Can you really get 20 % energy efficiency savings by 2020 without new technology? - Or what does really happen when you run out of CFLs?

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ABSTRACT

This paper will present some of the issues associated with forecasting energy efficiency potential over time, using those forecasts to set goals, exploring what impact new technologies can have on the forecast and suggestions for improvements in the methodology.

Introduction

In the last year a number of states and several countries have set very ambitious goals for energy efficiency –such as 20 percent by 2020. Often these goals are supported by forecasts of economic and achievable energy efficiency potential. These studies often present policy makers with difficult challenges such as – well we ran out of CFLs in 2012 with the new federal standards – and we may have not enough resources left that are cost effective to make 20 % in 2020. There is also some but limited experience with very aggressive energy efficiency goals over time.

This paper reviews the fundamentals of technical potential, presents some findings from recent studies, discusses some of the limitations of these studies especially as it relates to goal setting and will present some suggestions for dealing with the limitations and suggestions for improvements.

Overview of Energy Efficiency Potential

Energy Efficiency Potential is typically calculated in the following manner as shown in Figure 1 below:

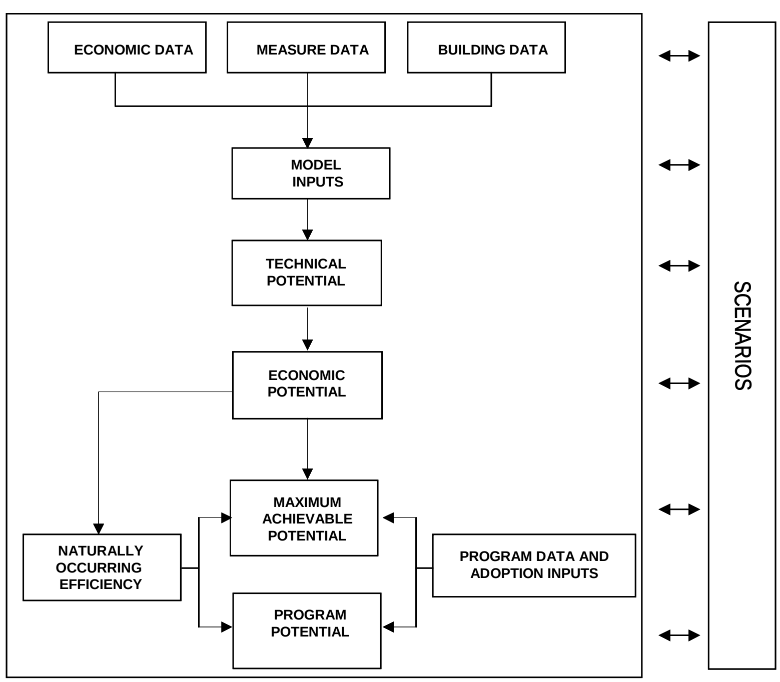

Figure 1. Simplified Conceptual Overview of Modeling Process

In most approaches this is done in a bottom-up manner, first **technical potential** is estimated for energy savings by integrating key measure and market segment parameters using the following equation:

$$\text{Technical Potential of Efficient Measure} = \text{Total sq. ft. or \# of Dwellings} \times \text{Base Case Equipment EUI or UEC} \times \text{Applicability Factor} \times \text{Not Complete Factor} \times \text{Feasibility Factor} \times \text{Savings Factor}$$

The then **economic potential is** estimated by first developing a supply-curve analysis. This analysis eliminates double counting of measure savings. On a market segment and end-use/technology basis, measures are stacked in order of cost effectiveness, and the energy consumption of the system being affected by the efficiency measures goes down as each measure is applied. As a result, the savings attributable to each subsequent measure decrease if the measures are interactive. Measures with a benefit/cost ratio greater than 1 are then passed on to our market penetration analysis.

Achievable potential is then estimated by assessing likely market penetration based on customer awareness and measure cost effectiveness. Alternatively achievable can also be calculated as a percentage of economic. KEMA uses a method of estimating adoption of energy efficiency measures that applies equally to our program and naturally occurring analyses. Whether as a result of natural market forces or aided by a program intervention, the rate at which measures are adopted is modeled in our method as a function of the following factors:

- The availability of the adoption opportunity as a function of capital equipment turnover rates and changes in building stock over time;
- Customer awareness of the efficiency measure, which can be influenced by program marketing and information efforts;
- The cost effectiveness of the efficiency measure; and
- Market barriers associated with the efficiency measure.

