Climate Change: How to Fight Destructive Effects in Urban Areas - Concepts, Planning Approaches and Measures in Germany

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Resumo

Enfrentar os desafios impostos pelas mudanças climáticas na Alemanha tem sido objeto de politicas públicas tanto no âmbito dos governos locais como federal sendo uma das prioridades a substituição das fontes de energia tradicionais por fontes renováveis. Implementar tecnologias mais eficientes em relação a redução de emissões de CO_2 e promover adaptações do espaço urbano aos picos climáticos se constitui na tônica do planejamento urbano. O trabalho apresenta exemplos do que vem sendo implementado na Alemanha e como o planejamento ambiental vem apoiando as decisões sobre uso e ocupação do solo urbano e possibilitado ações de redução da impermeabilização do solo e criação de mais áreas verdes urbanas. O uso de sensoriamento remoto e sistema de informações tem sido as ferramentas utilizadas para este tipo de planejamento integrado. Por fim, vale destacar que mesmo diante de resultados positivos não são poucas as reações negativas a mudança de abordagem e reação as inovações.

Palavras-Chave: Mudancas climáticas; Prevenção de emissão de gases efeito estufa (CO_2); planejamento ambiental integrado; Sensoriamento remoto e SIG.

Abstract

General Challenges caused by climate change are taken for serious both by federal and subordinated government officials in Germany. On the one hand energy supply is being shifted away from traditional production towards renewable sources. On the other hand development strategies aiming at prevention of CO_2 and at adaption of urban settlements to worse climate conditions in the future are being transferred to practical measures on the level of regions and municipalities. Some selected examples of the more important measures and how they can be applied, although there is strong resistance against innovations, are described in this paper. The examples are related to local sources of renewable energy, to combined environmental and ordinary land use planning, improvement of carbon storage, reduction of surface sealing and improvement of urban green. Remote sensing and GIS provide the most important tools for implementation of planning concepts.

Keywords: *Climate change; Prevention of climate gases (CO_2); Planning approaches; Remote sensing and GIS.*

Introduction

Challenges which are caused by destructive effects resulting from global climate change are taken for most serious in Germany, even by most politicians. There are two important political decisions to be mentioned in this context:

- The big shift of energy supply from traditional sources towards renewable energy sources;
- Development of strategies aiming both at prevention of CO_2 and other climate gases and at adaption of urban settlements to future climate conditions which are expected to become dramatically worse.

On the one hand most people live in urban settlements, and urban populations will suffer earlier and more severe from effects of climate change; on the other hand the major part of climate change is caused by human activities in urban areas. That is why concepts, planning approaches and resulting measures have to be allocated primarily in urban areas, on municipality or regional level.

It is easy to ask for reactions and for changes in general in order to cope with the challenges of global climate change. It is more difficult to figure out and quantify the necessities resulting from model calculations, based on observations, defined objectives and thresholds on global level; the remaining uncertainties hamper the acceptance of finally inevitable requirements. That is why it is most difficult to introduce practical measures on local or regional level which are the only way to any success in the field of climate protection.

Goals and Action Items on Local and Regional Level

Prevention of CO_2

In order to prevent as much CO_2 as possible, the German government has recently decided a strategy which implies quite ambitious goals. By 2050, 80 % of the country's total energy consumption has to be gained from renewable resources (today: more than 80 % is gained from "traditional" sources, including nuclear energy). Until 2022 all existing nuclear power plants will become matter of abolition. Under this main goal the following action items will require much endeavour. Some counties or regions and most of the German cities and municipalities have already worked out individual "Integrated concepts for protection of the climate on municipality level", containing suggested measures under the following typical topics:

- Improvement of heating installations, heat isolation of buildings;
- Promotion of the use of local sources of renewable energy;
- Shift from individual car traffic to public transportation or push-bikes;
- Reduction of energy consumption by both industry and private households;
- Reduction of urban land use which may cause unfavourable impacts to the climate;
- Improvement of carbon storage in the urban landscapes (wetlands, urban forestry).

For each topic and for each measure the resulting potential of decrease of CO_2 is figured out.

