CHAPTER 10. NATIONAL IMPACTS ANALYSIS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 10. NATIONAL IMPACTS ANALYSIS

10.1 INTRODUCTION

This chapter describes the method for estimating the national impacts of candidate standard levels (CSLs) for analyzed walk-in cooler and freezer equipment (hereafter "walk-ins" or "WICF"). In the national impact analysis (NIA), the U.S. Department of Energy (DOE) assesses the cumulative national energy savings (NES) and the cumulative national economic impacts of different CSLs. DOE measures energy savings as the cumulative quadrillion British thermal units (quads) of energy a CSL is expected to save the Nation. DOE measures economic impacts as the net present value (NPV) in 2009 dollars of total customer costs and savings expected to result from a CSL. The analysis period over which DOE calculates the NPV and NES is from 2015 to 2045. Results of the NIA described in this chapter include (1) national energy savings to the Nation as a result of standards; (2) monetary value of operating cost savings (primarily from reduced energy consumption) to the Nation as a result of standards; (3) increased total installed costs to the Nation as a result of standards; and (4) the NPV of these savings (the difference between the present monetary values of operating cost savings and increased total installed costs). The main portion of this chapter summarizes the results of these estimates. More detailed results are provided in appendices 10A (for NES results) and 10B (for NPV results).

Because a walk-in is designed to work as a single coherent unit, the characteristics of complete walk-in systems (*e.g.*, energy consumption, installed cost) must be considered for estimating the national impacts of walk-in CSLs. However, each walk-in does consist of two distinct parts, the envelope and the refrigeration system. DOE analyzes the two parts of a walk-in together for the purpose of calculating the national impacts, but DOE is considering separate standards for the two separate WICF components.

DOE determines both the NPV and NES for each CSL and each equipment class it selects in the engineering analysis (preliminary technical support document [TSD] chapter 5). In this rulemaking, DOE considers up to 15 CSLs for each of the envelope equipment classes and up to 9 CSLs for each of the refrigeration system equipment classes.

DOE performs all NIA calculations using a Microsoft Excel spreadsheet, available at www.eere.energy.gov/buildings/appliance_standards/commercial/wicf.html. Appendix 10A will provide instructions for using the spreadsheet.

The following sections describe in detail the methodology and inputs for the NIA. Several NIA inputs, including per-unit costs, per-unit energy consumption, and national shipments, are discussed in other analyses. In describing the inputs to the NIA, this chapter references those analyses and presents new information on installed stock. Section 10.2 discusses DOE's walk-in shipment forecasts by efficiency, the installed stock of walk-ins, and the mix of efficiencies of that stock. Section 10.3 discusses DOE's calculation of national energy consumption in the base and standards cases and the resulting difference in NES between these cases. Section 10.4 discusses the NPV calculation. Section 10.5 presents the NES and NPV results by equipment class.

10.2 BASE-CASE AND STANDARDS-CASE FORECASTED WALK-IN STOCKS AND EFFICIENCY DISTRIBUTIONS

The characteristics of DOE's shipment forecasts (such as equipment costs and operating costs) and projected walk-in stocks (such as average efficiency and energy consumption) are key aspects of DOE's NES and NPV estimates. This section describes these key characteristics of stock and shipments as they relate to the NES and NPV.

For example, the projected distribution of walk-in efficiencies shipped and walk-in efficiencies in stock are key factors in determining the NPV. Two inputs to the NPV are the per-unit total installed cost and per-unit annual operating cost. The per-unit total installed cost often varies with the efficiency of walk-ins shipped. When higher efficiency walk-ins are shipped, higher or lower installed costs are often incurred. The life-cycle cost analysis (preliminary TSD chapter 8) describes how per-unit total installed costs vary as a function of efficiency for each walk-in.

Per-unit annual energy consumption is a key input to the NPV (as an input to the per-unit operating cost) and NES. The per-unit annual energy consumption is a function of walk-in characteristics in the installed stock. The total installed WICF stock is used to determine total annual energy consumption, a key input into the NES and NPV calculations.

Also important to determining NES and NPV is the average efficiency of the walk-in stock. The engineering analysis (preliminary TSD chapter 5) discusses the relationships among walk-in system design, system input power, and walk-in efficiency. The energy use characterization (preliminary TSD chapter 6) describes how the per-unit energy consumption varies as a function of system input power and market sector application for each walk-in design.

Sections 10.3.2 and 10.4.2 discuss inputs to calculating the NES and NPV in further detail.

