Policy Brief

China

Use of Data Platforms to Identify and Verify Energy Savings in China

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Use of Data Platforms to Identify and Verify Energy Savings in China

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Acknowledgements

This policy paper was written by RAP Senior Advisor David Crossley, who has 38 years experience in the energy sector, providing advice on sustainable energy policy and programs to governments, regulators, energy companies, industry associations, and NGOs. In China, David manages the provision of technical assistance on demand-side management and energy efficiency to governments, regulators and the electricity industry.

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Abbreviations and Acronyms

API	application programming interface
DSM	demand-side management
GPRS	general packet radio service (a mobile data service)
GWh	gigawatt-hour
M&V	measurement and verification
MOF	Ministry of Finance
MW	megawatt
NDRC	National Development and Reform Commission
PSTN	public switched telephone network
SEED	standard energy efficiency data

Executive Summary

In response to Chinese government initiatives promoting DSM and energy efficiency, grid companies, government agencies, and private sector companies have been establishing data platforms in localities throughout China to identify and verify energy savings. The purpose of this paper is to make recommendations about how the various data platforms currently being established should be set up to maximize their effectiveness.

Data platforms can be used to carry out the following functions:

- identifying opportunities for energy savings;
- measuring and verifying energy savings;
- assessing the cost-effectiveness of energy efficiency;
- carrying out load forecasting; and
- remotely controlling the operation of appliances and equipment.

Data platforms in China are being established to achieve five main objectives:

- to monitor and collect data on energy use in industrial and tertiary sector customer facilities;
- to achieve energy conservation by reducing energy waste;
- to support the implementation of the orderly use of electricity, including the execution of demand response programs;
- to support security of electricity supply; and
- to enable government agencies to measure and verify energy savings achieved by customer facilities that are participating in government energy efficiency programs.

To achieve these objectives, specifications for data platforms in China should include the following capabilities:

- ability to link to multiple databases of energy use data with a standardized data taxonomy and database structure;
- a standardized, open-source Application Programming Interface (API);
- communication links to customer facilities and the ability to send a signal via the communication links to remotely control the operation of selected appliances and equipment located in the facilities.

Data platforms in China are currently collecting data on energy use that will eventually form a valuable national resource. To ensure that this resource is useful, it must be possible to share data across all the data platforms. The best way to achieve this goal is to develop and implement a National Standard for energy use data platforms that includes specifications for the three main elements identified above.

The energy use data will provide a unique insight into how energy is being used in China. This information will offer crucial insights to enable the development of government policies to significantly reduce both the energy intensity and the pollution emissions intensity of the Chinese economy. Therefore, it is important that steps are taken now to ensure that the various energy use data platforms are set up in ways that maximize their effectiveness.

1. Introduction

In November 2010, China's National Development and Reform Commission (NDRC) issued the document Demand Side Management Implementation Measures (发改运行 [2010] 2643号).[1] This guidance document requires grid companies in China to carry out demand-side management (DSM) activities, including both energy efficiency and load management, to achieve specified targets for reductions in electricity sales (GWh) and peak demand (MW). In addition, grid companies are required to install load monitoring equipment on 70 percent of the peak load, and load control equipment on 10 percent of the peak load, in any locality.

In July 2012, the Ministry of Finance (MOF) and the NDRC announced the establishment of a new incentive fund to support demand-side management (DSM) activities to be implemented by cities in China, initially as pilot programs. Cities have been asked to submit proposed DSM work plans to their provincial governments for validation and subsequent approval by the MOF and NDRC. In November 2012, the first four DSM pilot cities were officially announced: Beijing, Suzhou (Jiangsu), Tangshan (Hebei), and Foshan (Guangdong).[2] If the pilot programs are successful, China has plans to expand the DSM cities initiative to 100 cities.

In response to these two initiatives and other government energy efficiency programs, grid companies, government agencies, and private sector companies have been establishing data platforms in localities throughout China to identify and verify energy savings. The purpose of this paper is to make recommendations about how the various data platforms currently being established should be set up to maximize their effectiveness.

1 National Development and Reform Commission (2010).

2 Ministry of Finance and National Development and Reform Commission (2012).

2. What Is a Data Platform?

In the context of this paper, a data platform comprises computer software for managing the process of collecting, storing, using, and sharing data on energy use in industrial and tertiary sector customer facilities, such as factories and office buildings. In addition, some data platforms have communication links with individual facilities that enable automatic downloading of energy use data from electricity meters and that may also enable remote control of the operation of selected appliances and equipment located at the facility. A typical structure for a data platform is shown in Figure 1.

