Is DOE Leading Us Astray?

The agency's calculations of energy efficiency may be misleading the public.

Here's the dilemma: According to DOE, water heaters with a higher energy factor (EF) are more efficient. But just because an electric water heater has an EF rating of, say, 88% and a natural gas water heater has a lower EF rating of, say, 54%, does that mean that electricity heats water more efficiently than natural gas? The unequivocal answer is "No," but DOE's rating methodology might lead you to the opposite conclusion.

When you do the math, properly accounting for the delivered efficiency of the two energy forms, one sees that electricity is delivered at an overall efficiency of 27% and natural gas is delivered at an overall efficiency of 91% (using the above illustrative EFs). Thus, natural gas provides twice as much hot water compared to electricity for the *same amount of fuel* as shown below:

Electric: (88% efficient water heater) x (27% efficient site-to-source delivery) = 24% efficient.

Gas: (54% efficient water heater) x (91% efficient site-to-source delivery) = 49% efficient.

This is not a trifling point considering that one of DOE's claimed objectives is to use energy efficiency to reduce pollution. After all, a pound of NO_X (or any of the other relevant pollutants for that matter) generated by fuel combustion is still a pound regardless of whether it's generated at the point of energy production (e.g., at the generating plant) or at the point of use (e.g., at a home that uses gas).

At a minimum, *site-based* energy efficiency and environmental regulations are prime examples of Einstein's point that "*A problem can never be solved by thinking on the same level that produced it.*" Since the emission characteristics of different fuels can be drastically different, misguided energy efficiency metrics based upon simplistic measurement theories can and do significantly increase energy consumption and environmental degradation. With natural gas delivery efficiency being about three times that of electricity, coupled with the fact that coal is used to generate over 50% of the electricity in the United States, it shouldn't be surprising that electricity causes significantly more pollution relative to gas for typical home appliances. These include space-heating systems, water-heating systems, ranges and dryers. To illustrate, the following table compares average national "full-cycle" emissions per year between electric resistance and natural gas water heaters.

Energy Efficiency: Past to Present

DOE's position is that point-of-use energy efficiency metrics are mandated by legislation. If so (and it's debatable), such legislation is fatally flawed, and blind adherence to it only undermines legitimate congressional public policy goals. But regardless of legalistic debates over "congressional intent," my purpose is to identify DOE's "devil in the details" procedural problems that could be improved by wiser leadership. DOE's problem areas may be categorized as follows:

"Black box" analytical procedures. For example, the following computer programs (at a minimum) are involved for "National Appliance Energy Conservation Act" (NAECA) end-use modeling: NEMS: the Energy Information Administration "National Energy Modeling System"; REM: the "Residential Energy Model"; COMMEND: the "COMMercial sector END-use planning system"; REEPS: the "Residential End-use Energy Planning System"; ARC/Info and Earth Resources Data Analysis System (ERDAS). *If* you can get the source code, operating these programs usually requires expensive hardware (such as mainframes) and full-time programming staffs. Consequently, DOE models effectively preclude independent analyses. Additionally, skewing inconspicuous input assumptions buried in DOE's model(s) can significantly alter results. For example, DOE's inputs for ongoing water heater efficiency modeling assume electric-resistance water heaters retail markups are 3.3 times higher (50 percent versus 15 percent) than those for gas water heaters. Consequently, the economic justification for efficiency improvements are proportionately greater for gas water heaters compared to electric.

