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Viewpoint

Potential problems and limitations of energy conservation and energy efficiency

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ABSTRACT

We discuss that whilst energy conservation and energy efficiency both ultimately have the same goal they attempt to achieve this via very different approaches. We then discuss how both options face significant barriers to ultimately successfully reduce electricity consumption.

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1. Introduction

If you ever have been to an electricity conference, at some point, someone will utter the now tired phrase "the cheapest megawatt hour (MWh) of electricity is the one that is not produced"—sometimes this concept is referred to as a negawatt.

Also, from an early age we are taught to conserve. For instance, switching off lights when not in the room, do not run the water whilst brushing our teeth and shut the windows when the central heating is on are all examples of conservation "tips".

Ultimately energy efficiency and energy conservation within the electricity sector attempt to achieve the same outcome, namely reduced electricity consumption, however each mechanism attempts to achieve this in two separate, but interrelated, ways.

In a broad manner energy efficiency focuses on adjusting directly *input* requirements for a given output decision whilst energy conservation focuses on reducing overall *output* decisions, which then reduces the required amount of electricity.

Potentially with some of this in mind, at the end of 2010, twenty-six U.S. states have introduced some form of an energy efficiency standard/goal for regulated electricity utilities.[2] Often to comply with these standards the regulated utilities offer financial incentives, generally in the form of rebates, that attempt to lower the up-front cost of adopting energy efficiency measures.

The introduction of energy efficiency standards in the electricity sector have caused rate-payer funded energy efficiency program budgets to increase dramatically in recent years. In 2007 it is estimated that $2.7 billion was allocated to encourage the adoption of energy efficiency measures. Whilst in 2010 it is expected to be $5.4 billion.[3]

Below is a brief discussion of energy efficiency and energy conservation and how each mechanism faces different problems or limitations to their potential success in reducing electricity consumption. We conclude with how public policy makers may potentially be able to overcome some of the problems or limitations.

2. Energy efficiency

The demand for electricity is known in economics as a derived demand. That is, individuals and businesses do not generally demand electricity for its own sake but instead we consume electricity because the goods and services (output) that we ultimately desire generally require electricity as an input in its production. For example, individuals may want to use their air-conditioning units to cool their homes (output), which requires electricity (input).

Energy efficiency typically focuses on adjusting *input* requirements for a particular consumption decision (output)—typically by reducing the electricity-intensive nature of the production process.

For instance, recently there was a change in the minimum Seasonal Energy Efficiency Ratio (SEER) rating allowed for new

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[2] Satchwell et. al (2010).

[3] Consortium for Energy Efficiency (2010).

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residential air-conditioning (AC) units. Air conditioners manufactured after January 26, 2006 now must achieve a SEER of 13 or higher.[4] Thus, through time, due to new residential construction and replacement of older less-efficient AC units, the average SEER rating in the country will increase. This will ultimately mean that for a given amount of cooling the required amount of electricity to achieve that cooling will fall.[5]

One notion within the energy efficiency literature is the idea of an energy efficiency gap. Simply put, the energy efficiency gap focuses on trying to explain reasons why there is a relatively low penetration rate for apparently cost-effective energy efficiency technologies.

For instance, when looking at energy efficiency measures, often each measures' net present value (NPV) is estimated (and is positive) and/or the cost per kilowatt "saved" is calculated and it is less than the price of electricity.[6]

At first glance it appears that, due to the lack of wide adoption, households and businesses are ignoring profitable opportunities by *not* adopting energy efficient measures. Thus households and businesses are effectively "leaving money on the table" by their apparent hesitancy to fully engage in adopting energy efficient measures. The next task then is to attempt to explain this (seemingly curious) behavior.

The core approach to examining the desirability of energy efficiency options is generally an investment-based one. However, there is a large body of literature that looks at rebound effects (people increase the usage of a device because the marginal cost has fallen), which suggest than energy efficiency adoption may also be a consumption decision rather than just a means to save money.[7]

The investment strategy approach examines the trade-off within accepting higher initial capital/installation costs in exchange for (riskier) lower future electricity bills during the lifetime of the energy efficiency measure.

