Part I – Model Overview and Results

1. Introduction

A central component of strategies to combat climate change focuses on energy use, which is the primary generator of greenhouse gas emissions. In the minds of policy makers on local, national and international stages, therefore, two important questions result from this consensus: "*what kinds of policies encourage the appropriate market transformation to energy efficiency?*"; and "*how much impact can these policies have?*". LBNL's Bottom Up Energy Analysis System (BUENAS) contributes to the answering of these questions by considering the likely impacts of a specific subset of possible efficiency policies on a global scale.

BUENAS is an end use energy demand projection model developed by Lawrence Berkeley National Laboratory (LBNL) in the United States of America with support from the Collaborative Labeling and Appliance Standards Program (CLASP), the International Copper Association (ICA) and the United States Department of Energy (USDOE). As the name suggests, BUENAS is a tool to model energy demand by various types of energy consuming equipment and aggregate the results to the end use, sector or national level. BUENAS is designed as a policy analysis tool which creates scenarios differentiated by the level of actions taken – generally toward higher energy efficiency. Impacts of policy actions towards market transformation are calculated by comparing energy demand in the "business as usual" case to a specific policy case. BUENAS shares elements with a variety of models[1], including models of energy savings supporting the USDOE's appliance standards program. The characteristics that distinguish BUENAS are that it covers multiple countries, models energy demand at the technology level and projects efficiency improvement based on specific targets known to be achievable.

The main objective of the development of BUENAS is to provide a global model with sufficient detail and accuracy for technical assessment of policy measures such as energy efficiency standards and labeling (EES&L) programs. In most countries where energy efficiency policies exist, the initial emphasis is on household appliances and lighting. Often, equipment used in commercial buildings, particularly heating, air conditioning and ventilation (HVAC) is also covered by EES&L programs. In the industrial sector, standards and labeling generally covers electric motors and distribution transformers, although a few more types of industrial equipment are covered by some programs, and there is a trend toward including more of them. In order to make a comprehensive estimate of the total potential impacts, development of the model prioritized coverage of as many

[1] See 1. Mundaca, L., et al., *Evaluating Energy Efficiency Policies with Energy-Economy Models.* Annual Review of Environment and Resources, 2010. **35**: p. 305-44. for a survey of energy-economy models used to evaluate efficiency policy

end uses commonly targeted by EES&L programs as possible, for as many countries as possible. The model generally did *not* cover:

- Industrial processes
- 'Miscellaneous' end uses, or end uses not typically included in EES&L programs.

As mentioned above, BUENAS projects energy demand in order to calculate impacts of current, proposed or possible policies. National energy demand of each end use is constructed according to the following modification of the Kaya identity[2].

$$Energy = \frac{Activity \times Intensity}{Efficiency}$$

In this equation, *Activity* refers to the size of the stock, e.g., number of refrigerators or the air conditioned area of commercial buildings. *Intensity* is driven by the usage and capacity of each unit, such as the size of a water heater or the hours of use of a room air conditioner. Finally, *Efficiency* is the technological performance of the equipment, which can be affected by government policies.

BUENAS is implemented using the Long-Range Energy Alternatives Planning system (LEAP), developed by the Stockholm Environment Institute. LEAP is a general-purpose energy accounting model in which the model developer inputs all data and assumptions in a format that is then transparent to other users.

BUENAS projects energy consumption by end use from 2005 (base year) to 2030. The strategy of the model is to first project end use activity, which is driven by increased ownership of household appliances, and economic growth in the commercial and industrial sectors. The total stock of appliances can be modeled either according to an econometric diffusion model or according to unit sales projections, if forecasts are available. Electricity consumption or intensity of the appliance stock is then calculated according to estimates of the baseline intensity of the prevailing technology in the local market. Finally, the total final energy consumption of the stock is calculated by modeling the flow of products into the stock and the marginal intensity of purchased units, either as additions or as replacements of old units according to equipment retirement rates. The high efficiency or "policy" scenario is created by the assumption of increased unit efficiency relative to the baseline starting in a certain year. For example, if the average baseline unit energy consumption (UEC) of new refrigerators is 450 kWh/year, but a MEPS taking effect in 2012 require a maximum UEC of 350 kWh/year, the stock energy in the policy scenario will gradually become lower than that of the base case scenario due to increasing penetration of high-efficiency units under the standard. By 2030, the entire stock will generally be impacted by the standard.

