Codes and Standards Enhancement Initiative
For PY2003: Title 20 Standards Development

Analysis of Standards Options For Residential Clothes Washers

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1. Introduction

The Pacific Gas and Electric Company (PG&E) Codes and Standards Enhancement (CASE) Initiative Project seeks to address energy efficiency opportunities through development of new and updated Title 20 standards. Individual reports document information and data helpful to the California Energy Commission (CEC) and other stakeholders in the development of these new and updated standards. The objective of this project is to develop CASE Reports that provide comprehensive technical, economic, market, and infrastructure information on each of the potential appliance standards. This CASE report covers standards and options for residential clothes washers.

2. Product Description

In this report, a residential clothes washer shall mean an "Automatic clothes washer" as described by California Appliance Efficiency Regulations (Title 20)[1] that is also a federally regulated consumer product. Residential clothes washers consist of a cabinet containing a sealed outer tub and an inner tub that spins. Agitation is accomplished by a central agitator in vertical axis washers or fins or ridges on the inside of the inner wash tub in the case of horizontal axis tubs. Residential washers generally are "soft mounted" which means that they are not mechanically affixed to the floor and generally utilize pumps to drain water from the wash tub (rather than gravity flow).

Clothes washer size or capacity is expressed in volume (cubic feet) of the inner washtub and is a proximate indicator of wash load capacity. "Compact clothes washers" are defined by Title 20 as having a tub capacity of less than 1.6 cubic feet. Standard sized residential clothes washers' capacities average approximately three cubic feet on a shipment-weighted basis (AHAM, 2003a). While unusual just a decade ago, sales of horizontal axis washers (usually front-loading) have increased dramatically and likely hold over 10 percent of the market (assuming that over half of the 20 percent of Energy Star washers sold are horizontal axis)[2].(EPA, 2003a)

The most current energy efficiency metric established for residential clothes washers is called the modified energy factor (MEF) and is expressed in terms of cubic feet of tub volume divided by the energy use (kWh) per average cycle. Energy consumption attributed to clothes washers using the MEF metric includes energy for water heating, whether in an external water heater or from internal heating elements, motors and controls, and a calculated estimate of energy required to dry the load in a conventional clothes dryer after the wash cycle is complete. Clothes washer water efficiency is generally reported in terms of water factor (WF), which is expressed in gallons of water used per average cycle divided by the cubic feet of capacity.

[1] '"Automatic clothes washer" means a clothes washer that has a control system that is capable of scheduling a pre-selected combination of operations, such as regulation of water temperature, regulation of the water fill level. And performance of wash, rinse, drain and spin functions without the need for user intervention subsequent to the initiation of machine operation..." California Energy Commission, P400-03-016, April 2003, pg. 26.

[2] Most horizontal-axis Energy Star washers are relatively water efficient, where as some but not all Energy Star qualified vertical axis washers are water efficient.

3. Market Status

3.1. Market penetration

Market penetration of residential clothes washers is very high nationally and in California. EPRI research found that national penetration was 80 percent of all households (EPRI, 1998). Recent research in California shows that overall penetration in the State is approximately 80 percent with penetration in single story, single family homes exceeding 96 percent (RLW, 2000). Based on the U.S. Census Bureau's estimate of households in California in 2002 (12,508,000) and the 80 percent saturation, there are an estimated ten million residential washers in California homes. (US Census Bureau, 2003)

3.2. Sales Volume

In the year 2002, over seven million residential washers were shipped in the United States (AHAMb 2003). Based on the average annual nation sales over the last four years of 7.48 million units and using California's proportion of national population (12 percent), we estimate that approximately 900,000 washers are sold annually in California.

Table 1. U.S. Shipments of Clothes Washers, 1992-2002

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Shipment (thousands)	5,632	5,923	6,161	6,080	6,225	6,326	6,835	7,313	7,495	7,362	7,745

Source: AHAMb "Market Statistics" web page on 7/7/03 [http://www.aham.org/report/reportfirst.cfm]

