Southeast Asia Energy Performance Benchmarking for the Building Sector

FINAL REPORT

April 2013 to December 2014

A project under the Energy Efficiency and Clean Development Program

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This document was prepared for the United States Agency for International Development (USAID) by ICF International under the Energy Efficiency Leader with Associate Cooperative Agreement AID-OAA-L-11-00003.

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ACRONYMS

ADB	Asian Development Bank
ASATHI	Indonesian Hotel Engineers Association
ASHRAE	American Society for Heating, Refrigeration, and Air-Conditioning Engineers
BEA	Building Engineers Association (Indonesia)
CFL	Compact fluorescent
CO_2	Carbon dioxide
EEBC	Energy efficiency building code (Vietnam)
EECDP	Energy efficiency and clean development program
EPA	Environmental Protection Agency
EUI	Energy use intensity
GBCI	Green Buildings Council Indonesia
GHG	Greenhouse gas
GJ	Gigajoule
HVAC	Heating, ventilating, and air-conditioning system
ICED	Indonesia Clean Energy Development program
ICF	ICF International
IHRA	Indonesia Hotel and Restaurant Association
kWh	Kilowatt-hours
LEED	Leadership in Energy and Environmental Design
LPG	Liquid petroleum gas
LWA	Leader with Associate Award
m^2	Square meters
MEMR	Ministry of Energy and Mineral Resources (Indonesia)
$MMTCO_2e$	million metric tons of carbon dioxide equivalent
MOC	Ministry of Construction (Vietnam)
$MtCO_2e$	Metric tons of carbon dioxide equivalent
NEDA	National Economic Development Authority
NEECP	National Energy Efficiency Conservation Program (Philippines)
NEP	National energy policy (Philippines)
OA	Opportunity Assessment
O&M	operations and management
PDOE	Philippines Department of Energy
PHILGBC	Philippines Green Buildings Council
RDMA	Regional Development Mission for Asia
UNEP	United Nations Environment Program
US	United States
USAID	US Agency for International Development

EXECUTIVE SUMMARY

According to United Nations Environment Program (UNEP), buildings are responsible for approximately 40 percent of global energy use and up to 30 percent of global greenhouse gas (GHG) emissions.[i] With Asia's surging economies, the region is adding to its built environment at an unprecedented rate. Southeast Asian countries' new construction growth rates are approximately 5 percent annually, compared to 2 percent in Annex I countries. Moreover, over the next ten years, more than half of the world's new construction is expected to take place in Asia.[ii] By working together, the United States (US) and Southeast Asian countries can take advantage of their combined experience, technology, and services to reduce energy use and promote low carbon development. The question is how best to do so.

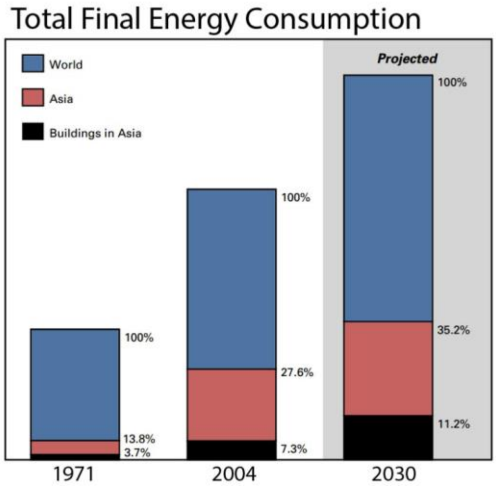


Figure 1 – Total Final Energy Consumption Proposed Projections Under Business-as-usual Scenario [ii]

A building energy performance benchmarking tool is a powerful mechanism for improving the energy performance of an existing stock of buildings. Its strength lies in providing a practical and equitable assessment of building performance in order to identify energy and financial savings opportunities and make the business case for energy efficiency investments. When used across a portfolio, it provides a good indication of which buildings should be targeted for audits or retrofits (due to underperformance). [iii] It is also valuable in measuring progress resulting from improvement projects[ivv] as well as identifying buildings that could achieve green building certification.[vi] Numerous cities in the US[vii] and China[viii] are now using building energy performance benchmarks to provide a snapshot of energy performance and to select buildings for audits and retrofit projects. Asian cities, in particular, indicate that they critically need building energy efficiency benchmarks to "set the bar" for identifying buildings for energy efficiency retrofits, thereby underpinning new policies for building retrofit,[ix] and to set minimum energy performance standards for buildings.[x] However, perhaps most significantly, a benchmarking tool provides a core platform for national and regional building energy efficiency programs, such as the US Environmental Protection Agency (EPA) ENERGY STAR® program. Such programs enable tens of thousands buildings to initiate energy performance improvements, contributing substantially to higher levels of efficiency and reductions in the carbon intensity of buildings. Over the past twenty years, the ENERGY STAR program has contributed to emissions reductions of 784.9 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) from buildings.[xi]

The US Agency for International Development (USAID) Southeast Asia Energy Performance Benchmarking for the Building Sector project, developed under the Energy Efficiency and Clean Development Program (EECDP), aimed to catalyze a regional solution to reducing energy use and carbon emissions. It focused on in the large and continuously expanding stock of commercial buildings in Asia through (1) *development* and (2) *demonstration* of a Southeast Asia regional building energy performance benchmarking methodology and tool, and (3) *engagement* of key regional partners to support replication and continued joint efforts on building energy performance benchmarking across the region.

From April 2013 to December 2014, the USAID EECDP project achieved the following results to cut energy consumption and carbon emissions in buildings in Southeast Asia:

- ***Developed a "proof of concept" hotel sector energy performance benchmarking tool,*** *with the potential to save 533 million kilowatt-hours (kWh) of electricity, avoid 381,214 MtCO*$_2$*e, equivalent to 9.7 million new trees planted, when applied across 1,000 hotels in Indonesia. Replication of the "proof of concept" benchmarking tool for additional sectors (commercial office, retail, and hospital) in four Southeast Asian countries (Indonesia, Philippines, Thailand, and Vietnam) could save 540 million gigajoules of energy and avoid emission of 7.9 MMTOC*$_2$*e, equal to 202 million new trees planted, across Southeast Asia over five years. This is approximately 3 percent less in carbon emissions than the business as usual scenario.* [xii]

- ***Built capacity on energy performance benchmarking among leading organizations responsible for building energy conservation policy in Southeast Asia****, including the Indonesia Ministry of Energy and Mineral Resources (MEMR), Philippines Department of Energy (PDOE), and Ministry of Construction (MOC) in Vietnam*.

- ***Developed and deployed an annual "Energy Benchmarking Survey,"*** *in partnership with Horwath HTL, in Indonesia, Singapore, and Malaysia, and made plans for expansion to Philippines, Vietnam, and Thailand to support sustained Southeast Asia regional work on energy performance benchmarking.*

- ***Partnered with the Bali Hotel Association, the largest hotel association in the world****, to deliver training and technical assistance on hotel benchmarking and energy management.*

- ***Completed a comprehensive suite of hotel energy management technical assistance tools, which can be customized and applied across Southeast Asia to drive energy use and emissions reductions in hotels****, including a chiller financial analysis tool, an automated "energy efficiency opportunity assessment" tool, an energy management checklist, a manual on hotel energy performance improvement, and case studies.*

- ***Trained 90 hotels on energy performance benchmarking and demonstrated annual electricity savings of 2.6 percent for hotels that benchmark using the prototype benchmarking tool****, on par with US Environmental Protection Agency (EPA) ENERGY STAR program data which shows annual energy savings of 2.4 percent for US buildings that benchmark using the ENERGY STAR Portfolio Manager tool.* [xxviii]

This report presents detailed achievements and results of the Southeast Asia Energy Performance Benchmarking for the Buildings Sector project during its one and one-half year implementation period, from April 2013 to December 2014.

The project was implemented by ICF International, Inc. (ICF), in collaboration with the USAID Indonesia Clean Energy Development (ICED) program.

PROJECT OVERVIEW

The **Southeast Asia Energy Performance Benchmarking for the Building Sector** project (hereafter referred to as the *Performance Benchmarking* project) sought to catalyze a regional solution to reducing energy use and carbon emissions in the large and continuously expanding stock of commercial buildings in Asia through:

1. *Development* and *demonstration* of a Southeast Asia regional building energy performance benchmarking methodology and tool; and

2. *Engagement* of partners around the Southeast Asia region to support replication and continued joint efforts on building energy performance benchmarking.

It is estimated that if building energy performance benchmarking tools for hotels, commercial offices, retail, and hospitals were available in Indonesia, Philippines, Vietnam, and Thailand over a five year period, they could facilitate savings of 540 million gigajoules of energy and avoided emissions of 7.9 $MMTOC_2e$, equal to 202 million new trees planted, across Southeast Asia over five years. This is approximately 3 percent less in carbon emissions than the business as usual scenario.[xii]

How a Benchmarking Tool Reduces Energy Use and Carbon Emissions in the Buildings Sector

- Quantifies the energy and financial savings potential to help make the business case for investments in energy efficiency.
- Identifies buildings where technology retrofits may be most cost-effective due to magnitude of energy savings.
- Measures energy and cost savings of building retrofit and operational improvement projects.
- Identifies buildings that could readily achieve Leadership in Energy and Environmental Design (LEED) or other local green building certification.
- Supports establishment of minimum energy performance standards and retrofit policies.
- Identifies buildings for audits and retrofits based on underperformance.
- Establishes a robust database to be analyzed to better understand the key energy performance drivers of buildings.
- Recognizes top performance, mobilizes widespread performance improvement to meet energy and carbon targets.

ACTIVITIES TO ACHIEVE OBJECTIVE

Activities to achieve project objectives included the following:

Component 1: "Proof of Concept" Benchmarking Tool Development

- Identify national pilot partner
- Obtain data required to develop the benchmarking tool
- Conduct analysis to develop the tool
- Build the initial offline benchmarking tool
- Test the tool with buildings:
  - Generate initial benchmark scores
  - Provide operational energy efficiency training to participating buildings
  - Document energy savings in participating buildings
  - Provide recognition of achievement
- Summarize technical results of the tool development process, including energy and CO_2 reductions

Component 2: Regional Engagement

- Identify regional partners
- Engage regional and bilateral USAID missions and programs to support the regional initiative
- Convene regional technical seminars on the fundamentals of the benchmarking tool and its methodology, and ways the rating system can be used as a basis for national and regional policies/programs/initiatives
- Frame next steps: activities, leadership, financing

SUMMARY OF ACHIEVEMENTS

COMPONENT 1, ACTIVITY 1: IDENTIFY NATIONAL PILOT PARTNER

In order to develop a proof of concept benchmarking tool quickly and cost-effectively, which could then be demonstrated in other Southeast Asian countries to catalyze regional activity on building energy performance benchmarking and energy efficiency, the EECDP team identified a single country and building sector, and relevant partners from government, non-government, academia with which to partner. Indonesia was identified as the focus for the prototype tool development due to a confluence of relevant existing USAID programs, including the ICED program, and interest among the USAID mission and ICED program implementation team, which would allow for rapid development. The hotel sector was then selected as an appropriate focus for the following reasons:

- The climate-sensitivity of the tourism sector due to its close connection with the environment and its large impact on global climate change. The tourism industry contributes approximately 5 percent of global CO_2 emissions, and hotels contribute 1 percent of global CO_2 emissions.[xiii]

- The rapid growth of Indonesia's hotel sector, making it an increasingly attractive destination for hotel developers and chains. Since 2006, the Indonesian hotel sector has been at the forefront of growth in Southeast Asia, experiencing annual increases in visitors between 9 percent and 13 percent. Foreign investments in the tourism sector in Indonesia reached US$ 7.3 billion for the first nine months of 2012.[xiv]

- The existence of a number of related initiatives in Indonesia (e.g., Ministry of Tourism and Creative Economy Green Hotel Award) and corresponding institutions (e.g., Green Building Council Indonesia), indicating interest in hotel energy performance benchmarking.

