

Energy Efficiency Policy Development Assistance – Views from the countries

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Beijing University of Technology

Energy Efficiency Standards in China: Technical Aspects and Relationship With The Project Activities

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Energy Efficiency Standards in China



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INTRODUCTION

1. **Technical support for EE Standards**
2. **Project Activities implemented in China**
3. **Challenges and trends in the future**



Technical support for EE Standards

WHY: technical support researches

1. EE Standards are usually simple on seeming
2. EE parameters take the core and key positions
3. These EE parameters will greatly influence the relevant industries or even destroy them.
4. These EE parameters should be hence determined **CAREFULLY**, based on the across-the-board technical researches

EXAMPLE:

GB12021.3-2004

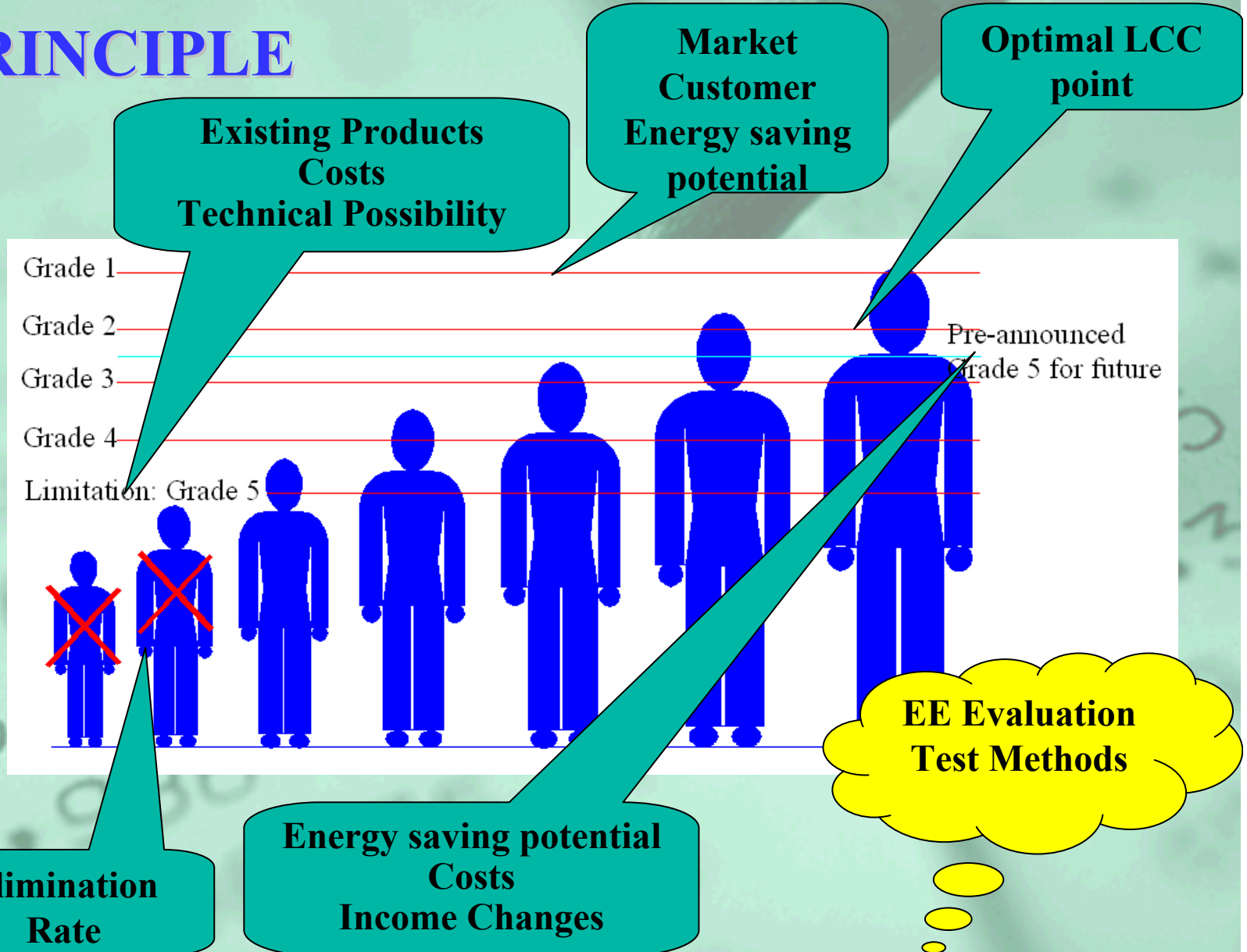
room air conditioners

| TYPE | Refri. Capacity (CC) W | Grade (EER) | | | | |
|--------|---------------------------|-------------|------|------|------|------|
| | | 5 | 4 | 3 | 2 | 1 |
| Window | | 2.30 | 2.50 | 2.70 | 2.90 | 3.10 |
| Split | $CC \leq 4500$ | 2.60 | 2.80 | 3.00 | 3.20 | 3.40 |
| | $4500 < CC \leq 7100$ | 2.50 | 2.70 | 2.90 | 3.10 | 3.30 |
| | $7100 < CC \leq 14000$ | 2.40 | 2.60 | 2.80 | 3.00 | 3.20 |



Technical support for EE Standards

PRINCIPLE



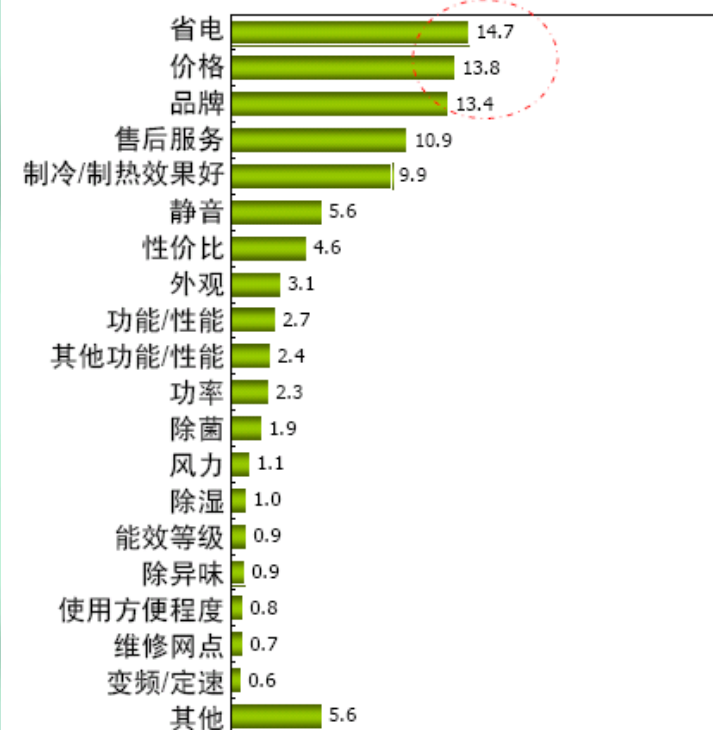


Technical support for EE Standards

EXAMPLE: air conditioners

1. Existing products and Market Researches

- Several thousands AC in market were investigated
 - ✓ Technical Specification data including EER and EE grades
 - ✓ Prices
- Customer Cognitive factors





