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Building Energy Code Toolkit

April 2017

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U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Acronyms and Abbreviations

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BECP	Building Energy Code Program
CESC	Clean Energy Solutions Center
DOE	U.S. Department of Energy
ECBC	Energy Conservation Building Code
PNNL	Pacific Northwest National Laboratory

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1.0 Background and Introduction

Building energy use accounts for over one-third of global energy use, and this share is growing as incomes rise and cities grow. Many countries and cities are looking at ways to encourage cost-effective energy savings in buildings. Building energy codes help lock in savings in new buildings and renovations. Today's codes can reduce energy use in buildings by half compared to buildings prior to codes, based on the experience in countries like China and the United States. Most countries have revised their codes in recent years to capture even greater energy savings. Looking forward, many countries have roadmaps to work on net zero energy building codes.

Under the Paris Agreement, 53 countries have committed to reducing their emissions through building energy efficiency and 38 specifically mention building energy codes in their Nationally Determined Contributions. These numbers are likely to grow as countries develop their implementation plans for their Nationally Determined Contributions. However, many countries today either do not have a building energy code or they have gaps in implementation.

This toolkit is designed as a first step in helping countries, cities and experts in developing, adopting and implementing their codes. In its present form, this toolkit is set out as a useful reference, but also as a means of assessing the potential of such information to help governments and other stakeholders. The toolkit covers five main topics: guidance for cities and jurisdictions that are just getting started, and tools that can provide inspiration and knowledge regarding code development, adoption, implementation and evaluation. However, this toolkit is also a research aide, helping understand where there may be gaps in information content or form. It can also be used to test the potential for scaling up of building energy code deployment using simple, replicable types of information sharing.

This toolkit was supported by the U.S. Department of State and the U.S. Department of Energy's Office of International Activities with the goal of helping countries and cities on building energy codes under the International Partnership for Energy Efficiency Cooperation (IPEEC). PNNL is also partnering with the Building Energy Accelerator and the World Resources Institute to assess gaps with code deployment and gaps with available tools. This work is being conducted in close collaboration with cities that have made commitments to implement codes in the Building Energy Accelerator.

2.0 Key Steps to Roll Out Building Energy Codes

Cities and countries that are just starting to work on building energy codes may be overwhelmed and unsure where to start. There are many elements to think about, but not all have to happen at once. Most countries improve their code over time, so knowing that can allow a jurisdiction to start and adjust the code based on experience or as stakeholders become more willing to increase the stringency of the code. A regular revision schedule (say every 3 years) can help the market learn to adapt. Implementing the code can also be challenging, so it is important to think it through carefully, possibly with a roadmap developed jointly with stakeholders. Some countries focus initial enforcement efforts on reviewing building plans and not inspecting construction for energy code provisions. This can help bridge capacity gaps initially, although including inspections improves the likelihood of compliance. One option to expand enforcement capacity rapidly is to use certified third-parties for inspections, with some checks and balances built in to avoid conflicts of interest.

This list of ten key steps summarizes the initial actions that jurisdictions may want to prioritize. The items that have a start time as soon as practical are not contingent on other elements, and hence, can begin whenever there is interest or funding. These steps are summarized below in Table 1.

Table 1 – Ten Key Steps for Building Energy Code Roll Out

Step	Title	Description	Start Time
1	Enabling legislation	Typically a government entity needs legislation or other formal direction to develop, implement, and enforce an energy code. Some jurisdictions begin work without this, but a strong legal base can help in working with stakeholders, ensuring accountability, and maintaining momentum.	As soon as practical
2	Survey of construction practices	A survey of existing construction practices is extremely useful to ensure that the eventual code is not too lenient or too strict in terms of what it requires. The more precise cost-benefit information that is possible with survey data is typically extremely useful in gaining stakeholder support. This is not an essential requirement to begin, so it is not necessary to delay development of a code for data, per se, but including data development in planning will be very beneficial. It is also possibly to survey construction practices even before there is enabling legislation.	As soon as practical, but this is not an essential step to get started
3	Analysis to develop a new code or adopt an existing code from a comparable country	A lot of thought and analysis should go into "what sort of code is needed" and "how should it be structured" and "what should it cover"? In many cases, countries adapt or modify a suitable code. For example, India and Vietnam developed their code based on ASHRAE 90.1 initially, while Turkey relies on European directives for its model. Adapting a code still typically requires analysis to	As soon as practical

