SHANGHAI'S COMMERCIAL BUILDING ENERGY GOVERNANCE

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Abstract

Energy use and CO_2 emissions by Shanghai's commercial sector is expected to become a key challenge, compared with other major global cities in East Asia. This paper attempts to explore and assess commercial building energy governance in Shanghai. In order to do so, it will examine the applicable policy and the regulation system, while considering those factors that facilitate or constrain the application of best practices at the global-city scale. A multi-scale governing analytical framework is employed to investigate different policy actors, stakeholder participation, and intergovernmental relationships that shape commercial building energy governance in Shanghai. The policy recommendations offered at the close of this paper include tightening building energy policies and regulations, providing more market-driven incentives, strengthening building energy audit and supervision, encouraging comprehensive and integrated urban planning, and continuing public education efforts for green mind-set transformations.

Introduction

As China's leading advanced city, does Shanghai, with its rapidly increasing stock of commercial buildings and related building energy consumption and CO_2 emissions, currently play a role as a hub of ideas and policy diffusion for commercial building energy governance? This paper attempts to explore the above question from an urban building energy governance

perspective. The policy instrument framework affecting the commercial building sector is complex and dynamic, ranging from national policies and regulations to local initiatives. This paper focuses on commercial building energy policies led by Shanghai Municipal Government, which are categorized and analyzed into three different types of policy instruments. Moreover, the paper discusses how relevant stakeholders' participation facilitates or constrains the role of municipal authorities in commercial building energy governance.

Challenges of Building Energy Governance in Urban China

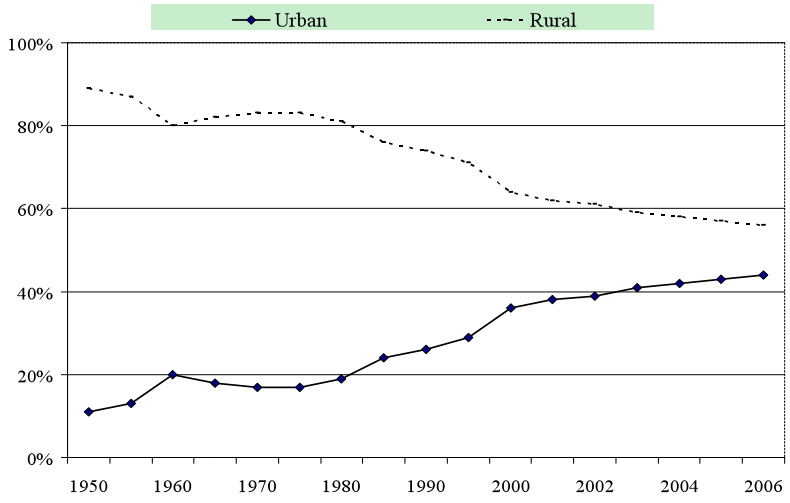
China has been undergoing tremendous socioeconomic and political transformation since the late 1970s. As one of the world's most rapidly developing economies, China joins the United States and other industrial nations as a major consumer of resources and energy, as well as a major polluter of local and global ecosystems (Flavin & Gardner, 2006). In addition, China has experienced rapid and widespread urbanization at a scale never seen before in history. Already, China counts 90 cities with more than a million residents (Pearce, 2006). Since the late 1970s, its urban population growth rate has risen from 17% to 45% while its rural population dropped from 83% to 55% (Lawrence Berkeley Laboratory, 2008, see Figure 1). The official rate of urbanization in China is expected to approach 70% by 2050, which equates to approximately 10 to 12 million people moving from rural areas into cities every year (Embassy of the P.R.C., 2003).

According to Lin (2002), China's urban structural change is a dual track system of urban settlements integrating large city dominance at the top with rapidly expanding small cities and towns at the bottom. Although large and extra large cities have declined relatively in terms of the growing urban population in China, massive built-up areas and infrastructure development among

those large and extra large cities along the eastern coast has reconsolidated the dominance of China's urban development pathway.[i] These cities contribute greatly to the Chinese national economy with massive commercial energy consumption and CO_2 impacts. Therefore, a better understanding of urban energy use in these advanced cities is essential for Chinese decision-makers at various levels in order to adequately address energy security, climate change mitigation, and local pollution abatement (Dhakal, 2009).[ii]

FIGURE 1

China's Population Growth Rate in Urban and Rural Areas from 1950-2006



Source: China Energy Data Book, Lawrence Berkeley Laboratory, 2008

Moreover, with a surging economy and ongoing urbanization, China is experiencing an extraordinary building boom (Butera, 2008; Long Siwei, 2004). China's Ministry of Housing and Urban-Rural Development (MOHURD) estimates that China has 40 billion square meters of

existing buildings and is adding an additional 2 billion square meters of floor area each year, a number almost half the global total (Asian Business Council, 2008; Li, 2007). Besides accounting for the world's largest construction market, more than one-half of these structures are being developed in cities (Lang, 2004). According to data from the World Bank (2001), more than one-half of China's urban residential and commercial building stock in 2015 will be post-2000 construction. The growth in urban building stock coincides with rising building energy consumption.[iii] In addition, urban households usually have higher energy demand than rural households (Li, 2007). Therefore, economic expansion and migration from rural areas to cities not only alters China's urban infrastructure and built environment, but also causes urban building energy governance challenges for Chinese cities. It is necessary to investigate and evaluate the current approach to building energy governance in order to decrease energy consumption and strengthen carbon management in modern urban China.

