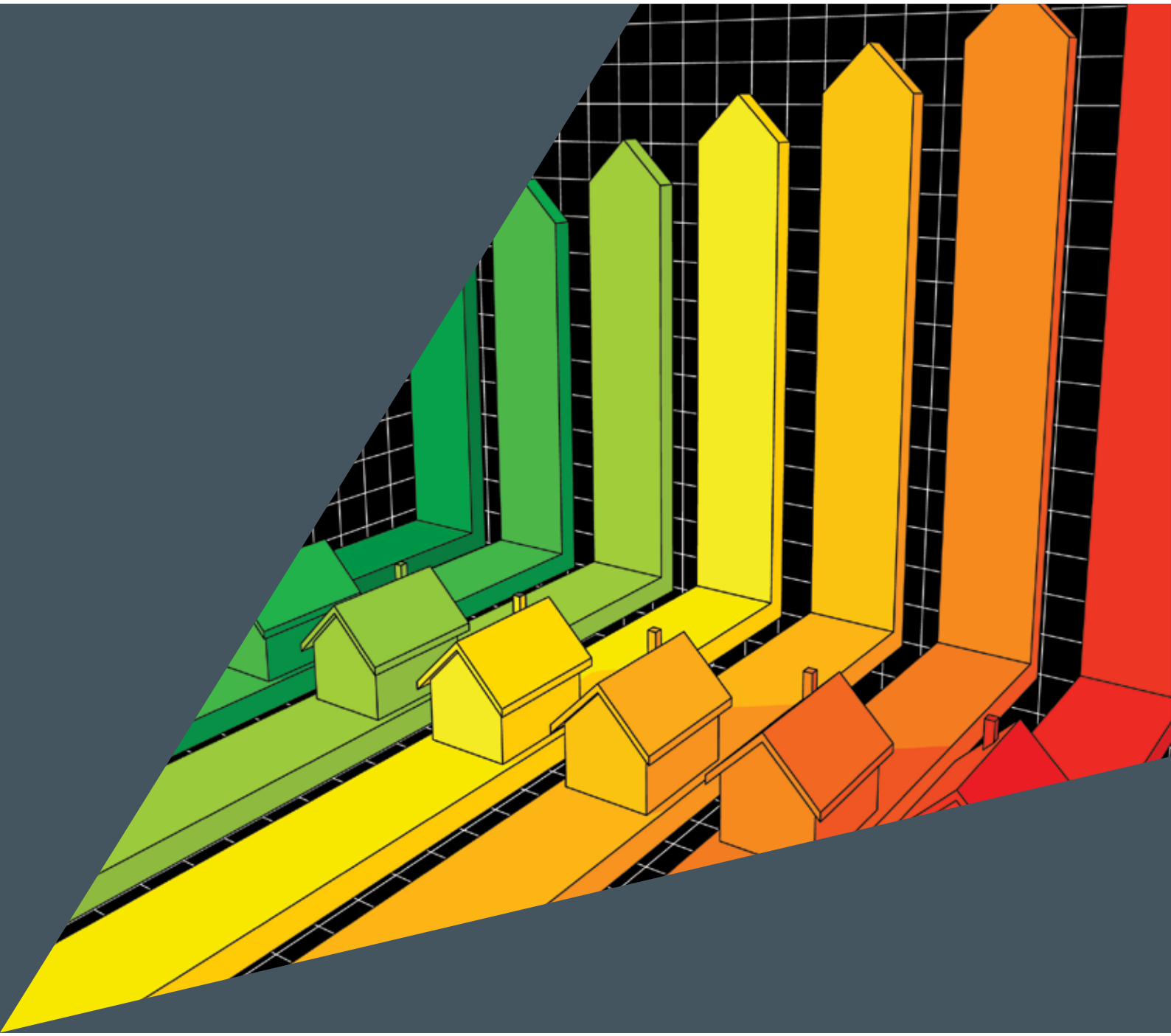
Report **September 2011**

RICS RESEARCH

ZC² – The 2010 RICS Global Zero Carbon Capacity Index

Incorporating comparison with results for 2008 and 2009



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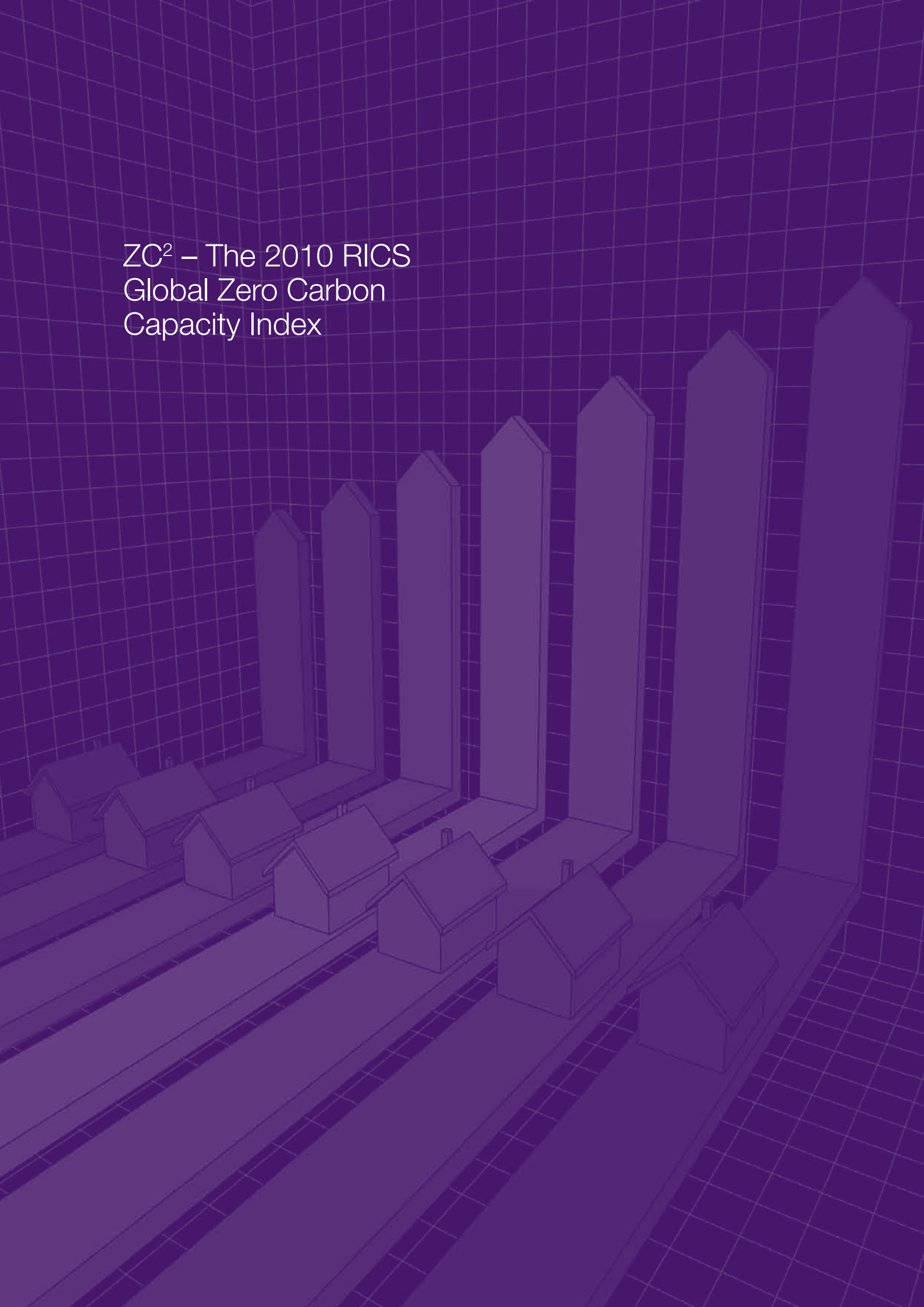
ZC^2 – The 2010 RICS Global Zero Carbon Capacity Index



A Report for Royal Institution of Chartered Surveyors

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A report for the Royal Institution of Chartered Surveyors