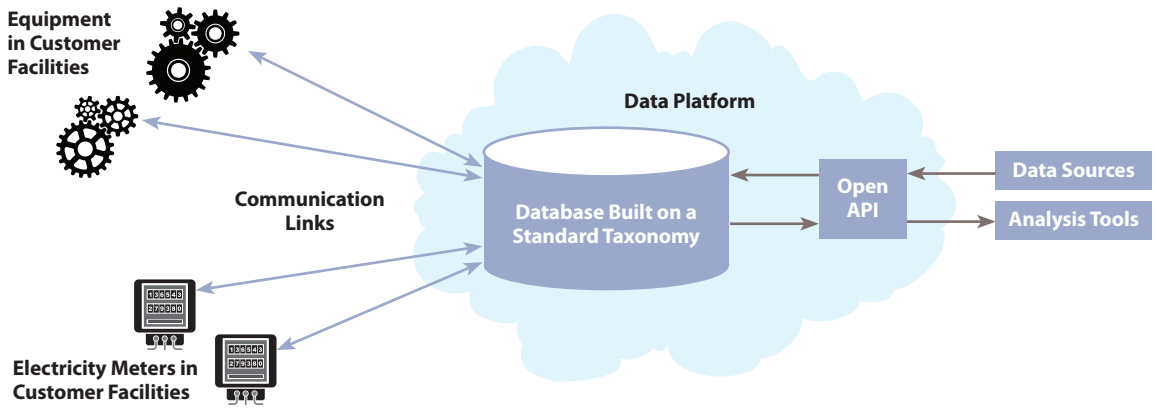
The *database* contains the actual data on energy use. Data platforms may include only one database or may allow individual facility owners to store energy use data in their own separate databases. In all the databases linked to a platform, data is input and stored according to a standardized data *taxonomy* and database structure. The taxonomy provides a rationalized structure for energy use data that can accommodate a wide range of customer facilities and equipment. The data taxonomy is likely to evolve over time as it is used.[4]

Separate databases with a standardized data taxonomy and database structure enable facility owners to maintain control over their own data, while still allowing data sharing among many platform users and data analysis across multiple customer facilities. Data sharing and analysis is typically carried out under strict conditions including, if required, maintaining confidentiality by not identifying *data sources*.

Data platforms typically allow platform users to conduct basic reporting from the data and make selected data available to others via a standardized, open-source *Application Programming Interface (API)*. This reduces the burden of data management, and enables third parties to build data analysis tools that function across many platform users and multiple customer facilities via a common API.

Figure 1

Typical Structure of a Data Platform[3]



3 Modified from Taylor et al (2012).

4 Taylor et al (2012).

Figure 2

Home Page from the US Department of Energy Buildings Performance Database[5]

