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SUSTAINABLE ENERGY FOR ALL

Tools for Energy Efficiency in Buildings

A GUIDE FOR POLICY-MAKERS AND EXPERTS

UNEP

Building Efficiency Accelerator

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A GUIDE FOR POLICY-MAKERS AND EXPERTS

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Disclaimer
This working paper is intended to assist cities to accelerate energy efficiency in the building sector. The findings, suggestions, and conclusions presented in this publication are entirely those of the authors and should not be attributed in any manner to SEforALL, UNEP, WRI or the Copenhagen Centre on Energy Efficiency.

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The content of this working paper along with a number of related webinar recordings is available at C2E2's Knowledge Management System – **http://kms.energyefficiencycentre.org**

About C2E2
The Copenhagen Centre on Energy Efficiency (C2E2) is a research and advisory institution dedicated to accelerating the uptake of energy efficiency policies, programmes and actions globally. C2E2 serves as the Energy Efficiency Hub of the Sustainable Energy for All (SEforALL) Initiative. The Centre's prime responsibility is to support SEforALL's objective of doubling the global rate of energy efficiency improvement by 2030.

About Building Efficiency Accelerator
The Sustainable Energy for All Building Efficiency Accelerator (BEA) assists sub-national governments in speeding up the process of adoption of best-practice policies and implementation of building efficiency projects, with the goal of doubling the rate of energy efficiency improvement in the building sector by 2030. The BEA global partnership is designed to complement existing networks of cities with a venue for engagement with private sector partners.

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Introduction

With growing urbanization, our cities are playing an increasingly important role in accelerating energy efficiency improvements and mitigating climate change (REN21 2016). Cities are one of the biggest consumers of energy in the world, representing almost two-thirds of global primary energy demand and accounting for 70 per cent of greenhouse gas (GHG) emissions in the energy sector (IEA 2016). Therefore, with urbanization forecast to continue cities will be a critical driver in the sustainable energy transition.

Typically city governments have direct decision powers to implement policy actions, which have the potential for immediate and high-impact results (C40 2016). According to the Carbon Disclosure Project, 553 cities globally representing 621 million people have reported on the climate actions they are taking in 2016, demonstrating a 70 per cent growth in climate actions and reporting efforts since 2015 (Holder 2016).

Population growth and urbanization are together expanding global building stocks that are increasing the urgency to reduce GHG emissions from the buildings sector by at least a quarter by 2030, in order to have a chance of limiting average global temperature increase to less than 2 degrees Celsius above pre-industrial levels (IEA 2016).

Building energy efficiency improvements present low-cost opportunities to reduce energy use and GHG emissions. Architectural designs, construction practices, and efficient technologies are available today that minimize energy and resource use in buildings and maximize the multiple benefits of efficient buildings – cleaner air, more comfortable homes, workspaces with healthier indoor environment, and lower energy bills.

Without strong and ambitious policy support, the energy efficiency potential of cities is likely to remain largely untapped. Often cities have the opportunity to implement policies and programmes in the building sector that are complementary, more stringent or reflect greater ambition than national activities. For example, these city-level actions may relate to energy efficiency targets, standards and codes for buildings, deep renovation programmes, financial incentives for energy efficiency actions or other supporting policy instruments and projects (IEA 2016).

In order to maximize the effectiveness of energy efficiency actions, it is important for local policy-makers and stakeholder to utilize planning and policy tools available to cities in their policy development efforts.

Numerous analytical tools and resources in the field of buildings energy efficiency are available, ranging from global- and city-scale inventories and target-setting guidance to individual building energy performance assessments.

Purpose of this paper

To map the existing range of tools and to facilitate building energy efficiency improvements, this working paper presents an overview and categorization of current tools, as well as offers a decision tree, illustrating the types of tools policy and project development in the field of energy efficiency in buildings.

This working paper aims at guiding local policy-makers, technical experts and other relevant stakeholders through the key steps of the policy and project development process through utilisation of publically available tools, helping them to navigate among various information sources on energy efficiency in buildings.

How to read this paper

This working paper offers three products: decision tree, catalogue of tools and tools' profiles, – which can be used independently or in combination with one another.

DECISION TREE helps to identify tools and information sources, which can be used at each stage of the policy or project development process in order to use available knowledge for more effective design and implementation.

CATALOGUE OF TOOLS presents 50 tools analysed for this working paper and categorizes them in accordance with several criteria, indicating whether the tool is interactive or more static in its nature, whether it focuses on policies or projects, at which stage of the policy development cycle it can be useful, and whether it targets cities directly or can support city level stakeholders with more general guidance.

TOOLS' PROFILES offer brief and structured summaries of information on each of the analysed tools in order to give a concise overview of their key features.

The main target audience of this working paper consists of the policy-makers and experts contributing to development and implementation of building energy efficiency policies and projects at the city level. The purpose of this working paper is assisting the target audience (the users) in selecting the tools, which can be helpful in their work on accelerating energy efficiency in buildings, based on their interests and preferences.

One of the strategies for the policy-makers to use this working paper is through consulting the decision-tree first. The decision-tree is designed around the key stages of the policy development cycle. At each of the stages policy-makers face a number of questions they need to address in order to ensure the effectiveness of their policy efforts. As the essential information can be fragmented, unavailable or costly, the decision-tree presents a quick opportunity to link policy-makers to some of the selected tools and sources, which they might find useful for answering common questions during policy and project development.

Decision-tree can give an idea for user on which tools can be appropriate for meeting their specific needs; however, it does not provide the detailed information of the tools. Therefore, as the next step for identification of helpful tools the user can consult the catalogue of tools, which provides more detailed information about all selected tools structured across five criteria: approach, scope, stage of the policy development cycle and city focus. This catalogue offers a quick-check in order to show where each of the tools stands in respect of these criteria. Based on the information from the catalogue the user can conclude whether a particular tool meets his/hers requirements.

Finally, the users can check the profiles of the tools they are interested in in order to acquire additional information and consult the original sources, if need.

Photo credit: Kris Krug

Setting the scene

There have been limited attempts to systematically review available analytical tools in the field of improving energy efficiency in the buildings sector. Most of the existing reviews of tools and methods have a broader scope than energy efficiency in buildings.

Recent attempts to systematize available tools typically cover fewer tools than the current working paper and do not focus specifically on energy efficiency in buildings.

NREL (2016), provides a concise visual snapshot (see Figure 1) of more than 40 tools in order to support adoption of data-driven energy action plans by cities. The tools covered in the snapshot are categorised by sector: residential, commercial, industrial, generation, transportation and land use, as well as by the city-planning phase: (1) gathering baseline data; (2) identifying energy sectors and demand; (3) analysing sector-specific strategies; (4) refining and optimizing projects; (5) measuring and managing the results. All the tools in this review target cities, however, are not specifically focusing on energy efficiency in buildings.

