

Exporting Green Development Technologies to China

Paper # 42232

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ABSTRACT

For the past two decades, China has ranked the world's fastest growing economy. The country's accession to the World Trade Organization (WTO) and its successful bid for the 2008 Olympics indicate the rapid pace with which China is moving into the world economy. China recognizes that its integration and acceptance into the international community depends, in part, on a paradigm shift – from one of pure growth to one that includes sustainable development. One area in which this commitment is being made, albeit slowly, is the booming building sector. China is a vast market for building materials and technologies. However, U.S. companies are finding it difficult to sell their advanced energy efficient and “green” products.

This presentation highlights key factors, including China's development of building codes and standards, which are both facilitating and hindering China's move toward sustainable buildings. The author concludes that U.S. companies must shift from selling individual products in response to China's new codes to a new paradigm – where green building project investments are encouraged by virtue of their attractive economics. To do this, multiple equipment suppliers should form alliances or work with intermediaries who are able to package green building projects as *highly competitive investments*. This approach will allow U.S. suppliers to capitalize on the huge untapped market for energy efficiency and other green building products.

INTRODUCTION

China's accession into the WTO and successful bid for the 2008 Olympics are only the most recent and visible forces pushing the country into the international arena. Behind the scenes are tens of millions of Chinese who are working virtually day in and day out to “catch up” with the West, economically and technologically. This in turn has resulted in a growing urban middle class, which is demanding higher living standards. Nowhere is this better seen than in China's booming real estate market

This paper presents an overview of some of the most important developments driving the building sector – especially the residential market – toward more energy efficient and green technologies. The paper will also discuss the central role that new codes and standards are playing in this market. It argues that the ultimate effect of China's new

codes and standards can be much greater if they are used as a platform to jumpstart a green building market.

The paper will show how a market-based, green building approach can help remove many of the barriers that currently prevent large-scale sales of energy efficient and related green products. The paper will also summarize the author's experience in testing this approach on projects in four cities in different climate zones throughout China.

OVERVIEW OF ENVIRONMENTAL SECTOR

China's Tenth Five-Year Plan (2000-2005) outlay for the environmental sector is \$85 billion or 1.3 percent of GNP. The Plan is expected to reduce air pollution by 10 percent from 2000 levels.¹ The environmental sector (those companies and institutes which design, engineer, install, or manufacture environmental protection technologies) is expected to grow by over 16 percent over the next five years, achieving \$17 billion in annual production by 2005.²

While the traditional source of funding for such investments has been governmental (central, provincial, and municipal allocations) – the government accounts for 70 percent of current investment – the trend since the 1990's has been increasingly toward the "polluter-pays" principle. For example, the Chinese government estimates that by allowing water treatment facilities to increase water management fees to users by "acceptable" levels, private investment could raise the percentage of urban people served by municipal wastewater treatment from the current 6 percent to 50 percent. Similarly, better fee collection could increase solid waste treatment from today's 2 percent to 30 percent over the same time period.³

A second, and related trend is toward cleaner fuels, technologies, and process equipment: in other words, minimizing the pollution created in the first place. The market is already helping to reduce SO₂ emissions. For example, the nongovernmental organization (NGO) Environmental Defense (formerly EDF), the U.S. EPA, and the World Bank have been working in several provinces to launch sulfur dioxide emissions trading programs.⁴

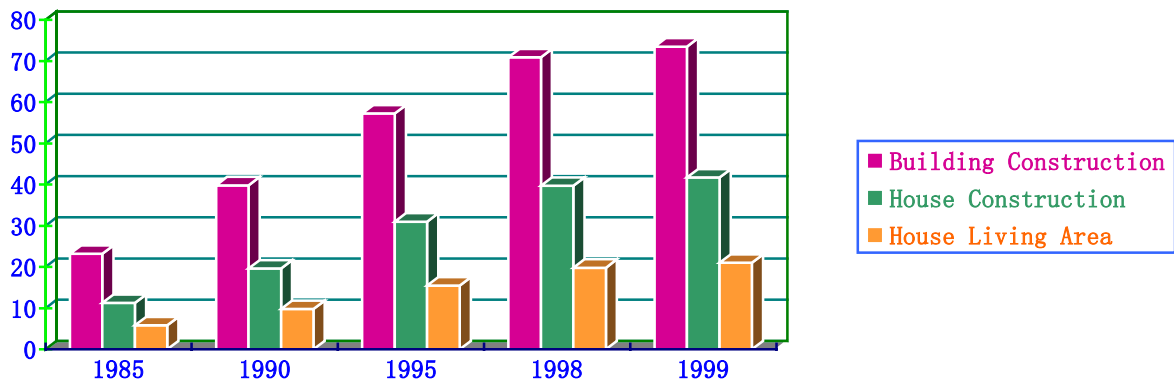
Despite these trends, China's pollution control industry is still underdeveloped – equivalent to only 1.6 percent of the U.S. environmental industry; this is despite the fact that absolute carbon dioxide emissions, for example, are expected to surpass those of the U.S. by 2020. Annual revenues from China's top environmental companies are revealing. A 1999 Department of Commerce sponsored report found only eleven out of 23 Chinese domestic environmental companies surveyed had annual revenues greater than \$3 million.

