sup>	Copenhagen (2004) <sup>106</sup>	Berlin (2008) <sup>107</sup>
Car	46.3 %	28 %	57 %	31 %	26 %	31 %
Transit	31.8 %	55 %	30 %	36 %	29 %	26 %
Walk	10.3 %	-	14 %	28 %	6 %	30 %
Bicycle	3.0 %	-		5 %	36 %	13 %
Other	8.6 %	17 %		-	-	

Source: see footnotes

<sup>101</sup> Newman, P. / Kenworthy, J. (1999), p. 108

<sup>102</sup> San Francisco Planning Department [ed.] (2010), p. 101

<sup>103</sup> The City of New York [ed.] (2011), p.93

<sup>104</sup> City of Vancouver, Department of Transport Planning (2011)

<sup>105</sup> Madreiter, T.: SUME Conference 05/03/2011

<sup>106</sup> [http://en.wikipedia.org/wiki/Modal\\_share](http://en.wikipedia.org/wiki/Modal_share) (03/07/2012)

<sup>107</sup> [http://en.wikipedia.org/wiki/Modal\\_share](http://en.wikipedia.org/wiki/Modal_share) (03/07/2012)

During recent years, the U.S., and especially the metropolitan areas in the U.S., made an enormous effort in improving and extending their public transit systems. The awareness of environmental impacts of motorized, private transportation and continuous congestion in America's cities have led to new directions towards environmentally friendly, green transport systems.

Federal funding used to prioritize the extension of the highway network. Today, it focuses more on the implementation of public transit.<sup>108</sup> Cities like Phoenix, that used to have a mode share of 0.8 percent of public transit and 99.2 percent of private transportation in the early 1990s, now build light rail systems and extend their bus network through federal funding. In Phoenix, a 20 mile light rail system was built in 2008.<sup>109</sup> In comparison, Vienna's light rail has been operating since 1865 (first by horses, then steam, then electricity).<sup>110</sup>

Furthermore, the largest metropolitan areas like New York City, Chicago, and Los Angeles try to improve the quality of their transit systems and extend their subway lines and bus service, which has led to an increase in ridership in the last years. However, a key challenge that remains is project funding. Americans pay less tax than Europeans, which makes it much more difficult to implement public transit projects.<sup>111</sup>

According to the American Public Transportation Association (APTA), the public transit ridership in the U.S. increased by almost 35 percent between 1995 and 2009. Also in Europe, the public transit systems are continuously being improved and extended due to population growth in urban areas and increasing demand. In Vienna, the number of public transit ridership per year increased from 2001 (700 million ridership) to

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<sup>108</sup> Stieninger, P. (2012)

<sup>109</sup> <http://www.valleymetro.org/>

<sup>110</sup> [http://de.wikipedia.org/wiki/Stra%C3%9Fenbahn\\_Wien](http://de.wikipedia.org/wiki/Stra%C3%9Fenbahn_Wien)

<sup>111</sup> Stieninger, P. (2012)

2010 (more than 800 million ridership) by almost 15 percent.<sup>112</sup> In comparison, the New York MTA ridership in 2009 was approximately 1.6 billion per year.<sup>113</sup>

Figure 15: New light rail in Phoenix, AZ



Source: author (11/22/2011)

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<sup>112</sup> <http://www.wien.gv.at/statistik/verkehr-wohnen/oeffentlich/index.html>

<sup>113</sup> <http://www.mta.info/>

Figure 16: New light rail station in Phoenix, AZ



Source: author (11/22/2011)

Figure 17: Light rail in Vienna, Austria



Source: author (7/13/2011)

## Walk and Bike

Due to their denser city centers and the availability of attractive sidewalks and bike lanes, many more people walk and bike in European cities compared to American cities. In Copenhagen and Berlin, the walk and bike mode share amounts to more than 40 percent (see Table 8).

In comparison, most North American cities have a walk and bike mode share below 10 percent. Exceptions are Vancouver, Boston, and San Francisco with a walk and bike mode share of about 10 to 15 percent. In cities such as Indianapolis, Las Vegas, or Detroit almost nobody uses their bike.<sup>114</sup>

According to Kate McGee, lead planner at the City of San Francisco, the main reason why people tend to use their bikes more often in San Francisco is because it's the fastest way to get from A to B. Public transit is not reliable and streets are congested.<sup>115</sup>

Another important reason that makes people walk, use their bike, or public transit is urban design, landscaping, and biophilia. If sidewalks and bike lanes have an attractive design and are safe, people will use them. Furthermore, using public transit always starts with walking to the station ("every transit rider starts with walking"<sup>116</sup>); that is, not only the transit stations and their surroundings have to be attractive and safe but also the ways people have to walk to get there.

Jan Gehl calls this the 5 km/h architecture versus 60 km/h architecture.<sup>117</sup>

A lot of cities and most suburbs are designed for cars. The streets are designed for a pass-through speed of 60 km/h. Therefore, billboards have a certain size and street names are not readable for pedestrians.

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<sup>114</sup> City of Vancouver, Planning Department (2011)

<sup>115</sup> Interview with Kate McGee (San Francisco, 11/17/2011)

<sup>116</sup> Interview with Matthew Roddis (Vancouver, 9/13/2011)

<sup>117</sup> Gehl, J. (2011)



For instance, if you walk along a one way street in Chicago, in the opposite direction to the traffic, you won't be able to read the names of cross streets. You have to turn around, in the direction of travel, to see it, as these signs are made for drivers, not for walkers. 60 km/h architecture cities are designed for "the view from the road. [...] as 'a sequence played to the eyes of a captive, somewhat fearful, but partially inattentive audience, whose vision is filtered and directed forward.'"<sup>118</sup>

In comparison, 5 km/h architecture focuses on pedestrians and cyclists and emphasizes urban design and landscaping accordingly. The availability of attractive sidewalks and bike lanes make attractive urban spaces, which increases the chance people will walk and bike.

San Francisco started the ROSE program (recreation open space element) in order to create walkable open space and make people walk. In addition, with the "pavement to parks" program, parking spots and other paved areas within the city shall be converted into green, natural areas, beer gardens, or bike locking facilities. Another major program in San Francisco resulted in the conversion of a highway into a pedestrian zone with bike lanes, parks, playgrounds, and beer gardens.