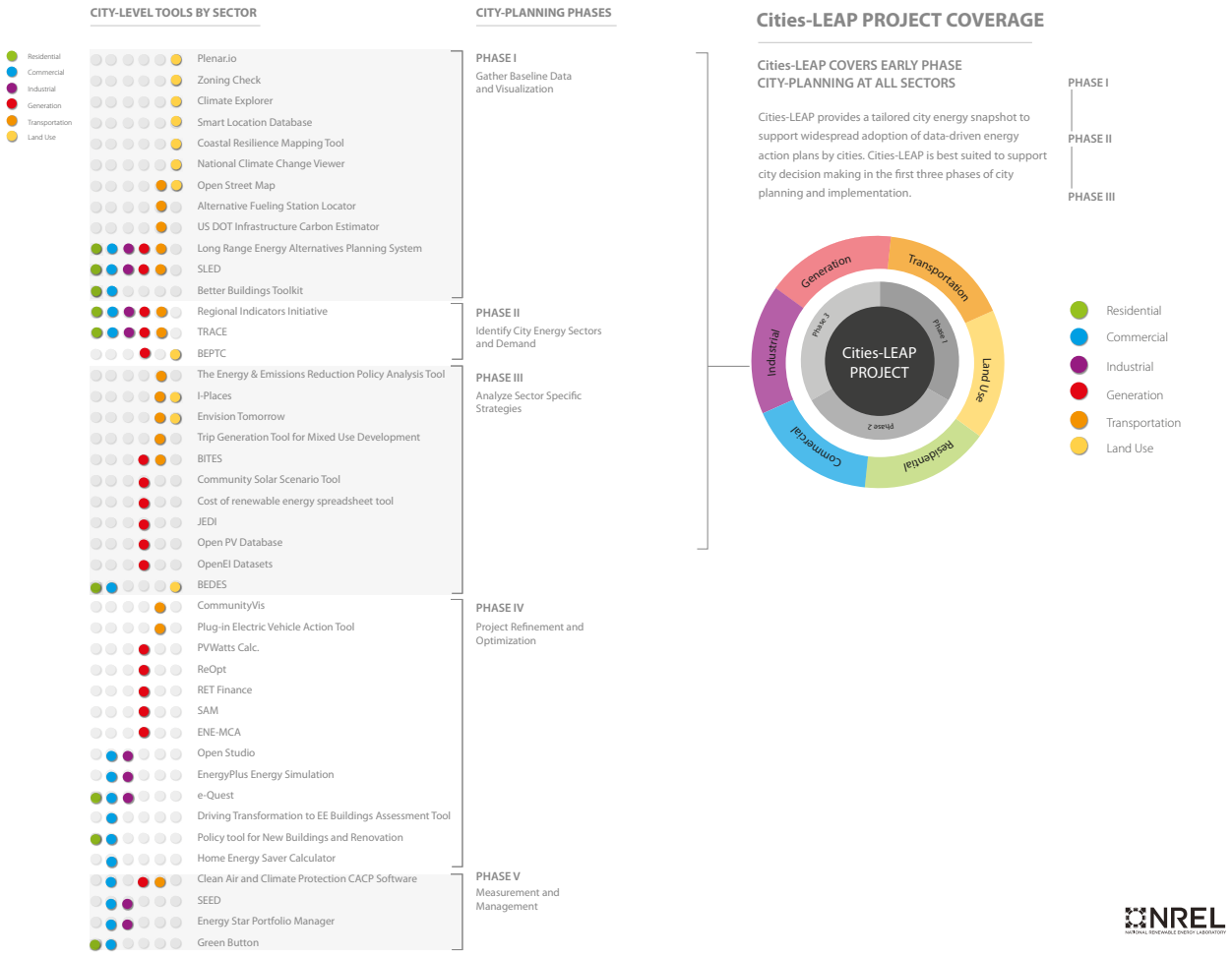

FIGURE 1. Tool Snapshot under the Cities Leading through Energy Analysis and Planning program
Source: NREL (2016)

The Energy Toolkit (Ochs et al. 2015) presented the overview of 18 selected tools and methodologies for low-emission, climate-resilient development planning in the energy sector. It is organized as a reference catalogue covering fixed features for each tool, namely: typical clients, current and past users, associated costs, contact information and more information. The information for each tool is structured in a matrix with four thematic areas: 'what is it?', key goals, data inputs and outcomes (Ochs et al. 2015).

SENTECH (2010) presents the review of ten tools, however, solely focused on energy audits. The study categorizes the tools into five main types: 1) web-based calculators; 2) prioritized lists of measures; 3) checklist or survey instruments; 4) asset rating tools; and 5) operational rating and audit tools).

Earlier reviews and classifications of tools have even broader scope, typically dealing with the environmental assessments, which makes it difficult to derive the information specific to energy efficiency.

Haapio and Viitaniemi (2008) presents the analysis and categorisation of existing tools in the field of building environmental assessment, discussing two classification systems for the environmental assessment tools: ATHENA and IEA 31 Classification Systems. A new categorisation framework is proposed, based on tools characteristics: assessed buildings, users of the tools, phases of the life cycle, database of the tools and forms of the results used (e.g. in forms of graphs, tables, grades, certificates or reports).

Ding (2008) has attempted a critical analysis of environmental building assessment methods used in different countries in terms of their characteristics and limitations in assessing building sustainability. Ding provided a long summary table covering the assessment methods and key characteristics for environmental building performance, as well as discussed approaches for single and multi-dimensional assessments.

Ness et al. (2007) have developed a sustainability assessment tool framework based on three areas: 1) indicators and indices; 2) product-related assessment tools with the focus on the material and/or energy flows of a product or service from a life-cycle perspective; and 3) integrated assessment, which are a collection of tools usually focused on policy change or project implementation. The authors distinguished between retrospective and forward looking tools.

Forsberg and von Malmborg (2004) conducted comparison of five tools on environmental assessments of the built environment by means of the evaluative framework for conceptual and analytical approaches used in environmental management. The framework developed covered various contextual aspects such as type of decision-maker, overall purpose, type of building and analysis. The framework also included methodological aspects including dimensions examined, environmental parameters, comparative analysis, system boundaries as well as presentation and aggregation of results.

Most of the overviews and analyses available in the literature are not specifically tailored to energy efficiency in buildings, have limited coverage of policy supporting tools and sources, and are rarely targeting city governments and stakeholders.

Therefore, the purpose of this working paper is to build on previous work (Becque et al. 2016) by describing and categorizing the range of publicly-available building energy efficiency-related tools for policy and project development and implementation with a specific focus on the relevance for the city governments and other stakeholders.

Photo credit: Krmt

Analysis of the tools

There is a significant number of various tools and information sources available at various platforms and directories. It might be overwhelming for policy-makers or experts to navigate in this pool of information in order to find the tool the most relevant for their purposes. Therefore, C2E2 in collaboration with WRI and under the umbrella of Building Efficiency Accelerator have selected and categorised 50 tools, which can inform and support city and sub-national governments in their work on policy and project development for accelerating energy efficiency in buildings.

The analysis of various tools and information sources for this working paper consists of three main parts:

1. Selecting the tools
2. Categorising the tools
3. Mapping the tools to the policy-making Decision tree for policy and project development

Selecting the tools

Selection of the analytical and information tools for building energy efficiency has been conducted based on the following criteria:

- Focus on energy efficiency in buildings;
- Are free and publicly available; and
- Support energy efficiency actions in a city.

To fulfil the purpose of this paper a thorough online search and the review of the recent literature in the field of energy efficiency in buildings have been conducted, which resulted in selection of **50** different tools in accordance to these criteria (see Table 1).

Categorising the tools

The content, possibilities and applications of the 50 selected tools have been analysed in order to identify common and differentiating features.

In the result of this process four categories have been identified with the aim to reflect the role of each tool in terms of its potential utilisation for supporting policy-making process at the city level:

1) Approach;
2) Scope;
3) Stage of the policy development cycle;
4) City focus.

Table 1 presents the summary of the categorization of the 50 tools according to these criteria.

1. Approach

Tools are distinguished in their approach between being passive and interactive.

Passive tools

Passive tools can provide outputs such as data, information, guidelines and recommendations that support the decision making process and do not provide the opportunity for interaction with the user (Haapio and Viitaniemi 2008). Such tools are typically represented by consolidated information or data pools, including guidebooks on policy instruments, databases, information documents and reports on policy design and implementation as well as recommendations for policy-makers.

Examples: Global Protocol for Community-Scale GHG Emissions (GPC), IEA Indicators, Building Energy Efficiency Policies (BEEP), Handbook of Sustainable Building Policies

Interactive tools

Interactive tools are able to provide calculation and evaluation methods which enable the user or decision maker to take a pro-active approach such as exploring a range of options in an interactive way (Baldwin et al. 2000). These tools usually incorporate algorithms, which require the input data or selections from the user, run pre-defined analysis and generate results. These interactive tools are often available to the user through various ways such as online assessments or

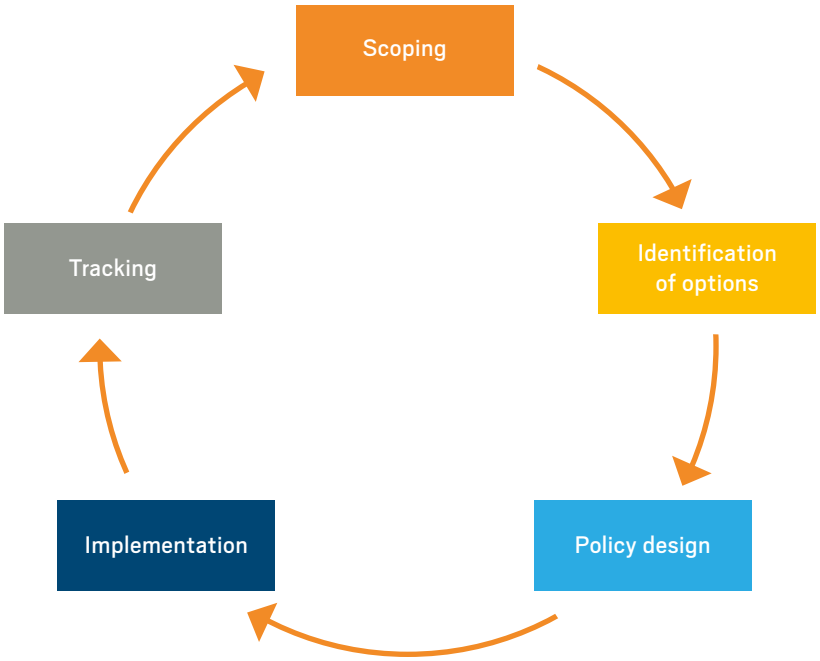

FIGURE 2. **Policy development cycle**

software tools, online visualization platforms, energy models or simulation software.

