

Building Energy Data Exchange Specification Scoping Report

Stakeholder & Technology Review

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U.S. DEPARTMENT OF
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Renewable Energy



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Challenge and Opportunity

One of the primary challenges to expanding the building energy efficiency retrofit market is the lack of data on the actual energy performance, combined with the physical and operational characteristics, of commercial and residential buildings. This makes it difficult for building-level decision-makers to understand the drivers of variations in building performance, identify efficiency investment opportunities, and project the likely savings from investments. Moreover, the lack of empirical market data limits the ability of public sector actors to tailor the design and implementation of energy efficiency programs and policies to be most effective given local market conditions and trends.

Recent technology, market and policy drivers (smart meters, energy performance disclosure laws, etc.) are resulting in a rapid increase in the generation of building and energy data that has the potential to address these issues. But this data is still hard to access, aggregate, share and utilize because it is being housed in many decentralized databases, and in different formats. Stakeholders consistently reported that they spend more time on data formatting and cleaning than they do on conducting analysis. ***The lack of standard data formats, terms and definitions is a significant ongoing barrier to realizing the full utility of empirical information about building energy performance.***

Vision for BEDES 1.0

The DOE's vision is to facilitate the optimal operation of the energy efficiency market by nurturing development of a robust ecosystem of interoperable private and public data tools.

The goal of BEDES is to facilitate the utilization and sharing of empirical building energy performance data among software tools and data collection and analysis activities, more easily and consistently and at lower cost. BEDES is intended to be used in tools and activities that help stakeholders make energy efficiency investment decisions, track building performance, and implement energy efficiency policies and programs.

The Building Energy Data Exchange Specification (BEDES) could serve as a central "data dictionary" that a range of tools and platforms can either utilize or map to. A common data format will increase interoperability among tools by mitigating the ambiguity and transaction costs associated with sharing and aggregating data. This would lower the cost and increase the availability of products and services that utilize energy data. As a result, these products and services will achieve greater market penetration and deliver better information to decision-makers.

About BEDES Beta

The Building Energy Data Exchange Specification (BEDES, pronounced “beads” or /bi:ds/) was originally developed for use by the DOE. ***A uniform format is intended to make it easier for external stakeholders to use DOE tools, streamline reporting for DOE programs, and help unlock the full utility of the data that the DOE collects.***

BEDES is designed to support analysis of the measured energy performance of commercial and residential buildings, with fields for building characteristics, efficiency measures and energy use. BEDES draws upon existing data formats and stitches them together into a comprehensive dictionary. BEDES beta was developed based on over forty common private sector and federal formats. It utilizes data fields from ENERGY STAR Portfolio Manager, Green Button and Home Performance XML, among others, and defines additional fields as needed.

BEDES is used in tools such as the Buildings Performance Database (BPD), the Standard Energy Efficiency Data (SEED) platform, and the Commercial Asset Score and Home Energy Score. It is also expected to be used for data collection activities for the State Energy Program and Federal building benchmarking and energy performance contracting activities.

The current version of BEDES is beta 2.3 and is available online at:

www.buildings.energy.gov/BEDES

About this report

While BEDES was originally developed for use by the DOE, many State and local governments, energy efficiency program administrators, and private software developers approached the DOE with interest in utilizing the data format for their own projects. In these conversations, stakeholders consistently reported challenges in exchanging and combining datasets.

The DOE commissioned this scoping study to explore whether common terms and definitions for building energy performance might have broader use and value to the industry. This report assesses stakeholder’s needs and current practices, inventories key related efforts, and explores the potential role of BEDES in the broader technical ecosystem of tools and programs.

The vast majority of stakeholders contacted for the scoping study confirmed the need for a common format to facilitate the exchange and aggregation of data. They said that increased consistency in the way that individual data points are defined and formatted will make it easier to combine information from different sources about the same buildings, use the same information for multiple purposes, and compare information among buildings and public programs. Many made comments such as, “It’s the wild west right now” and “Standardizing will unlock this industry.”

Stakeholders and Use Cases

Stakeholders' wide-ranging uses for empirical data about building-level energy performance generally fall into three main categories. These three kinds of activities all involve the same stakeholders and require using similar kinds of data.

Energy Efficiency Investment Decision-making. Owners and managers reported that they primarily use building energy performance information to make decisions about capital investments or the operation of their buildings.

Building Performance Tracking. The implementation of disclosure policies for public or private buildings requires public officials to collect, clean and analyze massive amounts of data, then share portions of it with the public.

Energy Efficiency Program Implementation and Evaluation. Energy efficiency programs often provide incentives or technical assistance to support owners' data collection and analysis activities. They also use data to conduct program design and outreach, track project performance, and evaluate programs.

Primary Stakeholder Groups Involved in Use Cases	
1. Owners	Building owners & managers as well as any party with a stake or role in building operations, e.g. building staff, tenants, asset managers, etc.
2. Implementers	Energy auditors, architects, engineers & contractors as well as any party involved or interested in the design aspects of a building, e.g. ESCOs, assessors, architects and engineers, consultants, installation contractors etc.
3. Administrators	Utilities and energy efficiency program administrators as well as their implementation contractors, program evaluators, PUCs and other parties that help design, implement and evaluate efficiency programs. Note that utilities also directly provide energy and related services.
4. Public Entities	Federal agencies, states and cities as well as all parties that work with public entities, e.g. regulators, foundations, institutes, etc.
5. Financiers	Lenders, insurers, appraisers, & investors as well as all parties with a financial stake in buildings, e.g. the real estate industry, stockholders, etc.
6. Researchers	Researchers, academics and advocates that conduct analysis of building energy and characteristic data to inform the activities of other stakeholders
7. Developers/ Standardizers	Standards entities, software developers and other parties that create databases, platforms or guidelines that support the activities of the other stakeholders. While standards bodies set official rules, specific tools (such as Portfolio Manager) often have a standardizing effect on data formats through their widespread use.

Technical Ecosystem Serving Use Cases

The DOE is committed to adopting the data spec in its own relevant projects in order to achieve alignment among public tools. **Several publicly-accessible tools** developed by the Federal government already align with BEDES:

- ENERGY STAR Portfolio Manager
- DOE's Commercial Building Energy Asset Scoring Tool and Home Energy Score
- DOE's Buildings Performance Database (BPD)
- DOE's Standard Energy Efficiency Data (SEED) Platform

Several software tools that the DOE uses for internal data management, also plan to utilize BEDES in the short term (1-2 years):

- The Compliance Tracking System (CTS) for EISA Section 432 Federal building benchmarking
- The Energy Service Company Project Analysis and Reporting System (EPARS)

There is also a robust and growing market of **Private sector software tools** that utilize energy performance data. Private tools will be essential to providing the best products and services to the market, While DOE does not endorse any specific private tools (and therefore none are profiled in this report), private tools could voluntarily adopt or align with BEDES to the extent that BEDES supports their use cases.

Data Collection and Analysis Guidelines

Stakeholders identified several projects that are seeking to standardize data collection and analysis practices, which do not dictate the use of any specific software tool or data format. **They said that the final BEDES should be designed so that it can be used in activities that follow methodological guidelines such as:**

- Department of Energy (DOE)- Uniform Methods Project (UMP)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)- Procedures for Commercial Building Energy Audits (*in development*)
- US Green Building Council (USGBC)- LEED Requirements & Green Building Information Gateway (GBIG)
- Institute for Market Transformation (IMT) & National Resources Defense Council (NRDC) - City Energy Project
- Environmental Defense Fund (EDF)- Investor Confidence Project (ICP)

Data Specifications

Several specifications have achieved substantial market traction, serve similar use cases to BEDES, and provide data terms and definitions that can be used for different parts of the BEDES spec. **These data formats and others can be “knitted together” so that BEDES v1 uses established, effective definitions wherever possible.**

- Green button
- HPXML (Home Performance XML)
- Integrated Energy Project (IEP)
- Real Estate Transaction Standard (RETS).

Conclusions

Feedback from stakeholders and a review of the technical landscape both confirmed that common terms and definitions for building energy performance would have broad use and value to the industry.

Public and private stakeholders alike reported that data formatting, cleaning and management is burdensome and creates a barrier to the full utilization of existing building energy data.

Building owners and managers use building energy performance information to make decisions about capital investments or the operation of their buildings. They said that better data would lower the cost and effort required to assess savings opportunities in individual buildings, develop energy strategies across portfolios, and increase the knowledge about local real estate markets

Public sector entities, including Federal, State and local agencies and energy efficiency programs, also drive a significant volume of data collection activities. Many public stakeholders expressed interest in aligning their data formats with each other to ease reporting burdens, facilitate comparisons between jurisdictions, and make it easier to re-purpose data for other uses.

Software developers and project implementers are often ultimately responsible for directly managing this data. Software developers and contractors therefore have the most direct experience with data and most nuanced understanding of what a common spec should include to serve their clients' needs.

BEDES can provide a common data format to support the growth of an ecosystem of interoperable tools and platforms. Stakeholders expressed interest in using BEDES beta as the basis for a common data spec, and said that it would be an appropriate role for DOE to convene a working group to refine the spec for broader use.

BEDES should aim to “knit together” existing data formats in order to use established, effective definitions wherever possible. BEDES can focus on creating new data fields and formats only in areas with the least consistency.

Yet the goal of BEDES should not be to achieve 100% adoption of the data format in the industry. Programs and tools can either adopt the spec or map to it. The spec can also be used to conduct activities that follow methodological guidelines which do not prescribe a data format.

Therefore, establishing and updating “mappings” between BEDES and other data formats will be crucial to its success. An ongoing update cycle will also be needed to ensure that users of BEDES can provide input on changes and additions.

More information about the BEDES project and next steps can be found at: www.buildings.energy.gov/BEDES

SECTION 1: INTRODUCTION

1.1 Challenge and Opportunity

One of the primary challenges to expanding the building energy efficiency retrofit market is the lack of empirical data on the energy performance and physical and operational characteristics of commercial and residential buildings. This makes it difficult for building-level decision-makers to identify efficiency investment opportunities, project the likely savings from investments, and understand the drivers of variations in building performance. Moreover, the lack of empirical market data limits the ability of public sector actors to tailor the design and implementation of energy efficiency programs and policies to be most effective given local market conditions and trends.

Recent technology, market and policy drivers (smart meters, energy performance disclosure laws, etc.) are resulting in a rapid increase in the generation of building and energy data that has the potential to address these issues. But this data is still hard to access, aggregate, share and utilize because it is being housed in many decentralized databases, and in different formats. Stakeholders consistently reported that they spend more time on data formatting and cleaning than they do on conducting analysis. ***The lack of standard data formats, terms and definitions is a significant ongoing barrier to realizing the full utility of empirical information about building energy performance.***

Data exchange specifications can unlock the power of data and make it easier for a range of products and services to interact. A data spec increases the clarity and consistency of individual data points, and therefore allows for more effective exchange, verification, and analysis of information. Data specs have been vital to the growth of technologies like the internet and cellular communications. For example, Universal Product Codes (bar codes) are used to identify trade items at the point of sale, and are based on a specification that is used to manage these items through supply and demand chains in multiple sectors. But building energy performance data is not currently standardized, particularly as relates to building equipment characteristics and energy conservation measures.

