



**Support for the establishment of energy-saving standards and labeling systems:**

# **Survey and Measurement of Home Electric Power Consumption in China**

The Japan Refrigeration and  
Air Conditioning Industry Association  
(JRAIA)

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4. Summary

Target area		Beijing		Shanghai		Guangzhou	
		House A	House B	House A	House B	House A	House B
Number of stories		5	8	1	5	12	26
Number of family members		3	5	3	3+1	5	5
Living room	Area	Under inquiry	Under inquiry	31m <sup>2</sup>	32m <sup>2</sup>	35m <sup>2</sup>	35m <sup>2</sup>
	Equipment	Floor unit, cooling/heating	Floor unit, cooling/heating	Floor unit, cooling/heating	Floor unit, cooling/heating	Floor unit, cooling/heating	Wall unit, cooling/heating
	Cooling	4.3kW	4.3kW	5.35kW	5.0kW	5.0kW	7.1kW
	Heating	(4.9+1.5kW)	4.5kW	5.7kW	5.5kW	6.3kW	7.8kW
Bed room	Area	Under inquiry	Under inquiry	8m <sup>2</sup>	13m <sup>2</sup>	5m <sup>2</sup>	12m <sup>2</sup>
	Equipment	Wall unit, cooling/heating	Wall unit, cooling/heating	Wall unit, cooling/heating	Wall unit, cooling/heating	Wall unit, cooling/heating	Wall unit, cooling/heating
	Cooling	2.3kW	2.3kW	2.6kW	2.6kW	1.83kW	2.6kW
	Heating	3.1kW	2.5kW	3.6kW	3.6kW	1.7kW	3.6kW
Measurement in summer		7/24/2009-8/5/2009		7/22/2009-8/5/2009		8/19/2009-8/31/2009	
Status	Controlled experiment	Not conducted in some bedrooms		Conducted (All)		Conducted (All)	
	Other	May have incomplete noise processing		Some data may have incomplete noise processing		Some data missing	
Measurement in winter		11/5/2009 -		1/23/2010 - 2/M		1/25/2010 - 2/M	Separate measurement due to failure of the measurement unit

# Measurement Device Used for Small Metering



## Main Measurement Unit

- Remote measurement and monitoring system 2300  
Milker: HIOKI
- Settings and data collection can be monitored via the web  
Can take all measurements of electric power, temperature, etc.



## External temperature and humidity data logger

- Data logger with built-in battery
- Data range: 16,000 or higher



## Auxiliary temperature data logger

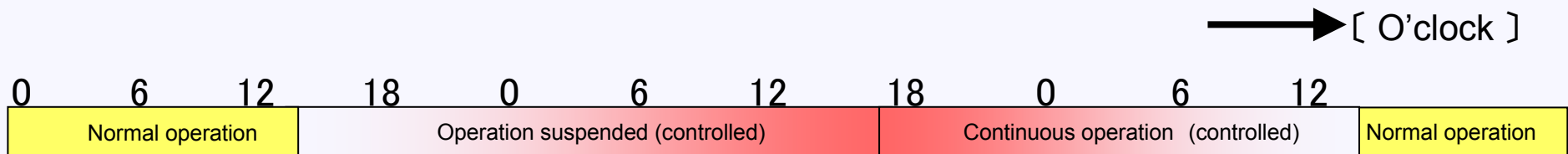
- Data logger with built-in battery
- Data range: 16,000 or higher

# Small Metering Requirements

## General requirements

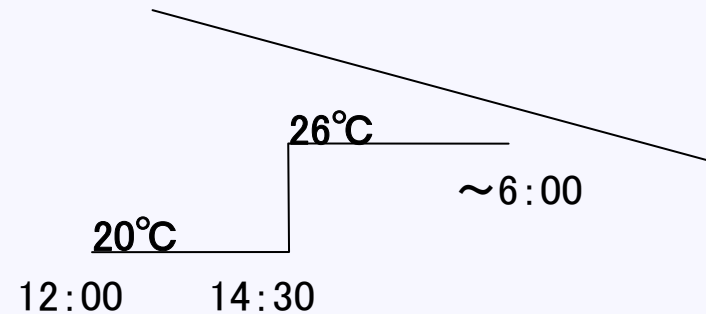
- Windows and doors must be closed, if possible, to keep the air-conditioned space contained.
- Record when the air conditioner is switched on and off.
- Complete questionnaire about the number of the family members, etc.
- Complete survey about daily habits, etc.
- Respond and initiate contact in cases of measurement trouble.