		ensure the measures are reasonable for the market. A new code typically requires even more analysis work but it may be worth it to ensure that the requirements are appropriate and cost-effective.	
4	Draft or adopt a model code	This is the step that most governments focus on, but there is a lot of work to do both before and after this step. This is an important step because having a code is a prerequisite for adoption and implementation.	This is critical to move forward.
5	Develop a roadmap for enforcement	Knowing in advance how the code will be enforced will help keep expectations reasonable. Engaging stakeholders in developing such a roadmap can ensure that they understand the process, and their feedback can often make the roadmap more realistic and robust.	As soon as practical
6	Develop code training and support materials	Training and support material (such as guides, checklists, and tip sheets) to help all stakeholders understand the code and how it will be enforced is a vital part of achieving support for the code.	Once code is developed, but before adoption
7	Develop software for code compliance	Compliance software can help in mainstreaming compliance, and can make compliance easier for all parties. However, it can be expensive to develop robust, user-friendly software. It may be helpful to consider in writing the code whether it will be possible to have software to help with calculations, and if not, then the code will likely be easier to implement if there is a simple, prescriptive path. Also, it is important to recognize that simple, robust software can reduce compliance costs.	Once code is developed, but ideally before adoption
8	Develop product testing and rating labs and protocols	Product testing and rating is a key component of most energy codes, and it can be hard to require product testing and labeling if the needed labs and protocols do not exist in-country. This step can take time to develop. That is one of the reasons it is good to think about it early. Other reasons include to improve energy savings and to prepare the market for meeting the energy performance requirements in the code.	As soon as practical, but it is possible to start without this.
9	Coordinate product availability with manufacturers	Product testing and rating is also very hard to implement in-country unless manufacturers are willing and able to produce products that meet the product testing and rating requirements.	As soon as practical
10	Plan for the future of the code	Once the code is implemented, issues such as enforcement monitoring, the need for a system to periodically revise the code, and continuing or expanded training will arise.	After implementation

3.0 Overview of the Toolkit

The tools and resources presented below cover four different stages related to building energy codes: development, adoption, implementation, and evaluation. Each stage is further broken down to help users find resources that may be relevant. For example, the section on implementation has 8 subsections including ones on developing implementation strategies, establishing institutions, and building enforcement capacity.

For each tool or cluster of tools, the tables below provide a brief title focusing on the purpose, a list of the stakeholders that might find this tool relevant, a description of the tool with a link to the actual tool, and a description of how countries and cities might use this tool (potential application).

The Pacific Northwest National Laboratory developed this toolkit by expanding upon a shorter, more targeted toolkit developed for smart cities in India. The toolkit is not meant to be a comprehensive reference of all code-relevant tools and resources, but rather, to highlight ones that might be relevant to countries that are seeking to develop new building energy code programs or are in the early years of developing such a program.

4.0 Tools and Resources for Code Development, Adoption, Implementation, and Compliance Evaluation

4.1 Code Development

Before cities and countries can make progress on large-scale energy efficiency improvements in new buildings, they need to develop a building energy code. National, regional, and local government officials need to understand the benefits of a building energy code, the components of the proposed building energy code, and how it would function.

Table 2 – Resources for Code Development

Tool	Stakeholders	Description	Example Application
Understanding building energy codes			
Conceptual materials on the codes	Local, regional, or national governments	(1) DOE's Building Energy Code Program (BECP) has developed a resource guide which explains the reasons for and benefits of a building energy code. These resources can assist policy makers to support the creation of building energy efficiency goals and standards. See: Building Energy Codes – Resource Guide. (2) The Clean Energy Solutions Center (CESC) hosted a webinar in collaboration with the International Energy Agency and the United Nations Development Program to discuss the importance and challenges of building energy codes, current practices and	A city could use these materials to build its own materials describing the benefits of and rationale behind a code.