Key achievements related to identification of a national pilot partner included:

Endorsement from the Ministry of Energy and Mineral Resources (MEMR) for Development and Demonstration of an Indonesia Hotel Energy Performance Benchmarking Tool

MEMR directs and administers Indonesia's energy sector at the national level. Its vision is achieving a secure and sustainable energy supply for Indonesia. MEMR's Energy Conservation and Energy Efficiency Department has responsibility and oversight for energy conservation and energy efficiency legislation and programs. MEMR's endorsement is critical to undertake successful energy efficiency projects in Indonesia.

Figure 2 – MEMR Logo

A key milestone for EECDP was, after introductory meetings and workshops in April and June 2013, MEMR indicated its commitment to support and leverage development of an energy performance benchmarking tool for the Indonesia hotel sector, which would catalyze Southeast Asia regional activity on benchmarking and energy efficiency. Specifically, Indonesia MEMR committed to the following:

- Provide national government endorsement for development and demonstration of an Indonesian hotel energy performance benchmarking tool, which would encourage Indonesia hotel sector participation.

- Participate and speak at EECDP training and capacity building workshops on hotel energy performance benchmarking in Indonesia and regionally (as appropriate).

- Receive training from EECDP on voluntary energy efficiency market transformation programs, similar the ENERGY STAR program, that incorporate energy performance benchmarking and building energy efficiency certification

- Assess use of the hotel energy performance benchmarking tool to assist in setting minimum energy performance standards for hotels.

- Allocate funding in its budget to support engagement with EECDP on benchmarking tool development and demonstration in Indonesia.

Commitment from Indonesia Ministry of Tourism and Creative Economy to Integrate Hotel Benchmarking into their Indonesia Green Hotel Award

The Indonesia Ministry of Tourism and Creative Economy is Indonesia's national agency responsible for administration of the tourism sector. Following introductory meetings with the EECDP and ICED teams, the tourism ministry indicated that it would include the hotel energy benchmark score as criteria for *Indonesia's Green Hotel Award*. The Green Hotel Award is a prestigious and competitive award given to hotels in Indonesia that have shown commitment and achievement for environmental and sustainable development issues. The tourism ministry also committed to include funding in its annual budget to support engagement and coordination with EECDP on benchmarking.

Figure 3 – Ministry of Tourism and Creative Economy Logo and Green Hotel Award

Working Group on Building Energy Performance Benchmarking Established

The EECDP and ICED teams also established a working group on hotel energy performance benchmarking tool development and demonstration in Indonesia. The working group consisted of MEMR, Ministry of Tourism and Creative Economy, Indonesia Ministry of Public Works, Indonesia Hotel and Restaurant Association (IHRA), Green Buildings Council Indonesia (GBCI), American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Indonesia Chapter, Building Engineers Association (BEA), and Indonesian Hotel Engineers Association (ASATHI). This working group participated in key aspects of tool development, such as hotel energy performance data collection, organizing and speaking at events and workshops on hotel energy performance benchmarking and energy efficiency, and integrating the benchmarking tool into ongoing policies and initiatives at their organizations.

COMPONENT 1, ACTIVITY 2: OBTAIN DATA REQUIRED TO DEVELOP A BENCHMARKING TOOL

Access to high quality data is a critical factor in the ability for policymakers and other technical institutions to develop accurate building energy performance benchmarking tools. Often, data is not collected through any systematic method, or in some cases, where such collection does occur, data is not made freely available. A key achievement of the *EECDP Performance Benchmarking* project was to develop Indonesia's first publicly available, national hotel energy performance database, including all data points required to develop a national hotel energy performance benchmarking tool.

To develop the comprehensive database, the EECDP team partnered with Horwath HTL, the world's largest hospitality consulting network,[xv] and its local partners – Indonesia's Ministry of Tourism and Creative Economy and IHRA – to design and implement an annual "Energy Benchmarking Survey" for Indonesia. The Energy Benchmarking Survey included questions pertaining to annual energy usage (all fuels), annual energy costs, and hotel attribute data needed for normalizing energy performance. The data points collected are similar to those collected in China and the US for development of building energy performance benchmarking tools.

Figure 4 – Summary of Findings from the 2013 Indonesia Energy Benchmarking Survey Published in the *Horwath HTL 2013 Indonesia Hotel Industry Survey of Operations*

The Energy Benchmarking Survey was implemented by Horwath HTL, the Ministry of Tourism and Creative Economy, and IHRA in 2012 and 2013. The survey ultimately obtained data for approximately 120 to 160 hotels annually (roughly the size of the data set used to develop the first ENERGY STAR benchmarking tool for US hotels). The data covered 3-, 4-, and 5- star hotels in 12 cities across Indonesia, with the majority of hotels in Bali, Jakarta, Yogyakarta, and Sumatera.

In addition to designing and implementing Indonesia's first Energy Benchmarking Survey, and associated database, the EECDP team completed an analysis and report summarizing key energy performance statistics for inclusion in the *Horwath HTL 2013 Indonesia Hotel Industry Survey of Operations*. The summary of findings from the 2013 Energy Benchmark Survey indicated a large spread between best and worst performing hotels in Indonesia – indicating ample opportunity for energy, cost, and carbon emissions reductions through improvements in energy efficiency. It also provided statistics on average and top energy performance for Indonesian hotels and potential energy, cost, and carbon savings available through low-, mid-range, and large capital investments in energy efficiency.

The survey results also showed high levels of commitment to sustainability among nearly all hotels surveyed, with more than 90 percent of hotels indicating they implemented energy efficiency, water efficiency, and energy monitoring measures. These measures were not numerous nor sophisticated. Therefore, despite the hotels' commitment to sustainability and taking action, we observed a lack of technical expertise in most hotels to identify and implement the global best-practice energy efficiency measures that would drive significant energy performance improvement. For example, all six hotels assessed in Indonesia for energy saving opportunities indicated they were implementing three to four simple energy efficiency measures before working with EECDP. Some of the measures included access key cards that automatically turn lights off when a guest leaves the room (standard for Asia); use of timers to regulate use of building equipment; toilet water reduction – to name a few. However, for each of these hotels, an additional 8 to 10 sophisticated energy efficiency/water efficiency measures were identified, with much higher energy-saving potential, such as de-lamping; chiller staging; or use of free cooling and/or pre-cooling. In most cases, hotels were unaware that these energy-saving measures existed and/or lacked the technical capacity to implement the measure correctly (if they were aware of the measure). The primary focus for any hotel is occupant comfort, and many hotel managers and engineers were in need of technical training on how to improve energy efficiency without sacrificing occupant comfort.

COMPONENT 1, ACTIVITY 3: CONDUCT ANALYSIS TO DEVELOP THE BENCHMARKING TOOL

Following the intent of the prototype benchmarking tool to provide a cost-effective, easy-to-use, equitable, and accurate benchmark of comparative energy performance within a national or regional context, the EECDP team adhered to the following key principles, widely accepted in building energy performance benchmarking methodology:

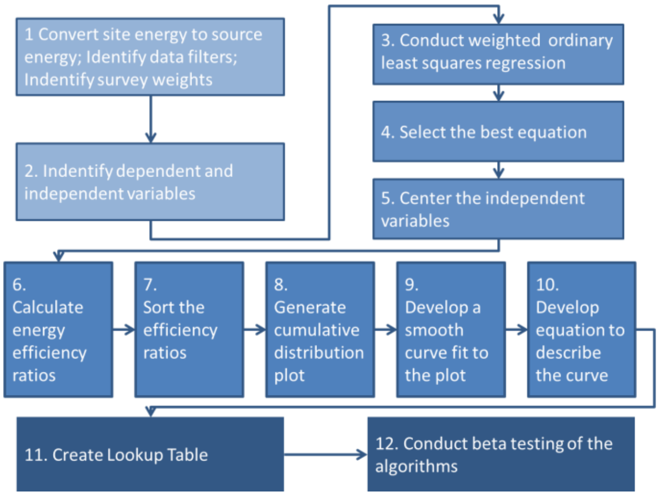


Figure 5 – Steps to Develop a Building Energy Performance Benchmarking Tool

- ***Measured energy performance benchmarking tool****,* which accounts for occupant behavior. The benchmarking methodology used by the EECDP team provides a measured, as opposed to calculated, quantification of energy consumption. Calculated ratings use simulation software to assess the energy performance of a building and are most often applied to new buildings. They can only provide a rough estimate of actual building energy performance. Measured benchmarks assess energy performance based on actual energy consumption (typically utility bills). A measured benchmark is often used to assess existing building energy performance, since it fully accounts for occupant behavior, which can have a significant impact on energy consumption.

- ***Normalization of the most significant drivers of energy consumption***. Within any given commercial building end-use market, annual energy use per square meter can range between 250-400 percent between the 10th and the 90th percentiles. This broad range suggests that beyond building type, there are numerous variables which influence the energy consumption of a building, such as size, climate, occupancy, and operating hours. To provide a fair comparison, a benchmarking methodology must adjust or "normalize" for the key drivers of energy consumption that cannot be controlled by the owner, such as operating hours, occupancy, and climate. However, the benchmarking methodology must *not* adjust for drivers of energy consumption that *can* be controlled by the owner, such as lighting technology and efficiency of the heating, ventilating, and air conditioning (HVAC) system.

- ***Normalization of weather impacts on energy consumption***. Annual energy consumption in buildings can vary up to 30 percent depending on local weather. An equitable and accurate benchmark methodology must remove the impact of weather by determining what the building's energy consumption would be during a "normal" weather year.

- ***Source energy as the energy convention***. Source energy (also called *total* or *primary* energy) represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, thereby enabling a complete assessment of energy efficiency in a building. This is the most equitable approach for comparing properties that use different fuel mixes. When source energy is used to evaluate energy performance, an individual building's performance does not receive either a credit or a penalty for using any particular fuel type. In contrast, use of site energy metric would provide a credit for buildings that purchase energy produced off site by a utility (such as electricity).[xvi]

- ***Relative reference based on a statistical model***. An absolute reference describes energy performance as compared to a single objective number, such as compared to 0 kilowatt-hours per square meter or against a net zero building. A relative reference is based against the performance of peer buildings derived from statistical data analysis (similar to grading on a curve). A relative reference is more easily understood by non-technical audiences and the preferred system for the United Kingdom (UK), US, and Australia. Only select European countries utilize an absolute reference system.

