November 23, 1992

TO: DICK BYERS

FR: JIM LAZAR

RE: SOLVING THE TOTAL RESOURCE COST TEST CHALLENGE: Using Consumer Willingness-To-Pay Criteria to Effectively Implement a Total Resource Cost Test Incorporating Non-Energy Benefits

On September 24, 1992, the Washington Utilities and Transportation Commission ordered Puget Power, the state's largest electric utility, to begin using the Total Resource Cost (TRC) test as the criteria for determining whether utility investment in conservation measures should be undertaken. Prior to that date utilities used various combinations of the Utility Cost (UC) test and TRC in determining conservation programs and payment incentive levels. Puget has agreed to file a revised conservation tariff by January 31, 1993 which implements the TRC directive.

The challenge to implementers and analysts is to find a way to adequately consider the non-energy benefits of some conservation measures. Residential heat pumps, window replacements, and many commercial lighting retrofits clearly are not cost-effective on the basis of energy savings alone. I believe, however, that the combination of energy benefits and non-energy benefits may justify installations in many cases. Including non-energy benefits in the cost-effectiveness calculation may satisfy the TRC in these situations.

THE PROBLEM

The problem identified by the WUTC is that Puget was providing partial funding for some conservation measures which cost, in total, more than the value of the energy savings. In these situations, Puget provided partial funding, and the residual cost was low enough that consumers would provide their own money to secure the measure. It is possible -- even likely -- that consumers were counting the same energy benefits from reduced power bills as Puget was counting against its avoided costs. The same energy benefits were being counted twice.

The clearest example of this was residential heat pumps, where the energy savings were found to cost about 13.4 cents/kwh. Puget was paying up to 7.8 cents/kwh for these savings (its avoided cost), leaving consumers with 5.6 cents/kwh of costs. Since the 5.6 cents/kwh was lower than Puget's retail rates that these customers would avoid by installing the heat pump, and the heat pump also may have offered some additional benefits such as air conditioning, many customers took advantage of Puget's program, possibly resulting in uneconomic expenditures of the combined Puget/consumer funds.

I suggest that there ought to be three categories of resources evaluated in development of the acquisition portion of a least cost plan, and that this problem and any potential solution involves only one of these three categories. In addition, there are two other categories of resources to be evaluated in a least cost plan which merit special consideration and are not susceptible to the "shortcut" proposed herein.

First, there are resources which satisfy the TRC on a stand-alone basis. An example of this is low-flow showerheads, which may cost about $10 each, and provide over $100 of life-cycle savings, at a cost of less than $.01/kwh. These should be included in the resource program, and the utility should be expected to provide whatever level of incentive is needed to assure that they are acquired, up to a limit of the total measure cost (which, by definition, is lower than the utility's avoided cost). While a goal should be to minimize the expenditure of utility funds, this should not be pressed to the point of reducing program performance.

Second, and the category pertinent to this discussion, are those resources where the total cost cannot be justified on the basis of saved energy, but there may be additional non-energy benefits. Examples of this might include residential replacement windows, heat pumps, commercial lighting retrofits, or replacement insulated doors. For these, the utility should provide partial funding if the combined total of energy benefits plus non-energy benefits exceeds the total cost. The complexity of this calculation may confound the regulatory process, particularly given the January 31, 1993 deadline imposed by the settlement stipulation between the parties to Puget's recently completed rate adjustment. This paper discusses one means by which the needed economic test can be performed.

Third, there are resources which fail the TRC on a stand-alone basis and have no significant non-energy benefits. An example of this might be residential-scale photovoltaic arrays, where the cost of the energy might be $.20/kwh. Since it is reasonable to assume that demonstration installations of photovoltaics, a non-commercial technology at this time, should be pursued in areas with high insolation, like the desert Southwest, no reasonable argument can be made that a demonstration project is reasonable. For these measures, the utility would provide no financial assistance whatsoever. As discussed below, there are also some resources which provide energy savings at less than avoided cost, but cost more than using alternative fuels, and thus fail the TRC when all available alternatives are considered. Above-code electric water heaters may be this type of resource.

