Technical Reports

GBPN
Global Buildings Performance Network

Building Policies for a Better World

ROBUST BUILDING DATA: A DRIVER FOR POLICY DEVELOPMENT

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ACKNOWLEDGEMENTS

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LIST OF ACRONYMS

3CSEP - Center for Climate Change and Sustainable Energy Policy
ACEEE – American Council for an Energy Efficient Economy
AEO - Annual Energy Outlook
AHS - American Housing Survey
BPIE – Building Performance Institute Europe
CBECS - Commercial Building Energy Consumption Survey
CEU - Central European University
CEUS - California End Use Survey
CO_2 - Carbon dioxide
CSEP - China Sustainable Energy Program
EC - European Commission
ECEEE – European Council for an Energy Efficient Economy
ECO-III - Energy Conservation and Commercialization Project - Phase-III
EED - Energy Efficiency Directive
EIA – Energy Information Administration
EJ – Exajoules
EPBC – Energy Performance Building Code
EPC - Energy Performance Certificates
EU – European Union
GBPN – Global Buildings Performance Network
GHG – greenhouse gas
Gt – Gigaton
HEB - High Efficiency Buildings
IEA – Internal Energy Agency
IGBC – India Green Building Council
IMT – Institute for Market Transformation
kW – Kilowatt
kWh - Kilowatt-hour
MOHURD - Ministry of Housing and Urban-Rural Development
Mt - Million-ton
Mtoe - Million ton of oil equivalent
NNEAP - National Energy Efficiency Action Plans
OECD - Organisation for Economic Co-operation and Development
RECS - Residential Energy Consumption Survey
SHAKTI - Shakti Sustainable Energy Foundation's Building Program
UNEP - United Nations Environment Programme
US -United States
USAID - United States Agency for International Development
WBCSD – World Business Council for Sustainable Development
WGBC – World Green Buildings Council

EXECUTIVE SUMMARY

The Importance of Building Performance Data

As buildings account for around a third of the global final energy use and 30 per cent of global energy-related carbon emissions, it is clear that this sector has the potential to bestow huge energy savings (Urge-Vorsatz et al., 2012, pp 3). For this reason the Global Buildings Performance Network's (GBPN) mission is to significantly reduce greenhouse gas (GHG) emissions associated with building energy use.

GBPN work in four priority regions – China, the European Union (EU), India and the United States (US) – together representing around 65% of global final building energy use in 2005 (ibid., pp 3). GBPN facilitates this action through regional Hubs and Partners in the four priority regions: China Partner - the China Sustainable Energy Program (CSEP); Europe Hub - Buildings Performance Institute Europe (BPIE); India Partner - Shakti Sustainable Energy Foundation's Building Program (SHAKTI); and the US Hub - Institute for Market Transformation (IMT). The regional Hubs and Partners provide the most up-to-date knowledge and data on building energy policies to decision-makers within their region.

It is estimated that by 2050, if we follow current policy trends the energy use from the building sector will increase by around a half of 2005 levels (ibid., pp 62). However, if current best practices were to become standard practice, it is possible to reduce global building final energy use by one third of 2005 levels (ibid, pp.62).

The focus of policy makers and building experts needs to be moving towards performance-based building codes and a more holistic approach to renovating existing buildings, rather than improving single building elements[1]. In order to accurately identify the potential energy savings in buildings and to design policies that target energy efficiency, data quality needs to be measured, David Eijadi with The Weidt Group says "to do better as a community of design professionals and as a society in making energy-efficient buildings, we need to know more than our current sets of data permit us to know" (NIBS, 2011, pp 10).

To build and renovate buildings that are energy efficient and sustainable, participants in the building sector must trust the data used to calculate the energy savings. To gain the confidence of policy-makers, builders, architects and all building sector stakeholders, the data must be both available (and storable) and credible (verifiable and transparent). Solid data cases provide known facts that can be used to influence decision-makers; therefore, it is essential that consensus be reached on the basis of credible data collection and its analysis. There is a need for a credible baseline and data series. The baseline is crucial for measuring impact and if objectives are being achieved.

Data Quality in the GBPN Regions

The quality of data around the world varies considerably; there are large data gaps, weaknesses and inaccessibility that preclude accuracy in modelling. This report presents a unique attempt to assess the quality of data of building types in each of the GBPN's regions (China, the EU, India and the US). The main aim of the report is to identify the omissions (or "white spots") in the data that prevent modelling and estimation of energy efficiency potentials in buildings. This will assist in the design of measures to improve the quality of data collection and in designing new policies that support a development towards low energy use in buildings. Strategies for overcoming these gaps are provided through advice and reasoned opinions from international experts.

Methodology

This project has collected information on the quality of data that relates to the energy performance of buildings, the parameters considered for this study were floor area, number of buildings, energy use, heating, cooling, hot water, lighting /

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[1] It is still important to maintain and gradually improve minimum energy performance requirements for individual building elements for cases of partial renovation, when for example a wall is replaced, or windows or floor insulation.

appliances, age profile, retrofit rates, urban / rural split, new building energy use, yearly construction, fuel mix, ownership (private / public) and tenure.

All data and information from this report was sourced directly from GBPN's hubs, partners, regional and global experts and modellers in the four regions and gathered in a data collection matrix. The structure of the matrix comprised of building types down the left hand column and performance data along the top row. GBPN's hubs and experts filled in the matrix by scoring each of the parameters with a quality rating between zero and five; see Table 1.1. At lease two unconnected parties, one global and one regional, filled in each region's data quality matrix.

Table 1.1. Weighting: Accuracy Descriptions.

Weighting	To what degree is the data that you have used accurate?
5	Data source accurate and fully reliable - official verified document or more than one independent source giving similar information.
4	Good, trusted data source i.e. an official document
3	Data generally available, but from mixed sources
2	Partial Data - data available not very accurate
1	Weak Data - little available data / not accurate
0	No Evidence - guess

Data Quality Findings

The data quality matrices of the four regions give an accurate perspective of how strong or weak the current data quality is. As expected, the quality of data varies significantly between regions although there are some recurring trends. This results gathered in the matrix are presented in a graph below.

The graphed data quality "spider webs" below (Figures 1.1 and 1.2) show the data quality of the four GBPN regions with the different requested parameters for both residential and commercial and public buildings. Generally, the US has the higher scoring data quality for most of the parameters, followed by the EU then China then India.

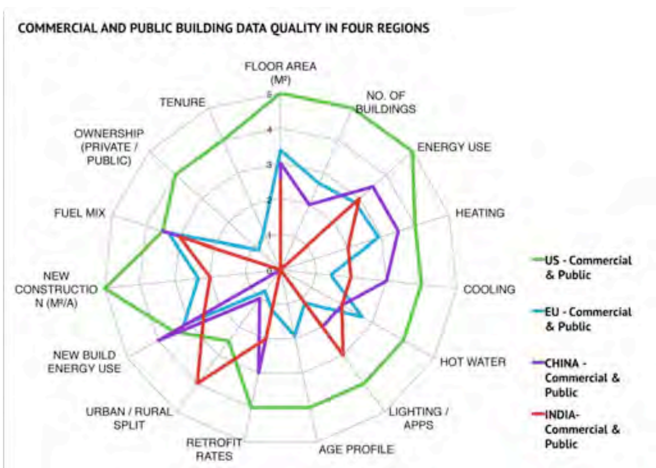

Figure 1.1. Data Quality Of 4 GBPN Regions Regarding Residential Buildings

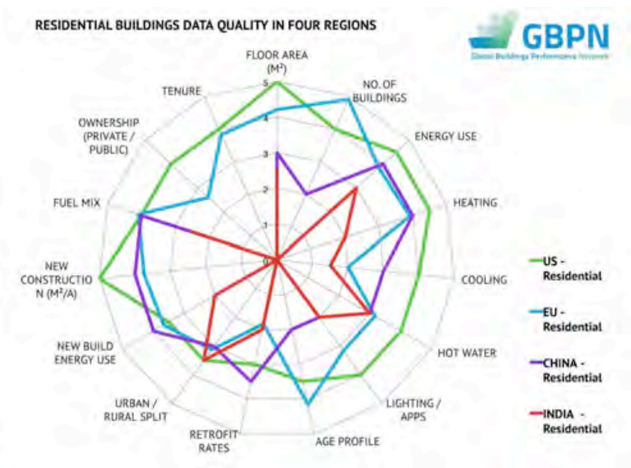

Figure 1.2. Data Quality Of 4 GBPN Regions Regarding Their Commercial & Public

Regional Comparison

At a first glance it is clear that there are not enough available data in all four regions for accurately modelling building energy performance. It is also clear that the quality of data differs vastly across the regions. Overall on average the residential stock scored a rating of 0.5 higher than the commercial building stock (therefore it is 10% more available and accurate than the commercial and residential building stock). When comparing the two graphs the commercial graph presents more data gaps than the residential.

No region could be considered as having exceptional data as there were significant gaps and weakness found in each region's data set, even after allowing for fields that were not actively investigated by the modellers and experts to be discounted. Figure 1.3 below demonstrates the difference of the data qualities in the four regions.

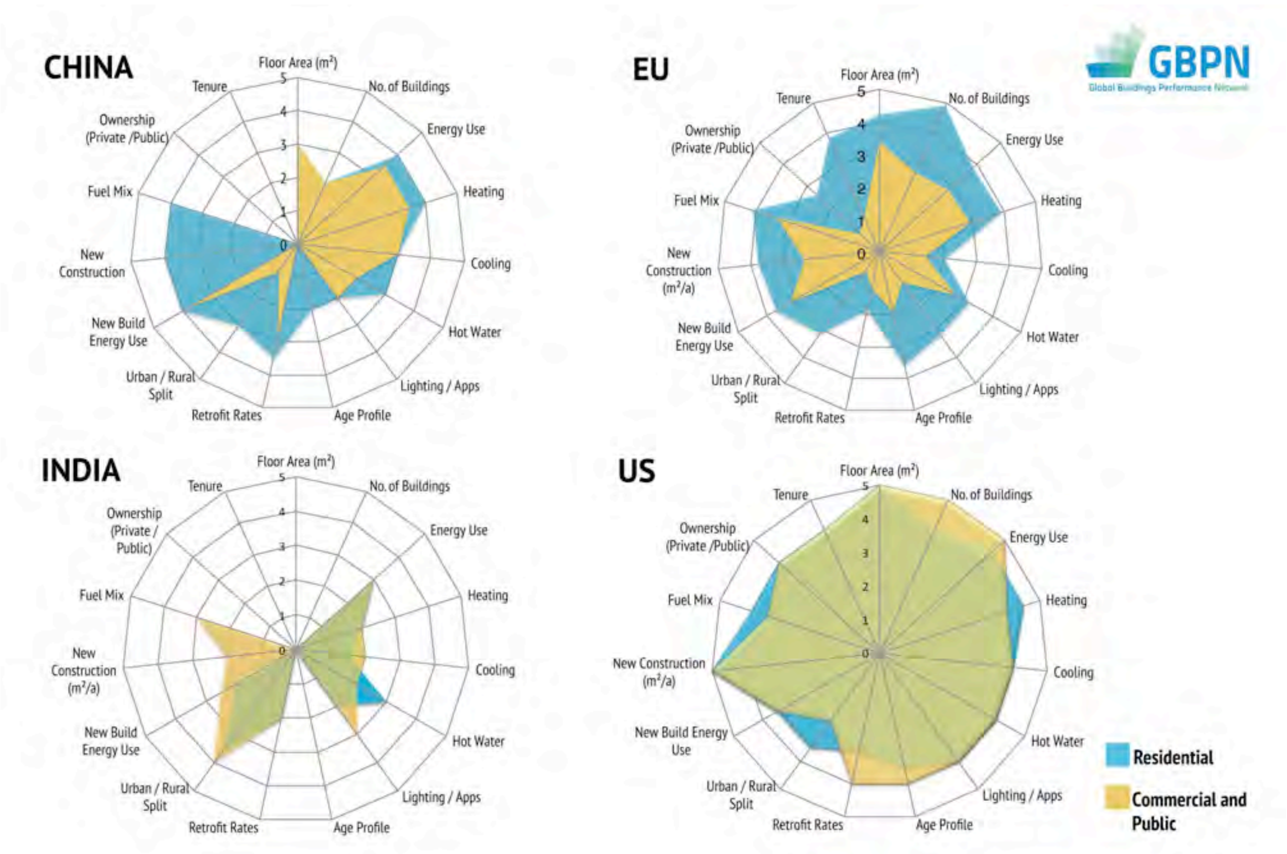

Figure 1.3. Residential vs. Commercial Data Quality in the Four GBPN Priority Regions.

Data in China

The residential building data in China scores on average 0.75 times higher than the commercial and public data. China's building performance data averages at around 2.5 in the valuation of the experts, which implies that there are either partial or available data, yet they are not always reliable.

The commercial and public building stock has the lower scoring data compared to the residential data in all the parameters except for seven that are equal. Six out of the fifteen parameters for the residential data are between 3.5 and 5, meaning that on average around a third of the data are deemed as being from a reliable and trustworthy source. The commercial and public building data have four parameters that fall into the "accurate / reliable" weighting category, this means a quarter of the data were weighted as being accurate. The rest of the data are not found to be accurate or even available.

Data in the European Union

Unlike the US, the EU does not have official data on the building sector as a whole region[2] and the quality of data varies significantly between the different states; therefore the EU results are taken from an average of 6 of the Member States – two countries that are below the EU "average", 2 average EU countries and two countries above the EU average, the countries used for this study were Austria, Germany, Poland, Spain, Sweden and the UK. The findings of the analysis found that the quality for both residential and commercial and public buildings in the EU is lower than the US.

The biggest difference between the quality of residential and commercial buildings is found in the EU; the average score of the residential sector was higher than the average commercial sector by just under 2, giving a 40% difference between the two sectors. In general, around two thirds of the residential data are deemed as being accurate (these parameters were found to be in the top two weighting categories). The commercial and public sector has the lower scoring data compared to the residential data in all the parameters. For almost half of commercial and public data there are sources available yet they are not deemed as being from a reliable or accurate source.

Data in India

The response of the experts and modellers in India showed that the data used for modelling are frequently inaccessible for the modellers of the survey. This could be due to data being difficult to locate or translate from the original language and it might be a result of the very diverse and regional structure of India. Although it was possible to estimate the existing residential and commercial building data to give an understanding of how energy use is split by end use, the experts weighted the accuracy of data on average as 1.7 out of 5 therefore they seem be unreliable.

The commercial and public stock has stronger data compared to the residential data in all the parameters except two that are equal and one that is higher. Only one of the parameters for both commercial and residential were scored as having accurate data, four out of the fifteen parameters from the commercial building sector have a score of 2.1-3.4, meaning that the majority of the data were deemed as being unavailable or inaccurate.

Data in the United States

On a scale of zero to five, the US commercial and public building data quality score on average 0.06 higher than residential data. The US has the strongest set of building energy data among the GBPN priority regions; this is supported by the Energy Information Administration's (EIA) national-level data surveys on the characteristics and energy use of commercial and residential buildings (EIA, 2013). However, the 2007 CBECS data was withheld due to survey design issues, and the 2011 survey was briefly postponed due to federal funding cuts, meaning the latest available data is over a decade old.

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[2] BPIE, GBPN's EU Hub has been developing a comprehensive database for EU building performance, this is the first time in Europe such a database has been established. It is increasingly being used by public authorities, in the absence of anything more comprehensive.

Out of the four regions the residential and commercial data sets in the US were the closest together with a difference of 0.06. The commercial and public stock has the strongest data compared to the residential data in all the parameters except three. Eleven out of the fifteen parameters (for both commercial and public and residential buildings) have a weighting of 3.6 – 5, meaning that in general the US building data are available and often the source is trusted – the source is taken from an official or accurate place (in this case most of data are taken from official energy statistics retrieved from the from the US Government - the EIA).

Understanding the Differences in Data Quality

Collecting data in multiple regions with different cultures, languages and political contexts is complex. Regions vary in their laws, standards, definitions and values connecting to data collection. The main reason for the data varying widely across the four regions is due to the different political approaches to data collection.

The findings of this research show that that some regions data collection methodologies are more advanced than others. Some regions have taken the first steps towards assessing data by completing specific surveys and setting up collection frameworks, for other regions collecting data is more complex. The demand for data is still low in developing countries; this makes the collection process more difficult. Some regions collect data at a national level and some at a more local level, the differences in levels of create further difficulty in having consistency.

