Evaluating Energy Efficiency Benefits for Energy Providers and Customers

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ABSTRACT

Energy providers have a unique position in the energy efficiency space, dedicated to delivering quality energy services to customers, while at the same time pursuing bottom lines based on meeting end-user energy demand. At first glance, energy efficiency may appear to run contrary to the commercial interests of energy providers. However, emerging research suggests an array of benefits accrue to energy providers and their customers as a result of end-use efficiency improvements. This paper reviews the major benefit categories and the progress made in quantifying them. The review suggests several areas where additional evaluation research is needed, notably quantifying the benefits of deferring network additions, wholesale market price effects, and reduced risk in resource portfolios.

Introduction

The power sector is a key target in global efforts to manage energy demand growth and reduce greenhouse gas (GHG) emissions. The IEA's 2011 World Energy Outlook estimates the power sector will account for two-thirds of cumulative emissions abatement to 2035 under a climate change stabilization scenario (e.g., the 450 Scenario), through switching to less carbon-intensive generation, more efficient plant operations, and lowered electricity demand (See Figure 1). Reducing electricity end-use demand alone accounts for one-third of reduced GHG emissions over the next 10-15 years (IEA 2011a).

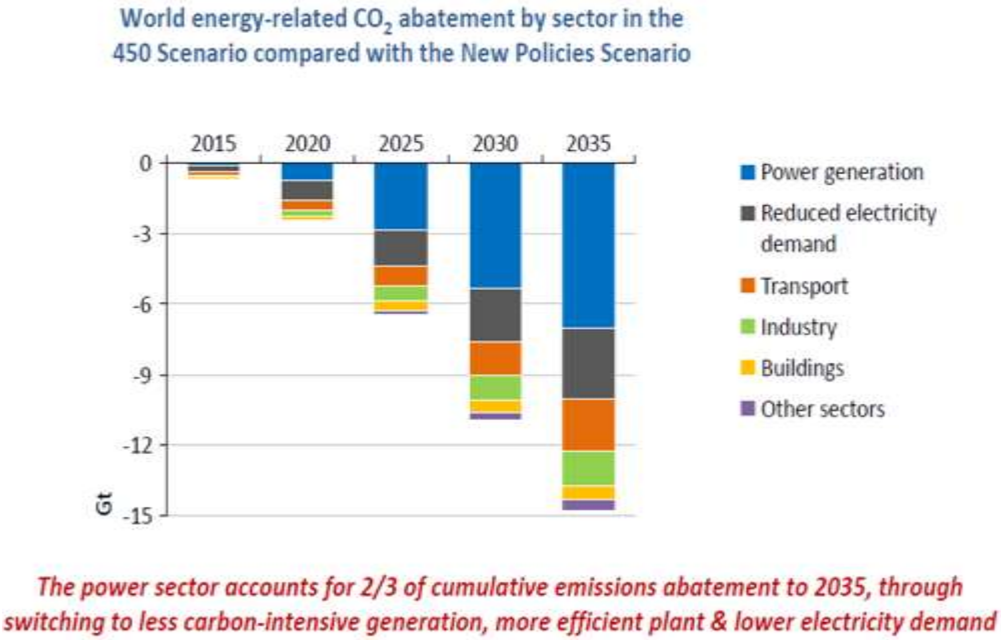


Figure 1: World energy-related CO2 abatement by sector in the 450 Scenario (IEA 2011a)

In many countries energy providers play a central role in delivering end-use energy efficiency improvements. Based on available data, annual global spending on energy efficiency financed through networked energy bills and/or delivered by energy providers is estimated at over €8 billion in 2011 (Lees 2012; Crossley and Swanson 2011; Faruqui 2011; Heffner 2012). Almost all of this spending stems from national and state/provincial efforts in Europe, North America, and Australia. Ratepayer-funded spending on gas and electricity efficiency in the United States and Canada topped USD 6 billion in 2011 and some energy providers spend over 3% of their revenue on energy efficiency (Consortium for Energy Efficiency, 2010; Sciortino et al 2011). In the UK, annual spending by energy retailers under the Carbon Emissions Reduction Target (CERT) supplier obligation has been €1.2 billion per year, while the Italian White Certificates scheme accounted for over €200 million in 2010 spending alone (Lees 2012). State schemes in Australia accounted for another €80 million in 2010 (Crossley 2011). Other G20 countries including China and Brazil have introduced targets and energy efficiency spending requirements for energy providers (Cowart 2012).