Within much of the energy efficiency literature the implicit assumption is that the household/business examining the financial viability of energy efficiency options is at the *replacement* stage with respect to their current measure installed. For example the household's current AC unit is broken and they are evaluating the return from installing a standard AC unit (where the "standard measure" may be already more energy efficient that their original installation) versus the return from installing a more energy efficient unit.[8]

This implicit assumption is made because typically only the additional costs – the difference in the price between the energy efficient AC unit and the standard/baseline unit – are incorporated into the initial up-front cost calculation. This type of analysis is only correct if the current standard measure is non-existent, either because it is not functioning or was not installed in the first place.

Thus, individuals who are not at the replacement stage have to bear an additional cost, foregoing some years of useful life from their current AC unit, if they adopt the energy efficient measure before current measures are in need of replacement.

Within a framework where the household is attempting to minimize overall *lifetime* electricity costs, coupled with the fact that many energy efficiency measures are durable goods, the additional cost associated with early adoption may potentially assist with explaining part of the relatively low penetration rates of seemingly profitable energy efficiency measures.[9] Simply put, if it is not broken then do not fix/replace it.

Another potential reason for the energy efficiency gap is the idea that households apply higher discount rates than what is assumed when calculating the net present value of a given option. Hausman (1979) was one of the firsts to document the idea that households may apply relatively high discount rates when evaluating appliances that have different costs and energy savings associated with them. Overall, Hausman estimated the aggregate discount rate was between 15% and 25%. He also found that the discount rate applied varied *inversely* with income. Hausman estimated that households with a mean income of $10,000 (1979$) have a discount rate of 39% whilst the households with a mean income of $50,000 (1979$) have a discount rate of 5.1%. Other studies have found similar, and sometimes even larger implicit discount rates, ranging from 25% to over 100%.[10]

There have been numerous reasons put forward to explain these high implicit discount rates. A reduction in product attributes, for instance a common criticism of compact fluorescent lighting (CFL) is its relatively "poor brightness quality".[11]

Uncertainty surrounding actual future energy savings may also prohibit the deployment of energy efficiency measures.[12] However, Metcalf (1994) shows that if there is uncertainty in energy prices, households and businesses should invest in energy efficiency options (and therefore accept a *lower* rate of return on these options) as energy efficiency options represent a hedge against risks in other areas of the economy.

The irreversibility/sunk cost nature of many large energy efficiency investments and the indecision about when to invest, should you invest in the current energy efficient product or wait for the next generation, have also been highlighted as potential explanations for the relative low levels of energy efficiency deployment in the electricity sector.[13]

Of course, one way to improve the rate of return on energy efficiency options is to intervene in the market and offer improved financial incentives. For instance as part of many energy efficiency programs utilities offer rebates on many energy efficiency options, which attempt to reduce the out-of-pocket expenses for customers and further improve the financial incentive to adopt (and to adopt early also). Some critics worry that larger incentives may encourage more free-riding behavior—individuals who would have adopted the measure without financial incentives from their utility company. In fact, many utilities when reporting the savings from energy efficiency measures encouraged have to attempt to adjust the reported savings for free riders. This calculation is incorporated into net-to-gross ratios (NTG).

Putting the issue/debate of higher implicit discount rates aside there are other explanations put forward to further explain the "energy efficiency gap". These include the following:

- lack of information;
- loss aversion;
- liquidity constraints;
- principal/agent problems.

[4] http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/ac_factsheet.pdf.

[5] Note that it will increase at a relatively slow pace, given that air-conditioning units are durable goods and thus last for numerous years.

[6] Or from the utility's perspective it is less than their avoided cost.

[7] See Khazzoom (1980), Greening et al. (2000), Sorrell and Dimitropoulos (2007), Sorrell et al. (2009) for a good review of the literature.

[8] Or the household does not even have a "standard measure" installed in the first place.

[9] To our knowledge no such study exists.

[10] See Sanstad et al. (2010) and Dubin (1992) for a good review of the literature.

[11] ICF International (2007).

[12] and that the projected savings may be lower if the rebound effect is present.

[13] See Gillingham et al. (2009) for an excellent overview of the issues mentioned.