DOE's nebulous and inconsistent procedures and terminology. Sometimes DOE uses a reasonable three-year simple payback and sometimes it considers any efficiency improvement

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Table 1
Total Full-Cycle Emissions
(Pounds per Water Heater per Year)

Technology	Pollutant SO_2	NO_X	TSP	CO	CO_2
Natural Gas Baseline	0.02	5.02	0.11	0.84	3306.5
Natural Gas – EF 0.58	0.02	4.67	0.10	0.79	3078.5
Natural Gas – EF 0.62	0.02	4.37	0.09	0.74	2879.98
Electric – EF 0.93	100.83	55.50	3.96	2.02	10389.33

Source: American Gas Association. "The Economic, Efficiency and Environmental Implications of More Stringent NAECA Standards for Residential Water Heaters." December 2, 1993.

that pays for itself (breaks even) within the lifetime of the appliance as cost-effective. The problem is that for ranges, furnaces and other end uses, lifetimes range from 10 to 30 years or more. The methodology that DOE uses to calculate energy costs is also flawed. DOE calculates energy costs by dividing revenue derived from a given market by the total amount of energy (e.g., therms or kWhs) sold into that market. However, real consumers realize economic efficiency through utility billing structures; not "average costs" that inflate savings up to 30 percent due to the inclusion of fixed costs (e.g., monthly service charges) that don't decline relative to reduced energy consumption.

A modeling subcommittee of DOE's "Advisory Committee on Appliance Energy Efficiency Standards" unanimously recommended such a consumer marginal energy rate (CMER) approach and provided considerable support analyses. However, DOE chose not to heed this advice within a time frame that impacts ongoing rulemaking. According to the rules, DOE only has to consider advice when there is a consensus. But, aligned stakeholders can "pack the bleachers" of committees, thus denigrating legitimate professional consensus into majority rule. Also, committee appointments last 2 years (it's only at that point that first-time appointees really gain an understanding of the game) but terms can be extended at the discretion of DOE's Secretary.

In short, definitional loopholes let DOE manipulate consensus processes and transparent and robust analytical methods called for by law that, in DOE's words, should be "as sound and well-accepted as possible, fully documented for the public, and produce results that can be explained and reproduced.[1] Worse yet, publicly available data used in DOE's models may soon be deemed confidential by DOE's Energy Information Administration[2] (EIA).

Adverse Consumer Impacts

In the marketplace, site-based energy efficiency metrics typically degenerate into fronts for cynical marketing ploys that hold nonelectric end-use technologies hostage to significantly higher standards. For decades, this bias has given electricity an unfair competitive advantage that has caused significant and completely avoidable societal costs and environmental degradation. According to Ed Meyers of the Washington D.C. Public Service Commission: "There is a lot of what we call gold plating. A lot of money is spent for consultants, administrative matters and on programs that don't tangibly conserve energy. Those ineffective efforts have the effect of raising bills for hard-pressed urban consumers while not helping the cause of conservation. [It's like] asking the tobacco industry to educate people about the dangers of smoking. The best thing a utility can do to earn money is to operate a program which ostensibly conserves energy but may not be all that effective. That way, they get [program] cost recovery, lost revenues and incentives without hurting sales all that much[3] [at a minimum]."

Additionally, they may recover so-called lost revenues (while actually increasing energy consumption), build rate-based power plants to serve increased consumption, and receive bogus emission reductions credits and IRS allowed demand-side management (DSM) write-offs.

According to a Texas Railroad Commission study,[4] households with electric space heating increased by over 40 percent while proportionately decreasing demand for natural gas after a decade of electric utility DSM within the state. Findings included significant life cycle emissions and consumer operating cost increases as a result of the vast majority of electric utility DSM programs in Texas. It is significant that DSM/IRP enabling legislation in Texas called for the "conservation of resources" and most electric utilities in Texas adopted the notion that "valley filling" and "strategic load growth" qualified through improved utilization of power plant "resources." With few exceptions, regulators and environmentalists ignore (or are oblivious to) DSM abuses.