Conventional wisdom holds that energy providers require multiple regulatory frameworks to overcome the structural disincentives to delivering energy efficiency to their end-users, recover the incremental costs of energy efficiency programmes, and provide new incentives for managers and shareholders to include energy efficiency in their operations (IEA 2010; US EPA 2007). Improved understanding of the multiple benefits that energy efficiency can yield for energy providers and their customers could create an additional incentive for energy providers to advocate energy efficiency and also help energy regulators to fine-tune regulatory frameworks and policy interventions to maximize these multiple benefits.

IEA’s earlier work on the multiple benefits of energy efficiency

The IEA first examined the multiple benefits of energy efficiency via a workshop held in Dublin in early 2011. This workshop focused on low-income energy efficiency programmes, which have been shown to have significant and multiple benefits not only for participants but energy providers and their customers (IEA 2011b). The workshop report concluded that financial, economic, health and social welfare benefits of low-income energy efficiency programmes can be considerable. Although programme participants enjoy the greatest benefits, energy providers can also benefit. Some of these energy provider benefits notably lower arrearages and fewer disconnections can be directly estimated and expressed in financial terms. However, the workshop found only a few efforts to evaluate these multiple benefits, and only a very few governments or regulators considering non-energy benefits in their programme evaluations. As a result, multiple benefits evaluation practices remain shallow and scattered.

Workshop participants also suggested that evaluation of multiple benefits be approached with care. There are many uncertainties to be addressed and pitfalls to avoid, such as the potential for double-counting, benefits persistence issues, complexities of monetizing benefits, and establishing attribution between interventions and outcomes. Multiple benefits evaluation requires approaches different from those found in conventional energy programme impact evaluations, making it necessary for evaluators to borrow data and methods from the broader evaluation literature. All these uncertainties and complexities translate into scope for collaboration on multiple benefits estimation (Heffner and Campbell 2011).

Multiple benefits of energy efficiency for energy providers and customers

Energy efficiency benefits energy providers and their customers in distinct ways – by reducing customer operations costs, accommodating peak demands without adding new generation or network capacity, reducing price volatility in wholesale markets, reducing resource portfolio cost and risk, and improving reliability. All of these benefits are distinct to the networked (gas and electric) energy sector, and they apply not only to energy efficiency but to demand side management generally. These benefits have been widely described, notably in an evaluation guide accompanying the 2007 US National Energy Efficiency Action Plan. This evaluation guide catalogued the multiple benefits of energy efficiency specific to energy providers, program participants, and ratepayers (US EPA 2007b).

Notwithstanding the literature specific to the multiple benefits of low-income energy efficiency, most work on energy provider multiple benefits draws from studies of demand response, or DR (US DOE 2006; Violette 2006; Quantec 2006; Heffner 2009; Neme and Sedano 2012). However, the same logical frameworks, causality and additionality arguments, and estimation methods can be used for both these forms of demand-side management (DSM). One of the challenges facing energy efficiency multiple benefit evaluators will be extracting promising evaluation methods from the DSM literature and applying them to estimating the multiple benefits of energy efficiency.

Operating cost savings

Evaluations of energy provider benefits from energy efficiency often focus on customer operations cost savings from low-income energy efficiency programmes. Energy efficiency improvements make gas and electricity bills more affordable for any customer, and there is evidence that energy efficiency targeted to low-income customers reduces arrearages by 25 percent or more (Skumatz 2011). Reduced arrearages have multiple benefits - reduced carrying cost on billing arrears; reduced spending on notices and collection agencies; fewer bad debt write-offs; and lower operating costs associated with service disconnections associated with non-payment. Reduced risk and avoidance of image problems associated with disconnecting vulnerable households are additional but less tangible benefits. Energy providers and their customers can additionally benefit if energy efficiency improvements reduce the need for direct energy subsidies to low-income households or loss- making sales on subsidised tariffs.

