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klimazwei – Research for Climate Protection and Protection from Climate Impacts

Proceedings 2007



RESEARCH

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Introduction

klimazwei – Research for Climate Protection and Protection from Climate Impacts

There has been considerable progress in climate research over the past years, deepening our scientific understanding of climate change on many levels. It allows us to see with increasing regional differentiation how temperatures, precipitation patterns or extreme weather events are likely to change in the future. Despite remaining uncertainties, we now know that climate change will affect almost every area of life and every region on Earth, although to different degrees. The effects are starting to be noticed and to influence our decisions in society, the economy and politics. Climate change is becoming a factor for development in regions and businesses and poses great challenges both worldwide as well as in our own country.

Politics, including research policies has a great responsibility in this context. The German Federal Ministry for Education and Research (BMBF) considers investments in research and development an essential part of a strategy to mobilise the strengths of German science and the economy for the twin goals of climate protection and protection from climate impacts.

With the research programme “klimazwei”, BMBF is bringing implementation-oriented projects to the forefront of its funding policies. A total of 39 projects are being funded to develop innovative technologies and strategies that strengthen our ability to act and secure our competitiveness under conditions of climate change. At the core of all these projects are innovative ideas on how to mitigate risks resulting from climate change and to seize opportunities for society and the economy.

These conference proceedings present abstracts of the projects funded under *klimazwei*.

The programme has two complementary parts: one features approaches to reduce greenhouse gas emissions (mitigation),

including areas such as transport and logistics, information and communication or utilisation strategies as well as production and process optimisation. The other part of the programme addresses strategies for adaptation to a changing climate and extreme weather events, ranging from sectors such as agriculture, forestry and water management to corporate finance, tourism, the building sector and urban planning. Regional network building is also part of the project portfolio, as are the development of decision support and early warning tools.

In addition, there are three accompanying projects supporting the funding programme.

The “Service Group Adaptation” (SGA) was set up to provide results from basic climate research (especially climate modelling) for the projects in *klimazwei*. SGA processes data according to the specific requirements of the individual research projects and advises project partners in the use of climate research results.

In a second accompanying project the Cologne Institute for Economic Research (IW) aims at improving information flows between scientific institutions, business and organisations, politics and a generally interested public. In particular, IW seeks to broaden the scope of opportunities for the effective implementation of strategies, methods and technologies.

IW also maintains the website of the funding programme www.klimazwei.de which includes comprehensive information about all projects as well as notes of special events, publications and the opportunity to sign up for the electronic quarterly *klimazwei*-newsletter.

The third accompanying project at the Europäische Akademie Bad Neuenahr-Ahrweiler focuses on the communication of climate change issues in schools. It develops recommendations on how to enhance the capacities to deal with the challenges of climate change through teaching and education.

Projects A: Mitigation

CO₂ Reduction during the Production of Basic Chemicals

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Key words:

Chloralkali electrolysis, CO₂ reduction, Oxygen depolarized cathode, Gas diffusion electrode, Energy saving

Summary:

Chlorine and caustic soda are essential basic chemicals produced by chloralkali electrolysis. The established electrolysis processes require enormous amounts of electrical energy. A major percentage of worldwide power generation is based on burning fossil fuels, a process which results in the emission of the greenhouse gas carbon dioxide (CO₂). **Oxygen Depolarized Cathode (ODC)** technology was developed to improve the economics of the NaCl electrolysis process. This new technology requires about 30 % less electrical power, which can also be translated into a corresponding CO₂ reduction.

To further optimize the prospects for this new process, a joint project (focusing on climate protection) with 11 industrial and university partners has been launched covering all the relevant aspects, such as raw materials, cell design, manufacturing of the ODC, and recycling of the used catalysts.

With the new process, an energy-saving potential of 25 million MWh per year can be achieved, which corresponds to an estimated annual CO₂ reduction potential of 25 million tons CO₂ worldwide, and approximately 2.3 million tons per year in Germany.

Abstract:

Chlorine and its associated product caustic soda are essential basic chemicals for the chemical industry. About 70 % of all chemical products are produced, directly or indirectly, using chlorine and/or caustic soda. Chlorine and caustic soda are produced on an industrial scale by the electrolysis of sodium chloride (chloralkali electrolysis).

Worldwide demand for chlorine has increased by around 60 %

over the last 20 years and is set to continue increasing. The current annual production of chlorine worldwide amounts to about 50 million tons, 4.5 million tons in Germany. Chloralkali electrolysis requires about 2,100 kWh of electrical energy per ton of chlorine produced. Roughly 1 kg of carbon dioxide (CO₂) is released per kWh when the electrical energy is provided from fossil fuels. At present, this amounts to CO₂ emissions in Germany alone of approx. 10 million tons per year. A clear reduction in the electrical energy demand, and thus in CO₂ emissions, can be achieved by using oxygen depolarized cathodes (ODCs), in modern membrane electrolysis cells (figure 1). The energy saving potential is 30 %, which corresponds to about 2.3 million t CO₂/year in Germany. Worldwide use of this new technology for chloralkali electrolysis would lead to a CO₂ reduction of at least 25 million t/a.

An evaluation of the economic feasibility (Jan. 2005) based on the current status of technology and using up-to-date energy costs (Germany) shows that economically viable use with the current state of development of ODC technology is not possible. Economic operation of the new electrolysis technology would be possible only by reducing the electrolysis voltage from the present 2.2 V to 2.0 V (at current density of 4 kA/m²) and lowering the investment costs for the electrolysis cells. The objective of the project is to optimize the design of ODC cells, ODC performance and the reduction of ODC production cost.

ODCs are highly complex structures. Different layers with different functions are needed inside the electrodes. Catalytically active, hydrophobic, hydrophilic and electrically conductive layers have to be built up in a very particular way. Thus, the current view is that new types of materials such as catalysts, carrier materials, PTFE components and additives will have to be developed. After finding suitable materials, the methods of production of these must also be scaled up, along with the method for manufacturing ODCs. As part of the overall development plan, the design of the electrolysis cells must be optimized and the future method of manufacture must be developed.

To achieve a successful realization of the project objective, know-how from a number of specialist disciplines such as alkali fuel cells, materials science, catalysis, electrochemistry, polymer chemistry and machine and plant construction is required. A consortium of 11 German partners drawn from industry, institutes and universities has been formed to solve this complex problem.

The prospects of successfully achieving the project objective are very high because these project partners represent the very best specialist competence available in Germany for solving the tasks at hand. In addition to research and development partners (DLR Stuttgart, University of Dortmund, Clausthal University of Technology), the consortium also includes potential users of the new technology (Bayer MaterialScience), producers and engineering companies (Bayer Technology Services, Uhde) as well as suppliers

of the feedstocks required (Dynea, Ferro, H.C. Starck). Therefore, worldwide application of the research and development results and associated positive effects on protecting the climate are expected. Rounding out the project concept are the development of recycling methods for the recovery of catalysts, PFTE (polytetrafluoroethylene) and nickel from used oxygen depolarized cathodes by integrating a recycling company (Siegfried Jacob Metallwerke

in collaboration with Dynea) and the development of a software package for site-specific determination of the economic and ecological opportunities for converting an existing plant or building a new plant using the new technology (RWTH Aachen).

The project was initiated in June 2006 with a planned run-time of 4 years and a total budget of €12 million.

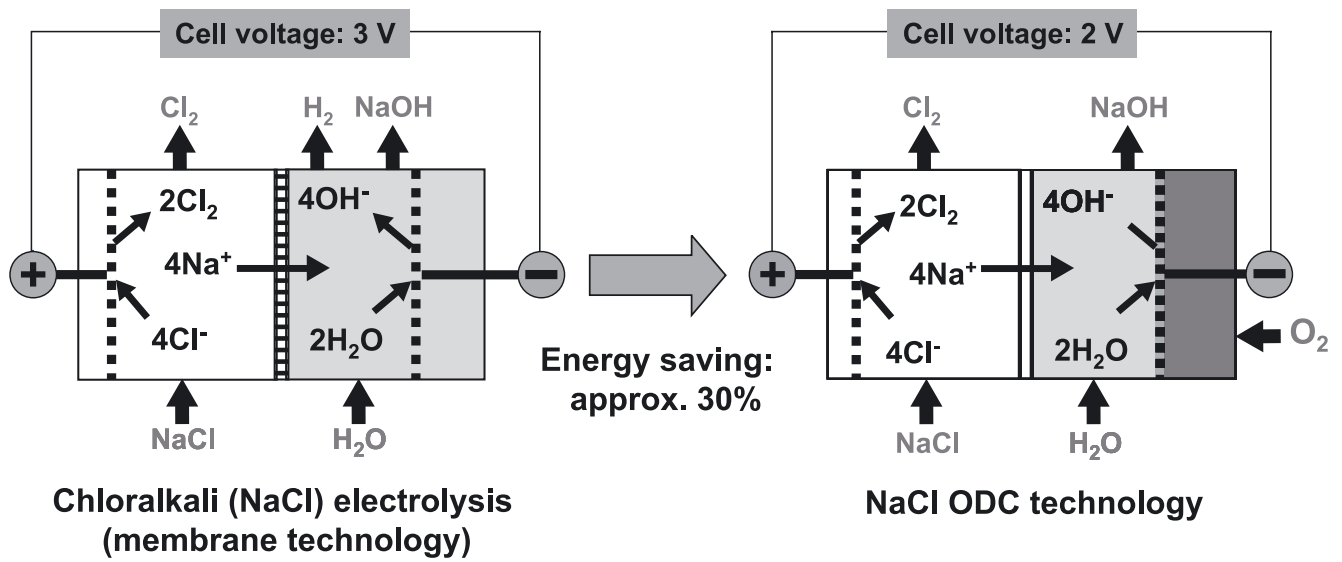


Fig.1: Energy saving/ CO_2 reduction at chlorine production with ODC (oxygen depolarized cathode) technology
 (Source: Bayer MaterialScience)

Reduction of Process Steps and CO₂-Emissions for the Production of Steel Strip by Industrializing the Strip Casting Technology

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Summary:

The aim of the present research project is to support the industrial introduction of the CO₂-emission-minimizing strip casting technology into the steel production process by reaching a maximum possible casting length similar to the conventional casting technologies. The conventional process route for the production of a steel strip out of a steel melt is separated into the single production steps casting and melting. Strip casting is a new technology for the steel strip production combining the up to now separated process steps into one process line.

The innovative process technology is characterized by the solidification of two strand shells on the surface of two counter-clockwise rotating water cooled casting rolls and the formation of a near net shape strip at the narrowest point between the two rolls. (Fig. 1)

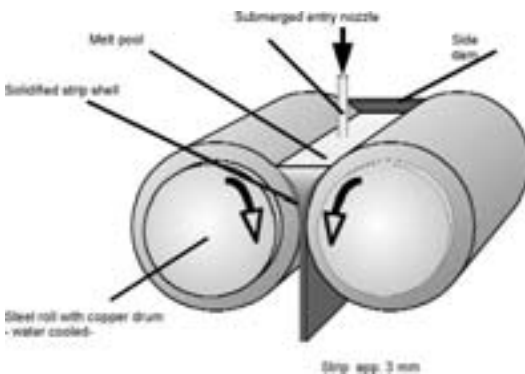


Fig. 1: Strip Casting Principle.

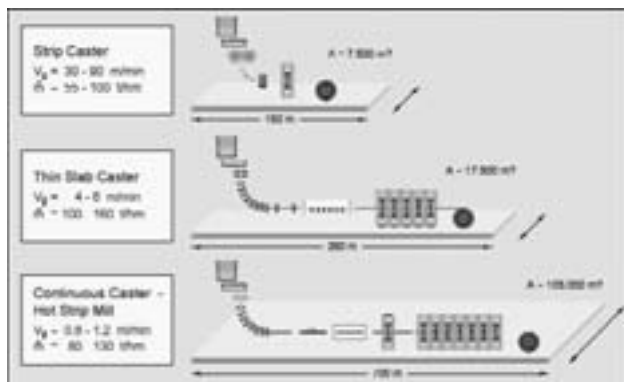


Fig. 2: Reduction of process steps for the hot strip production with the strip casting process.

The reduction of the separated process steps transportation, reheating of the slabs as well as the significant reduction of the required number of hot rolling steps leads to an enormous shortening of the process route (Fig. 2).

With the reduction of process steps a reduction of the energy consumption from 2,11GJ/t to 0,20GJ/t and a reduction of CO₂-emissions from 221kg/t to 37kg/t compared to the conventional production technology can be achieved (Fig. 3, Table 1). Thus the reduction potential for the energy consumption for unalloyed steel amounts to 90% and for the CO₂-emission to 85%. The required operation of the inductive heating system for the production of high alloyed austenitic steel grades with an enhanced deformation resistance leads to a higher energy consumption of 430MJ/t compared to the unalloyed steel grades (200MJ/t).

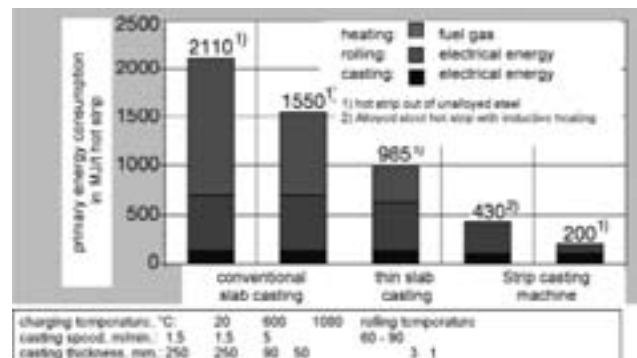


Fig. 3: Comparison of the energy consumption for the hot steel strip production [CAI98].

	CO ₂ -emissions in kg/tons hot strip	CO ₂ -emission-reduction potential with the strip casting process
Slab casting - reheating hot rolling mill	221	83%
Slab casting - direct charging in the hot rolling	185	80%
Thin slab casting	140	73%
Strip casting	37	-

Table 1: Comparison of the CO₂-emission* for the hot strip production of unalloyed steel.

*CO₂-equivalent:186g/MJ for energy mix 2005 /source Stahlinstitut, Düsseldorf, 2005/.

*CO₂-formation utilizing burnable gas: 65g/MJ [TAC/STEF04].

Due to the enhanced deformation resistance and the consequentially higher energy consumption for the conventional hot rolling process of high alloyed steel the strip casting process for high alloyed steel shows an even higher energy reduction potential than the strip casting process of unalloyed steel (Fig. 4).

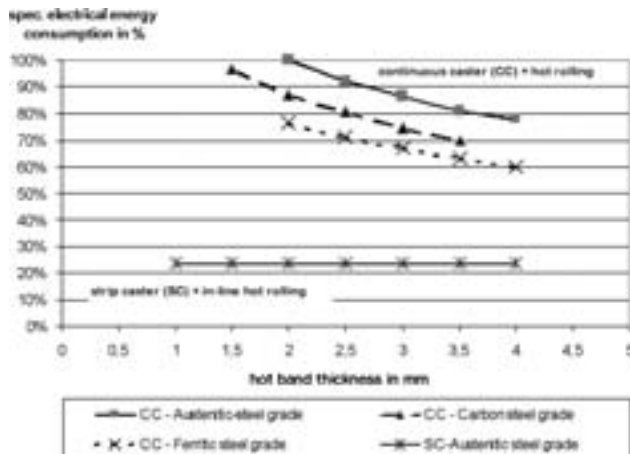


Fig. 4: Influence of the strip thickness and the steel grade on the specific energy consumption [LIN01-2].

In the running project phase of the strip casting project of ThyssenKrupp Nirosta the strip casting plant is operated semi-industrially with a small monthly production volume in order to demonstrate the potentials for the reduction of energy consumption and CO₂-emission as well as for the extraction of additional material properties. Before enhancing the production volume the yield of the strip casting production as a prerequisite for reaching economic efficiency has to be raised onto the level of the conventional production route.

Due to the common yield losses in the starting phase of casting processes the enhancement of the sequence length for the strip casting process is considered to be the determining step to reach an economical operation of this innovative energy-saving process.

In comparison to the conventional slab casting plant for stainless steel production at the steel works in Krefeld the strip casting plant reaches only a half as high maximum standard-sequence length of three (Fig. 5). The major reasons for the limited achievable casting length are partial damages of the casting rolls and the increasing roughness of the strip due to the wear of the working rolls of the hot rolling stand.

The present project aims at the enhancement as of the casting sequence length by prolonging the operating life of the casting roll coating and of the working rolls of the hot rolling stand. By developing a coating with higher hardness for the casting rolls and implementing a wear minimizing strategy for the inline hot

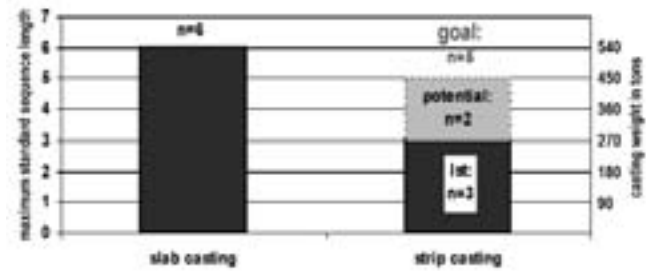


Fig. 5: Comparison of the maximum standard sequence length of the slab casting process compared with the strip casting process at the steel works in Krefeld.

rolling process the total casting length is to be raised on the level of the conventional slab caster.

The development of the process technology for a wear-resistant coating for the casting rolls is carried out by the MetallVeredlung GmbH&Co. KG in subsequent steps starting with the fabrication of laboratory scale samples, the coating of thermo-shock-rings and laboratory casting rolls leading to the final coating of industrial scale casting rolls.

The Institut für Bildsame Formgebung of the RWTH Aachen is investigating the coatings of the samples, the thermo-shock-rings and the coatings of the casting rolls on the applicability for the strip casting process. Following the principle of simultaneous engineering it is ensured that the gained results of the subsequent investigation step also flow backwards to the previous investigation step in a steady iteration process. In the sub-project reduction of wear in the hot rolling process the Institut für Bildsame Formgebung is accompanying the optimization process mainly by the empirical analysis of the various rolling parameters.

At the strip casting plant of ThyssenKrupp Nirosta GmbH the gained technical expertise in the field of coating systems and wear-minimizing process control for the hot rolling process will be validated and industrially implemented.

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CO₂ Reduction in Semiconductor and Solar Cell Fabrication

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Key words:

Semiconductor industry, solar cell production, environmental impact, CO₂ equivalent emissions, PFC emissions

Summary:

Three focus points to effectively reduce PFC/CO₂ equivalent emissions from semiconductor and solar cell fabrications have been identified. These are improvements of catalytical PFC reduction, integration of this in a fabwide concept, mastering the valuation of impacts in different environmental categories and provision of a software tool to support decisions affected by these topics.

Aim of the research in the framework of the funding programme:

The two cited industries are both high tech, but with different state of production maturity, and different impact on CO₂ equivalent emission.

Semiconductor industry contributes in absolute terms (Germany, but also worldwide) much more to CO₂ equivalent emissions than solar cell fabrication does, and will do so in the mid-term future also. CO₂ equivalent emissions are due to energy use (e.g. 40 MW electrical power required for one fab) and with about 30% perfluorocarbon compound (PFC) emissions. The 30% were estimated for emissions without PFC reduction measures in place.

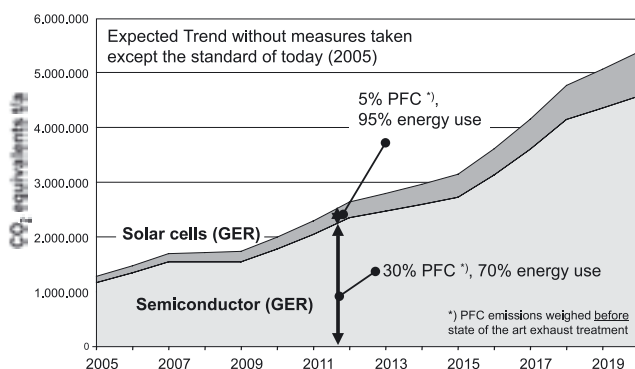


Fig. 1: Expected development of CO₂ equivalent emissions in semiconductor and solar industry (Germany)

(Source: M+W Zander database)

Self compliance of manufacturers to reduce PFC emissions is established, and exhaust treatment machines exist and are installed normally, they have been specifically developed for the needs of semiconductor fabrication by the supplier community. They belong to the principles: combustion, plasma, or catalyst. Older fabrications sites, however, are in many cases not equipped with efficient PFC reduction measures. The treatments cited can be regarded as a type of market standard, analysis of the overall ecological performance of these devices revealed however significant potential for improvement. So catalytic PFC decomposition was identified as most promising, but poor with regard to energy management in the machines available on the market so far.

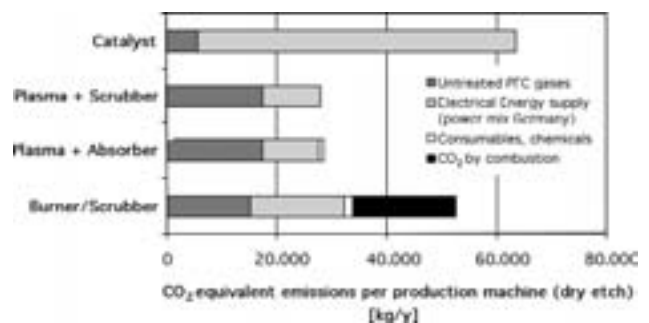


Fig. 2: Sensitivity analysis of four common methods to reduce PFC in semiconductor fab exhaust
(Source: see reference)

This led to the **first focus point** of the project, improvement of catalytic PFC decomposition. This shall be done by lab and beta testing.

The **second focus point** is driven by the fact that although PFC reduction is only responsible for 30% of the CO₂ equivalent emissions or less (and energy usage for 70% or more), energy saving measures are not perceived as equivalent to PFC reduction in the industry, because a holistic tool for calculation, communication and prioritisation of measures is not available, but decisions are based on single-point analyses. So, the calculation and assessment of fabwide concepts including all relevant parameters have to be provided in form of a suitable software model. Such a tool could also be used to support upgrade project in older semiconductor fab sites. Since a calculation basis for fab mass balance is given by the IDIOM software package in use within M+W Zander, this can serve as starting point to integrate the cited requirements in a software.

Environmental impact other than CO₂-emission (or global warming potential creation, GWP, respectively) do exist but are today regarded as of minor importance.

In **solar cell fabrication** however, toxic emissions are likely to be an important factor besides CO₂ equivalent emission, more than in semiconductor fabrication. Since no maturity and besides

that a significant diversity is observed with respect to production technology and production techniques, there is need for decision support in order to assess the ecological ranking of the respective technologies and techniques. CO₂ equivalent emissions are an important factor, but among many others.

This led to the **third focus point** of the joint research program: the valuation of multiparameter environmental impacts (impacts in different categories) and decision taking with conclusive action based on the holistic view. This aspect is already there in semiconductor fabrication, but he will be a dominating one in the solar cell fabrication case. So the results of this work will be a

bracket and link between the two high tech industries considered, leading to a jointly developed decision support algorithm. This will be used in the frame of the project to demonstrate the ability to integrate the proposed detail improvements into the frame of a production, both for semiconductor and solar cell fabs. The progress achieved will be quantified by the IDIOM calculation, as mentioned above.

References:

B. Lässig, F. Rall, M. Schmidt, M. Schottler, Electronics goes green 2004, Proceedings p. 809.

BIOCLEAN – Reducing Emissions of Climate – Active Gases and Particulates from Large Diesel Engines for Ship Propulsion Systems and Stationary Power Supply by the Application of Fuels from Renewable Sources

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Key words:

Ship emissions, Diesel emissions, bio fuel, alternative fuel, climate impact

Summary:

The project BIOCLEAN is focusing on gaseous and particulate emissions from large medium-speed Diesel engines and their potential impact on the global climate. BIOCLEAN investigates the expected benefit for the global climate if fossil fuel is replaced by CO₂-neutral fuels like alternative fuels or fuels from renewable sources. Large medium-speed Diesel engines are widely used for ship propulsion or power generation, particularly in developing countries. The emission characteristics of large medium-speed Diesel engines with respect to climate-active compounds like CO₂, NO_x and particulates, however, are almost unknown. This is in particular true for the application of alternative fuels or bio fuels from renewable sources.

