Carbon market in the new building sector in China – Programmatic-CDM, sectoral approaches, development of a national trade platform

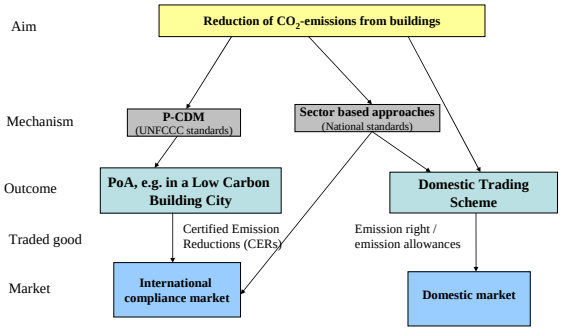
Introduction

Rapid urban development and climate change are paramount challenges in the 21st century. In China, energy consumption in buildings accounts for about 30% of the national primary energy consumption and contributes significantly to national greenhouse gas emissions. This share is expected to rise further as 2 billion square meters of new floor area are expected to be added to China's expanding urban areas every year. This construction boom, expected to continue for at least the next three decades, coupled with an increase of people's living standards, will inevitably lead to even higher energy consumption in buildings if no action is taken today.

A reversal of this trend can be achieved if new buildings are designed, constructed and assembled in an energy efficient manner and existing buildings are refurbished too. So far, the success of activities to increase energy efficiency has been limited due to a lack of proper means like holistic planning, effective supervision systems and due to peoples traditional behavior and structural barriers. Additional incentives and powerful drivers are required to speed up changes. Carbon trading schemes – both on national or international level – can provide cost-effective solutions that incentives increased energy efficiency and the utilization of renewable energy technologies.

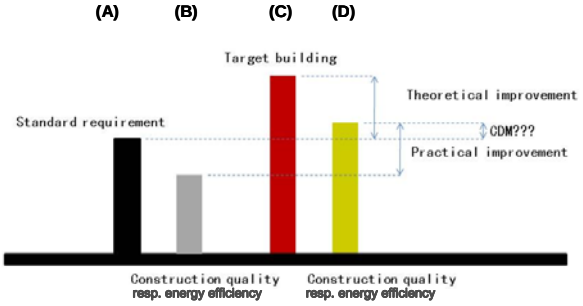
The Chinese Ministry of Housing and Urban-Rural Development (MOHURD), AHK, Tsinghua University, Climate Focus, HOPA International, BBS International, CSTC and the Xiamen Construction Commission have completed a project that provides the tools necessary for a successful application of international carbon finance to the building sector e.g. in building settlements in so-called "Low Carbon Building Cities". The work of the team covered the following:

- Development of a template Design Document (PoA-DDs) for a small scale CDM Programme of Activities(PoA) in the building sector in China's Hot Summer and Warm Winter climatic zone including the whole territory of Hainan, most of Guangdong and Guangxi province, south of Fujian, small part of Yunnan and Hong Kong, Macao and Taiwan.
- Establishment of tools for the calculation of benchmarks for cooling electricity consumption in seven sample building types in Xiamen.
- Design of a blueprint for a domestic trading scheme of credits from the building sector
- Evaluation of the feasibility for sectoral approaches in the building sector.



The results of the discussions on the Green Building Conference will be included in the Final Report of the project.

Big risks for the overall results in case of new buildings are deviations due to a lower planning and construction quality (see Figure below).



That means a voluntary based supervision of a holistic planning and application is very much advisable or necessary. As the quality of design and construction respective assembly decides the success of PoA implementation, the local coordinator of the PoA, the so called coordinating entity, is expected to make solid efforts in supervision, training and consultation of each project.

Energy Efficient Technologies

There are manifold energy efficient technologies now existing in the world market. China has gradually updated its energy regulation system, its standard system, and the material requirements issued in 1995. After 15 years of development, till 2010, many other energy efficient standards and regulations came into force to promote the usage of energy efficient materials, technologies, systems and solutions. However, the availability, commercial situation, and the performance of different energy efficient measures remains similar unclear like the understanding of their utilization and their application quality. Therefore, during this project the emphasis was laid on most effective, fully developed technologies, materials and systems which have reasonable costs and are quickly integrable. Not the standards, the missing holistic planning know how, the absence of effective supervision systems by very poor application and assembly quality as well as a traditional behaving of people takes away most of the possible sav-

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ings. This shows also the discrepancy (see second Figure) that carbon trade in building will finally trade the examined credits which should only rely on the calculation of metering result of a building's energy consumption.

Recommendations for the applicable area, suitable climates, and possible (holistic) system combinations of applicable technologies are displayed, also for a better understanding of important implementation criteria, since the same technologies may work remarkably different under different circumstances.