The following sections detail the forecasted distribution of efficiencies, installed walk-in stocks, and average efficiency of those stocks in the base and standards cases.

10.2.1 Installed Walk-in Stock

From the information and the shipment forecasts presented in chapter 9, DOE establishes the installed walk-in stock profile for all analyzed walk-in equipment classes. This information is an important input to the National Impacts Analysis because the national energy and financial impacts are directly related to the size and type of the walk-in stock. The following two tables show the installed walk-in stocks, which are the same in the base case and standards case. Table 10.2.1 presents the stock broken down into 5-year increments by the equipment class of the envelope portion of the walk-in. Table 10.2.2 breaks down the stock by refrigeration system equipment class instead. Because each walk-in includes both an envelope component and a refrigeration system, the total stock is the same in both tables.

Table 10.2.1 Installed Walk-in Stock by Year and Envelope Equipment Class

WICF Envelope Systems	Year and Stock						
	2015	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
Non-Display Cooler Small	202,025	215,869	231,723	249,314	267,200	286,372	306,924
Non-Display Cooler Medium	752,943	804,539	863,627	929,189	995,846	1,067,301	1,143,898
Non-Display Cooler Large	337,630	360,767	387,263	416,661	446,552	478,593	512,940
Display Cooler Small	8,619	9,255	9,980	10,782	11,607	12,496	13,454
Display Cooler Medium	157,522	169,148	182,392	197,045	212,122	228,367	245,873
Display Cooler Large	12,929	13,883	14,970	16,173	17,410	18,744	20,180
Non-Display Freezer Small	133,677	142,810	153,401	165,184	177,029	189,723	203,327
Non-Display Freezer Medium	430,401	459,806	493,907	531,845	569,981	610,852	654,654
Non-Display Freezer Large	170,565	182,218	195,732	210,767	225,880	242,077	259,435
Display Freezer Small	18,270	19,789	21,477	23,331	25,303	27,445	29,771
Display Freezer Medium	116,520	126,209	136,976	148,797	161,380	175,041	189,873
Display Freezer Large	9,135	9,894	10,739	11,665	12,652	13,723	14,885
Total	**2,350,236**	**2,514,186**	**2,702,186**	**2,910,753**	**3,122,962**	**3,350,732**	**3,595,214**

Table 10.2.2 Installed Walk-in Stock by Year and Refrigeration System Equipment Class

WICF Refrigeration Systems	Year and Stock						
	2015	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
Dedicated Medium Temperature Indoor Small	34,546	36,914	39,625	42,633	45,691	48,970	52,484
Dedicated Medium Temperature Indoor Large	62,540	66,834	71,750	77,205	82,753	88,701	95,077
Dedicated Medium Temperature Outdoor Small	157,378	168,162	180,512	194,216	208,148	223,084	239,094
Dedicated Medium Temperature Outdoor Large	500,411	534,807	574,190	617,882	662,326	709,980	761,075
Multiplex system Medium Temperature Small	10,101	10,793	11,586	12,466	13,360	14,319	15,346
Multiplex system Medium Temperature Large	706,693	755,951	812,292	874,764	938,458	1,006,819	1,080,192
Dedicated Low Temperature Indoor Small	22,859	24,420	26,232	28,246	30,272	32,443	34,769
Dedicated Low Temperature Indoor Large	34,863	37,244	40,006	43,079	46,168	49,479	53,027
Dedicated Low Temperature Outdoor Small	104,134	111,249	119,500	128,678	137,905	147,794	158,392
Dedicated Low Temperature Outdoor Large	288,562	308,682	331,906	357,706	383,806	411,819	441,885
Multiplex system Low Temperature Small	6,684	7,140	7,670	8,259	8,851	9,486	10,166
Multiplex system Low Temperature Large	421,467	451,989	486,918	525,619	565,222	607,841	653,707
Total	**2,350,236**	**2,514,186**	**2,702,186**	**2,910,753**	**3,122,962**	**3,350,732**	**3,595,214**

10.2.2 Efficiency Distribution of the Stock

Besides the size of the stock, the other information necessary to calculate the national energy impacts of the walk-in standard is the average energy consumption of the stock in both the base case and the standards case.