The Building Energy Data Exchange Specification (BEDES) could serve as a central “data dictionary” that a range of tools and platforms can either adopt or map to. A common data format will increase the interoperability among tools by mitigating the ambiguity and transaction costs associated with sharing and aggregating data. Moreover, this will enable data from multiple sources to be combined into richer datasets that can be used to conduct more advanced analysis.

The potential benefits from utilizing a common data format are staggering for the industry. It will lower the cost and increase the availability of products and services that utilize energy data. As a result, these products and services will achieve greater market penetration and deliver better information to decision-makers. This could increase investments in energy efficiency and lead to a greater recognition of energy efficiency’s contribution to buildings’ financial performance and asset value.

1.2 About BEDES Beta

The Building Energy Data Exchange Specification (BEDES, pronounced “beads” or /bi:ds/) was originally developed for use by the DOE. A uniform format is intended to make it easier for external stakeholders to use DOE tools, streamline reporting for DOE programs, and help unlock the full utility of the data that the DOE collects.

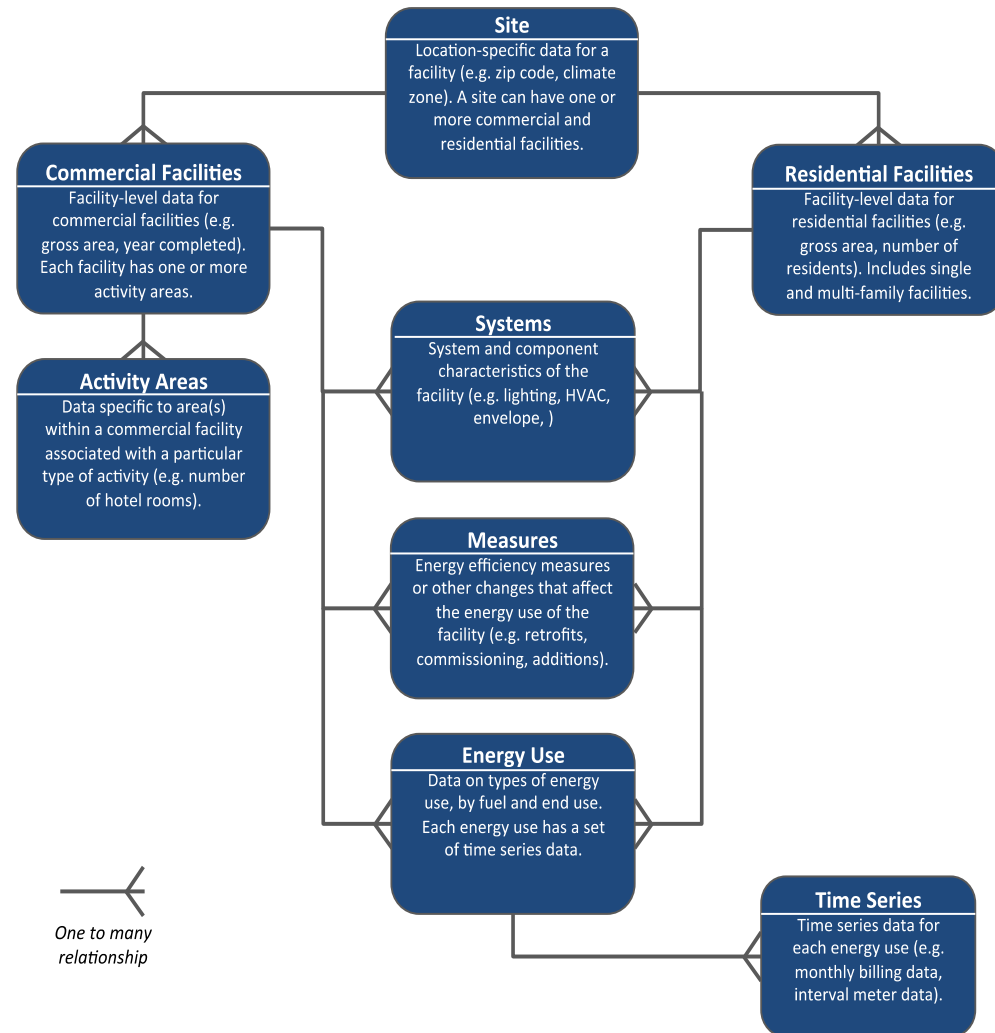
BEDES is designed to support analysis of the measured energy performance of commercial and residential buildings, with fields for building characteristics, efficiency measures and energy use. The BEDES specification currently includes the following elements:

- Field definitions
- Field type and units of measure (e.g. number, percentage, categorical list)
- Aligned specs and tools (specs and tools that utilize the same definition, type and units of measure for a specific field)
- Data Schema (relationships and dependencies between fields)
- .XML and .CSV formats for file transfer

BEDES draws upon existing data formats and stitches them together into a comprehensive dictionary for building performance information. BEDES beta was developed based on over forty common private sector and federal formats. It utilizes data fields from ENERGY STAR Portfolio Manager, Green Button and Home Performance XML, among others.

BEDES is used in tools such as the Buildings Performance Database (BPD), the Standard Energy Efficiency Data (SEED) platform, and the Commercial Asset Score and Home Energy Score. It will also be used for data collection activities for the State Energy Program and Federal building benchmarking and energy performance contracting activities.

Figure 1-1 BEDES beta structure



The current version of BEDES is beta 2.3. and is available online at:

www.buildings.energy.gov/BEDES

1.3 Taking BEDES to scale

About this report

While BEDES was originally developed for use by the DOE, many State and local governments, energy efficiency program administrators, and private software developers approached the DOE with interest in utilizing the data format for their own projects. In these conversations, stakeholders consistently reported challenges in exchanging and combining datasets.

The DOE commissioned this scoping study to explore whether common terms and definitions for building energy performance might have broader use and value to the industry. This report assesses stakeholder's needs and current practices, explores the potential role of BEDES in the broader technical ecosystem of tools and programs, and inventories key related efforts.

This report is informed primarily by the feedback of participating stakeholders and is not meant to constitute an exhaustive market analysis. Feedback was sought from more than 40 stakeholders, on an individual basis, across 7 different categories:

- Building Owners: 4
- Project Implementers: 2
- Program Administrators: 3
- Public entities: 20
- Financiers: 4
- Researchers: 2
- Software Developers and Data Standardizers: 10

Vision for BEDES 1.0

The DOE's vision is to facilitate the optimal operation of the energy efficiency market by nurturing development of a robust ecosystem of interoperable private and public data tools that support informed decision making. The vast majority of stakeholders contacted for the scoping study confirmed the need for a common data spec to fully realize this vision. Many made comments such as, "It's the wild west right now" and "Standardizing will unlock this industry."

Stakeholders recognized several benefits to using the DOE's internal data format as the basis for a common data spec. Most importantly, by committing to align all of its tools with BEDES, the DOE is acting as a first user of the spec. Moreover, through development of BEDES beta, DOE has already begun quality testing the spec, and has identified areas where existing data formats can be utilized and areas where common terms and definitions are more badly needed.

Yet stakeholders also said that the goal of BEDES should not be to achieve 100% adoption of the data format in the industry. There are a range of programs, tools, guidelines and specifications that deal with empirical building energy data for distinct purposes. Therefore, there will likely always be some fields in these tools and platforms that are either not in BEDES or are different from BEDES.

The goal of BEDES is to establish a central dictionary so that common definitions and enumerations can be voluntarily adopted wherever possible. Where translation is still needed between data formats, BEDES will serve as a "Rosetta Stone" so that if other data formats all maintain mappings to BEDES, then it will make it easier to translate between any of the individual formats.

1.4 Terms and Definitions

The following terms are utilized in this report.

Data Specification, or spec

A data spec establishes clear field names, definitions, formats (e.g. number, text) and enumerations (categorical lists) It serves as a guide to ensure that data is consistent among a range of sources and uses. For example, Green Button is a data specification that is used for utility customers' energy consumption information.

Data Schema

A data schema (or model) describes the structural relationships, hierarchies and dependencies between data fields. For example, a schema might dictate that energy consumption data should be associated with a meter and a space in a building. A data specification could be used as the basis for a schema. Schemas are then implemented in databases, software tools and platforms.

Database

A database stores data in an organized structure and allows for the data to be defined, added, edited and queried. The data are typically organized using a spec and schema that support software tools. Well-known database platforms (including the database and user software interface) include SQL, Microsoft Access and Oracle.

File Format

A file format is a specific encoding of a data spec in a computer file to be imported or exported by a software tool or viewed by a user. File extensions are used to denote different file formats. For example, a file formatted as comma separated values would have a file extension of .CSV. Many software tools and databases interact using .XML (Extensible Markup Language).

Software Tool

A software tool is a web or desktop-based computer program that performs specific activities for a user, such as building energy data analysis or data management. The software's source code establishes instructions on how to complete different activities using structured data. Portfolio Manager is an example of a web-based software tool that conducts analysis and stores information in a database.

Software Platform

A software platform is a specific combination of data specifications, databases and software tools that is delivered as a system for users. The Buildings Performance Database is an example of a platform that utilizes the BEDES spec, contains a database, provides its own software tool, and can also be accessed by third-party tools.

Use Case

A use case describes a scenario of activities used to achieve a desired outcome. Software tools and platforms are designed to serve specific use cases. For example, a building owner may conduct several analytical tasks in order to make an investment decision. The purpose of this report is to ensure that BEDES can be effectively utilized by databases, tools, and platforms that serve specific use cases.

Guidelines

A guideline is a set of protocols or best practices to utilize when collecting and/or analyzing data for a specific use case. Guidelines often do not prescribe use of a specific data spec, tool or platform. For example, ASHRAE's Procedures for Commercial Building Energy Audits and DOE's Uniform Methods Project describe analytical tasks that could be completed using the BEDES spec or other data formats.

SECTION 2: DATA USERS AND USE CASES FOR BEDES

2.1 Introduction

This section describes three main categories of use cases for building energy data, including an identification of the stakeholders involved and illustrative examples about how they may use energy performance data.