These benefits are important in principle because they should be estimable based on operating cost savings (Massachusetts DPU 2008). Some analysis of these cost savings was undertaken during the late-1990s but comparatively few recent studies can be found. For example evaluations of low-income energy efficiency programmes implemented by energy providers in California, Colorado and Kentucky found annual average arrearage cost reduction benefits of $30-$45 per weatherized household against an average programme cost of $1500. Such analysis formed the basis for suggesting a non-energy benefit “multiplier” of 4-8% on top of direct energy benefits (Howat and Oppenheim 1999; Skumatz and Dickerson 1998). In practice, however, the causality of these benefits is complicated by the tendency of energy providers and their partners (e.g., community service agencies) to deliver multiple programmes in tandem. For example, in the US low-income households may be eligible for Arrearages Management Programs (AMP), subsidized tariffs, direct subsidies (e.g., LIHEAP), and low-income weatherization. Sorting out the impact of these multiple benefits and accounting for the benefits strictly due to energy efficiency can be a difficult task.

One innovative approach to estimating operating cost savings is the net-back method. The net-back method considers the costs related to collection and arrears from vulnerable customers and calculates the total amount collected by energy providers minus the total expenses involved with the collection technique, to show the net effect on the utility's bottom line. Collection techniques are defined broadly and include traditional debt collection activities, disconnections and reconnections, energy assistance programmes and low-income energy efficiency activities. Net-back calculations have consistently demonstrated that assistance programmes have a positive effect on the bottom line. While bills issued to customers under a programme are generally lower, the revenue collected is higher both as a percentage of the bill and in real terms (Colton 2011).

System and network deferral benefits

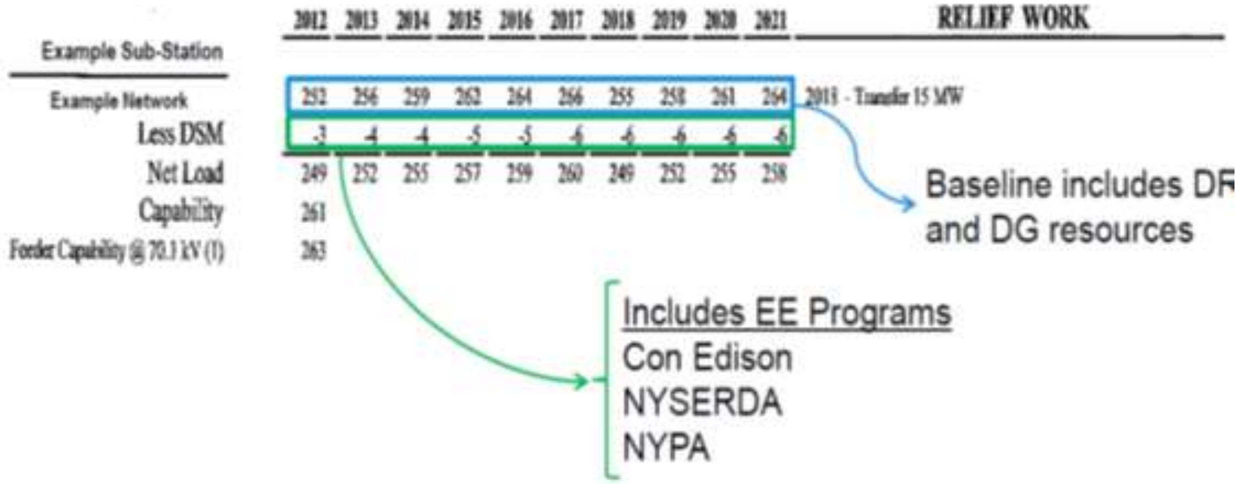
The use of energy efficiency to reduce or defer energy infrastructure additions has been examined in several countries. Energy efficiency has been shown to delay or even avoid capacity additions including energy supply and energy distribution networks by reducing both overall energy use and peak demand. A 2010 report in Australia found that improved energy efficiency in buildings could save up to an estimated USD 18 billion in infrastructure costs by 2020 - about a 10 % savings over "business as usual" (Langham et al. 2010).

A study undertaken by the IEA's DSM Implementing Agreement examined the benefits of network-driven demand-side measures including energy efficiency. The study found DSM benefits to be increasingly shared across different stakeholders and asset owners, including independent system operators, electricity network service providers, retailers, third party aggregators, and end-users. This diffuseness in the distribution of benefits, exacerbated by functional unbundling and market liberalization, makes it difficult for DSM or energy efficiency proponents to count or capture all of the benefits. Because network benefits and costs accrue across numerous beneficiaries, measuring the value of a network-driven DSM project is not a simple proposition (Crossley 2008).