Main recommendations for better data collection practices

The GBPN has a group of international experts working in the field of building sector energy efficiency. Thirty of GBPN's experts in the field of building energy data contributed to the survey on data sources, availability and quality.

The survey provided a valuable opportunity to gather expert opinion on how to improve data quality and collection around the world, and more specifically, in the GBPN's four key regions. As well as allowing for a more comprehensive understanding of how we can collaboratively improve data, there were a number of recurring recommendations that became obvious when analysing the advice from the experts from all regions.

There is overwhelming emphasis on the need for a comprehensive data collection framework to ensure the consistency of data. Many experts also strongly advised that data collection definitions and guidelines should be harmonised and clarified. Repeatedly, the main themes included:

- The need for a comprehensive framework;
- The need for data collection definitions and guideline;
- A collaborative effort to share data and begin the provision of open source data;
- The need for a collection and analysis tool (comprehensive database);
- The need to make data collection mandatory;
- The need for incentives and funding; and
- A dissemination of data collection best practices and case studies.

What conclusions can be drawn from this report?

What is clear is that regionally there are large differences in data quality and that large data gaps exist, making it difficult to analyse the current state of play in each region. Substantial efforts need to be made to fill these data gaps and inaccuracies. Although data are not deemed as being accessible, it does not necessarily mean they are not available or cannot be found, for instance by local actors in this region, but it demonstrated a need for an improvement of data access for these modellers.

We must continuously advance our collection techniques to harmonise and improve access to secure building energy data, alike. There is a need to share available data more broadly. Initially, It is essential to prioritise our most pressing needs regarding the most crucial data required by modellers and policy makers.

Since no one group of experts can do everything, there is a need to work together in order to make a difference. A collaborative approach towards ensuring transparency of data must be adopted so that data collection, monitoring, reporting and evaluation leave no gaps and produce accurate and reliable data. Data collection should be harmonised so that national and regional data collection systems relating to the energy performance of buildings are consistent.

The GBPN calls for a collaborative effort in harmonising definitions and measurement templates concerning the energy performance of buildings. Furthermore, the GBPN recommends the establishment of a database that includes all energy-performance building data and the diverse requirements of the building stakeholders.

INTRODUCTION

Context

Confronted by a changing climate, countries around the world are seeking effective ways of reducing their greenhouse gas (GHG) emissions. If the current GHG emission reduction targets set by policy makers are to be met, it is a necessary prerequisite that the building sector's emissions are tackled vigorously and comprehensively.

As buildings account for around a third of the global final energy use and 30 per cent of global energy-related carbon emissions, it is clear that this sector has the potential to bestow huge energy savings (Urge-Vorsatz et al., 2012, p. 3). It is estimated that by 2050, if today's current policy trends are followed, energy use from buildings will more than double (Urge-Vorsatz, ibid., p. 62). Therefore, in order to avoid the worst-case scenarios of climate change, it is essential to reduce our GHG emissions by 50% by 2050 and 25% by 2020 (UNEP-SBCI, 2009).

China, the European Union (EU), India and the United States (US) collectively represent around 65% of global final building energy use in 2005 (Urge-Vorsatz et al., 2012, pp 3). GBPN has chosen to significantly reduce GHG emissions associated with building energy use in these four priority regions. GBPN facilitates this action through regional hubs and partners in these regions: China Partner - the China Sustainable Energy Program (CSEP); Europe Hub - Buildings Performance Institute Europe (BPIE); India Partner - Shakti Sustainable Energy Foundation's Building Program (SHAKTI); and the US Hub - Institute for Market Transformation (IMT).

By 2050, the global floor area is expected to have increased by around 130% compared to 2005 levels and a rise in worldwide thermal comfort levels is anticipated. Despite this, it is still possible to reduce global building final energy use by one third compared to 2005 (by 34% for space heating and cooling and 29% for water heating) (Urge-Vorsatz et al., 2012 pp 62). However, this is only achievable if a "deep" scenario[3] is applied and realised. The deep scenario could be accomplished at a global level by applying today's state-of the art policies, technologies and demonstrated solutions.

The "deep" scenario means that the building sector needs to achieve much higher levels of performance. Current best practices will become standard practice and all new buildings and renovations will be of a very high energy-efficient design. The higher the performance, the more complex it becomes to design, construct or renovate a building. The focus of policy makers and building experts needs to move towards performance based building codes and more holistic approaches for improvements in existing buildings rather than improving single building elements[4].

The Importance of Data

Unless all members of the building sector can trust the data that demonstrates the achievement of these performance-based buildings, attempts to advance the building sector whilst reducing harmful GHGs will stall.

The Central European University (CEU) has made estimations on potential buildings sector energy savings in a report prepared for GBPN in 2012. However, the CEU claimed that there were deficits in the data they had used (mainly being data availability) In order to accurately identify the potential energy savings in buildings. Good data quality needs first to be measured, then improved. David Eijadi with The Weidt Group says "to do better as a community of design professionals and as a society in making energy efficient buildings, we need to know more than our current sets of data permit us to know." (NIBS, 2011).

[3] Description of the "deep" scenario can be found in Annex 1.

[4] It is still important to maintain and gradually improve minimum energy performance requirements for individual building elements for cases of partial renovation, when for example a wall is replaced, or windows or floor insulation.

To build and renovate buildings that are energy efficient and sustainable, participants in the building sector and policy makers must trust the data used to calculate potential energy savings. To gain the confidence of policy-makers, builders, architects and all building sector stakeholders, the data must be both commonly available (and storable) and credible (verifiable and transparent). Solid data cases provide known facts that can be used to influence policy development and decisions on energy efficiency at buildings level; therefore, it is essential that we find better ways of sharing data and that more transparency is reached on the basis of data collection and analysis.

Countries demonstrating examples of best practice in the implementation of energy efficiency show that there are a number of essential requirements that must be in place in order to successfully achieve GHG reductions (UNEP-SBCI, 2009). These consist of energy performance requirements, indicators and monitoring systems. Applicable data on the building sector and efficiency of buildings are needed to facilitate policies that deliver GHG emission reductions from buildings. Energy performance data allows for regions to have accurate information about their current levels of carbon emissions (and changes in these). This is essential to monitor potential reductions.

The Report

To improve building performance and standards of practice, an accurate measurement of current energy efficiency levels is crucial. The quality of data around the world varies considerably; there are large data gaps, weaknesses and inaccessibility that preclude accuracy in modelling. This report presents a unique attempt to assess the quality of data in building types in GBPN's four priority regions - China, the EU, India and the US.

This report will assess the data quality of these regions and highlight current data collection best practices and data gaps. The main aim is to identify the omissions in the data that prevent the modelling and estimation of energy efficiency potentials in buildings based on how this is seen by modellers. Strategies for overcoming these gaps are provided through advice and opinions from international experts.

This report attempts to discover what we know and what we can do to ensure better data quality, availability and accuracy for future modellers and policy-makers. It recommends better collection and collaboration of data. The findings of the report have been produced based on present monitoring research and expert advice.

METHODOLOGY

The aim of this project was to provide insight into data issues relating to the energy performance of buildings in China, the EU, India and the US. The information and data gathered for this report was sourced directly from experts and modellers from the four GBPN regions. For this, a data collection matrix (Figure 3.1) was developed by GBPN and sent out to modellers and experts in the four regions.

In order to provide recommendations as to how data collection and data quality can be improved in each of the regions a survey was designed by GBPN and conducted by GBPN's hubs, partners, data experts, and data modellers. The survey was designed to uncover both general global issues and specific regional issues in data collection. The findings of the survey formed the basis for the research findings and recommendations of the report.

A small expert reference group has been convened for this project, which includes members of the GBPN Network (both the Hubs and Partners – BPIE, CEPT, IMT and Shaktiº. The project also includes input from other organisations that are involved in modelling; this special reference group included the IEA, UNEP, WBCSD, Big EE, CEU, ACEEE, and ECEEE.

Phase One: The Data Collection Matrix

The data quality was gathered in the form of a matrix whose structure comprised of building types down the left hand column and performance data inputs along the top row. Initially a concentrated group experts reviewed the suggested parameters that were to be included in the matrix – the building types and energy performance building characteristics. They provided advice upon which characteristics they deemed were necessary when collecting and modelling data related to building performance. The matrix was then refined through multiple interactions and sent out to the group of experts.[5]

The experts were asked to complete the matrix based on their experience in the region. They filled in each field with a quality rating (between 0 – 5) that represents the accuracy of the data for the specific building type (left had row) and energy performance parameter (top column). The findings of each matrix were cross-compared to present the data quality of each parameter in each region.

The data quality matrix was designed to recognise how accurate and available the building performance data and other necessary parameters[6] are in each region. This exercise was undertaken using a team of experts in each region and also global modellers (each region's matrix was completed by at least two separate sources, a global and a regional source).

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[5] Find list of experts who filled in the matrix in the acknowledgements section.

[6] Also included in the matrix were other necessary inputs that are needed when modelling building energy performance and future trends.

MATRIX TEMPLATE		General	Existing Building:	Floor Area (m^2)	Number of Buildings	Energy Consumption: per floor area (kWh/m^2.year)	Heating	Cooling	Hot Water	Lighting / Appliances	Age Profile	Retrofit Rates	Urban / Rural Buildings Split	New Construction:	Energy Consumption: (kWh/m^2)	Yearly Construction (m^2)	New and Existing Buildings	Fuel Mix	Ownership (Private /Public)	Owned / Rented / Leased
Residential Buildings																				
	Single family houses																			
	Multi-Family Houses																			
	Other Residential Buildings																			
Commercial and Public Buildings																				
	Public Authorities Buildings																			
	Social Housing																			
	Offices																			
	Educational Buildings																			
	Health Facilities																			
	Restaurants																			
	Hotels																			
	Sport Facilities																			
	Shops / Trade Service																			
	Warehouse and Retail																			
	Other																			

Figure 3.1. Data Collection Matrix Template

Terms and Definitions of the Matrix

The modellers and experts were asked to weight each field of the matrix between zero and five the latter indicating that the data are most reliable. Table 3.1 shows the descriptions of the weightings.

Table 3.1. Weighting: Accuracy Descriptions.

Weighting	To what degree is the data that you have used accurate?
5	Data source accurate and fully reliable - official verified document or more than one independent source giving similar information.
4	Good, trusted data source i.e. an official document
3	Data generally available, but from mixed sources
2	Partial Data - data available not very accurate
1	Weak Data - little available data / not accurate
0	No Evidence - guess

These weightings were divided into four groups that were used to determine whether a given weighing was considered as accurate. The accuracy groups were created to abridge the data into necessary divisions. Most data points were averaged from many fields, giving numbers with decimal points. GBPN decided to create four different accuracy groups, thus the decimal number can fall into a specific group. The five weighting were divided into four accuracy groups, see Table 3.2.

Table 3.2. Weighting Accuracy Groups

Weighting Category	Accuracy Group
3.75 - 5.0	Reliable data
2.5 – 3.74	Data available with minor uncertainty
1.25 – 2.49	Partial Data with major uncertainty
0 – 1.24	Uncertain data

The top right row in the table below represented the performance information that the GBPN sought to explore; Table 3.3 describes the considered categories.

Table 3.3. Parameters Used to Assess Quality of Building Performance Data

To what degree is the data that you have used for ... (see below) ...accurate?	Give weighting of 0 - 5 for each section depending on the accuracy of data (unless all section has the same weighting, see "General")
General	If all the data for one of the building types has the same weighting - only fill the score into this box.
Existing Buildings:	(Below regards to the existing building stock)
Gross Floor Area (m^2)	To what accuracy is the total floor area inside the building's envelope known?
Net Floor Area (m^2)	To what accuracy is the total usable floor area in a building, measured to the inside of the enclosing walls known?
Number of Buildings	Is the number of buildings known in the area / region / country?
Energy Consumption: per gross floor area (kWh/m^2.year)	Depending on what type of consumption is commonly used in the country / region. What is the accuracy of consumption data?
Energy Consumption: per net floor area (kWh/m^2.year)	Depending on what type of consumption is commonly used in the country / region. What is the accuracy of consumption data?
Heating	To what accuracy is the data on final energy use for heating?
Cooling	To what accuracy is the data on final energy use for cooling?
Ventilation	To what accuracy is the data on final energy use for ventilation?

Hot Water	To what accuracy is the data on final energy use for hot water consumption? (Either per person or per litres)
Lighting / Appliances	To what accuracy is the data on final energy use for lighting and appliances?
Can you split the Age Profile into separate groups?	Is it possible to split the share of buildings into separate age categories? Split in to Age Profiles, if you have the data for 8 categories give this section a 5, if you have data for 4 categories give this section a 3, if you cannot split the current buildings into age profiles give this a 0.
Retrofit Rates (%)	The measures of how many buildings per year are retrofitted in your area - how accurate are your data on retrofit rates?
Demolition Rates (%)	The measure of how many buildings are demolished per year in your area - how accurate is your data on demolition rates?
% of Building that have been improved	The % of buildings that have been renovated / retrofitted to be more energy efficient - how accurate are the data on improved buildings?
% Of Urban / Rural Buildings	The % of the share of urban and rural buildings
Urbanisation Rate (% growth)	How many people move to urban areas per year - how accurate is the?
New Construction:	(Below regards to new construction)
Energy Consumption: per gross floor area (kWh/m².year)	Depending on what type of consumption is commonly used in the country / region. What is the accuracy of consumption data?
Energy Consumption: per net floor area (kWh/m².year)	Depending on what type of consumption is commonly used in the country / region. What is the accuracy of consumption data?
Yearly Construction (m²)	How accurate is the data on the amount of floor space of new construction per year?
New and Existing Buildings	(Below regards to new construction and existing buildings)
Fuel Mix	To what accuracy is the fuel mixture known in your region?
Ownership (Private /Public)	How accurate is the data on who owns the property? (This will have a bearing on the rate of renovations and depth of energy savings)
Tenure	How accurate is the data source that allows you to know whether the building type is owned / rented or leased?

The left hand column of the matrix lists different building types divided into two categories: Residential and Commercial Buildings. The two categories were broken down further into more detailed types of building, seen in Table 3.4.

Table 3.4. Building Types Used to Assess Data Quality of Buildings in Four Regions.

Building Type	Building Description
Residential Buildings	Average result of residential buildings below
Single family houses	E.g. Detached / semi-detached or terraced house
Multi-Family Houses	Apartment blocks, Accommodating several households typically ranging from 2-15 although in some cases 20-30 units
Other Residential Buildings	Holiday house, second house
Commercial and Public Buildings	Average result of commercial and public buildings below
Public Authorities Buildings	National Government Buildings, agencies and local authorities buildings
Social Housing	Public property or other form to be specified if the case
Offices	Offices in private companies and offices in all state, municipal and other administrative buildings, post-offices
Educational Buildings	Primary and secondary schools, high schools and universities, research laboratories, professional training and others
Health Facilities	Public and private hospitals, medical care, homes for handicapped, day nursery and others
Restaurants	Hotels, restaurants, pubs and cafes, canteens or cafeterias in businesses, catering and others. These may occupy the ground level of another type of building, this position should be clarified
Hotels	Hotels, Hostels, etc.
Sport Facilities	Gyms, Sport Halls
Shops / Trade Service	Detached shops, shopping centres, department stores, small retail, food and non-food shops, bakeries, car sales and maintenance, hairdressers, laundry, service stations, fair and congress buildings.
Warehouse and Retail	Warehouses, transportation and garage buildings, agricultural (farms, greenhouses) buildings, garden buildings
Other	i.e. industrial buildings

Phase Two: Improving Data Collection

A survey designed by GBPN was disseminated to a specific group of thirty experts specialising in building performance data. The survey consisted of some general data improvement questions and some specific questions that related to the global and regional trends of the matrix. The survey enabled discussions of possible improvements with the experts and was designed so that the expert responses produced recommendations for improving data collection and quality in the GBPN four regions and globally.

Question 1 asked the experts where they worked, thus enabling analysis of regions separately and together, thereby building a clear picture of the future steps that would make improvements in data collection possible. The following questions were asked:

1. How can we improve data availability?
2. Results show that the data on the split of Energy Consumption (Heating, Cooling, Ventilation, Lighting and Appliances) is not readily available. What can be done to change this?
3. How can we ensure better collaboration and the sharing of existing data?
4. What are the major barriers to the collection of building performance data?
5. What can GBPN do to improve data collection?