Adaption to and mitigation of destructive effects of climate change

Due to climate change an increase of excessive heat events, longer drought periods, excessive precipitation events and floods must be expected. Under this second main goal "Adaption and mitigation" the following topics and action items are handled in the framework of integrated concepts of climate protection for either municipalities or regions.

- Protection of areas which allow for origination or transportation of cool air masses to densely built-up parts of the cities;
- Reduction of surface sealing;
- Improvement of urban green;
- Prevention of damages by extraordinary weather events.

The main purpose of measures under this topic is to improve life quality for the inhabitants of those parts of a city which are suffering under particularly unfavourable climatic conditions. Moreover, additional effort for securing (or improving) the supply of the urban population is necessary, because of increasing threat by destructive climatic events. It is not too difficult to consider requirements which are derived from changing conditions of urban climate in the future for the construction of new buildings and settlements. However, since the major part of the German population is living and working in existing older buildings and settlements (and will remain there), where stress conditions resulting from changing climate previously have been disregarded, the improvement of old built volumes will have to be the main focus of adaption measures.

Requirements for Administration and Organisation

Most of the necessary measures which are required for climate protection purposes can only be implemented in a densely populated country or area by the government or its subordinated offices. This means at the same time, it cannot be implemented without interdisciplinary participation. Fig. 1 tries to demonstrate the necessary cooperation of many interest groups and stake-

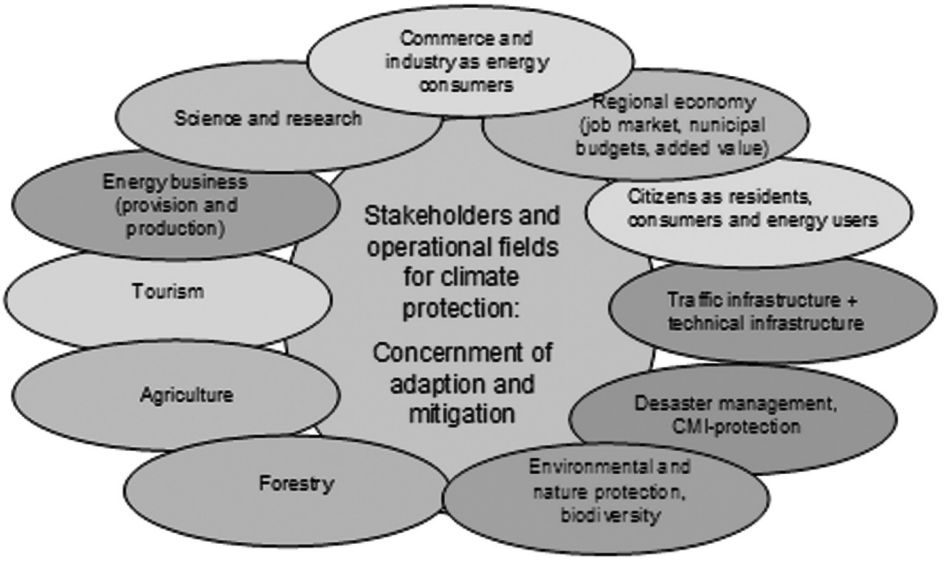


Fig. 1: Implementation of measures in the framework of climate protection on municipality level is difficult, because many fields of interests and many acting persons and organisations have to be taken into consideration. The figure tries to illustrate the overlap of interests and participation.

holders according to cooperative principles in a schematic and symbolic way.

In order to avoid one-sided views or overemphasizing any particular interest it is necessary to prepare decisions by prior comprehensive data acquisition and analyses which should take into consideration several possible approaches/solutions and spatial levels. This is the only way to ensure the planning results to become impartial and independent. Data processing has to regard the accuracy of spatial features and, moreover, vivid clearness. In general, data have to be up to date; in addition, results of monitoring procedures could be helpful to better understand dynamics of development. Typical data and the best way of meaningful data processing in Germany (Frick et al., 2007) will be presented at the end of this presentation with particular respect to implementation and practical use.

As there are many and to some part inconsistent possibilities of analysing planning data in the context of more sophisticated projects, in Germany some principles and procedures have been standardized in order to ensure successful planning and to regard official responsibilities (Fig. 2). The principle of sustainability can be regarded as the most important of these principles and will be discussed more comprehensively.