While there are other potential use cases for building performance data, these three were selected as the priorities for BEDES as they all involve the same stakeholders and the same kinds of data. Moreover, these activities are intended to reinforce and encourage each other:

I. Energy Efficiency Investment Decision-making

conducted by building owners and managers

II. Building Performance Tracking

conducted by public entities

III. Energy Efficiency Program Implementation and Evaluation

conducted by public entities and program administrators

The figure to the right, Figure 2-1, shows the primary stakeholder groups that could benefit from BEDES. Many data users fall into more than one of the stakeholder groups listed, but for the purpose of this report, segregating users allows for distinctions to be made in the value and use cases of BEDES.

Figure 2-1 Primary Stakeholder Groups	
1. Owners	Building owners & managers as well as any party with a stake or role in building operations, e.g. building staff, tenants, asset managers, etc.
2. Implementers	Energy auditors, architects, engineers & contractors as well as any party involved or interested in the design aspects of a building, e.g. ESCOs, assessors, architects and engineers, consultants, installation contractors etc.
3. Administrators	Utilities and energy efficiency program administrators as well as their implementation contractors, program evaluators, PUC's and other parties that help design, implement and evaluate efficiency programs. Note that utilities also directly provide energy and related services.
4. Public Entities	Federal agencies, states and cities as well as all parties that work with public entities, e.g. regulators, foundations, institutes, etc.
5. Financiers	Lenders, insurers, appraisers, & investors as well as all parties with a financial stake in buildings, e.g. the real estate industry, stockholders, etc.
6. Researchers	Researchers, academics and advocates that conduct analysis of building energy and characteristic data to inform the activities of other stakeholders
7. Developers/ Standardizers	Standards entities, software developers and other parties that create databases, platforms or guidelines that support the activities of the other stakeholders. While standards bodies set official rules, specific tools (such as Portfolio Manager) often have a standardizing effect on data formats through their widespread use.

Figure 2-2 Selected Use Cases for Building Energy Data by User Category

The table and definitions below outline some of the roles that different stakeholder groups play in the primary use cases. The three priority use cases involve many of the same stakeholders exchanging the same kinds of data for different purposes. Therefore stakeholders often have multiple roles in different use cases.

- **Primary User.** The Primary User is the user who directly utilizes data to conduct analysis for a specific use case. They may collect data from multiple sources to complete their tasks, and share the results with other end users.
- **Data Provider.** Data Providers provide or gather the data necessary for the Primary Users.
- **End User.** An End User often utilizes the outputs of analysis, but does often does not directly manage raw data or conduct the analysis.

Use Cases	Building Owners	Project Implementers	Utilities & Administrators	Public Entities	Financiers	Researchers	Developers/Standardizers
Energy Efficiency Investment Decision-making	Primary User	Data Provider/ End User	End User		End User		
Building Performance Tracking	Data Provider/ End User	Data Provider	Data Provider	Primary User		End User	End User
Energy Efficiency Program Implementation and Evaluation	Data Provider	Data Provider	Data Provider/ Primary User	Data Provider/ Primary User		Data Provider/ End User	End User

For example, in order for *building owners and managers* to make energy efficiency investment decisions, they may collect information from data providers including building staff, auditors and contractors. Once they complete their analysis of potential energy efficiency investments and decide on a course of action, the owner may share key information with end users such as project contractors, energy efficiency programs (to apply for incentives) or potential project lenders. And, while building owners and managers' needs are the main driver of the use case for energy efficiency decision-making, they are also key data providers for building tracking and disclosure efforts and energy efficiency program implementation activities. It would therefore be beneficial for all parties to be able to use the same data across stakeholders and use cases.

Each of the three use cases is explored in further detail on the following pages.

2.2 Energy Efficiency Investment Decision-Making

Building owners and managers, and some large tenants, have control over building energy systems and pay the associated capital and operational costs. These stakeholders said they have a primary concern with their business plan or investment strategy for the building. They often prefer energy saving opportunities that utilize proven technologies to achieve relatively short payback periods. This is at least partly due to concerns that ECMs will not perform as projected. Nevertheless stakeholders expressed interest in taking advantage of “smart” technologies to solve these problems.

Owners and managers reported that they primarily use building energy performance information to make decisions about capital investments or the operation of their buildings. They said that better data would lower the cost and effort required to assess savings opportunities in individual buildings, develop energy strategies across portfolios, and increase the knowledge about local real estate markets. In the future, they hope that data on energy efficiency performance will help inform asset value. The following are illustrative examples of ways that owners and managers use building energy performance information to make investment decisions:

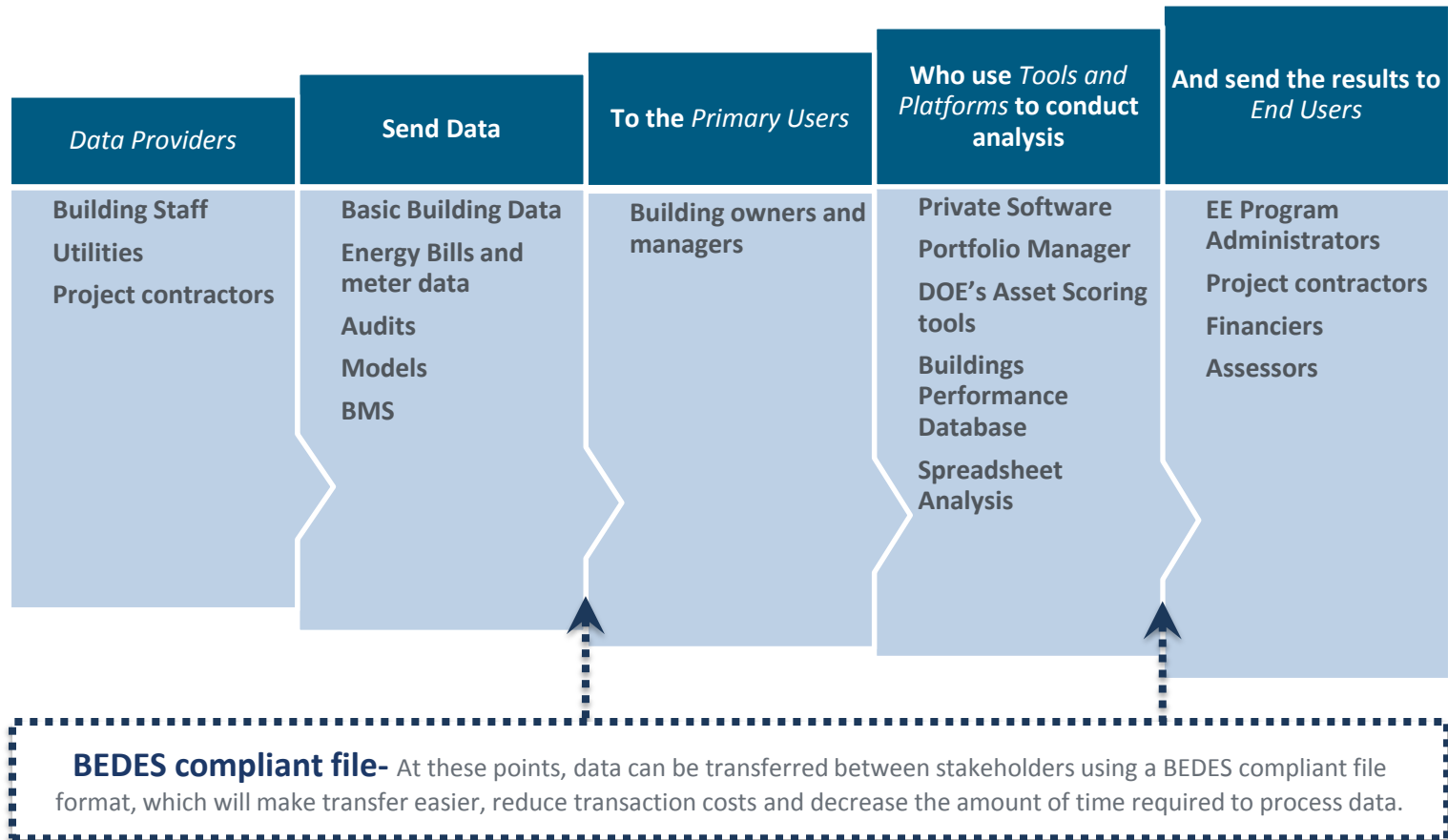
Building performance tracking. Building owners and managers collect information about the consumption of electricity and other fuels, along with information about building equipment and uses, in order to monitor energy use and cost over time. They may use Portfolio Manager, or another method of benchmarking to compare a building to its peers or its own past performance. This enables stakeholders to identify capital needs, conduct fault detection (such as equipment running overnight) and conduct commissioning to ensure that equipment is operating properly. Building performance data can also be shared among building stakeholders such as owners, managers, investors or tenants, and/or reported as part of participation in energy efficiency incentive programs or local disclosure laws.

Assessment of Energy Efficiency opportunities. building owners and managers were interested the potential for better data to significantly reduce the time and cost of conducting in-depth audits on individual buildings. These stakeholders may analyze a building’s performance information in order to understand whether it is performing well or poorly, identify potential efficiency opportunities, and estimate the savings from potential investments. They are also interested in comparing their buildings to peers in the same local market, or investment portfolio, in order to identify high and low performing buildings and develop portfolio-wide energy strategies. Currently, they primarily utilize energy audits, private software tools and spreadsheet analysis to conduct these activities. The DOE has also developed the Buildings Performance Database (BPD), the Home Energy Score, and the Commercial Building Energy Asset Scoring Tool to support these activities.

ECM Investment implementation and tracking. Owners and managers use energy performance information to select the appropriate technologies to install, and to check contractor’s savings estimates (both prospectively and retrospectively). After technologies are installed, data is used to track whether the technologies perform as expected and to analyze variations in the performance of the same ECM in different buildings. Stakeholders said they were particularly interested in using data for continuous monitoring and commissioning, and establishing accountability for staff and contractors. Some financing vehicles, such as ESPCs and MESAs track data to ensure energy savings guarantees are met. Project data may also be reported in order to receive energy efficiency program incentives.

Figure 2-3 Conceptual Data Flow for Use Case: Energy Efficiency Investment Decision Making

Building owners and managers are in a position to collect, control, report and exchange most of the building energy data for which BEDES is designed. In fact, the other two use cases ultimately aim to encourage actions by building owners.



2.3 Building Performance Tracking

More than 15 cities and states in the U.S. have passed laws requiring the benchmarking and disclosure of energy use in private commercial and residential buildings, and an increasingly large number of States and cities (and the Federal government) have committed to benchmarking public buildings. This process requires public officials to work with building owners, managers and contractors, among others, to collect and aggregate mass amounts of data, clean and analyze it, and then disclose the raw data and/or analysis findings to the public.

Most residential disclosure programs require utility data, building checklists, or audits to be disclosed at the time of sale and/or rental. In most cases, this information is directly shared between the parties, and no public entity collects it.