- ***Utilize a statistical model, as opposed to modeling or simulation***. Computer modeling and simulation can yield a refined indication of a building's efficiency, but only against the building itself, or against a design standard. Benchmarking a building against itself provides a baseline indication of the current performance of the building against where it could be, but offers no comparative indicator of performance against other buildings. Further, while codes control for the physical equipment in the building, they cannot describe the as-built operational and maintenance factors which contribute significantly to the energy performance of the building. Finally, modeling and simulation methods are generally too expensive and time consuming to be used across a large portfolio of buildings, further restricting their practical comparative power.

- ***Assess all building energy end-uses,*** including all energy required for heating, cooling, domestic hot water, lighting, mechanical ventilation, plug loads, and process loads. Avoiding elimination of any of these will provide the fairest overall assessment of building energy performance.

In addition to the adhering to the above-mentioned fundamentals associated with the technical methodology for benchmarking, the benchmarking tool has the following features and functions:

- The tool provides a simple 1-100 metric to help communicate that relative performance in a national context. A score of 50 indicates average performance, whereas a score of 75 indicates performance better than 75 percent of the market.

- The tool is as easy as possible to use, while offering the greatest accuracy supported by the available building energy consumption and attribute data. A minimum set of variables, including 12 months of energy consumption data and attribute data (such as climate, weekly operating hours, and occupancy) is all that is required to generate a benchmark score for a building.

- The tool provides additional relevant information related to building energy consumption, such as energy use intensity, energy cost, and carbon dioxide emissions.

The technical methodology applied by the EECDP team to develop the prototype benchmarking tool for Indonesia, followed a 12-step process (see Figure 5, above). The team has used this methodology to develop benchmarking tools for 19 building types for ENERGY STAR, which are currently used by more than 300,000 buildings, and in the development of similar building energy performance benchmarking tools in Canada and China.

1. ***Convert Site Energy to Source Energy for all Data Points; Identify and Apply Data Filters; Identify Appropriate Survey Weights.*** The EECDP team initiated tool development by working with the 2012 Indonesian national hotel energy performance database consisting of 158 hotels obtained through the Horwath HTL Energy Benchmarking Survey. They first converted site energy to source energy for energy consumed by the hotels so as to incorporate all transmission, delivery, and production losses, thereby enabling a complete assessment of energy efficiency of a service system in a building. The team also applied filters to define the peer group for the rating comparison to overcome any technical limitations in the data, including:
   - Program Filters: Basic program filters are applied to define the peer group of evaluation. For example, there may be a minimum threshold for operating hours per week.
   - Data Limitation Filters: Next, one or more filters are applied to the data, as necessary, due to limitations in the way information is reported.
   - Analytical Filter: Finally, once regression analysis begins, additional analytical filters may be required to eliminate outlier data points which have different behavior that cannot be assessed accurately with the rest of the data. For example, analysis may show that small hotels (i.e. smaller than 500 square meters) do not behave the same way as larger hotels, and therefore these buildings will be removed from the data set.

   Program, data, and analytic filters applied to the Indonesia data set are shown below:

Table 1
Filters for prototype benchmarking tool development

Data filters	Rationale	Number Remaining
Must have gross floor area (GFA) data	Exclude data with missing points	128
The GFA data > total square meter of total guest room	Exclude data with missing points	108
Operates more than 300 days per year	Full year operation as a hotel	108
Must have energy use	Exclude data with missing points	96
Have right natural gas unit	Exclude data with missing points	92
Have commercial refrigeration units	Exclude data with missing points	84
Extreme large energy use intensity (EUI)	EUI>20 GJ/M^2. Analytical filters - values determined to be statistical outliers.	82
Extreme Small EUI	EUI<0.1 GJ/M^2. Analytical filters -values determined to be statistical outliers.	76
Identify EUI (Gigajoules/Square Meter, GJ/M^2) 2nd standard	EUI>6.0 GJ/M^2. Analytical filters -values determined to be	75

deviation outlier	statistical outliers.	
Identify Number of Workers (NOW) per 100 square meter 2nd standard deviation outlier	NOW<0.1. Analytical filters - values determined to be statistical outliers.	74

Next, the team identified and applied appropriate survey weights. These were applied to individual observations in the analysis to explain how the survey data represented the hotels in Indonesia. The weights were developed based on hotel star levels, which is one of key factors relevant to energy usage. The weights for each stars level are listed in Table 2.

Table 2 Weights for Hotels	
Applicable Hotels	**Weights**
5 Star Hotel	3.000
4 Star Hotel	9.000
3 Star Hotel	35.154

2. ***Identify dependent and independent variables.*** The dependent variable in the Indonesian hotel analysis is source energy use intensity (EUI). Source EUI is equal to the total source energy use of the hotels divided by the gross floor area. Setting source EUI as the dependent variable, the regression analysis identified the key drivers of source EUI – those factors that explain the largest variation in source EUI in a hotel.

3. ***Conduct weighted ordinary least squares regression to analyze dependent variables, subject to various independent characteristics***. Statistical regression analysis was completed on the reference data set to identify key drivers (independent variables) of energy consumption for hotels. Based on regression analysis for 64 independent variables, the EECDP team identified the following five explanatory variables that can be used to estimate the expected average source EUI (gigajoules per square meter or (GJ/m^2)) in a hotel.
   - STR5: If hotel is a 5 star hotel (dummy variable, see table 3 below)
   - LNNOW: Natural Log of number of workers per 100 square meter
   - OCC* NOGR: Average occupancy rate annually times number of guest rooms per 100 square meter
   - EXPCRU: Exponent of number of number of commercial refrigeration units(total number of commercial walk-in, open and closed) per 100 square meters

Table 3 Dummy variables STR5			
Dummy Variables	5 Star Hotels	4 Star Hotels	3 Star Hotels
STR5	1	0	0

4. ***Select the best equation, which includes the combination of statistically significant operating characteristics that explained the greatest amount of variance in the dependent variable.*** The team evaluated the equations using multiple statistical tests including residual plots, model R2, and individual coefficient significance levels to select the most appropriate equation.

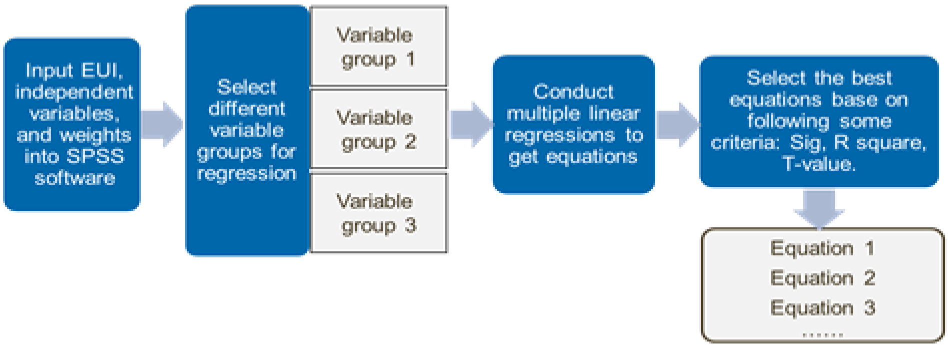


Figure 6 – Equation Selection Process

5. ***Center the independent variables relative to the mean to provide a more straightforward regression interpretation.*** To build a regression, independent variables can be entered in their actual reported form, or the values can be centered relative to the mean. Under both centered and un-centered approaches, the coefficients in the regression equation are *mathematically identical.* Centering provides a more straightforward interpretation. For the prototype tool, the final regression is a weighted ordinary least squares regression across the filtered data set of 74 observations. The dependent variable is source EUI. Each independent variable is centered relative to the mean value, presented in Table 4. The final model is presented in Table 5 and can also be expressed as the equation below.

   Predicted EUI = 1.711+0.653*STR5 + 0.244* C_LNNOW+0.575*C_OCC*NOGR + 0.127*C_EXPCRU

   As shown in Table 5, all model variables are significant at the 80 percent confidence level or better, as shown by the significance levels (a p-level of less than 0.300 indicates 70 percent confidence). The model has an R^2 value of 0.301, indicating that this model explains 30.1 percent of the variance in source EUI for hotel buildings. Because the final model is structured with energy per square meter as the dependent variable, the explanatory power of square meter is not included in the R^2 value, thus this value appears artificially low. Re-computing the R^2 value in units of source energy[xvii] demonstrates that the model actually explains 61.1 percent of the variation of source energy of hotels. This is a good result for a statistically based building energy model.

Table 4
Descriptive Statistics for Variables in Final Regression Model

Variable	Full Name	Mean	Minimum	Maximum
EUI	Source Energy Use per Square Meter	2.1116	0.1026	5.3113
STR5	If the Hotel is a 5 Star hotel (0 for no; 1 for yes)	0.5135	0.0000	1.0000
LNNOW	Natural Log of Number of Worker per 100 m^2	-0.4880	-1.8679	0.7957
OCC*NOGR	Occupancy times Number of Guest Rooms per 100 m^2	0.7446	0.0608	2.7112
EXPCRU	Exponent of number of Commercial Refrigeration Units (including Walk-in, Open, and Closed) per 100 m^2	2.2862	1.0075	8.8944

Notes:
- *Statistics are computed over the filtered data set (n=74 observations).*
- *Values are weighted by the Weight.*
- *The mean values except that of STR5, are used to center variables for the regression.*

Table 5 Final Regression Modeling Results				
Dependent Variable	Source Energy Intensity (GJ/m2)			
Number of Observations in Analysis	74			
Model R^2 value	0.301			
Re-computed Model R^2 value	0.611			
Model F Statistic	7.411			
Model Significance (p-level)	0.000			
	Unstandardized Coefficients	**Standard Error**	**T value**	**Significance (p-level)**
(Constant)	1.711	0.131	13.016	.000
STR5	0.653	0.300	2.180	.033
C_LNNOW	0.244	0.195	2.015	.048
C_OCC*NOGR	0.575	0.286	2.682	.009
C_EXPCRU	0.127	0.047	2.180	.000

Notes:

- *The regression is a weighted ordinary least squares regression.*
- *The prefix C_ on each variable indicates that it is centered. The centered variable is equal to difference between the actual value and the observed mean. The observed mean values are presented in Table 4.*
- *Unlike other variables, the yes/no variables STR 5 and STR4 are not centered. The coefficient adjustment represents the adjustment for Hotels with hotel star levels.*
- *Full variable names and definitions are presented in Table 4.*

6. ***Calculate energy efficiency ratios for each building system.*** The final model (presented in Table 5) yields a prediction of source EUI based on a building's operating constraints. Some buildings in the Horwath Energy Benchmark Survey data sample use more energy than predicted by the regression equation, while others use less. The actual source EUI of each Horwath Survey observation is divided by its predicted source EUI to calculate an energy efficiency ratio:

Energy Efficiency Ratio = Actual Source EUI / Predicted Source EUI

A lower efficiency ratio indicates that a building uses less energy than predicted, and consequently is more efficient. A higher efficiency ratio indicates the opposite.