The project investigates the emission of CO₂, NO_x, hydrocarbon compounds, SO₂, H₂SO₄ and particulates for different fuel types. The simultaneous consideration of climate-active trace species like NO_x, particulates and sulphur-containing particle precursors on one hand and of the most important climate-active exhaust constituent CO₂ on the other hand allows for the investigation of trade-off effects of CO₂ emissions reduction and possible increases in emissions of other climate-active trace constituents. The consortium considers the quantification of all key climate-active exhaust constituents as a very important task not only for fossil fuels but also for fuels from renewable sources. The evaluation of the climate impact of bio fuels requires precise knowledge on the difference in emission characteristics between conventional and bio fuels.

The accompanying model studies investigate the global reduction potential for both applications of large medium-speed Diesel engines in ship propulsion and power generation. These studies

will form the basis for decisions on reasonable applications of bio fuels. Furthermore, a first estimate of the expected reduction in CO₂ equivalent emissions by a replacement of fossil fuels with fuels from renewable sources will be provided. As a whole, the project will provide decision guidance and guidance on technological realisation for a world-wide use of CO₂ neutral fuels in the investigated applications of large Diesel engines.

Aim of the research in the Framework of the funding programme:

The CO₂ reduction potential of the project can be estimated from the worldwide installed power of 19.000 MW produced by large Diesel engines of the MAN type. These engines produce an annual CO₂ emission of approximately 50 Tg. Related to the total annual CO₂ emissions of 865 Tg CO₂ released by Germany in 2003, more than 1% of the national CO₂ emissions can be saved if 20% of the globally installed power is operated on fuels from renewable sources. The energy-efficient combustion of alternative fuels like waste oil in such modified engines instead of conventional inefficient waste combustion can save another not yet assessable amount of CO₂. Both savings of CO₂ emissions will directly support the German efforts on the reduction of emissions of greenhouse gases and on the protection of Earth's climate.

The project will contribute to the development of new concepts for emission-reduced large Diesel engines. The research focus covers not only CO₂ emissions but also the NO_x – ozone chain and particulate matter including their contributions to the indirect aerosol effects on clouds and climate. The project fits well into the national efforts on the efficient use of energy and on the application of fuels from renewable sources which are supported by the German Ministries for Environment (BUW), for Economics and Labour (BMWA), and for Food, Agriculture and Consumer Protection (BMVEL). The expected output of the project will make a significant contribution to the German efforts on the protection of Earth's climate because of the global application of the investigated engines in shipping and power generation. Expected deliverables are emission reduction technologies for climate-active gaseous and particulate compounds. The developed concepts should be realisable on a short- to mid-term time scale even for commercial applications since the project builds on existing technology. Besides, a stronger world market position of the involved industry for production and supply of large Diesel engines is expected.

Air Propulsion for Cargo Ships

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Key words:

Climate Change, Shipping, Emissions

Summary:

Cargo shipping is among the main global producers of climate damaging gases, since cargo ships are propelled using cheap, highly-sulphurous heavy fuel oil. Experts from the Lloyd's Register Quality Assurance (London) estimate that ship traffic produces a total of 10 million tons of sulphur dioxides per year – that is over 7 percent of the worldwide emissions.

In 2006 a set of national regulations was implemented by individual EU member states which prohibit the sale of marine bunker fuels with sulphur content above a specified level: 1.5%, 1.0% or 0.5%. These levels compare with the current IMO Annex VI global cap of 4.5% and maximum levels of 1.5% in proposed SO_x Emission Control Areas (SECAs).

SkySails is developing an innovative wind propulsion system based on large towing kites, which, compared to previously developed technologies, meets the requirements of modern shipping. According to the manufacturer's specifications, a ship's fuel consumption – and therefore its emissions – can be reduced by 10 – 35% on annual average by using the SkySails-System, depending on wind conditions and kind of ships. Under optimal wind condi-

tions, fuel consumption can temporarily be reduced by up to 50%. 60,000 merchant and fishing vessels are suitable for equipping with the SkySails-System.

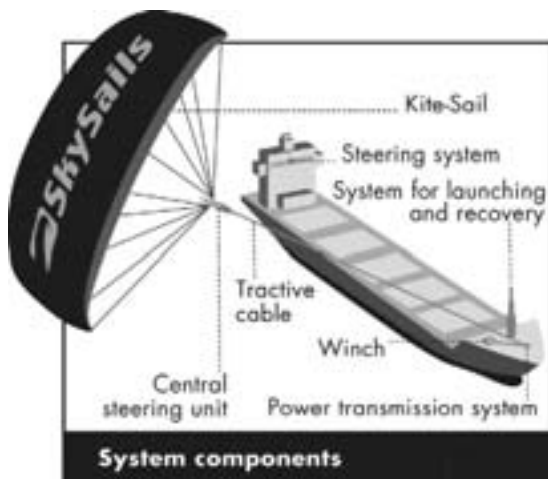
**Aim of the research in the framework
of the funding programme:**

The project's focus lies on the evaluation and forecast of the SkySails-System's effect on the energy and emission reduction of cargo ships.

Within the project the SkySails-System will be developed and tested under normal operating conditions with towing kites with areas of up to 160 square metres. During numerous test cruises, the project team will analyse the efficiency and the practicability of the SkySails-System.

The university of applied sciences Oldenburg/Ostfriesland/ Wilhelmshaven, under the leadership of the ANWI institute ("Institut für Angewandte Wirtschaftsforschung und Regionalanalyse") located in Emden, in cooperation with the "Institut Seefahrt Leer", investigates in the course of the project the energy and emissions savings potential of the SkySails wind propulsion system on board the 800 tons heavy vessel "Beaufort". Based on the data obtained from the experiences with the Beaufort the possible reduction of energy and emissions of cargo ships up to a travelling speed of 15 kn will be calculated as a function of wind speed and wind direction. A corresponding model will be developed.

This model allows a forecast of energy and emission savings for the worldwide use of the SkySails-System on assorted shipping lanes. This approach will give the opportunity to gain an overview on the global energy and emission savings by using the system worldwide. The first scientifically proven results are expected to be published in the course of 2007. Furthermore the scientists will point out the general conditions for the ship management and will develop a user guide as well as an IMO model course for the training of the crew.



(Source: SkySails GmbH & Co. KG)



The DockingPrinzip – Climate Protection by Emission Reduced Urban Transport

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Keywords:

Emission reduction, improved energy efficiency, public transport

Summary:

Main objective of the project consortium is the development of a new propulsion concept for public transport vehicles providing higher energy efficiency, reduced emission, and lower infrastructure effort compared to conventional systems. The system is based on public transport vehicles with an electric drive train and the possibility for the recuperation of brake energy. The consideration of current technical developments as well as ecological and economic evaluation of possible solutions is part of the project work.

Aim of the research in the framework of the funding programme:

In the frame of the discussion on climatic protection goals, emission reduced or emission free traffic concepts attain more and more importance. In urban and suburban areas mainly public transport can make a remarkable contribution for reaching climatic protection goals by reduction of climatic relevant and health-endangering emissions. Thus the project consortium is focused on making public transport more attractive by reducing local emission and more energy efficient.

The main objective of the project is the realization of a new electrical propulsion concept – the DockingPrinzip – which permits to operate vehicles of public transport – buses as well as trams:

- + locally emission-free,
- + highly efficient and,
- + with small expenditures for the wayside infrastructure.

The energy necessary for covering the requirements of the traction drive and the auxiliary system, while driving from station to station is loaded from wayside charging stations into an onboard energy-storage. The charging process has to be realized with a high peak power to avoid impact on vehicle schedule. A predictive energy management is controlling the energy flow by optimising the operating cycle and the operation of the auxiliary aggregates which are fed by the on board stored energy. Furthermore the on board energy storage makes recuperated brake energy available which leads to a reduced total energy

need. Thus the DockingPrinzip permits substantial energetic efficiency improvements in public transport means. The Docking-Prinzip offers a further system advantage by the punctual charging infrastructure. So without city architecture disturbing installations like catenaries zero emission propulsion technology is available.

The main project steps are simulative investigation and technical development of new components and control systems. In the context of the project the technical realisation will be done based on the Bombardier* MITRAC* Energy Saver at a Bombardier tram and regarding bus application at the Fraunhofer IVI test vehicle AutoTram®.

Apart from the technical developments in the context of the project comprehensive studies are performed both to economy and for ecological advantages of the technology. In this work package the Association of German Transport Undertakings (VDV) and the local public transport operator Dresdner Verkehrsbetriebe (DVB) are taking part.

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Fig. 1: Test vehicle AutoTram® (Fraunhofer IVI)



Fig. 2: Bombardier* MITRAC* Energy Saver
*Trademark of Bombardier Inc. or its subsidiaries

Environmental Compatible Flight Route Optimisation

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Keywords:

Air traffic, contrails, radiative forcing

Summary:

The aim of the project is to investigate possibilities for minimising the climate impact of aviation via inclusion of strategies for contrail avoidance in the optimisation process of flight routing. In total contrails contribute significantly to aviation’s share of anthropogenic effects on climate and the large scale cirrus clouds that evolve from the contrails under ice-supersaturated conditions have the potential to double that share. The project will contribute improved weather forecasts that include ice-supersaturated regions, and will provide for flight routing a measure for the expected effect on climate of a unit aircraft emission depending on location and time of the emission. Particularly contrails with a long lifetime at night will have the strongest warming effect. It will be tested whether such an environmentally compatible flight route optimisation is operationally feasible and economically justifiable.

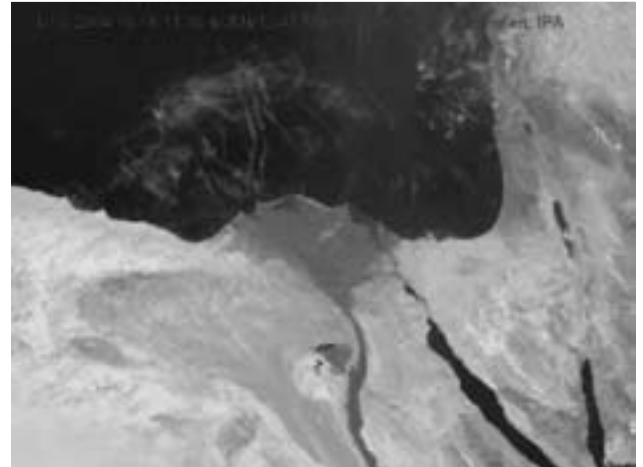


Fig. 2: Contrails over the Eastern Mediterranean and Egypt (Source: EUMETSAT, DLR)

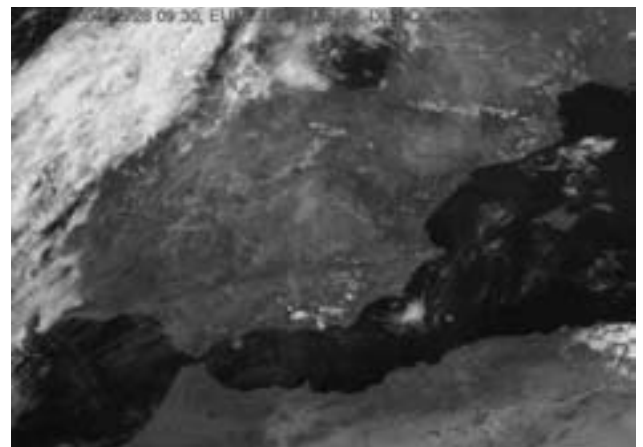


Fig. 3: Contrails and contrail cirrus over the Iberian Peninsula (Source: EUMETSAT, DLR)

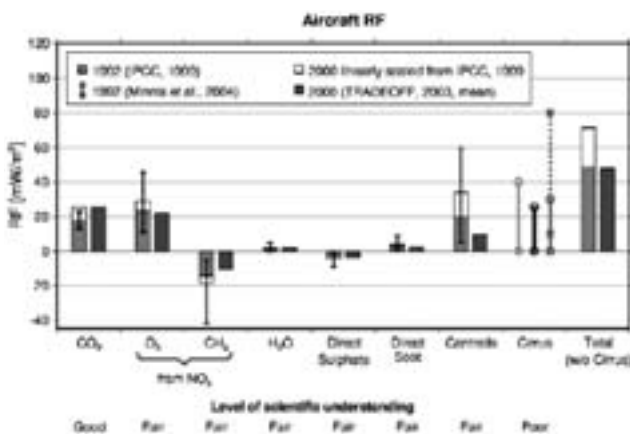


Fig. 1: Estimate of the global radiative forcing from air-traffic (Sausen et al. 2005)

Aim of the research in the framework of the funding programme:

Since the IPCC Special Report ‘Aviation and the Global Atmosphere’ (1999) it is known that linear contrails produced by air traffic have a net impact on the radiation budget in the same order of magnitude as the greenhouse gas CO₂ produced by the combustion process.

Therefore any strategy to mitigate the impact of aviation onto climate has to consider not only fuel consumption and the products of the combustion process, but also the radiative forcing resulting from the transformation of ambient water vapour into contrails and contrail cirrus. In particular the large scale cirrus clouds that evolve from the contrails under ice-supersaturated conditions have the potential to double aviation’s share of anthropogenic forcing of the climate. Hence it is possible to reduce the climate effect of aviation considerably by a clever strategy to avoid the formation of those contrails, which contribute most to the radiative forcing. Here we have to offer two novel strategies:

- 1 A recent study performed at DLR shows that it is possible to avoid half of the persistent contrails when aircraft go up or down 1000 ft whenever they fly into an ice-supersaturated region. On average, such regions are only 500 m thick, therefore often such small changes in flight altitude will lead

the aircraft out of the ice-supersaturated layer. A contrail avoidance strategy that rests on the avoidance of ice-supersaturation requests weather forecasts that are able to predict those regions.

- 2 The effect of a single contrail and the cirrus that evolves from it depends on a variety of factors, as time of the day, season, state of the background atmosphere (cloudiness, underground, synoptic situation), etc. Hence it is sufficient to avoid only those contrails that have a large warming effect on net radiation.

In the project we will combine both strategies into a metric that describes as a function of location and time the integrated radiative forcing a unit emission will have on the atmosphere. This metric will be input into the routine for flight route optimisation (which is operational at Lufthansa Systems) as one factor of the cost function. In this way, we hope, an optimal flight routing that combines safety, economic factors, and environmentally friendliness can be achieved.

The prospects of success will be analysed after two years. It will be tested whether environmentally compatible flight routing is feasible from both an operational and an economical viewpoint. To achieve this, “Lufthansa”, the “Deutsche Flugsicherung (DFS)”, the “Deutscher Wetterdienst (DWD)”, and the “Deutsches Zentrum für Luft- und Raumfahrt (DLR)” cooperate within the project “Environmentally compatible flight route optimisation”.

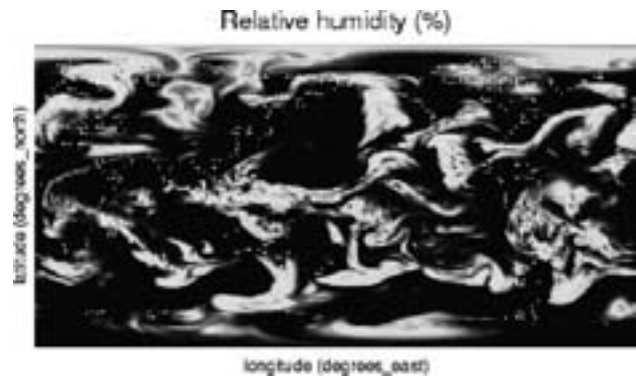


Fig. 4: Regions with ice-supersaturation in the 250 hPa level in a global weather model (Source: ECMWF, DLR)

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EINBLIK – Cumulative Emission Intensities to Assess the Climate Protection Performance along Supply Chains

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Keywords:

cumulative emission intensities, integrated supply chain, environmental management, comprehensive responsibility, climate indicator system, value-added chain, green house gas emissions, in-/outsourcing, climate efficiency, vertical range of manufacture, decision support system, decision process

Summary:

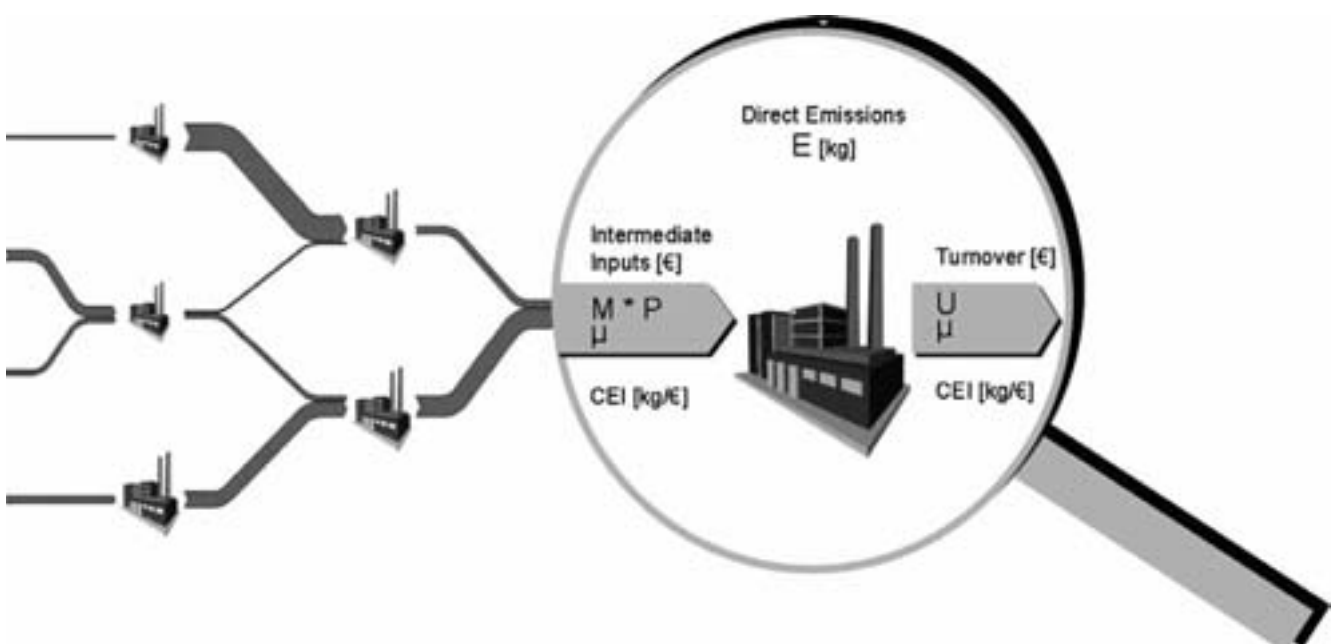
A crucial prerequisite to reduce Green House Gases (GHGs) effectively and efficiently is to measure and evaluate the climate impact of corporate activities. Therefore, environmental management needs information on the climate efficiency of corporate processes, products and services as well as of sites and companies as a whole. Adequate data and performance indicator systems are needed both for internal decisions and for the information of external stakeholders.

The challenges that managers face are the following: Firstly, the companies and the sites which are benchmarked produce different products and cover different parts within vertical ranges of manufacture. Secondly, society assigns comprehensive responsibility to companies for climate impacts of their preliminary and downstream processes outside the individual enterprise. Thirdly, the effort to implement and utilize climate efficiency evaluation methods has to be limited. These problems are aggravated by the fact that value-added chains have become more and more globalized and vertical ranges of manufacture have decreased.

The Institute of Applied Sciences in Pforzheim has developed a system of climate performance indicators that measures the climate efficiency on a company level. This system also considers comprehensive ecological responsibility for climate impacts outside the individual enterprise and it takes minimum effort to be implemented and utilized in order to make it suitable for practical usage.

The concept of Cumulative Emission Intensities (CEI) is a basic principle to figure out a company's climate efficiency which confronts a company's Global Warming Potential (GWP) with the (economic) benefit generated for its stakeholders, approximately represented by its value added. Indirect GHG emissions are allocated on a value basis. Therefore, a preliminary product is awarded few indirect GHG emissions, if its price is relatively low compared to the supplier's entire product range.

A company's CEI and the backpacks it assigns to its products



can be calculated quite simply with minimal organisational effort: A company only has to know the prices and amounts of the products bought and sold its turnover, its direct GHG emissions and the climate intensities of its suppliers. The concept of CEI doesn't need the calculation of the value added.

Reduction processes for the disposal of waste can also be introduced into the indicator system. The company passes its own CEI indicator on to its customers, to whom it delivers products or from whom it receives reducts. Thus, the concept integrates preliminary and downstream processes. These intensities can be used for an integrated supply and reduction chain management in order to select business partners systematically.

**Aim of the research in the framework
of the funding programme:**

The aim of the project is to advance the CEI approach in a way that it can be implemented in all companies within an entire production system. Therefore, the first step is to build a methodical framework for the CEI. This includes the questions of how to start a sustaining indicator system and which incentives have to be set up within the companies' business environments, e.g. by the state, customers or other stakeholders. Further questions of the first step affect the accounting principles and the data demand in order to balance companies' emissions properly. This step also contains the globalisation of the CEI approach. The second step is to integrate the CEI approach in operational decision support sys-

tems. The emphasis of this part lies on analysing the weaknesses of the CEI approach, expanding decision models and implementing the approach in the operational decision process. The third step is the practical usage of the CEI approach. Therefore, our business partners will apply the approach in practice, i.e. in case of the Volkswagen AG to compare sites with different vertical ranges of manufacture and in case of the Systain Consulting GmbH to apply the approach on a long value added chain in the textile industry. Thus the CEI approach will be tested horizontal and vertical.

Such an indicator system captures the climate intensities along the supply chain in times of an increasing complexity of value added chains with insourcing and outsourcing. The CEI indicator should be able to reduce GHG emissions by supporting companies' decisions to select climate efficient business partners or by becoming more climate-efficient themselves. Moreover, it becomes possible to build up an integrated supply chain management of a company's climate impact and to set target values and benchmarks for the CEI indicator in order to set up a perpetuating assessment system for decision support.

Reference:

Schmidt, M. and Schwegler, R. (2005): Wertschöpfungsbasierte Erfolgsmessung unternehmensbezogener Klimaschutz-Aktivitäten. Institute for Applied Sciences, University of Applied Sciences Pforzheim (Editor), Pforzheimer Forschungsberichte: No. 4, Pforzheim.

Measures to Abate Greenhouse Gas Emissions of Stationary and Mobile Processes in Logistics Companies Using the Example of Deutsche Post World Net (StaMoLo)

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Key words:

CEP sector, logistics, freight transportation, CEP terminals, greenhouse gas emissions, greenhouse gas abatement measures, eco-efficiency analysis

Summary:

Unlike other sectors, the level of greenhouse gases arising from transport rose slightly between 1990 and 2005, a large share of which is due to the road transport of goods. The courier, express delivery and parcel services (so-called CEP services) are characterised by particularly high growth in this sector. The current developments make further growth of the CEP market likely. Hence, action is needed in order to reduce greenhouse gas emissions in the logistics sector by means of various technical and non-technical measures.

Against this background, the project “Measures to abate greenhouse gas emissions of stationary and mobile processes in logistics companies using the example of Deutsche Post World Net (StaMoLo)” will develop working steps for a cost-efficient strategy for the abatement of climate-active emissions of CEP service providers. This collaborative project is led by Öko-Institut e. V. and carried out together with the Chair of Transport Systems and Logistics at the University of Dortmund, as well as Deutsche Post World Net (DPWN). In previous projects, the ways in which the environmental sustainability of CEP services can be improved by individual measures have already been demonstrated. However, up to now no overarching strategy for the abatement of climate-related emissions from the companies of the logistics and CEP industry has been developed.

The project’s point of departure is a status quo analysis of the greenhouse gas emissions of DPWN, which is the world’s leading logistics company. The main aim of the cost-efficiency strategy and the subsequent implementation plan is to derive abatement measures from the status quo analysis, which prove to have both an ecological and economical benefit as well as to be realisable. These measures should also be compatible with the previous

activities of the company. For the first time, stationary and mobile logistics processes will be considered equally in an integrative approach. This is important since the relevant quantities of emissions are not only caused by transportation, but also by handling operations in the CEP terminals (exemplarily demonstrated by the figure 1 below which shows the distribution of CO₂ emissions of an average parcel’s shipment). Furthermore, short-term measures for the abatement of greenhouse gas emissions are put into practice and evaluated at DHL Express Germany. Additional experiences and findings from research and practice shall be incorporated in actor workshops with a view to successfully transferring the working steps of the cost-efficiency strategy and practice-orientated implementation plan developed in the framework of the research project to other areas of DPWN as well as to other companies in the CEP sector. For this purpose, an evaluative tool for the eco-efficiency analysis of possible abatement measures of climate-related emissions is, inter alia, developed and made available to actors.



