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Market-based Instruments for Energy Efficiency

Policy Choice and Design

INTERNATIONAL ENERGY AGENCY

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Executive summary

Finding ways to unlock more energy efficiency is a priority for countries looking to meet their energy policy goals. Efficiency is central to making progress on decarbonisation and energy security, while also fostering economic and social development. At the same time, many market failures are holding back the realisation of the full potential that energy efficiency offers. For these reasons, there is growing interest in the role that markets can play in delivering cost-effective efficiency gains and reducing the need for direct government expenditure. At the Kitakyushu Energy Ministerial Meeting in 2016, G7 countries recognised energy efficiency as the "first fuel" and asked the International Energy Agency (IEA) to undertake research into market-based instruments (MBIs), such as energy efficiency obligations and auctions.[1] In response to that request, this report provides the first global overview by the IEA of the growth in the use of MBIs; their impact; and the key policy design issues associated with their successful implementation.

MBIs offer the potential for policy makers to access more cost-effective efficiency gains. All energy efficiency policy instruments interact with the market to some extent, whether by influencing investment decisions or affecting the way in which we consume energy. What distinguishes MBIs from other instruments is that, by giving market actors the freedom to choose the measures and delivery routes that work best for them, the market as a whole is able to discover the most cost-effective way to achieve the outcomes set out by policy makers.

Box ES.1• Defining MBIs for energy efficiency

MBIs for energy efficiency set a policy framework specifying the outcome (e.g. energy savings, cost-effectiveness) to be delivered by market actors, without prescribing the delivery mechanisms and the measures to be used.

The MBIs investigated in this paper can be divided into two main categories: obligations (including white certificate programmes and energy efficiency resource standards), where energy utilities are required to deliver efficiency outcomes; and auctions (including tendering programmes), where bids are invited for funds to deliver efficiency outcomes. Also, among the auction mechanisms investigated are forward capacity auctions that allow energy efficiency to compete against other supply- and demand-side resources to meet energy system adequacy requirements.

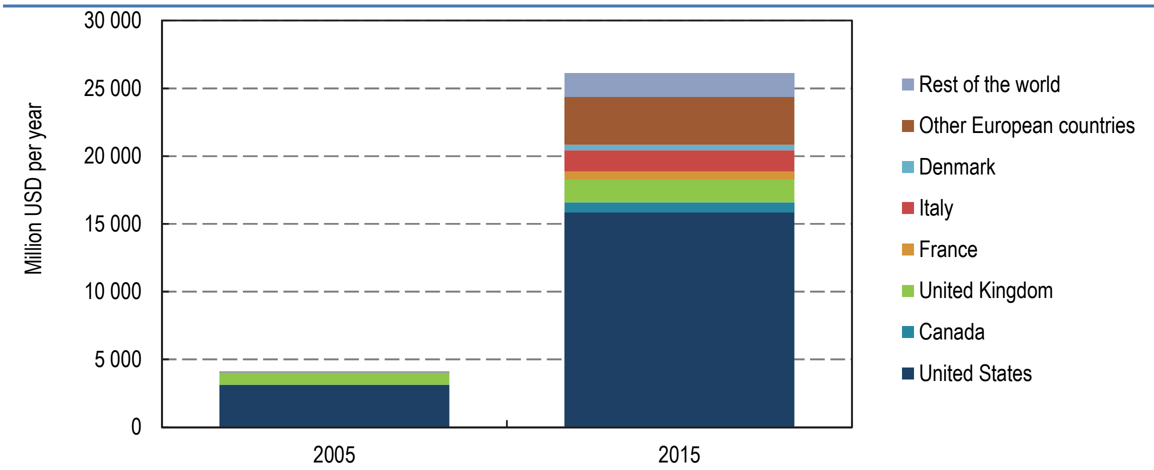
The number of MBIs has quadrupled over the last decade. In 2005 there were no energy efficiency auctions and only 13 obligations: seven in the United States, four in Europe and one each in Brazil and Korea. By 2016, 52 MBIs were in place, with 24 US States, 12 European countries, four Australian States and Territories, Brazil, Canada, China, Korea, South Africa and Uruguay all employing obligations, and energy efficiency auctions operational in six US and European jurisdictions.

The amount of investment generated by MBIs has increased six-fold over the last ten years. The increase in the number of MBIs, allied with an increase in their ambition, has seen a substantial increase in the expenditure by obligated parties and auction winners on energy efficiency. The total amount of efficiency investment generated varies by MBI, with programmes focused on low-income households tending to have the lowest leverage effect,[2] and those featuring more measures in the industrial sector having the highest. Total investment stimulated by MBIs was around USD 26 billion in 2015 (Figure ES.1), accounting for 12% of the USD 221

[1] The Group of Seven (G7) countries are: Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.
[2] Given that their main policy imperative would be to deliver energy efficiency outcomes to households that are less able to fund measures.

billion invested in energy efficiency globally (IEA, 2016). Of the investment stimulated by MBIs, just under half was provided by energy utilities and payments to auction winners.

Figure ES.1 • Investment stimulated by market-based instruments



Note: USD are in real terms. "Other European countries" are Austria, Belgium (Flanders) Bulgaria, Germany, Ireland, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovenia, Spain and Switzerland. "Rest of the world" is Australia, Brasil, China, South Africa and Uruguay.

Sources: IEA analysis based on ANEEL (2016b); Berg et al. (2016); BfE (2014); BMWi (2016); China Southern Power Grid Company (2015); Crossley (2016); DECC (2016a, 2016b); Durkan (2016); Eskom (2015); IEA (2016); IESO (2015); ISO-NE (2015); Kulevska (2016); Peña (2017); PJM (2016a); Rosenow and Bayer (2016); Sousa et al. (2015); State Grid (2016); Vendramin (2016); Winkler (2015).

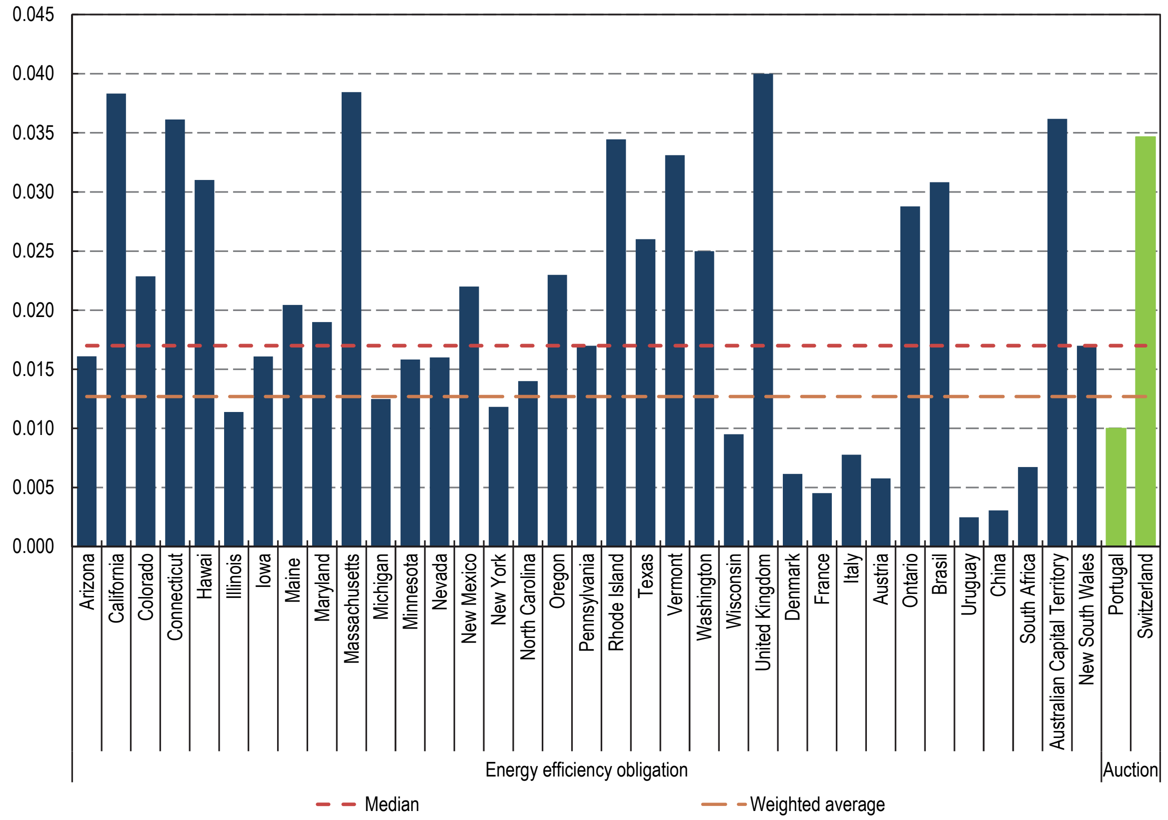
MBIs are saving significant amounts of energy for less than the cost of supply. In the most ambitious jurisdictions, cost-effective savings of 3% of annual electricity consumption are being generated each year, reducing consumer energy bills and the investment required on the supply side. As a result of a decade of investment through MBIs, world energy consumption was 1.5 EJ (exajoules) lower in 2015 than it would otherwise have been. If the current programmes maintain their level of ambition over the next decade, by 2025 this impact will double to 3 EJ, more than the current final energy consumption of Poland. Owing to a lack of evaluation evidence, there is no conclusive proof that, in practice, MBIs deliver efficiency outcomes more cost-effectively than equivalent options, such as grants allied with information programmes. Indeed, much of the best evidence is focused on MBIs in the United States, driven by the need to prove to regulators their cost-effectiveness. However, experience has shown that opening delivery channels to market discipline, supported by strong monitoring and verification has enabled efficiency gains to be made at a cost well below the typical cost of supplying energy. Across all programmes for which data are available, the average total cost per lifetime kilowatt-hour (kWh) saved is less than USD 0.03 (United States dollar). This is before taking into account the significant environmental and socio-economic benefits that energy efficiency also brings.