Technical support for EE Standards

EXAMPLE: air conditioners

2. LCC Analysis

- **Price (rising with EER)**
 - ✓ **Material costs only**
 - ✓ **Material price changes considered**
- **Operation Costs (dropping with EER)**
 - ✓ **Electricity price changes considered**



Technical support for EE Standards

EXAMPLE: air conditioners

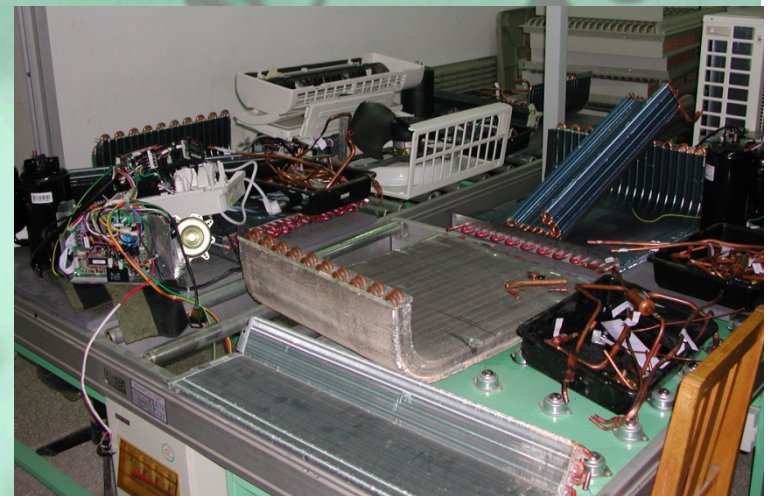
2. LCC Analysis

- LCC analysis model

Microsoft Excel - LCC-784hours-05013.xls

| 1匹变频空调器 | | | | | | | | | | | | | | | | |
|---------|---------------|-------------------|-------|-------|-----|------|--------|---------------|------------|----------------|-----------------|-------------|-----------|-------|-----|---------|
| 序号 | 节能设计方案 | 制造成本 | | 零售价 | 制冷量 | | SEER | 年耗电量 kWh/年 | 年费用 元/年 | 单项 偿还期 年 | 运行 时间 h/年 | 转移热量 kWh | 寿命周期成本LCC | | | 寿命 年 |
| | | 增加 R&D Cost | 总成本 | | kW | WW | | | | | | | 2% | 6% | 15% | |
| 0 | 基础样机 | 2.5 | 1,863 | 1,863 | 2.5 | 2.71 | 432.12 | 259 | 593 | 1,173.0 | 2,329 | 1,908 | 1,301 | 10 | | |
| 1 | 改善内螺纹铜管 | 2.5 | 1,880 | 1,880 | 2.5 | 2.81 | 416.77 | 250 | 1.30 | 501 | 1,173.0 | 2,246 | 1,840 | 1,255 | 10 | |
| 2 | 增加室外换热面积 | 2.5 | 1,933 | 1,933 | 2.5 | 2.96 | 396.50 | 238 | 1.64 | 379 | 1,173.0 | 2,137 | 1,751 | 1,194 | 10 | |
| 3 | 增加室内换热面积 | 2.5 | 1,962 | 1,962 | 2.5 | 3.04 | 385.94 | 232 | 0.72 | 316 | 1,173.0 | 2,080 | 1,704 | 1,162 | 10 | |
| 4 | 改进压缩机 | 2.5 | 2,022 | 2,022 | 2.5 | 3.12 | 375.38 | 225 | 1.17 | 252 | 1,173.0 | 2,023 | 1,658 | 1,130 | 10 | |
| 5 | 改善节流元件 | 2.5 | 2,141 | 2,141 | 2.5 | 3.21 | 365.89 | 220 | 2.01 | 195 | 1,173.0 | 1,972 | 1,616 | 1,102 | 10 | |
| 6 | 增加室外换热面积 | 2.5 | 2,268 | 2,268 | 2.5 | 3.37 | 348.59 | 209 | 1.70 | 092 | 1,173.0 | 1,879 | 1,539 | 1,050 | 10 | |
| 7 | 增加室内换热面积 | 2.5 | 2,387 | 2,387 | 2.5 | 3.50 | 334.71 | 201 | 1.37 | 008 | 1,173.0 | 1,804 | 1,478 | 1,008 | 10 | |
| 8 | 增加室外换热面积 | 2.5 | 2,521 | 2,521 | 2.5 | 3.67 | 319.64 | 192 | 1.33 | 918 | 1,173.0 | 1,723 | 1,412 | 963 | 10 | |
| 9 | 增加室内换热面积 | 2.5 | 2,745 | 2,745 | 2.5 | 3.93 | 298.81 | 179 | 1.88 | 793 | 1,173.0 | 1,610 | 1,320 | 900 | 10 | |
| 10 | 更改室内外风扇电机 | 2.5 | 2,894 | 2,894 | 2.5 | 4.13 | 283.96 | 170 | 1.12 | 704 | 1,173.0 | 1,530 | 1,254 | 855 | 10 | |
| 11 | 更换为高效压缩机 | 2.5 | 3,192 | 3,192 | 2.5 | 4.97 | 235.99 | 142 | 1.70 | 416 | 1,173.0 | 1,272 | 1,042 | 711 | 10 | |
| 12 | 更换为R410a直冷压缩机 | 2.5 | 3,758 | 3,758 | 2.5 | 5.60 | 209.63 | 126 | 2.85 | 258 | 1,173.0 | 1,130 | 926 | 631 | 10 | |
| 13 | | | | | | | | | | | | | | | | |
| 23 | 电费 | 0.5 元/kWh | marks | 1.49 | | | | | | | | | | | | |