Examples: Building Efficiency Policy Assessment Tool, Tool for Rapid Assessment of City Energy (TRACE), Policy Tool for New Buildings, ENERGYSTAR Portfolio Manager, RETScreen

2. Scope

In terms of the scope the tools can be categorized into two groups: policy tools and project tools.

Policy tools

Policy tools aim at assisting policy-makers at different stages of policy development process. They can provide insights and information for effective design and implementation of policy packages, as well as their impact evaluation.

Examples: Common Carbon Metric (CCM), The Co-benefits Evaluation Tool for the Urban Energy System, Solutions gateway, IPCC AR5 Chapter 9, Green Resources & Energy Analysis Tool (GREAT)

Project tools

Project tools help to design a construction or renovation building project, calculate building energy performance, simulate the effect of various building components and technologies and estimate potential savings from various energy efficiency measures.

Examples: EnergyPlus and eQUEST, Excellence in Design for Greater Efficiencies (EDGE), Building Energy Optimization (BEopt), Energy Model Input Translator (EMIT)

3. Stage of the policy development cycle

Policy tools can provide assistance to policy-makers at every stage of the policy cycle (Figure 2). At each stage of the cycle analytical tools can offer policy-makers and other stakeholders information that supports energy efficiency actions.

Tools for Scoping

At the beginning of the policy development process it is important to collect information on a number of parameters which characterize the status of energy efficiency in the targeted jurisdiction. This information may include: barriers to energy efficiency, energy use in the building sector, building typology and characteris-

tics, building trends and practices, existing policies and plans related to energy efficiency in buildings.

Tools, which can be used for 'scoping', usually offer the opportunity to collect and access data, establish proxies and verify assumptions. Such tools typically offer approaches for modelling building stock, its energy consumption for different end-uses, and/or related GHG emissions, which can give an indication of the current status of building energy use in a given location. Depending on the tool's methodology and assumptions, different levels of detail for the input data are required. Data availability for the building sector can often be a significant challenge for a number of jurisdictions. Potential data gaps should be identified at an early stage of the baseline construction and options to fill these gaps should be analysed.

Examples: Green Resources & Energy Analysis Tool (GREAT), Common Carbon Metric (CCM), the Co-benefits Evaluation Tool for the Urban Energy System, IPCC 4th Assessment Report Chapter 6

Tools for Identification

Having established the baseline for energy efficiency in buildings and analysed key barriers to energy efficiency, it is important to identify potential policy instruments, which can help to address these barriers. Analytical tools can suggest potential policy instruments based on the current situation in the jurisdiction or provide guidelines on how various stakeholders can be engaged in the process of identifying the suitable policy instruments.

Examples: Building Efficiency Policy Assessment Tool, Tool for Rapid Assessment of City Energy (TRACE), Benchmarking and Energy Saving Tool for Low Carbon Cities (BEST), ENERGYSTAR Energy Treasure Hunt Guide

Tools for Design

Policy instruments rarely work well in isolation, therefore, it is important to follow a holistic approach and bring different instruments into a well-designed policy package.

Existing tools and handbooks can provide the general information on design principles for different policy instruments, as well as highlight some common interactions between them , which can influence the effectiveness of the overall policy package. It is important to use these general principles only as guidance and carefully analyse local conditions to ensure maximum alignment of the policy package design to a specific situation. This group of tools also includes those, which can offer information on existing polices and best-practices in different countries or cities. Such information can be used by the policy-makers as a point of reference to relate to the conditions in their jurisdiction to better understand what policy mix might work the best, what gaps need to be filled and what opportunities should be prioritized.

Examples: Building Energy Efficiency Policies (BEEP), BigEE Policy Guide, Policy Tool for Renovation, Handbook of Sustainable Building Policies, IEA EE Governance Handbook

Tools for Implementation

Implementation stage signifies the concrete actions that need to be taken. It is important to ensure that policy-makers and implementing partners have sufficient information on the success factors and potential hidden obstacles for fostering energy efficiency in buildings. At this stage both policies and projects have to ensure that a transition towards a higher level of energy efficiency is happening. Implemented policies can support the initiation and execution of the projects aiming at constructing and renovating buildings to achieve higher levels of building energy performance.

The tools differ in terms of the analysis they can offer at this stage. On one hand, there are information sources, which provide important recommendations for the implementation of different policy instruments, demonstrate successful case studies and discuss lessons learnt from different parts of the world. There are tools, which can assist in the implementation of concrete building efficiency projects with concrete guidelines and assessments for energy efficient design and renovation measures. Such tools offer various calculation mechanisms, which can assist in selecting and combining energy efficient measures in a particular building, demonstrating how much energy can be saved under different building configurations. Some tools may specifically target new or existing buildings.

Examples: Policy focus – Solutions gateway, Handbook of Sustainable Building Policies, IEA EE Governance Handbook; Project focus – Excellence in Design for Greater Efficiencies (EDGE), RETScreen, Building Up-

grade Value Calculator, Commercial Building Analysis Tool for Energy-Efficiency Retrofit (COMBAT)

Tools for Tracking
In order to understand and demonstrate the impact of the implemented policy or project on building's energy efficiency, it is crucial to evaluate, monitor and track progress taking into account certain parameters. These parameters can be, for example, energy saved or GHG emissions avoided as a result of policy or project development, which are usually compared to the baseline, i.e. the situation prior to the intervention. Such tools typically include the option to construct scenarios or inventories for the building sector, which can be used at exploring potential future effects of different actions or measures. Indicators and benchmarking frameworks can also be useful to demonstrate the progress of the actions and compare the implementing jurisdiction to other locations.

Examples: Energy Forecasting Framework and Emissions Consensus Tool (EFFECT), ACEEE City EE Scorecard, The Co-benefits Evaluation Tool for the Urban Energy System, Building Energy Optimization (BEopt), ENERGYSTAR Portfolio Manager

4. City focus

The focus of this review is on the tools, which can help city-level governments to design and implement building energy efficiency policies and projects. Among analysed tools two groups can be highlighted: (1) Targeting Tools, specifically designed for fostering energy efficiency in cities; and (2) Supporting Tools, which do not have a specific focus at the city level, but can still be useful for informing energy efficiency actions at this level.

Targeting tools
The tools in this group are the ones directly targeting cities, with such focus being reflected in their scope, design, assumptions and/or methodology.

Examples: Local Energy Efficiency Policy Calculator (LEEP-C), Energy Forecasting Framework and Emissions Consensus Tool (EFFECT), Tool for Rapid Assessment of City Energy (TRACE), Green Resources & Energy Analysis Tool (GREAT), The Co-benefits Evaluation Tool for the Urban Energy System

Supporting tools
These tools can also be applied at the level other than the city. These tools can offer some more general support and lessons learnt to a city government in its policy development on a more general level, for example, through providing information, data, best-practices and case studies. Tools included in this group either provide general guidance for policy development, which can take place at any level of jurisdiction, or offer energy efficient design analysis at the level of an individual building.

Examples: Building Efficiency Policy Assessment Tool, Policy Tool for New Buildings, BigEE Policy Guide, Building Energy Efficiency Policies (BEEP), Commercial Building Analysis Tool for Energy-Efficiency Retrofit (COMBAT), Building Energy Optimization (BEopt)

Mapping the tools

One of the key outputs of this working paper is a Decision tree for policy and project development, which aims at assisting local policy-makers and experts to identify the tools available at each stage of the policy development cycle and, therefore, to encourage more ambitious and effective policy development.

In general terms, the Decision tree (DT) 'is a versatile information clustering and classification tool used in a wide range of scientific and industrial fields' (Mikučionienė, Martinaitis, and Keras 2014) environmental impact, economical rationality, comfort and duration under Life cycle point of view. DT methodology typically presumes grouping of a relatively large amount of data into smaller, interrelated parts. The data is usually presented in the table, based on which the tree is created according to certain rules. These rules or criteria allow for creating the nodes of the DT, which can be understood as a thematic point, at which the decision should be made. Based on the decision the next step should be made along one or alternative 'branches' of the DT (Mikučionienė, Martinaitis, and Keras 2014) environmental impact, economical rationality, comfort and duration under Life cycle point of view.

In this working paper the DT was created along the stages of the policy development cycle presented in Figure 2. The nodes were formed around common questions, which might be faced by policy-makers at each stage of the policy development. The questions were

Photo credit: Adam Cohn

determined and phrased based on expert judgements with the guiding principle of simplicity. The 'branches' of the tree follow the 'yes' or 'no' answer to these questions.

The questions presented by the stage of the cycle are following:

Scoping

- Do you have a baseline for energy efficiency status in your jurisdiction?
- Can you collect data required for establishing the baseline?
- Can you identify the barriers to energy efficiency based on the baseline analysis?

Identification of options

- Can you identify policy instruments to address existing barriers and prioritize them?

