Building energy benchmarks and rating tools

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What are building energy benchmarks and rating tools?

- Yardsticks to help us measure how well a building performs, or should perform, in terms of energy use.
- Benchmarks establish an energy use intensity (Btus/ft^2 or W/M^2) or efficiency level for a type of building in a certain climate region that can be either the average of the building stock, what's required by the building standard, or a target for the future, e.g., a net-zero building.
- Rating tools are similar except that they also provide a rating with a number of stars, letter value, etc.

Questions concerning energy benchmarks and rating

- Is the rating for the physical building and equipment, i.e., the “asset value” of the property, or the actual performance that can depend greatly on the operations and use of the building?
- With cars, DOE’s mileage ratings indicate the fuel efficiency in miles/gallon, but DOE does not attempt to predict the car’s actual fuel consumption or savings.
- With refrigerators, the technical rating conforms closely to the actual performance.

Questions concerning energy benchmarks and rating

- With buildings, its energy consumption depends partly on its physical assets, but also with how the building is operated and used.
- Technical ratings or benchmarks are largely derived using computer simulations that show how the building would perform under the assumed operating conditions.
- Performance ratings are done based on actual energy usage and are possible only after the building is completed and occupied.

Examples of energy benchmarks and rating tools in US and China

- ***Building standards*** (both US and China) – basically a technical rating
- ***Voluntary green building rating systems*** (LEED , MOHURD 3 Star Green Building Rating System) ***and building energy labels*** (various US efforts and MOHURD's building energy efficiency labeling system) – based on building energy standards, therefore also a technical rating (?)
- ***EnergyStar Buildings*** (US) – a performance rating
- ***CDM*** (UN, World Bank) – a combined technical/performance rating
- ***DOE prototypical building models*** (originally called benchmark commercial buildings) – provides prototypical building models for commercial buildings that comply with local building standards and are high-performance target buildings.

Benchmarks and ratings for several recent demonstration projects

Olympic Village
(LEED-ND Gold 2008)

“Micro-Energy” Building
(2008, unrated)

Agenda 21 building
(LEED Gold 2005)

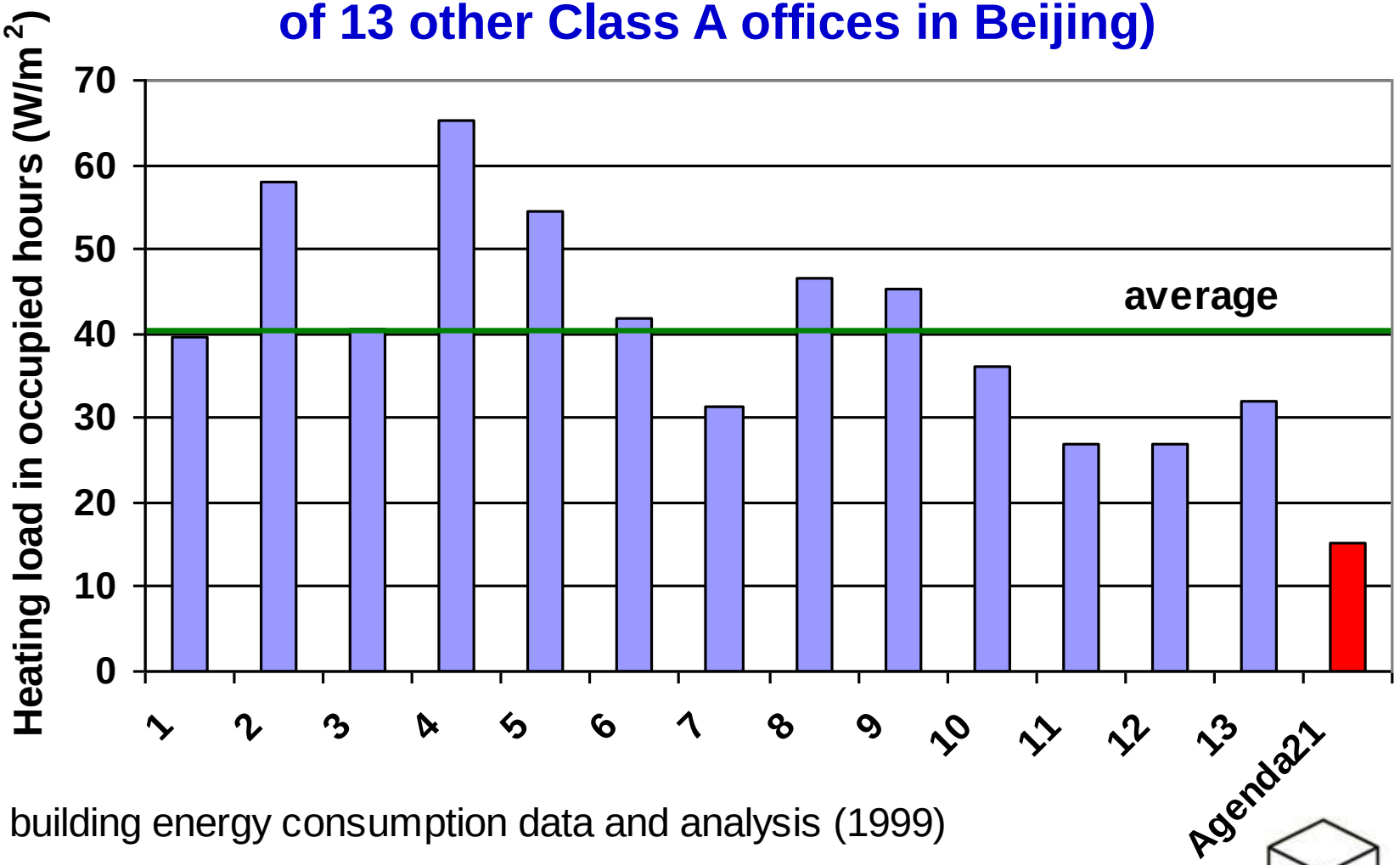
The US-China Agenda 21 Demonstration Energy-Efficient Office Building