Several energy providers have been successful in capturing network benefits from energy efficiency, beginning with early efforts by Pacific Gas and Electric Company some twenty years ago. These examples have shown that targeting energy efficiency efforts geographically can result in measurable and significant operating and/or capital cost savings (Pacific Gas and Electric 1994). For example, Con Edison has successfully mobilized its energy efficiency programmes to help relieve pockets of congestion and network overloading (See Figure 2), reducing its capital expenditures by over $1 billion over a ten year period. The deferral benefits of demand response and energy efficiency efforts targeted to a specific network can be as much as one-quarter to one-third of the total benefits (Gazze and Mazarlian 2011; Craft 2012).

Con Edison has developed new planning and business models to maximize the network deferral value of demand-side resources. Integrating demand-side resources into network planning offers both a downside hedge against demand growth as well as improved option value, as it becomes possible to defer projects until they are really needed without introducing undue risk from weather-related demand spikes and overloads. The planning and business models include creating load duration curves for each network, identifying the localized impacts of demand-side investments, and occasional targeting of programmes to specific assets. Con Ed's planning guidelines call for planners to look first at customer assets before considering capacity additions (Craft 2012).

Although targeted efficiency efforts can yield measurable network impacts and significant financial benefits, it requires considerable effort. To be successful requires intensive internal coordination, development of new planning and integration systems, and longer lead times than is usually the case with network additions (Neme and Sedano 2012).



Example Sub-Station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	RELIEF WORK
Example Network	252	256	259	262	264	266	255	258	261	264	2018 - Transfer 15 MW
Less DSM	-3	-4	-4	-5	-5	-6	-6	-6	-6	-6	
Net Load	249	252	255	257	259	260	249	252	255	258	
Capability	261										
Feeder Capability @ 70.1 kV (1)	263										

Baseline includes DR and DG resources

Includes EE Programs
Con Edison
NYSERDA
NYPA

Figure 2: Integrated network planning at Consolidated Edison (Craft 2012)

Market price benefits

Scaling-up demand side measures including energy efficiency can have beneficial price effects in wholesale and bilateral markets, yielding significant short- and medium-term financial benefits to electricity consumers. As wholesale markets for energy and capacity have grown, so has the potential for energy efficiency and demand response to affect market prices. Demand side measures can influence markets in two ways – by reducing the balance of energy supply and demand, especially during periods when price levels are high; and by competing directly with suppliers in the provision of capacity and energy resources. Both of these benefits represent economic transfers from energy producers to demand-side providers that can have a present value comparable to avoided energy supply costs. These market benefits of energy efficiency are routinely left out of programme cost-effectiveness evaluations, even though they benefit all energy users, not just those who participate in energy efficiency programmes. Analyses conducted for the PJM and ISO-NE spot and day-ahead energy markets suggest this can be from one third to as much as one half of the direct energy savings benefits enjoyed by programme participants (Hurley 2012).

Wholesale energy market price benefits are often referred to as demand response induced price effects, or DRIPE. Studies of same-day and day-ahead energy markets carried out for the PJM and ISO-NE have shown a significant DRIPE. A 2007 study estimated that reducing the super-peak loads in PJM by just 0.9% would produce energy market price reduction of $8-$25 per megawatt-hour, or 5-8% of the total market value during the 100-150 peak hours (Brattle Group 2007). Since both demand response and energy efficiency affect market clearing prices in the same way, illustrated in Figure 3, there would seem to be a strong basis for estimating energy efficiency-induced DRIPE. In fact studies in New England have estimated the DRIPE due specifically to energy efficiency. In 2009 the market price reductions from energy efficiency enjoyed by New England customers was estimated at 5 cents/MWh in 2009. In 2010 the total energy market demand reduction-induced price effects (DRIPE) of energy efficiency was estimated at $110-$150 million. This benefit, which accrues to all electricity customers, can be from one third to as much as one half of the direct energy savings benefits enjoyed by energy efficiency programme participants (Synapse Economics 2008; Hurley 2012).