Commercial Sector in Shanghai

Under global and local forces, Shanghai has not only functioned as the most important center of the Chinese national economy but also has served as the most attractive locus for foreign investment in China. Since the implementation of China's open policy in 1979, the "oriental pearl" has quickly emerged as the most important locale for many multinational corporations to set up their regional headquarters in China. Some studies have identified Shanghai as one of the leading Chinese cities in the global economy (Godfrey and Zhou, 1999; Lin, 2004; Zhou, 2002). Table 1 presents socioeconomic and energy indicators for Shanghai, vis-à-vis national data.

Shanghai's social/economic force has surpassed the national average along with high energy consumption.

TABLE 1

Shanghai's Major Social/Economic & Energy Indicators as a Percentage of the National Total

Indicators	Shanghai	Percentage of the National Total (%)
Land Area (10,000 sq km)	0.62	0.1
Population (millions)	18.15	1.3
Gross Domestic Product (100 million yuan)	13,698.15	4.6
Primary Industry	111.80	0.3
Secondary Industry	6,235.92	4.3
Tertiary Industry	7,350.43	6.1
Total Fiscal Revenue (100 million yuan)	7,532.91	12.3
Total Port Exports and Imports (100 million USD)	6,065.57	23.7
Imports	2,129.07	18.8
Exports	3,936.50	27.6
Foreign Direct Investment (100 million USD)	100.84	10.9
Energy Use (ton sce)	89.67	3.6
Energy Use per capita (ton sce/person)	4.94 (Shanghai)	1.87 (China)
Energy Intensity (Energy Use/GDP)	0.87 (Shanghai)	1.16 (China)

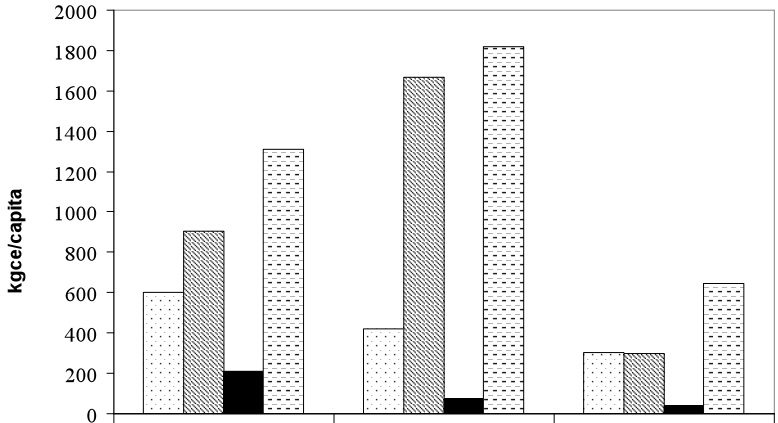
Source: Shanghai Statistical Yearbook 2009, Shanghai Municipal Statistics Bureau, 2009; Energy and Climate Policy in New York, Paris and Shanghai: Lessons for Developing Countries, Hammer & Mitchell, 2009

In terms of per capita energy consumption, Shanghai consumed more energy than Beijing and the national average (see Figure 2). According to the Asian Green City index published by the Economist Intelligence Unit this year, Shanghai ranks poorly in energy consumption and CO_2 emissions compared with other Asian cities (Economist Intelligence Unit, 2011).

Moreover, as part of its building boom, Shanghai is engaged in constructing giant iconic buildings and large development projects, enhancing city branding, and regenerating a new city skyline for global competition. Figure 3 demonstrates the changing urban skyline of Shanghai from 1978 to 2009. Building stocks are increasing exponentially.

FIGURE 2

Per Capita Energy Consumption by Energy Type

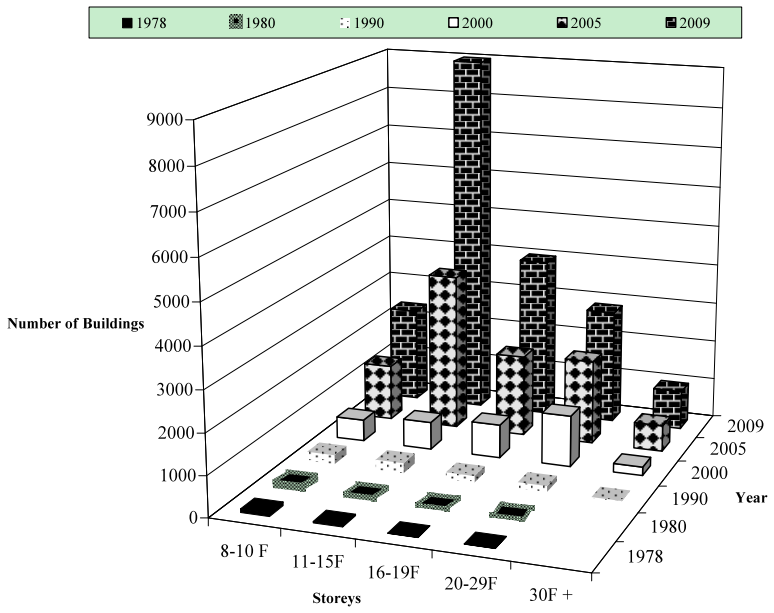


	Beijng	Shanghai	China
Total Coal	600	422.5	302.1
Total Petroleum	903.1	1668.1	296.9
Natural Gas	210.9	74.7	36.7
Electricity	1310.8	1820.9	643.9