CHINA'S RESIDENTIAL BUILDING SECTOR

Market Size

China's building sector is booming, with virtually every large city experiencing double-digit annual growth rates. Figure 1 illustrates the number of square meters, in millions, built since 1985 in total building construction, residential building construction, and the actual living area (this being the space other than hallways, garages, storage, etc.). *Total residential building construction in 1999 was 417 million m²*. In each category, the construction area has approximately doubled in the last decade.

Figure 1: New buildings and housing in urban area (million square meters)⁵



Year	1985	1990	1995	1998	1999
Building Construction	232	398	573	709	735
Residential Building Construction	113	196	310	397	417
House Living Area	58	98	155	198	210

Between 1999 and 2010, China's urban population will increase from 389 million to 465 million, or from 30.9 percent to 40 percent of the country's total population. This growth, in population and percent, is reflected in Table 1.

Table 1: China's Urban Population Growth⁶
(Expressed in Absolute Numbers and Percentages of Total Population)

Year	1999	2000	2005	2010
Population (millions) Living in Urban Areas	389	465	460	465
Percent Living in Urban Areas	30.9	35.3	35	40

This increase is expected to result in rapid growth in the building construction industry over the next five to ten years.

- During the Tenth Five-Year Plan, total residential building construction area is expected to be 5.7 billion m² of which 2.7 billion m² will be built in urban cities.
- By the year of 2010, an additional 5.8 billion m² of residential building construction will be built, of which 2.8 billion m² will be in urban areas.
- During the Ninth Five-Year Plan, average yearly urban residential building construction was 440 million m², which was much greater than the yearly rate of 240 million m² planned.
- In the next 10 years, average living area in urban area will reach 26 m² or about half of that of developed countries.

Shanghai alone will add 15 million sq. meter of new residential housing in each of the next five years. At 100 m² per home, that equals 150,000 new residential units. Private developers are expected to build as many as 400 new hotels in Beijing to accommodate visitors during the Olympics.

The Environmental Factor

Residential housing codes, which are well below ASHRAE standards, are only beginning to lift the standard of China's living quarters. Generally concrete walls and flat roofs are used, leaving little opportunity to install insulation either on the sides or roofs. In Shanghai, which is in the "hot summers/cold winters" zone, it is customary for tenants and homeowners to purchase their own electric heaters and window AC units. Needless to say, the operating costs of such "aftermarket" appliances are very high: typically more than \$100/month to heat a two-bedroom, 100-m² apartment.

Beijing's ambient concentrations of air pollutants far exceed international standards. According to a World Bank study, total suspended particulates in 1995 were 400 micrograms per cubic meter, against a WHO standard of 50 micrograms per cubic meter.⁷ In its bid for the 2008 Olympics, China committed to dramatic reductions in Beijing's air pollution, with a pledge of \$6.6 billion investment from 2003 to 2007 on clean energy and environmental protection. This ambitious investment plan includes:⁸

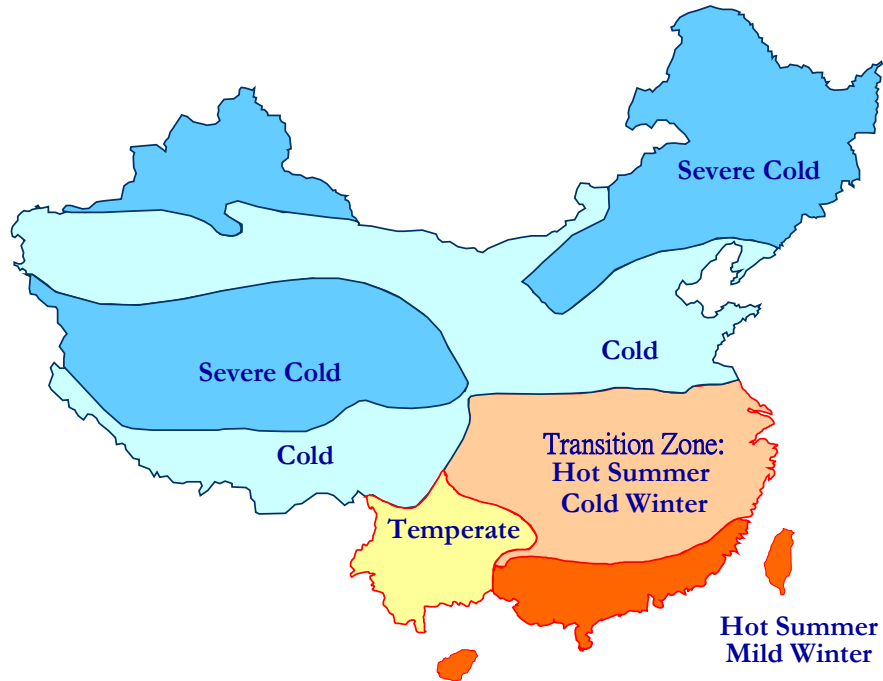
- Converting 90 percent of municipal buses and 70 percent of taxis to natural gas
- Developing 14 new wastewater treatment plants
- Employing solar and geothermal energy (heat pumps) to meet all the hot water needs and most electricity demand for cooling and lighting

Emerging Codes and Standards⁹

China is developing residential codes and standards using both a "top down" as well as "bottom up" approach. The national Ministry of Construction (MoC) in Beijing is currently preparing a national code that can be adapted at the provincial level. Map 1 illustrates China's six building climate zones, corresponding to six different sets of codes and standards that have or will be developed for the country.