Project development
1998 - 1999
Design development
2000 – 2001
Construction
2002 – 2003
Monitoring
2006 - 2009

First LEED Gold building in China
March 31, 2006
(no other rating system then available in China)

How is the energy performance of the Agenda 21 building ?

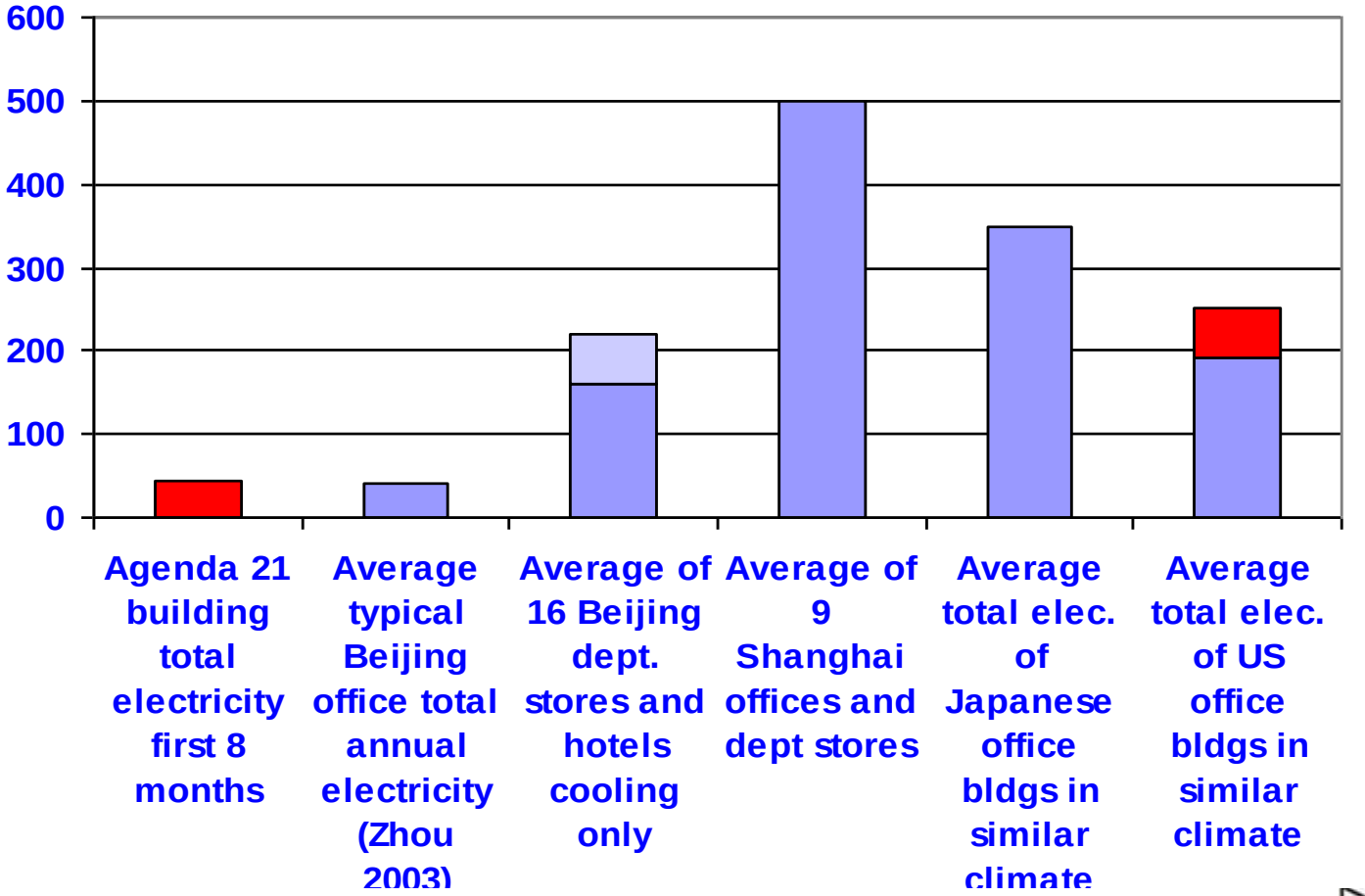
(60% lower heating EUI compared to the average of 13 other Class A offices in Beijing)