Design

- Do you have policy design guidelines and/or information on existing policy practices?
- Will your policy action track/include energy efficiency multiple benefits?

Implementation

- Do you have tools for implementation of building energy efficiency policies and related projects?

Evaluation and reporting

- Do you know how to evaluate the impact of policies you are planning?

The simple DT was designed to ensure it was easily accessible, and understood by policy-makers and other relevant stakeholders.

Mapping products

In the result of the tools' analysis conducted for this paper, three 'mapping' products have been developed:

1. Decision tree for policy and project development
2. Catalogue of tools
3. Tools' profiles

Each of these three products can be used as stand-alone applications, as well as in combination with each other.

The first mapping product – Decision tree for policy and project development (DT) – is shown in Figure 3, which presents relevant tools mapped to various nodes of the DT at different stages of the policy development cycle. This product is important to guide policy-makers in choosing tools appropriate for their specific policy needs, based on the stage of policy development and key questions related to the local context.

Table 1 presents the second mapping product – Catalogue of tools – which serves as a summary of the selected and categorised tools according to the criteria described earlier. The aim of this catalogue is to provide very quick information on the type of the tool a policy-maker or expert might be interested in. Using this tool requires prior understanding of the situation where the tool will be applied (e.g. policy or project development, particular stage of the policy development cycle, etc.) and, therefore, it can be used right after consideration of the Decision tree.

The third product – Tools' Profiles – is the collection of very concise and structured information on each of the analysed tools in order to provide the reader with the insight on how the tool can be used and for what purposes. There are two ways to use this product:

(1) For obtaining more detailed information on the selected potentially interesting tools after consultation with the Decision tree and/or Catalogue of tools

(2) For initial selection of the tools for policy or project development purposes through reviewing their profiles. Once certain tools are selected through this process, the Decision tree can be consulted in order to determine the key policy-making questions such a tool can help to answer.

Decision tree for policy and project development

A Decision tree (see Figure 3) has been constructed to assist local policy makers navigate the large number of tools on offer. It follows the logic of the policy development cycle (Figure 2) and for each stage of the cycle it presents a selection of relevant tools.

The first question, which can be posed to the city government, is whether there is a baseline for estimating energy use in buildings or not. The baseline may serve as a starting point for identifying potential energy efficiency improvement opportunities and related policy instruments or evaluating future policy development efforts and, therefore, is crucial. If the city has already established a baseline, it can move to the next question along the tree. If there is a need for the baseline development, certain tools can be suggested to support this process. Key principles for establishing a baseline are presented through tools such as CCM, GREAT and WGBC Principles and Build Upon.

If a city does not have a baseline and is planning to use the tools to establish it, the next question to answer would be whether the required data can be collected by the city or not. These data would usually come from city's statistical offices, as well as relevant stakeholders with the expertise in the field. It is difficult to recommend specific tools, as the data will vary from one city to another, however, some tools, for example TRACE, do contain some proxy data for selected cities, which can be used as a starting point.

Once the baseline is established it is important to determine the most important barriers to energy efficiency improvements, which exist in the local context of the city. Barriers to energy efficiency will vary from

one city to another; however, typical barriers are well documented in various sources and are presented in the Decision tree (e.g. Driving Transformation Report (DTR), IPCC 4th Assessment Report, IEA Governance Handbook).

Depending on the identified barriers the policy options to improve energy efficiency in buildings can be selected. Some sources have linked the key general barriers to energy efficiency in buildings to certain policy instruments, which typically prove to be effective for overcoming them. The DT suggests a number of such sources, such as Building Policy Assessment Tool, TRACE, BEST, IEA Governance Handbook, ENERGY-STAR Energy Treasure Hunt Guide and IEA 25 Recommendations.

The next step of the process is to design selected policies or a package of policy instruments. There are certain guidelines presented in various tools and sources, which can be beneficial for city governments in this process. Handbook of Sustainable Building Policies, Chapter 9 of IPCC 5th Assessment Report, IEA Governance Handbook, IEA 25 Recommendations, ESMAP Mayoral Guidance, WSBD Principles and Driving Transformation Report are examples of sources that provide important recommendations for building energy efficiency policy design and the effective combination of various policy instruments in a package.

Policy practices for energy efficiency improvement in buildings, existing in various locations, and lessons learnt can also be an important source of information for policy design in a particular city. Such information on existing policies often structured in the databases (e.g. IEA's Building Energy Efficiency Policies database (BEEP)) and collections of case studies (GBPN Tools, BigEE platform, Solution Gateway, C40 Urban Efficiency, RenoWiki, ESMAP EE Cities Case Studies, etc.). These sources often contain not only the information on existing policies, but also recommendations on how similar policies can be replicated and implemented.

One of the important aspects to consider at the policy design stage is multiple benefits of energy efficiency improvements. There are various benefits (e.g. improved air quality, health and productivity of inhabitants, job creation, energy security, reduction in energy poverty, etc.) linked to energy efficiency, which can provide additional motivation and increase effectiveness of a policy packages, if they are adequately taken into account and communicated to the relevant stakeholders. Guidebook 'The co-benefits evaluation tool for the urban energy systems' and IEA (2014) report 'Capturing the Multiple Benefits of Energy Efficiency' provide important overview of the key multiple benefits, while COBRA tool can help to conduct respectful assessment on the air quality, human health, and related economic benefits (excluding energy cost savings) of clean energy policies or programs.

One of the most important stages of policy development at the city level is implementation of energy efficiency policy instruments and projects. Different tools can be helpful depending on whether policy or projects, new or existing buildings are targeted. Tools targeting projects typically presume certain type of modelling of energy saving measures for buildings' design and/or renovation. Tools for policies implementation usually provide guidelines on how certain instruments can be implemented and effectively enforced, what the implementation steps are, as well as in some cases, how they can interact with other policy instruments.

In order to ensure that the progress towards higher levels of energy efficiency is taking place, the impact of the implemented policies and projects needs to be tracked. For policies the tools based on inventories, scenarios and indicators can be considered in order to establish the most relevant framework for tracking and reporting the progress on energy efficiency improvement. For projects the tools presented in DT (e.g. COBRA; ENERGYSTAR Portfolio Manager, EDGE, BEopt, COMBAT) usually presume ex-ante evaluation of energy savings from the implementation of selected energy efficiency measures.