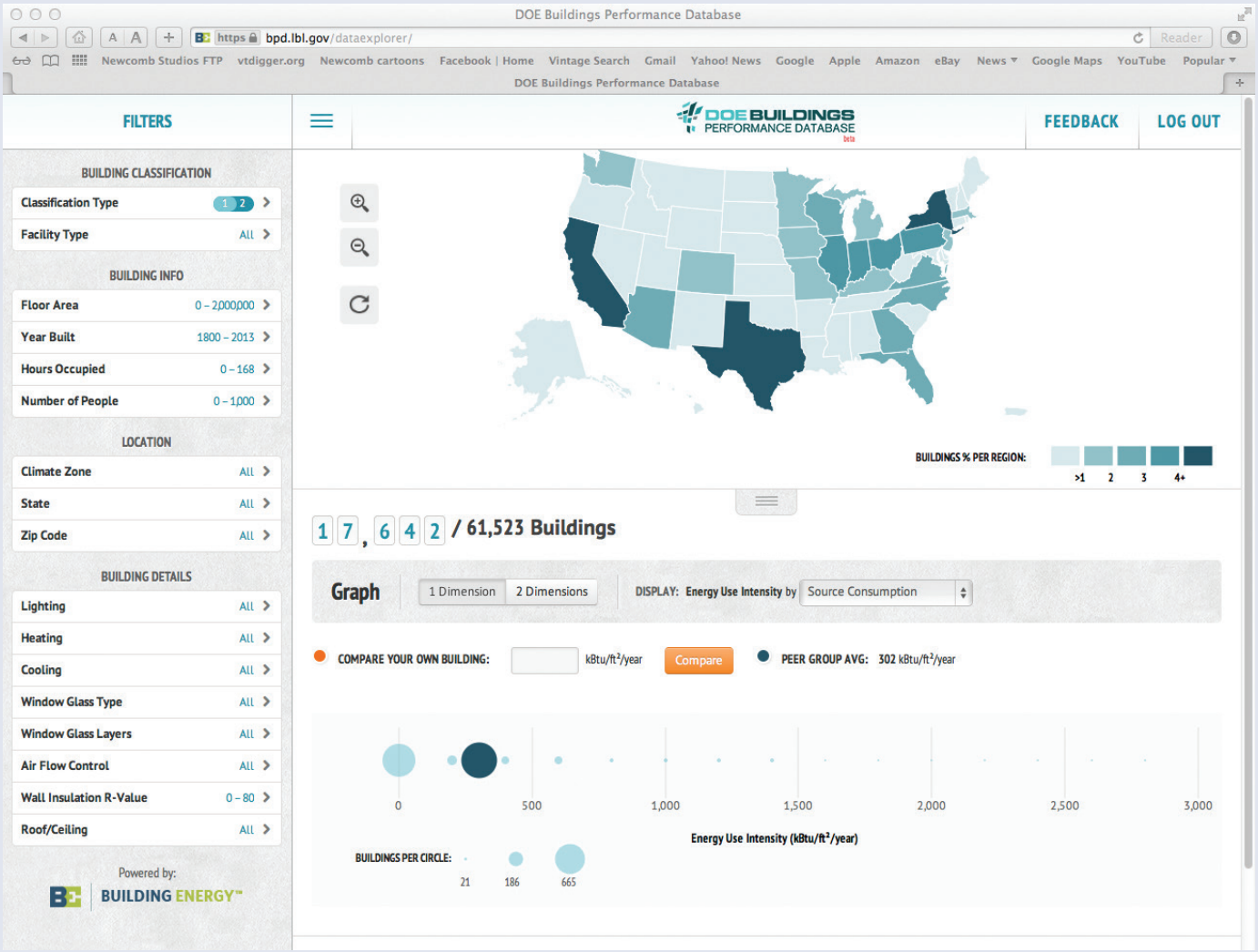


Figure 2 shows the home page from the US Department of Energy Buildings Performance Database, a data platform containing data on the performance of more than 60,000 buildings located throughout the United States. Platform users can use the tools on the home page to produce customized reports from the data stored in the database.

5 United States Department of Energy (2013).

3. Functions of a Data Platform

Data platforms can be used to carry out a range of functions, including:

- identifying opportunities for energy savings within a single customer facility (e.g. a factory or an office building), or across a portfolio of facilities;
- tracking the energy performance of a single customer facility over time;
- benchmarking the energy performance of a particular customer facility against similar facilities;
- evaluating the energy performance of a single customer facility before and after implementation of an energy efficiency project;
- measuring and verifying the energy savings achieved by implementing a particular energy efficiency project, or a group of projects;
- evaluating the persistence of energy savings from a particular energy efficiency project;
- forecasting the typical energy savings achieved by a particular energy efficiency project in a given facility type;
- assessing the cost effectiveness of an energy efficiency project;
- forecasting load in a particular geographic region;
- remotely controlling the operation of equipment (where communication links between the data platform and a customer facility have been installed).

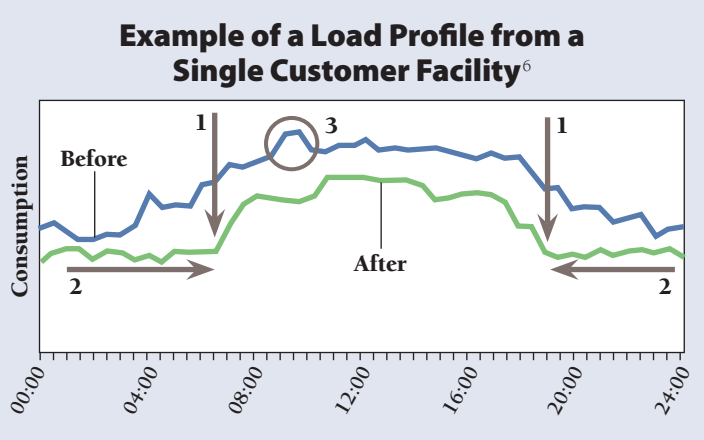
3.1 Identifying Opportunities for Energy Savings

3.1.1 Using Load Profiles

Data platforms are often used to develop load profiles over time for a particular customer facility or group of facilities. Visual inspection of such load profiles can be used as a simple method for identifying opportunities for energy savings. Figure 3 shows an example of a load profile from a single customer facility.

