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**Building Energy Codes Report
For Singapore**

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Building Energy Codes Report for Singapore



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Summary

Located near the Strait of Malacca, on the southern tip of the Malay Peninsula, the Republic of Singapore is truly a resilient and dynamic economy. At just 700 square kilometers, this densely populated economy is becoming increasingly more popular as a tourist destination, making tourism one of their largest industries. This island-nation possesses exceptionally large oil refining capabilities and has one of the busiest ports in the world.

Chinese traditions thrive on this island with over three quarters of its population of Chinese decent. Most Singaporeans speak Mandarin and, as a second language, English. A mostly Buddhist economy, Singapore has a median age of thirty-nine with a life expectancy of eighty-two.

A land barren of natural resources, the 4.6 million inhabitants depend heavily on imports and efficient use of their resources has become a chief concern. Even amid the current recession, Singapore has several commendable environmental and building initiatives underway.



Economy Background

Political and Social Structure

Singapore is an independent island city-stateⁱ that gained its independence from the Malaysian Federation in August of 1965 and amended its constitution to reflect their new found autonomy.¹ With parliamentary governance, Singapore has a government structure strongly modeled after the United Kingdom consisting of eighty-four legislative membersⁱⁱ elected for a five-year term and the executive branch, made up of the presidentⁱⁱⁱ and the presidentially-appointed Cabinet, including the prime minister.² Based on English common law, the judicial branch includes a supreme court and a court of appeals where - with counsel from the prime minister - several chief justices and judges are appointed by the president.³

ⁱ A City-state was a political term devised during the classical period of Greek civilization. It is an independent country whose territory consists of a single major city and the area immediately surrounding it. Singapore is one of few contemporary city-states in the world.

ⁱⁱ Singapore has a total of fifty-five parliamentary constituencies and voting is mandatory for individuals over the age of twenty-one.

ⁱⁱⁱ The Office of the President was created following Singapore's independence. Presidents are elected to a six year term. The president functions as the head of state and reserves power for certain financial decisions and key office appointments such as judges, council members, and other high-level government officials.



The economy is notorious for its lively political arena with five parties interspersed throughout its leadership:

- People's Action Party (PAP)
- Reform Party
- Singapore Democratic Alliance (SDA)
 - The SDA is a mixture of the Singapore Justice Party (SJP), Singapore National Malay Organization (PKMS), and Singapore People's Party (SPP)
- Singapore Democratic Party (SDP)
- Workers' Party (WP)⁴

An active elected official since 1984, the Honorable Mr. Lee Hsien Loong was presidentially-appointed as the third prime minister in 2004 and is a member of the People's Action Party (PAP).⁵ Currently, there are twenty-one Cabinet members responsible for the high-level management of the following fifteen ministries: community development, youth and sports, defense, education, the environment and water resources, finance, foreign affairs, health, home affairs, information, communications and the arts, law, manpower, national development, trade and industry, and transport.⁶



Figure 1: View of the Presidential Home in Istana. 1995. Source: Office of the President

Surprising to some, Singapore is a former colony that had independence forced upon it. Led by its government, this economy has persevered by concentrating on economic development and fostering a sense of nationhood that led Singapore to ultimately achieve the highest standard of living in Southeast Asia.⁷ Over the last thirty years, the government has been the vanguard for its people.

Economic Overview

Singapore's GDP per capita was \$52,000 as of 2008.⁸ Major industries in the economy consist of electronics, chemicals, financial services, oil drilling equipment, oil refining, rubber processing and rubber products, processed food and beverages, ship repair, offshore platform construction, life sciences, and repackaging/distribution trade. Singapore exports \$235.8 billion worth of machinery and equipment (including electronics), consumer goods, pharmaceuticals and other chemicals, and mineral fuels.⁹ The economy imports \$219.5 billion worth of machinery and equipment, foodstuffs, mineral fuels, chemicals, and consumer goods.¹⁰

Energy Assessment

Singapore serves as a major refining center for Southeast Asia. Located near the Strait of Malacca, a major route for oil tankers, Singapore's refining capacity of 1.3 million barrels of oil per day is nearly double its consumption of petroleum products. The economy's three refineries include ExxonMobil's Jurong/Pulau Ayer Chawan 605,000 bbl/d facility, Royal Dutch Shell's Pulau Bukom 458,000 bbl/d complex, and the Singapore Petroleum Company's Pulau Merlimau 273,600 bbl/d refinery. According to the Energy Information Administration, Singapore has no domestic oil reserves. However, from 2007



estimates, Singapore consumed 916,000 barrels of oil daily, a fifteen percent increase from 2000 levels. As a result of Singapore's use of fossil fuels, the economy's carbon dioxide emissions were about 141 million metric tons in 2006.