DOE calculates the energy consumption separately for each combination of envelope and refrigeration system equipment classes, at each possible combination of efficiency levels, for each possible combination of standard levels in each year. Because this results in a prohibitively large number of possible combinations of factors (24 equipment class combinations with some shipments, times 160 possible combinations of efficiency level in the equipment in the market, times 160 possible standard levels DOE could set for each equipment class, times 31 years = 19,000,000 + combinations), DOE does not present these calculations in detail here. However, DOE outlines its method below. The calculations themselves are available in the Microsoft Excel spreadsheet DOE used to conduct the National Impact Analysis. As mentioned above, this spreadsheet is available at www.eere.energy.gov/buildings/appliance_standards/commercial/wicf.html.

The method employed in that spreadsheet is as follows. Although, as mentioned above, there are many possible combinations of types of shipments, regular patterns in these combinations allow for simpler analysis. Based on manufacturer interviews and DOE estimates, DOE assumes that the great majority of the WICF market will use equipment roughly corresponding to CSL 0 in the baseline. Based on the same sources, DOE also assumes that WICF consumers are unlikely to deliberately purchase equipment that exceeds any minimum efficiency standards (sometimes called a "shift" effect). Instead, DOE judges that consumers are likely to purchase equipment that exactly meets any efficiency standards established (a "roll-up" effect).

Therefore, it is possible to characterize the efficiency implications of any possible standard in a fairly concise manner. At any given point in time, all walk-ins will either:

- meet the baseline efficiency level (DOE assumes this for all walk-ins installed before the standard goes into effect),
- meet the efficiency standard (DOE assumes these for all new walk-ins installed after the standard goes into effect), or
- partially meet the standard (DOE assumes this for all walk-ins in which the refrigeration system is replaced after the standard goes into effect, but in which the old, pre-standard, envelope is still in use).

DOE projects that walk-in owners will retire their walk-ins primarily in case of mechanical failure, change of business ownership, or for style reasons in the case of some display units. Since none of these reasons to retire a walk-in are affected by efficiency standards, walk-ins should be replaced at the same rate under any efficiency standard. Therefore, DOE concludes that the share of walk-ins that are at the baseline level, at the standard level, or partially at the standard level is the same in every scenario. DOE's projections of how many walk-ins are in each of these three categories in any given year (in any scenario) are presented in Figure 10.2.1. This information is based on the market growth rates, expected lifetimes of envelopes and refrigeration systems, and initial age distribution of the WICF stock, all as outlined in the shipments analysis (preliminary TSD chapter 9).