		progress needed to improve. See: Modernizing Building Energy Codes to Secure our Global Energy Future.	
Example of codes	Local, regional, or national governments	(1) China Academy of Building Research submitted a presentation to APEC on the design and implementation of green building codes in China. See: Overview of Building Codes, Building Energy Codes and Green Building Codes in China. (2) The Canadian Codes Center prepared a presentation on its National Energy Code for Buildings. See: Energy Efficiency in the National Model Construction Codes.	A national government or research organization supporting the government could gather ideas for a code or code revision from these documents.
Code development process	National governments	PNNL developed a presentation that defines a formal process for Vietnam's building energy code development. See: Setting up a Formal Energy Code Development Process in Appendix C.	Other countries could use these documents to plan their own process for code development.
Future trends in the codes	National governments Building industry experts	(1) This paper discusses the potential areas that can further improve energy efficiency of buildings and points out the need for the evolvement of codes, namely performance-based codes. See: A Perspective of Energy Codes and Regulations for the Buildings of the Future. (2) This paper compares the traditional compliance pathways and outcome-based pathways, and discussed the potential to integrate the outcome-based pathways with the traditional implementation process of India's building energy code. See: Building Energy Code Compliance in Developing Countries: The Potential Role of Outcomes-Based Codes in India. (3) CESC hosted a webinar to discuss the importance of the performance-based approach in the energy code design and experiences from pioneers. See: Lessons Learned on the Road to a Performance-Based Approach.	These documents could help countries consider different approaches for future code development. Many countries are interested in codes that regulate the ultimate performance of buildings, but this has many challenges, as described in document (2).
Training in drafting a code	Building research organizations Building industry experts National governments	PNNL organized a two-day seminar in Vietnam to train the Vietnamese experts to conduct analysis, revise, and improve the codes. See Appendix C – Agenda for Seminar on Analysis for Building Energy Code Development in Vietnam.	Other countries could use the information from this seminar to train their own experts in drafting a code and as a reference in preparing cost-benefit analysis on code measures and revisions.
Building up the structure			
Code format options	Local or regional governments	PNNL developed a comprehensive study on potential energy code formats, problems with current approaches, and proposed	Other countries could use this document to design

		solutions. This includes a sample of how to develop prescriptive packages and the logic model of commercial energy codes roadmap, see: Roadmap for the Future of Commercial Energy Codes.	their codes to focus on what is important to them.
Codes for commercial buildings	Local, regional, or national governments	(1) This is a presentation developed by PNNL to help stakeholders understand the building energy codes and barriers between design and building performance with proposed solutions. See: Roadmap Toward a Predictive Performance-based Commercial Energy Code. (2) This paper discusses an alternative approach to reduce compliance cost of building projects, namely precalculated packages, which provide more flexibility than prescriptive path in energy codes. See: Developing Commercial Code Precalculated Packages. A corresponding presentation is here: Developing Commercial Code Precalculated Packages. (3) PNNL prepared a presentation to introduce the performance rating path of the American Society of Heating, Refrigerating, and Air—Conditioning Engineers (ASHRAE) Appendix G. See: An Option for Bogota's Building Energy Code Developing a Performance Path Using. There is a detail report on the same topic, See: Developing Performance Cost Index Targets for ASHRAE Standard 90.1 Appendix G – Performance Rating Method	A government could use these documents to help in the development of a performance-based commercial building energy code, or in the development of a set of prescriptive packages for their code. Both approaches provide a lot more flexibility than a single prescription option.
Code Analysis			
Code assessment and improvement	Local or regional governments	(1) PNNL prepared this presentation for the seminar on analysis for energy code development in Vietnam. See: Assessing the Existing Code and Identifying Potential Changes in Appendix C. (2) This presentation explains one dimension to improve the code with clarified languages. See: How to Make the Code More Implementable: clarifying language and thinking about the user in Appendix C.	These presentations helped Vietnam to develop and improve its building energy efficiency code. Other countries can also learn to deal with those issues in their code development.
Prototype buildings	Building energy researchers	Prototype buildings are extremely helpful for building code development. They allow you to estimate the energy savings from a code using a representation of the buildings in your country. PNNL prepared a presentation to introduce the building prototype for Vietnam's building energy code development. See: Overview of U.S. Prototype Buildings in Appendix C.	Countries could use this presentation to understand the importance and use of a suite of prototype buildings for estimating the costs and benefits of a new code. Several countries have adapted U.S. prototypes to their own conditions.

Cost-benefit analysis	Local, regional, or national governments Building energy researchers	(1) This is a study supported by DOE to estimate the national benefits of the Building Energy Code Program. See: Building Energy Codes Program: National Benefits Assessment, 1992-2040. (2) This presentation discusses the importance and methods of cost benefit analysis of codes. See: Review of Cost Benefit Analysis of Code Measures in Appendix C.	Other governments could do similar cost-benefit studies on their codes to help develop the business case for energy codes.
Carbon emissions	Local or regional governments	This presentation introduces how to develop greenhouse gas inventories in building sector with a variety of assisting resource links. See: Emission Calculations and Greenhouse Gas Inventories in Appendix C	Governments interested in reducing carbon emissions could develop their own greenhouse gas inventories as a first step towards reducing their emissions.
Learning from others			
Action plans	Local, regional, or national governments	(1) France developed its action plan for energy efficiency in 2014. Residential-tertiary sector covered the buildings and the energy requirement covered appliances. See: Energy Efficiency Action Plan for France 2014. (2) Here is the German's action plan. See: Third National Energy Efficiency Action Plan for the Federal Republic of Germany.	Other governments could develop their own action plans to ensure that their code efforts ultimately provide the desired results.
Best practices in building codes	Local, regional, or national governments	(1) The Global Building Performance Network developed a policy paper to identify the best practices of building codes with its policy tools. See: Designing and Implementing Best Practice Building Codes: Insights from Policy Makers. (2) This ACEEE paper compares building energy codes in 15 countries and evaluates the most effective policies. See: Global Approaches: A Comparison of Building Energy Codes in 15 Countries.	Other countries could review these best practices as they are developing their own codes to see if there are usable ideas that make sense in their context.
Case studies	Local or regional governments	PNNL has developed a series of studies on the development of building energy codes of Asia-Pacific Partnership countries, including Australia, Canada, China, India, Japan, U.S., and South Korea. See Country Report: Australia; Canada; China; India; Japan; U.S.; South Korea.	Other countries could review these case studies in conjunction with the previous "best practices" as they are developing their own codes.