* building energy consumption data and analysis (1999)

How is the energy performance of the Agenda 21 building ?

(about the same electricity consumption as typical offices in Beijing, but less than a third that of US offices)



Olympic Village finished Feb. 2008

LEED-ND Gold certification obtained June 2008

The Beijing Olympic Village Micro-Energy Building

Building shell:

- Roof k=0.2 W/m^2•k (R-28)
- Wall k=0.3 W/m^2•k (R-19)
- Vacuum windows
  - k=1.0 W/m^2•k (U-0.17)
  - SC=0.60 (SHGC-0.53)

Lighting:

- dimmable T-5s w/daylighting and occupancy sensors

HVAC:

- Ground-source HP
- Seasonal thermal storage
- Hydronic radiant heating and cooling
- Liquid desiccant cooling w/solar regeneration

Energy retrofit of the China Association of Science and Technology (CAST) office building

Project development
2006 - 2007
Design development
2007 – 2008
Construction
2009 –

Benefit of energy benchmarks and rating tools

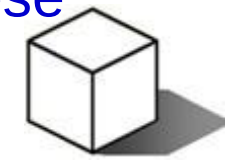
- A quantitative assessment of building energy performance
- Can be used to compare the theoretical to the actual performance of the building, and thus identify problem areas or distinguish efficiency from conservation.
- Benchmarks can provide a roadmap for future improvements in building energy effiiciency

Conclusions about benchmarking building energy use in China

- Need to establish appropriate benchmarks for building types in each country
- Use of US-based rating systems is skewed towards high energy usage of mechanically efficient systems.
- The low electricity usage in Chinese buildings is due partly to curtailed services or comfort levels, but largely to less reliance on centralized mechanical systems that often overprovide them when they're unnecessary nor even requested. This energy usage pattern should be promoted as a more sustainable lifestyle rather than disparaged as depravation, "energy poverty", etc.

Remaining technical issues for rating and labeling efforts in China

- Almost all theoretical calculations, i.e., simulation results, have not been correlated to actual building performance. This is a particularly important issue for China where “standard operating conditions” are quite distinct from actual usage patterns.
- Existing Chinese ratings and labeling programs still lack a clearly defined methodology for calculating building energy efficiency.
- There is plenty of room for technical and policy collaboration, but directly importing existing US programs into China suffers from the same problem that the calculational procedures do not fit well for Chinese buildings.