Climate – Regional and Global

Singapore is mostly hot and humid year round with temperatures that never drop below 20°C, even at night, and daily temperature usually reaching around 30 °C. Humidity is very high, often over seventy-five percent. There are two monsoon seasons, which can be divided into the Northeast Monsoon, starting in December and lasting until early March, and the Southwest Monsoon season, lasting from June to September.

In 2006, Singapore acceded to the Kyoto Protocol of the United Nations Framework Convention on Climate Change and became a non Annex-I economy. As a non Annex-I economy, Singapore does not have emission reduction targets. Singapore's National Climate Change Committee (NCCC) was formed to preside over promoting greater energy efficiency and less carbon intensive energy in key sectors, raising awareness amongst the private and public sectors on the impacts of climate change, promoting research and development of low carbon technologies, and understanding Singapore's vulnerability to climate change and facilitating adaptations. The NCCC is assisted by four main committees including buildings, households, industry, and transportation, along with the research and development sub-committee.

Construction Overview

Singapore's construction industry accounts for roughly four percent of their Gross Domestic Product (GDP). A projection of between S\$27 billion and S\$37 billion construction demand in 2008 emphasizes this sector's significance. The Building and Construction Authority (BCA), an agency under the Ministry of National Development, is responsible for ensuring that safety, quality, and sustainability is achieved in the construction sector. In conjunction with the BCA, the Singapore Management University (SMU) recently launched the SMU-BCA advanced management program, consisting of nine modules in which industry professionals are prepared for global challenges and outstanding issues including ecological and social awareness.

Sustainability

Singapore has invested \$600 million in the Green Plan 2012, which aims to reduce greenhouse gas emissions and reduce carbon intensity by twenty five percent by 2012 (when compared to 1990 levels). The Green Plan also targets Singapore's water consumption; the average person consumes about 162 liters of water daily. It would cut consumption to 155 liters per person per day by installing water saving hardware such as dual flush, low capacity, and flushing cisterns in all new buildings. The Plan also aims to increase recycling by adopting practices being utilized in countries such as Japan and Germany where product manufacturers are held accountable for their environmental impact.



Singapore's government also began an Inter-Ministerial Committee on Sustainable Development (IMCSD) and later released energy and environmental targets for 2030.¹¹ Broadly, the sustainability blueprint focuses on water conservation, air quality, recycling, public transit, cycling and walking networks, and parks and green space.¹² The blueprint consists of a four-pronged approach: boosting resource efficiency, enhancing the urban environment, expanding expertise/capacity, and fostering community action.¹³ Two notable goals are to achieve a thirty-five percent reduction in energy demand and to ensure that eighty percent of the building stock is green -- both to be achieved by 2030.¹⁴ The IMCSD awarded \$50M Singaporean towards a research fund for the built environment¹⁵ to help achieve these goals.

Government and Market-Based Programs for the Building Sector

As an effort to enhance building efficiency, in 1998, BCA established the Building Energy Efficiency Master Plan (BEEMP). BEEMP was the solution to a year-long investigation performed by the BCA's Inter-Agency Committee on Energy Efficiency (IACEE)^{iv} to "address the concerns over the increasing energy consumption of Singapore."¹⁶ Specifically, BEEMP "contains programs and measures that span the whole life cycle of a building" and are apportioned among six programs. These programs vary from reviewing and updating energy efficiency standards, conducting energy audits, encouraging performance contracting, create building performance benchmarks, and lastly, greater collaboration with the National University of Singapore (NUS) and Nanyang Technical University (NTU)^v in favor of research and development.¹⁷

The National Environment Agency (NEA) along with the Energy Sustainability Unit (ESU), a branch of NUS, developed the Energy Smart Building Scheme to improve the active management of energy use of buildings through an energy efficiency benchmarking system. The



