The Energy Policy Act: Assessing Its Impact on Utilities

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With passage of the federal Energy Policy Act in 1992, the United States will have uniform water efficiency standards for nearly all toilets, urinals, showerheads, and faucets manufactured after January 1994. Based on the combination of fixtures of different ages now in use, the average 2.63-person household uses about 121 gal/day for toilets, showerheads, and faucets. This will probably drop to about 55 gal/day by 2026 as the pre-1994 generation of fixtures is replaced by the post-1994 stock. The reduced water demand and wastewater volumes will influence policy and planning decisions of utilities. Some systems may need to determine the age and water demand of representative plumbing fixtures used in the community to determine conditions that will affect future demand. Oversized meters may need to be replaced to accommodate lowered water usage. The author proposes that all toilet manufacturers be required after 1994 to provide a minimum 10-year leak-free guarantee on all toilets produced. Use of treatment chemicals, utility demand for energy, and related energy combustion emissions are all expected to decrease with reduced water consumption.

A long-awaited conservation milestone was achieved in 1992 when national water efficiency requirements for plumbing products were established by the final passage of the federal Energy Policy Act.[1] For the first time, the United States will have uniform conservation standards for almost every toilet (water closet), urinal, showerhead, and faucet manufactured after January 1994. Some minor exceptions will apply for institutions such as prisons and for certain special uses (e.g., safety showers). Efficiency standards for toilets used in commercial installations will be phased in by 1997.

Because these new standards will influence water demand and wastewater volumes over the next several decades, utilities may benefit now by anticipating the impact of such changes on future water and wastewater demand forecasting, planning, and costs. The implications of the expected demand reductions may influence important policy and planning decisions of some systems.

Passage of the act is the culmination of more than five years of successful, sometimes arduous grass-roots work by numerous conservation specialists and water managers, environmental organizations, and elected representatives across the country. The effort started in the mid-1980s with local ordinances requiring low-volume toilets in Glendale, Ariz., and Goleta, Calif. Next the Commonwealth of Massachusetts and then 15 other states passed statewide plumbing code amendments or legislation requiring efficiency standards for toilets, urinals, showerheads, and faucets. The enactment of federal standards demonstrates that water conservation has gained a foothold on the nation's environmental agenda. It now seems likely that additional national conservation policy and program initiatives can be expected in the years ahead.

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This article outlines the act's major effects on water use and on related energy, environmental, and economic consequences expected from residential water demands. In addition, it outlines recommendations for future research in this area.

Energy Policy Act has three provisions

The Energy Policy Act has three basic components: the establishment of maximum-water-use standards for plumbing fixtures, product marking and labeling requirements, and recommendations for state and local incentive programs to accelerate voluntary fixture replacement. These requirements will be administered and regulated by the US Department of Energy (DOE) through its Office of Buildings Technologies.

Efficiency standards allow exemptions. The federal water efficiency standards for plumbing fixtures and fixture fittings set forth in the Energy Policy Act are shown in Table 1. Exemptions to the standards were allowed for products such as safety showers and toilets and urinals used in prisons, which require unique designs and higher flow rates. "Blowout" flushometer commercial toilets are allowed a higher water-use rate until they can be redesigned to operate reliably at a lower volume. White gravity tank–type toilets used in commercial settings will not be required to meet the 1.6-gal/flush maximum-use standard until 1997. It is not yet clear whether the state or federal rules will prevail in states whose existing water-efficiency requirements for fixtures exceed the act's standards. DOE has the authority to allow states to preempt the federal standards if the state's requirements are more stringent, and DOE is expected to issue regulations to clarify this matter late in 1993.[2]

Maximum flush volume requirements for toilets and urinals are established by the American Society of Mechanical Engineers (ASME) and the American National Standards Institute (ANSI) in national standard A112.19.6-1990, Hydraulic Requirements for Water Closets and Urinals. Marking and labeling requirements will be consistent with ASME–ANSI A112.19.2M-1990. Test procedures for showerheads and faucets are subject to ASME–ANSI A112.18.1M-1989, Plumbing Fixture Fittings. DOE retains the authority to establish more stringent standards as the technology improves, but the responsibility for this task is left largely with ASME–ANSI. If the national standards are revised by ASME–ANSI to improve the efficiency requirements, DOE can choose to adopt them. If DOE deems the revisions to be technologically unfeasible, not economically justified, not in the interest of public health and safety, or in some other way inconsistent with the purposes of the Energy Policy Act, it can reject ASME–ANSI's standards and set its own revised standards.