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Executive Summary

- For the past three years, RICS has commissioned the Global Zero Carbon Capacity Index (or ZC^2 Index) to measure the performance of a global sample of countries in making progress towards zero carbon built environments.
- The ZC^2 Index, devised and calculated by the UCL Environment Institute, uses robust data from the International Energy Agency (IEA) and World Bank. It is based on data for energy consumption in the residential, service (tertiary) and domestic transport sectors, together with data on the share of renewables in energy supply and a measure of the number of policy instruments in place directly targeted at reducing carbon emissions associated with the built environment.
- **Norway** has topped the Index for all three years 2008-10, although its lead over the next group of countries has fallen in 2010.
- **Brazil** and the **UK** have been ranked second and third for the last two years. Brazil moved up from 6th place in 2008.
- The fourth and fifth places are taken by **Australia** and **China** in 2010. The only change between 2009 and 2010 is that China has now fallen slightly behind Australia.
- The bottom of the Index rankings shows equal stability. **Russia**, **Luxembourg** and **Canada** are unchanged in the lowest positions. **Greece** and **South Africa** are only just above them.
- However, there has been considerable movement in the middle of the ranking. Looking across the period 2008-2010, six countries have shown notable improvement: **Finland**, **Sweden**, **France**, **the Slovak Republic**, **USA** and **Belgium**.
- **India**, **Ireland** and **Italy** have fallen significantly in their rankings over 2008-2010.

1.0 Introduction

The IEA estimates that buildings currently account for a third of energy consumption globally and are an equally important source of CO_2 emissions (IEA, 2010a). Around half of this consumption is a result of space heating and cooling and the heating of water. Figure 1 provides an illustration of energy use in buildings for both the commercial and residential sectors in the United States in 2010 (DOE, 2010).

In a recently developed set of scenarios, the IEA estimates that a business-as-usual approach will see final energy demand in buildings increase by 60% during the period 2007-2050 resulting in an almost doubling of CO_2 emissions from 8.1 Gt to 15.2 Gt. These increases are driven largely by an estimated 67% increase in the number of households worldwide by 2050 and a 195% increase of the floor area of service/tertiary sector buildings by 2050 (IEA, 2011a).

Consequently, it is vital that those responsible for the development and maintenance of the built environment are prepared to address the issue of increased energy consumption. However, according to the IEA (2010a) reducing energy use and subsequent emissions in the residential sector is hampered by the high initial cost of energy saving measures, lack of consumer awareness, split incentives and the low priority placed on energy efficiency. With regard to the service/tertiary sector the IEA identifies the need for policies to achieve improvements in the building shell of new buildings and improving the energy efficiency of heating, cooling and ventilation systems.

In 2008, RICS commissioned the Environment Institute at UCL to develop an index, RICS Global Zero Carbon Capacity Index or ZC² Index, in order to provide an indication as to how individual countries are progressing towards a decarbonised carbon built environment. 34 countries are included in the coverage of this index (Table 1). While the richest countries in the world are well represented in this sample, there is also representation from middle and lower income countries. The ZC² countries accounted for ca. 80% of global Gross Domestic Product (GDP) (Purchasing Power Parity (PPP)) in 2008.

Figure 1 **Energy end use in the US commercial and residential sectors (DOE, 2010).**