DOE's Office of Power Technologies (OPT) "coordinates the federal government's joint efforts [only] with electric utilities to implement energy efficiency programs."[5] During the summer of 1994, a workshop was held with OPT's predecessor, the Office of Utility Technologies (OUT), to assess fuel cycle analysis modeling abilities. Participants concluded: "There is a need for an analytical method to perform full and consistent comparisons of energy conversion technologies throughout the total fuel cycle of an energy resource." The proceedings made the following recommendations to DOE: Establish a fuel cycle assessment focus group; conduct an assessment of alternative total fuel cycle analysis approaches; further analyze the models presented at the workshop; and identify/develop data elements to support total fuel cycle analysis[6]

Fuel Cycle Analysis

Shortly after this workshop, around the time of DOE's well publicized congressional funding problems, people within OUT explained that the Edison Electric Institute (EEI) would influence budget cuts if OUT pursued anything remotely associated with environmental externalities. Subsequently, DOE attempted to restructure its integrated resource planning (IRP) program into a new "competitive resource strategies" program. However, DOE's efforts were apparently too-littletoo-late, as their IRP budget was still eliminated. Since then, I believe that DOE's objectivity became even more muddled. This would appear to be at the continued behest of outside interests such as EEI and the Electric Power Research Institute (EPRI) who has full-time staff working at DOE's headquarters.

Empowering Society

PC costs are virtually free-falling while computational abilities approach mainframes. The following discussion explores how comprehensive energy analyses can be developed using off-the-shelf PC software and hardware. Integrated subprocesses would include: selecting equipment performance characteristics; determining metered energy requirements thereof; pricing metered energy via utility rate and load profile inventories; determining and comparing consumer marginal energy economic and emissions analyses based upon "before and after" impacts of appliance alternatives; and life cycle forecasting of such economic and environmental impacts.

The primary databases integrated within this methodology would include: utility emissions; equipment performance factors; utility rates; and generic load profiles. Basic user inputs would include:

- select desired appliance performance specifications;
- input 12-month billing consumption (or select default load profiles);
- select utility rates (thereby also selecting utility emissions databases); and
- press "enter" to calculate marginal economic and environmental impact of their selections.

Comparisons could then be made between appliance alternative life cycle economic and environmental impacts through straightforward spreadsheet-based "what-ifs." Such analyses would represent present day baselines.

Refinements could include regionally adjustable spreadsheet routines to calculate total efficiency losses and emissions for energy delivered to the point of the end-use meter (not traditionally accounted for in emissions inventories). Additionally, baselines could be forecast through reasonable but divergent future scenarios. Local, state or national energy policy analysts could statistically weight numerous runs for more comprehensive initiatives. The only obstacle is the continued availability of publicly accessible utility information; for example, that from EIA.

A good example of an Internet-based ranking of utility emissions is the Natural Resources Defense Council's (NRDC) *Benchmarking Air Emissions of Electric Utility Generators in the U.S.*[7] EPA's Acid Rain Division also has a downloadable emissions database, "*Emissions & Generation Resource Integrated Database*" (E-GRID). E-GRID is a comprehensive source of data on the environmental characteristics of virtually every power plant and generating company in the country.[8] The data allow direct comparison of the environmental impacts of electricity from specific plants, companies, states or regions. E-GRID's PC interface allows users to browse data through standard Microsoft Access queries. Eleven Microsoft Excel spreadsheet files are included so data can be fully identified, sorted, graphed, etc.

Perhaps the most ambitious task to be performed is developing and maintaining a readily accessible and up-to-date national database of natural gas and electric rate structures. Commercial software developed by the Gas Research Institute for gas cooling feasibility analyses has demonstrated an alternative that appears to be more than adequate for the vast majority of gas and electric rate structures.[9] Figure 1 illustrates features of GRI's methodology.

Concluding Thoughts

In DOE's ostensible energy efficiency zealousness, it assumes "command and control" of a portion of the economy. Such political markets inevitably displace free markets, as vested interests organize and mobilize resources to protect and enlarge their abilities, against less powerful stakeholders, to determine regulatory outcomes. Consequently, important policies come up for grabs as well-funded interests position themselves to prevail in regulatory decisions.