DATA FINDINGS OF THE DATA COLLECTION MATRIX

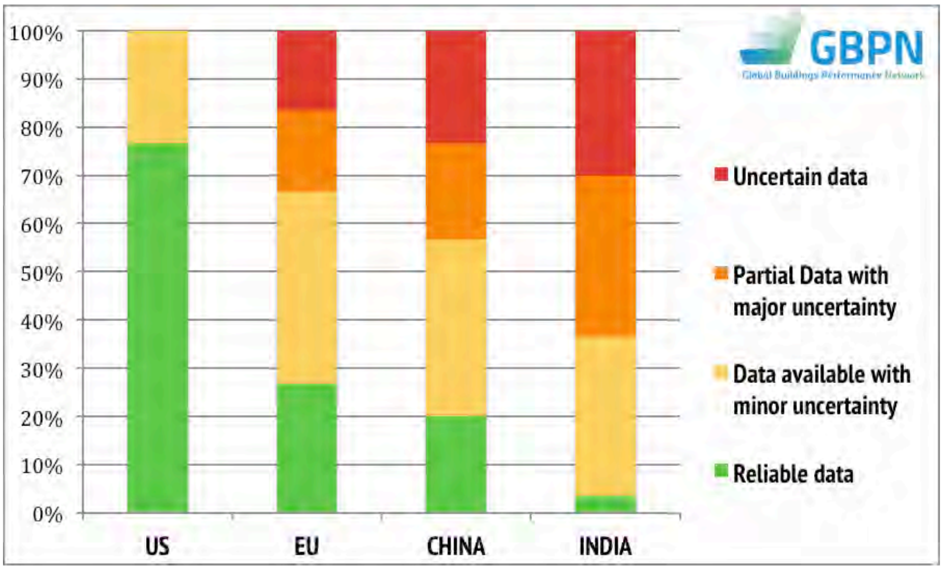
These results provide an up-to-date picture of where the four regions stand in terms of their buildings performance data. There are many gaps or weaknesses in existing building data, this chapter analyses the data quality in each of the four regions – China, the EU, India and the US. The data quality matrices of the four regions give an accurate idea of how strong or weak the current data quality is. The quality of data varies significantly between regions although there are some recurring trends that will be discussed.

General Data Quality

Below is a graph (Figure 4.1) that demonstrates the results from the matrices, showing the accuracy of building data in each region. "Reliable" data implies that the data are from an accurate source, i.e. an official document or website, "average" data implies that there was an available source yet this was fully reliable, "weak" data implies that there was either no data available or the data was not reliable.

Results were calculated using the accuracy groups as guidelines, see table 3.2 in the methodology section. The results show that the US was found to have the highest percentage of "reliable" data points with almost 80% of their data falling in the "reliable" category. It was found that the EU had the second best set of data, the majority of the data was found to fall in the top two categories, almost 30% of the data was deemed as reliable and more than 30% of the data was seen to be available with minor uncertainties. Data in China varied; just over half of the data was found in the top two accuracy categories, the majority of these were found in the "available with minor uncertainties" category. Finally, India was found to have around 5% of their total data being deemed as reliable while the majority, around 40%, was regarded as being either having "major uncertainties"[7].

Although the figure may seem transparent, there are several problems with this initial quality assessment. Firstly, the experts from different regions may have assessed data in their region differently to other experts from other regions; also global organisations may be bias in some regions. These uncertainties were overcome by ensuring that a global modeller assessed all regions, these results were compared with the regional responses[8].



4.1. Data Quality Comparison Of The Four GBPN Regions.

[7] Please see Appendix 2 for the full colour coded matrix.
[8] Please see limitations section for more details.

Key Trends in Four Regions:

Analysis was undertaken on the relative quality of the individual data parameters as an average of the four regions. Figure 4.2 ranks the parameters according to quality.

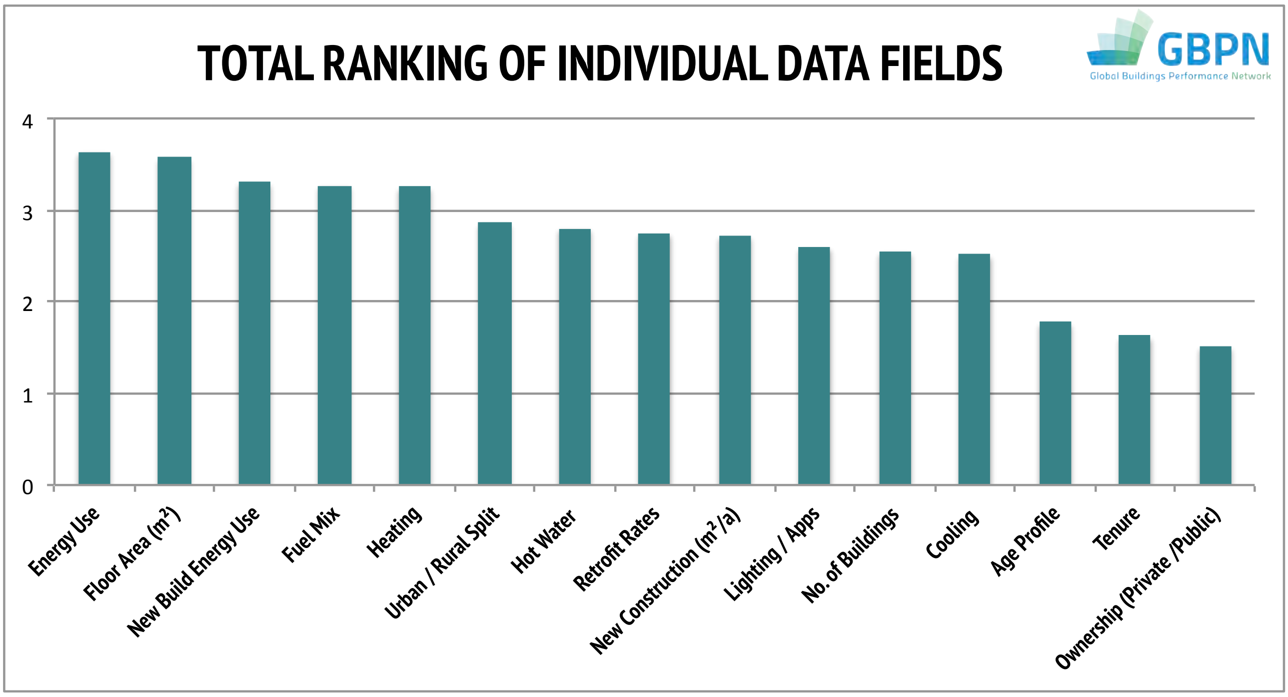


Figure 4.2. Ranked Scores for Individual Data Fields.

Overall, the highest quality data were found to be (ranked in order from strongest to weakest parameters):

- Existing building energy use
- Floor area
- New building energy use
- Fuel mix
- Energy Use for Space Heating.

The major data gaps in all the regions were found to be (ranked in order from weakest to strongest parameters):

- The individual divisions of energy consumption (heating, cooling, ventilation, water, lighting / appliances)
- Ownership (Private / Public)
- Tenure
- Age profile
- Cooling
- Number of buildings.

At a first glance, the categories where major gaps were found in all four regions seem to be more difficult to measure compared to those that were found to have the better data quality. The parameters where there are major gaps found are more complex to measure and the data collection process would be more complicated.

Comparing the Regions

The graphed data quality "spider webs" below (Figures 4.3 and 4.4) show the data quality of the four GBPN regions with the different requested parameters (please find the matrix with these weightings in Annex 2). The US has the best data quality for most of the parameters (these data are supported by EIA Energy Consumption Surveys (EIA, 2013)), followed by the EU, China and India.

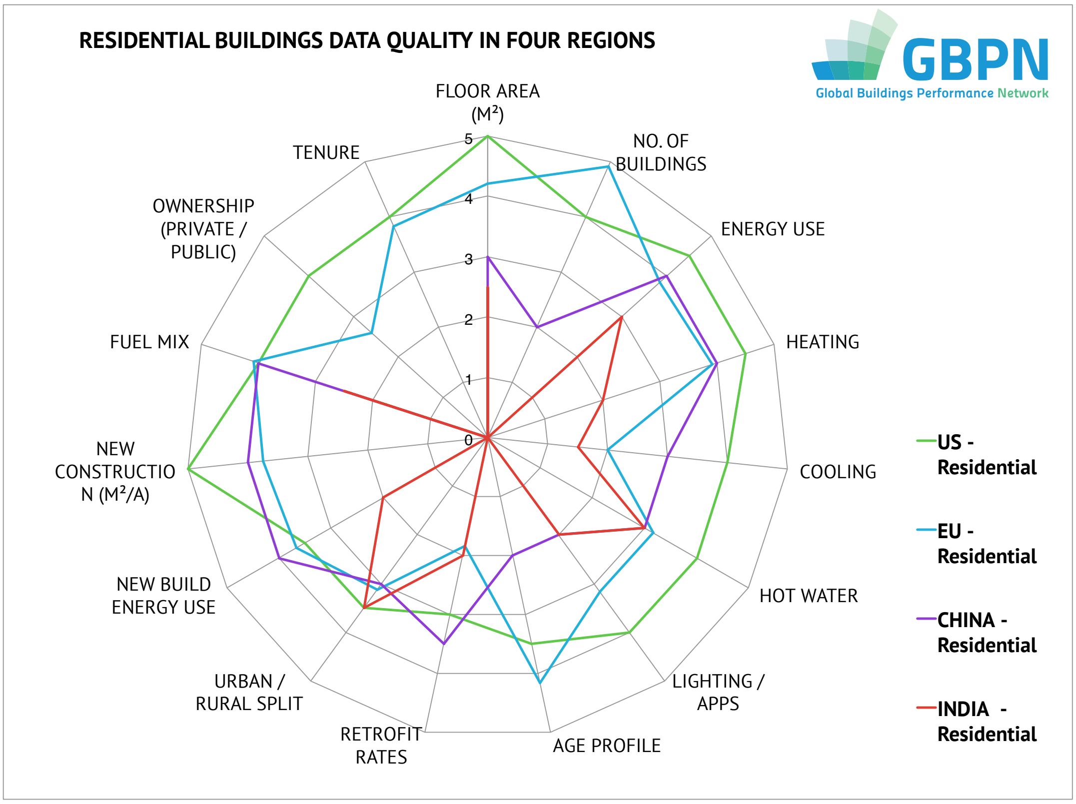


Figure 4.3. Data Quality of Four GBPN Regions Regarding Residential Buildings

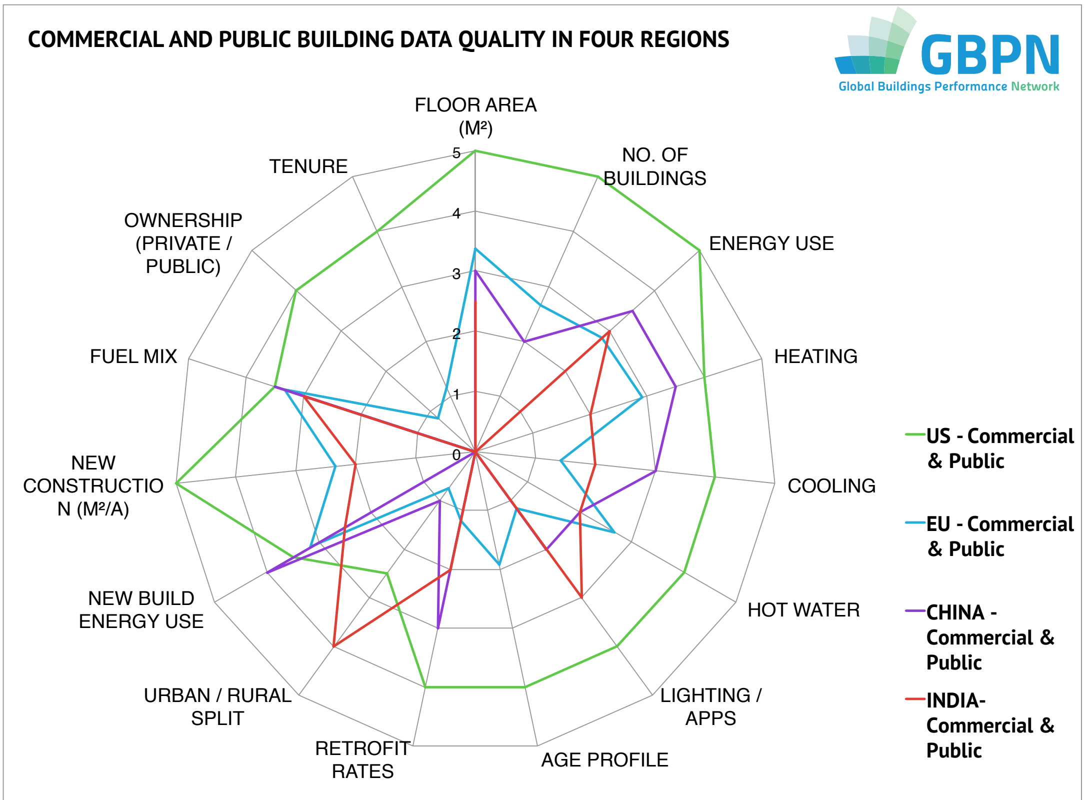


Figure 4.4. Data Quality of Four GBPN Regions Regarding Commercial & Public Buildings.

At a first glance it is clear that there are not enough available data in all four areas. It is also clear that the quality of data differ vastly across the regions. Overall on average the residential stock scored a rating of 0.5 higher than the commercial building stock. When comparing the two graphs the commercial graph presents more data gaps than the residential.

Residential and commercial gaps are not always found in the same parameters. In the residential building sector the paramenters where data gaps are commonly found across the regions are:

- Ownership
- Cooling
- Retrofit rates

The commercial and public sector has more data gaps commonly found across the regions (seven out of fifteen), they are found in these parameters:

- Ownership
- Cooling
- Tenure
- New Construction
- Age Profile
- Hot Water
- No. of buildings

Data gaps commonly found in both the residential and commercial sectors are: Ownership & Cooling.

Key Findings in Four Regions:

- Experts and modellers from the US, the EU and China provided accurate sources for most of the parameters in the residential building stock.
- India was found to have accountable data for one out of the fifteen fields: Urban / Rural.
- The EU and China's residential data scored higher than commercial.
- The US and India's commercial building stock were found to have higher quality data than the residential.
- The biggest difference between the quality of residential and commercial buildings is found in the EU; with a difference in weighting of around 2.
- Out of the four regions the assessment of residential and commercial data sets were the closest together in the US, with a difference in weighting of only 0.06.

Understanding the Differences in Data Quality

Collecting data in multiple regions with different cultures, languages and political contexts is complex. Regions vary in their laws, norms, definitions and values connecting to data collection. The main reason for the data varying widely across the four regions is due to the different political approaches to data collection.

The findings of this research show that that data collection methodologies vary from zone to zone. Some regions have taken the first steps towards data analysis through setting up collection frameworks and making surveys, while other are less advanced. The demand for data is low in developing countries, leading to challenges in obtaining reliable data. Regions also differ as to national or local data collection with resulting inconsistencies.

Regional Findings

The "Data Quality" graph displays the average weighting of data shown as a score between 1-5 for each region. The Figure 4.5 illustrates how accurate the data are and where the data gaps are. The blue area represents the residential buildings stock and the yellow area commercial and public.

No region could be considered as having exceptional data as there were significant gaps and weakness in each region's data set, even after allowing for fields that were not actively investigated by the modellers and experts to be discounted. The graph below demonstrates how different the data qualities of the four regions are. Figure 4.5 below demonstrates the difference of the data qualities in the four regions.