Marking and labeling required. Toilets, urinals, showerheads, and faucets will require product markings and labels as set forth in their respective ASME–ANSI standards. Toilets and urinals must bear permanent legible markings indicating water use expressed in gallons per flush. Showerheads and faucets must have permanent legible markings identifying the flow rate in gallons per minute or gallons per cycle.

The act includes a provision that commercial gravity tank–type white toilets must bear the label "For Commercial Use Only" placed "in a conspicuous manner" on any printed materials or displays for such products, including packaging and point-of-sale material, catalog material, and print advertising. This may be a problem. Because the majority of toilets sold for residential use are gravity tank–type white toilets, it is not clear what will prevent plumbers and homeowners from intentionally or mistakenly installing high-volume fixtures in homes. DOE and state enforcement efforts may be necessary to minimize such occurrences. Enforcement won't be easy, however, because many existing plumbing and building codes for efficiency requirements are not well heeded because of minimal inspection and enforcement at the local level.

Incentive programs encouraged. Under the Energy Policy Act, the secretary of the DOE must issue recommendations to states for establishing state and local incentive programs that encourage the acceleration of voluntary replacement by consumers of existing showerheads, faucets, water closets, and urinals with products that meet the act's standards. In developing the recommendations, the DOE is directed to consult with other federal agencies such as the US Environmental Protection Agency, state officials, the plumbingware industry, and "other interested parties." Not much else is described in this provision, leaving it open to interpretation and political initiative.

It is not clear what effect the Energy Policy Act will have on future fixture retrofit and replacement programs. If state and local incentive programs are developed, the number of programs will probably grow, and fixture replacements will be accelerated. On the other hand, there may be a disincentive for some utilities to support such programs, because similar savings can be expected to accrue automatically (although over a longer period of time) at no cost to the utility if new installations and replacements occur at a normal rate. In such an instance, it may be financially prudent to reassess the benefits and costs of fixture retrofit and replacement programs to determine if they should have different priorities than other conservation measures have.

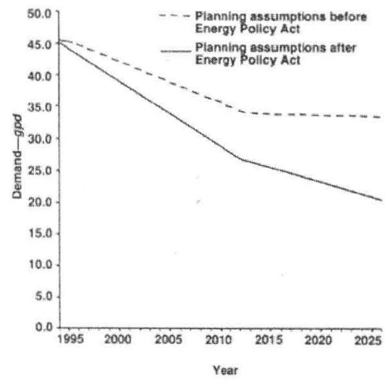
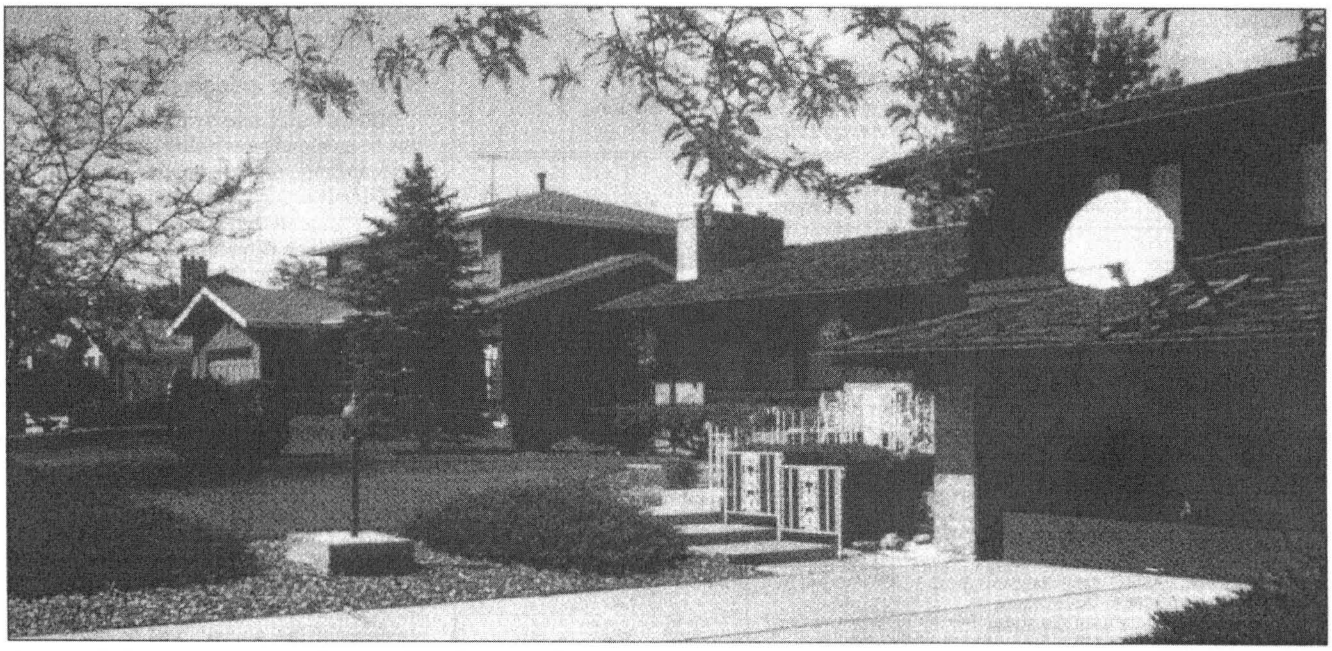


