Australian Bureau of Statistics

Green Growth: Measuring the Environmental Impact of Buildings

Consultative Document

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Summary

1. The aim of this document is to outline the ABS' thinking on how it can contribute to the statistical measurement of green growth focusing on green building. Various interpretations of green building (sometimes called green construction or sustainable building) do exist and these require exploration. However, the definition provided by the US Environmental Protection Agency (EPA) is particularly comprehensive and will be used throughout this paper. In addition, green building needs to be considered alongside broader concepts such as green growth and the green economy. It is hoped this consultation paper will help identify stakeholders that have an interest in the measurement of green building, and the green economy more generally, so that a measurement framework capable of answering key policy questions can be developed.

Background

2. The impact of human activity on the environment is an issue of growing importance. Governments worldwide are increasingly being tasked with developing and implementing policies to sustain and promote economic growth, whilst at the same time protecting the environment and transitioning to an era of carbon constraints and increasing natural resource scarcity. Various international initiatives have called for better information to support this challenge. These include the United Nations' (UN) *Green Economy Initiative*, the International Labour Organisation's (ILO) *Green Jobs Initiative* and the Organisation for Economic Co-operation and Development's (OECD) *Green Growth Strategy*.

3. The concept of a *green economy* is multifaceted and aims to incorporate notions of sustainable economic growth, reduced environmental impact, inter-generational equity, improving quality of life and harnessing growth opportunities from new technologies and products. Historically, much of the environmental data are concerned with reporting on the state of the environment and natural resources. While this remains important, there is also a need to better link changes in the state of the environment to economic and human activity, and to highlight actions and behaviours that result in progress towards a greener economy.

4. The OECD's 2011 report '*Towards green growth: Monitoring progress*', provides a range of measures designed to highlight the interaction between Australia's, and the rest of the world's, environment and its economy. The report suggests four areas to capture the concept of *green growth*: environmental and resource productivity; economic and environmental assets; environmental quality of life; and economic opportunities and policy responses. Underpinning the four themes is a preliminary set of around twenty headline indicators.

5. The United Nations '*System Environmental-Economic Accounting*' (SEEA) is an important overarching statistical framework from which to view and analyse information on the wide range of environmental themes that are of policy interest. An important dimension of the green growth and green economy concepts relates to the production of the environmental goods and services sector, employment in the sector, imports and exports of environmental

goods and services and expenditures on environmental protection and resource management. As a broad based statistical framework, the SEEA embodies the technical concepts, classifications and tables required to assess such data. Furthermore, it provides an integrating framework for the compilation of statistics on the various aspects of wider concepts.

6. Although not explicitly identified within the 2011 OECD report, green building is an important dimension of the 'greening' story. The notion is closely aligned with the report's first theme of 'environmental and resource productivity', which would include use of land, energy and water by residential and commercial buildings as well as the waste produced by these buildings.

What is green building?

7. At present there is an absence of a single, agreed definition for 'green building'. The OECD defines it as: '*reducing the harmful effects on the environment of building and construction activities'.* The United Nations view green building as the reduction of: '*energy consumption, CO_2 emissions, construction and demolition waste, and indoor air pollution'*. The US Environmental Protection Agency provides the most comprehensive definition: '*Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction'.* [1]

8. Green building is not limited to any single phase of a buildings existence, but incorporates its whole life-cycle. The broad scope of the green building concept presents a challenge to the development of an all-encompassing measurement. As eluded to above, key areas of green building include:
    - *Siting and structure design efficiency*: At the siting and design stage, green building seeks to minimize the environmental impact of a building throughout its life-cycle. For example, the design and orientation of a building can significantly impact the thermal performance of the structure. By adjusting the design to increase thermal performance, the amount of artificial heating and cooling required to maintain optimal thermal comfort for occupants will be reduced.
    - *Energy efficiency*: The energy efficiency of a building is a key area of green building. Green building seeks to reduce the energy requirements and CO_2 emissions produced during the operation of the building.
    - *Water efficiency*: Another objective of green building is the protection and conservation of water through efficient use, reuse and collection of alternate sources of water. For example; incorporating water conserving fixtures such as water saving shower heads, and/or collecting rainwater from roofs with water tanks.
    - *Materials*: Another important aspect of green building is the efficient use of environmentally preferable materials such as recycled, reusable, renewable and/or