Most cities in Europe and North America have started to implement climate action programs to fight greenhouse-gas emissions and their impact on climate change. In order to reduce transport-related CO<sub>2</sub> emissions, various programs to support walking and biking were put in place.

In Vienna, the "Klimaschutzprogramm" (KLIP) resulted in an increase in biking, walking, and the use of public transit. In 2010, only a 31 percent of work trips were traveled by car.<sup>119</sup>

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<sup>118</sup> Venturi, R. / Brown, D.S. / Izenour, S. (1972), p.74

<sup>119</sup> <http://www.wien.gv.at/english/environment/klip/> (5/18/2012)

Chicago implemented an extensive program to promote biking in the city by extending bike lanes and the number of bike racks, as well as implementing multi-modal solutions together with the Chicago Transit Authority, in order to combine the use of public transit and biking.<sup>120</sup>

The Complete Streets Policy in Minneapolis that supports the improvements of streets in terms of walkability, bikeability, and landscaping, resulted in an increase in bike commuting by 2 percent from 2000 to 2009. In 2011, Minneapolis was the number one bicycling city of the U.S.<sup>121</sup>

Figure 18: Bike lane in San Francisco



Source: author (11/17/2011)

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<sup>120</sup> <http://www.bike2015plan.org/> (10/12/2012)

<sup>121</sup> Stieninger, P. (2012)

Figure 19: Octavia Street in San Francisco, CA



Source: author (11/17/2011)

To sum up, there are two technical causes of energy consumption in the mobility field, travel distance and means of transportation. In addition, various root causes influence the decision whether or not to choose the energy efficient means of transportation.

First of all, the decision about the travel distance depends on the availability and accessibility of goods and services. If there are no attractive goods and services close to one's place, they would rather choose to go farther in order to satisfy their needs. Another important factor is the awareness of existing goods and services close to one's place. Other than that, factors like affordability (being able to afford a long drive to the next city vs. being able to afford the expensive products of the store in my neighborhood) and available time influence the decision of choosing the store, gym or restaurant etc. in the neighborhood vs. the ones in another city.

The distance that has to be traveled also influences the choice of means of transportation. Driving the car directly from A to B is much more convenient than changing trains or busses multiple times during one trip. However, taking the train for commuting to the city can be much more convenient than taking the car due to traffic congestion, the ability to read the newspaper on the train, etc. Also the time needed to find a parking spot or even the availability of parking at the destination has an influence on the choice of means of transportation.

The choice of means of transportation is a very complex decision process with a lot of personal factors that can hardly be influenced. Apart from the travel distance, it depends on the availability and the awareness of the given options. If there is no public transit, bike lanes, or sidewalks available in the suburbs, people are forced to driving their cars. Furthermore, in case of existing public transit or bike lanes etc., people have to be aware of the existence of these options. That is, it's not only about providing these types of infrastructure but also about informing people of their options.

If people can choose between driving, taking public transit, riding their bikes or walking, they would probably choose the most attractive and best accessible means. This choice also depends on personal factors such as habits, prejudices, opinions, and values, health issues like disabilities or personal budget and available time.

Furthermore, not everybody is in the position of being able to choose their means of transportation. For instance, people who have to go to work when there is no public transit available (e.g., at night), people who have to transport heavy goods, or people who don't have access or the availability of public transit need to use their cars.<sup>122</sup> "Most Americans rely

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<sup>122</sup> Grohmann, P. (2006)

on cars to meet the most basic needs of life.”<sup>123</sup> On the other hand, people who don’t have a driver’s license, or don’t have a parking spot at their destination, etc., rely on public transit.

## **4.5 Conclusion – what makes us consume energy?**

### **4.5.1 Technical causes of energy consumption**

### **4.5.2 Root causes & motives for energy consumption: the five A’s**

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<sup>123</sup> Farr, D. (2008), p. 23

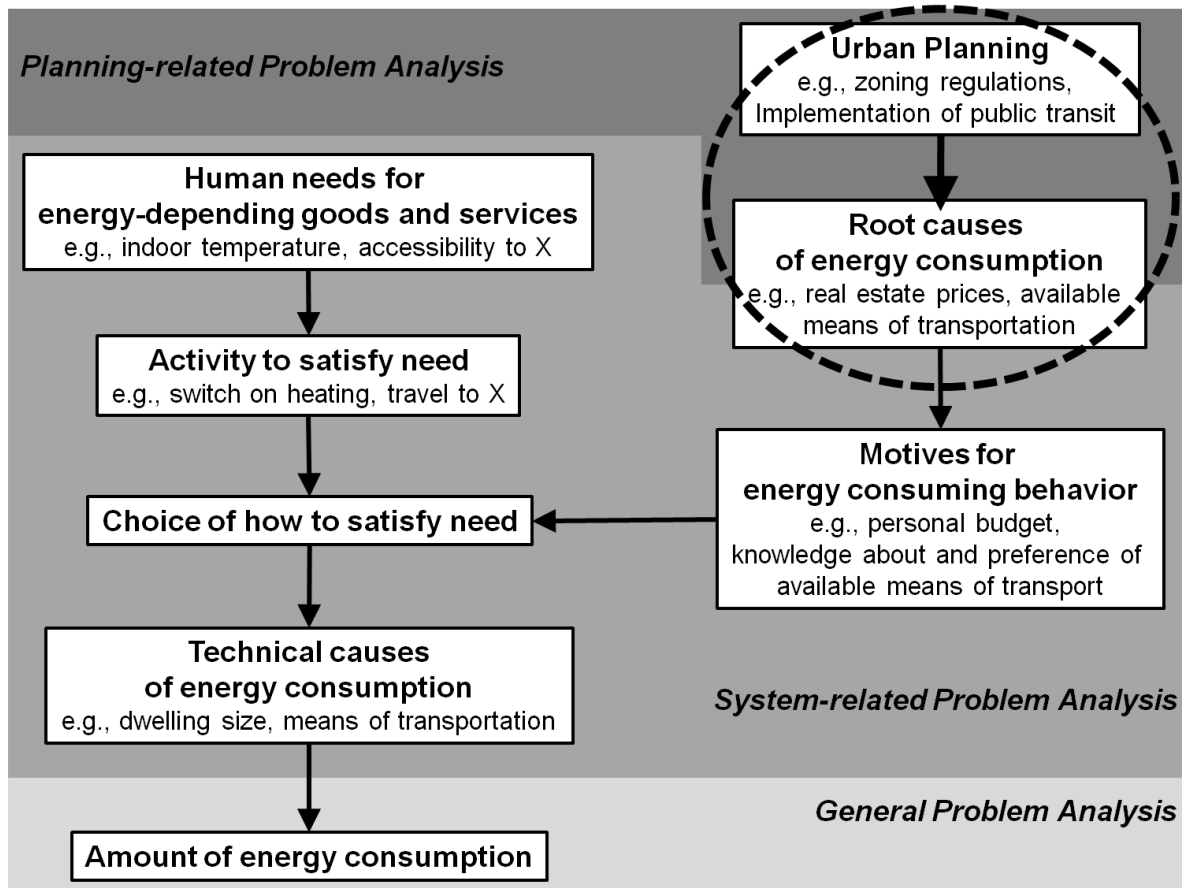
## **5. Planning-related problem analysis**