Our model estimates adoption under both naturally occurring and program intervention situations. The primary difference between the naturally occurring and program analyses is the participant. In any program intervention case in which measure incentives are provided, the participant benefit-cost ratios are adjusted based on the incentives. Thus, if an incentive that pays 50 percent of the incremental measure cost is applied in the program analysis, the participant benefit-cost ratio for that measure will double (since the costs have been halved). The effect on the amount of estimated adoption will depend on where the pre- and post-incentive benefit-cost ratios fall on the curve. This effect is illustrated in Figure 2. KEMA utilizes several different market-penetration curves to model different classes of measures, based on perceived market barriers that the measures may face.

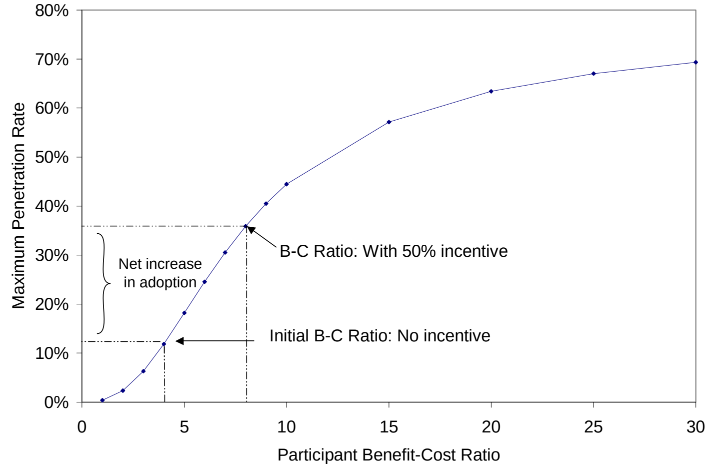

Figure 2. Illustration of Effect of Incentives on Adoption Level as Characterized in Implementation Curves

Results of Potential Studies

Figure 3 presents a summary of selected achievable potential studies. It should be noted that not all Achievable studies are calculated on a similar basis and until recently some studies might only present results for technical and economic potential. In some of these cases presented here both a Maximum achievable case was calculated and a Cost Effective Maximum achievable was calculated. As this figure illustrates % achievable per year ranges from .5 percent to 2.2 percent. The Maximum Achievable cases shown below are meant to be a very aggressive case

Maximum Achievable Potential

State	Conn-2004	Vermont	North Carolina	Georgia	California
Residential	17.00%	25.50%	20.40%	9.40%	15.00%
Commercial	17.00%	24.40%	22.00%	9.60%	13.00%
Industrial	17.00%	14.50%	17.50%	6.60%	12.00%
% Achievable/Yr.	1.70%	2.21%	2.01%	1.74%	1.56%
Total Achievable	17.00%	22.10%	20.10%	8.70%	14.00%
Length of Study (Yrs.)	10	10	10	5	9
End Year	2012	2015	2017	2010	2011

Maximum Achievable Cost Effective Potential

State	Conn-2004	Vermont	North Carolina	Georgia	California	EPRI / EEI
Residential	13.00%	21.30%	16.90%		10.00%	
Commercial	14.00%	21.30%	11.90%		10.00%	
Industrial	13.00%	14.50%	12.10%		11.00%	
% Achievable/Yr.	1.30%	1.94%	1.39%		1.11%	0.50%
Total Achievable	13.00%	19.40%	13.90%		10.00%	11.00%
Length of Study (Yrs)	10	10	10		9	22
End Year	2012	2015	2017		2011	2030

Figure 3. Summary of Selected Achievable Estimates[1]

[1] Sources include GDS, ICF,EPRI, and KEMA

Limitations of Potential Studies

Most potential studies provide supply curves of energy efficiency resource suggest significant economic resources. As noted in the previous section, different methodologies are used to calculate achievable potential and results can vary greatly. Limitations of these studies include:[2]