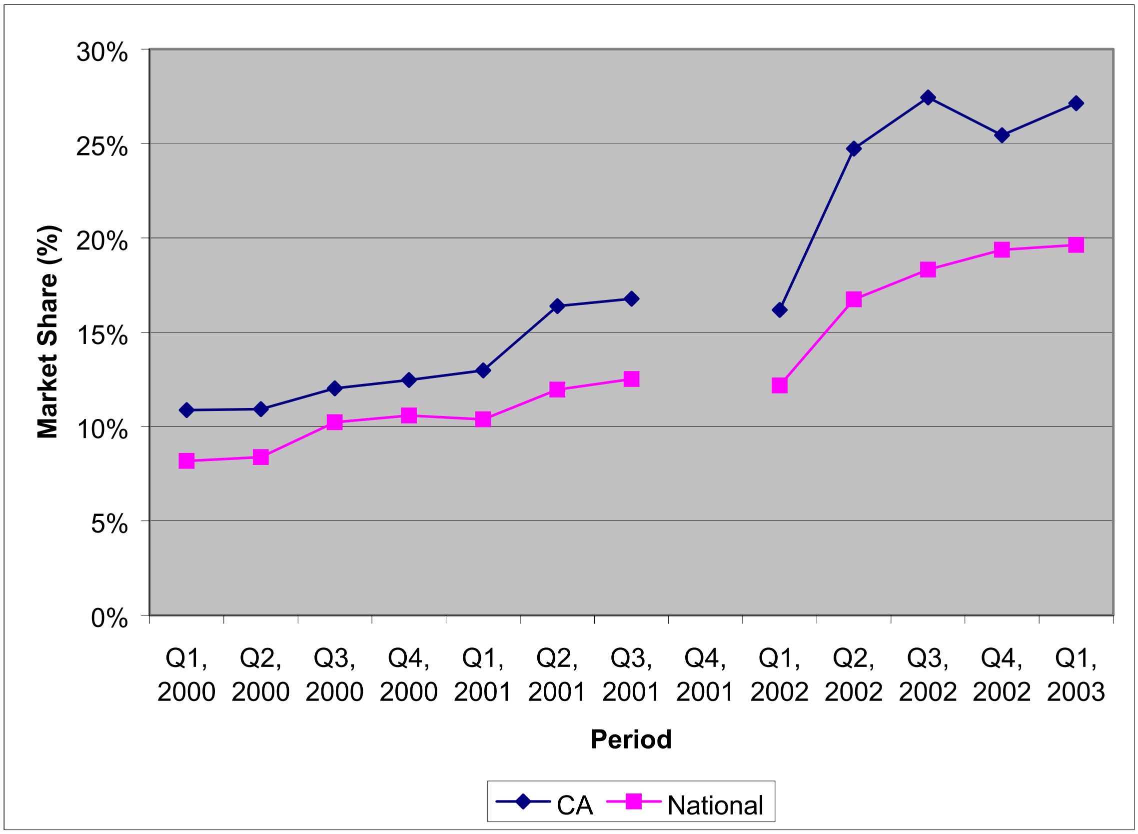
3.3. Market penetration of high efficiency options

There are a variety of energy and water efficiency measures that can be integrated into residential washers to increase either or both their energy and water efficiency, the most notable of which is the horizontal-axis design. Since high efficiency vertical-axis washers are available, however, we take advantage of the Energy Star designation as the most comprehensive indicator of penetration of energy efficiency options in the marketplace nationally and in California. Major domestic manufacturers and numerous foreign marketers of residential clothes washers market energy efficient washers as defined by the qualifying criteria of the EPA Energy Star program. It should be noted, however, that the EPA program does not have water efficiency requirements and certain products that qualify under the EPA program have water factors well in excess of 9.5, a value generally used as the threshold for minimum water efficiency in water utility programs around the country (EPA, 2003c).

The Consortium for Energy Efficiency, a consortium of energy and water utilities and other interested groups, has for almost a decade promoted a voluntary program framework for residential washers for use by utilities in implementing local programs that promote efficient washers. Unlike EPA, the CEE residential washer initiative's performance specifications do address water efficiency. The CEE frame work and its associated qualifying products list have been leveraged by many energy and water utilities around the country, particularly in California. In fact, these utilities have invested several million dollars for customer incentives over the last decade to assist manufacturers in promoting high efficiency washers to consumers.

As noted above, the market share for high efficiency washers has grown rapidly in recent years. Nationally, market share in the early 1990s was on the order of two percent (EPRI, 1998). As the chart below indicates, market share in California leads the national average and has recently exceeded 25 percent. (EPA, 2003a)

Figure 1. Market Share for Energy Star Washers



Source: US EPA Web site (EPA, 2003c)

As noted in a later section, the US DOE established a new federal energy efficiency standard for residential washers in 2000. At the time the standard was developed, the baseline energy efficiency, expressed in terms of MEF, for residential washers was an estimated 0.89 cubic feet/kWh (DOE, 1999). The new standard will phase in with two steps: in 2004, the MEF must meet at least 1.04 cubic feet/kWh (a 20 percent improvement). In January of 2007, the MEF requirement increases to 1.26 cubic feet/kWh (representing an estimated 35 percent improvement compared to baseline).

Signed into law by Governor Davis in September 2002, AB1561 requires the Commission:

"(1) Not later than January 1, 2004, amend any regulations in effect on January 1, 2003, pertaining to the energy efficiency standards for residential clothes washers to require

that residential clothes washers manufactured on or after January 1, 2007, be at least as water efficient as commercial clothes washers.

(2) Not later than April, 2004, petition the federal Department of Energy for an exemption from any relevant federal regulations governing energy efficiency standards that are applicable to residential clothes washers."

Thus, AB1561 directs the Commission to establish a water factor requirement for residential washers that is less than or equal to 9.5 WF.