Scheme is ready to be implemented in commercial office buildings, hotel buildings, and factories so that buildings in these categories may submit an application for the highly coveted Energy Smart Label award. The Energy Smart awards effectively promote energy efficiency and resource conservation in the buildings sector by annually awarding the highest performing building in each category an Energy Smart Building Label. For eligibility, buildings must be in the top twenty five percentile in terms of energy efficiency for their respective building stock and "air quality, thermal comfort, ventilation and lighting level" are also considered when evaluating submissions.¹⁸ Individuals from around the economy gather for an official ceremony to present a plaque for the building, crediting the success of the design and building professionals. Champions are inducted to a distinctive group where, currently, only fifteen celebrated and renowned buildings reside.¹⁹ The benefits being touted for this program include savings

^{iv} The Inter-Agency Committee on Energy Efficiency comprises of senior officers from various government agencies.

^v In 1980, the National University of Singapore was established by a merger of two predecessor institutions: University of Singapore and Nanyang Technical University (NTU), however, they continue to be listed distinctively for easier reference to benefit those in the buildings sector.



on energy costs, improved indoor air quality, positive corporate image, happier and healthier building occupants.²⁰

A further model to create a sustainable environment through buildings, being led by the BCA, is the Second Green Building Master Plan.²¹ While the first master plan emphasized greening new buildings and major renovations, the second develops a road map covering new buildings, existing buildings, and “beyond” buildings that will enable Singapore to achieve a sustainable built environment by 2030.²²

The Singapore government has also released a green building certification program called Green Mark. It encompasses new and existing buildings in both the residential and commercial sectors and has five main assessment criteria:

1. Energy efficiency
2. Water efficiency
3. Environmental Protection
4. Indoor Environmental Quality
5. Other

Depending on the building’s level of certification, the energy savings are said to be from ten to thirty percent annually. In order to sustain the Green Mark certification, buildings must be reevaluated each year to ensure that energy savings are maintained. As of 2008, there were eighteen buildings that achieved the Platinum rating and eighty-seven additional buildings with Certified, Gold, and GoldPlus ratings.²³ A total of two hundred and thirty-two Green Mark projects have been completed since the program's inception.²⁴ The city-state government is leading the market in Green Mark certification by requiring that buildings on government land achieve either Platinum or GoldPlus, and, by 2020, existing buildings that contain greater than 10,000 m² air-conditioned floor space must achieve GoldPlus.²⁵

Within a year of the program’s inception, in 2006, Singapore invested twenty million Singaporean in the Green Mark Incentive Scheme (GMIS) to motivate developers to achieve higher Green Mark ratings. Three years later, \$100 million Singaporean was set aside for the Green Mark Incentive Scheme for Existing Buildings (GMIS-EB) to encourage private owners of existing buildings to undertake retrofitting works to achieve improvement in energy efficiency.²⁶ The BCA is also working to educate the general public on the benefits and value of energy efficiency through commercials, bus signs, road shows, advertisements, video clips, and web sites.²⁷

Under the Green Mark Scheme, the BCA has fostered professional development in the building and trade sectors with their Certified Green Mark Manager (GMM) and Green Mark Professional (GMP). Additionally, the Energy Sustainability Unit of National University of Singapore (NUS) developed the Singapore Certified Energy Manager (SCEM) Program^{vi}, under the sponsorship of the Economic Development Board’s Locally-based Enterprise Advancement Program (LEAP).²⁸ The program offers

^{vi} The SCEM program is jointly administered by the National Environment Agency (NEA) and the Institution of Engineers, Singapore (IES) under a SCEM Monitoring Committee and is supported by a Curriculum and Examinations Board. Registration is undertaken by the SCEM Registry under the IES.



formal training and certification in energy management at the Associate and Professional levels.²⁹ Further, along with Nottingham University and Carnegie Mellon, the city is cultivating new entrepreneurs through executive programs and post-graduate courses on environmental sustainability to build up industry capabilities.³⁰

Scope of Building Energy Codes/Standards

Overview

There are two leading agencies that manage the buildings sector in Singapore: the Urban Redevelopment Authority (URA) and the BCA (Building and Construction Authority).

