

A Tale of Five Cities: The China Residential Energy Consumption Survey

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ABSTRACT

Consumption of electricity in the residential sector in China has risen faster than all other energy forms in China over the last 20 years, driven in part by the enormous increase in household appliance ownership, but few details are known about the characteristics of overall household energy use, particularly in the wake of the dramatic changes in the last two decades. Despite the growing importance of this sector to the evolution of future energy consumption patterns, few data exist about the nature and type of urban household energy consumption. This paper summarizes the initial results of a first-ever 5-city, 251-household comprehensive survey of Chinese household energy use, taken in the cities of Beijing, Guangzhou, Shanghai, Yixing, and Shenyang. Focus in this paper is on analysis of the major electricity consuming products in households, but summaries of the findings on housing characteristics, space heating, air conditioning, hot water supply and use, indoor lighting, cooking, refrigeration, other appliances, house insulation, energy consumption in winter and summer months, energy prices, and household demographic information are also included. The findings support the current policy to emphasize development of minimum efficiency standards for household equipment, as energy consumption from these sources are a significant portion of the household energy budget.

Background of China RECS

In 1980, fully 90% of household energy in China derived from the direct burning of coal. By 1998, this percentage had fallen to 44% and continues to decline. Meanwhile, natural gas, LPG, town gas, and electricity increasingly dominate the household energy budget, and the ownership of major appliances has soared from near-zero in 1980 to 80-100% in some urban centers. Although this dramatic change in residential energy use is well-documented at the national aggregate level, little if any information exists on nature of energy use within individual households. The China Residential Energy Consumption Survey (C-RECS) was developed as a pilot survey to develop a baseline energy consumption profile for urban residences and to demonstrate the need for a regular survey of this kind in the future.

C-RECS was designed on the basis of the United States Department of Energy/Energy Information Administration (USDOE/EIA) Residential Energy Consumption Survey (RECS) and is the first comprehensive survey of its kind in China. Currently, only partial information about residential energy use can be gleaned from the literature and national statistics. There exist some local surveys that do not capture regional differences in energy use (Zhou 2000), and various studies that focus only on certain aspects of residential energy consumption, such as appliance ownership (Sathaye and Tyler 1991). This lack of

information motivated the China Energy Group of the Lawrence Berkeley National Laboratory and its partners in China to formulate C-RECS.

As a survey questionnaire, C-RECS lacks corresponding end-use metered data that would allow a better balancing of apparent versus actual (bill-based) consumption data. The small sample size and limitations in the questionnaire constrain generalization of results. Although it captures major North-South differences in household energy use, it does not include any interior or western cities to elaborate on East-West differences. A larger “C-RECS II” project is being planned to increase survey size, include both ex-urban and rural households, and to improve the survey questionnaire. Other activities underway in China to meter and measure equipment energy use will also provide a stronger basis to develop better load-balancing procedures.

Undertaking of China RECS¹

C-RECS surveyed 50 households in the five Chinese cities of Shenyang, Beijing, Yixing, Shanghai, and Guangzhou, for a total of 251 households (51 households were surveyed in Beijing) during the summer of 1999. Representative households in the five cities covering three climate regions were chosen by the China National Bureau of Statistics (NBS) on the same basis as their sample household income and expenditures surveys².

Each household representative was asked questions on housing characteristics, space heating, air-conditioning, hot water, indoor lights, cooking, refrigeration, other appliances, house insulation, energy conservation and consumption, and background demographic information. The gender of respondents remained fairly even in all cities but Shenyang, where women respondents outnumbered male ones 2:1. Since the average variance between apparent energy and actual consumption in Shenyang varied very little with the other cities, the implications of this are unknown. Specific billing information for each energy form for January and June was also collected from the actual energy bills of residents.

