

DOCKETED

Docket Number:	15-AAER-05
Project Title:	Residential Lavatory Faucets and Showerheads
TN #:	205479
Document Title:	Energy Solutions Seattle PUC - How High Efficiency Restroom Fixtures Really Perform
Description:	N/A
Filer:	Patty Paul
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	7/24/2015 10:25:33 AM
Docketed Date:	7/24/2015

An On-The-Ground Perspective: How High Efficiency Restroom Fixtures Really Perform

Executive Summary

Study Background and Methodology

High Efficiency Toilets (HETs) and High Efficiency Urinals (HEUs) can reduce water use and associated water bills significantly. To increase use of these efficient fixtures in the Seattle area, the Saving Water Partnership and Resource Venture offer rebates to commercial and multifamily properties that install fixtures certified by the U.S. Environmental Protection Agency's WaterSense program.

In 2010, Seattle Public Utilities contacted facility managers that participated in the rebate program to assess their experience and gather information that can help other facility managers decide whether to install high efficiency toilets and urinals.

What do HET and HEU mean?

HET: a high efficiency toilet uses 1.28 gallons of water per flush or less

HEU: a high efficiency urinal uses 0.5 gallons of water per flush or less

Find products at

www.epa.gov/WaterSense/Products

This report summarizes the experiences of seven multifamily facilities and six commercial buildings that installed HETs and nine commercial buildings that installed HEUs. The findings address fixtures selected, project costs, installation experience, satisfaction and performance, and cost savings from three case studies.

Key Findings

- **Most facility managers were satisfied or very satisfied** with their high efficiency toilets and urinals. Multifamily facility managers were particularly satisfied.
- **Users at these facilities provided mostly or almost all positive comments on the new fixtures**, according to facility managers. However, several facilities with new urinals reported comments on splashing, and one facility with pressure-assisted toilets received negative comments on a variety of issues. Of the three commercial facilities whose users commented on flushing ability, two said the users quickly became accustomed to the new fixtures.
- **Maintenance requirements, maintenance costs, and cleaning needs were about the same or lower** than for their previous fixtures, according to most facility managers. However, two facility managers that installed Nano Pint urinal models reported higher maintenance costs and cleaning needs due to

How High Efficiency Restroom Fixtures Really Perform

Multifamily and Commercial Case Studies

urinal splashing and clogging concerns, and one facility manager reported needing to **replace parts of the flushing mechanism in the pressure-assisted toilets.**

- **Splashing was the most common maintenance issue or user complaint**, mainly from facilities that had installed the nano pint model. Two facility managers also **expressed concern about slow draining or clogging due to the very small amount of water used per flush**, one of whom reported regularly pouring water down urinals to prevent pipe clogging.
- Facility managers generally reported **limited special work needed for installation**: mainly adjusting for the difference in size compared to previous fixtures (wall and floor repair, changing heights of pipes) as well as using special fasteners or gaskets, repairing some valves and supply lines, and repairing or replacing carrier brackets and nipples.
- Facility managers reported installing fixtures from the following manufacturers:
 - Multifamily HET: ProFlo, American Standard, and Glacier Bay 1.28 gpf gravity tank toilets.
 - Commercial HET: Zurn and Toto 1.28 gpf Flushometer toilets and Gerber 1.1 gpf pressure-assisted toilets.
 - Commercial HEU: Zurn 0.125 gpf and Kohler 0.5 gpf urinals.
- **High efficiency toilets in multifamily buildings pay for themselves in about a year**, based on estimated water savings. With SPU rebates, projects costs range from free to \$130 per fixture and reduce water use by an estimated 5,600 gallons per year, saving an estimated \$100 annually.
- **High efficiency toilets and urinals in commercial buildings have an estimated pay-back period of 1.2 to 2.7 years**, based on project costs and water savings measured through SPU billing data, detailed in the table below.

		Building A	Building B	Building C
Building Details	Fixtures installed	450 HETs	261 HETs	166 HETs
		150 HEUs	--	56 HEUs
	Occupants	4,050	2,824	2,500
Project Costs	Project cost	\$267,000	\$124,000**	\$132,000
	Rebates*	(\$72,000)	(\$31,000)	(\$27,000)
	NET COST	\$195,000	\$93,000	\$105,000
Water Savings	Annual volume (MGY [†])	3.75 MGY	3.95 MGY	3.8 MGY
	Per occupant (GPD [†])	2.5	3.8	3.5
	Reduction in total use	26%	39%	44%
	ANNUAL COST SAVINGS [‡]	\$72,000	\$75,000	\$61,000
PAYBACK PERIOD		2.7 years	1.2 years	1.7 years

* SPU provided rebates of \$120 per fixture.

[†] Millions of gallons per year (MGY) and gallons per day (GPD)

[‡] Calculated using Seattle's 2011 average annual commercial water and sewer rate of \$14.24 per CCF.