The remainder of Part I of this document is devoted to providing an overview of the scope, applications, scenario definitions and results of the model (Sections 2-5). Part II provides the details of the methodology used to construct national level energy demand scenarios. In order to increase the usability of the document, not every modeling detail is included in the documentation. In some cases, we refer to previous documents to avoid redundancy. Foremost among these are [3] which describes the first construction and application of the model and [4], a journal publication that details the ownership model of residential appliances. In addition, this document can be considered a companion to the *BUENAS Inputs Spreadsheet*, an Excel spreadsheet developed as a container and documentation tool for important data streams and assumptions in BUENAS. The *BUENAS Inputs Spreadsheet* has been designed with documentation in mind. The goal of its construction and format are to allow advanced reviewers of the model and other members of the international energy analysis community to "drill down" to specific assumptions and data sources. In some cases, summaries of the data contained in the spreadsheet are provided in the document, with particular attention to assumptions and citations.

2. Scope of BUENAS

The first version of the model, completed in 2008, covered the entire world, broken into 10 regions, and relied heavily on extrapolation of 'marker country' data to represent an entire region. The current version of BUENAS diverges from global coverage and regional breakdowns. Similarly, the first version of the model made rough estimates of some end uses where equipment data were not available, in order to cover the great majority of energy demand in buildings. The current version places a higher value on detail and accuracy at the expense of some comprehensiveness. For example, the first version of the model included space heating and cooling in buildings for all countries and four other major end uses in the commercial sector, even though the details of equipment used for these end uses are not well known for many countries. In the current version, by contrast, many of these end uses were omitted for some countries due to the uncertainty of the data.

2.1. Country Coverage

BUENAS covers 12 countries individually, with the 27 Member States of the European Union modeled as a single 'country'. Countries currently included in BUENAS are: Australia, Brazil, Canada, European Union, India, Indonesia, Japan, Republic of Korea, Mexico, Russia, South Africa and the United States. Chinese appliance energy demand and efficiency potential has also been modeled in detail by LBNL[5]. LBNL's China appliance model is a component of the China 2050 Energy Model, which includes all energy demand sectors. The LBNL China appliance model (including industrial motors and distribution transformers) is currently being adapted to BUENAS and will be an integrated part of the model in the next version.

Since the model covers most of the world's large economies, the fraction of global energy consumption represented by modeled countries is large. According to IEA data on total energy demand in 2005[6], the countries covered account for 62% of global final; energy demand if China is not included. Once China is incorporated into the model, country energy coverage will total 77% of global demand. The breakdown of energy demand percentage by countries included in BUENAS is shown in Table 1 **[6]**.

Table 1 – Energy Consumption Percentage by Countries Included in BUENAS

Region	% Energy	Country	% Energy
Pacific OECD	8%	Australia	1.1%
		Japan	4.6%
		Korea	1.9%
North America	23%	United States	20.5%
		Canada	2.4%
Western + Eastern Europe	17%	European Union	15.6%
Former Soviet Union	9%	Russia	5.7%
Latin America	6%	Mexico	1.5%
		Brazil	1.8%
Sub-Saharan Africa	3%	South Africa	1.1%
Middle East + No. Africa	5%	-	-
Centrally-Planned Asia	16%	China	15.0%
South Asia - Other Pacific Asia	9%	India	4.7%
		Indonesia	1.6%
Total	**96%**	**Total without China**	**62%**
		Total including China	**77%**

Source [6]. 2005 data.