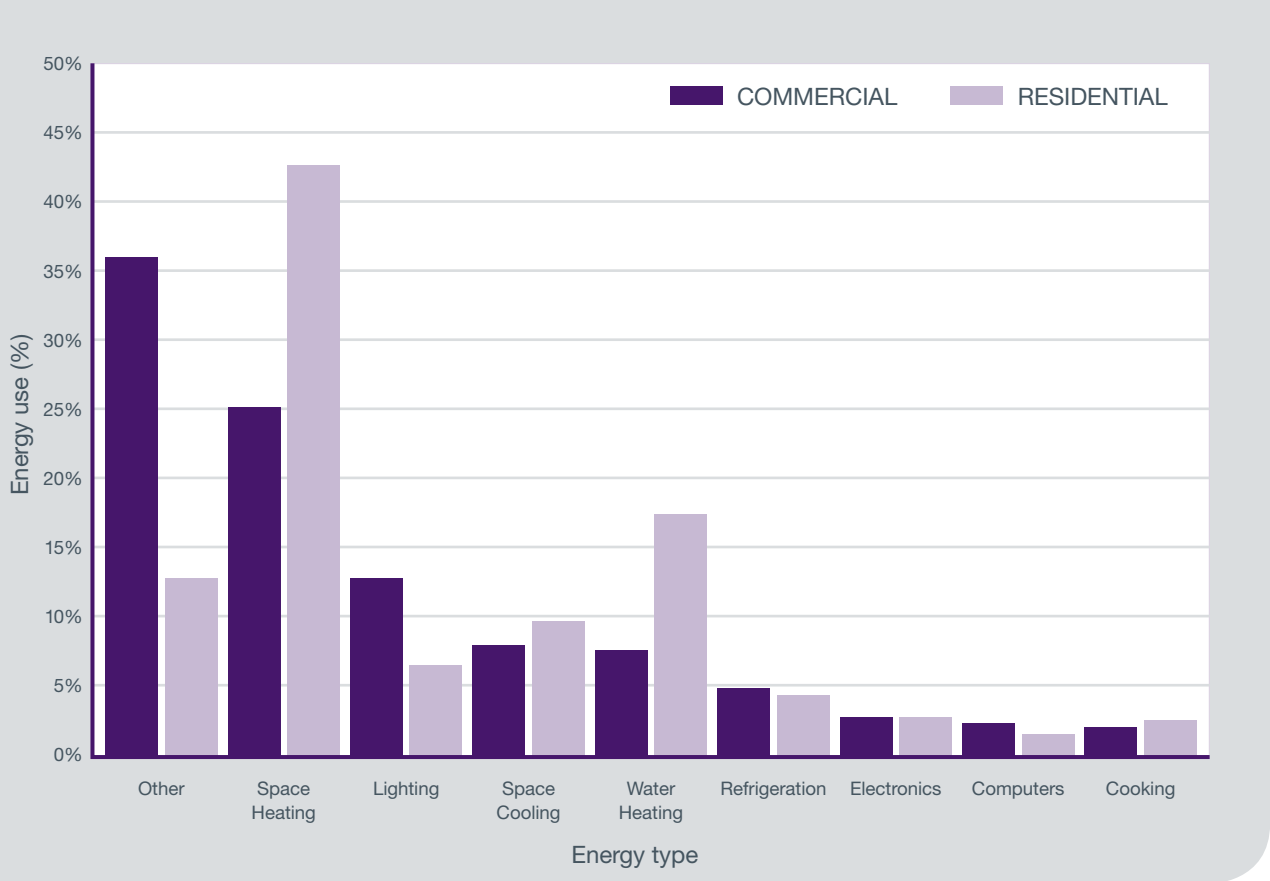


Table 1 **ZC² Index countries and income groups as defined by the World Bank.**

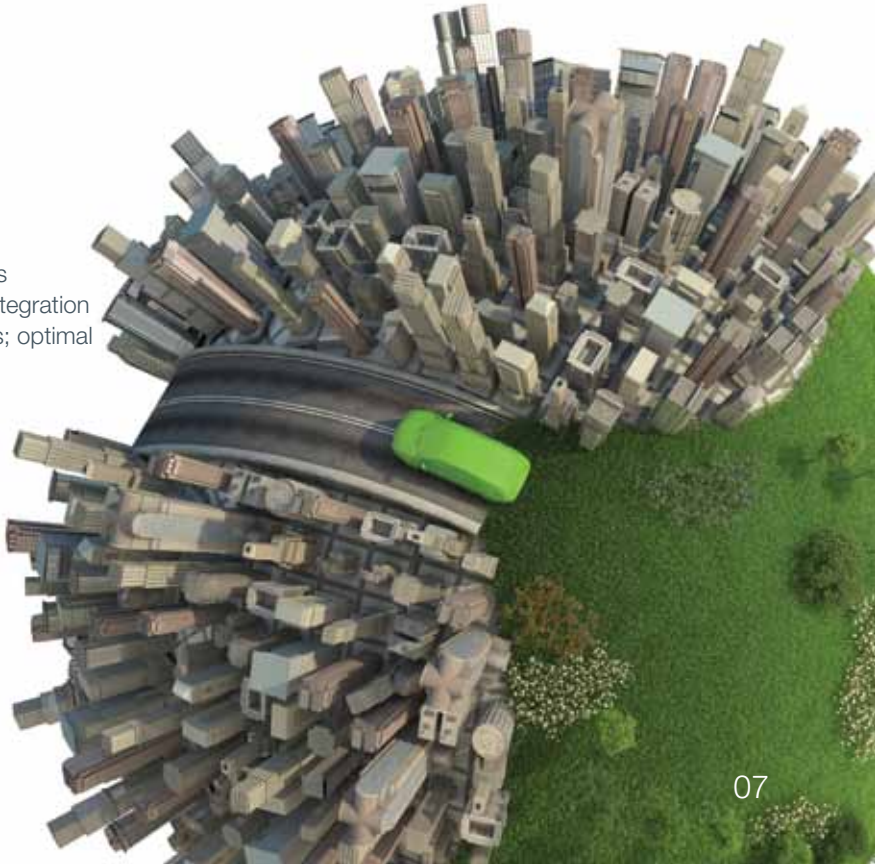
High	Upper Middle	Lower Middle
Austria, Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Holland, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, New Zealand, Norway, Portugal, Spain, Slovak Republic, Sweden, Switzerland, UK, USA	Brazil, Mexico, Poland, Russia, South Africa, Turkey	China, India

The index is constructed by using three sets of indicators. The first of these relates to the consumption of energy in the residential, tertiary and transport sectors on the basis that the energy demand from these sectors is associated with the form, layout and structure of the built environment. The second indicator is the contribution of renewable energy to total primary energy supply (TPES) which reflects the progress of decarbonisation of a nation's energy supply. The third and final indicator takes into consideration the policy frameworks that individual countries have in place to promote carbon reductions in the built environment, namely:

- Zero-carbon house building
- Zero-carbon non-domestic building
- Building certification system
- Retrofitting energy insulation
- Sustainable Public Procurement Policy
- Sustainable Construction Policy
- Green Leases
- Spatial Planning for reduced carbon emissions incorporating public transport/development integration considerations; cycling and walking provisions; optimal urban densities

A more detailed discussion of the methodology used when constructing the index can be found in Appendix 1 and Rydin et al., (2010).

The rest of the report covers the results of the index calculation for 2010 together with comparison to results from previous runs in 2008 and 2009. Each of the constituent elements of the index is considered alongside the aggregate index score.



2.0 Energy consumption and renewable energy use in ZC^2 countries

In 2008, global CO^2 emissions were 29.38 Gt up slightly from the previous year (IEA, 2010b). The 34 countries in the index accounted for around 77% of this total (Figure 2) with China and the US responsible for around 40% of global carbon emissions.

During this period global energy consumption was 8,428,407 ktoe representing a 1.7% increase from the previous year. In common with last year the ZC^2 index countries were responsible for about 73% of this consumption the largest consumers being the United States (18.3%) and China (16.2%). At the opposite end of the spectrum Denmark, Ireland, New Zealand and Slovakia each accounted for less than 0.2% of the total. The lowest energy consumer, Luxembourg, was responsible for just 0.05% of the total (Figure 3). These are, of course, all smaller countries in population terms. Renewable energy contribution to global total primary energy supply is around 13% and represents a small increase from the previous year (IEA, 2011c).

Figure 2 Percentage of global carbon emissions of the ZC² countries and the rest of the world (IEA, 2010b).

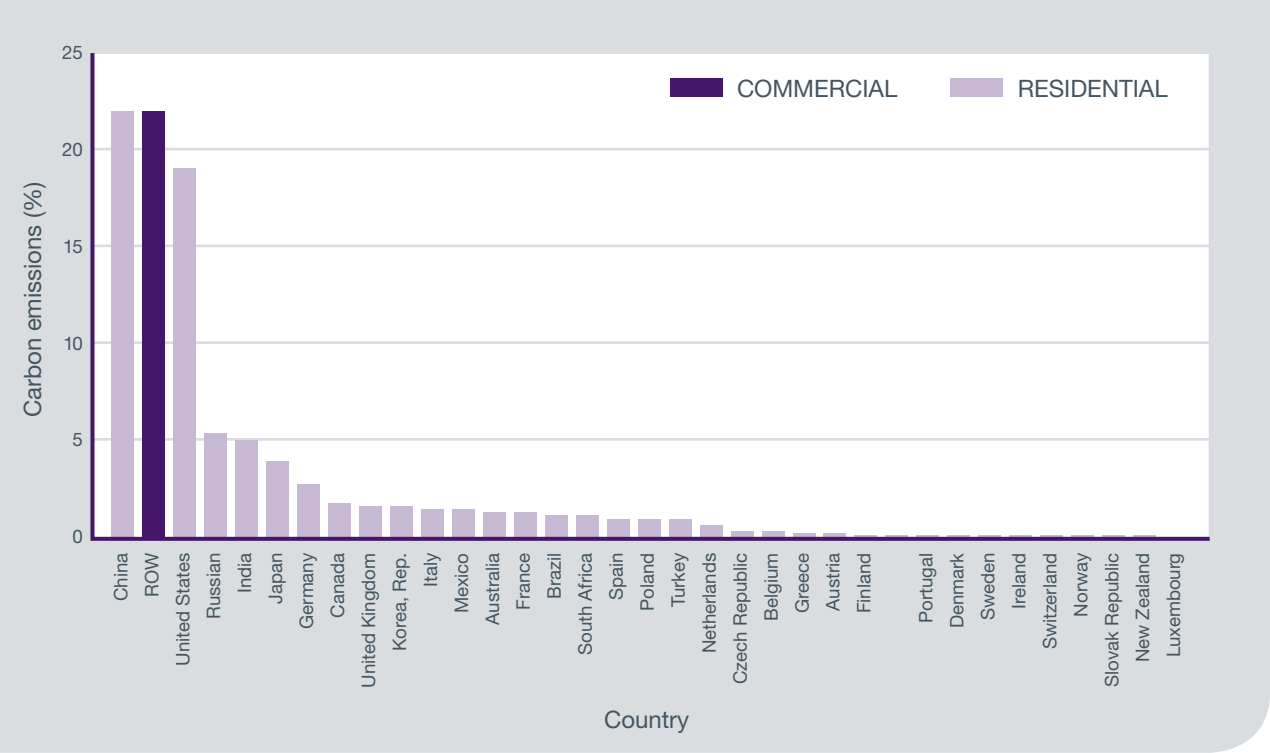
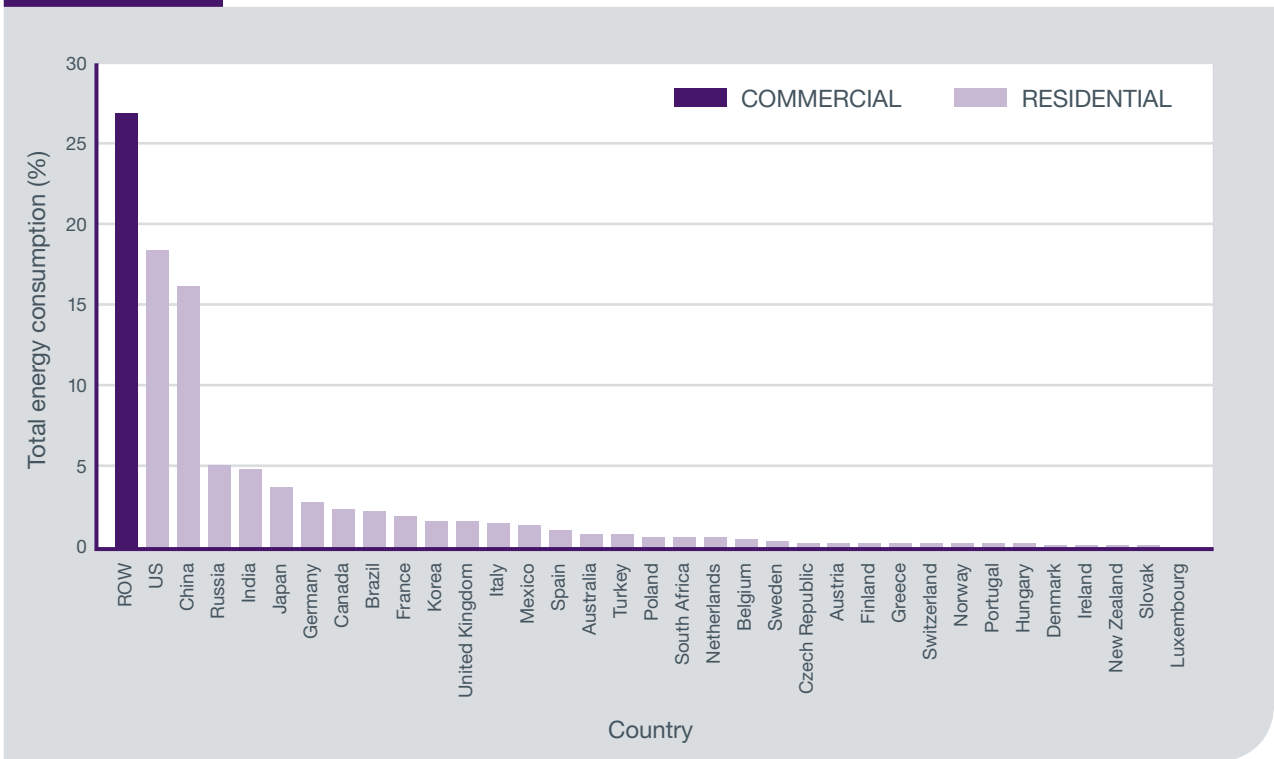