Source: China Energy Data Book, Lawrence Berkeley Laboratory, 2008

FIGURE 3

Changing Urban Skyline of (1978-2009)



Source: Shanghai Statistics Yearbook 2010, Shanghai Municipal Statistics Bureau, 2010

Under China's building energy regulation system (see Figure 4), the building sector is divided into civil and industrial subsectors; the civil subsector is further divided into residential and commercial buildings. China's commercial buildings include department stores, supermarkets, rental offices, apartments, hotels, restaurants, banks, post offices, airports, rail stations, and buildings used for education, science, research, medicine, sports, and communication services (Lang, 2004). Table 2 reveals the growth rate of 61% in Shanghai's total commercial buildings from 2000-2008. Stores, warehouses, offices and other structures increased more than 50% during this time.

FIGURE 4

China's Building Energy Regulation System

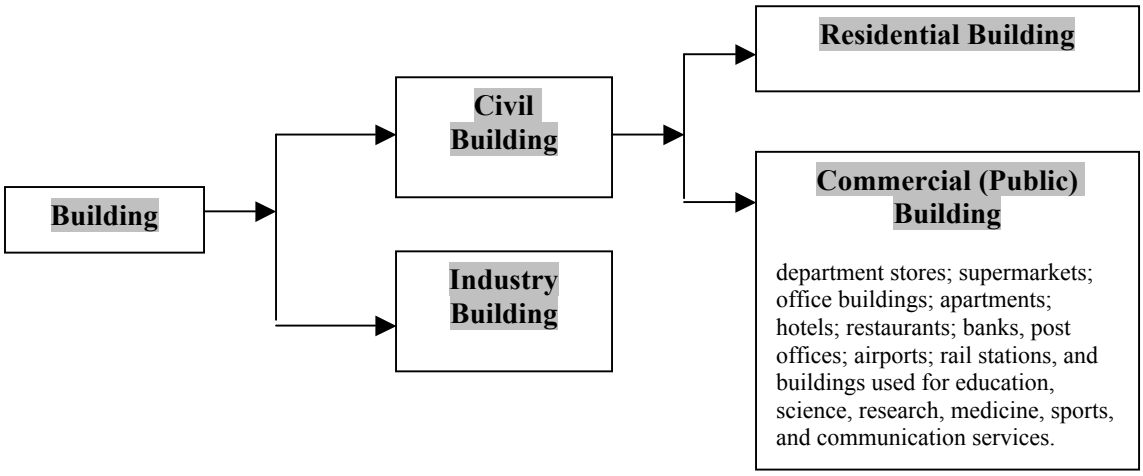


TABLE 2

Shanghai's Commercial Buildings in 2000, 2007, and 2008

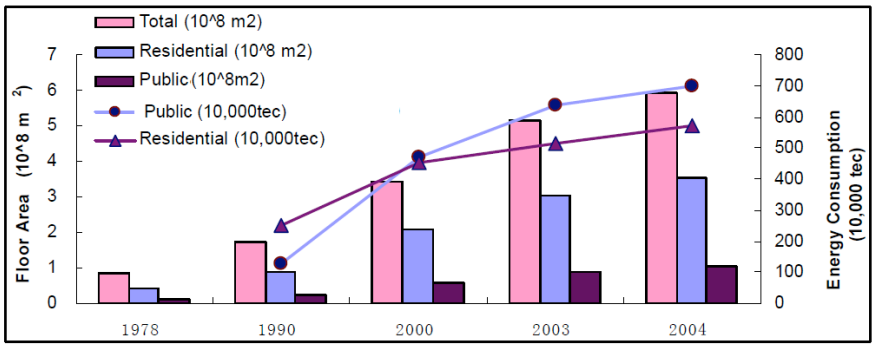
Items	2000 (in 10,000 sq.m)	2007 (in 10,000 sq.m)	2008 (in 10,000 sq.m)	Growth Rate from 2000-2008
Commercial Buildings Total	13,341	31,590	33,926	61%
Schools	1,417	2,562	2,699	47%
Warehouses	650	1,342	1,374	53%
Offices	2,416	4,972	5,269	54%
Stores	1,191	4,029	4,355	73%
Hospitals	367	602	630	42%
Hotels	376	679	799	53%
Theatres and Cinemas	47	72	73	36%
Others	1,138	2,806	3,269	65%

Source: Data provided by Shanghai Municipal Housing Security and Building Administration Bureau, Shanghai Statistical Yearbook 2009, Shanghai Municipal Statistics Bureau, 2009

Building floor area is a driver of total building energy consumption. Although the development of residential building construction has occurred very rapidly in Shanghai, energy consumption from commercial buildings is occurring at a faster rate than that of residential buildings in recent years (see Figure 5, "public buildings" refer to commercial buildings). Besides energy consumption, commercial buildings also account for higher share of electricity consumption in Shanghai, while residential buildings account for higher share at the national level (see Table 3)[iv].