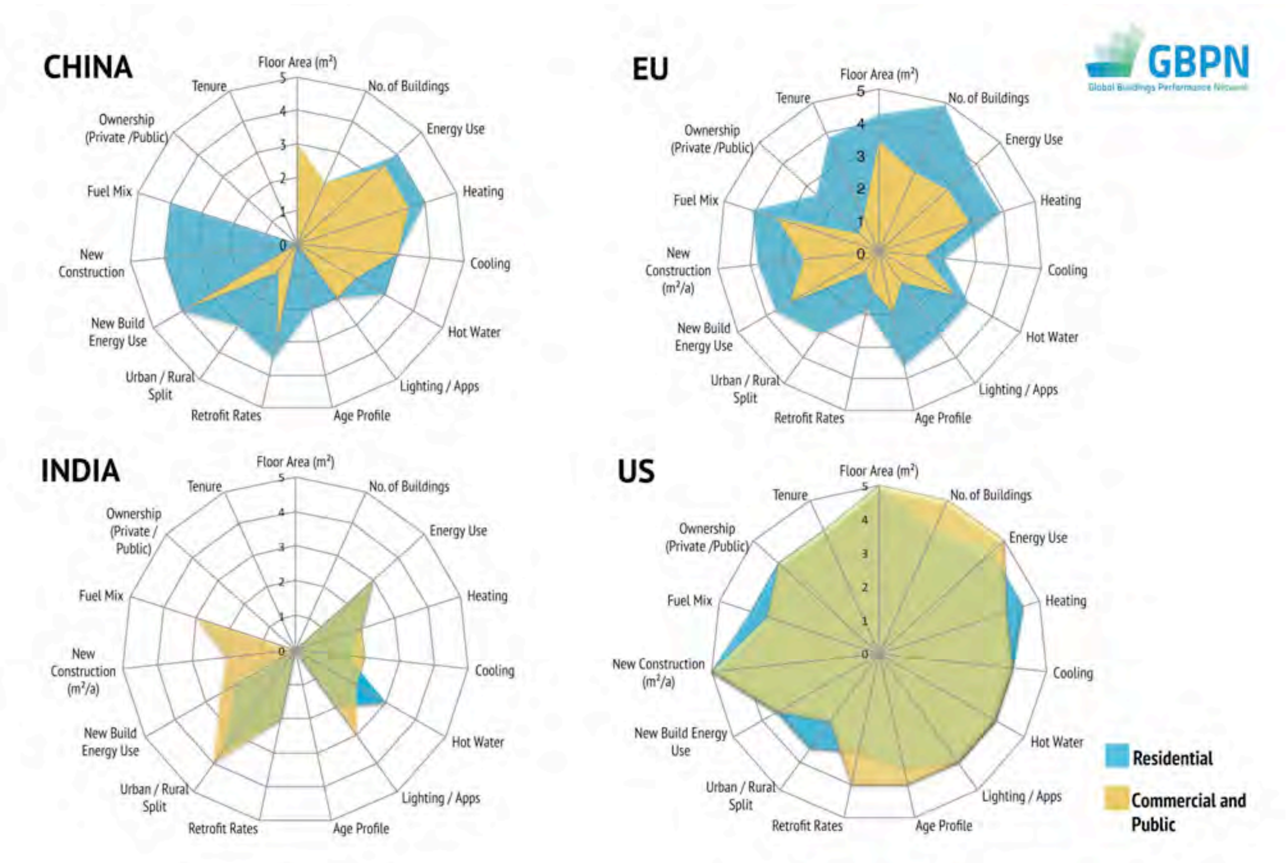


Figure 4.5. Residential vs. Commercial Data Quality in GBPN's Four Priority Regions

China's Data Quality

The residential building data in China are found to be on average 0.75 times higher than the commercial and public data. China's building performance data averages at around 2.5, which implies that there are either partial or available data but they are not always reliable.

It is necessary to point out that there are some barriers that may reduce the accuracy of the Chinese data sources. Firstly, China tends to measure building performance parameters as a whole (residential and commercial buildings together), these tend to have stronger data than that of specific building types. Secondly, a language barrier may weaken the interpretation of Chinese data given that data may be available, just not accessible to those who cannot read Mandarin.

Data reliability of the Chinese building stock **as a whole set** has a much stronger weighting score (in certain categories) as compared to the data available that is split between building type.

Figure 4.6 presents China's building performance data; from this is it clear that, many modellers at present do not have a full set of data on China. Data gaps are particularly prominent in the areas of:

- Tenure
- Ownership
- No. Of buildings
- Age profile

Parameters where both the residential and commercial and public building data were deemed as being the most reliable in China:

- Existing Building Energy Use
- Heating
- New Building Energy Use

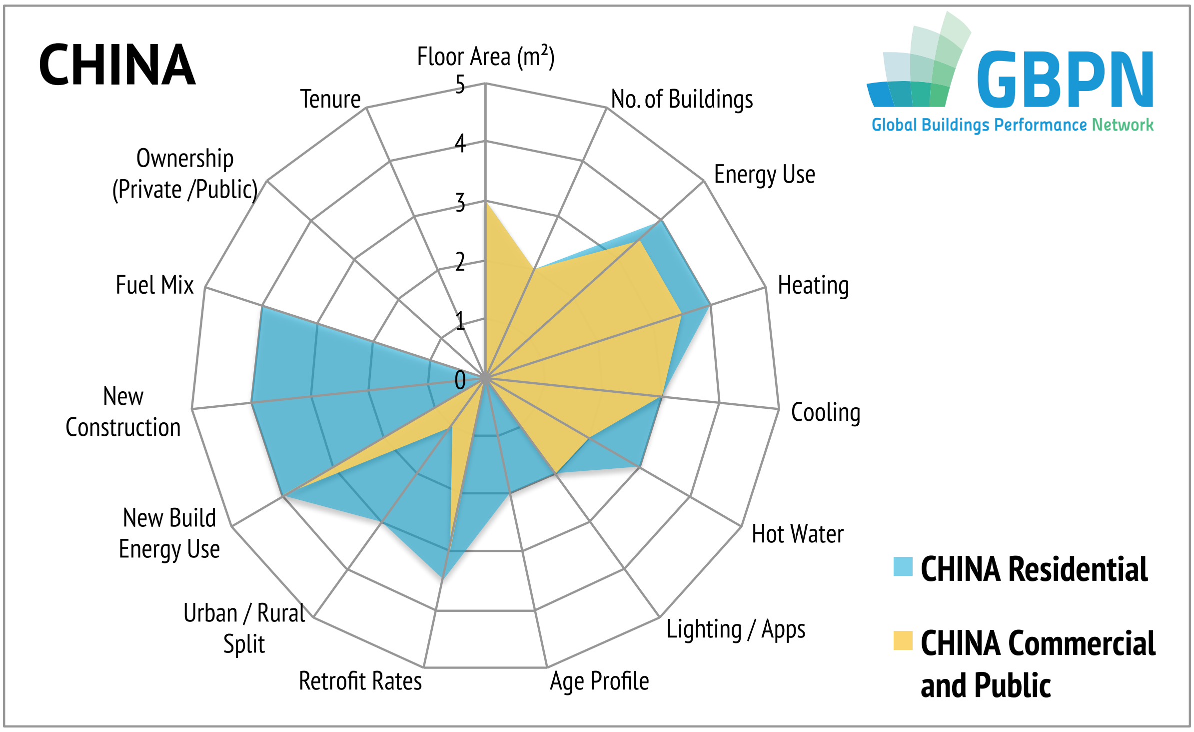


Figure 4.6. Comparison of Data Quality for Commercial and Residential Buildings in China.

The yellow area (commercial and public) has the lower scoring data compared to the residential data in all the parameters except for seven that are equal. Five out of the fifteen parameters for the residential data are assessed between 3.75 and 5, meaning that on general a third of the data are deemed as being from a reliable and trustworthy source.

The commercial and public building data have only one of the parameters that fall into the “accurate / reliable” weighting category. This means that the majority of this data can be weighted as being unreliable, being neither accurate nor even available.

Setting the Scene in China: Data Collection & Sources

When reporting building energy data, China uses a different classification scheme compared to OECD countries. Generally, buildings are classified as either civil or industrial, civil buildings are then classified as either residential or public. Commercial buildings are listed as a category within public buildings (Huang, 2010). This sets China apart from the other three GBPN regions.

Most of the Chinese data come from the Ministry of Housing and Urban-Rural Development (MOHURD). MOHURD are responsible for drafting policies, laws, and development plans related to the building industry, construction and municipal works.

In order to better understand the energy use characteristics of the Chinese civil building sector MOHURD initiated a survey in 2007 focused on 23 cities that consisted of nine statistical indicators: building name, building area, number of floors, building type, building function, completion time, types of energy consumed (e.g. electricity, coal and natural gas, plus various other information concerning building energy consumption), and types of heating and cooling systems. In 2007, these data were published as the “Statistical Report System on the Civil Public Building Energy Consumption” (Bin & Jun, 2012).

Since 1986, MOHURD have published a China Energy Statistic Yearbook (annually since 2004) that contains data describing national energy infrastructure development, energy production and consumption, and the balance of energy supply and demand (Bin & Jun, 2012). It serves as a data resource, and although it does not contain specific data related to building energy consumption, it does include data related to individual buildings and the construction sector, such as floor area, urbanisation rate, year of construction and ownership. The National Bureau of Statistics of China also publish a broader annual “China Statistical Yearbook” that includes other data such as statistics on the building stock. It represents the economic and social development of China (NBSC, 2013).

Other building performance data have been gathered by surveys mainly carried out by students, such as Tsinghua University who publish an annual report on building energy use in China, as of 2007 (Yu, 2013). This data were weighted as inaccurate or to some extend uncertain, as it has not been verified by official or independent sources.

Although there is a data collection framework set up in China it does not cover all areas concerning building performance data and hence, there are data gaps and weaknesses. The areas covered are very vague and normally statistics are given for the building sector as a whole. This is deemed, by the China Greentech Initiative, as a challenge to green building design and for energy simulation modelling. Another barrier that limits access to building performance data is the lack of monitoring of green buildings (Hove, Stover, et al., 2012).

Why is building performance data so important in China?

- China has a market that is swiftly urbanising; in one year (2010) there was more new housing built in China than that of the entire residential building stock of Spain (EIU & GBPN, 2012).
- In the years to come up to 2020, most of China’s building stock will be constructed.
- If sufficient political actions were put in to place now the collection of data of these new builds would become a standard process that can support better building performance.

European Union's Data Quality

Unlike the US, the EU does not have an overall[9] assessment of data on the building sector as a whole region; therefore the 27 Member States were all weighted by an external data expert and placed in ascending order from strongest to weakest[10]. An average of the 27 Member States was calculated. The EU results are taken from an average of six of the 27 Member States – two countries were deemed to be below the EU average, two represent the average EU weighting and two countries deemed as being above the EU average. The Member States selected were chosen based on two criteria:

- Geographical coverage (Northern, Western, Central & East, Mediterranean Europe)
- Diversity in the data quality level (i.e. above average, average and below average)

Based on these criteria the Member States chosen were Austria, Germany, Poland, Spain, Sweden and the United Kingdom.

The findings of the analysis showed the data quality for both residential and commercial and public buildings in the EU being lower than the US. It can be seen that in all instances, information in the residential sector is deemed to be of a higher quality than of the non-residential sector (Figure 4.7). This is particularly pronounced in the areas of:

- Tenure
- Urban/Rural split
- Age Profile

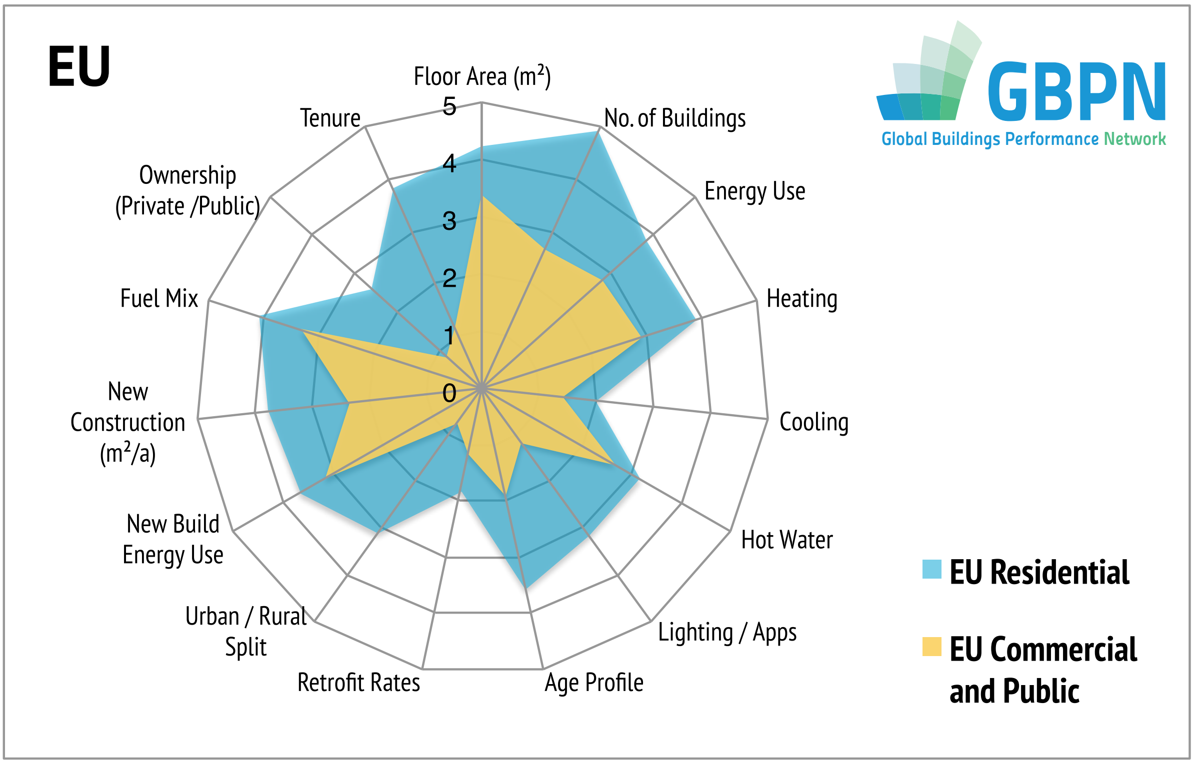


Figure 4.7. Comparison of Data Quality for Commercial and Residential Buildings in the EU.

The yellow area (commercial and public) has the lower scoring data compared to the residential data in all the parameters. Nine out of the fifteen parameters of residential buildings were found in the reliable category therefore, the majority of residential buildings are deemed as accurate with reliable sources available.

[9] BPIE, GBPN's EU Hub has been developing a comprehensive database for EU building performance, this is the first time in Europe such a database has been established. Public authorities are increasingly using it, in the absence of anything more comprehensive.

[10] See Appendix 3 for EU-27 Member States data quality score spreadsheet – the 6 countries shaded in grey were used to calculate the EU average.

As an average, the commercial and public building stock in the EU have no data that falls into the "reliable" weighting category, as no data are were weighted between 3.5 – 5. Four parameters were deemed as having available data, six as having data with uncertainties and four as being uncertain. Thus implying that the majority of data on commercial and public buildings in the EU not reliable.

Setting the Scene in the EU: Data Collection & Sources

The European Commission's (EC) recast of the Energy Performance of Buildings Directive (2010/31/EC) required for EU Member States to implement Energy Performance Certificates (EPC) (BPIE, 2010). The implementation of EPC schemes is key instruments supporting energy efficiency improvements in buildings across Europe. EPCs are required to include information on the energy performance of a building whenever the property is built, sold or rented and should be displayed somewhere in the property.

Although all the 27-EU Member States have functional EPC schemes in place, data from the EPC's are not routinely collated in all MS. A key factor that determines the data quality of the EU is the lack of information on the building sector as a whole - the EU Member States have individual approaches to monitoring building performance data and implementing the EPC schemes.

In relation to the Energy Efficiency Directive (EED) (2012/27/EU) the EU Member States must collect data related to energy efficiency and report them to European Commission. These demands from the EU could in turn lead to better data collection in the EU as a whole. The Member States' "National Energy Efficiency Action Plans" (NEEAP) should also lead to better data quality in the EU, they are to be prepared to comply with the EED. The EED outlines a framework of policies and measures that will help to realise savings potentials. These action plans should also lead to a more consistent set of data from the separate EU Member States.

Eurostat is the official statistical office of the EU whose task is to provide high quality, up-to-date statistics on Europe. Eurostat's role is to consolidate the data that is provided by Member States statistical authorities (Eurostat, 2013). They cover a vast array of general statistics on Europe. Eurostat does not cover all of the buildings performance parameters that were investigated in this report. The BPIE database is trying to compliment the statistics from Eurostat in order to have a full set of building performance data.

Finally, In order to provide solid input data to policy-makers and the building community, the BPIE, GBPN's European hub, undertook the first ever-comprehensive survey of the energy performance of buildings across 29 European countries in 2011. The survey-covered information ranging from building typology, energy use, energy performance, climatic zones, regulations and certification to information on the financial support schemes operating in each country. This information has now been made available in the first open data portal in the EU dedicated to the energy performance of buildings – www.buildingsdata.eu. Policymakers, modellers, the buildings community and indeed anyone interested in finding out more about energy use in buildings can download ready-made country factsheets, or produce tailor-made analysis and comparison across any of the parameters in the database, and then download in either PDF format or the underlying raw data as a CSV file. The tool is to be updated and expanded on an on-going basis and will serve to increase the transparency and sharing of Europe's building performance data.