4. Savings Potential

4.1. Baseline energy use

As noted above, in this analysis we do not specifically address the site energy consumption of residential washers, rather the focus is on water efficiency and any indirect energy savings that result from lower water use.[3] To establish the most probably baseline in 2007, the estimate must take into effect the impact of the 2007 DOE standard of 1.26 MEF. While the analysis used in the last DOE residential washer rulemaking assumed a baseline WF of over 13 (see Appendix D), general market trends and the future federal energy standard suggest that baseline water efficiency will have improved. Since the current Energy Star MEF level is that same as that for the 2007 DOE standard, we look to the population of Energy Star washers as an indicator of likely future baseline water efficiency. In looking at the Energy Star product list, the WFs provided are as large as about 12 WF (EPA 2003c). We further assume that due to cost competition, the baseline water factor typically would fall close to the lowest water factor seen in the Energy Star list in the same way that product energy efficiencies tend to cluster just above federal energy standards. In other words, the lowest marginal performers are often marginally cheaper to produce. Thus, we assume that in 2007, the baseline WF will be 12.

At an average of 12 WF, 36 gallons of water will be used per average load. Annually, at the average 392 cycles per year, that amounts to approximately 14,112 gallons per washer. The estimated ten million residential washers in California would have an aggregate water use of 141 billion gallons of water per year. Energy use due to water pumping, treatment, distribution and disposal, at 4.1 kWh per thousand gallons of water (see Appendix C), accounts for a statewide energy use of 578 GWh. Again these savings are based purely on water savings and do not account for any site energy savings that result from a water efficiency requirement.

[3] We note that this assumption is likely conservative, however. If a water factor of between 9.5 and 6.0 is established for 2007, it is highly likely that shipment weighted average energy efficiency levels in 2007 and beyond would be greater than with only the 1.26 MEF federal standard in place. This is true because certain design strategies used to meet water efficiency criteria (e.g. horizontal-axis washers and Whirlpool's Calypso vertical axis approach) generally lower energy use as a result of reduced wash water usage.

4.2. Proposed test method

The federal test procedure, 10 CFR Section 430.23(j) (Appendix J1 to Subpart B of Part 430) (2001) for residential washers allows for the calculation of water factor and should be used for the purposes of this proposed standard.

4.3. Efficiency measures

As noted above, all domestic and most foreign manufacturers with notable market share in the United States offer products that are energy efficient and most offer water efficient models as well. There are a variety of design solutions that can impact energy and water efficiency. For the recent Federal residential washer standards, the DOE analyzed a number of measures and estimated both energy and water savings. See Appendix D (DOE, 1999)

Perhaps the most significant efficiency solution is the horizontal-axis design. Inherent in the horizontal-axis design is the ability to use less wash water, which is frequently hot or warm, during the wash cycle. Less water is required because clothing need not be fully submerged and suspended to allow proper agitation (in both wash and rinse modes).

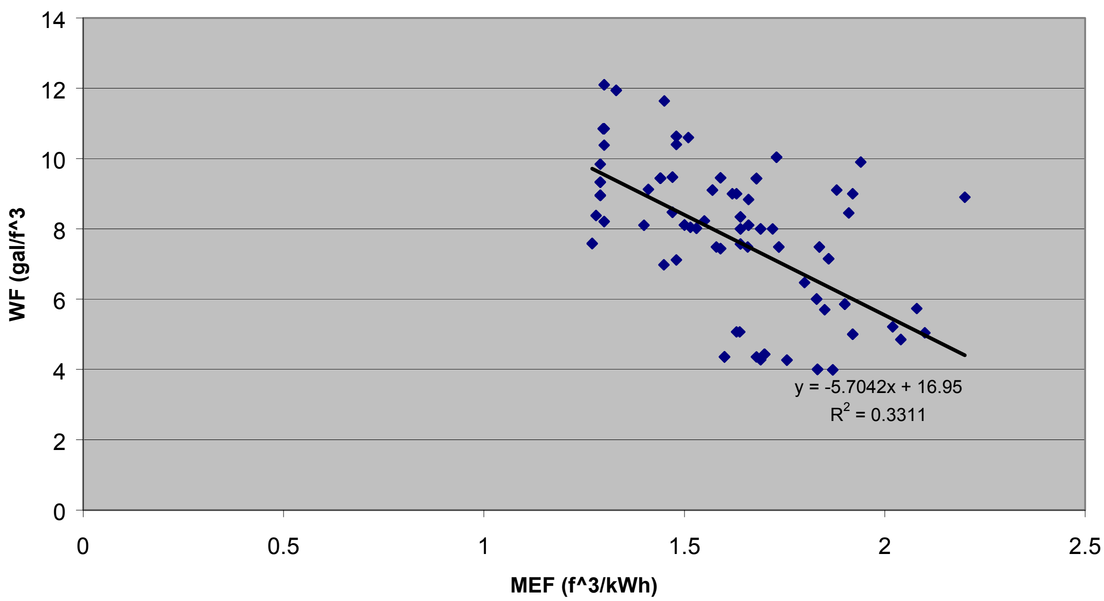
Manufacturers have also used thermal mixing valves to reduce average warm and wash temperatures below conventional settings to decrease energy use, but this does not save water. Spray rinses that replace deep rinses generally save water but not energy because in most cases heated water is not used during the rinse cycle. Manufacturers have developed innovative, vertically oriented agitators that allow for proper circulation and agitation of clothes using less water than usual in vertical-axis washer (e.g. the Whirlpool Calypso). High spin speeds are employed to achieve savings in the dryer (the benefits of which are captured in the MEF metric) by lowering the remaining moisture content of wash loads. Additionally, higher efficiency motors and controls strategies, including automatic fill control, can reduce energy and/or water consumption.