FIGURE 5

Building Floor Area and Energy Consumption in Shanghai



Source: Yang & Tan, Research on Building Energy Consumption Situation in Shanghai, 2006

TABLE 3

Commercial and Residential Buildings in Shanghai

Building Category	Energy Consumption (10,000 tec)				Electricity Consumption (billion kWh)			
	China		Shanghai		China		Shanghai	
Commercial	10,932.6	36.2%	700.7	55.0%	1,534	40.7%	169.2	65.1%
Residential	19,268.4	63.8%	573.2	45.0%	2,238	59.3%	90.6	34.9%
Sum	30,201.0	100%	1,273.9	100%	3,772	100%	259.9	100%

Source: Yang & Tan, Research on Building Energy Consumption Situation in Shanghai, 2006

Moreover, relevant research also emphasizes that commercial buildings are key issues and challenges for energy use and CO_2 emissions in Shanghai[v]. With only 37% of the total area, this sector consumes around 70% of total energy in whole building stock in Shanghai (Jiang & Tovey, 2010; Shanghai Municipal Statistical Bureau, 2008). Therefore, it is urgent to investigate and assess current commercial building energy governance in Shanghai.

Commercial Building Energy Initiatives in Shanghai

This section analyzes Shanghai's commercial building energy initiatives based on the framework of urban building energy policy instruments, which are categorized into three policy types. Regulatory and control instruments include building codes and standards and other mandatory programs and policies led by Shanghai Municipal Government (SMG). Market-based instruments and fiscal incentives include SMG's cooperation with energy service companies and its financial support for the purchase of energy efficient appliances or green buildings, or its subsidies for renewable energy application. Support, information and voluntary action aim at persuading urban dwellers to change their behavior by providing information and examples of successful implementation.

Nationally, although China has initiated mandatory building standards since the early 1980s, the low local implementation rate of national and local policies creates an enforcement gap of local building energy governance in China. Furthermore, local regulation often duplicates the content of national law without providing rules and guidance specifically tailored to the local jurisdiction. Therefore, it is important to mitigate the gap to strengthen China's building energy governance. China has a centralized Ministry of Housing and Urban-Rural Development (MOHURD) under

the State Council that is responsible for major national building energy policies and regulations. MOHURD supervises and oversees Shanghai Municipal Urban and Rural Construction and Transportation Commission (URCTC) and Construction Commissions of Districts and Townships. *Energy Conservation Design Standard for the Building Envelope and Air Conditioning for Tourist Hotels* was the first regulation tackling the rapid growth of hotel buildings in 1993. In 2005, *Design Standard for Energy Efficiency in Public Buildings* focused on the energy efficient design of new construction, additions and retrofits of existing public buildings. *Civil Building Energy Conservation Ordinance* requires government buildings and large commercial buildings to take the lead in energy retrofits. The law also encourages the use of renewable energy applications in local jurisdictions (Zhou, et al., 2010).

The SMG has committed in 2007 in the *Implementation Plan for Energy Conservation and Emission Reduction* that implemented a binding energy-saving standard for new buildings, which called for a 50% reduction in the energy used by new buildings that will likely become a 65% standard. New construction failed to meet the standard couldn't get a construction permit. *Shanghai Energy-efficient Building Design Standards* encourages contractors to use energy-efficient materials and adopt energy saving technologies for heating, cooling, ventilating, and lighting public buildings. Moreover, SMG issued the *Administration Procedures of Shanghai Municipality on Building Energy Conservation* (Shanghai Procedures) to strengthen the administration of building energy conservation and to foster use of energy efficient materials for buildings. The Shanghai Procedures encourage mandatory energy conservation standards to be met in all stages of building construction from design to supervision. The promotion of strengthened supervision and administration by municipal and district administrative departments of construction by the

Shanghai Procedures demonstrates that Shanghai has sought to establish an energy efficiency supervision system for government office buildings and large public buildings (APERC, 2009). In terms of regulatory and control policy instruments, the SMG followed MOHURD's guidelines and initiated the same or more ambitious targets for its building energy policies and regulations. The newly released *Regulation of Shanghai Building Energy Conservation,* put into effect this year, covers the most comprehensive energy policies for the building sector in Shanghai.

In terms of economic and market-based policy instruments, Shanghai in 2008 launched its own marketplace regarding environmentally-related financial products. The Exchange aims to become a forum for stakeholders in GHG reduction projects – mainly through disintermediation and improved access to international markets. The Exchange also initiates domestic trading schemes related to Pollution Discharge Rights, starting with sulfur dioxide and chemical oxygen demand and aimed at expanding soon to carbon dioxide under a voluntary trading scheme in a pilot phase, targeting the Building Sector. Further developments are likely under the 12th Five-Year Plan (World Energy Council, 2010). Moreover, SMG has provided funding and subsidies for the development and application of renewable energy projects and energy efficiency technologies for buildings.

Yet there remain limited commercial building energy regulatory/control instruments and market-based incentives (see Table 4), and SMG has adopted many support/information/voluntary building energy instruments. Shanghai's building energy saving has caught national government's attention since China's 10th Five-Year Plan.[vi] The 11th Five-Year Plan touched on the Shanghai's building energy saving management and eco-construction. Moreover, in order to facilitate the

promotion of energy efficiency, Shanghai will be the first city in China this year to launch a "green standard" in construction.