The analysis of the three fields of energy consumption showed the interrelations between the urban system and the amount of energy consumed. The planning-related problem analysis focuses on the influence of urban planning on the root causes of energy consumption.

Energy consumption is on the increase in North America and in Europe. Furthermore, on both continents, similar urban development trends took place in the past 100 years and similar planning aims are defined for the future. That is, technical causes of energy consumption were driven by similar root causes. Increasing dwelling sizes per capita and single-family houses resulted in growing residential energy consumption. Suburbanization has led to lower urban densities and resulted in longer travel distances and automobile dependency. These phenomena took place on both continents; to a much higher extent in America though.

The planning-related analysis will describe the historic settlement developments of both continents and planning approaches that have led to the current situation. Furthermore, it will describe current planning approaches that try to solve the problem and why they haven't achieved the goal yet. Synergies from both continents and lessons learned from past and current planning approaches will be the result of the planning-related problem analysis.

Figure 20: Objective of the planning related problem analysis



Source: author

## 5.1 General structure of planning approaches

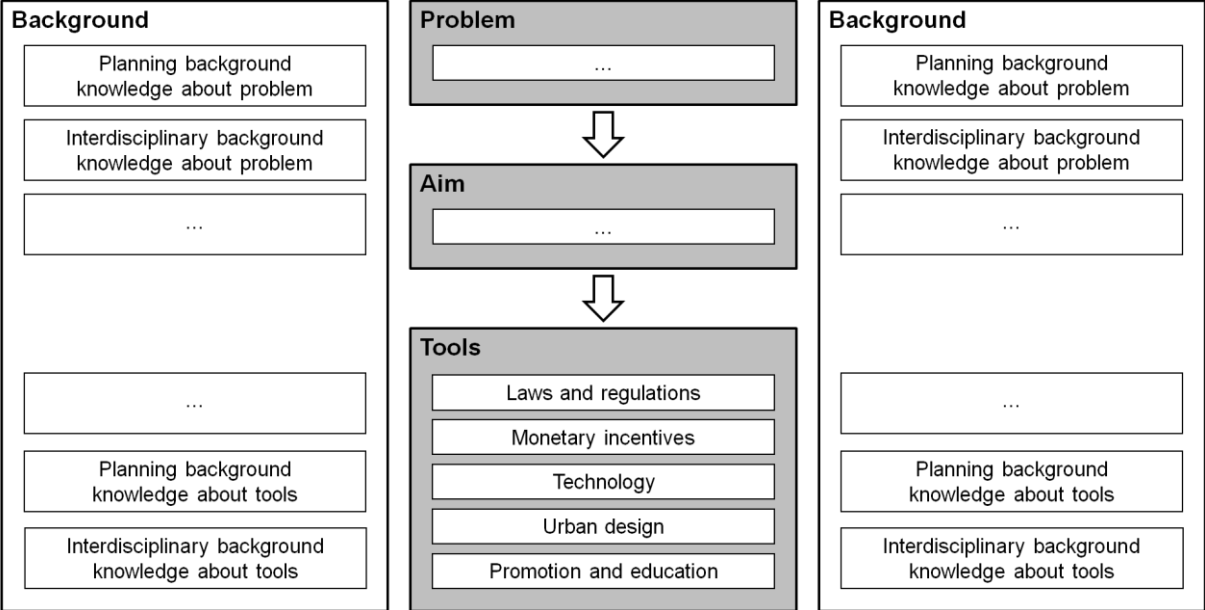
In order to compare different planning approaches within the planning-related problem analysis, the structure of planning approaches has to be generalized. Planning approaches contain four main components: the problem, the aim, the tools, and background knowledge about the problem.<sup>124</sup>

For the planning-related problem analysis, not only the planning aims and tools of past planning approaches, but also the prevailing problems

<sup>124</sup> Schönwandt, W. / Jung, W. (2007)

and paradigms of that time, have to be analyzed. In addition to planning-related background knowledge, interdisciplinary background knowledge (e.g., demographic data, geographic data, data about economic development, and also data about values, policies, etc.) has to be researched in order to understand planning decisions of the past.