Overview of the Five Cities

The five cities of C-RECS were chosen to represent China’s three main climate zones, which range from a northern temperate zone to a southern subtropical zone. The two northern cities of Shenyang and Beijing experience long, cold winters, typically coldest from November to February. Summers are short but hot. Winter in the Yangzi Valley cities of

¹ The four organizations responsible for C-RECS include the China Energy Group of the Lawrence Berkeley National Laboratory (LBNL), the Information Consultation Center at the China National Bureau of Statistics (ICC NBS), the Institute of Geographical Sciences and Natural Resources Research at the Chinese Academy of Science, and the Technical Economic and Energy System Analysis group at Tsinghua University. The design of C-RECS began in 1999. The preliminary survey questionnaire was completed by May of that year, at which time survey directors were trained and a practice run administered to determine the most effective methods of administration. ICC NBS then recruited survey administrators. After all surveys were completed, the Institute of Geographic Sciences and Natural Resources Research at the Chinese Academy of Science, and the Technical Economic and Energy Systems Analysis group at Tsinghua University compiled the data onto spreadsheets and prepared an initial report. The initial report and data were then delivered to LBNL for analysis.

² When compared to three other household surveys (one with a sample size of over 7,620), the percentage of households in a specific income category differed by at most only 11%, often by only 5% (C-RECS, Zhou 2000, O&M) The O&M samples were not representative; they were composed of persons intending to buy a refrigerator or air conditioner.

Yixing and Shanghai of central China is milder and shorter, coldest in December and January, but summers are hot and humid. Guangzhou's location on the Tropic of Cancer provides for almost no winter, and an extremely long, hot, and humid summertime (Figure 1 and Table 1). Climatic differences are reflected in air-conditioner ownership and usage patterns and in the use of wall and window insulation.

Figure 1. Location of the Five Cities



Table 1. Five Cities Characteristics

Indices \ City	Shenyang	Beijing	Yixing	Shanghai	Guangzhou
Temp Annual Avg °C (°F)	9.7 (49.5)	13.1 (55.6)	17.0 (62.6)	17.8 (64.0)	22.8 (73.0)
Density (persons/mi ²)	837.0	1171.0	852.4	3317.3	1459.2
Per capita GDP (yuan)	13,922	18,478	15,152	28,240	27,318
Avg Living Space per person (m ²)	18.7	19.4	33.1	16.6	20.8

Source: NBS 2000, except living space per person, from C-RECS

Beijing, Shanghai, and Guangzhou are China's leading metropolises. Beijing is China's capital, home to top government and educational organizations, and is generally regarded as somewhat culturally and politically conservative. Shanghai has traditionally been China's most outward-looking city and has a long history of international trade and commerce. It is China's wealthiest city and the economic center of the "Golden Delta" region of the Lower Yangzi Valley. Guangzhou, near Hong Kong, is South China's commercial and financial center and capital of Guangdong province, from which the majority of overseas Chinese derive. These ties strengthen Guangzhou's traditional focus on business over politics. All three are more densely populated and their residents wealthier than those in Shenyang and Yixing. Shenyang is in the heart of Northeast China's declining industrial belt, where first the Japanese, then later the Chinese with Soviet assistance, built an extensive array of heavy industries reliant on the plentiful raw materials in the Northeast. Yixing is a "small" (in Chinese terms) provincial town with long cultural traditions centered on the famed Yixing earthenware teapots and local tea production.

C-RECS Results

The following sections provide a summary by city of the results of the C-RECS data. The discussion here is based on preliminary data analysis and focuses primarily on the major electricity consuming equipment in households. Further work will be done to elaborate the results on other equipment and other fuels.

Household Demographics

Nearly two-thirds of households in each city are composed of three persons, usually two middle-aged parents and one child aged up to 25 (Table 2). Average household income exceeded 1000 yuan per month—considered an adequate living wage—although Shanghai and Guangzhou had wealthier households. Residents in these two cities also own the most appliances³. Education levels were uniformly high, but Yixing has the highest proportion of residents with only a primary education. On average, 42% of residents are not currently employed; this category includes those who are retired, under 18, and unemployed working-age people.

Table 2. Characteristics of Household Members

	Shenyang	Beijing	Yixing	Shanghai	Guangzhou	Average
Average People per Household	3.26	2.94	2.76	2.92	3.04	2.98
Average Age of Residents	38	41	36	40	37	38
Average of Income Categories*	3.1	3.4	3.2	3.7	3.8	3.4
University or Higher Educated	21%	28%	28%	25%	32%	27%
Middle School Educated	73%	58%	52%	66%	58%	61%
Primary School or less Educated	6%	14%	20%	9%	10%	12%
Worker/Office Staff	38%	35%	38%	45%	43%	40%
Other Job (Manager, Teacher, etc)	18%	25%	17%	9%	23%	18%
Retired, Under 18, Unemployed	44%	40%	45%	46%	35%	42%