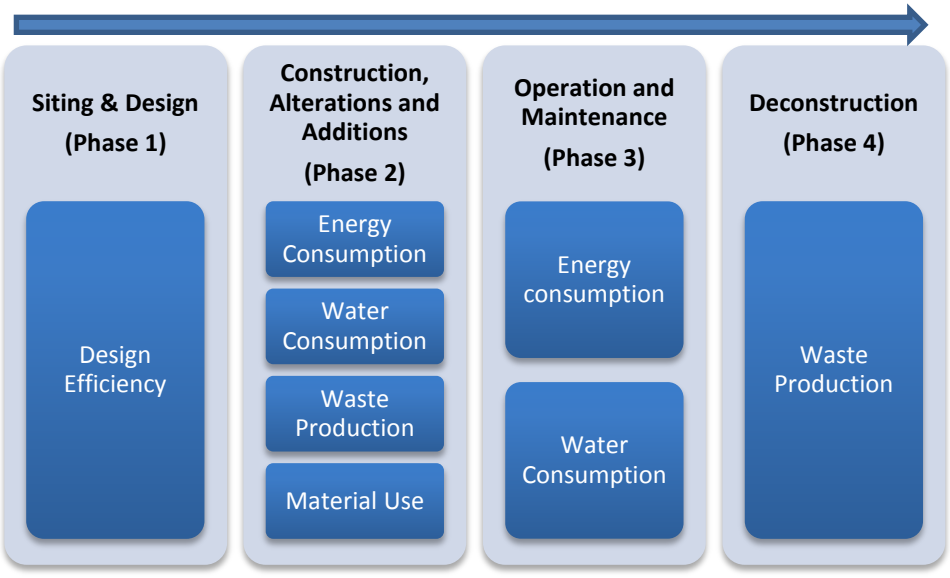
[1] http://www.epa.gov/greenbuilding/pubs/about.htm

non-toxic materials during the construction process. The production and transportation of building materials is also a consideration, but there are difficulties in attaining this type of data.

- *Waste reduction*: Another goal of green building is to reduce the amount of waste going to landfills. Waste reduction can be achieved throughout the life-cycle, but it is most relevant during the construction and demolition stages.
- *Indoor environmental quality (IEQ)*: The quality of the indoor environment is important to the health and wellbeing of occupants and is a consideration of green building. Some IEQ considerations include:
  - indoor air quality (IAQ), which focuses on airborne contaminants
  - using materials that do not emit or emit low levels of pollutants
  - health, safety, and comfort factors such as temperature control, ventilation, natural and artificial lighting, acoustics
  - aesthetics such as the views and integration of natural and man-made elements
  - access to potable water

9. The life cycle approach to green building is illustrated in Figure 1 below. Various elements are measured and evaluated independently and at different stages of a building's life cycle. This holistic approach enables the full environmental impact of a building from construction, through its operation, to its deconstruction, to be analysed.

Figure 1. Green building dashboard



10. As noted above, the concept of green building is very broad and each of the elements identified present their own measurement challenges. Developing a measurement framework that encapsulates as many of the elements as possible is the ultimate objective. However, the pragmatic approach would be to focus attention on individual aspects.

Policy issues and actions

11. In Australia, The Department of Climate Change and Energy Efficiency (DCCEE) reports that the energy used by Australian buildings accounts for approximately 20 per cent of Australia's greenhouse gas emissions. The DCCEE also forecasts electricity and gas consumption in residential, commercial and industrial buildings to increase significantly over the next decade. Limiting the environmental impact of such a shift in energy use presents a considerable challenge to policymakers. Statistical information is an essential ingredient in good policy making. As such, high quality data concerning the measurable aspects of green building are imperative to help inform policy decisions that aim to address this issue.

12. In 2009, the Council of Australian Governments (COAG) agreed to the National Partnership Agreement on Energy Efficiency (NPA EE) to establish a cooperative approach to delivering and implementing energy efficiency measures across all Australian jurisdictions. The NPA EE commits the Commonwealth, State and Territory governments to implement the 10 year National Strategy on Energy Efficiency (NSEE) plan. The NSEE sets out 37 measures to improve energy efficiency in Australia and allocates responsibility for each measure to Commonwealth, State and Territory governments, individually or collectively.

13. Australian state and territory governments have implemented varying forms of legislation, programs and initiatives to improve building practices. For example, New South Wales has introduced the Building Sustainability Index (BASIX). BASIX is a rating tool that measures a proposed residential building against energy performance, thermal comfort and water consumption targets.