Figure 1. Estimated daily residential water demand by toilets, showerheads, and faucets per person

Forecasting assumptions will change

Engineers, planners, municipal managers, and others need to be aware that there will be continuing and incremental



Average daily water use per 2.63-person household for toilets, showerheads, and faucets is anticipated to drop to 55 gal by 2026 as pre-1994 fixtures are replaced.

reductions in water demand from plumbing fixture usage over the next 25 to 40 years as existing high-volume equipment is replaced with new, more efficient models. Using projected estimates, this article reviews anticipated reductions in residential demand and explains how expected changes can be factored into water and wastewater demand forecasting assumptions used in utility capital facility and financial planning. Incorporating such changes will help ensure that future demand projections are realistic and that they reflect actual per-capita demand, not outdated assumptions that lead to overbuilding of water and wastewater infrastructure.

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The water conservation provisions of the Energy Policy Act will have far-reaching effects not only on water supply, but on such factors as energy and chemicals use, stream flows and aquatic ecosystems, utility rates and revenues, and water and wastewater system infrastructure requirements. For systems that have a large residential water use component, demand reductions could have a significant effect on future supply and demand.

Water demand reductions noted

Indoor water use by plumbing fixtures has been slowly declining as the high-volume toilets, showerheads, and faucets produced before 1980 have been gradually replaced by somewhat more efficient fixtures developed after major US droughts in the late 1960s and 1970s. This section will outline the projected residential water savings expected to accrue from fixtures as a result of the Energy Policy Act.

Estimates of average US household water savings are based on the US Department of Housing and Urban Development's (HUD's) 1984 "Residential Water Conservation Projects—A Summary Report."[3] Findings from the HUD study were derived from measured water use data collected in a nationwide survey of more than 200 households. The purpose of the survey was to document water demand by a variety of conventional and efficient fixtures. The HUD

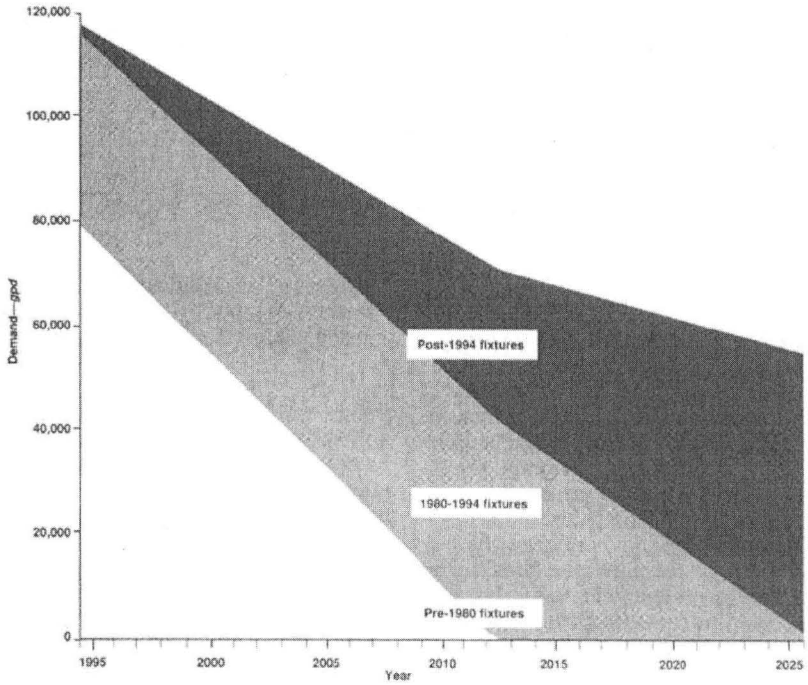

Figure 2. Estimated daily residential water demand by toilets, showerheads, and faucets per 1,000 households *(assuming 2.63 persons per household)*