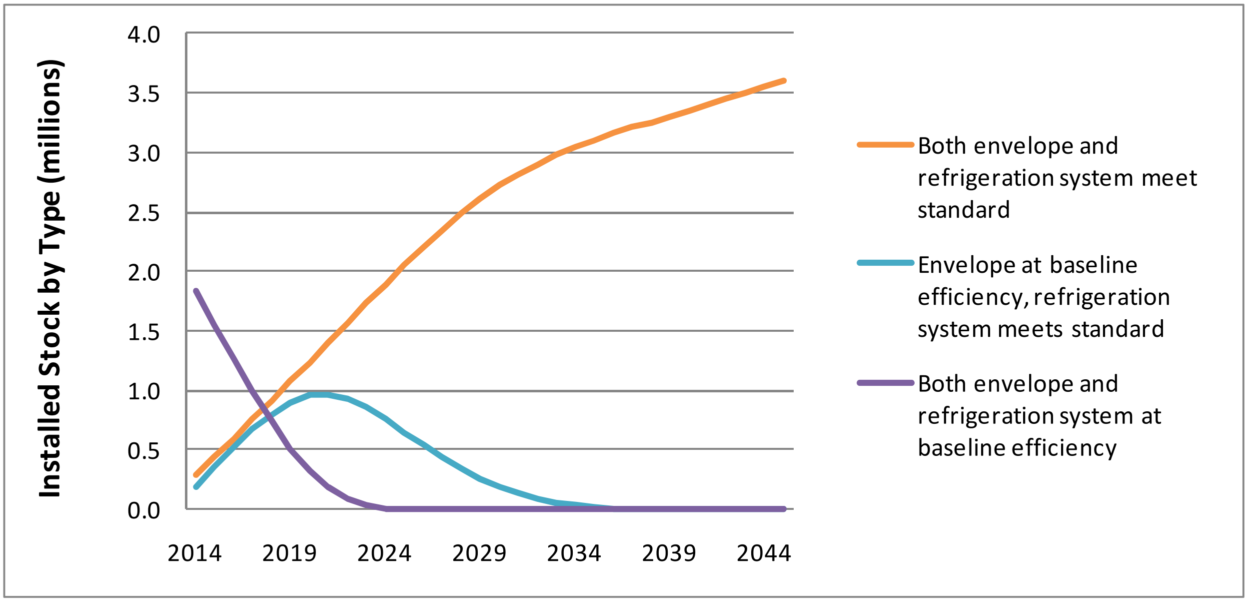

Figure 10.2.1 Walk-in Stock by Efficiency Level over Time

At each possible standard level, the total energy consumption and average efficiency of the stock can be determined by the information in Figure 10.2.1. At each possible combination of standard levels, the energy consumption of the WICF stock is the sum of the energy consumption of all baseline units, all units that meet the standard, and all units for which only the refrigeration system meets the standard. Those energy consumption levels vary by equipment class, but can be found in the energy use characterization (preliminary TSD chapter 6). The average efficiency is simply the total energy consumption divided by the size of the stock.

10.3 NATIONAL ENERGY SAVINGS

10.3.1 National Energy Savings Definition

DOE calculates annual national energy savings as the difference in annual national energy consumption (AEC) between the base case (without standards) and the standards case (with standards), adjusted by several factors. These factors are a heating, ventilation, and air conditioning (HVAC) factor, rebound factor, site-to-source conversion factor, and a discount factor. These are all described in sections 10.3.1.2 through 10.3.1.4. All together, the equation for calculating national energy savings takes this form:

$$NES_t = (AEC_{t,base} - AEC_{t,std}) \times src\_conv \times HVAC \times RF \times DF_t \quad \textbf{Eq. 10.1}$$

Where:

NES_t = national energy savings (in quads of source energy) in the year t,
AEC_t = annual national energy consumption each year (in kilowatt-hours [kWh] of electricity consumed onsite),
src_conv = conversion factor to convert from site energy (kWh) to source energy (quads, Btu/kWh),

HVAC	=	heating, ventilation, air conditioning factor,
RF	=	rebound factor,
DF_t	=	discount factor in the year *t*,
t	=	year in the forecast (*e.g.*, 2020 or 2030),
base	=	base case, and
std	=	standards case.

DOE defines the cumulative national energy savings as the sum of the national energy savings in each year of the analysis period, *i.e.*, from 2015 to 2045.

DOE calculated the AEC in any given year by multiplying the annual unit energy consumption for each type of walk-in (*i.e.*, each possible equipment class and efficiency level) by the number of walk-ins in stock that year of that type. This is shown in the following equation:

$$AEC_t = \sum_{PC,CSL} (UEC_{PC,CSL} \times STOCK_{PC,CSL,t}) \quad \textbf{Eq. 10.2}$$

Where:

UEC_{PC}	=	unit energy consumption (kWh per year),
$STOCK_{PC,t}$	=	the number of walk-ins of that type in stock in that year,
EC	=	a given combination of equipment classes, *e.g.*, small non-display cooler with small indoor medium-temperature dedicated system, and
CSL	=	a given combination of CSLs, *e.g.*, CSL 5 for the envelope and CSL 7 for the refrigeration system.

The terms of this equation are explained in the following section.

10.3.2 National Energy Savings Inputs

Table 10.3.1 lists the inputs for determining the NES.

Table 10.3.1 National Energy Saving Inputs

Input
Unit Energy Consumption by Walk-in Type and CSL ($UEC_{PC,CSL}$)
Walk-in Stock by Walk-in Type, CSL, and year ($STOCK_{PC,CSL,t}$)
Site-to-Source Conversion Factor (*src_conv*)
Heating, Ventilation, Air Conditioning Factor (*HVAC*)
Rebound Factor (*RF*)
Discount Factor (*DF*)

10.3.1.1 Unit Energy Consumption (UEC) and Walk-in Stock by Walk-in Type

Walk-in UEC and stock by type are inputs to the National Energy Savings calculation that are both described elsewhere in this preliminary TSD. UEC is described in the energy use characterization (preliminary TSD chapter 6). Stock is described above in section 10.2.1 and in the shipments analysis (preliminary TSD chapter 9).

