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Use the Carrot as well as the Stick

How to increase efficiency of energy and resources in the urban construction sector of the PR China

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Preface

Energy is an important basis for economic and social development. Energy efficiency is an important indicator for good economic and social management. Since longtime, because of several obstacles like institutional structural issues, economic management in China is quite crude and energy efficiency is still underdeveloped. This has led to energy spill and serious impact on environmental quality, which is incompatible with sustainable development strategy for China. Energy demand in buildings, in particular energy use for heating and air conditioning has a considerable share in the total energy consumption. Energy demand of urban buildings alone amounts to almost 15% of the total energy consumption. With improvement of life quality and increasing urbanization, the proportion of energy demand in buildings to the total energy demand will rise strongly. According to experience in industrialized countries, energy consumption in building will be higher than 30% of the total.

In China, because of restraints of some factors the thermal insulation of building shell including doors and windows is not advanced. Chinese buildings belong to high energy buildings kind. Inadequate administration leads to deplorable energy waste in buildings. According to statistics, the specific energy consumption per m^2 built area in China is 3 times higher than in industrial countries with comparable climate. Therefore the improvement of energy efficiency in buildings is a very important measure for energy saving and sustainable development.

Dr. Suding, division director for environmental protection and energy management of GTZ China, giving strong support to Sino-German technical cooperation, has studied in depth the Chinese energy efficiency. In the framework of the Sino- German project Environmental Sound Urban Energy Systems he has investigated the issues of energy consumption and – management in buildings. In reference with the experiences and standards made by developed countries he has analyzed the main causes of higher energy consumption in China: on the one hand incentive policies and precise regulations are missing, on the other hand sanctions to enforce standards are lacking. Another problem is the imperfect cooperation and coordination between the institutions and companies for construction, heat supply and electricity supply: everyone makes as he likes. Dr. Suding has pointed out in his report, that in order to increase energy efficiency in the building sector, we must not only create clear standards and regulations, but also the respective incentive and enforcement. Those who do not comply must be penalized. This it what the title of the report signifies: “use the carrot as well as the stick”. The report observes the problems in the energy utilization in China from a foreigner’s point of view. That is a singular perspective, which can broaden our field of vision. The report is very useful for the respective institutions and personals to in depth understand the problems and challenges in particular for the improvement of the energy management and the energy efficiency in buildings.

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1. Introduction and basic proposal

Future urban fossil energy consumption in China could be reduced significantly, allowing for a better quality of life at affordable costs to its citizens while mitigating atmospheric emissions. At the same time, the overall economics of urban energy systems could be improved by optimizing investment, making new technologies work for the people and developing modern industries for the future. Fast growing Chinese cities could meet their air quality targets. This general conclusion can be drawn from the joint Sino-German USE project[1]

The bad news is that energy-saving potentials in China are not being implemented in the current building boom, in that way foreshadowing future energy consumption and the environmental situation in its cities. [2] The current period may be considered as a period of missed opportunities.

Chinese authorities are implementing a policy for energy saving in urban buildings. In an attempt to push forward several trailing issues, the Ministry of Construction and Ministry of Finance, backed by 7 other ministries, took a forceful initiative in August 2003. The initiative focused on the enforcement of efficiency standards for new buildings, the introduction of control and metering equipment, consumption-based billing--considering heat as a commodity-- and also the opening of ways for franchises to engage in urban heat supply.

This article was conceived before August 2003. Many of its proffered suggestions were considered in the Chinese government's initiative. However, the basic proposal, i.e. to. broaden the policy approach and deal with barriers and the incentive structure, is still not fully taken into account.

The policy approach used by the Chinese Government of imposing and enforcing standards on industry practice is correct and necessary. Now the Chinese government is adding institutional and organizational changes, which is another step. Still missing, however, is the application of economic instruments for incentives and sanctions.

[1] USE is a joint project of NDRC and GTZ, sponsored by the German Federal Ministry of Economic Cooperation and Development (BMZ). USE is about energy conservation, use and supply in the urban building sector. The basic idea of USE is to change the urban energy system by introducing a new urban energy-planning concept. In its first phase, the USE had activities in 3 different cities and on the national level as well. During the work, the enormous saving potential in the sector became evident. However, it also became evident that it requires more than a change in planning procedures to tap the potential.

[2] China currently consumes about 130 million tons of standard coal equivalent per year just for space heating of urban residential and commercial buildings. Most of this energy is wasted. The most critical aspect of China's building energy waste problem is that the use of highly energy-inefficient designs, materials and constructions are continuing unabated through the current building construction boom." (World Bank)

Progress has been slow up to now. Implementation of standards meets obstacles; enforcement encounters reluctant stakeholders, altogether slowing down the process of change. It seems that the current incentive structure operates against new and more efficient solutions in urban energy systems. A very important step would be to overcome the reluctance to implement consumption-based billing.

This article argues for a focused revision of the whole incentive system in the building and heating sectors in order to support energy efficiency standards, or even encourage stakeholders, themselves, to improve efficiency over and above the minimum requirements.

2. The issues to be addressed: Persistent inefficiencies in building energy systems

Inefficiencies persist in all parts of the technical energy system of urban buildings China, i.e. building structure and shell, internal technical systems, energy supply systems. For example:

- *A significant share of new buildings being constructed in China is still based on older design principles, not on current standards.*
- *For the implementation of new standards planned for introduction in 2005, the practical solutions have not yet been demonstrated.*
- *No significant energy-saving modernization activity for existing buildings can be observed.*
- *In new buildings, heating systems of the past (even single pipe systems) are still being installed, particularly in low-cost construction and social housing.*
- *Installations to control heat supply in apartments are only installed in high-cost construction, a small fraction of the total.*
- *The introduction of consumption-based billing is postponed once again.*
- *Decentralized individual air conditioning split systems are the common feature in cooling and adding additional heating in winter, causing ever higher peak load demand.*
- *Advanced technologies (heat pumps) are only applied in modern commercial or public buildings, or in international cooperation projects.*
- *In district heating systems, high heat losses are common.*
- *In spite of idle heat generation capacities of district heating systems, new separate capacities are added instead of integrated optimization.*
- *Load factors of CHP are low.*
- *New cogeneration plants are few.*
- *Tri-generation (heating, cooling and electricity production) is hardly considered.*
- *Possibilities to use waste heat are rarely used.*
- *Gas supply systems are being built without clear complementary to district heating systems.*

In sum, the implementation of available technical options for energy efficiency in the system is quite slow, new standards and regulations come into being with delay and the enforcement of

standards on the municipal level is far from effective. In some cases there is outright non-compliance. Advanced environmental-friendly building, heating and energy production technologies are adopted only in specific circumstances.