Examples for work in progress will be shown both for the level of the metropolitan area of Berlin and of the city of Potsdam. Success beyond solely theory has to be based on the existence of comprehensive surveys, taking advantage of remote sensing data, and GIS-data bases and systematic application of monitoring techniques.

Climate protection has to deal particularly intensively with a set of problems which touch both its knowledge base and all measures which result from planning, including previous successes and flops. The main problem is the necessity on the one hand to always consider a long-term view, whereas, on the other hand, uncertainties and lack of definition resulting from the unknown, but

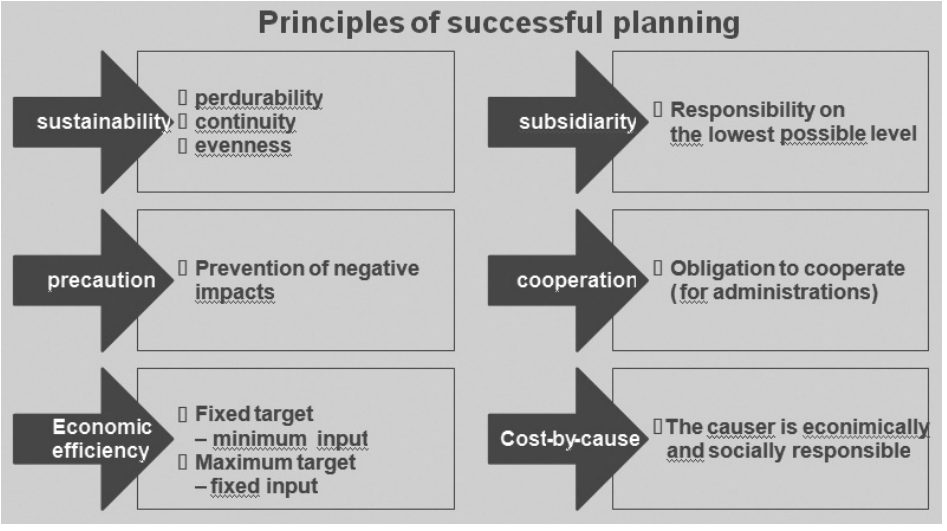


Fig. 2: Principles for successful planning

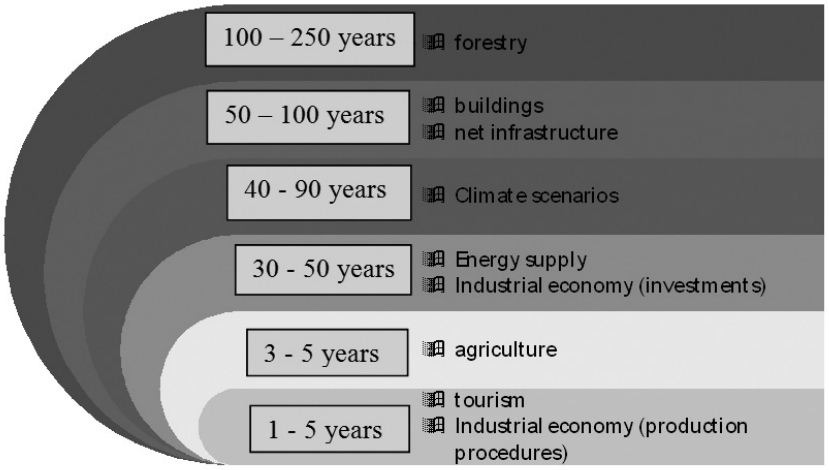


Fig. 3: Typical planning periods and valid times for some disciplines which are relevant for climate protection. Application of the most important planning principle "sustainability" has to take into account the different duration periods.

dynamic future development severely hamper the prognostic potential of planning. That is why monitoring procedures and readiness to steadily adapt and to change planning is a most important request. Depending from the respective subject matter the planning interval for considering the planning principle sustainability can vary significantly (Fig. 3).

In Germany quite a few compulsory standardized planning instruments have been introduced by legislation, concerning land use, building restrictions, environment and others, most of them addressing the regional or local level of planning. All of the mentioned planning principles (Fig. 2) have to be applied by these instruments.