Figure 3 shows how detailed half-hourly load profile data from a data platform can be used to identify opportunities for energy savings. The load profile is shown before and after energy efficiency projects were implemented at the facility. Three key types of potential energy savings (corresponding to the numbers in Figure 3) can be identified from the data:

Figure 3



1. **Base load reduction** – the overall base load of the facility can be studied and reduced, for example, by identifying unnecessary energy use such as equipment or lights left switched on when they are not being used.
2. **Process optimisation** – the load profile can be used to identify what equipment is running and when. Altering the start-up and shutdown times of key processes and equipment could reduce total energy use at the facility by limiting the duration of high energy use at the start and end of working schedules.
3. **Peak load reduction** – the load profile can be used to analyze timings and frequencies to identify the causes of peaks in energy use at the facility, such as particular activities or equipment operation that could be rescheduled away from peak times.

6 The Carbon Trust (2007).

3.1.2 Using Energy Benchmarking

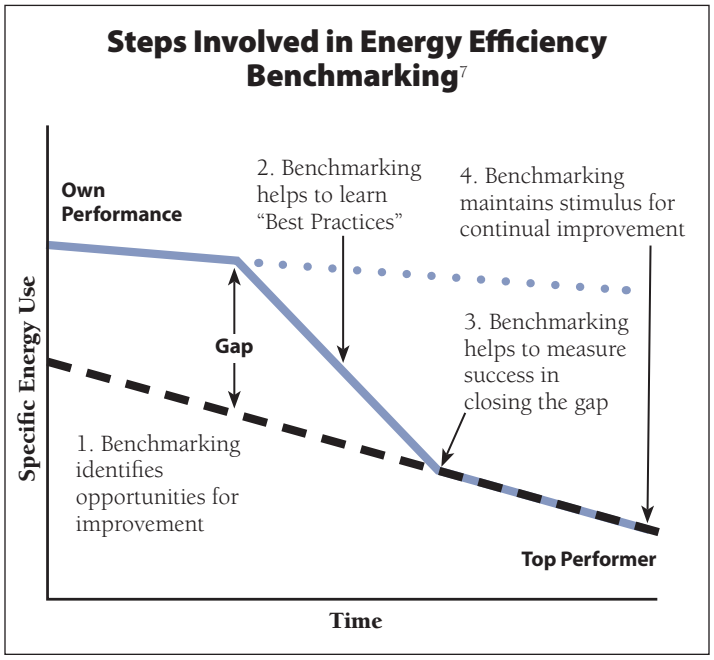
Energy benchmarking collects and analyzes data on energy use in different customer facilities to evaluate and compare energy performance among facilities that carry out similar activities. Data platforms can be used to carry out energy benchmarking provided that the owners of the data agree that the data can be shared among other facility owners and other platform users (such as energy management companies). The sources of the data can be hidden so that each facility owner sees the energy performance of their facility relative to that of other similar facilities, but the identities of the other facilities are kept confidential.

The energy performance of a customer facility is measured by its *specific energy use*, i.e. the energy used per unit of output. For example, the energy performance of a cement factory can be measured as the energy used per ton of cement produced. To enable the calculation of specific energy use, data platforms must also include production data, such as the tons of cement produced by a factory over a given time period. Using energy benchmarking, the energy performance of one cement factory can be compared with the energy performance of other cement factories.

Figure 4 shows the steps involved in using energy benchmarking data from a data platform to improve energy performance. There are four steps corresponding to the numbers in Figure 4:

1. **Identify opportunities for improvement** – when the specific energy use of a facility is higher than that of the top performing facility, there is an opportunity to improve energy performance.
2. **Implement best practices** – less efficient facilities can learn from the energy efficiency best practices that are being implemented by the top performing facility.
3. **Measure success** – as less efficient facilities become more energy-efficient, their progress can be measured by how close they are to the specific energy use of the top performer.
4. **Achieve continual improvement** – energy benchmarking data from the data platform show how the energy performance of all the facilities continually improves.