There is considerable variation in programme costs among MBIs.[3] The latest available data show that expenditure by obligated parties and payments to auction winners (programme costs) averages around USD 0.013 per kWh saved (Figure ES.2). The wide variation in programme costs can be explained by a number of factors, including ambition, policy focus, overlap with other instruments and approach to measurement. In the United States the more ambitious programmes, such as those in Rhode Island, Massachusetts, Vermont and California, have pushed delivery beyond the cheapest options, delivering greater savings but at moderately higher cost. In some jurisdictions, for example Brazil and the United Kingdom, the programmes have a strong

[3] Programme costs are the costs borne by obligated parties and the funds given to auction winners. Total costs include both the programme costs and the leveraged investment costs borne by participating consumers.

focus on fuel poverty, limiting the scope for savings and reducing the delivery options open to participants. In others, for example France, the ability to combine funding from the obligation programme with tax credits has reduced the cost to obligated parties. Furthermore, across the programmes analysed, there are different approaches taken to evaluating the energy savings resulting from energy efficiency measures, with varying degrees of rigour regarding the attribution of savings to defined programme activities.

Figure ES.2 • Expenditure by obligated parties and payments to auction winners per unit of energy saved (USD/kWh lifetime savings)



Sources: ANEEL (2016b); Berg et al. (2016); BfE (2014); BMWi (2016); China Southern Power Grid Company (2015); Crossley (2016); DECC (2016a, 2016b); Durkan (2016); Eskom (2015); IEA (2016); IESO (2015); Kulevska (2016); Ministerio de Industria, Energía y Minería (2016); Peña (2017); Rosenow and Bayer (2016); Sousa et al. (2015); State Grid (2016); Vendramin (2016); Winkler (2015).

MBIs put a premium on good policy design, including strong monitoring, verification and evaluation. The benefits of MBIs relative to other policy instruments stem from the freedom that private sector actors have to innovate and discover the technologies and delivery routes that work best in the market. The risk for policy makers is that, if designed or implemented poorly, the market will find ways to "game" the system or to focus delivery of the specified outcome in ways that policy makers would prefer to avoid, for example in cases where consumers received compact fluorescent lightbulbs that remained unused. This risk can be mitigated by good policy design, informed by high quality monitoring, verification and evaluation, including regular reviews to take account of changing market conditions. However, imposing too many restrictions on the choices available to market participants weakens the ability of MBIs to take advantage of the power of market forces.

Key policy design issues

MBIs must work within existing policy frameworks. They require supporting measures such as technical standards to function well and should interact with other policy instruments in a way that enhances the overall policy mix. For example, MBIs generally reward savings above minimum energy performance levels, thereby pulling the market towards even better technologies. In passenger transport, the scope for MBIs to make additional savings is limited to more behavioural measures, given that average new vehicle outcomes are already prescribed in corporate average fuel economy standards in many jurisdictions. Care also needs to be taken to make sure that grants, tax exemptions and other public subsidy programmes for energy efficient technologies are compatible with MBI programmes. In many cases, measures supported by public subsidies are not allowed to be counted towards the achievement of market-based instrument objectives. However, in some cases this has been allowed, for example in France, where recipients of some energy efficient technologies can receive a tax rebate as well. Policy instruments such as capacity auctions and emissions trading systems can co-exist successfully with MBIs, reducing the costs of delivering system adequacy and environmental goals, but experience shows that these complementary markets are insufficient, on their own, to drive the uptake of cost-effective efficiency potential.

Both obligations and auctions can be successful if the rules are well crafted. There is no conclusive evidence that one is better than the other and indeed in some cases they are combined, for example in Texas where the obligated party conducts an auction in order to generate the savings required. There is, however, considerably more evidence available on effective policy design for obligation programmes. The fundamental question is whether to prescribe the savings target (obligations), the total funding level (auctions), or both (obligations on regulated monopolies). Programme funding and the pace of energy savings are likely to be more stable if funds are raised as part of energy companies’ cost of service rather than as a governmental budget line that would be more open to annual political review.

Flexible programme design that permits savings to be delivered across a broad range of customers and fuels has proven to be a sound approach. Providing more choice to obligated parties and auction bidders increases the likelihood that the most cost-effective options will be discovered. Policy objectives, however, may make it sensible to limit options, for example where fuel poverty concerns are important (Ireland and the United Kingdom), or where it is important for a regional monopoly to be delivering benefits to local customers (as in many US States).

MBIs can be designed to achieve specific policy goals (e.g. longer-lived energy savings or deep retrofits) through incentive structures including minimum energy savings' requirements, limits on the installation of technologies with shorter lifetimes, greater rewards for deeper savings and the use of additional funding streams. Rewarding measures for the outcomes they are expected to deliver over their lifetimes, as opposed to in one year, is an important step in ensuring that longer-lived measures are treated fairly.

Programme rules should be as simple as possible but as complex as necessary. Most MBIs use “deemed savings” to measure at least some of the savings, whereby the delivery of measures is assumed to lead to a particular level of savings without needing to check each installation. The deemed savings method is a low-cost approach to savings calculations, and can capture average impacts if derived through a robust methodology, incorporating periodic updates informed by *ex post* evaluation. Where more complex and bespoke interventions take place, metered savings and engineering calculations tend to be used. The digitalisation of the energy sector is making metered savings a feasible low-cost option in more circumstances; increased use of metering will ensure more accurate measurement of savings at the individual project level.

Monitoring, verification and evaluation is vital for the integrity of programmes. Independent monitoring, verification and evaluation allows for more accurate calculation of impacts, can feed into regular policy reviews and provides confidence to participants, policy makers and the public. This can contribute to a self-sustaining policy framework that earns public trust, supports growth along the energy efficiency supply chain, and allows utilities and system operators to plan for lower long-term demand, avoiding some investment in supply-side assets. Rigorous and transparent monitoring, verification and evaluation are especially vital when system operators rely on the efficiency resource to meet reliability objectives. Efficiency programmes have satisfied this test and have been cleared to participate in capacity markets in the United States, where verification requirements for both supply- and demand-side resources are quite strict.