Figure 3 Percentage of total energy consumption by individual ZC² countries (IEA, 2011b).

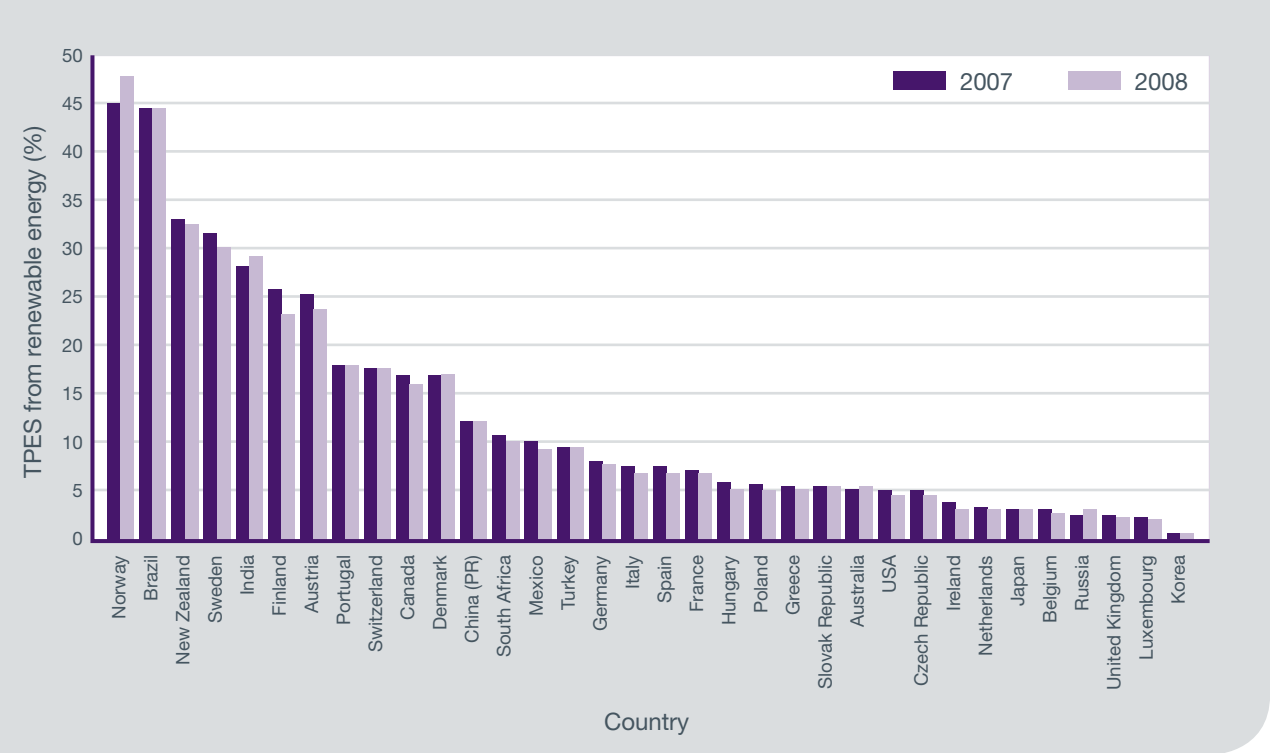


2.1 Renewable energy contribution

Renewable energy contribution to TPES consists of that energy which is derived from hydro, geothermal, solar, tide/wave/ ocean, wind, gas from biomass, liquid biomass, solid biomass and renewable municipal waste. The share of TPES for individual countries can be seen in Figure 4.

Values are similar to last year and there is no change in the five ZC² best performers. Similarly the five countries with the lowest contribution of renewable energy to TPES has remain unchanged although their positions has done with Belgium and the UK both gaining one place while Luxembourg and Russia have fallen one spot. Korea is still the worst performer in this sector. The stability in these figures reflects the lead time in investment on renewable energy infrastructure and the effort required to significantly shift the basis of energy generation in a country.

Figure 4 **Comparison of the share of renewable energy in TPES for 2007 and 2008 (IEA, 2011c).**

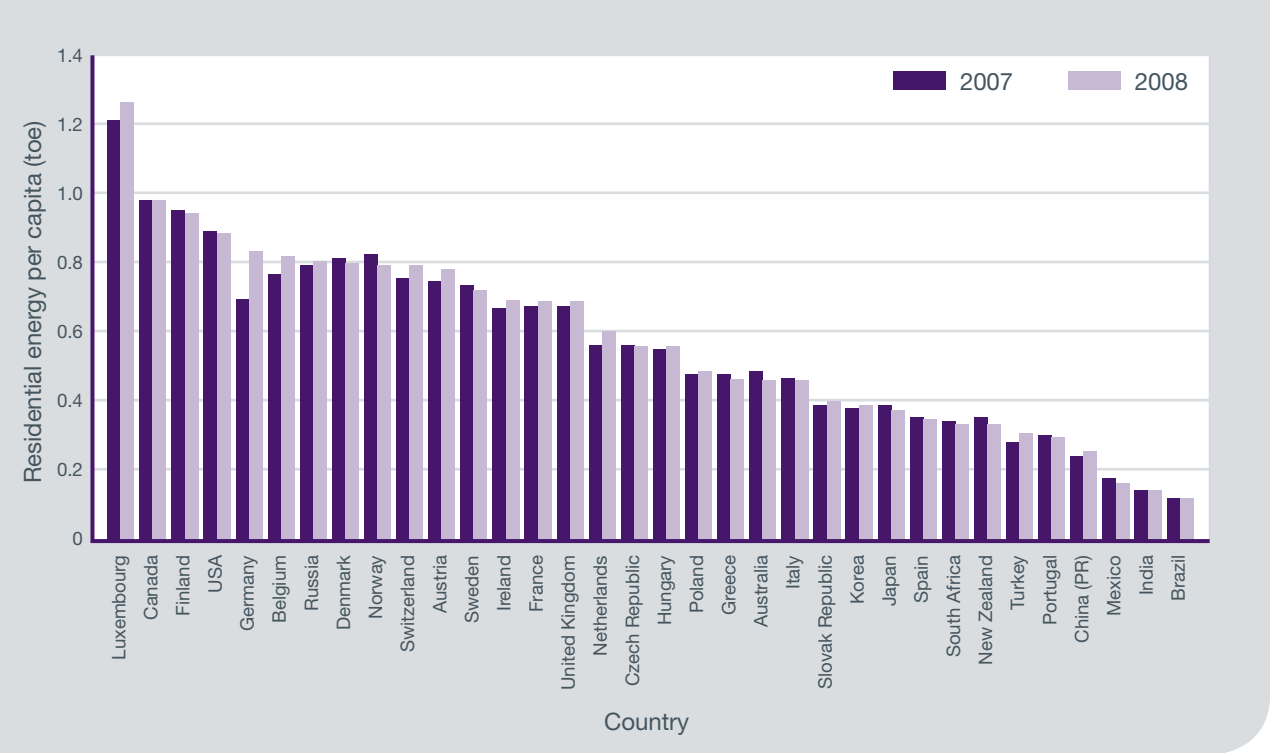


2.2 Residential energy consumption

The residential sector includes energy consumption by households (excluding transport energy consumption). It also includes households with employed persons [ISIC Division 95; i.e. servants, residential homes] which is only a small part of total residential consumption.