4.2 Code Adoption

Adopting a building energy code at the local level is the first step in implementation. It is very important to understand the legal framework, and adopt the code at the appropriate level and in a way that matches legal requirements. In some countries, building codes are in the national jurisdiction, while in others, they are in the state or local jurisdiction. It is rarely successful to implement a code if it is not adopted by the authority with jurisdiction. The easiest way to figure this out is to look at how jurisdictions have adopted health and safety building codes, like fire codes. Following that pattern will make it easier for code officials to have the power to enforce a code.

Once you have established jurisdiction, you can start building support for code adoption. At the local level, for example, a city needs to motivate stakeholders and get their buy-in on a code implementation roadmap in order to adopt an initial building energy code. In addition, the city needs to incorporate the building energy code into local building by-laws. Local governments could use technical support throughout this process.

Table 3 – Resources for Code Adoption

Tool	Stakeholders	Description	Example Application
Building general capacity			
Training materials for conceptual understanding	Local or regional governments Building owners Building developers Architects and engineers Building industry professionals	(1) PNNL developed training materials for local code officials, which provides a brief overview of India's building energy code and its benefits with a couple of case studies. See Energy Conservation Building Directives -2011. (2) PNNL organized state- and local-level stakeholder meetings to introduce India's building energy code and gain stakeholders' support. See Appendix A – Agenda Template for Building Energy Efficiency Code Introduction.	Other countries could use these materials as a template for training materials to be developed in their own jurisdiction.
Pilot building case studies	Local or regional governments Building owners Building developers Architects and engineers Building industry professionals	(1) Malaviya National Institute of Technology wrote a case study of its on-campus India Building Energy Code pilot building. See: Energy Conservation Building Code Compliance (ECBC) and Beyond: A Pilot Study. (2) PNNL developed a brochure on the pilot building. See: Pilot ECBC-Compliant Building in Jaipur: Background and Highlights of Prabha Bhawan.	Other countries could review these case studies to see if the pilot building case study approach might help with code adoption in their country.
City-level case studies	Local or regional governments Building owners Building developers Architects and engineers Building industry professionals	City-level case studies could help local governments have a big-picture view of how building energy code takes effect and interacts with other dimensions of the city. Natural Resources Defense Council's report Analyzes and offers recommendations for the Hyderabad buildings sector. See: Taking Energy Efficiency to New Heights: Analysis and Recommendations for the Buildings Sector from the Hyderabad Experience.	Other cities could review this case study to see if a similar case study for their city would provide useful information on the overall impacts of an energy codes. Many of the impacts noted here are likely

Tool	Stakeholders	Description	Example Application
			to be impacts in other cities as well.
Understanding the benefits and importance of the codes			
Benefit analysis	Local or regional governments Building owners Building developers Building industry professionals	(1) PNNL conducted an impact and benefit assessment for India's building energy code in Gujarat to show the potential for energy and economic savings in comparison with other building energy programs. See presentation: Potential Benefits of ECBC in Gujarat Impact Assessment Study by GCAM. (2) This report evaluates the potential energy saving from the implementation of India's building energy codes in the city of Jaipur. See: Potential of energy savings through implementation of Energy Conservation Building Code in Jaipur city, India.	Other governments could do similar cost-benefit analyses to determine the potential benefits of energy codes for their location. This type of analysis is typically needed to build up the "business case" for energy codes.
Codes adoption into law			
Adoption procedure and framework	Local or regional governments	BECP has developed a toolkit to help state governments understand code adoption and the adoption process. See: Building Energy Codes: Adoption Toolkit.	Other governments could use this document to help plan their own code adoption processes.
Building by-laws	Local or regional governments	Indian Ministry of Urban Development published 2016 model building by-laws to reference its building energy code as a requirement for certain types of buildings. See: 2016 Model Building By-laws.	Local and regional governments could use these by-laws as a template for their building by-laws and may extend requirements on the basis of it.