*Monthly Income Categories (yuan) 1: 500 or below; 2: 501-1000; 3: 1001-2000; 4: 2001-4000; 5: 4001-6000; 6001 or above

Over 90% of households in all cities but Beijing (75%) live in multiple storied buildings (Table 3). The 25% of single-family attached homes in Beijing are most likely traditional Beijing *hutong* residences (*siheyuan*), and all but four were built before 1949 (70%). In land-plentiful Yixing, homes are the largest (and the second highest energy consumers), while homes in densely-populated Shanghai are the smallest, both in terms of number of rooms and floor space. Insulation use and energy-efficient windows were most common in the colder northern cities. Only Shenyang and Beijing had significant amount of insulation, with 20% of households in each city using weather stripping on window frames, and 10% and 14% of households weather stripping the outside door frame. Other insulation was negligible. In Shenyang 48% of homes used double paned glass. In Beijing, 30% of homes used double-paned glass. Of this total, 16% used doubled-paned only in north-facing windows. The percentage of enclosed balconies is also highest in the north. Over 90% of homes with

³Apartments and houses in China all come unfurnished; all appliances are purchased by the renters or owners.

balconies in Shenyang had enclosed them, while only 42% of balconies in Guangzhou were enclosed. Foregoing dryers, both expensive to buy and operate, and space-consuming, many Chinese enclose balconies for drying clothes. In humid and hot Guangzhou, such a measure is less effective for clothes drying.

Table 3. Housing Characteristics

	Shenyang	Beijing	Yixing	Shanghai	Guangzhou	Average
Single Family detached	0%	0%	2%	0%	6%	2%
Single family attached	6%	25%	0%	4%	4%	8%
7 Stories or below	84%	49%	98%	92%	30%	71%
Tower 8 stories or above	10%	25%	0%	4%	60%	20%
Average Year Category of Construction*	3.42	2.78	3.92	3.04	3.40	3.30
Average Year Moved In	1991	1986	1993	1989	1991	1990
Average Number of Rooms	2.62	2.86	3.40	2.06	3.08	2.8
Average Floor Space (m2)	61.1	56.9	91.3	48.4	63.2	64.2
Have Insulation	38%	46%	0%	2%	14%	20%
Enclosed Balconies**	93%	97%	93%	79%	42%	81%
Single Pane Glass Windows	50%	68%	98%	98%	100%	83%
Metal Window Mounts***	58%	78%	94%	62%	94%	77%

*Categories 1: Before 1949; 2: 1950-1980; 3: 1981-1990; 4: 1991-1995; 5: 1996 after

Calculated as a percentage of balconied homes *Includes aluminum alloy

Energy Use Composition

Electricity now accounts for 59% of energy consumption in households in these five cities, and is the dominant fuel in all cities. Other fuel availability is largely determined by local energy supply infrastructure. (Table 4).

Guangzhou is the most “electrified” city, where 75% of household energy consumption comes from electricity. With few local energy resources, Guangdong has traditionally relied on imports (LPG) and local power production, and currently leads the nation in power generation capacity. In contrast, Beijing still has 24% of its households using honeycomb briquettes (so named for the “honeycomb” shape of the formed coal) for indoor heating, heating water, and cooking. In all but one case, coal use was restricted to the single-family attached homes that are not connected to the extensive district heating grids that supply apartment complexes. These households’ heavy reliance on coal (usage averages 65% of total fuel per household) may explain in part why energy consumption per capita in Beijing is the highest among all C-RECS cities.

Gas supply reflects China’s underdeveloped natural gas industry. Only Beijing and Shenyang are currently connected to natural gas pipelines, and natural gas has largely replaced the traditional low-calorific town gas produced from coal gasification or the coking process. Town gas is still a significant source of household energy in Shanghai, where natural gas arrived from a small offshore field only in 2000. For places not served by piped natural or town gas such as Yixing, bottled LPG is the main source of gas. Across cities, these gases compose 95% of cooking stove fuel, and 78% of the fuel used to heat water. Shenyang residents are the only ones to report fuel wood usage. On average, the surveyed households con-

sume 374 kilograms of coal equivalent (kgce) per year.⁴ Only Beijing and Yixing report the use of solar water heater installations for hot water supply, but only in 5 households.