While the dynamics of the building sector is dramatically high, it seems there is inertia in the energy-efficiency aspect of the system. A strong and almost ubiquitous resistance to change in the building sector causes this inertia on the part of many stakeholders. That is all the more surprising as China has adopted clear guidelines in favor of energy efficiency and is implementing a targeted and active policy for energy conservation. The efforts of the Chinese Government are intense, there are some important achievements, but the present visible results are not satisfactory.

The effect of the slow enforcement of energy efficiency in building sector policies is that energy consumption in urban buildings may rise from 130 million tons of coal equivalent to something like 450 million tons by 2015. Because of cleaner coal technologies and coal substitutions, emissions will not increase quite as dramatically. Still, this scenario is a nightmare for climate change.

Most stakeholders tend to decide against energy and resources efficiency, while others are noncommittal. Stakeholders do not feel compelled towards energy efficiency - and even less towards renewable energy – in buildings, because the economic incentives for that are not existent. The incentives are rather adverse.

We therefore recommend a change in policy, or rather a complementation of the policy with new elements on all levels, national, sectoral and municipal. The current command and control policy based on standards is not sufficient. It has to be complemented by incentives and other institutional changes in order to be appropriate for the new institutional environment where many stakeholders make decisions in their own right.

3. Why is implementation and enforcement of efficiency in buildings so slow?

3.1 Current policy in the new business environment

The Chinese Government has been pursuing an active policy of energy conservation since the mid-90s. A very general energy conservation law came into effect in 1998; however, the Ministry of Construction had already developed the1996-2010 Long-term Development Plan for Building Energy Efficiency in China, which plans to step up building heating energy efficiency levels. In 1996 the Energy Conservation Design Standard for heating of new residential buildings (Standard JGJ26-95) was enforced. Another standard of relevance is the Planning Standards for Residential Buildings (GB 50096-1999). Ministries try to ensure implementation (e.g. Ministerial Order from 2000: "*Residential Building Energy Conservation Management Regulation*"), as do provinces and cities ("*Planning and technical standards for the separate heat metering…*" issued by the Beijing Municipality.

China's approach to improving energy efficiency in buildings is a **command and control approach,** common to China's policies. It has a clear logical structure:

- The government issues a **guideline**. Its character is of a more general nature than that of legal acts westerners are accustomed to in their countries**.**
- **Research and development** is pursued by researchers in order to clarify the technical options.
- **Pilot and demonstration** plants are designed by design institutes and implemented within the relevant system in order to have proven technologies for elaborating reasonable standards.
- State-level authorities issue a **Standard** (e.g. 1995) case; there are recommendations given, which become industrial practice.
- **Implementation und Dissemination** of the standard is lead by the respective ministry on all levels, centrally and locally, and supported by regulations.
- The task of **Enforcement and Supervision** is then given to local governments, in this case in particular to municipalities and their construction bureaus.

This kind of approach has in the past been rather effective; however, in today's building sector, and in particular with regards to energy efficiency, it seems to fail its targets. In the new institutional environment, where many stakeholders act and the market place is supposed to produce the results with respect to quantity, quality and price, this approach has its limits.

The command and control approach works very well in an institutional setting, which exercises control over compliance and sanctions. It resembles the top-down instruction and supervision policy of the planned economy. Chinese organizations expect that it might work as effectively as in the past. But, institutional frameworks have changed fundamentally with the introduction of the market economy and administrative decentralization in China, and in a new institutional environment.

The change to a market economy has created many individual stakeholders in the building sector. These stakeholders are also more independent and even autonomous from the State and set their own objectives on the basis of market data. Even the managers of state-owned enterprises have considerable margins of freedom.

These changes make enforcement of standards and orders in general much more complex, because the stakeholders may not cooperate easily and information on quality and efficiency with respect to buildings is not easy to get. In effect, the energy quality of buildings is hidden. It is very difficult for a potential buyer or tenant to find out about future costs of heating and other energy services once the square meter related prices are abandoned.

In addition, decentralization has transferred more participation to municipalities.
At top levels, the competent ministry is backing energy efficiency strongly; and it is advantageous that the competences for building, building appliances and heating systems, gas

supply and urban planning rest with the Ministry of Construction and municipalities. There are, however, internal conflicts of interest, in particular in municipalities

3.2 Obstacles and resistance to change and trends in the wrong direction

Currently in China one can observe different phenomena of resistance to change in building energy efficiency.

Apart from the usual aversion to innovation, there are some specific tendencies, which are hard to break:

- Obstruction and delaying of new regulations
- Non-compliance to new standards
- Sticking to old industry rules, which have lost their rationale
- Barriers between vertical planning and services
- Preference for hardware
- Indifference to energy efficiency

3.2.1 Resistance to new regulations

Almost everyone agrees that metering and billing according to consumption is the key to more energy efficiency in the heating of buildings, both for its direct and indirect effects.[3] This logic is also widely accepted in China, and Chinese authorities are working hard to put metering and billing according to consumption into practice. What is surprising is that it takes so long to become implemented and enforced.

[3] In case of heating, the billing in more than 90% of the cases is still done by square meters and independent of consumption. That means that for the dweller there is no incentive for saving or disincentive for not saving. As long as it makes no difference to his expenses, the tenant of an apartment will not bother to adjust the hot water throughput of his radiators, even if he could. If he, on top of that, does not even have the possibility of controlling the heat supply in a given room, he will simply open a window in order to release excess heat. In existing buildings no incentives for investment forces
As long as the household's budget is not affected if energy input to heat an apartment is low or high, a prospective buyer or tenant will not give very much attention to heating energy saving features. The buyer will not consider the heating control and insulation standards of the apartment as an important factor as long as it will not have affect his or the tenant's future heating bills.

If these features are not in high demand, the developer has little interest in constructing energy efficient apartments—such energy-saving features remain an unimportant sales argument.