Material consumption tests





Technical support for EE Standards

EXAMPLE: air conditioners

3. Technical possibility and energy saving potential researches

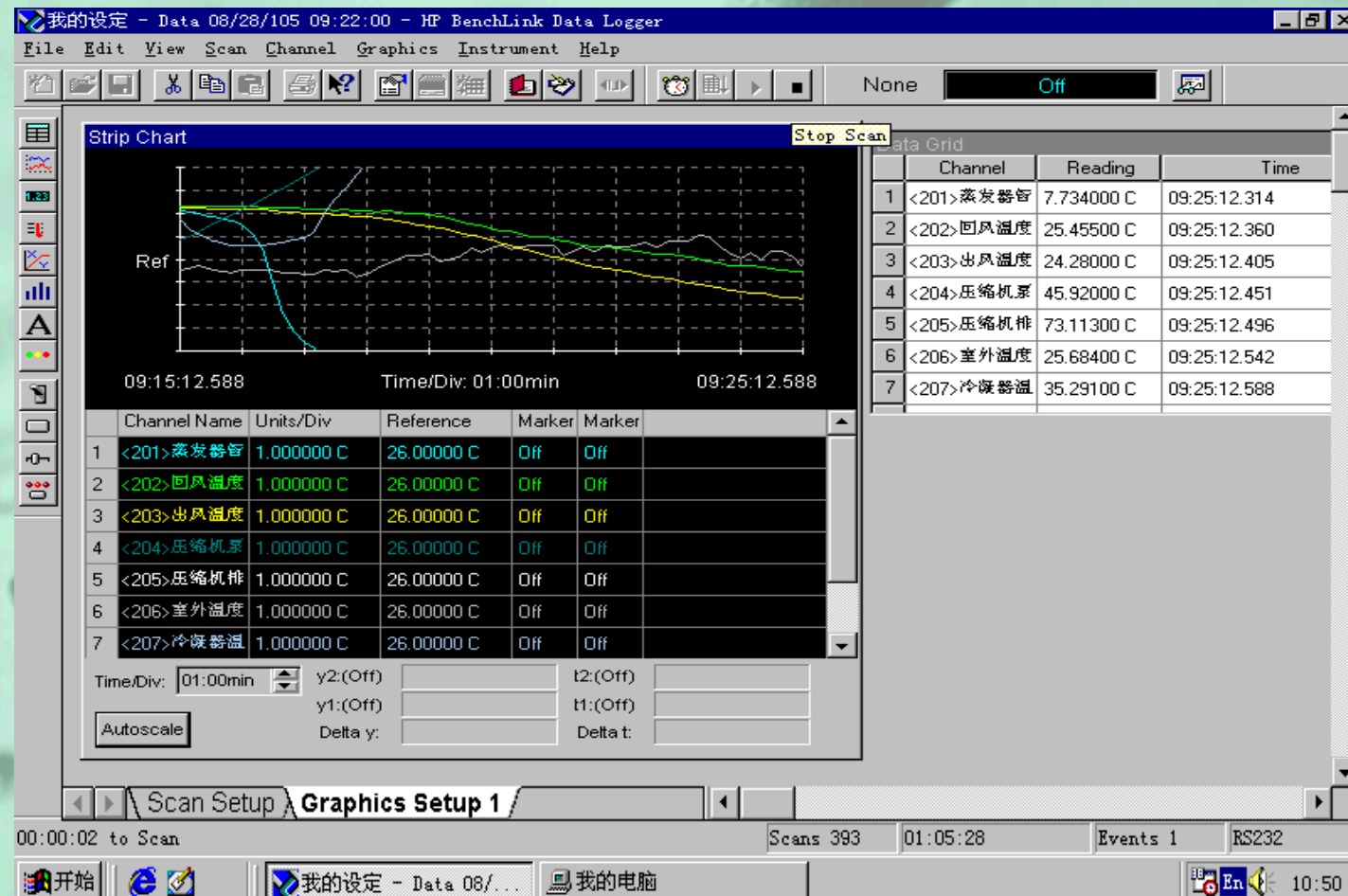
- Theoretical prediction and test verifications
- Key factors: energy saving technologies in:
 - ✓ Compressor
 - ✓ Heat exchanger
 - ✓ System design and optimization
 - ✓ Fan and its motor
 - ✓



Technical support for EE Standards

EXAMPLE: air conditioners

Sample machine tests





Technical support for EE Standards

EXAMPLE: air conditioners

4. Special researches on some key Technical problems--counterviews
 - **Dehumidification vs EER**
 - ✓ **High EER causes poor dehumidification?**
 - **Energy consumption during material manufactured**
 - ✓ **More materials for High EER causes great energy consumption?**
 - **Heating operation performance**
 - ✓ **High cooling efficiency resists high heating efficiency?**
 -



Technical support for EE Standards

EXAMPLE: air conditioners

4. Special researches on some key Technical problems

| Material | Ore needed | Mining | Mill run | Electrolyzing | Rolling | Total |
|-----------|-----------------------------------|----------------------------|-------------|----------------------------------|-------------|--------------|
| Copper | 151Tons/1Ton | 37kWh/Ton | 35.8kWh/Ton | 7780kWh/Ton | 9913kWh/Ton | 28677kWh/Ton |
| Steel | 396.69kWh/Ton | | | 6033kWh/Ton | 1550kWh/Ton | 7980kWh/Ton |
| Aluminium | 5833.5kWh/Ton | | | 15000kWh/Ton | | 20834kWh/Ton |
| Material | EER rises from grade 5 to grade 2 | | | Energy saving by AC in ten years | | |
| | Material increasing | Energy to produce material | | 1979kWh | | |
| Copper | 3kg | 138kWh | | | | |
| Steel | 1kg | | | | | |
| Aluminium | 4kg | | | | | |

