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Update of Appliance Efficiency Regulations For Residential Clothes Washers

Staff Report

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California Energy Commission

Staff Report

Update of Appliance Efficiency Regulations

For

Residential Clothes Washers

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1) Legislative Criteria

Section 25402 (c) of the Public Resources Code has, since 1975, required the California Energy Commission to adopt standards for the energy efficiency of appliances whose use requires a significant amount of energy on a state wide basis. New or upgraded standards must be feasible and attainable and must not "result in any added total cost to the consumer over the design life of the appliance." The added total cost is obtained by comparing the cost and performance of a typical model that the consumer would be expected to purchase with the proposed upgraded or new standard in effect, to the cost and performance of a typical model that the consumer would be expected to purchase without the proposed upgraded or new standard in effect.

In 2002 Governor Davis signed Assembly Bill 1561 into law that directs the California Energy Commission "to do all of the following:

(1) Not later than January 1, 2004, amend any regulations in effect on January 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 1, 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.
(3) Not later than January 1, 2005, report to the Legislature on its progress with respect to the requirements of paragraphs (1) and (2)."

2) History of California's Standards for Clothes Washers

In January 2001, the U.S. Department of Energy published new standards for residential clothes washers, that will become effective is two phases. In 2002, California adopted identical standards for residential clothes washers as shown in Appendix A. The Energy Commission also adopted standards for commercial clothes washers as shown in Appendix B.

3) Current Efficiency Measures

This report describes the Commission's conclusions related to proposed residential clothes washer standards pursuant to the legislation described above (AB 1561), and to show the cost effectiveness of those proposed standards.

Commission staff has determined that requiring a water factor standard of 8.5 (8.5 WF) on January 1, 2007, and a water factor standard of 6.0 (6.0 WF) on January 1, 2010 for residential clothes washers will save a significant amount of water and energy, will result in monetary savings that make the measure cost effective, and is readily achievable with current technology. (A water factor of 12 [12 WF] is considered to be the baseline water usage for residential clothes washers manufactured in 2007). The water factor of a clothes washer is calculated by dividing the total water used to wash and rinse a load of clothes by the wash tub capacity in cubic feet. A clothes washer with a 3 cubic-foot wash tub and a water factor of 12 will use approximately 36 gallons of water per load, whereas a clothes washer with a 3 cubic foot wash tub and a water factor of 8.5 would use 25.5 gallons of water per load, and a clothes washer with a 3 cubic foot wash tub and a water factor of 6.0 would use 18 gallons of water per load.

Instituting a water factor of 8.5 in 2007 would result in savings of $86 over the design life of the clothes washer; that is, the consumer will have a net savings of $86 after subtracting the initial increase in purchase price for the higher efficiency machine from the total dollar value of water savings over the design life of the clothes washer. Instituting a water factor of 6.0 in 2010 would result in additional savings of $139.89 over the design life of the clothes washer.

The present value of water savings is calculated by discounting the fourteen-year stream of water cost savings using a three percent discount rate. Table 1 below summarizes the cost savings for an 8.5 water factor, and Table 2 summarizes the cost savings for a 6.0 water factor.

Table 1 – Life Cycle Cost Effectiveness for 8.5 WF

Washing Machine 8.5 WF Cost Effectiveness		
Cost of Base Case (12 WF) Washing Machine	$550.00	
Cost of 8.5 WF Washing Machine	$624.05	
Incremental Cost for 8.5 WF Washing Machine	$74.05	
Number of loads washed per year	392	
Average washing machine life (years)	14	
Number of Units Sold per Year in CA	900,000	
	12 WF (baseline)	**8.5 WF**
Annual Water Savings (gal)	0	4,048
Present Value of Water Savings (based on $0.0035/gal)	-$160.04	
Statewide first-year Value of Water Savings	**$12,751,200.00**	
Statewide first-year pumping/treatment energy savings, GWh	14.94	
Net Present Value of Savings	($160.04)	
Total Life Cyle Savings (NPV of water savings minus incremental cost)	**$86.00**	