** Estimated based on similar projects; installation cost not reported by the building contact.

Background and Methodology

Study Objective

High Efficiency Toilets (HETs) and High Efficiency Urinals (HEUs) can reduce water use and associated water bills significantly. Through its WaterSense program, the U.S. Environmental Protection Agency certifies fixtures that meet rigorous performance and efficiency criteria (www.epa.gov/WaterSense/Products). To increase use of these efficient fixtures in the Seattle area, the Saving Water Partnership and Resource Venture offer rebates to commercial and multifamily properties that install these efficient toilets and urinals. In 2010, Seattle Public Utilities contacted facility managers that participated in the rebate program to assess their experience and gather information that can help other facility managers decide whether to install high efficiency toilets and urinals.

What are a HET and a HEU?

HET: a high efficiency toilet uses 1.28 gallons of water per flush or less

HEU: a high efficiency urinal uses 0.5 gallons of water per flush or less

Find products at

www.epa.gov/WaterSense/Products

This report summarizes the experiences of seven multifamily facilities and six commercial buildings that installed toilets and nine commercial buildings that installed urinals. The findings address fixtures selected, project costs, installation experience, satisfaction and performance, and cost savings from three case studies.

Methodology

Resource Venture administered an electronic and phone questionnaire to facility managers at 7 multifamily properties and 11 commercial buildings that had installed high efficiency toilets and urinals between 2008 and 2010 to assess project costs, installation experience, satisfaction, and performance. This report also describe field tests conducted previously to measure the actual flush volume of high efficiency toilets and three cases studies to highlight typical project costs, savings, and payback periods for installing efficient fixtures.

Resource Venture developed a list of multifamily and commercial facilities known to have installed high efficiency fixtures using the following information sources:

- Seattle Public Utilities (SPU) provided a list of facilities that had been granted rebates under the Multifamily Toilet Program and the Water Smart Technology Program in 2009 and 2010.
- Local manufacturers' representatives for all makes of high efficiency toilets and urinals provided names of facilities that had installed fixtures.
- An internet search for facilities in the Saving Water Partnership service area that had been rated by LEED (Leadership in Energy Efficiency and Design) identified projects whose descriptions mentioned high efficiency fixtures.

Resource Venture contacted facility managers at 20 multifamily properties and 20 commercial facilities known to have installed high efficiency fixtures to ask them to complete a 13-question form either

electronically by email or by phone. The following number of properties responded to the questionnaire:

- Seven multifamily buildings that installed tank-type HETs only.
- Two commercial facilities that installed flush-valve-type HETs only
- Four commercial facilities that installed both flush-valve-type HETs and HEUs
- Five commercial facilities that installed HEUs only

Due to substantial differences in the way fixtures are used, responses from multifamily and commercial facilities were listed and analyzed separately. The study did not consider no-water urinals as the utility no longer provides rebates or incentives for this type of fixture due to demonstrated short average fixture life for fixtures of this type previously installed with utility support.

Analysis Considerations

Small sample size: due to its small sample size, this study should be considered as a collection of anecdotal case studies and not as a true survey; results are not statistically valid.

Unclear questionnaire design – satisfaction ratings: due to the design of the question on overall satisfaction, some respondents appear to have marked “5–very dissatisfied” when they intended to mark “1–very satisfied.” Responses for one multifamily toilet respondent and three commercial urinal respondents were reversed because their responses to other questions about maintenance, cleaning, and user comments were all neutral or positive. One multifamily toilet respondent and one commercial toilet respondents marked “4–dissatisfied” while providing mostly but not completely neutral or positive responses to performance questions; their satisfaction responses were not altered due to uncertainty in their intentions.

Unclear questionnaire design – combined toilet and urinal projects: four commercial facilities installed both toilets and urinals. Due to question design, it was difficult to determine whether their responses to certain questions applied to toilets, urinals, or both. While most questions included separate response boxes for each fixture type, this was not the case for questions on reasons for selecting particular models, special work required for installation, maintenance or custodial issues, and issues mentioned by users. In this report, Resource Venture made educated guesses about which type of fixture (toilet, urinal, or both) the responses applied to.

Non-comparable project costs: Participant responses on approximate total project costs were not independently verified and may not include all project costs (fixtures, valves, other parts, and installation) or may include costs incurred at the same time but not related to high efficiency fixture projects. As a result, total costs are not necessarily comparable across projects and should be considered rough and possible incomplete estimates. Also note that costs below \$100 in this report are rounded to the nearest \$10; costs above \$100 are rounded to the nearest \$25.

Key Findings

Multifamily HET Installations (1.28 gpf gravity tank)

Models Installed (1.28 gpf)	Fixtures installed	Costs per fixture (after rebate)	Estimated annual savings per fixture
ProFlo , American Standard, Glacier Bay	6–127 per building 316 total	Fixture: \$0 to \$40 Installation: \$0 to \$90	5,600 gallons or more \$100 or more

Most multifamily respondents installed toilets made by ProFlo, which were the “free” option supplied by SPU and field tested to confirm an average flush volume of 1.3 gpf.