To deal with climate protection also means to deal with a certain set of problems which will influence the field of climate protection from its substructure up to derived measures and resulting effects in the environment: This is the long-term perception of climate protection which, however, is accompanied by uncertainties and fuzziness as far as future development and dynamic is concerned. Well designed monitoring procedures and readiness to modify planning in reaction on development will help to cope with this difficult situation (Fig. 3).

There are different models how to organize planning procedures and how to handle the mentioned planning instruments on municipality level. One of them is shown in Fig. 4.

Implementation and Practice

Due to restricted space for the printed version of this contribution only two examples for implementation measures for planning concepts as reaction on climate change can be described here, one of them tackling the regional level, and the other one the local (municipal) level. The oral presentation will contain further information.

Concept for organizing land use under the aspect "Energy and Climate Berlin-Brandenburg 2012"

This study was worked out on the authority of the two federal states Berlin and Brandenburg, covering the German capital region (Gemeinsame Landesplanungs-Abteilung, 2012). It is aiming at a guiding concept in the field of "planning reactions on impacts by expected climate change" for the period 2010 – 2040. It is subdivided under three aspects:

- Prevention of CO_2: the strategy for energy supply in the German capital region;
- Vulnerability scenario and resulting adaption measures Berlin-Brandenburg 2010 – 2040;
- Synopsis of future multi-function landscapes.

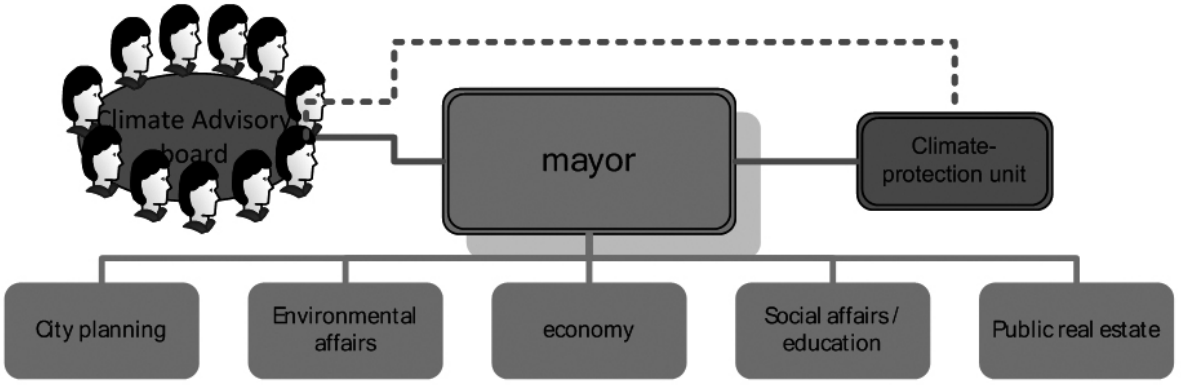
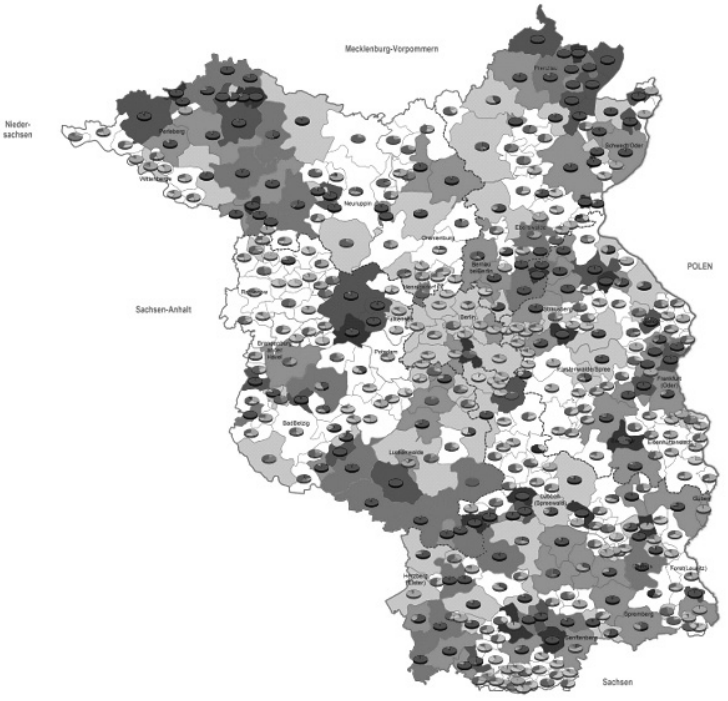


Fig. 4: Suggested organisation scheme for responsibilities and activities in the field of climate protection on municipality level. Alternative models can be matter of choice and decision by the autonomous city council(from Gemeinsame Landesplanungs-Abteilung, 2012).