All of the jurisdictions with disclosure programs for commercial buildings use the EPA's ENERGY STAR Portfolio Manager. The common use of Portfolio Manager has helped standardize the data fields that the tool collects (basic building information, operational characteristics and energy consumption) and generates (annual energy consumption metrics) about individual buildings.

Yet once data on individual buildings is reported to public agencies, it is often combined with additional building information from local property records, city planning databases, audits and retro-commissioning studies, and other sources, in order to enforce compliance and conduct more advanced analysis on trends in energy performance. Public agencies stated that unstandardized data specifications and formats for this information significantly increases the data management burden on public agency staff for merging and cleaning datasets. They also expressed a desire to compare the data with other jurisdictions, researchers, developers and standardizers.

Disclosure requirements are typically implemented to provide information feedback on individual building and jurisdiction-wide energy performance, and to track progress towards achieving public energy or environmental goals. The following are illustrative examples of ways that public agencies use building energy performance information to facilitate building performance tracking:

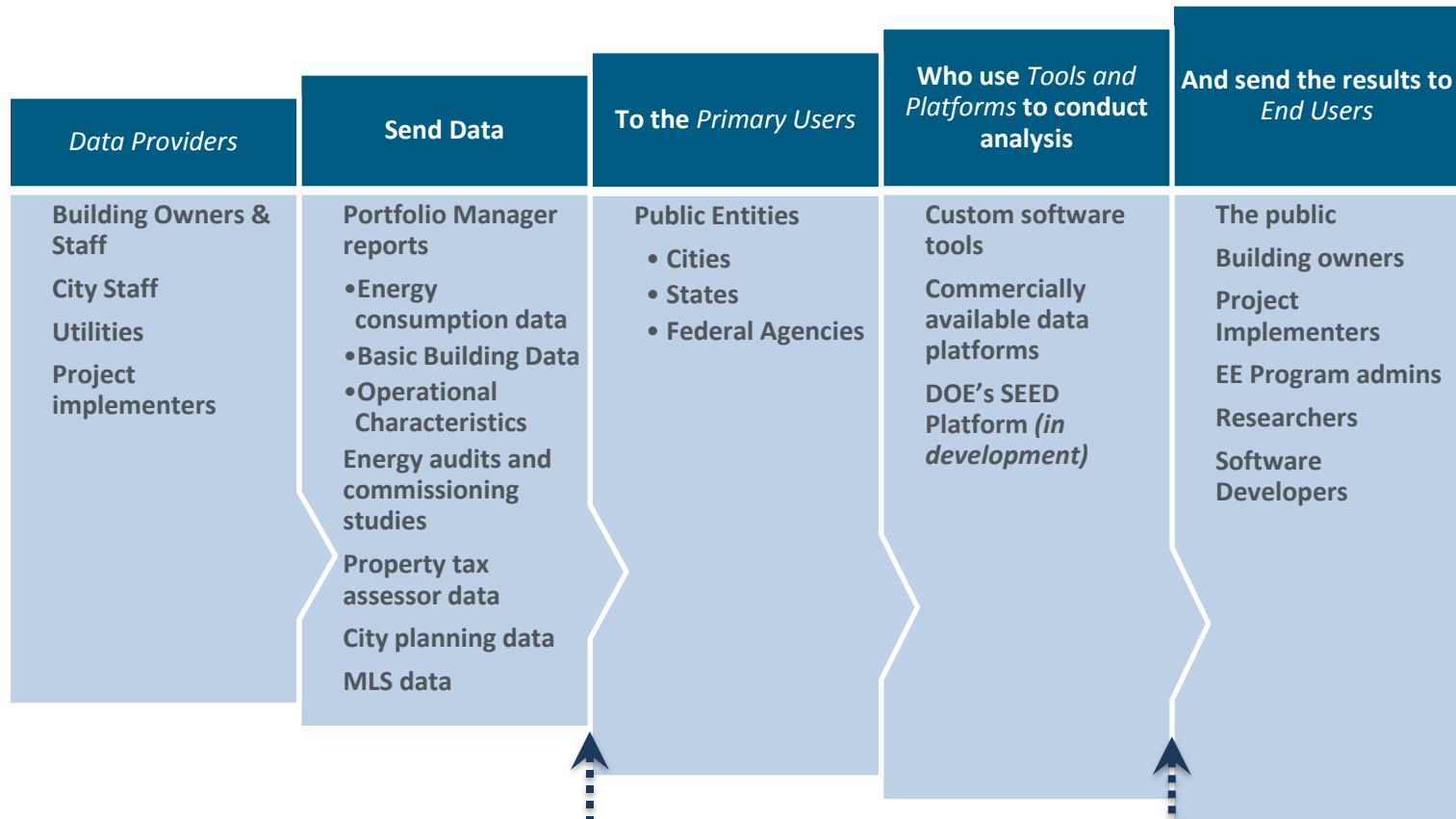
Building performance tracking. Public entities utilize building performance data to track participation in energy efficiency programs, compliance with policies, and progress towards energy-savings or climate goals across a portfolio or jurisdiction. Today, much of this data management is being conducted using either custom software tools or commonly available spreadsheet and database programs. Stakeholders were very interested in the potential for the DOE's Standard Energy Efficiency Data (SEED) platform to serve as a common open source database and software platform for these activities.

Market transformation. Public entities have limited budgets to promote energy efficiency across jurisdictions and therefore foster market solutions as much as possible. Providing information feedback about building performance relative to local and national peers, is one of the most low-cost and effective ways to transform investment decision making by building owners.

Assessment of Energy Efficiency opportunities. Large data sets with information about an entire local market or portfolio of buildings allow public entities to identify buildings types and energy conservation measures to target for additional policy and program interventions. The same data can then be used for program marketing and outreach activities.

Figure 2-4 Conceptual Data Flow for Use Case: Building Performance Tracking

Cities, states and federal agencies are in a position to design the structure for which data is collected and used and implement changes based off of information gathered from that data.



BEDES compliant file- At these points, data can be transferred between stakeholders using a BEDES compliant file format, which will make transfer easier, reduce transaction costs and decrease the amount of time required to process data.

2.5 Energy Efficiency Program Implementation and Evaluation

Energy efficiency program administrators, which may be utilities, public entities or third parties, are responsible for designing, implementing and evaluating policies and programs that are intended to drive energy efficiency adoption. Programs may provide technical assistance or financial incentives to building owners to encourage energy efficiency investments. These programs are typically publicly-funded and intended to have public benefits. Program administrators are therefore concerned with achieving the highest impact possible with limited public resources and ensuring that the impacts can be accurately measured, in order to refine their efforts and ensure accountability.

Multiple stakeholders from jurisdictions that are considered energy efficiency leaders reported that inconsistent program tracking and evaluation practices within their own agency's portfolio is inhibiting the full utilization of data they already have. Moreover, public agencies and program administrators expressed interest in integrating municipal assessor data, utilities' customer databases and historic EE program participation data to better identify prospects, provide information feedback to participants, and assess program effectiveness. Some noted that while it may not be in contractors' interest to share project data, they were eager for a common spec to combine public datasets for their own uses.

The following are illustrative examples of ways program administrators use building energy performance data:

Information for participants. Public programs often provide incentives or technical assistance to support data collection and analysis activities, such as audits and technical assistance, to encourage investment decision-making. They may also use data to drive behavioral change through on-site devices and social media platforms, energy maps, etc.

Program Design and Outreach. Data on local real estate market characteristics, from utility databases, market research or disclosure laws, can be used to prioritize building types and ECMs for program design. The same data can then be used to target program marketing and outreach activities.

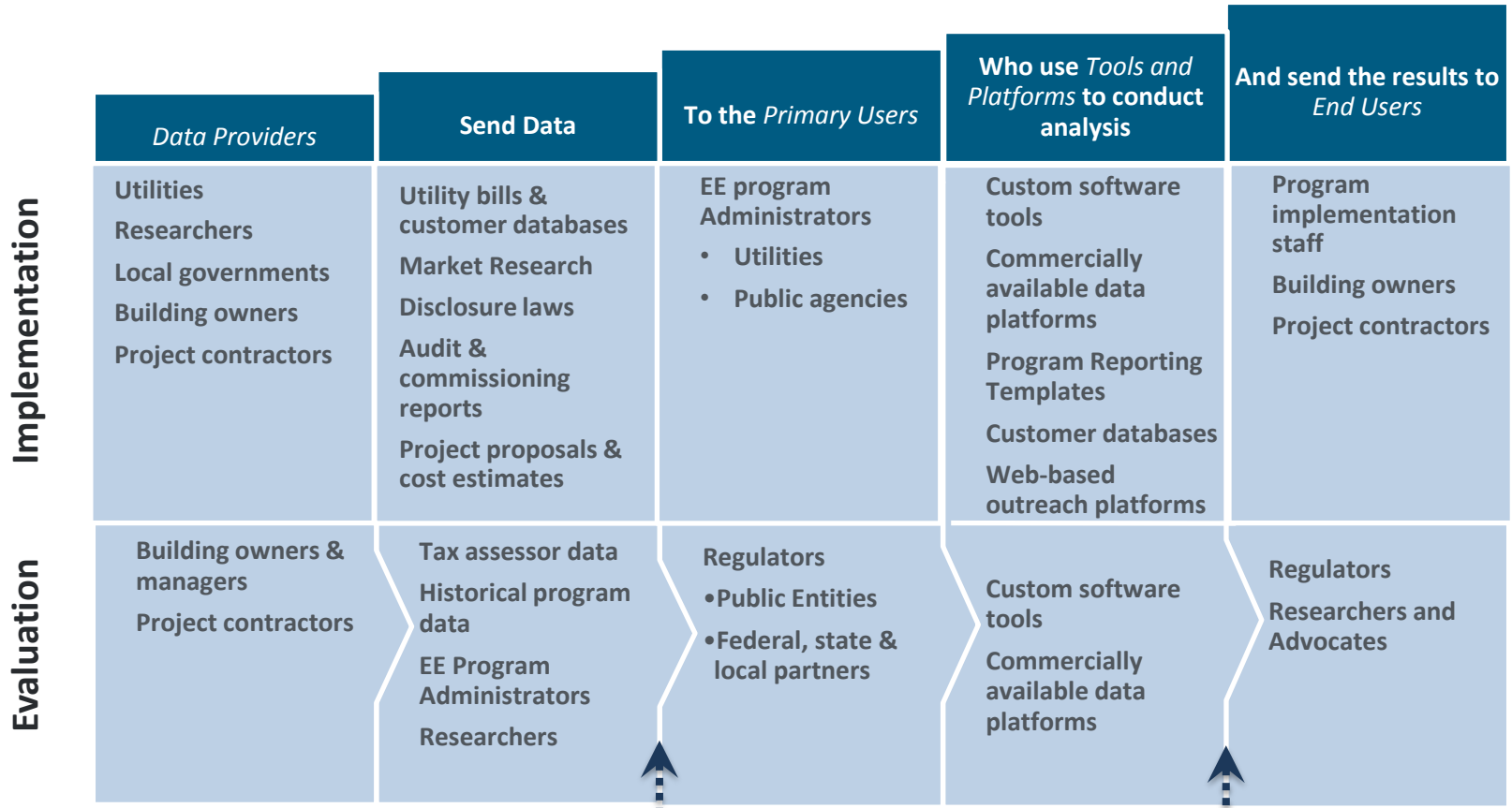
Project Implementation and Tracking. Energy efficiency programs often collect building performance data as part of their process for determining projects' eligibility for financial incentives, determining incentive levels and tracking post-installation savings. Many programs also offer performance-based incentives that tie compensation to verified savings. Some programs tie incentives to labels such as ENERGY STAR. Home Performance XML has gained some traction among energy efficiency programs and industry organizations as a data format for information about single family homes.