## □ Controlled Operation

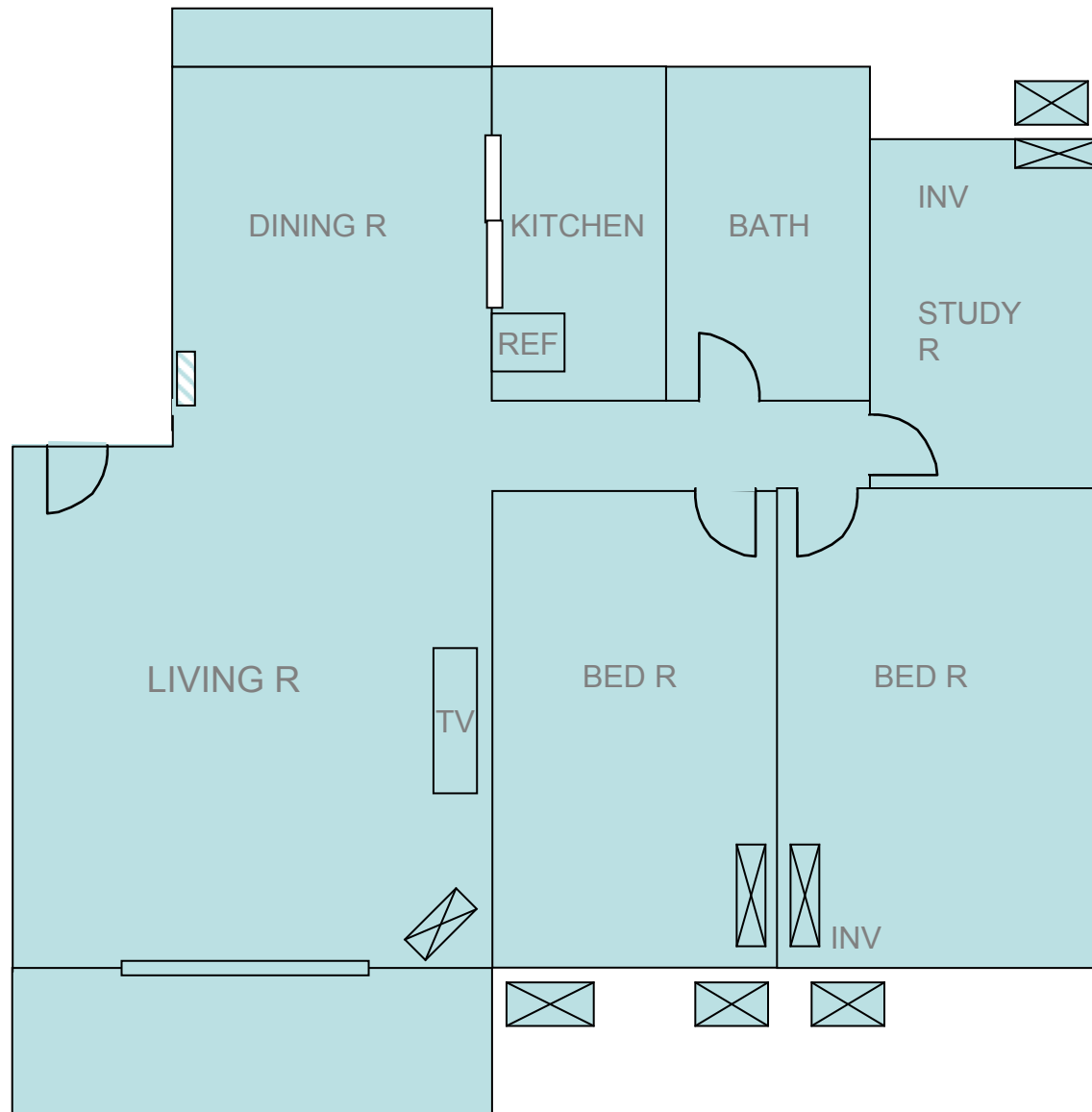


## Purpose of controlled experiment

- Rate of heat dissipation after continuous operation
  - **Understanding heat capacity**
- Comparison of suspended and continuous operation
  - **Understanding influence of sunlight**



Will be measured in the winter

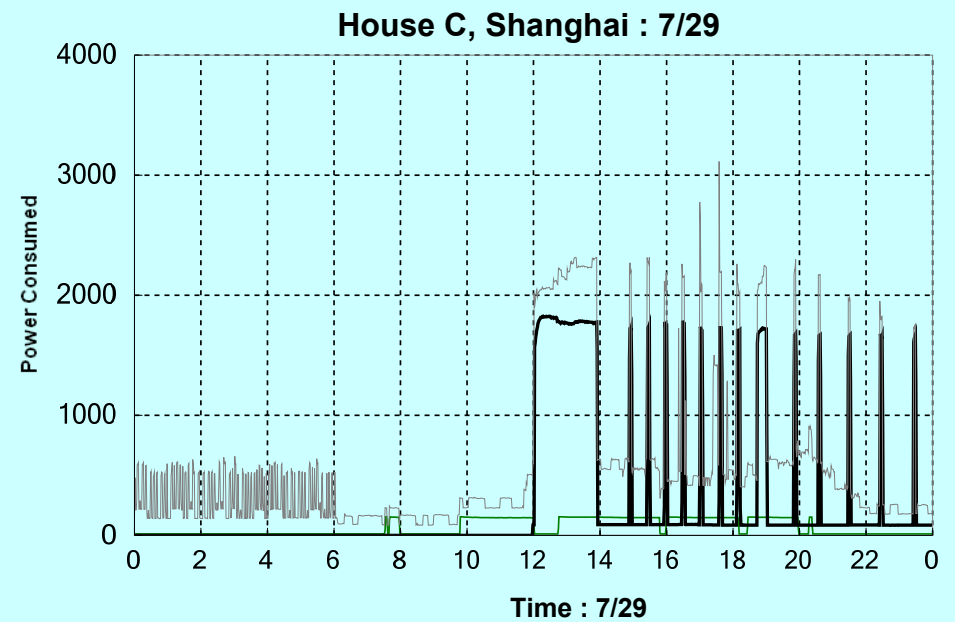
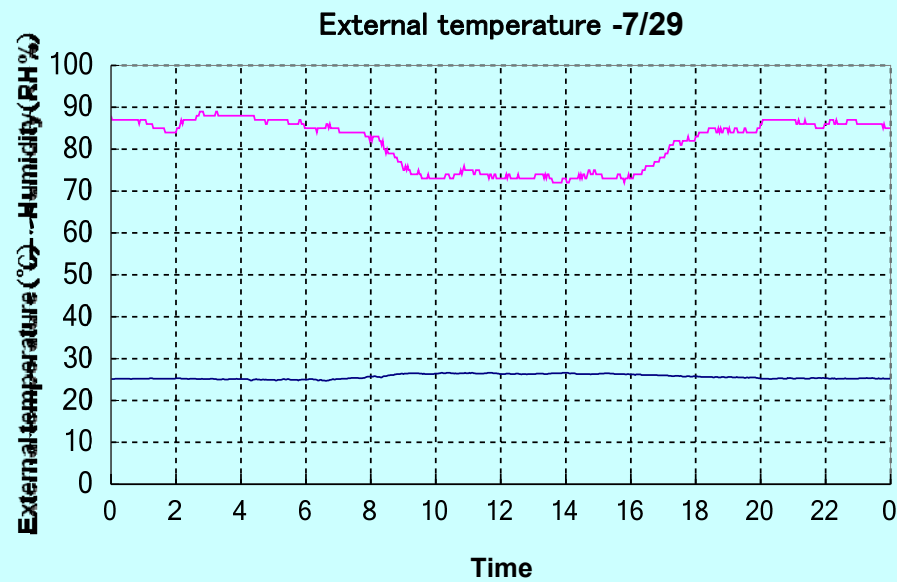
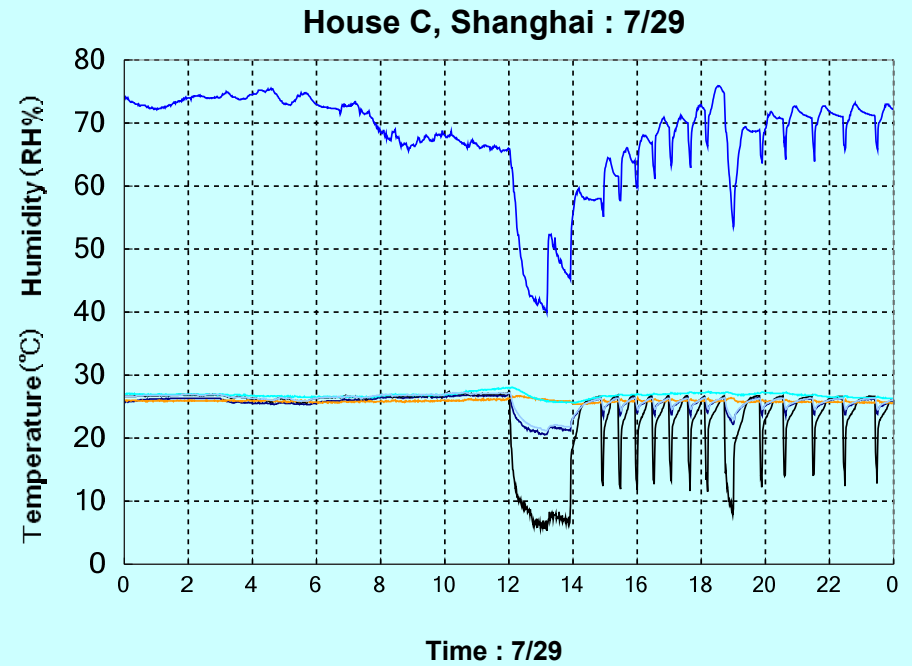


