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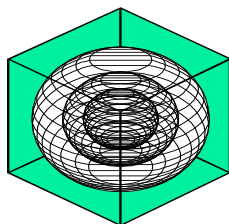**SEEC** *Southern Energy Efficiency Center*

REVIEW AND RECOMMENDATIONS OF EXISTING METHODS AND TOOLS FOR BUILDING ENERGY ANALYSIS

Subtask 2.4 for the Southern Energy Efficiency Center
Cooperative Agreement #: DE-PS26-07NT43185

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By:

ENERGY SYSTEMS LABORATORY

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Disclaimer

     Energy Systems Laboratory, Texas A&M University

EXECUTIVE SUMMARY

The Southern Energy Efficiency Center (SEEC) was established to substantially increase the deployment of high-performance "beyond-code" buildings across the southern region of the U.S. It is funded by the U.S. Department of Energy (DOE) Building Technologies Program, and administered by the National Energy Technology Laboratory. During its first 18-monthpilot phase, to expand the use of existing methods, procedures and tools for building energy efficiency in the marketplace; project efforts include identifying the existing tools from very simple calculators for estimating energy savings to detailed methods for measurement and verification of commercial building energy savings and defining their technical and practical characteristics. This work is defined under the SEEC Subtask 2.4 *Expand the Use of Existing Methods and Tools*. This report presents preliminary deliverables of this subtask developed and documented by the Energy Systems Laboratory (ESL) for use by the SEEC member state region.

The primary goal of this subtask is to provide the state energy offices with the list of available tools and recommendations for use. The deliverables for the SEEC Subtask 2.4 consists of three parts:
- Review of 38 building energy analysis tools from the U.S. DOE EERE's Building Energy Software Tools Directory;
- Review of 20 building energy analysis tools from the other websites; and
- Recommendations: the U.S. EPA ENERGY STAR Portfolio Manager, Weather-Normalized Utility Billing Analysis, and Smart Metering.

To identify the existing methods, procedures and tools for building energy analysis the U.S. DOE EERE's Building Energy Software Tools Directory website[1] was reviewed as well as the websites of major power companies, utilities, manufacturers, national laboratories, and research organizations. General search engines such as Google and Yahoo were also used. From this exhaustive search, 58 tools were identified. Appendix A and B presents the screenshots of each tool to give an idea how they look. Most of the tools investigated in this report are under continuous development, therefore, only the features available in March 2009 are considered for this analysis.

To capture the feature of each tool, a systematic comparison spreadsheet that defines the technical and practical characteristics of the tools has been developed. All identified 58 tools were mapped onto this matrix and presented in Table 2.2.1 and Table 3.2.1. The selected 13 technical and practical characteristics of the tools are as follows:
- General
    1) Availability, Web-based or Disk-based
    2) Building Type, Residential Buildings or Commercial Buildings
    3) Approach, Whole Building or Component
- Input
    4) Survey Information Level (Basic, Medium, or Detail)
    5) Site/Weather Description (Zip-Code) (Yes or No)
    6) Actual Energy Usage (Utility or Monitoring) (Yes or No)
- Output
    7) Weather Normalization (including Simulation Approach) (Yes or No)
    8) Interval Energy Data Monitoring (Yes or No)
    9) Diagnostics on Data (including Alarm Function) (Yes or No)
    10) Utility Billing Error Check (Yes or No)

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[1] U.S. DOE, EERE. 2009. *Building Energy Software Tools Directory*, Energy Efficiency and Renewable Energy, U.S. Department of Energy, Retrieved from http://apps1.eere.energy.gov/buildings/tools_directory/ (accessed March 30, 2009).

11) Parametric Run (Baseline Modifications and Comparisons) (Yes or No)
12) Recommendations/Suggestions (Yes or No)
13) Energy Benchmarking Information (Yes or No)

To classify the tools by their main function, nine categories were developed as follows:

A. Utility Bill Monitoring/Analysis Tools;
B. Smart Metering Tools;
C. Retrofit/ECM Implementation Simulation Tools;
D. Energy Profile Analysis Tools;
E. Code Compliance/Rating Simulation Tools/ HERS Software;
F. Field Auditing Tools;
G. Data Display Tools;
H. Utility Bill Disaggregation Tools based on Energy Audit Survey; and
I. Energy Calculation Tools.

By scrutinizing the information gathered, the recommendations were developed for each of the nine predefined categories (**Table ES.1**). These recommendations were suggested for a wide audience including homeowners, building operators and energy managers, state facility energy managers, and utility program managers.

Table ES.1. Recommendations for Each of the Nine Categories.

Nine Categories	Recommended Use	No. of Recommended Tools
A. Utility Bill Monitoring/Analysis Tools	To analyze the billing or interval energy data	5, 11, 13, 16, 17, 26, 30, 40, 48, 49, 50, 51, 56.
B. Smart Metering Tools	To track the real-time energy consumption daily or hourly, either for whole-bulidng or major end-use	4, 8, 9, 10, 15, 24, 31, 35.
C. Retrofit/ECM Implementation Simulation Tools	To estimate the possible savings from retrofits	2, 3, 7, 12, 19, 20, 21, 22, 25, 27, 28, 29, 32, 34, 36, 38, 43, 52.
D. Energy Profile Analysis Tools	To analyze the energy consumption in detailed profiles, including demand or end-use analysis	14, 39.
E. Code Compliance/Rating Simulation Tools/HERS Software	To calculate the code compliance or HERS rating for the residential buildings	18, 33, 54, 58.
F. Field Auditing Tools	To perfrom an energy auditing (energy inspectors and auditors)	6, 23.
G. Data Display Tools	To manage massive time series data sets	1, 37.
H. Utility Bill Disaggregation Tools based on Energy Audit Survey	To provide the customers of utilities or power companies with a self-guided energy bill analysis tool	44, 45, 46, 47, 53, 57.
I. Energy Calculation Tools	To conduct a simple energy assessment without the actual energy data	41, 42, 55.

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1   INTRODUCTION

The Southern Energy Efficiency Center (SEEC) was established to substantially increase the deployment of high-performance "beyond-code" buildings across the southern region of the U.S. It is funded by the U.S. Department of Energy (DOE) Building Technologies Program and administered by the National Energy Technology Laboratory. During its first 18-month phase, to expand the use of existing methods, procedures and tools for building energy efficiency in the marketplace; project efforts include identifying the existing tools from very simple calculators for estimating energy savings to detailed methods for measurement and verification of commercial building energy savings and defining their technical and practical characteristics. This work is defined under the SEEC Subtask 2.4 *Expand the Use of Existing Methods and Tools*. This report presents preliminary deliverables of this subtask developed and documented by the Energy Systems Laboratory (ESL) for use by the SEEC member state region.

The primary goal of this subtask is to provide the state energy offices with the list of available tools and recommendations for use. By scrutinizing the information gathered, these recommendations have been developed to encourage the use of a number of existing tools that are not widely used, but provide valuable information and insight on the benefits of building energy efficiency in the SEEC member states. The resultant summary spreadsheet will also allow them to choose the appropriate tool, either simple calculators or detailed methods, according to the inquiry.

1.1   Statement of Project Objectives of the Southern Energy Efficiency Center (SEEC)

This report presents the ESL's work to develop preliminary deliverables for the SEEC Subtask 2.4. These deliverables are intended to cover the SEEC's Statement of Project Objectives for the Subtask 2.4 outlined below:
- Define a list of methods, procedures and tools for building energy efficiency; and
- Suggest recommendations to expand their use in the marketplace.

1.2   Preliminary deliverables for the SEEC Subtask 2.4

The stated deliverables for the SEEC Subtask 2.4 consists of three parts:
- Review of 38 building energy analysis tools from the U.S. DOE EERE's Building Energy Software Tools Directory;
- Review of 20 building energy analysis tools from the other websites; and
- Recommendations for each of the nine predefined categories.

To identify the existing methods, procedures and tools for building energy analysis the U.S. DOE EERE's Building Energy Software Tools Directory website[2] was reviewed as well as the other websites of major power companies, utilities, manufacturers, national laboratories, and research organizations websites. The general search engines such as Google and Yahoo were also used. A systematic comparison spreadsheet that defines the technical and practical characteristics of the tools has been developed, and a short description for each identified tool with the screenshots is also included. Most of the tools investigated in this report are under continuous development, therefore, only the features available in March 2009 are considered for this analysis. Appendix A and B presents the screenshots of each tool to give an idea how they look.

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[2] U.S. DOE, EERE. 2009. op. cit.

Section 2 presents the review of 38 building energy analysis tools that are listed in the U.S. DOE EERE's Building Energy Software Tools Directory. A systematic comparison spreadsheet showing the technical and practical features of these tools is also included. Section 3 presents the review of 20 building energy analysis tools that have been identified from the other websites, along with a systematic comparison spreadsheet. Finally, Section 4 presents the analysis and recommendations that have been derived from the analysis of the information gathered. The recommendations have been made for each of the nine predefined categories.

2   BUILDING ENERGY ANALYSIS TOOLS FROM THE U.S. DOE EERE'S BUILDING ENERGY
    SOFTWARE TOOLS DIRECTORY

2.1   Overview

This section covers the review of 38 building energy analysis tools from the U.S. DOE EERE's Building
Energy Software Tools Directory. The U.S. DOE EERE's Building Energy Software Tools Directory
provides information on 359 building energy software tools, including databases, spreadsheets,
component/system analysis, and whole-building simulation programs. For each tool, the following short
description is provided: keywords, validation/testing, expertise required, users, audience, input, output,
computer platforms, programming language, strengths, weaknesses, technical contact, and availability.

Among the 359 software tools listed in the U.S. DOE EERE's Building Energy Software Directory, 38
building energy analysis tools for existing buildings have been identified. Table 2.1.1 shows the list of
the identified tools and the assigned number in the alphabetic order with the provider and country.
Appendix A presents the screenshots of these 38 tools with a short description of each tool that is
provided by the U.S. DOE EERE.

Since the EERE's Building Energy Software Tools Directory has a self-reporting system by the providers,
the recent updates of the programs may not be properly reflected in the directory. As a result, the
directory lists several tools that are no longer available, and there are some cases that the changes in
names, providers, or web addresses of certain tools are not updated in the directory. When the tool has
been updated or changed, this report tried to trace these changes and records the most updated
information on each tool as of March 2009.

A systematic comparison spreadsheet showing the technical and practical features of these 38 tools is
developed and displayed in Section 2.2. A matrix that defines several descriptive characteristics and
possible technical features of tools has been created, and all identified tools were mapped onto this
matrix. Section 2.3 presents the classification of the 38 identified tools by the primary function of each
tool.

Table 2.1.1. 38 Building Energy Analysis Tools from the U.S. DOE EERE's Building Energy Software Tools Directory.

No.	Tool Name	Provider	Country
1	Commodity Server	MightyWare	United States
2	Demand Response Quick Assessment Tool (DRAQT)	LBNL	United States
3	EA-QUIP (Energy Audit using the Queens Information Package)	Association for Energy Affordability,	United States
4	EBD (ENFORMA® Building Diagnostics)	Architectural Energy Corporation	United States
5	e-Bench	Energy and Technical Services	New Zealand
6	Ecasys	Fundamental Objects Inc	United States
7	Eco Lumen	Eco Lumen	India
8	eDNA	InStep Software	United States
9	EEM Suite	Itron, Inc.	United States
10	EffTrack	Efficiency Technologies Inc	United States
11	EMODEL	Energy Systems Laboratory	United States
12	Energy Audit - Residential/Light Commercial Energy Analysis	Elite Software	United States
13	Energy Lens	BizEE Software	United
14	Energy Profile Tool	EnerSys Analytics Inc.	Canada
15	Energy WorkSite	NorthWrite, Inc.	United States
16	EnergyCAP Enterprise	Good Steward Software, LLC	United States
17	EnergyCAP Professional	Good Steward Software, LLC	United States
18	EnergyGauge USA	Florida Solar Energy Center	United States
19	EZ Sim	Stellar Processes, Inc.	United States
20	FEDS (Facility Energy Decision System)	PNNL	United States
21	FRESA (Federal Renewable Energy Screening Assistant)	NREL	United States
22	Home Energy Saver	LBNL	United States
23	Home Energy Tune-uP	CMC Energy Services	United States
24	ION Enterprise	Schneider Electric.	Canada
25	MarketManager	Abraxas Energy Consulting	United States
26	METRIX4	Abraxas Energy Consulting	United States
27	MHEA (Manufactured Home Energy Audit)	ORNL	United States
28	NEAT (National Energy Audit Tool)	ORNL	United States
29	OptoMizer	Fielding Data Labs	United States
30	PRISM	Princeton University	United States
31	Prophet Load Profiler	Automated Energy Inc	United States
32	Rehab Advisor	D & R International Inc.	United States
33	REM/Rate	Architectural Energy Corporation	United States
34	RESEM (Retrofit Energy Savings Estimation Model)	LBNL	United States
35	SenseDat Analyzer	Informing Ecological Design	United States
36	TREAT	Performance Systems Development	United States
37	Visualize-IT	KEMA	United States
38	ZIP-Code Insulation	ORNL	United States

2.2   Comparison Spreadsheet

To collect detailed information of each tool, the web page information, brochures, and manuals of the products were reviewed. When the website provides the software program by free or a trial-version, these disk-based programs were downloaded and executed for the review. For the web-based programs, when the program is accessible by free or provides a demo version, it was executed via online. The source information of each tool is included in the comparison spreadsheet.

To capture the feature of each tool, a systematic matrix that defines several descriptive characteristics and possible technical features of tools has been created, and all identified tools were mapped onto this matrix. The selected descriptive and technical features are as follows:
- Tool Name
- Provider
- Availability
- Users
- Building Type (R: Residential, C: Commercial, B: Both)
- Approach (W: Whole Building, C: Component, B: Both)
- Input
    - Site/Weather Description (Zip-Code) (Y: Yes, N: No)
    - Survey Information Level (B: Basic, M: Medium, D: Detail)
    - Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)
- Output
    - Weather Normalization (including Simulation Approach) (Y: Yes, N: No)
    - Interval Energy Data Monitoring (Y: Yes, N: No)
    - Diagnostics on Data (including Alarm Function) (Y: Yes, N: No)
    - Utility Billing Error Check (Y: Yes, N: No)
    - Parametric Run (Baseline Modifications and Comparisons) (Y: Yes, N: No)
    - Recommendations/Suggestions (Y: Yes, N: No)
    - Energy Benchmarking Information (Y: Yes, N: No)
- Source (W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online)
- Comments
- Web Address

Table 2.2.1 presents a comparison spreadsheet that defines several descriptive characteristics and the technical and practical features for the 38 identified tools. The tools are sorted in the alphabetic order. The web-based tools can be directly accessed via the internet, while the disk-based tools can be downloaded or ordered from the websites. Some tools require a relatively small number of inputs, while other tools ask users to input detailed information on the buildings and operating schedule. Most tools use pull-down menus. Each tool supports different functions, including weather normalization, interval energy data monitoring, diagnostics on data. utility billing error check, parametric run,; recommendations/suggestions, and energy benchmarking information. No one tool supports all these functions. A short descriptive comment is also included at the end of the spreadsheet.

Section 4.2 presents more detailed analysis of these 38 building energy analysis tools, including the 20 tools from the other websites.

Table 2.2.1. Comparison Spreadsheet for 38 Building Energy Analysis Tools (U.S. DOE EERE's Building Energy Software Tools Directory).