Residential energy use per capita is illustrated in Figure 5. Those countries which use the lowest residential energy are: Brazil, India, Mexico, China and Portugal which has taken over from Turkey (now 6th) amongst the best five performers in this sector. The worst performers are Luxembourg, Canada, Finland, US, and Germany. Germany was 12th in last year's index but an almost 20% increase in residential energy use has resulted in a poor performance for this sector this year leaving it the 5th worst performer.

Figure 5 **Comparison of residential energy use per capita in 2007 and 2008 (IEA, 2011b).**

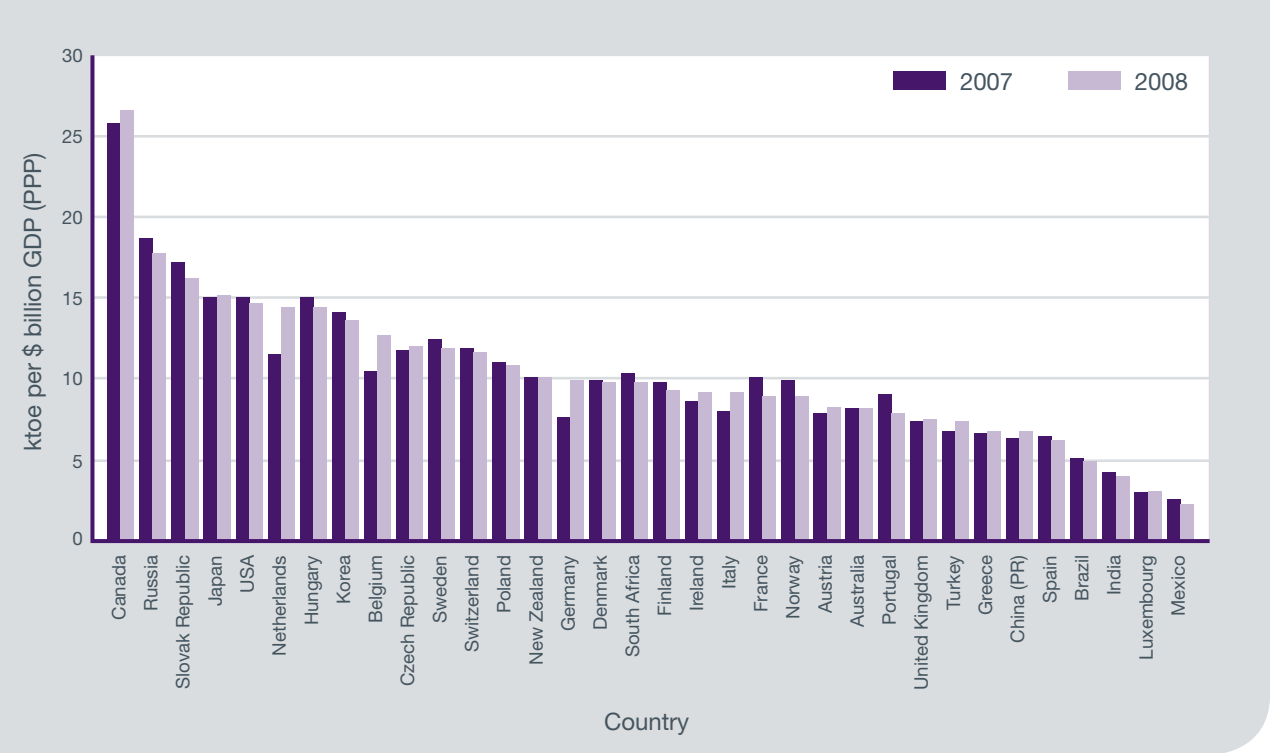


2.3 Tertiary energy consumption

The tertiary sector is a major user of buildings. In terms of data collection, commercial and public services include, for example, wholesale and retail trade; the operation of hotels and restaurants; post and telecommunications; real estate, renting and business activities; the collection, purification and distribution of water; maintenance and repair of motor vehicles and motorcycles; financial intermediation, except insurance and pension funding; computer and related activities; sewage and refuse disposal; public administration and defense; education; and other community, health, social and personal service activities [ISIC Divisions 41, 50-52, 55, 63-67, 70-75, 80, 85, 90-93 and 99].

In the tertiary energy sector the worst performers were: Canada, Russia, Slovakia, Japan, and the USA which replaces Hungary in the bottom five (Figure 6). The best performers were: Mexico, Luxembourg, India, Brazil, and Spain which replaces China, now 6th, amongst the best five performers. The largest shift in this sector is by Germany which is now the 15th worst performer (as opposed to 25th last year) due to an increase in tertiary energy consumption of around 30%.

Figure 6 **Comparison of tertiary energy use for 2007 and 2008. (IEA, 2011b).**

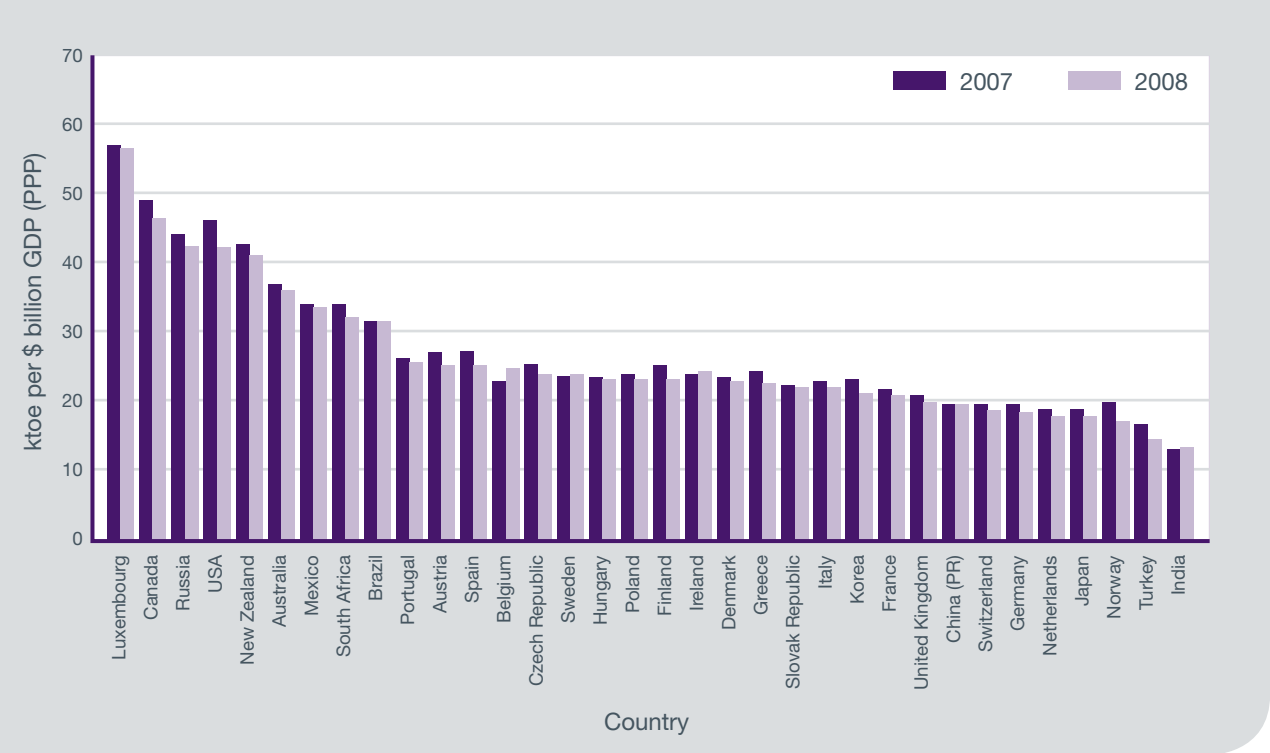


2.4 Transport energy consumption

Energy consumption from the transport sector includes that from: road; rail; pipeline transport; domestic navigation; and nonspecified transport. International aviation and domestic aviation are not included in this IEA sector, however for the purposes of constructing the ZC² Index the latter (i.e. domestic aviation) is included as it relates to the regional pattern of the built environment in some countries, particularly ones with a larger spatial area.