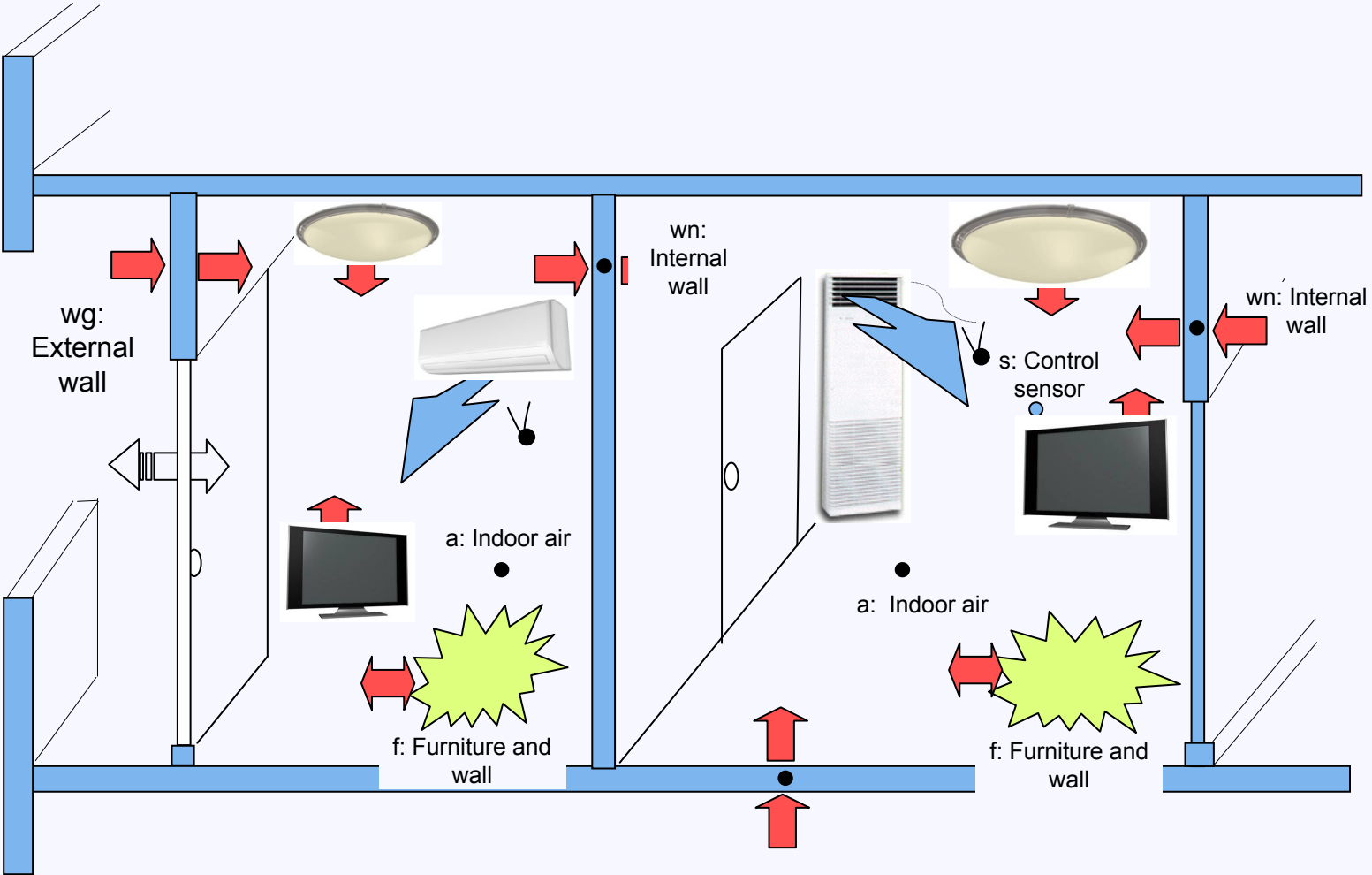
## House measured in Shanghai (1)