4.3 Code Implementation

Implementation is how the building energy code makes its impact. To facilitate implementation, a city or country needs to develop implementation strategies, establish institutions, build enforcement and compliance capacity, and provide compliance incentives. Useful resources and tools can smooth this process.

Table 4 – Resources for Code Implementation

Tool	**Stakeholders**	**Description**	**Example Application**
Understanding the benefits			
Economic impacts of the code implementation	Local or regional governments Building energy experts Building industry professionals	CESC hosted a webinar to review the progress with ECBC implementation in India and analyze the economic impacts of ECBC-compliant buildings. See: Large-scale Energy Efficiency in Indian Buildings: The Impact	Other governments could use the ideas presented in this webinar to develop their own impact analyses.

Tool	Stakeholders	Description	Example Application
	Architects and engineers	and Role of the Energy Conservation Building Code.	
Developing implementation strategies			
Implementation guidelines	Local, regional, or national governments Building energy experts	(1) PNNL developed a recommendation report to implement the Building Energy Code Rajasthan with a full discussion of implementation mechanisms. See: Recommendations on Implementing the Energy Conservation Building Code in Rajasthan, India. (2) This report summarized the status of building energy codes and their implementation in China. It also provided analysis on a couple of pilot cities with lessons learned. See: Synthesis Report on the Implementation of Building Energy Codes in China. (3) Here is a presentation, which introduces the implementation of building energy codes and their links to green building requirements in the U.S. with examples from Washington D.C., Portland, and Seattle. See: U.S. Experience in Building Energy Code Implementation in Cities.	Other governments could use these documents to help in the development of an energy code implementation plan.
Engagement of stakeholders	Local, regional, or national governments Building energy experts Other industry stakeholders	Involvement of stakeholders from various sectors is essential for code implementation. CESC hosted a webinar to discuss experiences in stakeholder engagement. See: CESC Webinar: Involving Stakeholders in Adoption and Implementation of Building Energy Codes.	Other governments could use this webinar to understand the importance of engaging stakeholders for a successful code implementation process.
Country-level case studies	Local or regional governments Building energy experts Architects and engineers Building industry professionals	(1) PNNL conducted a comparative study on building energy codes in the Asia-Pacific region, including the structure of the codes, and the enforcement and compliance frameworks. See: Shaping the Energy Efficiency in New Buildings: A Comparison of Building Energy Codes in the Asia-Pacific Region.(2) CESC hosted a webinar on the implementation of building energy codes, including case studies and lessons learned from the code implementation in other countries. See: CESC Webinar: Implementing Building Energy Codes: Implementation and Compliance Actions. (3) CESC hosted a webinar to present the status of building energy code implementation and compliance with experiences from China, France and the U.S. See: Status of Building Energy Code Development and	Other countries could use these case studies to plan their own code implementation processes.

Tool	Stakeholders	Description	Example Application
		Implementation Globally and in China, France, and the U.S.	
Establishing institutions			
Design of code implementation systems	National or regional governments Building energy experts Building industry professionals	(1) This paper studies the implementation systems for building energy codes of 22 countries, and identified the key elements of implementation. See: An international survey of building energy codes and their implementation. (2) This study compares the enforcement system in China to the U.S., covering testing and rating procedures, compliance software, and training and public information. See: Enforcing Building Energy Codes in China: Progress and Comparative Lessons.	Other countries could use these papers to help identify the key elements of code implementation for inclusion in an implementation plan.
Third-party system design	Local or regional governments Building energy experts Building industry professionals	(1) Third-party inspection is an important tool for code enforcement. PNNL developed a report on the scope and key elements of using the third-party inspectors in building code enforcement. See: Using Third-Party Inspectors in Building Energy Codes Enforcement in India. (2) PNNL also developed a paper on applying the third-party system in Rajasthan. The implementing model developed could be used in other states. See: Recommendations on Integrating Third Party System into Building Permitting Process in Rajasthan.	Other countries could use these papers to consider if the use of third-party inspectors as a supplement to or replacement for first party inspectors (government code officials) is appropriate for their country.
Training programs	Local or regional governments Building energy experts Building industry professionals	(1) Energy Code Ambassadors Program under the Building Codes Assistance Project can serve as a model for states and local governments to provide training and knowledge sharing. See website: http://bcapcodes.org/projects/ecap/ (2) PNNL organized stakeholder events in states and cities to discuss implementation options with stakeholders in India. See Appendix B – Agenda Template for Building Energy Efficiency Code Implementation.	Other countries could review these programs to see if the concept of an energy code ambassador or stakeholder outreach could help build support for implementation.
Software and tools			
Software and online approval system	National, regional, and local governments Building energy experts Building industry professionals Building developers Architects and engineers	(1) U.S. COM*check* is a tool that helps stakeholders to determine compliance of commercial buildings and high-rise residential buildings. And U.S. RES*check* is a tool that helps stakeholders to meet the requirements of new homes. (2) The Bureau of Energy Efficiency hosts ECOnirman as ECBC compliance checking software. PNNL provided technical assistance to help develop it. See user manuals at http://www.eco3.org/ECOnirman-Prescriptive/ (prescriptive) and	Other countries could review these tools to see if similar tools would be helpful in their country.