Figure 21: Planning approaches in general



Source: author

## 5.2 Former planning approaches in Europe and North America

### 5.2.1 Urban sprawl and separation of land uses

European cities were developed in times when walking was the main means of transportation. Therefore, the historic city centers of European cities are compact and walkable and consist of mixed land use. The main population growth was registered during the time of industrialization, in the 19th century. Due to new transportation technologies, in the



beginnings of the 20th century, cities dispersed and decentralized; separation of land uses took place and the suburbanization process began. “A hundred years ago, planners diagnosed ‘congestion’ in the city center as a public health threat, and proposed, as the solution, the decanting of populations to the urban fringe. Raymond Unwin’s slogan, ‘Nothing to Be Gained by Overcrowding’, was the rallying cry of the Garden City movement {...}.”<sup>125</sup>

At the same time, most American cities were at the very beginning of their development. They were built according to these new planning paradigms, separation of land uses and suburbanization. That is, urban sprawl wasn’t a result of “unplanned incremental urban development”<sup>126</sup> as it is defined by the EEA, “the planning movement played its part too, providing the intellectual justification for sprawl; zoning laws that rigidly separated housing, shopping and employment; and promoting exemplar low-density suburbs, [...]”<sup>127</sup>

The new planning approaches and technological improvements of transportation systems, cheap long-term mortgages for housing, and large-scale projects (master planning, shopping malls, etc.) on the green field in both the U.S. and Europe resulted in suburbanization. The first phase of suburbanization took place along public transit lines. Technological inventions like the automobile, electric power, and the telephone made it possible to separate homes from workplaces, which led to new urban patterns. “The tendency of the automobile ... is within limits to disperse population rather than to concentrate it [...]”; the

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<sup>125</sup> Ross, A. (2011), p. 76

<sup>126</sup> EEA (2006), p. 5

<sup>127</sup> Reeds, J. (2011), p. 151

telephone, the radio, and the parcel post had the same effect; so did electric power.”<sup>128</sup>

Figure 22: Urban Sprawl Los Angeles, California



Source: author (11/08/2011)

However, the phenomena of suburbanization and urban sprawl are not only American phenomena. The idea came from Europe and the so called Garden City movement that considered sprawl a good thing. Changing values that led “from community to individualism”<sup>129</sup> supported the unattached types of residence and individual, independent types of mobility. “We have spent the last 100 years or so running away from one another. In a small and overcrowded country whose population is shooting upwards this is plainly barmy, but it’s what we’ve been doing. Maybe we just dislike each other more with every year that passes –

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<sup>128</sup> Hall, P. (2002), p. 159

<sup>129</sup> Reeds, J. (2011), p. 9

where once a party wall sufficed, we've successively separated our homes with privet hedges, feather-edged fences and six-foot larch-lap panels in a bid to keep our neighbours at bay."<sup>130</sup>

Sir Ebenezer Howard believed that "garden city dwellers would enjoy the advantages, but not the disadvantages, of both town and country."<sup>131</sup> The "[...] idea was to separate where we lived from where we worked."<sup>132</sup>

This idea was seen as the ideal settlement pattern, and finally, Howard brought this idea to America.

During that time, the population growth in American cities succeeded the growth rates in European cities. Furthermore, mass motorization had already started in the U.S. in the 1920s whereas in Europe, the automobile became a common means of transportation in the 1950s and 1960s. In 1915, in Los Angeles, one out of eight people already owned a car. The national average for the U.S. was one car per 43 people. The car ownership of LA in the 1920s was reached in Europe in the 1980s.

Americans tended to "follow Ford's aphorism: they would solve the city problem by leaving the city"<sup>133</sup> which is why today American cities are much more sprawled than European cities. "Their Los Angeles would be a city of suburbs, a city where everyone could live in a city yet not be part of a city, a city where individualism and privacy would be untempered by the old urban constraints of collective living and collective movement."<sup>134</sup>

In 1930, 93.9 percent of LA's residential buildings were single-family houses. Between 1920 and 1930, American suburbs grew twice as fast as their city centers. Suburbanization reached its peak in the 1950s when

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<sup>130</sup> Reeds, J. (2011), p. 230

<sup>131</sup> Reeds, J. (2011), p. 56

<sup>132</sup> Reeds, J. (2011), p.36

<sup>133</sup> Hall, P. (2002<sup>3</sup>), p. 303

<sup>134</sup> Hall, P. (2002<sup>3</sup>), p. 303

the population of the suburbs grew ten times faster than that of the city centers.<sup>135</sup>

The urban sprawl phenomenon in the U.S. was addressed by building more roads. In comparison, stricter land use and zoning regulations, as well as the definition of urban growth boundaries, combined with public housing programs in European cities, resulted in less urban sprawl in Europe. In Stockholm and Vienna, city governments bought building areas within the cities in order to develop public housing projects. In the 1950s, a General Plan was elaborated for Stockholm that fostered transit-oriented suburban settlement development and traffic-free, mixed land use neighborhoods. The so called ABC communities (Arbete, Bostad, Centrum – workplace, dwelling, center) provided mixed use settlement patterns to avoid additional commuter traffic.

However, also in Europe, the automobile as mass means of transportation led to the development of new “city centers” outside the cities. In the 1980s and 1990s, the trend of completely car-based, so called edge cities (a linear stretch of business parks and shopping malls on the green field, containing shops like Toys ‘R Us, McDonald’s, Ikea, etc.) evolved. With this development, Europeans wanted to build shopping areas similar to the American, suburban shopping malls. Nobody considered the reason that actually led to the development of the American, suburban shopping malls. That is to say, to build shopping areas similar to European, compact city centers.<sup>136</sup>

The development of American shopping malls in European edge cities resulted in empty stores in the city centers and increasing traffic movements. Therefore, the construction of new shopping malls was soon

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<sup>135</sup> Hall, P. (2002<sup>3</sup>)

<sup>136</sup> Victor Gruen in “The Gruen Effect – Victor Gruen and the Shopping Mall”, movie written and directed by Anette Baldauf and Katharina Weingartner, Vienna, 2010

antagonized by new land use regulations and environmental protection laws.

Figure 23: Edge city along the Ennserrstrasse in Steyr, Austria



Google Earth (03/08/2012)

When the trends towards suburbanization and automobile evolved, European cities were already well developed and had similar population numbers like today. American cities grew with the development of highways and roads, which led to a much higher degree of suburban sprawl, lesser densities, and the fact that people got accustomed to traveling long distances.

Furthermore, Americans got used to low density settlements. The implementation of denser settlements is perceived as reduction in their quality of life. In Vancouver, for example, people complained about the new planning approach of the city's planning director who supported transit-oriented development and supported the implementation of higher

densities along the recently built subway lines. The dissatisfaction of the population about this sustainable urban density approach cost him his job.

