CHAPTER 9. SHIPMENTS ANALYSIS

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CHAPTER 9. SHIPMENTS ANALYSIS

9.1 INTRODUCTION

This chapter describes the U.S. Department of Energy's (DOE)'s methodology for projecting annual shipments of beverage vending machine (BVM) equipment and presents results of the analysis. BVM equipment shipment estimates are a necessary input to the national energy savings (NES) and net present value (NPV) calculations and the manufacturer impacts analysis (MIA).

According to an analysis of the BVM market,[1] there were about 3.67 million beverage vending machines in the United States in 2005. According to industry estimates, about 5 percent of these units are Class A machines intended for indoor use only, while 95 percent of these units are Class B machines that are intended for either indoor or outdoor use. Annual shipments have decreased from about 338,000 in the year 2000 to under 100,000 in 2006 (DOE estimates that the total of 2006 shipments was about 67,000 units). The industry estimates that about 10 percent of units shipped were Class A units, while 90 percent of units shipped are Class B machines, intended for either indoor or outdoor use.[2] DOE considered the fact that there may be Class A machines intended for either indoor or outdoor use as well as some Class B machines that are intended for indoor use only; however, DOE was not able to locate any sales data for these two equipment application scenarios, so their sales are assumed to be zero. So, although some Class A machines may be used outdoors, for the purposes of the ANOPR analysis, DOE assumes that all Class A machines are used indoors. Industry sources estimate that about 75 percent of Class B units are used indoors and 25 percent are used in outdoor locations.

9.2 MARKET SEGMENTS

BVMs come in a number of different sizes. DOE was not able to locate any market data concerning shipments by size (unit vending capacity); therefore, the shipments analysis focused on three sizes believed to be typical, each of which is assumed to be about one-third of the market for Class A units: large (410 12-oz. cans), medium (350 cans) and small (270 cans), and for Class B units: large (800 cans), medium (650 cans), and small (450 cans). BVMs are owned by a number of different business types and are used in many different kinds of business locations BVM units are divided into several market segments. Table 9.2.1 gives the business locations as well as the approximate size of market segments of the BVMs for the years 2002-2005.

Table 9.2.1 Market Segments for the U.S. BVM Market in the Years 2002-2005

Business Location	Percent of Units	Ownership	Percent of Units
Manufacturing	30.4%	Bottlers and Vendors	75.0%
Offices	23.1%	Business-Owned	25.0%
Retail	13.6%	Manufacturing	7.6%
Schools/Colleges	13.0%	Offices and Health Care	7.3%
Health Care	6.1%	Retail/Restaurants/ Bars/Clubs	4.1%
Hotels/Motels	3.0%	Schools, Colleges,	3.8%

		and Public Facilities (including correctional)	
Restaurants/Bars/ Clubs	2.6%	Military Bases	0.5%
Correctional Facilities	2.3%	Other (including hotels/motels)	1.8%
Military Bases	1.9%	Subtotal, Site Owned	25.0%
Other	4.0%	Total	100.0%
Total	100.0%		

Source: State of the Vending Industry (2006)[1]

Sales of BVM equipment have been decreasing at the rate of about 24 percent per year from 2000 to 2005. DOE assumed that all shipments after the year 2000 (about 630,000 units) were for replacement only. Even so, the stock of BVM units was estimated to have fallen from about 4.2 million units in the year 2000 to about 3.67 million units in 2005. Market shrinkage is now believed to have stopped and DOE assumes that future sales of new units will increase roughly in proportion to population growth (about 2 percent per year). Future replacement sales of standard units is limited by the total existing number installed and their age distribution.

The shipments analysis results are driven primarily by historical shipments data for the four equipment classes BVM equipment. The flow chart presented in Figure 9.2.1 outlines the structure of the shipments analysis model.