Table 4. Composition of Energy Consumption in Chinese Households*

Kgce	Shenyang	Beijing	Yixing	Shanghai	Guangzhou	Average
Fuel (conversion factor)						
Electricity (0.404kg/kWh)	140.4	186.5	264.0	207.9	296.8	219.1
Natural Gas (1.33kg/m ³)	23.2	71.4	0.0	0.0	0.0	18.9
Town/Coal Gas (0.59kg/m ³)	10.7	24.7	2.4	120.5	22.9	36.2
LPG (25.7kg/15kg bottle)	38.9	35.5	148.2	5.0	73.4	60.2
Coal Briquette (0.9kg/kg)	24.2	170.0	0.0	0.0	0.0	38.8
Wood (0.53kg/kg)	4.3	0.0	0.0	0.0	0.0	0.9
Total	241.6	488.1	414.7	333.3	393.1	374.2
Shares of Total						
Electricity	58%	38%	64%	62%	75%	59%
Natural Gas	10%	15%	0%	0%	0%	5%
Town/Coal Gas	4%	5%	1%	36%	6%	10%
LPG	16%	7%	36%	1%	19%	16%
Coal Briquette	10%	35%	0%	0%	0%	10%
Wood	2%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%

*Excluding water and solar power.

Electricity

As noted, electricity use now dominates household energy consumption. Therefore, this balance of this report focuses on the analysis of the major electricity-consuming equipment in households. As the survey collected equipment power, self-reported usage data, and actually billings, but included no end-use metering, adjustments were made to bring “apparent consumption⁵” into conformity with billing data.

This load-balancing exercise was anchored on adjustments of the air conditioner and refrigerator consumption figures, for which detailed datasets from other sources were available (ACEEE 1999; EPA 1997). In the case of air conditioners, reported average input power of the air conditioners metered in the 1999 monitoring survey of Beijing, Shanghai and Guangzhou differed little from those reported by C-RECS in these cities, but reported usage time in C-RECS ranged from 48% to 193% greater, depending on city, than the run-times measured in the monitoring study. Our calculation of apparent consumption is most likely overestimated, since it does not take into account the period in which the air conditioners are on but not cooling. Based on metering data, these periods are shorter in the north, where cooling use is less each day, and longer in the south, where cooling periods are much longer. Based on these differences, the C-RECS apparent consumption data for each city were ad-

⁴ Coal equivalent (ce) is China’s standard for expressing energy in a common form. One kgce=29.31 MJ.

⁵ “Apparent consumption” was calculated as the product of the device nameplate power rating, and reported usage hours per day, annualized.

justed downward. For refrigerators, the C-RECS data were incomplete and did not allow calculation of annual apparent energy consumption. However, since brand and model numbers were reported along with size and age, the data were crosschecked with other datasets of Chinese refrigerators that reported daily energy consumption, and these numbers were annualized. Television consumption was adjusted to 75% of its apparent value, as television operating power is usually lower than the design power rating. This adjustment will be modified as better understanding of Chinese televisions is gained.

After calculating the balance of apparent energy consumption excluding refrigerators, air conditioners, and televisions, the apparent energy consumption of other equipment in the households were uniformly adjusted to match the electricity billing data. Further analysis of individual equipment types will allow refinement of these adjustments.

Table 5 displays electricity consumption by appliance after adjustment. Of all end-uses in the household, refrigerators, air-conditioners, lighting, and televisions combined account for 69% of total household electricity consumption on average, ranging from 61% to 75% in different locations.

The major products with standby or low-power on-modes are televisions, computers, printers, fax machines, and consumer electronics such as stereos, tape players, VCRs, VCDs, and DVDs. Standby power alone may account for as much as 10% of total electricity use in Chinese households; however, actual standby use is highly influenced by Chinese residents' habit of unplugging these devices after use (Lin 2001).