TABLE 1

Federal water efficiency standards for plumbing fixtures and fixture fittings required by the US Energy Policy Act of 1992

Product	Maximum Water Use	Compliance Date
Toilets*		
Gravity tank-type	1.6 gal/flush	1/1/94
Flushometer tank	1.6 gal/flush	1/1/94
Electromechanical hydraulic	1.6 gal/flush	1/1/94
Blowout†	3.5 gal/flush	1/1/94
Commercial gravity tank-type, white two-piece§	3.5 gal/flush	1/1/94 to 12/31/96
Commercial gravity tank-type, white two-piece§	1.6 gal/flush	1/1/97
Flushometer valve‡	1.6 gal/flush	1/1/97
Urinals†,‡	1.0 gal/flush	1/1/94
Showerheads§	2.5 gpm (80 psi)	1/1/94
Faucets§		
Lavatory§	2.5 gpm (80 psi)	1/1/94
Lavatory replacement aerators	2.5 gpm (80 psi)	1/1/94
Kitchen	2.5 gpm (80 psi)	1/1/94
Kitchen replacement aerators	2.5 gpm (80 psi)	1/1/94
Metering	0.25 gal/cycle (80 psi)	1/1/94

*Compliance with ASME–ANSI Standards A 112.19.2M-1990 and A112.19.6-1990
†No data on conversion to lower volume
‡Must bear conspicuous label that states "For Commercial Use Only"
§Compliance with ASME–ANSI Standard A112.18.1M-1989

TABLE 2

Estimated residential water savings with 1.6-gal/flush toilet, 2.5-gpm showerhead, and 2.5-gpm faucet replacement

Water Use, All Fixtures	Maximum Water Use—*gpd**		Water Savings—*gpd*	
	Per Capita	Per 2.63-Person Household†	Per Capita	Per 2.63-Person Household†
Post-1994	21.4	56.3		
1980–94	33.9	91.5	12.9	34.8
Pre-1980	54.5	143.3	33.1	87.1

*Assumes an average of 4.0 toilet flushes, 4.8-minute showering time, and 4.0-minute faucet-use time daily per person, with adjustments for throttleback effect with showerhead and faucet use; factors based on findings derived from 1984 HUD study; source: reference 3

†Per 2.63-person household based on 1990 US census

TABLE 3

*Annual utility electric energy demands associated with water used by residential plumbing fixtures**

Fixture	Per Capita *kW·h†*	Per Household‡ *kW·h†*	Per 1,000 Households *kW·h†*
Post-1994 fixtures	22	59	59,463
1980–94 fixtures	35	94	94,206
Pre-1980 fixtures	57	151	151,776

*Toilets, showerheads, and faucets

†Combined average energy use for water treatment (1,500 kW·h/mgd) and wastewater treatment (1,400 kW·h/mgd); source: references 9

‡Per 2.63-person household based on 1990 US census

study data, although limited and now somewhat outdated, are the most generally accepted basis for estimating potential savings from water-efficient plumbing fixtures, particularly on a national scale. Because water use by fixtures may vary depending on local conditions, some utilities may want to develop more system-specific data to make precise forecasts of future demand changes.

An annual combined rate of 3 percent for installation and replacement of new fixtures was used to determine the water savings projections in this article, based on the average of 3 to 5 percent reported by the Plumbing Manufacturers Institute (PMI).[4] The lower part of the range was used to make conservative estimates, because actual replacement rates usually cannot be quantified reliably, particularly on a national scale.