- **High efficiency toilets pay for themselves in about a year**, based on estimated water savings.
- Most multifamily facility managers reported being **satisfied or very satisfied with their new toilets**.
- **Users provided mostly or almost all positive comments** on their new toilets, according to facility managers.
- Facility managers reported **limited special work needed for installation**: adjusting for the difference in size compared to previous fixtures (wall repair, changing heights of pipes and nearby shelving), repairing some valves and supply lines, and using special fasteners or gaskets. One respondent who needed to adjust for size differences in some fixtures noted that otherwise “most were quite straight forward.”
- **Maintenance requirements, maintenance costs, and cleaning needs were about the same or lower** than for their previous fixtures, according to all six facility managers.
- **Facility managers reported few maintenance issues**: one reported leaks and one needed to adjust chain length, but others had positive comments about their flushing ability and low noise.

Facility manager comments:

- *These are fantastic toilets: they never plug up and the tenants are so happy.*
- *“NO issues so far! We are very happy with this program/project!”*
- *Tenants are very happy. The toilets flush really great. The toilets are very well designed*
- All good comments, especially about the cost savings and the low noise and recovery time per flush.
- There were a couple of units that needed some sort of adjustment to a size or height differential, but very few. Most were quite straight forward.

Large Commercial HET Installations (1.28 gpf flushometer or 1.1 gpf pressure-assisted tank)

Models Installed	Fixtures installed
Zurn and Toto (1.28 gpf) Gerber(1.1 gpf)	120–450 per building 1,663 total

Commercial respondents installed toilets made by Zurn (1.28 gpf), Toto (1.28 gpf), and Gerber (1.1 gpf pressure assisted).

- **High efficiency toilets pay for themselves quickly** in water savings. One downtown building that installed 260 toilets will recoup its costs in an estimated 1.2 years.
- Most commercial facility managers reported being **satisfied or very satisfied with their new toilets**.
- **Users provided mostly or almost all positive comments on high efficiency flushometer toilets**, although some needed time to become accustomed to the lower flow, according to facility managers.
- Users had **some negative comments on the pressure-assisted tank toilets**, which were addressed by installing thicker toilet seats to lift them farther from the water spot, and by installing repair parts provided at no cost by the manufacturer. (None of the negative comments related to flushing ability.)
- Facility managers reported **limited special work needed for installation**: adjusting for the difference in size compared to previous fixtures (wall repair, floor tile work), shortening carrier brackets, and replacing cracked carrier nipples.
- **Maintenance requirements, maintenance costs, and cleaning needs were about the same or lower** than for their previous fixtures, according to most facility managers. One facility that installed pressure-assisted fixtures needed replacement parts for the flush mechanism, which were being supplied by the manufacturer under warranty.
- **Facility managers reported few maintenance issues or user complaints with the flushometer toilets**: of three respondents who commented on lower flushing volume, two said users learned to adapt to the new fixtures.

Large Commercial HEU Installations (0.5 gpf or 0.125 gpf urinals)

Models Installed	Fixtures installed
Zurn small pint and nano (0.125 gpf) Kohler (0.5 gpf)	7–299 per building 1,041 total

How High Efficiency Restroom Fixtures Really Perform

Multifamily and Commercial Case Studies

Commercial respondents installed urinals made by Zurn (small pint and nano models) and Kohler (with a 0.5 gpf diaphragm-type flush valve).

- Most commercial facility managers reported being **satisfied or very satisfied with their new urinals**.
- **In most facilities, users provided mostly or almost all positive comments on high efficiency urinals**, although users in several facilities commented on splashing.
- Facility managers reported **limited special work needed for installation**: most needed no special work and four needed to adjust for the difference in size compared to previous fixtures (wall repair, changing height of existing water or drain pipes) or use special fasteners or gaskets.
- **Maintenance requirements, maintenance costs, and cleaning needs were about the same or lower** than for their previous fixtures, according to most facility managers. Two facility managers that installed nano pint models reported higher maintenance costs and cleaning needs due to splashing and clogging concerns.
- **Splashing was the most common maintenance issue or user complaint**, mainly from facilities that had installed the nano pint model. Two facility managers also **expressed concern about slow draining or clogging due to the very small amount of water used per flush**, one of whom reported regularly pouring water down urinals to prevent pipe clogging.

Commercial Building Case Studies on Payback Periods

The estimated payback period for commercial toilet and urinal projects ranged from 1.2 to 2.7 years, based on questionnaire responses and actually monthly billing data obtained for three case studies. These projects reduced total building water use by 26% to 44%, saving between 2.5 and 3.8 gallons per occupant per day, as presented in Table 1.