14. The European Union (EU) has set out three key climate and energy objectives to be achieved by 2020: 20 per cent reduction in greenhouse gases, 20 per cent more renewable energy and a 20 per cent improvement in energy efficiency. Within the EU, buildings are responsible for 40 per cent of energy consumption and 36 per cent of CO_2 emissions. To address building energy performance, the EU's 2002 directive on energy performance of buildings (2002/91/EC)[2] requires member states to ensure that new buildings, as well as large existing buildings undergoing refurbishment, meet certain minimum energy requirements.

15. In the United States, energy efficiency and sustainable design features have been incorporated into Federal and other buildings through the Energy Policy Act (EPAct) of 2005 and the Energy Independence and Security Act (EISA) of 2007. In addition, a series of executive orders and agency-specific rules promoting green building have been introduced since the early 1990s.

Progressing the measurement of green building

[2] Summary, http://europa.eu/legislation_summaries/other/l27042_en.htm

16. After clarifying the concept and identifying key policies, the next stage in developing a measure for green building requires an assessment of available data sources. These data sources can then be evaluated on their ability to address current or expected needs. The ABS has done some preliminary work identifying potential data sources, both inside and outside of the ABS, which is outlined in the following sections. It should be noted that these are by no means exhaustive and the ABS would be very interested in further suggestions and proposals.

17. The multifaceted nature of the green building concept means a 'one size fits all' evaluation method is unlikely to be suitable; each stage of a building's life cycle presents different measurement challenges. The 'dashboard' approach illustrated in Figure 1 is a useful tool to identify the various environmental impacts of a building over the phases of its life-cycle. This approach could help support the measurement of various aspects of green building including, energy and water efficiency, and waste reduction at specific stages of a building's existence.

Potential ABS data sources

18. Current ABS collections do not explicitly collect 'green building' data. However, current data combined with other administrative datasets could be used to develop a measure of aspects of green building.

19. The ABS collects building construction data through several surveys such as the *Building Activity Survey* (cat. no. 8752.0) and *Building Approvals* (cat. no. 8731.0). These collections provide data on volume, value, sector, size and location for residential and/or non-residential building construction.

20. Relevant environmental publications include:
    - Energy use and energy efficiency by industry and households (*Energy Account, Australia* – cat. no. 4604.0)
    - Water use and water efficiency by industry, household water use per capita (*Water Account, Australia* – cat. no. 4610.0)

21. Another ABS survey that could provide assistance is the triennial household survey *Environmental Issues: Energy Use and Conservation* (cat. no. 4602.0.55.001). The survey provides household information on: dwelling characteristics, insulation in dwellings, sources of energy used inside and outside of the dwelling, heating and cooling in households, and electrical appliances in households.

22. The *National Balance Sheet* identifies the stock value of dwellings and non-dwelling construction within Australia. The data that underpin the *National Balance Sheet*, documented in the *Australian System of National Accounts* (cat. no. 5204.0) is another potential data source for green building estimates. Materials used by the construction

industry can be identified through the annual supply-use tables as well as the *Australian National Accounts: Input-Output Tables* (cat. no. 5215.0.55.001).

23. A 2007 statistical report prepared by the ABS for the then Department of the Environment, Water, Heritage and the Arts (DEWHA)[3] provides a valuable insight into the possible use of ABS data in combination with external datasets. The report used hedonic pricing models to analyse the statistical relationship between the Energy Efficiency Rating (EER) and the price of houses sold in the Australian Capital Territory in 2005 and 2006. The model used administrative transfer data from the ACT Planning and Land Agency (ACTPLA) in combination with ABS geographic and census data.

24. The ABS also collects data on the waste management industry through the *Waste Management Services* survey (cat. no. 8698.0). This survey includes data on the quantities of waste recovered/reprocessed or disposed of, which is relevant to the waste production element of green building. This survey was conducted in 1996-97, 2002-03 and 2009-10, but is limited in its usefulness for historical comparison due to changes in the ANZSIC classifications.

Potential non-ABS data sources

25. The Australian government is encouraging and providing support to innovation in energy efficient technologies and approaches through the National Strategy on Energy Efficiency (NSEE). To address issues concerning the efficiency of new buildings and major renovations, the NSEE has increased the energy efficiency requirements to a minimum of six stars (maximum 10 stars) in the 2010 update of the National Construction Code (NCC). While not compulsory, the NCC is given legal effect through state and territory legislation. Despite all states and territories across Australia largely adhering to the requirements set out in the code, wide variations in its application exist. It is understood, historical records of the ratings are held at council level, although this may not apply to all jurisdictions.