No.	Type	Provider	Availability	Users	Type (R: Residential, C: Commercial, B: Both)	Approach (W: Whole-Building, C: Component, B: Both)	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source (W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online)	Comments	Web Address
1	Commodity Server	MightyWare	Disk-based (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers	C	B	N	B	Y	N	N	N	N	N	N	N	W, M, &D	The Commodity Server is an energy database server and presentation system developed with a general time series database with user interface. The client was designed to e A-6. Field Auditing Tools xclusively manage time series data. It comes with a simple data management front end, basic security, and a graphical front end useful for creating presentations for web publishing.	http://mightyware.com/commodity_server.htm
2	Demand Response Quick Assessment Tool (DRAQT)	LBNL	Disk-based (Free)	Energy Program Managers; Energy Professionals; Facility Managers; Utility Companies	C	W	Y	M	N	Y	N	N	N	Y	N	N	W&M	The DRQAT predicts the energy and demand saving, the economic saving, and the thermal comfort impact for various demand responsive strategies for large commercial buildings. It is based on the most popular feature and capabilities of EnergyPlus. Users of the tool will be asked to enter the basic building information such as types, square footage, building envelope, orientation, utility schedule, etc. The assessment tool will then use the prototypical simulation models to calculate the energy and demand reduction potential under certain demand responsive strategies, such as precooling, zonal temperature set up, and chilled water loop and air loop set points adjustment.	https://gaia.lbl.gov/people/ryin/public/Download%20DRQAT.html
3	EA-QUIP (Energy Audit using the Queens Information Package)	Association for Energy Affordability, Inc.	Disk-based (Purchase, Free for Weatherization agencies)	Multifamily Building Owner; Facility Manager; Energy Professional	R (multi family)	W	Y	B&D	N	Y	N	N	N	Y	Y	N	W	The EA-QUIP is a user-friendly and easy-to-use energy auditing tool for multifamily buildings. EA-QUIP helps to choose the optimal energy-saving measures for a given building and within a chosen budget. The analysis approach is simulation. An extensive retrofit and cost libraries are also available for users. EA-QUIP continues to be approved by the US Department of Energy (DOE) for use by weatherization agencies in auditing multifamily buildings. For energy audit purposes, the DOE considers multifamily buildings to be those containing five dwelling units or more. EA-QUIP was adapted from the Computerized, Instrumented, Residential Audit (CIRA) developed in the early 1980s at the Lawrence Berkeley Laboratory. CIRA is a collection of programs related to building energy analysis and designed for a wide variety of microcomputers.	http://www.aeanyc.org/site/c.dhJJJTOzFoH/b.3075491/k.B3B6/EAQUIP.htm

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Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Approach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
4	EBD (ENFORMA® Building Diagnostics)	Architectural Energy Corporation	Disk-based (Purchase)	Facility Manager; Maintenance Staff; Commissioning Service Contractor	C	C	Y	M	Y	N	Y	Y	N	N	Y	N	W&B	The ENFORMA Building Diagnostics (EBD) is an energy performance evaluation program using the Building Automation System (BAS) data for the HVAC systems. EBD has automated the manual performance analysis process with sophisticated algorithms that identify problems often undetected by existing methods (e.g. BAS and manual monitoring). EBD's solutions typically result in projects with paybacks of less than one year.	http://www.enformadiagnostics.com/
5	e-Bench	Energy and Technical Services	Web-based (Purchase)	Building Owner; Facility Manager; Energy Managers	C	W	Y	D	Y	N	N	Y	N	N	N	Y	W	The e-Bench is an internet-based utility monitoring tool that measures energy and environmental efficiency. Energy and CO_2 is measured per facility or process, and this can be compared to benchmarks established from other facilities or processes around the country, New Zealand. The e-Bench enables invoices for these services to be checked for accuracy and compared with past records on an exceptions basis. This is achieved through an automatic email alert system to advice users of any inaccuracies in their invoices or if consumption patterns are other than what would be expected.	http://www.e-bench.com/
6	Ecasys	Fundamental Objects Inc	Web-based (Purchase)	Energy Program Managers	C	Both	Y	D	N	N	N	N	N	N	N	N	W&B	The Ecasys is a modular program that helps agencies to integrate all energy and building related programs within a user-friendly environment. It offers various functions, such as work orders, profile setup, pricing, invoicing and reporting. Ecasys supports remote audits to allow energy inspectors to electronically retrieve customized audit forms while offsite. Completed audit forms can then be submitted to the central office electronically.	http://www.fundamentalenergy.com/
7	Eco Lumen	Eco Lumen	Web-based (Free)	Building Owner; Facility Manager; Lighting Designer	C	C	N	M	N	N	N	N	N	Y	Y	N	W, B &D	The Eco Lumen is user-friendly lighting design software to optimize the lighting electric energy consumption while providing suitable lighting level to occupants. For existing buildings, Eco Lumen recommends the upgrade options for lighting retrofits to maximize re-use the existing fittings. An extensive database of lighting products from leading companies is also available for users.	http://www.walawalkar.com/info/EnergyManagement/EcoLumen/EcoLumen.htm

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Approach	INPUT				OUTPUT (Y: Yes, N: No)							Source	Comments	Web Address
							R: Residential, C: Commercial, B: Both	W: Whole-Building, C: Component, B: Both	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online		
8	eDNA	InStep Software	Disk-based (Purchase)	Facility Manager; Energy Program Managers; Utility Company	C	W	Y	B	Y	N	Y	Y	N	N	N	N	W	eDNA is a real-time performance data historian for acquiring, storing, and displaying large amounts of operations and engineering information. eDNA collects data from electronically enabled utility meters as well as handheld devices. and stores it in a highly compressed format, allowing decades of high-frequency, time-series data to be stored online in its original resolution. Weather data can be collected and correlated with utility consumption for a complete view of energy needs. eDNA enables accurate and timely performance-based decisions that improve operating costs. eDNA also interfaces to the EBS utility information management and billing system (a subsidiary ledger for utility information).	http://www.instepsoftware.com/EEM_eDNA.asp
9	EEM Suite	Itron, Inc.	Web-based (Purchase)	Facility Manager; Accounting Manager	C	W	Y	B	Y	Y	Y	Y	Y	N	N	Y	W&B	The EEM Suite is a web-based energy, water and cost monitoring and management program across multiple facilities to help users identify the billing errors and overcharges. In addition, an extensive analysis of energy and cost allows users to monitor building performance against budgets, estimate energy requirement for a certain activity, and improve operational efficiency through benchmarking processes. For the benchmarking within the facilities or against external organizations, the ENERGY STAR® National Energy Rating System is integrated.	http://www.itron.com/pages/products_detail.asp?ID=itr_000400.xml&pgtype=&subID=fb
10	EffTrack	Efficiency Technologies Inc	Web-based (Purchase)	Mechanical Engineer; Chiller Plant Operator; Energy Professionals	C	C	Y	D	Y	N	Y	Y	N	N	Y	N	W&B	The EffTrack reveals the actual costs of chiller operations to optimize chiller performance. This program diagnoses inefficiency and gives step-by-step recommendations for improvement. EffTrack uses a proprietary Calculated Part Load Value (CPLV) which is an industry standard efficiency calculation method, to determine an optimal operation point of chiller at any operation condition.	http://www.efftec.com/

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type (R: Residential, C: Commercial, B: Both)	Approach (W: Whole-Building, C: Component, B: Both)	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source (W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online)	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
11	EMODEL	Energy Systems Laboratory	Disk-based (Purchase)	Facility Manager; Building Owner; Energy Auditors; Energy Professionals	C	B	Y	B	Y	Y	N	N	N	N	N	N	M&D	EModel integrates the previously laborious tasks of data processing, graphical analysis and regression modeling in a user-friendly Windows environment. It is used by researchers, national laboratories, consultants and utilities to measure retrofit savings and analyze measured time-series data. The method of measuring savings is recommended by the International Performance, Measurements and Verification Protocols (IPMVP), the Federal Energy Management Program (FEMP) Measurement and Verification Guidelines and ASHRAE Guideline 14.	http://esl.eslwin.tamu.edu/esl.html
12	Energy Audit (Residential/Light Commercial Energy Analysis)	Elite Software	Disk-based (Purchase)	Mechanical Engineers; HVAC Contractor; Energy Professionals	B	C	Y	B&D	Optional	Y	N	N	N	Y	N	N	W	The Energy Audit program calculates monthly and annual heating and cooling costs for residential and light commercial buildings. It can simulate nearly all types of HVAC systems, and optionally can analyze appliances and hot water costs. Still it has another option for utility companies that want to show disaggregated past utility bills. For calculation, Energy Audit uses heating degree days, weather bin data, and full load cooling hours in its calculations. Energy Audit also performs acoustic analysis and an economic analysis that allows you to compare system types over any given study period. Pictures and technical data for numerous equipment models are included as well. Finally, Energy Audit provides a wide selection of nicely formatted color charts, graphs, and reports.	http://www.elitesoft.com/web/hvacr/elite_auditw_info.html
13	Energy Lens	BizEE Software	Disk-based (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers	C	W	N	B	Y	N	N	N	N	N	N	N	W&D	The Energy Lens is a software tool for charting and analyzing energy consumption. Energy Lens enables the rapid analysis of interval energy consumption data in Excel. Energy Lens facilitates the creation of charts and figures from interval data, making it easy to determine energy consumption patterns, to identify and quantify energy waste, and to track energy performance. A range of user-selected charts and tables can be created on demand.	http://www.energylens.com/
14	Energy Profile Tool	EnerSys Analytics Inc.	Web-based (Purchase)	Building Owner; Facility Manager; Utility Companies	C	W	Y	B&D	Y	Y	N	N	N	Y	Y	Y	W&E	The Energy Profile Tool is an energy analysis tool to provide users detailed profiles of their energy consumption. This program also allows users to compare their energy consumption with benchmarks and to identify opportunities to reduce their energy use and cost. The analysis approach is simulation that closely agrees with DOE-2 simulation models, and calibration against actual billing data is provided.	http://www.energyprofiletool.com/subscription/default.asp

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type (R: Residential, C: Commercial, B: Both)	Approach (W: Whole-Building, C: Component, B: Both)	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source (W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online)	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
15	Energy WorkSite	NorthWrite, Inc.	Web-based (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers; Utility Companies	C	W	Y	M	Y	Y	Y	Y	N	N	Y	Y	W&B	Energy WorkSite powered by NorthWrite Inc. is a web portal, which contains dozens of powerful software applications called WorkSite Tools to help you developing energy savings, management, and sustainable practices. Energy WorkSite Tools consist of Energy Tools and Sustainability Tools. Energy Tools include: Communicator, Energy Expert, Energy Management Report, Energy Star, Performance Report, Portfolio Benchmarking, Utility Bill Manager, and Wireless Monitoring. Sustainability Tools include Calendar, Document manager, Links, Projects and Tasks, Reports and Statistics, and Snapshots. Energy WorkSite also supports buildings to acquire LEED-EB Credits by using several Tools together, including Energy Expert and Energy Star export function.	http://www.energyworksite.com/corporate/default.asp?cwpID=85
15-1	Energy Expert		Web-based + Hardware (Purchase)		C	W	Y	M	Y	Y	Y	Y	N	N	N	N		The Energy Expert is intended to optimize the energy performance of existing buildings. This program is an easy-to-use self-training software to create a "smart model" of the building using interval data and weather data. Then, this program allows users to compare their daily energy consumption with this norm and CO2 reduction and gives notifications for over-consumption. Interval energy data is obtained via wireless monitoring.	http://www.energyworksite.com/corporate/default.asp?cwnpID=90
15-2	Energy Star Export Tool		Web-based (Purchase)		C	W	Y	M	Y	N	N	N	N	N	N	Y		Energy Star automates upload of required data, monthly energy usage data, into ENERGY STAR and displays the results across the portfolio with historical trending for specific sites. It helps to identify trends of the building(s)' energy consumption to achieve an ENERGY STAR qualified label.	http://www.energyworksite.com/corporate/default.asp?cwnpID=91

Energy Systems Laboratory, Texas A&M University

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Approach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
16	EnergyCAP Enterprise	Good Steward Software, LLC	Web-based (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers	C	W	Y	M	Y	Y	N	Y	Y	N	N	Y	W	The EnergyCAP Enterprise is designed to be the best energy information software available for total integration and management of an organization's diverse utility bill and energy management needs. Enterprise options offer the full range of capabilities: bill tracking, manual and EDI (Electronic Data Interchange) entry, automatic bill auditing system, correct "to-the-penny" rate schedules, interval data tracking and analysis, tracking of production (or any other independent variables), cost avoidance calculations (M&V), sub meter tracking, and more. Bill Audit process checks each bill 47 ways and issues warnings on possible bill errors. Using world-respected meteorological data from AccuWeather, regression analysis of daily weather vs. energy use is displayed. EnergyCAP Enterprise also interfaces with the EPA's ENERGY STAR Portfolio Manager for benchmarking information.	http://www.goodstewardsoftware.com/products/energycap-enterprise
17	EnergyCAP Professional	Good Steward Software, LLC	Web-based (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers	C (Institutional buildings)	W	Y	M	Y	Y	N	Y	Y	N	N	Y	W	The EnergyCAP Professional is a limited version of EnergyCAP Enterprise for public school districts and other organizations that need straightforward utility bill tracking, energy management reports, calculation of the cost avoidance attributable to energy management activities, and overall energy information management. Bill Auditor checks each bill 21 ways and reports warnings on possible bill errors, and regression analysis of daily weather vs. energy use is displayed. EnergyCAP Professional also interfaces with the EPA's ENERGY STAR Portfolio Manager for benchmarking information.	http://www.goodstewardsoftware.com/products

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Appr oach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
18	EnergyGau ge USA	Florida Solar Energy Center	Disk-based (Purchase)	HERS Provider; Energy Auditor; Weatheriza tion Agencies; Homeowne r	R	W	Y	M	N	Y	N	N	N	Y	N	Y	W&D	ENERGYGAUGE USA is a user-friendly residential building energy simulation which allows calculation and rating of energy use of residential buildings around the United States. It includes Manual-J system sizing analysis, and an improvement analysis mode to analyze cost-effectiveness of energy upgrades. It rapidly performs Home Energy Ratings (HERS) with a proven hourly calculation engine to provide reliable results. Alternately, it is powerful enough to provide utility planners with time-of-day information to evaluate peak demand impact of residential programs.ENERGYGAUGE USA uses DOE-2.1E with a number of enhancements which allow superior simulation of duct air leakage and heat transfer (thermal conditions of zones in which ducts are located strongly affects performance) as well as improved calculation of air conditioners, heat pump and furnaces performance.	http://www.en ergygauge.co m/usares/
19	EZ Sim	Stellar Processes, Inc.	Disk-based (Purchase)	Facility Manager; Utility Companies ; Resource Conservati on Managers	C	W	Y	B	Y	Y	N	N	N	N	N	N	W	The EZ Sim is a quick spreadsheet tool for utility billing analysis that can diagnose energy patterns and consumption and calibrate the mode against actual billing data. Once it matches the building's utility bills, the simulation model can provide reliable estimates of potential conservation savings.	http://www.ez sim.com/
20	FEDS (Facility Energy Decision System)	PNNL	Disk-based (Purchase, Free for federally-funded project)	Facility Manager; Utility Companies ; Energy Profession als	C	W	Y	B&D	N	Y	N	N	N	Y	Y	N	W, B, &M	The U.S. Department of Energy's Facility Energy Decision System (FEDS) is an easy-to-use building energy efficiency software tool that quickly and objectively identifies energy efficiency improvements that maximize life-cycle savings. Once the model is simulated, FEDS is highly flexible and can help to quickly perform a range of ECMs and forecasting functions, such as evaluating fuel switching opportunities, new technologies, and the impacts of change—including changes to energy rates, occupancy or mission, and more.	http://www.pn l.gov/feds/

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type (R: Residential, C: Commercial, B: Both)	Approach (W: Whole-Building, C: Component, B: Both)	INPUT Site/Weather Description (Zip-Code) (Y:Yes, N: No)	INPUT Survey Information Level (B: Basic, M: Medium, D: Detail)	INPUT Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	OUTPUT Weather Normalization (including Simulation Approach)	OUTPUT Interval Energy Data Monitoring	OUTPUT Diagnostics on Data (including Alarm Function)	OUTPUT Utility Billing Error Check	OUTPUT Parametric Run (Baseline Modifications & Comparisons)	OUTPUT Recommendations/ Suggestions	OUTPUT Energy Benchmarking Information	Source (W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online)	Comments	Web Address
21	FRESA (Federal Renewable Energy Screening Assistant)	NREL	Web-based (Free)	Facility Manager; Energy Professionals	C	C	Y	B	N	Y	N	N	N	Y	N	N	W, M &E	The Federal Renewable Energy Screening Assistant (FRESA) is a first-order screening tool to identify potentially cost-effective applications of renewable energy technology on a building and facility level. Currently available technologies include: photovoltaic (PV), solar hot water heating, wind energy, solar vent preheat, biomass, geothermal heat pump, and solar swimming pool heating. This program allows sophisticated analyses of technology performance and cost while keeping data requirements to a minimum. Life-cycle cost calculations comply with 10 CFR 436.	http://analysis.nrel.gov/fresa/
22	Home Energy Saver	LBNL	Web-based (Free)	Homeowner	R	W	Y	D	N	Y	N	N	N	Y	Y	Y	W&E	This web-based tool estimate energy bill for an input house and suggest several potential tips to improve energy efficiency of an input house. To obtain an accurate result, the users are required to input lots of detail information about their houses. As a result, this tool suggests very detailed and customized information to improve home energy efficiency, including cost and payback information and some purchasing tips.	http://hes.lbl.gov/
23	Home Energy Tune-uP	CMC Energy Services	Web-based (Purchase)	Energy Auditors; Home Energy Inspectors	R	B	Y	D	N	N	N	N	N	N	Y	N	W	The Home Energy Tune-uP® software allows for trained energy auditors to perform residential energy audits with the goal of providing affordable and accessible energy audits. To use this program, it is required to take a Home Energy Tune-uP® training course. The collected data, typically anywhere from 70 to 100 questions, is analyzed by the software that will in turn produce an energy report for the home owner. The report provides an itemization of each energy-saving opportunity in a table format that presents its action, e.g., repair, replace, upgrade, etc., with its estimated cost for improvement and simple payback. A second table produces a listing of measures that will pay for themselves if financed at a selected finance rate and term. It is strongly hoped that presenting the financing option will encourage more home owners to follow through with the report's recommendations. The highest energy-saving measures will be included, too, and a clear individual breakdown of the respective measures follows in a page-by-page format. The report also lists health and safety concerns to ensure that the home owner is fully informed of issues beyond energy efficiency measures.	http://www.homeenergytuneup.com/