Map 1. China's Six Climatic Zones

China's Building Climate Zones



Source: Lawrence Berkeley National Laboratory (LBNL)

Codes and standards are not new to China. The country's first codes, set in 1985 by the "Energy Saving Design Standards of Civil Architecture," applied to the two coldest regions: the "severe cold" and "cold" zones. The purpose was to reduce energy demand by thirty percent relative to 1980 levels. A revised standard, with a targeted savings of fifty percent, was introduced in July 1996. Enforcement has been relatively good, at least to the extent that most new buildings are equipped with heat pumps.

In 2001 a new residential code for China's Transition Zone (hot summers/cold winters) was issued with technical assistance and funding from U.S. DOE's Lawrence Berkeley National Laboratory (LBNL), the National Resource Defense Council (NRDC), and the U.S. Energy Foundation. This region, with a population of over 400 million and covering 11 provinces, is centered around the Yangtze River Basin and includes the large cities of Shanghai, Nanjing, Hangzhou, Nanchang, Wuhan, Changsha, Chongqing, and Chengdu.

Temperatures in this region average 25-30° C (77-86° F) in summer, with peaks of 40° C (104° F). Winter temperatures average 0-10° C (31-50° F), with possible below-freezing temperatures. By addressing cooling needs for the first time, the Transition Zone codes were an attempt to provide more comfortable living conditions for the growing urban middle class.

The code was designed to keep construction costs within 10 percent of baseline costs. The baseline building consisted of single-glazed windows in a metal frame, uninsulated brick walls 240 mm thick, and a hollow, uninsulated roof. The space heating system was an electric radiator with a COP of 1.0 and the assumed space cooling system was a wall AC unit with a COP of 2.2. The code was based on achieving the following indoor temperatures for bedrooms, living room, and dining room: 18° C (65° F) in winter, and 26° C (79° F).

The final code, which was prepared using DOE-2 (a computer model developed by the US Department of Energy, used to analyze the energy performance of buildings), presented compliance options that were both prescriptive and performance-based. The prescriptive elements focus on the building envelope. Table 2 presents the K (=U) values that must be met.

Table 2. Transition Zone: Prescriptive Requirements For Building Envelope (average thermal transmission coefficient (k in $W/(m^2 \cdot K)$) and heat tardiness index (d)).

Partition wall and floor	Roof	Exterior wall	Windows (including balcony door fenestration)	Raised floor (natural ventilation below)	Entrance door
$K \leq 2.0$	$k \leq 1.0$ $d \geq 3.0$	$k \leq 1.5$ $d \geq 3.0$	$k \leq 4.7$	$k \leq 1.5$	$k \leq 3.0$

Developers may also comply through the performance criteria, given in Table 3.

Table 3. Performance Requirements For Overall Building
(building heat loss index & annual electricity consumption for heating and building cool loss index & annual electricity consumption for air-conditioning, where HDD18 = heating degree day base 18°C [64.4°F], and CDD26 = cooling degree day base 26°C [78.8°F])

Heating Criteria			Cooling Criteria		
HDD18	q_h (W/m ²)	E_h (kWh/m ²)	CDD26	q_c (W/m ²)	E_c (kWh/m ²)
800	14.0	17.1	25	11.1	6.9
900	14.9	19.7	50	12.6	8.4
1000	15.7	22.2	75	14.0	9.8
1100	16.5	24.7	100	15.5	11.3
1200	17.3	27.3	125	17.0	12.8
1300	18.1	29.8	150	18.5	14.3
1400	18.9	32.4	175	20.0	15.8
1500	19.7	34.9	200	21.5	17.3
1600	20.5	37.4	225	22.9	18.7
1700	21.3	40.0	250	24.4	20.2
1800	22.1	42.5	275	25.9	21.7
1900	23.0	45.1	300	27.4	23.2
2000	23.8	47.6			
2100	24.6	50.1			
2200	25.4	52.7			
2300	26.2	55.2			
2400	27.0	57.8			
2500	27.8	60.3			

While the performance criteria give developers greater room to use innovative green materials and technologies, they also increase the developers’ transaction costs by placing on them the burden of proof.