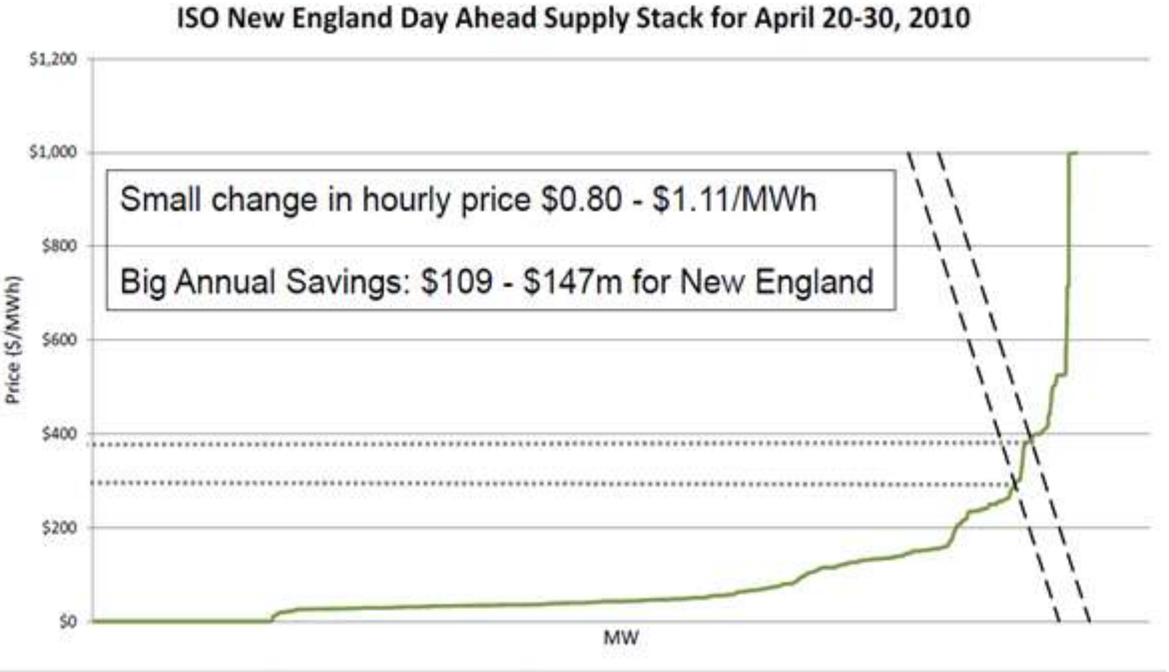


Figure 3: Basis for estimating demand response induced price effects in wholesale energy markets (Hurley 2012)

The second category of market price benefits comes from allowing demand-side measures such as energy efficiency to participate in competitive resource procurement. The potential for energy efficiency to out-bid new supply has been demonstrated through several rounds for Forward Capacity Market (FCM) auctions conducted by independent system operators in the US. Energy efficiency has accounted for over half of total resources acquired in several FCM auctions (ISO New England 2011). However a systematic analysis of how energy efficiency has affected FCM auction prices has not yet been performed.

Resource portfolio benefits

Integrated Resource Planning (IRP) studies directly estimate the financial benefits of demand side measures by comparing the difference in total utility costs between a “base case” and a “demand side case” resource plan. A variety of different “demand side cases” makes it possible to gauge the benefits of different portfolios and choose one which minimizes the net present value of the revenue requirement (e.g., the least-cost plan). Incorporating probabilistic techniques such as dynamic modeling and portfolio analysis into the IRP process brings additional benefits, allowing the physical and financial hedging value of demand side resources during “stress years” to be captured and the impact of different resource mixes under distinct scenarios to be modeled (Eckman 2012; Northwest Power Planning Council 2010). These IRP methods are still based on capturing the in the net present value of total levelized annual revenue requirements over the forecast period.

Of interest from a multiple benefits perspective is the potential of these methods to capture the risk reduction or hedge value of energy efficiency as distinct from supply-side resources. The integrated regional resource planning methods of the Northwest Power Planning Council have isolated this benefit. Fully one-third of the regional resource stack is comprised of energy efficiency, the result of thirty years of integrated resource planning. The latest (Seventh) Electric Power and Conservation Plan calls for energy efficiency to increase, to replace coal-fired power plants scheduled for retirement in 2020. The portfolio analysis approach has revealed that not only is energy efficiency the least-cost resource available, it is also the least-risk resource, as energy efficiency avoids GHG emissions while providing option value by delaying the need for new generation build decisions (See Figure 4).