Program evaluation. Project-level data is used to develop program level metrics such as the total energy and peak demand savings, program realization rates, and cost-benefit ratios. These program metrics are used to track the market penetration, and compare the impact and cost-effectiveness, of different programs. DOE's Uniform Methods Project provides guidelines for many of these activities.

Data can also be used to compare ECM performance among program participants. Stakeholders expressed interest in using program level data to identify factors that influence whether project-level savings are achieved, such as installation and commissioning practices, and the training and certifications of contractors.

Figure 2-5 Conceptual Data Flow for Use Case: Energy Efficiency Program Design and Evaluation

Program administrators are in a strong position to set data requirements for participants and vendors in their programs and to provide a wide range of data for potential use by building owners and managers and other stakeholders. This graphic shows the data flows for program implementation and evaluation only, as the other illustrative examples on the previous page are inputs to the energy efficiency investment decision-making use case.



BEDES compliant file- At these points, data can be transferred between stakeholders using a BEDES compliant file format, which will make transfer easier, reduce transaction costs and decrease the amount of time required to process data.

SECTION 3: TECHNICAL ECOSYSTEM SUPPORTING USE CASES

3.1 Introduction

The goal of BEDES is to support a technical ecosystem of software tools and standardized data collection and analysis practices that help stakeholders achieve the identified use cases more easily and consistently and at lower cost. This section reviews related software tools and efforts that could directly adopt or align with BEDES.

As discussed in the previous section, stakeholders utilize a range of private and public tools and platforms to conduct activities related to the three main use cases. BEDES is intended to provide a common language so that this ecosystem of tools and platforms can be interoperable. It will do so by establishing a central dictionary so that common definitions and enumerations can be used where possible.

The DOE is committed to adopting the data spec in its own relevant projects in order to achieve alignment among public tools. However the range of tools and efforts in the market have differing use cases, and therefore they may always have some fields that are either not in BEDES or different from BEDES. Where translation is still needed between data formats, BEDES will serve as a “Rosetta Stone” so that if other data formats can all maintain mappings to BEDES, it will be easier to translate between any of the formats.

There is a robust and growing market of **Private sector software tools** that utilize energy performance data. private tools will be essential to providing the best products and services to the market, While DOE does not endorse any specific private tools (and therefore so not profile any in this report), private tools could voluntarily adopt or align with BEDES to the extent that BEDES supports their use cases.

Several publicly-accessible tools developed by the Federal government already align with BEDES:

- ENERGY STAR Portfolio Manager
- DOE’s Commercial Building Energy Asset Scoring Tool and Home Energy Score
- DOE’s Buildings Performance Database (BPD)
- DOE’s Standard Energy Efficiency Data (SEED) Platform

DOE’s publicly-accessible software tools that are primarily used for more detailed analysis and modeling, such as EnergyPlus, Open Studio and MulTEA, could align with BEDES in the medium to long term, when new levels of detail are added to the specification.

Several software tools that the DOE uses for internal data management, also plan utilize BEDES in the short term (1-2 years):

- The Compliance Tracking System (CTS) for EISA Section 432 Federal building benchmarking
- The ESCO Project Analysis and Reporting System (EPARS)

BEDES will enable Federal government tools to be combined to provide comprehensive program delivery and tracking. For example, The State Energy Program Area 1 grantees will be using Portfolio Manager and the Commercial Asset Score to assess their own building portfolios and identify opportunities for investment. DOE will internally manage the resulting data using SEED and publish it anonymously through the BPD.

3.2 Private Sector Software Tools

The use cases described in the last section are supported by a robust and growing technical ecosystem of software tools and platforms. Building owners and public entities are the “first movers,” because their needs often drive data collection requirements. But software developers respond to this market needs with products and services to collect and analyze this data. Software developers are therefore important to engage in the finalization of BEDES because they have the most direct experience with data and most nuanced understanding of what a common spec should include.

Software developers clearly recognize the need for a common spec. One said that 80-90% of their cost is in data import, another complained that “you may have 10 different ways to define the same thing” and they have to rely on engineers to figure it out. Software developers would benefit from being able to accept and provide data to building owners and public entities in a standard format. Moreover, they may choose to voluntarily adopt the BEDES spec for their own products and services if it proves useful to them.

Examples of Software Developers and Tools Include:

-1010data	-Gridium	-Performance Systems Development	-UTRC
-Autogrid	-GridNavigator	-PlotWatt	-Viridity
-Bidgely	-Honest Buildings	-Pulse Energy	-Webfortis
-Bright Power	-Joule Assets Inc.	-Retroficiency	-Wegowise
-Building Energy	-Kiewit Building Group Inc	-Salesforce	<i>Other custom software for:</i>
-C3 Energy	-KWHours	-Simuwatt	<i>-Customer service</i>
-CKAN	-Lucid Design Group	-Socrata	<i>-Energy use and billing</i>
-Core Logic	-MyEnergyPro	-SkySpark	<i>-Program tracking</i>
-CoStar	-Nest	-SPARC 5twenty	<i>-Real estate listings</i>
-Ecofactor	-New Buildings Institute	-Stem	
-Empowered Energy Solutions	-Noesis	-Sustainable IQ	
-Energyai	-Opower	-Tendril	
-EnergyHub	-Oracle	-TRC Solutions	
-FirstFuel	-Peregrine Energy Group		

3.3 Federal Tools for Public Use

There was widespread recognition by stakeholders of the value already provided by federal analytical tools, such as Portfolio Manager, the asset scoring tools, and BPD. Stakeholders also anticipate the value that SEED will provide when it is complete. Aligning the data formats for all these tools and activities would reduce the data management burden for external stakeholders and help unlock the full utility of data that is already being collected.

The current version of BEDES beta adopts the Portfolio Manager and Green Button data fields and formats in their entirety. BEDES beta then goes on to define additional fields that have not yet been standardized, such as equipment information. The BPD and SEED tools contain all BEDES beta compliant data fields. The Asset Scoring Tools, Compliance Tracking System and EPARS either currently are, or will utilize a subset of BEDES fields.

Figure 3-1 Use Cases and Federal Tools

Use Cases	PM	CAS	HES	BPD	SEED
	Portfolio Manager	Commercial Building Energy Asset Score	Home Energy Score	Buildings Performance Database	Standard Energy Efficiency Data
Energy Efficiency Investment Decision-making	★	★	★	★	
Building Performance Tracking	★			★	★
Program Implementation and Evaluation					★

