Singapore’s Green Building
Energy Efficiency Standards
Singapore BCA Green Mark Scheme

• A green building rating tool for the tropics
• Launched in Jan 2005
• To evaluate buildings for its environmental impact & performance
Towards a Sustainable Singapore

80% of the Entire Building Stock to be “Greened” by 2030

Focus
- Greening New Buildings
- Greening Existing Buildings
- Greening Occupants and Tenants
Multi-Pronged Approach

Green Building Masterplan

Government Taking the Lead

Incentivising Private Sector

Development Work in Green Bldg Technology

Building Industry Capabilities Through Training

International Profiling & Raising Awareness

Imposing Minimum Standards

6 strategic thrusts

with emphasis on existing buildings, beyond & within buildings
### Building Sustainability

- **Greenmark Platinum** for new buildings (A/C FA > 5,000m²)
- **Greenmark GoldPLUS** for buildings (A/C FA > 10,000m²) by 2020
- **Greenmark Gold** for small and mid-sized existing buildings (GFA>5000m²) by 2020

### Office Sustainability

- Green Mark Gold for **Office Interior** at next retrofit
- **Indoor Air Temp** >24°C

### Green Procurement

- **ENERGY STAR** for ICT equipment
- **Office rental** in Green Mark GoldPLUS buildings

### Capability Building

- **Training** for SMs & FOMs

### New

- **Water Efficient Building**
- Install private water meters
- Recycling programmes
- Events and functions to be held in Green Mark certified hotels, convention centre
- Green leasing of government buildings and premises
Incentives & Financing Schemes

**Bonus Gross Floor Area**

- **Green Mark-GFA**
  - 58,000 m²
  - Committed

**Incentive Schemes**

- **$20m New Buildings**
  - Fully Committed
- **S$100m Existing Buildings**
  - Fully Committed
- **S$5m Design Prototype**
  - S$2m Committed
- **S$50m Existing Building and Premises**
  - NEW!

**Financing Schemes**

- **Building Retrofit Energy Efficiency Financing (BREEF)**
  - Co-share risk with Private Financial Institutions
### Legislating Minimum Green Building Standards

#### Building Control (Environmental Sustainability) Regulations 2008

- **Minimum GM standards for new buildings**

#### Environmental Sustainability Measures for Existing Buildings (2012)

- **Minimum GM standards for existing buildings**
- **Three-yearly energy audit on cooling system and compliance of design system efficiency**
- **Annual submission of building information & energy consumption data**
Mandatory Energy Data Disclosure by Building Owner

Building Energy Consumption

Building Energy Submission System (BESS)

Analysis of consumption patterns

Building Energy Benchmarking Report (BEBR)

Building Owners’ & Tenants’ Electricity Consumption

Office Buildings
- 51% Building Owner
- 49% Tenant

Retail Buildings
- 49% Building Owner
- 51% Tenant

Phased approach in energy disclosure and building energy display

Voluntary Building Energy Performance Disclosure
Building Energy Benchmarking Report

Where are we?
What can we do?

EUI of Offices

Average EUI: 253 kWh/m² yr

1,667

Each Column represents the EUI of One Building

36th (90th)
89th (75th)
176th (50th)
264th (25th)
316th (10th)
351st (1st)

Buildings (Percentile)
Legislating Minimum Green Building Standards

Existing Building Legislation Phase I

(effective from 2nd Jan 2014)

- Building Types: Commercial Buildings
- Area: GFA >15,000m²
- Trigger Point: Major energy use change i.e. Install/replace Chiller
Legislating Minimum Green Building Standards

Existing Building Legislation Phase II

(effective from 2nd Jan 2017)
## Green Mark Criteria for Air-Con Plant Efficiency

### Water-cooled chilled water systems

<table>
<thead>
<tr>
<th>Green Mark Rating</th>
<th>Peak Building Cooling Load (RT)</th>
<th>Efficiency (kW/RT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;500 ton</td>
<td>≥ 500 ton</td>
</tr>
<tr>
<td>Certified</td>
<td>0.85</td>
<td>0.75</td>
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<tr>
<td>Gold</td>
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<td>0.70</td>
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<tr>
<td>GoldPlus</td>
<td>0.75</td>
<td>0.68</td>
</tr>
<tr>
<td>Platinum</td>
<td>0.70</td>
<td>0.65</td>
</tr>
</tbody>
</table>