As Singapore's national land use planning authority, the URA formulates and coordinates all local and national development.³¹ After years of research and assessment, the URA released a comprehensive project entitled the Master Plan 2008^{vii}, which provides clear guidance to landowners regarding allowable land use and construction intensity.³² The Master Plan 2008 directs growth for both commercial and residential buildings over the next forty to fifty years, incorporates an extensive rail network, expands recreational choices, increases flexibility for businesses, and introduces greater residential density.³³ It is scheduled to be reevaluated every ten years to ensure that national development is balanced with the needs of the future.³⁴ This is especially important since Singapore's landmass is only 700 square kilometers and currently has a population of 4.6 million people.

The majority of the building directives stated in the Master Plan 2008 are found in two electronically published handbooks: *Development Control Parameters for Residential* and *Development Control Parameters for Non-Residential Development*. Both publications clarify zoning provisions set by the Master Plan 2008, such as: building floor to floor height, roof gardens, building setbacks, car parking requirements, balconies, road buffers, open spaces, retaining walls, etc.³⁵ The handbooks are updated frequently, and thus are only available online through the URA website. Other longstanding building regulations were established in May of 1989 in the Building Control Regulations, Chapter Twenty-Nine of the Building Control Act and are available via hardcopy.³⁶

The Building Control Regulations^{viii}, Part II through Part VI, comprise the subsections of primary interest:

Part II: Submission and Approval of Plans – developers must apply for construction approval and building plan approval through the Commissioner of Building Control

Part III: Duties of Qualified Persons, Site Supervisors, and Builders During Construction – requires site supervision by a qualified person for any building construction, extension, or demolition

Part IV: Design and Construction – requires that all building works shall be constructed in accordance with performance-based requirements set out in *Schedule Five* (staircases, lighting, ventilation, etc)

^{viii} The Building Control Regulations has been revised several times; this report is based upon the 2003 revision.



Part IV A: Installation of Exterior Features – enumerates how windows and air-conditioning units should be installed through use of registered and approved contractors

Part V: Occupation of Buildings – establishes the role of the Commissioner of Building Control in issuing a certificate of statutory completion before the building may be occupied³⁷

Part VI: Miscellaneous – outlines procedures and standards, inspections, and penalties

The Building Control Act requires the developer to submit applications for building permits to the Commissioner of Building Control before any construction commences.³⁸ It is during this application process that building plans are given a *buildability score* which indicates whether the building design can be constructed efficiently; the higher the score, the more efficient labor use and overall higher productivity at the construction site.³⁹

Singapore’s Building Control Act released the first Code of Practice on Buildable Design in December of 2000^{ix} -- which utilizes the Buildable Design Appraisal System (BDAS).⁴⁰ The BDAS provides a method to compute the buildability score^x, which is achieved from a scoring combination of three components: 1) structural system – maximum of fifty points 2) wall system – maximum of forty points and 3) other buildable design features – maximum of ten points^{xi}.⁴¹ Within the Code of Practice, the minimum buildability score for each building category is set out according to the type of use and gross floor area (GFA).⁴² If the developer’s blueprints do not achieve the minimum buildability score within its respective development category, the plans must be modified and improved for a more efficient structure.

Figure 2: Minimum Buildability Scoring According to Building Category, Source: Code of Practice on Buildable

CATEGORY OF BUILDING WORK / DEVELOPMENT	MINIMUM BUILDABILITY SCORE		
	2,000 m ² ≤ GFA < 5,000 m ²	5,000 m ² ≤ GFA < 25,000 m ²	GFA ≥ 25,000 m ²
Residential (landed)	57	59	62
Residential (non-landed)	63	65	68
Commercial	65	72	75
Industrial	67	74	77
School	64	69	72
Institutional and others	60	66	69

Design

There are several performance-based guidelines described in Schedule Five of the Building Control Regulations that concern specifics regarding staircases, construction materials, elevators and escalators, artificial lighting, ventilation, and energy efficiency measures such as roof thermal transmittance (u-value).⁴³

^{ix} The most recent Code of Practice on Buildable Design was released in September 2005.

^x The section for buildability scoring is found in Chapter 29, Section 49 of the Building Control Act and does not pertain to projects that are: repairs, alterations or additions to an existing building, theme parks, power stations, places of worship, waste processing/treatment plant, and culvert, bridge, dock, wharf, underpass, etc.

^{xi} If the developer or architect utilizes prefabricated items or precast household shelters in the design, they may receive additional points towards the buildability score.