The Transition Zone codes and standards, like those in other regions, are expected to lead China to higher standards of materials and technologies. In addition to the general ratcheting up of standards, groups like the U.S. Steel Framing Alliance have worked closely with authorities in Beijing to get their products included in the national codes and standards.¹⁰ This should result in new exports for the U.S. steel industry, and allow Chinese developers to begin to utilize greater amounts of insulation materials in their walls and roofs. The new codes will also bring cleaner practices to the Chinese building industry: In the example above, finished steel products will replace on-site pouring of concrete, and unlike concrete construction, all of the waste and scraps will be readily

recycled. Also, greenhouse gas emissions will be reduced as a result of increased residential energy efficiency. It is estimated that implementation of the Transition Zone codes could reduce Chinese carbon dioxide emissions by over twelve million tons per year.¹¹

Limits of the Regulatory Approach

Although codes and standards are a critical part of any well designed energy efficiency program, they do have their limitations, the most important of which are summarized below:

Economics: As a regulatory approach (the “stick” versus the “carrot”), codes are mandated by the government. The developer has no choice but to comply or not comply. Since compliance is assumed, there is no attention paid by the developer to the economic benefits of compliance. In Shanghai, for example, the codes were established with the intent of keeping the cost of compliance to no more than 10 percent above baseline costs, but the developer does not know (nor have an incentive to calculate) the projected energy and cost savings.

Enforcement: Without any clearly defined economic benefit, codes will be hard to enforce. Even if project approvals and commissioning require documentation that compliance has been met, there will no doubt be developers who circumvent the rules.¹²

Level of Standards: The new codes and standards, which fall well below levels of developed countries, are purposely designed to encourage compliance. This is understandable, but does little to promote the use of the best available materials and technologies on the international market.

Innovation: By emphasizing prescriptive criteria (products), codes do not encourage developers to use innovative design features, such as siting for passive solar, natural lighting and ventilation, and the use of landscaping and trees for shading. Such features are generally the most inexpensive way to provide a comfortable, healthy building environment with minimal electricity load.

Export Opportunities: While no country’s codes are written to minimize imports from abroad, it is worth noting that the Chinese codes will have this effect. The fact that the program is intended to promote change in small increments gives Chinese manufacturers time to make the necessary adjustments to their products with minimal need for technology transfer from abroad. The approach will continually limit demand for U.S. and other advanced products.

TOWARD A MARKET-BASED APPROACH

Benefits of a Market-Based Approach

The main benefits of the market-based, green building approach for China are summarized below:

Green buildings have minimal incremental capital costs: As many U.S. Green Building Council case studies prove, green buildings can be built without any additional capital cost; where many special features are incorporated into a “gold” or “platinum” certified green building, the incremental costs rarely exceed 10-15 percent. Just as in the U.S., the higher costs associated with many U.S. products sold in China can be absorbed by the many trade-offs and cost-reducing features of green projects.¹³

Green buildings are investments: Unlike the regulatory approach, the integrated, green approach, with its rigorous technical and economic analyses, results in investment-grade projects with competitive returns-on-investment.

Green buildings minimize risk: Unlike individual sales of equipment, which at best come with short-term warranties, green projects can be sold to developers with “wrap around” performance guarantees. These guarantees can have terms equal to the period of debt service, thus minimizing the most important risk to the developer.

Green Building projects benefit from innovative financing: Unlike individual equipment sales, green building projects can be bundled and packaged for innovative financing such as credit enhancements, loan guarantees, and carbon credits. The sale of carbon reduction units can bring additional revenue to the developer, thus reducing or eliminating any incremental capital costs that may have been incurred.

The following section summarizes some of the important early steps that China is taking to create a market-based green building industry.

China’s Definition of Green Buildings

At the national level, the Ministry of Construction has taken a first step in promoting a market-based green building approach in 2001 when it issued nine criteria for “Green Ecological Housing,” summarized below:¹⁴

1. *Power system:* Housing should avoid multiple power sources/pipelines for single household; and design shall consider an energy efficient thermal envelope and HVAC systems (thermal envelope being the structural and material elements forming a barrier between the indoor and outdoor environments). Buildings should achieve 50% or more in energy efficiency against a constructed baseline.

2. *Water:* A gray water and rainwater collection system should be installed. The topology, hydrology, and landscaping need to be designed and integrated into the overall water treatment plan to minimize stormwater runoff and prevent stormwater from mixing with septic water. Water supply systems shall be water and energy efficient.

3. *Air:* Outdoor air quality needs to fulfill Class II standard (the national air quality standard set forth by the Central Government, regulating SO₂ [60 µg/m³], NO₂ [100 µg/m³], and TSP [60 µg/m³]). Indoor design should consider natural

ventilation, bathrooms should be equipped with ventilation systems, and kitchens should be equipped with centralized smoke ventilation system.

4. *Noise*: Noise reduction systems should be incorporated so that noise level in the house does not exceed 35db during the day and 30db at night.

5. *Light*: Buildings should be designed to maximize natural lighting. Housing areas should not contribute to light pollution and, where possible, use renewable energy sources for lighting.

6. *Heating*: Optimal indoor temperature during winter should be 20 to 24° C (68-75° F); and 22 to 27° C (71-80° F) in summer. HVAC systems should use clean energy sources.