How High Efficiency Restroom Fixtures Really Perform

Multifamily and Commercial Case Studies

Table 1. Cost Savings and Payback Period for Three Case Studies

		Building A	Building B	Building C
Building Details	Fixtures installed	450 HETs	261 HETs	166 HETs
		150 HEUs	--	56 HEUs
	Occupants	4,050	2,824	2,500
Project Costs	Project cost	\$267,000	\$124,000**	\$132,000
	Rebates*	(\$72,000)	(\$31,000)	(\$27,000)
	NET COST	\$195,000	\$93,000	\$105,000
Water Savings	Annual volume (MGY[†])	3.75 MGY	3.95 MGY	3.8 MGY
	Per occupant (GPD[†])	2.5	3.8	3.5
	Reduction in total use	26%	39%	44%
	ANNUAL COST SAVINGS[‡]	\$72,000	\$75,000	\$61,000
PAYBACK PERIOD		2.7 years	1.2 years	1.7 years

* SPU provided rebates of \$120 per fixture.

[†] Millions of gallons per year (MGY) and gallons per day (GPD)

[‡] Calculated using Seattle's 2011 average annual commercial water and sewer rate of \$14.24 per CCF.

** Estimated based on similar projects; installation cost not reported by the building contact.

Cost Savings Information

Theoretical cost savings were calculated for multifamily projects, and actual costs savings were calculated for three commercial projects. Savings from reduced water use were calculated using Seattle's 2011 annual average commercial water and sewer rate of \$14.24 per CCF (100 cubic feet).

Theoretical Multifamily HET Savings

Multifamily facilities are estimated to recoup the project costs in about a year by saving at least \$107 annually per fixture from reducing water use by a projected 5,600 gallons per fixture per year based on the following assumptions:

- Conservative estimate of seven flushes per day per fixture (as is typical for a hotel)
- Estimated savings of 2.2 gpf (ranging from 3.5 gpf to 1.3 gpf)

Savings may be even greater because residential users are likely to flush more often than hotel users and the project may replace a significant number of leaking fixtures.

Actual Large Commercial HET and HEU Savings

The estimated payback period for commercial toilet and urinal projects ranged from 1.2 to 2.7 years, based on questionnaire responses and actually monthly billing data obtained for three case studies. These projects reduced total building water use by 26% to 44%, saving between 2.5 and 3.8 gallons per occupant per day, as presented in Table 2 and case studies below.

Table 2. Cost Savings and Payback Period for Three Case Studies

		Building A	Building B	Building C
Building Details	Fixtures installed	450 HETs	261 HETs	166 HETs
		150 HEUs	--	56 HEUs
	Occupants	4,050	2,824	2,500
Project Costs	Project cost	\$267,000	\$124,000**	\$132,000
	Rebates*	(\$72,000)	(\$31,000)	(\$27,000)
	NET COST	\$195,000	\$93,000	\$105,000
Water Savings	Annual volume (MGY [†])	3.75 MGY	3.95 MGY	3.8 MGY
	Per occupant (GPD [†])	2.5	3.8	3.5
	Reduction in total use	26%	39%	44%
	ANNUAL COST SAVINGS [‡]	\$72,000	\$75,000	\$61,000
PAYBACK PERIOD		2.7 years	1.2 years	1.7 years

* SPU provided rebates of \$120 per fixture.

[†] Millions of gallons per year (MGY) and gallons per day (GPD)

How High Efficiency Restroom Fixtures Really Perform

Multifamily and Commercial Case Studies

* Calculated using Seattle's 2011 average annual commercial water and sewer rate of \$14.24 per CCF.

** Estimated based on similar projects; installation cost not reported by the building contact.

Downtown Office Building A

This facility's project to install 450 sensor-operated HETs (1.28 gpf) and 150 sensor-operated HEUs (0.125 gpf) reduced total building water use by 26% and has an estimated pay-back period of 2.7 years. The net project cost was about \$195,000 after a utility rebate of \$120 per fixture. The building saves a calculated \$72,000 per year on its water and sewer bill through reduced water use estimated at 3.75 million gallons per year, or 2.5 gallons per occupant per day.

Downtown Office Building B

This facility's project to install 261 manually operated HETs (1.28 gpf) reduced total building water use by 39% and has an estimated pay-back period of a little over one year. The facility reported a fixture cost of \$52,000 but did not report an installation cost. Based on other projects, we assume a total project cost of project cost was about \$475 per fixture and subtract a utility rebate of \$120 per fixture for a net total project cost of nearly \$93,000. The building saves an estimated \$75,000 per year on its water and sewer bill through reduced water use estimated at 3.95 million gallons per year, or 3.8 gallons per occupant per day.

Downtown Office Building C

This facility's project to install 166 manually operated HETs (1.28 gpf) and 56 manually operated HEUs (0.5 gpf) reduced total building water use by 44% and has an estimated pay-back period of 1.7 years. The net project cost was about \$105,000 after a utility rebate of \$120 per fixture. The building saves a calculated \$61,000 per year on its water and sewer bill through reduced water use estimated at 3.2 million gallons per year, or 3.5 gallons per occupant per day.

Detailed Questionnaire Results

Project and Installation Details

Installation Dates

Respondents reported installing fixtures between 2008 and 2010. Based on installation date, commercial respondents have more experience with their fixtures than multifamily respondents.

	2008	2009*	2010
Multifamily HET	--	--	7
Commercial HET	--	6	--
Commercial HEU	1	5	1

*Includes commercial respondent reporting installation in 2009–2010.