Trading adds an additional layer of complexity and sometimes extra cost to obligation programmes that may exceed the benefits. In some obligation programmes, compliance can be traded in the form of "white certificates", which can be generated by third parties and traded through intermediaries or on spot markets, the only liquid example of which is in Italy. This system is most beneficial where there are many obligated parties or efficiency supply businesses, putting greater emphasis on price transparency. The additional costs associated with managing a trading system need to be set against this benefit. However, if these costs are covered by the transacting parties, trading is unlikely to add overall costs to the programme.

Auctions can be structured to mitigate the risk of overpayment and reduce administration costs. In both Germany and Switzerland price caps have been put in place through maximum payments per kWh and by setting maximum contributions from the auction to project costs. In addition, if fewer bids are put forward for consideration, the programmes only accept a maximum proportion of bids (e.g. 80% in Switzerland). Allowing multiple projects to be bundled into programmes is commonly used to enable smaller measures to take part without excessive administration costs. In Germany, a maximum size criterion is applied to ensure that funds are not concentrated in too few projects.

Capacity auctions reward energy efficiency for one of the multiple benefits they provide, but cannot be relied upon to drive the uptake of efficiency on their own. The only auctions where there is direct competition between supply- and demand-side resources are two of the capacity markets in the United States, where only efficiency resources with an additional revenue source have been able to bid at competitive prices. In New England for example, 99% of the winning efficiency measures were expected to be funded through obligation programmes and the level of funding generated through the capacity auctions represented only around 10% of the expenditure by obligated parties. There is considerable policy interest in the scope for capacity auctions to drive efficiency gains and the report considers the need both to ally such measures with other funding sources and to ensure that auction rules enable efficiency to compete on an equivalent basis with supply-side resources.

Outlook for market-based instruments

The coverage and strength of MBIs is expected to grow. A number of factors point to a continuation of the trend seen over the last decade. More jurisdictions are considering obligations and auctions as ways to engage markets to deliver the efficiency savings needed to meet policy goals, whether they are energy system adequacy requirements, climate commitments, energy poverty reduction or industrial productivity. In the EU for example, the European Commission has recognised the potential of obligations and promoted them as a way of meeting energy savings targets to 2030. Sharing knowledge across jurisdictions will be central to the success of the next wave of policy development, given the importance of good policy design in this area, and the diversity of experience across the world.

Introduction

There is increasing interest in market-based instruments (MBIs) to deliver energy efficiency. The introduction of the Energy Efficiency Directive (2012/27/EU), for example, has led to an increase in the number of MBIs across the European Union, with 16 Member States now implementing them.[4] In the United States, an increasing number of States employ MBIs, with many increasing their level of ambition. Countries in Asia and Latin America also show increased interest in MBIs and there are long-standing programmes in place in Australia, Brazil, China, Korea and South Africa.

There are three main reasons for the popularity of MBIs among policy makers:

- By harnessing market forces through competition and private sector profit-maximisation, energy efficiency improvements can (in principle) be delivered more cost-effectively.
- MBIs are less prescriptive than traditional regulatory and financial instruments as they focus on the outcome (e.g. energy savings) rather than the means (e.g. technology, delivery methods), thus driving innovation and cost reductions.
- In most cases, MBIs do not appear on government balance sheets (if financed through obligations on energy companies).

There are of course also risks associated with MBIs:

- MBIs encourage the cheapest possible efficiency improvements, sometimes in ways that policy makers do not foresee. If not designed carefully, MBIs can lead to outcomes that do not fully match policy objectives. However, imposing too many restrictions on the choices available to market participants weakens the ability of MBIs to take advantage of the power of market forces.
- Where MBIs are funded through obligations on energy companies, the costs are usually passed through to end users through increases in energy prices. This raises concerns as to whether they have a regressive impact, though it depends on a number of other variables too, such as the energy costs avoided, whether the programme lowers system clearing prices, and the participation rate of low-income households (State and Local Energy Efficiency Action Network, 2015). MBIs could require additional policy measures to minimise any regressive effects, particularly if the benefits are not spread widely across the customer base.

MBIs typically serve a set of objectives rather than just cost-minimisation. For example, they may be employed to address social equity and energy costs as well as to reduce carbon emissions. The potential tension among those different objectives is often reflected in the design of MBIs.

This report provides the first global assessment of the impact of MBIs for energy efficiency by the IEA, both in terms of investment and energy savings, analysing 52 instruments from across the world. It shows the increasing importance of MBIs in number, geographical coverage, energy savings and investment. Furthermore, the report analyses the critical design features of a selection of 20 case studies and evaluates best practice as well as the contextual diversity in which those instruments operate.

[4] The European Commission's proposed package of measures "Clean energy for all Europeans", released in November 2016, proposes an extension of the current policy framework to 2030 and beyond (EC, 2016). If adopted, this may lead to a similar level of ambition in terms of energy savings and continue to be a driver for MBIs in the European Union.

Definition of MBIs for energy efficiency

The term MBIs originates from the environmental economics literature, where it is used to describe policies that harness market forces to achieve environmental goals (Stavins, 2003). MBIs for energy efficiency "use market forces to minimise the cost of saving energy" (Farinelli, 2005). The following definition of MBIs for energy efficiency will be used in this report:

Box 2• Definition of MBIs

MBIs for energy efficiency set a policy framework specifying the outcome (e.g. energy savings, cost-effectiveness) to be delivered by market actors, without prescribing the delivery mechanisms and the measures to be used.

Following this definition, MBIs are distinct from other energy efficiency programmes, which typically prescribe the *means* for delivering savings, i.e. the types of technologies or interventions that are supported, as well as the levels of support provided (Bertoldi, 2013). MBIs as defined here specify the *outcome* that has to be achieved (energy savings) without prescribing the means through this is achieved (as long as those means meet the eligibility criteria for the programme).

Two broad programme types fit well with this definition and are included in the analysis for this report:

- Energy efficiency obligations (including white certificate programmes and energy efficiency resource standards in the United States), which require utilities to carry out a defined level of activity delivering energy savings but leave it to them to find the best delivery routes for doing so.
- Auction mechanisms (including tendering programmes and forward capacity auctions), which allow market actors to put forward bids either in competitive tenders where the lowest bid wins, or within a framework setting the price per unit of energy savings inviting proposals to deliver savings at that price.

Some programmes have not been included in the analysis that nevertheless could be considered MBIs, such as India's Perform, Achieve and Trade (PAT) scheme (Box 2). Each of these programmes (that are still different in nature from the two categories above) has been considered and excluded for one reason or another. In the case of the PAT scheme, for example, it was deemed too different to compare with the others because the obligations are placed on the end user and not the utilities.

It is common for MBIs to use a range of criteria when selecting energy efficiency projects (quality, technology, location, etc.). For example, the Portuguese tendering mechanism uses several criteria for ranking bids, with the main difference compared to standard public tendering procedures being the explicit use of the metric USD/kWh as a key criterion.[5]

[5] The Portuguese Energetic Services Regulatory Authority launched the Plano de Promoção da Eficiência no Consumo de Energia Elétrica (PPEC) in 2007, which is a competitive tendering mechanism for energy efficiency projects. It tenders biennially for energy efficiency projects seeking co-financing from PPEC. A range of eligible promoters (suppliers, network operators, consumer or business associations, academic institutions and others) can tender. The projects are selected by means of a competitive process and based on a comprehensive cost-benefit analysis.

Box 3 • Energy savings certificates under India's Perform, Achieve and Trade programme

The first cycle of India's PAT programme (2012-15), a mandatory market-based trading instrument, managed to reduce the energy consumption of more than 400 energy-intensive enterprises ("Designated Consumers") by 5.3% - more than the initial programme target of 4.1%.

The trading of energy saving certificates (ESCerts) is central to the PAT programme and serves as an incentive to reach or surpass the mandatory targets. The ESCerts, equivalent to 1 tonne of oil equivalent (toe) of energy savings, are given based on quantified energy savings verified by an accredited energy auditor. The ESCerts are awarded after a designated consumer (DC) surpasses its target and can then be sold to another DC that has failed to achieve its target, with the price determined through market supply and demand. The ESCerts can also be banked to contribute towards meeting future targets as the PAT programme expands. While until now no ESCerts had been traded, trade will commence later in 2017. However, demand for ESCerts is expected to be relatively low, given that about 3.8 million ESCerts have been issued, of which about 1.5 million need to be absorbed by the DCs who are falling short of targets.