Figure 1: Percentage share of stationary and mobile process steps of a parcel's shipment in terms of CO₂ emissions (Source: StaMoLo)

Aim of the research in the framework of the funding programme:

The research project proposal draws upon the three funding approaches of “Subsection A: Abatement of greenhouse gas emissions”:

The project pursues the goal of making an important contribution to a production process in the CEP sector with a view to reducing climate gas emissions and enhancing cost-efficiency

through the cooperation of a research project with industry. Particularly due to its constant growth rates in recent years, the CEP sector has become an increasingly important emitter of greenhouse gases. Abatement measures in the CEP sector thus substantially contribute to the abatement of national greenhouse gas emissions.

Compared to other sectors, the CEP sector is characterised by greater cost pressure and competition. Therefore, an important requirement of greenhouse gas abatement measures is that they pay off economically. The StaMoLo research project allows for this requirement by comprehensively analysing whether abatement measures conform with eco-efficiency aspects. In this way, the project will not only lead to environmental improvements, but

will also make a contribution to the innovation capacity and competitiveness of the CEP sector.

Within the scope of this project, integrated and innovative climate protection strategies are developed for the CEP sector, which can be achieved in both the mobile and stationary areas of logistics processes by means of short-, middle- and long-term measures. To this end, the project will present practice-orientated solution paths. Short-term measures are realised within the duration of the project by DHL Express Germany, a subsidiary of DPWN. Communication of the findings coupled with support of the specific goals of climate protection (e.g. via co-operation with the publishers of the German logistics paper Deutscher Verkehrs-Verlag GmbH) will follow comprehensively for the CEP sector.

GEKKO – Climate Protection: Sustainable Refurbishment, Constructing, and Habitation through Communication

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Key words:

Climate Protection, Communication Strategy, Energy Efficiency of Buildings, Refurbishment

Summary:

Unlocking the enormous potential of carbon dioxide savings by enhancing the energy efficiency of buildings not only protects the climate but stimulates the economy and contributes to financial discharge of households in view of rising energy prices. By now exists a variety of proven and practical technological solutions to enhance buildings-related energy efficiency and there-

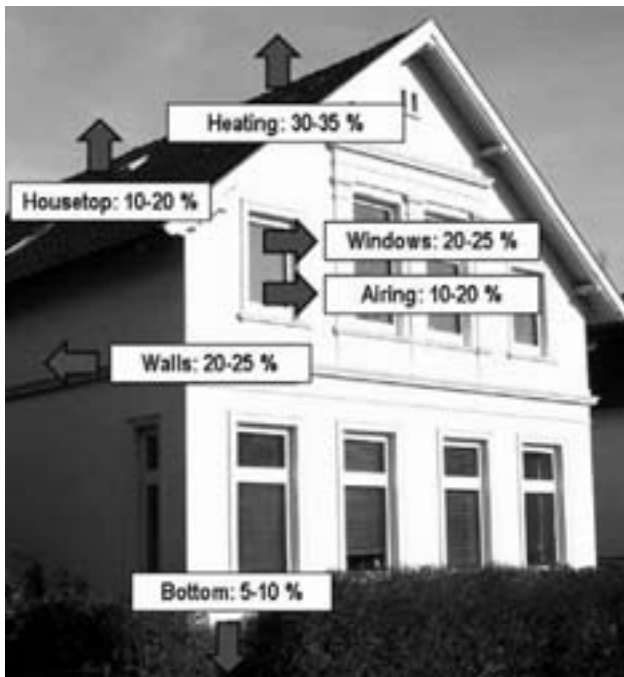


Fig. 1: Averaged heat loss of a non-renovated house.

fore to reduce energy-related costs. Nevertheless, in practice building owners chose not to adopt these easily available technologies because of a lack of specific knowledge and therefore interest in the matter. In order to identify and tackle existing information and motivation deficits, new communication strategies orientated at economic and culture-scientific approaches of consumer and innovation diffusion research are necessary.

Aim of the research within the framework of the funding programme:

It is planned to develop a networking and communication strategy that is applied exemplarily to a structurally suitable city. Oldenburg was selected because its heat energy consumption in residential buildings is circa 30% above the federal average. The research objectives concern:

- + Advancing the status quo in the field of sustainability-related innovations and diffusion research with particular reference to climate protection through the enhancement of buildings-related energy efficiency
- + Interlocking of local climate protection concerns with a perspective of sustainable income-generating activities; creation of future high potential markets
- + Development, strengthening and enhancement of local competencies concerning buildings-related energy savings and climate protection
- + Development of an innovative network strategy in order to interconnect relevant local decision makers and multipliers in order to activate possible momentums and synergetic effects.
- + Development of a communication strategy contributing to the cultural connectivity of the issue of buildings-related energy savings and climate protection and covering the whole range of communication instruments from sensitisation to consulting.
- + Research, mobilisation and scientific processing of endogenous potential linked to local energy savings and climate protection and aimed at communal and regional transferability

The theoretical and empirical part of the project contains three scientific basic studies:

1. Network formation and network management as an instrument of local climate protection.
2. Communication strategies for buildings-related energy savings and climate protection.
3. Innovation and diffusion of sustainable and marketable solutions in constructing and habitation business.

Since local climate protection can be successful exclusively as a common action, not only the communication between different stages of the supply chain, but also the integration of media, organizations, educational institution, environmental initiatives, societal institutions exerting influence over the public opinion is

important. Moreover, integrating the customers in order to test different elements and steps of the developed communication strategy in practice will be of fundamental importance. The main project partner is the “Kompetenzzentrum Bauen und Energie e.V. (KoBE)” which assists in implementing instruments of sensitisation, information, and consultation. The practical sensitisation and information measures are characterised by an innovative use of different media channels and comprise:

- + Live broadcast of a monthly TV magazine including a telephone hot line that customers can use to address questions to energy experts who attend the studio (local TV station “oldenburg eins”)
- + Internet platform covering issues concerning buildings-related energy savings and climate protection in Oldenburg: online database for customer related information and consultation modules, best practices, presentation of a broad range of energy efficiency measures and application of renewable energy technologies with respect to different building types
- + Information campaign: different activities, events, and performances with relevant co-operation partners; special workshops und seminars for house owners and house builders
- + On-site consultations: public offering of 20 comprehensive inspections of representative buildings in Oldenburg, issuing of an energy passport; using the results for accompanying research
- + Collection of best practices in Oldenburg: public-oriented representation of positive examples (new buildings and refurbishment); local competition “Who has the most energy-economical house in Oldenburg?” with an award in the context of a “Climate Protection Gala”
- + Guidelines for local climate protection in buildings: Development of criteria for climate-friendly constructing and refurbishment as a result of networking and exchange of experiences
- + “The Transparent Building Site”: public-oriented representation of an energetic building refurbishment in Oldenburg; opening it for other house owners considering to take similar measures; documentation by a camera team.

All these measures will be accompanied and analysed by university staff, in order to integrate the hands-on experience in the scientific basic studies.

Climate Protection: Diffusion on Initiative Approach of SME – KliDiff RUE Ambassadors – a Future Model for Enhancing Energy Efficiency in SME

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Key Words:

Climate protection, energy efficiency, rational use of energy, energy conservation, Initiative Approach, RUE Ambassadors, Energy Efficiency Ambassadors, small and medium-sized enterprises (SME)

Summary:

Raising energy efficiency – rational use of energy (RUE), reducing energy cost and thus strengthening the competitiveness of small and medium-sized enterprises (SME) are the primary objectives of this research project. Finally, improved energy efficiency represents an important contribution to environmental protection.

This project develops and tests the new model of Initiative Approach, which can be used in any consultation between an external expert and the management that is founded on an established mutual trust.

The RUE Ambassadors are the key actors of this project. In already scheduled consultations (usually at management level concerning microeconomic matters) they are to address the subject of energy efficiency competently and convincingly (Initiative Approach), thereby raising awareness in the clients and encouraging them to take further action.

With the participation of RKW Hessen GmbH, the project involves an institution that enjoys a good reputation among small and medium-sized enterprises in Hessen and that cultivates close relations to SME in the field of consultancy, which will serve as a basis for putting the RUE Ambassador model into action.

As these Ambassador consultations are essential to the success of the project, all elements and materials being developed are aimed at making them as effective and sustainable as possible.

Also involved will be research institute Fraunhofer ISI, which can call on a great body of experience in the fields of energy research

and project evaluation. In addition to contributing to the project on content matters, the Fraunhofer ISI will take over the monitoring and evaluation.

Management of the project lies with the RKW Competence Centre, which is also the applicant body for this project.

The result is a RUE Ambassador model with materials for Ambassador training and Ambassador consultations.

It will be made accessible to other institutions within the RKW network and can theoretically be applied to other fields (e.g. material efficiency) as well.

The project was launched on 10.01.2006 and will conclude on 09.30.2008.

Aim of the research in the framework of the funding programme:

Approximately 90 per cent of all German industrial enterprises are SME with fewer than 300 employees. They have a significant share in overall energy consumption and are responsible for a correspondingly high percentage of climate-affecting emissions.

Potential measures concerning the rational use of energy (RUE) are rarely realised despite the existence of a great number of cost-efficient investment and organisational measures that would improve energy efficiency. These possibilities often fall within the realm of general purpose technologies: technologies employed across a range of industry sectors that are more easily optimised than those specific to one particular operational process. The reasons for such delayed implementation are numerous and have frequently been under examination. Fully tapping the potential for energy conservation requires that new methods be developed.

This project develops and tests the new model of Initiative Approach, which can be used in any consultation between an external expert and the management that is founded on an established mutual trust.

There will be developed:

Training and qualification measures for the RUE Ambassadors

An RUE Ambassador portfolio – a working foundation for Ambassador consultations containing methodological, didactic

and technical instructions on competently and successfully approaching decision-makers in SME.

An RUE brochure – a compilation of information to be given to the client containing information, check lists, and questionnaires.

Aptitude criteria for RUE Ambassadors

Measures to be implemented:

RUE Ambassador training

200 Ambassador consultations

Evaluation

Corporate Management in a Climate Change Environment

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klima/en/homepage.htm

Key words:

Climate change, adaptation strategies, scenarios, risk management, real options

Summary:

Climate change induces a changed business environment: on the one hand, climate change has an impact on ecosystems (e. g. extreme weather events, rising sea levels), on the other hand, the political and economic environment (e. g. climate policy, emissions trading systems) of companies change. A strategic management ought to consider these ecological and social developments by designing adaptation strategies. The research project CO₂-Navigator analyses how companies may identify and efficiently implement actions given an assumed climate policy. Pricing the now scarce resource CO₂ changes corporate decisions by influencing cash flows, especially opportunity costs. Future economic and social developments as well as technological innovations must be considered in this decision process.

Companies will be supported in identifying and evaluating possible strategies for the reduction of greenhouse gas emissions to encourage climate-change related adaptation strategies in their business activities. A decision model will be developed that explicitly considers the financial risk associated with a non-CO₂ informed strategy and balance it against the economic benefits of a CO₂ aware strategy and technology including the valuation of future strategic options. This decision model will illustrate the mutual dependence of CO₂ price, value at risk and strategic real option value.

Aim of the research in the framework of the funding programme:

As the Research Programme of the German Federal Ministry of Education and Research focuses on the development of hands-on strategies, all deliverables will be developed in cooperation with companies. Moreover, the final deliverable will be a software, companies can use during the decision process.

Therefore the following steps will be executed:

Plausible scenarios: a manageable number of rational scenarios will be determined **Quantification of risk reduction potential:** the risks of not including CO₂ certificates in the corporate risk portfolio will be identified and the related costs will be calculated

Evaluation of adaptation options: potential strategies under an existing emissions trading system will be identified and evaluated, future uncertainties will be considered and possible, flexible **corporate decisions will be implemented CO₂-Navigator:** the decision model will be aggregated into a user-friendly software program

Planned work packages

The decision model will be developed along eleven work packages:

Work package 1:

The companies' strategic starting position: First, the general macroeconomic conditions, including social, technological, ecological, legal and economic conditions will be analyzed. Based on those analyses, a manageable set of indicators, crucial for the scenarios, will be determined.

Work package 2:

Future scope: To describe future developments, trends will be identified using the previously determined indicators and approximated as point estimates of an expectation value or as distribution functions. Besides the predictable developments, incalculable extreme events are considered, e.g. political or economic crises as well as ecological disasters.

Work package 3:

Possible actions: Parallel to the first two work packages, feasible alternative actions will be identified and structured. Correspondingly, the companies may develop their adaptation strategies.

Work package 4:

Rational scenarios: A manageable number of consistent, rational scenarios will be selected from the multitude of possible scenarios. Therefore worst- and best-case-scenarios applying lower and upper bounds will be applied.

Work package 5:

Risk assessment: In order to enable the companies to quantify their CO₂-risk at a certain time t_0 , cash inflows and outflows as well as a CO₂-risk component will be considered.

Work package 6:

Evaluation of the adaptation strategies: The model will be developed using the real option approach that suits perfectly given the specific starting situation. The model of Schwartz (2002) and Insley (2003) will build the theoretical background of the real option model for the further investigation.

Work package 7:

Decision model: The three dimensions of the model, CO₂ pricing scenarios, value at risk and real options value, will be synchronized in a decision model describing their interdependency.

Work package 8:

Software CO₂-Navigator: The hitherto theoretical decision model will be implemented as software that facilitates own evaluations.

Work package 9:

Empirical test of the model: The implementation in prototypical companies will give the empirical prove of the decision model.

Work package 10:

Recommendable strategies: For companies strategies for investment decisions within the framework of an emissions trading system will be developed. For policy maker the consequences of economic and climate policies on companies are shown.

Work package 11:

Communication: An active communication and multiplication will accompany the project. Qualified multipliers accompany the project as partners.

Containment and Monitoring of Direct and Indirect Emissions of Ozone Depleting Gases and Certain Greenhouse Gases in the Refrigeration and Air-conditioning Sector

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Key Words:

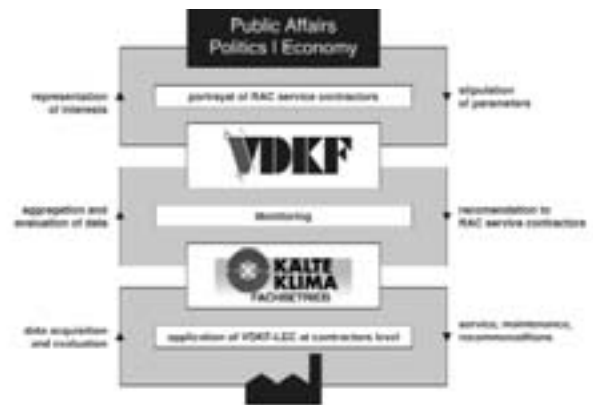
CO₂ minimization, Energy efficiency, TEWI, ODP GWP, Refrigeration and air-conditioning engineering

Summary:

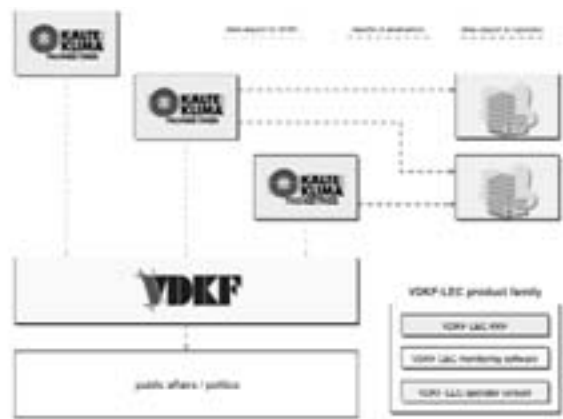
The VDKF e. V. has developed a software especially for refrigeration and air-conditioning contractors for the purpose of reducing CO₂ emissions. This VDKF-LEC leakage & energy control software can be used to handle all necessary recording, reporting and monitoring tasks stipulated by European and national regulations. VDKF-LEC provides reliable data from the sector and ensures the logging of regular leakage inspections. These include, for example, refrigeration statistics, emissions data, ozone depleting potentials and global warming potentials, CO₂ equivalents, data on energy efficiency and TEWI (overall greenhouse effect).

Aim of the research within the framework of the funding programme:

The expansion of VDKF-LEC into a product family comprising an operator version, an EU version and monitoring software is aimed at achieving the following objectives: National and EC-wide information policy, introduction and dissemination of the project, sensitization of operators and motivation and mobilization of small and middle size enterprises in plant construction. In addition to the expansion of VDKF-LEC, there are also plans for attending international exhibitions, training programs and presentations as well as marketing and PR measures.



VDKF-LEC - Monitoring



VDKF-LEC – product family

Fig. 1: (Source: VDKF)

Climate Mitigation via Peatland Management – Assessment of the Effects of Alternative Peatland Management on Climate Mitigation Potentials, on Farm-level Economics and on Macroeconomics

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Key words:

Peatland, management, restoration, climate-mitigation, GHG-exchange, farm-level economics, macro-economics

Summary:

German peatlands are estimated to contribute up to 12 Tg C eq. a⁻¹ to the GHG-budget. More extensive land-use types or restoration hold the potential to reduce these emissions significantly. The current mitigation potential will be studied in six German peatlands along an intensity gradient of different land-use types, using chamber based methods and modelling. Upscaling will be done with remote sensing techniques. The economic effects (farm-level as well as macro-economics) will be studied, to finally decide, if these mitigation options are viable in the framework of the climate protection programme.

Aim of the research in the framework of the funding programme:

The major aims of this project are, to assess the current contribution of peatlands for the GHG-budget and to quantify the climate-mitigation potential of alternative peatland-management strategies together with their effects on the farm-level economics and the macroeconomics.

A review of the state of the art of GHG-studies in European peatlands revealed a very unevenly distributed data-set (Byrne et

al. 2004). However, a tendency for climate-mitigation following reduced land-use intensities (e.g. farmland -> grassland -> natural areas) could be identified. Using the Byrne et al. (2004) estimates, Germany is 7th in peatland area in Europe but 2nd in global warming by peatland GHG emissions! This is due to agriculture as the dominant land-use of German peatlands. The man-made emissions from German peatlands are estimated to 12 Tg C-eq. a⁻¹ (Freibauer et al., in prep.) or 6.3 Tg C-eq. a⁻¹ (Byrne et al., 2004) as the lowest margin, respectively. These emissions correspond to 2,3-4,5% of German total emissions. Therefore even in a highly industrialized country like Germany emissions from peatlands can be a major source.

To which extend can these emissions be reduced by climate-friendly peatland management?

Byrne et al. (2004) concluded that for example the shift from farmland to grassland can reduce the emissions by 1-2 t C eq. ha⁻² a⁻¹ (European average). Farmland on peatlands contributes with around 5.6 t C eq. ha⁻² a⁻¹ to global warming, whereas natural peatlands hold emissions below 0.5 t C eq. ha⁻² a⁻¹. However at that stage, no data were available to estimate the effect of restoration on NEE in fen-peatlands.

Therefore for the assessment of the potential role of peatland management for climate mitigation in Germany it is strictly needed to widen the database on the emissions factors of different land-use types, including the three biogenic trace gases CO₂, CH₄ and N₂O. Measurements (chamber based) and modelling of GHG-exchange will be undertaken in six representative peatland areas spread over the major peatland regions of Germany (see Fig. 1) for the entire years 2007 and 2008. Laboratory-studies on the GHG exchange of peat-columns under defined conditions will help to further parameterize the GHG-exchange models, covering (potentially future) extremes of climate conditions. Indicators (like vegetation and land-use type, peat quality, water level a.s.o.) will be tested as parameters for up-scaling the GHG-balances via remote sensing techniques.

From the state of the art it is expected, that a reduction of the land-use intensities will reduce the GHG-emissions from peatlands.

Therefore we will study a wide gradient from intensively managed agricultural peatland (e.g. farmland, deeply drained and fertilized grassland) over low intensity types (e.g. unfertilized meadows) to restored types (with higher water-level and very extensive or absent management, like restored cutover peatlands). More-over, peatlands used for renewable primary products (like

specific grassland types and willow plantations for biomass-production) and restored cutover peatlands will be included in the span of the management types.

Once a climate mitigation effect via land-use change towards lower intensity management can be confirmed, the key question is how this land-use change can be put into practice. Here the economics are crucial, which will be studied at two levels, the farm-economics and the macro-economics. The current hypothesis is that climate-friendly management options lead to lower incomes at the farm level. However, an economic assessment of the services for the society (macro-economic perspective) will finally clarify, if the farm-level loss is overcompensated by a higher welfare for the society. These economic balances will offer the basis for local, regional and federal decisions on political programmes to support the mitigation options via climate-friendly peatland management. A specific work package on political advisory will outline the strategies for an implementation of the concept.

The sketch of the internal structure (see Fig. 2) visualizes the interdisciplinary approach of the project, integrating both natural sciences as economics to finally answer the key questions: What is

the potential contribution of climate-friendly peatland management for helping to fulfil Germany’s future commitments, at which individual and societal costs can these compensations be achieved and, as an outlook, what could be the strategies for an implementation within the German climate protection programme?

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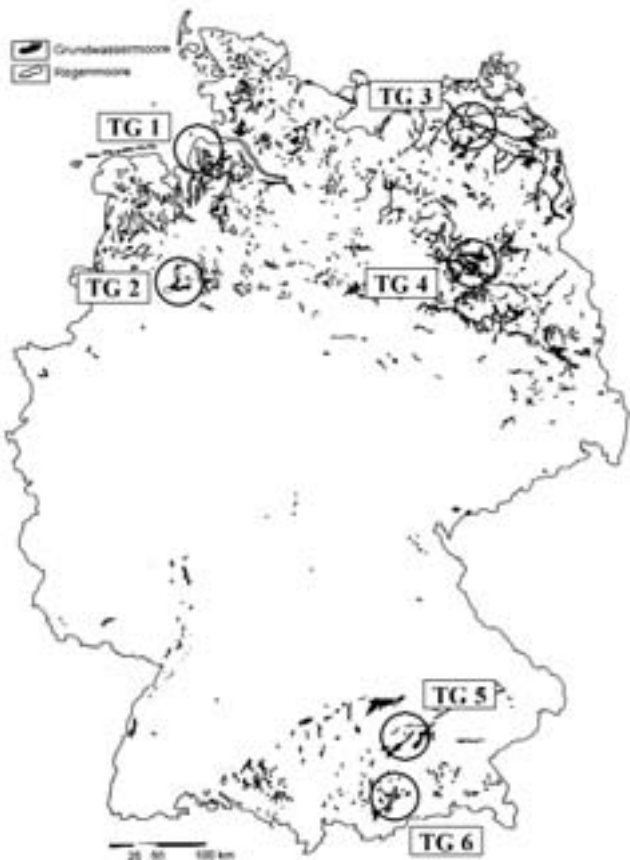


Fig. 1: Measurement areas: TG1 Ahlen-Falkenberger Moor, TG2 Niedermoore in der Dümmer-Region, TG3 Peene-Flusstalmoor, TG4 Rhin-Havelluch, TG5 FreisingerMoos, TG6 Mooseuracher Moore. (Source: TU München)

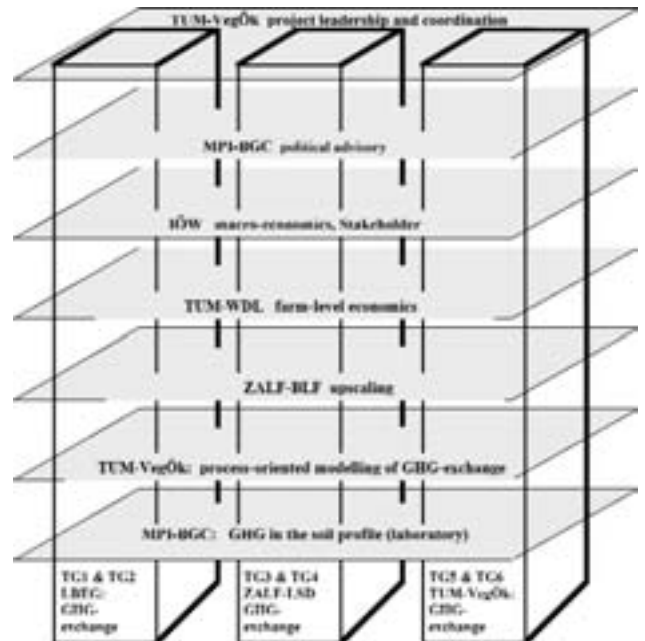


Fig. 2: Interdisciplinary structure of the project. For the work-packages, just the lead partners are displayed. (Source: TU München)

Energy Savings of 50% in Horticulture under Glass by Application of New Glass Foil Combination, Pilot Application in the Horticultural Plant Business, Determination of Energy Savings and Beneficial Effects on the Cultivation of Plants

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Key words:

Energy saving measures, glass/foil combination as new glazing system for greenhouse applications

Summary:

The beneficial effect of a new developed glass/foil glazing system for horticultural applications was investigated in a commercial greenhouse. It was shown that 50% energy savings and an improved plant yield and quality could be achieved.