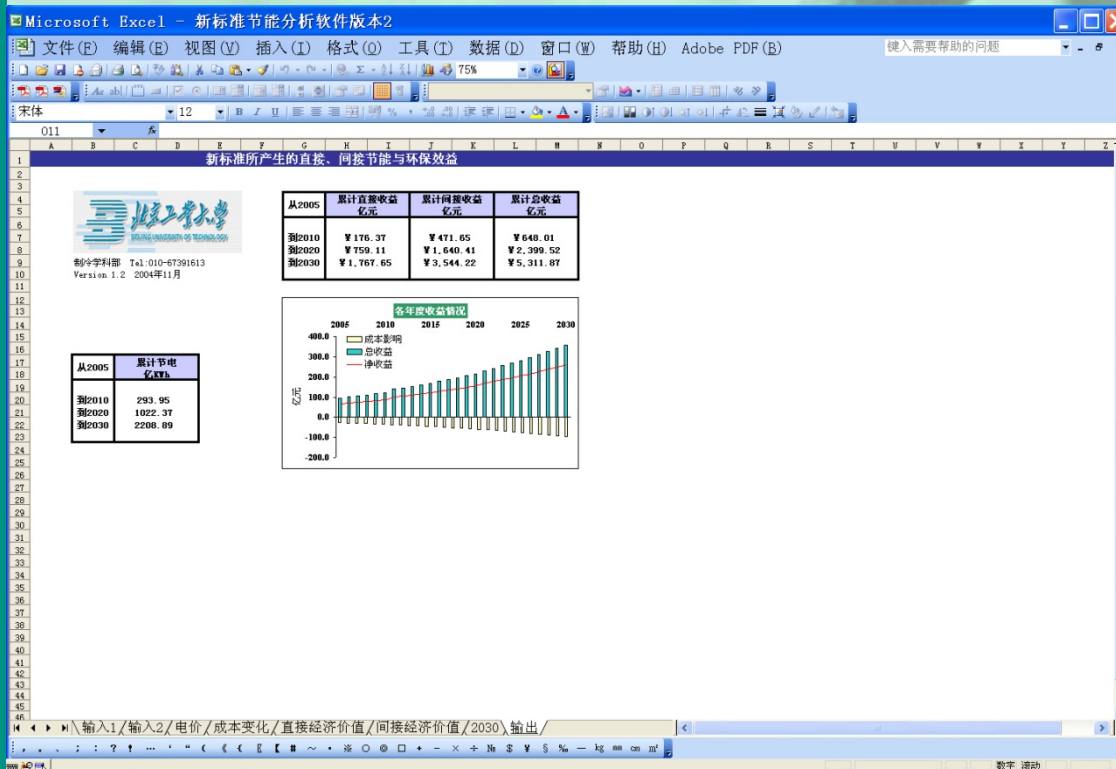


Technical support for EE Standards

EXAMPLE: air conditioners

5. Effect evaluation of energy saving and others

- Different energy efficiency level results in different effect
- A special model was developed to evaluate the benefits of different schemes





Technical support for EE Standards

EXAMPLE: air conditioners

SPECIAL FOR VARIABLE SPEED AC

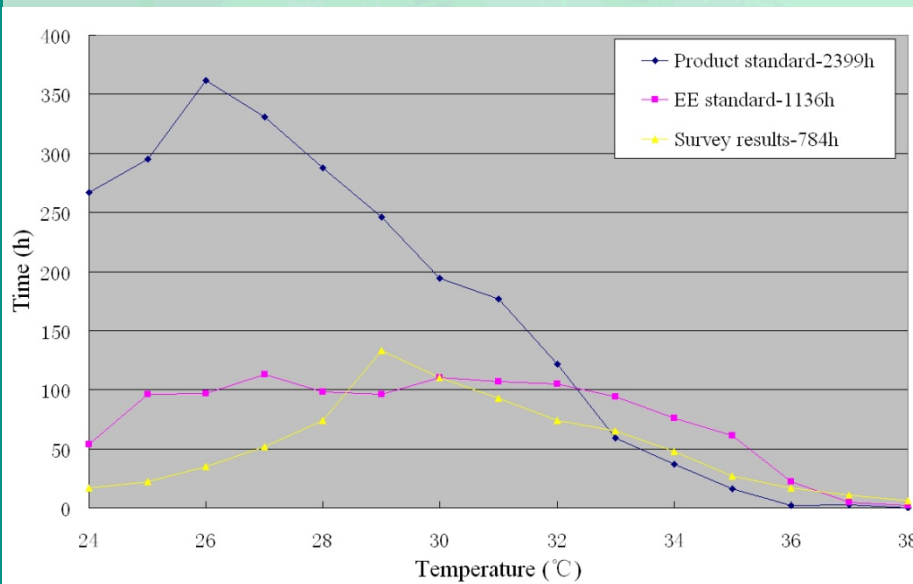
6. **Cooling operation time at different temperatures in cooling operation season—operation time vs temperature curve**
 - **China AC product standard has defined such a curve, but it departure form the real situation**
 - **This curve was revised in EE standard based on the survey of Chinese customer's operation habit**
 - **Since the curve will influence the SEER value, it should be as close as to customer's operation habit**
7. **The unitive evaluation platform both for constant and variable speed air conditioners**
 - **Good ideal and exigent wish of AC manufacturers**
 - **Failed to do so because of poor technical base and accumulations**