The fourth category consists of resources which may serve to retain load which would otherwise be eliminated, or would retain load which would otherwise migrate to another fuel. These should be evaluated with care. Resources which are susceptible to fuel switching should be compared with the avoided costs of the alternative fuel, as well as the avoided cost of the electricity saved; if the alternative fuel is less expensive, these resources may be relegated to Category Three above (those which fail TRC) and should not be supported. Examples of this may be conversion of evaporative cooling to mechanical air conditioning, or encouraging installation of above-code electric water heaters in areas where gas service is available.

The fifth and final category consists of research, demonstration and market development programs, such as Long Term Super Good Cents / Certified Comfort Plus and Puget's compact fluorescent lamp rebate. These may fail TRC based on current costs and market availability and contractor experience, but may be properly characterized as an effort to move the market and bring down prices. These types of programs may be permissible if they are assigned a definite time period over which progress towards the goal of cost-effectiveness will be monitored, and the programs discontinued if progress is not demonstrated.

EXAMPLE OF INEFFICIENT INVESTMENT

Assume the following: the energy savings from insulating a house have a present value, at the utility's avoided cost and discount rate, of $2,000. The total cost of insulating the house is $2,500. There are no discernible non-energy benefits from this action. It is clearly not cost-effective. If insulated, the consumer will save $200/year in energy bills. Suppose that the utility is willing to pay up to 80% of it's avoided cost (i.e., $1,600) for the house to be insulated. This means that if the consumer is willing to pay $900, the job will go forward.

In this case, if the consumer demands no better than a 4 1/2 year payback on their investment, the society will pay $2,500 for something worth $2,000 -- $900 from the consumer and $1,600 from the utility. Assume that the consumer actually only demands a 6 year payback -- and would thus be willing to spend up to $1,200 for the savings. The utility may argue that it is getting $2,000 in savings to the utility for $1,600 in costs. The consumer, who values these savings at $1,200, thinks they are getting $1,200 in savings for $900 in costs, also a good deal. The problem is that both parties are counting the same energy savings. The society is $500 worse off.

This is the exact concern which Public Counsel expressed about Puget Power's residential heat pump retrofit program.

TRC IS THE PROPER TEST

The justifications for the TRC are many. First, only the TRC ensures that society's dollars are providing benefits in excess of costs. Second, in many cases a UC can be used as a "load retention" tool, discouraging more economic fuel choice. Finally, use of criteria other than the TRC can encourage consumers to invest money in technologies which do not provide them with monetary savings. Many regulatory commissions have rejected the UC as a basis for determining program elements. As the California PUC stated recently:

> *We remain committed to using the TRC as the primary indicator of cost-effectiveness for DSM programs. ... As described above, the TRC test is the only test of cost-effectiveness that looks at the total resources costs of DSM, regardless of who pays for the measure or equipment.* [Decision 92-02-075, P. 35]

In the recent Puget docket, the Company, and, on reconsideration, the Commission Staff advocated the UC test. The biggest advantage of the UC is that it is simple to administer. If the number of dollars expended by the utility does not exceed the value of the energy savings produced, the measure is deemed cost-effective. The biggest disadvantage is that consumers, who contribute to measure cost, may invest their own dollars based upon their expected retail bill savings, which in fact is a double counting of the benefits which the utility is considering.

This problem came to a head when it was found that Puget Power had expended 52% of it's 1991 residential "weatherization" expenditures on electric heat pumps. The consumer contributions were

typically about half of the cost, with the utility paying the other half. Investigation showed that the energy savings were costing approximately 13.4 cents/kwh when all costs were considered -- nearly two times the utility's avoided costs. Nearly all members of Puget's Technical Collaborative, including the Commission Staff, acknowledged that some problems existed when they learned that over half of the program expenditures had gone to support heat pumps.