Table 5. Composition of Household Electricity Consumption, Annual kWh/Household

	Shenyang	Beijing	Yixing	Shanghai	Guangzhou	Average
Refrigerator	429.1	483.7	308.3	431.6	418.0	414.2
AC	7.8	241.3	440.5	311.7	666.5	333.6
Lights	119.9	149.1	291.2	192.9	311.6	212.9
Television	136.9	139.6	156.6	150.9	162.3	149.3
Rice Cooker	105.3	55.6	244.5	154.0	178.9	147.7
Home Electronics	48.6	109.0	118.4	53.3	202.1	106.3
Water Cooler	32.6	32.1	249.5	58.3	0.0	74.5
Large Appliances	6.7	26.3	43.3	106.5	95.5	55.7
Kitchen Appliances	21.2	13.3	66.0	75.1	48.4	44.8
Water Heater	73.1	45.1	27.5	31.1	0.0	35.4
Space Heating	6.9	60.8		31.8	0.0	24.9
Hot Water Bottle	56.2	1.8	15.0	20.7	12.5	21.2
Total	1044.5	1357.5	1960.7	1618.1	2095.8	1620.3

These households, on average, use only 16% as much electricity as the average US household, including 30% as much for refrigeration and 20% as much for air conditioning (RECS 1997). This reflects the smaller average Chinese refrigerator size and the low usage hours on average of Chinese air conditioners.

Major Electrical Appliances: Refrigerator, Lighting, Air Conditioning, Television

A summary of refrigerator ownership appears in Table 6. This table also includes comparative numbers taken from a 1997 survey of 3,217 consumers in Shenyang, Beijing, Yixing, Shanghai, and Guangzhou (Ogilvy & Mather 1997). The two sets of numbers com-

pare favorably with the exception of Yixing, where refrigerator ownership has increased significantly since the Ogilvy & Mather survey was conducted. Note that 19% of Yixing respondents had purchased their refrigerator within the previous two years.

Households across all five cities typically own a standard sized and type of refrigerator. Nearly three-quarters of all homes own a 2-door top-mounted refrigerator, the majority of which are between 171 and 220 liters in volume. This is nearly one-third the size of the typical American refrigerator. On average, less than 20% of refrigerators are less than two years of age, while nearly half in some cities are over 10 years old. This may indicate a growing market for purchases of replacement refrigerators.

On an annual average basis, refrigerator energy consumption accounts for 16% to 41% of total household electricity consumption. As expected, the percentage is lower in households with significant air-conditioner usage. In Shenyang, for example, where air-conditioners account for only 1% of total consumption, refrigerators are responsible for 41% of a household's electricity bill. In Yixing, refrigerator electricity consumption is lowest at 16% of the total. The actual number may be larger as the survey results show a probable exaggeration of water cooler and hot water bottle (used to heat and store water for drinking) energy consumption. Many households reported use of the hot water bottle for 12-24 hours a day, inherently overestimating consumption since it was calculated with rated power.

Table 6. Refrigerator Characteristics

	Shenyang	Beijing	Yixing	Shanghai	Guangzhou
Number of Units Owned	RECS (O&M)	RECS (O&M)	RECS (O&M)	RECS (O&M)	RECS (O&M)
0	6% (15%)	0% (6%)	14% (32%)	2% (6%)	2% (10%)
1	92% (82%)	88% (78%)	86% (63%)	96% (88%)	98% (85%)
2 or more	2% (3%)	12% (16%)	0% (5%)	2% (5%)	0% (5%)
% with Auto-Defrost	23	44	54	37	72
Age (years)					
Under 2	10%	7%	19%	8%	12%
Two – four	8%	18%	17%	12%	20%
Five – nine	31%	21%	36%	30%	31%
Ten – fifteen	48%	49%	29%	50%	37%
Over 16	2%	5%	0%	0%	0%

Another major power consumer in households is lighting, and all households reported the use of at least one lighting fixture (Table 7). Lighting consumes approximately 11 to 15% of total household electricity. Incandescent lighting still accounts for 56% of lighting electricity use, while CFL usage is 6% of the total. On average, 12% of household lamps were CFLs; the highest penetration is in Shanghai (15%), where electricity rates are fairly high. Usage of CFLs was highest in the old single-family attached homes in Beijing, where aggregate electricity usage may still be constrained by 5-ampere wiring.

Yixing households are the largest and consume the most electricity for lighting, on average nearly twice that of a Shanghai household. On a per-square-meter basis, the gap narrows significantly, with Yixing consumption only 5% higher than that of Shanghai.