TABLE 4

Commercial Building Energy Policies Led by Shanghai Municipal Government

Policy Types	Policy Instruments
Regulatory/ Control	• Regulations of Shanghai Municipality on Energy Conservation • Regulation of Shanghai Building Energy Conservation • Design Standards of Shanghai Municipality for Energy Saving in the Renovation of Existing Buildings • Shanghai Energy-efficient Building Design Standards (under draft) • Procedures of Shanghai Municipality on the Administration of Building Energy Conservation
Economic/ Market-based / Fiscal	• Clean Development Mechanism for Building Sector (under the 12th Five-Year Plan) • Procedures of Shanghai Municipality on the Administration of Special Funds for Energy Conservation and Emission Reduction • Shanghai Government funding/subsidies for the development of networking equipment for renewable energy • Energy Efficiency Fund
Support/ Information/ Voluntary	• Shanghai Building Energy Saving Outline in 10th Five-Year Plan • Shanghai Building Energy Saving Measures Management and Recognition • Shanghai Building Energy Management Approach • The 11th Five-Year Plan of Shanghai Municipality for Environmental Protection and Eco-Construction • The 11th Five-Year Plan of Shanghai Municipality for Energy Sources Development • The 11th Five-Year Plan of Shanghai Municipality for Saving Energy • Implementation Plan for Energy Conservation and Emission Reduction in Shanghai • The Suggestion for Further Strengthening the Energy Conservation Work in Shanghai • Schemes and Methods for Energy Saving Calculation Monitoring and Evaluation • Key Work Arrangement for Energy Saving, Carbon Reducing, and Climate Change in Shanghai • Green Energy Efficient Building Standards • Shanghai Green Electricity Scheme • Shanghai Green Lighting • Garden Lane • Azia Center Breen Building Demonstration • Chongming Island – Low Carbon Eco-Practice Area • Lingang New City – Low Carbon Development Practice Area • Hongqiao Hub – Low Carbon Business Practice Area

SMG also has adopted a "self-governing" mode, which establishes the capacity of local government to govern its own activities for the improvement of energy efficiency in governmental offices and other municipality-owned buildings as demonstration projects. With a growing emphasis on green buildings to meet national building energy targets, the Azia Center in Shanghai's Pudong financial district became the first LEED-EB[vii] Gold Building in China, thereby setting an example for the rest of the nation. The Shanghai government also has recently committed to retrofitting the historic buildings along the Bund, a prominent section of the city that is a popular tourist destination. Moreover, there are three ongoing low carbon area projects in other sections of the city, including Chongming Island, Lingang New City, and Hongqiao Hub. Shanghai also initiated "Garden Lane" project, which is an urban renewal project based on energy efficiency building principles. Eighteen old factory buildings in the area were renovated with efficiency standards pursuant to the Leadership in Energy and Environmental Design (LEED) international green architecture standards and the Chinese 3A Green Building Efficiency Standard. The SMG also proposed a "Green Lighting" project for reducing electricity consumption for lighting in commercial buildings. In terms of renewable energy applications, the Shanghai Green Electricity Scheme offers electricity consumers in Shanghai the opportunity to "green" their electricity consumption by buying some amount of green electricity.

Relevant Stakeholders

Besides the static building energy policy instrument framework identified above, this section analyzes the multi-scale governing framework that includes the dynamic relationships that exist among relevant stakeholders who serve to facilitate or constrain the SMG's effectiveness on

commercial building energy governance.

City Mayor's Willingness/Leadership

Current Shanghai Mayor Han Zheng has announced a halt to the construction of projects with high energy consumptions and the halting of electricity and water supplies to block high-energy consumption projects under operation. Han urges for energy saving buildings and fosters a market mechanism to support energy saving service for building sector. Under the stable governance of Mayor Han Zheng, who assumed office in 2003, SMG's building energy policies are relatively predictable and longer lasting, when compared with the experiences of some Chinese mayors who encounter varied institutional challenges within China's complex policymaking environment.[viii]

Municipal Governance Capacity

The competencies of municipal governments concerning their powers and duties are critical in shaping the capacity for urban energy governance (Betsill & Bulkeley, 2007). Shanghai is directly under the central government's rule as a level of government. The central government sets macro-policies and appoints top leaders under the hierarchy system. Overall, SMG has restricted authority in its jurisdiction's affairs. However, SMG has wide autonomy with respect to economic development, urban planning, infrastructure, civic facilities and budget. Being a leading city of China, the SMG has enough autonomy and support on urban building energy saving practices.

Interdepartmental Relationships

In terms of vertical interdepartmental relationship, as mentioned above, the MOHURD has the major authority for China's building energy administration. The SMG and Shanghai Municipal Urban and Rural Construction and Transportation Commission (URCTC) needs to