Technical support for EE Standards

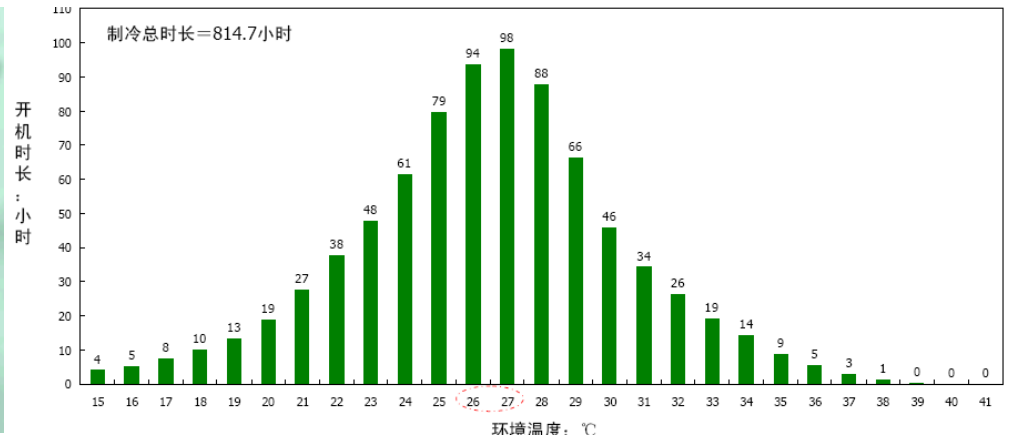
EXAMPLE: air conditioners

SPECIAL FOR VARIABLE SPEED AC



速空调开机时间与温度-制冷

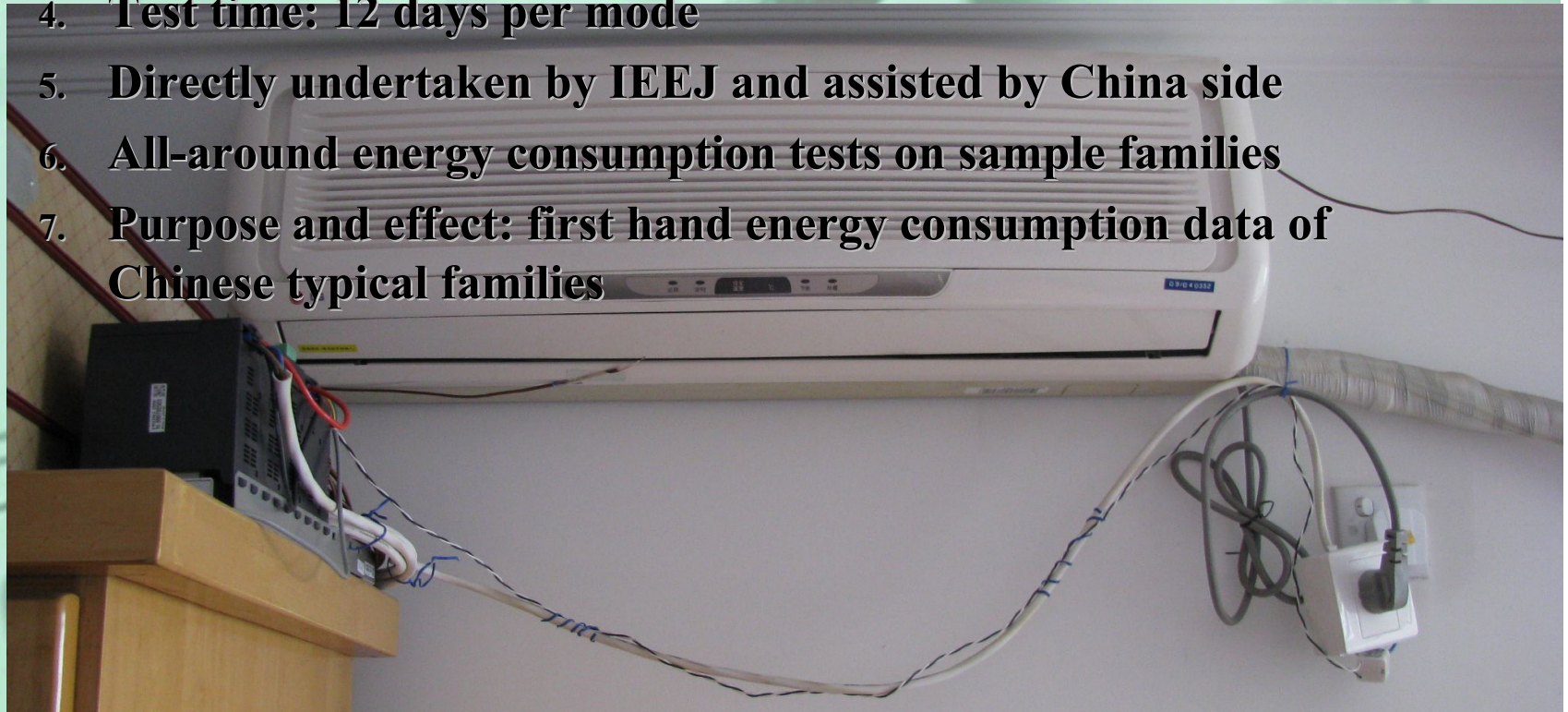
制冷状况下，使用最频繁时候的温度为26、27°C。
 制冷状况下，使用时间分布如下：



Project Activities implemented in China

Small-scale Metering

1. **Venue: Beijing, Shanghai, Guangzhou**
2. **Tested number: three families per city**
3. **Operation mode: cooling and heating**
4. **Test time: 12 days per mode**
5. **Directly undertaken by IEEJ and assisted by China side**
6. **All-around energy consumption tests on sample families**
7. **Purpose and effect: first hand energy consumption data of Chinese typical families**





Project Activities implemented in China

APF workshop in Tianjin, China

1. **Title: Workshop on the energy testing method for Air-Conditioners**
2. **Presentations:**
 - **Concepts and current situation of energy efficiency standards in Asia -- expert from Japan (IEEJ, Mr. Kudo)**
 - **The energy testing method for Air-Conditioners in China (BJUT, Dr.LI Hongqi)**
 - **Manufacturer's view on the energy efficiency trends in the Chinese market (Panasonic)**
 - **Manufacturer's view on the energy efficiency trends in the Chinese market (Haier)**
 - **Objective of the small sampling study on the energy consumption of typical families (Mr. Sagawa)**
 - **Study on the energy consumption of typical families (Mr. Sugawara)**
3. **Discussion: Trend of the energy testing method for Air-Conditioners (EER or APF)**
4. **China AC manufacturers were greatly interested and many were supplanted outside due to small meeting room**



Project Activities implemented in China

Workshops on the Lifestyle and Usage of Air-conditioner

1. **Venue: Beijing, Shanghai, Guangzhou**
2. **Participants:**
 - Japanese experts
 - Responsible persons of small-scale metering in local city
 - Chinese expert on residential environment
 - Chinese expert on architecture
 - Local AC customer
 - Local AC manufacturers
3. **Discussion: living habit, AC operation situation, building characteristics, etc**
4. **Purpose and effect: deep understandings to Chinese customers and family energy saving. Important support to the policy developments**