Tool	Stakeholders	Description	Example Application
		http://www.eco3.org/ECOnirman-WBP (whole-building performance). (3) The State of Telangana is developing an online building approval system that is quick and easy to use. Integrating India's building energy code into the system and replicating the system in urban local bodies, increases the ability of local governments to rapidly expand code implementation. See: Building a Better Future: Implementing the Energy-Saving Building Code in Hyderabad.	
Excellence in Design for Greater Efficiencies (EDGE)	Architects and engineers Building developers Building industry professionals Building energy experts	The International Finance Corporation has developed software that allows building designers and developers to compare the efficiency of their proposed building compared to a reference. EDGE is also linked to a process to certify buildings that are 20% more efficient than the reference. The software is available at: https://www.edgebuildings.com/software/.	Building designers can use this tool to understand how to improve the efficiency of their buildings.
Material testing and rating			
Material testing and rating system design	National governments Building energy experts Building industry professionals	This report discusses the key elements and institutional design for building material testing and rating in developing countries. See: Building Material Testing and Rating in Developing Countries.	Other countries could use this report to help them set up a building material testing and rating program.
Supervision System Design	National government Building energy experts Manufacturers	A study on the existing supervision system over China's Energy Labeling System, existing issues and methods to improve compliance. See: What Works in Enforcement and Compliance: Experience with the Local Supervision System for China's Energy Label.	Other countries could review this paper to see if a labeling supervision system such as this is appropriate for their country.
Building enforcement capacity			
Training materials for the enforcement community to understand enforcement elements	Local or regional governments Building energy experts	BECP has developed a toolkit to help enforcement communities to deal with issues during the building code enforcement and implementation process. See: Building Energy Codes Enforcement Toolkit.	Other countries could use this toolkit as a resource or template for their code official training programs.
Identifying barriers and approaches to enforcement	Local or regional governments Building energy experts	CESC hosted a webinar to discuss the barriers to implementing rigorous enforcement systems for new buildings, with examples of good enforcement, other best-practice measures for supporting implementation, and lessons learned from implementing such measures. See: Getting Building Codes Right: Implementation and Enforcement.	Other countries could use this webinar to identify barriers to enforcement of their own energy code and to help identify solutions to those barriers.
Case studies on enforcement improvement	Local or regional governments	This study proposes a streamlined building energy code compliance process to reduce enforcement challenges at local level. See:	Other countries could use this case study to help

Tool	Stakeholders	Description	Example Application
	Building energy experts	Streamlining the Energy Code Compliance Process to Reduce Enforcement Challenges and Harvest Real Energy Savings.	streamline their own code compliance process.
Building compliance capacity			
Training materials to understand the compliance procedures/paths	Local or regional governments Architects and engineers Building owners Building developers Building industry professionals	(1) BECP has developed a toolkit to help building community to understand the codes, requirements, and the compliance path. It can serve as an example for local governments to develop training materials on compliance. See: Building Energy Codes Compliance Toolkit. (2) This is a training course prepared by DOE to help the building community to understand how to achieve compliance. See: Energy Code Compliance Paths, Which One Will Work Best For Your Project?	Other countries could use these materials as a template for their own training materials for the design community.
Methods to determine compliance	Local, regional, or national governments Building energy experts Building industry professionals	This report has been developed by DOE to help the public or private entities to increase the level of compliance by reviewing different options for verifying compliance. See: Compliance Verification Paths for Residential and Commercial Energy Codes.	Other countries could use this report to develop their own options and procedures for verifying code compliance.
Case studies on compliance rate improvement	Local, regional, or national governments Building energy experts Building industry professionals	(1) This report is developed by Center for Energy and Environment, aiming at improving the compliance rate in Minnesota with two innovative approaches. See: Pilot Program with Two Focused Approaches to Enhance Energy Code Compliance. (2) This study identified the best practices in code compliance and enforcement in Arizona, which could be potentially promoted and replicated in other places. See: Building Energy Codes in Arizona: Best Practices in Code Support, Compliance, and Enforcement. (3) This report evaluated the energy code compliance in New York State and proposed recommendations for compliance improvement in other states or countries. See: Improved Code Enforcement: A Powerful Policy Tool Lessons Learned from New York State.	Other countries could review these case studies for ways to increase the compliance rates for their own codes. Countries could also use these documents for ideas on how to assess their code compliance programs.
Providing incentives			
Incentives for energy-efficient buildings	Local or regional governments Building owners Building developers Building industry professionals Utility industry	This Natural Resources Defense Council report summarizes incentives for energy-efficient buildings across India. See: Greener Construction Saves Money: Incentives for Energy Efficient Buildings Across India.	Other countries could learn the potential value of incentives for energy-efficient buildings from this report.