As a first step a comprehensive inventory on the present situation of renewable energy sources (both existing production and potentials) was carried out (Fig. 5). It was supplemented by maps which show various kinds and intensities of vulnerability (heat, drought, floods), based on regional climate scenarios for 2040. This information base was used for a SWOT analysis in order to find out the most urgent measures and the best places (municipalities) where to put them into action.

The different types of energy generation, e.g. wind, are subject of varying restrictions by law, according to locations and local conditions; wind parks are not allowed in distances closer than 500 m to existing human settlements, and they are forbidden in nature protection areas.



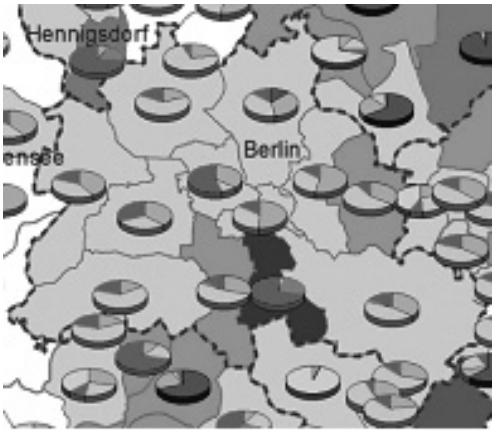


Fig. 5: Density of produced renewable energy (kw/ha) in the states of Berlin (to the left) and Brandenburg (at the top) and the local composition of different types of energy generation, status 2010. The spatial sub-units represent municipalities in Brandenburg and city districts in Berlin. The maximum future potentials of energy generation can be shown in the same way (from Gemeinsame Landesplanungs-Abteilung, 2012).

That is why in practice only few areas remain as potential locations for wind parks.

Fig. 5 is just one map (out of about 20) in this study. They explain basic data, contribute to understanding goals and restrictions, illustrate both variations of spatial and functional results, various indicators for vulnerabilities, obvious conflicts and, finally, agreed and accepted measures.

The regional level and its small-scale maps are insufficient for detailed planning. However, they allow for calculations and supervision on state or regional level; moreover, they define potentials and restrictions for municipalities and enterprises and their large-scale planning. The fractions of energy generation may change over the time according to new legislation or progress of technology. Insofar they can be regarded as a suitable toll for monitoring purposes.

The resulting final synoptic plan is difficult to be understood without having traced all the intermediate steps of analysis, restrictions and decisions. The planned measures in total can be regarded as