In this analysis, we do not attempt to assess savings potential for water or energy on a measure-by-measure basis because a variety of high efficiency washers demonstrating all of these measures are well established in the market. As of May 8, 2003, there were 145 distinct model numbers listed on the Energy Star website. While in many cases several listed model numbers represent essentially one product with different permutations of minor features such as color, there is nonetheless an impressive range of products with varied energy and water performance.

As previously noted, certain measures used to achieve water efficiency (e.g. horizontal-axis washers and Whirlpool's Calypso vertical axis approach) generally lower energy use as a result of reduced wash water usage. Other measures affect just water or just energy efficiency. Thus, under different standards scenarios, certain measures used to achieve efficiency in one resource (e.g. water) may or may not as a byproduct reduce the use of the other. One, therefore, would not expect water efficiency to correlate closely with energy efficiency within limited ranges of WF (e.g. 8.0 to 10 .0 WF) in settings where water efficiency is not mandated. In fact, the DOE life cycle cost analysis shown in Appendix D shows WF increasing at higher MEF levels. The performance of recently available high efficiency washers, however, shows both the lowest WFs and the highest MEFs can be achieved in the same models.

Figure 2 below shows a scatter plot of MEF versus WF for all Energy Star listed products for which both MEF and WF are provided. As can be seen, there is not a significant correlation (R squared of 0.33) between these two product attributes for the listed Energy Star washers.

Figure 2. Water Efficiency Versus Energy Efficiency



Source: Energy Star Web site (EPA 2003c)

4.4. Standards Options

Given that a Federal energy efficiency standard is already set to take effect for residential washers and that AB1561 only specifically directed the Commission to address water efficiency, energy efficiency improvements beyond federal standards are not proposed. The baseline analysis noted earlier presumes that the federal energy efficiency standards have taken effect. When looking at the full range of Energy Star-qualified residential washer performance levels, there is little correlation between energy efficiency and water efficiency. As noted in section 4.1, we take the bottom end of the current Energy Star listed products' water efficiency performance to serve as the estimate for future water efficiency baseline. The actual baseline in 2007 could be higher or lower depending on technologies manufacturers use to meet the federal standard in 2007 (and of course in what proportions customers purchase these different products).

In terms of a potential standards level, there appears to be a significant range of possibilities that meet the Commission requirements for a feasible standard. Off-the-shelf water efficiencies range from over 13 down to 4 WF (EPA 2003c). While many past voluntary programs have used a water factor of 9.5 gal/kWh, this leaves substantial savings on the table. This voluntary level has been in use for over a decade and is in need of a downward adjustment. In this report, the water efficiency standards levels shown in Table 2 were analyzed.

Table 2. Standards Options

Water Efficiency Standards Options	
Option 1	WF = 6.0
Option 2	WF = 8.5
Option 3	WF = 9.0
Option 4	WF = 9.5
Baseline in 2007	WF = 12.0

4.5. Energy and Water savings

The statewide savings column represents the hypothetical statewide impact after all existing washers have been changed out with new ones that qualify at the option levels. The four standards options would result in the electricity savings shown in Table 3, below. Appendix B contains more detailed calculations summarized in Table 3.

Table 3. Estimated Savings for Proposed Standards Options

Standard Option	Per Unit Annual Savings (kWh)	Statewide Savings (GWh)
Option 1: WF=6.0	28	284
Option 2: WF=8.5	16	165
Option 3: WF=9.0	14	136
Option 4: WF=9.5	12	117

These energy savings shown above are derived entirely from water savings attributable to the standards options. Each 1,000 gallons of saved water results in a statewide average savings of 4.1 kWh for water pumping, treatment, distribution and disposal (Appendix C provides more details on the energy embedded in water use).

As suggested above, some improvements in WF will result in reduced use of heated water, and energy use to heat the water. This quantity of energy is difficult to estimate and varies from design to design, and thus has been ignored in these calculations.