Another reason for the extensive urban sprawl in American cities is the almost nonexistence of urban growth boundaries. America's population density (U.S.: 33.7 p/ km<sup>2</sup>; Canada: 3.41 p/ km<sup>2</sup>) is much lower than that of Europe (72.5 p/ km<sup>2</sup>)<sup>137</sup>. There has always been enough land available for everyone, which is why planners didn't see the necessity of growth boundaries. U.S. cities with dense city centers like New York (in particular, Manhattan), San Francisco, or Boston are dense due to geographical restrictions. These cities were built on peninsulas and don't have much space to grow on their edges.

Portland, Oregon was the first city in the U.S. that defined urban growth boundaries, as they noticed it is not only a question of land available but of environmental impacts of urban sprawl.<sup>138</sup> Nevertheless, the city is still sprawled out with an urban density of 1,655 people per km<sup>2</sup> and only a 26 percent of the population of its metropolitan region living in the city of Portland itself. U.S. city planners argue that the strong property rights in the U.S. make it almost impossible to determine settlement boundaries and forbid people to build on their land.<sup>139</sup>

European cities are rather compact and dense, they have strict zoning regulations and growth boundaries, and people are used to short distances and multi-modal transportation. Most European cities experienced their major population growth during times when the automobile was not yet invented. Therefore, they grew along transit lines.

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<sup>137</sup> <http://www.wikipedia.org> (11/17/2012)

<sup>138</sup> Hoch, Ch. (2011), "History and Theory of Planning" class at the University of Illinois at Chicago; College of Urban Planning and Policy Affairs

<sup>139</sup> Interview with Jacob Zonn (Phoenix, AZ; 11/23/2011)

Furthermore, the short distances and density of European cities enabled planners to set rules and regulations that forced people to leave their cars outside the city center and choose walking or biking as a means of transportation. “Beginning in the 1960s, and continuing today, many European cities have been gradually pedestrianizing parts of their city-centers - taking space away from cars and parking and returning it to the pedestrian. This has had the effect of not only helping to control the automobile, but also creating city-centers and downtown areas that are much more inviting places to visit and shop.”<sup>140</sup>

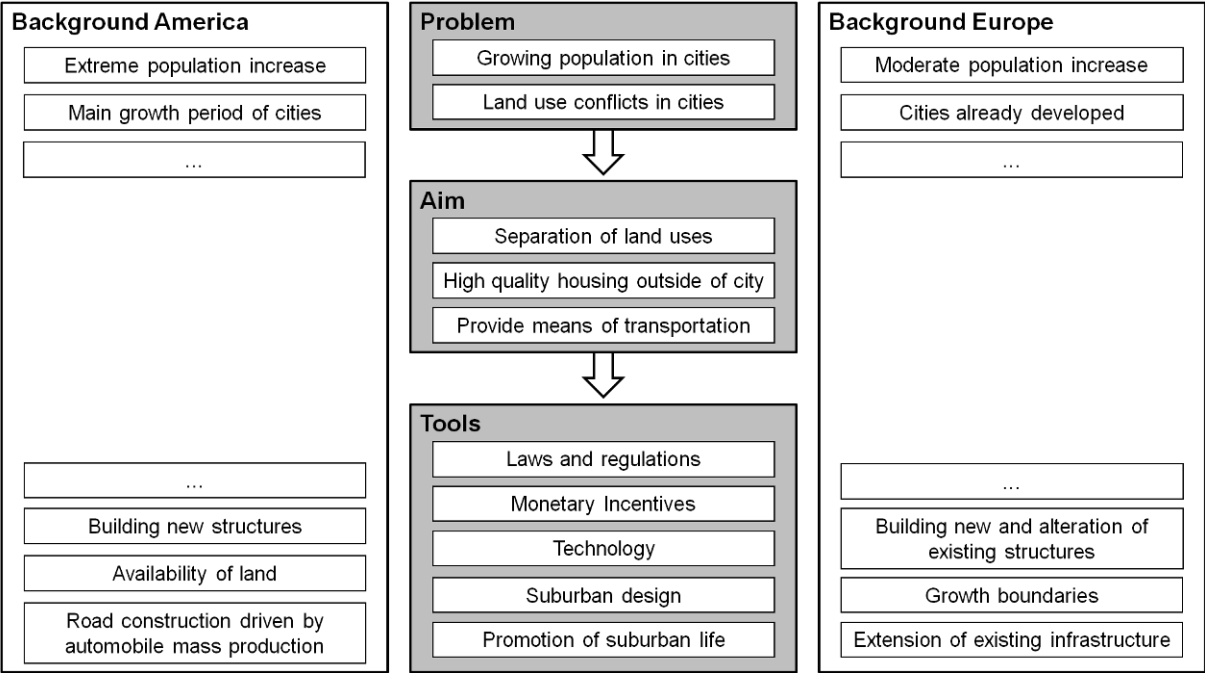
### **5.2.2 Planning approaches that have led to the problem**

The analysis of former planning approaches that have led to the current problem shows that North America and Europe had to deal with similar problems: Cities were growing and land use conflicts increased. Furthermore, planners from both sides of the Atlantic defined similar planning aims and tried to solve them with similar tools, separation of land use and green field development of suburbs, shopping malls, etc. However, the backgrounds, and therefore the extent of the problems, differed. Europe had to deal with the problem within existing structures, as the cities were already very well developed and available land was scarce. Regulatory growth boundaries and settlement development along existing public infrastructure shaped their settlements. European cities had grown hundreds of years depending on the available means of transportation (first walk, then bike and public transit and at last the automobile). Furthermore, the lack of land made growth boundaries necessary.

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<sup>140</sup> Beatley, T. (2000), p. 93

Figure 24: Difference of former planning approaches, America and Europe



Source: author

In North America, entire new cities were developed through these land use separating planning approaches; additionally driven by new technologies like the automobile. The main population growth took place during times when automobile mass production was already ongoing. The new technology and the availability of land enabled them to build huge suburban areas without taking any settlement density issues into account.