1F, 110M<sup>2</sup>

House of Mr. Sun  
(Quality Management)

# Controlled Experiment: Living Room House C, Shanghai 7/29

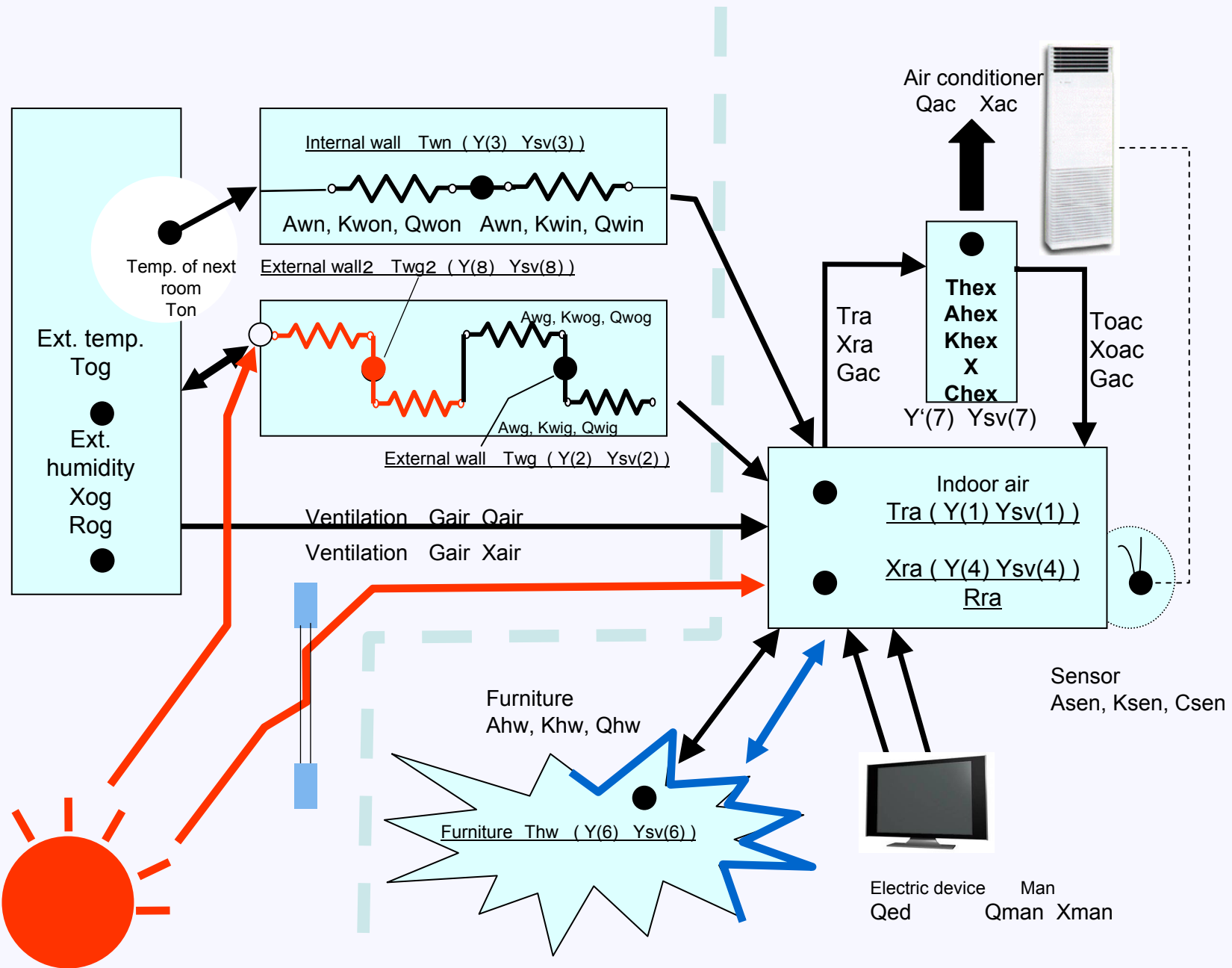




**Thermal model**



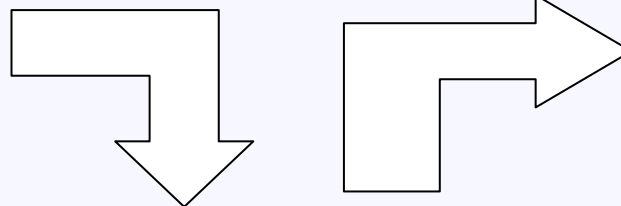
# Summary of Thermal Model



# Air Conditioner Analysis System

## Input

- House performance
  - Heat transfer rate
  - Area
- Daily habits
  - Heat generation in room
  - Number of people in room
  - Number of family members
  - Weekday/Weekend
- Climate data
  - Temperature and humidity
  - Sunlight
- Air conditioner performance