7. ***Sort the efficiency ratios***. The efficiency ratios are sorted from smallest to largest. The best building systems may have ratios as low as 0.25, indicating that their source EUI is only 25 percent of the predicted source EUI. The worst building systems can use over 3 times as much energy as predicted, corresponding to ratios of 3.0.

8. ***Generate a plot showing the cumulative percent of the population described at each ratio, working from smallest to largest***. When the ratios are sorted from smallest to largest, the cumulative percent of the population at each ratio can be computed using the individual observation weights from the dataset. A plot is generated showing the cumulative percent of the population described at each ratio, working from smallest to largest. Figure 7 presents a plot of this cumulative distribution.

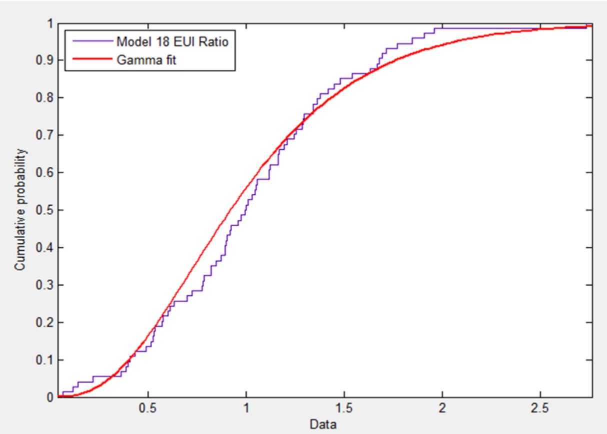


Figure 7 – Plot Showing Cumulative Percent of the Population Described at Each Ratio

9. ***Fit a smooth curve to the cumulative distribution plot. Typically, a gamma distribution is fit to the data.*** A smooth curve (shown in red) is fitted to the data using a two parameter gamma distribution. The fit is performed in order to minimize the sum of squared differences between each building's actual percent rank in the population and each building's percent rank with the gamma solution. The final fit for the gamma curve yielded a shape parameter (alpha) of 3.95606 and a scale parameter (beta) of 0.260935.

10. ***Develop an equation that describes the curve fit to the data. Use the curve's equation to compute the efficiency ratio at each percentile (1 to 100) along the curve.*** Once a smooth curve is fit to the data, it can be described by an equation. The curve's equation is used to calculate the efficiency ratio at each percentile (1 to 100) along the curve. For example, the ratio on the gamma curve at 1 percent corresponds to a rating of 99; only 1 percent of the population has a ratio this small or smaller. The ratio on the gamma curve at the value of 25 percent will correspond to the ratio for a rating of 75; only 25 percent of the population has ratios this small or smaller.

11. ***Use the energy efficiency ratios to create a Lookup Table, which lists the efficiency ratio associated with each percentile (1 to 100).*** The Lookup Table maps each energy efficiency ratio to a cumulative percent in the population. It identifies whether the energy efficiency ratio for a building or building system is larger or smaller than the ratios of its peers, and returns a rating on a scale of 1-to-100 for a building system. A portion of the Lookup Table is presented below. In order to read this table, note that if the ratio is less than 0.2100 the rating for that building should be 100. If the ratio is greater than or equal to 0.2100 and less than 0.2595 the rating for the building should be 99, etc.

Table 6
Lookup Table for Hotel Rating

Rating	Accumulative Present	Energy Efficiency Ratio		Rating	Cumulative Percent	Energy Efficiency Ratio	
		>=	<			>=	<
100	0%	0.0000	0.2100	50	50%	0.9467	0.9591
99	1%	0.2100	0.2596	49	51%	0.9591	0.9717
98	2%	0.2596	0.2954	48	52%	0.9717	0.9843
97	3%	0.2954	0.3246	47	53%	0.9843	0.9971
96	4%	0.3246	0.3499	46	54%	0.9971	1.0101
95	5%	0.3499	0.3725	45	55%	1.0101	1.0231
94	6%	0.3725	0.3932	44	56%	1.0231	1.0364

12. ***Conduct Beta testing of the algorithms. Look for an even distribution of scores (1 to 100) and X-Y plots with random distribution of scores. Revise algorithms as needed.*** The sample plots below show an assessment of score distribution and x-y plots with random distribution of scores.

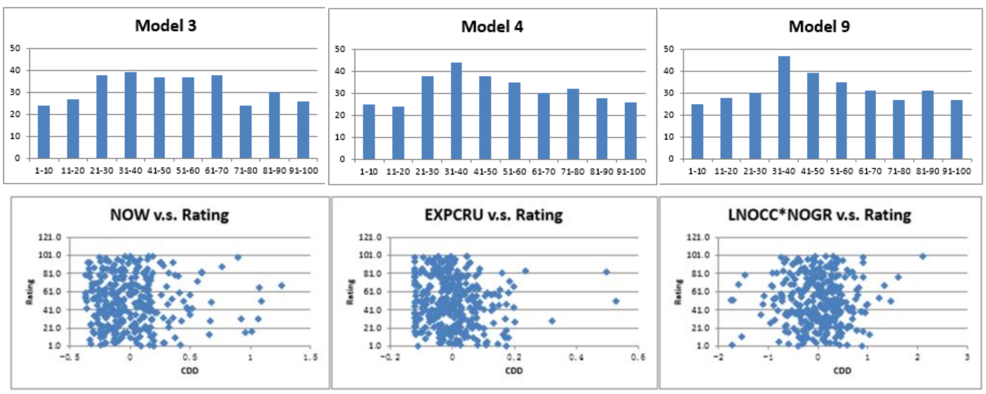


Figure 8 – Score Distribution and X-Y Plots from Beta-test of Benchmarking Tool Algorithms

COMPONENT 1, ACTIVITY 4: DEVELOP AN OFFLINE "PROOF OF CONCEPT" BENCHMARKING TOOL FOR SOUTHEAST ASIA

Developed an Offline Benchmarking Tool for Southeast Asia

Once the hotel benchmarking tool algorithms were completed, following the steps outlined above, the EECDP team developed an Excel-based benchmarking tool which housed the algorithms.

The tool required basic inputs, including:

- 12 months of complete energy use information for all energy types (electricity, natural gas, liquid petroleum gas (LPG), diesel fuel oil, etc.)
- Specific physical building information and activity: city location; year built; star category; gross floor area; number of guest rooms; number of workers on main shift; number of commercial refrigeration units (all); and occupancy rate.

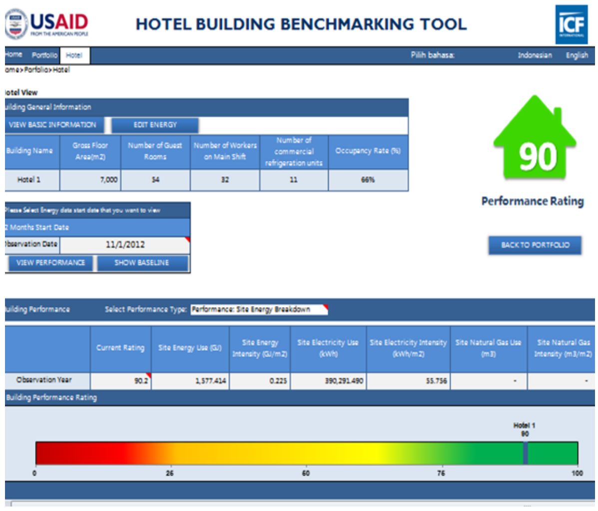


Figure 9 – Indonesia Hotel Benchmarking Tool Interface

Based on these basic inputs, the tool generates a score 1 to 100 indicating the energy performance of the hotel relative to the national stock. A score of 50 indicates average performance, and a score of 75 indicates performance better than 75 percent of the market.

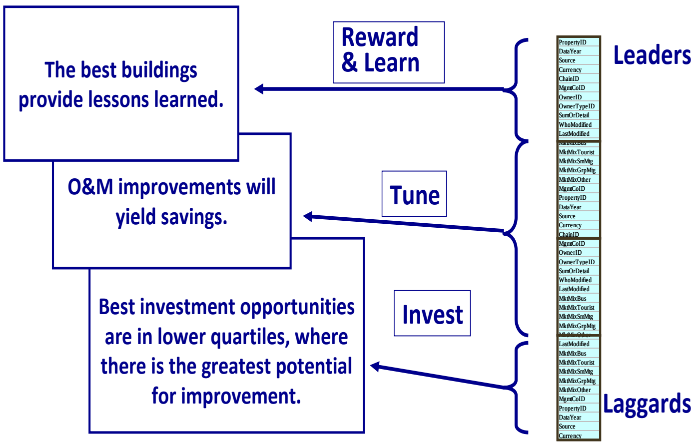


Figure 10 – Benchmarking Score Distribution Helps Identify Appropriate Measures for Building Energy Performance Improvement

Research shows that an operational benchmark's strength is in providing a practical and equitable assessment of building performance in order to identify energy and financial savings opportunities and make the business case for energy efficiency investments. When used across a portfolio, it provides a good indication of which buildings should be targeted for audits or retrofits (due to underperformance).[xviii] It is also valuable in measuring progress from improvement projects[xixxx], as well as identifying buildings that could achieve green building certification (such as US Green Building Council's LEED certification or local certifications).[xxi] Numerous cities in the US (such as New York City,[xxii] San Francisco, Washington, DC, and San Francisco) and in Asia (Shanghai,[xxiii] Beijing, Ningbo[xxiv]) are using (or evaluating the use of) operational benchmarks to provide a snapshot of energy performance and to select buildings for audits and retrofit projects in city buildings. Asian cities, in particular, indicate that they critically need building energy efficiency benchmarks to "set the bar" for identifying buildings for energy efficiency retrofits, thereby underpinning new policies for building retrofit,[xxv] and to set minimum energy performance standards for buildings.[xxvi]

COMPONENT 1, ACTIVITY 5: DEMONSTRATE THE "PROOF OF CONCEPT" BENCHMARKING TOOL IN THE MARKETPLACE

Since 2005, ICF has worked with approximately 10,000 commercial buildings across Asia to reduce energy consumption and carbon emissions for a variety of government-led programs. ICF monitoring and verification (M&V) data for 124.3 million square meters of floor space, and case studies for more than a dozen buildings and portfolios, show that hotels and offices can save an average of 10 percent in energy consumption annually through benchmarking and no-/low-cost operational improvements and low-cost technology retrofits. The US EPA ENERGY STAR program also estimates 10 percent annual energy consumption reduction through operational improvements.[xxvii]

Based on this prior experience, the USAID EECDP team engaged the Indonesian hotel sector to demonstrate the viability of a hotel benchmarking tool, coupled with simple, no-/low-cost operational energy saving measures, to drive energy consumption and carbon emissions reductions. The USAID EECDP and ICED teams worked jointly to design and implement an "Indonesia Hotel Energy Benchmarking and Strategic Energy Management Pilot Program."