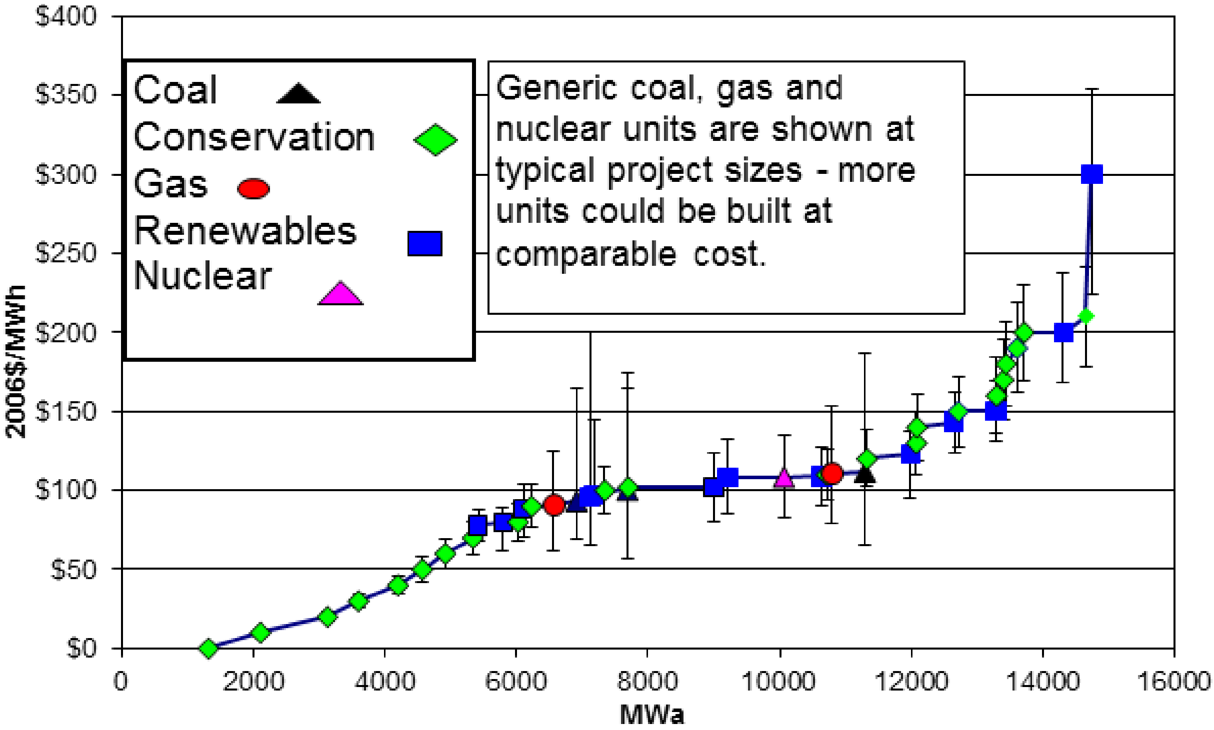


Figure 4: NWPPC Seven Electric Power and Conservation Plan – Cost and Risk Evaluation (Eckman 2012)

The hedging value of energy efficiency emerges from combining the results of scenario analysis using distinct scenarios – high growth/low growth, normal weather/abnormal weather, high carbon price/low carbon price, and high energy price/low energy price. Scenario results found that the pace of energy efficiency development does not vary significantly between least-cost and least-risk scenarios, nor does it depend on climate policy assumption. It also leads to the lower future consumer energy bills. At present these hedging benefits of energy efficiency are captured in a qualitative way in the selection of the optimal resource portfolio, but it may be possible to express this hedging value in monetary terms.

Estimation approaches and issues

The most common approach to estimating energy efficiency benefits for energy providers and their customers are the avoided costing approaches embodied in standard practice manuals such as the California Standard Practice Manual (SPM). These methods evaluate the impact of demand-side programmes on the utility's cost of business using the revenue requirements method. Many of the multiple benefits described above – operating cost savings, the value of deferring network additions, even the hedging value of resource portfolios – can be estimated using some variant of the SPM and the revenue requirement method. The revenue requirements method is resilient and flexible because it is basic, considering changes to the Net Present Value (NPV) of an energy provider's stream of levelized annual revenue requirements (LARR) over the relevant forecast or evaluation period. The revenue requirements method makes it possible to compare the effects of any specified alternative on capital budgets and operating budgets expressed on a common basis and take into account the time value of money (Sullivan Wicks, and Luxhoj 2005).