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Appr oach	INPUT				OUTPUT (Y: Yes, N: No)							Source	Comments	Web Address
					R: Residential, C: Commercial, B: Both	W: Whole-Building, C: Component, B: Both	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online		
24	ION Enterprise	Schneider Electric.	Web-based + Hardware (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers	C	C	N	B	Y	N	Y	Y	N	N	N	N	W&B	The ION Enterprise is an energy management software to track real-time power conditions, analyze power quality and reliability, and respond quickly to alarms to avoid critical situations. ION Enterprise can manage a network of intelligent ION energy meters to help users to analyze data, and decide on new courses of action. It allows tracking historical trends to reveal energy waste or unused capacity as well as verify efficiency improvements and allocate costs to buildings, departments or processes. The software includes sophisticated load aggregation and arithmetic calculation.	http://www.powerlogic.com/product.cfm/c_id/2/sc_id/16/p_id/30
25	MarketManager	Abraxas Energy Consulting	Disk-based (Purchase)	Facility Manager; Utility Companies; Energy Professionals	B	W	Y	B&D	N	Y	N	N	N	Y	Y	N	W&M	The MarketManager models any type of commercial, institutional, industrial, and residential facility and determines the energy and cost impact of virtually any type of energy conservation measure or utility rate schedule. The program's calculations are based upon methods outlined in ASHRAE Fundamentals and used in DOE-2.	http://www.abraxasenergy.com/marketmanager.php
26	METRIX4	Abraxas Energy Consulting	Disk-based (Purchase)	Building Owner; Facility Manager; Energy Managers	C	W	Y	M	Y	Y	N	N	N	N	N	N	W, M &D	The Metrix4 is a standalone utility energy auditing program that allows defining the baseline and targeting energy usage pattern. One big feature of the Metrix4 is its utility bill weather normalization based on HDD and CDD, and this regression analysis is following the ASHRAE Guideline 14 and IPMVP. Once the baseline of energy usage is determined, the users can set up a target scenario by applying energy-saving measures with the expected savings (%) to the baseline model, and can compare the result with the actual savings.	http://www.abraxasenergy.com/downloadmetrix4.php

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Appr oach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			**OUTPUT (Y: Yes, N: No)**									
27	MHEA (Manufactured Home Energy Audit)	ORNL	Disk-based (Free)	Homeowner; Energy Auditors; Utility Companies; State and local weatherization Agencies	R (mobile homes)	W	Y	M	N	Y	N	N	N	Y	Y	N	W, M, &D	A user-friendly, window-based energy audit, the Manufactured Home Energy Audit (MHEA) for mobile homes has been developed by the Buildings Technology Center at Oak Ridge National Laboratory (ORNL) for the U.S. Department of Energy's Weatherization Assistance Program. This program allows users to identify the cost-effective energy-efficiency retrofit measures for a home after taking into account local weather conditions, retrofit measure costs, fuel costs, and specific construction details of the home. Energy consumption is calculated using the variable-based degree day method. The Weatherization Assistant is designed specifically to help states and local weatherization agencies implement the U.S. Department of Energy (DOE) Weatherization Assistance Program, although it is also used by utilities and other home energy professionals. The output includes estimates of the dollar value for the projected energy savings, savings-to-investment ratios (SIRs), installation costs, a list of the quantities of the major materials necessary to perform the recommended weatherization retrofits, and design heating and cooling loads needed to size any replacement equipment.	http://weatherization.ornl.gov/national_energy_audit.htm
28	NEAT (National Energy Audit Tool)	ORNL	Disk-based (Free)	Homeowner; Energy Auditors; Utility Companies; State and local weatherization Agencies	R (single-family)	W	Y	M	Optional	Y	N	N	N	Y	Y	N	W, M, &D	The National Energy Audit Tool (NEAT) for site-built single-family homes has been developed by the Buildings Technology Center at Oak Ridge National Laboratory (ORNL) for the U.S. Department of Energy's Weatherization Assistance Program. This program allows users to identify the cost-effective energy-efficiency retrofit measures for a home after taking into account local weather conditions, retrofit measure costs, fuel costs, and specific construction details of the home. Energy consumption is calculated using the variable-based degree day method. The output includes estimates of the dollar value for the projected energy savings, savings-to-investment ratios (SIRs), installation costs, a list of the quantities of the major materials necessary to perform the recommended weatherization retrofits, and design heating and cooling loads needed to size any replacement equipment. The majority of the energy algorithms used in NEATwere taken from the Computerized Instrumented Residential Audit (CIRA), which was developed at Lawrence Berkeley Laboratory. CIRA is a collection of programs related to building energy analysis and designed for a wide variety of microcomputers.	http://weatherization.ornl.gov/national_energy_audit.htm

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Appr oach	INPUT			OUTPUT (Y: Yes, N: No)							Source	Comments	Web Address
29	OptoMizer	Fielding Data Labs	Disk-based (Purchase)	Energy Auditor; Facility Manager; Lighting Designer	C	C	N	M	Optio nal	N	N	N	N	Y	N	N	W&B	The OptoMizer is a multi-user and network-ready lighting audit retrofit software for the design, data collection, analysis and energy reporting of lighting retrofit project. It supports an unlimited number of system users and audits due to its relational database design. OptoMizer incorporates all of the lighting technology needed to create reports that range from parts lists, to detailed energy studies, to complete proposal packages. The parts facilities within OptoMizer enables the lighting designer to track individual lighting component parts and pricing for use in the creation of luminaire designs. Assigning an operating schedule to an audit space then allows the system to calculate accurate energy usage and savings utilizing the existing and design wattage in conjunction with the existing and design operating schedules.	http://www.fdlabs.com/products/optomizer.html
30	PRISM	Princeton University	Disk-based (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers	C	W	Y	B	Y	Y	N	N	N	N	N	N	W	The PRISM is a standardized tool for estimating energy savings from billing data. The advanced version of PRISM (Princeton Scorekeeping Method) makes it easy to transform run-of-the-mill billing data into statistically sound savings estimates. With PRISM, utilities and energy analysts can systematically estimate total savings from a conservation or demand-side management program, for large samples of houses or buildings participating in the program, and for comparison groups as well. Using a statistical procedure with daily temperature data published by the National Oceanic and Atmospheric Administration, PRISM produces a weather-adjusted Normalized Annual Consumption (NAC) index. A key feature of the method is its estimation of best reference temperature to which heating and cooling degree-days in the model are computed.	http://www.princeton.edu/~marean/

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Appr oach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
31	Prophet Load Profiler	Automated Energy Inc	Web-based (Purchase)	Energy Program Managers; Energy Professionals; Facility Managers; Utility Companies	C	W	Y	B	Y	N	Y	Y	N	N	N	N	W	The Propehet Load Profiler is an web-based software to manage energy profiles and reduce costs. The Prophet delivers real-time and near-real-time energy information on energy consumption and demand for any size facility. A number of facilities can be managed using consumption data gathered in 15 minute, 30 minute, 60 minute, daily, weekly and monthly intervals. Users can immediately view and analyze data with an eye toward load shedding, cost avoidance strategies, energy budget management, utility cost validation and energy forecasting. The enhancement of the latest version 3.1 includes a display of energy consumption with relative humidity, HDD. and CDD.	http://www.automatedenergy.com/index.jsp
32	Rehab Advisor	D & R International Inc.	Web-based (Free)	Homeowner; Energy Auditors; Utility Companies; Development Agencies	R	W	Y	B	N	Y	N	N	N	N	Y	N	W&E	The Rehab Advisor is a web-based tool developed with funding from the U.S. Department of Housing and Urban Development, Office of Policy Development and Research. The purpose is to help the housing community improve energy efficiency in existing buildings during rehabilitation and renovation, a significant step toward achieving High Performance Housing. The Advisor draws extensively on information from the U.S. Department of Energy and the U.S. Environmental Protection Agency. The Advisor lists recommended measures and the incremental cost, savings, and payback produced by choosing the energy efficient measure compared to the minimum required by the governing code or standard. The data provided are based on computer models of typical single family and typical multifamily buildings in the climate zone. The energy efficiency recommendations are based on ENERGY STAR specifications, where applicable.	http://rehabadvisor.pathnet.org/index.asp

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type (R: Residential, C: Commercial, B: Both)	Approach (W: Whole-Building, C: Component, B: Both)	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source (W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online)	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
33	REM/Rate	Architectural Energy Corporation	Disk-based (Annual license fee and a rating/use fee for each home certified)	HERS Provider; Energy Auditor; Weatherization Agencies; Homeowner	R	W	Y	B&D	N	Y	N	N	N	N	Y	Y	W	The REM/Rate is a user-friendly residential energy analysis, code compliance and rating software used by organizations which operate Home Energy Rating Systems (HERS). HERS rates the energy efficiency of homes for identifying cost-effective improvements and providing energy-efficient mortgages. Climate data are available for cities and towns throughout North America. REM/Rate produces a home energy rating report based on the RESNET (Residential Energy Services Network) National HERS Technical Standards. In addition to an energy rating, REM/Rate creates value added information including energy efficiency mortgage report, energy appraisal addendum, energy code compliance (MEC, IECC, and ASHRAE), improvement analysis (existing homes), design optimization (new homes), heating and cooling equipment sizing, utility DSM compliance analysis, and U.S. EPA Energy Star Home analysis.	http://www.archenergy.com/products/rem/
34	RESEM (Retrofit Energy Savings Estimation Model)	LBNL	Disk-based (Free)	Energy Auditor; Facility Manager; Commissioning Service Contractor	C (Institutional buildings and hospital)	W	Y	B	Y	Y	N	N	N	N	N	N	W, M, &D	The Retrofit Energy Savings Estimation Model (RESEM) is a simulation-based tool designed to allow Department of Energy (DOE) Institutional Conservation Program (ICP) staff and participants to reliably determine the energy savings directly caused by ICP-supported retrofit measures implemented in a building. RESEM incorporates several innovative techniques into an interactive tool designed to ease completion of this demanding analytical task. For maximum accuracy and validity, energy savings are calculated directly from actual utility data, with sophisticated corrections for weather (bin data) and use variations between the pre-retrofit and post-retrofit utility data collection periods.	http://btech.lbl.gov/tools/resem/resem.htm
35	SenseDat Analyzer	Informing Ecological Design	Disk-based (Purchase)	Facility Managers; Utility Companies; Building Owners	C	W	N	B	Y	N	Y	N	N	N	N	N	W	The SenseDat Analyzer is an energy information display software that is the heart of SenseDat Meter™. This program uses 15-minute energy data, and display patterns in energy use, including periods of peak demand with energy costs and greenhouse gas emission costs. SenseDat Analyzer has also been used to monitor use of natural gas and water. Using 15-minute resource data, Analyzer creates a time series graph and a cost table that displays typical electric utility bill information. A built-in note function also encourages users to describe building events and record experiments to understand better how their building uses energy. Analyzer also creates reports in Excel for additional analysis.	http://www.sensedat.com/how_it_works.html

Table 2.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Approach	R: Residential... Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
36	TREAT	Performance Systems Development Inc.	Disk-based (Purchase)	Homeowner; Energy Auditors; Utility Companies; State and local weatherization Agencies	R	W	Y	D	Y	Y	N	N	N	Y	Y	N	W&M	The TREAT is designed to provide support for weatherization programs, building performance contractors and energy auditors. TREAT performs hourly simulations for single family, multifamily and mobile homes with highly accurate calculations which consider waste heat (base load), solar heat gain, and fully interacted energy savings calculations. Comprehensive analysis tool includes tools for retrofitting heating and cooling systems, building envelopes (insulation and infiltration), windows and doors, hot water, ventilation, lighting and appliances, and more. Weather normalizes utility bills for comparison to performance of model. The New York State Energy Research and Development Authority has funded the TREAT software project as part of their Building Performance Market Enhancement Initiative. TREAT utilizes the SUNREL building physics simulation engine developed by the National Renewable Energy Laboratory. TREAT is approved by US DOE for use in Weatherization Assistance Programs.	http://treatsoftware.psdconsulting.com/
37	Visualize-IT	KEMA	Disk-based (Purchase)	Facility Managers; Utility Companies; Building Owners	C	B	N	B	Y	N	Y	N	N	N	N	N	W	Visualize-IT™ is a Windows application designed to help you explore, summarize and analyze time series interval data. Visualize-IT has been developed specifically for electric and gas load data, but it is equally useful as a general purpose data visualization tool for other time series measurements such as weather, industrial process control, and water quality.	http://www.rlw.com/vizit.cfm
38	ZIP-Code Insulation	ORNL	Web-based (Free)	Homeowner; Energy Auditors	R	C	Y	B	N	N	N	N	N	N	Y	N	W&E	The ZIP-Code Insulation is a web-based program for estimating the economic levels or R-values of insulation in new or existing single family homes. It calculates economic levels of insulation for attics; cathedral ceilings; exterior wood frame and masonry walls; metal-framed buildings; ductwork over unheated spaces, slab floors, basement and crawlspace walls; ductwork in unconditioned spaces; and water heaters. Since the recommendations are made based on life-cycle costs, it may not correspond to local building/energy code.	http://www.ornl.gov/~roofs/Zip/ZipHome.html

2.3   Classification of 38 Building Energy Analysis Tools

To classify the tools by their functions, nine categories have been defined as follows: A. Utility Bill Monitoring/Analysis Tools; B. Smart Metering Tools; C. Retrofit/ECM Implementation Simulation Tools; D. Energy Profile Analysis Tools; E. Code Compliance/Rating Simulation Tools/ HERS Software; F. Field Auditing Tools; G. Data Display Tools; H. Utility Bill Disaggregation Tools based on Energy Audit Survey; and I. Energy Calculation Tools.

Table 2.3.1 shows the nine categories of 38 building energy analysis tools. Every tool falls into at least one of the nine categories. The objectives of the tools in each category are as follows:
- Category A. *Utility Bill Monitoring/Analysis Tools* allows users to track and analyze their utility bills;
- Category B. *Smart Metering Tools* allows users to monitor and diagnose real-time interval energy data for commercial buildings;
- Category C. *Retrofit/ECM Implementation Simulation Tools* allows users to estimate the possible savings from retrofits or energy saving strategies, including an implementation of various ECMs (Energy Conservation Measures);
- Category D. *Energy Profile Analysis Tools* allows users to analyze their energy consumption in detailed profiles to identify opportunities of energy and cost reduction, including demand or end-use analysis;
- Category E. *Code Compliance/Rating Simulation Tools/HERS Software* are code compliance or rating software tools for residential buildings. These tools calculate the above code performance of a building or a HERS rating (Home Energy Rating Systems[3]) based on the RESNET (Residential Energy Services Network) National HERS Technical Standards;
- Category F. *Field Auditing Tools* are designed to help users (energy inspectors and auditors) perform an energy auditing;
- Category G. *Data Display Tools* are data visualization tools to help users display and manage general time series interval data;
- Category H. *Utility Bill Disaggregation Tools based on Energy Audit Survey* perform utility bill disaggregation analysis based on the monthly utility bill and user survey regarding heating and cooling systems and appliances; and
- Category I. *Energy Calculation Tools* calculate the energy consumption and costs based on the user inputs. No actual energy usage data is needed.