PROBLEMS WITH TRC

For many resources, which have total costs lower than the value of the energy saved, there is no problem with the Total Resource Cost test. For example, a low flow showerhead may cost $10, and provide $100 in energy savings. In these cases, the utility should be expected to have programs in place to ensure that the savings are achieved. If the utility can accomplish this with information alone, with information plus some funding, or with 100% full funding, the society is better off by the difference between total cost and energy savings.

At the opposite end of the scale are resources with total costs in excess of the value of energy savings, and no or very few discernible non-energy benefits. A good example of this may be a heat pump. In this situation, there is no social purpose achieved by the utility providing any financial assistance whatsoever, and the resource should not be a part of utility programs.

The big problem with using TRC is that many resources have total costs in excess of the value of energy savings, but may also have non-energy benefits. A clear example is insulated windows. These units provide considerable energy savings, which is valuable, but typically not equal in value to the cost of the measures. However, these windows provide other benefits -- reduced condensation, noise reduction, and greater perceived comfort. The replacement of the windows often includes caulking and weatherstripping, and therefore energy savings and comfort gains from infiltration reduction, which may not be fully counted when energy savings are estimated. Another example is compact fluorescent lamps, which not only save energy, but also last as long as ten regular lamps, saving on both lamp cost and the labor to replace the lamps.

While the energy benefits may be easily quantifiable, window replacement will typically not meet TRC on the basis of energy savings alone. When all of the benefits are considered, window replacement may well be a good investment, as illustrated by the fact that the largest natural gas utility in the state sells replacement windows through it's merchandising and jobbing operation, with no utility financial assistance (other than long-term market-rate loans); at regional natural gas rates, the units are far from cost-effective to the consumer. An economist can only assume that either the public is unaware of the poor economics associated with replacement windows (lack of perfect information), or values the non-energy benefits at a level sufficient to justify the total investment.

Limiting utility contributions to resources which satisfy the TRC on the basis of energy-benefits only may preclude many investments which are socially desirable. Two caricatures of the problem should make this evident.

> WINDOW REPLACEMENT: Assume, *arguendo*, that the ugliest aluminum storm window costs less than the utility's avoided cost. Based on the TRC, we can conclude that the utility should

encourage and provide financial assistance for this conservation measure on the basis of the energy savings. Should the utility then prohibit the consumer from paying the extra cost of attractive wood-frame or vinyl replacement windows, in order to get both the energy savings and the aesthetic improvement of these windows? Most analysts would agree that the consumer should be permitted to make that contribution.

COMMERCIAL LIGHTING: The single largest ergonomic complaint in the office environment is glare on computer screens from overlighting. A commercial lighting retrofit can install an indirect ambient plus direct task lighting system which uses 50% less energy and also eliminates the glare problem. Measured strictly on energy savings, however, the installation may not be cost-effective. Should the consumer be prohibited from investing their own money in the project in order to secure the energy benefits and the employee productivity benefits? Most analysts would agree that the business should be permitted to make this contribution.

UNDER WHAT CIRCUMSTANCES SHOULD UTILITIES ASSIST WITH COSTS OF RESOURCES WHICH FAIL THE TRC BASED ON ENERGY SAVINGS ALONE?

Simply stated, a utility should assist with the acquisition of resources which have a total value in excess of total cost. The level of assistance should never exceed the energy benefits to be derived, and should not encourage consumers to invest their own money in ways that, when added to the utility investment, result in total expenditures in excess of total value.

The simple formula is:

If Total Cost is less than Energy Benefits plus Non Energy Benefits, the resource should be acquired, and the utility should support acquisition up to the level of its avoided costs.

If Total Cost exceeds the value of Energy Benefits plus the value of Non-Energy Benefits, the resource should not be acquired and the utility should offer no support for it.

The problem is that it is extremely difficult to measure the value of the non-energy benefits. Some means to quantify or estimate the value of these benefits must be found in order for the TRC to be fairly implemented.