Table 7. Lighting*

Incandescent	Shenyang	Beijing	Yixing	Shanghai	Guangzhou	Average
Average Bulbs per Household	4.1	3.8	4.7	4.3	3.8	4.1
Average watts per bulb	31.1	31.6	31.1	33.5	31.9	31.8
% of total kWh	46%	71%	55%	63%	43%	56%
% of total bulbs	61%	64%	49%	60%	52%	56%
Fluorescent						
Average Bulbs per Household	1.9	1.5	3.6	1.8	2.8	2.3
Average watts per bulb	38.5	26.6	32.9	28.7	32.5	32.3
% of total kWh	47%	22%	41%	30%	52%	39%
% of total bulbs	28%	24%	37%	25%	39%	32%
CFL						
Average Bulbs per Household	0.7	0.7	1.3	1.1	0.7	0.9
Average watts per bulb	18.0	22.8	15.4	12.5	11.2	15.6
% of total kWh	7%	7%	4%	7%	5%	6%
% of total bulbs	11%	12%	14%	15%	10%	12%
Total Annual kWh per household	149.2	195.6	272.4	137.2	186.5	188.9
Annual kWh/m ² living space	122.13	175.28	149.18	141.77	147.29	147.1

*Annual kWh is based on the estimate that for a given day, summertime lighting is 70% of a winter's day.

Air conditioner ownership has increased dramatically in China in the last five years. In the year C-RECS was taken, average urban household penetration of air conditioners nationwide reached only 24% (NBS 2000). This aggregate number masks regional differences based on climate, which are apparent in Table 8.

Table 8. Air Conditioning

	Shenyang	Beijing	Yixing	Shanghai	Guangzhou	Average
Own Air Conditioner	8%	61%	74%	72%	88%	61%
Will buy in the next year	4%	18%	32%	18%	40%	22%
Cooling Only						
Window	0.0%	21.6%	2.2%	13.6%	29.3%	18.0%
Mini Split	0.0%	27.0%	6.7%	9.1%	61.3%	31.0%
Multi Evaporative Split	0.0%	0.0%	0.0%	2.3%	0.0%	<1%
Cabinet	0.0%	0.0%	0.0%	0.0%	2.7%	<1%
Cooling/Heating (Heat Pump)						
Window	25.0%	0.0%	2.2%	2.3%	1.3%	2.0%
Mini Split	50.0%	51.4%	75.6%	63.6%	5.3%	42.0%
Multi Evaporative Split	25.0%	0.0%	0.0%	2.3%	0.0%	<1%
Cabinet	0.0%	0.0%	13.3%	6.8%	0.0%	5.0%
Total cooling only	0.0%	48.7%	8.9%	25.0%	93.3%	50.3%
Total cooling/heating	100.0%	51.4%	91.1%	75.0%	6.7%	49.7%
Frequency of cooling (n)	-	18	4	11	70	103
Frequency of cooling/heating (n)	4	19	41	33	5	102

As expected, ownership of air conditioners is higher in the hotter climates of the south. In Shenyang where the average annual temperature is 50 °F, few households own air conditioners and few intend to buy them. In Guangzhou, where the average annual temperature is 73 °F, nearly all households own one or more air conditioners.

Similarly, air conditioners with combined cooling and heating functions are most common in northern and central regions where additional heating in the winter is needed. Shanghai and Yixing, both south of the Yangzi River, where historically the government has not provided for district heating as in the north, residents must provide their own winter heating. Consequently the majority of air conditioners owned in Yixing and Shanghai are models with heat pumps.

The survey also reflects the recent trend away from window units to mini-splits. On average, 75% of air conditioners are mini-splits, including multi-evaporator splits, which have become more popular in the last few years as a way to cool more than one area of the house. Of all model types, the most popular was the mini-split heat pump, which accounted for 42% of the total.

Unlike refrigerators, for which annual energy usage is fairly stable, air conditioning usage is highly seasonal. Averaged over the year, however, air conditioning energy consumption accounted for only 1% of energy use in Shenyang, while in Guangzhou is it nearly one-third of the total electricity bill.

The fourth major electricity consumer is televisions, owned by 99% of households in the five cities, the majority of which are color sets (Table 9). Televisions accounted for 8-13% of total electricity consumption. Viewing times generally clustered around 4 hours per day, highest in the southern city of Guangzhou where television offerings include the more varied Hong Kong stations. Average rated power per television was 100 Watts. Less than 2% of televisions were black & white models.