10.3.1.2 Site-to-Source Conversion Factors

Because walk-ins are powered by electricity, the amount of energy they consume indirectly at the point of electricity generation is greater than the amount of energy they use directly. To account for this, DOE uses a site-to-source conversion factor to convert its estimates of onsite energy consumption (in the form of electricity) into primary or source energy consumption (in the form of, *e.g.,* fossil fuels). This conversion factor depends on the generation sources used to produce electricity, which can vary over time. For the preliminary analysis, DOE used a site-to-source conversion factor of 10,147 Btu/kWh, which is the average site-to-source conversion factor of a concurrent rulemaking that applies to the same analysis period. During the next phase of the analysis, DOE intends to derive new site-to-source conversion factors specific to each year of this analysis using the version of the Building Technologies version of the National Energy Modeling Systems (NEMS-BT) that will correspond to the 2010 version of the Energy Information Administration's *Annual Energy Outlook* (*AEO 2010*).[1]

10.3.1.3 Interactions with Heating, Ventilation, and Air-Conditioning (HVAC) Systems

The heat output from a walk-in interacts with the functioning of the HVAC systems in its building. Walk-ins of greater efficiency may produce slightly less heat, altering that interaction. Theoretically, this might change the walk-in's interaction with the building's HVAC systems. However, the models that can capture this interaction have not been developed to an adequate degree. Therefore, DOE assumed that this interaction was not substantial and that estimating its precise nature and extent was not feasible. In large part, this is because most walk-ins are cooled by outdoor compressors, which reject their waste heat outside the building rather than inside. For this analysis, DOE assumed an HVAC factor of 1, or no measurable effect.

10.3.1.4 Rebound Factor

Under economic theory, a "rebound effect" refers to the tendency of a consumer to respond to the cost savings associated with more efficient equipment in a manner that actually leads to marginally greater equipment usage, thereby diminishing some portion of anticipated benefits related to improved efficiency. This typically manifests in the tendency for consumers to either make more frequent use of equipment that is highly efficient (*e.g.*, leaving efficient lights on more often) or adjusting equipment for greater thermal comfort (*e.g.*, turning the thermostat on a more efficient furnace up a degree). However, because walk-ins must cool their contents at all times, it is not possible for consumers to operate them more frequently. And because most walk-ins operate within a narrow thermal range that is determined by sanitary and other non-comfort reasons, it is unlikely that consumers would significantly decrease the operating temperature of their walk-ins simply because the units were more efficient. For this analysis, DOE assumed a rebound factor of 1, or no effect.

10.3.1.5 Discount Factor

DOE multiplies the value of energy savings in future years by the discount factor (DF) to calculate the present value of these energy savings. The following equation describes how to calculate the discount factor for any given year:

$$DF = 1/(1+r)^{(t-t_p)}$$ **Eq. 10.3**

Where:

r = discount rate,
t = year of the monetary value, and
t_p = year in which the present value is being determined.

DOE provides results calculated with both a 3-percent and a 7-percent real discount rate, in accordance with the Office of Management and Budget's (OMB's) guidance to Federal agencies on the development of regulatory analysis (OMB Circular A-4, September 17, 2003),[2] and section E, "Identifying and Measuring Benefits and Costs," therein. These discount rates are based on estimates of the average real rate of return on private investment in the U.S. economy. DOE defined the present year as 2010 (the current year) for this preliminary analysis.

10.4 NET PRESENT VALUE

10.4.1 Net Present Value Definition

An NPV is the value in the present of a series of costs and savings over time. The NPV presented here is the value in the present of the total changed in purchase costs and operating costs that DOE forecasts WICF consumers would face from energy conservation standards on walk-ins. Note that this is not the same as the sum of all costs and benefits from such standards, *e.g.* environment benefits or costs of this rule are not included in the NPV calculation. The NPV is calculated as follows:

$$NPV = PVS - PVC$$ **Eq. 10.4**

Where:

PVS = present value of the total operating cost savings over time, and
PVC = present value of the total increase in installed costs over time.

The *PVS* and *PVC* are determined according to the following expressions:

$$PVS = \sum_t (OCS_t \times DF_t)$$ **Eq. 10.5**

$$PVC = \sum_t (ICS_t \times DF_t)$$ **Eq. 10.6**

Where:

OCS_t = total operating cost savings in year t,
ICS_t = total installed cost increases in year t,
DF_t = discount factor in year t, and
t = year (*PVS* and *PVC* are summed over 2015-2044).

DOE determined the contributions to PVC and PVS for each year from the effective date of the standard, 2015, to 2045, discounted for the preliminary analysis to the present year (2010). DOE calculated costs and savings as the difference between a standards case (*i.e.*, with standards) and a base case (*i.e.*, without standards). DOE calculated a discount factor from the discount rate and the number of years between the "present" (*i.e.*, 2010, the year to which the sum is being discounted) and the year in which the costs and savings occur. DOE calculated the net present value as the sum over time of the discounted net savings (which is equivalent to the approach shown in equations 10.4 through 10.6).