Aim of the research in the framework of the funding programme:

An area of 5,000 hectares under glass in Germany and about 90,000 hectares in total in the EU make sure the high potential of savings in heating energy in horticulture. The new covering system is to minimise the heat losses by one half.

A new covering system for green houses, which combines a higher transparency with the halved heat transfer, fulfils this requirement. Additionally to the saving of heating energy, the higher and spectrally more advantageously distributed daylight corresponds to a better plant development.

Apart from the principal purpose of the research programme for the climate protection of the BMBF limiting the emission of the greenhouse gas CO₂ (part A), the following aspects are also to be considered at the planned project

- + Diffusion of technologies beyond industry borders:
The improved covering for greenhouses are favourably applicable also in the architectural area for all other kinds of transparent cover surfaces.
- + Visionary concepts, long-term effects:
The respective specific advantages of glass and foil are united to a synergetic component, which deduces thereby new characteristics beyond the sum of the component characteristics. During the typical life time of decades for greenhouses and building facades, we must expect sustainable energy saving.

- + Application orientated projects: implementation in the near future:

In a practical application case the new system is come as pilot scheme into operation just in the beginning of the project and then further developed can be made gradually with feedback to the experiences during the practical operation.

- + Starting support for self runners:

The project is equipped with a fast practical start and a systematic scientifically accompanied evaluation phase. The evaluation of the measuring data for heating energy consumption will provide relatively fast for further comparable constructional measures.

Results:

A new glazing system was developed by combining the materials glass and foil giving a glass based foil cushion glazing system.

This system of high transparent ETFE foil with low-iron, antireflective coated solar glass was presented as a prototype from the Research Center Juelich and the companies Centrosolar Glas and Siedenburger Gewächshausbau at the international plant fair (IPM 2005 and 2006). It offers for the first time in horticulture the possibility to increase the transparency of the cover and to simultaneously reduce the heat transfer by up to 50%. Both materials are highly UVB transmissive, which is favourable for the quality and the hardening of ornamental plants. In addition, the thermal insulation of the glass/foil combination is switchable by taking out the air from the cushions and therefore offers the possibility to get the roof area free from frost or snow by heating. This is not possible for conventional insulating covers often leading to light loss thus to a lower production yield.

First results were obtained by a prototype system at the Research Center Juelich. As a first commercial project at Cramer company in Bad Salzuflen a greenhouse of approx. 1,000 m² area for cultivation of ornamental plants was completely equipped with the glass/foil combination.

According to simulation calculations and first measurements the amount of saving in heat energy is approximately 50%. To determine the latent energy flow caused by condensation of humidity at the greenhouse cover, hot box equipment is actually prepared for systematic measurements of several roof elements. It could be shown that the plants developed faster due to the beneficial light conditions resulting in a reduced cultivation time which gives significant economic advantages by a improved use of the production area. Additionally, the increased amount of UVB radiation leads to a stronger plant constitution and to a

more intensive colour development.

As a first result it can be summarised, that the amortisation of the technical costs are not yet to be financed by the energy sav-



Fig. 1: Test stand at Research Center Jülich for weathering test of different cover materials, in particular glass foil combination



Fig. 2: Greenhouse compartment with the glass foil combination on roof and wall area

ings alone at present, but the additional benefit by the better plant development will lead to a high acceptance of these energy saving measures.



Fig. 3: Details of the roof and wall area with the G/F cover

Elimination of Technical, Legal and Economic Restraints for the Feed-in of Biogenous Gases into the Gas Network with the Aim of Reducing Climate Relevant Emissions by Means of Developing and Applying a Georeferenced Database – Strategy Development for the Political and Techno-economic Realization

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Key words:

Biogas; bio natural gas; biogas feed-in; biomass; energetic utilization of biomass; emission reductions; CO₂ reduction; climate protection geographical information system

Summary:

The utilization of biomass is increasingly gaining in importance due to receding fossil resources, commitments concerning climate protection, need for security of supply and a necessary diversification in energy supply. One major problem is the integration of biomass into existing energy systems.

The accumulation of biomass is distributed over vast spaces and the utilization is usually restricted to local the generation of energy. Especially biogas production has up to now been characterized by a mainly local utilization of agricultural residues, e. g. liquid manure. The consequences are: small, uneconomic plants induce costs that are not balanced by economic benefits; existing biomass potentials are not fully exploited, and waste heat can hardly be used which leads to low energy efficiency ratios.

Thus, the central objective of the joint project »biogas feed-in« is to extend the possibilities for the energetic utilization of biomass by overcoming restraints in the generation, conditioning, feed-in and distribution of biogas via the gas network. Extending the utilization of biogas onto the transportation sector and combined heat-/power generation could help to achieve higher emission reductions compared to the currently practiced local power generation at biogas plants. This way, substantial potential for climate protection could be opened up.

The distribution of conditioned biogas (bio natural gas) via the nationwide gas network offers a number of advantages: local disparities in demand could be overcome; the bio natural gas could be used with a high efficiency in modern combined heat-power-(cold-)plants; new ways of utilization could be found – especially in the transportation sector and in the field of private households.

Although the technical requirements for processing and feed-in of biogas into the gas network can mainly be met the realization is impeded by logistic, administrative, legal and other matters. Thus, it is the main objective of the joint project »biogas feed-in« to identify concrete restraints and develop solutions which help in overcoming them.

A central part of the project is the development of a geographical information system (space-oriented and non-space-oriented data, complemented by methods) for examining the possibilities of combining biogas production and feed-in into the gas network by the example of selected model regions. One aim of this information system is the spatial analysis with regard to defined prerequisites and based on this the determination of optimal plant locations and entry points as well as of the entire biogas feed-in potential. Apart from that, socio-economic, economic and ecologic effects are included as well. At the end of the project the developed geographical information system will be an instrument which serves to transfer the model calculations to other regions as well.

The final evaluation of the results and the transfer of the conclusions onto Germany as a whole will provide the basis for giving strategic recommendations. A strategic catalogue of measures relating to the various possibilities of energetic utilization of biomass as a contribution for achieving national goals of climate protection will be proposed.

Microbial Oxidation of Methane in Landfill Top Covers (MiMethox)

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Key words:

Landfill gas, methane oxidation, greenhouse gas emission, carbon emissions trading

Summary:

In Europe, 30 % of the anthropogenic methane emissions are estimated to originate from landfills, constituting the second largest source (EEA 2006). In mixtures with air, methane is explosive and therefore poses a threat to security on site. On a 100 year basis, its climate effect is 23fold compared to carbon dioxide (Wuebbels and Edmonds 1991). For the treatment of landfill methane emissions that do not meet the calorific requirements for energetic utilization or flaring, the microbial oxidation in biofilters or cover soils is considered a viable and sustainable option. Although several research projects have indicated the suitability of engineered landfill covers for successfully mitigating methane emissions (e.g. Huber-Humer 2004; Barlaz et al. 2004; Bogner et al. 2005), technical guidelines on how to design these covers and assess their performance are still missing. The scope of the biological mitigation of landfill methane emissions in engineered landfill top covers ranges from landfills in the initial phase of operation, old landfills, the complementation of forced in-situ aeration measures to sites containing material of low gas generation rate. The latter will become increasingly relevant in Europe with the EC landfill directive (1999/31) having come into effect, stipulating that only material of low biological activity may be deposited.

In contrast to technically elaborate solutions capital and operational costs of the biological treatment of low calorific landfill gas are low. However, as operational conditions influencing methane oxidation rates are hardly manageable in a landfill cover, the successful mitigation of landfill methane fluxes is subject to particular constraints. These need to be observed when choosing materials and design. Quantitative proof of the success of the mitigation measures requires a reliable combination of methods to assess

the magnitude of the methane fluxes entering and leaving the landfill cover. Overall aims of the joint research project MiMethox are therefore to develop cover designs suited for the sustainable reduction of methane fluxes from landfills generating low calorific gas and to develop and validate a method for balancing the methane budget of whole landfills. To this end, a comprehensive investigation concept was developed by the project partners, integrating methods from the fields of waste management, modelling, microbiology, soil and atmospheric sciences (Figure 1).

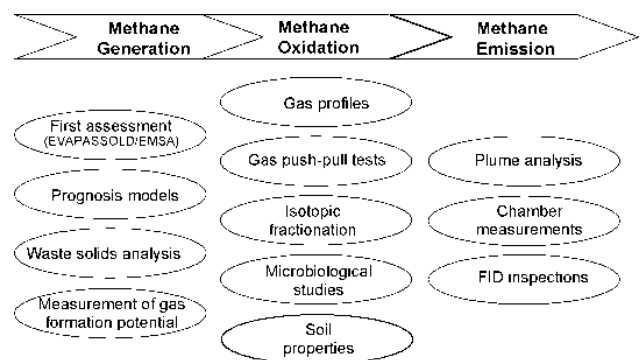


Fig.1: Overview of the investigation concept of the MiMethox project.

Research will be carried out in two phases of three years duration each within a total of five work packages. Phase I focuses on baseline studies on up to five selected model sites and on the efficacy of designed biocover test cells on a landfill taking in mechanically and biologically treated (MBT) waste. The selected model sites will differ with respect to gas generation and cover properties. Results on the performance and the properties of the covers at the model sites and the MBT landfill will serve to derive development objectives for landfill covers at the end of phase I. In phase II, these will be used to design different variants of biocover setups. Their performance will be investigated in test field plots on an old landfill. Phase II will conclude with the draft for two technical guidelines, one addressing the balancing of methane fluxes for entire landfills and the second proposing the design of landfill covers optimised for the purpose of mitigation of methane emissions.

Aim of the research in the framework of the funding programme:

The project is part of the BMBF-programme "Research for Climate Protection and Protection from Climate Impacts". It aims to develop a methodology to sustainably mitigate greenhouse gas emissions from old landfills and from landfills containing material of low gas generation rate by optimising the microbial oxidation of methane in engineered landfill covers. The project thereby targets at providing the means for significant contributions to the

National Climate Protection Programme and thus to the obligations arisen from the ratification of the UN framework convention on climate change and the Kyoto protocol.

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Methakat: Catalytic-thermal Disposal of Lean Gases Containing Methane

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Keywords:

Methane, lean gases, ceramic foams, silicon carbide, calcium aluminate catalyst

Summary:

Climate-relevant problem, aim of the project:

Lean gases (< 25% methane) from landfills and coal mines constitute a major part of the climate-relevant methane output in Germany. These gases cannot be removed at present as there is a lack of simple, reliable and efficient technologies. Without applying an adequate gas removal technology the gases directly escape into atmosphere, and so contribute to global warming. The project network "Methakat" focuses on this problem within the scope of the funded project "Research for Climate Protection and Climate Effects".

It is the aim of the project to develop a long-term stable, ceramic supported catalyst insert which guarantees the simple and stable combustion of lean gases. Furthermore, the required process and plant technology as well as the pilot plant are to be developed and installed. At the end of the project a robust and cost-efficient technology for lean gas removal in landfills and coal mines is to be introduced.

Previous solutions:

Experimental studies of international research groups show that residue-free combustion of lean gases is possible by using high-temperature resistant and contamination resistant catalysts [1, 2, 3]. In the past years, the promising group of aluminates – mainly substituted hexaaluminates – was comprehensively researched. They seem to be resistant to sintering processes at high temperatures > 1200°C as well as to evaporation and corrosion [4, 5]. Furthermore, a simple doped calcium aluminate catalyst in form

of a honeycomb reactor was developed and built in a R&D project with the partners IE, UVE and CDM (then A3). By using this lean gas catalyst in a pilot plant at the landfill Dresden Langenbrücker Straße, the residue-free combustion of fuel gases with low methane content could be proved [6, 7]. However, there is currently the problem that the required thermal mechanical resistance can not be guaranteed because of the unfavorable material properties of the catalysts (high thermal expansion, low thermal conductivity, strength).

Intended research:

The unfavorable properties of the catalyst are to be countered with stable support structures. Thus, ceramic foams with good thermal mechanical stability and high permeability are to be developed as catalyst carriers. For that purpose, silicon carbide ceramics can be used which show good thermal shock resistance due to their low thermal expansion and high thermal conductivity. The project leader Fraunhofer IKTS has extensive experience and know-how in this field, especially in materials and component development, e.g. for burners, metal melt filters and diesel particulate filters [8]. By stabilizing thin catalyst layers on the highly permeable structures the ceramic carrier can be functionalized. Results from studies regarding the catalytic and thermal properties of the system are used to design the burner insert by process simulation. In practice relevant laboratory tests as well as by installing and operating a pilot reactor under real application conditions the suitability of the developed technology is proved. At the end of the project the production and operational costs are determined in order to check the economic efficiency. Table 1 gives an overview of the project partners and their tasks in the project.

Application potential:

In the future, the developed catalyst inserts are to be integrated into existing flare systems which are temporarily used for rich gas removal. Thus, investment costs can be saved. A high acceptance of the new technology is to be expected.

By applying this technology from 2010, approx. 0.8 Mio tons of CO₂ equivalents – for the long-term even approx. 2.4 Mio tons – could be avoided in Germany providing a significant contribution for climate protection. Furthermore, jobs in plant engineering, operating companies as well as in the ceramic industry can be created or maintained.

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Institution	Tasks within the project
IKTS, Dresden	+ Substrate development and catalyst-support + Upscaling of ceramic technologies + Project coordination and management
UVE, Berlin	+ Catalyst development (sub-order IKTS)
IEC, Freiberg	+ Investigations on catalyst activity + Process fundamentals
IE, Leipzig	+ Upscaling of the process and testing
Pall, Crailsheim	+ Industrial realization of supported catalysts
CDM, Bochum	+ Realization and development of pilot plant
Lambda, Wuppertal	+ Selection of landfill site + Installation and operation of pilot plant

Table 1: Project partners and their tasks within the project

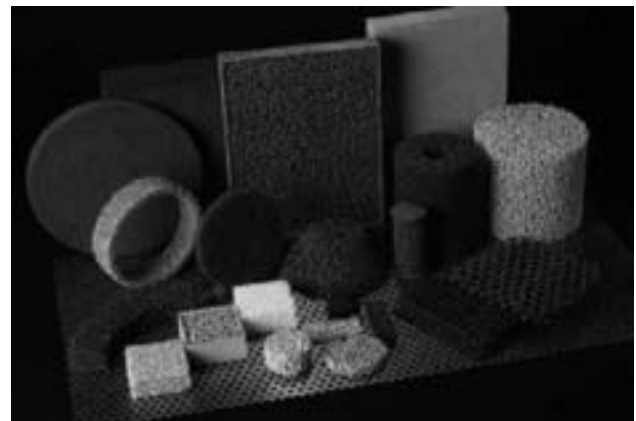


Fig. 2: Shaped parts of ceramic foams

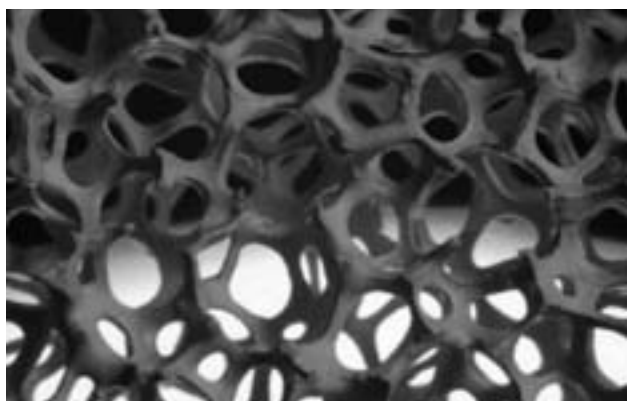


Fig. 1: Structure of open-cell ceramic foams

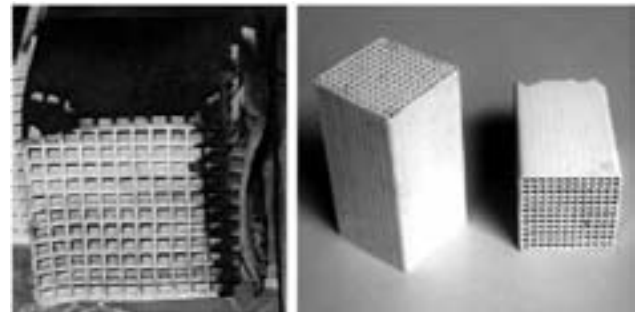


Fig 3: Calcium aluminate honeycomb before (left) and after application (right) in a system for tar cracking



Fig. 4: Flare system at a landfill

Geothermal Utilisation of Smouldering Waste Dumps

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Key words:

Smouldering waste dumps, geothermal utilisation

Summary:

Smouldering waste dumps of coal mines are a common phenomenon in mining industry. The fires ignite by frequently high residual coal contents which tend to smoulder when the organic matter oxidises. Such fires are almost arbitrary distributed on waste piles and they tend to emit toxic gases of incomplete combustion processes. The largest portion of the emissions is however CO₂ which is less hazardous but significantly contributes to the greenhouse effect.

Experience shows that it is difficult to extinguish these fires. Efforts have been very expensive, time consuming and frequently not successful. A partial or complete denudation of smouldering waste piles causes substantial emissions of gases, dust and noise. Therefore denudation is usually no option in densely populated areas. As a consequence these smouldering waste dumps require long term safeguard, frequently even decades after the closure of the coal pits. The former coal company and owner of the waste piles remain liable for environmental damage and personal injuries. The obligatory safeguard is expensive and does not evolve any earnings.

Alternatively, smouldering dumps are a potentially useful but so far unappreciated thermal resource: In many spots of smouldering piles temperatures in excess of 500 °C have been recorded at a depth of less than 5 m below surface. This heat and the corresponding flue gases vanish unused into the atmosphere. The thermal utilisation of this energy resource appears feasible in a number of sites.

In order to deal with smouldering fires more adequately fundamental research is necessary in some areas. This will facilitate both concepts of heat extraction and methods of fire extinction. Furthermore, there are several obvious synergetic effects with coal fire research which may offer substantial benefit if exploited. With respect to smouldering waste dumps a better understanding of the combustion processes and reaction kinetics of fires in heap of debris is needed. Furthermore, a thorough evaluation of controls on such fires and measures of increased heat recovery shall be identified.

In combination with conventionally available data the simulation of these processes will help to evaluate the long-term feasibility of heat extraction via geothermal heat exchangers and to engineer potentially commercial heat extraction. Various techni-

cal concepts and modes of operation will be tested, and the heat capacity as well as the ideal temperature within the geothermal heat exchanger will be determined. Based on this data, a concept of heat utilisation for nearby customers will be developed. Potential options are heat supply of a local district heating system, energy supply for an absorption cooling device or – potentially – for a power generation via ORC turbine. Such concepts are well established for geothermal application however the technical and commercial feasibility of this approach on a smouldering waste dump needs to be investigated.

Aim of the research in the framework of the funding programme:

This project will present a new approach in research of understanding and improved treatment of smouldering coal fires as well as a technical concept of utilisation of smouldering fires and their commercial and ecological advantages as a result. The potential advantages are obvious: The energy can be used for district heating systems and for absorption cooling systems. In some cases electrical power generation via ORC-turbines like in geothermal applications may be a commercial option. This utilisation would save fossil fuels otherwise consumed for heat and electricity and respective CO₂ emissions are prevented.

Therefore, this research project is based on a stepwise approach and it comprises small-scale laboratory experiments, field experiments and tests of technical applications. The data collected from lab experiments is necessary to modify and improve existing numerical models for this application. These models are later on calibrated in field experiments and serve finally for optimising heat extraction and improved predictions of the behaviour of the smouldering fires.

A thorough analysis of the processes and controls of smouldering fires on waste dumps of coal mines will improve the understanding of such fires. This will also facilitate the development of new concepts of fire extinction and fire control. Furthermore, the models and simulation may be transferred to coal seam fires.



Fig. 1 (Source: DMT GmbH)

Fire Prevention During Storage of Biomass Fuels

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Keywords:

Self-ignition, Fire prevention, Biomass, Renewable Energy,
Numerical Simulation

Summary:

Biomass is becoming more and more important as a source of renewable energy. At the actual state of the technology, there are combined heat and power units with capacities up to 100 MW (thermal) and 20 MW (electric). The fuel used is scrap wood or woodcut, in quantities of many hundred of thousands tons.

A technical problem to be overcome is the prevention of undesired fires during the stock keeping, in which especially the self ignition of biomass is of practical relevance, as some recent accidents show [1,2]. Slow oxidation reactions with the oxygen from air can arise on the particle surface already at room ambient temperature, thus producing heat. In case that the heat production inside the bulk is bigger than the heat dispersions to the outside, heat will accumulate and the bulk will become critical. That leads to an exponentially increasing temperature inside the bulk and finally to its ignition. That means that self ignition can occur already at low temperatures.

The self-ignition temperature (SIT) is defined as the temperature, at which the bulk pass from a thermal stable non-critical (no self ignition) to a critical condition (self ignition). The isoperibolic hot storage is currently the method for the experimental determination of the self ignition temperature [3] as well of kinetic constants (activation energy, pre exponential factor) of these processes. The following improvements of the hot storage experimental process were applied in the BAM:

- + the gaseous products of the combustion (CO_2 , H_2O , CO , CH_4 among others) can be quantified on line in a FTIR-Spectrometer;
- + with a macro-thermobalance also the mass loss can be measured.

It is known that the SIT depends on the volume/surface ratio (V/A) and that it decreases as V/A increases [3]. This effect is exploited in the laboratory practice: the experimentally determined data of the inverse of the absolute self-ignition temperature $1/\text{SIT}$ are traced in a diagram versus the Logarithm of the volume/surface ratio $\log(V/A)$. The points lay on a straight line that can be then extrapolated to technically interesting volumes. This method has many disadvantages:

- + it can be used only for easy shapes, where V/A is known (cubes, spheres or cylinders);
- + the maximum volume, to which the extrapolation is applicable, is not known;

Furthermore, large-scale experiments of 100-1000 m^3 are not easily practicable and the induction periods can be of the order of month or even years.

An alternative to this methodology is the numerical simulation of heat and mass transport processes [4-6]. Therefore a mathematical model to predict the self ignition and fire spread in this kind of storages has been developed in the BAM [7,8]. This complex model comprises coupled heat and mass transfer in the bulk material:

- + heat transfer;
- + mass transfer of the most important species;
- + evaporation and condensation of water (either absorbed in the bulk or coming from the outside). This term is necessary, since water or vapor can bring from non critical to a critical conditions [9];
- + various reactions of the solid components.

The model developed until now made the following assumptions [10]:

- + in the bulk, only the molecular transport processes (heat conduction and diffusion of the gaseous species) are considered. This assumption is valid, when no convection can occur in the cavities;
- + the properties of the material do not depend on time and space. This is accomplished, if the size distribution of the particles constituting the bulk is small.

The improvements of the new model should be the following:

- + consideration of an heterogeneous structure of the bulk through the introduction of space dependent transport coefficients or through the modeling of different zones of the storage site;
- + implementation of the convective transport inside the bulk;
- + from analytic investigations (elemental analysis, FTIR-spectroscopy) equations for the progress of the reaction should be derived, in order to permit a more precise consideration of the effective composition of the reaction product in the calculations.

In the simulation of the selfignition temperature processes, the reliability of the input parameters is very important, especially the kinetic properties. Thus, this parameter will be determined in the isoperibolic hot storage tests. Additionally the purchase of an adiabatic reactor is planned, as an alternative way to asses kinetic parameters with self ignition experiments [3, 11]. In this case, the big advantage is the independence on the volume and the possibility to work with small samples, and then to extrapolate the data to larger volumes. The results from the adiabatic reactor

should be compared with the ones from the isoperibolic hot storage and can also be used also as validating parameter.

Aim of the research in the framework of the funding programme:

The aim of the project is the development of measures of fire prevention in biomass storage devices. In this way, the energetic utilization of the biomass would be secured. Furthermore, the use of non renewable fuel to bypass the production downtime due to the fire would be avoided. Finally, the prevention of emissions to the atmosphere due the uncontrolled combustion would be guaranteed (according to our estimations, avoidance of this kind of accidents could prevent up to 355.000 tons CO₂ to be released in Germany, with an associated economical save of about 8,9 mill. euro per year).

The application of the results to the practice follows in a manual, which should be published.

In this manual clear instructions should be found, with the help of whom:

- + the determination of reliable pile dimensions;
- + the determination of reliable storage periods;
- + the elaboration of fire prevention measures, as for example the determination of safety alleys, provision of extinguishing water or alarm systems.