QUANTIFICATION OF NON-ENERGY BENEFITS

The obvious means to quantify the non-energy benefits is to identify each benefit and calculate the value of it. For the compact fluorescent lamp, it is possible to estimate the cost of ten replacement lamps it makes unnecessary, and the labor required to replace those lamps. While we have tools to do this for each measure, they are complex analyses, unique to every circumstance, and probably too unwieldy to be useful. For example, in a business where highly paid maintenance personnel replace lamps, the labor cost for lamp replacement is arguably different than in a low income household.

For the commercial lighting retrofit, those non-energy benefits consist of employee productivity and

aesthetic improvement. In theory these could be quantified by measuring the economic value of the employee productivity and identifying a proxy, such as acquisition of artwork or elegant furniture which produce the same aesthetic amenity.

For the window retrofit, the non-energy benefits consist of reduced condensation and reduced noise, and again, in theory, one could measure the cost of circulating sufficient warm air near the windows to eliminate condensation (we do this with the defogger in our cars, rather than have double-glazed windshields), and by comparing the property value of homes located in noisier areas relative to identical homes in quieter areas.

It should be clear that while possible, this is a difficult path to follow. Trepidation about quantifying these non-energy benefits is rampant among the members of Puget's technical collaborative.

AN ALTERNATIVE: QUANTIFICATION OF THE CONSUMER WILLINGNESS TO PAY FOR ENERGY BENEFITS

An alternative to measuring the non-energy benefits is to establish a principle that the total to be expended by the utility and consumer for energy benefits shall not exceed the value of the energy benefits, and then to allow consumer willingness to pay for non-energy benefits to guide the ultimate investment decision.

Numerous studies have indicated that consumers demand 2-6 year paybacks on their investments, for implied nominal discount rates of 15-50%, much higher than typical social discount rates of around 8%, and utility discount rates of 9%.

If the utility provides funding for only the portion of the energy benefits in excess of those the consumer is willing to pay for, it should be possible to fashion a program to ensure that cost-effective savings are achieved, and that non-cost-effective savings are eschewed. In this scenario, the maximum utility contribution would be equal to the avoided cost of the energy to be saved less the (computed) consumer willingness to pay for those savings.

Suppose that on the basis of research, we conclude (as we assumed above) that consumers are willing to pay for up to 6 years energy savings for long-lived measures. The utility would then offer funding assistance for up to the avoided cost of the measures, less six years energy savings. This would apply only to resources which fail the TRC on a stand-alone basis, but which are determined to have some significant non-energy benefits.

Again, let us use the example of insulated windows. The estimated energy savings are worth $200/year to the consumer, and $2,000 over the life of the measure at the utility's avoided cost and discount rate, just like the insulation package. The cost of the measure is $3,000. The value of the noise reduction and condensation reduction is unknown.

Use the postulated approach, the utility would make a payment not to exceed the value of the savings -- $2,000 -- less the expected consumer willingness to pay for those savings -- $1,200; the total utility payment would be $800. The consumer would decide whether or not to pay the remaining $2,200 for

the measure. If the consumer did so, since we know that the energy benefits were worth $1,200 to the consumer, we would know that the non-energy benefits were worth at least $1,000. Under this approach, the resource satisfies the TRC stated above -- Total Benefits exceed Total Costs.

NOT ALL CONSUMERS HAVE THE SAME ECONOMIC CRITERIA

It is well understood that not all consumers have the same economic criteria. For example, businesses in cyclical industries may have shorter payback criteria than homeowners. Renters and low income individuals may have very short time horizons. In order to tailor programs to the different implied discount rates of different types of consumers, it would be necessary to group consumers in some logical fashion, and make financing available based upon their individual payback criteria. I believe that it would be unacceptable politically to have a tariff which discriminates either between business and residential consumers, or between buildings which are owner-occupied and those which are rented.