Table 2 – Life Cycle Cost Effectiveness for 6.0 WF

Washing Machine 6.0 WF Cost Effectiveness		
Cost of Base Case (12 WF) Washing Machine	$550.00	
Cost of 6.0 WF Washing Machine	$685.80	
Incremental Cost for 6.0 WF Washing Machine	$135.80	
Number of loads washed per year	392	
Average washing machine life (years)	14	
Number of Units Sold per Year in CA	900,000	
	12 WF (baseline)	**6.0 WF**
Annual Water Savings (gal)	0	6,973
Present Value of Water Savings (based on $0.0035/gal)	-$275.69	
Statewide first-year Value of Water Savings	**$21,964,950.00**	
Statewide first-year pumping/treatment energy savings, GWh	25.73	
Net Present Value of Savings	($275.69)	
Total Life Cyle Savings (NPV of water savings minus incremental cost)	**$139.89**	

Tables 3 and 4 below show the simple payback method of cost effectiveness for a washing machine with a water factor of 8.5 and 6.0. The data indicate that the monetary payback in water savings to the consumer for these efficiency measures is 5.2 and 5.56 years, far shorter than the estimated lifespan of 14 years for the clothes washer.

Table 3 – Simple Payback Cost Effectiveness for 8.5 WF

Added First Cost	Annual Unit Reduction in Water Use (gallons)	Annual Unit Reduction in Operating Cost (based on $.0035/gallon)	Simple Payback (years)	Design Life (years)
$74.05	4,048	$14.17	5.2	14

Table 4 – Simple Payback Cost Effectiveness for 6.0 WF

Added First Cost	Annual Unit Reduction in Water Use (gallons)	Annual Unit Reduction in Operating Cost (based on $.0035/gallon)	Simple Payback (years)	Design Life (years)
$135.80	6,973	$24.41	5.56	14

The *added first cost* indicated in Tables 3 and 4 is the increased cost of the clothes washer based on the costs involved in making the clothes washer more water efficient by a variety of means by the manufacturer. The *annual unit reduction in water use* is the result of changing from a baseline washing machine model with a water factor of 12 to a model with the proposed water factor of 8.5 and 6.0. This water saved is then converted to a monetary equivalent by multiplying the 4,048 gallons and 6,973 gallons by the estimated cost of each gallon of water ($0.0035 per gallon), resulting in an annual dollar savings of $14.17 and $24.41, respectively, shown in Tables 3 and 4 as the *annual unit reduction in operating cost*. The *simple payback (years)* is then determined by dividing the *added first cost* by the *annual unit reduction in operating cost,* which results in a payback period of 5.2 and 5.56 years.

*

Based on the above discussion, staff finds, in compliance with Section 25402 of the Public Resources Code, that the proposed water efficiency standards for residential clothes washers:

1. Are Based on a reasonable use pattern;
2. Affect an appliance which requires a significant amount of energy on a statewide basis;
3. Are feasible and attainable; and
4. Will not result in any added total costs to the consumer over the design life of the appliance.

Appendix A

Current Standards for Residential Clothes Washers

(p) **Clothes Washers.**

(1) **Energy Efficiency Standards for Clothes Washers**. The energy factor and modified energy factor of clothes washers that are consumer products shall be not less than the applicable values shown in Table P-2.

Table P-2
Standards for Clothes Washers

Appliance	*Minimum Energy Factor [ft^3/(kWh/cycle)] Effective May 14, 1994*	*Minimum Modified Energy Factor [ft^3/(kWh/cycle)]*	
		Effective January 1, 2004	*Effective January 1, 2007*
Top-loading compact clothes washers	0.90	0.65	0.65
Top-loading standard clothes washers	1.18	1.04	1.26
Front-loading clothes washers	N/A	1.04	1.26

(2) **Energy Design Standard for Top-Loading Semi-Automatic Clothes Washers and Suds-Saving Clothes Washers.** Top-loading semi-automatic clothes washers that are consumer products and suds-saving clothes washers that are consumer products shall have an unheated rinse water option.

(3) **Energy Design Standard for Front-Loading Clothes Washers.** Until December 31, 2003, front-loading clothes washers that are consumer products shall have an unheated rinse water option.

Appendix B

Current Standards for Commercial Clothes Washers

(p) **Commercial Clothes Washers.**

(1) **Energy Efficiency Standards for Commercial Front-Loading and Commercial Top-Loading Automatic Clothes Washers**. The modified energy factor and water factor of commercial front-loading and commercial top-loading automatic clothes washers manufactured on or after the dates indicated in Table P-3 that are not consumer products shall be not less than (modified energy factor) and not more than (water factor) the applicable values shown in Table P-3.