Figure 4



3.2 Measuring and Verifying Energy Savings

Measurement and verification (M&V) is the process of reliably determining the actual energy savings achieved within an individual customer facility by implementing energy efficiency projects. Energy savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured energy use before and after implementation of an energy efficiency project, making appropriate adjustments for changes in conditions.[8]

M&V activities include some or all of the following:[9]

- installing, calibrating and maintaining electricity meters;
- collecting and screening energy use data;
- developing a calculation method and acceptable estimates for energy savings;
- performing calculations with measured data; and
- reporting results and carrying out quality assurance and third party verification of reports.

7 Bertrand (2012).

8 Efficiency Valuation Organization (2012).

9 Efficiency Valuation Organization (2012).

Data platforms can greatly assist M&V activities by providing the data needed to enable comparison of energy use before and after implementation of an energy efficiency project. Energy use data are sourced from meters located at a customer facility and careful attention should be paid to how many meters are installed and where they are located. In a facility where an energy efficiency project results in a significant reduction in total energy use, one meter at the site boundary may be sufficient. More meters may be required when an energy efficiency project is implemented in only a part of a facility. In this case, any reduction in energy use may be too small to identify if energy use is measured only at the whole site level.

3.3 Assessing the Cost-Effectiveness of Energy Efficiency

In many countries and jurisdictions, energy efficiency is widely recognized as a low-cost, readily available resource that offers a variety of benefits. In many jurisdictions in the United States, great effort is expended on determining whether energy efficiency is cost-effective, that is whether achieving reductions in energy use is cheaper than supplying the same amount of energy. In most cases, energy efficiency is found to be significantly cheaper than energy supply.

In China, the grid companies currently do not assess the cost-effectiveness of acquiring energy efficiency resources, as compared with purchasing bulk electricity from generators. Data platforms can assist a grid company to assess the cost-effectiveness of a particular energy efficiency project by providing data on energy use before and after the project is implemented. To complete the assessment, the grid company will also require data on all the costs they will avoid by not purchasing from generators an equivalent amount of electricity to the energy savings from the energy efficiency project.

After a grid company has completed cost-effectiveness analyses for a number of individual energy efficiency projects, it should be possible to apply the results of the analysis to other similar energy efficiency projects and customer facilities. In this way, it will be possible for grid companies to determine whether energy efficiency is generally more cost-effective than purchasing bulk electricity.

China could significantly reduce costs and increase economic efficiency by requiring grid companies to acquire all cost-effective energy efficiency before purchasing electricity from generators.

3.4 Load Forecasting

Load forecasting is the process of predicting the load on the electricity supply system in a defined geographical area over a specified time interval in the future. The purpose of load forecasting is to estimate how much energy will have to be supplied to meet customer demand. Load forecasts form the basis for developing strategic system plans. Accurate load forecasting is critical because the future load characteristics will determine the location, size, and construction timing for new infrastructure, such as power stations and transmission and distribution substations and lines.

Grid companies in China currently carry out load forecasting using customer energy use data from their billing and operational systems. Data platforms can augment this energy use data to enable grid companies and government agencies to carry out more accurate load forecasting. Information available from data platforms may include the geographical locations and time periods in which energy use is occurring, and the contributions of different types of customer facilities to the overall load. Such detailed information is highly valuable for improving the accuracy of load forecasts.

3.5 Remotely Controlling the Operation of Equipment

Where data platforms have communication links to customer facilities such as factories and office buildings, it may be possible to use these communications links to remotely control the operation of selected appliances and equipment located in the facilities. This enables customer loads to be changed in response to particular events, such as periods of peak loads or when there are problems on the electricity network.

Typically, switching of customer loads is initiated remotely by a signal sent by the program operator through communication links to the connected appliances and equipment; a second signal is sent to restore normal

operation at the conclusion of an event. The program operator may be a grid company, a government agency, or a third party such as an energy management company.

Switching of customer loads may involve:

- cycling loads on and off according to pre-set timing schedules;
- reducing loads to pre-set levels; or
- switching off loads completely.

The ability to use data platforms to remotely control electrical appliances and equipment provides increased flexibility to manage the orderly use of electricity and to develop more sophisticated demand response programs.