A large portion of the Building Control Regulations concentrates on high-level management of all professionals in the construction and design fields. The Commissioner of Building Control is responsible for maintaining a catalog of registered architects, designers, contractors, and other building professionals as well as their relevant qualifications in respect to their duties while at the construction site.⁴⁴

The most recent addition to Singapore's building regulations was released in April of 2008; known as the Code for Environmental Sustainability of Buildings^{xii}. The Code for Environmental Sustainability was designed to establish a paradigm shift towards an environmentally-friendly built environment.⁴⁵

Emulating the Green Mark building rating system, this code sets out the minimum environmental sustainability standards for buildings and applies to all new building works which involve a "gross floor area of 2,000 m² or more", as well as additions or extensions to existing buildings which involve "increasing the gross floor area of 2,000 m²."⁴⁶ The code motivates building designers to be environmental stewards by incorporating eco-friendly materials, eco-conscious construction practices, water and energy efficiency, natural lighting, as well as building life-cycle concerns. To further establish the new environmental initiatives, amendments were made to the Building Control Act that set a minimum fifty point Green Mark score for both residential and non-residential new building work.⁴⁷

Technical Requirements

In 2000, to provide a more accurate measure of a building's thermal performance, the BCA performed a thorough review of the Overall Thermal Transfer Value (OTTV)^{xiii}.⁴⁸ This specialized examination produced an improved formula and, to differentiate it from the previous method, it was renamed Envelope Thermal Transfer Value (ETTV)^{xiv}.⁴⁹ There are two further thermal measurements: Roof Thermal Transfer Value (RTTV) and Residential Envelope Transmittance Value (RETV).⁵⁰ All three values are described, in detail, within the *Codes of Practice on Envelope Thermal Performance for Buildings*.⁵¹

Compliance Methods

The Department of Mechanical Engineering of the National University of Singapore, in collaboration with the BCA, created a program called the Building Energy Standards (BEST).⁵² This modeling tool was designed for professionals in the building sector to demonstrate compliance with prescribed energy standards.⁵³

BEST is capable of the following:

^{xii} The environmental sustainability code is found in Section Fifty-Two of the Building Control Act.

^{xiii} Since first incorporated in the Building Control Regulations in 1979, the OTTV standard applied only to air-conditioned non-residential buildings.

^{xiv} Along the same lines as the OTTV, the ETTV requirement does not apply to non air-conditioned buildings such as residential buildings that are designed to be naturally ventilated.



- “Calculation of the envelope thermal transfer value (ETTV) and the roof thermal transfer value (RTTV) for prescriptive standard compliance.
- Estimation of the annual energy consumption of buildings.
- Estimation of the peak design loads for air-conditioning equipment sizing and zone thermal comfort design.
- Calculation of the building’s lighting power allowance and receptacle power density using user-defined design values.
- Prediction of effects of multi-parametric changes on the energy use of buildings.
- Selection of energy saving options to reduce annual energy consumption of buildings.”⁵⁴

Further compliance methods are described in the various *Codes of Practice*^{xv} handbooks as well as Singapore Standards, and for recent amendments, the Commissioner of the BCA promptly releases *Acceptable Solutions*^{xvi}. This lists the objectives of each regulation and how it can be achieved using an acceptable solution, which enables the design community to be freely innovative.⁵⁵

Enforcement Mechanisms

The BCA, under the Ministry of National Development, is accountable for building regulation enforcement whose mission is to "shape a safe, high quality, sustainable and friendly built environment."⁵⁶ Its core functions are allocated among six sizeable divisions.⁵⁷

Non-compliance with the Building Control Act and subsequent regulations results in a significant penalty— an individual is found to be guilty of an offense and fined (not more than \$20,000 Singaporean) or imprisoned for up to six months.⁵⁸ Continuing failure to comply may result in additional fines (not exceeding S\$500 for each day).⁵⁹

BCAP Recommendations

Singapore is a small yet densely populated nation that is aspiring to create an optimum land-use plan that supports several critical objectives. Because Singapore has no natural resources, it was imperative that a sustainable approach was incorporated while drafting the nation’s land-use and resource planning measures.⁶⁰

The recently unveiled Code for Environmental Sustainability of Buildings is a step in the right direction as it set mandatory conditions on heat loss through the building envelope, efficiency standards for air

^{xv} Codes of Practice are available on: Envelope Thermal Performance for Buildings, Energy Efficiency Standard for Building Services and Equipment, Mechanical Ventilation and Air-Conditioning in Buildings, Artificial Lighting in Buildings, Lighting of Work Places – Indoor, Structural Use of Concrete, for Foundations, Structural use of Timber, etc.

