# Hixon Center for Urban Ecology Student Research Fellows

## Trends and Determinants of Household Water, Electricity and Fuel Consumption in Shanghai, China Han Shi

#### **Problem Investigated:**

China's urban population may grow from 456 million in 2000 to 875 million in 2030. With rapidly growing urban population, rising standards of living, and decreasing family size, household water, electricity and fuel consumption will continue to grow over the next few decades. In 2005, the residential electricity consumption in Shanghai soared to 10.92 TWh, representing a 20.5% increase as compared to that of 2004. Associated environmental impacts such as water pollution, acid raid, and greenhouse gas emissions will continue to mount as well.

Lack of systematic statistics and empirical research about China's household water, electricity and fuel consumption has limited informed policy-making for mitigating the negative impacts of these trends. The research aims to elucidate the patterns of household water, electricity, and fuel consumption and to explore the driving forces underlying the patterns for Shanghai, China's largest city.

### Approach:

A questionnaire was developed to survey household annual water and electricity consumption, as well as household size and composition, disposable income, education level, and tariffs of water, electricity, and waste management. The research randomly selected 210 households from three types of residential communities in Shanghai, i.e. C1-high-rise housing (8 stories and above), C2-multistoried housing (4-6 stories), and C3-traditional courtyard/two or three-story buildings for in-house interviews. Statistical analysis was conducted on the basis of the data collected from 189 households which meet the data quality criteria. Dr. Marian Chertow, Faculty Advisor

#### **Discussion:**

Per capita water and fuel use in Shanghai grows relatively slow while per capita electricity consumption keeps in rapid rise. Although the advance of building and consumption technology leads to declining water and electricity use per unit of floor space, the remarkable growth in per capita housing space offsets the technology efficiency gain (i.e. rebound effects). There are three main categories of residential buildings in Shanghai: 1) High-rise houses including luxury apartments and 8-story or taller buildings, 2) Multistoried houses, mainly 5 to 7-storied employee houses (left, below), and 3) Low-standard houses, primarily old low-rise buildings up to 4 stories (righ, below).



The per capita annual electricity consumption of Category 1 house residents is 37% and 56% higher than that of Categories 2 and 3 respectively. By reviewing the monthly consumption data, the mounting electricity use can be substantially attributed to July-September (Cooling Seasons) and December - February (Heating Season). With the further replacement of Category 2 and 3 houses by Category 1 houses, it is projected that residential electricity consumption in Shanghai will continue to soar over the years to come. The major drivers for rapidly rising household electricity consumption include: increasing urban population; growing gross residential houses and per capita floor space; increase in the percentage of Categories 1 and 2 house residents and decrease in the proportion of Category 3 house residents; and rising ownership of durable consumer goods, particularly air conditioners and water heaters. Counterintuitively, per capita annual water and fuel consumptions of three house categories are relatively similar. Some possible reasons are initially identified and need further verification. First, Category 3 house residents tend to be retired and spend much more time than the residents of Categories 1 and 2 houses at home. Particularly, Category 1 residents eat out much more frequently. Second, senior retired people often host their children and grandchildren at home during the weekends. Third, the pipelines and other appliances of Category 3 houses installed before 1950 tend to be obsolete and less efficient than those of Categories 1 and 2 houses.

Category of house	Average	C1-High-rise houses	C2-Multistoried houses	C3-Low-standard houses
Percentage with a retired resident	66%	50%	67%	87%
Monthly disposable income (yuan)	1851	2937	1456	991
Floor space (m <sup>2</sup> )	21.4	27.4	20.7	12.7
Water use (m <sup>3</sup> )	50.9	52.8	49.5	51.3
Electricity use (kWh)	568.4	708.8	518.2	454.9
Fuel consumption (MJ)	1797.9	1820.6	1842.3	1645.6

Por capita incomo fl	loor space, appual	water electricity and fi	uel consumption in 180 l	ousobolds in Shanabai in 2005
rei capita income, il	ioor space, annuar	water, electricity and it		iousenoius in Shanghai in 2005

Per unit floor space annual water	electricity and fi	uel consumption in f	189 households in	Shanghai in 2005

Category of house	Average	C1-High-rise	C2-Multistoried	C3-Low-standard
		houses	houses	houses
Water use (m <sup>3</sup> )	2.38	4.03	2.39	1.93
Electricity use (kWh)	26.57	35.73	25.00	25.86
Fuel consumption (MJ)	84.05	129.24	88.87	66.44

*Research for this project was funded by the Hixon Center for Urban Ecology.*