### Air-cooled chilled water systems / Unitary

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<th>Peak Building Cooling Load (RT)</th>
<th>Efficiency (kW/RT)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>&lt;500 ton</td>
<td>≥ 500 ton</td>
</tr>
<tr>
<td>Certified</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Gold</td>
<td>1.0</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>GoldPlus</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Platinum</td>
<td>0.78</td>
<td></td>
</tr>
</tbody>
</table>

### New Technology
- All-Variable Speed Chiller Plants
- High-Efficiency Optimized Chiller Plants
- Conventional Code Based Chiller Plants
- Older Chiller Plants
- Chiller Plants with Correctable Design or Operational Problems

### Performance Ratings
- Excellent: kW/ton 0.5, C.O.P. (7.0)
- Good: kW/ton 0.6, C.O.P. (5.9)
- Fair: kW/ton 0.7, C.O.P. (5.0)
- Needs Improvement: kW/ton 0.8, C.O.P. (4.4)
Mandating Periodic Energy Audit of Chiller Plant

(effective from 2\textsuperscript{nd} Jan 2014)

Energy Consumptions in Buildings

Cooling system accounts for as much as 50\% of the building’s total energy consumption.

Regular maintenance & optimisation of the cooling system is critical to ensure that it continues to operate efficiently.
Mandating Periodic Energy Audit of Chiller Plant

*(effective from 2\textsuperscript{nd} Jan 2014)*

**3-Yearly Cycle**

- **START**
  - Building completes chiller retrofit and has obtained BCA’s AB approval

- **YEAR 3**
  - Issues notice for Energy Audit
  - Building Owner appoints a professional to carry out Audit
  - PE(Mech)/EA ensure M&V and Audit comply to Code and submit to BCA
  - BCA Issues notice of Approval

- **YEAR 6**
  - Issues notice for Energy Audit
  - Building Owner appoints a professional to carry out Audit
  - PE(Mech)/EA ensure M&V and Audit comply to Code and submit to BCA
  - Issues notice of Approval

- **YEAR 9**
  - Issues notice for Energy Audit
  - Building Owner appoints a professional to carry out Audit
  - PE(Mech)/EA ensure M&V and Audit comply to Code and submit to BCA
  - Issues notice of Approval

- **YEAR 12 ...**
  - Issues notice for Energy Audit
  - Building Owner appoints a professional to carry out Audit
  - PE(Mech)/EA ensure M&V and Audit comply to Code and submit to BCA
  - Issues notice of Approval

- **RESTART**
  - Building replace/change Chillers or redevelops site
Mandating Periodic Energy Audit of Chiller Plant

*effective from 2\textsuperscript{nd} Jan 2014*
Measurement & Verification Requirements for Chilled Water Systems

Chilled-water side:

\[ T_S + T_R + \text{Flow Meter} = \text{Cooling load} \]

Condenser-water side:

\[ T_S + T_R + \text{Flow Meter} = \text{Heat Rejection} \]

Main Control Board:

\[ \text{Power Meters} \]

(Chillers, Pumps and Cooling Towers)

\[ +/- 0.05 \, ^\circ\text{C end-to-end} \]

\[ \text{Up to 2\%} \]
Energy Use Intensity (EUI) of 100 Retrofitted Existing Buildings

Average EUI Before retrofit = 328 kWh/m² yr

Average EUI After retrofit = 274 kWh/m² yr

Average Energy Savings of 17%

* Graph is available in BCA Building Energy Benchmarking Report 2016
Study on Air-Con System Efficiency

40-50% Energy Savings Achieved by Adopting a Systems-based approach in Retrofitting Existing Chiller Plants

![Graph showing efficiency before and after retrofit](image-url)