Some benefits are not amenable to the revenue requirement method, and new approaches are needed. The use of market simulations to estimate demand-response induced price effects and use of portfolio analysis to identify risk hedging benefits are two emerging approaches. Numerous evaluations have been carried out for one or more of the multiple benefits describe above, adapting the evaluation approach to the nature of the benefit (See Table 1).

Table 1: Energy provider and customer multiple benefits evaluation approaches (Heffner 2009)

Source of Benefits	**Evaluation Approach**	**Estimation Methododogy**	**Reference**
Customer operations cost reductions	Operating cost savings	Direct analysis of utility operating budgets	Mass DPU 2008 Howatt & Oppenheim 1999 Skumatz and Dickerson 1998 Skumatz 2011
	Revenue impacts	Net-back analysis of how energy providers can capture bad debt write-offs through energy efficiency	Colton 2011
Deferring network additions	Network Planning Approaches	Direct analysis of revenue impacts; estimated hedge value of improved decisions	Gazze and Mazarlian 2011 Craft 2012 Neme and Sedano 2012
Demand response induced price effects	Market clearing price differentials	Market simulations	Brattle Group 2007; Synapse Economics 2008; Hurley 2012
Reduced resource portfolio cost and risk	Analysis of alternative long-term resource plans	Net present value (NPV) of utility levelized annual revenue requirements (LARR) under multiple alternative weather and availability scenarios using a portfolio analysis approach	Eckman 2012 NW Power Planning Council 2010

Conclusions

Energy efficiency delivered by energy providers is forecast to double over the next five years in North America, Australia and the European Union (Heffner 2012). Other governments are also beginning to call on energy providers to lead the delivery of comprehensive, cost-effective energy efficiency programs which preserve company profitability.

A considerable body of work has begun to explore the benefits of energy efficiency programs to energy providers. These benefits are relatively modest by themselves, but taken together approach the magnitude of direct energy benefits (see Table 1). Of course the relative magnitude of multiple benefits varies widely accordingly to the programme design, type of customers, whether the programme is targeted, and the particulars of the energy provider itself.

Table 2: Magnitude of energy efficiency programme multiple benefits for energy providers

Multiple Benefit Category	**Potential magnitude relative to energy benefits**	**Source**
Customer operations cost reductions	10%	Howatt & Oppenheim 1999 Skumatz and Dickerson 1998
Deferring network additions	25%	Craft 2012
Demand response induced price effects	33-50%	Hurley 2012
Reduced resource portfolio cost and risk	N/A	NW Power Planning Council 2010

It is important to note that some benefits are affected by electricity market structure. In particular, the potential for market price benefits exists only in regions with organised energy markets and where demand-side measures such as energy efficiency can compete with supply-side options in energy and capacity markets. Similarly, forward capacity markets do not yet exist even in regions with wholesale energy markets.

Based on this review some priorities for evaluation research into energy provider multiple benefits of energy efficiency can be suggested:

1. Existing standards such as the California Standard Practice Manual needs to be updated to accommodate multiple benefits. It is entirely possible to continue using the SPM platform with augmentations that extend the embedded avoided cost methods to capture other benefit categories and broaden the economic test perspectives to capture the additional market participants created by market liberalization.
2. The evaluation methodologies for DRIPE are in a state of flux, with no single approach dominating. Estimating market benefits is a big job, requiring an economic supply model of the wholesale power market. It would be worthwhile to collate and compare the different estimation methods used in far-flung forums such as customer infrastructure “business cases” filed in support of smart meter deployments. Possible research approaches include simulating California market conditions using tools such as the Dayzer curve or developing an Option Value formulation for DR using power market data from Platts or other comparable sources.
3. Additional potential benefits, such as risk mitigation in the resource plan, need to be examined more closely. Some analysts have suggested that an additional justification for making energy efficiency first in the resource loading order is that it has inherently less risk

associated with its deployment than any supply-side option. However this resource plan risk mitigation benefit has not been analyzed or quantified.

4. Relating energy efficiency to demand response benefits. Although energy efficiency is not dispatchable in the same way as demand response, there may be characteristics of certain energy efficiency measures which increase the inherent resiliency of the power system. This needs to be studied further using load modeling approaches and weather sensitivity analysis.

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