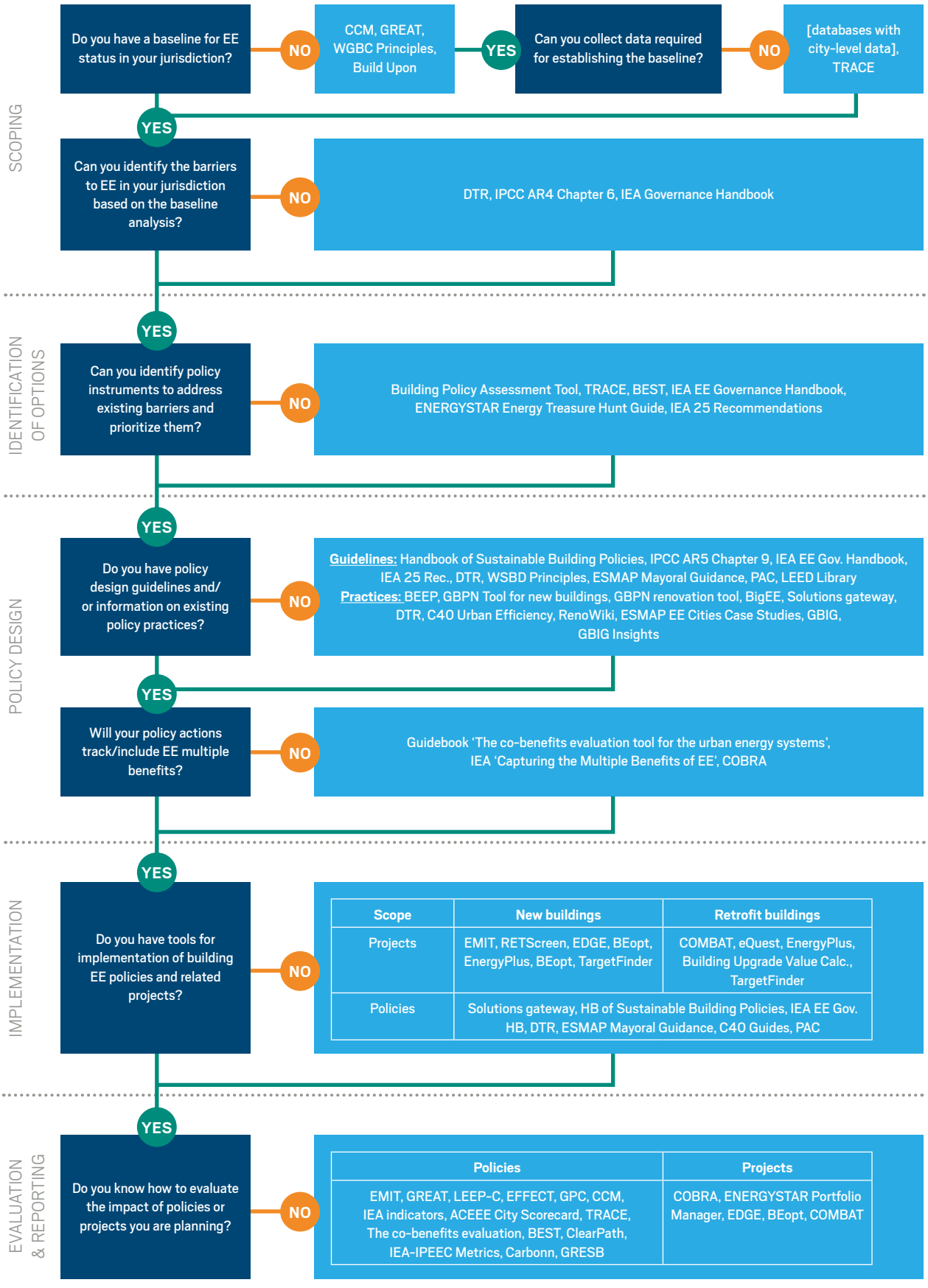

FIGURE 3. **Decision tree for policy and project development at the city level**

Catalogue of Tools

Table 1 presents all the tools selected and reviewed for this paper and provides a visual snapshot of the results of the analysis across four criteria discussed in Categorisation of the tools Section. For all 50 tools there is an indication of whether the tool is passive or active in its approach, whether its scope focuses mainly on policies or projects, at which stage of the policy development cycle it can be useful, and whether in terms of its city focus it targets the cities directly or can support city level stakeholder with more general information. The catalogue does not provide information on tools beyond relevance to the four criteria. More detailed information for a particular tool can be found in Tools' profiles in the next section.

Photo credit: Dimboukas

TABLE 1. Catalogue of tools

NAME OF THE TOOL	APPROACH		SCOPE		STAGE OF THE POLICY DEVELOPMENT CYCLE					CITY FOCUS	
	Passive	Inter-active	Project	Policy	Scoping	Identifi-cation	Design	Imple-menta-tion	Track-ing	Target-ing	Sup-porting
Driving Transformation Report (DTR)	x			x	x		x	x			
Key Principles for Colaborative Policy-Making	x			x	x		x	x			x
IPCC AR4 Chapter 6	x			x	x		x				x
Green Resources & Energy Analysis Tool (GREAT)		x		x	x				x	x	
Common Carbon Metric (CCM)		x		x	x						x
Build Upon Stakeholder Mapping Tool	x			x	x						x
Build Upon Resources	x			x	x						x
Tool for Rapid Assessment of City Energy (TRACE)		x		x	x	x			x	x	
IEA EE Governance Handbook	x			x		x	x	x			x
ENERGYSTAR Energy Treasure Hunt Guide	x		x			x	x				x
IEA 25 Recommendations for Buildings	x			x		x	x				x
Benchmarking and Energy Saving Tool for Low Carbon Cities (BEST)		x		x		x			x	x	
Building Efficiency Policy Assessment Tool		x		x		x					x
Handbook of Sustainable Building Policies	x			x			x	x			x
Solutions gateway	x			x			x	x		x	
C40 Report Urban Efficiency	x			x			x			x	
ESMAP Mayoral Guidance on Buildings	x			x			x	x		x	
Co-Benefits Risk Assessment (COBRA)		x		x			x		x	x	
BigEE Policy Guide	x			x			x				x
Building Energy Efficiency Policies (BEEP)	x			x			x				x
Policy Tool for New Buildings		x		x			x				x
Policy Tool for Renovation		x		x			x				x
RenoWiki	x			x			x				x
Energy Efficient Cities Case Studies Database	x			x			x			x	
Capturing the Multiple Benefits of Energy Efficiency	x			x			x				x
The Co-benefits Evaluation Tool for the Urban Energy System		x		x			x		x	x	
IPCC AR5 Chapter 9	x			x			x				x
Policy & Advocacy Collection (PAC)	x			x			x	x			x
LEED Credit Library and Resources Library	x		x	x			x	x			x
The Green Building Information Gateway (GBIG)		x		x			x				x
GBIG Insight / Sustainable Cities Collection	x			x			x				x
Building Energy Optimization (BEopt)		x	x					x	x		x
Commercial Building Analysis Tool for Energy-Efficiency Retrofit (COMBAT)		x	x					x	x		x
Excellence in Design for Greater Efficiencies (EDGE)		x	x					x	x		x
Target Finder		x	x					x	x		x
Building Upgrade Value Calculator		x	x					x			x
Energy Model Input Translator (EMIT)		x	x					x			x
EnergyPlus and eQUEST		x	x					x			x
RETScreen		x	x					x			x
C40 Good Practice Guides	x			x				x		x	
ACEEE City EE Scorecard	x			x					x	x	
ClearPath		x		x					x	x	
Energy Forecasting Framework and Emissions Consensus Tool (EFFECT)		x		x					x		x
ENERGYSTAR Portfolio Manager		x	x						x		x
Global Protocol for Community-Scale GHG Emissions (GPC)	x			x					x	x	
IEA Indicators	x			x					x		x
Local Energy Efficiency Policy Calculator (LEEP-C)		x		x					x	x	
Carbonn Climate Registry		x		x					x	x	
IEA-IPEEC Building Energy Performance Metrics	x			x					x		x
GRESB Base Level Survey		x		x					x		x

Tools' profiles

Driving Transformation Report (DTR)

Organisation	Institute for Building Efficiency
Description	The tool will be most effective when used to assess policy options and priorities for one market segment at a time, such as residential new construction or existing commercial buildings. Market segments might be selected based on potential energy savings, economic impact, or other factors. To help policymakers begin to design a policy strategy.
Aim	To help policymakers begin to design a policy strategy.
Target audience	Policy-makers, Stakeholders
Approach	Passive
Scope	Policy
Stage of PD cycle	Scoping, Design, Implementation
City focus	Supporting
Source	http://www.buildingefficiencyinitiative.org/sites/default/files/legacy/InstituteBE/media/Library/Resources/Energy-and-Climate-Policy/Driving-Transformation-to-EE-Buildings-Assessment-Tool.pdf

Key Principles for Collaborative Policy-Making

Organisation	World Green Building Council (WGBC)
Description	This tool aim's to provide a blueprint or 'checklist' for GBCs who are setting up collaborative partnerships to solve public policy issues with their governments and communities.
Aim	To help collaborative partnerships solve public policy issues.
Target audience	Policy-makers
Approach	Passive
Scope	Policy
Stage of PD cycle	Scoping, Design, Implementation
City focus	Supporting
Source	http://www.worldgbc.org/infohub/key-principles/

IPCC AR4 Chapter 6

Organisation	Intergovernmental Panel on Climate Change (IPCC)
Description	This report devotes most attention to improving energy efficiency in new and existing buildings, which encompasses the most diverse, largest and most cost-effective mitigation opportunities in buildings.
Aim	To help improve energy efficiency in new and existing buildings.
Target audience	Policy-makers
Approach	Passive
Scope	Policy
Stage of PD cycle	Scoping, Design
City focus	Supporting
Source	https://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter6.pdf

Green Resources & Energy Analysis Tool (GREAT)

Organisation	U.S. Department of Energy
Description	The GREAT Tool for Cities is an integrated bottom-up, energy end-use based modelling and accounting tool for tracking energy consumption, production and resource extraction in all economic sectors on a city, provincial or regional level. The model uses the Long-range Energy Alternatives Planning System (LEAP) software developed by the Stockholm Environmental Institute and includes a national average dataset on energy input parameters for residential, commercial, transport, industry and agriculture end-use sectors.
Aim	To track energy production and consumption.
Target audience	Policy-makers, Experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Scoping, Tracking
City focus	Targeting
Source	https://china.lbl.gov/tools/green-resources-energy-analysis-tool-great

Common Carbon Metric (CCM)

Organisation	United Nations Environment Programme (UNEP)
Description	This tool provides a way to establish a baseline, measure, report, and verify energy savings and emissions reductions from buildings around the world in a consistent and comparable way.
Aim	To help indicate reduction of emissions.
Target audience	Policy-makers, Experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Scoping
City focus	Supporting
Source	http://www.unep.org/sbci/pdfs/UNEPSBCICarbonMetric.pdf

Build Upon Stakeholder Mapping Tool

Organisation	Build Upon
Description	This tool help to identify which organisations need to work together to deliver ambitious renovation strategies.
Aim	To help policy makers deliver renovation strategies.
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Scoping
City focus	Supporting
Source	http://buildupon.eu/stakeholders/#stakeholder-maps