Although electric utilities are still allowed to "buy the business" through DSM, they have apparently discovered improved economic efficiencies by getting energy and environmental codes and standards adopted that are more to their liking. For example, according to the October 23, 1998 edition of EEI's *Washington Letter*, "a source-based standard could have cost the electric power industry billions of dollars." This is tantamount to saying that electric utilities are receiving billions of dollars of government subsidies by maintaining site-based energy efficiency standards.

Site-based energy efficiency regulatory capture goes hand in hand with self-fulfilling "manifest destiny" prophecies for an energy monoculture such as EPRI's recent prediction that "Replacement of industrial and residential technologies that directly burn fossil fuels with electrotechnologies will help solve environmental problems." This was accompanied by an optimistic forecast of average yearly U.S. kWh use per capita (see Table 2)[10]

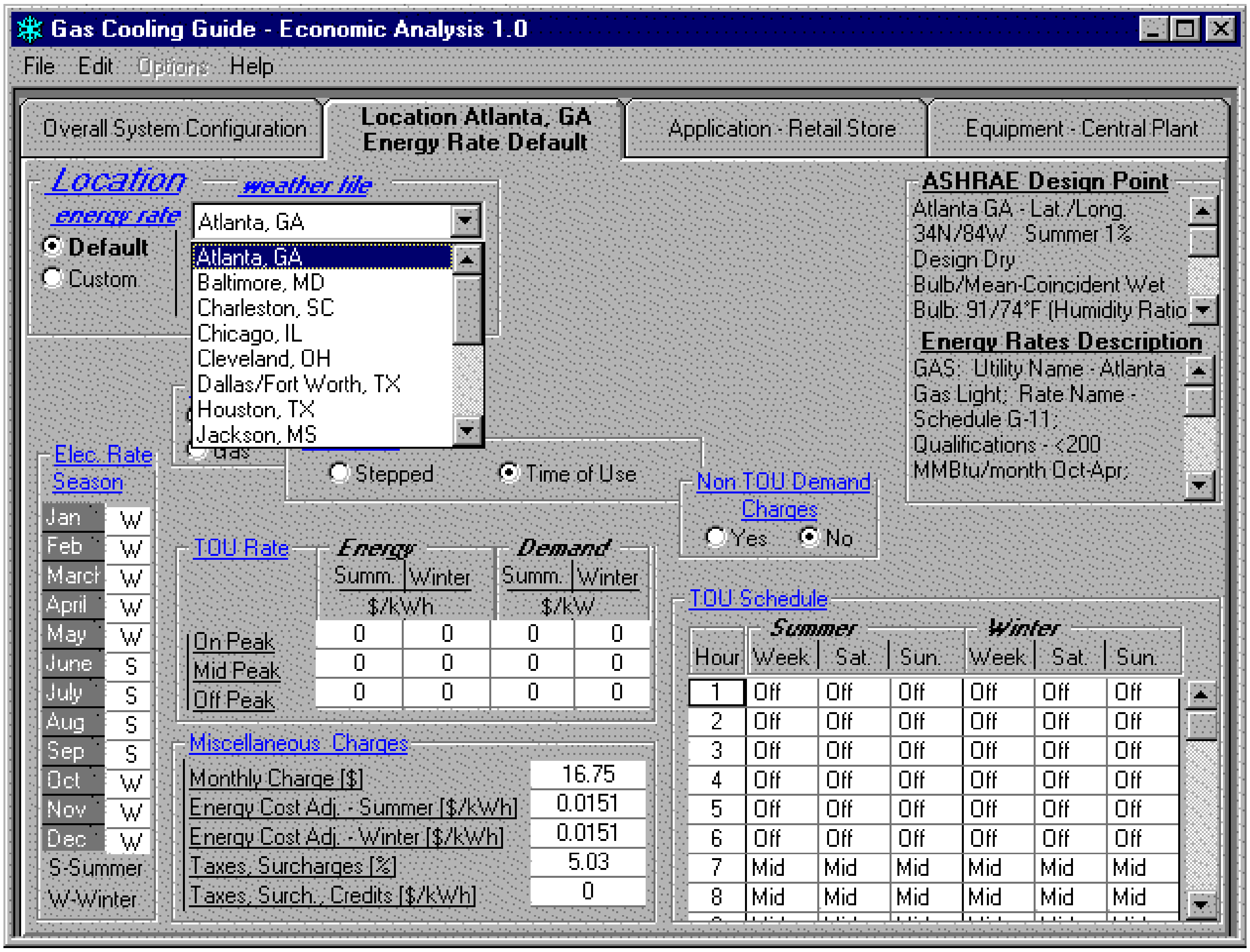
A recent EPRI conference reported that their goal is now to "increase electrification 50 percent over the next 10 to 15 years." Bob Galvin, chair of Motorola's Executive Committee, who headed DOE's "Task Force on Alternative Futures for the National Laboratories" (a.k.a. the" Galvin Task Force" that permitted DOE's national labs to work directly for "industry"), expressed sentiments at this conference that made EPRI's predictions look meek[11]