2.2. End Use Coverage

BUENAS covers a wide range of energy-consuming products, including most end uses generally covered by Energy Efficiency Standards and Labeling (EES&L) programs around the world. End uses currently covered are:

- Residential Sector: Air Conditioning, Cooking + Dishwashing, Fans, Lighting, Refrigeration, Space Heating, Standby, Televisions, Water Heating and Laundry
- Commercial Building Sector: Air Conditioning, Lighting, Refrigeration, Space Heating and Laundry
- Industrial Sector: Electric Motors and Distribution Transformers

In order to cover as many end uses as possible, the model as originally created sacrificed some detail and products were grouped into categories rather than being modeled as individual technologies (e.g. refrigerators and freezers are grouped into a single "refrigeration" category). Since only major end uses were covered, total energy consumption modeled does not equal total sector consumption. However, the end uses covered are estimated to include over 80% of the residential and commercial building sectors. In the industrial sector, only electric motors over 750 kW are covered. This type of motor typically accounts for over half of industrial electricity consumption.

In the original "regional" version of BUENAS, an attempt was made to make an estimate for every end use for every region, even in the absence of data. This required the use of proxy data; that is, the assumption that data for one country applies to the entire region, and in some cases to multiple regions. In addition, useful energy consumption[2] for heating and cooling was modeled by heating and cooling degree days (see [3]). In the current version of the model, the strategy prioritizes accuracy over comprehensiveness and therefore minimizes the use of proxy data with the consequence that significant gaps remain in the coverage. In fact, some of the end uses listed above are modeled for only one or two countries. A continuing effort will be made going forward to address these gaps as reliable country-specific data are made available. Table 2 summarizes the end use coverage in the current version of the model by country/economy.

Table 2 – BUENAS End-use / Country Coverage

Sector	End Use Category	Appliance	AUS	BRA	CAN	EU	IDN	IND	JPN	KOR	MEX	RUS	USA	ZAF
Residential	Air Conditioning	Air Conditioner	■		■	■	■	■	■	■	■	■	■	■
		Central AC	■		■						■		■	
	Cooking + Dishwashing	Cooking Products				■							■	
	Fans	Fan	■	■	■	■	■	■	■	■	■	■	■	■
	Lighting	Lighting	■	■	■	■	■	■	■	■	■	■	■	■
	Freezers	Freezers				■							■	
		Refrigerator	■	■	■	■	■	■	■	■	■	■	■	■
	Space Heating	Boiler			■	■								
		Furnace			■								■	
		Electric Space Heating							■				■	
	Standby	Standby	■	■	■	■	■	■	■	■	■	■	■	■
	Television	Television	■	■	■	■	■	■	■	■	■	■	■	■
	Water Heating	Water Heater	■		■	■			■		■		■	
	Laundry	Clothes Dryers											■	
		Washing Machine				■				■	■		■	
Commercial	Air Conditioning	Space Cooling	■	■	■	■	■	■	■	■	■	■	■	■
	Lighting	Lighting	■	■	■	■	■	■	■	■	■	■	■	■
	Refrigeration	Refrigeration	■	■	■	■	■	■	■	■	■	■	■	■
	Space Heating	Electric Space Heating											■	
	Laundry	Commercial Clothes Washers											■	
Industry	Motors	Motor	■	■	■	■	■	■	■	■	■	■	■	■
	Distribution Transformers	Distribution Transformers	■		■			■	■	■	■	■	■	

By summing up the energy demand estimates modeled by equipment included in Table 2, it is possible to evaluate the energy demand by BUENAS as a fraction of sector within each economy. These estimates are shown in Table 3.

Differences between the sum of energy demand in BUENAS and top-down estimates from national statistics arise primarily from end uses that are not included in the model. However, differences may also indicate over- or underestimates in the BUENAS. These two effects are difficult to identify in bottom up modeling. Finally, the top-down estimates are also subject to uncertainty, as evidenced by significant differences between sources. For these reasons, the table should be understood as a rough guide of the level of coverage of the model instead of an exact measure. In some cases, top-down data were not available at a level of detail necessary to make a meaningful comparison.

[2] "Useful" energy refers to only energy needed to provide comfort, and does not include losses from inefficiency, which were subsequently added.