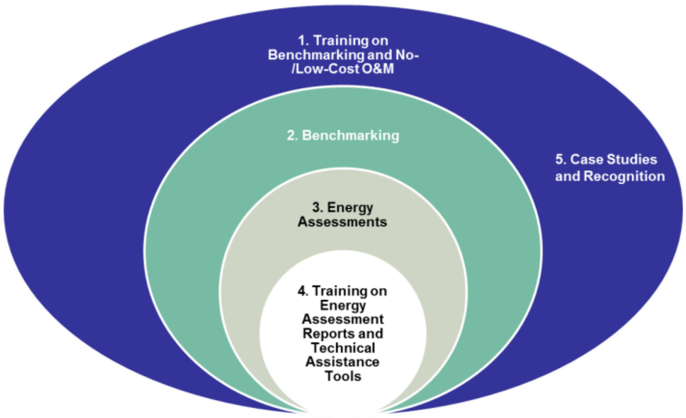


Figure 11 – Indonesia Hotel Energy Benchmarking and Strategic Energy Management Pilot Program Activities

Pilot activities consisted of the following:

- Training on energy benchmarking and no-/low-cost energy management best practices that can save up to 10 percent annually in hotel operating costs.
- Benchmark assessment of energy performance compared to other hotels in the Indonesia market to identify best practices and investment opportunities.
- Site assessments for six pilot hotels to identify specific no-/low-cost operations and management (O&M) measures to improve hotel energy performance, and detailed guidance on how to implement energy-saving measures.
- Training and receipt of a suite of technical assistance tools, including case studies, hotel energy management checklists, retrofit calculators, etc.
- Recognition for participating and high-achieving hotels through an event or case studies.

Based on the EECDP team's estimates, through improved energy efficiency at 1,000 hotels in Indonesia, annual energy, cost, and carbon savings could equate to the following:

- Total annual energy savings: 533,166,666 kilowatt hours (kWh)[xxviii]
- Total annual energy cost savings: US$ 38,867,850
- Total annual CO_2 emissions reductions: 381,214 $MtCO_2e$
- Equivalent incandescent lamps switched to compact fluorescent lamps (CFLs): 9,971,593[xxix]

The following section details specific milestones and accomplishments in the "Indonesia Hotel Energy Benchmarking and Strategic Energy Management Pilot Program."

Step 1. Development of Suite of Technical Assistance Tools

While a building benchmarking tool is an effective tool to evaluate actual metered energy use, indicating the level of energy performance, and comparing buildings to a national population, it cannot, by itself, explain why a building is performing well or poorly and how to improve energy performance. To address this gap, the EECDP team developed and provided pilot participants with a suite of training modules and technical resources to assist hoteliers in improving their hotel energy performance after benchmarking to be used during the pilot program.

These tools included:

- *"Hotel Strategic Energy Management No-/Low-Cost Approaches to Improve Energy Performance" training module* which provides stepwise guidance for implementing more than 30 no-/low-cost operational and technical measures to improve performance of lighting, heating ventilating and air conditioning (HVAC) equipment, etc.

- *Excel-based Opportunity Assessment Tool,* which generates a report with recommended no-cost and low-cost operational measures to improve a building's energy performance. The report is based on responses to a series of questions about the building's current conditions.

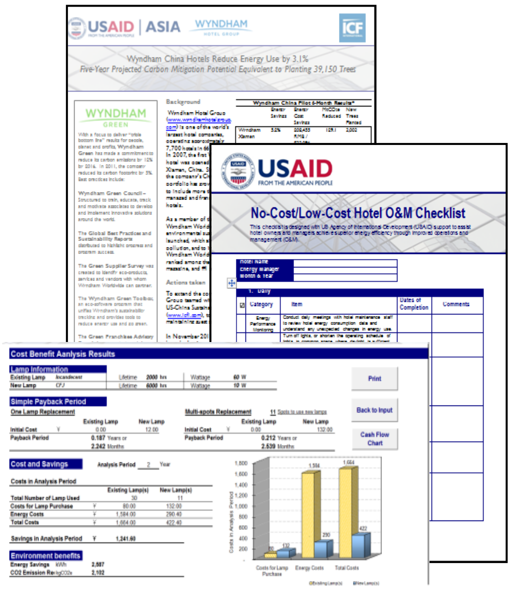


Figure 12 – Technical Assistance Tools (front to back), Chiller Retrofit Financial Analysis Tool, O&M Checklist, and Case Study

- *Hotel Energy Management Checklist*, which assists hotel managers and engineers to implement monthly, weekly, and daily energy performance improvement measures at hotels.

- *Case Studies,* which describe successful implementation of O&M measures at hotels and resulting energy, financial, and carbon reductions.

- *Technology Snapshots,* which briefly describe technologies to improve hotel energy performance. They include environmental and financial benefits, such as typical payback and return on investment from use of the technology.

- *Chiller Retrofit Financial Analysis Tool,* which is an Excel-based tool that provides lifecycle cost comparison; cash flow analysis; and GHG emission comparisons for replacing existing chillers and lighting technology with more efficient options.

- *Lighting Cost-Benefit Analysis Tool*, which provided detailed information on the costs and benefits of replacing existing building lighting with more efficient lighting to support end-use energy efficiency among building portfolios.

To maximize the utilization of these tools and resources, the ICED team also produced an *Indonesia Hotel Energy Management Manual.* The manual includes guidance for improving the energy performance of the Indonesian hotel sector through use of a benchmarking tool to calculate energy performance before and after operational and technical upgrades; no-/low-cost energy management strategies; case studies; and access to new tools developed by EECDP and ICED, such as the chiller retrofit calculator, the Opportunity Assessment tool, and the hotel energy management checklist.

Step 2. Hotel Recruitment

In September 2013, the EECDP and ICED teams conducted recruiting workshops in three cities – Denpasar, Jakarta, and Yogyakarta. Following the workshops, 75 percent of hotels (90 hotels) signed up to participate in the "Indonesia Hotel Energy Benchmarking and Strategic Energy Management Pilot Program." An important milestone and indication of the program's appeal was commitment from 26 hotels in the Bali Hotel Association, which is the largest hotel association in the world, to participate in the pilot program.

Figure 13 – USAID EECDP and ICED Teams with representatives of the Bali Hotel Association Board and MEMR at the Denpasar Workshop

Step 3. Energy Efficiency Opportunity Assessments at Six Pilot Hotels

Prior to carrying out training on no-/low-cost energy efficiency improvements in Indonesian hotels, the EECDP and ICED teams conducted six pilot energy efficiency "Opportunity Assessments" at Indonesian hotels. The purpose of these assessments was to first, identify the most relevant no-/low-cost energy saving measures for Indonesian hotels. The measures identified would form the basis of the upcoming training workshop for the 90 hotels participating in the "Indonesia Hotel Energy Benchmarking and Strategic Energy Management Pilot Program." Second, the assessment provided six motivated hotels in Indonesia with opportunities to gain in-depth, tailored, technical assistance on how to improve the energy performance of their hotel. Finally, local engineers from ASHRAE Indonesia would participate in the site visits, receiving training to allow them to conduct an additional 24 energy efficiency assessments for hotels under the ICED program.

The Opportunity Assessment was not intended to comprehensively address all opportunities to improve energy performance at visited sites, but to identify the simple no-cost and low-cost measures that could implement immediately to help improve energy performance prior to making any large capital investments.

The Opportunity Assessments consisted of the following:

- An interview with hotel management staff to understand the building's energy and sustainability management practices, goals, and challenges.
- An interview with hotel engineering staff to understand the building's current operations and maintenance (O&M) practices.
- A half-day visit to the hotel to gain familiarity with the hotel's building equipment, layout, and access.
- An analysis of information gathered during the tour and interviews.
- A final report, summarizing observations and providing no-cost and low-cost recommendations with sufficient detail for engineering and management staff to improve the operational performance of the hotel – thereby reducing energy usage, costs, and carbon emissions.

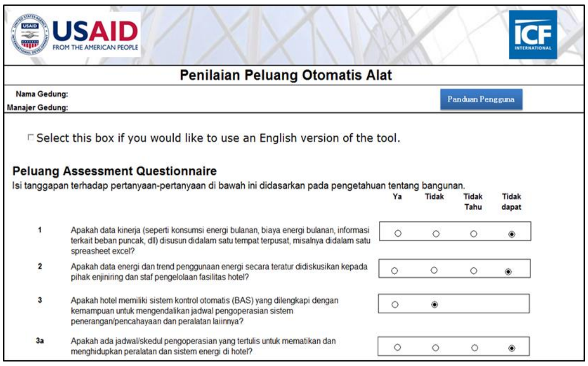


Figure 14 – Automated "Opportunity Assessment" Tool in Bahasa Indonesian

Since not all hotels in the pilot program could participate in the assessments, an Excel-based *Opportunity Assessment Tool* was developed by EECDP. This tool includes a short questionnaire to be completed by hotel operators, allowing them to identify the most appropriate no-/low-cost O&M measures to improve hotel energy and carbon performance.

The EECDP and ICED teams made the following observations associated with the Indonesia site assessments:

- The level of attention to energy efficiency is very impressive – hotels carry much larger engineering/O&M staff than the hotels we've seen in North America.
- Staff essentially acts as the automation system, following sequence of operations and checklists to ensure everything gets done.
- Hotels, particularly those over 15 years old, are operating original inefficient chillers and boilers, the two main energy consuming equipment. Retrofits of these systems represent significant savings opportunities given current technology.

Step 4. Training and Capacity Building

In November 2013, the EECDP and ICED teams jointly trained management and engineering staff for 90 hotels from three cities – Denpasar, Jakarta, and Yogyakarta. The teams provided a full-day of training, including interactive sessions, on building energy performance benchmarking and strategic energy management for hotels.


Figure 15 – A Training Participant in Yogyakarta Inputting his Hotel's Energy Consumption Data into the Benchmarking Tool

Curriculum 1: "Introduction to the Indonesia Hotel Benchmarking Tool"

1. Background and context
2. What is building energy performance benchmarking, and why is it important?
3. Different approaches to building energy benchmarking globally
4. Overview of Indonesia's prototype energy benchmark
5. How does the benchmarking tool generate at "score?"
6. What does my score mean?

The introductory training presented the rationale for building energy performance benchmarking and how the benchmarking tool works to evaluate a building's energy performance. Training participants then received the Excel-based version of the prototype benchmarking tool and were trained step-by-step on how to enter their hotel's energy and attribute data into the benchmarking tool to generate an energy performance rating (or score). The participants had prepared their hotel energy and attribute data in advance of the workshop so that each individual participant could enter their actual energy performance data into the tool on their laptop and generate an energy performance benchmark score for their hotel during the training session. During the training, the EECDP and ICED teams collected all hotel energy and attribute data and benchmark score information that participants were willing to share.