^{xvi} Released in May 2009, this Acceptable Solutions focuses on the Fifth Schedule of the Building Control Act of <http://www.bca.gov.sg/Publications/BuildingControlAct/others/Approveddoc.pdf>



conditioners and air conditioning systems, air tightness and leakage rates, as well as maximum budgets for lighting that also stipulate installation of occupation sensors.⁶¹

Over the past several years, Singapore made additional strides towards a sustainable future – actions that support and go beyond efficient building codes. With the Master Plan 2008, the BCA’s Green Mark Incentive Scheme, and the Inter-Ministerial Committee on Sustainable Development’s Sustainable Blueprint, the Singapore government is laying the groundwork for a built environment that is eco-friendly for generations to come. Sustainable growth objectives are most successful when a nation’s leadership makes substantial investments to create the needed infrastructure and establishes the means for citizens to actively participate.

Moving forward, Singapore should strive to achieve greater public awareness and engage the broader population by focusing efforts on citizen interests, concerns, and environmental or energy-related programs. The BCA has already set in motion public and industry education efforts, but more support is needed. A more effective, comprehensive approach -- similar to New Zealand’s ENERGYWISE public education campaign -- would be extremely beneficial. This campaign joined together numerous stakeholders from the energy, building, government, and climate sectors to educate New Zealanders on climate change, energy efficiency, building provisions, tax incentives, and renewable energy, among countless other items. Fostering community action is one of the four prongs of the sustainable blueprint, thus Singapore may have plans for new activities and programs poised for public release. Successfully drawing from other programs and efforts modeled by members of the APEC community and applying them within Singapore may help “Sustainable Singapore” to become a reality.



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- ¹ The Central Intelligence Agency. The World Factbook. Republic of Singapore. <https://www.cia.gov/library/publications/the-world-factbook/geos/SN.html>
- ² MongaBay. Country Studies, Singapore – Government Structure. http://www.mongabay.com/reference/country_studies/singapore/GOVERNMENT.html
- ³ The Central Intelligence Agency. The World Factbook. Republic of Singapore. <https://www.cia.gov/library/publications/the-world-factbook/geos/SN.html>
- ⁴ Id.
- ⁵ Id.
- ⁶ Singapore Government. The Cabinet. <http://www.cabinet.gov.sg/AboutTheCabinet/index.htm>
- ⁷ MongaBay. Country Studies, Singapore – Government Structure. http://www.mongabay.com/reference/country_studies/singapore/GOVERNMENT.html
- ⁸ The Central Intelligence Agency. The World Factbook. Republic of Singapore. <https://www.cia.gov/library/publications/the-world-factbook/geos/SN.html>
- ⁹ Id.
- ¹⁰ Id.
- ¹¹ Chong, Tan Tian. Singapore’s Green Building Master plan. Presentation at Alliance to Save Energy’s Energy Efficiency Global Forum and Exposition, Paris, France. April 2009.
- ¹² Id.
- ¹³ Sustainable Singapore. <http://app.mewr.gov.sg/web/Contents/ContentsSSS.aspx?ContId=1290>
- ¹⁴ Id.
- ¹⁵ Id.
- ¹⁶ National University of Singapore. Centre for Total Building Performance. BEEMP Section. http://www.bdg.nus.edu.sg/BuildingEnergy/energy_masterplan/index.html
- ¹⁷ Id.
- ¹⁸ E² Singapore. About Energy Smart Building Labelling Programme. <http://www.e2singapore.gov.sg/buildings/energysmart-building-label.html>
- ¹⁹ Id.
- ²⁰ Id.
- ²¹ Id.
- ²² BCA Media Release: 2nd Green Building Masterplan. <http://www.buildingcareers.sg/uploaded/news/BCA%20Media%20Release%20-%202nd%20GB%20Masterplan.pdf> April 2009.
- ²³ Chong 2009.
- ²⁴ Id.
- ²⁵ Id.
- ²⁶ Building and Construction Authority (BCA). BCA Green Mark Scheme Background Page <http://www.bca.gov.sg/GreenMark/GMIS.html>
- ²⁷ Chong 2009.
- ²⁸ E² Singapore. About SCEM <http://www.e2singapore.gov.sg/scem.html>
- ²⁹ Id.
- ³⁰ Chong 2009.
- ³¹ Urban Redevelopment Authority. Introduction and About Section. <http://www.ura.gov.sg/about/ura-intro.htm>
- ³² Urban Redevelopment Authority. Master Plan 2008. <http://www.ura.gov.sg/MP2008/intro.htm>
- ³³ Id.
- ³⁴ Id.