Table 3 – Percentage of Final Energy in BUENAS by Country, Sector and Fuel in 2005[3]

Sector	Fuel	AUS	BRA	CAN	EU	IND	IDN	JAP	KOR	MEX	RUS	ZAF	USA	Total
Residential	Electricity	56%	105%	27%	N/A	100%	N/A	53%	69%	69%	36%	N/A	59%	**60%**
	Gas	32%	0%	92%	N/A	N/A	N/A	72%	0%	N/A	0%	N/A	65%	**44%**
	Total	46%	58%	62%	57%	N/A	7%	61%	23%	N/A	4%	N/A	62%	**50%**
Commercial	Electricity	36%	50%	27%	N/A	56%	N/A	38%	22%	72%	22%	N/A	64%	**52%**
	Gas	0%	0%	0%	N/A	N/A	N/A	0%	0%	N/A	0%	N/A	54%	**36%**
	Total	29%	44%	13%	21%	N/A	33%	27%	18%	N/A	9%	N/A	60%	**37%**
Industrial	Electricity	N/A	58%	37%	N/A	54%	N/A	102%	59%	44%	40%	N/A	79%	**64%**
	Gas	N/A	0%	0%	N/A	N/A	N/A	0%	0%	0%	0%	N/A	0%	**0%**
	Total	N/A	38%	17%	18%	N/A	18%	73%	45%	15%	9%	N/A	22%	**21%**

Sources: [7],[8],[9],[10],[11],[12-14],[15], [16],[17]

Table 3 shows that BUENAS coverage in residential electricity is the highest of the three sectors, with BUENAS demand accounting for at least half of the sector demand, where data are available. Sector totals are weighted by sector energy for each fuel where these data are available. Residential gas coverage is significant only for Australia, Canada, Japan and the U.S., where sufficient data were available to model space heating and/or water heating. Commercial sector electricity coverage is lower than residential sector electricity coverage, but high for some countries where space cooling is important, because BUENAS includes this end use (in addition to lighting, which is usually the main commercial building end use). Commercial building gas coverage is zero for all countries except for the United States due to lack of available data for commercial space heating and water heating. Finally, in the industrial sector electricity coverage is moderate while gas is not covered in BUENAS. This is to be expected since motors, which are covered, generally account for a significant portion of industrial electricity. A significant amount of electrical energy in industry comes from heavy industry processes such as electric arc furnaces in the steel sector. These types of industrial processes are not covered in BUENAS. Likewise, most of the non-electric fuel use in industry comes from heavy industrial heating processes, which are out of the scope of BUENAS.

In some instances, the comparison of BUENAS to top-down estimates exposes some apparent overestimations in the model. Examples of these are residential electricity in India and Brazil and industrial electricity in Japan. While much of residential electricity in Brazil and India is concentrated in end uses covered by BUENAS (lighting, refrigeration and air conditioning), the total should of course not exceed 100% of the actual reported consumption. This is likely due to an overestimate of energy demand in one or more of the end uses. It should be pointed out, however, that there is significant variation in reported electricity consumption in India, due to significant "non-technical losses" (electricity theft) in the residential sector in India. In addition, BUENAS models demand, not consumption. These two approaches differ by up to 20% in India due to chronic shortages. These two effects may also explain the apparent overestimate by BUENAS. The overestimate of industrial electricity in Japan is likely due to overestimation of energy consumption of motors in that country. This difference may be the subject of a calibration in subsequent

[3] Final, or 'delivered' energy does not include electricity input energy or losses in transmission or distribution. Percentages of 'primary' energy inputs would therefore be significantly different.

versions of the model.

3. Applications of BUENAS to Date

The original objective in the construction of a global model was to provide the best assessment to date of the potential for energy savings and greenhouse gas emissions reductions from energy efficiency standards and labeling (EES&L) programs. Since that time, the model has been applied to more specific policy scenarios and has provided insight specific to particular regions.