The differentiating weightings of the Member States in the EU mean that some countries would have a similar data quality to that of the US while others would be significantly below the US.

For example, the best EU Member State data quality was found in France and the best US data quality was found in California.

Comparing the “spider webs” show that these places have very similar, good data quality.

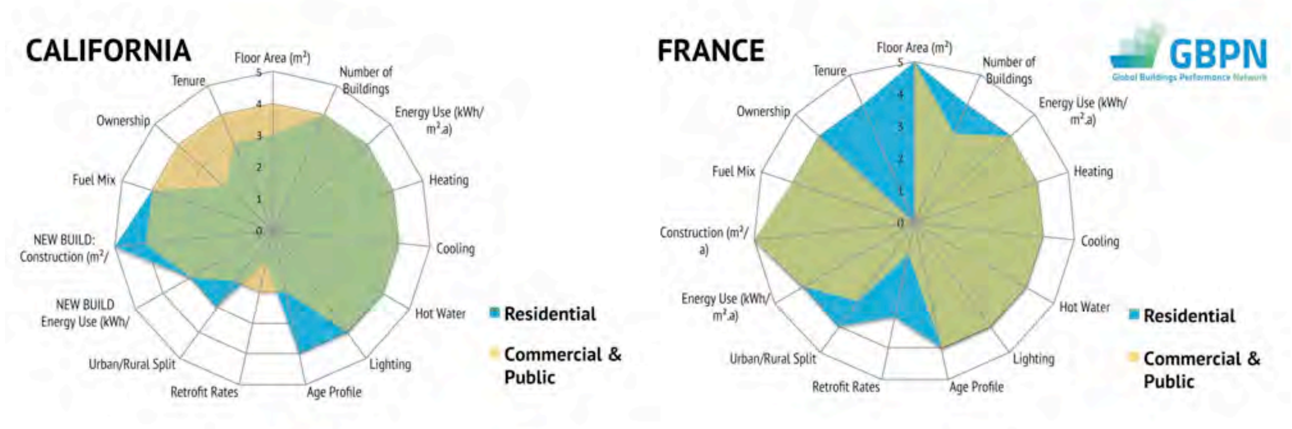


Figure: Residential vs. Commercial in Best Practice - France and California.
These are currently deemed as the 4 regions best practice data collection areas.
Please find these best practices (France and California) in Annex 4[11].

Looking at trends in all EU Member States[12]:
Highest scoring countries were found to be: France, Lithuania and The Netherlands
Most Member States fall into the AVERAGE category, with scores ranging between 2.1 and 3.5

Patterns in groups of countries from the EU:
The three smallest Member States – Cyprus, Luxembourg and Malta – all fall into the lower scoring groups. This may be a reflection of the limited resources and expertise available within these smaller populations (each under 1 million) by comparison with more populous Member state.
Another similarity in the lower scoring countries are those with warmer climates: Cyprus, Malta, Greece and Portugal – these have traditionally had less concern over the energy performance of the building stock by comparison with those in colder climates.

[11] Annex 4 shows the graphs more clearly.
[12] Annex 3 shows the finding of the data quality in all 27 EU-Member States

India's Data Quality

The response of the experts and modellers in India showed that the data used for modelling is frequently inaccessible. Although it was possible to estimate the existing residential and commercial building data to give an understanding of how energy use is split by end use, the experts weighted the accuracy of the data on average as 1.7 out of 5. This means that data are either only partly available or have large uncertainties as they come from non-verifiable sources. Commercial buildings were ranked as having more robust data than residential buildings by around 0.3 as an average. The difficulty in collecting data in India creates uncertainties in the energy performance data of buildings as well as on the building stock itself and the future development of this stock. One of the large problems in India is the large diversity and the regional states, which are at very different levels of development. Data might hence be collected at state level but not aggregated at country level, similar to the situation in Europe.

Figure 4.8 presents India's building performance data; from this is it clear that, at present, India has a very weak set of data. Only one of the parameters fell into the accurate data category, urban / rural split. The only categories regarded with an available data, scoring between 2.5-5 were:

- Floor area
- Existing building energy use
- Hot water
- Lighting / Appliances
- Urban / rural split
- Fuel mix

Only one of the above parameters were deemed as having reliable data, urban / rural split. The remaining 8 out of the 15 categories were deemed as being inaccurate or partially available with major uncertainties.

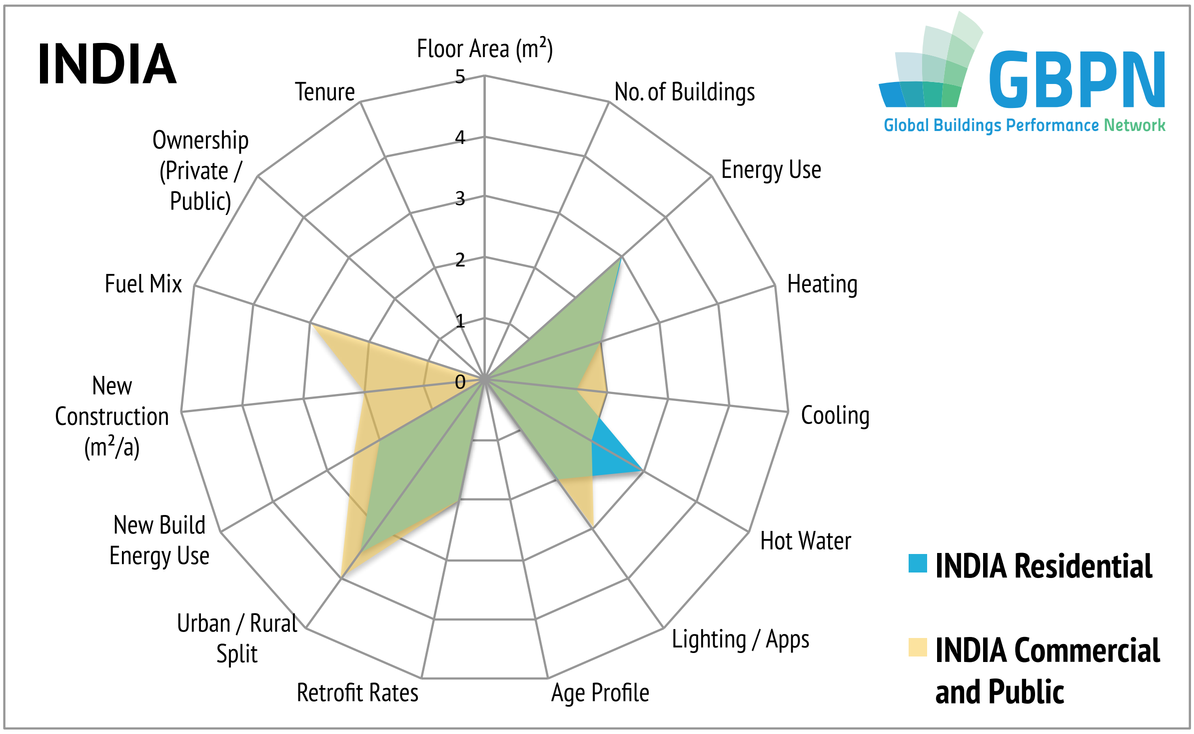


Figure 4.8. Comparison of Data Quality for Commercial and Residential Buildings in India.

The yellow area (commercial and public) has stronger data compared to the residential data in all the parameters except two that are equal and one that is higher. Only one of the parameters for both commercial and residential had accurate data, four out of the fifteen parameters from the commercial building sector have available data with a weighting of 2.5-3.4. The remaining nine parameters, meaning the majority of the data, have a weighting that deems the data either unavailable or inaccurate. The residential sector has data that are even more inaccurate. The residential sector has data that are even less valuable – around 70% of the data are rated as insufficient.

Setting the Scene in India: Data Collection & Sources

Uncertainties in India's energy future are substantial. A recent report by an American NGO, the Natural Resources Defence Council, says that energy efficiency in buildings is among the fastest, cleanest and cheapest ways to help India meet its energy needs (Vedala, Khosla, et al., 2012). Data collection can help make informed decisions to improve energy efficiency. Without this data such a development is unlikely to happen.

There is need for a significant improvement of India's data in order to, *inter alia*, accurately assesses the huge potential savings available. Data varies from region to region leaving many unfilled gaps in information and very difficult access to this information, especially for international modellers. In order to better calculate the potential energy savings in India's building stock, a clear differentiation of the different building types and energy used is required. There is also a need for data to be accessible and in some cases translated or better documented.

There is some understanding of how India's energy use is split by end use for existing residential and commercial built up space, yet there is still no formal framework set up to collect this information in India. All figures used in India's data evaluation are based on average energy use, there is no split by age as the first energy codes for buildings will soon become mandatory, therefore there is no distinction based on energy use related to the age of the property.

When looking at specific building types it is clear that larger buildings in the commercial and public sector are the most regulated sector in terms of energy performance, this links to the new building code (Energy Conservation Building Code, ECBC) that targets this part of the building sector. The new buildings section is filled out on the basis of energy data for buildings that follow this code. Since the code is still voluntary, this data does not represent all new construction per se and is only indicative.

The residential sector varies substantially, from high-rise and larger rental complexes to informal housing, temporary structures or slums. The differences in the residential building sector makes accessing and measuring the data quality even more difficult.

Some of the most common sources of data in India include:

- Indian Household Surveys – providing data on electricity use and ownership (Yu, 2013).
- USAID ECO-III Project: 'USAID India energy Assessment Guide for Commercial Buildings', USAID, New Delhi, India [Jan 2010].
- 'Reducing GHG Emissions for the Buildings Sector in India; A Strategy Paper by Environmental Design Solutions (EDS) for ClimateWorks Foundation, Environmental Design Solutions, New Delhi, India. [April 2010].
- 'Energy Conservation Building Code User Guide', Published by Bureau of Energy Efficiency, New Delhi; Developed by: USAID ECO III Project, New Delhi [April 2011].
- Construction Industry reports & Environmental Design Solutions analysis based on 'The Metamorphosis – Changing Dynamics of the Indian Realty Sector'- Cushman & Wakefield- 2008.
- Census2011, Government of India.

United States' Data Quality

The quality of US commercial and public building data scores on average 0.06 higher than residential data. The US has the strongest set of building energy data; this is supported by the Energy Information Administration's (EIA) national-level data surveys on the characteristics and energy use of commercial and residential buildings. It can be seen that with few exceptions data in the commercial and public sector is of the same or a higher quality than in the residential sector (Figure 4.9).

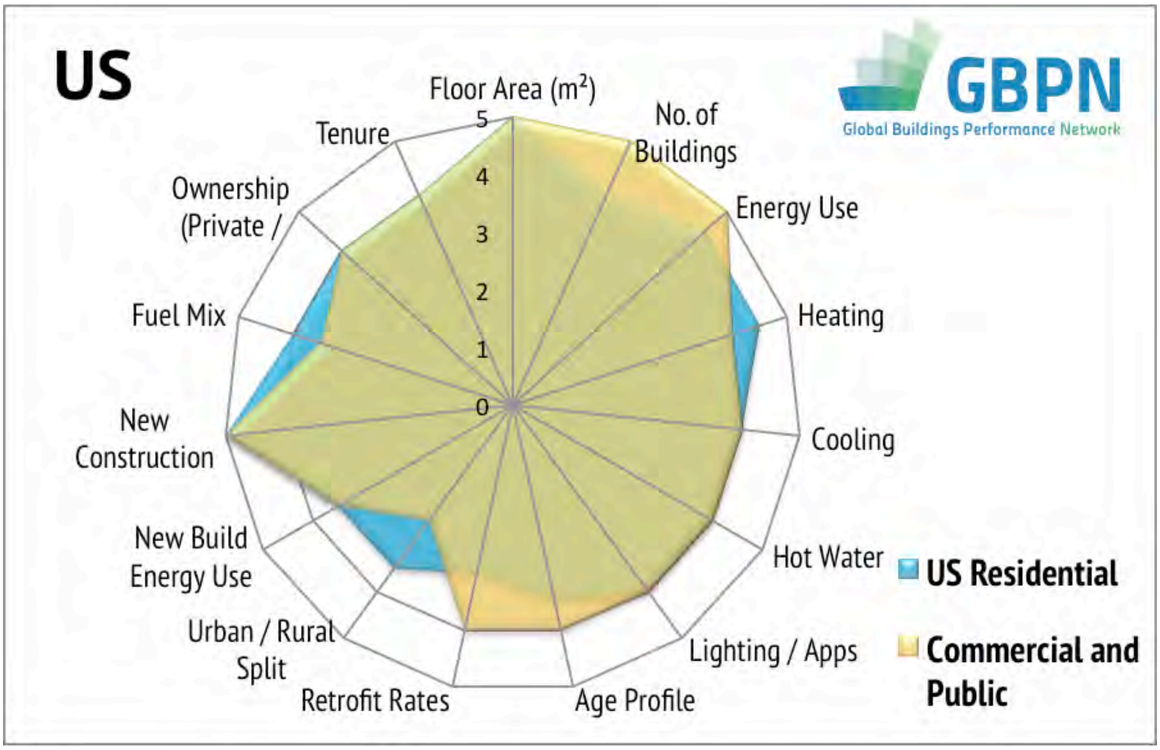


Figure 4.9. Comparison of Data Quality for Commercial and Residential Buildings in the U.S.

The yellow area (commercial and public) has the strongest data compared to the residential data in all the parameters except for three, Heating, Urban/Rural and Fuel Mix. Twelve out of the fifteen parameters in the commercial and public buildings category are considered to be reliable. Eleven out of fifteen parameters in the residential category are considered to be reliable. This means that the US building data are almost always available with a trusted or official source and deemed as being accurate.

Setting the Scene in the US: Data Collection & Sources

The EIA have separate surveys for commercial buildings: Commercial Building Energy Consumption Survey (CBECS) and residential buildings: Residential Energy Consumption Survey (RECS). These surveys are normally conducted every 3-4 years and have been in place since 1979 (Waide, Amann & Hinge, 2007). The 2007 CBECS data was withheld due to survey design issues, and the 2011 survey was briefly postponed due to federal funding cuts, meaning the latest available data is over a decade old.

The CBECS and RECS surveys are administered to a nationally representative sample of building units.

RECS: Data are calculated for the RECS survey (the latest survey conducted in 2009 used a selection of 12,083 housing units that represent the US's 113.6 million homes) by specially trained interviewers who collect energy characteristics on housing units, energy usage patterns, and household demographics. This information is combined with data from energy suppliers to these homes to estimate energy costs and usage for heating, cooling, appliances and other end uses (Hassett & Mathur, 2012).

CBECS: The CBECS survey is the national-level survey that measures energy use characteristics of commercial buildings. The survey collects data on building characteristics of between 5,000 – 7,000 buildings nation-wide (Michaels, 2008).

The US data are deemed as being the most accurate of the four regions. Although data collection varies across the different states the CBECS and RECS calculations are able to find a good representative idea of the US building stock. Most individual states would probably fall into the "average" or "poor" category (Stellberg, 2012). California would be the exception, as they have a state equivalent to CBECS/RECS called the California End Use Survey (CEUS). Please find a best practice case study on California's commercial building data collection techniques in Annex 2.

Other sources of data in the US include:

- **U.S. Annual Energy Outlook (AEO) -** The Annual Energy Outlook is an annual publication by EIA of projections for long- term energy markets. AEO supplies a comprehensive summary of "current trends in the supply of and demand for all types of energy consumed and produced by firms and households" (AEO 2012).
- **Real Estate / Construction Data - American Housing Survey (AHS)** -The AHS is a national housing survey that provides a continuous series of data on selected housing information and demographic characteristics such as; size and composition of the nation's housing inventory, vacancies, physical condition of housing units, characteristics of occupants, indicators of housing and neighbourhood quality, mortgages and other housing costs, persons eligible for and beneficiaries of assisted housing, home values, and characteristics of recent movers.
- **Reed Construction Data** is a private provider of national, regional and local construction data.
- **CoStar Group, Inc**. - is a provider of commercial real estate research and information services for property investors and sales professionals.

SURVEY FINDINGS: HOW CAN WE IMPROVE DATA QUALITY AND COLLECTION METHODOLOGIES?