Massive application feasibility in short term is another very important criterion. Technologies which are reliable, low priced, easily and wide-spread installable and have a relatively good performance are much more useful, than high-tech ones, even though they have better performance, because of a too long integration time. The scale of urbanization forces all involved parties to apply solutions with immediate energy efficiency effect and can solve successfully common problems.

International carbon trading

The Clean Development Mechanism (CDM) is one of the flexible mechanisms under the Kyoto Protocol. It aims at assisting developed countries realizing their emission reduction commitments more cost efficiently and at the same time help developing countries in achieving sustainable development. Under its programmatic enhancement, known as Programme of Activities ("PoA"), the CDM allows the inclusion of numerous small emission reduction projects within one settlement under one umbrella, thus paying tribute to the requirements of the scattered nature of emission reductions in buildings. This was the reason why the application of the CDM to single building projects has been limited in the past. The development of reliable baselines as a basis for the calculation of emission reductions and the high CDM transaction costs have so far been a major barrier to the development of PoAs in the building sector. This Project pioneers in solving these bottlenecks as it provides approaches to baseline establishment and facilitates the development of PoAs through the provision of a template PoA Project Design Document for a new buildings sector in a hot and humid climate. The verification in other climates with different boundary conditions and requirements is necessary in the future.

The sale of project based emission reduction certificates ("Certified Emission Reductions" or "CERs") on the international carbon markets creates necessary additional revenues for energy saving projects in order to render them more economically attractive. In this project, carbon revenues help the local construction authorities in Xiamen, Fujian Province of China to effectively improve the performance of new buildings beyond the mandatory building standards.

Template PoA-Design Documents

The PoA Design Documents (PoA-DDs) form an integral part of the CDM development and are a major cost item in the development process. The project has developed a template PoA-DD available to CDM developers and project proponents that can significantly reduce development costs. The templates contain the necessary parts of the CDM SSC-PoA-DD (Version 01) and cover emission reductions from a range of energy saving measures and applicable CDM baseline and monitoring methodologies. The template will be made available on the website of AHK (www.bj.china.ahk.de).

	Proiect activity	*Methodology name and Meth No*
	Non-residential buildings:	
1	Improved insulation of the external walls and ceilings and improved insulation through the installation of energy-efficient windows going beyond the mandatory national building efficiency standards applicable for Xiamen Improved energy efficiency of cooling devices.	Energy efficiency and fuel switching measures for buildings (AMS-II.E)
2	Installation of cooling/heating/hot water producing facilities from renewable energy sources (advanced solar-thermal, sea water and air source heat pumps)	Thermal energy for the user (AMS-I.C)
3	Installation of non grid-connected power-generating facilities from renewable energy sources (photovoltaic)	Renewable electricity generation for captive use and mini-grid (AMS-I.F)
	New residential buildings:	
4	Improved insulation of the external walls and ceilings energy-efficient windows going beyond the mandatory national building efficiency standards applicable for Xiamen leading to electricity savings generated from fossil fuels. Installation of cooling/heating/hot water producing facilities from renewable energy sources (advanced solar-thermal, sea water and air source heat pumps); Installation of power-generating plants from renewable energy sources (photo-voltaic).	Energy efficiency and renewable energy measures in new residential buildings ((AMS-IIIAE)
Source: UNFCCC. http://cdm.unfccc.int/methodologies/index.html		

Determination of benchmarks for cooling energy consumption in different building types in Xiamen

To set up a benchmark for cooling energy consumption, the Xiamen Government delivered statistical data of the observed cooling electricity consumption for the buildings in Xiamen as well as respective data for seven sample buildings for these types. The data was taken in the years 2009/2010. The calculated energy demand for the sven sample was derived with the BEED software according to the thermal design code GB 50176-93 and GB 50019-2003 being currently used in China. The estimated energy demand for the seven building types is rounded to the nearest 5 or 10 digit expressing that the result is related to a building type, not a single building.

No.	Building type	Cooling electricity consumption in seven sample buildings in Xiamen based on the statistical data (kWh/m²)	Calculated cooling electricity demand of seven sample buildings in Xiamen based on the applicable energy efficiency standard in Xiamen (kWh/m²)	Estimated energy demand for cooling for seven sample building types in Xiamen (kWh/m²)
a.	Single family house	33.58	31.35	40
b.	Multi-storage house	37.77	42.23	40
c.	Office building	43.23	36.80	40
d.	Shopping centere	84.50	74.75	75
e.	Hotel	109.91	119.21	115
f.	Congress/Fair building	n.a.	n.a.	110
g.	School	60.53	58.20	55

Low Carbon Economy in Cities in China - BEE (Building Energy Efficiency) Simulations – Possibilities to estimate the national potential of CO_2-emissions for buildings

Aim of this part of the research was the calculation of the energy consumption and the $C0_2$ emissions of the seven characteristic building types for new buildings in China under the climate conditions for the "hot summer and warm winter" region by imple-

menting a building energy efficiency simulation. In this case, the possible variables, including building type, size, height, orientation according to azimuth of the buildings, the different ratios of the wall-/window areas of the facades, different uses and quality standards of the building services installations for energy distribution and energy production, are taken into account. Furthermore, the range of influence on planning- / arithmetic errors and execution mistakes had to be described.