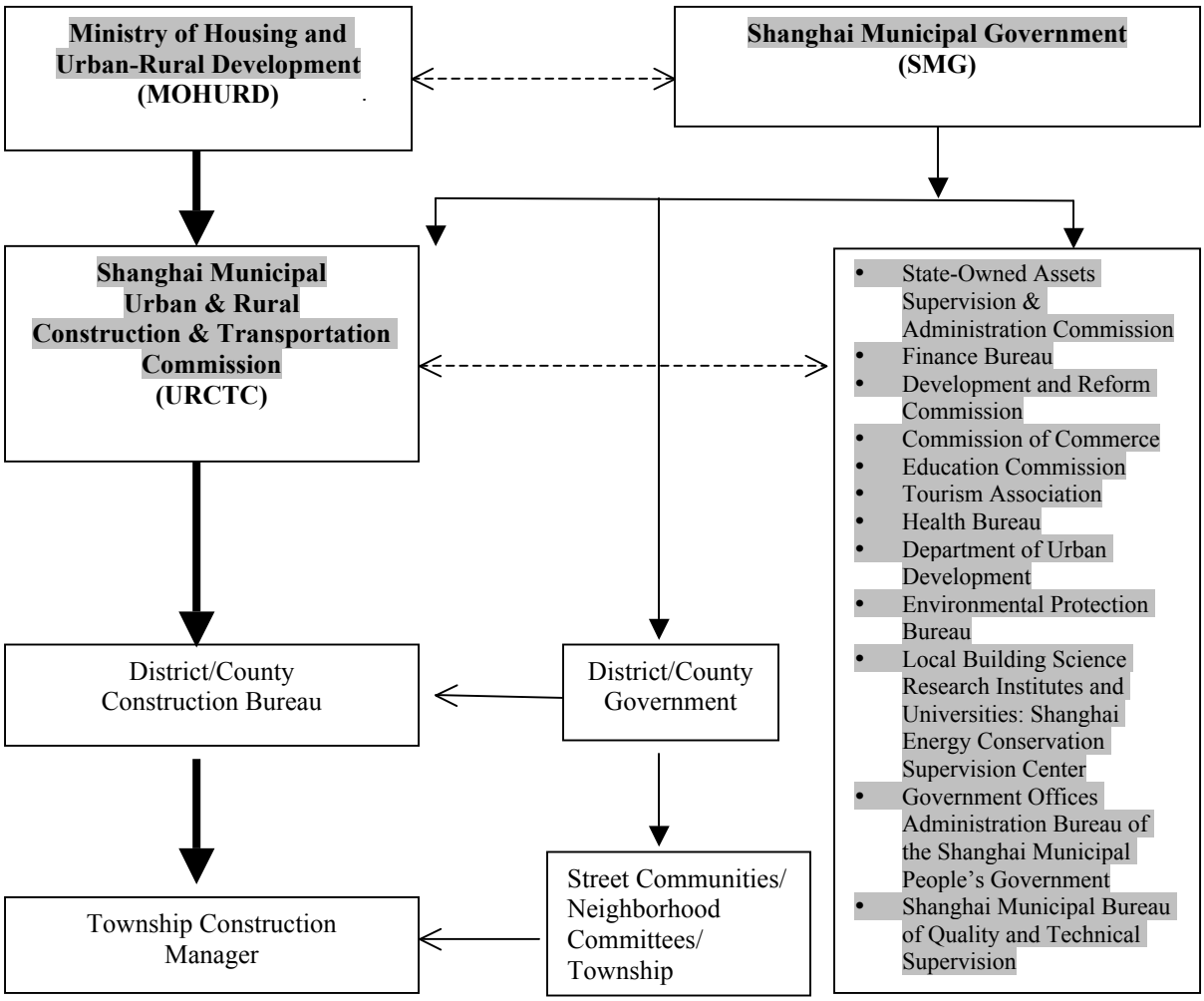
follow the MOHURD's policies and regulations. District/County Construction Bureau and Township Construction Manager need to follow URCTC's direction. A group of departments under the SMG explains the horizontal interdepartmental relationship on Shanghai's building energy governance. URCTC plays the major role in Shanghai's building energy administration. The Finance Bureau initiates economic incentives and is responsible for energy use by financial institutions. The Education Commission accounts for schools, while the Tourism Association addresses hotels, the Health Bureau deals with hospitals, and the Commission of Commerce covers stores and shopping centers etc. The State-Owned Assets Supervision and Administration Commission and Government Offices Administration Bureau are in charge of public or municipality-owned buildings. Bureau of Quality and Technical Supervision is in charge of organizing and implementing "Energy Conservation Law of the People's Republic of China" with relevant departments and implements the system of management of energy efficiency labeling.

Intergovernmental Relationships

A key question entails how to integrate commercial building energy governance vertically such that the national and local authorities' efforts are coordinated in reducing energy consumption by the commercial sectors. China's historic reliance on a top-down approach means that mayors will not solve this problem alone. Hence, a balance between local government engagement and central government oversight on this issue is crucial for building energy governance. Local issues are governed by 19 subdivisions under SMG, each of them of considerable size to achieve economies of scale. In terms of horizontal relationships, the question of how city building energy policies enable other local governments to reduce emissions from buildings requires further study.

FIGURE 6

Power Structure of Building Energy Administration of Shanghai Government



Public and Private Partnerships

SMG cooperated with Energy Service Companies (ESCOs) on large, existing office retrofit projects as successful demonstrations. However, it is critical to switch the government-led model towards a more market-driven mechanism. SMG needs to provide more financial incentives to overcome financing barriers in order to stimulate Shanghai's ESCO system toward a more market-driven one. Besides the promotion of ESCO system, the private sector also provides technical support for Shanghai's green building and energy efficient projects through public private partnership.