According to Galvin: "To me, 50 percent seems overly conservative. I would look for multiples. The opportunity to enhance the service to society with energy ought to be multiplied three to five times in the course of 15 years." Otherwise, Galvin rationalizes: "If we don't do it, others will, and they may put in the wrong kind of energy systems." Whether by regulatory design or negligence, the end result is that Galvin's Task Force

Table 2
EPRI Projected Per Capita kWh Consumption

Year	1950	2000	2050
kWh per capita	1,100	11,000	25,000

Figure 1
Aspects of GRI's Gas Cooling Feasibility Analysis



opened the door to policy for hire. This intent was alluded to by EPRI's conference report's road map directed "at the policymaking community [that] would reveal the essential leverage to be gained from a coordinated R&D approach" [allowing] "EPRI and the national laboratories to carve out appropriate niches and begin to work together in new ways."

We stand at a crossroads. The progress of our democracy demands purging regulatory capture attempts and replacing that with efficient means to help consumers make informed choices. Assuming that our government still embraces free markets and environmental protection, it's imperative that consumers have ready access to objective and unbiased information to make knowledgeable energy decisions. As opposed to picking political favorites and Big-Brother policies that conveniently view consumers as incapable of making "correct" purchase decisions, competing technologies should be allowed to win or lose according to merit or lack thereof. With comprehensive disclosure and price being equal, knowledgeable consumers would ordinarily choose the cleaner energy product. Conversely, lack of energy choices and knowledge only obstructs competition and ensures that efficiency and environmental policies become tragic farces.

End Notes

[1] 10 CFR 430, subpart C, Appendix A 1 (g)

[2] Federal Register: July 17, 1998 (Volume 63, Number 137 Page 38620-38625
http://www.regwarn.org/fr_notice98_7.htm

[3] The Demanding Side of Utility Conservation, David Lapp
http://www.essential.org/monitor/hyper/mm0994.html#econ

[4] The Impacts of Electric Utility DSM Incentive Programs and Rate Structures on the Natural Gas and Propane Industries in Texas, The Texas Railroad Commission, May 1995, page 4 (referencing 1980 vs. 1990 Census)

[5] http://www.eren.doe.gov/EE/utilities.html

[6] Summary and Recommendations: Total Fuel Cycle Assessment Workshop, NREL/TP-463-7671

[7] Benchmarking Air Emissions of Electric Utility Generators in the U.S., NRDC Online
http://www.nrdc.org/nrdcpro/util/index.html

[8] Emissions & Generation Resource Integrated Database, EPA
http://www.epa.gov/acidrain/egrid/egrid.htm

[9] GRI Gas Cooling Guide (630) 415-0468

[10] Kurt Yeager, Senior Vice President, EPRI. Power Engineering magazine, February 1994 issue, page 10

[11] Technology and the Transformation of the Electricity Industry, Brent Barker
http://www.epri.com/EPRI_Journal/nov_dec96/techtrans.html