Could be realized, in order to minimize the potential dangerousness of a fire during the storage of biogenic solid materials.

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Projects B: Adaptation

Management of climate change effects in the Metropolitan Region Hannover-Braunschweig-Göttingen

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Key Words:

Adaptation to climate change, management strategies, decision and planning support tools

Summary:

In recent publications there is consensus, that global climate change is inevitable and already takes place. Experts expect, that extreme weather conditions such as storms, droughts and floods will increase, also in Germany (e.g. UBA 2005). According to the Munich Re Group in the US costs caused by natural disaster increased fourteen-fold within the last 40 years (Münchener Rück 2000). Damages to ecosystems, agriculture and forestry caused by the “unspectacular” climate change effects are unvalued thereby.

To prevent or compensate for medium and long term negative effects to society, economy and the environment, the research project proposed aims to develop marketable planning instruments and decision support tools for adaptation to climate change. The framework will be exemplified to develop integrated management solutions for agriculture, forestry, nature protection and water management.

Aim of the research in the framework of the funding programme:

Inevitable climate change demands for development of management strategies to prevent medium and long term negative effects to society, economy and the environment.

In the Metropolitan Region Hannover-Braunschweig-Göttingen climate protection is already a central issue, and scientists, politicians, economists and planners are working on innovative solutions for further reduction of CO₂ emissions (mitigation). However, up to now only little efforts are made to cope with forthcoming negative effects associated with climate change (adaptation), and actors operate mainly independent from each other. The aim of the research project “Management of Climate Change” is

- + to bundle these existing activities,
- + to built up an information network among scientists, stakeholders, governmental representatives and practitioners, and

- + to develop tools for an integrative management of climate change effects.

The research project consists of two parts: the pre-study, which started in September 2006 and the main study to be proposed.

Aim of the pre-study:

- + Identify and discuss relevant issues of the metropolitan region, which are already, or which will be affected by climate change in the future.
- + Describe scientific research needed to thoroughly understand effects of climate change, including interactions among different issues such as farming, water management, forestry or nature protection.
- + Discuss integrative management tools and planning instruments needed to handle climate change effects integrative and effectively.

The first moderated workshop was held on October 30th 2006 in Hannover, Germany. Herein identified key issues associated with climate change will be included in the main study which will be submitted to the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF) by May 2007.

To ensure the practical applicability of the framework developed, the proposed management tools and planning instruments will be discussed with competent authorities and stake holders in a second workshop, held on March 5th 2007.

Aim of the main-study:

- + Based on the global and national scenarios introduced by the Federal Environment Agency (Umweltbundesamt, www.Umweltbundesamt.de), climate change effects will be modelled on a regional and local scale.
- + Development and optimisation of integrative adaptation strategies to prevent, or to compensate for negative effects associated with climate change.
- + In close cooperation with the competent authorities and stakeholders, management tools and planning instruments will be developed and exemplarily implemented within the Metropolitan Region of Hannover-Braunschweig-Göttingen.

As a result of the first workshop held in October 2006 water management was identified to be of particular importance regarding climate change in the metropolitan region. Changes in the regional water balance (e.g. ground water table, rain fall amount, evaporation etc.) among others will have severe impacts on water supply, agriculture, forestry and nature conservation issues. For this reason the framework will be exemplified to develop integrative man-

agement solutions for adaptation to climate change for these sectors. Figure 1 shows the preliminary scheme of the applied research project. Based on information provided by the three sub-projects “Local climate change scenarios”, “Water balance” and “Site related conditions”, five sub-projects will work out climate change effects related to water management, biomass energy, agriculture, forestry and nature conservation issues. Four “cross cutting” projects concerning knowledge transfer, advanced training, specialist counselling and integrative evaluation and planning instruments including GIS-based interactive mapping will support regional network building.

The framework developed in the main study will be applicable to other German and European regions. It is planned to check up on its transferability in a second study to be submitted.

BMBF-funding no.: 01LS05038

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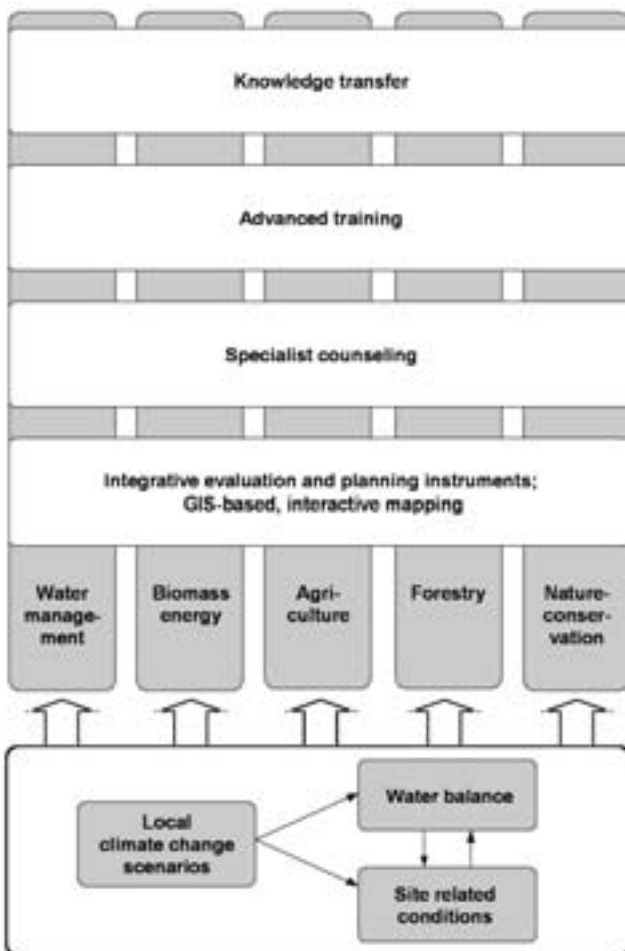


Fig. 1: Preliminary scheme of the applied research project

KLARA-Net – Network for Climate Change adaptation in the Region Starkenburg

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Key words:

Adaptation strategy, stakeholder dialog, regional cooperation, interdisciplinary approach, Region Starkenburg

Summary:

Efforts to the reduction of greenhouse gas emissions on global (e.g. Kyoto protocol), EU, national (e.g. National Sustainability Strategy Germany) as well as on regional and local level (e.g. Agenda 21) are currently taken place. The necessity of building up strategies for adaptation to the ongoing climate change is however not yet equally in consciousness by differently affected stakeholders (e.g. Industry, City and Regional Planning, Tourism and Health sector). The effects of climate change will differently meet regions in Europe. Especially in high urbanised regions large damage and high economical losses have to be expected. Therefore, it is important for future actions to measure these effects and to develop strategies und new techniques for different industries (e.g. Agriculture and Forestry, Building industry), in order to define fields of action to avoid negative consequences of climate change, but also to be aware of potential positive consequences. This is the motive of the research project KLARA-Net. The research area is the Region Starkenburg in south of Hesse that belongs in parts to the metropolitan Region Frankfurt/Rhine Main. The region is economically and with regard to its natural-space a rather heterogeneously region. Different consequences of climate change need to be taken into account and adaptation strategies must be defined related to diverse spatial circumstances. Heterogenic consequences of climate change require answers and actions from various stakeholders. Therefore, KLARA-Net is focusing on the establishment of a regional stakeholder network that works out fields of action and particular measures for climate change adaptation. Additionally, KLARA-Net is undertaking actions to raise public awareness in matters of climate change. In the current phase of the project four working groups (1. Agriculture, Forestry and Winegrowing; 2. Building Economy, Water Economy and Planning; 3. Health; 4. Tourism) are discussing and creating adaptation measures for the region. One steering group is coordinating a regional strategy. In this project the adaptation of climate change is understood as an interdisciplinary task that builds on a “bottom-up” approach which has the potential to work out actions that are clearly region specific but also give first answers for other regions in Europe.

Aim of the research in the framework of the funding programme:

The research project KLARA-Net is following on the one hand the aims of the Framework Programme “Research for Sustainability” for a sustainable, innovative society and on the other hand the programme “Research for climate protection and protection against climatic impact”.

The main aim of KLARA-Net is to strengthen the understanding of required adaptation measures between stakeholders and to develop an interdisciplinary adaptation strategy for the whole region. The development of new services and products includes also chances to strengthen the innovative sector and hence the regional economy. Therefore, KLARA-Net is supporting the Framework Programme “Research for Sustainability” in the **field of action 1**: concepts for sustainability in industry and business and within the programme “Research for climate protection and protection against climatic impact” in the field of development of technologies, proceedings and products.

The selected regional context of the project makes it possible to involve regional knowledge that seems to be compulsory for the creation of specific adaptation measures. The regional spatial scale of the research project opens the possibility to understand the consequences of climate change for a specific region and with that to engage stakeholders to be involved in such a network that is considered necessary for a longer period of time. The interdisciplinary approach offers as well a wide understanding of aspects of climate change so that it gets a kind of societal importance. New impulses are expected concerning the development of new methods and instruments especially in the field of environmental planning. This approach corresponds to the Framework Programme “Research for Sustainability” **field of action 2**: Sustainable use concepts for regions and within the programme “Research for climate protection and protection against climatic impact” the aspect of influence on economic and social management systems and knowledge transfer and innovation management.

Aspects of field of action 3:

“Concepts for sustainable use of natural resources of the Framework Programme “Research of Sustainability” are strongly connected to the character of the region with its variety of natural space. The use of natural resources needs to be regarded in a regional context. Especially the future use of forest and agricultural areas is discussed within the network.

While working on adaptation, aspects concerning climate protection are necessarily involved in the process and through that directly fitting to the approach of the Funding Programme. The inseparability of climate protection and adaptation is evident in the network.

A Region's Climate Protection and Adaptation Potentials and their Development – the case study “Chiemgau-Inn-Salzach”

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Key words:

Regional development, mobilization of stakeholders and consumers, renewable energy, water retention, regional climate scenarios

Summary:

The project aims to mobilise and focus the innovative development forces of a region with regard to climate protection and adaptation. These innovative forces are further to be supported using scientific knowledge resources. The project encompasses three phases: in the conception phase a regional strategy as well as a regional network for climate change and adaptation are to be built. In this network as second phase path-breaking model projects are to be identified and tested. The regional experiences gained in the model projects are to be made applicable to other regions in the third phase.

Aim of the research project within

the framework of the funding Programme:

The aim of this research project is to mobilise the existing regional development forces of innovative business stakeholders with regard to climate protection and adaptation using the example of the “Chiemgau-Inn-Salzach” region. These development forces are further to be focused and supported using scientific knowledge resources. A self-supporting network structure, which translates the arising opportunities of the climate change into model projects, is to be built and tested. The achieved results and experiences are to be condensed into a regional climate protection and adaptation strategy. Using good examples, the economic and social potentials of this strategy will be demonstrated to the stakeholders of the region and to other regions.

The research project aims at two challenges in particular:

1 Action and knowledge resources are to be joined in a way which allows for the existing knowledge to be developed as a value-added productive force. In this process, the questions will be oriented by the practical need for knowledge.

2 Questions regarding climate change are to be made a subject of discussion in such a way that the region (i.e. business stakeholders, common welfare oriented actors, consumers/population) is mobilised as extensively as possible for climate protection and adaptation. The focus lies on those protection and adaptation measures which also promise added value potential.

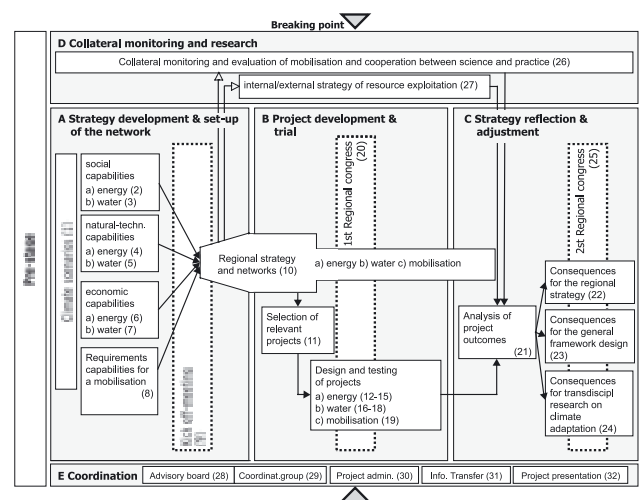


Fig. 1: Schematic view of the course of events.

The following course of events is planned (see figure 1): By means of a pilot study and a regional climate symposium, the manifold starting points for climate protection and adaptation were condensed into three fields of action: a) Use of renewable regional energy resources, b) water retention and land use as well as c) mobilisation of the consumers/population. In a first phase, the existing climate scenarios for the region and the demands of the involved actors are initially to be specified. Simultaneously, a regional strategy is to be developed based on the natural-technical, social and economic potential of the three fields of action. The corresponding networks are to be built as well. In a second phase, path-breaking model projects for the implementation of the strategy are to be identified and tested within the scope of the network. In a third phase, the experiences from the construction and the testing of the network are to be evaluated and the consequences for the regional strategy, the design of the framework conditions and the trans-disciplinary climate adaptation research are to be developed. The strategy and project development and testing are to be monitored and evaluated in parallel with regard to their effects. In this way, the experiences of the requested project are to be made useful for the construction of networks for climate change and adaptation in other regions.

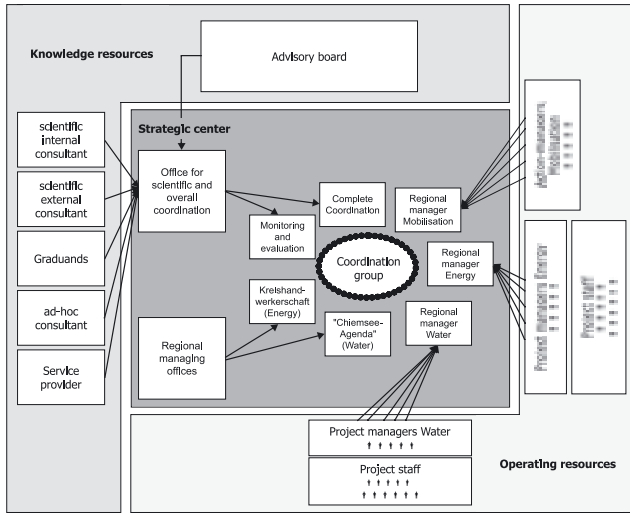


Fig. 2: Overview of the involved actors.

A substantial challenge of the research project lies in the appropriate connection of knowledge and action resources. Figure 2 provides an overview of the involved actors. The strategic centre of the project is formed by the coordination group, which con-

nects the knowledge resources (consultation and service) with the action resources (project development and implementation). The three regional managers are established stakeholders (power promoters) in the region. They are responsible for a successful implementation of the partial networks and are supported by two regional coordination offices. The strategic centre is supported by diverse experts (knowledge resources). They include scientists of the TU München and of other research institutions and cover the relevant subject areas. Experienced consultants (ad hoc consultants) are included as additional knowledge resources. They are to support the project coordinators and staff (action resources) in implementing the model project by providing practically oriented knowledge. In addition, the project is to be strategically guided by an advisory board which is composed of supraregionally known experts in the field of climate change and adaptation as well as mobilisation.

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Water Sensitive Urban Design, Network for Sustainable Development of Regional Environmental Engineering at Climate Trends and Extreme Weather

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Keywords:

Climate change, water sensitive urban design, sustainable development

Summary:

With regard to the climate change it is anticipated, that first an increase of storm events combined with longer droughts will result in overcharges of drainage systems with harmful consequences for surface and underground water. Secondly longer dry weather periods and an increase of the annual average air temperature may produce a shift of water balance and a decrease of available water resources. Due to the currently foreseeable remodelling of settlement areas – not least activated by the looming population development in Germany (PINNEKAMP et. al. 2005) and Europe – should be taken action to counteract the consequences for water management out of the climate trends and the shift of extreme weather statistics and to work out and realise sustainable solutions for the adaptation of the water management to the above-named climate trends.

Aim of the research in the framework of the funding programme:

To meet the challenge and based on the application an interdisciplinary competence network should be formed. The interdisciplinary cooperation shall assure that with water sensitive methods the prognosticated harmful externalities on the urban water management not only can be attenuated but even compensate each other. Aim of the network in the BMBF-aided project is to localise within one year an area and to realise prearrangement with whom these problems can be resolved.

Work plan:

According to the verbalised aims the handling of the following questions is intended for the network:

- + Identification of problems in consideration of interdisciplinary aspects (initialisation of the cooperation network)
- + Identification of representative communes for a corporately development and for a future realisation of the developed methods/projects
- + Work out of development scenarios and conduction of method plans, including suggestions for concrete methods/projects

Initialisation of the cooperation network:

For the initialisation of the network activity a workshop has been hold, which has contained the following points:

- + Work out a common target definition
- + Identification of problems of the different disciplines
- + More interdisciplinary cooperation partner
- + Identification of a basic scope

Identification of representative communes:

Cities and rural districts will be identified, where already knowledge exist about the interrelation between an accumulation of impacts of extreme weather events in recent years and a movement of population density. In addition concepts will be handled for representative communes with prognosticated changes in events of extreme weather and in the demographical structure of their population. Some of the relevant parameters of water management are for example:

- + volume of changes of expected extreme weathers,
- + dimension of absorbing surface and underground water,
- + average ground slope and extraneous water rate of the sewerage system,
- + connected area,
- + drinking water resource or regeneration rate of groundwater,
- + population density and its change,
- + population and settlement development as well as
- + effect of the structural change on land use.

Furthermore is to consider, when choosing the commune, the prediction of the economic trend, which has a significant influence on the water economical characteristics.

Work out development scenarios and conduction of method plans:

Together with the then chosen communes will be produced

- + development scenarios and
- + method plans.

In form of prearrangement this will be part of the application phase for a following project for the realization of these methods.

Within the assessment of the development scenarios is it also possible to make an assessment of the currently existing design and dimensioning directives if required.

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Strategies and Concepts for Urban Planning to Mitigate the Impacts of Climate Extremes on Well-Being and Health of People in Cities (Cooperative project KLIMES)

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Key words:

Regional climate change, heat stress, urban quarters, urban planning, mitigation strategies

Summary:

Recent results of climate simulations for Central Europe predict an increase of extreme heat waves during summer. This background situation is intensified by the urban heat island effect with the consequence that the quality of human life in urban quarters will be affected more frequent, over longer periods and stronger in the future. This was impressively demonstrated by the heat waves 2003 and 2006 (Figs. 1 to 3).

In the context of the precautionary principle, urban planning has to respond to the negative impacts of local climate change on city dwellers. Against the background of existing urban structures, planning strategies need to be developed to ensure human thermal comfort outdoors and indoors even during extreme weather conditions in summer. In addition, a strong public interest in the

quality of open urban spaces becomes apparent and it is acknowledged that they can contribute to the quality of life within cities.

Identifying the human-biometeorological fundamentals required for the development and application of such mitigation strategies are the objectives of the joint research project KLIMES (Strategies and concepts for urban planning to mitigate the impacts of climate extremes on well-being and health of people in cities). KLIMES is carried out by an interdisciplinary research group consisting of experts in urban climatology, urban development and geoinformatics at three German universities. Due to the objectives, a co-operation and permanent dialogue with local planning authorities and the public is necessary and happens in different extensive ways. Therefore, KLIMES has the character of an extremely application-related project.

To analyse the influence of different urban quarters, which are typical of future objects in urban planning and development in our climate region, on the human thermal comfort, the research design covers various methods coordinated with respect to the objectives of KLIMES: problem-related literature research to identify deficiencies, experimental investigations of the microclimate conditions in urban quarters to determine the human thermal comfort using the updated physiologically equivalent temperature PET* as thermal index, interviews with city dwellers on their thermal perceptions and simulations of thermal comfort outdoors and indoors under current as well as future climate conditions using the models ENVI-met and BOTworld. The city of Freiburg represents the site for all investigations, as it is the warmest city in Germany due to its location at the eastern border of

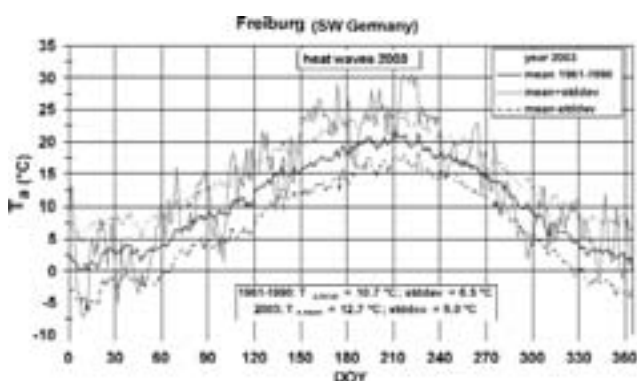


Fig. 1: Daily mean values of air temperature T_a in 2003 and averaged over the climate standard period 1961-1990 including standard deviation $stddev$ in the city of Freiburg (data source: German Weather Service)

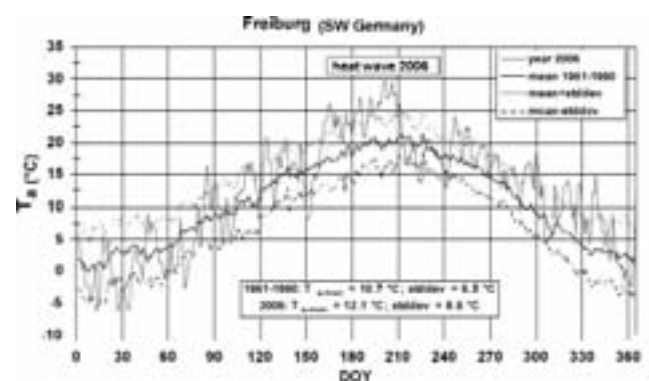


Fig. 2: Daily mean values of air temperature T_a in 2006 and averaged over the climate standard period 1961-1990 including standard deviation $stddev$ in the city of Freiburg (data source: German Weather Service)



Fig. 3: Drought effects of the heat waves 2003 in the city of Freiburg, SW Germany
(Photo: H. Mayer)

the N-S oriented southern upper Rhine valley. The city of Kassel has been selected to examine the general application of the results obtained in Freiburg.

Taking into account environmental compliance, the synthesis of all results will lead to modified concepts and a guideline for urban development, which consider enhanced requirements to

human thermal comfort outdoors and indoors in cities due to impacts of regional climate change.

**Aim of the research in the framework
of the funding programme:**

The joint project KLIMES represents a contribution to the subprogram "Adaptation to Climate Trends and Extreme Weather" of the BMBF research program "Research for Climate Protection and Protection Against Climate Impacts". With respect to the significance of weather and climate for different economic sectors, KLIMES is related to the economic branch "urban development". As it is linked to urban structures and infrastructures, which are used for several decades, urban development is characterised by long-term projection periods. They can not dodge climate trends and extreme weather. Therefore, adaptation strategies significant to urban planning are to be developed for the subject of protection "people" and to be tested for their application. The lack of urban development and buildings adapted to climate change yet causes enhanced morbidity and mortality rates. The sustained objective of KLIMES is to mitigate the human stress of climate trends and extreme weather, particularly in summer, so that the quality of life for city dwellers is improved and protected against negative effects of regional climate change. Urban development and buildings compatible to extreme heat stress will have a distinct reassessment in the future.

Adaptation of Winter Sports Tourism to Climate Change and Weather Variability in German Low Mountain Ranges. (GIS-Klischee)

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Key Words:

GIS, Decision Support System, winter sports, tourism, climate change, modeling, adaptation strategies, low mountain ranges

Summary:

Traditionally, winter sport tourism is the most important economic factor in German low mountain ranges, which influences decisively the economic prosperity and development of these mountain areas. In the future, adaptation of winter sports to expected climate changes is absolutely essential and should be considered in further spatial development concepts and intentions. Following questions are particularly important:

- + Which changes in spatial snow cover distribution have to be expected?
- + Which areas will be available for winter sports tourism on a given period of time?
- + How can “stranded investments” be avoided in this context?
- + Which adaptation strategies can be developed for German low mountain ranges?

The GIS-Klischee project pursues the objective target to estimate the local snow potential on the basis of meteorological variables, relief parameters, land use, wind flow fields, net input radiation and satellite images. Future climate states derived from a regional climate model will be used together with derived spatial patterns of snow cover to estimate future snow cover response. Furthermore, the result will be integrated in an existing Geographic Information System so that a complete expert system tool for spatial planning will be made available. This expert system, amongst other things, combines data of infrastructure facilities, ecological precedence areas and economic parameters. The application can be a useful tool in decision-making, investment matters and also for the development of suggestive strategies of adaptation depending on the modelled snow cover availability.