Per-capita use to drop. The introduction of standards for the latest low-volume or "high-efficiency" post-1994 fixtures will reduce residential water use for toilets, showerheads, and faucets by 62 percent for pre-1980 replacements and 39 percent for fixtures installed during the period 1980–93 (Table 2). Jones suggests the term "high-efficiency" instead of "low-volume" to denote water-efficient plumbing fixtures that also offer quality performance and user acceptability, in contrast to the badly received "showerhead restrictors" introduced in the late 1970s and 1980s.[5] These estimates have also been disaggregated into more detail previously.[6] In terms of just these three fixtures, the drop in average per-capita demand until 2026 is quite dramatic (Figure 1). Adjusting for fixture replacements assumed to have already taken place, the estimated current water use of 46 gpcd use for the three fixtures will be reduced to about 21 gpcd—more than 50 percent—by 2026, when almost all installed fixtures are expected to meet the requirements of the Energy Policy Act.

Total residential consumption to drop. The expected reductions in residential

Innovations in efficient fixture designs are increasing the chances of even further reductions in residential water demand.

per-capita water demand by fixtures can be used to adjust total indoor residential consumption figures. Although each system will have its own unique per-capita figures based on its particular residential customer mix, it is useful to consider how the national averages will change. The new adjusted total indoor demand will average about 51 gpcd for households that meet the act's requirements. Using the 77.3-gpcd figure cited in the HUD report, which was based on household fixtures installed before 1980, this represents a 34 percent savings in water use. There will of course be exceptions to these projections, partly because some of the old high-volume fixtures will be kept in place beyond 2026. At the same time, innovations in efficient fixture designs are likely to emerge in the next 30 years, thereby increasing the chances of even further reductions in residential water demand.

Systemwide figures are striking. Demand reductions in residential fixture use are the same percentages as for the per-capita estimates, but are more striking when considered on a systemwide basis. At present, based on the combination of fixtures of different ages now in use, the average water use per 2.63-person household for toilets, showerheads, and faucets is about 121 gpd based on assumed replacement rates for existing fixture stocks. This will probably drop to about 55 gpd by 2026 as the pre-1994 generation of fixtures is replaced by the post-1994 stock. Per 1,000 households, this translates into about 118,000 gpd by 1994; it would be reduced to 76,000 gpd by 2010 and to 56,000 gpd by 2026 (Figure 2). Again, it is important to recognize that such savings projections presume that all pre-1994 fixtures have been replaced and that there are no further improvements to fixture efficiency. Because the actual situation will probably be somewhat different, other factors affecting savings also need to be examined when future demand is forecasted.

Several factors affect estimated savings. Projected water and related savings are provided as estimates. Although they are derived from generally accepted, conservative assumptions based on average national data, actual measured savings among individual residential customers and systems are likely to vary from these estimates. As a result, several factors should be considered when fixture-related savings are projected for a specific area.

- In most homes, plumbing fixtures have been installed at different times depending on replacement and remodeling needs. These fixtures have different consumption rates. As a result, individual household savings may not follow the consumption patterns of the fixture groups, although they may when taken as an average. Projecting savings specific to the service area may involve determining the local mix of fixtures.
- Typical household size for a given water system may vary from the US national average. This will increase or decrease average household water savings. In addition, the US Census Bureau reports that the 1990 average of 2.63 persons per household is expected to slowly decline. As a result, projected water savings per household may also decline, although per-capita and total savings will be the same.
- As mentioned earlier, the Energy Policy Act's requirements contain a bit of a loophole for commercial commodes

until 1997. Before then, white two-piece gravity tank–type toilets will not be required to meet the 1.6-gal/flush standard for commercial-only applications, and some of these products may find their way into residential markets. Thus, it is difficult to determine to what extent high-volume toilets will continue to be used in residences. This problem might be obviated if DOE allows state fixture standards that do not exempt commercial fixtures from efficiency requirements to prevail.

- Some toilets rated at 1.6 gal/flush may actually be using more water because of poor design or operation, according to the results of a study conducted by the East Bay Municipal Utility District in Oakland, Calif.[7] The extent of this problem for other communities is not known. On the other hand, several toilets on the market use less than 1.6 gal/flush (usually about 1.0 gal/flush), which may tip this effect on savings in the other direction.
- In addition to water savings that may have already been initiated by local or state requirements for efficient fixtures, previous or planned showerhead and toilet retrofit and replacement programs should be evaluated to determine their effect on per-capita and future system demand scenarios.
- Increased showering time with low-volume showerheads has been reported by several communities, which may reduce the savings projected. This appears to be due to differences in spray patterns and reductions in surface water temperature that have been associated with some low-volume showerheads. Figures for these differences seem to vary by community, and no national data are yet available on this phenomenon.[5]
- A recent drought or prolonged water shortage may have accelerated voluntary fixture retrofit or replacement and more careful water usage habits.
- Installation of high-efficiency fixtures, particularly toilets, in houses with severe leakage problems may show above-average savings because of initial leakage reduction. Such savings may diminish over time as even the high-efficiency toilets start to develop "normal" leaks from deteriorated flapper valves, ballcocks, and other sources.