Figure 2.3.1 shows the classification of 38 building energy analysis tools by the primary function of each tool, although several tools support more than one function. The results were as follows:
- Category C. *Retrofit/ECM Implementation Simulation Tools* accounts for 42%;
- Category B. *Smart Metering Tools* accounts for 21%;
- Category A. *Utility Bill Monitoring/Analysis Tools* accounts for 18%;
- Category E. *Code Compliance/Rating Simulation Tools/HERS Software* accounts for 5%;
- Category F. *Field Auditing Tools* accounts for 5%;
- Category G. *Data Display Tools* accounts for 5%; and
- Category D. *Energy Profile Analysis Tools* accounts for 3%.

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[3] HERS rates the energy efficiency of homes for identifying cost-effective improvements and providing energy-efficient mortgages.

Table 2.3.1. Nine Categories of 38 Building Energy Analysis Tools (U.S. DOE EERE's Building Energy Software Tools Directory).

No.	Tool Name	A. Utility Bill Monitoring/Analysis Tools	B. Smart Metering Tools	C. Retrofit/ECM Implementation Simulation Tools	D. Energy Profile Analysis Tools	E. Code Compliance/Rating Simulation Tools/HERS Software	F. Field Auditing Tools	G. Data Display Tools	H. Utility Bill Disaggregation Tools based on Energy Audit Survey	I. Energy Calculation Tools
		Nine Categories (Y:Yes, P:Partial)								
1	Commodity Server							Y		
2	Demand Response Quick Assessment Tool (DRAQT)			Y						
3	EA-QUIP (Energy Audit using the Queens Information Package)			Y						
4	EBD (ENFORMA® Building Diagnostics)		Y					P		
5	e-Bench	Y						P		
6	Ecasys						Y			
7	Eco Lumen			Y						
8	eDNA		Y		P			P		
9	EEM Suite		Y		P			P		
10	EffTrack		Y					P		
11	EMODEL	Y						P		
12	Energy Audit - Residential/Light Commercial Energy Analysis			Y						
13	Energy Lens	Y			P			P		
14	Energy Profile Tool				Y					
15	Energy WorkSite	P	Y		P			P		
16	EnergyCAP Enterprise	Y						P		
17	EnergyCAP Professional	Y						P		
18	EnergyGauge USA			P		Y				
19	EZ Sim	P		Y						
20	FEDS (Facility Energy Decision System)			Y						
21	FRESA (Federal Renewable Energy Screening Assistant)			Y						
22	Home Energy Saver			Y						
23	Home Energy Tune-uP						Y			
24	ION Enterprise		Y					P		
25	MarketManager			Y						
26	METRIX4	Y						P		
27	MHEA (Manufactured Home Energy Audit)			Y						
28	NEAT (National Energy Audit Tool)			Y						
29	OptoMizer			Y						
30	PRISM	Y						P		
31	Prophet Load Profiler		Y		P			P		
32	Rehab Advisor			Y						
33	REM/Rate			P		Y				
34	RESEM (Retrofit Energy Savings Estimation Model)	P		Y						
35	SenseDat Analyzer		Y		P			P		
36	TREAT	P		Y						
37	Visualize-IT				P			Y		
38	ZIP-Code Insulation			Y						

38 Building Energy Analysis Tools
(U.S. DOE EERE's Building Energy Software Tools Directory).

- A. Utility Bill Monitoring/Analysis Tools (18%)
- B. Smart Metering Tools (21%)
- C. Retrofit/ECM Implementation Simulation Tools (42%)
- D. Energy Profile Analysis Tools (3%)
- E. Code Compliance/Rating Simulation Tools/HERS Software (5%)
- F. Field Auditing Tools (5%)
- G. Data Display Tools (5%)
- H. Utility Bill Disaggregation Tools based on Energy Audit Survey (0%)
- I. Energy Calculation Tools (0%)

Figure 2.3.1. Classification of 38 Building Energy Analysis Tools by the Primary Function of Each Tool (U.S. DOE EERE's Building Energy Software Tools Directory).

3   BUILDING ENERGY ANALYSIS TOOLS FROM THE OTHER WEBSITES

3.1   Overview

This section covers the review of 20 building energy analysis tools from the other websites, including major power companies, manufacturers, national laboratories, the U.S. government and individual state, and research organizations, as well as general search engines such as Google and Yahoo. The details are as follows:

- General Search Engines;
  - Google
  - Yahoo
- Major Power Company Websites;
  - Southern Company (Alabama Power, Georgia Power, Gulf Power, Mississippi Power)
  - FPL (Florida Power Light)
  - Duke Energy Corporation
  - Entergy
  - ONCOR
  - CenterPoint Energy
  - AEP (American Electric Power)
  - Austin Energy
  - PG&E (Pacific Gas and Electric Company)
- Major Manufacturers Websites;
  - ITRON
  - NorthWrite
  - Trane
  - Honeywell
  - Simens
- National Laboratory Websites;
  - ORNL (Oak Ridge National Laboratory)
  - LBNL (Lawrence Berkeley National Laboratory)
  - PNNL (Pacific Northwest National Laboratory)
- The U.S. Government and State Websites; and
  - U.S. DOE (Department of Energy)
  - U.S. EPA (Environmental Protection Agency), ENERGY STAR
  - SECO (State Energy Conservation Office)
- Research Organization/Institute/Company Websites.
  - E Source Company
  - RMI (Rocky Mountain Institute)
  - ESL (Energy Systems Laboratory)
  - FSEC (Florida Solar Energy Center)
  - ACEEE(American Council for an Energy Efficient Economy)
  - EPRI (Electric Power Research Institute)
  - Southface
  - NARUC (National Association of Regulatory Utility Commissioners)

Table 3.1.1 shows the list of the identified tools and the assigned number in the alphabetic order with the provider and country. Appendix B presents the screenshots of these 20 tools to give an idea how they look.

A systematic comparison spreadsheet showing the technical and practical features of these 20 tools is developed and displayed in Section 3.2. The same matrix that defines several descriptive characteristics and possible technical features of tools in Section 2.2 has been used and all identified 20 tools were mapped onto this matrix. Section 3.3 presents the classification of 20 identified tools by the primary function of each tool.

Most of the tools investigated in this report are under continuous development. Thus only the features available in March 2009 are considered for this analysis.

Table 3.1.1. 20 Building Energy Analysis Tools from the Other Websites.

No.	Tool Name	Provider	Country
39	ASHRAE 1093 (Diversity Factor)	ASHRAE	United States
40	ASHRAE IMT (Inverse Modeling Toolkit)	ASHRAE	United States
41	ATCO Energy Sense House	ATCO EnergySense	Canada
42	ATCO EnergySense Energy Scorecard	ATCO EnergySense	Canada
43	CommercialEnergySuite™	Apogee Interactive, Inc.	United States
44	Energy Depot® for Business	Enercom	United States
45	Energy Depot® for Homes	Enercom	United States
46	ENERGY Guide Business Analyzer	Aclara Software	United States
47	ENERGY Guide Home Analyzer	Aclara Software	United States
48	ENERGY STAR Home Energy Yardstick	USEPA	United States
49	ENERGY STAR Portfolio Manager	USEPA	United States
50	Energy Watchdog Pro	Utilivision, Inc.	United States
51	ETracker	University of Dayton	United States
52	HomeEnergySuite™	Apogee Interactive, Inc.	United States
53	HomeVIEW™	Volt Viewtech	United States
54	IC3 (International Code Compliance Calculator)	Energy Systems Laboratory	United States
55	My Home	Green Mountain Power	United States
56	Online Home Energy Survey	Southern California Edison	United States
57	Residential Energy Bill Analyzer (REBA™)	Electrotek Concepts	United States
58	TCV (Texas Climate Vision)	Energy Systems Laboratory	United States

3.2   Comparison Spreadsheet

To collect detailed information of each tool the web page information, brochures, and manuals of the products were reviewed. When the website provides the software program by free or a trial-version, these disk-based programs were downloaded and executed for the review. For the web-based programs, when the program is accessible by free or provides a demo version, it was executed via online. The source information of each tool is included in the comparison spreadsheet.

To capture the feature of each tool, the same systematic matrix that defines several descriptive characteristics and possible technical features of tools in Table 2.2.1 has been used, and all identified tools were mapped onto this matrix. The selected descriptive and technical features are as follows:
- Tool Name
- Provider
- Availability
- Users
- Building Type (R: Residential, C: Commercial, B: Both)
- Approach (W: Whole Building, C: Component, B: Both)
- Input
  - Site/Weather Description (Zip-Code) (Y: Yes, N: No)
  - Survey Information Level (B: Basic, M: Medium, D: Detail)
  - Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)
- Output
  - Weather Normalization (including Simulation Approach) (Y: Yes, N: No)
  - Interval Energy Data Monitoring (Y: Yes, N: No)
  - Diagnostics on Data (including Alarm Function) (Y: Yes, N: No)
  - Utility Billing Error Check (Y: Yes, N: No)
  - Parametric Run (Baseline Modifications and Comparisons) (Y: Yes, N: No)
  - Recommendations/Suggestions (Y: Yes, N: No)
  - Energy Benchmarking Information (Y: Yes, N: No)
- Source (W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online)
- Comments
- Web Address

Table 3.2.1 presents a comparison spreadsheet that defines several descriptive characteristics and the technical and practical features for the 20 identified tools. The tools are sorted in the alphabetic order. The web-based tools can be directly accessed via the internet, while the disk-based tools can be downloaded or ordered from the websites. Some tools require a relatively small number of inputs, while other tools ask users to input detailed information on the buildings and operating schedule. Most tools use pull-down menus. Each tool supports different functions, including weather normalization, interval energy data monitoring, diagnostics on data, utility billing error check, parametric run, recommendations/suggestions, and energy benchmarking information. No one tool supports all these functions. A short descriptive comment is also included at the end of the spreadsheet.

Section 4.2 presents more detailed analysis of these 20 building energy analysis tools, including the 38 tools from the U.S. DOE EERE's Building Energy Software Tools Directory.

Table 3.2.1. Comparison Spreadsheet for 20 Building Energy Analysis Tools (Other Websites).

No.	Type	Provider	Availability	Users	Type	Approach	INPUT			OUTPUT (Y: Yes, N: No)							Source	Comments	Web Address
					R: Residential, C: Commercial, B: Both	W: Whole-Building, C: Component, B: Both	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online		
39	ASHRAE 1093 (Diversity Factor)	ASHRAE	Disk-based (Purchase)	Facility Manager; Energy Auditors; Energy Professionals	C	B	N	B	Y	N	N	N	N	N	N	N	M&D	The ASHRAE 1093 Diversity Factor presents the method used to derive the diversity factors and typical load shapes of lighting and receptacle loads in office buildings. The user is required to assure that his/her new datasets do not show any seasonality (Summer-Winter operational changes) and/or weather dependency, as this would produce a non-typical diversity factor and load shapes. To produce new sets of diversity factors, one whole year of hourly data is required. If the new data is then cut and pasted into an existing workbook, the whole workbook then will be updated automatically as the data will be sorted into weekdays and weekends: new tables of diversity factors and the typical load shapes will be produced, and new DOE-2, BLAST, and EnergyPlus Input Files will be written. In the percentile analysis, the 50th percentile was used to calculate the diversity factors and the typical hourly load shapes; other statistics are reported as well, including: the mean, the mean plus or minus one standard deviation, and the 10th, 25th, 75th, and 90th percentiles.	http://www.ashrae.org/
40	ASHRAE IMT (Inverse Modeling Toolkit)	ASHRAE	Disk-based (Purchase)	Facility Manager; Energy Auditors; Energy Professionals	C	W	Y	B	Y	Y	N	N	N	N	N	N	M&D	ASHRAE Inverse Modeling Toolkit (IMT) is a FORTRAN 90 application that identifies best-fit regression models for measuring retrofit energy savings in buildings. The toolkit was developed under ASHRAE RP-1050 (Development of a Toolkit for Calculating Linear, Change-Point Linear and Multiple Linear Inverse Building Energy Analysis Models) by the Energy Systems Laboratory. IMT can identify linear, change-point linear, variable-based degree day and combined multiple linear regression, which have been shown to be especially useful for modeling building energy use.	http://www.ashrae.org/
41	ATCO Energy Sense House	ATCO EnergySense	Web-based (Free)	Homeowner	R	B	N	B	N	N	N	N	N	N	N	N	W&E	The ATCO EnergySense House is an interactive tool designed to help you better understand your natural gas and electricity costs. The ATCO EnergySense House allows users to conduct a room-by-room review of the major appliances and equipment. All calculations in the ATCO EnergySense House are based on average consumer use, and the costs reflected are for energy only and excludes delivery charges.	http://www.atcoenergysense.com/Flash/webhaus.html

Table 3.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Approach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
42	ATCO EnergySense Energy Scorecard	ATCO EnergySense	PDF File	Homeowner; Energy Auditor	R	B	N	D	N	N	N	N	N	N	Y (General Tips)	N	W&D	The ATCO EnergySense Energy Scorecard is a tool that allows users to conduct their own home energy assessments. The users are expected to walk through the home with this booklet, a pencil, and a calculator, and determine their home efficiency.	http://www.atcoenergysense.com/NR/rdonlyres/EF972E83-2FB3-44AF-9DD7-36D49A7B800D/0/EnergyScorecard.pdf
43	CommercialEnergySuite™	Apogee Interactive, Inc.	Web-based (Purchase)	Utility Company; Building Owner; Facility Manager	C	B	Y	M	N	Y	N	N	N	Y	Y	Y	W&E	The CommercialEnergySuite is a web-based online comprehensive self-help resource tool for commercial building operators and energy managers. It includes the Commercial Energy Calculator, Commercial Energy Systems, and Understanding Demands. The Commercial Calculator, the core application in the suite, estimates of energy usage and costs based on the inputs, and presents a comparison of three efficiency levels for each calculation.	http://www.apogee.net/ces.aspx
44	Energy Depot® for Business	Enercom	Web-based (Purchase)	Utility Company; Building Owner; Facility Manager	C	W	Y	M	Y	Y	N	N	N	N	N	N	W&E	Energy Depot for Business is a web based do-it-yourself, business energy audit that addresses the full range of energy systems found in most small and medium commercial facilities. Once users are authenticated, their billing data is securely imported and presented for the review and energy analysis. The business questionnaire allows customers to complete their audit in about 20 - 30 minutes. Once the questionnaire is answered, users receive a highly graphic Business Energy Profile report, including energy usage and cost graph, annual energy cost by energy system/appliance and specific recommendations with cost savings estimates. Recommendations can be hyperlinked to your program, product and service offers and articles in the Energy Library.	http://www.enercomusa.com/energydepotbusiness.asp

Table 3.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Approach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT		OUTPUT (Y: Yes, N: No)										
45	Energy Depot® for Homes	Enercom	Web-based (Purchase)	Utility Company; Homeowner	R	B	Y	B&D	Y	Y	N	N	N	N	Y	N	W&E	Energy Depot for Homes is a web-based do-it-yourself home energy audit that addresses the full range of home energy systems and appliances, as well as home safety and security. Once users are authenticated, their billing data is securely imported or manually entered and presented for the review and energy analysis. Users can choose between the standard and EZ audit. The new EZ audit questionnaire takes only about 5 - 7 minutes to complete. Once the questionnaire is completed, users receive a highly graphic Personal Energy Profile report, including energy usage and cost graphs, annual energy cost by energy system/appliance and specific recommendations with cost savings estimates. Recommendations can be hyperlinked to a relevant program, product or service offers and to articles in the Energy Library so customers can learn even more about home energy use.	http://www.enercomusa.com/energydepothome.asp
46	ENERGY Guide Business Analyzer	Aclara Software	Web-based (Free)	Building Owner; Facility Manager	C	B	Y	B&D	Y	Y	N	N	N	N	Y	Y	W&E	The ENERGY Guide Business Analyzer is a web-based self-guided, energy-efficiency analysis for a small or mid-sized business. It allows a comparison of a facility's energy consumption with peer group, and suggests cost-saving recommendations, including links to special services and incentives. ENERGYguide is also an affiliate of the ENERGY STAR program of the Environmental Protection Agency.	http://www.energyguide.com/audit/baintro.asp
47	ENERGY Guide Home Analyzer	Aclara Software	Web-based (Free)	Homeowner	R	B	Y	B&D	Y	Y	N	N	N	N	Y	Y	W&E	The ENERGY Guide Home Analyzer is a web-based self-guided, energy-efficiency analysis for homes. It allows a comparison of the user's energy consumption with peer group, and suggests cost-saving recommendations, including links to special services and incentives.. ENERGYguide is also an affiliate of the ENERGY STAR program of the Environmental Protection Agency.	http://www.energyguide.com/audit/haintro.asp
48	ENERGY STAR Home Energy Yardstick	USEPA	Web-based (Free)	Homeowner	R	W	Y	B	Y	Y	N	N	N	N	Y	Y	W&E	This simple web-based tool allows users to compare their utility bills to similar homes and suggests several simple methods to improve home energy efficiency and comfort.	http://www.energystar.gov/index.cfm?fuseaction=HOME_ENERGY_YARDSTICK.showGetStarted