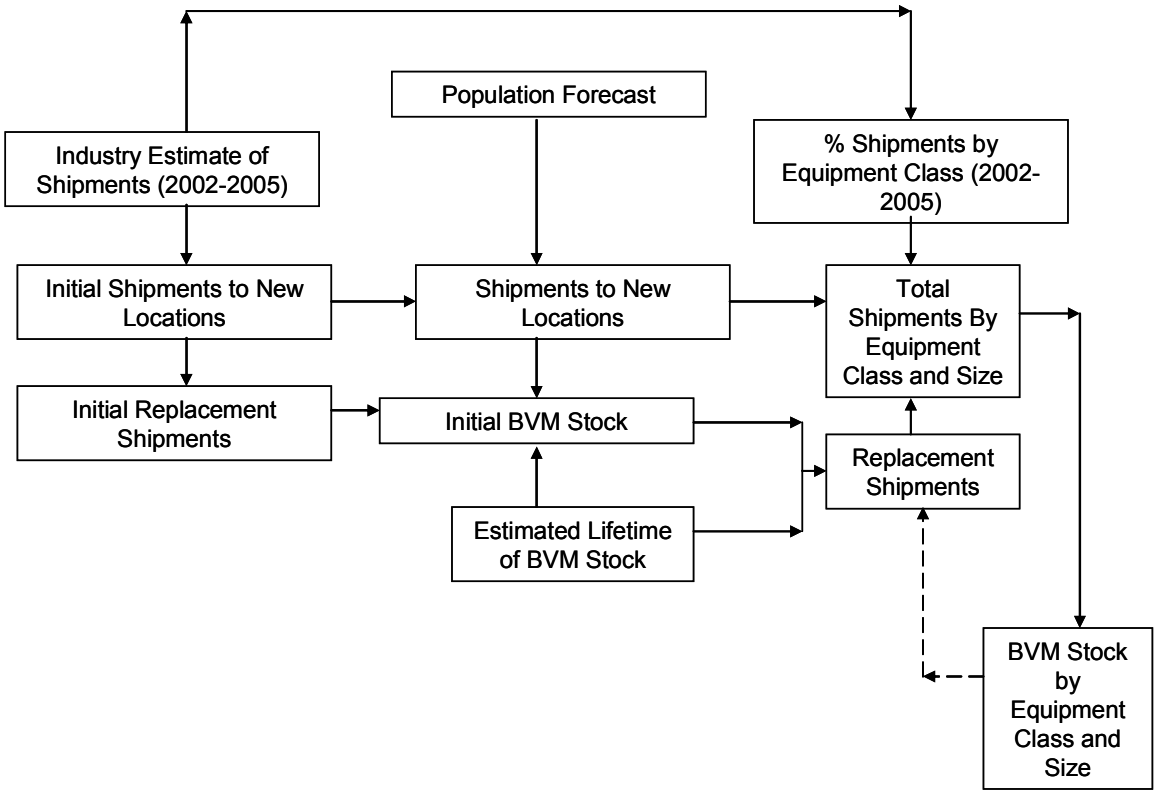

Figure 9.2.1 Flow Chart Showing Inputs to the Shipments Analysis Model

The analysis model assumes that, in each year, the existing BVM equipment stock either ages by one year or breaks. Broken equipment is replaced. In addition, new equipment can be shipped into new commercial floor space, and old equipment can be removed (not shown in the diagram).

The balance of this chapter explains the shipments analysis in more detail. Section 9.3 presents the mathematical formulation of the model, section 9.4 describes the data inputs to the model, and section 9.5 presents the results for different efficiency level scenarios.

Shipments forecasts were determined for all of the candidate standard levels for which NES and NPV are required. DOE is considering up to eight candidate standard levels for each of the four equipment classes and three sizes.

9.3 SHIPMENTS ANALYSIS MODEL EQUATIONS

The shipments analysis model is a description of BVM equipment stock flows as a function of year and age. While there are two equipment classes, no coupling is assumed between them, so the equations describe each type of equipment independently. The shipments analysis is conducted using a Microsoft Excel spreadsheet (NES spreadsheet) that is accessible on the Internet. Chapter 10 of this TSD discusses how to access the spreadsheet and other related spreadsheets and provides basic instructions for using them.

Section 9.3.1 defines the different BVM equipment stock categories. DOE formulated the equations as updates of the distribution of stock in year t as a function of age a to year $t+1$. Then DOE presented the different purchase decisions and, in section 9.3.2, provided a description of the data sources. DOE used this calculation of existing stock, and the average age of the equipment, as a basis for calculating replacement sales in section 9.3.2.1. Then, in section 9.3.2.2 DOE subtracted replacement sales from historical total sales statistics to calculate the new sales of new BVM equipment. DOE forecasted new sales as a function of population, which is assumed to result in new business locations for BVMs. Sales of new and replacement equipment are recorded by the year sold, and each annual vintage is depreciated over the estimated life of the equipment (approximately 14 years). Sales in each year are allocated to the two equipment classes in proportion to their relative historical sales.

9.3.1 Mathematical Formulation of the Shipments Model

DOE uses two BVM equipment stock categories. The category $U_0(t,a)$ is the stock of existing units. Available information suggests that all units have had normal repairs that do not affect the lifetime of the equipment.