Aim of the research in the framework of the funding programme:

The research project bases on the principles of sustainability like they were formulated by the Federal Ministry of Education and Research (BMBF):

- + Generation responsibility, that is to protect concerns of the succeeding generations and to derive reliable scenarios forms the basis of the research project. Prognosis of snow cover changes and usability of winter sport areas should conduct both recreation activities and convenient snow sports establishments. In this context it is possible to assess future development potentials whereby at the same time natural resources are applied carefully, economically and gainfully.
- + The principle of integration, through which social, economic and ecological goals are balanced and combined, is a major point within the strategy of the research project. The scientific focus serves to obtain complete data sets to all of the three fundamentals of sustainability: Economic key dates, statements to the spatial structure of land use and infrastructure and the natural potential and environmental frameset. This concept forms the fundament of the models that will be developed. This different data will be adequately accessible and usable through the all combining GIS.
- + The scientifically based concepts and suggestion for regional development serve for the participation of locally acting participants. The results help to locally provoke responsibility and to trigger developments that serve to initiate socially and ecologically balanced economic activities. In the light of possibly unsuccessful investments many urgently needed investments have been held back since decades. Applied scientific expertise is urgently needed in order to develop more trust in regional abilities. By these means suitable snow sports concepts and alternative strategies can be considered.

The scientific project will formulate which specific impacts of climate change must be considered in the designated areas of investigation.

By this means gradual changes of ecological challenges will be shown in order to provoke political consequences which than can be supported with designated instruments.

“Research for climate prevention and prevention from climate impacts” is a key issue within the frame programme “Research for sustainability” of the BMBF.

The research project bundle aims at these politically set research goal. The central aspect of the research will be to assess

climate change and future weather patterns. Information on future climate data is an essential need for many stakeholders and interest groups that depend on winter sport tourism.

The more profound estimates based on measurements and modelling are, the more precise the resulting planning processes will

be. This project offers chances to the tourism industries to effectively adapt the products to climate conditions in the future. Thereby, it will help to overcome the insecurities that hamper investments in this sector.

Climate Change and Tourism: Strategies for Adaptation and Sustainable Development (KUNTIKUM)

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Key words:

Climate change, tourism, adaptation, cooperation, capacity building

Summary:

The anticipatory adaptation to extreme weather events and expected climate change is an important aspect of sustainable development. Especially for economic sectors such as tourism, which are sensitive to weather and climate, the changing climate is an important challenge. Tourism is confronted with prognoses and scenarios, which predict e.g. shifting zones of snow, increase in extreme weather events or raising sea level. A strategically oriented tourism policy and business is therefore challenged to integrate climate change into their decision-making processes in order to minimize socio-economic risks and take advantage of new opportunities. The anticipatory adaptation requires activities on the level of the individual tourism actors as well as processes of cooperative learning and joint decision-making in tourism regions. However, studies on tourism and climate change show, that tourism business is focused on short term decision-making and that climate change is not integrated adequately into management procedures.

Before this background our project focuses in two focus regions (North Sea Coast and Black Forest) on four goals:

- 1 Analysis of trends in climate change and tourism in the focus regions.
- 2 Development of strategies for new products and infrastructures in the focus regions.
- 3 Capacity building for climate-related decision-making in the focus regions.
- 4 Synthesis of the results within an integrated concept.

We aim to reach this goals with an transdisciplinary approach in which different natural and social science disciplines work together with (regional) actors from tourism policy and business. The scientific sub-projects provide expertise on the following aspects:

- 1 Project coordination and cooperation processes
- 2 Tourism analysis and strategy

- 3 Weather and climate change analysis
- 4 Information and communication system
- 5 Knowledge transfer and capacity building

The actors from tourism policy and business in the two regions are integrated in the project by a structured research and development design, which is divided into four phases:

1 Diagnosis

In the first phase the current situation as well as the expected trends in tourism and climate are analyzed. The project partners from science and praxis explore which data are crucial for decision-making and to what extent current decision-making procedures in policy and tourism business are adequate.

2 Assessment

In the second phase the (preliminary) results of the diagnosis are assessed with regard to the specific challenges of the two focus regions and the business-related goals of the praxis partners. Based on the assessment the aim is to identify areas for action.

3 Strategy/Product design

The strategy development for new infrastructures and products in the two regions is at the centre of the third phase. A mix of participation and brainstorming methods are employed to facilitate the joint learning and decision-finding process.

4 Evaluation

In the final phase the scientific and praxis partners evaluate jointly to what extent the transdisciplinary research and development process contributed to improve the individual, institutional and collective competencies for the anticipatory management of climate change in tourism policy and business.

The scientific projects and the praxis partner are brought together in this collaborative research and development process in order to focus the research activities to the needs of the tourism actors and to develop jointly adaptation strategies. Beyond the concrete results for the two case study regions the project aims at producing generalized knowledge, how to stimulate processes in tourism regions for anticipatory adaptation to climate change.

Aim of the research in the framework of the funding programme:

Our research and development project aims at three central goals of the funding programme: development of strategies and products for adaptation, cooperation and network building, and the improvement of competencies for planning and decision-making.

ing. This goals are especially relevant for tourism. A sustainable tourism development needs as well strategies to reduce its environmental impact as strategies to handle the environmental impact (climate change) on tourism itself. Our project will contribute to the latter.

SAFE – Sensor-Actuator-based Early-Warning System for Hazard Protection in Extreme Weather Conditions

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Adolf Thies GmbH & Co. KG, Göttingen
Kisters AG, Aachen
Regnauer Fertigung GmbH & Co. KG, Seebruck
Wacker Chemie AG, Burghausen
Marktgemeinde Mering, Mering

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Keywords:

Disaster management, early warning, extreme weather hazards, extreme weather prognosis, sensors, sensor networks, information logistics, actuators, facility telematics

Summary:

Climate research suggests an increase of extreme weather events in the decades to come. The damages caused by these extreme weather hazards might increase significantly in the future. Insurance companies are already experiencing increasing insurance claims – in particular in industrialized countries with their vulnerable infrastructures. These human and economic costs caused by climate change will be a major challenge for the societies and economies worldwide. One answer to these challenges can be early-warning and disaster prevention that assist in reduction of possible damages. SAFE is a research project aiming at local early-warning systems of high quality, supported by technological disaster prevention measures that can make a significant contribution to protection from extreme weather hazards effects caused by the climate change in Germany and Europe.

Experiences from existing extreme weather hazard warning systems indicate a lack of local preciseness of weather hazard prognosis as well as targeted information dissemination necessary for preparedness and hence effective damage prevention or mitiga-

tion. These are the two main challenges for which solutions are sought in this research project. The approach of SAFE is to enhance the local quality of weather hazard prognoses and to realize targeted information dissemination for affected persons and systems. The research in the project focuses on three major tasks.

Sensors and data

Local availability and preciseness of meteorological data will be improved by a dense network of specialized low-cost sensors and sensor networks. Experiences from existing weather hazard warning systems indicate that the missing of local sensor data is one of the major obstacles for better local prognosis. Due to the high investment and maintaining costs, the density of the existing network of weather stations and their data transmission intervals are limited. In SAFE, new low-cost sensor types specializing in measurements for storm, heavy rain, and hail due to weather hazard prognosis will be developed. Furthermore, the flexible integration of other useful data sources such as sensors from authorities (i.e., road sensors) or even private weather stations will be realized based on an open data management platform.

Prediction methods

New prediction methods for a better local weather hazard prognosis will be developed. Especially the improved availability of local data sources combined with data obtained from remote sensing by satellites, aircraft mounted sensors, and radar systems allow for an extension of the prognosis horizon and an improved preciseness of local weather hazard warnings. Special emphasis lays on improving nowcasting capabilities by assimilating all these available data – importantly, with respect to their temporal resolution. This comes together with improving classical model output statistics (MOS) to increase the accuracy for day 2-5. This is achieved by switching to certain nonlinear statistical methods that reflect (from a mathematical point of view) much better the meteorological requirements than classical linear regression techniques, e.g., positivity of wind speed, precipitation etc. Furthermore, these better prognoses will serve as an input for new methods and models of local impact estimation such as the risk of flooding of streets and buildings.

Targeted warning

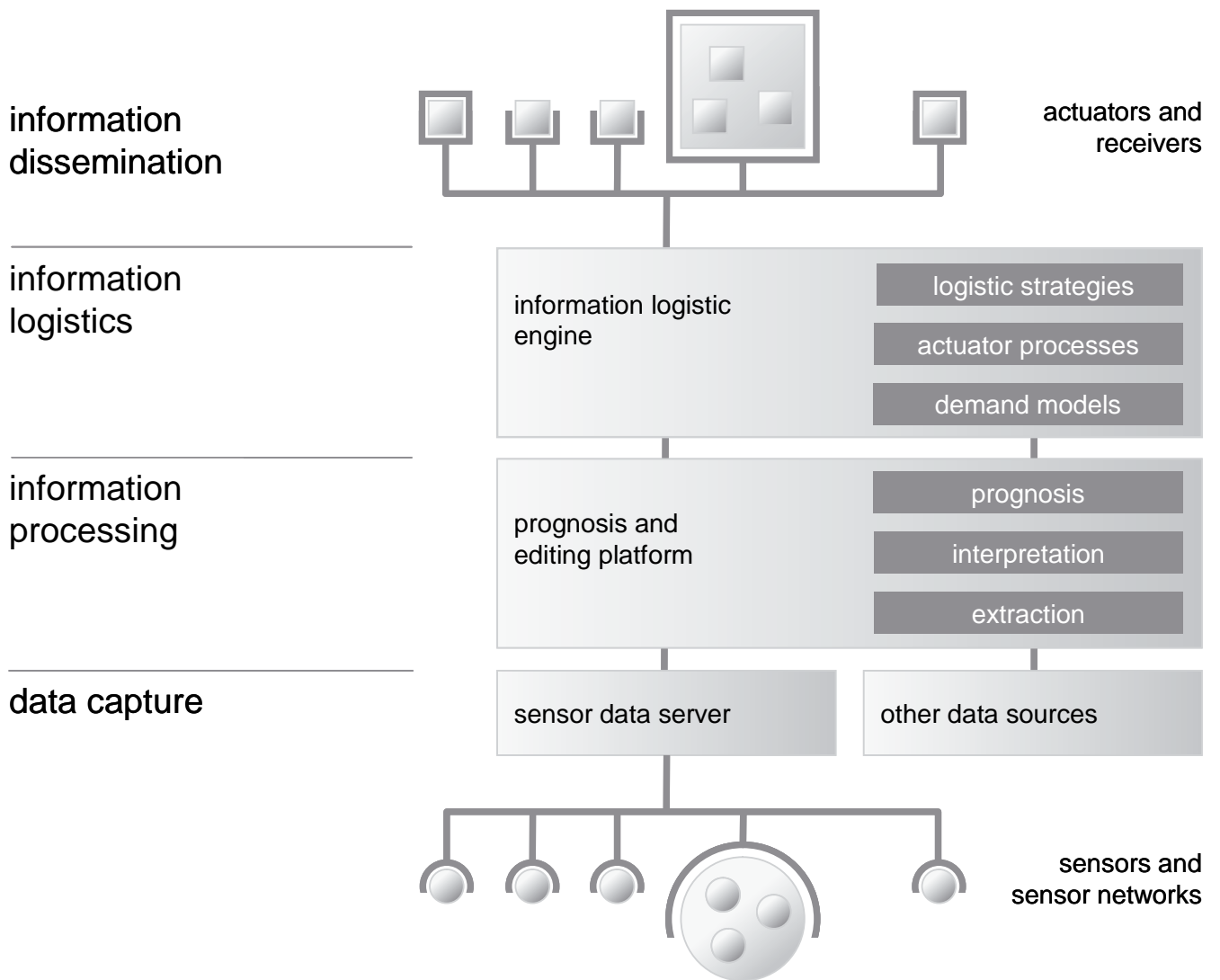
Warnings will be generated and distributed according to the needs of local prevention and mitigation measures. A new kind of information logistic platform will be developed that provides the means

for targeted just-in-time warnings for fire brigades, the public, and even telematic systems (i.e., automatic closing of windows). The platform will provide actuator process models that represent the receivers of warnings and their information needs as well as their prevention abilities and serve as a basis for the control of the necessary information flows for better prevention and mitigation.

These three innovative technologies will be combined in a new kind of early-warning system for local impacts of extreme weather hazards. Its feasibility and effectiveness will be evaluated in a field test in the town of Mering and in the chemical industry plant of Wacker in Burghausen in 2008 and 2009. The aim is to prove the expected benefits and to show the applicability for other communities and industries in the future.

Aim of the research in the framework of the funding program:

The objectives of the SAFE project comply with the second main aim of the funding programme, better adaptation to and protection from climate change effects. The projects focuses on the effects of increasing extreme weather events, especially on hazards such as heavy rain, freezing rain, hail, storm (tornados and down bursts), and flooding often caused by convectively induced severe weather events. SAFE will search, implement, and test new technologies for improved local prediction and better warning dissemination and hence provide a better protection from damages of industrial plants, urban areas, and private homes.



From sensors to actuators: Process layers in SAFE

Regional Risk of Convective Extreme Weather Events: User-oriented Concepts for Trend Assessment and Adaptation

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Keywords:

Severe convective storms, Climate change, Assessment and adaptation

Summary:

The objective of the BMBF-funded project RegioExAKT is to estimate the impact of the expected climate change until 2030 on convective severe weather events and vulnerability focusing on southern Germany, and to quantify the changes compared to the present state. As a measure for adaptation to the trends to be expected, novel nowcasting techniques will be developed for Munich international airport being an especially weather-sensitive user. In addition, the adequacy of present planning regulations for building codes (high-wind events) and urban drainage (heavy precipitation events) will be reviewed. The Munich Reinsurance Group as another target user will benefit as well from the generated knowledge on climatic trends of severe weather risk in southern Germany in the adaptation of their damage claim scenarios.

Aim of the research in the framework of the funding programme:

Extreme weather events from severe convective storms (straight-line winds and tornadoes, hail, heavy precipitation and lightning) pose a threat to life and safety of European citizens and lead to significant property damage each year. For Germany, the

Munich Re Group estimates a total damage of 1 to 2 billion EUR per year. For Europe as a whole, thunderstorms are likely to cause 5 to 8 billions EUR annual total damage. Yet, in assessing the economic and climatologic risk, knowledge gaps remain despite, e. g., the recent availability of a pan-European database of such event reports, the ESWD (www.essl.org/ESWD/). A field of particular concern, and also at the cutting edge of science, is the estimation of regionalised severe convective storm risk in a changing climate with time horizon 2030.

There is a strong demand for regionalised risk assessments and adaptation strategies by weather-sensitive economic sectors like the insurance industry, international airports, water management, and also national weather services like the DWD in Germany in its efforts for optimisation of forecasts and warnings of such events.

The adaptation of existing building codes with respect to wind loads and precipitation maxima to climatic trends in extreme weather events is also economically relevant. From these target groups, Munich international airport and the Munich Re Group were chosen as exemplary users.

RegioExAKT belongs to part B: "Anpassung an Klimatrends und Extremwetter (Adaptation to climate trends and extreme weather events)" of the research programme "Forschung für den Klimaschutz und Schutz vor Klimawirkung (Research for climate protection and protection from climate impacts)", and relates to the BMBF framework programme "Forschung für Nachhaltigkeit (Research for sustainability)" by addressing the problem to assess the future threat of weather-sensitive sectors by severe weather, and by developing sustainable early warning and adaptation strategies.

The BMBF-funded project RegioExAKT has the following main objective:

Determination of the trends in occurrence of, and threat by, severe convective storms in (southern) Germany until 2030, as well as the development of concepts for adaptation for targeted main users (Munich Reinsurance Group, Munich international airport) on the spatial and temporal scales relevant for their business operations.

The RegioExAKT project links these and other users with an interdisciplinary research group. The three-year project which started in January 2007 develops the hydro-meteorological and insurance-related scenarios of extreme weather events following from regionalised climate and vulnerability projections compared to the present state. This will help to enable timely adaptation of business strategies in the insurance industry and of building codes. For Munich international airport, a concept for optimised thunderstorm nowcasting and drainage will be developed based on the scenarios.

Meteorological models (regional and global climate, weather forecasting), wind and water engineering, socio-economic approaches, advanced remote-sensing and in-situ observational tools are available to address and satisfy user demands for adap-

tation guidance. Dissemination of the RegioExAKT results by dedicated workshops and the web portal www.regioexakt.de to new user groups, stakeholders, policymakers, the science community and the public forms another key activity.

Simulation-supported Automation for Sustainable Air-Conditioning of Buildings in Summer

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Key words:

Simulation automation, online prediction tools, sun-shading systems, ventilation, air-conditioning, online simulation, dynamic building simulation, building automation system, building installations

Summary:

Non-residential buildings have increasing energy demand for air conditioning in summer, as comfort requirements grow and temperature levels rise. This adds to the electricity consumption, which is already on the rise in office buildings. To limit the energy consumption for cooling, external gains should be efficiently controlled with sun-shading systems and energy efficient cooling methods should be employed. Until now, simulations for building installations were used predominantly as planning tools. The innovation in this project lies in the continuous use of all software tools during every stage of the project: the planning phase, in the hardware-in-the-loop test of the controllers that are used and

during the online simulation at diverse locations while the building is in operation. For this purpose, the research centre for sustainable energy technology zafh.net is developing simulation-based operation management strategies and implements these in cooperation with building automation companies in the form of marketable building automation systems or automated room stations. To reduce the consumption of energy for the air-conditioning of buildings, the use of renewable energies to cover the rising cooling demand has top priority. For buildings, whose primary energy consumption makes up about thirty to forty percent of the total country consumption, shading and facades are the most important energy-related factors but alternative cooling methods also play an important role. Intelligent automatic control of these components insures that the energy conservation of the building is optimized, which not only leads to cost savings but also a high comfort level for the building's occupants. The extreme temperatures that occur in the summer are making constructional and energy system improvements increasingly more necessary in order to insure comfortable interior temperatures. Yet such improvements in existing buildings are often problematic and insufficient. The integration of room automation often makes the system only a little more efficient. The software tools that are to be developed will guarantee an efficient integration of the improvements into the existing controlled environment. This insures a sustainable reduction of energy consumption for the operation of existing as well as of newly constructed buildings. The dynamic building simulation tools that until now have only been used in planning stages will be used in the operation of the buildings on a daily basis. The implementation of the use of pre-



Innovative concepts for shading systems and daylight usage shown at the Festo Technology Center in Esslingen Germany (Photo: Festo AG & Co. KG)

diction tools and simulations for technical building installations leads to an intelligent operation with an optimized cooperation between each of the building's technical components.

**Aim of the research in the framework
of the funding programme:**

The goal of this research network project is the development, implementation and assessment of control strategies for technical systems in buildings and the building operation itself. In this process, climatic conditions and prediction tools that are available online are implemented and this information is intelligently

incorporated into the system. Hereby, the regulation possibilities of the building envelope such the use of shading devices, or the adaptive automatic control of building installations such as ventilation and air-conditioning units, thermal and electric cooling, lights etc. are checked for their energy saving potential. The software tools that will be developed for this purpose are stored in standardized libraries for use with all kinds of simulation platforms. Here, close collaboration takes place with the manufacturers of building automation systems and building management tools. These concepts are implemented practically in commercial buildings belonging to the project partners.

Adaptation Strategies for Climate Change and Extreme Weather Conditions and Measures for a Sustainable Groundwater Management

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Summary:

Climate change affects groundwater management by altering the groundwater recharge as well as the use of groundwater, e.g. public water consumption or irrigation. Groundwater modeling is carried out to quantify the changes in groundwater balances and levels for different climatic scenarios until 2100. Different kinds of strategies and adaptive measures are evaluated to counterbalance the impacts of climate change for a sustainable groundwater management.

Goals:

Groundwater and springs cover 70 % of public drinking water supply in Germany and 95% in the state of Hesse. Groundwater management has to meet many demands in a dense populated and highly industrialised country like Germany. In general not mean but extreme high or low groundwater levels cause problems in residential areas, farming, forestry, and biotopes. Because climatic conditions have a strong impact on groundwater management one major aim of the research project is to assess the implications of climate change on the groundwater balance. The overall aim of the project is to develop adaptation measures and strategies for a sustainable groundwater management.

Contents and work plan:

A large porous aquifer in South Hesse (Hessisches Ried) and the adjacent fractured aquifer of the Odenwald encompass the areas under investigation. The groundwater balances of the porous aquifer are calculated by a three-dimensional groundwater model. The model will be calibrated and validated for the observation period 1960-2004. Groundwater recharge for both areas is estimated by a conceptual approach, which evaluates the base flow index of rivers and their corresponding catchment areas considering spatial distributed factors like precipitation and

evapotranspiration, soil type, and land use. By alternative means groundwater recharge of the porous aquifer is quantified by distributed soil water modeling based on the Richards' equation. The impacts of climate change on soil water and groundwater balances will be quantified by longterm-continuous simulations until 2100 based on the three IPCC emission scenarios A1B, A2 and A1. Due to the requirement of high-resolution climate data CEC Potsdam GmbH downscales the data of the general circulation model ECHAM 5 with their statistical-empirical WettReg-method. Climate changes as well as demographic effects will alter the use of groundwater in the future. This has to be compared with the impact of climate change on the yield of groundwater resources.

The following objectives will be accomplished:

- to evaluate the supply guarantee of local facilities for public water use (e.g. springs in the Odenwald),
- + to quantify the impact of climate change on high-/low-levels of groundwater table,
- + to assess the extent of conflicts of groundwater utilization with other kinds of land use,
- + to reveal capabilities and limitations of groundwater management to counterbalance the impact of climate change on groundwater resources,
- + to develop strategies for an integrated regional water management in order to cope with alterations in groundwater table and resources due to climate change.

The results in respect to

- + the efficiency of adaptive measures to counterbalance the impact of climate change on groundwater resources (e.g. connecting water works),
 - + the increase of monitoring to strengthen regional groundwater management, or
 - + the capabilities of the expansion of groundwater recharge by artificial infiltration,
- may be transferred to other regions.

Important fields of adaptive measures are wine- and fruit-growing, agriculture and forestry. This research project will provide reliable data about the changes in soil moisture in the future (e.g. frequency and duration of droughts), which are essential basics for the planning in these fields.

Climate Change Adaptation of Wheat Production in Germany through Plant Breeding

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Key words:

Climate change, crop production, plant breeding, early flowering

Summary and aims of the Research in the Framework:

Global climate change has considerable impacts on local environments. While global mean temperature is expected to increase by 2-5°C over the next decades, specific regional impacts in Germany can only be assessed with regional climate models, related case studies and sensitivity analyses. Some regions will on average become drier, while others will face higher precipitation levels. Timely adaptation of agricultural crops to long-term climate trends through plant breeding requires investment in research and development for a targeted utilisation of their genetic potential. Wheat is the most important food and feed crop in Germany and Europe, and demand on international markets is expected to rise in the future. In recent years, observed annual yield increases in Germany were close to zero. A major reason are increasingly dry conditions in early summer, which lead to an early termination of the grain filling period. Particularly the summer heatwave in 2003 revealed that the expected climate changes can result in considerable yield losses, which could have serious economic effects. Stabilisation of crop yields will be predominantly achieved by the development of new varieties. Plant breeding provides the means for developing varieties with good resistance to abiotic stress. The objective of this project is to find cost-effective ways of adaptation to climate change in the area of plant breeding research.

1 The need for climate change adaptation in wheat production in Germany until 2030 to 2050. In order to determine the pressure of adaptation of the wheat production in Germany global climate predictions are used to develop locally restricted climatic scenarios with a very high spatial resolution. The aggregated

results of the different models and especially the regional and seasonal distribution of precipitation, temperature and radiation are to some extent uncertain. Several various regional climate simulations are going to be analyzed and their results will be compared with the present climatic conditions to estimate the certainty of the simulated climate change. Various climate scenarios will be used to force a dynamic vegetation model. In this manner the effect to the crop of wheat will be assessed. The simulated change will be described by appropriate stress indicators.

Spatially explicit production effects will be aggregated for all of Germany, in order to calculate the supply effects on domestic markets. For the assessment of additional trade effects and long-term changes on international commodity markets we will use a number of scenarios. As a result, the economic impacts of climate change for wheat production in Germany can be derived. Product quality effects and agricultural employment effects will be captured in consistent side calculations.