Build Upon Resources

Organisation	Build Upon
Description	The tool is a collection and visual presentation of resources related to energy efficiency in buildings, including an interactive map for collaboration.
Aim	To enhance collaboration.
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Scoping
City focus	Supporting
Source	http://buildupon.eu/resources/

Tool for Rapid Assessment of City Energy (TRACE)

Organisation	Energy Sector Management Assistance Program (ESMAP)
Description	This tool is a decision-support tool designed to help cities quickly identify under-performing sectors, evaluate improvement and cost-saving potential, and prioritize sectors and actions for energy efficiency (EE) intervention. It covers six municipal sectors: passenger transport, municipal buildings, water and waste water, public lighting, solid waste, and power and heat.
Aim	To prioritize sectors and actions for energy efficiency interventions.
Target audience	Local policy-makers
Approach	Interactive
Scope	Policy
Stage of PD cycle	Scoping, Tracking
City focus	Targeting
Source	http://esmap.org/TRACE

Energy Efficiency Governance Handbook

Organisation	International Energy Agency (IEA)
Description	This handbook draws on the experience of hundreds of energy efficiency experts around the world as well as extensive searches of energy efficiency good governance case studies and literature. The findings from this study are presented as guidance to practitioners and stakeholders on how to address the many EE governance issues. EE governance is a complex topic, so this handbook is organised according to the three main governance areas – enabling frameworks, institutional arrangements and co-ordination mechanisms – and contains individual chapters addressing specific governance topics
Aim	To provide guidance for establishing effective energy efficiency governance and policy development
Target audience	Practitioners, Stakeholders
Approach	Passive
Scope	Policy
Stage of PD cycle	Identification, Design, Implementation
City focus	Supporting
Source	http://www.iea.org/publications/freepublications/publication/gov_handbook.pdf

ENERGYSTAR Energy Treasure Hunt Guide

Organisation	U.S. Environmental Protection Agency
Description	The Energy Treasure Hunt is a dynamic, effective process for identifying energy savings opportunities. By focusing on energy savings, Energy Treasure Hunts support implementation of an energy management program.
Aim	To identify energy saving opportunities.
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Project
Stage of PD cycle	Identification, Design
City focus	Supporting
Source	https://www.energystar.gov/sites/default/files/buildings/tools/Energy_Treasure_Hunt_Guide_Jan2014.pdf

IEA 25 Energy Efficiency Policy Recommendations

Organisation	International Energy Agency (IEA)
Description	This tool includes policies to cost-effectively increase energy efficiency by establishing market signals to motivate effective action, accelerate the introduction of new technologies, and strengthen and enforce minimum energy performance standards (MEPS) for appliances, lighting, equipment and building energy codes.
Aim	To promote cost-effectively energy efficient policies.
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Identification, Design
City focus	Supporting
Source	https://www.iea.org/publications/freepublications/publication/25recom_2011.pdf

Benchmarking and Energy Saving Tool for Low Carbon Cities (BEST)

Organisation	Berkeley Lab
Description	The tool is designed to provide city authorities with strategies they can follow to reduce city-wide carbon dioxide (CO_2) and methane (CH_4) emissions. The tool quickly assesses local energy use and energy-related CO_2 and CH_4 emissions across nine sectors (i.e., industry, public and commercial buildings, residential buildings, transportation, power and heat, street lighting, water & wastewater, solid waste, and urban green space), giving officials a comprehensive perspective on their local carbon performance.
Aim	To help quickly assesses local energy use and energy-related CO_2 and CH_4 emissions.
Target audience	Local policy-makers
Approach	Interactive
Scope	Policy
Stage of PD cycle	Identification, Tracking
City focus	Targeting
Source	https://eaei.lbl.gov/tool/benchmarking-and-energy-saving-tool-low

Building Efficiency Policy Assessment Tool

Organisation	World Resource Institute (WRI)
Description	The tool offers a simple framework to help decision-makers set policy priorities with input from stakeholders. It outlines a workshop designed to support consensus-based, multi-stakeholder collaboration and uses visual tools to build consensus and prioritize building efficiency policy options and strategies.
Aim	To help decision-makers set policy priorities.
Target audience	Policy-makers, stakeholders
Approach	Interactive
Scope	Policy
Stage of PD cycle	Identification
City focus	Supporting
Source	http://www.buildingefficiencyinitiative.org/articles/driving-transformation-energy-efficient-buildings-policies-and-actions-2nd-edition?

Handbook of Sustainable Building Policies

Organisation	United Nations Environment Programme (UNEP)
Description	A practical decision support pack to aid policy makers and experts in developing countries. The objective of the Sustainable Building Policies in Developing Countries (SPoD) project is to enable authorities at national and local levels to analyse existing policies affecting the building sector, and to identify packages of policy instruments for sustainable buildings, which can be adapted to fit local conditions.
Aim	To enable authorities to develop and implement energy efficiency policies in the building sector, taking into account local situation
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design, Implementation
City focus	Supporting
Source	http://www.unep.org/sustainablebuildingpolicies/pdfs/SPoD-Handbook%20final-Full.pdf

Solutions gateway

Organisation	ICLEI
Description	This tool is a comprehensive collection of solutions, packages and case studies, which Local Governments can utilise to enhance low emissions development in their communities
Aim	To increase the energy-efficiency of urban water supply.
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design, Implementation
City focus	Targeting
Source	http://www.solutions-gateway.org/

C40 Report Urban Efficiency

Organisation	C40
Description	This tool is a resource for city officials around the world as they design new policies for building energy efficiency, or review existing ones. It aims to capture the range of different policies being implemented in cities, and is an initial attempt to reduce the current evidence gap regarding city-level activity in this field. It provides detailed information on the necessary conditions, opportunities and potential challenges when introducing and implementing such initiatives, and analyses what approaches have been successful in which context and why.
Aim	To capture a range of different opportunities for policies' design and implementation in cities.
Target audience	Local policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Targeting
Source	http://www.kankyo.metro.tokyo.jp/en/int/c40/c40_pse_r.html

ESMAP Mayoral Guidance on Buildings

Organisation	Energy Sector Management Assistance Program (ESMAP)
Description	This guidance note outlines how cities can tap into a wide array of proven technologies, policies, and financing mechanisms to improve energy efficiency and capture cost-effective energy savings in buildings. It offers city leaders advice on how to get started in introducing energy efficiency measures, and provides lessons and examples from successful programs that have been introduced worldwide.
Aim	To provide guidance on accelerating energy efficiency and present good examples from successful programs.
Target audience	Local policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design, Implementation
City focus	Targeting
Source	www.esmap.org/node/55263

Co-Benefits Risk Assessment (COBRA)

Organisation	US Environmental Protection Agency
Description	This tool can calculate the value of clean energy policies such as energy efficiency or fuel switching, which can help state and local governments to consider both the costs and benefits of policy choices and support a balanced decision-making process.
Aim	To calculate the value of clean energy policies.
Target audience	Local policy-makers, Experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Design, Tracking
City focus	Targeting
Source	https://www.epa.gov/statelocalclimate/co-benefits-risk-assessment-cobra-screening-model

bigEE Policy Guide

Organisation	Wuppertal Institute
Description	Tool that contains a package of policies and measures with different functions in order to gradually mainstream Ultra-Low-Energy new buildings, high energy savings in building renovation, and super-efficient appliances.
Aim	To promote energy efficient buildings and appliances.
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	www.bigee.net/en/policy/guide/

Building Energy Efficiency Policies (BEEP)

Organisation	International Energy Agency (IEA)
Description	The BEEP database provides a detailed breakdown of policies for energy efficiency in buildings around the world, including those supporting buildings codes, labels, incentive schemes and zero-energy buildings.
Aim	To provide a breakdown of policies for energy efficiency.
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	www.iea.org/beep/

Policy Tool for New Buildings

Organisation	Global Building Performance Network
Description	This interactive tool gives the opportunity to compare the dynamic energy efficiency policies for new buildings (residential and commercial). It reviews 25 best practice building energy efficiency codes using 15 criteria developed with some of the world's leading experts in the field.
Aim	To compare energy efficiency policies.
Target audience	Policy-makers, Experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	www.gbpn.org/databases-tools/purpose-policy-tool-new-buildings

Policy Tool for Renovation

Organisation	Global Building Performance Network
Description	The tool allows to: compare policy packages based on different criteria by selecting and deselecting criteria; access detailed information about each of the policy packages and generate graphs based on time series data for energy performance in the respective countries/regions.
Aim	To compare and access data on energy performance.
Target audience	Policy-makers, Experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	www.gbpn.org/databases-tools/purpose-policy-tool-renovation

RenoWiki

Organisation	Build Upon
Description	A tool that is trying to create a collaborative community to help countries design and implement their strengthened national renovation strategies.
Aim	To support design and implementation of renovation strategies
Target audience	Policy-makers, Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	http://buildupon.eu/initiatives/#the-renowiki