- Lack of consideration of systems integration
- Assumptions that once implemented measures no longer improve
- Non Energy benefits are not included
- Impacts on energy price are ignored
- Arbitrary maximum penetration rates
- Excluded measures

Other limitations can include:

- Limited data available to support the study
- Dated data to support the study
- Unknown or no clear treatment of naturally occurring energy efficiency in the forecast used
- Codes or standards not included

Limited Experience with Very Aggressive Programs

Since 2004 a number of states have been assessing goals for energy efficiency resource standards (EERS). These vary with California and Vermont having some of the highest targets. Some examples of years with high savings from a number of jurisdictions can be found in a recent paper by Synapse Energy Economics[3]:

[2] Goldberg, David, Natural Resources Defense Council, "Extreme Efficiency: How Far Can We go if We Really Need to?" ACEEE Summer Study, 2008.

[3] "The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date"; K. Takahahsi and D. Nichols, Synapse Energy Economics, Inc, ACEEE 2008 Summer Study.

Table 1. Examples of High Annual Electric Energy Savings Realized through DSM

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Jurisdiction or Entity	Annual Savings (Percent)	Year(s)	Source
Interstate Power & Light (MN)	3.0	2001	Garvey, E. 2007. "Minnesota's Demand Efficiency Program."
San Diego Gas & Electric (SDG&E) (CA)	2.1	2005	SDG&E 2006. Energy Efficiency Programs Annual Summary
Minnesota Power	1.9	2005	Garvey, E. 2007
Sacramento Municipal Utility District (SMUD) (CA)	1.9	1994	Data provided by SMUD
Vermont	1.8	2007	Efficiency Vermont 2008. 2007 Preliminary Results and Savings Estimate Report
Southern California Edison (SCE)	1.7	2005	SCE 2006. Energy Efficiency Annual Report
Western Mass. Electric Co. (MA)	1.6	1991	MA Dept. of Telecommunications & Energy (DTE) 2003. Electric Utility Energy Efficiency Database
Pacific Gas & Electric (PG&E) (CA)	1.5	2005	PG&E 2006. Energy Efficiency Programs Annual Summary
Massachusetts Electric Co.	1.3	2005	MECo 2006. 2005 Energy Efficiency Annual Report Revisions
Connecticut IOUs	1.3	2006	CT Energy Conservation Management Board (ECMB). 2007
Commonwealth Electric (MA)	1.2	1990	MA DTE 2003.
Cambridge Electric (MA)	1.1	2000	MA DTE 2003.
Seattle City Light (WA)	1.0	2001	Seattle City Light 2006. Energy Conservation Accomplishments: 1977-2005
Eastern Edison (MA)	1.0	1994, 1998	MA DTE 2003.

This study also provides examples over multiple years. The next few years should provide data on the response to the recent state EERS over time. These data to date show that savings of over 2 percent per year have been accomplished, but there is less data on sustained savings. Best examples provided in this paper are Connecticut, Efficiency Vermont, Interstate Power and Light; and San Diego Gas and Electric.

KEMA Model Experience with Aggressive Standards

In the last 2 years, KEMA has been asked by clients to model aggressive energy efficiency scenarios. Challenges we have run into while doing that include:

- Running out of certain measures over time –especially CFLs and other lighting equipment – hence making it difficult to achieve 2% per year sustained in a modeling framework
- Higher standards and codes taking away program potential
- Uncertainty about new measures and their actual performance
- Uncertainty about where the "max" point on the market penetration curve really is
- Uncertainty about how much embedded energy efficiency is in a given load forecast and how that relates to current programs.
- Using old data
- Higher energy prices driving up naturally occurring energy efficiency

Suggested Improvements to Achievable Potential Modeling

KEMA is currently working to improve its achievable potential modeling to better model aggressive standards so that they can be explored with more accuracy. These include:

- Modeling new technologies – both explicitly and generically
- Adding more systems based measures – both explicitly and generically
- Modeling codes and standards more explicitly
- Further research into the modeling of naturally occurring energy efficiency at current energy prices
- Further research on what is a realistic “max” on the market penetration curve.
- And last but not least - more primary data collection.

Actual results from a study where these approaches were used should be available at the time of the conference.