Table 3.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type (W: Whole-Building, C: Component, B: Both)	Approach	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
							INPUT			OUTPUT (Y: Yes, N: No)									
49	ENERGY STAR Portfolio Manager	USEPA	Web-based (Free)	Building Owner; Facility Manager	C	W	Y	M	Y	Y	N	N	N	N	N	Y	W&E	This web-based energy and water management tool allows users to track and access energy and water consumption across their entire portfolio of building. The buildings' energy performance may be rated on a scale of 1–100 against a peer group of facilities, with adjustments for climate, facility size, hours of operation, and number of occupants. The peer group database is derived from the U.S. DOE EIA's national survey known as Commercial Building Energy Consumption Survey (CBECS). Top-rating buildings may qualify for the ENERGY STAR label, and the buildings that demonstrate wide-improvements of reducing the portfolio's energy use by 10%, 20%, 30% may qualify ENERGY STAR Leaders.	http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
50	Energy Watchdog Pro	Utilivision, Inc.	Web-based (Purchase)	Building Owner; Facility Manager	C	W	Y	B	Y	Y	N	N	N	N	N	N	W	Energy Watchdog is an easy to use fully web-based energy tracking and utility bill management tools. The users enter their monthly utility bill information into the system, and receive reports and valuable advices to reduce utility use and cost. Energy Watchdog also tracks and correlates weather data to energy use with WeatherDog. Cooling Degree Day (CDD) and Heating Degree Day (HDD) weather data are automatically uploaded from the National Weather Service for over 1,000 weather stations each month.	http://www.energywatchdog.com/
51	ETracker	University of Dayton	Disk-based (Free)	Facility Manager; Building Owner; Energy Auditors; Energy Professionals	C	W	Y	B	Y	Y	N	N	N	N	N	N	W&D	ETracker is a user-friendly software that tracks energy consumption and measures retrofit savings in buildings. ETracker was developed with support from for the US EPA Energy Star Buildings Program, and is used to help determine if buildings qualify for this label. ETracker uses ambient-temperature regression models to reduce the influence of changing weather so that retrofit savings can be more accurately measured. ETracker automatically merges the energy use and temperature data, and develops a best-fit regression model of energy use and temperature from before the retrofit. To measure energy savings, energy use from after the retrofit is compared to the model's prediction of how much energy the building would have consumed if it were not retrofitted. This method of measuring savings is recommended by the International Performance, Measurements and Verification Protocols (IPMVP), the Federal Energy Management Program (FEMP) Measurement and Verification Guidelines and ASHRAE Guideline 14.	http://www.engr.udayton.edu/faculty/jkissock/http/RESEARCH/ETracker.htm

Table 3.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Appr oach	INPUT			OUTPUT (Y: Yes, N: No)							Source	Comments	Web Address
					R: Residential, C: Commercial, B: Both	W: Whole-Building, C: Component, B: Both	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)	Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online		
52	HomeEnergySuite™	Apogee Interactive, Inc.	Web-based (Purchase)	Utility Company; Homeowner	R	B	Y	M	N	Y	N	N	N	Y	Y	Y	W&E	The HomeEnergySuite is a web-based online self-help resource tool that includes the Home Energy Calculator, Energy Library, Interactive House, Kids Korner and more. The Home Energy Calculator estimates energy use and costs, and suggest recommendations to better manage the energy use and costs with estimated energy savings under various scenarios, such as upgrading your heating system or adding insulation to your home. Lighting and Appliance Calculators also enable specific investigations of energy use, with output linked to the Home Energy Calculator.	http://www.apogee.net/hes.aspx
53	HomeVIEW™	Volt Viewtech	Web-based (Purchase)	Utility Company; Homeowner	R	W	Y	D	Y	Y	N	N	N	Y	Y	N	W&E	HomeVIEW is an energy bill analysis program that provides a report with up to forty-one (41) energy end-uses with money-savings recommendations while on-line, after the users answers questions about their lifestyle and home features, selects a weather zone, and keystrokes twelve (12) months of billing data. After reviewing the results, users can change their survey responses and consider "what if" scenarios. HomeVIEW™ Energy Bill Analysis balances actual consumption with disaggregated estimates using a proprietary algorithm consistent with industry standards and references established by the ASHRAE, DOE, AHAM, ARI and others.	http://www.viewtechfinancialservices.com/homeview.htm
54	IC3 (International Code Compliance Calculator)	Energy Systems Laboratory	Web-based (Free)	Energy Auditor; Weatherization Agencies; Homeowner	R	W	Y	M	N	Y	N	N	N	Y	N	Y	W, M, &E	IC3 (International Code Compliance Calculator) is a publicly accessible energy code compliance software based on the Texas Building Energy Performance Standards (the 2000 International Energy Conservation Code (IECC) with 2001 Supplement). IC3 has the sole purpose to provide an energy efficiency certificate for homes built with wood framing, conventional systems, one or two stories, and less than 20,000 sqft conditioned space. The analysis approach is based on the DOE-2 simulation models.	http://ic3.tamu.edu/
55	My Home	Green Mountain Power	Web-based (Free)	Homeowner	R	C	N	M	N	N	N	N	N	N	Y (General Tips)	N	W&E	My Home is a web-based program that allows users to analyze their own home's electrical usage. The users can build the rooms in their home and put the appliances in the same places by following the simple steps. My Home automatically calculates and display their home appliances' energy use and cost with the last month utility bill.	http://www.gmpvt.com/energy101/myhome.shtml

Table 3.2.1. *(Continued)*

No.	Type	Provider	Availability	Users	Type	Approach	INPUT				Weather Normalization (including Simulation Approach)	Interval Energy Data Monitoring	Diagnostics on Data (including Alarm Function)	Utility Billing Error Check	Parametric Run (Baseline Modifications & Comparisons)	Recommendations/ Suggestions	Energy Benchmarking Information	Source	Comments	Web Address
					R: Residential, C: Commercial, B: Both	W: Whole-Building, C: Component, B: Both	Site/Weather Description (Zip-Code) (Y:Yes, N: No)	Survey Information Level (B: Basic, M: Medium, D: Detail)	Actual Energy Usage (Utility or Monitoring) (Y: Yes, N: No)								W: Website, B: Brochure, M: Manual, D: Downloaded, E: Executed via Online		
								OUTPUT (Y: Yes, N: No)												
56	Online Home Energy Survey	Southern California Edison	Web-based (Free)	Homeowner	R	W	Y	B	Y	N	N	N	N	N	Y	Y	W	The Online Home Energy Survey is a web-based simple 15-minute survey provided by the Southern California Edison (SCE) for the SCE residential customer. If users answer the questions about household energy usage, they can get several energy-saving tips that are tailored especially for users to maximize savings.	https://websafe.kemainc.com/scescg/gatewaysce.asp
57	Residential Energy Bill Analyzer (REBATM)	Electrotek Concepts	Both (Purchase)	Utility Company; Homeowner	R	W	Y	B&D	Y	Y	N	N	N	Y	Y	N	W	The REBA was designed to assist both the utility and customer in understanding and managing energy consumption. REBA provides access to recent and historical energy consumption information - helping identify trends and the potential for savings, permitting evaluation of different utility rates, and allowing "what if" analysis of usage and costs. REBA automatically performs a thermal load analysis when the customer's billing data is first entered - either through interfacing with a utility's customer billing system or through manual entry by the user. Comparing energy usage against climate data for the utility's service area, this analysis separates total energy consumption into three end-use categories - heating, cooling, and bases (all other uses).	http://reba.rebaworks.com/
58	TCV (Texas Climate Vision)	Energy Systems Laboratory	Web-based (Free)	Energy Auditor; Weatherization Agencies; Homeowner	R	W	Y	M	N	Y	N	N	N	Y	N	Y	W, M, &E	The Texas Climate Vision (TCV) Software is a web-based, code compliant, software system that builders use to demonstrate the performance of proposed single family residences according to the Texas Building Energy Performance Standards. TCV is intended to cover the majority of site built houses being produced in the City of Austin, Texas. These are homes built using wood framing, conventional systems, one- or two- stories, and under 10,000 square feet conditioned space. Other types of residential construction may not be candidates for this software and the Builder should contact their local Building Official for other Energy Code compliance options. Repairs and remodels of existing construction are not addressed with this software. TCV does more than calculate the above code performance of a new home. It also calculates how much pollution has been reduced (emissions reductions) through the home's energy efficiency. The software produces reports showing the cumulative savings. The analysis approach is based on the DOE-2 simulation models.	http://tcv.tamu.edu/

3.3   Classification of 20 Building Energy Analysis Tools

To classify the tools by their functions, nine categories have been defined as follows: A. Utility Bill Monitoring/Analysis Tools; B. Smart Metering Tools; C. Retrofit/ECM Implementation Simulation Tools; D. Energy Profile Analysis Tools; E. Code Compliance/Rating Simulation Tools/ HERS Software; F. Field Auditing Tools; G. Data Display Tools; H. Utility Bill Disaggregation Tools based on Energy Audit Survey; and I. Energy Calculation Tools.

Table 3.3.1 shows the nine categories of 20 building energy analysis tools. Every tool falls into at least one of the nine categories. The objectives of the tools in each category are as follows:
- Category A. *Utility Bill Monitoring/Analysis Tools* allows users to track and analyze their utility bills;
- Category B. *Smart Metering Tools* allows users to monitor and diagnose real-time interval energy data for commercial buildings;
- Category C. *Retrofit/ECM Implementation Simulation Tools* allows users to estimate the possible savings from retrofits or energy saving strategies, including an implementation of various ECMs (Energy Conservation Measures);
- Category D. *Energy Profile Analysis Tools* allows users to analyze their energy consumption in detailed profiles to identify opportunities of energy and cost reduction, including demand or end-use analysis;
- Category E. *Code Compliance/Rating Simulation Tools/HERS Software* are code compliance or rating software tools for residential buildings. These tools calculate the above code performance of a building or a HERS rating (Home Energy Rating Systems[4]) based on the RESNET (Residential Energy Services Network) National HERS Technical Standards;
- Category F. *Field Auditing Tools* are designed to help users (energy inspectors and auditors) perform an energy auditing;
- Category G. *Data Display Tools* are data visualization tools to help users display and manage general time series interval data;
- Category H. *Utility Bill Disaggregation Tools based on Energy Audit Survey* perform utility bill disaggregation analysis based on the monthly utility bill and user survey regarding heating and cooling systems and appliances; and
- Category I. *Energy Calculation Tools* calculate the energy consumption and costs based on the user inputs. No actual energy usage data is needed.

Figure 3.3.1 shows the classification of 20 building energy analysis tools by the primary function of each tool, although several tools support more than one function. The results were as follows:
- Category A. *Utility Bill Monitoring/Analysis Tools* account for 30%;
- Category H. *Utility Bill Disaggregation Tools based on Energy Audit Survey* account for 30%;
- Category I. *Energy Calculation Tools* account for 15%;
- Category C. *Retrofit/ECM Implementation Simulation Tools* account for 10%;
- Category E. *Code Compliance/Rating Simulation Tools/HERS Software* account for 10%; and
- Category D. *Energy Profile Analysis Tools* account for 5%.

Of 20 tools, six tools (30%) fall into the category of H. *Utility Bill Disaggregation Tools based on Energy Audit Survey*. Most of the power companies provide one of these programs to their customers or have their own program which is quite similar to the one in this category. For example, Southern Company (parent company of Alabama Power, Georgia Power, Gulf Power, and Mississippi Power)

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[4] HERS rates the energy efficiency of homes for identifying cost-effective improvements and providing energy-efficient mortgages.

allows their customers to access the Energy Depot (Tool No. 44 and 45) through their website. Austin Energy has its own program which is quite similar to the Energy Depot. Once users are authenticated, their billing data is securely imported and presented for the review and energy analysis.

Table 3.3.1. Nine Categories of 20 Building Energy Analysis Tools (Other Websites).

No.	Tool Name	A. Utility Bill Monitoring/Analysis Tools	B. Smart Metering Tools	C. Retrofit/ECM Implementation Simulation Tools	D. Energy Profile Analysis Tools	E. Code Compliance/Rating Simulation Tools/HERS Software	F. Field Auditing Tools	G. Data Display Tools	H. Utility Bill Disaggregation Tools based on Energy Audit Survey	I. Energy Calculation Tools
		Nine Categories (Y:Yes, P:Partial)								
39	ASHRAE 1093 (Diversity Factor)				Y					
40	ASHRAE IMT (Inverse Modeling Toolkit)	Y								
41	ATCO Energy Sense House									Y
42	ATCO EnergySense Energy Scorecard									Y
43	CommercialEnergySuite™			Y						
44	Energy Depot® for Business	P							Y	
45	Energy Depot® for Homes	P							Y	
46	ENERGY Guide Business Analyzer	P							Y	
47	ENERGY Guide Home Analyzer	P							Y	
48	ENERGY STAR Home Energy Yardstick	Y								
49	ENERGY STAR Portfolio Manager	Y								
50	Energy Watchdog Pro	Y						P		
51	ETracker	Y						P		
52	HomeEnergySuite™			Y						
53	HomeVIEW™	P							Y	
54	IC3 (International Code Compliance Calculator)			P		Y				
55	My Home									Y
56	Online Home Energy Survey	Y								
57	Residential Energy Bill Analyzer (REBA™)	P							Y	
58	TCV (Texas Climate Vision)			P		Y				

**20 Building Energy Analysis Tools
(Other Websites).**

- A. Utility Bill Monitoring/Analysis Tools (30%)
- B. Smart Metering Tools (0%)
- C. Retrofit/ECM Implementation Simulation Tools (10%)
- D. Energy Profile Analysis Tools (5%)
- E. Code Compliance/Rating Simulation Tools/HERS Software (10%)
- F. Field Auditing Tools (0%)
- G. Data Display Tools (0%)
- H. Utility Bill Disaggregation Tools based on Energy Audit Survey (30%)
- I. Energy Calculation Tools (15%)
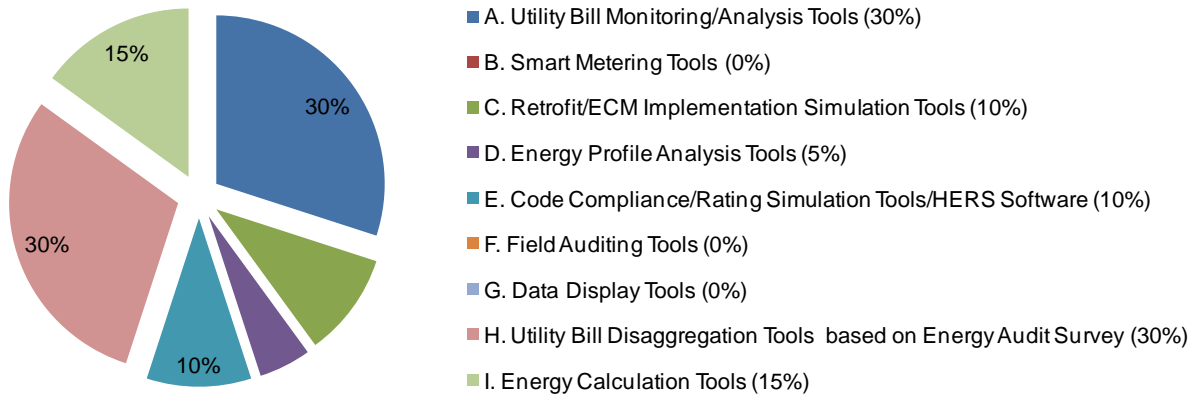
Figure 3.3.1. Classification of 20 Building Energy Analysis Tools by the Primary Function of Each Tool
(Other Websites).