7. *Greening*: Green areas should serve three functions: (a) ecological, (b) leisure; and (c) landscaping and cultural.

8. *Waste*: Household waste should be collected in bags and put in closed containers, with a 100 percent collection rate. A waste collection system should be implemented that sorts waste into the following categories: (a) hazardous, (b) inorganic, and (c) organic; at least 50 percent of total waste should be sorted and disposed by the categories above.

9. *Material*: Wherever possible, developers should adhere to the principle of “3R’s” (reusable, recyclable, renewable), and they should use non-toxic and hazard-free materials that promote human health and living comfort.

Unfortunately, there is no certification or green building rating system to date in China. The MoC criteria are vague, and developers need not “prove” that their projects achieve certain quantifiable metrics before labeling themselves “green.” In Shanghai, however, the Shanghai Green Building Alliance plans to devise such a rating system, which could be a model for a national scheme.

Shanghai Green Building Alliance

Although there are, to date, no commercial green buildings or development projects in China that would meet the criteria established by the U.S. Green Building Council, some efforts are underway to develop a market for “truly” green buildings. The most aggressive activities are taking place in Shanghai, China’s commercial center and a place where business leaders are most open to market mechanisms.

In July 2001, Tongji University – one of China’s leading universities – and a US green-building consulting firm co-sponsored the first *Shanghai Green Building Workshop*, which included nine expert speakers from the U.S. and more than seventy participants from the Chinese real estate industry, senior municipal government officials, universities and energy institutes, architects, and equipment suppliers.¹⁵ Workshop papers were presented on green technologies, economics of green buildings, diagnostic tools, the

process of green building development, and supportive policies and market transformation activities.

The workshop, in turn, resulted in the formation of a new *Shanghai Green Building Alliance*. The Alliance is now officially established under the Shanghai Municipal Housing Authority, which is responsible for all residential housing. The Board of Directors includes senior officials drawn from the leading municipal government offices that are responsible for the building sector, as well as select real estate developers, architectural design institutes, and building materials/equipment suppliers. Represented are:

- Shanghai Municipal Housing Authority
- Shanghai Bureau of Construction
- Shanghai Commercial Building Committee (under Bureau of Construction)
- Shanghai State Economic and Trade Commission (SETC)
- Shanghai Energy Efficient Building Materials Office

The Alliance's three-year draft program is summarized below:¹⁶

Component 1: Institutional Capacity Building

The first component is to develop the institutional capacity of the Alliance and a framework for a green building market to evolve. Activities include:

Research. A research program will be implemented to develop economic and other market incentives that can be used to accelerate investment into green building technologies.

Training. Staff and community training will be conducted to build Shanghai's institutional capacity in working with (and adapting) whole-building diagnostic tools, such as PV Planner[©], PV Watt[©], BIPV Designer^{©17} and DOE-2.

Green Certification. The Alliance will work with the Shanghai community and the Pittsburgh Green Building Alliance (PGHGBA) to develop a Shanghai green building certification standard for residential buildings; and it will develop a "fast track" certification for eligible green materials and products.

Financing Tools. New financing and risk management tools will be developed, such as an energy efficiency mortgage program, an energy efficient loan facility and the use of performance contracting to guarantee minimum energy savings.

Component 2: Pilot Project Implementation

The second component involves working with strategic partners to facilitate pilot project preparation. Activities include:

Data Collection. Data on technology performance characteristics and cost will be collected as inputs for the whole-building- and other technical analyses. These inputs are necessary to calculate various investment scenarios against both constructed baselines.

Pilot Projects. Four or five pilot residential real estate projects per year will be developed by Shanghai Pacific Energy Center, Asia Pacific Technology Company (a subsidiary of Shanghai Electric Company) in collaboration with a US green-building consulting firm under the Alliance. These projects will demonstrate the green building approach, materials and technologies, finance strategies, and economics. They will also help the Alliance better understand the types of economic incentives that will be needed to jumpstart investments in green projects.

GHG Baseline Studies. A study will be undertaken to build carbon baselines against which actual carbon reductions can be measured, monitored and verified. The studies will be forward-looking and dynamic, i.e., they will take into consideration projected changes in macroeconomic and utility practices and other variables, and they will be revised periodically.

Measurement and Verification (M&V). Working closely with developers of pilot projects, program staff will analyze various M&V protocols to determine which are likely to be most effective in achieving a reasonable balance of scientific accuracy and cost (of installing and implementing the protocols). The program staff will also work with international carbon funds to qualify projects for sales of certifiable emissions reductions within a carbon trading scheme.

Component 3: Information Dissemination & Outreach

Under this component a number of activities will be undertaken to educate real estate developers, investors, policymakers, and other stakeholders about various benefits associated with green buildings.

Case Studies. The program will publicize the pilot projects through a series of case studies to be disseminated through a variety of print and electronic media.