The GBPN has a group of international experts working in the field of building sector energy efficiency. Thirty of GBPN's experts in the field of building energy data contributed to the survey on data sources, availability and quality. They were asked a series of questions relating to quality of data, the areas that the matrices indicated had gaps and to make general comments on how data quality and collection could be improved.

The purpose of this was to define what the experts considered to be good strategies for improving current data sets and collection methodologies and, ultimately, to arrive at a clear set of recommendations for good data collection and collaboration practices.

Survey Findings & Recommendations from the Global Data Experts

Question 1. How can we improve data availability?

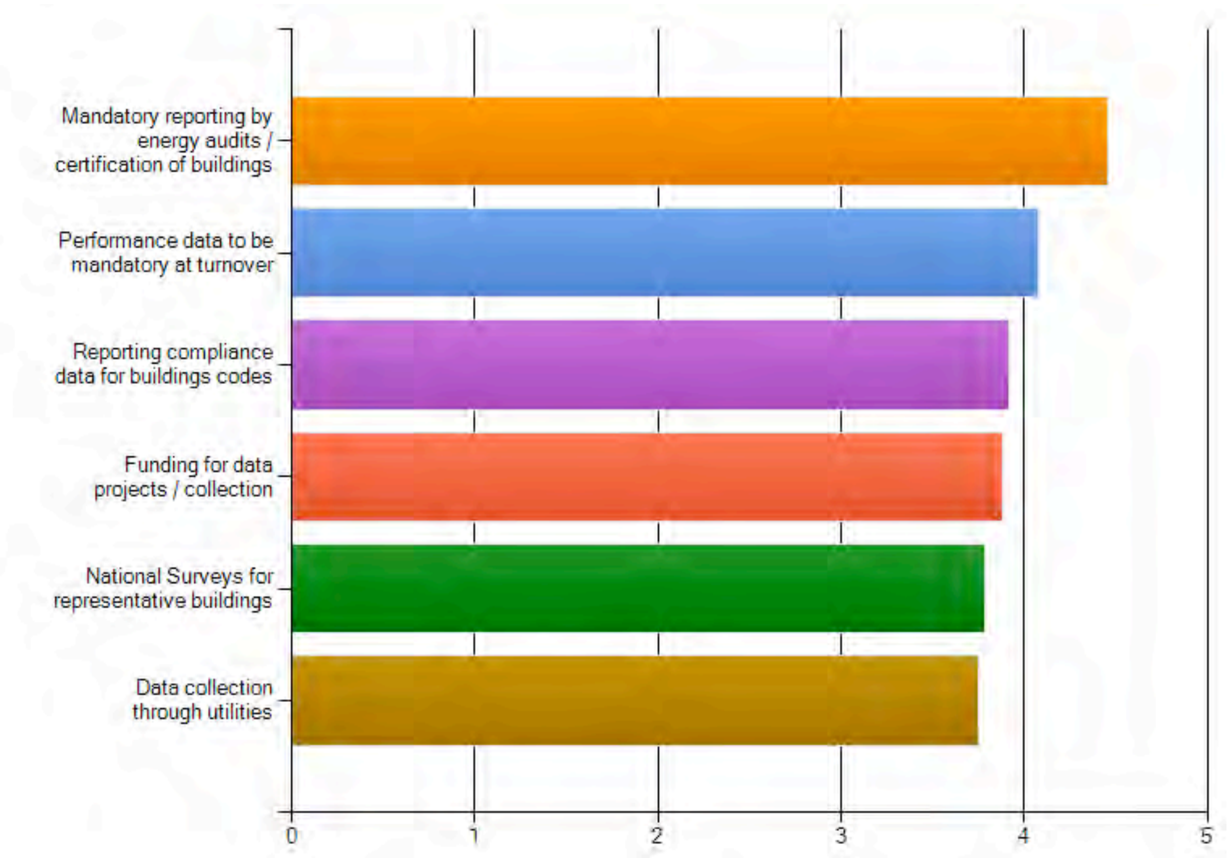


Figure 5.1. Results: Improving Data Availability (*shows the top 6 responses from all the global experts - importance weighting between 1-5, 5 being of highest importance).*

Most experts consider that the main focus area for improving data availability globally should be through the mandatory reporting of data via energy auditing and certification of buildings. The second most important factor is linked to the first in that performance data should be mandatory at turnover. The experts therefore believe that in order to make data available a mandatory requirement for data must be put in place via laws or regulation. Also linked to governing acts is the third choice that requires the reporting of the compliance with building codes. Other scenarios that would enable good data availability are:

- Funding for data projects;
- National surveys; and
- Data collection through utilities.

Question 2. What can be done to improve the data on the split of Energy Consumption (Heating, Cooling, Ventilation, Lighting and Appliances)?

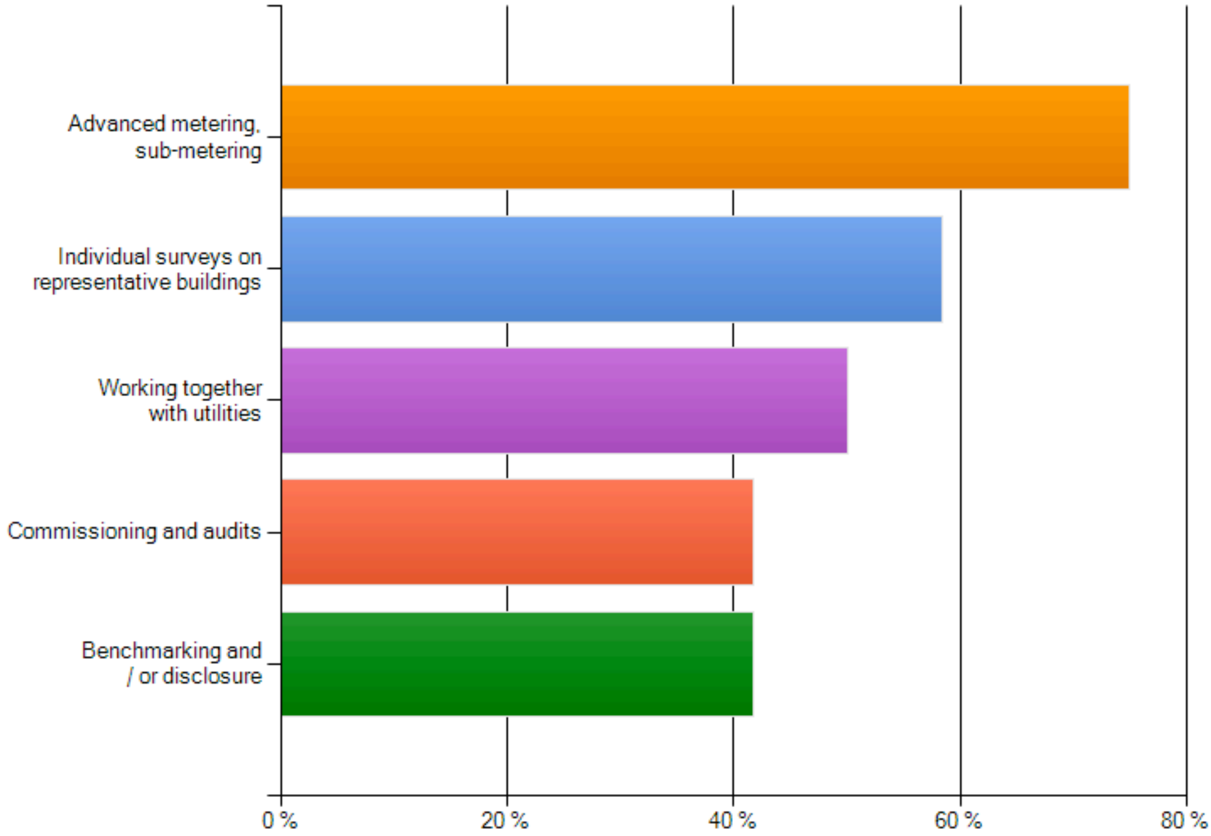


Figure 5.2. Results: Improving Data on the Split of Energy Consumption *(shows the top 5 responses from all the global experts - importance in per cent).*

Around 75% of the respondents think that data on the energy consumption split can become more readily available if advanced sub-metering was to be employed. Experts also stated that surveys on individual buildings representing the entire buildings stock would be a useful way of gathering this data. Other practical strategies for collection of this data were:

- Working with utilities;
- Commissioning and auditing; and
- Benchmarking and / or disclosure.

Question 3. How can we ensure better collaboration and the sharing of existing data?

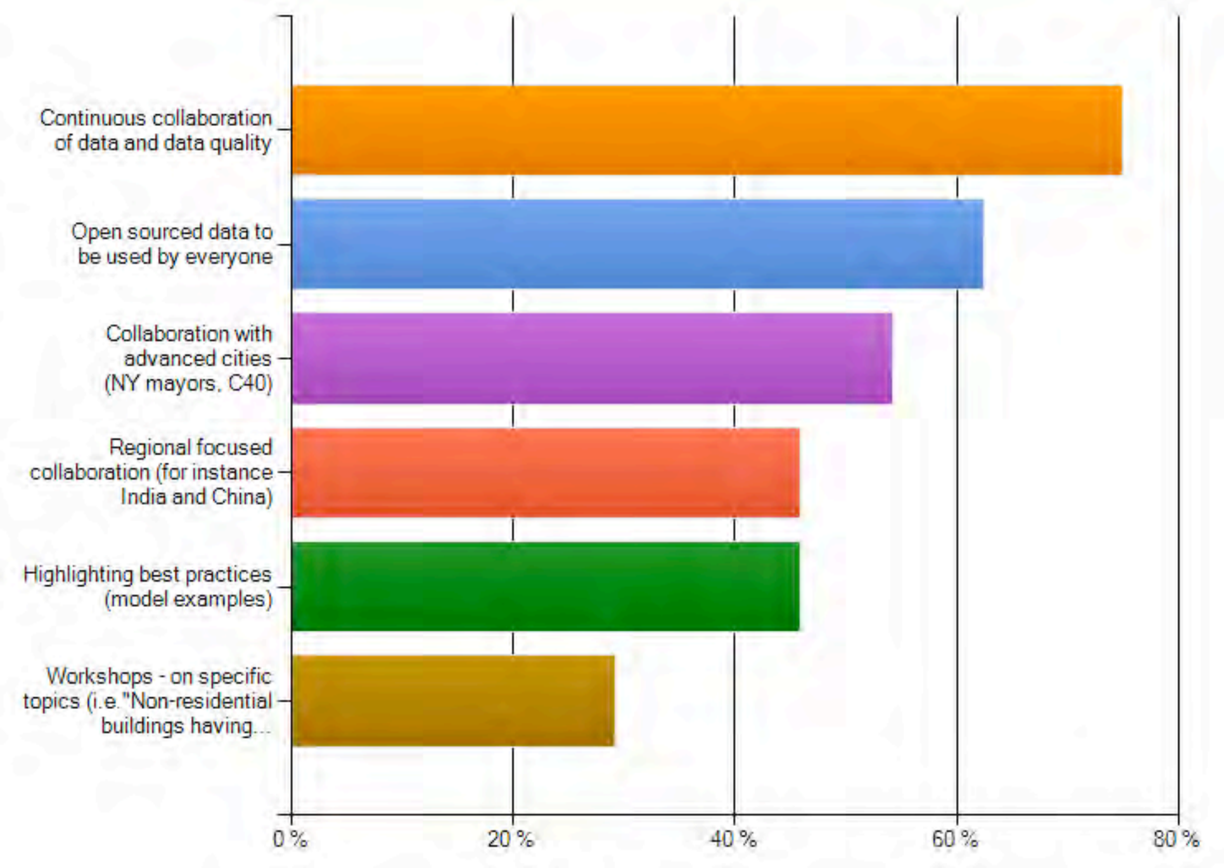


Figure 5.3. Results: Ensuring Better Collaboration of Existing Data (*shows the top 6 responses from all the global experts - importance in per cent).*

Around 75% of the respondents think that in order to achieve enhanced collaboration, building performance data sharing must be a continuous and on-going process where data and the data quality are updated and distributed regularly. There was also a general demand for open source data sharing that could be used by everyone. Over half the experts thought that data collaboration could be improved through links with advanced cities to establish an international standard for good data collection techniques.

Other practical strategies for better collaboration and sharing of known data are:

- Regionally focused collaboration (for instance China and India);
- Highlighting best practices (model examples); and
- Workshops on specific topics.

Question 4. What are the major barriers to the collection of building performance data?

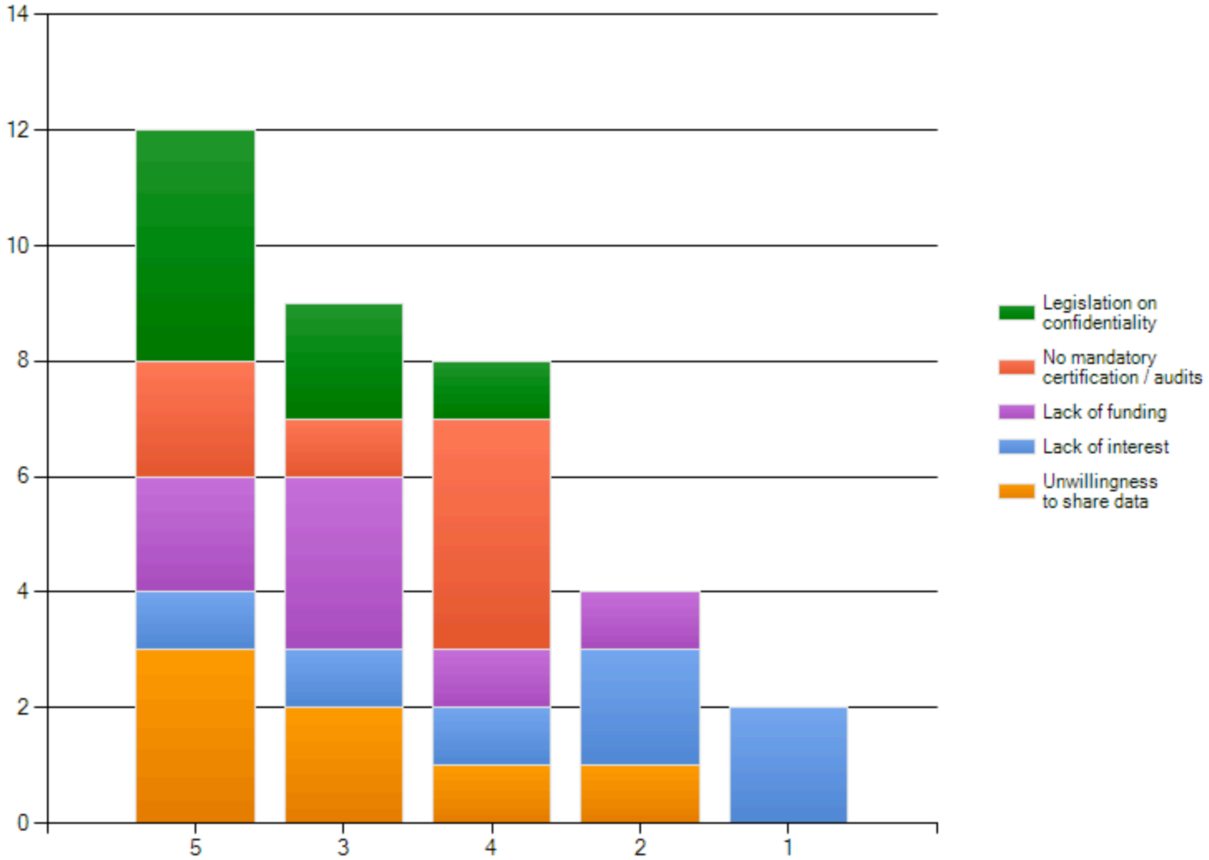


Figure 5.4. Results: Major Barriers in Building Performance Data Collection (*shows the 5 total responses ranked in order of importance by all the global experts).*

The experts deemed the biggest barrier to be overcome in collecting data is legislation on confidentiality; this prevents access and can hamper the sharing of data. The second barrier that hinders the collection of data is the lack of mandatory certification / audit schemes that request collection data nationally or regionally. Other barriers include:

- A lack of funding being allocated to data collection;
- A lack of interest relating to data collection; and
- An unwillingness to share available data.

Question 5. What can GBPN do to improve data collection?