4   ANALYSIS AND STRATEGIC RECOMMENDATIONS

4.1   Overview

This section summarizes the analysis of 58 building energy analysis tools both from the U.S. DOE EERE's Building Energy Software Tools Directory and from the other websites. The recommendations were also selected from the analysis of the information gathered. These recommendations were suggested for a wide audience, certainly including homeowners, building operators and energy managers, state facility energy managers, and utility program managers.

Section 4.2 presents the analysis summary, and Section 4.3 introduces the recommendations for each of the nine predefined categories.

4.2   Analysis

This section contains the analysis of 58 building energy analysis tools. Total 58 tools were identified from the U.S. DOE EERE's Building Energy Software Tools Directory and other websites, including major power companies, manufacturers, national laboratories, the U.S. government and individual state, and research organizations websites, as well as general search engines such as Google and Yahoo. Nine categories were developed based on the primary objective of each tool, and to capture the feature of each tool, a systematic comparison spreadsheet that defines the technical and practical characteristics of the tools has been developed. All identified tools were mapped onto this matrix and presented in Table 2.2.1 and Table 3.2.1.

Thirteen technical and practical characteristics of the tools have been selected for the analysis, including:
- General
  1) Availability, Web-based or Disk-based
  2) Building Type, Residential Buildings or Commercial Buildings
  3) Approach, Whole Building or Component
- Input
  4) Survey Information Level (Basic, Medium, or Detail)
  5) Site/Weather Description (Zip-Code) (Yes or No)
  6) Actual Energy Usage (Utility or Monitoring) (Yes or No)
- Output
  7) Weather Normalization (including Simulation Approach) (Yes or No)
  8) Interval Energy Data Monitoring (Yes or No)
  9) Diagnostics on Data (including Alarm Function) (Yes or No)
  10) Utility Billing Error Check (Yes or No)
  11) Parametric Run (Baseline Modifications and Comparisons) (Yes or No)
  12) Recommendations/Suggestions (Yes or No)
  13) Energy Benchmarking Information (Yes or No)

The first three are the general characteristics of the tools, including whether the tools are web-based or disk-based, whether the tools are for residential buildings or commercial buildings, and whether the tools take whole-building approach or component approach. The next three are the input characteristics of the tools, including whether the complexity of inputs is basic-level, medium-level or detail-level, whether the tools ask the site/weather description information, and whether the tools require actual energy usage information. The last seven are the output characteristics of the tools, including whether the tools normalize the energy consumption to the weather, whether the tools provide the interval energy data monitoring, whether the tools have the function of diagnostics on data, whether the tools have the function of utility billing error check, whether the tools have the function of parametric run, whether the tools provide recommendations or suggestions, and whether the tools provide energy benchmarking information.

Figure 4.2.1 shows nine categories of 58 building energy analysis tools by the primary function of each tool, although several tools support more than one function. The results were as follows:
- Category C. *Retrofit/ECM Implementation Simulation Tools* accounts for 31%;
- Category A. *Utility Bill Monitoring/Analysis Tools* accounts for 22%;
- Category B. *Smart Metering Tools* accounts for 14%;
- Category H. *Utility Bill Disaggregation Tools based on Energy Audit Survey* accounts for 10%;
- Category E. *Code Compliance/Rating Simulation Tools/HERS Software* accounts for 7%;
- Category I. *Energy Calculation Tools* accounts for 5%;
- Category D. *Energy Profile Analysis Tools* accounts for 3%;

- Category F. *Field Auditing Tools* accounts for 3%; and
- Category G. *Data Display Tools* accounts for 3%.

Figure 4.2.2 categorizes the tools according to their availability: web-based or disk-based. The analysis shows that 33 tools are web-based, 23 tools are disk-based, and one tool is available in both web-based and disk-based. One tool that is neither web-based nor disk-based is provided as a PDF file.

Figure 4.2.3 categorizes the tools according to the building type: residential buildings or commercial buildings. The analysis shows that 22 tools are for residential buildings, 34 tools are for commercial buildings, and two tools are for both residential and commercial buildings.

Figure 4.2.4 categorizes the tools according to the approach: whole-building or component. The analysis shows that 36 tools adopt whole-building approach, nine tools take component approach, and 13 tools allow both whole-building and component approach.

Figure 4.2.5 categorizes the tools according to the complexity of inputs: basic-level, medium-level or detail level. The analysis shows that the survey information level of 22 tools fall into basic-level, 18 tools fall into medium-level and eight tools fall into detail-level. Ten tools have two input mode, and users can select either basic-level or detail-level mode.

Figure 4.2.6 categorizes the tools according to the input item: whether site/weather description information (including zip code) is required or not. The analysis shows that 47 tools ask for site/weather description information, while eleven tools do not.

Figure 4.2.7 categorizes the tools according to the input item: whether actual energy usage information (either utility or monitoring) is required or not. The analysis shows that 34 tools require actual energy usage information, while 21 tools do not. For three tools, users can optionally input their actual energy usage information.

Figure 4.2.8 categorizes the tools according to the output item: whether the tools normalize the energy consumption to the weather or not. The analysis shows that 38 tools support weather normalization, including simulation approach, while 20 tools do not.

Figure 4.2.9 categorizes the tools according to the output item: whether the tools provide the interval energy data monitoring. The analysis shows that nine tools support interval data monitoring, while 49 tools do not.

Figure 4.2.10 categorizes the tools according to the output item: whether the tools have the function of diagnostics on data, including alarm function. The analysis shows that 10 tools provide diagnostics on data, while 48 tools do not.

Figure 4.2.11 categorizes the tools according to the output item: whether the tools have the function of utility billing error check. The analysis shows that only three tools provide utility billing error check function, while 55 tools do not.

Figure 4.2.12 categorizes the tools according to the output item: whether the tools have the function of parametric run, including baseline modifications and comparisons. The analysis shows that 20 tools allow parametric run function, while 38 tools do not.

Figure 4.2.13 categorizes the tools according to the output item: whether the tools provide recommendations or suggestions. The analysis shows that 27 tools provide users with the energy improvement tips, recommendations or suggestions, while 31 tools do not.

Figure 4.2.14 categorizes the tools according to the output item: whether the tools provide energy benchmarking information to allow a comparison of the consumption with an average consumption of peer groups. The analysis shows that 18 tools present the energy benchmarking information, while 40 tools do not.