For instance, about 2.4 million people live in the metropolitan region around Vienna. With 1.7 million people living in Vienna, about 70 percent of the population lives in the city itself. Mödling is a typical suburb in the Vienna region. 20,000 people live in Mödling in a total area of 9.95 km<sup>2</sup>, which is a population density of 2,100 p/km<sup>2</sup>.<sup>141</sup> The settlement pattern

<sup>141</sup> <http://www.wikipedia.org/> (11/28/2012)



consists of mainly single-family houses but also apartment buildings and a relatively dense town center.

In comparison, 9.5 million people live in the Chicago metropolitan region whereas Chicago has a population of 2.7 million people; that is, only 28 percent of the population lives in the city. A typical Chicagoen suburb like Orland Park has a population of more than 50,000 people in an area of 57.4 km<sup>2</sup>, which is a population density of 890 p/km<sup>2</sup>. Orland Park is a large single-family house settlement area with a huge shopping mall and a commercial area sprawled across the center.

European suburbs are small towns that reflect the luxury of single-family houses with a decent population number on a reasonable area compared to the central city. American suburbs have the size of European cities.

Figure 25: Suburb of Vienna: Mödling, Austria



Source: Google Maps (11/24/2012)

Figure 26: Typical American suburb: Orland Park, IL



Source: Google Maps (11/24/2012)

### 5.3 Current planning approaches in North America and Europe

Current planning aims of North American and European urban planners are again very similar. “After fifty years of planning that ignored the spaces between projects and buildings, that isolated uses and people, and that elevated the car and marginalized the pedestrian, [...]”<sup>142</sup> increasing energy prices, environmental pollution, and climate change lead to a new focus on sustainable development, the promotion of green technologies, the extension of public transit systems, green and energy efficient building as well as the development of walkable and bikeable neighborhoods. The new planning paradigm is all about eco-city

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<sup>142</sup> Calthorpe, P. / Fulton, W. (2001), p. 9

planning, zero emission, zero energy, zero carbon, zero greenhouse-gas emissions, etc.

### **5.3.1 Eco-city planning**

Most regulations in North America are voluntary for the private sector though, whereas in Europe, both the private and the public sector are required to fulfill certain standards. Energy efficiency in America is incentives-driven. For example, in Phoenix, AZ, no energy efficiency standards are legally required. However, with the Phoenix Green Construction Code, people don't have to pay permit fees if they execute energy retrofits such as installation of new air conditioning, more energy efficient appliances, or green building certifications. The Certificate of Occupancy certifies the new project as green building; no fees for plan review or permits have to be paid.<sup>143</sup> In comparison, in Vienna, buildings have to comply with a certain energy efficiency standard. Otherwise you won't get the permit to build it.

Almost any city in Europe and North America has their climate action plan, energy efficiency plan, or similar documents where their planning aims related to climate protection, reduction of greenhouse-gas emission, and energy conservation are outlined.

- Climate Protection Plan in Berlin, Germany
- Climate Action Plan in Chicago, Illinois
- Plan for the Sustainable Use of Energy and Climate Change Prevention in Madrid, Spain
- PlaNYC 2030 in New York City, New York

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<sup>143</sup> Interview with Jacob Zonn (Phoenix, AZ; 11/23/2011)

- Climate Protection Program in Vienna, Austria
- Green City Action Plan in Vancouver, Canada

What Americans currently start to build, already exists in Europe. However, the new planning approach leads to new structures in America and to alteration or extension of existing structures in Europe.

America tries to make their cities more walkable and bikeable. Planners became aware of the potential of shifting from automobile use to walking and biking in order to avoid environmental impacts and traffic congestions. Due to their density, most European cities already provide these qualities, which is why in most European cities, the mode share of biking and walking is much higher than in North American cities. Several programs to promote biking and walking, by making cities and certain neighborhoods more walkable and bikeable, are being implemented in North America. Public spaces, like they exist in European cities, shall be created with these programs.

In the Bike 2015 Plan and the Chicago Pedestrian Plan in Chicago, the extension and improvement of bike lanes, landscaping for more attractive sidewalks, and the implementation of multi-modal facilities are outlined. The goals are to implement 500 miles of bike lanes, “[...] installing 10,000 bike racks, more than any city in the United States, permitting bicycles on Chicago Transit Authority (CTA) trains and equipping their fleet of 2,000 buses with racks that carry bikes [...]”.<sup>144</sup>

The PlaNYC 2030 in New York City promotes the extension of bike lanes and pedestrian zones. “In just four years we’ve built hundreds of acres of new parkland while improving our existing parks. We’ve created or preserved more than 64,000 units of housing. We’ve built whole new

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<sup>144</sup> <http://bike2015plan.org/>, <http://chicagopedestrianplan.org/> (05/02/2012)

neighborhoods with access to transit. We've provided New Yorkers with more transportation options. We've enacted the most ambitious laws of any city in the country to make existing buildings more energy-efficient. And we've reduced our greenhouse gas emissions 13% below 2005 levels. Over 97% of the 127 initiatives in PlaNYC were launched within one-year of its release and almost two-thirds of its 2009 milestones were achieved or mostly achieved."<sup>145</sup>

Figure 27: Bike lane in New York City



Source: author (09/28/2011)

Furthermore, in 2009, New York City converted an historic freight rail line on Manhattan's West Side, running from the Meatpacking District up north to the 34th Street into a public park, the Highline. An unused, industrial construction which's deconstruction would have been too

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<sup>145</sup> <http://www.nyc.gov/html/planyc2030/html/home/home.shtml> (09/20/2011)

expensive can now be used as a recreational area for walking, running, or just relaxing.<sup>146</sup>

Figure 28: The High Line in New York City



Source: author (09/28/2011)

A former highway was changed into a walkable and bikeable street area (Octavia Street) with landscaping features, bike lanes, playgrounds, coffee shops, and beer gardens.<sup>147</sup>

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<sup>146</sup> <http://www.thehighline.org/> (11/12/2012)

<sup>147</sup> Interview with Kate McGee, San Francisco (11/17/2011)

Figure 29: Octavia Street in San Francisco



Source: author (11/18/2011)

Figure 30: Sidewalk in Phoenix, AZ



Source: author (11/23/2011)

The form-based code zoning that is being executed in Denver, CO and is currently being implemented in Phoenix shall regulate the interaction of the buildings with their streets environment. The goal is to create urban environments instead of sprawled building blocks such as Downtown Phoenix.<sup>148</sup>

Even though the bike share in European cities is already high and bike lanes and sidewalks are already available, European cities continue implementing new bike and pedestrian plans to further increase the number of cyclists and pedestrians. Vienna already provides a bike lane network of more than 1,200 km<sup>149</sup>, which is double of what is available in Chicago today with only half of the population (within the city borders).