- **Before retrofit**: 1.1 kW/RT
- **After retrofit**: 0.64 kW/RT
Continuous Monitoring Through Chiller Efficiency

Smart Portal

- Continuous monitoring
- Performance base-lining by machine learning
- Trend Analytics to spot performance variance
- Autonomous alarm
Continuous Monitoring Through Chiller Efficiency
Smart Portal

1. Detect performance deviation with automatic base-lining
2. Receive e-mail or SMS alerts when performance degrades

Benefits for Building Owners

3. View portfolio of buildings and compare trended data
4. Empower building owners to enhance their contracting efficiency by targeting specific areas for improvement
Air Distribution System Efficiency Study

Distribution of Energy Within Air-Conditioning System

Air distribution system contribute significantly to the total energy performance.
The studies did not reveal strong relationship between W/CMH and kW/RT.
Air Conditioning System Efficiency

High potential savings in air distribution system
Energy Labelling and Standards for Appliances & Equipment

- NEA administers the Mandatory Energy Labelling Scheme (MELS) and Minimum Energy Performance Standards (MEPS)

- Mandatory Energy Labelling Scheme (MELS)
  - Empowers households to make better purchasing choices
  - Encourages suppliers to bring in more EE appliances as technology improves
  - Covers air-conditioners, refrigerators, clothes dryers, televisions and lamps for general lighting purposes

- Minimum Energy Performance Standards (MEPS)
  - Help households avoid being locked into high energy consumption and energy costs of the most inefficient appliances
  - Improve lifecycle cost savings for households
  - Cover air-conditioners, refrigerators, clothes dryers and lamps
Energy Labelling & Standards for Air-conditioners

- Covers single-phase, non-ducted air-conditioners

- Multi-split (wall mounted, cassette, ceiling etc.)
  - Up to 17.6 kW

- Single-split (wall mounted, cassette, ceiling etc.)
  - Up to 17.6 kW

- Casement / Window
  - Up to 8.8 kW
Energy Labelling & Standards for Lamps

- Covers incandescent lamps for general lighting purposes and lamps intended as their direct replacements

<table>
<thead>
<tr>
<th>Incandescent (25 – 200W)</th>
<th>Compact fluorescent (up to 60W)</th>
<th>LED (up to 60W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tungsten-filament</td>
<td>Compact fluorescent lamps with integrated ballasts (CFLi)</td>
<td>Non-directional LED lamps with integrated ballasts</td>
</tr>
<tr>
<td>Tungsten-halogen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Studying feasibility of extending MEPS/MELS to other lamp types
Building owner can work with an **Energy Performance Contracting (EPC)** firm to achieve greater energy efficiency with **zero capital outlay**.

A **standard reference document** for both sides of the industry: the building owners and the EPC firms when procuring energy efficiency retrofit or renewable energy installation works.

**Objective**
To accelerate energy efficiency retrofits.

**Close Collaboration with Singapore Green Building Council**

**Zero Capital Partnership Scheme**

- Building Owner
- Accredited EPC Firm
- Greater Energy Efficiency
- Zero Capital Partnership Scheme
- Financing and Funding
- Green Mark Certification

**Energy Performance Contract**

A standard reference document for both sides of the industry: the building owners and the EPC firms when procuring energy efficiency retrofit or renewable energy installation works.
Singapore Green Building Week 2017

IGBC - The Premier Green Building Event in Asia

International Green Building Conference 2017
Singapore

12 – 14 September 2017
Marina Bay Sands,
Singapore

What to anticipate at IGBC 2017:
❖ Behind the Success of Positive/Zero/Super Low Energy Buildings
❖ Digitalisation of Buildings
❖ A Bird’s Eye View of the Sustainable Built Environment
❖ Updates of Green Mark Schemes
❖ Changing Behaviour towards Sustainability
❖ Building Healthy Spaces
❖ Green Tours

Organised by:
Building and Construction Authority, Singapore Green Building Council, Reed Exhibitions

Strategic Partners:

Co-located Events:

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SGBW Facebook page: https://www.facebook.com/igbcsg
Thank you