58 Building Energy Analysis Tools.

- A. Utility Bill Monitoring/Analysis Tools (22%)
- B. Smart Metering Tools (14%)
- C. Retrofit/ECM Implementation Simulation Tools (31%)
- D. Energy Profile Analysis Tools (3%)
- E. Code Compliance/Rating Simulation Tools/HERS Software (7%)
- F. Field Auditing Tools (3%)
- G. Data Display Tools (3%)
- H. Utility Bill Disaggregation Tools based on Energy Audit Survey (10%)
- I. Energy Calculation Tools (5%)
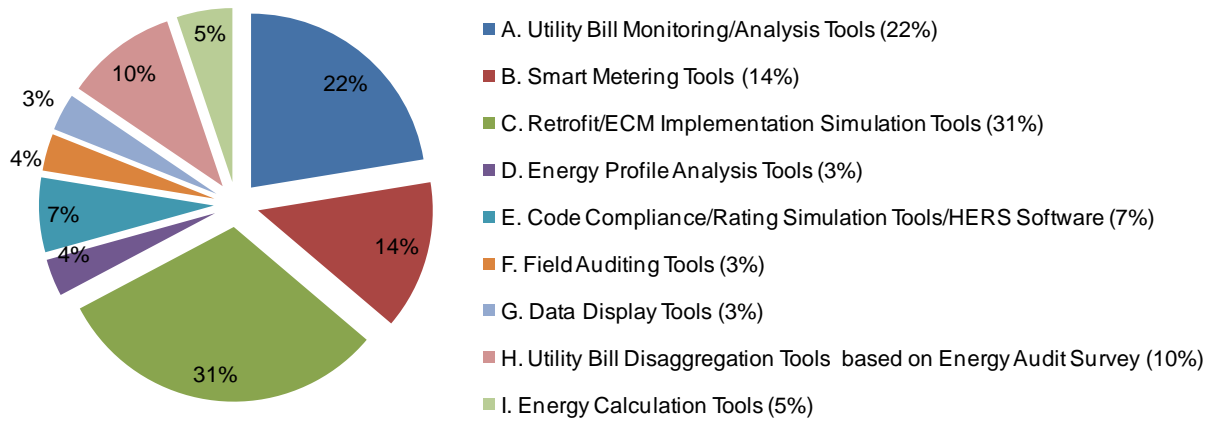
Figure 4.2.1. Classification of 58 Building Energy Analysis Tools by the Primary Function of Each Tool.
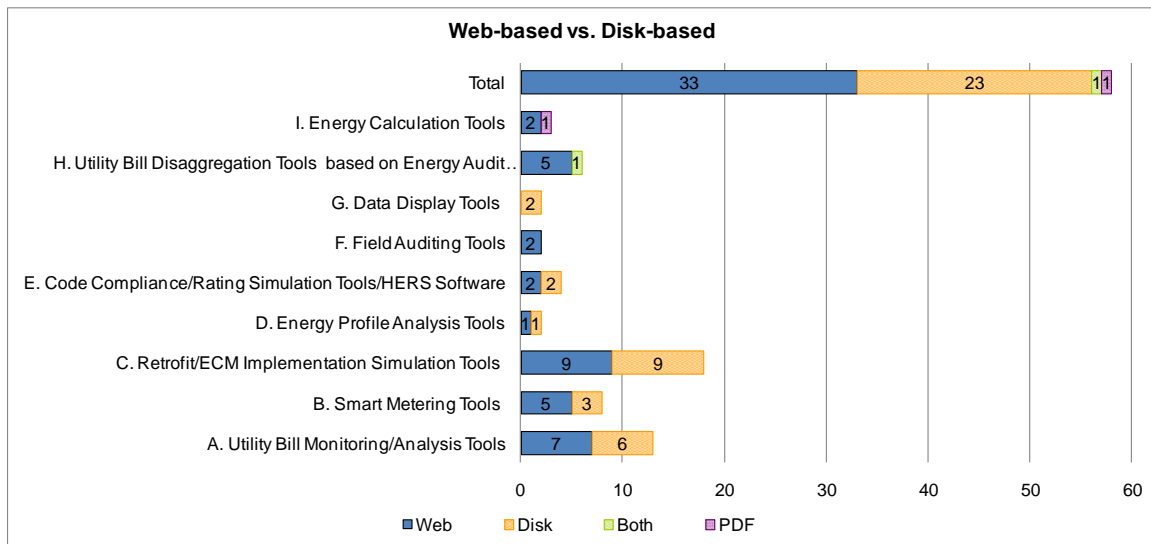
Figure 4.2.2. Tools by Availability - Web-based or Disk-based.
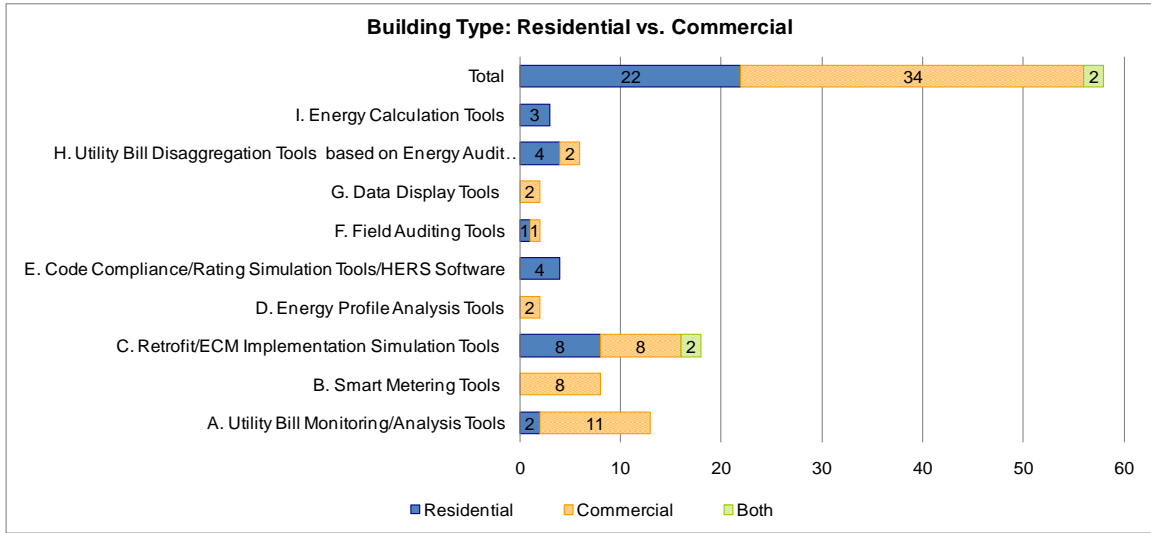
Figure 4.2.3. Tools by Building Type - Residential or Commercial.
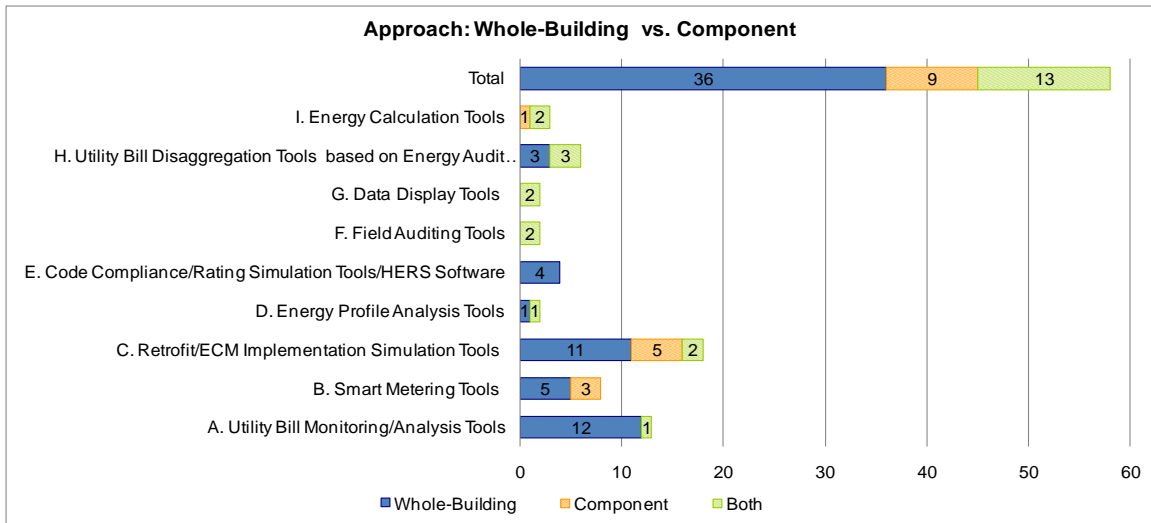
Figure 4.2.4. Tools by the Approach - Whole-Building or Component.
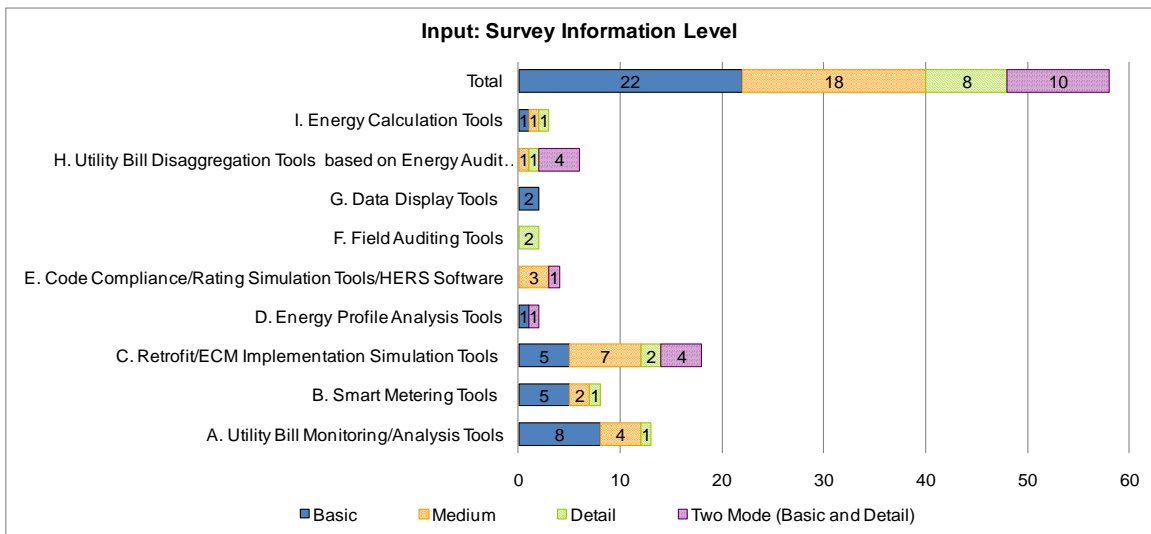
Figure 4.2.5. Tools by Input: Survey Information Level (Basic, Medium, or Detail).
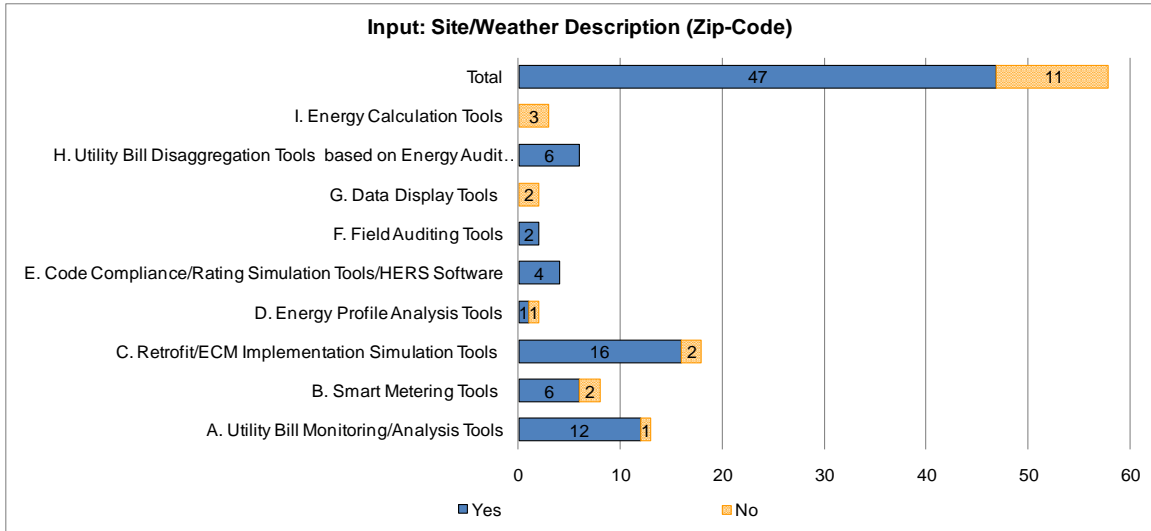
Figure 4.2.6. Tools by Input: Site/Weather Description (Yes or No).
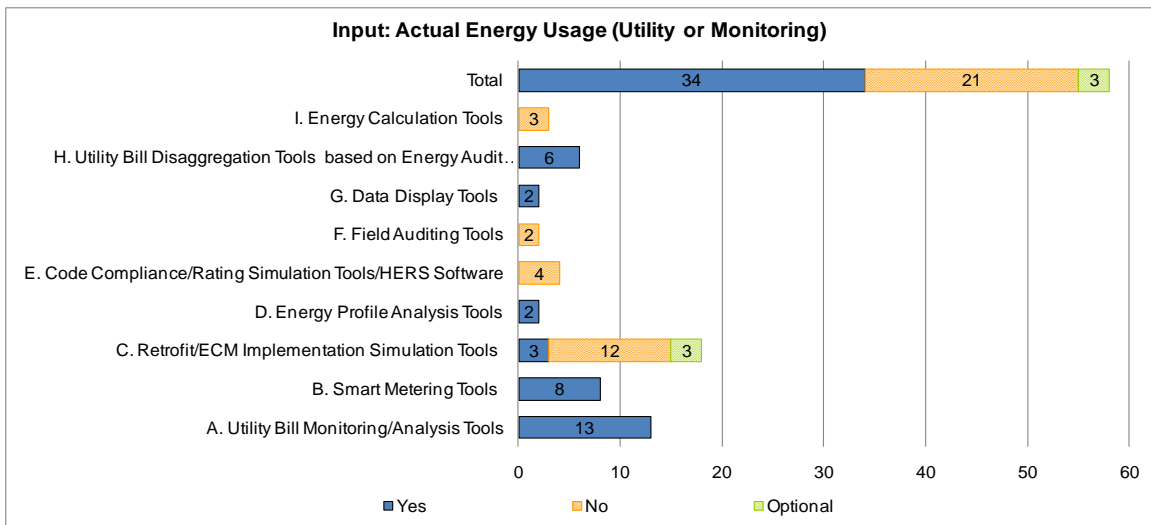
Figure 4.2.7. Tools by Input: Actual Energy Usage (Yes or No).
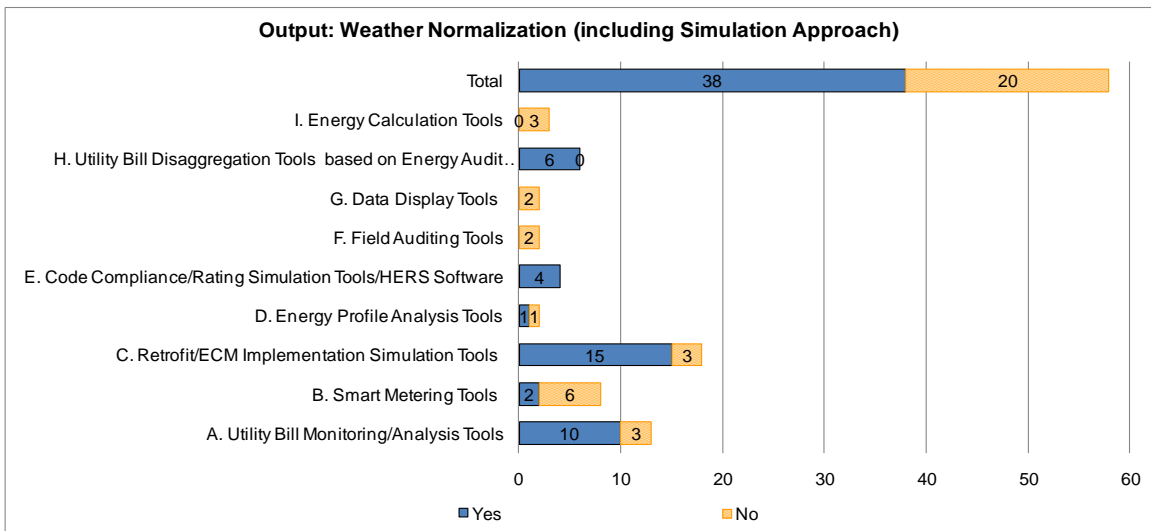
Figure 4.2.8. Tools by Output: Weather Normalization, including Simulation Approach (Yes or No).
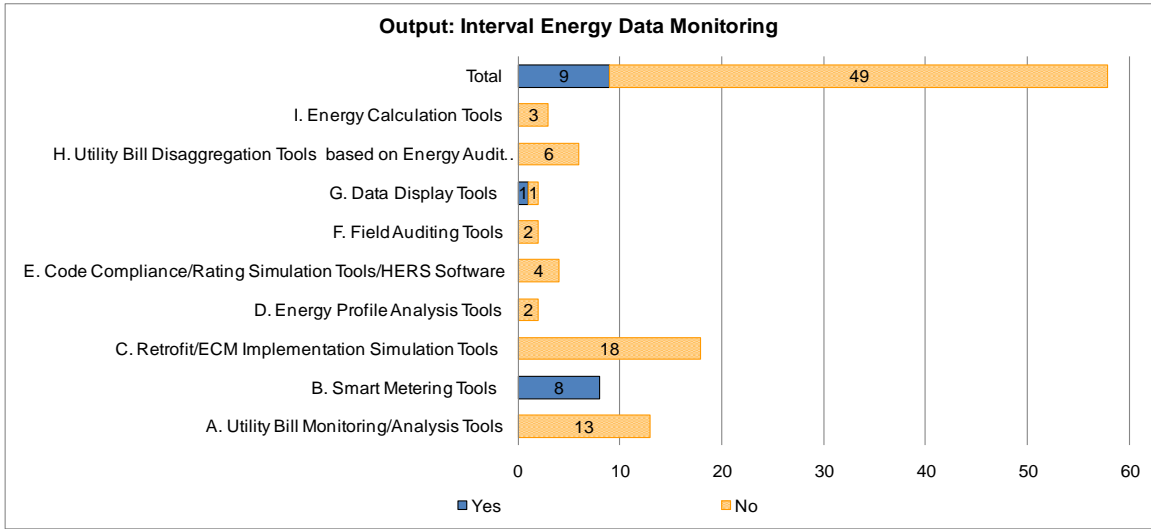
Figure 4.2.9. Tools by Output: Interval Energy Data Monitoring (Yes or No).
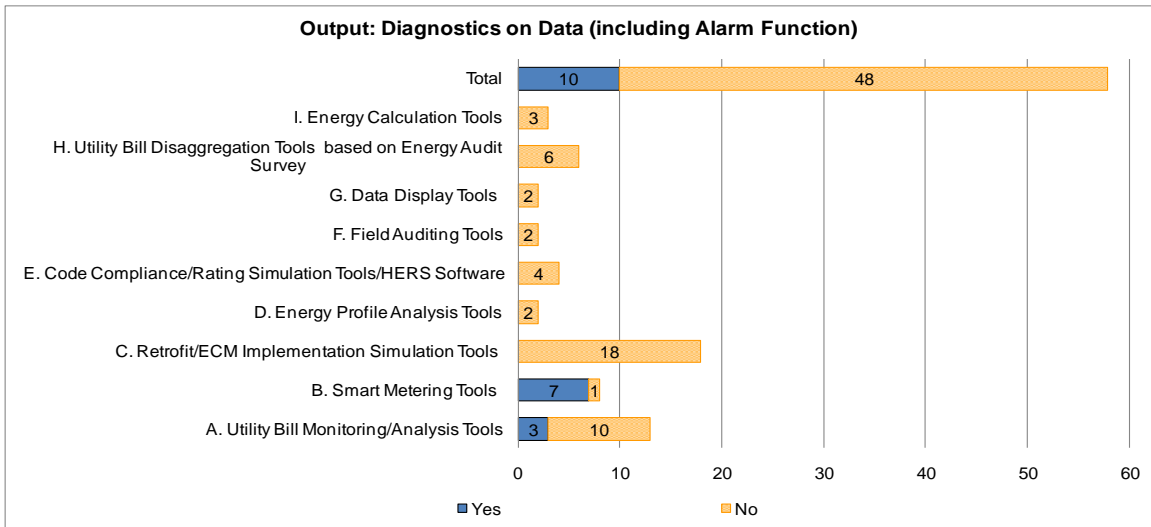
Figure 4.2.10. Tools by Output: Diagnostics on Data (Yes or No).
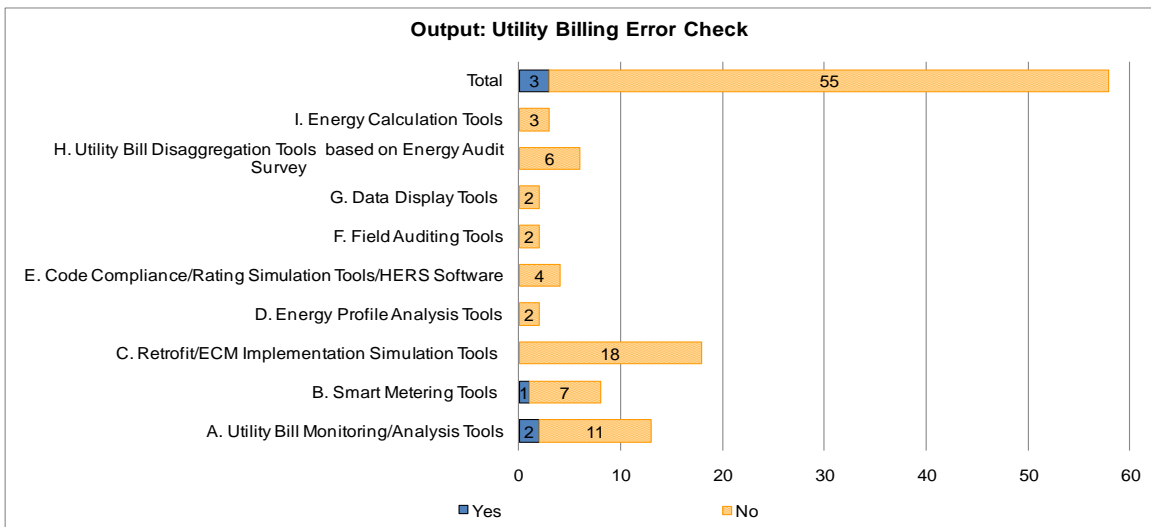
Figure 4.2.11. Tools by Output: Utility Billing Error Check (Yes or No).
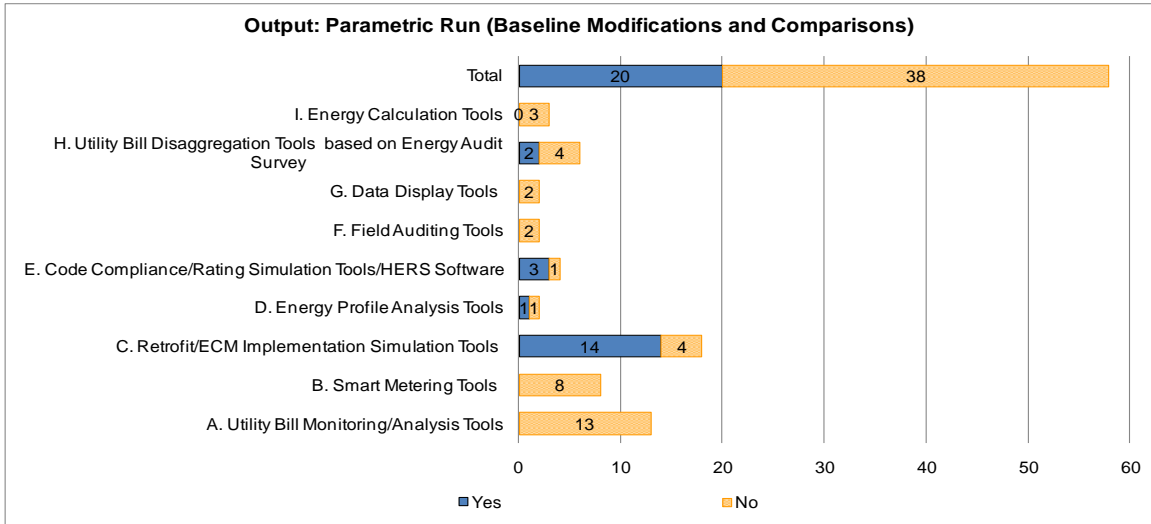
Figure 4.2.12. Tools by Output: Parametric Run (Yes or No).
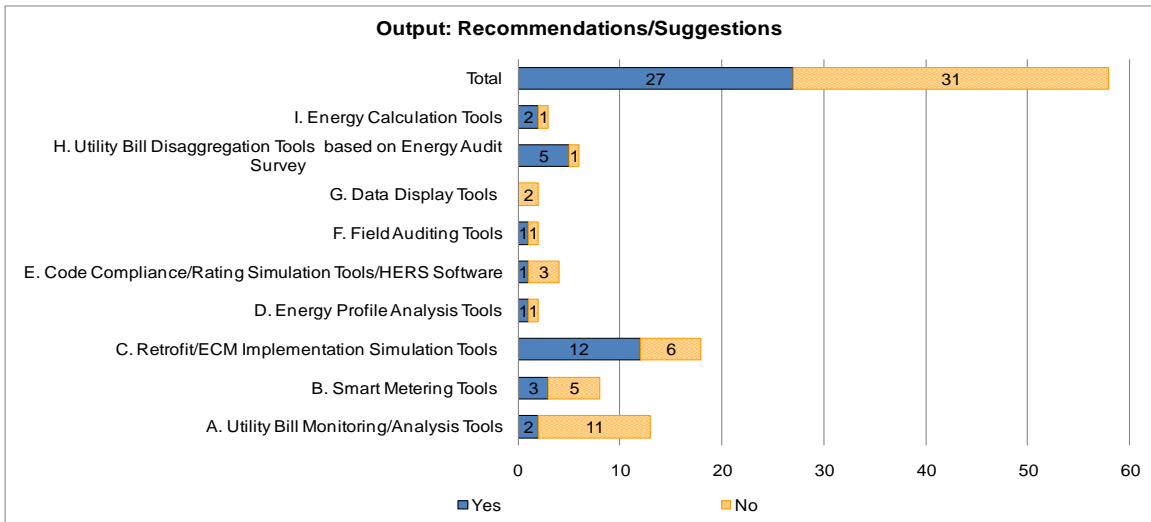
Figure 4.2.13. Tools by Output: Recommendations/Suggestions (Yes or No).
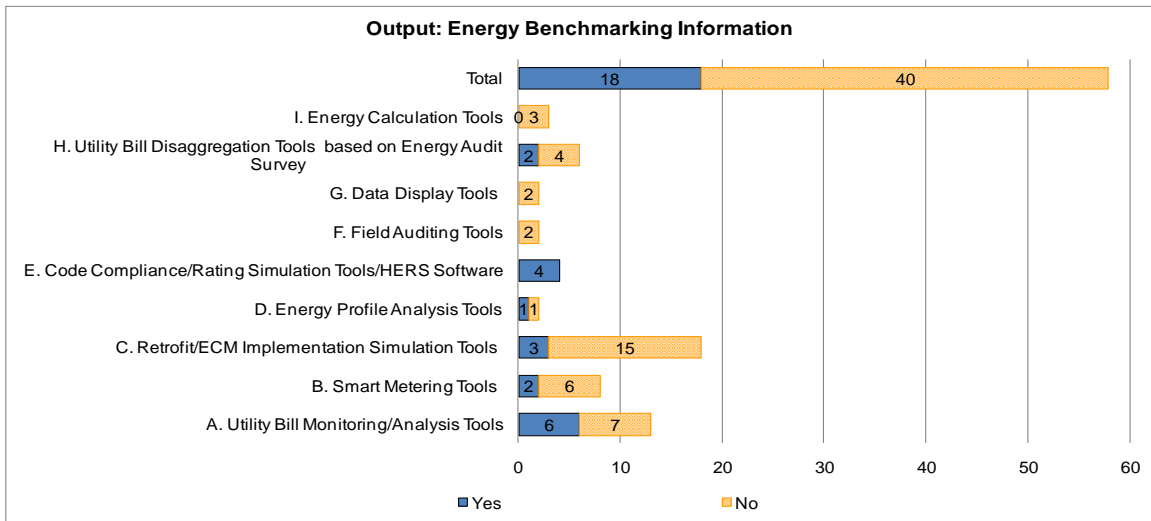
Figure 4.2.14. Tools by Output: Energy Benchmarking Information (Yes or No).