## Analysis adjustments

- Interval: 1 second
- 0:00 – 24:00
- Continuous operation and inverter machines

## Air conditioner analysis system

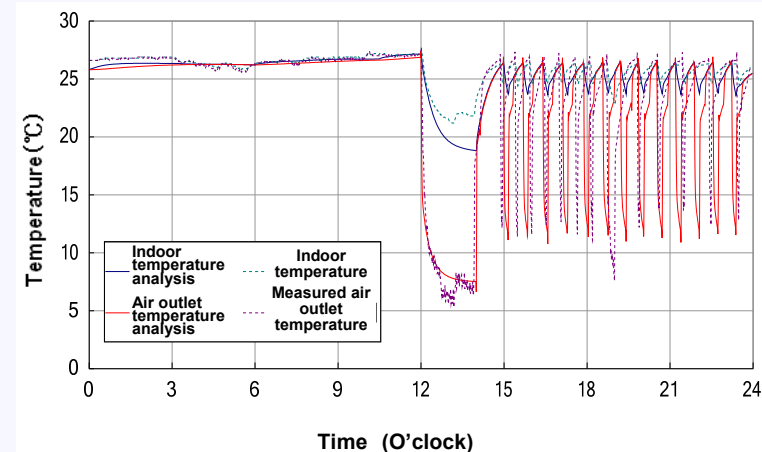
- Active Basic
- Analysis of air conditioner operation

## Output

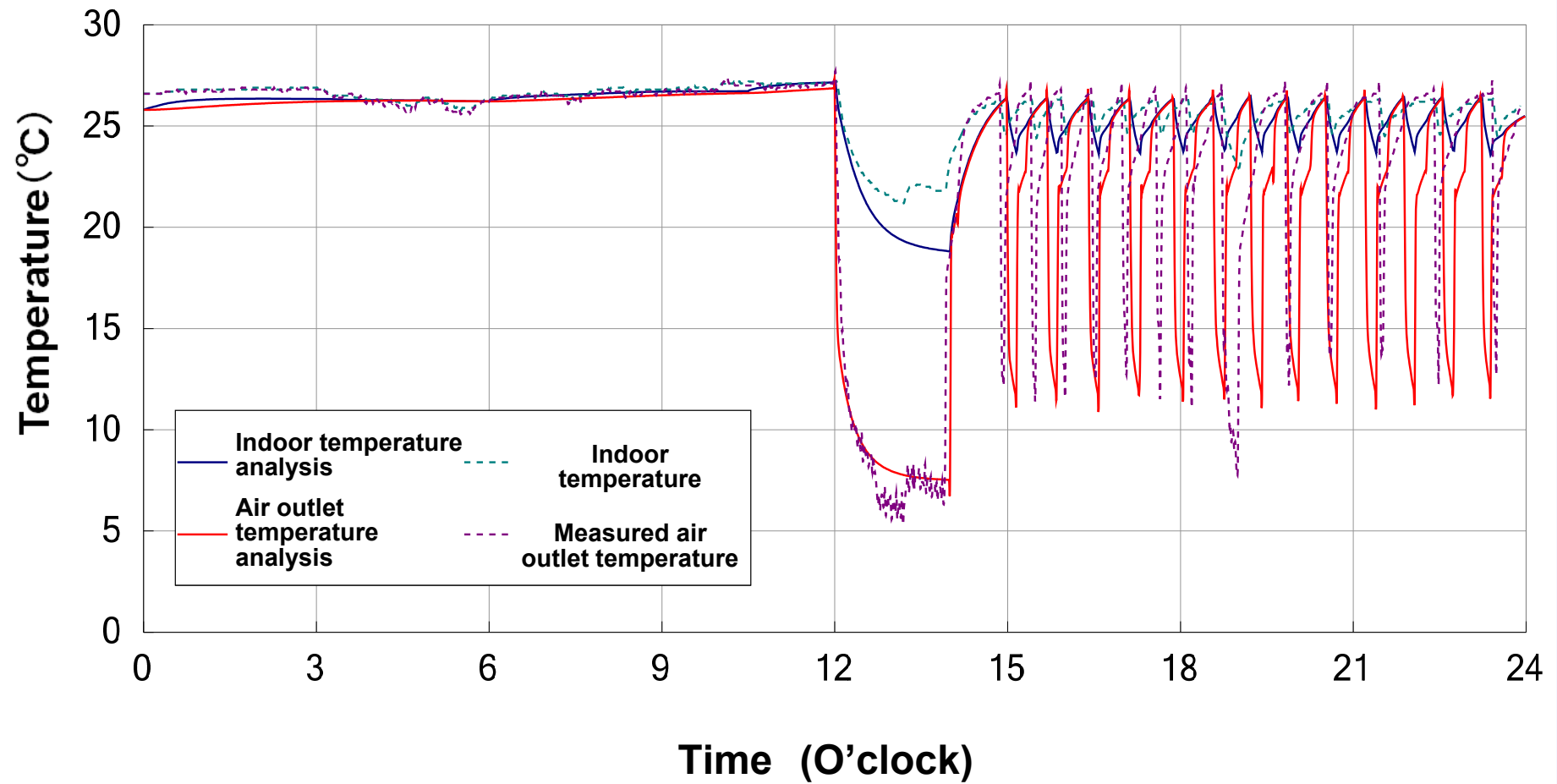
In living room and bedroom in each area

- Power consumed per day
  - Power consumed per year
- Estimated effect of power saving standardization