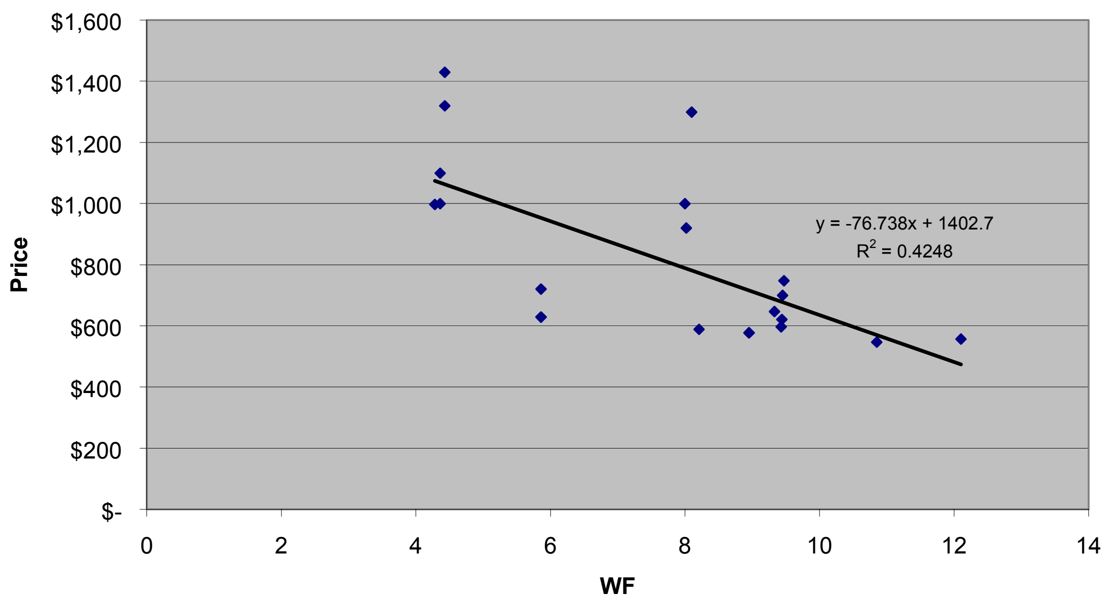
5. Economic Analysis

5.1. Incremental cost

To assess the impact of water efficiency standards on retail product costs, we evaluated the correlation between retail prices and water factor for Energy Star listed products. We obtained current prices for 21 products primarily from the Lowes and Whirlpool websites. These products covered the range of price, performance and features from five manufacturers. Energy Star is the appropriate subset to work from as the current Energy

Star specification is equivalent to the federal standard taking effect in 2007 and therefore is a reasonable (though likely overstated) representation of future costs. The correlation between water efficiency and price was demonstrated to be quite low. Within the subset of Energy Star washers with water factors of 6 and greater for which price data was recently collected, water efficient units do not necessarily cost substantially more than less water efficient units. Even at the sub-6.0 WF level, other product features, such as number of cycles and style, could very well be the main drivers of the larger price differences.

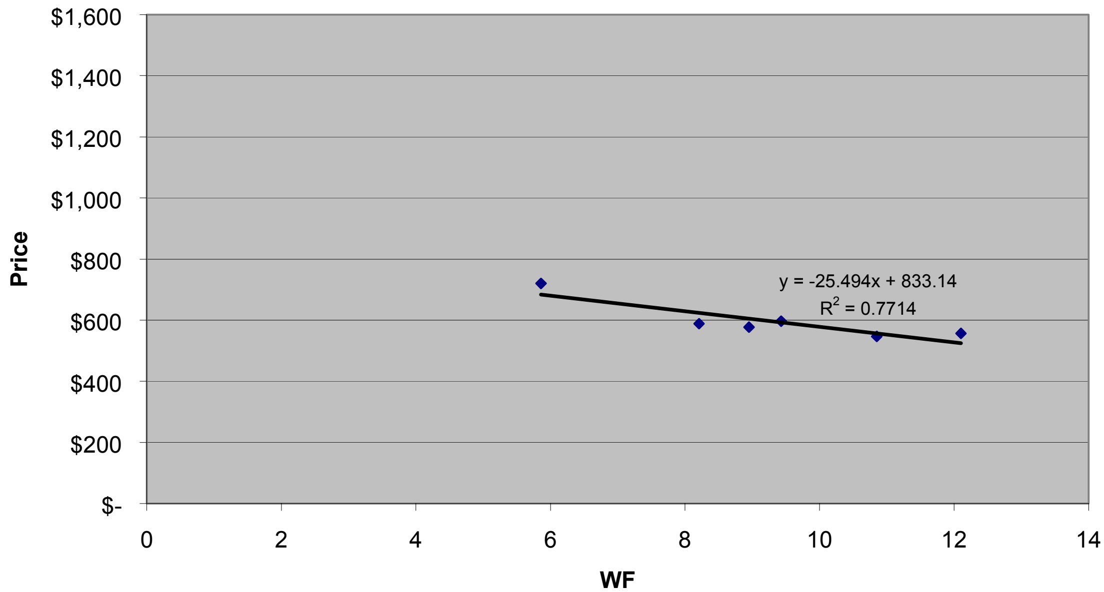
Figure 3. Water Efficiency Versus Retail Price