10.4.2 Net Present Value Inputs

Table 10.4.1 summarizes the inputs to the NPV calculation.

Table 10.4.1 Net Present Value Inputs

Input
Total Installed Cost Increases (ICS_t)
Total Annual Operating Cost Savings (OCS_t)
Discount Factor (*DF*)

10.4.2.1 Total Annual Installed Cost Increases

DOE calculates the increase in total annual installed costs as the difference between the total annual installed costs in the standards case minus those in the base case. This is shown in the following equation:

$$ICS_t = (IC_{t,base} - IC_{t,std}) \qquad \textbf{Eq. 10.7}$$

where:

ICS_t = the total installed cost increases in the year t,
$IC_{t,base}$ = the total installed cost in the year t in the base case, and
$IC_{t,std}$ = the total installed cost in the year t in the standards case.

DOE determines the total installed cost (IC) in each year by adding up the product of annual operating cost for each type of walk-in (*i.e.*, each possible equipment class and efficiency level) by the number of walk-ins shipped that year of that type. This is shown in the following equation:

$$ICS_t = \sum_{PC,CSL} (IC_{PC,CSL} \times SHIP_{PC,CSL,t}) \qquad \textbf{Eq. 10.8}$$

where:

$IC_{PC,\,CSL}$ = the installed cost for a particular type (equipment class and CSL) of walk-in, and
$SHIP_{PC,\,CSL}$ = shipments of walk-ins of that type in year t.

Installed cost numbers are calculated in the life cycle cost analysis (preliminary TSD chapter 8). Shipments are calculated in the shipments analysis (preliminary TSD chapter 9), as noted above.

10.4.2.2 Total Annual Operating Cost Savings

DOE calculated the total annual operating cost savings in the same manner as the total installed cost increase, *i.e.*, as the difference between the total annual installed costs in the standards case minus those in the base case. The equation takes the same form as equation 10.7, so it is not shown here to avoid redundancy. Similarly, DOE determines the total operating cost (TOC) in each year by adding up the product of annual operating cost for each type of walk-in (*i.e.*, each possible equipment class and efficiency level) by the number of walk-ins in stock that year of that type. This equation takes the same form as equation 10.8, except that operating cost savings are calculated based on the size of the walk-in stock in a given year rather than the number of walk-in shipments in that year.

Operating cost numbers are calculated in the life cycle cost analysis (preliminary TSD chapter 8). As described in chapter 8, the major component of operating cost is electricity costs, though other components, such as maintenance costs, are also included. Stock is calculated in the shipments analysis (preliminary TSD chapter 9), as noted above.

10.5 NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE RESULTS

The NIA spreadsheet model provides estimates of the NES and NPV due to various CSLs. The inputs to the NIA spreadsheet are discussed in sections 10.3.2, National Energy Savings Inputs, and 10.4.2, Net Present Value Inputs.

Table 10.5.1 summarizes the inputs to the spreadsheet model that calculates the NES and NPV. A brief description of the data is given for each input. As noted above, the model is freely available online at www.eere.energy.gov/buildings/appliance_standards/commercial/wicf.html.

Table 10.5.1 National Energy Saving and Net Present Value Inputs

Input Data	Data Description
Walk-ins Stock	The initial stock is taken from the Shipments Model (preliminary TSD chapter 9). This model is based on estimated historical shipments based on Commercial Buildings Energy Consumption Survey 2007[3] data and U.S. Census Bureau Current Industrial Reports data[4], DOE and manufacturer estimates of walk-in lifetime, and forecasted growth rates from the Annual Energy Outlook 2009 and the U.S. Census of Agriculture[5].
Shipments	Annual shipments from the walk-in Shipments Model (preliminary TSD chapter 9). Sources are the same as for stock estimates.
Effective Date of Standard	2015
Analysis Period	2015 to 2045
Unit Energy Consumption (kWh/yr)	Established in the Energy-Use Characterization (preliminary TSD chapter 6) by walk-in type and CSL.
Total Installed Cost	Established in the Markups Analysis (preliminary TSD chapter 7) and the LCC Analysis (preliminary TSD chapter 8) by walk-in type and CSL.
Electricity Price Forecast	EIA forecasts (to 2030) from the *AEO2009* (April version*)[6] and extrapolation for beyond 2030.[7]
Electricity Site-to-Source Conversion	Based on a concurrent preliminary TSD, based on *AEO2008*[8] forecasts (to 2030) of electricity generation and electricity-related losses. DOE intends to derive new estimates for the notice of proposed rulemaking (NOPR) stage.*
HVAC Interaction Savings	Negligible.
Rebound Effect	Negligible.
Discount Rate	3 and 7 percent real.
Present Year	2010.