Metering and billing according to consumption would create incentives for saving in the short term; it would create demand for control equipment and lead to efficiency consciousness in the housing market. This assumption can already be proven in Beijing, particularly, and other places where natural gas has been introduced and the cost of heating has risen significantly: decentralized gas boilers are installed in large quantities, which allow individual control and billing of the heating costs. Apartment owners demand better insulation and install better windows by themselves. Developers voluntarily offer higher building standards

The discussion in this matter seems to revolve around the question of appropriate metering: in particular, whether it is sufficient to have "proxy" metering by indicators or whether it is necessary, in spite of higher costs, to have "exact" heat metering. This discussion has taken years and many essays and pilot projects have been carried out in China. Interestingly, such discussions have not taken place, for example, in Germany, where evaporation proxy meters were accepted without much delay during the 1970s

It sometimes seems that the discussion on metering methods has only been a means of delaying the introduction of new billing. Those stakeholders who could be on the losing side may have prolonged this discussion. To name a few:

- Housing administrations might receive less cash flow but still be forced to make important installation investments.

- Small heating companies fear lower sales income, which they might not be able to balance with their present cost structures.

- District heating companies also fear lower sales income which would only partly be offset by lower heat procurement costs, and might force them to cut costs and high fixed-cash flows.

Metering and billing according to (reduced) consumption actually might hit existing heating companies Heating companies have significant interest in energy conservation on the user side, as long as they get paid per m^3 heated. If metering is introduced and only smaller bills are posted, the income of these companies diminishes and they may not be able to cut costs accordingly. Actually, many of these heating companies are in the red already and have huge difficulties adjusting costs in the existing, rather comfortable, fixed-income situation.

Even the municipality may not be clearly in favor of energy efficiency and, for example, billing according to metering. On the one hand, the environment, urban planning and construction and other departments of the municipalities are pushing for environmental friendly solutions. On the other hand, the municipality has to take into account the interests of the housing, heating and gas companies and their employees, as well as the taxes that are paid from the heating businesses, etc. This may not be in the interest of the municipalities, in particular of the administration commissions as owners, if these companies' lower cash flow and subsequent cost-cutting were to result in a loss of jobs.

There is, however, one winner in this long quarrel: the manufacturers of small wall hanging gas heating systems: Natural gas availability has lead to the emergence of decentralized small apartment gas heating as strong competition for central and, in particular, urban large heating systems. This is a reasonably good system, which has taken advantage of the non-ending quarrel about metering methods.

3.2.2 Non-compliance with existing improved standards

With great effort, municipal construction bureaus try to enforce standards. However, there is an obvious non-compliance to existing standards, most flagrant in those heating systems where single pipe systems are still being installed. The non-compliance is less flagrant in insulation because more difficult to verify. Supervision and enforcement becomes an important issue, difficult to organize and perhaps even costly.

Apparently, the existing standards or regulations are not convenient for some stakeholders. They do not get rewards for complying with standards. Quite the opposite: up to now they may even profit from not complying.

Investors (developers for the free real estate market) receive few rewards for higher standards and they fear ensuing costs which are difficult to recover

The developer of a building will incur additional costs installing heating controls, efficient heating systems and insulation only if he is forced to by standards and effective supervision, or if he can sell the apartment at a better price and more quickly.

As long as there is a price regulation in the real estate market based on m3 prices, there are incentives for substandard construction. The real quality of the apartment has little effect on the selling price, as the quality is hard to prove (in particular if it is not easily verifiable, e.g. wall insulation quality).

For much the same reasons developers and investors in social housing also tend to build in substandard quality.

Similarly, construction companies may save on energy-saving installations when there is competitive bidding and they have to make a profit by cost-cutting.

Design institutes, architects and planners receive no rewards for energy efficient planning. Although they have no interest in the substandard, they also have few rewards for dealing with complicated matters of energy efficiency and passive solar housing. In general, they receive a rather limited time and money budget for the planning. So they tend toward standardized solutions: a nice appearance but not necessarily good operative quality.

Among the few stakeholders interested in compliance to higher standards are wall material and new technology companies. These would profit from change; however they do not wield direct decision-making power on the investment side. The developer makes the final decisions in the framework of norms and standards. Wall material and technology suppliers, therefore, have to lobby for higher insulation and modern heating at the governmental and standard-setting levels.

3.2.3 Outdated rules of thumb

Existing informal rules and procedures have impeded development, in particular in the urban heating and electricity supply systems. All these habitual rules have their historic technical and economic rationale. However, new technological development and changed framework conditions often render the historic rationale invalid. The problem is that the rules of thumb have become so deeply rooted in peoples minds, that they prevent innovative thinking and experimentation with new methods. Sometimes even informal rules of the past are incorrectly presented and understood as actual law.

Two examples may illustrate this behavior:

Case 1: The city of Beijing ran into a huge problem when it wanted to switch to natural gas…. The programs of switching from coal to natural gas fuel require substantial investment, which operators of boilers were not prepared to make, even if the cash flow increased because of the higher price for gas-generated heat. The operators had to be ordered to do so.

Small CHP stations, which could improve financial feasibility by switching to gas, have not been introduced, especially because there is no clear possibility for selling electricity to the grid at reasonable prices. This is especially odd because of the increasing electricity demand. Other arguments against the CHP idea were: the use duration is too short because the heating season has less than 3000 hours, and CHP plants must have at least 17 MW. Why? Apparently, the electric utility has set up internal guidelines, which are considered as strict constraints.

Case 2: *In Hohhot, an existing power plant was to be used as the source for expansion of the district heating system. For that purpose the heat transport line had to be extended. There seemed to be a rule, however, that heating supply lines should not exceed 12 km. This rule became a very significant obstacle for the project but has finally been overcome.*

These cases are certainly not unique. We believe that such rules are quite often upheld because of the benefits they bring to an interested party. In effect, they often prevent more efficient and innovative solutions.

3.2.4 Barriers between municipal services and utilities

Urban building energy systems options are increasingly complex. There are more and more alternatives to the common scheme of supplying a given number of square meters by a coal-fired block heating system. Extreme passive solar heating, which would render a heating system obsolete, is an option as well as heating, cooling and electricity produced by a small internal cogeneration plant. Many other possibilities exist. Their complex solutions involve more and more parties or stakeholders: urban planners, developers, architects, appliance dealers, gas, electricity and /or district heat suppliers and more.

In general, municipalities have to pursue different goals for economic, social and ecological development. The different departments of the municipal government have different objectives, which have to be coordinated by the mayoral administration. This coordination is based on a general mid-term planning, which is also the case with respect to energy and the environment. However, the planning and decision-making at the municipal level does not take into account the many options of energy saving and energy supply in any integrated way. Instead, in most cases, district heating, gas and electricity supply planning is carried out separately. In addition, buildings and their energy features are conceived in their own right, without looking at different savings and supply options. Only in a few cases is urban planning trying to optimize an integrated system of planning[4].