Table P-3
Standards for Commercial Clothes Washers

Appliance	*Clothes Container Compartment Capacity (ft^3)*	*Minimum Modified Energy Factor Effective January 1, 2005*	*Maximum Water Factor Effective January 1, 2007*
Front-loading clothes washers	< 3.5 ft^3	1.26	9.5
Top-loading clothes washers	< 1.6 ft^3	0.65	9.5
	≥ 1.6 ft^3 and < 4.0 ft^3	1.26	9.5

(2) **Energy Design Standard for Commercial Top-Loading Semi-Automatic Clothes Washers and Commercial Suds-Saving Clothes Washers**. Commercial top-loading semi-automatic clothes washers and commercial suds-saving clothes washers manufactured on or after January 1, 2005 shall have an unheated rinse water option.

Appendix C

A Generic Discussion Of Cost-Effectiveness Calculations

The law states that the Commission's appliance standards may not "result in any added total costs to the consumer over the design life of the appliance." (Public Resources Code section 25402(c)(1).) This means that over the life of an appliance, consumers must be better off monetarily (or at least no worse off) if the appliance is subject to the applicable standard than they would be if the appliance were not subject to the standard. This concept is also referred to as "cost-effectiveness."

There are two basic ways in which consumers are affected financially by a new appliance standard. First, consumers (usually) must pay more for a more efficient appliance, because what typically makes the appliance more efficient are additional materials, parts, or research and development, all of which tend to cost more money. Second, consumers save money because they pay less in energy and water costs to run the appliance. (There may be other costs or savings, such as in maintenance costs, but those tend not to be effected by changes in efficiency.) A proposed standard is cost-effective if the cost savings resulting from the standard would equal or exceed the additional costs resulting from the standard, over the "design life" of the appliance. In most cases, the design life of the appliance is not changed by the standard. The present value equation on p.11 assumes that this is the case.

Added Total Costs, expressed in dollars, are determined by subtracting the cost savings resulting from the standard from the **Added First Cost** resulting from the standard. If **Added Total Costs** are equal to or less than zero, then the proposed standard is cost-effective.

Added First Cost, expressed in dollars, are all of the added costs that a standard imposes on a typical consumer, including the additional costs to purchase the appliance (first cost) and any other additional costs such as added installation costs. For instance, some very efficient gas water heaters require more expensive venting systems, which are not part of the water heater.

Added First Cost, expressed in dollars, is calculated by comparing the estimated purchase price of an appliance of the most common size and design sold today[1] with the estimated purchase price of an appliance, of that size and design, that barely meets the proposed standard. **Added First Cost** includes added sales tax paid by the consumer.

Energy Costs used in calculating cost effectiveness are based on the costs of energy paid by consumers. These costs vary from appliance to appliance, depending on the type of tariff charged and the time of year that the appliance is typically used. For instance for residential size water heaters, use is year round and the costs to consumers are those for residential customers; whereas for large air conditioners, the use is predominantly in the hotter months and the costs are those for nonresidential building customers. The fundamental differences in these costs often relate to the economies of scale related to large quantities of sales of energy. Although time of day charges are rarely used for the appliances in this analysis, seasonal tariffs are generally used. Energy costs are not the same as rates. Often rates are designed to accomplish goals that are separate from costs. An example of this is the baseline rates that limit the rate charged for the first block of energy purchased. This baseline may not represent the true cost of energy. Similarly, the marginal costs of providing new services may be spread across all customers in a utility and not charged directly to the ratepayer. This analysis is an aggregated statewide average analysis; this analysis uses an estimated statewide average cost to provide energy to each appliance type. These costs vary by time of use, a forecast model developed for the Energy Commission's Energy Information and Analysis Division was used to estimate future cost by each time of use. The actual costs per kWh, therm, or gallon are identified in the discussion for each type of appliance.

Electricity costs are from recent analysis by the Commission's Energy Information and Analysis Division (see endnote i) ; natural gas prices are taken from the Commission's *Natural Gas Market Outlook 2000 – 2020*, (see endnote ii) Appendices C and H. The prices are different for residential, small commercial, and medium-size commercial customers. Energy costs vary from year to year.

[1] For those appliances, for which there already exists a minimum performance standard, this is typically one that just complies with that standard.

Design Life is the expected life of the appliance. In most cases the expected life does not change with a new standard. There are, however, notable exceptions such as lamps. In these cases, the cost effectiveness calculation becomes more complicated. For instance, if the base case lamp has a two year life and the more efficient lamp has a ten year life, the comparison is made over ten years and assumes, for the base case, that the lamp is replaced four times in the ten years.