I have made some preliminary analysis of consumer payback criteria based on different discount rates. The table below shows the result for a measure with an assumed 20 year lifetime, $.05 initial electric rate, 5% inflation, 1% electricity cost escalation, and a 78 mills/kwh resource and utility avoided cost:

DISCOUNT RATE Real	DISCOUNT RATE Nominal	CONSUMER REQUIRED PAYBACK (Years)
3%	8.2%	13
5%	10.3%	11
10%	15.5%	8
15%	20.8%	6

While there have been studies of implied discount rates supporting levels higher than 21% nominal, I personally find it difficult to endorse anything much above the VISA card rate. Therefore, I recommend that, for Category Two resources (those which fail TRC on an energy-only basis but have other benefits), that the tariff provide for the Company to pay it's avoided cost less five years of energy savings to the consumer. For simplicity, it could be calculated at current rates, although my analysis above was based on escalating rates. Just as the current tariff language, a two-year contribution, is intended to ensure that virtually no resources are lost, this option should ensure that very few truly cost-effective resources are lost. Some draft tariff language is attached.

It may be that requiring homeowner consumers (with personal discount rates of less than 21%) to contribute 5 years savings will encourage non-cost-effective measures, and requiring renters and low income consumers to contribute more than a few months or 1 year of savings will ensure that no affected measures are acquired, regardless of how cost-effective they are. If this is the case, then a single payback standard will encourage some inefficient investment, and discourage some efficient investment. The alternative, however, separate tariff requirements for renters, owners, business and homeowners are, in my opinion, unfeasible. I encourage response by reviewers on this issue.

A separate issue is the treatment of resources with different lifetimes. Requiring consumers to put up 5 years bill savings towards a 20 year or 30 year measure is arguably different than requiring the same

contribution towards a lighting system with an expected lifetime of 10 years. The real question is whether consumers have a high discount rate or whether they have a short time horizon. An alternative would be to require the consumers to pay a minimum of either 5 years of savings or the expected savings during 50% - 75% of the measure life, whichever is less. Again, I encourage response by reviewers on this issue.

SUMMARY

The key to implementation of the TRC is to quantify the value of non-energy benefits. Direct quantification is dauntingly difficult. A reasonable alternative is to attempt to quantify the consumer's willingness to pay for energy benefits, and assume that any consumer willingness to pay above that level represents the non-energy benefits to that consumer. Since analyses of consumer measured and implied discount rates are available in the literature, we may have a fighting chance to prepare a defensible estimate of this. By doing so, we may be able to finesse the much more difficult analytical task of directly measuring non-energy benefits.

I urge WSEO to consider committing some time to reviewing the literature on consumer willingness to pay. At the time of development of the NCAC Model Plan (1981-82), we found evidence of 35% implied consumer discount rates; I suspect that in the intervening decade, this issue has been researched with some rigor. Drs. Dan Dodds and Jonathan Lesser can probably contribute to the discussion; Dr. John Hansen at NWNG and Dave Hoff at Puget may also be aware of some relevant research, as may be Terry Morlan and Wally Gibson at NWPPC.

EXAMPLES OF TRC METHODOLOGY

Resources with Non-energy Benefits

HOMEOWNER 5 Year Payback Requirement

Heat Pump (also provides air conditioning)

A	Heat Pump Installation Cost:	$3,000	
B	Avoided Cost of Energy Savings:	$1,500	
C	Annual Customer Bill Savings:	$ 150	
D	5 Year's Bill Savings	$ 750	C x 5
E	Utility Grant to Customer:	$ 750	B - D
F	Net Cost to Consumer:	$2,250	A - E
G	Minimum Non-Energy Benefits If Purchased:	$1,500	≥(F-D)
H	Minimum Total Benefits	$3,000	≥(B+G)
I	Minimum TRC Ratio:	1.0	A/H

Insulated Windows (also provides condensation and noise reduction)

A	Window Installation Cost:	$3,000	
B	Avoided Cost of Energy Savings:	$2,000	
C	Annual Customer Bill Savings:	$ 200	
D	5 Year's Bill Savings	$1,000	C x 5
E	Utility Grant to Customer:	$1,000	B - D
F	Net Cost to Consumer:	$2,000	A - E
G	Minimum Non-Energy Benefits If Purchased:	$1,000	≥(F-D)
H	Minimum Total Benefits	$3,000	≥(B+G)
I	Minimum TRC Ratio:	1.0	A/H