2 The potential of plant breeding to develop wheat varieties adapted to climate change. Our focus is to develop wheat varieties adapted to the abiotic stress complex heat/drought. In this context we will examine early flowering as an escape mechanism to counteract increasing early summer drought stress in Germany. Three groups of genes are well-known to be involved in controlling flowering time of wheat. Photoperiod response genes (Ppd), vernalisation genes (Vrn) and earliness per se genes (Eps) are essential in the phasic development of wheat. Conscious selection for these photoperiod response genes in plant breeding programs will yield varieties with better adaptation to future climate conditions. In order to determine the potential of early flowering in wheat, a wide range of germplasm from all over the world showing considerable genetic variation in flowering time is being examined. This set of wheat lines will be analysed with molecular markers to determine which known genes are present. In parallel we will develop doubled haploid mapping populations to identify new monogenic as well as quantitative loci with an influence on flowering time. In addition, all plant material under molecular examination will be phenotypically characterized in field trials and in the greenhouse. This plant material will be used to combine most suitable loci for early flowering which eventually will be transferred into modern winter wheat varieties. It will also be investigated, if new wheat varieties with an earlier flowering time show positive production effects under changing climate conditions. Adaptation potential through crop substitution within the EU as well as through trade with third countries will also be assessed.

Climate Change and Fruit Growing in Germany (KliO)

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Key words:

Climate change, fruit growing, impacts, adaptation strategies, adaptation costs

Summary:

The vulnerability of economic sectors to climate change depends on both the expected regional climate change and the sectors' ability to adapt. In Germany, 80 % of the total area of land is used by the agriculture and forestry sectors and they belong to the most climate-sensitive branches. Climate change will have a significant impact on this sector. In comparison to crop production, where adaptation-strategies can be realised relatively fast through the implementation of a wide range of cultivars and species or by using short rotation periods in vegetation, the planting and rearrangement of orchards requires a consideration of the more long-term aspects of climate change impact. The adaptation of fruit plantation to climate change takes time and requires long-term investments. Returns are not realised before 3 to 6 years after the initial investments. Capital recovery can take as long as 25 years. Therefore, a detailed investigation on the impact of climate change on fruit growing is necessary.

Earlier research has shown that the first impact of climate change on certain fruit species can already be observed. For example, since the end of the 1980's the blossoming of fruit trees in Germany has advanced by several days (Fig. 1, Chmielewski et al. 2004). The general growing season in Europe and Germany has been extended by 10 days during the last decades (Chmielewski and Rötzer 2001, 2002). Because of the earlier blossoming of trees, in some regions of Europe the risk of late frost damages has increased (Susnik and Zust 2001, Zinoni et al. 2002, Anconelli et al. 2004). Likewise, the number of pest populations in orchards has risen, e.g. the occurrence of the codling moth (Palm 2006).

The overall objective of this project is to investigate the possible regional impacts of climate change on fruit-growing in Germany. The main fruit growing regions in Germany are likely to be impacted differently by climate change and therefore these regions will be vulnerable to the impact of climate change in a varying degree. The KliO project intends to develop application-relevant strategies for adaptation and evaluate the impact of

these adaptation measures on the sectors profitability and productivity. In this context, different levels of adaptation will be considered. This project should help to maintain the competitiveness and profitability of fruit growing in Germany. In this way, the project contributes to the sustainable development of this economic sector. This is seen as relevant for the impact of fruit growing on land-use, as well as a guarantee to keep employment and a stable income level in this economic sector.

The contributions of the project partners can be summarized as follows:

Humboldt-University of Berlin (HU)

- + Changes in agro-climatic conditions for fruit growing (growing degree days, soil water budget, hail- and frost risk, occurrence of extreme weather events, etc.)
- + Potential shift of fruit growing areas (limits for fruit growing)
- + Recent and future changes in plant development (phenology)
- + Changes in crop yields, quality parameters for fruits, etc.
- + Regional vulnerability of fruit growing areas

Fruit Growing and Consulting Service in Jork (OVB) together with Fruit Growers

- + Modelling of pest populations, e.g. codling moth (*Cydia pomonella*)
- + Development of new methods for pest control
- + Suggestions for the implementation of new fruit species and varieties
- + Development of adaptation strategies for fruit growers

German Institute for Economic Research (DIW)

- + Estimation of additional costs for fruit-growers by adaptation methods such as irrigation, hail- and frost protection, etc.
- + Cost-benefit analysis of adaptation strategies at different levels of adaptation

Beside risks, climate change also provides new opportunities. By implementing appropriate adaptation strategies, the risks of climate change (frost, hail, extreme weather, water shortage, etc.) must be minimized and the new opportunities given by, for example an extended growing season or a higher temperature level, should be efficiently used. This could be possible by an adequate selection of fruit species and fruit varieties. For example, stone fruits are generally more sensitive to cold, so that they could benefit in case of warming.

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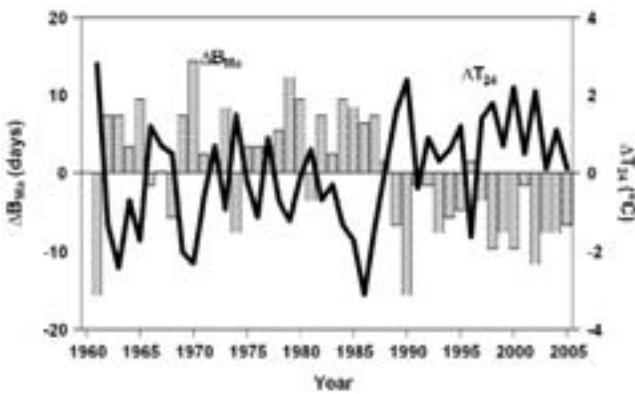


Fig.1: Anomalies in the beginning of apple tree blossom (ΔB_{Ma}) and in the average temperature from February to April (ΔT_{24}) in Germany

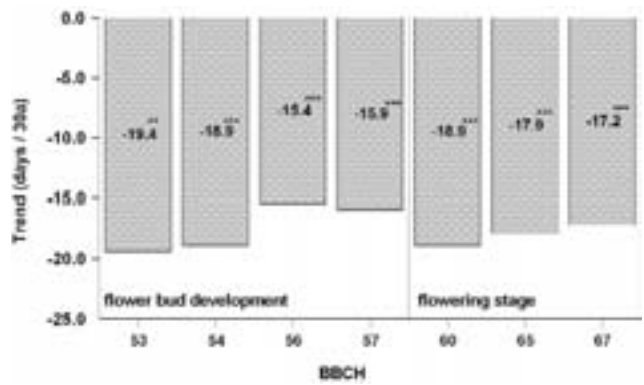


Fig. 2: Trends in flower bud development and flowering stages for apple trees in the region 'Altes Land', 1976-2005



Fig.3: Coddling moth (*Cydia pomonella*)



Fig. 4: Late frost damages on cherry flowers

Soil Amelioration and Cultivation Technologies for Arable Land Exposed to Drought: BATroS

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Key words:

Soil enhancer, biomass production, soil amelioration, drought exposure, adaptation strategies, water management, cultivation systems, agriculture, seeds

Summary:

For various parts of Germany present climate scenarios indicate a potentially increasing risk of drought events primarily occurring in the growing season (e.g. Gerstengarbe et al. 2003; Stock 2004). Among these areas Lusatia is supposed to be most affected as to the continental climate being characterized by a low average precipitation of 560 mm per annum and extended drought periods in summer time. The regionally prevailing nutrient poor sandy substrates reinforce the impacts of drought and call for alternative options in order to adapt the traditional agricultural management practices to the changing climatic conditions. New amelioration and cultivation technologies may either help to adapt the existing management systems to water stress or may be based upon alternative landuse strategies rather orienting on the selection of drought tolerant species and mere biomass production, i.e. for matter processing or energy transformation purposes.

Therefore, BATroS has been launched for testing soil amelioration technologies which may increase the water storage capacity of soils and, hence, the access of plants to soil water. The project will apply an alternative approach for testing the adaptation of selected seeds and crops to drought, considering traditional crops but also those plant species known to be suitable for maximising phyto-mass productivity. Special emphasis will be placed on effects of soil enhancers on the water storage capacity of soils and on encapsulated seeds, both supposed to increase the drought tolerance of plants during germination and in the phase of growth and maturation.

The main objectives of BATroS are:

- + Development and improvement of combined soil enhancers and seed capsulation technologies

- + Optimisation of amelioration technologies for the application of soil enhancers
- + Selection of drought resistant plant species with particular focus on bioenergy and CO₂-sequestration.

The collaborative project is co-ordinated by the Research Center Landscape Development and Mining Landscapes at the Brandenburg University of Technology at Cottbus.

Aim of the research in the framework of the funding programme:

As a response to scenarios indicating a drastic change of climatic conditions in the next decades, policy has initiated various activities to increase the public awareness, to stimulate a public discourse on this issue and to call for joint research efforts on how to mitigate or counterbalance negative impacts of a global climate change at regional scales and for regional economies. Two general strategies have been mapped out to minimise the effects of climate change. First, big efforts are made worldwide to reduce the emission of CO₂ e.g. by promoting renewable energy sources such as biomass. On the other hand, research is carried out to find suitable adaptations of land-use strategies as a reaction to climate change. Consequently, the funding programme of the BMBF promotes initiatives which are looking for (1) reduction of greenhouse gas emissions and (2) for precautionary measures to mitigate or compensate for the impacts of climate change in the private and public sector.

BATroS aims at combining these two general strategies of the funding programme. The production of biomass for energetic purposes as a renewable energy source contributes to the important objective of reducing the emission of greenhouse gases. Additionally, the cultivation of crops known to be adapted to low fertility agricultural sites and extended drought may provide an alternative option for farmers in regions such as Lusatia where traditional crop production had frequently not been cost-covering or had even failed completely in the last decade due to unfavourable climatic conditions. In consequence, traditional rural structures and landscape elements may disappear in such regions and may, thus, trigger a paradigm shift with regard to the requirements of a future oriented agricultural land use. Thus, the BATroS project is challenged to develop appropriate technologies and forms of land use which help managers to compensate for decreasing water resources.

Soil enhancers (Humentos®, HumiComplete® and Geohumus®) of two co-operating manufacturers will be tested and combined in different field and greenhouse experiments. Further, site specific cultivation systems with drought tolerant plant species will be evaluated. In addition, the specifically encapsulated seeds will

be tested and improved to guarantee a germination in due time. The effects of different soils enhancers, application techniques and seeds on physical soil properties and yields will be thoroughly investigated for both above- and below-ground compartments. A major benefit of carrying out the experimental work in the Lusatian post-mining landscape relates to the prevailing extreme edaphic and climatic conditions which facilitate a comparison with other – namely arid – regions worldwide where dry climate conditions hamper the agricultural and horticultural production. This is well reflected by already existing cooperations that BATros partners already established with the Arab Emirates.

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Adaptation Strategies for Sustainable Forest Management under Climate Change – Decision Support System (DSS) Forest and Climate

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Key words:

Climate change, forest management, adaptation, site-specific strategies, decision support system DSS

Summary:

Forests in Germany cover one third of the land surface. They do not only perform important environmental functions, but also provide a multitude of services for the human population. The expected climate changes like increase of temperature, changes in distribution and intensity of precipitation, as well as extreme weather conditions like droughts and storms in combination with changes in the chemical climate, namely the increase of CO₂ and nitrogen eutrophication will induce severe impacts on the ecological, economic and social basis of German forestry.

In contrast to agricultural ecosystems forests are characterized by their longevity and the tremendous heterogeneity of site conditions. These two factors complicate the prognosis of how to adapt the management strategies of an existing forest stand at a specific site. This information, however, is urgently needed, because the decisions made today have to reflect the environmental conditions of the next 80 to 100 years.

The objective of the integrated project is to develop a dynamic decision support system which allows the forest owner to adapt his management strategies with regard to the changes of the environmental and socio-economic conditions of the next decades. The system will be site- and stand-specific, includes the emerging risks for the existing forests and the adaptation potential of different tree species. The system is web-based and has access to a GIS-data base. It allows the user to ask explicitly in time and space for the risks emerging and possible adaptation strategies for a specific stand and site.

Aim of the research in the framework of the funding programme:

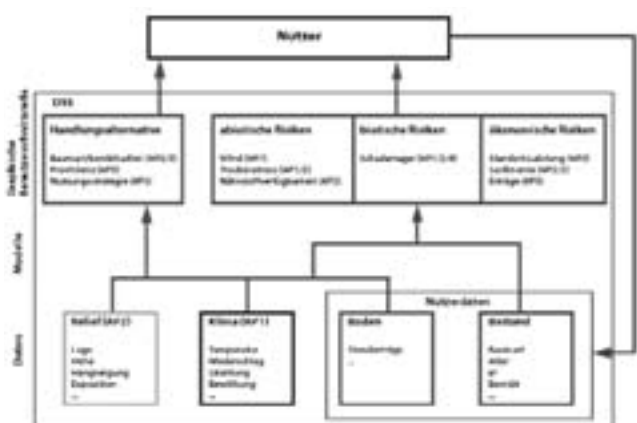
This integrated project refers to the part “adaptation to climatic trends and extreme weather events” of the overall research programme “Research for Climate Protection and Protection from Climate Impacts”.

The key goal is to provide forest management authorities/agencies and further stakeholders in Germany with a flexible and reliable tool to support management decisions. The development is performed under permanent participation of selected representative forest administrations and enterprises as partners from practice. The knowledge-based Decision Support System “Forest and Climate Change (DSS-WuK)” is developed as a web-based tool. Guiding criteria in this process are the establishment of deep and durable interdisciplinary linkups in accessible knowledge on the one hand, and the persistent joint development with partners from practice and stakeholders on the other.

The project integrates the input of seven work packages:

- 1 Spatial Decision Support System (SDSS) “Forest and Climate Change”
- 2 Development of a DST (decision support tool) submodel for the risk assessment of abiotic damages
- 3 Development of a dynamic site model on the basis of spatial information
- 4 Decision-supported silvicultural strategies
- 5 Forest protection scenarios
- 6 Economic strategies
- 7 Optimization of the information transfer by the SDSS

The figure shows the structural connections and information flows within the integrated project.



Start of project DSS-WuK planned for March 2007, subject to final funding approval by BMBF.

Land, Climate and Resources (LandCaRe) 2020 – Foresight and Potentials in Rural Areas under Regional Climate Change

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Keywords:

Adaptation, agriculture, climate trends, dynamic decision support system, plant production, patch to landscape level

Summary:

Adaptation to climate change requires knowledge on the potential regional and local impact of climate and weather extremes. Effects of climate change on agriculture may be positive or negative, depending on the variability of weather conditions, site quality, land use and management. Adaptation must consider sustainability with respect to high plant production without losing different ecosystem services like soil protection, purification and recycling of water, maintenance of biodiversity, etc. Further, adaptation measures should not enhance climate change but reduce greenhouse-gas emissions. That implies decision making to consider both socio-economic and ecological consequences of adapted management.

The project LandCaRe2020 (funding period 11/2006-10/2009) deals with effects of regional climate change and weather extremes on agriculture and water and material fluxes at the landscape level. Tools will be provided which produce knowledge for decision making in agriculture, related industries and environmental issues in rural areas. Central objective of the project is the development of a dynamic decision support system (LandCaRe-DSS), exemplarily developed for two different regions in eastern Germany (1) the “Uckermark” in the dry lowlands of Brandenburg and (2) the “Weißeritzkreis” in the humid mountain area of Saxony. Adaptation of the DSS to other regions and land-use types will start in the second phase of the project and can be

continued afterwards. The DSS includes modules for past and future climate (scenarios and weather statistics), ecology (quantitative indicators for greenhouse gas emission, natural plant production potentials, biodiversity), and economy (land-use change, development of farm income and employment, economic risks). Integration of the modules is based on a geographic information system (GIS) and predictions can be performed from individual agricultural fields up to the landscape level. Based on FACE (free-air carbon dioxide enrichment) experiments, a unique parameter set of effects of increased atmospheric carbon dioxide on plant production and water use will be included. The DSS is dynamic because it allows new model runs with various sets of scenarios and parameters by the user. All results can be questioned and visualized from a virtual reference book. Through a communication process including interviews, workshops and DSS training units a user panel will be created with representatives from agricultural and environmental administrations and organisations, agricultural industry and farms. As far as possible, their requirements on specific matters, indicators or design will be included in the DSS during the developing process. Further, it is possible to create specific versions of the DSS based on data of the respective user. The project is open for participation in the user panel and collaboration with other related projects. At the end of the project, the DSS verified for the two exemplary regions will be accessible via internet. The model framework, adapted software and a defined set of required data provide for transfer to other regions.

Aim of the research in the framework of the funding programme:

The research project provides a model-based DSS to support adaptation of agriculture and related areas to climate change and extreme weather conditions. It addresses

- 1 administrations, organisations and companies at the regional level and
 - 2 rural co-operatives, farms and their consultants at the local level.
- Besides the free use of the first version of the DSS adapted to the regions Uckermark and Weißeritzkreis, the conceptual framework and software of the DSS allows to create other versions based on the relevant regions, specific requirements and data of the users. The new service offers relevant knowledge for decisions within the following areas of economy and administration: agricultural insurances, plant breeding, pest management, agricultural management and technology (variety selection, seasonal timing, crop rotation, soil improvement, irrigation, air conditioning) including renewable resources. Further, consulting, planning and steering activities with respect to land use and land-use change, resource management and conservation policy are supported.

Success Factors for Climate Change Mitigation and Adaptation [ErKlim]: Communication Strategies in Housing and Mobility

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Key words:

Communication strategies, environmental psychology, behavioural change, climate change mitigation, climate change adaptation

Summary:

This project takes an innovative approach to climate change because it considers simultaneously the until now mostly unlinked subjects of both, mitigation and adaptation. Thereto, a series of workshops with experts on both subjects will be held that identifies the barriers and options for mitigation and adaptation strategies. The focus will be put on private households in the action fields of housing/building and mobility. Consequently, psychological knowledge will be applied how to promote changes in environmentally relevant behaviour. Especially, in every step of the project it will be looked for potential conflicts and synergies between mitigation and adaptation. The workshops follow a systematic of three logical steps: first, the relevant measures will be analysed which are effective for mitigation as well as for adaptation. Second, suitable strategies to communicate the relevant measures will be identified for both fields and their interaction. Third, together with actors relevant for the practical implementation new specific projects will be developed and will be applied in a follow up phase.

Aim of the research in the framework of the funding programme:

Climate change demands to cope with two challenges at the same time: mitigation of and adaptation to climate change. To mitigate climate change above all human activities must be changed, which are responsible for the emission of the greenhouse gases. However, measures to adapt to climate change and its impacts are also required. But the realization of mitigation and adaptation in Germany is far behind the necessary and possible. This applies especially to behaviour in housing and mobility:

- + Mitigation: this far, the existing strategies were neither sufficient to support a broad implementation of innovative technologies nor could they trigger the desired changes in people's behaviour.
- + Adaptation: There is too little awareness of the necessity and the measures to adapt to climate change and its most serious consequence: the increase in weather extremes.
- + Synergies and conflicts: There are synergies and conflicts between mitigation and adaptation: synergies are for instance given by insulating buildings as a means of energy efficiency and protection from heat waves, conflicts by the susceptibility of solar panels to hail. These synergies and conflicts have hardly been clarified.



The ErKlim Kyoto-Navigator: Integration of climate change mitigation and adaptation

ErKlim objectives

Consequently, the objectives of the ErKlim project (German project title: Erfolgsfaktoren für Klimaschutz und Klimaanpassung) are:

- + Analysis of the reasons why some dissemination strategies for mitigation and adaptation have succeeded while others have not – this will be done with the focus on private households; analysis of the synergies and conflicts between mitigation and adaptation in housing and mobility.
- + Improvement of strategies for an integrative promotion of mitigation and adaptation.
- + Application of the insights gained by developing new strategies to promote mitigation and adaptation measures.

ErKlim approach

Besides its simultaneous analysis of mitigation and adaptation, the ErKlim project is innovative in its systematic integration of knowledge from environmental psychology on behavioural

change and expert knowledge on climate change mitigation, adaptation, and natural hazard management. Success factors of strategies to promote behavioural change are the specificity of strategies for the target behaviour and group, involvement of target group members and key figures, utilisation of different behavioural motives and self organization processes, combination of different dissemination methods, etc. This psychological knowledge is brought into expert workshops with representatives from civil society, government, industry, and science. These workshops follow a systematic of three logical steps: first, the relevant measures will be analysed which are effective for mitigation as well as for adaptation. Second, suitable strategies to communicate the relevant measures will be identified for both fields and their interaction. Thereby, it will be taken into account why cur-

rent approaches might have failed. Third, together with actors relevant for the practical implementation new specific pilot projects will be developed and will be applied in a follow up phase. The main output of the project will be a practical guide (the so-called Kyoto-Navigator) for housing and mobility. This guide will contain the insights from the expert workshops and the scientific literature on behavioural change, focussing on:

- + effective strategies for the promotion of climate change mitigation and adaptation in housing and mobility, and
- + sustainable combinations of measures for using synergies and avoiding conflicts between mitigation and adaptation and other ecological, economic, and social objectives as well as between housing and mobility.

Acting in the Framework of Climate Change Stakeholder Orientated Risk-Communication Based on Insecure Knowledge

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Key words:

Climate change adaptation, Climate change communication,
Climate change education, Stakeholder orientated risk-commu-
nication, insecure knowledge, action research project, Weser
river basin area, transfer of education conditions and methods,
communication tools, multimedia products, online-communica-
tion-tool "iDelphi@".

Summary:

The aim of this social action research project is to raise the stake-
holder consciousness for the climate change in the Weser river basin
area. Referring to the existing knowledge in the climate change
debate the project will consider the potential regional climate
change impacts, degrees of adaptation and adaptive capacity. One
of the main focuses of the project is getting profound information
how the sectors agriculture, tourism, urban planning are affected
by climate change adaptation in socioeconomic circumstances.

The effects of climate change will be communicated directly to
the stakeholder groups. For this purpose communication tools for
climate change adaptation in the form of stakeholder approaches
are being promoted. The stakeholders' subjective knowledge
needs to be recognised and combined with the scientific results of
climate change. In the focus of this sort of risk-communication
are social science methods with which barriers can be overcome
and acceptance can be gained. The results will be used in a one-
year process of dissemination to gather experiences in the trans-
fer of education conditions and methods. In this phase advanced
forms of communication and multimedia products have to be
developed to reach the general public.

The research process will be evaluated by an external board of
experts, who will work with the online-communication-tool
"iDelphi@" that has been produced by the Sustainability Center
Bremen.

In the focus of the research activities is a series of workshops fol-
lowing a method that was introduced by the Sustainability Center
Bremen with the name of "risk-communication in cascading
workshops". (Figure 1)

The research project is funded by the Federal Ministry of
Education and Research of Germany and partly by the regional
climate change agency, the Bremer Energie-Konsens GmbH.

**Aim of the research in the framework
of the funding programme:**

The aim of this social action research project is to raise the stake-
holder consciousness for the climate change in the Weser river
basin area. New approaches of risk-communication methods and
the development of multimedia tools will be used to communi-
cate the effects of climate change directly to the stakeholder
groups (agriculture, tourism, urban planning). The results will be
used in a one-year process of dissemination to gather experiences
in the transfer of education conditions and methods.