Important opportunities for energy and investment savings are being missed because of the separate planning and management of buildings and heating systems in urban areas. Buildings and their supply systems are not currently considered as one system due to the fact that different entities are involved, parties which may have more interest in saving on building investment (developers, investors) or expanding energy supply systems (appliance suppliers, heating companies, gas companies, electricity companies). Thus at present there is very little lobbying in favor of integrated low energy solutions.

The planning for urban energy systems in China is departmentalized and project-oriented instead of strategically comprehensive. Not only is the planning for the user systems (buildings) independent from the planning of supply systems (networks and production); even each network-bound energy supply system (gas, district heating, electricity) is separately planned. Therefore many combination opportunities, "synergies", are missed. This all leads to higher investment costs, higher energy consumption and higher emissions.

The institutional separation of urban supply companies negatively affects the cause of efficiency as long as there is no energy planning coordination by the municipality or no orderly competition in the marketplace. Thus it can happen that district heating and gas and electricity companies plan to supply heating services to the same market, not taking other suppliers into account and not considering savings possibilities on the demand side.

Another factor not taken into consideration is cogeneration possibilities, particularly small, decentralized options. Cogeneration involves an optimization between the generation of electricity and heating (and cooling) with regard to consumption and production. As the optimal production of the two or three products does not coincide with the demand structure of a given user or a user group, there is a necessity to feed surplus electricity or heat into the network of a third party. In China, this feed-in is not regulated. It can be refused. If it is accepted, the remuneration for this feed-in is very insufficient. The network operator does not like to buy back energy. The so-called *Distributed Generation*, the scheme in which many small suppliers feed electricity into the local network, is still an unknown concept in China.

[4] The integrated planning approach is the trademark of the USE project as has been applied in the city of Hohhot, in a residential area in Beijing and an industrial park in Suzhou.

Electricity suppliers are not forced to take in decentralized electricity; heating suppliers are not keen to take in recovered heat. And there are *no incentives* for them to do so. Up until now electricity companies have had no rewards for taking in electricity from distributed sources.

That means that it is necessary to create incentives. It is also necessary to reconsider the organization of energy planning and supply on the municipal level.

3.2.5. Preference for visible hardware and supply expansion

In China, the political and financial rewards are in general higher for expanding visible supply systems than invisible saving systems—especially the political rewards. Municipal leaders are considered rather politically successful when new infrastructures are highly visible. Creating an integrated energy system, which would render obsolete some of the infrastructure capacities, reduce investment, reduce environmental damage and save energy, might go completely unnoticed.

The uncoordinated way of independently planning supply and demand strategies may even cause a vicious circle of capacity expansion and higher consumption and material flow. Once supply capacity is existent, superfluous demand may be created. Once inefficient housing creates demand, supply is necessary and so on.

3.2.6. Indifference towards energy efficiency and loss of traditional wisdom

Many key actors in the building sector are indifferent to energy efficiency. Architects and engineering companies receive the same payment whether or not their designed system is energy efficient. If they are not familiar with energy saving concepts, they will, of course, not apply them, unless they are not forced or asked to. Planners in China work under very short time constraints. This is especially unfortunate as architect and building engineers are key planners.

The current urbanization process in China has certain features which drive up energy and other resources' consumption, in particular the separation of work and living locations of professionals as well as individual transport. Chinese urban planners have recognized the dangers of these tendencies and developed mixed urbanization models that do not require extensive daily movements from home to the workplace.

With respect to building energy, there is a tendency to forget about some traditional energy and resources efficiency concepts. Chinese urban planners should maintain the highly appropriate four to six story apartment houses with fronts facing south design concept. Such buildings maximize passive solar gain, forego expensive and energy-consuming elevators and offer other possibilities for energy, water and material savings, and in general also allow for a more social, self-controlled way of living.

Similarly, urban planners should reconsider traditional courtyard housing in the city's outskirts instead of energy-intensive North American type suburbs[5].

3.3 Stakeholders interest analysis and conclusion

As can be seen from the preceding analysis, only a small fragment of the stakeholders in the building energy system actively support the energy and resources efficiency policies of the Chinese government. A first listing shows that there are more stakeholders against than in favor of energy efficiency-- because there are more disincentives than incentives.

With very few drivers, a great number of breakers and some disinterested passengers, it is little wonder that the energy system of buildings does not advance quickly.

In the following table, a tentative listing is made. This analysis is still very incomplete. There are many other less obvious barriers, which may work more indirectly. The entire building and urban development system should be scrutinized for such barriers in order to find ways to remove or overcome them. Studies in other countries have identified hundreds of such obstacles.

Active	*In favor of energy conservation*	*At present not in favor*	*Neutral Noncommittal*
Ministry of Construction *Energy Efficiency Bureau,* *Some legislators,* *Urban planners,* *Urban Environmental Protection Bureau*	*Building material suppliers,* *Technologies providers*	*Developers,* *Investors in real estate,* *Heating utilities,* *Gas utilities* *Electricity generators,* *Electricity distributors,* *Municipal administration office*	*Consultants,* *Designers,* *Constructors,* *Owners/buyers of buildings/apartment,* *Tenants,* *Danwei decision makers,* *Standards enforcement officer,*

In such a study, formal rules and informal guidelines should be analyzed as well as the interests and incentive structure of the stakeholders and their collaborators. With the perspective of change, the potential driving forces for the cause of energy and resources efficiency and the use

[5] As a matter of fact, Chinese urban construction seems to be turning more and more to the energy and resources consuming life style of North American housing models and some European cities, abandoning its own knowledge of appropriate construction when constructing high rises in urban centers and villas in the suburbs. *Urban planning and architecture in North China seem to abandon an energy thrifty tradition*: Citing the American architect Jo Carter*: "Chinese cities (used to) end in six story walk up flats. Most housing faces south to maximize passive solar gain. They forego expensive and energy consuming elevators. New high density Chinese cities are becoming a series of large, gated, isolated islands surrounded by widened roads…Unsustainable sprawling suburbs of most North American cities …now making their appearance in Chinas cities*". One wonders why the Northern Chinese courtyard house is not being kept and further developed with some modifications, it being the most appropriate local building design for hot summers and cold and windy winters.

of necessary incentives to mobilize these forces should also be identified. That is already a first recommendation, from which other recommendations would follow:

4 Recommendations

On the basis of the preceding analysis and the experience in other countries, particularly in Germany,[6] we suggest a number of recommendations to be considered. According to respective competencies, the recommendations are directed principally to:

- Ministry of Construction
- Municipalities
- National Development and Reform Commission, China Electric Power Regulation Commission and State Environmental Protection Agency

4.1 Recommendations for the State-level government policy towards the building sector: Change the incentive structure

For many stakeholders, rewards for holding onto old habits, technologies and rules in the building energy sector are higher than any sanctions. Consequently they tend to stick to old ways and thereby cause a lot of unnecessary energy and resources consumption.