Project Activities implemented in China

Large-scale Metering of AC operation

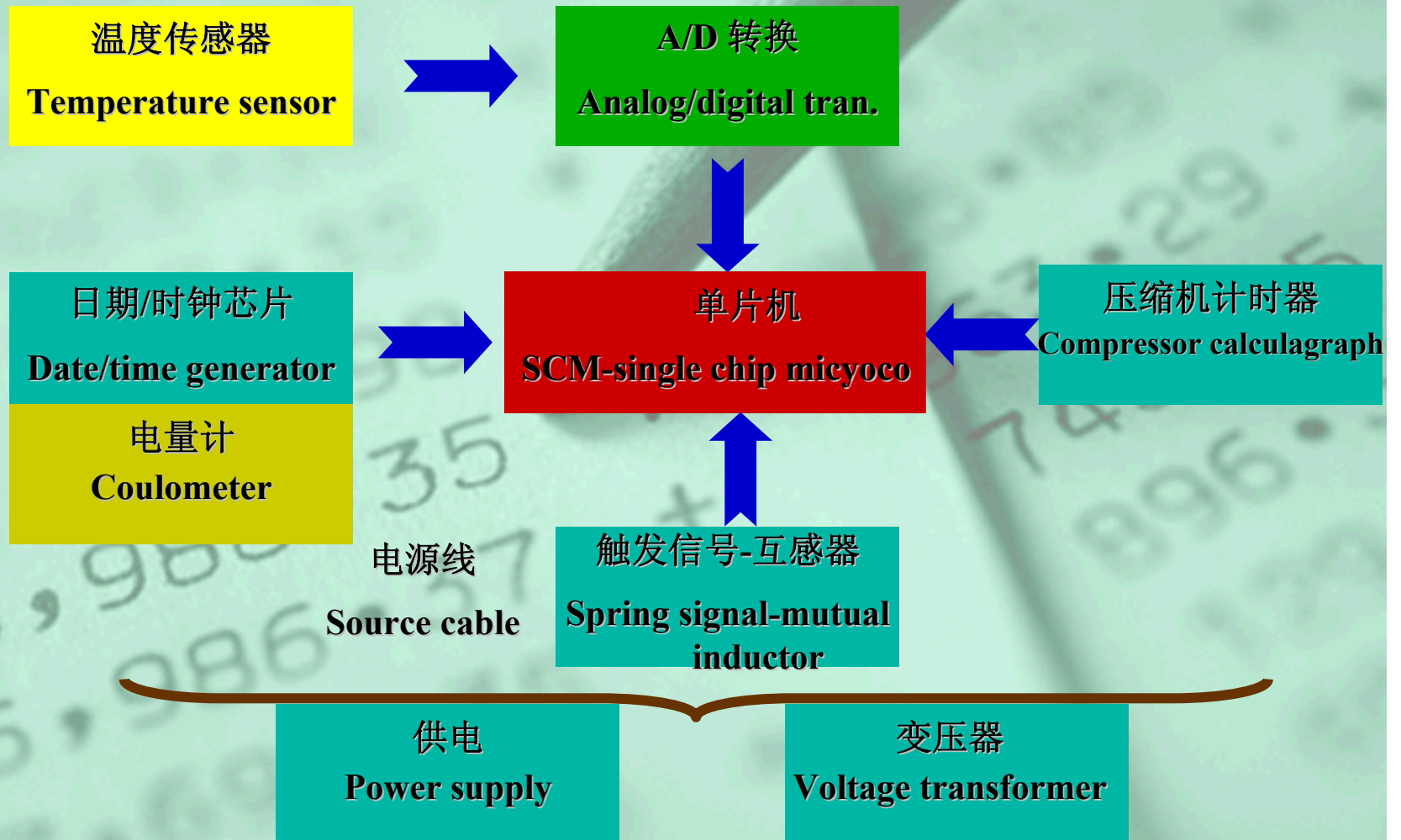
ACTIVITY DESIGN

- **Offset survey limitation with test data**
- **10 typical cities, 50 samples per city, 500 ACs tested**
- **Special meter was designed for this purpose**
- **Test time: one calendar year**
- **Tested parameters:**
 - ✓ **On/off time of AC**
 - ✓ **Indoor temperature during AC operation**
 - ✓ **Cumulated energy consumption of AC**
 - ✓ **Cumulated operation time of compressor**
 - ✓ **Total consumptions (electricity, water and gas) of sample family**
 - ✓ **Outdoor temperature hour by hour per city**



Project Activities implemented in China

METER DESIGN

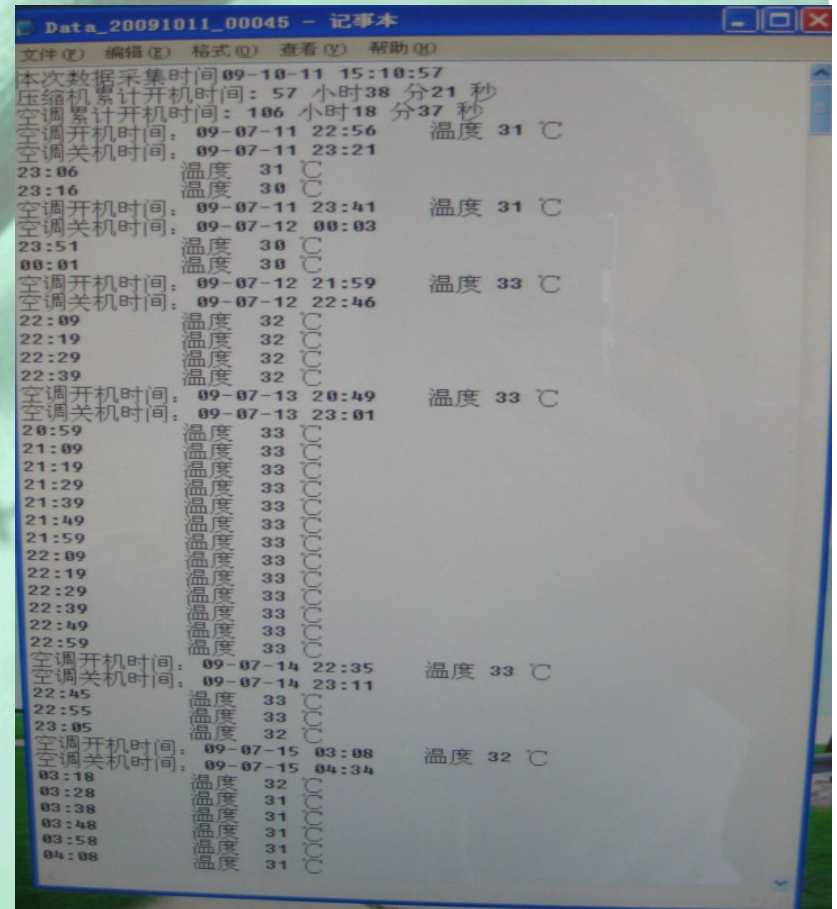




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METER DESIGN





Project Activities implemented in China

SAMPLING

- Four levels: country, province, city, family
- Country: meteorologic area
- Province: diffusive rate of AC
- City: population, GDP
- Family:
 - ✓ Income
 - ✓ Contruction area of the house
 - ✓ Family structure
 - ✓ Type of AC
 - ✓ Direction of room
 - ✓ Floor
 - ✓ Building structure

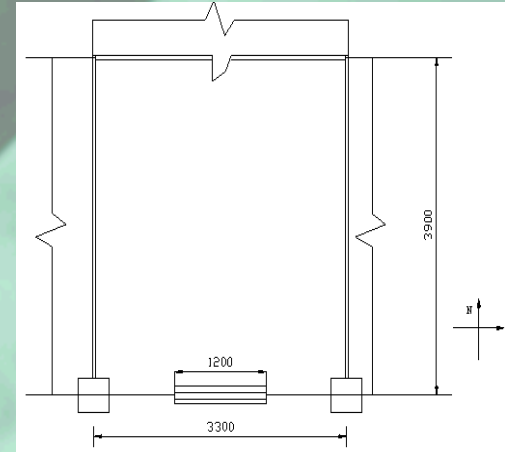




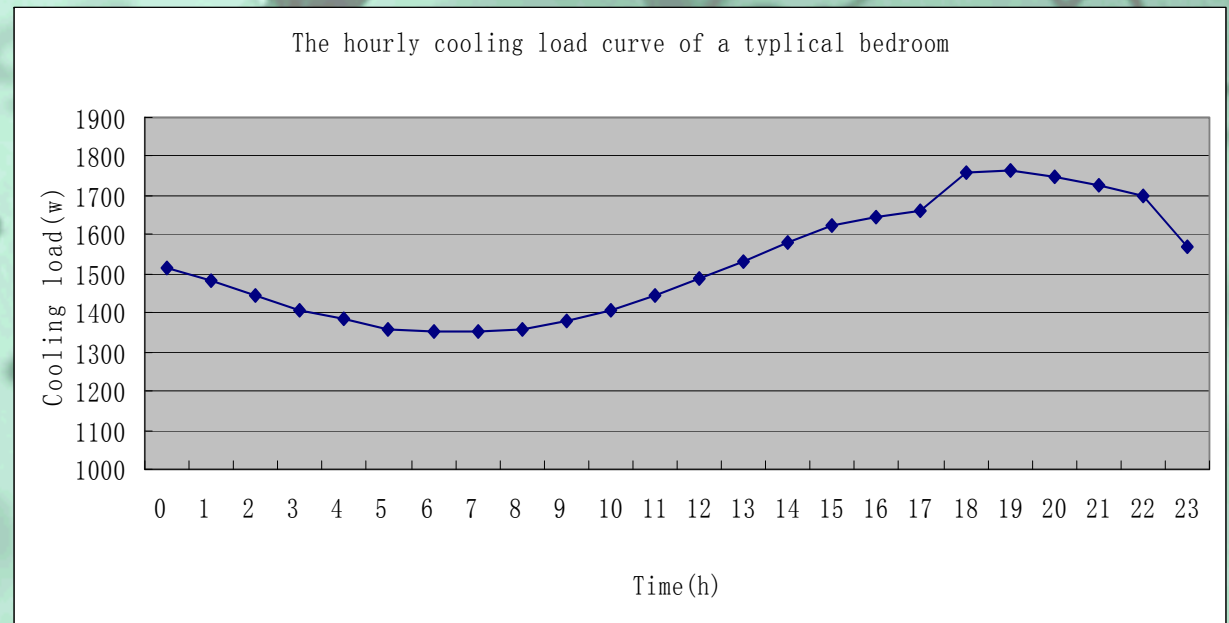
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EXAMPLE TEST DATA