Energy Efficient Cities Case Studies Database

Organisation	Energy Sector Management Assistance Program
Description	Tool that contains several dozen urban energy efficiency case studies across all sectors – transport, buildings, lighting, water, solid waste, heating/power – in both developing and developed countries.
Aim	To present urban energy efficiency case studies.
Target audience	Experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Targeting
Source	http://www.esmap.org/node/231

Capturing the Multiple Benefits of Energy Efficiency

Organisation	International Energy Agency
Description	Report which is trying to build knowledge of the multiple benefits of energy efficiency, and to demonstrate how policy makers and other stakeholders can use existing tools to measure and maximise the benefits they seek. Five key benefits areas: macroeconomic development; public budgets; health and wellbeing; industrial productivity; and energy delivery – are investigated in-depth, showing compelling returns when the value of multiple benefits is calculated alongside traditional benefits of energy demand and greenhouse gas emissions reductions.
Aim	To help maximise the multiple benefits of energy efficiency.
Target audience	Policy-makers, stakeholders
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	http://www.iea.org/publications/freepublications/publication/capturing-the-multiple-benefits-of-energy-efficiency.html

The Co-benefits Evaluation Tool for the Urban Energy System

Organisation	United Nations University
Description	The tool evaluates climate co-benefits for the urban energy system based on different scenarios of socioeconomic, technological and demographic developments. The tool relates systematically the climate change based on the specific energy demand in different sectors in cities to the corresponding social, economic and technological factors that affect this demand.
Aim	To evaluate climate co-benefits for the urban energy system.
Target audience	Policy-makers
Approach	Interactive
Scope	Policy
Stage of PD cycle	Design; Tracking
City focus	Targeting
Source	http://tools.ias.unu.edu/sites/default/files/manual/Energy_Evaluation_Tool_Guidebook.pdf

IPCC AR5 Chapter 9

Organisation	Intergovernmental Panel on Climate Change (IPCC), Working Group III
Description	The chapter presents the overview of the key mitigation options for buildings, potential reductions of energy use or emissions, energy efficiency co-benefits, key barriers as well as policy options for the sector
Aim	To evaluate the performance of climate models.
Target audience	Policy-makers, experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter9.pdf

Policy & Advocacy Collection (PAC)

Organisation	U.S. Green Building Council
Description	Webpage collection of policy and advocacy briefs and case studies, on a range of building policy topics such as resilience, energy efficient affordable housing, and other aspects. Examples: DC, Building a Green Code case study; Green Buildings for Cool Cities, Better Buildings through Executive Action, and Green Building and Climate Resilience. The collection also includes legislative text for several policies.
Aim	To provide policy ideas, examples, technical information, and reasons for considering various policies
Target audience	Governments (officials and staff), advocates
Approach	Passive
Scope	Policy
Stage of PD cycle	Design, Implementation
City focus	Supporting
Source	http://www.usgbc.org/resources/grid/advocacy-policy and http://www.usgbc.org/about#advocacy

LEED Credit Library and Resources Library (LEED Library)

Organisation	U.S. Green Building Council
Description	Guidance on strategies to achieve green building; numerous credits include calculators and other resources. Note: credit library and most resources are free/public access.
Aim	To provide clear performance-based sustainable building practices
Target audience	Experts, Practitioners
Approach	Passive
Scope	Policy, Project
Stage of PD cycle	Design, Implementation
City focus	Supporting
Source	http://www.usgbc.org/credits and http://www.usgbc.org/resources/grid/leed

The Green Building Information Gateway (GBIG)

Organisation	U.S. Green Building Council
Description	Searchable database of buildings and places around the world with features such as energy certifications and other activities such as case studies
Aim	To provide transparent data
Target audience	Policy-makers, Practitioners, Experts, General Public
Approach	Interactive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	http://www.gbig.org/

GBIG Insight / Sustainable Cities Collection

Organisation	U.S. Green Building Council
Description	Articles and case studies focused on city policy information, as well as best practices. Examples include Green Infrastructure: City Climate Action Planning, Pittsburgh 2030 District: A City-Focused Initiative Driving Growth Via Building Performance
Aim	To provide data and examples to support private and public sector progress on buildings
Target audience	Experts, Practitioners, Policy-Makers
Approach	Passive
Scope	Policy
Stage of PD cycle	Design
City focus	Supporting
Source	http://insight.gbig.org/topics/cities/

Building Energy Optimization (BEopt™)

Organisation	National Renewable Energy Laboratory
Description	BEopt is a software tool that can evaluate residential building designs and identify cost-optimal efficiency packages at various levels of whole-house energy savings along the path to zero net energy. It is used to analyse both new construction and existing home retrofits, as well as single-family detached and multi-family buildings, through evaluation of single building designs, parametric sweeps, and cost-based optimizations.
Aim	To help evaluate building design and cost-optimal efficiency packages.
Target audience	Policy-makers, experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation; Tracking
City focus	Supporting
Source	https://beopt.nrel.gov/

Commercial Building Analysis Tool for Energy-Efficient Retrofits (COMBAT)

Organisation	China Energy Group
Description	The Commercial Building Analysis Tool for Energy-Efficiency Retrofit (COMBAT) is created to facilitate policy makers, facility managers, and building retrofit practitioners to estimate commercial (public) buildings retrofit energy saving, cost and payback period. Common commercial building models area created, and the retrofit measures and their effects are pre-computed by EnergyPlus by taking different building types and measures interactions into account.
Aim	To help estimate energy savings from buildings retrofit.
Target audience	Policy-makers, experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation, Tracking
City focus	Supporting
Source	https://china.lbl.gov/tools/commercial-building-analysis-tool-energy

Excellence in Design for Greater Efficiencies (EDGE)

Organisation	International Cooperation Finance
Description	EDGE calculates the utility savings and reduced carbon footprint of a green building against a base case. For non-residential buildings, user can see how much extra it costs to build green – and how short a time it takes to earn back the money through operational savings.
Aim	To help calculate energy savings of a green building.
Target audience	Policy-makers, experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation; Tracking
City focus	Supporting
Source	https://www.edgebuildings.com/software/

Target Finder

Organisation	Energy Star
Description	Target Finder is an online calculator that helps architects, engineers, and property owners and managers assess the energy performance of commercial building designs and existing buildings.
Aim	To help analyse the energy performance of buildings.
Target audience	Experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation; Tracking
City focus	Supporting
Source	https://www.energystar.gov/buildings/service-providers/design/step-step-process/evaluate-target/epa%E2%80%99s-target-finder-calculator

Building Upgrade Value Calculator

Organisation	Energy Star
Description	This tool analyses the financial value of efficiency-related capital investments in commercial real estate. By entering information – such as square footage, annual utility bill, the projected cost and savings for each investment, and financing terms – the user is able to determine a particular investment's energy and financial benefits.
Aim	To help analyse the financial value of the energy investment.
Target audience	Policy-makers, experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation
City focus	Supporting
Source	https://www.energystar.gov/buildings/tools-and-resources/building-upgrade-value-calculator

Energy Model Input Translator (EMIT)

Organisation	Rock Mountain Institute
Description	This software tool is a compilation of spreadsheet based calculators that were developed in response to the building energy modelling community's need for tools that translate design data and code requirements into typical energy model inputs.
Aim	To help experts calculate the building energy model.
Target audience	Experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation
City focus	Supporting
Source	http://www.rmi.org/rmi/ModelingTools

EnergyPlus and eQUEST

Organisation	U.S. Department of Energy
Description	This tool is a simulation software which is being used by engineers, architects, and researchers for modelling energy consumption for heating, cooling, ventilation, lighting, and plug and process loads – and water use in buildings.
Aim	To help engineers simulate various energy efficiency measures for buildings.
Target audience	Experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation
City focus	Supporting
Source	http://apps1.eere.energy.gov/buildings/energyplus/

RETScreen

Organisation	Natural Resources Canada (NRCAN)
Description	RETScreen is a Clean Energy Management Software system for energy efficiency, renewable energy and cogeneration project feasibility analysis as well as ongoing energy performance analysis.
Aim	To conduct feasibility and energy performance analysis.
Target audience	Policy-makers
Approach	Interactive
Scope	Project
Stage of PD cycle	Implementation
City focus	Supporting
Source	http://www.nrcan.gc.ca/energy/software-tools/7465

C40 Good Practice Guides

Organisation	C40 Cities
Description	This guide focuses on the key elements to successfully deliver building energy efficiency in municipal buildings, leading to better economic, social, and environmental outcomes for cities.
Aim	To deliver successful energy efficient buildings.
Target audience	Local policy-makers, experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Implementation
City focus	Targeting
Source	http://c40-production-images.s3.amazonaws.com/good_practice_briefings/images/8_C40_GPG_MBE.original.pdf?1456789018