26. The Commercial Building Disclosure (CBD) program was established by the Building Energy Efficiency Disclosure Act 2010. It is managed by the DCCEE and implemented by state and territory governments. Under the CBD program, a building owner/lessor is required to provide a Building Energy Efficiency Certificate (BEEC) when they sell, lease or sub-lease office space of more than 2,000 square metres. As at 1st November 2011, BEEC's are required to be publicly available through the Building Energy Efficiency Register. This could be a potential data source for green building estimates. A component of a BEEC is a National Australian Built Environment Rating System (NABERS) energy rating. NABERS is a rating system that can be used to measure a building's operational energy and water efficiency, indoor environmental quality (IEQ) and waste recovery against a set of national benchmarks. The rating system applies to commercial buildings, and assesses the environmental performance on a scale of one to six stars.

[3] DEWHA, 2007, '*Energy efficiency rating and house price in the ACT*', http://www.nathers.gov.au/about/publications/pubs/eer-house-price-act.pdf

27. Green Star is an environmental rating tool for commercial buildings, developed and administered by the Green Building Council of Australia (GBCA). A Green Star environmental rating evaluates a building based on the following environmental impact categories: management, IEQ, energy, transport, water, materials, land use and ecology, emissions and innovation. Green Star ratings are *voluntary* (in turn limiting their scope) and often used as an environmental marketing tool to differentiate a project in the market. Green Star rated buildings are designed to higher environmental standards making them non-representative of the Australian commercial building market.

How could the data be presented and used?

28. A proposed data product will be developed and presented as a series of tables that combine socio-economic data with measures of environmental pressure. From a socio-economic perspective, possible data could include factors such as monetary value of investment in construction materials, which could further be disaggregated into material types, or data on square metres of construction developments. As illustrated in the green building dashboard in Figure 1, measures of environmental pressure can include factors such as water and energy consumption, and waste production. The proposed outputs should be considered flexible as they can be modified or adapted to meet client/user requirements.
In line with the measures of green growth[4], which in turn build on the SEEA quality of life indicators, measurement frameworks can then be produced that help policymakers make better informed policy decisions.

29. One approach is to analyse the energy efficiency of a building's structure. For residential construction, Energy Efficiency Ratings (EER) could be used to evaluate the environmental specific changes to the construction industry over time. EER's are issued on at the design stage of a building's life-cycle (Phase 1). Possible output tables and measurement frameworks can be found in Table 1 and Figure A of the Appendix. Current state and territory legislation require EER ratings to be provided for new residential construction. The National Strategy on Energy Efficiency is phasing in mandatory disclosure of residential building energy, greenhouse and water performance at the time of sale or lease across Australia.

30. In addition to residential energy efficiency disclosure, the NSEE also has a commercial building equivalent that has been implemented through the Commercial Building Disclosure Scheme. The scheme requires a building owner/lessor to provide a Building Energy Efficiency Certificate (BEEC) when they sell, lease or sub-lease office space of more than 2,000 square metres. This information could be used to develop a non-residential building equivalent of Table 1 and Figure A.

31. By combining data on the materials used during the construction, alteration and additions stage of a building's life cycle (Phase 2) with information on the size of a development, a

[4] OECD, 2011 Draft Report, '*Measures of green growth'.*

measurement of the material intensity of the building's construction can be produced. This can be further disaggregated to analyse the efficient use of specific materials used. There are a range of possible ways in which the material intensity measurement can be interpreted. In physical volume terms, tonnes of materials used are combined with data on the area, i.e. m^2, of development. This produces a metric reflecting the intensity of materials used per square metre of development. To assess from a monetary perspective, the dollar value of materials used (adjusted by a deflator) is divided by the gross value added of the specific industry classification[5] to provide an idea of the industry output per dollar of materials used. Tables 2 and 3, and Figure B of the Appendix provide an idea of the possible format of the tables used to compile the data as well as green building measurement frameworks that the data could be used to produce.