BUSINESS CUSTOMER 5 Year Payback Requirement

Commercial Lighting Retrofit (also provides for increased productivity)

A	Lighting Retrofit Installation Cost:	$50,000	
B	Avoided Cost of Energy Savings:	$20,000	
C	Annual Customer Bill Savings:	$ 2,000	
D	5 Year's Bill Savings	$10,000	C x 5
E	Utility Grant to Customer:	$10,000	B - D
F	Net Cost to Consumer:	$40,000	A - E
G	Minimum Non-Energy Benefits If Purchased:	$30,000	≥(F-D)
H	Minimum Total Benefits	$50,000	≥(B+G)
I	Minimum TRC Ratio:	1.0	A/H

LOW INCOME / RENTER 5 Year Payback Requirement

Replacement Insulated Steel Door (also provides for security)

A	Door Installation Cost:	$ 250	
B	Avoided Cost of Energy Savings:	$ 50	
C	Annual Customer Bill Savings:	$ 5	
D	5 Year's Bill Savings	$ 25	C x 5
E	Utility Grant to Customer:	$ 25	B - D
F	Net Cost to Consumer:	$ 225	A - E
G	Minimum Non-Energy Benefits If Purchased:	$ 200	≥(F-D)
H	Minimum Total Benefits	$ 250	≥(B+G)
I	Minimum TRC Ratio:	1.0	A/H

A. MEASURES WHICH ARE COST-EFFECTIVE EXCLUSIVELY ON THE BASIS OF ENERGY SAVINGS

Measures and modifications which have a total cost, including the Company's administrative cost, which is less than the Company's full avoided cost as set out below are cost-effective. The cost of cost-effective measures and modifications shall be shared by the Customer and the Company as follows:

The Customer shall pay a percentage of the full cost of the measures and modifications. This percentage is based on the ratio of the Customer's first two-year estimated savings to the Company's full avoided costs shown above. The percentage of the cost of the measures paid by the Customer may be reduced if the Company determines such reduction is necessary to facilitate installation of the measures.

The Company will pay the difference between the full cost of the measures and modifications and the Customer's portion of such costs, provided that in no case will the Company's proportional payment exceed its full avoided costs. Any measures and modifications for which the total cost exceeds the Company's avoided costs shall be treated under Part B below.

B. MEASURES WHICH ARE NOT COST-EFFECTIVE EXCLUSIVELY ON THE BASIS OF ENERGY SAVINGS, BUT WHICH HAVE OTHER BENEFITS

Measures and modifications which have a total cost, including the Company's administrative cost, which exceeds the Company's full avoided cost as set out below may receive financial assistance from the Company if they satisfy the following criteria:

1) The measures have significant identifiable non-energy benefits, such as improved amenity levels, additional comfort services, increased productivity, or reduced maintenance costs.

2) The total cost of the measures can be identified at the time of a Company analysis.

3) The energy savings are quantifiable, and the measures are not expected to displace a potential use of an alternative fuel source to achieve the same energy goals.

For measures and modifications which fail the test specified in Part A, but satisfy these criteria, the Company shall provide financial assistance as follows:

The consumer will be provided a grant equal to the utility's avoided cost, less five times the expected first year energy bill savings to the consumer. The consumer will be responsible for all costs in excess of this amount.

C. MEASURES WHICH HAVE A TOTAL COST IN EXCESS OF THE COMPANY'S AVOIDED COST, AND HAVE NO SUBSTANTIAL NON-ENERGY BENEFITS

Measures and modifications which have a total cost, including the Company's administrative cost, which exceeds the Company's full avoided cost as set out below, and do not meet the criteria set forth in Part B above, will not qualify for financial assistance from the Company.

D. MEASURES WHICH MAY LEAD TO RETENTION OF LOAD WHICH CAN BE MORE COST-EFFECTIVELY SERVED WITH ANOTHER FUEL, OR WHICH WOULD OTHERWISE BE UNLIKELY TO CONTINUE ON ANY FUEL.

Language Needed.