Number and Type of Fixtures Installed

Multifamily respondents most commonly reported installing the “free” tank-type toilet made by ProFlo, but one each had chosen models by American Standard and Glacier Bay, as shown in Table 3. Multifamily respondents reported installing 6 to 127 HETs each, rated to use 1.28 gallons per flush (gpf). Field testing by SPU of one set of ProFlo models using a digital in-line meter confirmed an average flush volume of 1.3 gpf.

Commercial HET respondents reported installing 120 to 450 fixtures each; most respondents (five high rise office buildings) installed 1.28 gpf wall-hung flushometer toilets made by Zurn or Toto while one large hotel installed 1.1 gpf floor-mounted, back outlet pressure-assist tank toilets made by Gerber. About half of the commercial HETs were manual and half were auto-flush. Field tests of three sets of toilets found that HETs rated at 1.28 gpf used no more water than expected; one set of toilets used much less water (0.8 to 1.0 gpf) and was later adjusted to use more water in response to user complaints about flushing capacity.

Commercial HEU respondents reported installing 7 to 299 HEUs each. Eight facilities installed one of three different models of 0.125 gpf sensor-operated Zurn urinals. One facility installed 0.5 gpf manual flush urinals by Kohler, using the existing diaphragm-type flush valves. No HEU fixtures were field tested during this study; however, similar tests conducted previously at the University of Washington on 0.125 gpf urinals confirmed flushing volumes consistently near that figure, while tests of 0.5 gpf assemblies found slightly higher volumes (0.6 gpf) to be typical.

How High Efficiency Restroom Fixtures Really Perform

Multifamily and Commercial Case Studies

Table 3. Number and Type of Fixtures Installed

		Number of Respondents	Fixtures per building	Total Fixtures
Multifamily HET	ProFlo (1.28 gpf)*	5	20–127	294
	American Standard (1.28 gpf)	1	16	16
	Glacier Bay (1.28 gpf)	1	6	6
Commercial HET[†]	Zurn (1.28 gpf)	3	120–450	799
	Toto (1.28 gpf)	2	176–273	449
	Gerber (1.1 gpf)	1	415	415
Commercial HEU	Zurn (0.125 gpf)[‡]	8	7–299	937
	Kohler (0.5 gpf)	1	104	104

* One respondent with ProFlo fixtures did not report gpf rating and is assumed to have the utility-provided 1.28 gpf model.

[†] Zurn models featured automatic flushing; Gerber models used pressure-assisting flush valves.

[‡] Includes three Zurn models (the pint, small pint and nano pint).

Reasons for Selecting Models

Multifamily respondents most commonly reported selecting the ProFlo model because those fixtures were provided free by the Utility, while commercial respondents most commonly reported selecting models because installation did not require significant work, as shown in Table 4. Both types of respondents also reported considering whether the fixtures were rated highly, mentioning recommendations from SPU, fixture suppliers and manufacturers, and a chief engineer at another hotel. One commercial HET respondents reported testing four sample brands before purchasing.

Table 4. Reasons for Selecting Models

	Multifamily HET	Commercial HET	Commercial HEU
Installation did not require significant work	3	3	5
High ratings by (identify agency or contact)	3	2	2
Fixtures were provided free by the utility	6	--	--
Low cost of fixtures	3	1	--
Replacement parts are easily available	1	--	--
Other	--	1	2
TOTAL RESPONDENTS	7	6	7

Approximate cost of new fixtures

Multifamily HET respondents reported purchase costs per fixture ranged from \$0 (free toilet) to \$40 (which is assumed to be the net cost after deducting the \$100 utility rebate), as shown in Table 5. Reported installation costs per fixture ranged from \$0 to \$90.

Costs cited by **commercial HET** respondents varied significantly and are not considered reliable enough to report.

Five **commercial HEU** respondents that provided total project cost figures (including both product costs and installation costs) for their HEU installations, ranging from \$200 to \$1075 per fixture. The least expensive project installed new Kohler “Dexter” urinals using existing manual flush valves upgraded with 0.5 gpf diaphragm replacement kits. Only three respondents provided clear information differentiating product compared to installation cost: the product costs per fixture ranged from approximately \$425 to \$550 while installation costs per fixture varied significantly from \$60 to \$650. Both respondents who reported the highest and lowest installation costs reported that no special work was necessary during or after installation.

Table 5. Reported Cost Estimates per Fixture

	Multifamily HET	Commercial HET	Commercial HEU
Product cost per fixture	\$0 to \$40	NA	\$425 to \$550
Installation cost per fixture	\$0 to \$90	NA	\$60 to \$650
TOTAL RESPONDENTS	6	NA	3

Special Work Needed for Installation

Respondents most commonly reported needing to repair walls (9 respondents) or needing to do no special work during or after installation (8). Table 6 presents the number of respondents reporting each type of special work needed.