Curriculum II: "Hotel Strategic Energy Management No-Cost and Low-Cost Approaches to Improve Energy Performance"

In the afternoon, the EECDP and ICED teams provided training on no-/low-cost strategies to improve hotel energy performance, drawing on the results of the Indonesia hotel Opportunity Assessments, ENERGY STAR's guidelines for strategic energy management, and ICF's extensive experience working with hundreds of hotels across Asia to reduce energy use and carbon emissions through no-/low-cost operational techniques. The training covered the following topics:

1. Overview of the hotel strategic energy management pilot program
2. Challenges and opportunities for hotel energy efficiency
3. Opportunities identified in Indonesia "demo" energy assessment hotels
4. Guidelines for energy management
5. Recommended no-cost and low-cost efficiency measures
6. Tools and resources
7. Case studies-O&M strategies in practice
8. Next steps

Figure 16 – Guidelines for Energy Management from ENERGY STAR

The specific O&M strategies trained included 30 measures associated with data management, energy performance benchmarking, equipment use optimization, lighting, appliances, indoor and outdoor air, HVAC maintenance, and general management strategies.

The feedback received from training participants was positive.

Hotel Strategic Energy Management Pilot Program Trainee Feedback

"Thank you very much for the training, it is really great innovation to have benchmarking tool to supporting us for energy control. I am waiting for the next invitation for the new innovation."
- Ketut Nesa Maha Yasa, Chief Engineer, Alila Jakarta

"I thank you, too, for the good training and for the useful sharing of knowledge. It has inspired us to keep the passion for inventing the strategic way in Energy Management Program."
- Didik Maryanto, Chief Engineer, Novotel Jakarta

Step 5. Preliminary Results

To-date, hotels participating in the pilot program that have reported data, have **saved 10 percent in electricity usage**, in aggregate, from November 2013 to September 2014, as compared to the same period in the previous year. The average electricity savings for these hotels is approximately 2.6 percent, which is on par with the average of 2.4 percent annual energy savings achieved by US hotels which benchmark their energy performance using the ENERGY STAR Portfolio Manager tool.[xxx] The results indicate that benchmarking is an effective method for reducing electricity use in hotels in Southeast Asia. Furthermore, benchmarking encourages buildings to pursue deeper energy savings. At least one hotel in the pilot program invested in a more detailed audit after the benchmarking training workshop. ICED worked with Synergy Carbon to conduct the audit under a grant project on energy efficiency. The hotel covered 30% of the cost share and a lighting replacement was undertaken following the audit.

Activities to Achieve Results

Out of the hotels that volunteered information on what energy-saving measures they implemented during the Indonesia pilot program,* observations indicate that the most popular measures (those implemented by at least three-quarters of hotels volunteering data) relate to operations and management practices, and not technology (only lighting replacement was technology-focused). Given the aggregate energy savings of hotels participating in the pilot program, these findings suggest that **management commitment, energy data tracking, and operations and management** are most critical to success. Technology alone will not drive energy savings.

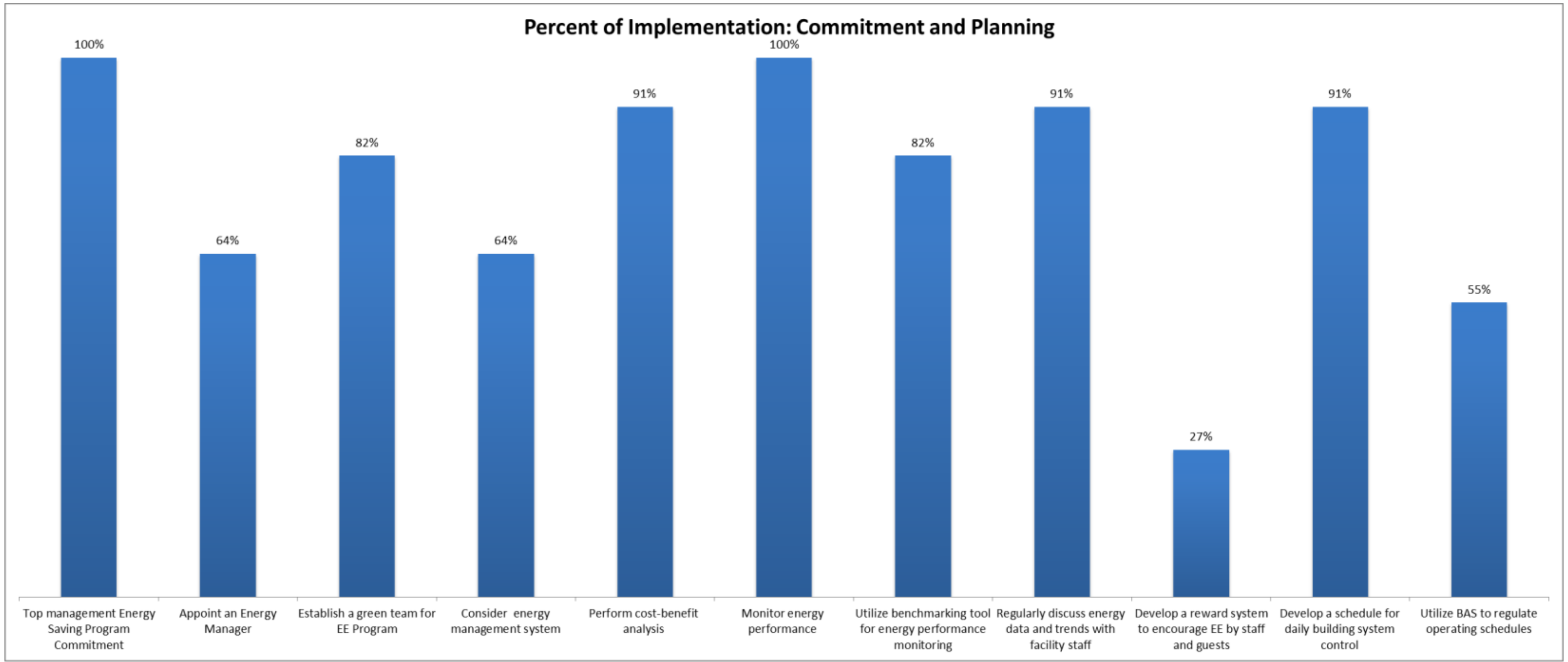
The “Top 16” energy saving measures for pilot hotels include:

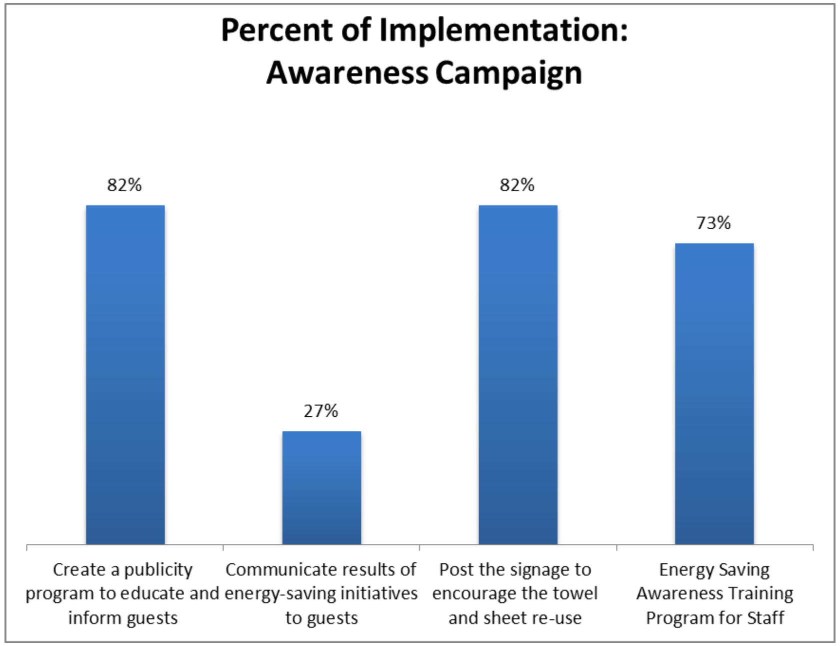
1. Top management energy savings commitment
2. Monitor energy performance
3. Routine cleaning and inspecting of air dampers
4. Perform cost benefit analysis
5. Establish a green team
6. Utilize a benchmarking tool to monitor energy performance
7. Regularly discuss energy data with staff
8. Develop a daily schedule for operation and control of building systems
9. Create a publicity program to educate and inform guests
10. Post signage to encourage towel and sheet re-use
11. Lighting replacement
12. Use a thermostat to control the domestic hot water pumps
13. Manually shift off both the kitchen air handling unit and all hood exhaust fans
14. Routine cleaning and inspecting of HVAC coils and filters
15. Establishing a cooling tower maintenance plan
16. Employing housekeeping staff to reset all air-conditioning to a certain degree

** Approximately 12% of pilot program hotels provided detailed information on what energy saving measures they implemented during the pilot program. Unfortunately, while the EECDP and ICED survey requested information on the exact start date of implementing the energy-saving measure, only 1 hotel provided start-date information. The remainder of hotels left this information blank and only indicated whether they were implementing the energy-saving measure after the training event. Thus, we can only confirm that hotels were implementing these measures after the training – but we cannot confirm whether or not this was a change in behavior that specifically resulted from the training event (or simply a continuation of an existing energy saving measure). In the future, the data collection form will be designed such that it will be easier for hotels to indicate the timeframe in which they implemented an energy-saving measure.*

Detailed results regarding energy-saving measures implemented by Indonesian hotels are as follows:

- **Commitment and Planning**
  In the area of commitment and planning, all hotels indicated a commitment to top energy performance management in their hotels and monitoring of energy performance. More than 90% regularly discuss energy performance data and trends with facility management staff and have a schedule for daily building system control. More than 80% of hotels also indicate having establishing a green team for energy efficiency program implementation and utilization of the new Indonesia hotel benchmarking tool to manage energy performance. Nearly two-thirds of hotels have appointed an Energy Manager and have considered an energy management system. Only about one-half of hotels, however, utilized a building automation system (BAS) to regulate equipment operating schedules (which is not surprising for Asia, since labor is a cost-effective alternative to automation). Less than 30% of hotels have a reward system in place to incentivize staff to improve energy efficiency.