*While this analysis will rely on the most recent (2010) version of the *AEO* for the NOPR stage, that version was not available in time for the preliminary analysis.

10.5.1 National Energy Savings Summary Results

The following section provides summary NES results. Results are cumulative to 2045 and are shown as primary energy savings measured in quads at particular combinations of equipment classes and CSLs. More detailed NES results are provided in appendix 10A.

Table 10.5.2 and Table 10.5.3 show summary NES results. Results are shown for selected CSLs. There is one matched combination of envelope and refrigeration system CSLs per matched combination of WICF envelopes and refrigeration equipment classes. The selection criteria are as follows. The selected CSLs in the table are those for the highest primary energy savings for which the net present value is a positive number (at a 7-percent discount rate). In other words, the tables show the maximum possible energy savings for each equipment class that would result in a net financial benefit to WICF users. In many cases, this corresponds to the highest CSL considered for both the envelope and the refrigeration system. This is because most of the CSLs analyzed in this rulemaking are associated with positive net present values. In cases where more than one possible combination of CSLs provides the same energy savings at positive LCC savings, the lowest possible combination of CSLs that can provide those savings is selected.

The tables are laid out as follows. For conciseness, each table presents three numbers for each equipment class. The top number is the maximum energy savings in quads. The lower numbers are the CSLs at which these energy savings are achieved—envelope CSL on the left, refrigeration system CSL on the right. The first table shows results calculated at a 7-percent discount rate, and the second shows results calculated at a 3-percent discount rate.

Table 10.5.2 Maximum Energy Savings for Which Net Present Value of Savings Are Greater than Zero at a 7 Percent Discount Rate and Corresponding CSLs (2015-2045)

Envelope Equipment Class	**Maximum Energy Savings (quads) and CSLs for Envelope and Refrigeration Unit (a,b)**					
	Refrigeration System Equipment Class					
	Dedicated Indoor Small	**Dedicated Indoor Large**	**Dedicated Outdoor Small**	**Dedicated Outdoor Large**	**Multiplex System Small**	**Multiplex System Large**
Non-Display Cooler Small	0.02 13,7	-	0.09 13,8	-	0.00 10,3	-
Non-Display Cooler Medium	-	0.08 13,7	-	0.36 13,8	-	0.24 10,3
Non-Display Cooler Large	-	-	-	0.62 15,8	-	0.16 11,3
Display Cooler Small	-	0.00 15,7	-	0.02 15,8	-	-
Display Cooler Medium	-	-	-	-	-	0.56 15,3
Display Cooler Large	-	-	-	0.42 15,8	-	-
Non-Display Freezer Small	0.04 15,8	-	0.19 15,9	-	0.01 15,4	-
Non-Display Freezer Medium	-	0.15 15,8	-	0.64 15,9	-	0.44 15,4
Non-Display Freezer Large	-	-	-	0.78 15,9	-	0.23 15,4
Display Freezer Small	-	-	-	0.10 15,9	-	-
Display Freezer Medium	-	-	-	-	-	0.46 4,3
Display Freezer Large	-	-	-	0.51 10,8	-	-

Table 10.5.3 Maximum Energy Savings for Which Net Present Value of Savings are Greater than Zero at a 3 Percent Discount Rate and Corresponding CSLs (2015-2045)

Envelope Equipment Class	Maximum Energy Savings (quads) and CSLs for Envelope and Refrigeration Unit (a,b)					
	Refrigeration System Equipment Class					
	Dedicated Indoor Small	Dedicated Indoor Large	Dedicated Outdoor Small	Dedicated Outdoor Large	Multiplex System Small	Multiplex System Large
Non-Display Cooler Small	0.04 13,7	-	0.18 13,8	-	0.01 10,3	-
Non-Display Cooler Medium	-	0.16 13,7	-	0.74 13,8	-	0.51 10,3
Non-Display Cooler Large	-	-	-	1.26 15,8	-	0.34 11,3
Display Cooler Small	-	0.01 15,7	-	0.04 15,8	-	-
Display Cooler Medium	-	-	-	-	-	1.18 15,3
Display Cooler Large	-	-	-	0.87 15,8	-	-
Non-Display Freezer Small	0.09 15,8	-	0.40 15,9	-	0.01 15,4	-
Non-Display Freezer Medium	-	0.32 15,8	-	1.32 15,9	-	0.94 15,4
Non-Display Freezer Large	-	-	-	1.61 15,9	-	0.50 15,4
Display Freezer Small	-	-	-	0.21 15,9	-	-
Display Freezer Medium	-	-	-	-	-	1.00 4,4
Display Freezer Large	-	-	-	1.05 10,7	-	-