Public and NGO Cooperation

The World Wildlife Fund (WWF) launched a Low Carbon City Initiative in 2008, partnering with SMG to explore ways to marry economic development with the primary focus on improving energy efficiency in buildings (WWF, 2009). Some international environmental and energy NGOs cooperated and participated in building energy saving policies and projects in Shanghai.[ix] Shanghai Energy Conservation Supervision Center (SECSC), affiliated to Shanghai Economic Commission, is the first non-profit energy conservation administration organization in China. SECSC has taken an active part in the dissemination of energy conservation information, good case studies, technological consultation and energy conservation training. SECSC also has undertaken major activities regarding the development and implementation of Shanghai's building standards and regulations. Moreover, central and local building science research institutions and universities have provided significant technical support and assistance for reducing building energy consumption in Shanghai, such as the Shanghai Research Institute of Building Science and Tongji University.

Global Cities' Peer Pressure

After Beijing's Olympic Games, Shanghai's World Expo featuring the "Better City Better Life" slogan revealed its interest in the "green" wave of current global trends. In the process of holding the international event, Shanghai appeared more committed to energy efficiency and energy saving regulation and supportive policies. However, whether these policies endure in the post-Expo era should be observed continuously.

Transnational Municipal Networks

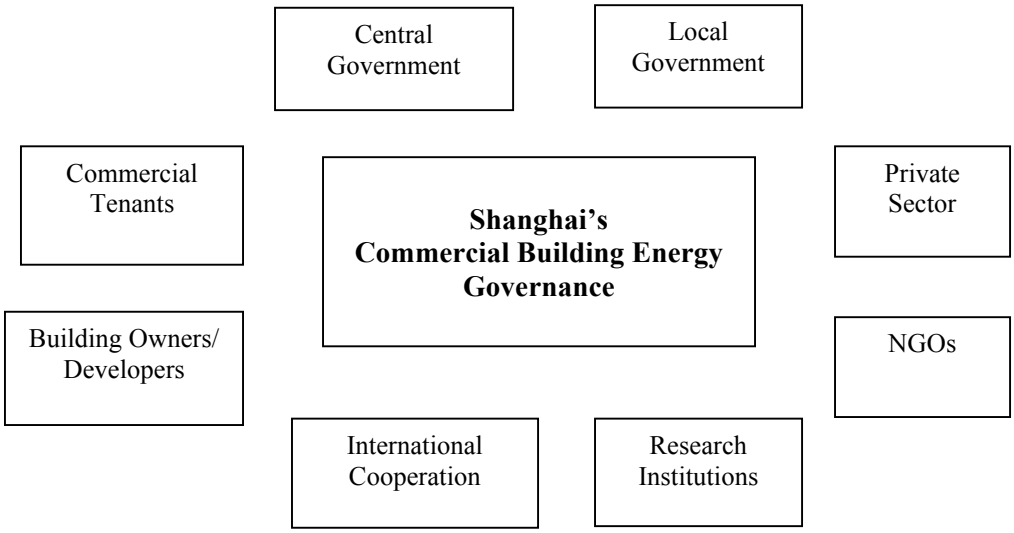
Shanghai has joined the C40 and United Cities and Local Governments[x] for international cooperation and experience exchange. It requires further evaluation on the effectiveness of joining these transnational municipal networks with regard to urban building energy governance.

Other Stakeholders

The relationships between landlord and tenant represent the common contradiction of "split incentives," meaning that the benefit of energy savings does not go to the person who makes the initial investment.[xi] Moreover, developers or investors who have the final decision-making authority on commercial buildings usually hinder the adoption of energy efficiency designs, technologies and practices because of cost consideration. They pursue short-term profit maximization and tend to emphasize the initial cost rather than the life cycle cost because energy costs are irrelevant to them. A strict supervision system could create market opportunities for new, efficient technologies, while incentive policies could encourage developers to exceed the code. Therefore, the SMG should provide more incentives and policies to improve the common issue for tackling its growing commercial building energy consumption.

FIGURE 7

Relevant Stakeholders of Shanghai's Commercial Building Energy Governance



Conclusion and Policy Recommendation

The paper aims at analyzing relevant commercial building energy policy instruments and multi-scale governance in Shanghai. Although SMG has fewer control and regulatory building energy policy instruments, the recent passed and implemented *Regulation of Shanghai Building Energy Conservation* reveals the local authority already paid close attention and started to take mandatory action for the pressing issue. SMG also took the lead for clean development mechanism on building sector in China. Moreover, there are many support and voluntary plans and demonstrations related to building energy governance in Shanghai. Regarding relevant stakeholders of Shanghai's building energy governance, this paper pointed out that political will does influence Shanghai's efforts on building energy saving. Although under a top-down governance model, Shanghai has autonomy for more ambitious building energy saving policies and

initiatives. However, fragmented building energy administration under SMG needs better coordination and cooperation. Over all, Shanghai stands a good base towards better building energy governance due to its global city status with important local and international forces. The status also brings more active public and private partnership and public and NGO cooperation for its building energy governance. Some policy recommendations are provided as follows:

- Tighten Building Energy Policies and Regulations

In terms of regulatory and control policy instruments, the SMG basically followed the national government and MOHURD guidelines. However, laws, regulations, standards and implementation rules with more stringent energy saving requirements could be issued and enforced by SMG to address the enforcement gap in urban building energy governance, especially for newly constructed commercial buildings. Moreover, it is important to strengthen capacity in subordinate administrative levels under SMG for better compliance and enforcement.