4. Maximizing the Effectiveness of Data Platforms in China

4.1 Objectives and Specifications for Data Platforms

Data platforms are currently being established in China to achieve five main objectives:

- to monitor and collect data on energy use in industrial and tertiary sector customer facilities;
- to achieve energy conservation by reducing energy waste;
- to support the implementation of the orderly use of electricity, including the execution of demand response programs;
- to support security of electricity supply; and
- to enable government agencies to measure and verify energy savings achieved by customer facilities that are participating in government energy efficiency programs.

These objectives fit well with the functions of data platforms identified in section 3. In addition, as explained in section 3.3, data platforms can be used to assess the cost-effectiveness of energy efficiency and this may become increasingly important in China in the future.

To achieve the identified objectives, specifications for data platforms in China should include the following capabilities:

- ability to link to multiple databases of energy use data with a standardized data taxonomy and database structure;
- a standardized, open-source Application Programming Interface (API);
- communication links to customer facilities and the ability to send a signal via the communication links to remotely control the operation of selected appliances and equipment located in the facilities.

4.2 Multiple Databases and Standardized Data Taxonomy

Multiple databases, each controlled by a facility owner, enable the identity of the data sources to be kept confidential while the data can be shared among all the facility owners and made available for analysis and benchmarking studies.

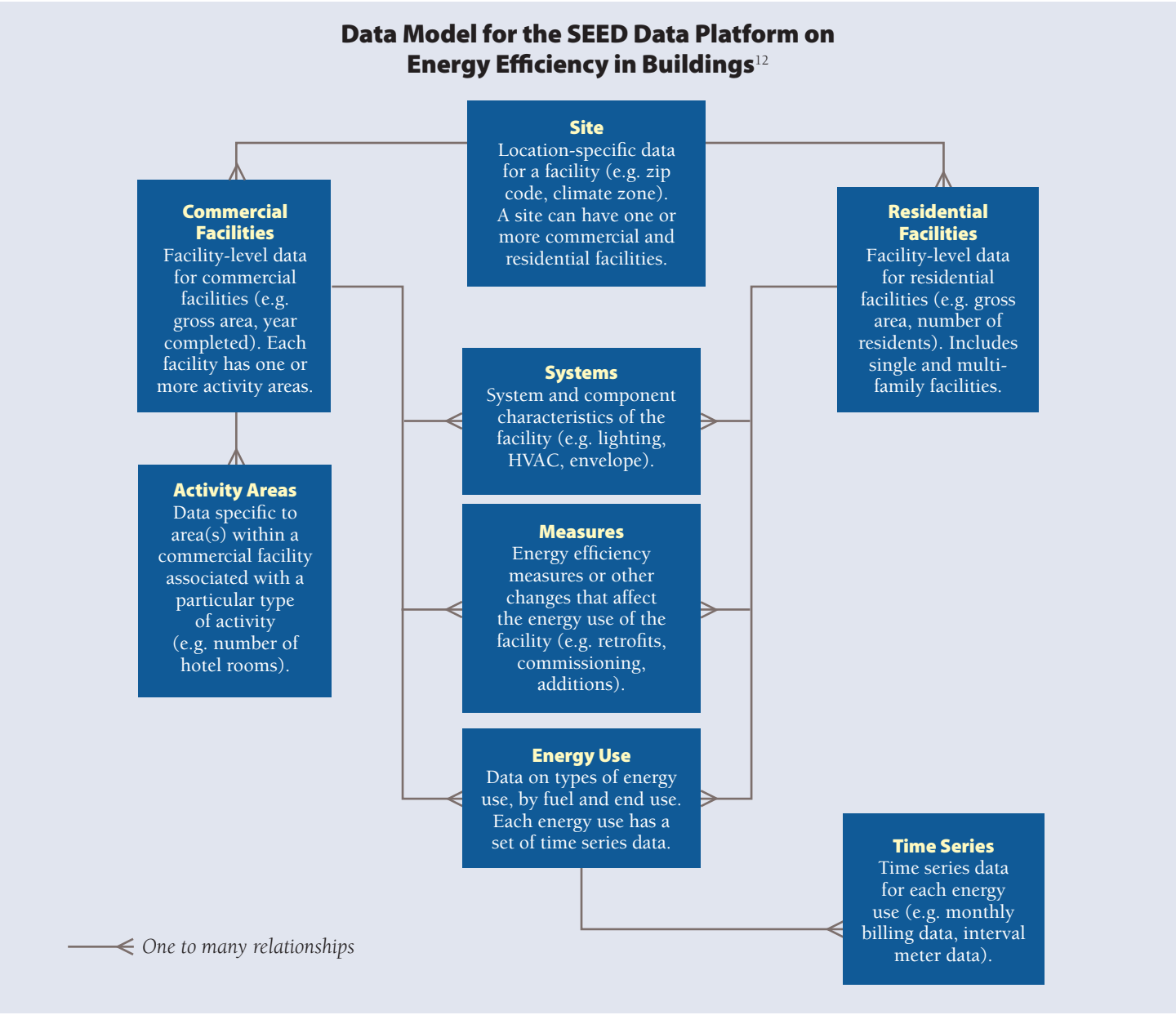
A standardized data taxonomy and database structure is essential to enable sharing of data among platform users and analysis of data sourced from different customer facilities. Typically, a data taxonomy consists of a data model and data dictionary. The data model describes the logical relationships among data categories and individual data fields in the taxonomy, and the data dictionary contains definitions of each data category and field. These definitions are key to ensuring that various organizations using the taxonomy all have a common understanding of its terms, so that data can be comparable.[10]