No.	Building type	**Simulated energy demand** (mean value) for cooling, heating, dehumidification acc. act. Energy Standard China	
		kWh/m²	kg CO_2/m²
a.	Single family houses	43.10	36,59
b.	Multi-storage houses/multiple families	54.28	46,64
c.	Office buildings	101.29	87,03
d.	Shopping centers	114.02	97,97
e.	Hotels	164.93	141,71
f.	Congress/Fair buildings	112.60	96,74
g.	Schools	76.37	65,61

The simulated energy demand is simulated with TRNSYS based on structural-physical characteristics of the buildings according to the Chinese requirements in the relevant regulations (for residential buildings: JGJ75-2003, resp. for public buildings: GB50189-2005), boundary conditions of the users behaviour, the size of the building, the ratio of area to volume (A/V) of the building etc. By the end of the project, the PoA-DD will contain specific CO_2-emission reductions in a CDM scenario.

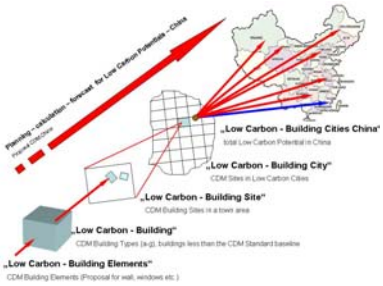
CO_2-emission reduction potential

The transfer of the results of the single buildings to complex Low Carbon Building Cities was reviewed by the city of Xiamen/Jimei. The following CO_2-emissions could be found in the different building types.

XIAMEN-Jimei		(t CO_2/a)			
Building type	Floor area (m²)	Baseline	3 *	4 *	5 *
Single family houses	125969	4624	3558	2562	2242
Multi storage houses	1142439	47464	34690	24977	21855
Office buildings	946974	68184	52622	49853	47083
Multi storage houses / Office buildings (mix)	1247028	64288	42639	40395	38151
Shopping Centers	647986	52158	38783	37032	34975
Hotels	142016	16831	8190	7759	7328
Congress / Fair	11192	1078	748	709	669
Schools	68966	3493	1931	1829	1728
Other buildings	535384	40473	30718	29198	27576
TOTAL	4867954	298594	213879	194313	181606
Total (in % of baseline)		**100%**	**72%**	**65%**	**61%**

CO_2-emissions for heating, cooling and dehumidification MIN values. Standards according to: Baseline = applicable Chinese standard ; 3* acc. Chinese Green Building Standard; 4* German ENEV2001); 5* German ENEV 2009.

Even considering regional characteristics, it is shown that there is a possibility to determine the CO_2 potential for „Low Carbon Cities" of China. The results will constitute a basis to make decisions by implementing a new CDM-baselines to limit the Energy Demand in a special „Low Carbon Standard", a standard quite above the actual energy standard of China.



The possible CO_2-emission reduction potential of the Low Carbon Cities currently being planned shows that an economic and ecological building process in China will be realizable once the requirements of the energetic quality of the buildings are reasonable increasing as well as the requirements for efficient energy distribution and energy production systems. This building process may path the way to accomplish global restrictions of CO_2 emissions in the construction sector. To establish China as a pioneer for the CDM in the building sector, measures have to be done in a short term.

Sectoral Approaches

According to the Copenhagen Accord, 100 bn Euro per year financed by the Annex-I countries shall be spend in a post Kyoto period after 2012 until 2020 on Greenhouse Gas mitigation and other measures in developing countries including sectoral approaches. Sectoral approaches are one type of Nationally Appropriate Mitigation Actions (NAMAs) as called in the Bali Action Plan, which are mechanisms for promoting GHG abatement actions in a Post-2012 international framework. Basically, sectoral approaches are designed for improving the whole sector's energy efficiency performance and reduce its emissions with external climate change financing. Currently, options such as the Sectoral Emissions Trading, the Sectoral No-Lose Target, Sustainable Development Policies and Measures, Policy CDM and Technology Targets are discussed. The Sectoral No-Lose Target (SNLT) aims at reducing emissions from a certain sector below a pre-defined baseline standard. It is a baseline and credit mechanism, meaning that emission reductions will be generated ex-post (after verification of the real emissions and comparing them to those agreed in the baseline scenario). Since China as a developing country rejects accepting binding emission reduction targets, we come to the conclusion that an SNLT, where the host developing country faces no penalties if the baseline is not met, is the likeliest option for China.