There has been no change in the best and worst five performers in the transport sector (Figure 7). The accepted wisdom is that there is an inverse linear relationship between population and density i.e. as density increases, so transport energy will decrease (Newman and Kenworthy, 1989). An obvious anomaly in the index is Luxembourg, the worst performer. However this can be explained by the fact that transport energy consumption accounts for 55% of total energy consumption in Luxembourg and that an estimated 80% of all diesel and gasoline sales are made to cross-border workers (ca 40% of the workforce) who take advantage of low taxes on energy products (IEA, 2009).

Figure 7 **Comparison of transport energy use for 2007 and 2008 (IEA, 2011b).**



3.0 Policy Measures

The policy indicators were obtained from the IEA Energy Efficiency Policies and Measures Database; the results can be seen in Table 2. This compares the results for 2010 with those for previous years. Dark purple shading of a box indicates an improvement on the previous year; light purple shading indicates deterioration.

The maximum score a country can achieve is 8. In common with last year Australia and the UK have the highest number of policies in place. Below this are six countries equally placed with four policies: China, Denmark, Finland, Germany, Ireland and the USA. Of these Denmark has one more policy than the previous year while Finland has increased its policy number by two. This is the biggest change in policy number seen this year. The countries with the lowest number of policies in place (just one) are: Brazil, Greece, India, Mexico, Russia and South Africa all of which had just one policy last year as did Turkey which now has two policies in place.

Table 2 **Ranking of countries by ZC² policy indicator**

Country	2008	2009	2010
Australia	5	6	6
UK	6	6	6
China (PR)	4	4	4
Germany	3	4	4
Ireland	4	4	4
USA	3	4	4
Denmark	3	3	4
Finland	2	2	4
Austria	5	3	4
Canada	3	3	3
France	2	3	3
Netherlands	3	3	3
Italy	3	3	3
Japan	3	3	3
Korea	3	3	3
New Zealand	3	3	3
Slovak	2	3	3
Switzerland	3	3	3
Belgium	1	2	3
Sweden	1	2	3
Norway	3	3	2
Czech	2	2	2
Hungary	2	2	2
Luxembourg	2	2	2
Poland	2	2	2
Portugal	1	2	2
Spain	2	2	2
Turkey	1	1	2
India	1	1	1
Mexico	1	1	1
Brazil	0	1	1
Greece	1	1	1
Russia	1	1	1
South Africa	0	1	1

IMPROVEMENT DETERIORATION

4.0 Results

The results of the ZC² Index calculation will be presented in terms of the constituent elements and then the aggregate score. Comparisons with the previous scoring for 2008 and 2009 are also included.

Table 3 shows the ranking of countries over 2008-10 for energy consumption in the residential, domestic transport and tertiary sectors. The dark purple shading indicators an improvement in energy efficiency over the previous year; the light purple shading shows deterioration. The countries in bold are those whose ranking has changed four or more places since 2008.

It can be seen that Korea, Slovakia and Hungary have recorded the greatest relative improvement in terms of reducing energy consumption. The Netherlands and New Zealand have dropped most in ranking over 2008-2010.

Table 3 Ranking of countries by energy consumption indicators

Country	2008	2009	2010	Movement 2008-10
India	1	1	1	-
Turkey	2	2	2	-
China (PR)	3	3	3	-
Mexico	4	4	4	-
Brazil	5	5	5	-
Spain	6	6	6	-
Portugal	8	8	7	Up 1 place
Greece	7	7	8	Down 1 place
Italy	9	9	9	-
UK	10	10	10	-
Japan	12	14	11	Up 1 place
Poland	11	13	12	Down 1 place
Korea	17	15	13	Up 4 places
Norway	14	21	14	-
South Africa	13	17	15	Down 2 places
France	19	18	16	Up 3 places
Ireland	18	16	17	Up 1 place
Germany	15	11	18	Down 3 places
Czech Republic	22	19	19	Up 3 places
Netherlands	16	12	20	Down 4 places
Australia	20	22	21	Down 1 place
Slovak Republic	26	24	22	Up 4 places
Austria	25	20	23	Up 2 places
Switzerland	24	23	24	-
Denmark	21	26	25	Down 4 places
Hungary	30	27	26	Up 4 places
New Zealand	23	28	27	Down 4 places
Sweden	28	29	28	-
Finland	29	30	29	-
Belgium	27	25	30	Down 3 places
USA	31	32	31	-
Luxembourg	32	31	32	-
Russian Federation	33	33	33	-
Canada	34	34	34	-

IMPROVEMENT DETERIORATION

4.0 Results

Table 4 shows the ranking of countries by the share of renewable in TPES for 2008-10. Again the dark purple and light purple shading shows movements down and up the rankings year by year. The countries with the largest movements over the three years are indicated in bold. Canada, Germany and Hungary have all significantly improved their rankings for this indicator.

Table 4 Ranking of countries by renewable energy indicator

Country	2008	2009	2010	Movement 2008-10
Norway	2	1	1	Up 1 place
Brazil	1	2	2	Down 1 place
New Zealand	3	3	3	-
Sweden	5	4	4	Up 1 place
India	4	5	5	Down 1 place
Finland	6	7	6	-
Austria	7	6	7	-
Portugal	8	8	8	-
Switzerland	10	9	9	Up 1 place
Canada	19	11	10	Up 9 places
Denmark	11	10	11	-
China (PR)	12	12	12	-
South Africa	14	13	13	Up 1 place
Mexico	15	15	14	Up 1 place
Turkey	13	14	15	Down 2 places
Germany	20	16	16	Up 4 places
Italy	16	18	17	Down 1 place
Spain	17	17	18	Down 1 place
France	18	19	19	Down 1 place
Hungary	24	23	20	Up 4 places
Poland	22	24	21	Up 1 place
Greece	19	22	22	Down 3 places
Slovak Republic	25	21	23	Up 2 places
Australia	21	20	24	Down 3 places
USA	23	25	25	Down 2 places
Czech Republic	26	26	26	-
Ireland	29	28	27	Up 2 places
Netherlands	28	29	28	-
Japan	27	27	29	Down 2 places
Belgium	31	31	30	Up 1 place
Russia	30	30	31	Down 1 place
UK	32	33	32	-
Luxembourg	33	32	33	-
Korea	34	34	34	-

IMPROVEMENT DETERIORATION

Together with the policy indicator, reported in Table 2, these indicators are combined in the ZC² aggregate score. Table 5 provides these final results for 2010. The figures for the actual score range around zero due to the normalising method used. Table 6 then compares these with the results for 2008 and 2009 and indicates movements over these three years.