- Provide More Market-Driven Incentives

Shanghai has limited municipal-led market-based incentives. Local demonstration projects often receive limited and unstable special funds and subsidies that failed to promote long-term energy efficient building projects. Moreover, as mentioned above, developers, building owners, and building users have split incentives to improve energy saving and energy efficiency for buildings. Therefore, more market-based mechanisms are needed for Shanghai's commercial building energy governance. The growing energy conservation service industry should be encouraged continuously and energy efficiency retrofit projects for large-scale public buildings should be kept as priority.

- Strengthen Building Energy Auditing and Supervision

In terms of building energy auditing in Shanghai, there are insufficient energy consumption statistics. Yet these statistics are required to enhance policy design and effectiveness and can be acquired through expanded surveys, monitoring and establishing meaningful baselines of building energy consumption and efficiency. Standardization of data gathering methodologies and greater public availability of data are needed to inform further policy design and monitoring. Moreover, building energy consumption data and data reporting methodologies should be made more transparent for better evaluation of policy progress, including analysis by outside independent organizations (Zhou, et al., 2010). Also, SMG needs to strengthen building energy efficiency inspection and supervision patterns to establish a more reliable building energy consumption database from Shanghai's commercial sector and further report to national government. Correspondingly, the capacity building for relevant staff and institutions is needed.

- Encourage Comprehensive and Integrated Urban Planning

SMG should encourage comprehensive and integrated urban land-use planning for improving the energy structure, reducing its reliance on coal by promoting high-energy efficiency technologies and renewable energy application. Comprehensive and integrated urban planning also can have a positive influence on the commercial sector. It takes the whole building life cycle of energy consumption into account and further provides a wholesome urban building energy system.

- Continue Public Education for Green Mind-Set Transformations

SMG promoted energy efficiency buildings and green buildings as successful demonstrations. Moreover, SMG should continue to make a concerted effort to educate the public on energy

management of large-scale public and governmental buildings. It is necessary to provide more commercial building energy saving training programs for relevant stakeholders and the general public for mobilizing public participation. The public should be more informed and motivated about the need to take individual and collective actions to reduce energy consumption and enhance energy efficiency in buildings. However, it takes time to change not only public consciousness but also attitudes and behavior. Although public consciousness of energy saving is still a long way off and constitutes the most difficult obstacle for SMG, efforts should be continued to accelerate transformations of urban dwellers to a green mind-set, the foundation of a low-carbon urban future.

[i] Among all cities, large and extra large cities (in the study, large cities refer to urban population between 0.5-1 million; extra large cities refer to urban population more than 1 million) received more than 60% of all fixed assets capital invested in cities in the 1990s. Over 63% of the fixed assets investment in cities was directed to the Eastern region. Among the special economic zones, open coastal cities, and open economic regions, Shanghai has been selected by the Chinese government as a new growth center, thus receiving the largest increase in fixed assets investment between 1990 and 1998 (Lin, 2002).

[ii] Dhakal examined 35 cities in China that represent provincial capitals as well as cities mentioned in the national plan and found that they have a disproportionate influence on China's energy and economic activity. These highly urbanized and economically significant cities claimed only 18% of China's population but produced 41% of GDP, consumed 40% of commercial energy, and contributed 40% of national CO_2 emissions in 2006 (Dhakal, 2009).

[iii] If the urban building stock doubles, corresponding building energy consumption may undergo a twofold increase, with the potential for even greater growth (China Council for International Cooperation on Environment and Development, 2009).

[iv] Energy consumption refers to primary energy while electricity consumption refers to secondary energy. Secondary energy is an energy form which has been transformed from primary energy.

[v] Institute for Global Environmental Strategies also indicates estimates of Shanghai's commercial sector that stand to become key issues for energy use and CO_2 emissions, in comparison to other major global cities in East Asia (IGES, 2003).

[vi] China's Five-Year Plans are a series of economic development initiatives shaped by the Communist Party of China through the plenary sessions of the Central Committees and national congresses. The 1st Five-Year Plan from 1953-1957. The 12th Five-Year Plan (2011-2015) hailed as the "Greenest FYP in China's History," contains one-third of social and economic objectives relating to natural resources and environmental issues, aming to build sustainable development practices into Chinese industries.

[vii] Leadership in Energy and Environmental Design for Existing Buildings (LEED-EB) is certified by U.S. Green Building Council. It is estimated that AZIA center will reduce its carbon emissions by over 8,000 metric tons annually or about 40% of the total previous emissions. Further, it is estimated that the building will also reduce its water consumption by more than 1.4 million gallons annually (Jones Lang Lasalle, 2010).

[viii] Although mayors are appointed to 5-year terms, many hold their post an average of just 30 months before moving on to their next assignment (Landry, 2008), making it difficult to sustain momentum on complex planning initiatives. It also forces mayors to focus on short-term victories, emphasizing progress on pressing daily challenges rather than strategies with a longer time horizon.

[ix] Those NGOs include Energy Foundation; Natural Resource Defense Council; Join US-China Collaboration on Clean Energy (JUCCCE), among others.

[x] C40 is a group of global cities committed to tackling climate change. United Cities and Local Governments also has a climate change program for its member cities.

[xi] The landlords often purchase the heating and air conditioning equipment and other hard-wired equipment, while the tenant pays the utility bills. As a result, the landlord is typically not rewarded for investing in energy efficiency. Conversely, when the landlord pays the utility bills, the tenants are typically not motivated to use energy efficiently.

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