Calculated hourly cooling load of a typical bedroom-type users

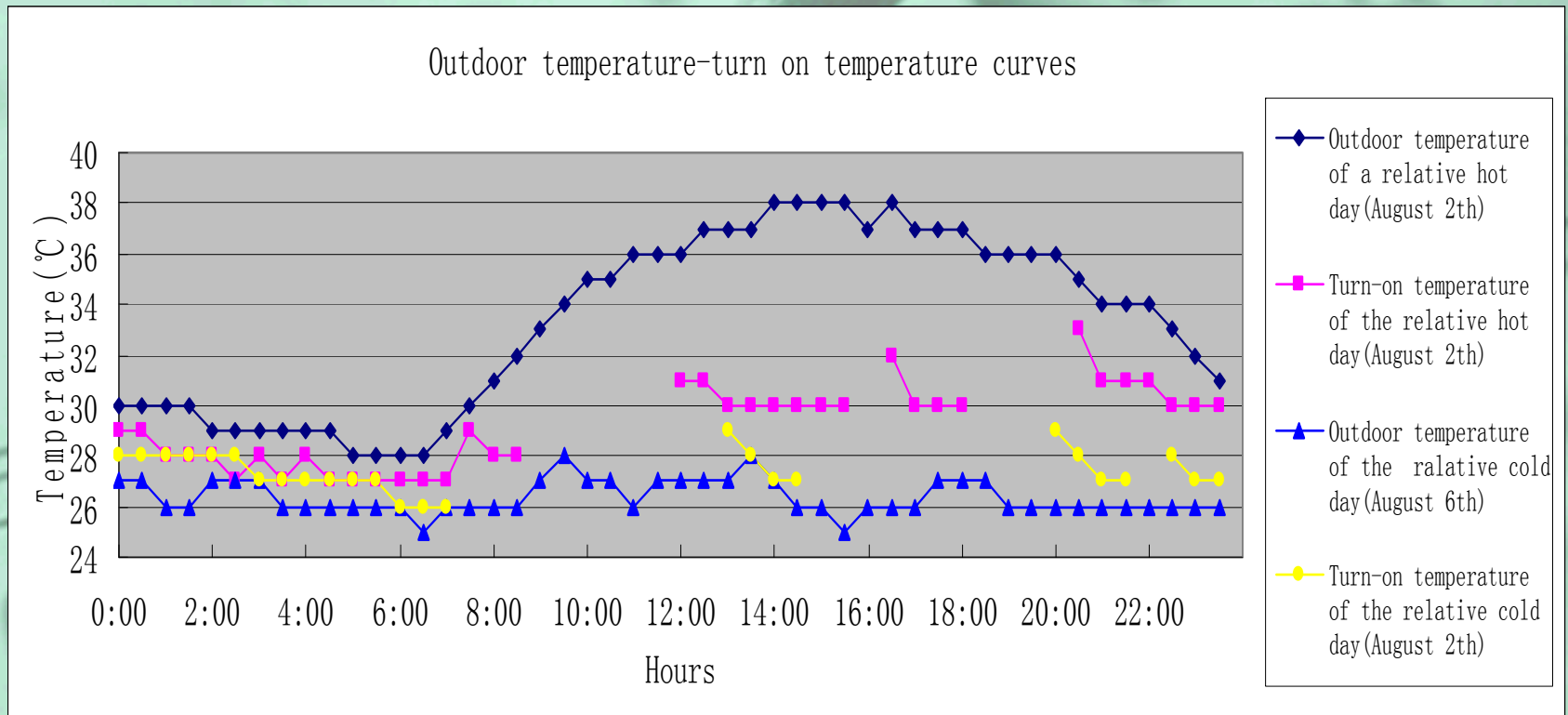




Project Activities implemented in China

EXAMPLE TEST DATA

The relationship between turn-on temperature and running time of a typical bedroom-type users