Thank you
谢谢

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Following is a personal comment about net-zero buildings

(Slide courtesy of Bruce Baccei, formerly of Consul and now of SMUD)

BIRA Partners

Premier Homes

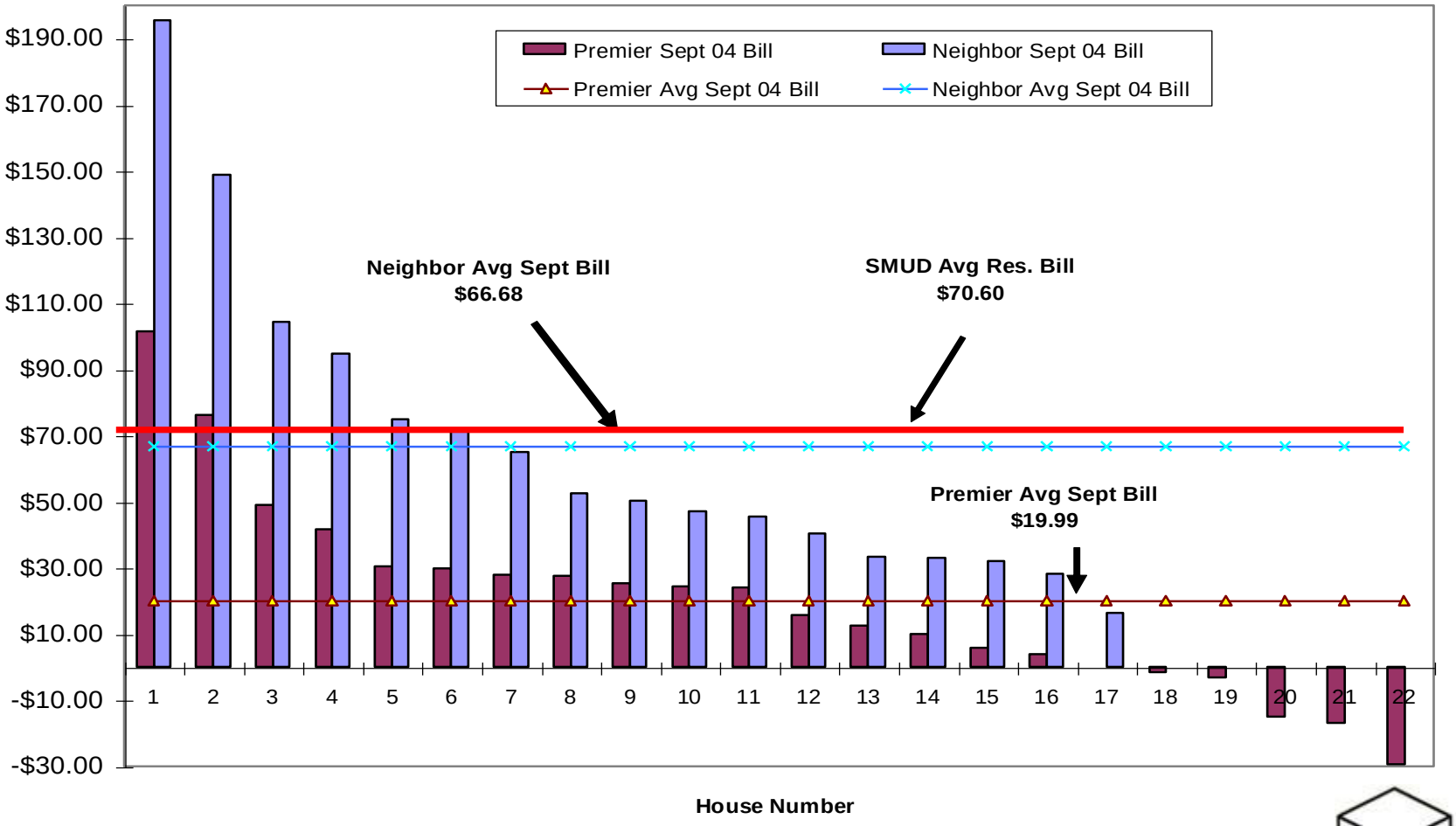
SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT

(Slide courtesy of Bruce Baccei, formerly of Consul and now of SMUD)

Side-By-Side Developments

(Slide courtesy of Bruce Baccei, formerly of Consul and now of SMUD)

Premier Gardens



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