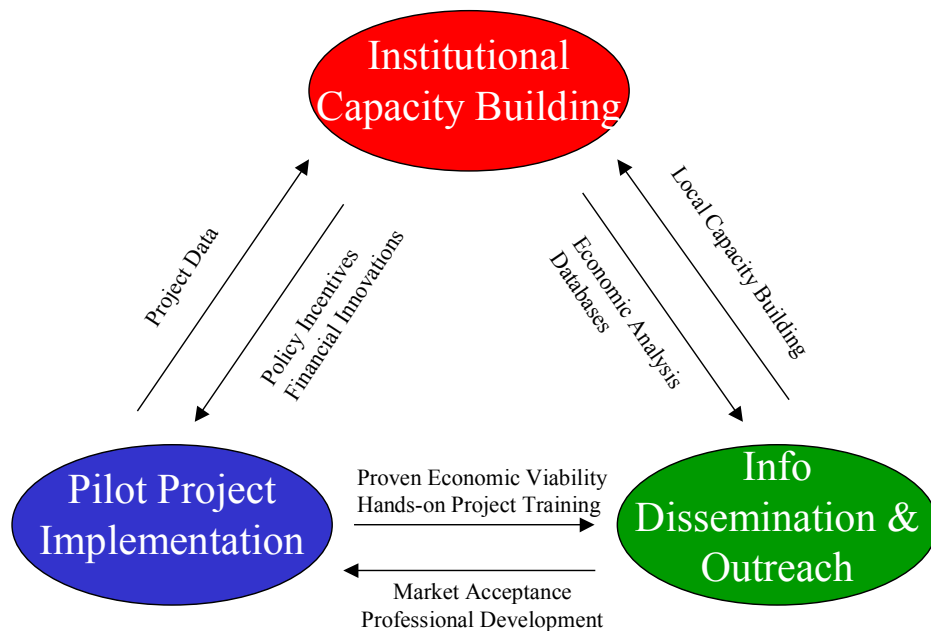
Stakeholder Network. The program will create a network by which to disseminate information, case studies, and to facilitate communication and dialogue between stakeholders.

Award Program. A green building award program will be implemented to give publicity to selected projects and publicize the concept of green buildings.

The Alliance sees the three main components – institutional capacity building; information dissemination/outreach, and pilot project implementation – as forming a critical feedback loop. For example, the inputs from various stakeholders (outreach) will help shape the policy agenda (under institutional capacity building); pilot project implementation will reveal the need for new economic incentives (under institutional capacity building), as well as the levels of such incentives; and new tools (institutional

capacity building) will be needed to design those very incentives for pilot projects. Figure 2 illustrates the interaction between the Alliance’s main program components.

Figure 2: Shanghai Green Building Alliance: Three Program Components



Green Building Pilot Projects

The author is involved in the development of pilot projects in four cities throughout China: Harbin, in the “severe cold” zone; Beijing, in the “cold” zone; and Shanghai and Hangzhou, in the “hot summer/cold winter” zone. Individual projects, which consist of commercial, residential, and public buildings (e.g., hospitals, schools) range in size from 2,000 square meters to over 150,000 square meters. These projects offer opportunities for many U.S. products in key areas, including:

- Architectural design and engineering services
- Building materials
- Low emissivity and “smart” windows
- Building control systems
- Absorption chillers, stand alone and connected with solar thermal

- Ground source heat pumps
- Natural gas boilers and cogeneration systems
- Solar thermal and PV systems
- Biological waste-water treatment

Experience, to date, suggests that Chinese real estate developers are very interested in being perceived as “green.” Several real estate projects are in the process of registering for certification under the U.S. Green Building Council – a label that is highly coveted in China. Although the residential housing developers have, until recently, been reluctant to pay international fees for the services associated with the green building process (e.g., charrettes, architectural design reviews, whole building analyses, commissioning), they accept the idea that a green building *may* have a higher capital cost than a traditional building. In return for their commitment to pay a premium, these developers are seeking product differentiation, publicity, and a competitive advantage in their industry.

Residential real estate developers are also hopeful that the risk they are taking (incremental costs) will be recovered in the sales price of subsequent buildings, once the energy savings to the homeowners can be documented. The question of whether developers of green residential units will be able to pass the higher capital cost on to homebuyers, who are expected to realize the energy/cost savings, is still unanswered.

However, most developers indicate that China’s growing middle class is, in fact, *demanding* more comfortable housing and that they should be willing to pay a premium for both the amenities and future energy savings. In Shanghai, the Municipal Housing Authority recently completed a “healthy living” project, where five pilot residential housing developments showcased healthier materials and practices. According to the housing authorities, these projects were highly desirable and commanded a premium in the market.

In the commercial sector, developers have been willing to pay the fees required to conduct green building architectural and engineering analyses. Such developers have larger design budgets, are more accustomed to paying international consultants, must include heating and cooling solutions (and see how the savings will benefit them directly), and are more sensitive to international trends, especially if they desire to attract foreign multinationals as tenants.