The present value of the life cycle cost of energy, water and other resources in buildings is very substantial, more than half of the total present value of all costs. Instead of spending this money on natural resources consumption, it could be used for investing in technology that would conserve natural resources and protect the environment. That would change the cost structure but could be done without higher overall life-cycle costs.

The building energy market volume is big and growing. All stakeholders (developers, owners, tenants, heat suppliers, building materials and equipment suppliers) should have sufficient opportunities for business development and good housekeeping with energy and resources efficiency. With the proper incentives, the stakeholders would look for business in efficiency investment. Some incentives must be urgently introduced.

4.1.1 Consumption-based billing: Accelerating its implementation by giving incentives to stakeholders

The principle that consumers pay according to consumption and have the means to control their own consumption is key to energy efficiency improvements in the building energy sector, because it has not only direct effects (consumers adjusting the consumption to needs) but also long term indirect effects (owners and tenants make improvements, energy saving features become an important argument in the housing market).

A new pricing system must be introduced immediately in all new construction--- heat meters should be allowed as well as proxy allocation metering systems. For existing buildings, the

[6] See Suding, Paul H.: Space Heating Energy Conservation Policy in Germany, in Energy Efficiency in Buildings in China for 21st Century, Proceedings for International Seminar, WWF Beijing 200.12

payment duty should be passed along to the tenants after establishing control and metering installations and after granting them a proportional income increase. At the same time, tenants should have the possibility of regulating their heating and pay according to consumption.

As to metering systems and methodology, both types of metering should be allowed to apply: "exact" heat metering and "proxy" allocation.

The strong resistance to change by potential losers must be overcome by allowing them to recognize and participate in the advantages.

The new principle would create new business opportunities.

4.1.2 Existing energy efficiency standards: Vigorous enforcement for all new buildings

The enforcement of building standards needs a boost of credibility. Stakeholders should clearly understand that the municipal authorities take it seriously. State authorities, therefore, must insist on severe sanctions for non-compliance and even more severe for fraud and lack of transparency. Complacent supervision officers must be punished (see 4.2.1)

4.1.3 New Standards for new buildings

- **Define new standards in a broad way and as a minimum standard**

In general, standards should not be defined narrowly. For example, it should not be prescribed that a certain technology (x mm of thickness of wall and y quality of windows) be used. The important factor is that the heat transmission value of the building shell conforms to the standard. It should be left to the responsible party to decide which of the many technological options he shall use.

If standards are defined in technologically overly specified ways, this could lead to a technological fix and exclude many other technologies which might also be appropriate. They will thus inhibit more efficient solutions to attaining the same technical efficiency.

A good balance has to be found. In the beginning some examples should be given of how the standard can be fulfilled. In the long run, narrowly defined standards prevent technical progress.

- **Efficiency standards are minimum, open to surpassing**

Another rule should be that energy efficiency standards are to be understood as only a minimum threshold. It should not only be possible but also encouraged to over-comply.

Standards create an orientation for the industry. Products are designed to exactly comply with standards. Therefore, a standard has always a long lasting effect, and is more difficult to overcome the longer it is known and the longer it is valid.

For this reason, standards should always be examples of achieving higher levels of energy efficiency with regard to respective technologies and products available.

- **Create a voluntary higher standard (low or zero energy building)**

Voluntary higher standards should be elaborated for low energy buildings. This would allow for exploring the possibilities of achieving clearly higher levels of efficiency in a coordinated way. This could be started in areas of North China with high winter sunshine hours, as well as in temperate South China areas.

- **Create a higher standard for higher level apartment buildings and villas**

The up-market segment of villas and apartments would be another appropriate area to introduce higher standards. Additional energy saving features would not substantially increase capital costs in these buildings, whereas future lower operating costs would be highly welcomed by the homeowners.

- **Incentives for innovative concepts toward overachieving standards**

In order to promote higher standard and innovative concepts, the state and municipal authorities could create some specifically targeted incentives, e.g.:

- Fast track approval for planned good objects
- Reduced fees for approval
- Awards for excellence
- Architecture and engineering contests

- **Organizing a permanent efficient building exhibition**

Building authorities, in cooperation with developers and other stakeholders in the real estate market, could organize a building exhibition, which would serve as a laboratory and example for additional interested stakeholders. Such an exhibition should be actively promoted in and easily accessible to the public. Not only energy efficiency but also other resources efficiency (in particular, water) and ecological sanitation concepts should be demonstrated.

- **Urbanization Models**

The next step would be to create ensembles of highly energy and resources efficient buildings as models, inhabited by owners and tenants. Such model urbanizations can be created in cooperation with developers, mortgage banks, building companies and housing companies (for example, the housing service for civil servants).

Beijing Olympics 2008 and Shanghai Expo 2010 are excellent opportunities for permanent building exhibitions or model urbanizations of this nature.

4.1.4 Modernization program for existing buildings

A great deal of existing buildings have sufficient structural quality to enable a long period of continued use. In particular, the typical urban 4 to 6 story-buildings represent an optimal density and resources efficiency because of their human-size dimension--such, that they are worthy to be preserved.
At present, the Chinese leadership is giving high priority to this issue.

- **Development of appropriate concepts for modernization of existing buildings**

There is currently no proven concept for a socially and ecologically appropriate, coherent modernization of existing buildings in China. Such concepts are urgently needed, as first attempts at modernization demonstrate. In this regard, China could learn from the examples of modernization of type-apartments in, for example, Eastern Germany.

The technical heating system must not only become more efficient, it also has to be equipped with appropriate systems of control and metering, starting with adjusting single pipe heating. The modernization process should not only include better-insulated windows but also improved external insulation.