Table 6. Special Work Needed for Installation

	Multifamily HET	Commercial HET	Commercial HEU
None	2	1	5
Wall repair (e.g. re-tiling, patching, wall papering)	1	4	4
Changing height of existing water or drain pipes	1	--	1
Using special fasteners or gaskets	1	--	1
Extending studs or waste nipples	--	1	--
Other work necessary to allow installation	3	3	--
TOTAL RESPONDENTS	7	6	9

Other work mentioned by **multifamily HET respondents** included modifying shelving due to height differences between old and new toilets, installing new floor brackets, and repairing some valves (assumed to be wall stop valves) and buying new supply lines.

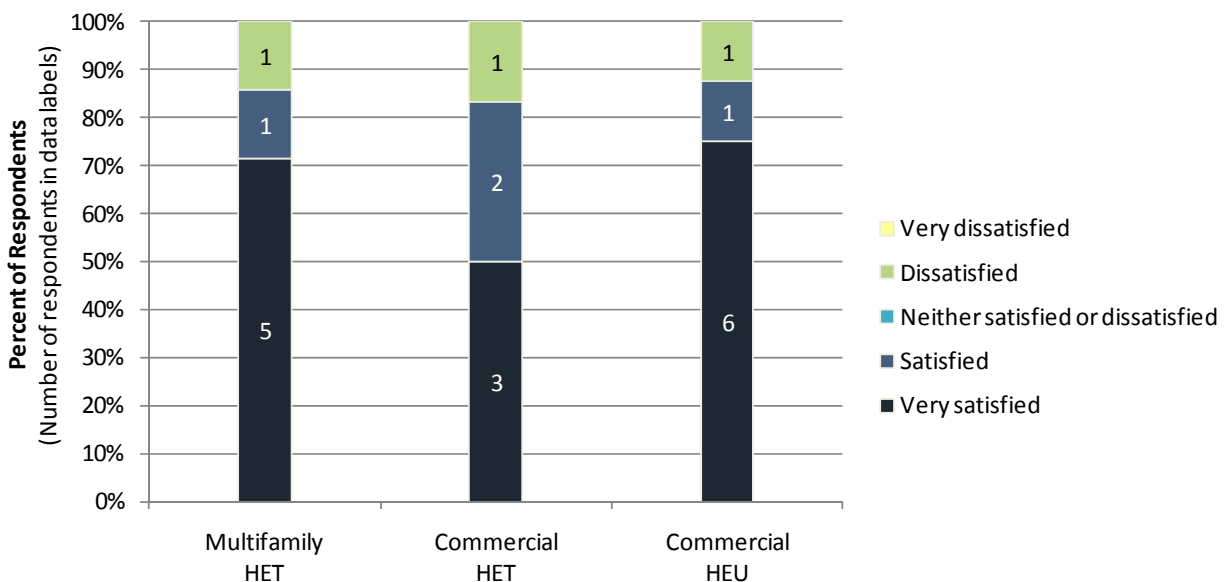
Other work mentioned by **commercial HET respondents** included cutting off 1" on each of the four carrier bracket all threads on the handicap because washers could not compensate for the difference between the thicker original fixtures, enlarging footprint with floor tile work, and replacing several cracked carrier nipples.

Performance

Overall Satisfaction with Fixtures

The majority of multifamily and commercial respondents that installed both HETs and HEUs reported being satisfied or very satisfied with their fixtures, as shown in Figure 1.

Figure 1. Satisfaction with Fixtures*



* Four respondents (one multifamily HET and three commercial HEU) appear to have reversed the response scale, marking 5 (very dissatisfied) while also reporting no problems, positive comments from users, or making positive comments about the fixture themselves. This chart re-categorized these respondents as being very satisfied. Two other respondents appear also to have inadvertently marked “dissatisfied” instead of “satisfied,” but they have not been re-categorized because their responses to other questions were not as clearly positive.

Fixture Maintenance and Cleaning

The majority of all respondents reported similar or lower maintenance requirements, maintenance costs, and cleaning needs for their new fixtures compared to their previous fixtures, as shown in Figure 2.

No **multifamily HET** respondents reported increases in maintenance requirements, maintenance costs, or cleaning needs. However multifamily facilities may have replaced old fixtures reaching the end of their lifespans with new HETS, resulting in very positive responses. Two respondents did not check anything, which may be taken to indicate “about the same” for them as well.