32. The resource efficiency of buildings during the operational stage (Phase 3) of their life-cycle is a key component in the measurement of green building. Most angles of analysis focus on energy and water consumption, however, it is also particularly complex and conceptually challenging area. Determining reliable parameters by which to estimate the relative environmental efficiency of a given building is particularly tricky. The area (m^2) of or number of rooms in a given building could potentially be used to produce intensity estimates for water and energy use. However, this could be a very data intensive process, there may be problems with the quality and accessibility to the required data, and questions may be raised over the accuracy of the generated resource intensities.

33. Another approach to green building is to take a broader view and assess the progress of the construction industry as a whole. This approach would involve comparing the output of the construction industry, as measured by gross value added (at its disaggregated ANZSIC classifications) against its environmental inputs over time i.e. water, energy and material consumption. Through comparing the intensities of the various resources used by the industry over time, policymakers can assess the construction industry's progress towards greener practices and make more informed decisions. Examples of how this data can be compiled and assessed are in Table 4 and Figure C of the Appendix.

34. Waste generation represents another possible measure of green building. Waste produced during construction (Phase 2) and deconstruction (Phase 4) could be evaluated by the diversion rate of these activities. The diversion rate is calculated as the proportion of waste received at all waste management facilities that are diverted from being disposed[6]. This includes recyclable materials that are recovered or reprocessed. An example of how such data could be compiled is displayed in Table 5 of the Appendix.

[5] Industry classification systems such as the Australian and New Zealand Standard Industrial Classification (ANZSIC).

[6] 8698.0 - Waste Management Services, Australia, 2009-10: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/8698.0Explanatory%20Notes12009-10?OpenDocument#interpretation

Feedback

Whilst all feedback is welcome, we are most interested in comments relating the following:

1. Do you currently define the concept of green building, any of its aspects or the green economy more generally? If so, how are these concepts defined?

2. Do you make any decisions relating to green building, and if so what data do you use to support your decision-making? If so, do you have any suggestions for improving these data.

3. What data do you hold, or are aware of, that could be used in the compilation of a measure for green building in Australia?

4. Can you suggest appropriate methods, current and future, for the collection of data on the measureable aspects of green building?

5. What current or future work, if any, are you conducting that may align with the ABS's work on developing a measurement of green building?

6. Do you have any other suggestions or observations that may support the construction of a measure of green building in Australia?

7. Are there any other areas that you feel are applicable to the discussion that have not yet been identified?

Feedback can be forwarded to brendan.freeman@abs.gov.au or a hard copy to Director, Centre of Environment Statistics, Australian Bureau of Statistics, Locked Bag 10, Belconnen, ACT 2616.

Alternatively, please call Michael Vardon (02 6252 7348), Brendan Freeman (02 6252 6579) or Sam Larsen (02 6252 6887) during business hours.

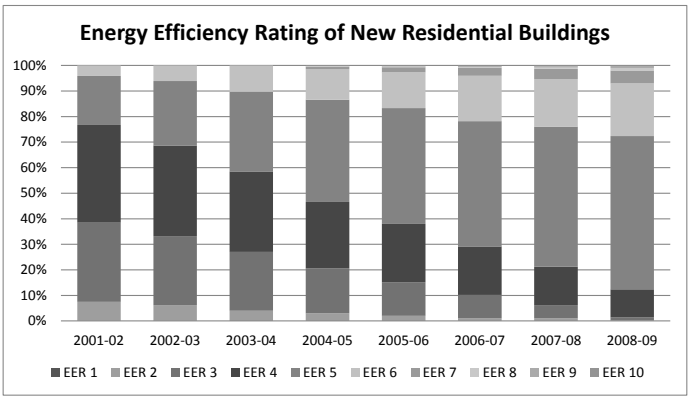
Appendix – Examples of Proposed Outputs

Siting and design (Phase 1)

Table 1 - Energy efficiency rating of new residential buildings (%)

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
EER 1								
EER 2								
EER 3								
EER 4								
EER 5								
EER 6								
EER 7								
EER 8								
EER 9								
EER 10								

Figure A



Construction, alterations and additions (Phase 2)

Table 2 – Materials intensity (monetary approach)

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
E Construction Industry								
Materials Used ($)								
Construction Industry GVA ($)								
Material Intensity								
3001 Residential Building Construction								
Materials Used ($)								
New Dwellings ($)								
Material Intensity								
3002 Non-Residential Building Construction								
Materials Used ($)								
New Non-Dwellings ($)								
Material Intensity								

Table 3 – Materials intensity (physical approach)