National Perspective

We have analyzed possible design options of the SNLT from the perspective of the central national government (e.g. MOHURD). Since China can sell international carbon credits only in case of "beating" an internationally agreed "sector crediting baseline", we recommend establishing a Chinese domestic cap-and-trade system that limits the amount of emissions that each participant of the scheme is allowed to emit. This is the most cost-effective approach to ensure that the relevant trading entities will reach the whole sector's target set by the central government.

Approaches to determine the optimum amount of emissions that the building sector is entitled to emit under the Chinese trading system and the related applicable allocation mechanisms issues

of penalty and compensation have been analyzed. Main role of the Chinese central government includes the implementation and supervision of the emission trading system as well as managing the cash flow between international carbon markets and the trading entities.

Local Perspective

After discussing the design of a domestic cap-and-trade system from the perspective of the central government, we have analyzed what actions have to be taken by the trading entities and what the financial impact of such an emission trading system for them is. Moreover, we come up with advice for optimal decisions on energy efficiency means and investments by trading entities suitable for the relevant climates in China.

If the international community comes to a post-2012 agreement which includes the option of a SNLT for the Chinese building sector, we suggest seriously considering this kind of carbon finance mechanism.

Domestic carbon trading

In order to control carbon emissions from the building sector, greenhouse gas emissions from a certain segment of the building sector can be capped under a domestic carbon trading scheme. In order to meet the mandatory cap, participants are allowed to trade emission allowances or emission reduction credits. A market for emission reduction credits or emission allowances would thus be created. The project has identified two options for the design of a domestic trading scheme. The pilot application will be limited to one region/city, at a later stage, it can be applied countrywide.

Trading in the commercial building sector

Large non-residential buildings consume larger amounts of energy relative to residential buildings and contributing significantly to carbon emissions by cities. This scheme caps the emissions from the overall energy consumption of large commercial buildings. Building owners as the participants of the scheme are required to reduce their greenhouse gas emissions against current levels. Emissions are controlled through the issuance of emission allowances that entitle participants to emit a certain amount of CO_2. Allowances are allocated to the buildings based on historic or simulated emission levels, factoring in an annual emission reduction against baseline emissions. If the emissions of a building exceed the stipulated amount, building owners have to reduce emissions through investments in energy savings / application of renewable energies or purchase additional allowances from the market. Building owners with excess allowances can sell those to generate additional income. Whether a building exceeds its emission levels is determined by independent auditors using measured energy consumption data.

Trading in the residential building sector

The Chinese government has launched an ambitious program for the retrofit of residential buildings in Northern China, supported by a large subsidy scheme. The proposed trading model supports the retrofit activities as it increases the efficiency of subsidy allocation for the retrofit of residential buildings and introduces binding emission reductions. The recipients of the emission reduction targets are districts of cities that are in charge of implementing the retrofits. Districts that fail to meet their targets have the option to purchase excess emission reduction credits from other districts. This allows an optimal allocation of carbon abatement activities as energy saving measures will be implemented where cost-efficiency is highest while those districts with high energy saving costs will turn to the market for compliance. This is currently not the case, as subsidy capital is applied irrespective of the districts' abatement costs, leading to an inefficient use of public money. Efficiency gains are achieved on district level through performance-based allocation of subsidy money: Energy Service Companies (ESCOs) that are in charge of the development and implementation of retrofit plans compete for subsidy-money and only those retrofit plans with highest cost-efficiency will receive funding. Compliance with the energy saving targets is determined by independent auditors using default energy saving values for different retrofit measures.

In a next step, the trial application of such scheme is recommended. To this end, a pilot city will be selected. With the help of experts, the proponent of the trading scheme will then determine the detailed setup of the organizational framework of a carbon trading scheme, research and define emission reduction targets and implement the scheme.

Conclusions and next steps

This project could successfully evaluate a template solution for a pCDM project in new buildings in a Low Carbon Building City in China's south-eastern region, even when there are still a lot of practical barriers. The result shows that there are high potential savings to be gained by carbon incentive mechanisms. Given the existence of a post-Kyoto regime, sectoral approaches were feasible for China, probably on the basis of Sectoral No-lose Targets. Parallel to existing international mechanisms, a domestic carbon trading scheme is able to provide incentives for energy saving and CO_2-emission reduction targets based on national rules. Against the background of the results of the project, future tasks are:

- To implement pCDM in the pilot city Xiamen and verify the performance of this energy saving method for a large number of buildings.
- Develop a similar approach for other climatic regions to verify that this method is transferable to other boundary conditions and Low Carbon Building pilot cities.
- To test the domestic carbon trading scheme in a trial application and determine details of organizational setup, targets and implementation structures.