Table 5 ZC² Scores 2010

Rank	Country	Score
1	Norway	75
2	Brazil	68
3	UK	66
4	Australia	63
5	China (PR)	61
6	Finland	59
7	New Zealand	56
8	Sweden	51
9	India	44
10=	Denmark	39
10=	Austria	39
12	Germany	18
13	Switzerland	16
14	Portugal	12
15	Ireland	8
16	Italy	4
17	Turkey	2
18	France	-6
19	Japan	-14
20	Spain	-15
21	Slovakia	-18
22	Netherlands	-22
23	Korea	-24
24	Mexico	-28
25	USA	-31
26	Poland	-35
27	Belgium	-36
28	Czech	-44
29	Hungary	-45
30	South Africa	-48
31	Greece	-50
32	Canada	-62
33	Luxembourg	-96
34	Russia	-122

4.0 Results

Table 6 Comparison of ZC² scores for 2008, 2009 and 2010

Country	2008	2009	2010	Movement 2008-10
Norway	1	1	1	-
Brazil	6	2	2	Up 4 places
UK	4	3	3	Up 1 place
Australia	7	4 =	4	Up 3 places
China (PR)	2	4 =	5	Down 3 places
Finland	13	16	6	Up 7 places
New Zealand	5	6	7	Down 2 places
Sweden	14	10	8	Up 6 places
India	3	7	9	Down 6 places
Austria	8	8	10 =	Down 2 places
Denmark	9	12	10 =	Down 1 place
Germany	15 =	9	12	Up 3 places
Switzerland	10	11	13	Down 3 places
Portugal	17	13	14	Up 3 places
Ireland	11 =	14	15	Down 4 places
Italy	11 =	15	16	Down 5 places
Turkey	15 =	22	17	Down 2 places
France	24	17	18	Up 6 places
Japan	18 =	18 =	19	Down 1 place
Spain	18 =	21	20	Down 2 places
Slovak Republic	26 =	20	21	Up 5 places
Netherlands	20	18 =	22	Down 2 places
Korea	22	23	23	Down 1 place
Mexico	21	24	24	Down 3 places
USA	30	25 =	25	Up 5 places
Poland	23	25 =	26	Down 3 places
Belgium	32	31	27	Up 5 places
Czech	26 =	27	28	Down 2 places
Hungary	29	28	29	-
South Africa	31	29 =	30	Up 1 place
Greece	25	29 =	31	Down 6 places
Canada	26 =	32	32	Down 6 places
Luxembourg	33	33	33	-
Russia	34	34	34	-

IMPROVEMENT DETERIORATION

Six countries have risen in the index over 2009-2010, eighteen have fallen and ten remain unchanged. In common with the previous year, the top three performers are Norway, Brazil and the UK. Norway's overall index score is much reduced from the previous year; this can be explained by a reduction in the zero-carbon policy measures in place from 3 to 2. The UK has six policies in place which contributes to a high overall score while Brazil's high overall score is a result of its low energy use when compared with other countries and the high contribution of renewable energy to TPES which at 44% is on a par with that of Norway (45%).

Last year Australia and China shared fourth spot in the ranking however this year Australia is in fourth place and China fifth. The cause of this shift is an increase in energy consumption in the residential (7%) and tertiary (5%) sectors in China. In Australia these sectors exhibited a fall of around 5% and no change respectively. Australia's renewable energy contribution to TPES dropped by 4% but there was no change in this indicator for China.

The most notable climb in the rankings is that of Finland who has moved from 16th position in 2009 to 6th position in 2010. Over the last year Finland has seen a 3% increase in economic growth as measured by GDP (PPP) and a minor decrease in residential energy consumption. However there has been a significant reduction of both transport energy consumption (-8%) and tertiary energy consumption (-6%) from the previous year's levels. This reduction in energy use has been complimented by an almost 11% increase in renewable energy which now contributes almost 26% of energy to the country's TPES. This shift towards decoupling economic growth and energy consumption and decarbonising energy supply would be sufficient to increase Finland's index score significantly. However it is the increase in the number of built environment-related policies focusing in reducing carbon (from 2 to 4) which is primarily responsible for the large increase in the overall index score and subsequent rise up this year's ranking.

Other countries that have seen significant improvements are Belgium and Turkey. Belgium (up four places from 27 to 31) has seen increases in consumption in all energy sectors: renewable energy (17%), residential (7%), tertiary (21%) and transport (8%). However, the addition of an extra policy along with a 17% increase of renewable energy to TPES resulted in the higher index score. In contrast, Turkey's (up 5 places from 22 to 17) greatest improvement has come in the transport sector where energy use was 12% lower than the previous year. Increased energy use was seen in both the residential (8%) and tertiary (11%) sectors while the contribution of renewable energy to TPES fell by 1.5%. However in common with Belgium, Turkey also has an additional policy measure in place which results in an improved overall score.

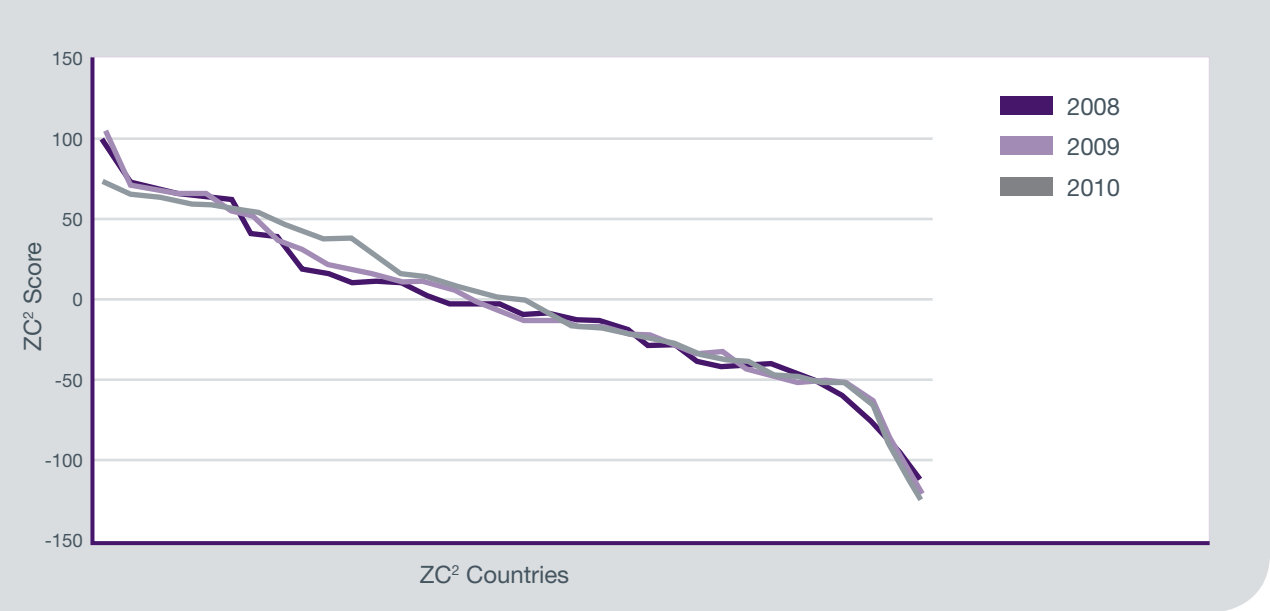
The five countries that fared the worst in the index are the same as last year: Russia, Luxembourg, Canada, Greece and South Africa. Russia has just one policy in place, is one of the highest users of energy across all sectors and has a low contribution of renewable energy to TPES. The same is true for Luxembourg however the unique situation of transport energy use in that country is a contributory factor to its low overall score and has already been discussed. Despite having three policies in place and a renewable energy contribution of 17% it performs poorly in the energy consumption sector. Greece and South Africa both have just one policy in place and do not perform particularly well in any indicator.

The largest decline is that of the Netherlands which has fallen from 18th position and is now 22nd. The number of policies in place (3) remains the same. The contribution of renewable energy to TPES has increased by 15% and transport energy has declined by 5%. However there has been a 6% increase in residential energy use and more significantly a 24% increase in the use of energy by the tertiary sector. This last factor helps explain the lower index score obtained by the Netherlands this year and its subsequent fall in the overall rankings.

4.0 Results

Looking at the actual index scores it is interesting to note that the index scores for Brazil, UK, Australia and China are similar to the previous year. Norway's however is considerably lower due to a reduction in policy numbers that contribute to the overall index score. Figure 8 plots the index scores for the last three years and this shows a general closing up of the gaps between scores among the better performing countries. There is little change in the overall pattern at the bottom of the rankings.