4.4 Compliance Evaluation

After the adoption and implementation of the building energy code, compliance evaluation can demonstrate the effectiveness of code enforcement and, therefore, provide feedback to improve building energy codes and implementation mechanisms. Currently, compliance evaluation gets less attention in many countries than code adoption and implementation. Thus, there is space for improvement in evaluation and a great need for technical assistance.

Table 5 – Resources for Compliance Evaluation

Tool	Stakeholders	Description	Example Application
Evaluating the code impact and benefits			
Code impact in general	National, regional, or local governments Building energy professionals Building industry professionals	This report assessed the prospective impacts of the building energy codes at the national level in the U.S. The assessment methodology and analysis framework can be borrowed by other countries. See: Impacts of Model Building Energy Codes.	Other governments could use this methodology to assess the impacts of their own codes.
Code impact on energy cost	Local or regional governments	This report evaluated the energy cost impact of a variety of code requirement to identify the priority of measures to be improved in the future. Both the outcome and methods can be helpful in other cases. See: Energy Cost Impact of Non-Residential Energy Code Requirements.	Other governments could use this methodology to prioritize measures for development of their own codes.
Understanding compliance evaluation			
Compliance evaluation methods	Local, regional, or national governments Building energy experts Building owners Building developers	(1) This paper examined lessons learned from the U.S. and China on compliance assessment and provide information on options for conducting compliance evaluation. See: Building Energy Efficiency in India: Compliance Evaluation of Energy Conservation Building Code. (2) This paper discussed issues and trend in code enforcement and compliance evaluation methodologies. See: Lessons Learned from Building Energy Code Compliance and Enforcement Evaluation Studies. (3) This website provides numerous documents related to the most current energy code compliance evaluation methods used by DOE. See: https://www.energycodes.gov/compliance/energy-code-field-studies.	Other countries could learn how compliance evaluation has been done and decide which methods might work best for them.
Case studies – outcomes of implementation and pilot projects	Local, regional, or national governments Building energy experts	(1) Here is a report of the India's building energy codes implementation at state-level for Rajasthan by PNNL. See Capturing Energy-Saving Opportunities: Improving	Other countries could review these case studies for specific examples of how to conduct pilot

Tool	Stakeholders	Description	Example Application
	Building industry professionals	Building Efficiency in Rajasthan through Energy Code Implementation. (2) This paper discussed a code evaluation pilot designed to test an integrated, empirically-based methodology to evaluate compliance and energy performance in fully constructed and occupied commercial buildings. See: Measuring What Matters: A Methodology for Moving From Code Compliance to Code Evaluation.	studies related to code evaluation and implementation.

5.0 Conclusions

Building energy codes can have significant impacts on the energy footprint of new buildings. Cities and countries all around the world are expanding their ambition on building energy efficiency and codes. This toolkit aims to provide resources to help with many different stages of the code cycle, including development, adoption, implementation and evaluation. Although each country and city is different, there is a wealth of global experience on codes, that, when compiled and shared, we believe can provide insights to help speed deployment and achieve results. We are also happy to receive feedback on this guide to improve it and understand gaps where better information may have a greater impact.