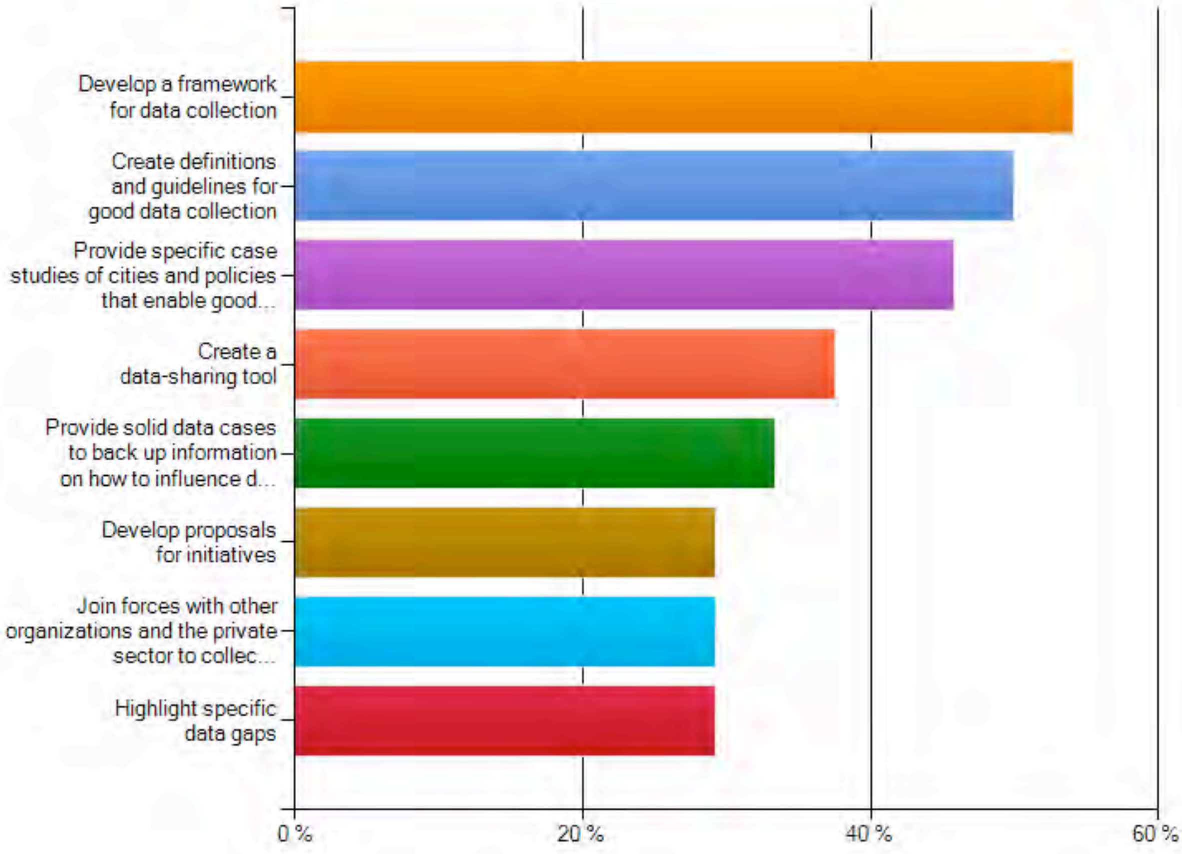


Figure 5.5. Results: How GBPN Can Improve Data Collection *(shows the 8 total responses from all the global experts - importance in per cent).*

The majority of the experts considered the most useful way for the GBPN to improve data collection is to develop and establish a standard framework for collecting data so that all regions and areas use the same guidelines when collecting data. Around half of the respondents thought that GBPN should produce fixed definitions and guidelines for "good" data collection for the regions to follow in order to establish good data collection practices, this would inevitably allow regions to become more consistent and comparable. For example, defining a universal data collection standard. A data category that is thought to have a common definition may be seen differently depending on the region. The third improvement recommended by the experts was for GBPN to provide best practice case studies of cities, countries and/or policies in data collection and to disseminate these to other regions or countries, enabling them to benefit from these positive experiences. This advice complements the second suggestion, in that both improvements call for a consistent standard to be employed.

Other improvements the respondents considered important for the GBPN to do were to:

- Create a data sharing tool;
- Provide solid data case to back up information on how to influence policy makers & key stakeholders;
- Develop proposals for initiatives;
- Join forces with other organisations and the private sector to collect data; and
- Highlight specific data gaps.

Recommendations for Better Data Collection Practices

The survey provided a valuable opportunity to gather expert opinion on how to improve data quality and collection around the world, and more specifically, in the GBPN four key regions. As well as allowing for a more comprehensive understanding of how we can collaboratively improve data, there were a number of recurring recommendations that became obvious when analysing the advice from the experts from all regions.

There is overwhelming emphasis on the need for a comprehensive data collection framework to ensure the consistency of data. Many experts also advised that data collection definitions and guidelines should be harmonised and clarified. Repeatedly, the main themes include:

- The need for a comprehensive framework;
- The need for data collection definitions and guidelines;
- A collaborative effort to share data and begin the provision of open source data;
- The need to ensure mandatory data collection;
- The need for incentives and funding; and
- A dissemination of data collection best practices and case studies.

Framework

Most experts proposed that a comprehensive framework for data collection of building energy data could be set up to help to harmonise data sets. This would ensure consistency when collecting data while accommodating the various levels of data fidelity in the different regions and in general improve the data quality. Common methodologies should be agreed upon when collecting, reporting and analysing data and therefore tangible concrete outcomes would lead to improved energy efficiency practices in the building sector.

Defining & Guidelines

Good quality data are used for many different purposes. Very often data sets are not comparable or consistent, it is important to define from the beginning which data are the most crucial for modellers in order to give a realistic estimation of the existing building stock and determine future steps. A challenge for modellers is to have consistent data, it is difficult for modellers to have good data in one region and poor in another, and yet still come up with credible scenarios or modelling results. Guidelines can be developed to ensure for data to be well organised, well documented and well structured.

Open source & Collaboration

Open source and collaborative data collection efforts must be lead with the focus on sharing data with stakeholders such as governments, countries, cities and private sector parties. There should be an active movement towards sharing data as openly as possible; this will put pressure on others to share their data[13].

Data should be made publically available and be shared as openly as possible, equally, if a region has large data gaps this should also be made public. Best practice sharing techniques should be made available to all interested parties.

Mandatory

The collection of data is an important, complex and challenging task and in order to obtain this information we need the help of governments. Data provision should be made mandatory. This can be managed in several ways:

- Data release whenever the property is built, sold or rented
- Utilities to upload energy use data
- Mandatory benchmarking processes.

Stronger regulation can be set in place so that data collection, reporting and distribution will safeguard the quality of data.

Incentives & Funding

Our current data sets need to be improved, be more rigorous and of a higher quality. Inevitably, this involves higher costs in terms of time and money. A major barrier that hinders the collection of data is the lack of available funding. If incentives and resource support were offered to collectors / analysers, there would be more cohesive work in this field. Funding can advance

[13] As BPIE are doing.

surveys and can help obtain the data that are required to measure building energy data. Funding is hence critical; however, the need for funding can be reduced by combining, sharing and initiating smart ways of collecting data.

Best Practice & Case Studies

When highlighting the necessity of good data, it is crucial to be supported by examples of best practices and good case studies. By collecting these, they can then be disseminated, providing regions with cost effective ways of improving their data availability and quality. Please find two examples of best practices case studies in Annex 4.

Region Specific Recommendations

Recommendations for China

Out of the 30 experts who filled in the survey, 8 of these responded based on deeper experience in China. The general recommendations provided in this section are based on the suggestions provided by the regional experts during the survey.

Expert Advice: What would you do to ensure better data quality and availability in China?

"Be certain that data are being reported consistently (whole building, not just certain end uses; primary, delivered or final energy)" Adam Hinge (Sustainable Energy Partnerships)

China has established an operating data collection system. However, their data accuracy, when analysed, was not seen being reliable as there are little data available on different building types. In order to improve the collection of data for all of China's buildings stock, clearer definitions of the data required and guidelines for measurement need to be established in order to reliably assess the efficiency of buildings.

The Chinese respondents highlighted the accessibility of data in China as a barrier, a way to overcome this is by creating a data-sharing tool that is clearly defined and user friendly. The tool can be used to publicise inspection data and will therefore provide access to data that are currently unavailable.

Recommendations for Europe

Out of the 30 experts who filled in the survey, 13 of these responded based on experience in the EU. The general recommendations provided in this section are based on the suggestions provided by the regional experts during the survey.

Expert Advice: What would you do to ensure better data quality and availability in the EU?

"Make public where good data are available, and equally make public where there are major data gaps." Oliver Rapf (BPIE)

Transparency should be a key part of data collection in the EU; this will promote increased participation among countries and cities aiming to boost their competitiveness by opening access to data streams. 90% of the EU experts felt that data collaboration and sharing could be improved by open sourced data being used by everyone. The unwillingness to share data is seen as a major barrier to good data quality and collection in the EU.

As an independent third party BPIE should be funded to be a main data collection point for such energy performance data. Their managing the collected data would avoid anti-trust issues. This funding could help BPIE to proceed with more frequent collaborations, such as BPIE's country-by-country survey, to ensure better data quality and availability

Another main barrier seen by the experts in the EU is that mandatory certification or audits are not required; the use of energy performance certification requirements needs to be improved. The compulsory monitoring and disclosure of energy data should be required.

Recommendations for India

Out of the 30 experts who filled in the survey, 7 of these responded based on deeper experience in India. The general recommendations provided in this section are based on the suggestions provided by the regional experts during the survey.

Expert Advice: What would you do to ensure better data quality and availability?

"Work with the government, educational and research institutions to develop a framework for data collection and analysis."

Satish Kumar (Schnider Electric)

The crucial advance that India must make in order to ensure better data quality is to create a framework for data collection and analysis, including guidelines and definitions. Practically, this will require the government to mandate for this with the help of educational and research institutions around India. The government must be willing to contribute industry resources to ensure tangible and concrete outcomes leading to improved energy efficiency practices in data collection in the building sector.

Local governments and national governments can create model programs to make benchmarking mandatory, primarily managing energy audits for their own buildings. These can then be transferred to collect annual / quartile energy use data for all buildings in India. This benchmarking system can create a baseline for all buildings that can be used to compare the energy use of "similar" buildings.

Regulation should be adopted so that building performance data are continually reported and shared. The main barriers that currently hinder good data collection are the lack of interest, technology and finance; incentive programs can help overcome these barriers. Utilities should become more involved in the reporting process. Third party audits of building data can help to ensure the data collected in authentic and consistent.

Recommendations for the United States

Out of the 30 experts who filled in the survey, 10 responded based on experiences in the US. The general recommendations provided in this section are based on the suggestions provided by the regional experts during the survey.

Expert Advice: What would you do to ensure better data quality and availability in the US?

"The US need better guidelines at regional and national levels on data standards, privacy concerns, standard building definitions, etc."

Jayson Antonoff (IMT)

In order for data to be of good quality, the collection methods must be right for the region. Generally, in order to ensure better data collection in the US, the experts recommended the use of better guidelines at regional and national level concerning data standards, privacy concerns and standard building definitions. Experts believed that data collection should be made mandatory at regional and national levels, employing standard guidelines to ensure consistency of data across the US.

Incentives and resource support should be offered to those providing the raw data and also to those who perform the analysis. Therefore, there should be sufficient on-going funding for the EIA to collect performance data.

The major barrier cited by the US is legislation confidentiality. Over 70% of the experts thought that data quality would be improved by compulsory reporting of energy audits and for performance data to be mandatory at turnover. Therefore, to ensure accurate and available data, the US government should recognise the importance of building performance data and set guidelines for this.

CONCLUSION

Report Findings

This report has presented the current level of building energy data quality in China, the EU, India and the US. It is the first time such a global comparison has been made. There are significant differences in data quality as well as large data gaps within most of the regions. This makes it exceedingly difficult to analyse the current state of play in the building sectors in each region. This is an intra-regional problem as well as an inter-regional concern. While there are efforts underway to make improvements, much more work is needed to supplement these omissions and correct inaccuracies. While current data sets and practices are far from perfect, GBPN is taking the lead towards creating a platform for better collaboration amongst multiple stakeholders and organisations in order to improve this.

In order to develop robust buildings energy performance strategies, the issue of data quality is fundamental. Importantly, in order to understand the magnitude of the mitigation potential or to build scenarios to assess different policy scenarios, credible data is key. Modellers can make allowances for data quality and data gaps, but those come with their own analytical risks.

Because buildings energy performance strategies are designed for the long term, there is a need to understand the current state of data, learn from it and take the necessary steps to improve it. While there is a mixed picture of data quality in the four regions, there is a need for a systematic and collaborative effort to change this picture as quickly as possible. But there is also need to build a sustainable data collection system.

We must advance our collection techniques to share and improve access to secure building energy data. These reliable data are required by international modellers to ensure accuracy of calculation and by policy makers in the design and implementation of consistent working policies and incentive schemes. This is a key element to drive essential change in the building sector.

Key Recommendations

Stakeholders of the building community need numerous kinds of data to achieve high-performance building targets. Such data is also needed to track progress ad success of different policies, which can help regions to learn from each other.

- It is recommended that a higher priority be given to data collection and to overcome our most pressing needs regarding the crucial data required by modellers and policy-makers.

Transparency is key. GBPN will support initiatives to publicise data sets, sources and practices in order to improve the quality, stop duplication and increase consistency.

- It is recommended that, in order to produce consistent data sets, there should be complete collaboration so that all parties have access to the data supplied by others with this data coming from reliable sources and be well documented.

No one group of people can do everything, but by working together, we can make a difference. A trustworthy and continuous data collection process is a necessary requirement for effective policy making.

- It is recommended that a collaborative approach towards ensuring transparency of data should be adopted so that data collection, monitoring, reporting and evaluation leaves no gaps and produces accurate and reliable data.

- It is recommended that data collection should be harmonised so that national and regional data collection systems relating to the energy performance of buildings are consistent.

Finally, GBPN will support clarification and harmonisation of national and regional data collection systems concerning the energy performance of buildings. It is essential to have an open source collection tool to begin with so that when data is collected it can be stored safely and accessed by all who need it. GBPN will focus on ways of enabling all stakeholders to come together to create a single repository of energy usage information. This includes working continuously on linked open data that will allow multiple stakeholders to benefit from the same source of data.

- It is recommended that open databases be established that concern all high-performance building data and the diverse requirements of the building stakeholders.

This report has shown how dramatically data availability varies between regions. In order to take successful action to improve the data quality and energy performance of buildings worldwide, all regions need to collaborate and communicate to implement harmonised procedures for data collection. This would close the gaps in data existing today and allow policy makers to make accurate and appropriate decisions regarding the impact of buildings on climate change.

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ANNEX 1 – THE 'DEEP' SCENARIO

The "deep" scenario designed by the Central European University, found in the Report: "Best Practice Policies for Low Carbon & Energy Buildings, report 2012, commissioned by GBPN."

Deep Scenario

This scenario demonstrates how far today's state-of-the-art construction and retrofit know-how and technologies can take the building sector in reducing energy use and CO_2 emissions, while also providing full thermal comfort in buildings. In essence, the CEU determine the techno-economic energy efficiency potentials in the building sector.

In this scenario, exemplary building practices are implemented worldwide for both new and renovated buildings (with an accelerated retro fit rate of 3%). Over the 10-year period from 2012 to 2022 "advanced" buildings[14] are widely proliferating in all regions, replacing conventional new and retrofit buildings on the market. The transition period allows markets and industries to prepare for the large-scale deployment of the high efficient building construction technologies, materials and know-how.

Necessary ambitious enabling policies can also be implemented and the vital supporting institutional framework introduced. After 2022, most renovations and newly built structures will be of a very high-energy efficient design as exemplary buildings in the same (or a similar) climate zone.

[14] Advanced buildings, according to the model's logic, have a state-of-the-art design, which allows for a significant reduction of thermal energy demand in most climate zones (up to 90%). This assumption is also in line with the concept of a passive house, which often does not include any "active" heating or cooling systems, with the usual energy performance for space heating and cooling presented at the level of 15 kWh/m^2 year in final energy. However, advanced buildings considered in this study are incorporated in a broader concept, as they include any high efficient buildings, regardless energy efficiency measures (e.g. "passive" or "active" heating system), but with very low level of thermal energy use.