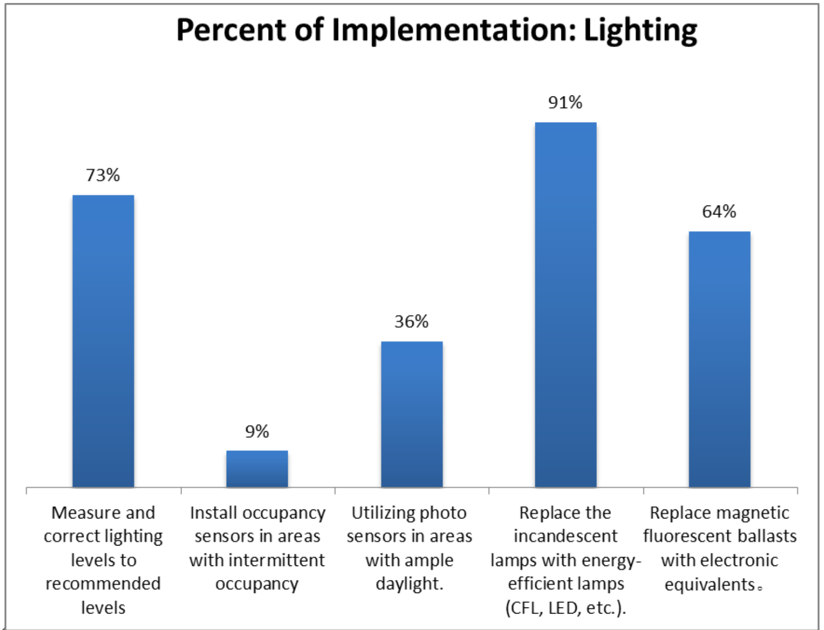


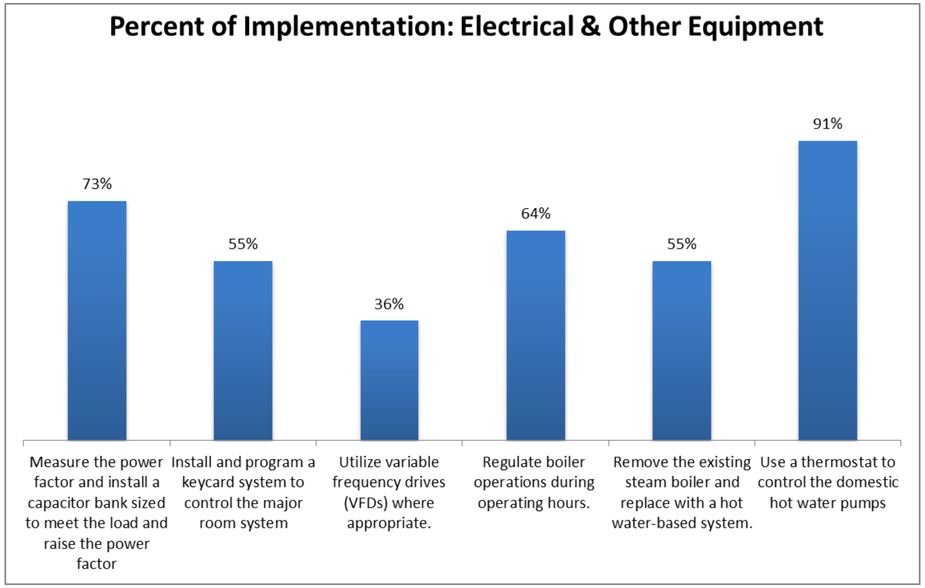
- **Awareness Campaign**

In the area of awareness promotion, more than 80% of hotels have created a public program to educate guests and have posted signage to encourage towel and sheet re-use by guests (fairly common in the hospitality industry). Further, nearly three-quarters train staff on energy saving. However, only approximately one-quarter communicate energy saving initiatives to guests.

- **Lighting**

  In the area of lighting, more than 90% of hotels reported having replaced incandescent lamps with energy-efficient lamps. Over two-thirds measure and correct lighting levels and replace magnetic fluorescent ballasts with electronic equivalents. Less than half utilize photo sensors or occupancy sensors.



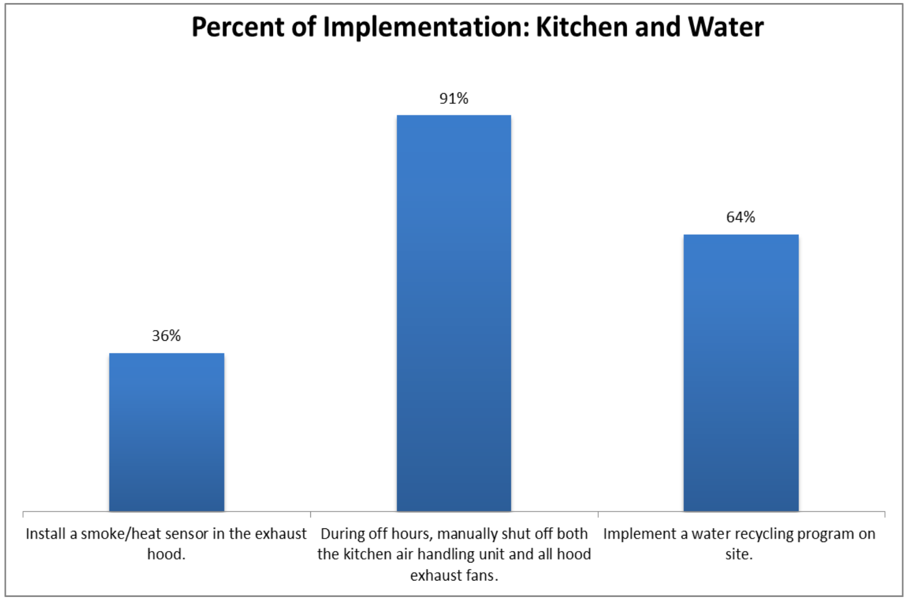


- **Electrical & Other Equipment**

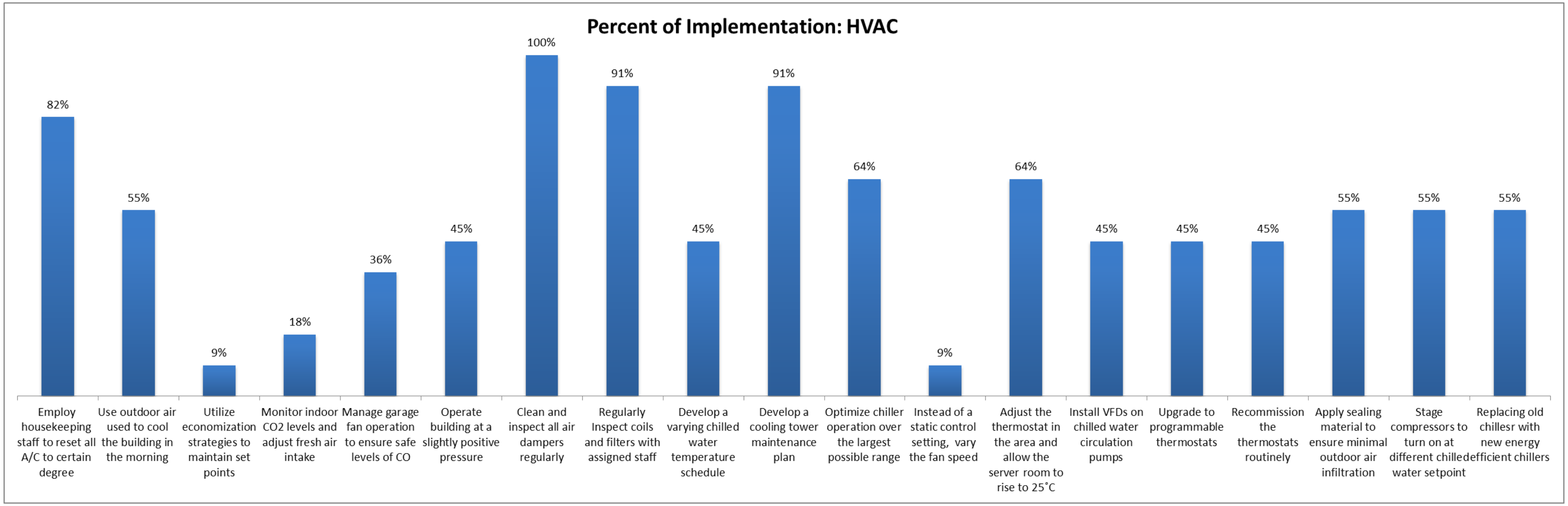
In the area of electrical and other equipment, more than 90% apply thermostats to control domestic hot water pumps. More than two-thirds measure the power factor and have installed a capacitor bank to meet the load and raise the power factor and regulate boiler operation during operating hours. Over half install and program keycard systems to control major room systems and have replaced their existing steam boiler with a hot water based system. Only approximately one-third utilize variable frequency drives where appropriate.

- **Kitchen and Water**

  In the area of kitchen and water, more than 90% of hotels manually shit off both the kitchen air handling unit and all hood exhaust fans. Nearly two-thirds implement a water recycling program on-site. Over one-third have installed a smoke/heat sensor in the exhaust hoods in kitchens.



- **HVAC**
In the area of HVAC, the energy-saving measures most commonly implemented (>90%) were: cleaning and inspecting of air dampers; inspecting and cleaning coils and filters of dust and debris; establishing a cooling tower maintenance plan. Other frequently-implemented measures were employing housekeeping staff to reset all air-conditioning to a certain degree and optimizing chiller operation and adjusting the thermostats in server rooms to allow higher set point temperatures. Energy-saving measures infrequently implemented include varying fan speed; utilizing economization; and monitoring carbon dioxide levels and adjusting fresh air intake.



Step 6. Public Recognition

The final step of the "Indonesia Hotel Energy Benchmarking and Strategic Energy Management Pilot Program" was to host an event at which to provide recognition to all hotels that participated in the pilot program and to recognize the single hotel that demonstrated the greatest commitment to energy performance excellence throughout the pilot program. The following criteria were developed on which to select the best performing hotel:

Table 7 – Strategic Energy Management Pilot Program Assessment Criteria

Criteria	Evaluation Form/Verification Document	Score	Weighted Score
Policy/Commitment	Policy documents or pictures of any particular energy efficiency events (dissemination of management commitment in energy savings)	No policy: 0 Policy without proper dissemination: 1 Policy with proper dissemination: 3	**30%**
Energy Team/Green Team	Establishment of energy team or energy manager in the hotel	No energy manager: 1 Energy manager assigned: 3	**15%**
Program			**25%**
Participation Level in EECDP & ICED Program	Based on list of attendance (3 of workshops + 2 focus group discussions), held by ICED & EECDP	1 workshop: 1 2 workshop: 2 3 workshop: 3 Pro-active during the discussion: additional 1 point added	**5%**
Total no-cost activities for energy efficiency	Derived from evaluation form/questionnaire	To be adjusted based on all completed forms	**5%**
Total Activities with Investment for Energy Efficiency	Derived from evaluation form/questionnaire	To be adjusted based on all completed forms	**5%**
Total Capacity Building Activities/Training for Staff in Energy Efficiency Topics	Derived from evaluation form/questionnaire	To be adjusted based on all completed forms.	**5%**
Hotel's Initiatives - Programs Before ICED & EECDP Engagement	1. Derived from evaluation form/questionnaire 2. Best practice in the energy audit reports	Early initiative: 3 No initiative before ICED and EECDP programs: 2	**5%**
Impact			**25%**
Energy Savings	Monthly energy consumption data in 2014	1-3% energy use reduction: 2 3-5% energy use reduction: 4 5-7% energy use reduction: 6 >7% energy use reduction: 8	**7%**

Energy Use Intensity (EUI) score	Monthly energy consumption data in 2014 – to be compared with the previous EUI score and compared across other hotels	EUI reduction: 3 Constant EUI: 2 EUI increase: 1	**6%**
Benchmark Score	Monthly energy consumption data in 2014 – to be compared with the previous benchmark score of the respective hotels	Score reduction: 3 Constant score: 2 Increase score: 1	**6%**
Economic Impacts	Derived from evaluation form/questionnaire (investment, payback period and savings data) - if any		**6%**
Specific (unique) Programs	Derived from evaluation form/questionnaire - if any		**5%**
Total			**100%**

While a public recognition event was originally planned for the final quarter of 2014, the EECDP and ICED teams made the strategic decision to postpone the public recognition event due to the political situation in Indonesia in October 2014 – the installment of Indonesia's new government, led by President Widodo. According to discussions with ICED, the change in political leadership meant that numerous high-ranking government officials would change and that there was too much risk associated with involving a new government officer, who was not familiar with the program, in the final recognition event. The ICED team will conduct a smaller event to recognize pilot program hotels in January 2015. Due to the timing of the EECDP program closeout (December 2014), the EECDP team will not participate in the event. However, its analysis of hotels' energy savings will be taken into account by ICED in selecting the recipients for awards associated with the pilot program. Outcomes from the event will be shared with EECDP and the USAID Indonesia mission but, due to timing, are not contained in this report.