Other Electricity-Consuming Equipment

Space heating electricity use is minor (0-4%) as a percent of total household electricity consumption. Electricity is rarely used for heating in the north as 100% of households in Shenyang have an outside heating supply and 76% of Beijing households do. In contrast, 38% of Shanghai households use an electric heater for indoor heating (including households with heat-pump air conditioners), for an average of 3 hours a day, 50 days a year. For residents of Yixing and Guangzhou, heat pumps alone appear to be the main source of household heating, though the survey was unable to distinguish heating and cooling energy consumption, and thus all electricity use is counted in the AC total.

Table 9. Televisions

	Shenyang	Beijing	Yixing	Shanghai	Guangzhou	Average
1 TV only	84%	67%	54%	58%	66%	66%
2 or more TVs	14%	33%	46%	40%	34%	33%
Color	98%	98.6%	100%	94.4%	100%	98%
Hrs/day viewed	4.3	3.7	3.8	4.0	4.4	4.0
Days/yr viewed	342	319	299	340	285	317
Screen size (in)	22.6	22.6	22.7	22.3	23.6	22.8

More than 70% of **hot water** is obtained from a hot water heater. Over two-thirds of such heaters are instantaneous, and the majority (87%) are gas-fueled. Shenyang has the highest number of electric powered water heaters at 13, compared to just 12 in the other four cities combined. Hot water is used almost exclusively for bathing in hot, humid Guangzhou; 80% of households showered 13 or more times per week, in contrast to the mere 4% who do so in the colder northern city of Shenyang. Hot water is also used for dishwashing and to a limited extent, clothes washing.

Over 90% or more of the households own a **clothes washer** in all cities but Shenyang (64%). Few households use hot water for washing clothes. Usage rates ranged from 0% in Shenyang to 17% in Beijing. Only two households of the 251 surveyed own **clothes dryers**, and both were in Guangzhou where a humid climate makes for drying clothes outside difficult. None owned a dishwasher. The size, operating costs, and water consumption of dishwashers may discourage ownership, so **sterilizers** (small heating and UV cabinets) are more common. The electricity consumption of clothes washers, clothes dryers and sterilizers is summarized in Table 5 under “Large Appliances,” consuming 1-7% of household electricity use.

Kitchen appliances account for 1 to 5% of electricity usage. These include the stove, oven, toaster, microwave, and fryer. All ovens are electric powered. **Rice cookers**, used in most households on a daily basis, consume a considerable amount of electricity, and as a separate category account for an average of 9% of total household consumption. 46% of households overall owned a microwave. Electricity, however, is not the main fuel for cooking, as it is not particularly suited to the wok- and stir-fry-based methods of much of Chinese cooking.

Home electronics and minor equipment consume a total of 3 to 10% of household electricity. These include computers, stereos, tape players, VCRs, VCDs, DVDs, printers, fax machines, along with dehumidifiers, humidifiers, blow dryers, fans, range hood exhaust fans, and other exhaust fans.

Conclusions

Despite the small sample size, C-RECS provides insight to the differences in household appliance and equipment ownership and usage patterns in 5 Chinese cities over three climate zones. As expected air conditioning ownership and use increases as one moves from the north to the hotter south. Heat-pump air conditioners also play an important role in space conditioning for areas outside of China’s traditional district heating zones of the north. In general, the wealthier cities of Shanghai and Guangzhou have the highest rates of appliance and electronics ownership, while land-rich but poorer areas such as Yixing have larger

households, affecting total lighting consumption, for example. The average small size of households, combined with average low income of a developing country, has constrained adoption of appliances such as dishwashers and clothes dryers. The survey also highlights the commonalities of Chinese food culture by the widespread ownership of rice cookers and the predominance of a direct gas flame for cooking.

The survey also confirms the macro trend away from coal towards electricity and gas fuels has taken place in all cities, although residents' options on fuel use are limited by local infrastructure. In Beijing, the survival of traditional single-family homes unconnected to district heating grids appears to be the reason for the continued use of coal-briquette usage for heating. When compared to US household consumption, the survey reveals the persistence of traditional frugality in the use of appliances and other household equipment despite ownership rates nearing US levels in some cases.

This preliminary analysis has not included further research into possible differences in usage or behavior between income levels of residents of the same city, and the sample size may be too small to make it meaningful. It does provide an initial basis to quantify potential household energy savings from the purchase of efficient appliances, and it permits the distinction of efficiency payback by region.

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