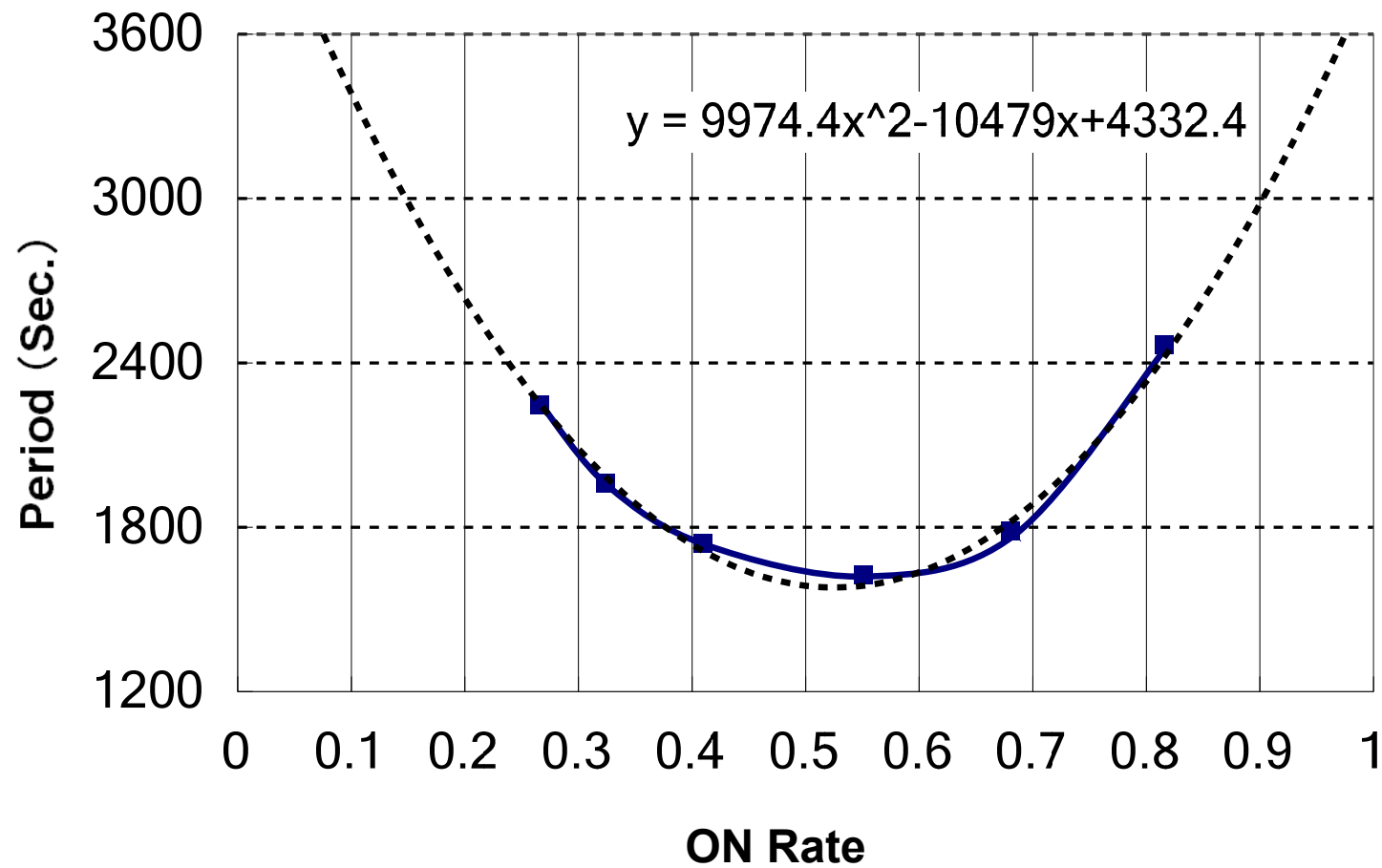
**Small Metering Dats**  
 (2 houses each in Guangzhou, Beijing, and Shanghai)  
**Metering Data**  
 (500 houses in 9 cities in China)