Figure 3-2 Federal Tools and Their Relationships

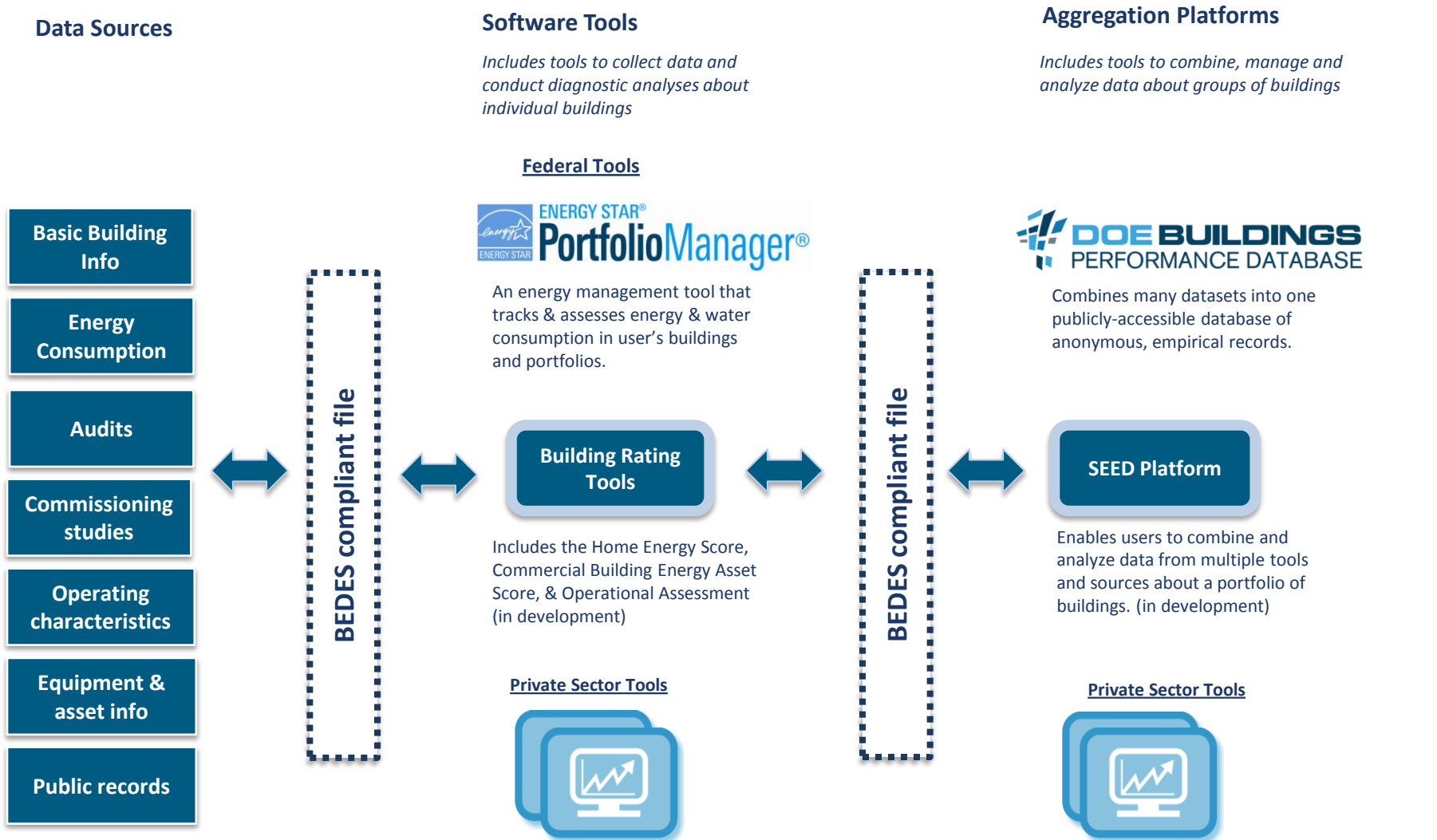


Figure 3-3 Federal Tools and Their Relationships

Data Formats	Functionalities		
	Data collected	Comparison framework	Analyses
ENERGY STAR Portfolio Manager	<ul style="list-style-type: none"> Basic Building Characteristics Operational characteristics Whole building energy use 	<ul style="list-style-type: none"> Datasets consisting of statistically representative national samples of buildings by type, from CBECS & other sources Comparisons within a user’s portfolio, and to a building’s own median and prior year energy use 	<ul style="list-style-type: none"> Weather normalized EUI Whole building score, based on actual energy performance Create custom reports summarizing key statistics Report selected fields and records to other parties
Commercial Building Energy Asset Score & Home Energy Score	<ul style="list-style-type: none"> Basic Building Characteristics Equipment & Systems Info 	<ul style="list-style-type: none"> Energy model of the building as built Compared to an absolute scale of energy use intensity (EUI) 	<ul style="list-style-type: none"> Whole building score, based on as-built physical characteristics independent of operations Identification of inefficient systems & potential upgrades
Buildings Performance Database	<ul style="list-style-type: none"> Basic Building Characteristics Equipment & Systems Info Operational characteristics Whole building energy use Identified & implemented ECMs 	<ul style="list-style-type: none"> Large, anonymized dataset of real buildings (cleansed & validated by national labs) 	<ul style="list-style-type: none"> Energy performance distributions of user defined peer groups Energy & financial savings projections for retrofit measures An API will allow other software developers to conduct analyses using the BPD data.
The Standard Energy Efficiency Data Platform (SEED)	<ul style="list-style-type: none"> Basic Building Characteristics Equipment & Systems Info Operational Characteristics Whole building energy use Identified & implemented ECMs Personnel & contractor info User-customized fields 	<ul style="list-style-type: none"> Users import their own datasets from multiple sources about the same group of buildings (such as Portfolio Manager, Asset Scores, Audits, Property Tax Assessor databases, etc.) 	<ul style="list-style-type: none"> Analyze compliance with benchmarking & disclosure laws. Make selected fields & records publicly accessible Create custom reports summarizing key statistics

3.3.1 ENERGY STAR Portfolio Manager

Portfolio Manager is an interactive energy management tool that allows users to track and assess energy and water consumption across an entire portfolio of buildings. After users enter energy consumption and cost data, Portfolio Manager enables users to identify investment opportunities, verify efficiency improvements, benchmark building energy performance, assess energy management goals over time, and receive EPA recognition for superior performance.

Building stakeholders can use EPA ENERGY STAR Portfolio Manager to measure and track the energy use of any commercial building. For many types of buildings, they can go a step further and rate the building's energy performance on a scale of 1-100 relative to similar buildings nationwide. EPA calculates the 1-100 score using statistically representative models developed from national survey data. Buildings that achieve a score of 75 or higher are eligible to apply for the ENERGY STAR label. More than 300,000 buildings across the country have benchmarked their energy use with Portfolio Manager. It is also used as the basis for many incentive programs and disclosure laws.

Relationship to BEDES

Because Portfolio Manager (PM) is so widely used, it has had a standardizing effect on the fields that it collects, such as basic building information (age, size, uses), energy consumption data and operating conditions. BEDES currently fully adopts the PM data definitions and will continue to do so. BEDES may add additional fields or detail as needed, such as multiple definitions of square footage (e.g. gross, net, rentable), but will always indicate which version Portfolio Manager uses. This will help increase the quality of data inputs for Portfolio Manager and other tools.

Website: EnergyStar.gov/benchmark

3.3.2 Commercial Building Energy Asset Scoring Tool

The Commercial Building Energy Asset Scoring Tool is a free tool that helps building owners, operators, and others understand the "as-built" energy efficiency of their buildings and evaluate investment opportunities. The scoring tool collects information about the building's physical characteristics and major energy related systems and equipment. Data Inputs include general information, envelope components, fenestration, lighting fixtures, mechanical components, service water heating and operations.

After applying standard operating assumptions based on building type, the scoring tool then generates a 1-100 whole building energy efficiency score using the EnergyPlus modeling engine that is independent of occupancy and operational choices. The tool also helps building owners and operators gain insight into the efficiency of their individual building systems by disaggregating building energy information and identifying inefficient systems and potential opportunities for upgrade. This information can also help inform asset valuation and distinguish efficient properties in the market.

Relationship to BEDES

An early version of the Tool schema was mapped to BEDES beta. Going forward, BEDES and the Tool schema will be harmonized for data fields common to both.

Website:

<http://www1.eere.energy.gov/buildings/commercial/assetscore.html>

3.3.3 Home Energy Score

The U.S. Department of Energy's Home Energy Score helps homeowners and contractors assess energy efficiency opportunities. The Home Energy Score is comprised of three parts including: 1) the Score itself, 2) facts about the home and its expected energy use, and 3) recommended improvements to increase the home's energy efficiency and Score.

To generate a Home Energy Score, a Qualified Assessor collects information on a home's physical characteristics and major energy using equipment (~40 data points), and then uses the Home Energy Scoring Tool to estimate the home's likely energy use and generate a climate specific 1-10 score (10 being excellent energy performance). Based on standard operating assumptions, the Home Energy Score allows consumers to compare homes on an equal basis nationwide, putting aside the effect of homeowner behavior, home location, non-permanent house features (non-fixed assets), or number of occupants.

Relationship to BEDES

Like the Commercial Building Energy Asset Scoring Tool, the Home Energy Score fields were mapped to BEDES beta. Going forward, BEDES and the Tool schema will be harmonized for data fields common to both.

Website: HomeEnergyScore.gov

3.3.4 Buildings Performance Database (BPD)

The BPD is compiling and cleansing the largest, publicly-available dataset about real commercial and residential buildings. This critical mass of empirical information will support better decision-making among building owners and managers, government agencies, energy efficiency program administrators, and financial institutions alike.

The BPD enables users to perform statistical analyses on an anonymous dataset of tens of thousands of commercial & residential buildings from across the country. Users can define a custom peer group and examine statistics about their energy performance in relationship to physical and operational characteristics in order to quantify the likely energy savings, financial performance, and risk profiles of specific energy efficiency improvements. Other software tools will also be able to access the BPD to run their own analyses, via an API (Application Programming Interface), while maintaining the anonymity of individual records.

In addition, many public entities and energy efficiency program administrators are using the BPD as a means to make the data they already collect available and useful to the market without violating privacy of individual buildings.

As of July 2013 the BPD is publicly available and includes about 70,000 buildings from over 20 public and private sources. It was accessed by almost 4,000 users in the first month after launch. The BPD currently features a "Peer Group" and a "Retrofit Analysis" tool, and a tool for conducting financial performance analyses is under development.

Relationship to BEDES

The BPD was developed in parallel with BEDES and aligns fully with the data specification.

Website: Buildings.Energy.gov/BPD

3.3.5 Standard Energy Efficiency Data (SEED) platform

Many State and local governments are beginning to track the performance of publicly-owned buildings or to require private buildings to disclose their performance. These entities share a need to merge, cleanse, track and store data from multiple sources about large groups of buildings, using BEDES format. To support these efforts, the Department of Energy is building a standard database platform that provides an easy, flexible, and free method to manage and share data about large portfolios of buildings. It allows users to establish a secure, local data repository while using a common open source framework. Users can select data to be published, contributed to the BPD, or access by private software tools. The common database platform will also make it possible for software developers to build and market plug-in “apps” that can be utilized by all SEED users.

As of July 2013, the SEED platform has been tested in beta form by about 10 local governments with benchmarking and disclosure laws. The DOE OWIP Program is also planning to use SEED for managing data resulting from building benchmarking and showcase projects conducted through the State Energy Program Area 3 (Lead by Example). LBNL released an RFP in June to solicit a software developer to build a production-quality version of the tool. The DOE is also developing a long-term strategy to move towards a financially sustainable business model where SEED is maintained and promoted by the user community.

Relationship to BEDES

SEED is aligned fully with the BEDES specification and the V1 will remain aligned throughout updates to either the BEDES specification or the SEED platform.

Website: Buildings.Energy.gov/SEED

3.3.6 DOE’s Modeling Tools

The three main uses cases identified as short term priorities for BEDES do not necessarily require detailed building modeling. Yet other use cases do exist that require detailed building modeling and simulation at the equipment and component level, and there is another set of software tools, analytical methods, and data specifications to serve these use cases.

Building contractors and the A&E community use a small set of building energy modeling engines that includes several supported by DOE (EnergyPlus, DOE-2.1E, DOE-2.2) and several developed by other entities, such as TRACE, HAP, TRNSYS and CSE among others.

These engines accept building descriptions in differing formats and degrees of detail and produce energy consumption reports with similar variance. There are multiple ongoing efforts to standardize building energy simulation input and output and to build engine-specific translations from and to these standard schemas. DOE is using OpenStudio as a platform for these efforts.

In the following section tools which hold potential for medium to long term alignment with BEDES but are not currently included in BEDES beta scope are highlighted. While BEDES does not seek to cover this level of detail in the short term, in the medium term there is value to being able to “roll up” detailed building data into BEDES-level data and/or to use empirical data and modeled data as checks for each other.

In the long term, BEDES could expand to cover the level of detail needed for modeling program data inputs and outputs. As some of these tools and platforms are still nascent, BEDES may be able to encouraging the use of a common format.

3.3.6.1 EnergyPlus and Open Studio

EnergyPlus is DOE's state-of-the-art, open-source whole-building energy simulation engine. Taking in a detailed description of a building's physical assets (envelope, mechanical systems, and lighting systems) and operating conditions (occupancy, thermostat set points, plug and process loads, and weather), EnergyPlus calculates a building's energy consumption at sub-hourly intervals, integrating those into annual profiles. EnergyPlus is used in the holistic design of buildings, their mechanical systems and control systems. It supports energy-efficiency code development and compliance. It underpins programmatic tools for utilities, companies, and jurisdictions. And it forms the basis of large scale analyses that drive policy.

OpenStudio is a cross-platform (Windows, Mac, and Linux) collection of software tools to support whole building energy modeling using EnergyPlus and advanced daylight analysis using Radiance. OpenStudio is an open source project to facilitate community development, extension, and private sector adoption of tools that leverage EnergyPlus modeling engine. OpenStudio includes graphical interfaces along with a Software Development Kit (SDK).