Figure 5 (page 12) shows the data model that was developed by the US Department of Energy for the standard energy efficiency data (SEED) platform for managing the process of collecting, storing, using, and sharing data on energy efficiency in buildings. This data model is designed from a top-down perspective, currently describing the top levels of a hierarchical approach to building energy characteristics. The taxonomy also contains structure to describe time-series energy use data. It is anticipated that the SEED data taxonomy will evolve over time to include more detailed descriptions of building characteristics.[11]

10 Taylor et al (2012).

11 Taylor et al (2012).

Figure 5



4.3 Standardized Application Programming Interface

An application programming interface (API) is a protocol intended to be used as an interface by software components to communicate with each other. Typically, an API includes a library that contains specification for routines, data structures, object classes, and variables. An API can take many forms, including an International Standard.

Including a standardized open-access API in a data platform enables sharing of data among platform users and third parties. Selected data from the platform database(s) can be made available for query by software analysis tools developed by third parties. With appropriate confidentiality safeguards, analysis results can then be made available to platform users and (where agreed by data owners) to a broader audience.

12 United States Department of Energy (2012).

4.4 Communication Links and Ability to Remotely Control Loads

Data platforms require communication links with individual customer facilities for two purposes:

- to facilitate automatic downloading of energy use data from electricity meters; and
- to enable remote control of the operation of selected appliances and equipment.

A complete load control system using a data platform consists of three basic elements as shown in Figure 6[13]:

- technology included in the data platform;
- communications technology; and
- technology located at the customer facility.

Load control technology included in the data platform has two functions:

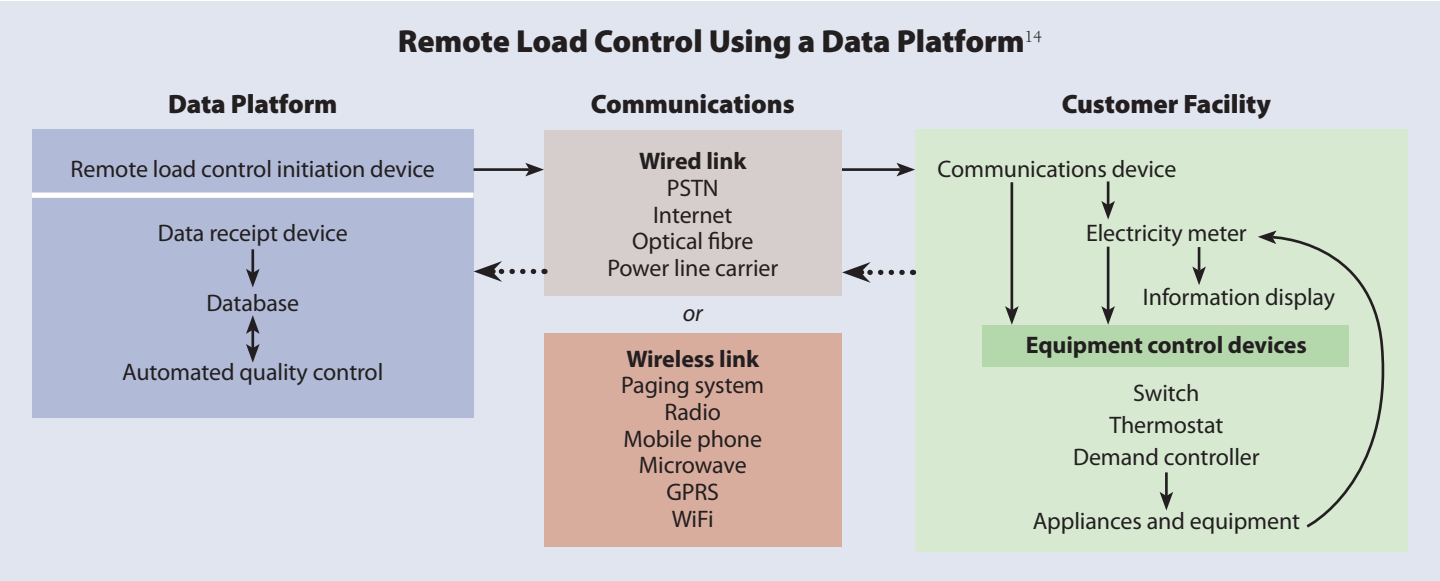
- **Load control initiation:** The program operator must be able to generate and send signals to initiate (and terminate) a load control program event. Coded signals are sent directly to instruct any connected appliances and equipment how to respond.
- **Data receipt and storage:** For operational and billing purposes, the program operator requires data about the quantity and timing of load reductions achieved through the load control program. Two-way communication links between the program operator and the connected appliances and equipment allow this data to be collected in near real time.