ANNEX 2 – MATRIX: ALL REGIONS

Residential and commercial & public and building energy use subsections

	US	Percentage	EU	Percentage	CHINA	Percentage	INDIA	Percentage
Highly reliable data	23	77%	8	27%	6	20%	1	3%
Data available with minor uncertainty	7	23%	12	40%	11	37%	10	33%
Partial Data with major uncertainty	0	0%	5	17%	6	20%	10	33%
Uncertain data	0	0%	5	17%	7	23%	9	30%
Total	30	100%	30	100%	30	100%	30	100%

Figure 2.1. Four Regions Data Split into Reliability Groups.

	Floor Area (m²)	No. of Buildings	Energy Use	Heating	Cooling	Hot Water	Lighting / Apps	Age Profile	Retrofit Rates	Urban / Rural Split	New Build Energy Use	New Construction (m²/a)	Fuel Mix	Ownership (Private /Public)	Tenure
US - Residential	5	4	4.5	4.5	4	4	4	3.5	3	3.5	3.5	5	4	4	4
US - Commercial & Public	5	5	5	4	4	4	4	4	4	2.5	3.5	5	3.5	4	4
EU - Residential	4.21	4.916666667	3.83	3.9166667	2	3.1666667	3.17	4.16666667	1.83	3.13	3.67	3.75	4.08	2.58	3.83
EU - Commercial & Public	3.38	2.666666667	2.83	2.9166667	1.416667	2.6666667	1.17	1.91666667	1.167	0.75	3.17	2.33	3.33	0.83	1.17
CHINA - Residential	3	2	4	4	3	3	2	2	3.5	3	4	4	4	0	0
CHINA - Commercial & Public	3	2	3.5	3.5	3	2	2	0	3	1	4	0	3.5	0	0
INDIA - Residential	2.5	0	3	2	1.5	3	2	0	2	3.5	2	0	2.5	0	0
INDIA- Commercial & Public	2.5	0	3	2	2	2	3	0	2	4	2.5	2	3	0	

Figure 2.2.. Four Regions Data, Weightings are Colour Coded According to Accuracy Groups.

ANNEX 3 – EU-27 DATA QUALITY SPREADSHEEET

The countries shaded in grey are those used to calculate the EU-27 average data quality.

EU		Floor Area (m²)	Number of Buildings	Energy Use (kWh/m².a)	Heating	Cooling	Hot Water	Lighting	Can you split by Age Profile?	Retrofit Rates	Urban/Rural Split	NEW BUILD Energy Use (kWh/m².a)	NEW Construction (m²/a)	Fuel Mix	Ownership	Tenure	AVERAGE
GOOD	EU Average	3.9	3.1	2.7	2.5	1.7	1.7	2.2	3.2	1.4	2.0	3.1	3.0	3.3	2.6	1.7	2.6
	France	5.0	3.5	4.0	4.0	4.0	4.0	4.0	4.0	2.0	3.5	4.0	5.0	4.0	4.0	2.0	3.8
	Lithuania	5.0	5.0	4.0	3.0	3.0	3.0	3.0	3.0	2.0	5.0	4.0	4.0	4.0	5.0	2.5	3.7
	Netherlands	4.0	4.0	3.5	3.5	3.5	3.5	3.5	2.5	2.5	5.0	4.0	4.0	3.5	4.5	2.0	3.6
ABOVE AVERAGE	Latvia	5.0	5.0	3.5	4.0	4.0	0.0	4.0	5.0	4.0	5.0	2.0	5.0	2.0	4.0	0.0	3.5
	Finland	5.0	3.5	4.0	4.0	4.0	4.0	4.0	5.0	2.0	0.0	3.0	2.0	4.0	4.0	2.0	3.4
	Bulgaria	4.5	3.5	4.5	3.5	3.0	3.5	3.5	4.0	0.0	2.5	4.0	2.5	3.5	3.5	3.0	3.3
	Czech Republic	4.5	3.5	4.0	3.0	3.0	3.0	3.0	4.5	2.0	2.0	4.0	3.0	3.0	2.5	2.0	3.1
	Sweden	5.0	5.0	3.0	4.0	2.5	4.0	2.5	2.5	2.0	1.5	4.0	4.0	4.0	1.5	1.5	3.1
	UK	4.0	3.5	4.0	4.0	1.0	2.0	3.0	4.0	1.0	2.0	4.0	3.5	4.0	3.0	2.0	3.0
	Romania	4.5	2.5	4.0	3.0	3.0	3.0	3.0	2.5	0.0	2.5	3.0	2.0	4.0	3.5	2.5	2.9
	Slovenia	5.0	2.0	3.0	2.5	2.5	2.3	2.5	5.0	2.0	2.5	4.0	5.0	2.0	2.0	0.5	2.9
	Italy	3.5	5.0	1.5	2.5	2.5	2.5	2.5	4.0	3.0	1.0	4.0	3.0	4.0	2.0	1.0	2.8
	Germany	4.5	3.0	4.5	2.5	0.0	0.0	2.5	2.5	3.0	0.0	4.0	5.0	4.0	0.0	4.0	2.6
	EU Average	3.9	3.1	2.7	2.5	1.7	1.7	2.2	3.2	1.4	2.0	3.1	3.0	3.3	2.6	1.7	2.6
	Spain	5.0	2.5	3.0	3.0	3.0	3.0	3.0	2.0	1.0	2.5	0.0	2.0	5.0	0.0	2.5	2.5
BELOW AVERAGE	Hungary	4.0	4.0	2.5	3.0	0.5	0.0	3.0	3.5	1.0	2.0	4.0	2.0	2.5	3.0	2.5	2.5
	Estonia	4.0	2.5	2.0	2.0	0.0	0.0	2.0	5.0	0.0	2.5	4.0	5.0	5.0	2.5	0.0	2.4
	Denmark	4.5	2.5	2.5	1.0	1.0	1.0	1.0	3.0	0.0	0.0	4.0	5.0	5.0	5.0	0.0	2.4
	Austria	3.0	3.8	2.0	2.0	0.0	0.0	0.0	2.5	1.5	3.8	4.0	1.8	4.0	3.8	3.0	2.3
	Belgium	4.5	3.5	2.5	1.5	0.0	1.5	0.0	3.5	3.0	2.5	3.0	3.0	2.5	2.0	2.0	2.3
	Slovakia	4.5	2.0	3.0	3.0	3.0	0.0	3.0	4.5	0.5	0.0	4.0	1.0	3.0	2.0	1.5	2.3
	Poland	2.5	5.0	2.0	2.0	2.0	2.0	2.0	1.5	0.5	1.5	4.0	2.0	2.5	2.0	2.0	2.2
POOR	Greece	4.0	4.0	1.0	2.5	0.0	0.0	2.5	4.0	0.0	4.0	0.0	0.0	2.0	4.0	2.5	2.0
	Portugal	1.5	1.0	3.5	1.5	1.5	1.5	1.5	1.5	2.0	0.0	4.0	4.5	3.5	1.0	0.0	1.9
	Malta	2.5	1.5	2.0	2.0	2.0	2.0	2.0	2.5	0.0	0.0	1.0	1.5	2.0	2.0	2.0	1.7
	Ireland	2.5	3.0	0.0	0.0	0.0	0.0	0.0	2.5	0.5	1.5	4.0	2.0	4.0	2.5	2.5	1.7
	Cyprus	4.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	1.0	1.0	2.0	1.5	1.4
BAD	Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.5	0.0	0.0	0.5

Figure 3.1. Data Quality of EU-27 Member States.

ANNEX 4 - BEST PRACTICE CASE STUDIES

California

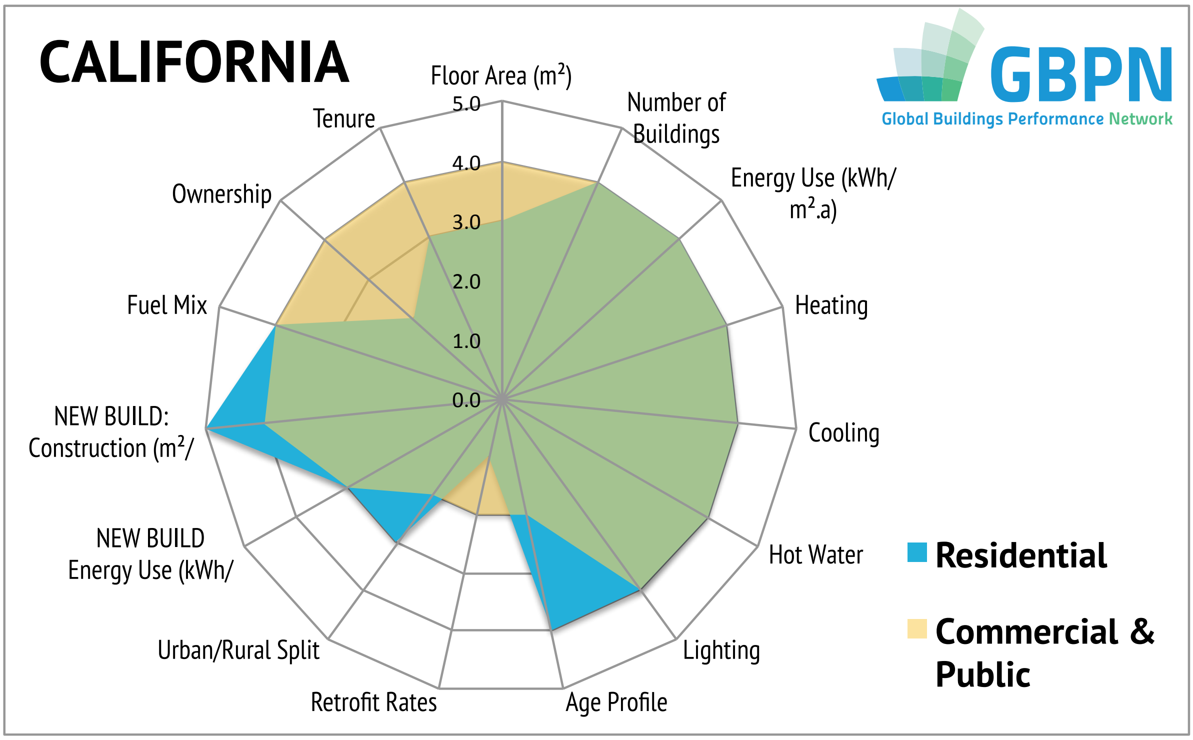

Figure 4.1. California Residential vs. Commercial Building Data Quality.

California stands in front in the depth of state-specific energy consumption data of commercial buildings. It has an exceptional wealth of energy consumption data thanks to the California Commercial End-Use Survey (CEUS) that is prepared for by the energy commission. The California Energy Commission's consultant report describes the purpose in more detail...

"The California Commercial End-Use Survey (CEUS) is a comprehensive study of commercial sector energy use, primarily designed to support the state's energy demand forecasting activities. Itron performed the survey under contract to the California Energy Commission. The survey captures detailed building systems data, building geometry, electricity and gas usage, thermal shell characteristics, equipment inventories, operating schedules, and other commercial building characteristics.

A stratified random sample of 2,800 commercial facilities was targeted from the service areas of Pacific Gas & Electric, San Diego Gas and Electric, Southern California Edison, Southern California Gas Company and the Sacramento Municipal Utility District. The primary sampling unit was the premise, defined as a single commercial enterprise operating at a contiguous location. The sample was stratified by utility service area, climate region, building type, and energy consumption level.

Specialized software developed for the CEUS project generates energy simulation models automatically from the on-site survey data. Simulated energy use for each survey participant was calibrated to actual historical energy consumption from utility billing records. The software creates end-use load profiles and electricity and natural gas consumption estimates by end-use for user-defined commercial market segments. Its capabilities allow evaluation of energy efficiency measure installation, energy rate schedules, weather parameters, and many other scenarios against baseline usage patterns or conditions.

For each utility service area, floor stocks, fuel shares, electric and natural gas consumption, energy-use indices (EUIs), energy intensities, and 16-day hourly end-use load profiles were estimated for twelve common commercial building type categories." (CEUS, 2013).

France

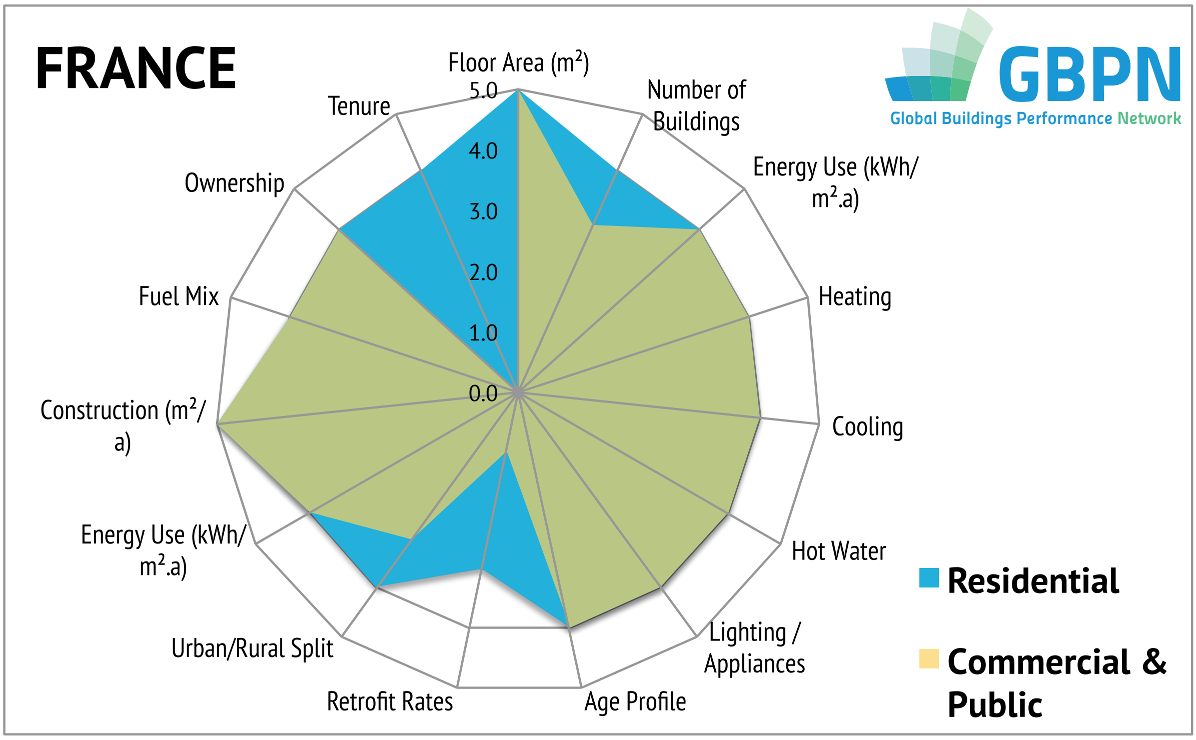

Figure 4.2. France Residential vs. Commercial Building Data Quality.

The French template is an example of best practice data collection. Building performance data collection in France is coordinated by the French Agency for Environment and Energy Management (ADEME).

ADEME is one of largest, best-funded and longest established energy agencies in the EU. It also has a national perspective covering the whole of France, which is often not the case in other countries with federal structures. ADEME has an experience base that covers all sectors, which means they have built up a good knowledge base across most dimensions of building energy efficiency – residential & non-residential. ADEME also coordinates the SAVE Program of the European Commission and within this a project called ODYSSEE. ODYSEE is a project that aims to monitor energy efficiency policies across whole Europe. ADEME explains that...

"In order to monitor and compare energy efficiency progress achieved in Europe a coordinated approach is required:
Accurate energy efficiency indicators, harmonised between the different countries covered: these are provided by the SAVE / ODYSSEE project. A database covering energy efficiency policies in Europe: this is provided by the MURE (Modèles d'utilisation rationnelle de l'énergie) project. A cross-referencing of these two tools, linking energy policy to energy indicators.

ODYSSEE aims to establish and produce energy efficiency indicators for the various sectors of the economy (industry, transport, etc.) with a detailed breakdown by usage: heating, cooking, domestic hot water, household appliances, etc. The aim is to set up a permanent technical structure to monitor annual sectorial progress in energy efficiency and CO2 emissions, nationally and at the European level. Around 150 energy efficiency indicators are calculated in the ODYSSEE database for 27 EU countries plus Norway and Croatia." (ADEME, 2013).

GBPN
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About GBPN The Global Buildings Performance Network (GBPN) is a globally organised and regionally focused network whose mission is to advance best practice policies that can significantly reduce energy consumption and associated CO_2 emissions from buildings.