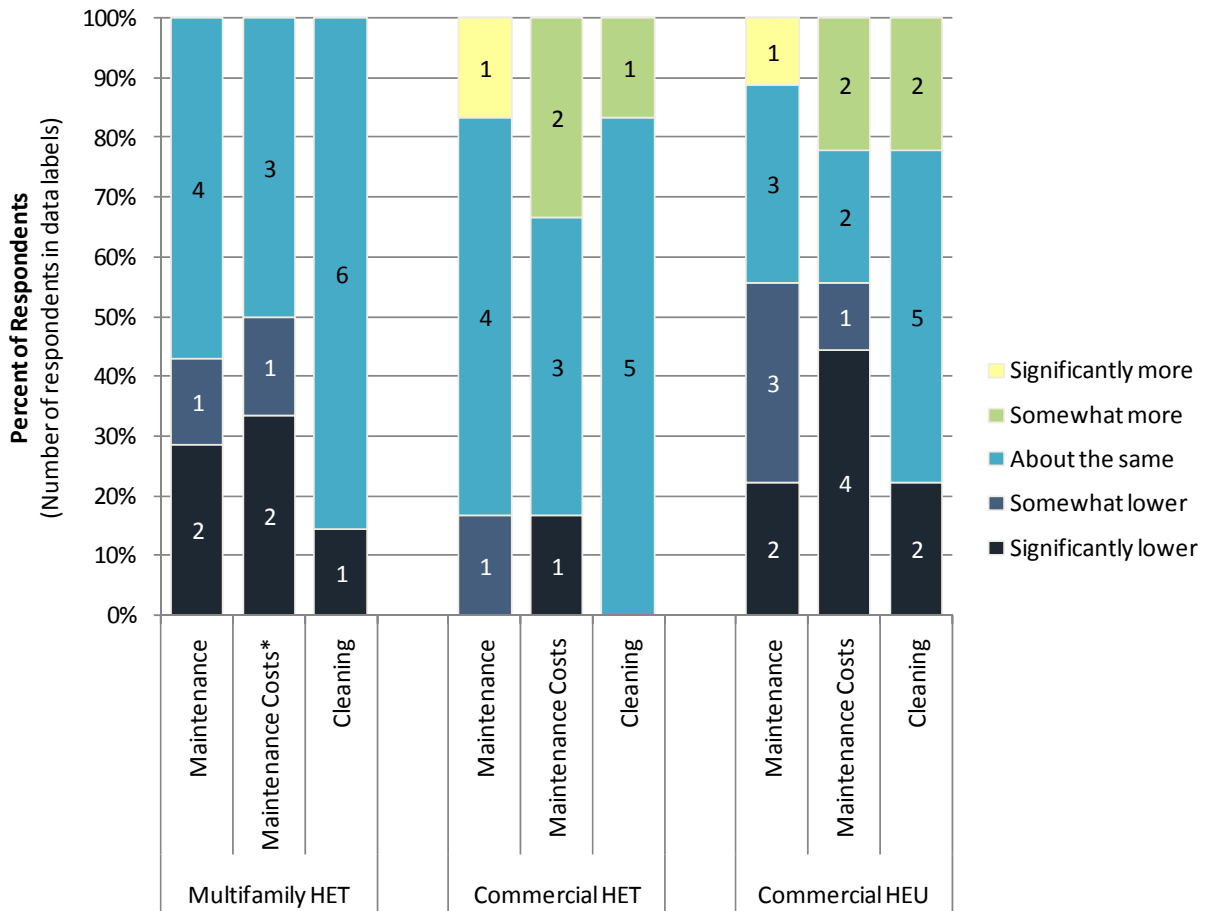
One **commercial HET** respondent reporting more maintenance requirements and costs had installed pressure-assisted models and reported failures of the in-line strainer in the supply line and of the upper supply assembly in tank. The other commercial HET respondent who reported higher maintenance costs and cleaning needs also reported that maintenance requirements were about the same, mentioned no specific maintenance issues, and said that almost all user comments were positive.

The two **commercial HEU** respondents reporting significantly lower maintenance requirements, maintenance costs, and cleaning needs had previously used “no-water” urinals. One respondent reporting more maintenance requirements, maintenance costs, and cleaning needs mentioned splashing issues and the need to regularly dump water down urinals to prevent clogging. Another respondent with splashing issues also reported somewhat higher maintenance costs and cleaning needs.

How High Efficiency Restroom Fixtures Really Perform

Multifamily and Commercial Case Studies

Figure 2. Reported Maintenance and Cleaning Needs



* One multifamily HET respondent did not rate maintenance costs.

Maintenance or Custodial Issues

The majority of multifamily and commercial respondents reported experiencing no significant maintenance or custodial issues with their new fixtures or left this question blank, although one multifamily HET respondent reported leaks. Table 7 presents the numbers of respondents reporting no problems or specific issues. The commercial HET respondent who experienced incomplete flushes also noted that complaints about this issue dropped significantly after the “learning curve” was over. Four commercial HEU respondents reported splashing, three of which had installed a particularly small variety of urinal, which is possibly related to the reported splashing problem.

Table 7. Maintenance or Custodial Issues

	Multifamily HET	Commercial HET	Commercial HEU
None	4	2	4
Splashing	--	--	4
Incomplete (short) flushes	--	1	1
Clogging	--	--	1
Frequent battery replacement	--	--	1
Leaks	1	--	--
Multiple automatic flushes for one user	--	--	1
Bowl streaking or staining	--	--	--
Excessive (long) flushes	--	--	--
Other repair, maintenance, or custodial issues	1	1	1
TOTAL RESPONDENTS	6	4	9

One **multifamily HET** respondent mentioned needing to loosen the chains on the handles, but added a very positive comment that “these are fantastic toilets: they never plug up and the tenants are so happy.” Another respondent commented “NO issues so far! We are very happy with this program/project!”