3.1. Potential Studies

The original development of BUENAS commissioned by the Collaborative Labeling and Appliance Standards Program (CLASP), was intended to provide a more precise estimate of the potential impacts of EES&L programs worldwide. Until the development of BUENAS, rough estimates of the global potential of EES&L programs were based on a percentage savings of residential and commercial energy use by region (10-15% of residential + commercial energy in emerging economies is one commonly used estimate). This first project using BUENAS completed in 2008 produced a much more detailed (and therefore more accurate and defendable) global estimate[18]. The primary (but not exclusive) motivation of that project was to bring attention on the global stage of the value of EES&L policies. A secondary accomplishment of this project was to rank the potential impacts from EES&L policies among various countries or regions and among various energy-consuming products. The details of this project, including the details of the original model methodology are provided in [3]. Beginning in 2010, BUENAS has been used to support the activities of the Super-Efficient Equipment and Appliance Deployment initiative (SEAD), an activity within the Clean Energy Ministerial process. A main use of BUENAS within SEAD is to provide analysis of the remaining potential impacts of appliance efficiency programs specifically for SEAD member countries, in addition to reporting impacts from ongoing progress of efficiency programs.

3.2. Planning and Prioritization

Subsequent to the initial development of the model, much of the model development focused on those regions that are high-priority targets of ClimateWorks Foundation, a major funder of CLASP. During 2008-2009, the model was used primarily as a planning tool for CLASP, in order to refine potential estimates for only the highest priority end uses, which may be the subject of CLASP's short and medium-term activities in its role as a ClimateWorks Best Practice Network (BPN).

In addition to this multi-country planning role, BUENAS has also been used as a tool to look closely at the potential for efficiency improvement in individual countries. For example, the International Copper Association supported the use of BUENAS as a tool to evaluate the cost-effective efficiency potential for the United States [19]. This effort will be followed by studies for other countries. In addition, BUENAS has been used as a tool in collaboration with CLASP to support the development of MEPS in developing countries, particularly Mexico, Chile and member states of the Association of South East Asian Nations (ASEAN). In this manner, BUENAS is used as a prioritization tool, highlighting end uses with most significant improvement potential.

4. Energy Demand Scenario Definitions

In constructing a model of energy demand, every attempt is made at accuracy. This includes collecting the best data on market trends, technologies, use patterns and regulations. The accuracy of these parameters is subject to an objective definition of correctness. The definition of scenarios used to evaluate potential policy impacts, on the other hand is a choice made by the analyst. There is undoubtedly some level of subjectivity in this definition. It is critical, however, that scenarios be clearly described, and used uniformly/consistently in order to allow correct interpretation of results.

4.1. Business As Usual Scenario

Any evaluation of the impacts of a policy, either prospective or retrospective, must define a baseline for comparison. In order to do this, BUENAS creates a Business as Usual (BAU) case that projects energy demand by end use through the year 2030. Much of the modeling content of BUENAS is contained in the construction of the BAU case, and the other scenarios are modifications of it. Most important in the construction of the BAU scenario is the projection of growth in energy demand, which is driven by growth in both activity and intensity. One notable feature of the BUENAS scenarios is that activity and intensity projections are assumed equal for all scenarios. This assumption implies that scenarios differ *only* by the efficiency of products – changes in stock of equipment and usage patterns are not included as effects of policy.

In addition to growth in activity and intensity, the BAU case also includes a specific assumption of efficiency. By default the BUENAS BAU case assumes "frozen efficiency" from 2010 on, that is, while usage may evolve over time, the efficiency of new products remains constant. Exceptions to this arise when projections are available that include 'market-driven' efficiency improvements[4], which are then included in BUENAS. The assumption of frozen efficiency is a consequence of the absence of systematic estimates of market-driven improvement, which are likely end-use specific. A current research project will attempt to develop end-use specific estimates of market-based efficiency improvement for implementation in subsequent versions of BUENAS[5].