4.3   Recommendations

This section contains the recommendations for each of the nine predefined categories, which were derived from the analysis of the information gathered. The nine predefined categories by their primary functions are as follows: A. Utility Bill Monitoring/Analysis Tools; B. Smart Metering Tools; C. Retrofit/ECM Implementation Simulation Tools; D. Energy Profile Analysis Tools; E. Code Compliance/Rating Simulation Tools/ HERS Software; F. Field Auditing Tools; G. Data Display Tools; H. Utility Bill Disaggregation Tools based on Energy Audit Survey; and I. Energy Calculation Tools.

- Category A. *Utility Bill Monitoring/Analysis Tools*

  1) The primary function of *Utility Bill Monitoring/Analysis Tools* is to allow users to track and analyze their utility bills. For further analysis, several tools normalize the energy consumption to weather or provide energy benchmarking information for a comparison of the consumption with an average consumption of peer groups. The users who want to do energy consumption analysis from their billing or interval energy data are recommended to use one of the tools listed below. These thirteen tools are marked with a "Y" at the Category A in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 5, 11, 13, 16, 17, 26, 30, 40, 48, 49, 50, 51, 56.

- Category B. *Smart Metering Tools*

  1) The primary function of *Smart Metering Tools* is to allow users to monitor and diagnose real-time interval energy data for commercial buildings. Tracking energy consumption daily or hourly, either for whole-building or major end-use, will allow building owners and operators to identify the potential improvements of the building's energy performance. The users who want to track their real-time energy consumption are recommended to use one of the tools listed below. These eight tools are marked with a "Y" at the Category B in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 4, 8, 9, 10, 15, 24, 31, 35.

- Category C. *Retrofit/ECM Implementation Simulation Tools*

  1) The primary function of *Retrofit/ECM Implementation Simulation Tools* is to allow users to estimate the possible savings from retrofits or energy saving strategies, including an implementation of various ECMs (Energy Conservation Measures). Most tools support the function of parametric run that enables baseline modification and comparison. Several tools adopt component approach that supports retrofits of only one component such as lighting, insulation or HVAC systems. The users who want to estimate the savings from retrofits are recommended to use one of the tools listed below. These eighteen tools are marked with a "Y" at the Category C in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 2, 3, 7, 12, 19, 20, 21, 22, 25, 27, 28, 29, 32, 34, 36, 38, 43, 52.

- Category D. *Energy Profile Analysis Tools* allows users to analyze their energy consumption in detailed profiles to identify opportunities of energy and cost reduction, including demand or end-use analysis.

  1) The primary function of *Energy Profile Analysis Tools* is to allow users to analyze their energy consumption in detailed profiles to identify opportunities of energy and cost reduction, including demand or end-use analysis. The users who want to analyze their energy consumption in detail are recommended to use one of the tools listed below. These two tools are marked with a "Y" at the Category D in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 14, 39.

- Category E. *Code Compliance/Rating Simulation Tools/HERS Software*

  1) The *Code Compliance/Rating Simulation Tools/HERS Software* are code compliance or rating software tools for residential buildings. These tools calculate the above code performance of a building or a HERS rating (Home Energy Rating Systems[5]) based on the RESNET (Residential Energy Services Network) National HERS Technical Standards. The users who want to calculate the code compliance or a relative energy use index of their homes are recommended to use one of the tools listed below. These four tools are marked with a "Y" at the Category E in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 18, 33, 54, 58.

- Category F. *Field Auditing Tools*

  1) The *Field Auditing Tools* are designed to help users (energy inspectors and auditors) perform an energy auditing. The users who want to perform an energy auditing of a building are recommended to use one of the tools listed below. These two tools are marked with a "Y" at the Category F in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 6, 23.

- Category G. *Data Display Tools*

  1) The *Data Display Tools* are data visualization tools to help users display and manage general time-series interval data. The users who manage massive time series data sets are recommended to use one of the tools listed below. These two tools are marked with a "Y" at the Category G in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 1, 37.

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[5] HERS rates the energy efficiency of homes for identifying cost-effective improvements and providing energy-efficient mortgages.

- Category H. *Utility Bill Disaggregation Tools based on Energy Audit Survey*

  1) The *Utility Bill Disaggregation Tools based on Energy Audit Survey* perform utility bill disaggregation analysis based on the monthly utility bill and user survey regarding heating and cooling systems and appliances. Once users are authenticated, their billing data is securely imported and presented for the review and energy analysis. Most of the power companies provide one of these programs to their customers or have their own program which is quite similar to the one in this category. The utilities or power companies are recommended to provide one of the tools listed below for their customers. These six tools are marked with a "Y" at the Category H in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 44, 45, 46, 47, 53, 57.

- Category I. *Energy Calculation Tools*

  1) The *Energy Calculation Tools* calculate the energy consumption and costs based on the user inputs. No actual energy usage data is needed. Based on the results, several tools provide recommendations or suggestions for energy improvement. The users who want to conduct a simple energy assessment of their buildings without the actual energy data are recommended to use one of the tools listed below. These three tools are marked with a "Y" at the Category I in Table 2.3.1 and Table 3.3.1. The detailed information on each tool is presented in Table 2.2.1 and Table 3.2.1.

  2) No. of Recommended Tools: 41, 42, 55.

5   SUMMARY

This report presents the Energy System Laboratory's work to develop preliminary deliverables for the SEEC Subtask 2.4 *Expand the Use of Existing Methods and Tools*. These deliverables are intended to cover the SEEC's Statement of Project Objectives for the Subtask 2.4 outlined below:
- Define a list of methods, procedures and tools for building energy efficiency; and
- Suggest recommendations to expand their use in the marketplace.

To provide the state energy offices with the list of available tools and recommendations for use, a number of existing building energy analysis tools were reviewed. At last, 58 tools were identified from the U.S. DOE EERE's Building Energy Software Tools Directory and from the other websites, including major power companies, manufacturers, national laboratories, the U.S. government and individual state, and research organizations websites, as well as general search engines such as Google and Yahoo. Appendix A and B presents the screenshots of each tool to give an idea how they look.

To capture the feature of each tool, a systematic comparison spreadsheet that defines the technical and practical characteristics of the tools has been developed. All identified 58 tools were mapped onto this matrix and presented in Table 2.2.1 and Table 3.2.1. The selected thirteen technical and practical characteristics of the tools are as follows:
- General
    1) Availability, Web-based or Disk-based
    2) Building Type, Residential Buildings or Commercial Buildings
    3) Approach, Whole Building or Component
- Input
    4) Survey Information Level (Basic, Medium, or Detail)
    5) Site/Weather Description (Zip-Code) (Yes or No)
    6) Actual Energy Usage (Utility or Monitoring) (Yes or No)
- Output
    7) Weather Normalization (including Simulation Approach) (Yes or No)
    8) Interval Energy Data Monitoring (Yes or No)
    9) Diagnostics on Data (including Alarm Function) (Yes or No)
    10) Utility Billing Error Check (Yes or No)
    11) Parametric Run (Baseline Modifications and Comparisons) (Yes or No)
    12) Recommendations/Suggestions (Yes or No)
    13) Energy Benchmarking Information (Yes or No)

To classify the tools by their main function, nine categories were developed as follows:
    J.   Utility Bill Monitoring/Analysis Tools;
    K.   Smart Metering Tools;
    L.   Retrofit/ECM Implementation Simulation Tools;
    M.   Energy Profile Analysis Tools;
    N.   Code Compliance/Rating Simulation Tools/ HERS Software;
    O.   Field Auditing Tools;
    P.   Data Display Tools;
    Q.   Utility Bill Disaggregation Tools based on Energy Audit Survey; and
    R.   Energy Calculation Tools.

By scrutinizing the information gathered, the recommendations were developed for each of the nine predefined categories to encourage the use of a number of existing tools that were not widely used but

provide valuable information and insight on the benefits of building energy efficiency in the SEEC member states. These recommendations were suggested for a wide audience, certainly including homeowners, building operators and energy managers, state facility energy managers, and utility program managers.

APPENDIX A. Screenshots of 38 Building Energy Analysis Tools from the U.S. DOE EERE's Building Energy Software Tools Directory.

Among the 359 software tools listed in the U.S. DOE EERE's Building Energy Software Directory, 38 building energy analysis tools have been identified. The detailed review of these 38 tools is described in Section 2, and Table 2.1.1 shows the list of the tools and the assigned number with the provider and country. With the screenshots, a short description of each tool that is provided by the U.S. DOE EERE is also displayed together. The original documents of this information could be found in http://apps1.eere.energy.gov/buildings/tools_directory/.

- Source:
  U.S. DOE, EERE. 2009. *Building Energy Software Tools Directory*, Energy Efficiency and Renewable Energy, U.S. Department of Energy, Retrieved from http://apps1.eere.energy.gov/buildings/tools_directory/ (accessed March 30, 2009).

- The U.S. DOE EERE's Building Energy Software Tools Directory provides information on 359 building energy software tools, including databases, spreadsheets, component/system analysis, and whole-building simulation programs. For each tool, the following short description is provided: keywords, validation/testing, expertise required, users, audience, input, output, computer platforms, programming language, strengths, weaknesses, technical contact, and availability.

- Most of the tools investigated in this report are under continuous development. Thus only the features available in March 2009 are considered for this analysis.

The enclosed file "SEEC 2.4_Tool_Summary_Appendix_A.xlsx" presents the screenshots of the 38 building energy analysis tools that are listed in the U.S. DOE EERE's Building Energy Software Directory. This Excel workbook consists of 42 spreadsheets. The first three taps named "Coverpage," "Executive Summary," and "Table of Contents" provide the information of this report, and the fourth tap named "List" presents the table of the 38 tools and the assigned numbers in the alphabetic order with the providers and countries. The assigned numbers are the names of the rest of the 38 spreadsheets. The list of the tools and the assigned number is as follows:

1	Commodity Server
2	Demand Response Quick Assessment Tool (DRAQT)
3	EA-QUIP (Energy Audit using the Queens Information Package)
4	EBD (ENFORMA® Building Diagnostics)
5	e-Bench
6	Ecasys
7	Eco Lumen
8	eDNA
9	EEM Suite
10	EffTrack
11	EMODEL
12	Energy Audit - Residential/Light Commercial Energy Analysis
13	Energy Lens
14	Energy Profile Tool
15	Energy WorkSite
16	EnergyCAP Enterprise

17	EnergyCAP Professional
18	EnergyGauge USA
19	EZ Sim
20	FEDS (Facility Energy Decision System)
21	FRESA (Federal Renewable Energy Screening Assistant)
22	Home Energy Saver
23	Home Energy Tune-uP
24	ION Enterprise
25	MarketManager
26	METRIX4
27	MHEA (Manufactured Home Energy Audit)
28	NEAT (National Energy Audit Tool)
29	OptoMizer
30	PRISM
31	Prophet Load Profiler
32	Rehab Advisor
33	REM/Rate
34	RESEM (Retrofit Energy Savings Estimation Model)
35	SenseDat Analyzer
36	TREAT
37	Visualize-IT
38	ZIP-Code Insulation

APPENDIX B. Screenshots of 20 Building Energy Analysis Tools from the Other Websites.

A total of twenty building energy analysis tools have been identified from the other websites, including major power companies, utilities, manufacturers, national laboratories, and research organizations websites and the general search engines such as Google and Yahoo. The detailed review of these 20 tools is described in Section 3, and Table 3.1.1 shows the list of the tools and the assigned number with the provider and country.

- Information Sources:
  - **General Search Engines**;
    - Google
    - Yahoo
  - **Major Power Company Websites**;
    - Southern Company
      (Alabama Power, Georgia Power, Gulf Power, Mississippi Power)
    - FPL (Florida Power Light)
    - Duke Energy Corporation
    - Entergy
    - ONCOR
    - CenterPoint Energy
    - AEP (American Electric Power)
    - Austin Energy
  - **Major Manufacturers Websites**;
    - ITRON
    - NorthWrite
    - Trane
    - Honeywell
    - Simens
  - **National Laboratory Websites**;
    - ORNL (Oak Ridge National Laboratory)
    - LBNL (Lawrence Berkeley National Laboratory)
    - PNNL (Pacific Northwest National Laboratory)
  - **The U.S. Government and State Websites**; and
    - U.S. DOE (Department of Energy)
    - U.S. EPA (Environmental Protection Agency), ENERGY STAR
    - SECO (State Energy Conservation Office)
  - **Research Organization/Institute/Company Websites**.
    - E Source Company
    - RMI (Rocky Mountain Institute)
    - ESL (Energy Systems Laboratory)
    - FSEC (Florida Solar Energy Center)
    - ACEEE(American Council for an Energy Efficient Economy)
    - EPRI (Electric Power Research Institute)
    - Southface
    - NARUC (National Association of Regulatory Utility Commissioners)

- Most of the tools investigated in this report are under continuous development. Thus only the features available in March 2009 are considered for this analysis.

The enclosed file "SEEC 2.4_Tool_Summary_ Appendix_B.xlsx" presents the screenshots of the 20 building energy analysis tools. This Excel workbook consists of 24 spreadsheets. The first three taps named "Coverpage," "Executive Summary," and "Table of Contents" provide the information of this report, and the fourth tap named "List" presents the table of the 20 tools and the assigned numbers in the alphabetic order with the providers and countries. The assigned numbers are the names of the rest of the 20 spreadsheets. The list of the tools and the assigned number is as follows:

39	ASHRAE 1093 (Diversity Factor)
40	ASHRAE IMT (Inverse Modeling Toolkit)
41	ATCO Energy Sense House
42	ATCO EnergySense Energy Scorecard
43	CommercialEnergySuite™
44	Energy Depot® for Business
45	Energy Depot® for Homes
46	ENERGY Guide Business Analyzer
47	ENERGY Guide Home Analyzer
48	ENERGY STAR Home Energy Yardstick
49	ENERGY STAR Portfolio Manager
50	Energy Watchdog Pro
51	ETracker
52	HomeEnergySuite™
53	HomeVIEW™
54	IC3 (International Code Compliance Calculator)
55	My Home
56	Online Home Energy Survey
57	Residential Energy Bill Analyzer (REBATM)
58	TCV (Texas Climate Vision)