In order to estimate incremental costs at each standards options level, we used the same data set used for the above graph but removed data points for products that had similar water efficiency as cheaper models on the list. In other words, we conclude that for those products designed just to meet a given standard, it is logical to assume that the future average retail price estimate that is most appropriate is no greater than the lowest current price for products now available at that performance level.[4] After removing these data from the analysis, a stronger correlation results (R squared of 0.77). The equation for this trend line (where price equals -25.494*WF + 833.14) can be used to estimate incremental costs for each proposed standard level. Again, this incremental cost is relative to a future cost baseline estimated at $550 in 2007 when the Federal 1.26 MEF standard takes effect. Comparing costs to standard products now in the market is entirely inappropriate, because as manufacturers have strongly asserted and the DOE analysis (Appendix D) shows, the average price after the 2007 MEF standard is expected to be higher than for today's products.

[4] In fact, this assumption no doubt overstates the future baseline cost of models that meet the proposed standard. This is because current Energy Star-qualified washers have more features (in addition to their efficiency) than the cheapest conventional washers sold today.

Figure 4. Water Efficiency Versus Price Within Standards Options Range



These incremental costs are likely overstated, not only for reasons noted above, but because appliance standards history shows that the retail prices at a certain level of efficiency tend to drop as new standards redefine that performance level as baseline.

Table 4: Incremental Retail Costs

Standard Option	Estimated Incremental Cost as of 2007 ($ 2003)
Option 1: WF=6.0	$130
Option 2: WF=8.5	$66
Option 3: WF=9.0	$54
Option 4: WF=9.5	$41

5.2. Design life

In past rulemakings, the US DOE has assumed that the design life of a residential washer is 14 years. A fourteen-year life was used to determine the present value of electricity and water costs, per the California Energy Commission's Average Statewide Present Value of Electricity data (14 year values were interpolated).

5.3. Life Cycle Cost

Using the assumptions outlined above, we calculated the following life-cycle cost of a single residential clothes washer under each of the proposed standards scenarios. While the water efficiency standard options result in electricity savings at the State and water utility level, as described in Sections 4.1 and 4.5 above, we assume no energy savings at the consumer's site associated with the proposed standards options. In fact, we expect that there will be site energy savings, but for the sake of simplicity in this analysis we do not attempt to include them. Water and wastewater savings are, however, specifically relevant to the consumer's economic analysis—just as much so as the incremental cost. The present value of water savings is calculated by discounting the fourteen-year stream of water bill savings using a three percent real discount rate. See Appendix A for more detailed calculations.

Table 5. Life Cycle Costs

Proposed Standard	Design Life (years)	Annual Water Savings (gallons)	PV of Water/ Waste Water Savings* ($)	Incremental Cost, Retail ($)	Consumer Net Present Value** ($)
Option 1: WF=6.0	14	6,915	$273	$130	$143
Option 2: WF=8.5	14	4,014	$159	$66	$92
Option 3: WF=9.0	14	3,434	$136	$54	$82
Option 4: WF=9.5	14	2,854	$113	$41	$72

* Present value of water savings calculated using a real discount rate of 3 percent
** Positive value indicates a reduced total cost of ownership over the life of the appliance.

6. Acceptance Issues

6.1. Infrastructure Issues

As noted in earlier sections, the market share for high efficiency washers has increased significantly and is approaching 20 percent nationally. Many of these energy efficient models are also at least somewhat water efficient compared to current baseline washers. All major manufacturers are selling multiple models of Energy Star qualifying products and most retailers appear to offer Energy Star qualifying washers. As water efficient Energy Star-qualified washers are available in top loading, front loading, horizontal-axis, and vertical-axis configurations, there appear to be no substantive customer acceptance or distribution channel acceptance issues for standards 2, 3, and 4. In other words, manufacturers have demonstrated an ability to meet all customer configuration preferences with already available, reasonably priced water and energy efficient models years ahead of standards effective dates.

6.2. Existing Standards

As noted, a Federal energy efficiency standard is in place for residential washers as is a very successful Energy Star initiative. The performance criteria for these are listed below.

Criteria/Product Class	Current	January 1, 2004	January 1, 2007
ENERGY STAR-top and front loading	MEF[1] $\geq$1.26	MEF $\geq$1.42	No Change
Federal Standard-top and front loading	EF[2] $\geq$ 1.18	MEF $\geq$1.04	MEF $\geq$1.26

[1]MEF = modified energy factor

[2]EF = energy factor, use of this term discontinued after January 1,2004

Note: Neither Energy Star nor Federal standards establish water efficiency requirements.