# Tuning

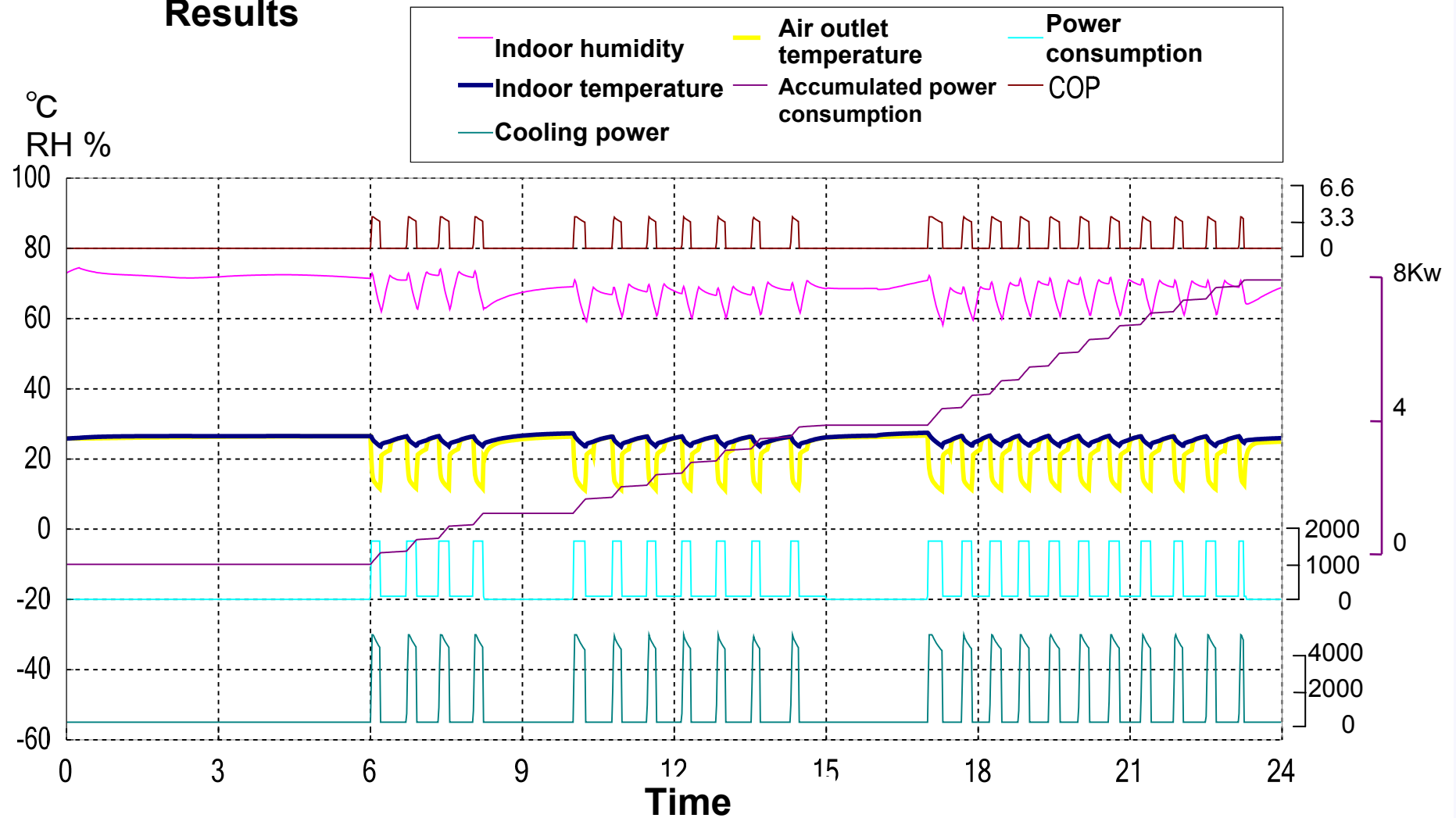


## Sample Analysis of Relationship Between Compressor ON-OFF Period and ON Rate

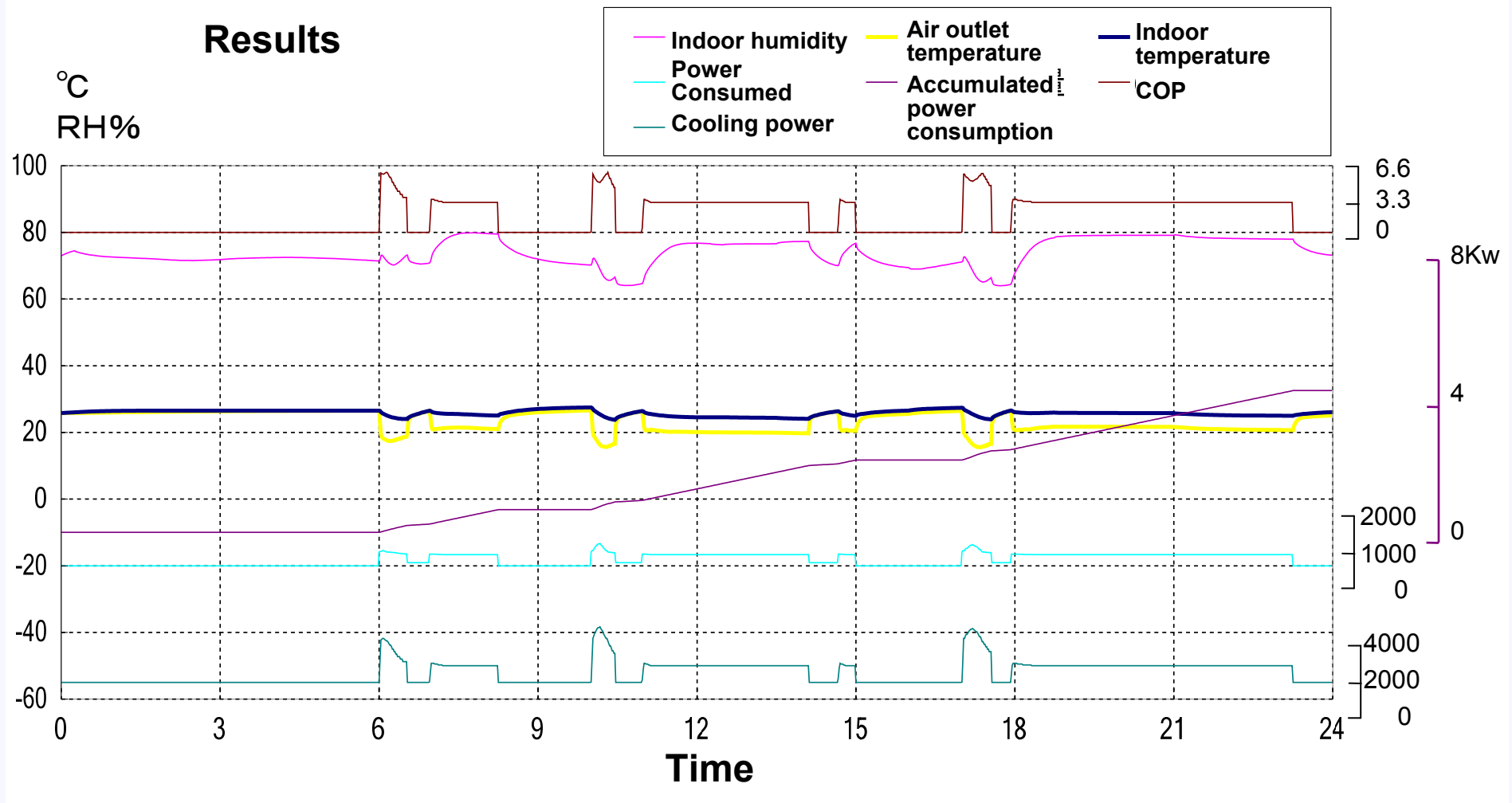


# Sample Analysis of Non-INV Unit

## Results



# Sample Analysis of INV Unit



## **APF (Asian Performance Factor) Research Workshop**

**— New power saving standards for air conditioners in accordance with region, climate, housing, and lifestyle —**

### **(1) Selected area**

- There are 5 climate areas in China. If the survey area is to expand, we should include inland areas such as Chungking, Chengdu, or Xian.