The estimates shown are provided as a guide to potential residential water demand reductions that are expected to occur as a result of the new fixture efficiency standards. Actual changes in water consumption will probably vary from those described in this article depending on the specific customer characteristics and supply conditions within a given water service area. For some systems, it may be useful to conduct a study to determine the actual age and water demand of a representative sample of plumbing fixtures used in residential, commercial, and institutional settings to determine local conditions that will affect future demand forecasts.

TABLE 4

*Annual utility emissions of carbon dioxide, nitrogen oxides, and sulfur dioxide associated with energy demand created by plumbing fixture water use**

Fixture	Utility		
	Per Capita *lb/kW·h†*	Per Household *lb/kW·h†*	Per 1,000 Households *lb/kW·h†*
Post-1994 fixtures	43.4	114.1	114,088
1980–94 fixtures	68.7	180.8	180,747
Pre-1980 fixtures	110.7	291.2	291,203

*For water use by toilets, showerheads, and faucets

†Emissions per kW·h—1.89 lb carbon dioxide, 0.00914 lb nitrogen oxides, and 0.0195 lb sulfur dioxide, based on total electric energy demands; source: reference 10

Estimated projections considered in perspective. There is a lack of comprehensive, well-tested, and current data from which to accurately project water savings and other consequences of efficient plumbing fixtures (and of most other conservation measures, for that matter). However, there are clear indications that the Energy Policy Act will begin to have a measurable effect as new fixtures replace the old. To what extent is not certain. If the projected savings are high, even scaled-back estimates will likely be significant. This is further underscored by the fact that the projected savings shown are only for household water use. They do not include additional savings that will most certainly be realized in the daily water demand of plumbing fixtures used in offices, hotels, schools, and hospitals.

A recent drought or prolonged water shortage may have accelerated voluntary fixture retrofit or replacement and more careful water usage habits.

Wastewater systems affected less significantly. Water savings from efficient fixtures will also affect wastewater systems. However, these savings probably will not be as significant compared with the total wastewater loads, which are typically higher than total water supplied. Septic tank systems will be subjected to reduced wastewater volumes but the same waste loads, thereby extending their useful capacity.

Energy demand linked to water savings

Three stages of energy demand reductions are associated with water savings from efficient plumbing fixtures and other conservation measures: first, energy used to pump and transfer water and wastewater in a distribution system; second, energy required during the treatment process; and third, energy used to heat water for showers, dishwashers, and other appliances. This section will consider the first two categories only; the third category has been discussed elsewhere by Jones,[5] Dyballa and Connelly,[8] and others.

Energy use associated with surface water and groundwater systems ranges from 1,200 to 1,800 kW·h/mgd for treatment, pumping, and distribution—an average of about 1,500 kW·h/mgd. For wastewater, the range is 1,000–1,800 kW·h/mgd for an average of approximately 1,400 kW·h/mgd.[9]

Difference in energy demand expected. Based on the per-capita water demand associated with fixtures, there is a marked difference in energy demand and savings associated with the new efficiency standards required under the Energy Policy Act. The post-1994 per-capita energy demand figures are roughly half of those required for the pre-1980 fixtures and about one third of the 1980–84 group (Table 3). In other words, for every individual using pre-1980 fixtures, more than two people could be similarly accommodated with the same energy requirements using the post-1994 fixtures.

Systemwide, the lower energy demand created when efficient fixtures reduce water and wastewater treatment needs is also significant. The annual savings from replacing 1980–94 fixtures with post-1994 fixtures is more than 34,700 kW·h per 1,000 households a year, a 37 percent load drop (Table 3). This figure is even higher when the pre-1980 fixture group is factored into the equation. Energy demands for water and wastewater treatment have been estimated to represent 3 percent of the total energy demands in the United States, so such projected re-

TABLE 5
Twelve chemicals most commonly used in water treatment

Calcium chloride
Lime (slaked)
Caustic soda
Soda ash
Sodium bicarbonate
Alum
Chlorine
Hydrochloric acid
Carbon dioxide
Ferric chloride
Ferric sulfate
Ferrous sulfate

Source: reference 12

ductions will probably permanently reduce the fixture component of that load.