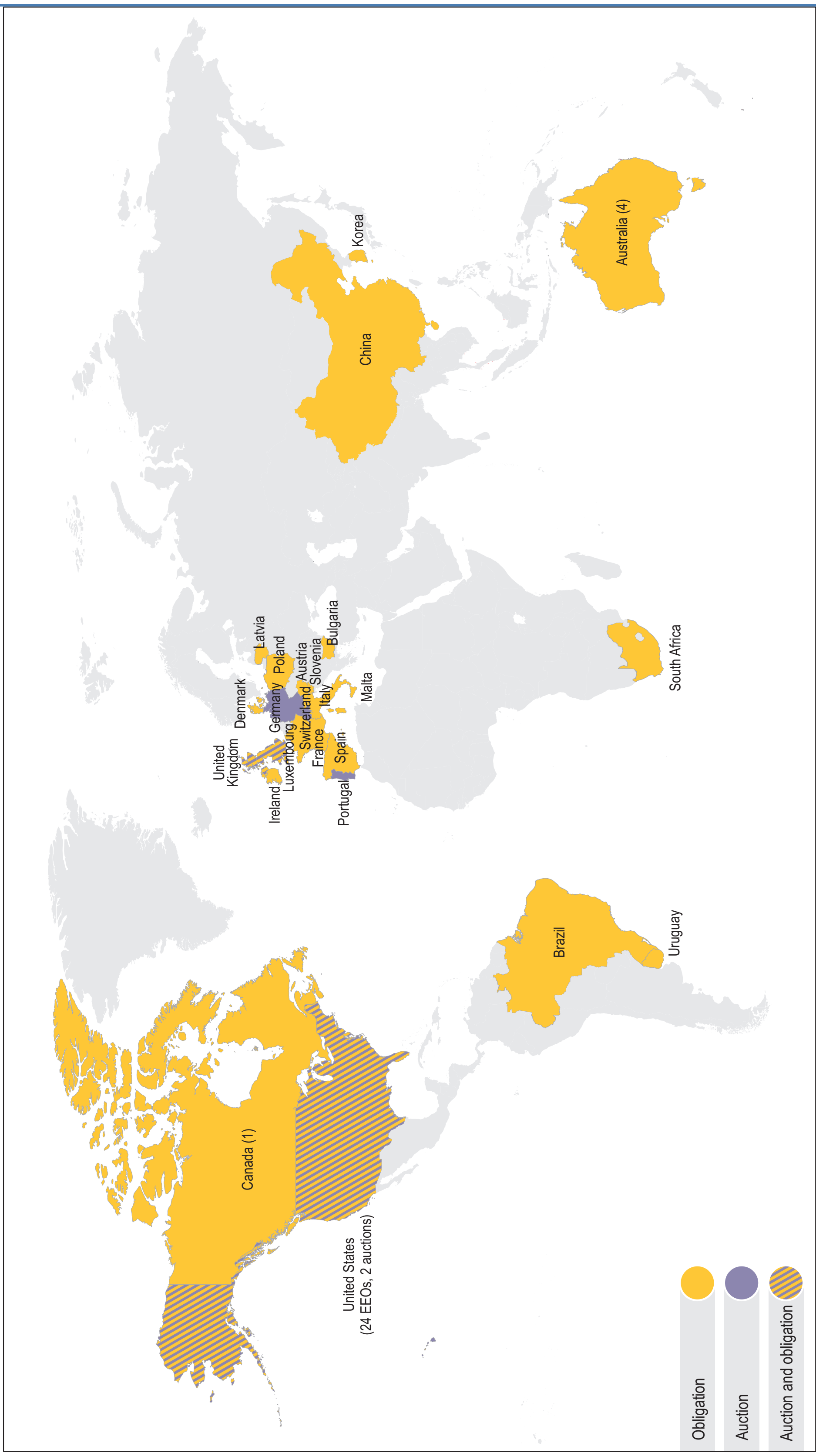
The penalty for non-compliance is INR 1 million (about USD 16 000) plus the value of the energy savings that have not been obtained by the DC. For the second PAT cycle (2016-19), coverage will be extended to other DCs and sectors, bringing the total to over 600 DCs including petroleum refinery, electricity distribution and railways. The Indian government has also created financial instruments to support the DCs covered under the PAT programme, such as the Partial Risk Guarantee Fund for Energy Efficiency and the Venture Capital Fund for Energy Efficiency. As the low-cost measures start being implemented, this additional support will assist DCs to invest in higher-cost energy efficiency measures.

MBIs for energy efficiency: Status and trends

Number of MBIs

There are now around 46 energy efficiency obligations across the globe: 24 in the United States, 12 in Europe (Austria, Bulgaria, Denmark, France, Ireland, Italy, Luxembourg, Malta, Poland, Slovenia, Spain and the United Kingdom) with another three due to start shortly (Croatia, Greece, Latvia), four in Australia, and one each in Canada, China, Brazil, Uruguay, Korea, and South Africa (Figure 1). In addition, there are six auction mechanisms, of which two are in the United States, and one each in Switzerland, United Kingdom, Portugal and Germany. Note that some obligated parties use auctions as a procurement mechanism (e.g. Brazil, South Africa and Texas). In this report, those mechanisms are treated as obligations, given the focus on decisions taken by government policy makers.

Figure 3 • Global coverage of MBIs for energy efficiency

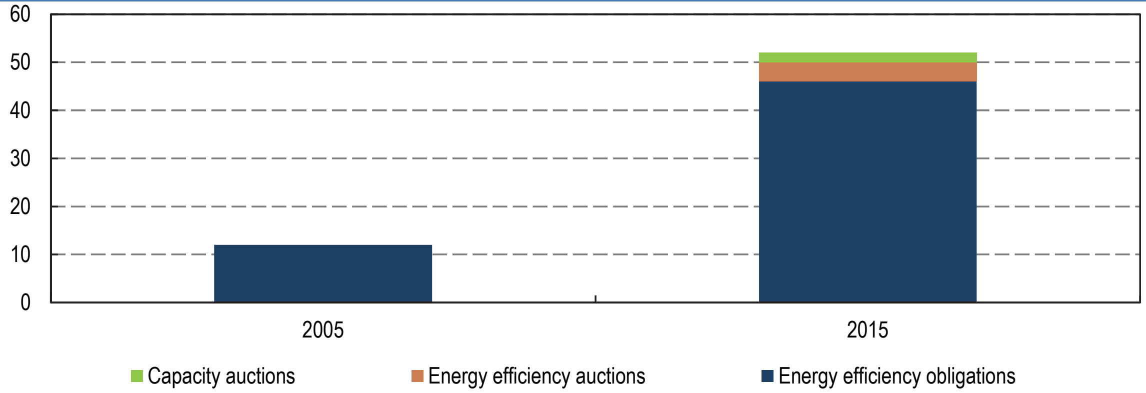


This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Sources: ACEEE, 2016; ANEEL, 2016a; BfE, 2014; BIGEE, 2016; BMWI, 2016; DECC, 2015; EC, 2017; Energy Efficiency Exchange, 2016; IESO, 2016; Lees, 2010; Neme et al., 2014; RAP, 2012; Rosenow, Fawcett, Leguijt et al., 2016; Sousa et al., 2015; State Grid, 2016.

The number of MBIs has quadrupled over the last decade (Figure 2). Ten years ago there were only 13 obligations, of which seven were in the United States, four in Europe, one in Brazil and one in Korea (Downs et al., 2014; ENSPOL, 2015; Broc et al., 2012; RAP, 2012).[6] No auction mechanisms have been identified that were in existence ten years ago.

Figure 4 • Number of MBIs identified, 2005 and 2015



Sources: ACEEE, 2016; ANEEL, 2016a; BfE, 2014; BIGEE, 2016; BMWI, 2016; DECC, 2015; EC, 2017; Energy Efficiency Exchange, 2016; IESO, 2016; Lees, 2010; Neme et al., 2014; RAP, 2012; Rosenow, Fawcett, Leguijt et al., 2016; Sousa et al., 2015; State Grid, 2016.