Discount Rate is based on the real after-tax cost of capital for building owners or purchasers of commercial equipment on the basis that major purchases can be funded through financing with tax deductible interest. A simple way to estimate the discount rate is:

Estimated Discount Rate

	8.9%	interest rate for loan
X	63.0%	tax effect (assuming 28% federal tax rate and 9% state tax rate)
=	5.6%	after-tax interest rate
-	2.6%	inflation rate (as forecast by Council of Economic Advisors) (see endnote iii)
=	3.0%	real after-tax discount rate

Different assumptions for the interest rate, tax rate, and inflation rate could yield different discount rates, but the 3 percent rate is plausible for reasonable combinations of assumptions, since higher interest rates would be correlated with higher inflation rates. In the current market, even without tax considerations, loan rates are approximately 3 percentage points above inflation. (see endnote iv)

The **Present Value** of a dollar of savings (or costs) in each future year is calculated by reducing the savings (or costs) by the **Discount Rate**.

The equation for determining the present value of a dollar in a future year is:

$$\text{PresentValue} = \frac{\text{FutureValue}}{(1 + \text{DiscountRate})}$$

The present value for one year is then:

$$\text{PresentValue} = \frac{1}{(1 + 0.03)} = 0.970874$$

The **Present Value** of a dollar saved (or spent) two years from now is:

$$\text{PresentValue} = \frac{1}{(1+0.03)^2} = 0.942596$$

and so on. All costs and savings that occur in any year other than the first year of the **Design Life** are reduced to a present value.

Following is a table showing the present value of one dollar in each of 30 future years.

Present Value of Dollar for Next 30 Years

Single Payment Present Value Factors	
Year Number	Present value of one dollar
1	0.970874
2	0.942596
3	0.915142
4	0.888487
5	0.862609
6	0.837484
7	0.813092
8	0.789409
9	0.766417
10	0.744094
11	0.722421
12	0.70138
13	0.680951
14	0.661118
15	0.641862
16	0.623167
17	0.605016
18	0.587395
19	0.570286
20	0.553676
21	0.537549
22	0.521893
23	0.506692
24	0.491934
25	0.477606
26	0.463695
27	0.450189
28	0.437077
29	0.424346
30	0.411987

Appendix D

Studies, Reports, and Documents Relied On

Fernstrom, Gary B., PG&E. "Analysis of Standards Options for Residential Clothes Washers", September 2003.

Endnotes

[i] California Energy Demand 2000-2010, June 2000, MCP estimates from CEC Staff (Richard Grix etc.) Updates for DSM programs. Assumptions provided in Market Clearing Prices Under Alternative Resource Scenarios 2000-2010, Feb.2000, Sales by customer class are from the Demand Office (Richard Roeher) demand estimates, various utility financial statements, and business plans

[ii] Gas price estimates in 1998 real dollars were provided in supporting documentation to the Commission's Natural Gas Market Outlook 2000-2020. These prices were updated to 2001 real dollars for this analysis.

[iii] Council of Economic Advisors, Economic Report to the President, January, 2001

[iv] Website, Bankrate.com, March 19, 2001, 30 Year Fixed rate home loan – 6.83%, Home equity loan - 8.8%, New car loans – 9.49%.

[vii] Simple Payback is a simpler, but less precise, method of calculating cost-effectiveness.
Simple payback = added first cost divided by the first year energy cost savings; The simple payback period is the number of years required to make up for the added cost through energy cost savings.

Addendum to the
Update of Appliance Efficiency Regulations for Residential Clothes Washers
Staff Report, September 2003, Publication #P400-03-021

December 10, 2003

The cost analysis in the original Staff Report on Residential Clothes Washers took into account on-site water savings and off-site electrical savings only. We have since received new data that indicates that a significant amount of energy savings, both gas and electric, can be ascribed to the washing machine end-user, that is, on-site energy savings. This amendment to the Staff Report takes into account these on-site energy savings.

Additionally, the original cost analysis in the Staff Report assumed that the average base model of residential clothes washer had a water factor of 12.0. New market data indicate that the base model water factor is closer to 10.5, which is the value used in this re-analysis.

Incorporating the changes and additions indicated above, the proposed water factor standards described in the original staff report remain cost effective, benefiting California consumers, water utilities, and power utilities.