Website: Buildings.Energy.gov/EnergyPlus

3.3.6.2 NREL Building Component Library

"The Building Component Library (BCL) is the U.S. Department of Energy's comprehensive online searchable library of energy modeling building blocks and descriptive metadata."⁷ While BCL is tightly integrated with DOE's OpenStudio energy modeling platform and derivative tools, it is agnostic, and can contain many types of data for a variety of modeling tools.

A repository of building content used to create and transform building energy models, BCL contains components and measures that are searchable via web or application program interfaces. Model components are used to construct models and include windows and wall constructions, schedules, weather data, space type definitions, PV modules, and more. Measures are modeling scripts that can transform energy models in specific ways. Examples include automatic generation of building envelopes with particular geometries, building rotation, or application of specific energy conservation measures.

The level of detail of the data collected for the BCL is currently too granular for the BEDES beta but further engagement is being explored for long term alignment.

Website: BCL.NREL.gov

7: <https://bcl.nrel.gov/about>

3.3.6.3 MulTEA

MulTEA will produce an investment grade audit and provide auditors with an improved energy simulation and weatherization measure selection tool for multifamily buildings. MulTEA is being developed in response to feedback from professionals in the field that to appropriately address multifamily specific building energy calculations. MulTEA will provide a recommended scope of work for a project based on Savings to Investment Ratio (SIR).

The Multifamily Tool for Energy Audits is being developed in two phases. Version 1.0 is for users who work on less complex low-rise multifamily buildings of four stories or less as 70-80% of all 5+ unit multifamily buildings are in small multifamily buildings according to RECS. Version 1.0 will be available for use in the field November, 2013.

Version 2.0 will include high rise buildings, more complex buildings and systems, central plant heating and cooling systems and more complex weatherization measures. A major innovation planned for Version 2.0 of MulTEA is that the building energy use can be calibrated against actual billing data using hourly historical weather data that prevailed during the billing period. Version 2.0 will be available in early 2014.

3.4 DOE Tools for Internal Data Management

The DOE also collects data for its internal activities ranging from Federal building benchmarking and energy service contracts to the Better Buildings Initiative and the State Energy Program. The software tools that the DOE uses for internal data management are also expected to harmonize with BEDES over the next few years. An integrated suite of tools for DOE’s building-energy-performance related programs will ease the reporting burden for federal agencies and their contractors, and support data sharing and disclosure in standard format.

Figure 3-4 Use Cases and DOE Internal Tools

Use Cases	CTS	EPARS
	Compliance Tracking System	ESCO Project Analysis and Reporting System
Energy Efficiency Investment Decision-making		★
Building Performance Tracking	★	
Policy and Program Design and Evaluation		

3.4.1 Compliance Tracking System (CTS)

The Federal facility Compliance Tracking System (CTS) tracks Federal agency progress toward meeting the requirements of EISA Section 432 (42 U.S.C. 8253(f)) for Federal facility energy and water management and benchmarking. CTS tracks agency performance of energy and water evaluations, project implementation and follow-up measures, and annual building benchmarking requirements.

The CTS accepts required Federal agency reporting on:

- Designation and location of facilities and assignment of energy managers
- Annual building benchmarking metrics including energy and water consumption
- Energy and water evaluations completed at covered facilities
- Implementation of energy and water efficiency measures (ECMs), including estimated cost and savings
- Follow-up status on implemented measures, including measured savings and persistence of savings

Relationship to BEDES

Some federal agencies are using Portfolio Manager to report building level benchmarking data, while some that have campuses are reporting facility-level metrics. The remaining information about the facility and ECMs mostly align with BEDES. DOE is working internally to conduct a mapping of the CTS fields to BEDES fields so that CTS data can be contributed to the Buildings Performance Database, and the CTS and BEDES be harmonized in the medium term.

Website:

http://www1.eere.energy.gov/femp/regulations/facility_cts.html

3.4.2 Energy Service Company (ESCO) Project Analysis and Reporting System (EPARS)

EPARS is a user interface on an LBNL-NAESCO database that has been built and maintained over the past ten years by Lawrence Berkeley National Laboratory (LBNL) in collaboration with the National Association of Energy Service Companies (NAESCO), with funding from the DOE.

NAESCO accreditation requires that ESCOs report 50 types of information for each of their projects, and some records also come from state energy offices and FEMP. EPARS serves as an objective information resource on the ESPC and ESCO industry, with over 4,100 projects in 49 states representing about \$10B in total investment. Analyses are conducted on ESCO industry and market trends, project performance and market activity, as well as trends in savings, investment levels, customer preferences, and market penetration of EE/DG technologies.

The DOE is currently planning a modernization of the tool so that it can also be used for data reporting and contract management for energy savings performance contracts (ESPCs) in Federal Buildings. The new tool is being developed by LBNL in collaboration with State Energy Offices so that it can be used for reporting of ESPC project information across all levels of government.

Relationship to BEDES

EPARS can utilize BEDES data fields and formats to collect and process the building performance and ECM project information. EPARS will have additional, Federal government-specific fields for detailed contract terms and milestone tracking, which are outside of BEDES' scope.

Website: <https://oahu.lbl.gov/esco/login.html>

SECTION 4: DATA COLLECTION & ANALYSIS METHODOLOGIES

4.1 Introduction

This section gives an overview of a unique category of projects that are seeking to standardize data collection and analysis practices. These efforts seek to standardize an analytical process, such as program evaluation or project underwriting, without dictating a specific software tool or data format through which it is implemented. BEDES can be used to conduct data collection and analysis activities that follow these guidelines.

While there many data collection and analysis efforts that could utilize BEDES, these five were mentioned most often by stakeholders. BEDES should therefore prioritize engagement and collaboration with these projects and others that align with BEDES priority use cases:

1. Department of Energy (DOE)- Uniform Methods Project (UMP)
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)- Procedures for Commercial Building Energy Audits
3. US Green Building Council (USGBC)- Leadership in Energy and Environmental Design (LEED) Requirements & Green Building Information Gateway (GBIG)
4. Institute for Market Transformation (IMT) & National Resources Defense Council (NRDC)- City Energy Project
5. Environmental Defense Fund (EDF)- The Investor Confidence Project (ICP)

Figure 4-1 Use Cases and Data Collection Methodologies

Use Cases	Uniform Methods Project	ASHRAE Audit Procedures	LEED Reporting & GBIG Database	City Energy Project	Investor Confidence Project
Energy Efficiency Investment Decision-making		★	★		★
Building Performance Tracking		★		★	
Policy and Program Design and Evaluation	★		★	★	

4.1.1 Department of Energy (DOE)- Uniform Methods Project (UMP)

The Uniform Methods Project is standardizing the analytical methods for determining savings from certain energy efficiency programs. One central goal of the project is to mitigate the perceived risks of investing in energy efficiency by increasing the reliability of energy efficiency results reported by program administrators and implementation contractors.⁴

The UMP provides straightforward methods for determining energy and demand savings that result from a core set of commonly deployed energy efficiency measures implemented through state and utility efficiency programs, such as lighting, controls, HVAC, boiler, furnace, refrigerator, and whole building upgrades. The methods represent generally accepted standard practices within the EM&V profession, have been written by technical experts within the field, and have been reviewed by a group of industry experts that collectively conduct over 70% of all energy efficiency program evaluations. The first set of protocols were published in April 2013.

Relationship to BEDES

UMP and BEDES share the goal of supporting energy efficiency program implementation and evaluation. The Uniform Methods Project does not prescribe a data format, but BEDES beta covers most of the information needed to conduct the UMP analyses. BEDES revisions will ensure that BEDES can be used for all UMP analyses.

Use of BEDES by UMP users will reduce data acquisition and processing cost, facilitate data transfer and pooling and shorten the time to obtain EM&V results. It will also make it easier to repurpose program evaluation data for other uses.

Website: http://www1.eere.energy.gov/office_eere/de_ump.html

4.1.2 ASHRAE Procedures for Commercial Building Energy Audits

ASHRAE's publication, "Procedures for Commercial Building Energy Audits" defines best practices for energy survey and analysis for purchasers and providers of energy audit services, and defines energy audit Levels 1, 2 and 3.

In recent years, several disclosure laws and energy efficiency programs have tied activity requirements to ASHRAE audit levels. ASHRAE recently launched a Standard Project Committee to develop a standard (Proposed Standard 211), partly in response to this need to translate ASHRAE audit activities into code-enforceable products.

Relationship to BEDES

The Audit Procedures were mapped to BEDES beta primarily related to the systems and energy auditing data, and BEDES is ready to be used to capture data from level 1 and level 2 audits. The BEDES team continues to work closely with the members of the Standard 211 Committee as the actual audit standards take shape. Revisions to BEDES will be coordinated with the standards committee to ensure that it can be used to collect data for ASHRAE level 1 and 2 audits in the short term, and level 3 audits in the long term.

Reporting audit data to owners using BEDES would make it easier to compare and combine audit results. It would also lower the cost of audits and make it easier for cities to create and implement legislation requiring audits based on ASHRAE procedures.

Website: http://www.tc76.org/spc211/?page_id=2

4.1.3 US Green Building Council (USGBC)- Green Building Information Gateway (GBIG) LEED Reporting

GBIG provides a searchable database of LEED project locations, teams, certifications, labels, awards, and credits over time. GBIG is a platform discover, explore, and analyze the green attributes and performance of projects, buildings, places, and portfolios.

The tool provides maps, analytics and insights that reveal trends, patterns and processes in green building practice. GBIG provides project-level transparency ("What is green"), context (comparison and benchmarking), and analytics (customized reporting for places and collections).

Relationship to BEDES

As part of the requirements for LEED certification, reports that include various energy metrics and building characteristics must be submitted. USGBC maintains many databases which do not currently utilize a standard data format and would benefit from linking to BEDES' standardized data schema, data exchange standards, and reporting requirements. BEDES can be used to link to information about a wide-variety of LEED and non-LEED green building activities, buildings, and portfolios across the United States and around the world.

Website: GBIG.org

4.1.4 Institute for Market Transformation (IMT) & National Resources Defense Council (NRDC) City Energy Project (CEP)

CEP is a pioneering initiative to support major US cities that are ready to capture energy savings in large buildings. The CEP will work in long term partnership with 10 cities to craft and implement cutting edge plans that significantly reduce community energy costs and carbon pollution, create local demand for skilled workers and produce new market opportunities for private sector investment in the building stock. The actions of these 10 cities will establish replicable policy models that will help shape and define energy efficiency efforts in the communities nationwide.