In the European Union, the Energy Efficiency Directive triggered several new obligations. Before the Directive, only five obligation programmes existed in the European Union, whereas 12 were operational in 2015 and a further two are about to start (Fawcett et al., 2016).

Future prospects

Many member countries of the EU and the wider Energy Community[7] may choose to put energy efficiency obligations in place as part of implementing the Energy Efficiency Directive. Bosnia and Herzegovina for instance is developing such plans (USAID, 2015).

Utility spending on energy efficiency in China could increase in the coming years if demand-side management (DSM) and energy efficiency expenses are allowed as costs in setting prices for transmission and distribution. While it depends on the implementation details, breaking the regulatory link between electricity sales and grid company revenues may open up greater opportunities for grid companies to support energy efficiency and DSM (along the lines of pricing reform pilots) (Central Committee of the Communist Party and State Council of China, 2015).

Thailand is considering the implementation of an obligation programme (Suerkaemper et al., 2014). The 20-year Energy Efficiency Development Plan aims to reduce energy intensity (energy consumption/GDP) by 25% compared to 2010 (equivalent to the reduction of final energy consumption by 23.5% in 2030). According to the plan, an obligation is one of the key measures to achieve this goal.

[6] Energy efficiency programmes have been delivered by some electric and gas utilities in the United States since the 1970s, and as early as 1990 some States (e.g. Vermont) required utilities to acquire all cost-effective efficiency resources (VTPSB, 1990). The first purely numerical target was adopted by the state of Texas in 1999.

[7] The Energy Community consists of the 28 EU Member States and contracting parties (Albania, Bosnia and Herzegovina, Kosovo, the Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Serbia and Ukraine). Georgia is a candidate and Armenia, Norway and Turkey are observers. Note on Kosovo: This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo's declaration of independence.

Box 4 • Brooklyn-Queens interconnection

Market-based Instruments for energy system resources, including energy efficiency, can be used to avoid not just generation capacity and energy costs, but also transmission and distribution network expenses. A leading example is taking place in New York City, where the local distribution utility, Consolidated Edison, is investing USD 200 million in customer-based efficiency and other distributed resources in order to avoid or defer substation and feeder upgrades that were expected to cost USD 1.2 billion.

The Brooklyn-Queens Demand Management (BQDM) programme was launched in 2014 to avoid or defer very expensive substation additions and feeder upgrades in Brooklyn and Queens, two rapidly-growing parts of New York City. Consolidated Edison sought permission from the New York Public Service Commission to conduct an open solicitation for demand-side solutions to reduce load by at least 52 MW for periods as long as 12 hours per day in peak summer days. Through an open "Request for Information" it proposed to "seek multiple solution providers so that multiple approaches and technologies can be evaluated to determine the best aggregate solutions." (State of New York Public Service Commission, 2014). In BQDM, the utility is building on previous experience with "targeted demand side management" in which distribution system upgrades were avoided or deferred using auctions to acquire demand reductions from third parties; in those cases 95% of the reductions came from installing energy efficient lighting, and price alone was the determining factor in the solicitation. However the BQDM is including a broader array of winning solutions, which are being evaluated on a multi-factor scoring system. As of the 4th quarter of 2016, the utility reported that it expects to achieve a large portion of the needed load relief through installation of efficiency measures at over 3 700 small businesses, 1 000 multi-family buildings, and 2200 residences in the community (Consolidated Edison, 2016). In addition to avoiding the capital cost of the network upgrades, efficiency investments also benefit the participating customers; Consolidated Edison reports that the 3 700 participating small businesses will each save an average of USD 3 455 on their power bills each year (Consolidated Edison, 2016). The BQDM program is also supporting distributed generation, demand management, and energy storage solutions, in concert with more traditional utility distribution management techniques.

It is too early to assess the long-term costs and benefits of the BQDM program, which will depend on which traditional system upgrades can be avoided for how long, and which deferrals will become permanent. But this project illustrates that open solicitations of efficiency and other distributed resources can be used to lower costs and quickly address system reliability problems on power distribution networks (Energy Futures Group, 2015).

Genuine auction mechanisms are still small in number but Germany started a new energy efficiency tender mechanism in June 2016 (BMWI, 2016) and Brazil is considering the introduction of an auction for energy efficiency too. Some countries are exploring options to follow the United States in using capacity markets to deliver energy efficiency. The United Kingdom for example started the Electricity Demand Reduction Pilot, an auctioning mechanism alongside the capacity market that supports energy efficiency measures (DECC, 2015).

Box 5 • Germany's competitive efficiency tender

Germany introduced an auction mechanism, the competitive efficiency tender, in 2016. It was implemented as part of the National Action Plan on Energy Efficiency (BMWI, 2014). The three-year pilot project for the competitive tendering scheme in electrical energy efficiency, called STEP up!, has a total budget of USD 333 million.

Projects with the best economic cost-benefit ratio are selected but need to achieve at least USD 0.11/kWh (lifetime) and have a lifetime of at least ten years. The funds provided to the winning bidders cover costs up to a maximum of 30% of the capital costs of the proposed measures. There are two types of tender: open tenders covering all sectors and technologies, and closed tenders covering specific sectors and technologies.

The scheme is funded through the German Energy Efficiency Fund and is being evaluated on an ongoing basis during the programme. An *ex post* evaluation will be conducted in 2018 (IEPPEC, 2016).

Investment through MBIs

State of play

As a result of the growing number of instruments and the ambition of their targets, expenditure through MBIs for energy efficiency has increased by a factor of close to six over the last decade. Approximately 4% of programme expenditure can be attributed to auctions, with the remaining 96% supporting obligations. Programme expenditure represents the cost to the public through surcharges on energy bills or funding derived from general taxation. The amounts do not include the investment made by programme participants (e.g. the beneficiaries that retrofit their building and receive a partial contribution from a programme).

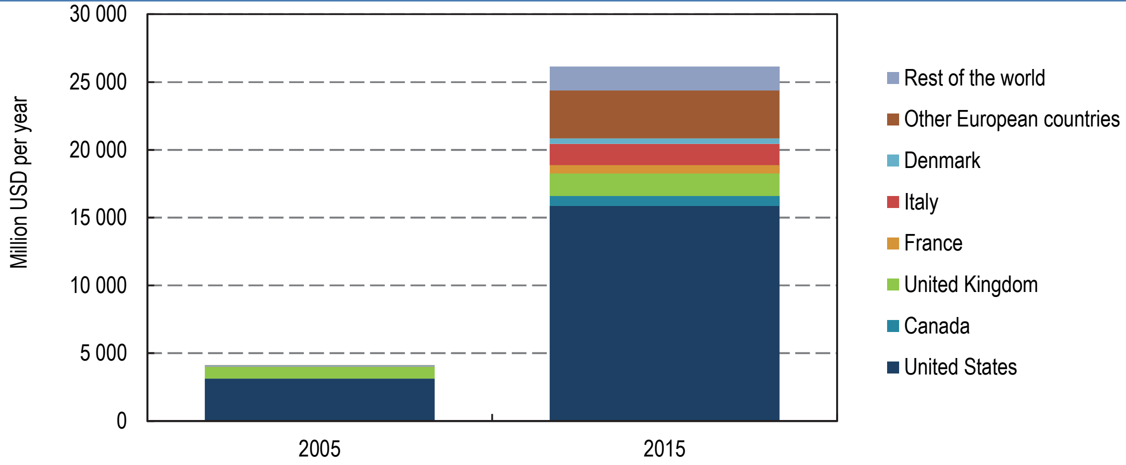
Data on the total investment triggered by MBIs (defined as the sum of programme expenditure and the cost to the participants) are not readily available and would require detailed surveys on the cost to the participants. Instead, total investment can be estimated by applying leverage factors. Typically, the total investment is two to three times the programme expenditure, because programmes leverage additional investments by consumers. A study of several obligations in the United States estimates the total investment at 241% on average of the programme expenditure. This means that, on average, a programme costing utilities USD 1 billion per year results in an additional investment of 1.4 billion by consumers and total investment by society of USD 2.4 billion per year (Molina, 2014). Another assessment for the United States suggests that total investment is twice programme expenditure (Hoffman et al., 2015), with variation across sectors: 174% in the residential sector, 217% in the commercial, industrial and agricultural sector, and only 106% in the low-income residential sector. An investigation in Europe (Rohde, 2015) found the following leverage effects (total investment as a percentage of programme expenditure):

- United Kingdom: 187% of obligated parties' cost (2002-05), 144% (2005-08, residential sector only)
- France: 137% (programme expenditure includes expenditure by Government on tax credit)
- Denmark: 300% of obligated parties' costs (industry sector only).