ACEEE City EE Scorecard

Organisation	American Council for an Energy Efficiency Economy (ACEEE)
Description	This report measures the progress of city policies and programs that save energy while benefiting the environment and promoting economic growth. It ranks 51 large US cities for their energy efficiency efforts across five policy areas: local government operations, community-wide initiatives, buildings, energy and water utilities, and transportation. The Scorecard also gives examples of best practices in each policy area.
Aim	To offer a roadmap for any local government aiming to improve its energy efficiency by learning from other cities' successes
Target audience	Local policy-makers
Approach	Passive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Targeting
Source	http://aceee.org/research-report/u1502

ClearPath

Organisation	ICLEI
Description	It is a cloud based-tool for energy and emission management. It can forecast multiple scenarios for future emissions, analyse the costs and benefits of emissions reduction measures, visualize alternative planning scenarios etc.
Aim	To forecast and analyse energy savings from energy efficiency measures.
Target audience	Experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Targeting
Source	http://icleiusa.org/clearpath/

Energy Forecasting Framework and Emissions Consensus Tool (EFFECT)

Organisation	World Bank
Description	This modelling tool is devoted to estimating and forecasting of energy balances, as well as greenhouse gas (GHG) emissions under a range of development scenarios or policy choices. It focuses on sectors that contribute to and are expected to experience a rapid growth in emissions. The tool is accompanied by a self-paced e-learning course offered by World Bank Institute.
Aim	To estimate and forecast sectoral energy use and GHG emissions
Target audience	Policy-makers, experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Supporting
Source	http://esmap.org/EFFECT

ENERGYSTAR Portfolio Manager

Organisation	Energy Star
Description	The tool assists the user to measure and track energy use, water use and greenhouse gas emissions through a secure online environment. The results can be used to locate under-performing buildings, set investment priorities, verify efficiency improvements, and receive EPA recognition for superior energy performance.
Aim	To measure and track energy use, water use and greenhouse gas emissions in buildings
Target audience	Policy-makers, experts
Approach	Interactive
Scope	Project
Stage of PD cycle	Tracking
City focus	Supporting
Source	https://www.energystar.gov/buildings/tools-and-resources/portfolio-manager-quick-start-guide

Global Protocol for Community-Scale GHG Emissions (GPC)

Organisation	WRI, ICLEI, C40
Description	A framework for accounting and reporting city-wide greenhouse gas emissions. It offers guidance to cities on developing a comprehensive greenhouse gas inventory, including establishing the base year for the inventory, setting emissions reduction targets and tracking cities' performance. The tool also allows for aggregation of the estimates at the subnational and national levels
Aim	To develop GHG inventory at the city level
Target audience	Policy-makers, experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Targeting
Source	http://www.ghgprotocol.org/city-accounting

IEA Indicators

Organisation	International Energy Agency
Description	A series of energy indicators to study energy-use developments and analyse factors behind changes in energy use and CO2 emissions. The manual identifies key energy efficiency indicators for each sector of economy and outlines data needs in order to develop these indicators. It also provides certain recommendations on how typical difficulties with data collection might be addressed
Aim	To offer the indicators framework to collect data and measure progress on energy efficiency
Target audience	Policy-makers, experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Supporting
Source	http://www.iea.org/publications/freepublications/publication/energy-efficiency-indicators-fundamentals-on-statistics---.html

Local Energy Efficiency Policy Calculator (LEEP-C)

Organisation	American Council for an Energy-Efficient Economy
Description	The tool provides the opportunity to analyse the impacts of 23 different policy types from 4 energy-using sectors: public buildings, commercial buildings, residential buildings, and transportation. Impacts of policy choices are analysed in terms of energy savings, cost savings, pollution reduction, and other outcomes over a time period set by the user. The tool also allows for assigning the weights to different policy options based on community priorities in order to tailor policy development process to community goals.
Aim	To evaluate impacts of policy choices
Target audience	Local policy-makers, Stakeholders
Approach	Interactive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Targeting
Source	http://aceee.org/research-report/u1506

Carbon*n* Climate Registry

Organisation	ICLEI
Description	Reporting platform to enhance transparency, accountability and credibility of climate action of local and subnational governments.
Aim	To enable local governments to publicly and regularly report on their greenhouse gas (GHG) reduction commitments, emissions inventories and climate mitigation / adaptation actions
Target audience	Policy-makers, experts
Approach	Interactive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Targeting
Source	http://carbonn.org/data/

IEA-IPEEC Building Energy Performance Metrics

Organisation	International Energy Agency, International Partnership for Energy Efficiency Cooperation
Description	A report indicating the metrics data needed to measure the progress and identify opportunities for improvement in building energy performance. The report covers the period between 2000 and 2012 and uses historic drivers such as population, building sector size, economic activity, building energy policy, among others.
Aim	To evaluate the progress on building energy performance.
Target audience	Policy-makers, experts
Approach	Passive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Supporting
Source	http://www.buildingrating.org/sites/default/files/1448011796IEA_IPEEC_BEET4_Final_Report.pdf

GRESB Base Level Survey

Organisation	GRESB
Description	Tool to assess sustainability, including energy efficiency, of a portfolio.
Aim	The benchmark results present the opportunity to identify the areas in which an entity can improve its sustainability performance, both in absolute terms and relative to peers. Furthermore, the results can be used as a toolkit for internal and external stakeholder engagement
Target audience	Real estate managers, including government bodies with property
Approach	Interactive
Scope	Policy
Stage of PD cycle	Tracking
City focus	Supporting
Source	https://gresb.com/realestate2015/products_for_participants

References

Baldwin, R, P Russel, S Nibel, C. Boonstra, and T Lützkendorf. 2000. 'Results of IEA-ECBCS Annex 31 Work on Environmental Assess- Ment of Buildings and Related Tools'. In . Maastricht, the Netherlands.

Becque, R, E Mackres, J Layke, N Aden, N Liu, K Managan, C Nesler, S Mazur-Stommen, K Petrichenko, and P. Graham. 2016. 'Building Efficiency Tools for Cities. Appendix 1'. In *Accelerating Building Efficiency: Eight Actions for Urban Leaders*. World Resources Institute, Johnson Controls. http://publications.wri.org/buildingefficiency/#a1.

C40. 2016. 'Why Cities? Ending Climate Change Begins in the City.' http://www.c40.org/ending-climate-change-begins-in-the-city.

Ding, Grace K.C. 2008. 'Sustainable construction—The Role of Environmental Assessment Tools'. *Journal of Environmental Management* 86 (3): 451–64. doi:10.1016/j.jenvman.2006.12.025.

Forsberg, A, and F von Malmborg. 2004. 'Tools for Environmental Assessment of the Built Environment'. *Building and Environment* 39 (2): 223–28. doi:10.1016/j.buildenv.2003.09.004.

Haapio, A, and P Viitaniemi. 2008. 'A Critical Review of Building Environmental Assessment Tools'. *Environmental Impact Assessment Review* 28 (7): 469–82. doi:10.1016/j.eiar.2008.01.002.

Holder, M. 2016. 'Number of Cities Disclosing Climate Action Passes 500 Globally'. *Business Green*, August 4. http://www.businessgreen.com/bg/news/2467011/number-of-cities-disclosing-climate-action-passes-500-globally.

IEA. 2014. 'Capturing the Multiple Benefits of Energy Efficiency'. Paris Cedex, France: International Energy Agency (IEA).

———. 2016. 'Energy Technology Perspectives 2016'. Paris, France: International Energy Agency.

Mikučionienė, Rūta, Vytautas Martinaitis, and Eugenijus Keras. 2014. 'Evaluation of Energy Efficiency Measures Sustainability by Decision Tree Method'. *Energy and Buildings* 76 (June): 64–71. doi:10.1016/j.enbuild.2014.02.048.

Ness, B, E Urbel-Piirsalu, S Alkass, and L Olsson. 2007. 'Categorising Tools for Sustainability Assessment'. *Ecological Economics* 60 (3): 498–508. doi:10.1016/j.ecolecon.2006.07.023.

NREL. 2016. 'Cities-LEAP PROJECT. City-Level Tools'. http://energy.gov/sites/prod/files/2016/03/f30/CLEAP_Tools_v2016-3.PDF.

Ochs, A, A.M Majano, J Yeboah, and S.S Krishnan. 2015. 'Energy Toolkit. Leading Instruments & Methodologies for Low-Emissions Development Planning in the Energy Sector'. LEDS Energy Working Group & Worldwatch Institute.

REN21. 2016. 'Renewables 2016 Global Status Report'. http://www.ren21.net/status-of-renewables/global-status-report/.

SENTECH. 2010. 'Review of Selected Home Energy Auditing Tools'. In Support of the Development of a National Building Performance Assessment and Rating Program. The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. http://energy.gov/sites/prod/files/2013/11/f5/auditing_tool_review.pdf.

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