COMPONENT 2, ACTIVITY 1: ENGAGE REGIONAL PARTNERS

Simultaneous to developing and demonstrating a proof of concept benchmarking tool and methodology for the Southeast Asia region, the EECDP team identified and initiated outreach to prospective partners across the region with potential interest in replication and future collaboration on benchmarking. Targeted outreach focused on regional organizations, including the Horwath HTL, the Asian Development Bank (ADB), and organizations in two target countries (beyond Indonesia): Vietnam and Philippines.

Meetings with Horwath HTL were held in April 2013 in which Horwath HTL indicated their strong interest in working with the EECDP team to expand their Energy Benchmarking Survey, which is now implemented in China, Indonesia, Singapore, and Malaysia (as a result of engagement with USAID) to additional countries in Southeast Asia, including Vietnam, Philippines, and Thailand.

Meetings with ADB were held in May 2013 to identify synergies between the EECDP *Performance Benchmarking* project and ADB's ongoing work in the buildings sector, as well as options for ADB to leverage a Southeast Asia regional benchmarking tool. ADB also participated in the January 2014 EECDP Energy Performance Benchmarking workshop in Manila, Philippines and supported involvement of Philippines in the EECDP *Performance Benchmarking* project.

Additional key regional partners were engaged and subsequently indicated a need for building energy performance benchmarking tools in their countries and/or a strong desire to participate in the Southeast Asia EECDP *Performance Benchmarking* project. These included:

Table 8 – Regional Engagement		
Country	**Regional Key Partner**	**Additional Stakeholders**
Vietnam	**Ministry of Construction (MOC)** – the national agency responsible for issuing the Vietnamese Construction Standard on Energy Efficiency Building Code (EEBC). The MOC hosted the April 2013 Vietnam Green Buildings Workshop and endorsed the EECDP's work on building energy performance benchmarking.	**Vietnam Green Buildings Council** – a national, non-profit organization that manages the green building certification, LOTUS. LOTUS is based on various international green building standards but relates to Vietnam's local codes. The Vietnam Green Buildings Council participated in the April 2013 Vietnam Green Buildings Workshop and indicated that Vietnam "needed training and technical support on benchmarking and practical, no-/low-cost building energy efficiency techniques" to support their green and energy-efficient building efforts. **Vietnam Association of Architecture** – a national organization which researches and assesses green buildings. They also participated in the April 2013 Vietnam Green Buildings Workshop.
Philippines	**Philippines Department of Energy (PDOE)** – the lead agency in the country for building energy policy. It wrote the National Energy Policy (NEP) and runs the National Energy Efficiency Conservation Program (NEECP). PDOE indicated a strong interest to participate in the EECDP *Performance Benchmarking* project and to develop a building energy performance benchmarking tool.	**Philippines Green Buildings Council (PHILGBC)** – a national, non-profit organization that promotes green building practices in the market to ensure a sustainable environment. They have indicated a strong willingness and readiness to support development of a building energy performance benchmarking tool in coordination with PDOE.

COMPONENT 2, ACTIVITY 2: ENGAGE BILATERAL AND REGIONAL USAID MISSIONS

In addition to engaging potential government, non-government, industry, and academic organizations on benchmarking across the Southeast Asia region, the EECDP team engaged bilateral and regional USAID missions to discuss opportunities to leverage the EECDP project and expand work on building energy performance benchmarking. This included:

- In April 2013, discussions with the USAID Regional Development Mission in Asia (RDMA), based in Bangkok, Thailand. At this meeting, the EECDP team gained strong endorsement for the project from USAID RDMA and assistance with coordination with Southeast Asia USAID bilateral missions to set up technical workshops on benchmarking and discuss options for mission buy-in through the EECDP Leader with Associate Award (LWA) mechanism.

- In April 2013, meetings with USAID Vietnam on objectives and options for involvement by USAID Vietnam in the Southeast Asia Energy Performance Benchmarking project through the LWA mechanism. USAID Vietnam indicated that Vietnam needs a building energy performance benchmarking tool and practical support on low-cost, operational building energy performance improvement strategies.

- In December 2013, meetings with USAID Indonesia on options for extending the Southeast Asia Energy Performance Benchmarking project in Indonesia through the LWA mechanism.

- In December 2013 and January 2014, meetings with USAID Philippines on objectives and options for involvement by USAID Philippines in the Southeast Asia Energy Performance Benchmarking project through the LWA mechanism.

COMPONENT 2, ACTIVITY 3: CONVENE TECHNICAL SEMINARS ACROSS THE REGION ON BENCHMARKING

Vietnam Ministry of Construction Green Building Workshop

In April 2013, the USAID EECDP team presented to key stakeholders in Vietnam, including the Vietnam MOC, Vietnam Green Buildings Council, Vietnam Association of Architects, and the Vietnam USAID mission on "US Green and Energy- Efficient Building Policies," including their basic structure, tools that contribute to success, such as the ENERGY STAR Portfolio Manager benchmarking tool, and lessons learned. Following the presentation, USAID Vietnam and the Vietnam Green Buildings Council indicated that they "needed training and technical support on benchmarking and the practical, no-/low-cost building energy efficiency techniques," that ICF presented, to support their green and energy-efficient building efforts.

Philippines Green Buildings Workshop

In January 2014, a technical workshop to introduce the concept of building energy performance benchmarking was held in Manila, Philippines. The workshop was attended by 40 key stakeholders, including PDOE Undersecretary Ayson, the PDOE Director of the National Energy Efficiency Conservation Program, Jess Anunciacion, and the President of the PHILGBC, Chris de la Cruz. Other participating organizations included Philippines National Economic Development Authority (NEDA), USAID Philippines, ICLEI, ADB and others. As a result of the January 2014 workshop, all of these stakeholders indicated their strong desire to leverage EECDP to develop a benchmarking tool for the Philippines.

FRAMING NEXT STEPS

The *EECDP Performance Benchmarking* project catalyzed a regional solution to reducing energy use in Southeast Asia by *developing* and *demonstrating* a "proof of concept" benchmarking tool that has the potential to save 533 million kilowatt-hours (kWh) of electricity, avoid 381,214 MtCO2e, equivalent to 9.7 million new trees planted, when applied across 1,000 hotels in Indonesia.

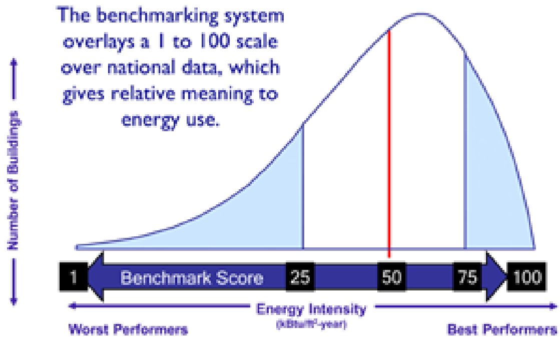


Figure 17 – Benchmarking Gives Relative Meaning to Energy Use

The Excel-based benchmarking tool was made available to Indonesia's Ministry of Energy and Mineral Resources (MEMR), the national agency that administers and organizes the energy sector, and the Ministry of Tourism, which is the agency chiefly responsible for administration of the tourism industry in Indonesia. Extensive discussions were held with MEMR at the close of the program with regard to the specific requirements for owning and maintaining an on-line building energy performance benchmarking tool. This included information on what is required to develop a benchmarking tool; host the benchmarking tool on a national website; maintain and update the national energy performance database and benchmarking tool; intellectual property issues; and potential future costs associated with maintaining and expanding an on-line operational benchmarking tool.

Following these discussions, MEMR determined that, while it saw the value of the energy performance benchmarking tool and understood the ENERGY STAR program model, it was not prepared to commit further resources into development of an on-line building energy benchmarking tool to expand use. While there is not commitment to make the tool available on-line at this point, the ICED team produced an Indonesia Hotel Energy Management Manual. The manual includes guidance for improving the energy performance of the Indonesian hotel sector through use of the Excel-based benchmarking tool to calculate energy performance before and after operational and technical upgrades.

This project included outreach and information-sharing with other countries in Southeast Asia – including Philippines, Vietnam, and Thailand – which have all expressed strong need and readiness to design and implement their own national benchmarking systems to reduce energy use and carbon emissions in their building stocks. The tools could adhere to a common regional methodology demonstrated under the *EECDP Performance Benchmarking* project (the ENERGY STAR methodology) in order for regional collaboration on building energy performance analysis, standard-setting, policy development, and improvement to take place. This is a potential opportunity for follow-on work through an Associate Award or other program mechanism.

Key outcomes of a project could include:

- Continued knowledge built among stakeholders of benchmarking approaches for buildings, and their utility for supporting national and regional energy and carbon targets, policies, and programs;

- Significantly enhanced capacity among key stakeholders for designing and implementing benchmarking approaches in the buildings sector; and

- An elevated understanding at the regional level, and among key regional institutions, of the broad applicability of benchmarking as a key regional approach to address growing energy use and carbon emissions.

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[x] Indonesia Ministry of Energy and Mineral Resources (MEMR) Director of Energy Conservation, Ibu Maritje Hutapea, indicated Indonesia's interest in utilizing a benchmarking tool to set minimum energy performance standards.

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[xv] Horwath HTL, *Horwath HTL History* (accessed December 16, 2014); available from http://horwathhtl.asia/about-us/company-history/.

[xvi] ENERGY STAR Portfolio Manager Technical Reference, Source Energy (accessed December 22, 2014); available from https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf

[xvii] The R2 value in Source Energy is calculated as: 1 – (Residual Variation of Y) / (Total Variation of Y). The residual variation is sum of (Actual Source Energyi – Predicted Source Energyi)^2 across all observations. The variation of Y is the sum of (Actual Source Energyi – Mean Source Energy)^2 across all observations.

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[xxiv] China's Ministry of Housing and Urban-Rural Development (MOHURD) initiated a World Bank/Global Environment Facility (GEF)-funded Energy Performance Benchmarking and Disclosure Program (EPB&PD) program in July 2014. The EPB&PD program will deploy a national web-based operational energy performance benchmarking and a building energy performance benchmarking and disclosure policy. The EPB&PD program will conduct pilot projects in Beijing and Ningbo from 2015 to 2017 in advance of phased national roll-out, anticipated to begin in 2018.
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