In the United Kingdom, leverage ratios are also available for able-to-pay and low-income households. In the period 2005-08, total investment was 190% for able-to-pay households and 120% for low-income households, similar to the results for the United States cited above.

The data above suggest that one dollar of public investment triggers around one to two dollars of private investment. Applying these leverage factors to the programme costs of all MBIs operational in 2015, suggests that total investment through MBIs was between USD 23 billion and USD 30 billion, with a central estimate of around USD 26 billion per year.

Figure 5 • Investment stimulated by MBIs



Note: USD are in real terms. "Other European countries" are Austria, Belgium (Flanders) Bulgaria, Germany, Ireland, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovenia, Spain and Switzerland. "Rest of the world" is Australia, Brasil, China, South Africa and Uruguay.

Sources: IEA analysis based on ANEEL (2016b); Berg et al. (2016); BfE (2014); BMWi (2016); China Southern Power Grid Company (2015); Crossley (2016); DECC (2016a, 2016b); Durkan (2016); Eskom (2015); IEA (2016); IESO (2015); ISO-NE (2015); Kulevska (2016); Peña (2017); PJM (2016a); Rosenow and Bayer (2016); Sousa et al. (2015); State Grid (2016); Vendramin (2016); Winkler (2015).

The leverage ratio depends on a number of factors (Table 1). The more aggressive the target and level of ambition, the more difficult it becomes to persuade additional beneficiaries to contribute private capital. Focusing on low-income customers increases the monetary contribution made by the programme. If the additionality requirements are relaxed, it is possible to count savings even from beneficiaries who would have made the investment anyway; this may result in a high calculated leverage ratio but there is a clear trade-off. Finally, the available data indicates that the highest leverage ratios are achieved in the industrial and commercial sectors.

Table 1 • Factors affecting leverage of MBIs

	Leverage ratio low	Leverage ratio high
Aggressiveness of target or ambition level	High	Low
Focus on low-income beneficiaries	Yes	No
Approach to additionality	Stringent	Relaxed
Sectors	Low-income residential sector	Commercial, public and industrial sector

The leverage factors vary by instrument, technology, market segment and geography. A more granular estimation is not possible due to scarce data. Furthermore, no leverage factors for auction mechanisms could be found. It is likely for those to be within a similar range as the beneficiary is presented with a financial incentive sufficient to trigger the investment and is often not aware of the funding mechanism operating in the background. Thus, it makes no difference to the beneficiary whether the financial incentive is provided through an obligation or auction mechanism.

Costs to the programme administrator are not included in the data presented. In general, administrative cost includes the following:

- Allocating the government-set savings target to the obligated parties (only obligations).
- Determining the accreditation process for energy savings.
- Issuing technical guidance on eligible measures.
- Accrediting energy savings.
- Putting in place mechanisms to track any transfer or trade of savings (only obligations).

- Running the tendering process (only auctions).
- Monitoring and verification.

Analysis of European obligations suggests administrative costs of 0.2-1.4% of programme expenditure (Rosenow and Bayer, 2016). The more complex the programme and the more rigour the administrator applies to running it, the higher the administrative costs. For example, among the European programmes, the Italian obligation incurs the highest share of administrative costs, which is most likely a result of the high share of traded certificates and the associated administrative effort. Previous analysis has shown that trading increases the administrative burden due to additional costs in setting up and running trading platforms, although there may be good reasons for including trading provisions in a system with broad sectoral coverage (Bertoldi et al., 2010). The current white certificate programme in Italy sees the costs of trading embedded in fees proportional to the amount of energy savings. This ensures that trading only takes place when it is of value to the participants.

Future prospects

Future investment is difficult to predict because it depends heavily on the policies in place and the calibration of the different MBIs. However, it is likely that the investment levels triggered through MBIs will increase further over the next 5-10 years.

Expenditure by utilities driven by obligations in the United States has been projected to rise to USD 15.6 billion by 2025, an increase by a factor of more than 2.5 compared to 2015 (Barbose et al., 2013). States that have only recently adopted obligation programmes are likely to expand the energy savings targets over time, now that the regulatory framework has been established (as other US States have done in the past). Also, the development of statutory or regulatory requirements that utilities acquire “all cost-effective” energy efficiency are likely to drive an increase in spending. Such requirements require utilities and programme administrators “to define and invest in the highest level of efficiency determined to be cost-effective” (Gilleo, 2014) and MBIs seem to match this definition perfectly.

As discussed previously, the Energy Efficiency Directive means that both EU Member States and members of the Energy Community are likely to introduce new MBIs (mainly obligations but also auctioning mechanisms). Assuming similar levels of programme expenditure to existing obligations, close to USD 100 million will be added by 2020 (based on Rosenow and Bayer, 2016). The Winter Package published in November 2016 proposes that the targets of the Directive (Article 7) remain at similar levels post-2020 (EC, 2016) and means that investment levels need to be maintained in order to achieve those targets. The final ambition level will depend on the negotiations in 2017. Should targets be tightened, the level of investment will have to increase beyond current levels. The Directive’s policy framework provides certainty in the medium term that energy efficiency spending will remain stable or increase further.

Depending on the evaluation of the Electricity Demand Reduction Pilot in the United Kingdom, additional investment for energy efficiency may be mobilised through that mechanism in future. And Germany’s new energy efficiency tender mechanism has a budget of USD 56 million in 2016, USD 112 million in 2017 and USD 168 million in 2018 (BMWI, 2016).

Cost-effectiveness

Data on public investment through MBIs and on savings delivered per year allow calculation of their relative cost-effectiveness. The costs of avoided generation per kWh saved as a result of obligations are particularly useful for comparing such programmes and are commonly used across the world when assessing costs and benefits of energy efficiency programmes (Gillingham et al., 2006). The costs can then be compared to the cost of energy supplied to final customers (megawatt costs).

Drawing conclusions as to the cost-effectiveness of different obligations is challenging as the methodologies used by countries to estimate and report costs and savings are not consistent:

- Some countries discount energy savings whereas others do not.
- Estimates for free-ridership vary across countries.
- Rebound effects are taken into account to different degrees.
- Lifetimes of measures are not always the same.
- Some evaluations are ex-ante, others ex-post. The rigour is not the same across all countries.

Consequently, a number of assumptions had to be made when calculating the savings from specific technologies.

Programme expenditure (costs) and savings data for 37 MBIs around the world have been identified (Figure 6). The median programme cost is USD 0.019/kWh lifetime savings and the average weighted by the reported energy saved is USD 0.013/kWh.