Source: EPA 2003b

In 2001, California established state standards for commercial clothes washers, which were not subject to Federal standards. California adopted an MEF of 1.26 effective in January of 2005 and a water efficiency standard of 9.5 WF effective in January of 2007. The range of water efficiency levels and design strategies available from commercial washers was (at the time that standard was developed) more limited than those of residential washers.

7. Recommendations

While all evaluated standards options appear feasible and cost effective, a level of 8.5 WF may represent the best compromise for implementation in the immediate future. At this level it is clear from the variety of products already in the market that cost effective models using a variety of design approaches can qualify and therefore a standard at this level would not result in any substantive loss of consumer utility. Furthermore, because a variety of existing product design approaches can achieve this level, economic impacts on manufacturers are minimized.

As part of this proceeding, the Commission should also consider a second stage standard that sets a more aggressive water factor a few years later in order to allow manufacturers time to respond (including amortizing current investments in platforms that may not meet a second stage standard). Setting a more lenient water requirement than is justified in this proceeding would result in lower water and energy savings, with only a limited chance for cost-effective, future standards improvements.

8. References

Association of Home Appliance Manufacturers (AHAM) 2003a, "Clothes Washers Energy Efficiency and Consumption Trends" (fact sheet dated 3/18/03.

Association of Home Appliance Manufacturers (AHAM) 2003b: Association of Home Appliance Manufacturers, "Market Statistics" web page, on the Market Tends and Forecast Report, from (http://www.aham.org/report/reportfirst.cfm) on 7/7/03

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US Census Bureau 2003: US Census Bureau Web site: http://eire.census.gov/popest/data/household/HU-EST2002-01.php, on August 12, 2003

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United States Environmental Protection Agency (EPA) 2003b: U.S. Environmental Protection Agency, Energy Star Web site, Clothes Washers Key Product Criteria, August 15, 2003. www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

United States Environmental Protection Agency (EPA) 2003c: U.S. Environmental Protection Agency, Energy Star Web site, Residential Clothes Washer Product List (Excel file), http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers

9. Appendix A: Customer Net Present Value Detail

(See Table 5)

Assumptions		
Discount Rate	3%	Used only for calculating PV of water cost savings and detergent savings
PV Electric Cost / kWh	$ 1.209	(extrapolated for 14 year life From CEC 2001 Title 20 Life Cycle Cost Analysis Appendix A Table 12)
Annual Detergent Savings	$ -	Zero savings is an extremely conservative assumption as studies show savings
Incremental Cost	= -25.494*WF + 833.14	See WF VS Price 6+ Tab**
Base Cost	$ 550.00	Based on average price of lowest Energy Star qualified high WF products

Product	Life Span (years)	Incremental Cost ($)	PV Detergent Savings ($)	PV Water Savings	Annual Energy Savings (kWh)*	PV Electricity Costs ($/kWh)	PV of Lifetime Energy Savings ($)	**Added Total Costs (NPV) ($)**
Option 1 (WF=6.0)	14	$ 130.18	$0.00	($273.39)	0	$ 1.209	$0.00	($143.21)
Option 2 (WF=8.5)	14	$ 66.44	$0.00	($158.70)	0	$ 1.209	$0.00	($92.26)
Option 3 (WF=9.0)	14	$ 53.69	$0.00	($135.76)	0	$ 1.209	$0.00	($82.07)
Option 4 (WF=9.5)	14	$ 40.95	$0.00	($112.83)	0	$ 1.209	$0.00	($71.88)

*Note: energy savings from water pumping etc., is not included here because it is not incurred by consumer, but savings are real statewide

** Note the R squared is low (~0.77) for this trendline

10. Appendix B: Statewide Impacts

(See Section 4.5 and Table 3)

	Annual Per Unit Impacts						Annual Statewide Impacts	
	Site Energy Savings/Units (kWh)	Site Energy Savings/ Units ($)	Site Water Savings/Unit (gal)	Site Water Savings/ Unit ($)	Energy Savings/ Unit (kWh)	Energy Savings ($)	Statewide Energy Savings of Stock (GWh)	Reduction in Peak Demand of Stock (MW)
Baseline (WF=12.0)	0	0	-	$ -	-	$ -	-	-
Option 1 (WF=6.0)	0	0	6,915	$ 24.20	28	$ 2.55	284	32
Option 2 (WF=8.5)	0	0	4,014	$ 14.05	16	$ 1.48	165	19
Option 3 (WF=9.0)	0	0	3,434	$ 12.02	14	$ 1.22	136	15
Option 4 (WF=9.5)	0	0	2,854	$ 9.99	12	$ 1.05	117	13