### **(2) Family**

- Family (Husband & Wife + Child + 2 Grandparents)

The grandparents live separately but stay in the house during the day. If there are no grandparents living nearby, they usually employ a housekeeper.

- Families in the south tend to have stronger connections between family members than those in the north.

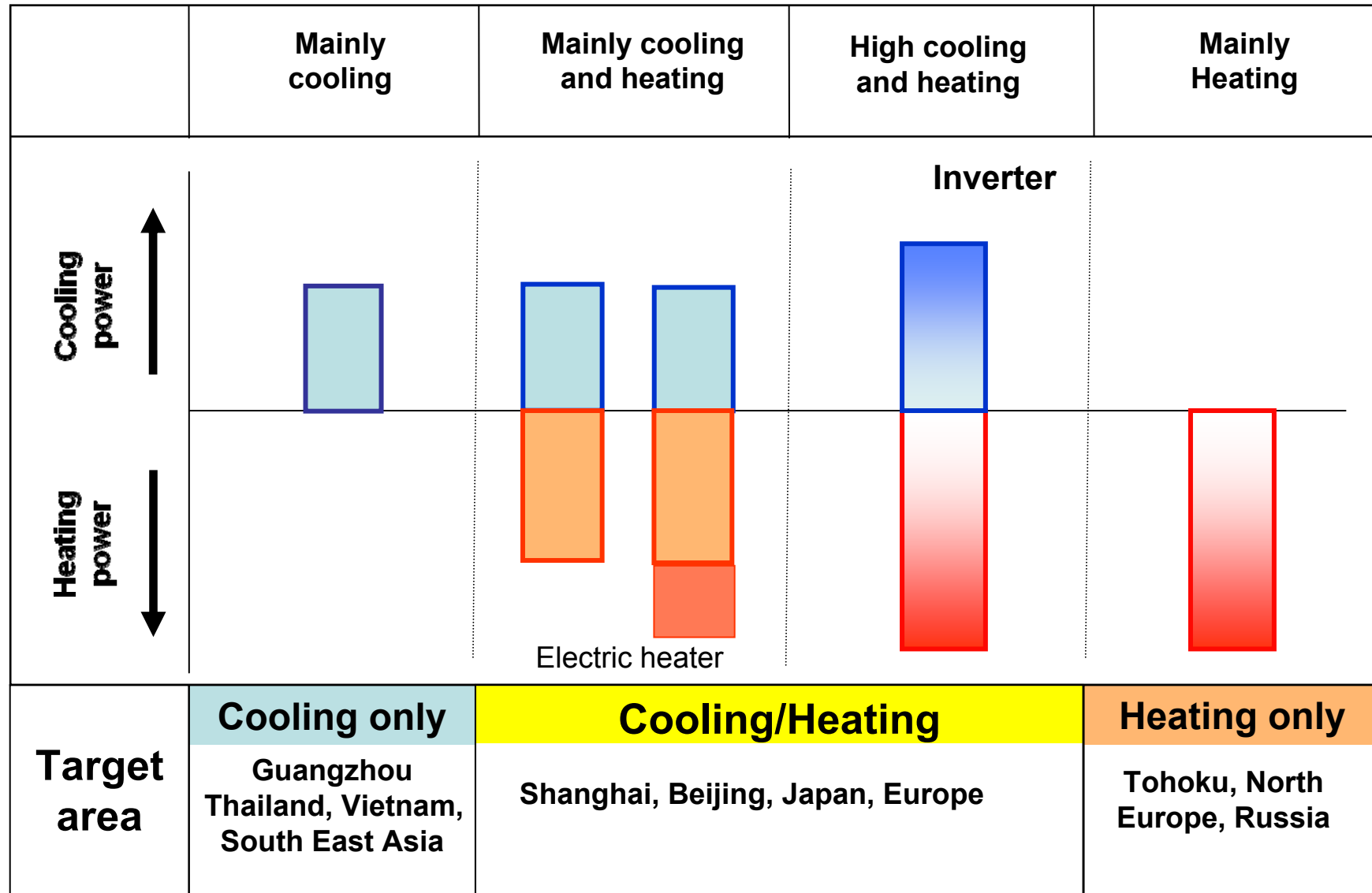
### **(3) Usage awareness of air conditioners**

- Varies depending on the region, age, income, etc.
- Temperature settings used in Guangzhou, where air conditioners have long been used, is standard.
  - Temperature settings are different depending the experience with air conditioners.
  - Settings are expected to be 26°C for cooling and 20-22°C for heating in the near future.

### **(4) Housing structure**

- Each area has its own structural standards, although the houses were actually built under old standards.
- Different standardizations are necessary for different regions.

# Air Conditioner Performance and Area





**Toward the establishment of APF (Asian Performance Factor)**  
**— New power saving standards for air conditioners in accordance with region, climate, housing, and lifestyle —**

**(1) Adjustments of Analysis Program**

- After cooling analysis adjustments → Adjustment of heating analysis, overall adjustment

**(2) Obtaining climate data for each city and region in China → Regional classification**

- Regional classification of the number of family members, living room/bedroom, weekday/weekend
- Reporting the metering results (regional expansion and measurement over one year) and the questionnaire results.

**(3) Study of daily habits, standard climate data, and standard houses in each region**

- Living rooms and bedrooms in each region, integration of weekdays and weekends

**(4) Study of induced load in each region**

- Correction of external temperature occurrence time using the analysis system → Induced load  
(Correction of appearance time by comprehending the rise in property)
- Classification of regions and houses; Separation/Integration of weekdays and weekends

**(5) Analysis of the properties of induced load and power consumed**

- Indication of the APF direction