Investment in higher apartment quality, including better heating comfort and savings, must be amortized. Above all, tenants and owners living in modernized buildings must accept and adjust to the new concept of heat as a commodity, i.e. they have to pay their heating bills themselves on the basis of their individual consumption. In order to avoid a negative income effect, tenants, for whom others (employer) used to pay heating costs, have to receive some kind of compensation, e.g. in the form of higher income. With the proper control systems in place, the tenants can then decide for themselves how they wish to spend the additional money.

- **Pilot modernization programs in public property**

Some government agencies have already started to establish a modernization program for buildings in their domain. This is useful in order to gain experience and to assure the startup of activity in this direction, even if many problems occur because of insufficient know-how. Inadequate experience in the building industry translates into lacking standards and appropriate products with which to economically apply industry standards.

In any case, such programs in public property or under government supervision should be endorsed, including retrofitting plus consumption-based individual billing. These programs create examples and references for future standards

- **Create new industry standards for modernization of buildings as orientation**

Building modernization needs appropriate technical standards in order to assure the availability of know-how and appropriate products. In the beginning, however, such standards should not be mandatory, as they might be a deterrent to owners and tenants from undertaking modernization.

- **Incentives for modernization of privately-owned existing buildings**

Incentives for modernization of privately-owned buildings could include tax cuts for owners who live in their own apartment. For rental apartments, rules should be defined to pass on retrofitting costs in a sustainable way to tenants, who then benefit from a reduced energy bill.

Incentives should only be granted if certain efficiency standards are achieved.

4.1.5 Standards and selective incentives for equipment

The combination of standards setting and incentives should also be used with respect to energy transformers and distribution systems in a building.

- **Assure the possibility of control by the user**

Users should be able to control their energy services (i.e. heating, cooling, hot water and other) levels. Standards should foresee this feature for all equipment, besides the efficiency standard of labeling. This is, as has already been said, the precondition for rational use of energy.

- **Change the incentives structure in favor of central cooling**

A particular issue is the admission and efficiency of individual heating and cooling devices. If these are electrically driven, they have a strong impact on electricity peak loads in summer and winter, as well as on emissions in the electricity system. At present, incentives favor the individual split system, in particular for cooling, because developers can thereby leave the investment to the tenants.

The use of individual split air conditioners should be restrained. At least high efficiency standards should be defined. Electricity tariffs should be reconsidered and peak load pricing should be used more vigorously. In the case of cooling, central building systems should be promoted in such a way.

- **Total system efficiency of heating and hot water should be promoted**

In the case of heating and hot water, systems with an overall high efficiency should be fostered--also with direct incentives. For example, solar hot water should be combined with the heating system wherever possible and the use of heat pumps should be advocated. The promotion of such systems should be made an obligatory part of the utilities' Demand Side Management Programs.

Direct or storage electrical heating should not be promoted further. Off peak electricity tariffs should be revised in order to avoid coal-based electricity being used for home heating.

Central cooling could provide the feasibility for trigeneration. With cooling as a third product to be produced and sold in summer; the load factor of a small or medium sized cogeneration plant could be expanded. Thus a highly efficient energy system can become economically viable.

4.1.6 Awareness, information and capacity-building

With greater awareness and information, the effects of incentives and standards are raised to a higher level. Therefore, any new policy must be accompanied by awareness campaigns, information and some basic capacity-building to demonstrate the advantages and operation of energy efficient buildings. A number of programs would serve this purpose:

- Awareness raising and information in the media
- Effective research and demonstration, technology transfer in energy efficient and renewable energy technologies
- Modernization of higher education for architects, urban planners and developers, incorporating resources efficiency in the curricula
- Further training of urban planners and architects in new building and heating technologies
- Establishment of vocational training to increase the competence of construction and equipment technicians
- Increasing competence of construction workers

4.1.7 Raise transparency of efficiency features in buildings

Once buyers are more conscious of energy efficiency features, this quality aspect of buildings and apartments should be made transparent. To that end, buildings could be classified according to their energy efficiency and certificates could be granted, which would then allow a differentiation in prices of apartments and houses accordingly. As buyers and tenants would in all likelihood be prepared to pay higher prices or rents for well-insulated dwellings and highly efficient equipment, this would in turn bring about more incentives towards efficiency.

4.2 Recommendations for the municipal level: Conceptual, operational and institutional changes

4.2.1 Urgent enforcement of existing standards and enabling construction supervising and sanctioning of non-compliance

Municipalities are at the forefront in the enforcement of building standards, so that their habits and culture of tolerating non-compliance is counterproductive. Only if it is costly for the developer or builder or owner not to comply with them are standards really efficacious. (See 4.1)

4.2.2 Prepare and enact new building energy efficiency standards to take effect in 2005

In view of the time lag in enforcement, which is clearly observed with respect to existing standards, it is high time to come up with suggestions for new standards. The central government has already given the orientation in principle (another 30%), but few municipalities have come up with implementing suggestions. Development of next generation standards must be expedited in order to implement them fully in 2005.

This requires the broad introduction of external insulation.

Endless discussions of methods must be avoided. Encourage and observe pilot and demonstration objects with or without international participation; however, let innovation blossom! Authorities should not become an obstacle in the process by trying to be involved in each project.

4.2.3 Make integrated energy planning part of urban development planning and the basis for decision-making

- **Integrated energy system planning for cities**

Integrated urban energy planning has been developed and used as a concept by municipalities in other countries. First applications in China have demonstrated the potentialities: in particular, identified the options for reducing energy consumption growth and reaching desired air quality standards despite rapid urban growth.

An integrated planning of the energy system is based on the given situation of energy systems distributed throughout urban space, and begins with the projection of future energy demands and the options available to reducing demand. Based on demand scenarios, supply options are considered and optimized by each urban district, block or building. The result is a number of demand supply scenarios which can be evaluated on the basis of their financial, socio-economic, ecological, and other impacts. The city then makes strategic decisions, which reflect the directions in which it wants the energy system to evolve. Planning of this kind can become the information basis for all stakeholders' activities.

Such planning concepts should be introduced and supported by a concerted effort of urban and infrastructure planning institutions, co-financed by science and technology authorities. Municipal planning commissions, environmental bureaus, urban planning, construction and administration bureaus should base their joint planning of urban energy systems on an integrated urban energy planning concept.

An integrated energy concept should be part of urban development master planning. The existing energy planning of the cities has only general information for the whole city.