Assumptions			Source
Loads/year	392	/year	USDOE Technical Support Documents for Residential Washer Rulemaking.
Electricity Pumping	$ 0.09	/kWh	Estimate based on CEC table 13 B in Appendix A of Life Cycle Cost Analysis
Water/Waste Water Cost	$ 0.0035	/gallon	From 2001 AB970 work papers--the high value is LADWP's combine water and waste water rate ($4.01 per 100 cubic feet) per Mark Gentili of LADWP on 12/5/00. The low value is US DOE Nat'l avg
Water/Waste Water Pumping Energy	0.0041	kWh/gal	Calculated from: "Energy Use In the Supply, Use, and Disposal of Water in California". January 25,
Total Units in Stock	10,006,214		Based on # California households times saturation of 80% per RER study

11. Appendix C: Energy Savings From Water Supply, Distribution and Treatment

Water supply, treatment, and disposal energy use:

Total energy used to pump and treat water exceeds 15,000 GWh or at least 6.5 percent of total electricity used in the state
Total water use in the state is 42.6 million acre-feet (does not include water delivered to and left in river systems)
Agricultural use of water constitutes approximately 80% of all water used (or 33.8 million acre-feet)
Urban use of water constitutes 20% of water used in California 8,800,000 acre/ft (6.7 million is surface water and 2.1 million is ground water)

Of the 15,000 GWh used, 4,400 GWh are used by Agricultural purposes. Also 1,600 GWh are used in waste water treatment

Urban water transport, delivery and treatment consumes 8,600 GWh which is 977 kWh/acre-foot or 0.002999 kWh/gallon
for 8.8 million gallons of which something on the order of half goes through the waste treatment system
With an estimated 4.5 million gallons using 1600 GWh, the energy needed to treat and dispose of waste water is 0.00109

Thus including supply, treatment, and delivery of fresh water and collection, treatment and disposal of waste water
The total energy use per gallon is estimated to be 0.0041 kWh/gallon

Bill Maddaus of Maddaus Water Management indicated that his estimate for fresh water supply was .0025 kWh/gallon which is close to the estimate above
not including waste water treatment and pumping.

Sources:
Energy Use In the Supply, Use, and Disposal of Water in California. January 25, 1999 Prepared by Carrie Anderson of Process Energy Group for CEC.
Bill Maddaus, Maddaus Water Management--personal communication relayed by California Urban Water Conservation Council on 12/6/00
"Electricity Efficiency Through Water Efficiency", 1992, Southern California Edison.

12.Appendix D: DOE Life-Cycle-Cost Analysis

(See Section 4.3)

This is an analysis from DOE for the Residential Washer Standards Rulemaking Process Available From the DOE Web site

Standard Clothes Washer: Cost, Energy-Use and Water-Use Data

							ENERGY USE PER WASHER CYCLE						Water Use / Cycle		
								WATER HEATING ENERGY			DRYER ENERGY				
Level	Description	% Change over Baseline	Incr. Mnfr Cost* (AHAM)	Mnfr Markups on Incr. Cost *Average*	*Distr.*	Purchase Price** SWA	MOTOR Energy *(kWh)*	Elec WH *(kWh)*	Gas WH *(MMBtu)*	Oil WH *(MMBtu)*	Elec Dryer *(kWh)*	Gas Dryer *(MMBtu)*	Hot Water *(gal)*	Total Water *(gal)*	
			(1997 $)			*(1997 $)*									
0	Baseline (MEF=0.817)	0%				$421	0.209	1.587	0.007220	0.007	1.430	0.005	8.82	39.18	Baseline
1	5% Impr. (MEF= 0.86)	5%	$0.09	0.945	0.945	$421	0.209	1.543	0.007	0.006	1.413	0.005	8.57	38.61	
2	10% Impr. (MEF= 0.908)	10%	$0.90	1.135	1.135	$423	0.209	1.408	0.006	0.006	1.400	0.005	7.82	38.61	
3	15% Impr. (MEF=0.961)	15%	$4.33	1.215	1.215	$429	0.209	1.216	0.006	0.005	1.407	0.005	6.76	38.62	
4	20% Impr. (MEF=1.021)	20%	$15.10	1.255	1.255	$449	0.218	1.113	0.005	0.005	1.408	0.005	6.18	38.45	
5	25% Impr. (MEF=1.089)	25%	$64.13	1.270	1.270	$541	0.304	0.715	0.003	0.003	1.273	0.005	3.97	26.60	
6	35% Impr. (MEF=1.257)	35%	$128.17	1.295	1.295	$666	0.133	0.462	0.002	0.002	1.270	0.005	2.57	21.03	Proposed (
7	40% Impr. (MEF=1.362)	40%	$128.59	1.295	1.295	$666	0.133	0.462	0.002	0.002	1.263	0.005	2.57	21.03	
8	45% Impr. (MEF=1.485)	45%	$180.28	1.295	1.295	$765	0.114	0.429	0.002	0.002	1.107	0.004	2.38	23.41	
9	50% Impr. (MEF=1.634)	50%	$187.26	1.295	1.295	$778	0.114	0.413	0.002	0.002	1.047	0.004	2.29	23.41	

** Shipment Wt'ed Avg*

*** Using Average Mnfr Markup*