Atmospheric pollution to decrease. The reduction in carbon dioxide, nitrogen oxides, and sulfur dioxide outputs from electricity saved can also be estimated based on the nationwide mix of electric generating plant types—coal, gas, hydroelectric, nuclear, and others.[10] Again the outputs associated with post-1994 fixtures are less than half those for the pre-1980 devices (Table 4). This equates to about 114 to 290 lb/year, respectively, for those fixture groups per 1,000 households. For a water system serving 1 million residential customers, the difference equals nearly 180,000 lb of atmospheric pollutants dumped each year—waste worth avoiding.

Operating cost savings to be realized. The savings in energy demand apply not only to water and wastewater service providers, but to energy utilities as well in the form of reduced operating costs.

Chemical use expected to decline

Reduced water use will also reduce chemical use, because less water will be treated in treatment plants. The types and amounts of chemicals used in water treatment vary considerably from system to system because of local treatment requirements, raw water quality, and other factors. The 12 chemicals most commonly used in water treatment are shown in Table 5. The estimated amounts of chemical use avoided by a water system can be projected by identifying the types and total volume of chemicals used for a specified time (i.e., total average year) and dividing by the total amount of water supplied during that time. A similar formula can be used for wastewater, although the adjustments in chemical use might not be as significant because of differences in concentrations of wastewater strength.

The chemical-use coefficients derived for each unit of water will probably be a range, because treatment requirements vary from year to year. For example, the extent of algae blooms depends on weather and other factors, so chemicals to control the blooms, such as copper sulfate, may be applied in varying amounts from one year to the next.

Accurately accounting for the pollution effects avoided by reduced energy and chemical consumption is not well understood, although research is growing in this area. Similarly, the extent to which demand reductions from water conservation programs can enhance stream flows and related aquatic ecosystems is often difficult to quantify. However, whether they can be measured or not, the reduced demand and exploitation of essential natural resources like water and energy and the corresponding avoided pollution and health burdens are highly desirable and achievable goals worth pursuing even in the absence of reliable measurement tools. In addition, downsizing and deferral or avoidance of new capital facilities are also beneficial in that they reduce consumption of energy, chemicals, and construction materials.

Downsizing meters and pipes leads to savings

Reduced water demand and flows from the installation of water-efficient fixtures and appliances present opportunities and a few potential (though solvable) problems. Permanent water savings can and should be factored into future plumbing requirements for new construction by downsizing pipe and meter specifications. The result will be material cost savings. In addition, reduced flows in distribution systems and buildings can be measured by smaller meters, thereby reducing costs for new and replacement meters. However, if existing meters are replaced before their useful lives have ended, some additional metering costs will be added and passed on to customers.

In Boston, Mass., past metering practices "usually required that meter size be determined by the size of the supply pipe. Thus a 1-in. meter was installed on a 1-in. service pipe, a 2-in. meter on a 2-in. pipe, and so on."[11] Sullivan and Speranza suggest reconsidering previous estimates of water use and meter size if conserving plumbing fixtures and devices have been installed. They further note that the pipes used in most buildings are also usually too large for the flow rates of the new fixtures. This is because pipe size is based on plumbing codes that factored in outdated total volume and pressure requirements of fixtures. Most sizing requirements date back to the 1940s and are based on a modeling system known as the Hunter method. The result of these conservative sizing methods—appropriate in their day for high-volume fixtures but unrealistic for today's new stock of high-efficiency fixtures and appliances—is oversized pipes and meters that are underrecording flows. The potential underrecording of flows and the associated lost revenue may become a problem for some systems, particularly those with oversized meters.

Effect noted on bills and revenues

The water efficiency requirements promulgated by the Energy Policy Act, like other conservation measures, will affect utility and customer finances in several ways. First, customer water savings should result in somewhat lower water bills, thereby also reducing system revenues until rates can be adjusted to accommodate changes in demand. Second, the problem of oversized meters and lost revenues may be exacerbated by the growing influx of low-volume fixtures. Correcting such problems will incur additional capital costs for meter replacement and installation. Third, reduced water demand will correspond to reduced operating costs, thereby lowering the overall cost of water delivery. Fourth, reductions in revenues, with adjustments for avoided cost savings, may necessitate rate increases to recover system costs. Customers who install efficient fixtures or take other conservation measures should not expect higher bills, because even though the cost of water will increase, their use will decrease enough to compensate for the difference. In addition, theoretically such customers should see a slight decrease in their bills because of system savings from avoided treatment costs. Fifth, long-term incremental reductions in per-capita water demand as a result of the Energy Policy Act may allow the delay or indefinite postponement of supply-capacity expansion plans, thereby avoiding major capital cost investments and interest payments by customers.