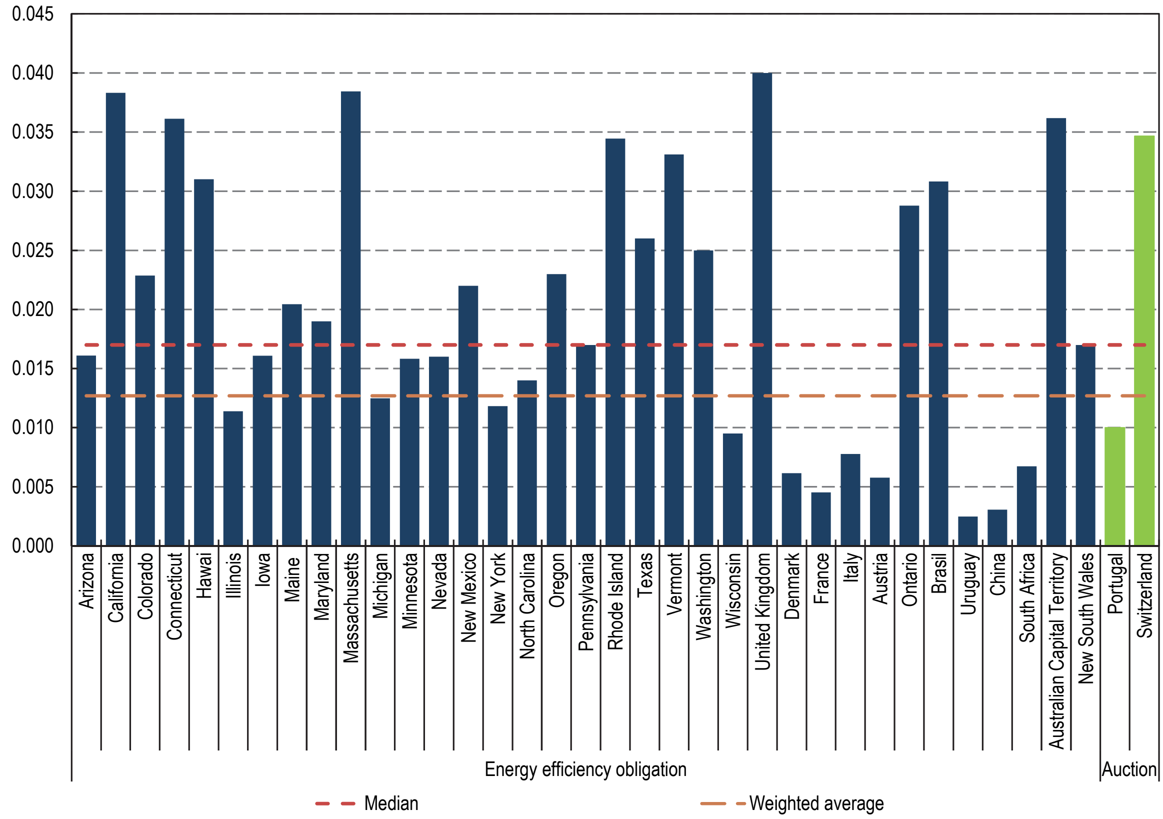
Applying the leverage factor of two to three to the programme costs suggests median total costs of between USD 0.038 and 0.057/kWh lifetime savings and a weighted average of between USD 0.026/kWh and USD 0.039/kWh lifetime savings (Hoffman et al., 2015). This is well below the typical costs of energy supplied in most sectors and locations, and does not factor in all of the multiple benefits that efficiency can provide.

The differences in cost-effectiveness are explained by several factors:

- Depending on how the programmes are designed they deliver energy efficiency measures with different cost profiles (e.g., low-income programs have higher costs or considering the magnitude of the non-energy benefits).
- More robust monitoring, verification and evaluation (MVE) is likely to result in lower estimates of delivered energy savings, which in turn results in higher cost per kWh estimates.
- Programmes offer different levels of support to beneficiaries, ranging from only a small contribution to close to full funding of the investment.

These issues are explored in much more detail later in this report.

Figure 6 • Expenditure by obligated parties and payments to auction winners per unit of energy saved (USD/kWh lifetime savings)



Sources: ANEEL (2016b); Berg et al. (2016); BfE (2014); BMWi (2016); China Southern Power Grid Company (2015); Crossley (2016); DECC (2016a, 2016b); Durkan (2016); Eskom (2015); IEA (2016); IESO (2015); Kulevska (2016); Ministerio de Industria, Energía y Minería (2016); Peña (2017); Rosenow and Bayer (2016); Sousa et al. (2015); State Grid (2016); Vendramin (2016); Winkler (2015).

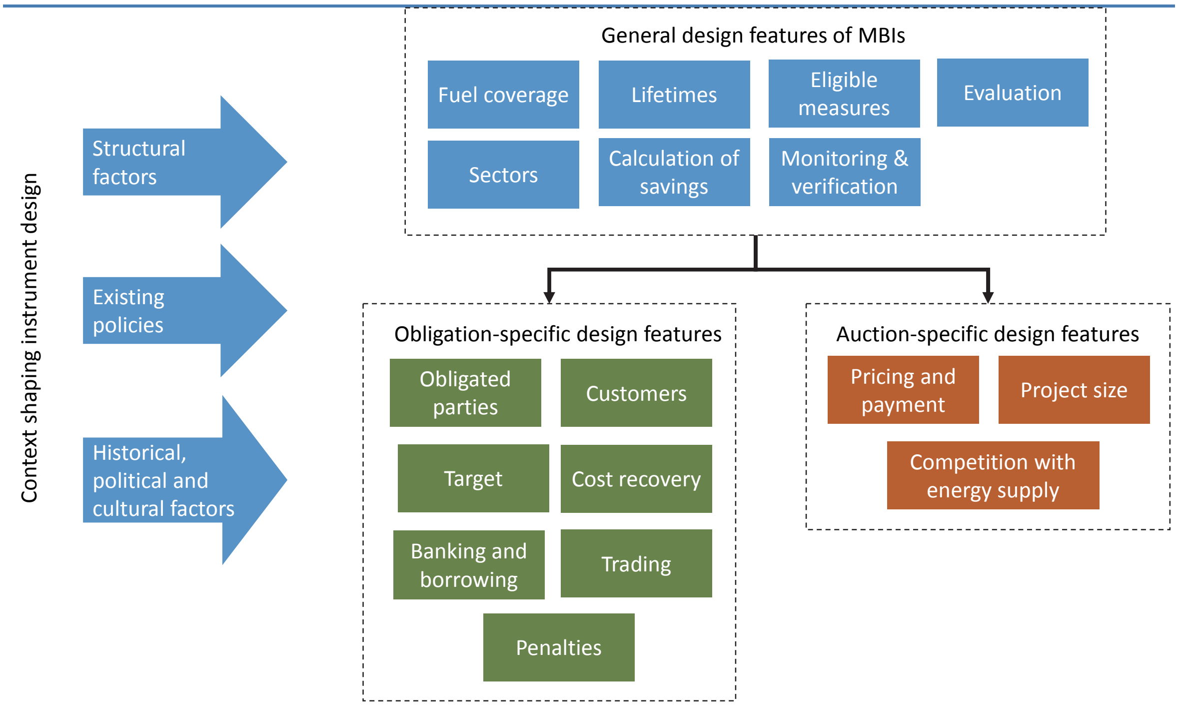
Evaluation of design features of MBIs

This section is divided in four parts. First, the contextual factors that shape the design of MBIs are discussed. Next, the general design features present in all MBIs are analysed. The last two parts present research on the design features specific to obligations and auction mechanisms separately.

Twenty case studies have been analysed in depth to assess the design features of MBIs and the contexts in which particular calibrations of those features might be most appropriate. Details of the case studies can be found in the appendix, in the matrix covering all identified MBIs. Rather than a descriptive overview, the case studies are referred to when discussing specific elements of the analysis.

The case studies were selected with a view to a) achieving good global coverage and b) ensuring diversity of programme design. Specific criteria used to select the cases included: length of time programme has been in place (longer-established MBIs are more likely to reveal insights into the underlying design logic and success factors); data availability (good data is a precondition for drawing wider conclusions, something that is not always the case even for long-running MBIs); significant changes during programme operation (revealing insights into lessons learned and unintended consequences); and interesting design features.

Figure 7 • Design features of MBIs and contextual factors



Based on the criteria, 15 energy efficiency obligations and five auctions were selected (Table 2). There are fundamental differences between the auction mechanisms: two auctions (PJM and ISO New England) are organised through capacity markets whereas three (Portugal, Switzerland, Germany) are dedicated energy efficiency auctions with no direct competition with energy supply.[8]

Table 2 • Selected case studies for analysis

Energy efficiency obligations				Auctions	
California (United States)	Texas (United States)	Poland	China	Portugal	PJM (United States)
Massachusetts (United States)	Austria	United Kingdom	South Africa	Switzerland	ISO New England (United States)
New York (United States)	France	New South Wales (Australia)		Germany	
Vermont (United States)	Italy	Brazil			

Contextual analysis of MBIs

Before discussing specific design features of MBIs, the contextual factors affecting the choice and design of MBIs have to be analysed. This includes structural factors (degree of market liberalisation, number of energy companies, energy efficiency potential), interplay with existing policies, and historical, political and cultural factors.