Beverage vending machine equipment lifetimes range from one year to as many as 20 years, but based on discussions with industry, the typical value is 14 years, based on discussions with industry contacts and that the industry practice that BVM equipment is withdrawn from service and renovated at 3-5 year intervals, with two renovation cycles. Most equipment is not renovated a third time (see chapter 8 for further details). Also, data obtained from multiple industry and government sources suggests that the initial existing stock of equipment is assumed to have an initial replacement rate of about 5 percent per year, based on

the 14-year lifetime of a unit of equipment, and the historical annual replacements for the past 10 years. The total stock of age *a* in a given year *y* is represented by

$$U(t,a) = U_0(t,a) \qquad \textbf{Eq. 9.1}$$

and the average age of the stock in year *y* is defined as

$$StockAge(y) = \sum_a U(t, a) \times a / \sum(U(t,a)) \qquad \textbf{Eq. 9.2}$$

where:

$U(t,a)$	= total stock of age *a* in a given year *t*
$U_0(t,a)$	= stock of existing units
$StockAge(y)$	= average age of stock in year *y*
a	= age of stock in years
t	= year.

The shipments of new stock in a given year are *Uship(t)*. By definition, the age of the equipment is zero in the year that it is shipped, so that *Uship(t) = U(t,0)*.

9.3.2 Stock Events

In the transition from year *t* to year *t+1*, two things could happen to the stock of beverage vending machines:

- existing equipment could break or be removed and be replaced, or
- the stock could simply age by one year.

In the model, early replacements (i.e., existing equipment that is replaced before the end of its useful life) are not considered, and all broken equipment are replaced. The following sections present the equations used to represent each possible event.

9.3.2.1 Replacing Equipment

DOE determined the probability that BVM equipment of age *a* from stock U_0 will break or will be replaced before the end of their useful lifetime using a known function $PB_0(a)$ (based on the average age of BVM equipment *a* and Weibull statistical distribution). Similarly, the probability that equipment of age *a* from stock U_1 will break is given by a known function $PB_1(a)$. These probabilities do not depend on the model year *t*. DOE defines the quantities of replaced existing equipment as

$$UB(t, a) = PB_0(a) \times UB_0(t,a) \qquad \textbf{Eq. 9.3}$$

where:

$UB(t,a)$	= stock of existing units
$PB_0(a)$	= probability that stock of existing units will break, or will be replaced
$UB_0(t,a)$	= stock of existing units in year 0

a = age of stock in years
t = year.

All broken units are assumed to be replaced.

9.3.2.2 New Equipment

As shown in Table 9.2.1, new BVM equipment will be purchased to replace BVM equipment as described above and to serve increased numbers of customers at existing as well as new geographical locations which results in new unit locations. Available information suggests that the purchase of new BVM equipment serving new customers in new locations is driven by the rate of population growth.

By definition:

$$E(t) = E(t\text{-}1) + NE(t) - RE(t) \qquad \textbf{Eq. 9.4}$$

where:

E(t-1) = the unit locations in year *t-1*
NE(t) = the new unit locations in the year *t* (described in section 9.4.2)
RE(t) = the unit locations removed in year *t* (described in section 9.4.2).

The number of BVM units going into new buildings is

$$UN(t) = UN(t\text{-}1) \times A_0 \times (1+(E(t)/ E(t\text{-}1)) \qquad \textbf{Eq. 9.5}$$

where:

UN(t) = the number of units going into new locations in year t
A_0 = an overall scale factor which accounts for the number of units covered by the standard which are not used in all commercial building types. The default value for A_0 is 1.0, and values of 0.5 and 1.5 are used for sensitivity testing.

DOE has no information on the variation in the market saturation of BVM equipment by building type or over time. Therefore, in the model, the purchase of new equipment is driven by growth in customer population (assumed to be about 2 percent per year), the new units are allocated to building type according to historical percentage shares, and broken or removed equipment is replaced on a one-for-one basis.

9.4 DATA INPUTS

9.4.1 Historical Shipments

Historical shipments are critical to the development of the shipments model, since DOE used the historical data to calibrate the model. DOE's primary source of historical data for shipments of refrigeration equipment was data in an e-mail from NAMA, and the *State of the Vending Machine Industry* (2006). NAMA provided DOE with shipments data (from 1998 to 2006, there has been a reduction in shipments of 86.4%; also that Class A machines now

approach 10% of shipments and the trend is to increase this number as the number of beverages offered in containers of all shapes, sizes and material increases.) that allowed DOE to allocate sales of equipment to refurbished and new units and among the two equipment classes.[2]

9.4.2 Historical Shipped Units

Historical shipped units depict the annual amount of BVM equipment capacity introduced into the marketplace. DOE converted shipped units to percent of shipped units for use in the shipments analysis model, to establish the beverage vending machine market share attributed to each equipment class. The market share calculation and its use in forecasting shipments are explained in section 9.3.2.2. Table 9.4.1 presents the historical shipments of BVM equipment by capacity ranges and the year of shipment. The shipments analysis relies on the three sizes each of the two equipment classes to represent the BVM equipment market.