Recommended Strategies for U.S. Exporters

For the reasons discussed above, the author believes that codes will not provide U.S. manufacturers with much new marketing leverage in China. Rather, equipment suppliers will continue to have to sell their higher priced products based on superior performance, energy savings, life-cycle costs, and environmental factors (e.g., lower emissions). U.S. vendors will find this approach very limited, since lifecycle costs, environmental factors, and even higher performance are generally not big drivers in procurement decisions, especially where low-cost domestic alternatives are available.

It is the opinion of this author that U.S. equipment manufacturers would be better served by creating value through a market approach *not* tied to codes and standards. Specifically, they should work with intermediaries (e.g., consulting firms, industry associations, multilateral development banks) that can package multiple green products into projects using an integrated, systems approach. And green buildings do just that – integrate design, materials, and technologies to provide project developers with highly competitive returns-on-investment (ROI).

Such an approach should result in significant:

- 1) Trade and investment opportunities for U.S. manufacturers
- 2) Energy and cost savings for Chinese developers
- 3) Reductions in sick building syndrome and increased comfort
- 4) Emissions reductions (local, regional, and global)¹⁸

A market approach will have maximum benefits if it is developed jointly by various stakeholders, including Chinese and U.S. government agencies, international organizations, nongovernmental organizations (NGOs) and U.S. equipment manufacturers. The logical role of each group is summarized below:

Chinese and U.S. Government Agencies: Chinese entities need to work at the central government, provincial and local government levels to build an institutional framework that will support such an industry. This includes putting into place economic and other market incentives that will attract private capital to green building projects. The U.S. government¹⁹ can make a similar commitment. Under the Department of Energy, a new interagency Clean Energy Technology Export (CETE) program is currently under design. Programs like CETE can help fund policy initiatives and pilot projects to ensure that U.S. technologies play a central role in the China's large building sector, including the 2008 Beijing Olympic Village. U.S. government agencies, such as LBNL, can extend their technical support from the development of codes and standards to market-based approaches.

Foundations, NGO's and International Organizations: Foundations, nongovernmental organizations (NGO's), and international organizations (e.g., multilateral development banks, the International Energy Agency) should develop programs that offer technical and financial support for areas of international concern, such as carbon reduction schemes. For example, international organizations can provide assistance in developing carbon baselines, monitoring and verification protocols, and certification of pilot green building projects for GHG emissions trading under the Kyoto Protocol's Clean Development Mechanism or alternative mechanisms.

Industry Associations: Industry associations, such as the U.S. Green Building Council and state green building alliances, can play an important role in creating and supporting new stakeholder groups like the Shanghai Green Building Alliance.

U.S. Private Sector: U.S. manufacturers should form alliances or work through third-party intermediaries who are able to package green building projects as highly competitive investment opportunities. In the U.S. project developers are able to create green buildings by working with and coordinating the efforts of green architects, contractors, financial institutions, etc. In China, where the concept of green buildings is virtually unknown, intermediaries can provide real estate developers with a comprehensive package that includes green architects, technical consultants (capable of whole-building analyses), and U.S. equipment manufacturers. The main reasons are:

- 1) *Chinese developers are very “technology” oriented.* They will be more likely to accept proposals for green projects where specific equipment suppliers have been identified, pre-qualified, and “authorized” by third-party intermediaries.
- 2) *Chinese developers don’t pay for studies.* Chinese developers expect vendors to give them, at no cost, analyses that support sales of their equipment. They are not used to paying for green building studies, where the product is a report. Therefore, U.S. equipment manufacturers should be willing to pool their resources and share the costs of such pre-investment studies.
- 3) *Chinese projects are on very tight schedules.* Chinese projects are typically fast tracked, with little time for studies, much less for delays caused by the procurement of foreign (e.g., U.S.) products. Therefore, U.S. products should be tested and, if necessary, certified for use in China well before any procurement decision. Insofar as possible, equipment manufacturers should be pre-qualified by the intermediary (prime contractor) so that the developer is confident that the technology vendors will provide technical “start-up” assistance and acceptable after-sales service, including spare parts.

CONCLUSION

China represents a vast potential market for energy efficient and related “green” materials and technologies.²⁰ As a consequence, western manufacturers are moving into the Chinese market in increasing numbers. In the building sector, multinationals such as Trane, Owens Corning, Johnson Controls, Honeywell, and American Home Builders are positioning themselves for the growing market for energy efficient and green technologies. Nevertheless, U.S. companies are finding it generally difficult to make significant sales, especially if their products have higher capital costs than domestic alternatives.

One reason is that Chinese procurement is based more on up-front costs than lifecycle costs. Another reason has much to do with China’s codes and standards – the centerpiece of China’s strategy to bring more energy efficient technologies to the building sector. Although codes and standards should form the core of every national energy efficiency program, the regulatory approach has inherent limitations. These include the following:

- Compliance is *perceived* to have no economic benefit

- Enforcement is difficult
- China's prescribed efficiency standards are low compared to international codes
- Chinese manufacturers can adapt easily to new codes, which minimizes the need for foreign technology (exports, technology transfer, licensing agreements, etc.)