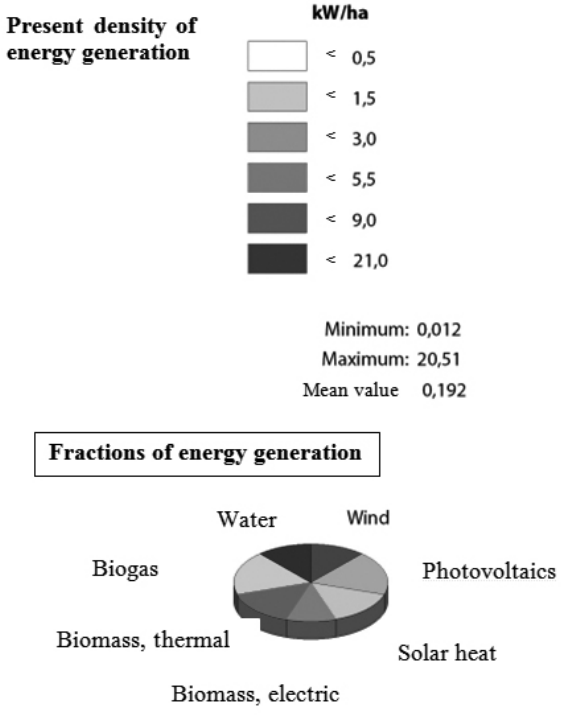


Fig 6: Legend for the map of fig. 5

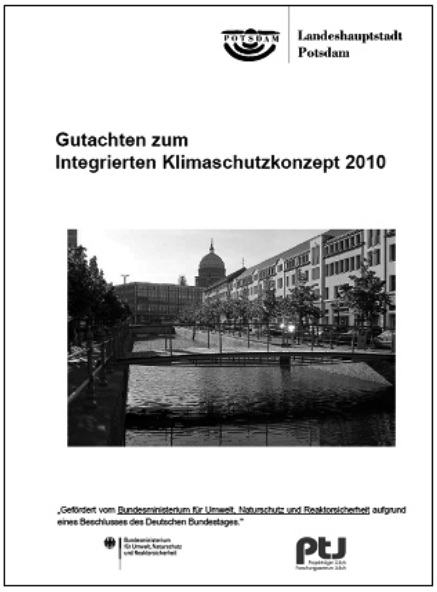


Fig 7: Frontispiece and interdisciplinary approach of the integrated concept for climate protection Potsdam 2010/2011 (Landeshauptstadt Potsdam, 2010).

quite ambitious. Due to remaining uncertainties some calculations limit themselves to intermediate periods of planning. The increase of renewable energy will amount to 61 % between 2010 and 2020. Planning on local (municipal) level is obliged to conform to the final version of the regional plan.

Example of planning for climate protection on municipal level: The integrated concept for climate protection Potsdam 2010/2011

The concept study (Fig. 7; Landeshauptstadt Potsdam, 2010) for the capital of the German federal state Brandenburg was a result of two years of cooperative work of a team of 25 experts, representing the following disciplines:

As a result 100 measures on city level were suggested and to some part tested. Some of the measures aiming both at CO_2-reduction and at adaption will be presented in this contribution. For CO_2-reduction the following topics and activities are suggested or at least taken into consideration:

- Status of all existing individual buildings, particularly with respect to heating and insulation;
- Gaining energy from renewable resources, particularly thermal sun power and photovoltaic;
- Reduction of individual car traffic;
- Reduction of energy consumption, both by private households and industry;
- Reduction of CO_2-emission by disadvantageous land use (drainage of wet peatland);
- Recovery of CO_2-storage in the landscape (e.g. sustainable urban forestry, restoration of wetlands).
- In order to contribute to adaption of urban settlements to climate change and to mitigate impacts by climate change the following topics and activities are discussed:
- Analysis of local hotspots;
- Conservation of unimproved open land for recharging cool air masses and for their movement towards hotspots in densely built-up urban areas;
- Reduction of surface sealing;
- Analysis and monitoring of urban green volume;
- Measures for mitigation of impacts by extreme weather events;
- Reaction on reduced biodiversity (loss of species, change in composition of ecosystems).

Fig. 8: Inventory of incident solar radiation on roofs (Ludwig et al., 2008)
For each house the general potential is obtained by this procedure automatically. Influences from shaddow reduce this potential. Finally the exspected amount of achievable energy from each house is calculated. It can be looked up in the internet.