One **commercial HET** respondent who had installed a pressure-assist model reported failure of the in-line strainer in the supply line and of the upper supply assembly in tank.

One **commercial HEU** respondent reported slow draining urinals in heavy use areas, noting that the lack of water on pint flush has created urine crystals in the drain line.

User Experience

User comments

The majority of respondents reported receiving mainly positive comments or few to no comments from users, as shown in Figure 3.

How High Efficiency Restroom Fixtures Really Perform

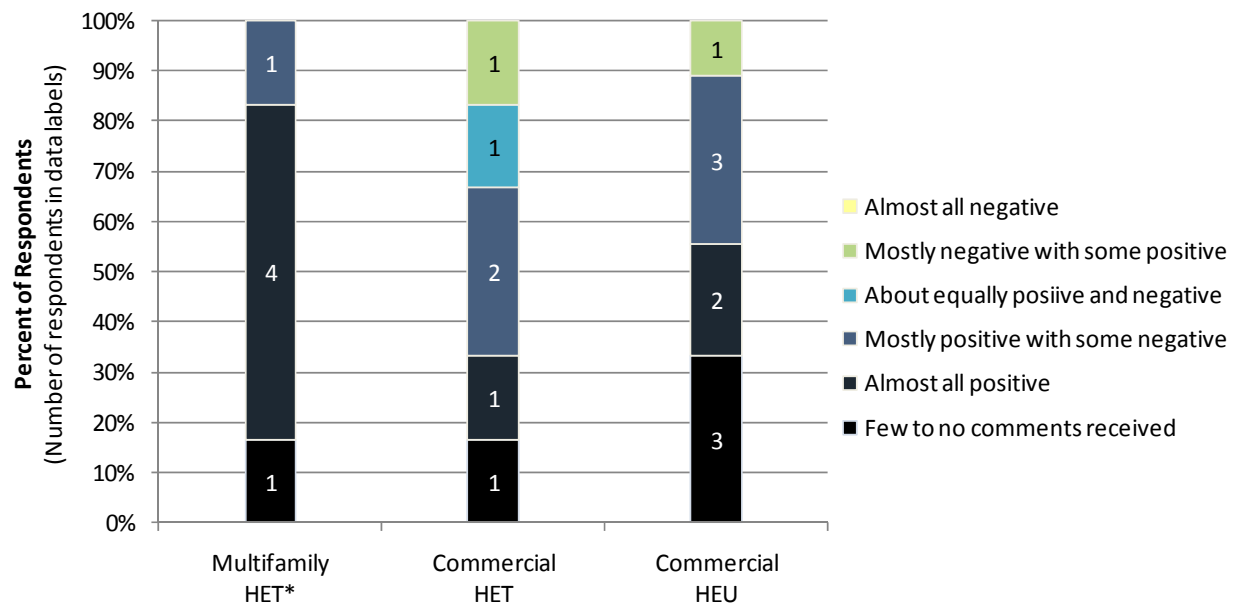
Multifamily and Commercial Case Studies

Among **multifamily HET** respondents, four reported receiving almost all positive user comments and one received few to no comments.

The **commercial HET** respondent reporting mostly negative comments had installed pressure-assist fixtures; the respondents who received equally positive and negative comments reported that complaints dropped significantly over time after the “learning curve” was over.

The **commercial HEU** respondent reporting mostly negative comments had also reported splashing issues and regularly dumped water down the urinals to prevent clogging.

Figure 3. User Comments



* One multifamily HET respondent did not characterize user comments.

User issues

Among **multifamily HET** respondents, five reported no user issues and two seemed to indicate users had positive comments on the issues mentioned: one noted that the appearance was “better than old pink toilets” and the other had reported that user comments were mostly positive. Table 8 presents the number of respondents reporting specific issues mentioned by users. Respondents reporting no issues also added positive comments

- Tenants are very happy. The toilets flush really great. The ProFlo toilets are very well designed.
- All good comments, especially about the cost savings and the low noise and recovery time per flush.

Two of the three **commercial HET** respondents reporting that users commented on lower flush volume or flushing ability also said that users had become accustomed to the new fixtures over time. Other issues included fixture height (which was solved with thicker toilet seats) and loud flush volume.

How High Efficiency Restroom Fixtures Really Perform

Multifamily and Commercial Case Studies

While five **commercial HEU** respondents reported that users had commented on splashing, four reported no user issues. Other issues included various issues with flushing (including automatic flushing), fixture height and, and odor.

Table 8. Specific User Issues

User Issues	Multifamily HET	Commercial HET	Commercial HEU
None	5	1	4
Splashing	--	--	5
Lower flush volume	--	3	1
Flushing ability	1	1	1
Fixture height	--	1	2
Automatic flushing, including multiple flushes	--	--	1
Odor	--	--	1
Appearance	1	--	--
Streaking	--	--	--
Other issues (please specify)	--	1	--
TOTAL RESPONDENTS	7	6	9