Figure 31: Bike lane Arndtstraße in Vienna, Austria



Source: <http://www.wien.gv.at/> (11/12/2012)

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<sup>148</sup> Interview with Jacob Zonn, Phoenix (11/23/2012)

<sup>149</sup> <http://www.wien.gv.at/verkehr/radfahren/bauen/index.html> (05/17/2012)



Scandinavian cities have a very high mode share of cyclists; e.g., Aarhus, Denmark (27 percent), Malmo, Sweden (24 percent), Copenhagen, Denmark (36 percent), and Amsterdam, Netherlands (22 percent).<sup>150</sup>

Another trend in urban planning in North America, and also in Europe, is the implementation of transit-oriented development (TOD) which supports the increase in settlement densities along transit lines and around transit stations to make public transit more cost-efficient (see also chapter 4.4).

In Minneapolis, MN, a new light rail line is currently being built, together with a settlement development program that supports social and environmental sustainability.<sup>151</sup>

Also, the 22 mile light rail line corridor in Phoenix, Arizona that was built in 2008 is part of a TOD program. Along the light rail corridor bike lanes and attractive sidewalks were built, and landscaping measures were implemented. Furthermore, the city government offers incentives for people and companies to settle along the corridor. Due to the economic crisis, investments in Phoenix went down, which has resulted in a 22 mile light rail corridor with beautiful landscaping and attractive bike lanes and sidewalks, funded by the government, that runs through the middle of nowhere.<sup>152</sup>

In Vienna, the extension of the U2 subway line to a new development area called Seestadt Flugfeld Aspern shall motivate people and companies to settle in this new settlement development area outside the city center.

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<sup>150</sup> [http://en.wikipedia.org/wiki/Modal\\_split](http://en.wikipedia.org/wiki/Modal_split) (05/17/2012)

<sup>151</sup> Stieninger, P (2012)

<sup>152</sup> Interview with Jacob Zonn (Phoenix, AZ; 11/23/2011)

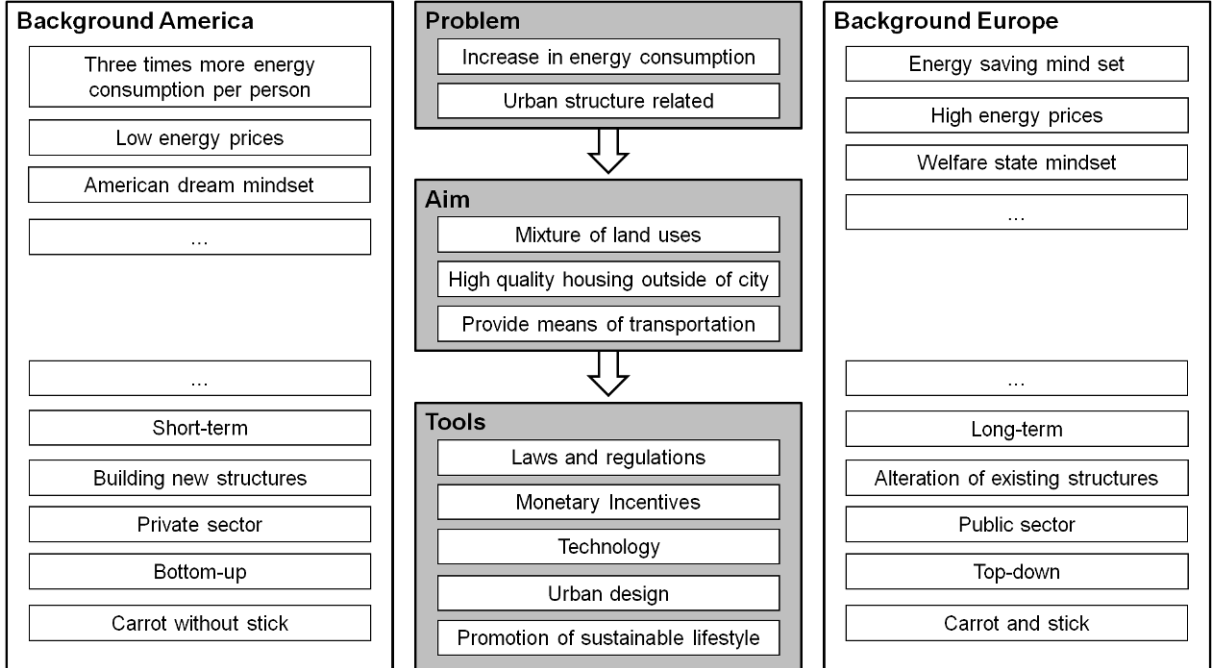
Similar to what happened before, during the development of the Garden City movement, when planners tried to solve urban problems by building new towns or settlement areas outside the city, today, with the so called eco-city planning movement, planners develop new zero-energy or zero-emission settlement areas. Some of them in the city, in existing settlement areas or on a brown field area (e.g., High Point in Seattle, WA or Vastra Hamnen in Malmo, Sweden); some of them outside the city (e.g., Valdespartera in Zaragoza, Spain or Seestadt Flugfeld Aspern in Vienna, Austria).