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Building Construction								
Materials Used (tonnes)								
Building Construction (m^2)								
Material Intensity								
3001 Residential Building Construction								
Materials Used (tonnes)								
New Dwellings (m^2)								
Material Intensity								
3002 Non-Residential Building Construction								
Materials Used (tonnes)								
New Non-Dwellings (m^2)								
Material Intensity								

Figure B

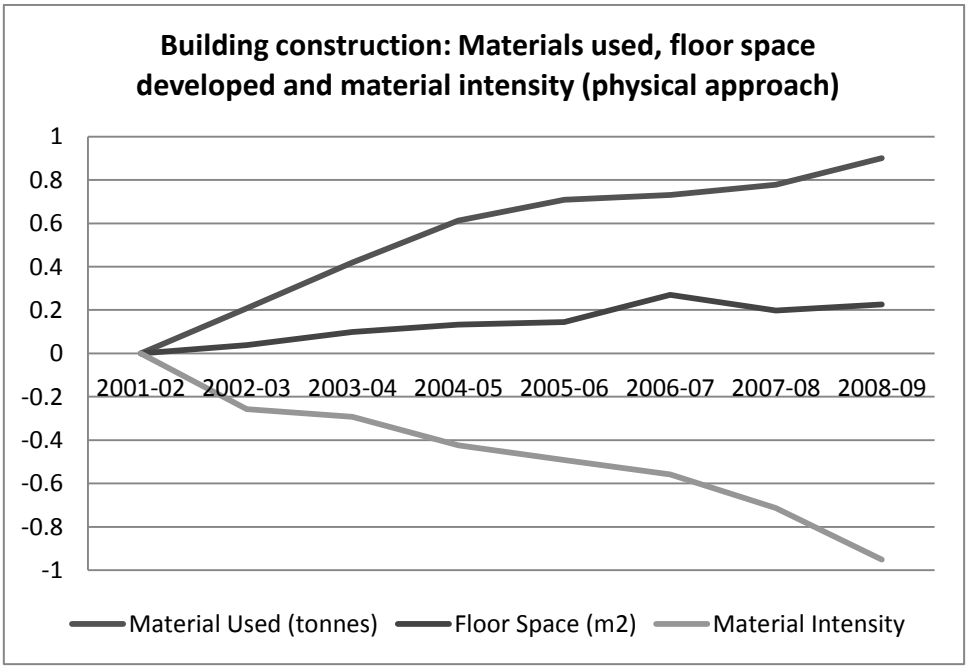


Table 4 - Energy intensity of the construction industry

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
E Construction Industry								
Energy Consumption (PJ)								
Construction Industry GVA ($)								
Material Intensity								
3001 Residential Building Construction								
Energy Consumption (PJ)								
New Dwellings ($)								
Energy Intensity								
3002 Non-Residential Building Construction								
Energy Consumption (PJ)								
New Non-Dwellings ($)								
Energy Intensity								

Figure C

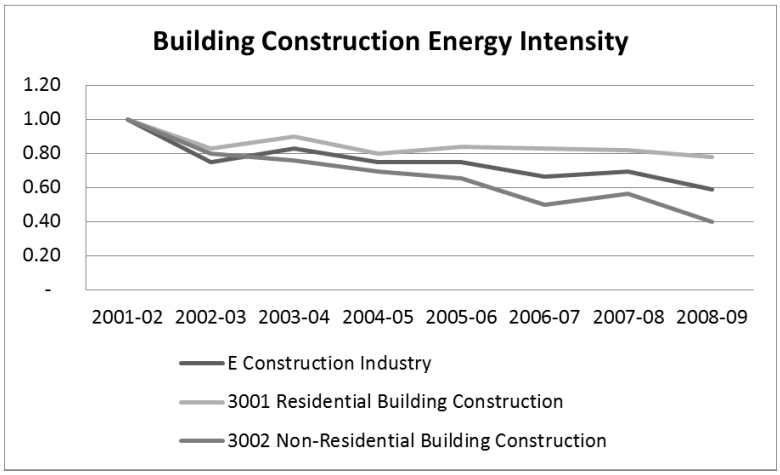


Table 5 – Waste generation by the construction industry

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
E Construction Industry								
Waste Generated (Tonnes)								
Waste Disposed (Tonnes)								
Waste Recycled (Tonnes)								
Diversion Rate (%)								
Building Construction								
Waste Generated (Tonnes)								
Waste Disposed (Tonnes)								
Waste Recycled (Tonnes)								
Diversion Rate (%)								