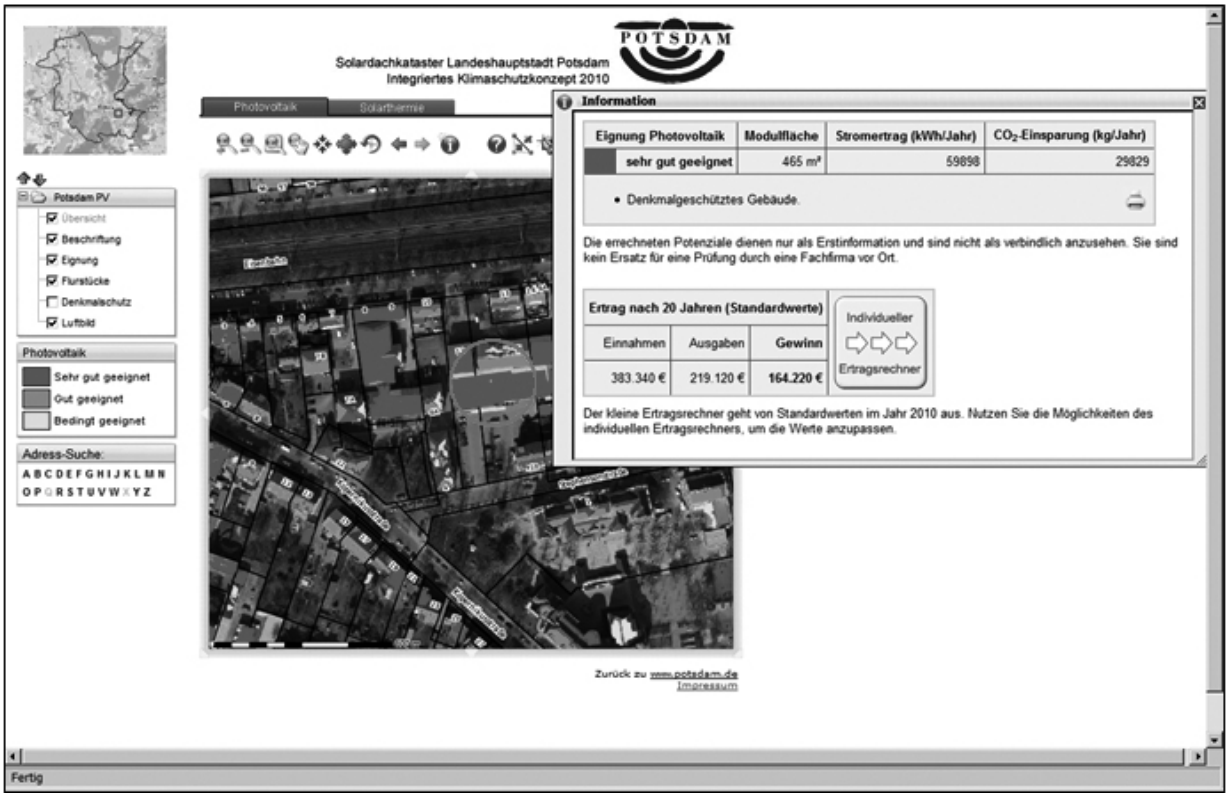


Fig. 9: Website, where each household can look up its individual potential of solar energy (Landeshauptstadt Potsdam, 2010).

As examples taken from the field of environmental planning are subject of a poster presentation, a part of the topic “gaining energy from renewable resources” is chosen for demonstration in more detail, because this example is typical for the course of action.

From existing data, e.g. laser-scanning, digital aerial photography, digital terrain models, etc. a 3D-map of all existing buildings is derived (Ludwig et al., 2008). From slope and aspect of roof surfaces and the energy potential of the sun, the potential of achievable energy is calculated automatically. The owner of the respective house can look up the result of this analysis in the internet for free. However, he cannot be squeezed into a compulsory investment in photovoltaic or solar heat; but the German state is providing subsidies for such investment quite successfully.

Not all of the suggested measures in the “integrated concept” of the city of Potsdam have been advanced to the same status as the potential of solar energy before the end of 2010. However, in the meantime (until mid 2012), research and development projects have been contracted in order to better specify those suggestions which due to missing time, data or financial funds could only be worked out more in general than precisely and in detail. Intentions to initiate changes always meet resistance which to some part is well-founded and may be insurmountable. That is why interdisciplinary participation and negotiations in many cases play a more important role than problems of technology or a unilateral view of economy.

Conclusions

The very ambitious strategy of Germany for both shifting the country’s energy-supply from “traditional” to “renewable” and to implement a great variety of measures in favour of climate protection requires multidisciplinarity and coordinated actions on all levels of planning. Cities and urban development have to play a central role in this context. The most sophisticated framework of this movement is difficult to handle. Undesirable development in some parts, resistance and conflicts in others, are inevitable and have to be settled. Remote sensing and appropriate handling of geo-spatial data can contribute significantly to an unobstructed progress of this settlement. Public participation and multidisciplinary negotiations form another column for success of this process.

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