³⁵ Urban Redevelopment Authority. Development Control Parameters for Non-Residential Development. June 2009.

http://www.ura.gov.sg/circulars/text/dcdnrhb_d0e4.htm

³⁶ Building and Construction Authority. Building Control Act

http://www.bca.gov.sg/BuildingControlAct/building_control_act.html

³⁷ Building and Construction Authority (BCA). Building Control Act

http://www.bca.gov.sg/BuildingControlAct/building_control_regulations.html#1073363468-001420

³⁸ Building and Construction Authority (BCA). Code of Practice on Buildable Design, September 2005.

<http://www.bca.gov.sg/BuildableDesign/others/copbdsep05.pdf>

³⁹ Id at 13.

⁴⁰ Id at 3.

⁴¹ Id.

⁴² Building and Construction Authority. Building Control Act 2003, Chapter 29, Section 49 – Buildability Scoring

http://www.bca.gov.sg/BuildingControlAct/building_control_buildable_design_regulations.html

⁴³ Building and Construction Authority. Building Control Act 2003, Schedule Five

http://www.bca.gov.sg/BuildingControlAct/building_control_regulations.html#1073363468-001420

⁴⁴ Building and Construction Authority (BCA). Building Control Act

http://www.bca.gov.sg/BuildingControlAct/building_control_regulations.html#1073363468-001420

⁴⁵ Building and Construction Authority (BCA) 2008. Code for Environmental Sustainability of Buildings.

http://www.bca.gov.sg/EnvSusLegislation/others/Env_Sus_Code.pdf

⁴⁶ Id.

⁴⁷ Building and Construction Authority, Building Control Environmental Sustainability Regulations.

http://www.bca.gov.sg/BuildingControlAct/building_control_env_sus_regulations.htm

⁴⁸ Building and Construction Authority, *Codes of Practice on Envelope Thermal Performance for Buildings*.

<http://www.bca.gov.sg/PerformanceBased/others/RETV.pdf>

⁴⁹ Id at 5.

⁵⁰ Id at 6.

⁵¹ Id.

⁵² Chou, S.K. 2001. Energy Efficiency in Building Design - Building Energy Standards, paper presented at the Seminar on Energy Efficiency in Building Design, organized by the Building and Construction Authority (BCA) of Singapore, April 2001, Singapore.

<http://www.bdg.nus.edu.sg/BuildingEnergy/publication/papers/Paper2.html>

⁵³ Chou, S.K. 2001. Energy Efficiency in Building Design - Building Energy Standards, paper presented at the Seminar on Energy Efficiency in Building Design, organized by the Building and Construction Authority (BCA) of Singapore, April 2001, Singapore.

<http://www.bdg.nus.edu.sg/BuildingEnergy/publication/papers/Paper2.html>

⁵⁴ Id.

⁵⁵ Leng, Ong Chan 2002. Building Control – Singapore Experience, speaker at the Asian Forum Conference, Singapore 2002.

<http://www.asian-forum.net/conference/ppt/17-2002PPTSingaporeOD0A.pdf>

⁵⁶ Building and Construction Authority (BCA). About Section. http://www.bca.gov.sg/AboutUs/about_bca.html

⁵⁷ Id.

⁵⁸ Building and Construction Authority, Building Control Act 1989

http://www.bca.gov.sg/BuildingControlAct/building_control_act.html#946439071-000193

⁵⁹ Id.

⁶⁰ Id.

⁶¹ Building and Construction Authority (BCA) 2008. Code for Environmental Sustainability of Buildings.

http://www.bca.gov.sg/EnvSusLegislation/others/Env_Sus_Code.pdf