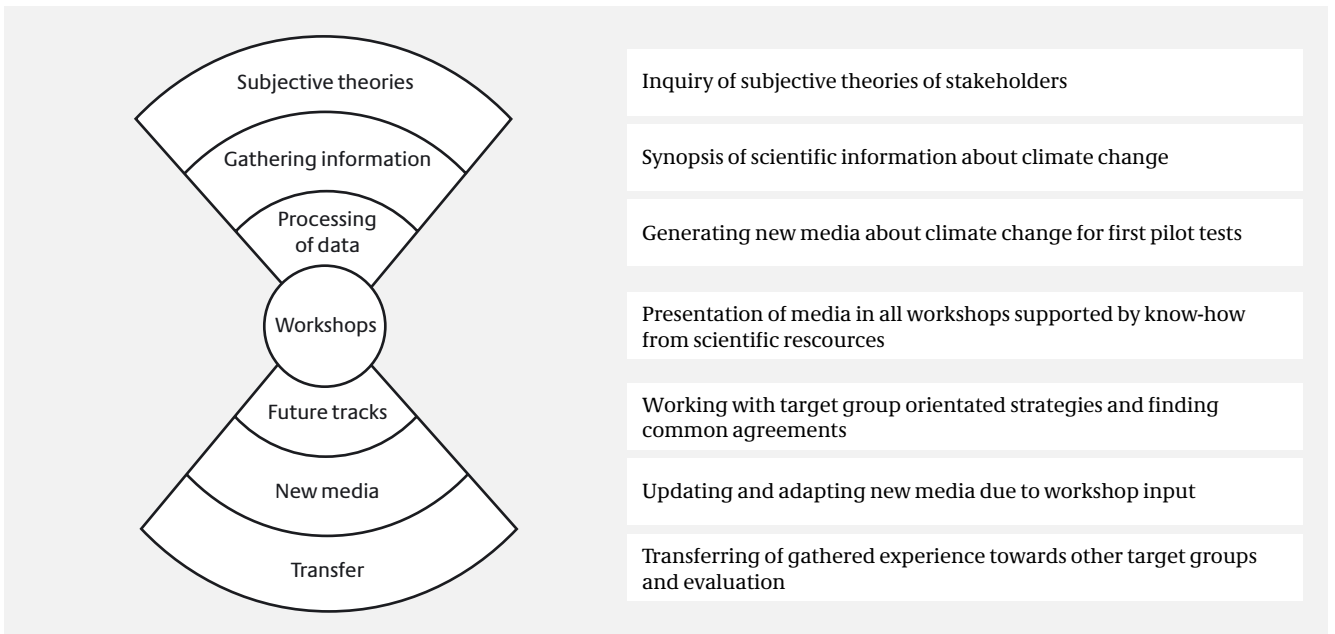


Figure 1: "risk-communication in cascading workshops"



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Mainstreaming of Climate Risks and Opportunities in the Financial Sector:

Climate-Related Opportunities and Risks in Insurances, Asset Management and Lending (with a focus on asset management)

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Summary:

Climate change entails substantial risks, and also opportunities, for the financial sector: Damages in the billions threaten the performance of investments and even companies, while at the same time new business segments will emerge. If the financial sector succeeds in adapting to this situation rapidly and comprehensively, opportunities could be seized ensuring – along with effective climate protection – social and economic surplus. Therefore, institutional investors, insurance companies, asset managers and pension funds have increasingly been dealing with climate change issues in recent years. This comprises both mitigation and adaptation aspects.

Open issues in this context are the main topic of the three-year-project “Mainstreaming of Climate Risks and Opportunities in the Financial Sector”. The endeavour started in 2006 and is funded by the German Federal Ministry of Education and Research (BMBF). Project partners are Germanwatch (consortium manager), the University of Potsdam, the German Institute for Economic Research (DIW), the Wuppertal Institute for Climate, Environment and Energy, as well as the Potsdam Institute for Climate Impact Research (PIK) and the European Climate Forum (ECF). Further partners include financial service providers such as Munich Re, WestLB, HypoVereinsbank, Allianz Global Investors and the Society of Investment Professionals in Germany (DVFA).

Starting from actual requirements voiced by German financial service providers, the project develops and proposes solutions on how to adequately incorporate climate-related risks and opportunities into financial management. This includes the valuation of companies (analysis), risk measurement and control, investment decisions and asset management.

Aim of research in the framework of the funding programme:

The project aims at developing instruments, methods and techniques enabling financial analysts, asset managers, underwriters and investors to integrate climate change and protection considerations into their decision-making process. This applies both for adaptation and mitigation issues. An adequate implementation-oriented, expert-based classification system shall be compatible with and integrable into tools used by sell-side analysts, portfolio managers and underwriters.

One focus is to develop new approaches to risk assessment. Climate change is modifying general climatic and political frameworks in such a way that statistical methods and a simple extrapolation of previous trends are no longer suitable for drawing reliable conclusions regarding future developments. Thus, an increasing number of decisions is taken on an uncertain basis. A promising approach lies in Bayesian risk management techniques. They facilitate improved assessments of climate change impacts, as well as of climate policy and its financial implications. Bayesian risk management techniques therefore constitute a core element of the project. Results shall be achieved in collaboration with selected financial service providers, and shall be made available to financial market actors, who can then use them to set the course for improved adaptation and climate protection measures in the economy.

Core items of the working programme are to raise the status quo as well as actual requirements. Options will be sounded out by means of interviews and stakeholder processes. The project partners will examine both financial service providers' abilities of appropriately modelling climate risks, and the compatibility of different techniques with existing risk management practices. On this basis, three case studies will be carried out, which will serve to develop and implement new products and procedures. Finally, the results of the case studies will be analysed both separately and jointly, in order to draw conclusions for products and procedures designed for financial service providers. Further examinations, studies, expert meetings and workshops will complement research work on this subject and enhance the practice- and solution-oriented approach of the project. Consequently, all project activities are directly linked to financial market activities, thus gaining the most far-reaching effects possible.

In cooperation with the European Climate Forum, the working group “Bayesian Risk Solutions”, which is jointly run by the University of Potsdam, the Potsdam Institute for Climate Impact Research and the German Institute for Economic Research, provides tools and techniques for Bayesian climate risk management. These tools and techniques will be adapted and/or newly

developed in such a way that they can be used throughout the project. The German Institute for Economic Research furthermore brings in its skills for the projection of time series on energy consumption, shipping demand, oil price development and other variables essential to the project.

Projects C:
Accompanying projects
supporting the programme
klimazwei

Linking Research and Business – the Supportive Process of “klimazwei – Research for Climate Protection and Protection from Climate Impacts”

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Keywords:

Communication, economic perspective, information platform, supportive process, transfer

Summary:

The main objective of the project “Generation and conversion of action-oriented knowledge of global change” carried out by the Research Center Economics & Environment of the Cologne Institut for Economic Reseach (IW Köln) is to act as an interface between the research projects on one side and businesses and the generally interested public on the other. Within the process, aspects of economic relevance should be integrated into various projects and research findings will be transferred to the business world. Furthermore, extensive information about the research projects will be provided to businesses, policy makers, scientists and the public.

The funding priority “Research for climate protection and protection from climate Impacts” combines technological research with the assessment of economic and social impacts. Its aim is to discover chances and to help avoiding risks. Therefore, mitigation of greenhouse gases and medium term adaptation to the expected climate change are equally weighted. However, the developed strategies and options for an efficient climate protection and for the protection from climate effects will only be successful if appropriate players in business and society are informed and convinced of the research findings.

The project will serve as the interface between business, academia and society. Within this supportive process, aspects of economic relevance should be integrated into the various research projects. Furthermore, communication and information between the projects and transfer of research findings to the business world will be promoted.

The supportive process aims at spreading the developed strategies, procedures and technologies in enterprises of different industries. Research findings will be communicated in cooperation with the project partners through publications, lectures, workshops and other events. The addressees are representatives of businesses and economic associations, scientists and policy makers as well as the interested public. A broad impact is expected from a conference which is scheduled to take place in 2008/2009.

Heart of the supportive process is the website www.klimazwei.de. It displays all projects, project partners and project purposes in English and German. A quarterly electronic newsletter can be subscribed. It reports interesting developments of the projects. Additionally, the website acts as an information platform for all project partners, the media and the interested public. An archive with publications and press comments will soon be available as well as a download area for information material of the projects like reports or flyers. Finally, there are updated references to project events or information about climate change in general.

An advisory board has already been constituted on a first meeting in December 2006. It should help to guarantee a tight orientation towards business practice. The board consists of representatives of private companies, economic associations, administration and research institutions. They will help to identify suitable applications beyond the promoted projects and involved industries.

The main task of the advisory board is to advise the supportive process and to act as a link between business and research. This includes discussing the relevance of global change topics for the German economy, indicating research needs and contributing to the improvement of the cooperation between business and specific research projects. In addition, the advisory board should support the transfer of the results and make suggestions for further research.

Additionally, the Research Center Economics & Environment of the Cologne Institute for Economic Research carries out an extensive survey among medium-sized businesses about the relevance of global change topics. Chances and risks of climate change and the further research needs from the enterprises’ point of view are asked for as well. The survey is based on interviews with experts which were carried out for its preparation during summer 2006. A conference to discuss the results is planned for 2007/2008.

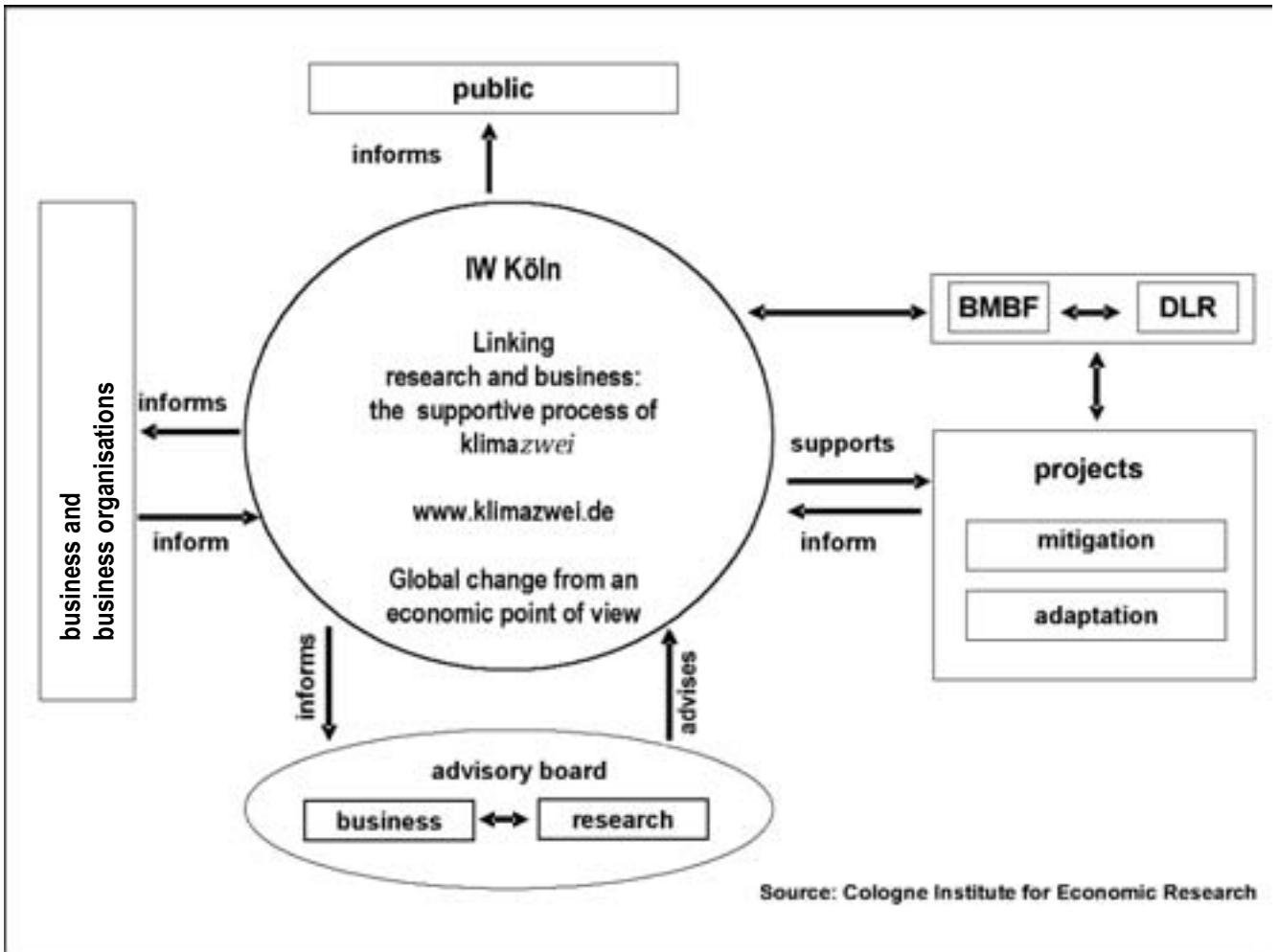


Fig. 1: Structure of the supportive process

DLR: German Aerospace Center

BMBF: German Federal Ministry of Education and Research



Fig. 2

Responsibility for Future Generations. Implementation of Sustainability in Schooling

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The project is conducted by an interdisciplinary project team. Members of the team are scientists from different universities and other institutions.

Key words:

Responsibility for future generations, sustainability, education, schooling, long-term decision-making, rationality, ethics, competences

Summary:

The assumption of responsibility for future generations requires a broad development of competences in perceiving, reflecting and solving problems of a long-term dimension. Hitherto, the advancement of such competences has not yet been a systematic subject of schooling and thus, it appears in the curricula only occasionally. The project will develop the basis for this implementation.

Extended abstract:

A successful implementation of the concept of sustainability in social planning and acting presupposes that it is supported by as many people as possible. Thus, the adolescent generation should be enabled to identify long-term problems as early as possible, to reflect on them rationally and to cope with them legitimately in view of their responsibility for future generations. Therefore, the project will give justified recommendations on how the adequate assumption of responsibility for future generations and a sound reaction on the desiderata of a sustainable development can be promoted by schooling.

Particularly the project "Responsibility for Future Generations. Implementation of Sustainability in Schooling" aims to justified recommendations on what exactly is to be promoted in school: What does it mean to assume responsibility for future generations adequately? How is 'sustainability' to be defined, if a sustainable development should measure up the responsibility for future generations? Which competences are to be developed and promoted to meet the challenges?

To work on these tasks, an interdisciplinary working group was established in early 2006. Macro- and micro-economists, philosophers, educationalists, specialists in decision-theory and risk-analysis as well as teachers work together on these tasks until the end of 2007 and will present an integrated study with detailed recommendations in mid 2008. It started with an explorative inventory of the status quo of the education for sustainability in Germany, working out that in the governmental guidelines for schooling the idea of sustainability is only of a marginal range and the daily practice in school is foremost dependent on the teachers' own initiative and conviction. In most cases it regularly submits a concept of preservation of natural resources instead of a concept of rational and accountable utilization as is implied in the idea of sustainability.

Hence in the very first place an offer is to be submitted for a plausible and comprehensible understanding of sustainability that meets as well the requirements both of the now living and of the future generations. A survey of the different concepts of sustainability and, since it is an essential part of it, of the different concepts of justice will be given and the pros and cons of each discussed. A so-called critical sustainability will be recommended that allows (a) controlled but principally unrestricted use of some classes of resources, as long as equivalent substitutions are hold available, (b) only restricted and controlled use of those resources that are not substitutable and (c) no use of unique resources that are destroyed by any utilisation.

Only those people will act according to standards as these that are motivated to. One and certainly the most effective way to motivate actors to behave in a certain way is to give reasons so that it will be their own rational choice. And since any manipulation of pupils is interdicted (and on the long run not effective) it will be the only way. So it is a further task to examine how and in how far such reasons can be given. Some reasons are given by pure egoistic rationality, e.g. in the area where there are convenient economic incentives. In other areas rational ethical arguments may demonstrate the appropriateness of behaving in accordance to sustainability principles. Besides these, aesthetical arguments will be proved.

In addition to pure motivation, competences to behave in accordance to sustainability principles are needed, too. Therefore a further and a central result of the project will be the deduction of a canon of competences that is inevitable for any sustainable action planning. This canon will certainly comprise some comprehension of the complex consequences of consumption and resource usage. But this will again require a trained competence to cope with huge masses of not necessarily coherent information. Moreover, in most relevant cases information will be accessi-

ble only incompletely and deciders have to cope with probabilities and profound uncertainties. So, beside others these are certainly some of the essential shaping-competences (Gestaltungskompetenzen) that should be promoted by any education for sustainability. Others may be the capacity to take the conse-

quences of one's own behaviour into account even if, in relation to the overall amount, it may be insignificant (e.g. the reduction of one's individual CO₂-emission compared to the total emergence), or the capacity of effective and cooperative participation in collective decision making.

'Service Group Adaptation' Supports Interdisciplinary Activities with Application Oriented Focus on Adaptation to Regional Climate Change

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Keywords:

Adaptation, regional climate change, Interdisciplinary Approach

Summary:

The German funding priority "klimazwei" promotes interdisciplinary projects from various thematic backgrounds to develop possible strategies and techniques on how to adapt to the imminent regional climate change in the upcoming decades. A special focus is laid on project schemes with an application oriented approach. Having members from several disciplines, the joint projects address various aspects of suitable adaptation processes in different geographical regions. Thus, the 'Service Group Adaptation' (SGA) has been established to provide a common database and methodological background to the project partners.

SGA provides both, simulated regional model data and climatological observations. To address this task SGA consists of two parts. One has been implemented as a project of the national climate research service group 'Model and Data' at the Max Planck Institute for Meteorology in Hamburg and provides model data and products. The second mission is carried out in close cooperation with the German Meteorological Service (DWD) in Offenbach and is concerned with long-term observation data.

Consulting and supporting the interdisciplinary project partners is understood to be the comprehensive purpose of SGA's work. Another superior goal is to facilitate the communication between the climate experts having a scientific background and the climate data users from all parts of society aiming at application oriented strategies.

Objectives of the Service Group Adaptation

Common data base:

The preparation of a well-founded database consisting of reliable climate observation data on the one hand and climate model simulations on the other hand is one of the main goals of SGA.

Long term observational data:

In close cooperation with the German Meteorological Service (DWD, Offenbach) long term data from routine observations throughout Germany and other European countries are supplied. In-situ observations and results of the climate monitoring are made available to the klimazwei projects by the web portal of the DWD. The SGA scientist at the DWD assists the klimazwei projects in their data request and data processing.

The access to climate time series of monthly, daily and hourly values is realized by the web application WebWerdis. As a result of the EUMETNET [1] programme UNIDART [2] WebWerdis is designed to incorporate also data from other European countries. Klimazwei projects contact sga@dkrz.de to get free access to the WebWerdis portal. The registered user may choose the different stations, meteorological parameters and time periods. The tool is adapted and developed further according to the requirements of the klimazwei projects. The requested data are provided together with describing metadata as XML files.

The observation data are completed by climate monitoring products like average means or gridded fields (resolution 1km) of different monthly values and – for precipitation only – additionally of daily values. These products are not yet integrated in WebWerdis but may be provided on request.

Up to now, a lot of historical meteorological observation is not yet available in digital form – especially data from earlier than 1951. Thus, the German Meteorological Service initiated the project KLIDADIGI, to digitize additional historical german climate observations in order to enlarge the number of long running (>100 years) time series of daily values.

Regional climate model simulations:

SGA-Hamburg presently processes and consolidates the output of regional climate simulations and prepares a certain set of climate indices and tools for extreme event analysis. The long term simulations of two regional climate models, CLM [3] and REMO [4], are provided on numerical grids with a horizontal resolution of about 20 km and 10 km, respectively. The model area of CLM covers the west European region while the REMO model has been run for the German, Swiss and Austrian area. The climate simulations describe the climate of the present and future decades up to the end of the 21st century under several possible climate conditions. The model variables are meteorological and physical parameters of the atmosphere and soil. The full list of model variables is available on the respective website of SGA [5] and REMO [4].

Data formats:

The output of the climate simulation runs consists of binary numerical data, which is provided as time series of the meteorological parameter fields on the respective model grid. For numerical reasons both regional models are computed on grids with rotated coordinates. The simulated data on the rotated grid is called ‘data stream 2 (DS2)’ to distinguish it from data products, which are post-processed (see below). The binary data format of data stream 2 is netCDF [6] in case of CLM data, while REMO data is written in IEG format [see 4]. The model data is archived together with a meta data description giving useful information on the model parameters. Basis for the meta data description is the international CF-convention [7], which is a worldwide accepted standard for climate data description. It serves e.g. to identify the appropriate model parameter if data from different models shall be compared.

The time series of the model output variables consist of single parameter fields given in certain time intervals. The time resolution depends on the given meteorological parameter and ranges from hourly values to 3-hourly (CLM only) or 6-hourly (REMO only) and daily values. The simulations include 2-dimensional near surface fields as well as 3-dimensional atmospheric parameters on several air pressure levels (REMO: 3 pressure levels, CLM: 6 pressure levels) and a set of soil fields in several layers below the surface (REMO: 5 layers, CLM: 10 layers).

Data products:

As a special service for the klimazwei project partners, SGA post-processes the original model data from the computational rotated grid (DS2) and transforms it into a dedicated data set of the meteorological parameters as time series on an equidistant geographical grid (REMO: 0.1°, CLM: 0.2° horizontal resolution). These time series on the equidistant geographical grid are called ‘data stream 3 (DS3)’. Additionally, a set of statistical indicators like mean or accumulated values for different time periods (daily, monthly, yearly, 30-year climate reference) and certain climate indices are in preparation and will be provided along with the data.

The following table shows the climate indices for which the appropriate statistical tools will be provided. The indices refer to each calendar year and are computed according to the recommendations of the CLIVAR expert group [8a,8b]. The 30-year climate reference values will be prepared for the model parameters ‘2m-temperature’ and ‘total precipitation amount’ for the reference periods 1961-1990, 2021-2050 and 2071-2100, respectively. Other periods and parameters may be processed on user request.

Temperature indices	Precipitation indices	Other indicators
frost days, frost days where no snow, ice days, summer days, tropical nights	wet days, heavy precipitation days, very heavy precipitation days (> 1,10,20 mm/day)	wind chill temperature
consecutive frost days, consecutive summer days, heating degree days	consecutive dry days, consecutive wet days	humidity index
several temperature indices with respect to given percentile of climate reference period	several precipitation amount indices with respect to given percentile of climate reference period	strong breeze days, strong gale days, hurricane days (> 10.5, 20.5,32.5 m/s)
heat wave duration index, cold wave duration index, warm spell days, cold spell days	highest 1 day precipitation amount, highest 5 day precipitation amount	
intra period extreme temperature range, growing season length	simple daily intensity index	

Archive:

The simulation data and the data products are archived in the climate database of the World Data Centre for Climate WDCC [9]. This database is a long-term archive which is run and maintained by the group 'Model and Data' [10] at the Max Planck Institute for Meteorology in Hamburg. The WDCC data base provides both, a user friendly web based search and download interface CERA [11] and a remote access mechanism to handle large user downloads in a comfortable way.

Download and availability:

SGA advises and supports the project partners in downloading the simulation and observation data from the respective database and to choose the suitable graphical tool for illustration of the data sets.

The regional climate simulations with the REMO model are available on request via email to remo-daten@dkrz.de. Currently, the model simulations with the CLM model are being processed. The data of the complete simulation period from model year 1960 to 2100 is expected to be launched by the end of 2007. See SGA's website [5] for the actual status of the model data availability. For further questions please address to sga@dkrz.de.

Project monitoring**Topics:**

The project proposals that are grouped in the BMBF funding priority *klimazwei* cover a wide range of strategies on how to adapt certain parts of public life, economy, society and the natural environment to the impacts of regional climate change. The topics are widely spread over urban management, building services engineering, agriculture, forestry, water and energy management and cover aspects of extreme events and the impact on tourism. The subjects of regional networking, education and communication are addressed as well. Participants from different disciplines are joined together in all projects. This allows for an application oriented approach towards the projects goals and promotes a variety of starting points to investigate and develop manifold adaptation strategies.

Project specific service:

Due to the widespread range of project topics and consequently different levels of meteorological expertise of the project partners, one of SGA's main objectives is to offer an individual service to the climate data users, who might not be familiar with handling climate model data or climate observations. Hence it is vital to raise the overall level of understanding for the characteristics, performance, power and limits of climate model simulations, climate observation data and future scenarios. SGA gives advice to the clients on handling and application of climate data in their respective project context.

User dialogue:

The dialogue with this user group, having expertise in their particular fields, is essential. In order to avoid misunderstandings we

carefully discuss and explain technical terms from meteorology and climate modelling, which might have different meanings in different disciplines. The high potential of the application oriented players from different thematic backgrounds to develop innovative adaptation strategies to regional climate change should not be lost due to misunderstandings.

Communication platform:

In case of problems and questions of the data users concerning climate modelling, observations or general topics of climate change, SGA offers individual advice and helps to get in contact with climate experts in the particular field. On this behalf SGA initiates a climate expert communication platform on its website [5], where the topics from various fields are introduced and the contact to the particular experts may be arranged. SGA encourages transdisciplinary cooperation between participants from business, society and different scientific fields and helps to establish a fruitful dialogue with the climate researchers.

The joint project partners with their individual skills in meteorology and climatology may use the communication platform for their respective purpose. It aims on the one hand at an exchange of experience between the project partners (who themselves are concerned with aspects of climate observation or climate modelling) and the appropriate climate experts. On the other hand, for those who are less familiar with climate research themselves, talking to specialists helps to deepen the general insight into the complex climate system. An insight, which is crucial in order to use the climate data in a sensible and successful way according to the actual project scheme.

Besides the initiation of this communication point, SGA maintains the contact with other European activities in the field of regional adaptation to climate change. The project partners are welcome to benefit from this to gain more information on similar efforts in other European countries.

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Notes

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