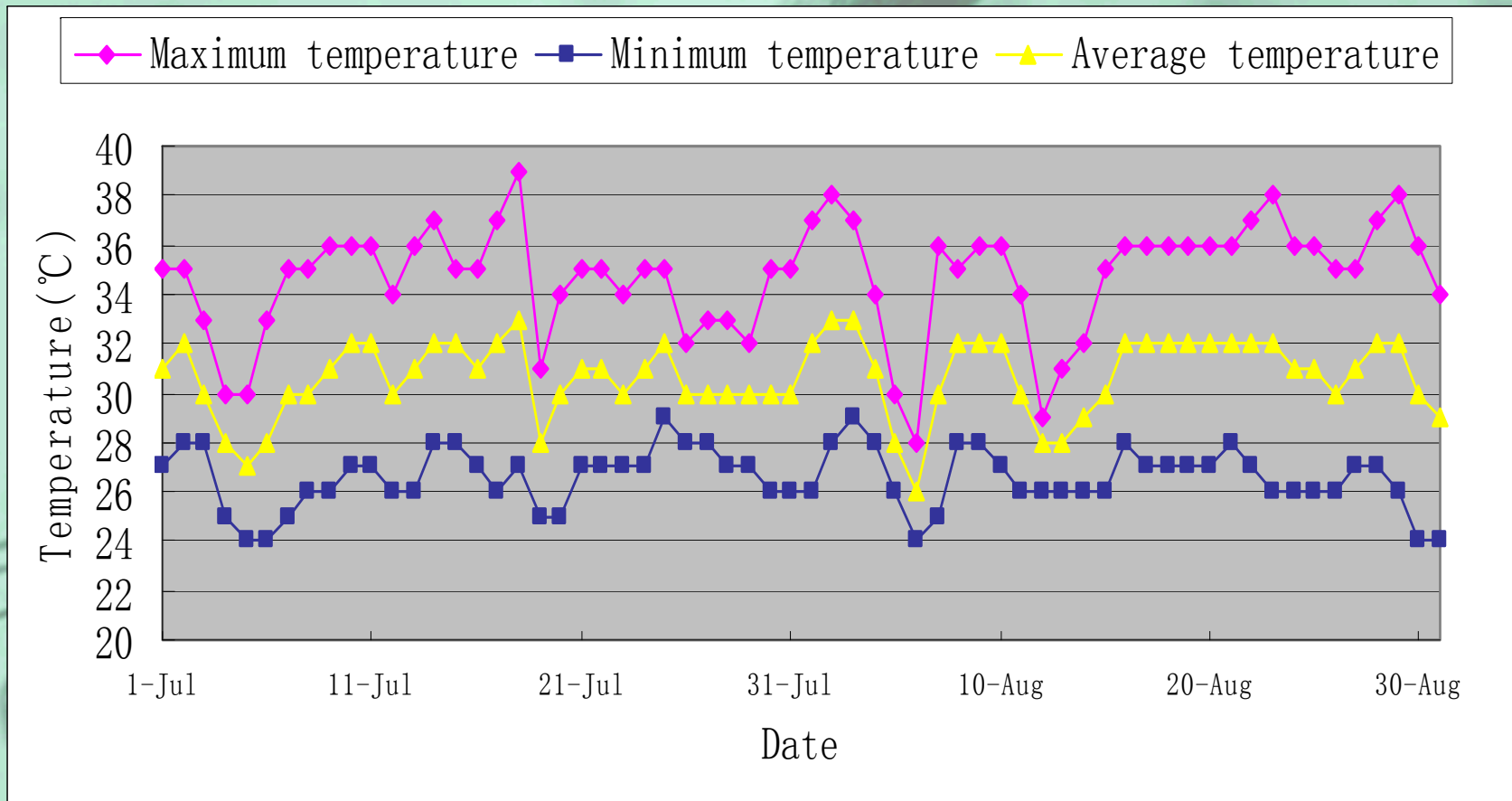




Project Activities implemented in China

EXAMPLE TEST DATA

Outdoor temperatures in Guangzhou (from July 1st to August 30th)

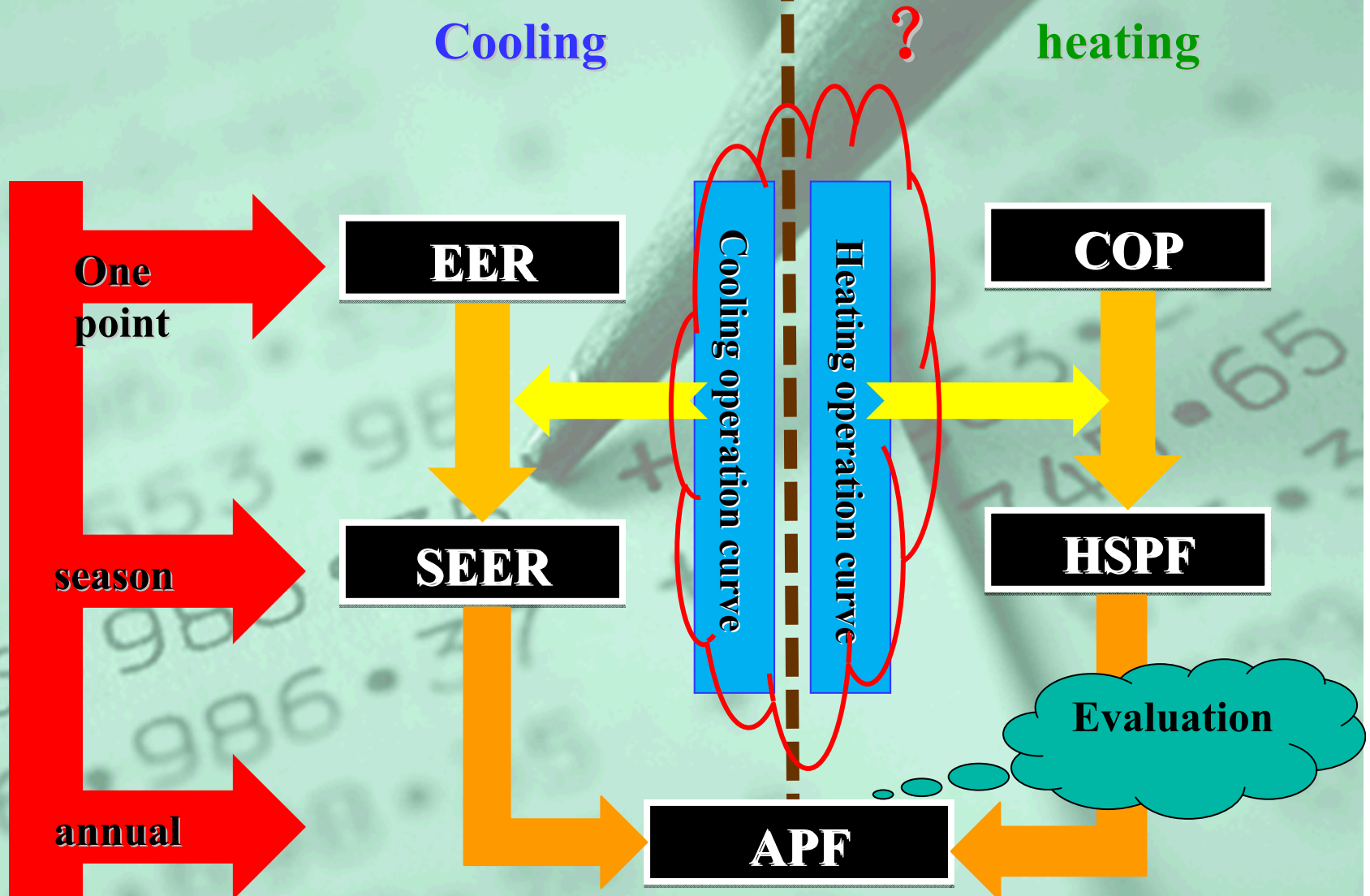


Challenges and trends in the future



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IMPROVEMENT OF EE EVALUATION SYSTEM





Challenges and trends in the future

Unitive evaluation platform both for constant and variable speed air conditioners

1. **Very important task for China due to the co-existing of both ACs**
2. **Very difficult task due to:**
 - **Too many influence factors**
 - **Poor technical data accumulations**
 - **Drastic contention between different technical genres**
 - **Great amount of technical researches and test verification are needed**
 - **Finance limitation**
3. **Principle: both kinds of ACs with same EE data (SEER or APF) should have same energy consumptions**
 - **Customer convenience during purchasing**
 - **Justice consideration to different technical genres**
4. **All activities of the project are helpful and useful but more and further work is needed, such as test verifications and simulation analysis**



消费者空调器使用习惯入户测试

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Thanks for your attention!

Thank IEEJ

Any questions?