Reductions in per-capita water demand as a result of the Energy Policy Act may allow the delay or indefinite postponement of supply-capacity expansion plans.

Leak-free guarantee recommended

Several recommendations are suggested for regulations still to be developed by DOE as part of the Energy Policy Act. First, all toilets—whether high- or low-volume—will eventually leak. On average, about 20 percent of toilets leak, some up to 50 gpd. Such unnecessary waste can undermine the savings that can be achieved by the installation of efficient plumbing fixtures. Plastics and materials science has advanced considerably since toilet flapper valves, ballcocks, and other components were invented in the late 1800s. However, the advances

It is proposed that after 1994 all toilet manufacturers be required to provide a minimum 10-year leak-free guarantee on all toilets produced.

have not been used by the plumbingware industry to tackle water waste—partly because the industry hasn't really been challenged to do so. As water inefficiency problems go, leaking toilets seem to be eminently solvable. Therefore, it is proposed that after 1994 all toilet manufacturers be required to provide a minimum 10-year leak-free guarantee on all toilets produced. If there are additional costs for improved materials and construction of flapper valves and ballcocks, these costs are worth a higher fixture price to realize the long-term benefits such a guarantee would offer.

Second, guidelines for state and local fixture replacement programs can be used to help set higher standards for addressing problems such as toilet leakage. One strategy would be to require that toilets specified for rebate and replacement programs be required to have the leak-free guarantee. Replacement programs should also include collection and recycling requirements for used fixtures that have been removed. Several toilet rebate programs in Mexico and California have already successfully incorporated these elements into their programs. Finally, DOE's guidelines could also call for the development of a low-interest revolving loan fund to help initiate startup fixture replacement programs. Capital and interest payments could be partly realized through water and energy utility bill savings or paybacks from reduced water use.

Future research needs outlined

The establishment of national water efficiency standards for plumbing fixtures under the Energy Policy Act has highlighted the need for improved understanding of and revisions to the plumbing and infrastructure that support water service delivery systems. Such research needs include the following items.

(1) An expanded study of the 1984 HUD Residential Water Conservation Project is needed to gather more broadly representative data on water use by existing plumbing fixtures. Data are also needed regarding the number and range of fixture types and flow rates now in use, fixture replacement rates, and motivational factors affecting use of efficient fixtures compared with conventional high-volume products.

(2) The Hunter method used for pipe sizing is badly in need of revision. Water use by plumbing fixtures has changed dramatically since the 1940s, and additional adjustments can be expected in the future. A revised methodology for sizing water distribution pipe is needed now, both to revise meter-size requirements for existing buildings and to reduce the size and cost of pipes and meters in new buildings and distribution systems.

(3) Empirical research data identifying and quantifying the environmental externalities associated with high-efficiency plumbing fixtures (as well as other conservation measures) are also badly needed. These data are needed by utilities to determine both the potential savings associated with conservation measures and the reduced environmental burdens conservation programs are helping to achieve. Better identification and quantification of the beneficial environmental effects of water conservation will also aid assessment and integration of demand management into water planning, particularly for systems that are conducting integrated resource planning (see Roundtable, page 26).

(4) Wastewater utility managers also need to consider the effect of the Energy Policy Act on their existing and planned facilities and distribution systems. Conservation's effect on wastewater systems has not been well studied or documented, despite the obvious planning and financial implications.

(5) Water use by plumbing fixtures in nonresidential settings is not well understood or documented. The water savings estimates in this article represent only residential demand reductions that will accrue from the Energy Policy Act. Utility planners need to consider potential nonresidential water savings as well when making future demand forecasts.

Conclusion

The water savings that are projected to be realized by the Energy Policy Act of 1992 will make an important and permanent contribution to the progress of water conservation in the United States. In addition, reduced consumption of energy, chemicals, and materials and other environmental and economic benefits associated with water savings from efficient plumbing fixtures will make their own unique and beneficial contribution to a more sustainable future environment.

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