Communication technology for load control programs enables signals to be sent by the program operator and also enables the program operator to receive data from controlled loads. A variety of wired and wireless communications technologies can be used in load control programs, as shown in Figure 6.

Load control technology at the customer facility has four functions:

- **Communications:** Signals sent by the program operator must be received by a communications device at the facility and conveyed to connected appliances and equipment. These signals may go directly to the appliances and equipment or via the electricity meter.
- **Controlling appliances and equipment:** The appliances and equipment which are to be controlled must be able to respond to the signals sent by the program operator. Equipment control devices that can respond to signals from the program operator must be attached to the appliances or equipment. These devices may include simple on-off switches, programmable thermostats, and sophisticated programmable demand controllers.
- **Load measurement:** The program operator must be able to measure the load reductions achieved through the load control program. This is typically done using interval electricity meters that automatically measure and record energy use over many, relatively short, time intervals.

Figure 6



13 The following description is based on Crossley (2008).

14 Modified from: Lockheed Martin Aspen (2006).

- Information display: Some load control programs make use of information display devices to provide information to end-use customers about their energy use and costs. The information provided may include: the current electricity tariff, the current energy consumption in the customer's premises, the cost of the current energy consumption, and various messages and alerts about load control events, times at which time of use tariff levels will change, etc.

In China, orderly use of electricity programs implemented by government to maintain system reliability currently have the capability to remotely curtail total loads at customers' facilities. This does not include the ability to control the operation of specific equipment. At present, grid companies are unwilling to affect their customers' operations by remotely controlling equipment at customers' facilities. However, it is important that data platform specifications include this capability. In the future, it is likely that financial incentives will be provided to customers who agree to allow remote control of equipment at their facilities to enable implementation of demand response programs.

4.5 A National Standard for Energy Use Data Platforms

Platforms collecting data on energy use in industrial and tertiary sector customer facilities are currently proliferating throughout China. Eventually, the data collected through these platforms will form a valuable national resource.

It appears that each data platform is being developed independently with little thought about whether it will be possible to share data across platforms. If this continues, it will severely limit the usefulness of the national resource of energy use data. Therefore, it is important that steps are taken to ensure that it will be possible to share energy use data across all the data platforms being developed and implemented in China.

The best way to achieve this goal is to develop and implement a National Standard for energy use data platforms. This Standard should include specifications for the three main elements of such a platform:

- a standardized data taxonomy and database structure;
- a standardized, open-source Application Programming Interface (API); and
- communication links to customer facilities and the ability to remotely control the operation of selected appliances and equipment.

5. Conclusion

The energy use data being collected by data platforms will eventually form a valuable national resource that will provide a unique insight into how energy is being used in China. This information will offer crucial insights to enable the development of government policies to significantly reduce both the energy intensity and the pollution emissions intensity of the Chinese economy. Therefore, it is important that steps are taken now to ensure that the various energy use data platforms are set up in ways that maximize their effectiveness.

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