It should be noted that although we do not include such savings in this or previous reports, analysis indicates that there is a strong potential for significant detergent savings at both water factor levels described herein.

The cost effectiveness of the residential clothes washer water factor standards, using the new data, is shown below in a series of tables.

Tables 1 and 2 below supersede Tables 1 and 2 in the original Staff Report dated September 2003. These revised tables use a more conservative baseline water factor of 10.5 rather than 12, and reflect on-site energy savings. Both water factor levels result in positive total life cycle savings to the consumer, meaning that the consumer will gain more in water and energy savings than they will pay in added costs to purchase the more efficient clothes washers.

Table 1 – Revised Life Cycle Cost Effectiveness for 8.5 WF

Cost of Base Case (10.5 WF) Washing Machine	$550.00	
Cost of 8.5 WF Washing Machine	$616.44	
Incremental Cost for 8.5 WF Washing Machine	$66.44	
Number of loads washed per year	392	
Average washing machine life (years)	14	
Number of Units Sold per Year in CA	900,000	
	10.5 WF (baseline)	**8.5 WF**
Annual Water Savings (gal)	0	2,352
Annual Site Energy Savings (kWh)	0	13
Annual Energy Savings (Therms)	0	3
Present Value of Water Savings (based on $0.0032/gal)	-$85.02	
Present Value of Electrical Savings (based on $0.115/kWh)	-$16.89	
Present Value of Gas Savings (based on $0.63/therm)	-$21.35	
Net Present Value of Savings	($123.26)	
Total Life Cyle Savings (NPV of savings minus incremental cost)	**$56.82**	

Table 2 – Revised Life Cycle Cost Effectiveness for 6.0 WF

Cost of Base Case (10.5 WF) Washing Machine	$550.00	
Cost of 6.0 WF Washing Machine	$680.18	
Incremental Cost for 6.0 WF Washing Machine	$130.18	
Number of loads washed per year	392	
Average washing machine life (years)	14	
Number of Units Sold per Year in CA	900,000	
	10.5 WF (baseline)	**6.0 WF**
Annual Water Savings (gal)	0	5,292
Annual Site Energy Savings (kWh)	0	18
Annual Energy Savings (Therms)	0	4
Present Value of Water Savings (based on $0.0032/gal)	-$191.29	
Present Value of Electrical Savings (based on $0.115/kWh)	-$23.38	
Present Value of Gas Savings (based on $0.63/therm)	-$28.47	
Net Present Value of Savings	($243.14)	
Total Life Cyle Savings (NPV of savings minus incremental cost)	**$112.96**	

Tables 3 and 4 below supersede Tables 3 and 4 in the original Staff Report dated September 2003. These tables show the “simple payback” for the water and energy efficiency measures being proposed, and both the water factor of 8.5 and 6.0 result in a payback period of approximately six years, far sooner than the 14-year lifespan of residential clothes washers.

Table 3 – Simple Payback Cost Effectiveness for 8.5 WF

Added First Cost	Annual Unit Reduction in Water Use (gallons)	Annual Unit Water Cost Savings (based on $.0032/gallon)	Annual Unit Reduction in Electrical Use (kWh)	Annual Unit Electrical Cost Savings (based on $0.115/kWh)	Annual Unit Reduction in Gas Use (therms)	Annual Unit Gas Cost Savings (based on $0.63/therm)	Simple Payback (years)	Design Life (years)
$66.44	2,352	$7.53	13	$1.49	3	$1.89	6.1	14

Table 4 – Simple Payback Cost Effectiveness for 6.0 WF

Added First Cost	Annual Unit Reduction in Water Use (gallons)	Annual Unit Water Cost Savings (based on $.0032/gallon)	Annual Unit Reduction in Electrical Use (kWh)	Annual Unit Electrical Cost Savings (based on $0.115/kWh)	Annual Unit Reduction in Gas Use (therms)	Annual Unit Gas Cost Savings (based on $0.63/therm)	Simple Payback (years)	Design Life (years)
$130.18	5,292	$16.93	18	$2.07	4	$2.52	6.0	14

Studies, Reports, and Documents Relied On

Energy Solutions *for* Gary B. Fernstrom, PG&E. "Comments of PG&E Regarding Proposed Residential Clothes Washer Water Factor Standards (Docket No. 03-AAER-01)(RCW), November 26, 2003.