The last point is worth rephrasing. The new codes and standards will not create huge markets for U.S. equipment manufacturers even if compliance rates are high. The codes do not go very far in ratcheting up the efficiency and performance levels. As a consequence, Chinese companies will be able to fill the technology gap. In other words, state-of-the-art U.S. technologies will rarely be needed to meet code.

This author believes that the alternative is for U.S. companies to work with intermediaries, such as qualified consulting firms, industry associations, or multilateral development banks, which can help sell their products to Chinese real estate developers as part of integrated, green building packages. The green building approach can be successful where codes cannot because it sells whole projects – and not individual products – as competitive investment opportunities. Higher capital costs associated with many energy efficient technologies are “absorbed” by the many economic tradeoffs (e.g., the ability to downsize the HVAC system if the thermal envelope is improved).

The role of intermediaries is important in delivering to Chinese real estate developers a kind of “turnkey” project that not only includes architectural design consulting and whole-building analyses, but also equipment procurement, financing, and risk management. Moreover, the intermediary acts as a prime contractor, giving the developer a single point of contact that can take responsibility for the complete delivery of services.

Residential developers perceive the public relations value in building “green,” and they are acutely aware of that the rising middle class is demanding more comfortable and healthier living and working environments. Nevertheless, the short-term opportunity is with the commercial building market, where developers a) have significantly higher budgets, b) are more image-conscious, c) are more likely to provide central heating (e.g., in Shanghai, where heating and cooling are not required for residential units), and, d) benefit *directly* from the energy savings.

In China's residential market, developers are not confident that they will be able to recover any incremental costs through lower operating costs. Before developers will take this risk, it must be shown that the projected energy savings can actually be achieved and that such savings are sustainable (will last from year to year.). This could be done through a series of demonstration projects that institute rigorous monitoring and verification (M&V) protocols. Since developers are unlikely to undertake such activities on their own, it is recommended that the U.S. Government, foundations, and international organizations consider cost-sharing such a program. A public-private partnership program of this kind should provide many profitable trade and investment opportunities for U.S. companies, and result in significant annual greenhouse gas emissions reductions for the life of the buildings.

ACKNOWLEDGEMENTS

The author gratefully acknowledges his many friends and colleagues in the Shanghai Green Building Alliance, who have contributed to the author's understanding of the China building market through technical papers at the Shanghai Green Building Workshop (July 2001) and through personal communications. In this regard, special thanks go to Professor Xu Jihuan of Tongji University, who served a co-chair of the workshop and whose untiring efforts have made possible the creation of the Shanghai Green Building Alliance; Mr. Chen Yong Xiang of Asia Pacific Technology Company (a subsidiary of Shanghai Electric Company, Ltd.), Mr. Xie Zhong Hua of Office of Energy Efficiency of Shanghai's SETC, and Dr. Joseph Huang of Lawrence Berkeley National Laboratory, a key member of the team that drafted the Shanghai codes and standards.

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- ¹⁰ Personal communication with Geoff Stone, consultant to the North American Steel Framing Alliance.
- ¹¹ Sun, C., China Environment Series, Issue 4, 2001, p150, "*Paying for the Environment in China: The Growing Role of the Market.*"
- ¹² A Chinese official, who wishes to remain anonymous, has indicated to the author that, aside from heat pumps, compliance by real estate developers with the Beijing codes was, for a long time, only 5 percent. In the last few years, compliance rates appeared to have risen.
- ¹³ Some example are energy efficient windows resulting in less heat gain in summer, allow the developer to downsize the HVAC system; autoclaved aerated concrete blocks lowering the building weight, lower foundation costs; well sited building using passive solar design reduce lighting load.
- ¹⁴ Translation by Environmental Market Solutions.
- ¹⁵ The workshop was funded by Conservation International (the U.S. environmental group), Environmental Market Solutions, and Tongji University.

¹⁶ Implementation of this program is contingent upon funding.

¹⁷ The University of Delaware's Center for Energy & Environmental Policy (CEEP) plans to train staff of the Shanghai Pacific Energy Center in the use of PV diagnostic tools developed by CEEP. Similarly, DOE's Lawrence Berkeley National Laboratory (LBNL) is offering training to various Shanghai organizations in whole-building analysis tools, including DOE-2. The Shanghai Pacific Energy Center is the technical arm of the Shanghai Green Building Alliance.

¹⁸ This paper does not discuss the potential reductions of air pollutants and greenhouse gas emissions that could result from a wide-scale deployment of green building technologies. Suffice it to say that such reductions could have a significant impact on air quality and contribute to global reductions of greenhouse gas emissions. A recent unpublished paper by this author indicates that a program to develop 10 green building projects in each of three Chinese cities of Shanghai, Beijing, and Chengdu could result in carbon dioxide emissions reductions between 250,000 and 500,000 tons over the life of the buildings. If the program were to result in green building taking 2 percent of the total annual building construction market, reductions of CO₂ in Shanghai alone could reach 118-237 million tons during the same period.

¹⁹ Such as the Department of Energy, the Environmental Protection Agency and the Trade and Development Agency.

²⁰ An unpublished report by U.S. DOE puts the export potential at \$200 billion over ten years.