Table 9.4.1 Estimated Historical Shipments (Units Shipped) and Stock (Units) of BVM Equipment

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Estimated Shipments	372,000	477,000	338,000	150,000	150,000	100,000	90,000	73,000	67,300
Assumed Replacements	150,000	166,000	150,000	150,000	150,000	100,000	90,000	73,000	67,300
New Shipments	222,000	311,000	188,000	-	-	-	-	-	-
Estimated Stock	3,765,000	4,076,000	4,264,000	4,200,800	4,140,760	4,033,722	3,922,036	3,798,934	3,676,287

Table notes: Allocation of units to refurbished and new units is based on industry estimates of total stock
Source: State of the Vending Industry (2006) and DOE assumptions

The total of new beverage vending machines is the estimated total shipments in units for 2005, multiplied by an index of new unit locations for each future year. The average annual rate of change in the new unit locations between 2020 and 2030 (2.0 percent) is projected forward after 2030 until 2042, the last year in which BVM units are added. .

9.4.2.1 Market Shipments

DOE used the above shipments data to estimate the market shipments in year t of each BVM equipment class y (*MKTSHIP(t,y))* defined in terms of units shipped for both new and replacement markets. Because the percent of shipments in each equipment class is relatively constant over time and the lifetime of each equipment class is the same (14 years), the ratio of shipments to equipment class is indicative of the market share for that class (*MKT(y))*. DOE estimated the *MKT(y)* for a particular equipment class to be a constant value equal to the average of the yearly percent historical shipments for that equipment class. These percentages are 10 percent for Class A machines and 90 percent for Class B machines for the year 2005. Each equipment class was further divided into large, medium, and small sizes, each with a third of the market for the particular equipment class.

$$MKTSHIP(t,y) = MKT(y) \times (UN(t) + UB(t)) \quad \textbf{Eq. 9.6}$$

Where:

MKTSHIP(t,y) = total market shipments of equipment class *y* in year *t*
MKT(y) = percentage of total market shipments of equipment class *y*
UN(t) = total shipments to new locations in year *t*
UB(t) = total replacement shipments in year *t*

DOE estimated total sales by adding replacement sales to new sales in each year. DOE estimated the total number of units for each type that were replacement units. DOE assumed that new units last an average of 14 years, that their lifetimes follow a Weibull distribution (commonly assumed for equipment failure studies). The initial size of the existing stock was back-calculated. DOE set up an inventory accounting scheme to keep track of required replacements and the aging of new units as they are added to the inventory each year.

9.4.3 Equipment Price

Equipment price is the price paid by the customer for beverage vending machines. It includes both the purchase price of the equipment and installation costs. As discussed in the engineering analysis (chapter 5) and the life-cycle cost and payback period analysis (chapter 8), equipment prices in this analysis are a function of efficiency (or reduced energy consumption). DOE based equipment price projections on potential equipment efficiency options, but did not develop estimates of market trends in efficiency. DOE developed an efficiency mix for the base case (i.e., the case without new efficiency standards) and for each standard efficiency level. The standard efficiency levels are discussed in detail in chapter 10.

9.5 RESULTS

Table 9.5.1 shows the forecasted shipments for BVM equipment classes for the baseline efficiency level (Level 1) for selected years from 2012 to 2042. As equipment purchase price increases with efficiency, a drop in shipments would be expected. Although there is a provision in the shipments analysis spreadsheet for a change in shipments as the efficiency level increases, DOE had no information with which to calibrate such a relationship. Therefore, for the ANOPR analysis, DOE presumed that shipments do not change with efficiency level.

Table 9.5.1 also shows the cumulative shipments for BVM equipment for the entire 31-year period from 2012 to 2042.

Table 9.5.1 Forecasted Shipments for BVM Equipment (Baseline Efficiency, Level 1) for Selected Years (thousands of units shipped)

Equipment Class	Thousands of Units Shipped								
	2012	2015	2020	2025	2030	2035	2040	2042	Cumulative Shipments (2012-2042)
A-L-IN	7.7	7.6	7.9	8.3	8.8	9.2	9.7	9.9	265.9
A-M-IN	7.7	7.6	7.9	8.3	8.8	9.2	9.7	9.9	265.9
A-S-IN	7.7	7.6	7.9	8.3	8.8	9.2	9.7	9.9	265.9
B-L-IO	77.6	77.0	79.8	84.2	88.8	93.4	98.4	100.5	2,688.3
B-M-IO	77.6	77.0	79.8	84.2	88.8	93.4	98.4	100.5	2,688.3
B-S-IO	77.6	77.0	79.8	84.2	88.8	93.4	98.4	100.5	2,688.3

REFERENCES

[1] Automatic Merchandiser. 2006. *State of the Vending Industry Report*. www.amonline.com, August 2006.
[2] Eils, Larry (NAMA). 2007. e-mail message saying that shipments have reduced by 86.4% from 1998 to 2006; and also that glass fronts now approach 10% of shipments and the trend is to increase this number, dated May 24, 2007.