The key to success is the weaving together of individual energy efficiency strategies, creating an integrated framework of policies and programs that becomes more than the sum of its parts. CEP will work collaboratively with individual municipalities to develop and implement solutions that maximize local opportunities and respond to local challenges. Each city will implement a plan that may include benchmarking, audit, lighting upgrades, sub-metering and/or retrocommissioning policies as well as other supporting activities like institutional challenges, energy-efficient financing and energy code compliance programs.

Relationship to BEDES

The CEP will encourage cities to collect and manage data related to the implementation of their plans. Some of this information will be reported to CEP to track the progress of program implementation. Setting a mandatory standard data format (BEDES) will increase data transferability and usability and facilitate collection. BEDES beta and CEP have been developing in parallel and are exploring collaborations wherever possible.

4.1.5 Investor Confidence Project (ICP)

The Investor Confidence Project is enabling a market for investment quality energy efficiency projects, by reducing transaction costs and engineering overhead, while increasing the reliability and consistency of savings.

The Investor Confidence Project is developing project level protocols that standardize both the engineering and documentation of an energy efficiency retrofit resulting in reduced investor transaction costs and manageable performance risk. The protocols present required elements, procedures and documentation to reduce risk and help ensure a successful energy efficiency project, with regards to developing baselines, savings calculations, design, construction and commissioning, operations and maintenance, monitoring, and measurement and verification.

This system will support the acceleration of energy efficiency investments in the commercial and multifamily building sector. By enabling the monetization of energy efficiency investments, the ICP will allow investors to manage performance risk while ensuring building owners achieve the many benefits of energy efficiency.

Relationship to BEDES

ICP's goals of creating transparency and standardization in the energy efficiency market in order to mitigate risk are aligned with BEDES' goals. While ICP does not dictate a data format, the BEDES format could be used to complete ICP analyses.

Website: eepformance.org

SECTION 5: BUILDING ENERGY DATA SPECIFICATIONS

5.1 Introduction

While there are many efforts now underway to standardize various aspects of energy data for various types of buildings, there appears to be a short list of specifications that have achieved substantial market traction, serve similar use cases to BEDES, and provide data terms and definitions that can be used for different parts of the BEDES spec (such as energy consumption data, physical characteristics, etc). These data formats and others can be “knitted together” so that BEDES v1 uses established, effective definitions wherever possible.

1. Green button
2. HPXML (Home Performance XML)
3. Integrated Energy Project (IEP)
4. Real Estate Transaction Standard (RETS).

Note that Portfolio Manager was profiled earlier as a software tool, but it also provides a commonly used data format.

Figure 5-1 Use Cases and Data Exchange Pathways

Use Cases	Green Button	HPXML	Integrated Energy Project (IEP) Model	Real Estate Transaction Standard (RETS)
Energy Efficiency Investment Decision-making	★	★	★	★
Building Performance Tracking	★			
Energy Efficiency Program Design and Evaluation				

The following sections describe each of these key specifications and their relationship to BEDES. BEDES will be mapped to each of these specifications. Field names and definitions will be harmonized as far as possible. Where use cases or other considerations preclude such harmonization, rules for translating data fields from these specifications to BEDES will be defined.

5.2 Green Button

The Green Button initiative is an industry-led effort that responds to a White House initiative to provide utility customers such as building owners and managers and major tenants with easy and secure access to their energy usage information in a standardized electronic format. Using Green Button Download My Data, customers are able to securely download their own detailed energy usage with a simple click of a literal "Green Button" on electric utilities' websites. Using Green Button Connect My Data, customers may authorize a growing array of online services to dynamically access their data to help them track and manage their energy use over time and save on their bills.

Green Button data represents energy usage information, specifically electricity but including gas if provided, with the ability to include additional energy data streams in the future. It allows for different levels of resolution for energy use data i.e. monthly, hourly, etc. Additionally, it includes data fields for customer cost information, if provided by a customer's utility.

Green button is being adopted widely throughout the US. As of July 2013, Eight utility companies have already implemented green button, and another 30 have committed to implement it, which together serve more than 27 million utility customers. Dozens of software apps and services have already been developed to utilize the data.

Relationship to BEDES

All the data fields in Green Button have been mapped to BEDES beta. BEDES data fields will always be fully harmonized with the Green Button data standard as it evolves.

Website: Greenbuttondata.org

5.3 Home Performance XML (HPXML)

HPXML is designed to facilitate exchange and transfer of data among all stakeholders involved in residential energy efficiency programs. The standards are intended primarily for use by energy efficiency programs, such as Home Performance with ENERGY STAR® and utility-sponsored residential retrofit programs. HPXML has been adopted as a Building Performance Institute (BPI) standard and the National Home Performance Council has coordinated the BPI working group.

HPXML contains data fields for building characteristics, energy efficiency measures, energy consumption, and health and safety testing, as well as consumer and contractor information. These data fields are intended to describe a whole-house energy upgrade or a single-measure installation at various points in the work flow, including initial audit, work scope, test-out and quality assurance.

Three energy efficiency programs – NYSERDA in New York, LEAP in Virginia and APS in Arizona – require contractors to use the BPI data standards. Four software developers –CSG, Energy Design Systems, Energy Savvy, and Optimiser – are already working to meet the requirements of the standard, and several other developers have expressed plans to participate in the near future.

Relationship to BEDES

HPXML data fields have been mapped to BEDES beta and there was significant effort to harmonize the common fields in both specifications, which will continue as they evolve.

Website: Homeperformancexml.org

5.4 Integrated Energy Project (IEP)

The IEP model is a data exchange format focused on retrofit projects incorporating Solar PV and thermal into retro-commissioning projects alongside Energy Efficiency Measures – it provides a comprehensive, standardized definition of a project, as well as how stakeholders can communicate between each other about that project. Development of the IEP model was funded by the California Public Utilities Commission California Solar Initiative (CSI) Research Development & Deployment (RD&D) Program.

The IEP model includes data fields for general information about commercial and residential buildings, building systems, solar PV, solar thermal systems, efficiency measure details. The model includes fields for information throughout the entire project lifecycle including initial measure costs and savings estimates, contracted costs, final costs, and verified savings. It also includes fields that describe the project stakeholders, their relationship to the project, and pertinent certifications.

The IEP model has been adopted by several Solar PV software tools (e.g. Solar Nexus, Solar Design tool, SimuWatt) and the Sun Spec Alliance – a solar industry alliance.

Relationship to BEDES

The IEP Model covers nearly all of the major data fields of BEDES covers at present, and has been mapped to the BEDES beta.

Website: iepmodel.net

5.5 Real Estate Transaction Standard (RETS)

RETS is a data exchange standard for real estate transactions, developed by the Real Estate Standards Organization (RESO). RETS facilitates data exchange between different real estate systems and multiple listing services (MLS).

RETS covers property and asset information relevant to real estate transactions, including basic building information, as well as some asset data such as heating, cooling type.

RETS is used by Corelogic and LPS – the two largest MLS vendors in the US, and is gaining wider adoption.

Relationship to BEDES

The RETS data fields have not yet been mapped to BEDES. A preliminary review indicates that much of the property and asset information overlaps with BEDES. RETS also covers many other data fields important real estate transactions (e.g. listing price, etc.) that are not within the scope of BEDES.

Website: Reso.org/rets

5.6 Other Data Specifications

Several other specifications were also considered, but determined to have less aligned use cases, and therefore lower priority for the short term. For example, many data specs are oriented to use cases for design, construction and code compliance checking for new buildings or major reconstruction projects. These use cases require more fine-grained and detailed descriptions of building systems and components, which is beyond the scope of the short term goal of BEDES.

Figure 5-1 lists various data specifications and formats that were reviewed and considered in the process of developing BEDES beta version and/or this scoping study. Data formats that may be appropriate to consider synchronizing with BEDES in a future phase of work: COMcheck, REScheck, gbXML, Industry Foundation Classes (IFC). COBie, CEC HVAC Data Model, Open Automatic Data Exchange, Project Haystack, and the ASTM Building Energy Performance Assessment Standard.

Additional data specifications and formats reviewed

- ASHRAE PMP Best Practice
- ASTM Building Energy Performance Assessment
- CEC HVAC Data Model
- CEUS database
- EDDP
- EPA BASE Study
- Fannie Mae Multifamily Market Research Energy and Water Survey
- GRI Reporting Protocols
- HES Data Dictionary
- IAI Industry Foundation Classes
- ISO Standard 12655
- MISMO
- NAESB PAP 10
- OmniClass
- OpenADE
- Project Haystack

SECTION 6: CONCLUSION

Feedback from stakeholders and a review of the technical landscape both confirmed that common terms and definitions for building energy performance would have broad use and value to the industry. Public and private stakeholders alike reported that data formatting, cleaning and management is burdensome and creates a barrier to the full utilization of existing building energy data.

Building owners and managers use building energy performance information to make decisions about capital investments or the operation of their buildings. They said that better data would lower the cost and effort required to assess savings opportunities in individual buildings, develop energy strategies across portfolios, and increase the knowledge about local real estate markets

Public sector entities, including Federal, State and local agencies and energy efficiency programs, also drive a significant volume of data collection activities. Many public stakeholders expressed interest in aligning their data formats with each other to ease reporting burdens, facilitate comparisons between jurisdictions, and make it easier to re-purpose data for other uses.

Software developers and project implementers are often ultimately responsible for directly managing this data. Software developers and contractors therefore have the most direct experience with data and most nuanced understanding of what a common spec should include to serve their clients' needs.

BEDES can provide a common data format to support the growth of an ecosystem of interoperable tools and platforms. Stakeholders expressed interest in using BEDES beta as the basis for a common data spec, and said that it would be an appropriate role for DOE to convene a working group to refine the spec for broader use.

BEDES should aim to “knit together” existing data formats in order to use established, effective definitions wherever possible. There are a series of existing data formats that have already helped to standardize pieces of the puzzle, such as Green Button, Portfolio Manager, HP XML and others. BEDES can pull these together and focus on creating new data fields and formats only in areas with the least consistency, such as building equipment characteristics and energy conservation measures.

Yet the goal of BEDES should not be to achieve 100% adoption of the data format in the industry. The range of programs, tools and guidelines that deal with empirical building energy data can use the spec in several ways:

- Public policies and programs, and private software tools may choose to directly adopt the spec.
- In cases where policies, programs and tools use their own data formats, mappings to BEDES can facilitate translation among them.
- The spec can also be used to conduct activities that follow methodological guidelines which do not prescribe a data format.

Therefore, establishing and updating “mappings” between BEDES and other data formats will be crucial to its success. The BEDES documentation should indicate the sources for individual fields, or note that a new field was created. Programs, policies and tools will also be able to use mappings to show where their fields align with or diverge from BEDES. An ongoing update cycle will be needed ensure that users of BEDES can provide input on changes and additions.

For more information on BEDES and updates on this project:

Visit: www.buildings.energy.gov/BEDES

Contact: BEDES@ee.doe.gov