### **5.3.2 Addressing similar planning aims in different backgrounds**

The problem and the planning aims are similar in America and Europe and planners try to solve it with similar tools in different backgrounds. Due to their backgrounds, European planners tend to prefer laws and regulations, urban design, and promotion as their main planning tools. American planners mainly use monetary incentives and technology. Generally, the development of environmental protection laws and the awareness of negative impacts from automobile use and energy consumption evolved at the same time in North America and Europe. The urban structure and attitudes towards energy saving differ though. North America's development is driven by economic factors and the private sector. Even in terms of infrastructure, public spaces, and other planning fields that are mainly public in Europe, the private sector calls the shots. In the U.S. and Canada, local governments define goals which are voluntary for the private sector. For example, Chicago and Atlanta require certain LEED-certifications for public buildings only. Private buildings may be LEED-certified too, which results in subsidies from the local government, but no fines or permit rejections. In European

countries, laws and regulations are much stricter than in America. People are forced to more energy efficiency by law. If the requirements aren't met, fines have to be paid. However, if they meet specific energy efficiency standards, they receive additional subsidies.<sup>153</sup>

Figure 32: Difference of current planning approaches, North America and Europe



Source: author

In North America, people only get the carrot but almost never the stick. Furthermore, with the private sector as driver for planning activities, planning approaches tend to be bottom-up. In addition, many American cities haven't provided public transit at all, which requires the creation of completely new structures (inclusion of public transit and bike lane infrastructure as well as densification).

Europeans get the carrot and the stick. If your house doesn't meet the required energy standards, you are not allowed to build it. Although

<sup>153</sup> Stieninger, P (2012)

planners in Europe want to improve the involvement of private people into planning activities, still most planning approaches are handled top-down. Due to existing settlement densities and existing public infrastructure systems, European planners focus on the improvements and extension of an existing urban structure. From an energy efficiency point of view, Europe's urban system is provided with a better starting position than America's.

#### **5.4 Conclusion – planning failures and lessons learned**

Comparing former planning approaches with current planning approaches, the results are very disillusioning. It seems that planners haven't learned their lessons from failures of the past. Again, green field master planning is one planning approach in the eco-city era. Other than Garden Cities or suburbs, we are now planning eco-cities on the fringes of cities. Eco-city planning is driven by new technologies whose impacts and future are yet unknown. Subsidies are given for energy efficient buildings and the use of new technologies without considering the entire urban system.

Most plans refer to the urban structure only. Hardly ever, the whole urban system is considered, and moreover, hardly ever, the people who live in the urban system are considered. It is “[...] ordinary people doing ordinary things”<sup>154</sup> in a given environment. Depending on the root causes, people choose their way of living.

Where is the sense in an energy efficient building, twenty miles outside the city, if you consume all the energy saved through energy efficient

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<sup>154</sup> Gardener, G.T. / Stern, P.C. (2002), p. 26

building structure by commuting from one place to the other? “It is no longer acceptable to build a high-performance building in a Greenfield, automobile-dependent context and have it certified as ‘green’.”<sup>155</sup>

The task of planning should be to “see the big picture”. It’s not only about building a road, bridge, or whatever and the discussion of its design or location. The question is if we really need a road, bridge, or whatever. The main problem of past and current urban planning is the missing holistic view. This problem is much more extensive in America than in Europe.<sup>156</sup>

Due to the privately driven planning initiatives in America, planners practice much more community planning than comprehensive planning. For example, in Vancouver, Canada, they’ve just started to elaborate their first comprehensive plan that includes settlement and infrastructure planning for the entire city of Vancouver. Up to now, in Vancouver, only neighborhood planning has been practiced.

In Chicago, Illinois, a comprehensive plan was elaborated in the early 19th century; a plan that is still used by urban planners. Since the 1970s, every ten years, the City of Vienna develops a new comprehensive development plan (Stadtentwicklungsplan, STEP) for the entire city. Additionally, several planning organizations deal with the interconnections of the city of Vienna and its surrounding suburbs.

In Europe, the task of planning is seen as a public challenge and “[...] serves as a tool for translating political purposes into specific policies, programs, and projects, [...]”<sup>157</sup> Due to much larger amounts of public funding, planning aims in Europe tend to be long-term.

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<sup>155</sup> Farr, D. (2008), p. 41

<sup>156</sup> Hoch, C.: “History and Theory of Planning”, class at CUPPA, UIC (9/19/2011)

<sup>157</sup> Hoch, C. (1994), p. 111

This is not the case in North America. “Most planners want to make plans that do more than fight or finesse the purposes of the powerful. They hope to refine the purposes of the powerful by composing plans that will meet the needs and solve the problems of many different groups of citizens; [...]” That is, in comparison to European urban planning, in North America and particularly in the U.S., the private sector is much more dominant, also in the planning process. This economy-driven planning approach leads to short-term planning decisions. “This lack of institutional authority handicaps professional planners when they offer advice from their government offices. When planners expose the conflicts between private purposes and the public good, they receive little institutional support.”<sup>158</sup>

Although different historical settlement developments took place in America and Europe, starting in the end of the nineteenth century, planners tried, and are still trying, to solve similar problems with similar planning approaches on both sides of the Atlantic. Both former planning approaches that have led to the current problem, as well as current planning approaches that try to solve the problem, are mainly driven by the problem itself.

The problem of growing urban population and land use conflicts was solved by creating suburban settlements and enabling individual lifestyles by the mass production of automobiles. The problem of increasing energy consumption is now addressed by creating eco-city settlements and the redevelopment or new development of alternative means of transportation.

The main differences between America and Europe can be seen in their backgrounds. These different backgrounds lead to a slightly different

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<sup>158</sup> Hoch, C. (1994), p. 9

application of the same planning tools. For instance, due to their carrot without stick attitude, American planners tend to use positive monetary incentives and new technologies in order to achieve their planning aims. Due to the mainly public function of planners in Europe, they tend to use laws and regulations, as well as urban design (of public spaces), as their tools.

Both America and Europe are focusing too much on the technical causes, though. Root causes are only slightly touched but hardly directly considered.

## **6. From energy efficient settlements to energy efficient people**

**6.1 Towards an holistic system approach**

**6.2 Creation of a new planning approach**

**6.3 How to make it happen**

**6.4 Imbedding the new planning approach in an overall policy – European reality or just an American dream?**

## **7. Conclusion – to plan is human, to implement divine**



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