- **Integrated energy concepts for large projects**

In the building sector standards are important, especially for the less diversified housing sector, in order to reduce transaction costs. It is not efficient or effective to develop energy concepts for each individual building.

However, in those building segments where energy consumption is significant and individual planning is to a certain extent necessary, like hospitals, universities, hotels, commercial buildings etc., it is advisable to develop an integrated energy concept**.** In particular it is important to

develop an energy concept for industrial parks, commercial centers as well as new urbanization projects.

Integrated urban planning should be considered a prerequisite for approval of urban energy projects by the authorities; in particular, to make sure that before new energy supply systems are approved, the efficient options for energy saving on the demand side have been considered and implemented.

4.2.4 Adjust the institutional set-up of municipalities: franchising and ESCOs

Significant transformations of institutional structures for energy supply in the cities are under way. The State Government is opening the possibilities of franchising utilities' operations. This way, a clearer separation between policy and business operations will be practiced. Some municipalities have already started to utilize the new systems.

This change is a great opportunity for rendering the urban energy systems more efficient, in economic as well as in energetic terms.

However, there is also the risk that integrated concepts cannot materialize. It is therefore of utmost importance that sustainable energy and transport concepts are integrated into urban planning, and that urban planning provides a clear framework for the franchise. The franchise bidding should be based on integrated energy concepts.

The possibility of multi-utility companies (gas, district heating, electricity, water, sewage and others) for districts or areas, which can internally prepare optimal integrated energy and other services schemes, should be considered

Another concept to be pursued is the creation of Energy Service Companies (ESCOs) or Energy Management Companies (EMCos) which will provide the most economic services to the customers, independent of the kind of energy or technology.

4.3 Recommendations for energy and environmental policy

The improvement of energy efficiency in the building sector would be greatly enhanced if some adjustments were to be made in framework conditions. The objective should be a level playing field for energy efficient concepts.

Chinese energy policy is presently under revision and important decisions will be made in the near future. In connection to the reform of the electricity sector, some regulations are being considered which are extremely important for urban energy efficiency.

4.3.1 Improve conditions for distributed power generation

Many efficient energy concepts include decentralized electricity generation mostly as a by-product. As long as there is a discrimination against auto-production, all these cogeneration concepts are at a disadvantage. The Energy Bureau and the China Electricity Regulatory Commission should consider significant changes, in particular:

- Auto-generation of electricity by users should be given more freedom.
- Local electricity companies should be obliged to transport electricity for 3rd parties.
- Local electricity companies should be obliged to buy back electricity at reasonable prices.
- Electricity from renewable sources and waste should receive preferential treatment (the right to feed in electricity at guaranteed prices).
- Electricity tariffs should be structured in order to avoid peak load.

4.3.2 Promote cleaner coal and coal substitution in urban energy systems

Low-priced coal is the major heating fuel in China, thus the basis for the system. The low price availability of coal is a blessing for the economy and households but also a very significant barrier to introducing more environmentally-friendly systems. As long as coal is subsidized, this is a subsidy in the wrong direction.

The use of coal can only be tolerated in the future if it can be utilized in an environmentally benign way. That specifically implies investing in a technology of higher efficiency and emission mitigation. One important way to achieve this would be the expansion of cogeneration of heat and power in coal power plants.

The State government has already introduced a new and more rigorous regulation for emissions levels. This sanction must be enforced vigorously.

The next step will be the introduction of emission trading. However, it is to be considered that emission rights should be very restricted in urban areas.

In addition to such an economic instrument to sanction emission-intensive industries, there are also direct mandatory measures which can be taken; as in Beijing for example, where coal use has simply been banned in the inner areas of the cities. This can only be done, however, if a reasonably economical alternative fuel is available.

All these measures indirectly improve the options for cleaner fuels and renewable energy in urban areas.

4.3.3 Make building energy projects eligible for Clean Development Mechanism

Energy efficient urban energy systems clearly contribute to the mitigation of greenhouse gas emissions and thus contribute to the fight against climate change. Some innovative energy systems in buildings and also in supplies are still not financially competitive in China; but, in terms of the Clean Development Mechanism, they do not belong to the baseline either. Therefore, these innovative concepts might, in fact, meet the criteria for the application of CDM, opening up some additional financing possibilities for them.

The authorities in charge of the application of CDM in China should broaden access to CDM for urban energy saving and supply systems in the respective regulations.

4.3.4 Include the enforcement of all building standards and some overachievement in the criteria for selecting Eco-Model Cities

SEPA as well as MoC have set up criteria for awarding the title of "Eco-Model Cities." No city should be named an Eco-Model City if it has not strictly enforced all energy efficiency standards.

4.3.5 Require integrated energy planning as prerequisite for the approval of important urban energy infrastructure projects

In the approval process for important urban energy supply and urbanization projects, the competent state authorities (NDRC) and local authorities should not accept a feasibility study which has not taken an integrated look at energy saving possibilities. The principle "energy efficiency before new energy supply" should be applied where it is economically feasible.

5. Conclusion

As the scenarios in the following annex demonstrate, energy consumption in urban buildings may rise to 450 million tons of coal equivalent by 2015, up from 130 million tons in 2000. That would cause CO2 emissions of around 750 million tons, three times today's level.

If China wants to restrain CO2 emission growth, the building sector is one of the most important areas in which to begin, even if it is today only third in importance behind industry and public electricity generation. What makes it appealing is that there is a high substitution and efficiency potential. Instead of for fossil energy, capital goods as innovate building material and modern heating technology can be used together with human intelligence to satisfy the demand for living comfort. This would also have a positive impact on Chinas technology and industrial development.

Annex: Will China consume 500 million tons of coal for urban heating energy by 2015?

1. Business As Usual Scenario BAU 2015: High energy consumption growth and strong emission increase

China currently consumes about 130 million tons of standard coal equivalent per year just for space heating of urban residential and commercial buildings.[7] Considering that most of this energy is produced by coal, resulting annual CO2 emissions from this source create 250 million tons of CO2

The local emissions in most Northern Chinese cities exceed grade 2 of the composite National Ambient Air Quality Standard (NAAQS), a minimum goal which all cities want to attain. This is, however, only partly due to the heating of buildings; natural dust and emissions from industry, including power stations as well as transport, contribute substantially to the composite emission level.

A simple calculation shows that the current trend (*business as usual* – BAU) threatens to lead to a dramatic increase of energy consumption and consequent strain on resources and the environment.