10.5.2 Net Present Value Summary Results

Table 10.5.4 and Table 10.5.5 provide summary NPV results. Results are cumulative to 2045 and are shown in billion 2009 dollars. The tables are laid out in the same way as Table 10.5.2 and Table 10.5.3. As in those tables, one CSL combination is shown per equipment class combination, and in each case, it is the same CSL combination as was shown for the tables above; *i.e.*, net present values are shown for the CSL that generates the maximum energy savings at a positive net present value.

The NPV summary results vary more widely that the NES summary results, from 0.01 billion $2009 to 7.90 billion 2009$. However, this is not necessarily a reflection of greater variation in NPV results than in NES results. Rather, it is simply a result of the way in which summary results are presented. As noted above, the CSL combinations used in these summary tables are selected on the basis of maximum NES rather than maximum NPV. Therefore, the

NES summary numbers vary less widely than the NPV summary numbers. This does not apply, however, to the detailed NPV results. Those are presented in appendix 10B.

Table 10.5.4 Net Present Value at Maximum Level of Energy Savings for Which Net Present Value is Greater than Zero at a 7-Percent Discount Rate and Corresponding CSLs

Envelope Equipment Class	NPV (Billion 2009$) and Corresponding CSLs for Envelope and Refrigeration Unit (a,b)					
	Refrigeration System Equipment Class					
	Dedicated Indoor Small	Dedicated Indoor Large	Dedicated Outdoor Small	Dedicated Outdoor Large	Multiplex System Small	Multiplex System Large
Non-Display Cooler Small	0.08	-	0.29	-	0.01	-
	13,7		13,8		10,3	
Non-Display Cooler Medium	-	0.15	-	0.90	-	0.21
		13,7		13,8		10,3
Non-Display Cooler Large	-	-	-	0.52	-	0.29
				15,8		11,3
Display Cooler Small	-	0.05	-	0.24	-	-
		15,7		15,8		
Display Cooler Medium	-	-	-	-	-	3.05
						15,3
Display Cooler Large	-	-	-	6.56	-	-
				15,8		
Non-Display Freezer Small	0.53	-	2.29	-	0.03	-
	15,8		15,9		15,4	
Non-Display Freezer Medium	-	1.52	-	6.44	-	1.22
		15,8		15,9		15,4
Non-Display Freezer Large	-	-	-	7.90	-	0.75
				15,9		15,4
Display Freezer Small	-	-	-	0.05	-	-
				15,9		
Display Freezer Medium	-	-	-	-	-	0.08
						4,3
Display Freezer Large	-	-	-	0.09	-	-
				10,8		

Table 10.5.5. Net Present Value at Maximum Level of Energy Savings for Which Net Present Value is Greater than Zero at a 3-Percent Discount Rate and Corresponding CSLs

Envelope Equipment Class	NPV (Billion 2009$) and Corresponding CSLs for Envelope and Refrigeration Unit (a,b)					
	Refrigeration System Equipment Class					
	Dedicated Indoor Small	Dedicated Indoor Large	Dedicated Outdoor Small	Dedicated Outdoor Large	Multiplex System Small	Multiplex System Large
Non-Display Cooler Small	0.19 13,7	-	0.67 13,8	-	0.02 10,3	-
Non-Display Cooler Medium	-	0.41 13,7	-	2.25 13,8	-	0.87 10,3
Non-Display Cooler Large	-	-	-	1.91 15,8	-	0.85 11,3
Display Cooler Small	-	0.10 15,7	-	0.47 15,8	-	-
Display Cooler Medium	-	-	-	-	-	6.63 15,3
Display Cooler Large	-	-	-	13.38 15,8	-	-
Non-Display Freezer Small	1.08 15,8	-	4.65 15,9	-	0.07 15,4	-
Non-Display Freezer Medium	-	3.16 15,8	-	13.30 15,9	-	3.42 15,4
Non-Display Freezer Large	-	-	-	16.33 15,9	-	2.06 15,4
Display Freezer Small	-	-	-	0.05 15,9	-	-
Display Freezer Medium	-	-	-	-	-	0.00 4,4
Display Freezer Large	-	-	-	0.06 10,7	-	-

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