4.2. Recent Achievements Scenario

BUENAS provides estimates of the impacts of minimum efficiency performance standards (MEPS) programs in countries participating in SEAD in order to demonstrate the effectiveness of these programs and the potential results of augmenting and accelerating them through international cooperation, including the SEAD program. One category of impacts to be presented is those from

[4] Examples are forecasts made by national governments for the purpose of setting regulations.
[5] Market-driven efficiency improvement is also omitted by default in high-efficiency scenarios, creating a somewhat compensating effect to its omission in the BAU scenario.

existing regulations. The following regulations have so far been modeled, according to the schedule of announcement and implementation:

1. Regulations implemented between January 1, 2010 and April 1, 2011 (effective date)
2. Regulations issued between January 1, 2010 and April 1, 2011 (announcement date)
3. Regulations in progress between January 1, 2010 and April 1, 2011 (with scheduled announcement date)

The current version of BUENAS includes only MEPS. Subsequent versions of the model are expected to include the impact of labeling programs.

4.3. Best Practice Scenario

The second major scenario included in BUENAS considers the potential impacts of regulations in the near- to medium- term. This scenario corresponds roughly to the scenario used in the first "Global Potential" study because it includes efficiency improvements judged to be ambitious but achievable for all countries. There are many possible ways of defining global potential, including cost-effectiveness, removal of a certain fraction of low-efficiency models from the market, or adoption of best available technology. Due to data limitations, the most practical approach has been to rely on an evaluation of best practices. The best practice scenario assumes that all countries adopt stringent standards in modeled end uses by 2015, where 'stringent' is interpreted in the following way:

1. Where efficiency levels are readily comparable across countries: the most stringent standard issued by April 1, 2011 anywhere in the world.
2. Where they are not: the most stringent comparable (e.g., regional) standard issued by April 1, 2011.
3. In the case where an obvious best comparable standard was not available, an efficiency level was set that was deemed to be aggressive or achievable, such as the most efficient products in the current rating system.

In addition, the best practice scenario assumes that standards are further improved in the year 2020, by an amount estimated on a product-by-product basis. This scenario either assumes that the same level of improvement made in 2015 is repeatable in 2020 or assumes that a specific target, such as current 'best available technology' is reached by 2020.

5. Results

The main outputs of the BUENAS model are impacts of appliance efficiency policies, either achieved, planned, or potential. Table 4 shows savings in 2030 for the *Recent Achievements Scenario*. As defined in the previous section, the achievement of these savings depends on a wide variety of factors with various levels of certainty. The savings shown correspond to MEPS implemented since 2010 or in development for a subset of countries modeled by BUENAS. Savings from Category 1 and 2 MEPS are relatively certain, since these regulations are already defined and have a definite implementation date. Savings from Category 3 are more speculative, since the parameters of these regulations have not been finalized. Assumptions for these MEPS are taken from preparatory studies when available; otherwise, assumptions are made based on international benchmarks. Details of the construction of this scenario are given in Part II of this document.

Table 4 – Energy and Emissions Savings in 2030 for MEPS since January 2010 – Recent Achievements Scenario

Category	**Quantity**	**Unit**	**Australia**	**Canada**	**EU**	**Korea**	**Mexico**	**US**	**Total**
1.Implemented	Electricity	TWh	1.9	1.9	56.0	1.7		197.1	**259**
	Gas	PJ						6.3	**6**
	CO_2	mt	1.4	0.4	18.8	0.7		112.7	**134**
2.Announced	Electricity	TWh		7.5	21.8		0.4	0.8	**30**
	Gas	PJ		20.3			67.4	44.2	**132**
	CO_2	mt		1.6	7.3		4.0	8.0	**21**
3.In Progress	Electricity	TWh			74.3		3.2	22.9	**100**
	Gas	PJ	6.4		204.0			1.1	**211**
	CO_2	mt	0.4		40.0		2.1	21.2	**64**
Total	Electricity	TWh	1.9	9.3	152.1	1.7	3.6	220.7	**389**
	Gas	PJ	6.4	20.3	204.0		67.4	51.6	**350**
	CO_2	mt	1.8	1.9	66.2	0.7	6.1	141.9	**219**

It should be noted that omission of a country in Table 4 does not imply a low level of MEPS activity in the country. For example, Japan has one of the most aggressive and expansive efficiency standards program in the world (the Top Runner program). These results were not included because of a lack of data in the current version of the model. The scope of this analysis will be widened in future versions of the model. For the same reason, not all MEPS could be included for the countries that were covered. For example, while Korea implemented several MEPS in the period considered, only those that were easily modeled could be included. The remainder will require additional research to evaluate energy consumption and baseline efficiency levels.