Appendix A Seminar on Introducing the Code: Agenda Template for Building Energy Code Introduction

[City name] [Code name] [Event] – [Location], [Date]

Time	Topic
30 min	Registration
10 min	Opening remarks – [local government official]
40 min	Code introduction (Codes 101), benefits and best practices in other countries and cities – [building energy expert]
20 min	International experience on energy code implementation and enforcement – [building energy expert]
10 min	Q & A
60 min	Code roadmap • Current status of code in [city name] and need for assistance in the building sector – [local government official] (30 min) • Recommendations to amend building by-laws – [building energy expert] (30 min)
60 min	Panel discussion (moderator: [local government official]) • Incorporating code into local building by-laws • Incentive policies and other government support • Needs for capacity building and plans for third-party assessor system • Pilot building
10 min	Closing remarks – [building energy expert]

Appendix B Implementation Seminar: Agenda Template for Building Energy Code Implementation

[City name] [Code name] [Event] – [Location], [Date]

Time	Topic
30 min	Registration
10 min	Opening remarks – [local government official]
35 min	Best practices in other countries and cities – [building energy expert] • Presentation (30 min) • Q & A (5 min)
25 min	International experience on building code implementation in cities – [building energy expert] • Presentation (20 min) • Q & A (5 min)
60 min	Code implementation guidelines • Current status of Green Buildings in [city name] – [local government official] (30 min) • Recommendations on code implementation guidelines in [city name] – [building energy expert] (30 min)
70 min	Panel discussion (moderator: [local government official]) • Key elements of code implementation guidelines • Necessary institutional set-up for code implementation • Incentive program and other government support • Needs for capacity building • Pilot buildings
10 min	Closing remarks – [building energy expert]

Appendix C Agenda for Seminar on Analysis for Building Energy Code Development in Vietnam

This training seminar on developing a building energy code took place in Hanoi, Vietnam in January 2016. The presentations mentioned below may be helpful for other countries and cities as work on code development and revision. They can all be found at: http://www.globalchange.umd.edu/technology-and-policy/building-energy-codes/bec-seminar-vietnam2016/.

Dates: January 12-13, 2016

Location: Hai Phong Room, Sofitel Plaza 1 Thanh Nien Road, Ba Dinh District, Hanoi, Vietnam
The Pacific Northwest National Laboratory is organizing this training event in conjunction with the Ministry of Construction and the Building Technique Institute.

Focus: The focus of this seminar is to train Vietnamese experts in the analysis needed to revise a code. This includes cost-benefit analysis of new technologies and changing conditions, improving understanding of buildings to better assess measures, using existing and incomplete data, and integrating lessons from code implementation and stakeholder engagement in code modifications. During the meeting, we will also discuss a roadmap on standards to support VBEEC, including for building materials.

Audience: Vietnamese institutes involved in energy code development. Other technical organizations from the private sector and government are also welcome to attend all or part of the training. PNNL expects approximately 20 participants to the training.

Seminar Schedule: Day 1
Morning session
Panel: Code Revision Overview
Moderator: Dr. Nguyen Trung Hoa – BTI
Presentation 1: Setting up a formal energy code development process – (Meredydd Evans, PNNL)
Presentation 2: Assessing the existing code and identifying potential changes (Mark Halverson, PNNL)
Presentation 3: PNNL's recommendations on changes to the VBEEC (Meredydd Evans, PNNL)
Discussion 1: Identifying roles and defining objectives in the code development process – Moderated by MOC
Discussion 2: Recommendations for VBEEC revision

Afternoon session
Panel: Code Revision Analysis
Moderator: Dr. Nguyen Trung Hoa, BTI
Presentation 1: System of building energy-efficient standards and codes in Vietnam (Nguyen Son Lam, IBST)
Presentation 2: Review of cost benefit analysis of code measures (Mark Halverson, PNNL)
Presentation 3: Analysis conducted to develop previous versions of the VBEEC (VACEE)
Presentation 4: Emission calculations and greenhouse gas inventories (Meredydd Evans, PNNL)
Discussion: Collecting the necessary information to do cost-benefit analysis for energy code changes

Seminar Schedule: Day 2
Morning session

Panel: Incorporating implementation lessons
Moderator: Dr. Nguyen Trung Hoa, BTI
Presentation 1: Context and process of code implementation in Vietnam (Nguyen Thu Nhan, IFC Vietnam)
Presentation 2: How to make the code more implementable: clarifying language and thinking about the user (Meredydd Evans, PNNL)
Presentation 3: Overview of U.S. prototype buildings (Mark Halverson, PNNL)
Discussion 1: Implementation and code provisions in the future Vietnamese code
Discussion 2: How to develop prototype buildings in Vietnam
Discussion 3: Options to link implementation and code revisions
Discussion 4: Priorities for VBEEC revisions

Afternoon session
Panel: Roadmap on VBEEC standards
Moderator: Dr. Nguyen Trung Hoa, BTI
Presentation 1: Overview of current standard-setting process (Dr. Luong Duc Long – VIBM)
Presentation 2: Recommended priorities for technical standards and guidelines to support VBEEC (Mark Halverson, PNNL)

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