The requirements for comfortably heating urban buildings in China will increase very intensely during the next decades. The demand for heating services will be driven by several factors (see table 1), most significantly:

1. Rise in urban population
2. Rise in living space demands (floor area per person)

In addition, requirements will increase because of

3. Higher comfort (indoor temperature) in buildings already heated (heating zones)
4. New heating in current non-heating zones (higher comfort)

The combination of all these factors will result in heating energy services demands in 2015 which are about 5 times those of 2000.

This does not, however, necessarily mean that energy consumption will increase at the same rate. The **energy input** actually used to meet heating demands varies and is determined by a number of technical and behavioral factors:

- Building design (direction, compact, ..)
- Building shell (heat conduction, ventilation losses and passive solar gains)
- Heating system (transformation efficiency, distribution losses, control technology)
- User behavior (control according to needs)

[7] Ministry of Construction

Table 1: Business as usual scenario			
		Status 2000	BAU 2015
Factors that increase demand for energy services	Urban Population	= 100	= 180
	Floor area per person	9,5 = 100	18 = 200
	Indoor temperature	16^0 C, partly heated = 100	= 120
	Heating in non-heating zones	100	120
Heating energy services		100	~520
Factors that reduce energy consumption to cover energy services	Building design and shell	South, compact, low quality windows, external insulation = 100	Varying, improved windows, partly external insulation = 81
	Heat supply system	Low transformation efficiency, high distribution losses = 100	Efficiency improved, reduced distribution losses = 92,5
	Control systems, behavior and incentives	100	90
Total efficiency		100	67,4
Energy consumption to cover services	Index	100	~ 350
	In M tons coal equivalent	130	~ 450

The present policy (BAU scenario) could lead to a reduction of more than 30% of the energy consumption required to satisfy energy services (see table 1.).

That would mean that energy consumption for heating urban buildings in 2015 would “only” be 3.5.times that of 2000. The BAU scenario would show an increase of energy consumption for urban heating of approximately 450 M tce from 130 M tce in 2000.

If natural gas could be substituted for coal to a certain degree, that might mean that CO2 and other emissions would not grow accordingly. Nevertheless, CO2 emissions from this energy use segment would reach some 750 million tons of CO2, 3 times that of 2000

It becomes clear that under such circumstances many fast-growing cities in North China will not be able to meet grade 2 of the National Ambient Air Quality Standard (NAAQS), thus missing their marks.

Aggregately, this urban consumption increase will be somewhat offset by the decrease of rural populations and their energy consumption.

2. Enforcement Scenario ENF 2015: Reduced energy consumption growth and mitigated emission increase

The factors determining the demand for energy services are considered to be factors external to the energy system. Higher urbanization and higher living standards (more comfortable living space) are desired objectives; therefore there is no interest in limiting the development of these factors.

The factors which determine energy input, however, can technically be reduced very significantly without reducing comfort. This can be done more easily and effectively and at lower costs for new construction but is also possible in existing buildings.

The 30% efficiency gains overall (energy input/energy services) assumed in the BAU scenario are based on the assumption that, in line with actual experience, standards are not fully enforced.

Table 2: Enforcement scenario

Year	2000	2015				
Vintage of building	Pre 2000	Pre 2000	2000 - 2005	2005 - 2015	Average	
Building design and shell	100	95	80	70	81	BAU
		85	67	50	65,7	ENF
Heating system	100	95	95	90	92,5	BAU
		90	90	85	87,5	ENF
Control systems, behavior and incentives	100	95	95	85	90	BAU
		85	85	85	85	ENF
Share in 2015	1	0,4	0,1	0,5	1	
Efficiency in 2015 2000= 100					0,674325	BAU
					0,488644	ENF

In a first alternative scenario, it is assumed that existing and planned building standards and conventional measures with respect to heating technology and control can be effectively enforced. This would lead to a much higher efficiency gain: more than 50% instead of 30%. (See different factors efficiencies' assumptions by vintage of building and their shares in table 2)

In this case energy consumption for buildings would go up only by 150% (2.5 times 130 M tce = 325 M tce, over 550 M t CO2).

To reduce energy input per heated square meter by 50% is a target which can effectively be achieved in the long run. Germany, for example, is today heating more than double the building space of 1974 with less energy.

3. Vigorous Scenario

Even more can and should be achieved. Considering the high sunshine input in winter in Northern China, passive solar houses (low or even zero energy houses) are much more promising than in Northern and Middle Europe, where they have become commercially viable.

Far-reaching technical options, systemic requirements and economic constraints of such strategies are not the subject of this paper. With rising awareness, political support, the introduction of concepts through research and development as well as international cooperation and localization of productions and commercialization of materials and equipment, vigorous low energy strategies would be perfectly fitting to China. The limiting factors are the time needed for implementation and the costs.

The Environment Protection and Energy Management Division of GTZ China

Presentation

Germany, China's largest European economic and trading partner and one of the leading countries in environmental protection, is playing a key role also in international cooperation on environment protection. Acting on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ - German Technical Cooperation) has been engaged in the People's Republic of China for more than twenty years. Since 1999, GTZ operates a section focusing entirely on environmental protection and energy management – meanwhile a cornerstone in Sino-German development cooperation. GTZ cooperates in some cases closely with her sister company Kreditanstalt für Wiederaufbau (KfW) in charge of German bilateral financial cooperation and increasingly with multilateral donors such as World Bank, European Union and Asian Development Bank (ADB).

Under the umbrella of the Ministry of Commerce (MOFCOM), several Chinese counterparts like the State Environmental Protection Administration (SEPA), the National Development and Reform Commission (NDRC), municipalities, utilities, design and university institutes and others work with GTZ in defined projects. All work is based on the principle of participation and sustainability, merging the various contributions from Chinese and German partners to achieve the most appropriate, economically, socially and ecologically sound solutions.

The Environment Protection and Energy Management Division of GTZ China from time to time publishes a document under the heading: **Results – Experience – Best Practice**, when we and our counterparts consider that results of its work should be made available to a wide public. This document is No 2 in the series. No 1 was published in the year 2000 on Renewable Energies in Rural areas under the titel: **Simply Fitting Human Needs**: Exploiting the Potential for Social and Economuic Development in Rurak Atreas of the Peoples's Republic Of China

Ecological construction and environmental protection is the key to ensure China's prosperity. GTZ is proud to participate in it. We hope you will find the documents from our work interesting and inspiring.

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