Of the countries studied, the United States and Europe show by far the highest expected achievements in terms of projected energy savings. This is due to both the size of these two large economies, the high level of efficiency activities, and the wider availability of data.

Table 5 shows savings in 2030 for the *Best Practice Scenario* for countries included in Table 2. The best practice scenario is the best estimate for what is feasibly achievable from appliance efficiency policies. There is necessarily some subjectivity and incompleteness in these results, but they are meant to be indicative of the scale of the potential and the breakdown by end use. Details of the construction of this scenario are given in Part II of this document.

Table 5 – Energy and Emissions Demand and Savings Potential in 2030 – Best Practice Scenario

Sector	End Use	2030 Demand			2030 Savings			2030 Percent Reduction		
		Elec TWh	Gas PJ	CO_2 mt	Elec TWh	Gas PJ	CO_2 mt	Elec TWh	Gas PJ	CO_2 mt
Residential	Air Conditioning	576		214	114		52	20%		24%
	Fans	149		100	77		54	52%		53%
	Lighting	379		195	111		55	29%		28%
	Refrigerators & Freezers	479		201	118		56	25%		28%
	Space Heating	129	11236	776	0	482	38	0.2%	4%	5%
	Standby	201		97	135		93	67%		95%
	Television	151		66	13		6	8%		10%
	Laundry	147		76	31		20	21%		26%
	Water Heating	413	3922	322	133	429	98	32%	11%	31%
Sub Total		**2695**	**15158**	**2082**	**731**	**911**	**477**	**27%**	**6%**	**23%**
Commercial	Lighting	1356		611	322		147	24%		24%
	Refrigeration	364		155	90		39	25%		25%
	Air Conditioning	116		259						
Sub Total		**2739**		**1434**	**610**		**274**	**22%**		**19%**
Industry	Distribution Transformers	612		323	82		141	13%		44%
	Motors	4482		2141	160		97	4%		5%
Sub Total		**5094**		**2465**	**242**		**238**	**5%**		**10%**
Grand Total		**10529**	**15158**	**5981**	**1583**	**911**	**988**	**15%**	**6%**	**17%**

As Table 5 shows, overall potential emissions reductions for the scope of equipment covered is about 988 Mt of CO_2, or about 4.5 times what has been achieved since January 2010. This would imply very significant achievements in the past two years. We note, however, that this calculation is highly dependent on the actual achievements of in-progress standards. Table 5 also shows that a significant percentage of electricity and gas would be saved in the Best Practice scenario. Savings are compared to demand in 2030. Electricity savings is most pronounced in the residential sector, where savings of 27% are projected. Electricity savings are similar, at 22% in the commercial sector. In general, savings are much smaller for fuels. This is because some major space heating and water heating technologies are not yet included in the model, and because space heating in particular is already a relatively high efficiency end use[6]. Similarly, savings from industrial motors are small in percentage terms.

Finally, it is interesting to note that the initial 'regional' version of BUENAS showed total emissions savings potential of 1.4 Gt of CO_2 for buildings only. These results are reasonable due to the decreased coverage of end uses and countries in the current version of BUENAS.

[6] Due to the large footprint of space heating, however, savings in absolute terms from this end use can be very large.

As with all forecasting models, there are significant areas of uncertainty involved in the BUENAS results. While these are somewhat difficult to quantify, a qualitative description of the level of uncertainty of input variables and their subsequent effect on model outputs is possible. This discussion is given in a section below following the description of relevant input variables.