Figure 8 **Pattern of ZC² Index scores for 2008, 2009 and 2010.**



5.0 References

DOE (2010) *Buildings Energy Data Book*. Accessed at: http://buildingsdatabook.eren.doe.gov/

IEA (2009) *Energy Policies of IEA Countries – Luxembourg*. Accessed at: http://www.iea.org/textbase/nppdf/free/2008/Luxembourg2008.pdf

IEA (2010a) *Energy Technology Perspectives: scenarios and strategies to 2050: Executive Summary*. Accessed at: http://www.iea.org/techno/etp/etp10/English.pdf

IEA (2010b) *CO_2 emissions from fuel combustion: highlights.* Accessed at: www.iea.org/co2highlights/co2highlights.pdf

IEA (2011a) *Technology Road Map. Energy efficient buildings: heating and cooling equipment.* Accessed at: http://www.iea.org/papers/2011/buildings_roadmap.pdf

IEA (2011b) *World Energy Balances.* Accessed at: http://www.esds.ac.uk/international/support/user_guides/iea/iea.asp

IEA (2011c) *Renewables Information*. Accessed at: http://www.esds.ac.uk/international/support/user_guides/iea/iea.asp

Newman, P. and Kenworthy, J. (1989). Gasoline Consumption and Cities; A Comparison of U.S. Cities with a Global Survey. *Journal of American Planning Association*, 55(1), pp. 24–37.

Rydin, Y., Maguire, S. and Austin, P. (2010) Dilemmas in developing a sustainable built environment index. *Urban Planning and Design*, 163(4), pp. 159–168.

6.0 Appendix 1 – Index Methodology

The pilot run of the ZC² Index in 2008 was based on an unweighted combination of data on the share of renewable energy in TPES, energy consumption averaged across the domestic, transport and tertiary sectors (each appropriately normalised) and a composite policy indicator, that took account of the number of policy frameworks in place as weighted by the results of a survey of an advisory panel on the implementation of these frameworks. Three changes were made from this pilot methodology.

First, the decision to weight the policy indicator with reference to the results of an advisory panel was based on two factors. The literature on indicators and indices emphasises the benefits of involving relevant stakeholders from the target audience in the creation of the indicator or index to generate buy-in. Hence it was decided to try and involve key members of the property sector through the medium of an advisory panel. In addition, since the focus of the ZC² Index is on the capacity to create zero-carbon built environments, it was felt to be an advantage to have a measure of how likely the identified policy measures were to have an impact.

However, the operationalisation of the survey of an advisory panel proved extremely problematic. Not only was it extremely time-consuming, it proved impossible to assemble a representative advisory panel for the extended sample of countries or to generate sufficient survey responses to give a robust basis for a weighting factor. Therefore it was decided to omit the survey element and the associated weighting of the policy indicator.

Second, the energy consumption for the tertiary sector was calculated per unit of value added for this sector. Data for valued added for the tertiary sector was only available on the basis of the $ value of GDP. To ensure consistency, this measurement of GDP was also used to normalise energy consumption for the transport sector. However, when calculating the change in these indicators from year to year, it became clear that movements in the value of different currencies against the $ were going to have a significant impact on the calculation of the indicators. Therefore it was decided to move towards a Purchasing Power Parity (PPP) basis for calculating GDP when normalising the energy consumption for the tertiary and transport sectors.

Third, as a result of the above decision, it was no longer possible to normalise the indicator for energy consumption in the tertiary sector by the value added for this sector. Instead energy consumption is calculated per unit of GDP for both the tertiary and transport sectors.

The index thus is calculated using an unweighted average of three indicators:

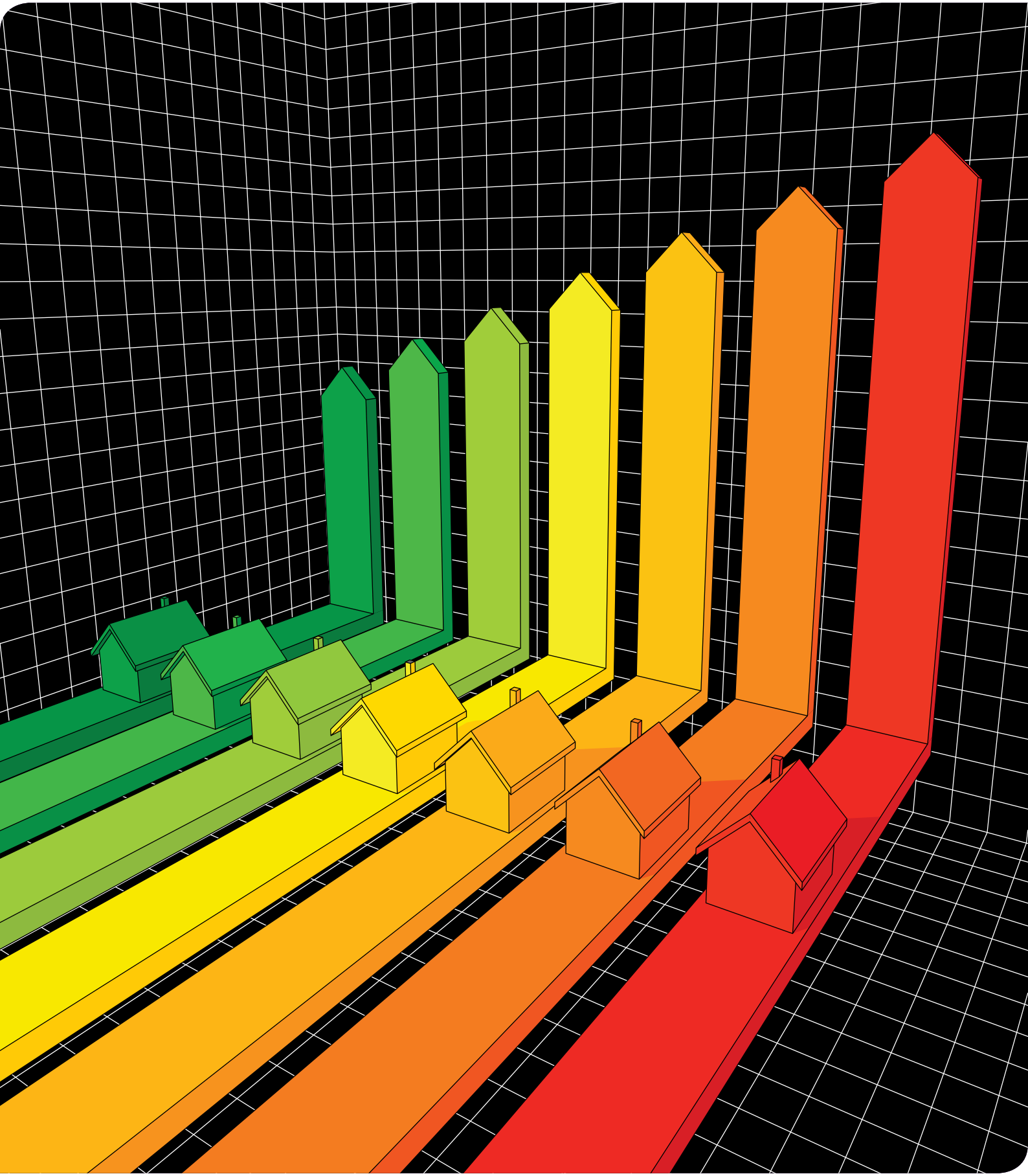
Indicator	Data Source	Datum
Renewable energy as a percentage of total energy generated	IEA	For each year's run, the data is available for two years before, i.e. 2008 data for 2010 run
Energy consumption, calculated as an unweighted average of: 1. Residential energy consumption per capita 2. Tertiary sector energy consumption per unit of GDP (PPP) 3. Domestic transport sector energy consumption per unit of GDP (PPP)	IEA World Bank	For consumption, GDP and population data, the data is available for two years before, i.e. 2008 data for 2010 run
Number of eight pre-identified policy frameworks that are in place	IEA	For each year's run, policy data is available for that year, i.e. 2009 data used for 2009 run

In all instances, the indicators are normalised using the Standard Deviation method.

The revised approach provides a consistent, efficient and robust basis for runs of the ZC² Index. The data for 2008 pilot run was recalculated using the revised methodology and this is the basis of all comparisons in this and other ZC² reports.

The process of developing the ZC² Index is discussed in more depth in:

Rydin, Y., Maguire, S. and Austin, P. (2010) Dilemmas in developing a sustainable built environment index. *Urban Planning and Design*, 163/DP4, P. 159 – 168.



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