[8] The independent system operator for the market serving the six New England States is called ISO-New England. PJM is the system operator for a very large market covering much of the Mid-Atlantic and Mid-West regions of the United States, including all or parts of 13 states and the District of Columbia. It is named for its origins managing the power pool serving Pennsylvania, New Jersey, and Maryland. ISO-New York is a single-state system operator.

Instrument choice

When deciding whether to introduce an MBI and if so what kind, policy makers face a number of questions:

- Should we simply mandate that savings to a certain level be achieved by individual consumers, for example via mandatory upgrade legislation on private housing?
- Should we instead assign a public agency to deliver energy savings to end users through providing subsidies, essentially taking this function inside the government?
- Should we impose obligations on energy utilities or, in unbundled markets, on either retail suppliers or on distribution ("wires and pipes") companies?
- Should we create a special form of obligated entity, such as a public-purpose corporation, or quasi-governmental organisation to deliver energy savings?
- Should the amount of resources put into the energy efficiency programme be capped or the quantity of energy savings be fixed?
- Should the energy efficiency programme be funded through general taxation or on energy bills, either through a surcharge or just rolled in with other costs?

Answering those questions is not a trivial task and depends on the specific context in which the decision for or against a specific type of MBI is made.

An important issue is how different types of MBI are funded (Figure 7). Obligations are funded through energy tariffs, either as a surcharge (regulated or unregulated) on energy bills, or simply as a cost of doing business, and paid for by all consumers or a segment of consumers (e.g. only residential customers). Auctions can be funded through a variety of funding streams, the most typical being funds from general taxation as in the United Kingdom and a levy on energy bills allocated to the auction as in Portugal (Sousa et al., 2015). Other funding mechanisms are possible as well, for example ringfencing revenues from auctioning CO_2 allowances and using them to fund auctions.[9] In some US markets, capacity auctions pay for efficiency via capacity charges paid by all retailers and thus the costs are included in the final rates along with capacity charges for generators, transmission charges and other costs of doing business.

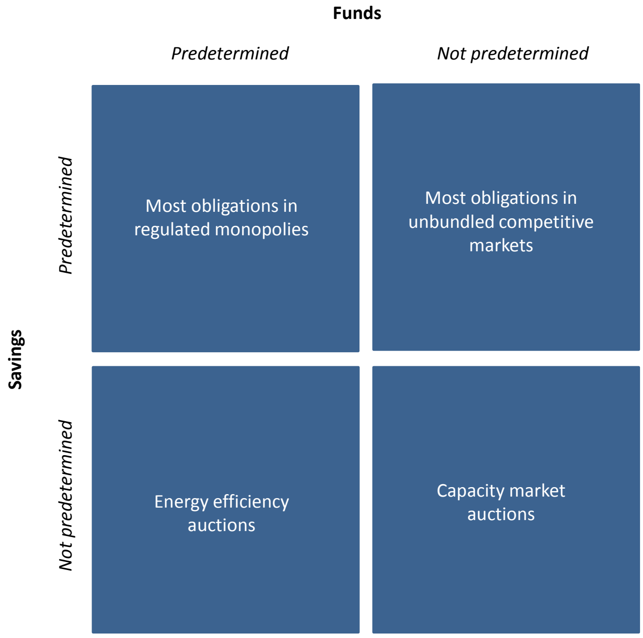
How an MBI is funded may not have a major impact on how it is delivered but has important social equity implications. Raising funds through energy bills is more regressive than doing so through general taxation (provided taxation is progressive). While regressive impacts on the cost side may be offset by broader cost reductions,[10] and can also be offset through progressive delivery of energy savings, this may be a concern. Policy changes in the United Kingdom, for example, have been driven partly by a debate around the impacts of obligations on energy bills.

In addition to the funding question, the degree of control over the outcome (in terms of energy savings) varies between the different types of MBIs. Obligations set a firm target for energy savings to be delivered and historical experience shows that the target is usually achieved, with some exceptions (Lees et al, 2016). While auctions specify the outcome (energy savings), they do not predetermine the total quantity of savings being delivered. Instead, efficiency-only auctions typically have a defined budget used to deliver the outcome. Programme administrators may carry out an ex-ante analysis around expected savings and ex-post evaluations of achieved savings but they are not able to specify the total amount of savings possible for obligations.

[9] Germany has an energy and climate fund part-funded by revenues from the EU Emissions Trading System. This is used to finance the auction mechanism (BMWI, n.d.a).

[10] For example, by avoiding the cost of transmission and distribution upgrades that would be paid for by all consumers, or by lowering the cost of capacity payments and other reliability services, which are also rolled into the power costs that all customers, including low-income customers, must pay.

Figure 8 • Differences between MBIs regarding predetermination of funds and savings



Obligations operating in unbundled, competitive markets often estimate the amount of funding required to deliver the outcome (they may even require obligated parties to report on this for transparency reasons). However, unless the cost-pass through to consumers is regulated, as is the case for most obligations operating in vertically integrated markets, the amount of funds required in order to deliver the savings cannot be predetermined. In contrast, in vertically integrated markets with regulated monopolies, the utility must have the regulator approve the cost passed to the consumer; the savings required are predetermined and then the utility must determine the funds needed to meet that savings levels and request the regulator approve it. Once agreement has been reached, both the savings and the costs passed through are predetermined.

Capacity market auctions are different altogether as it is not clear how many energy efficiency resources will clear the auction nor is the clearing price known prior to a capacity market auction. The way they are designed, there is no mechanism to predetermine either savings or funds.

In addition to funding, decision-makers often wonder whether MBIs are better suited or more successful in traditional, vertically-integrated power and natural gas markets, or in unbundled, competitive environments. The studied sample reveals that they can work well in any of the usual market structures operating in power and gas markets today.

Vertically-integrated systems: In the United States (as in Brazil and China), obligations got their start in the regulated, vertically-integrated market structure present in each State during most of the 20th century. In reaction to rising fuel costs, cost over-runs at nuclear power plants, and a growing environmental movement, many State legislatures and regulators required utilities to engage in "Least-Cost Planning" or "Integrated Resource Planning". In some instances, this meant procuring energy efficiency savings on an equal basis with supply-side resources (York et al., 2012). Beginning in the 1980s, utility procurement plans for end-use efficiency and demand-response resources were launched in most States. They were widespread and subject to much the same design choices and oversight regimes that govern obligations almost everywhere today.[11] About half of States have retained vertically-integrated utilities, and many also have obligation mandates for these utilities.

The important point is that obligations have worked well for many years in vertically-integrated power systems, and many are operating that way today. In our sample, Vermont is fully integrated, while California and Massachusetts are officially unbundled but the large majority of customers are served by the historic utilities under "default" service arrangements.[12]

Unbundled, competitive markets: In the 1990s, following the lead of the United Kingdom, many countries and states adopted reforms that unbundled power generation from delivery and retail. In Europe and Australia, the process of moving to competition took hold, and (to varying degrees) both wholesale and retail competition has been implemented. The answer in most places was to create an efficiency obligation that would be competitively neutral, either by imposing it on the residual monopoly distribution company, or by imposing it equally on all (or all large) competitive service suppliers. This is now the case for many of the jurisdictions in our sample (see below). Many of these unbundled jurisdictions now have or have had highly-successful obligations in place. In our sample, the United Kingdom, Texas (United States), and New South Wales (Australia) demonstrate the viability of the obligations model in competitive environments.

In theory, policy makers may want to limit the number of obligated parties, both to keep transaction costs low and to encourage new market entrants by exempting smaller energy retailers. In practice, we find that even where there are large numbers of energy retailers operating in the same market, policy makers place the obligation on all but the smallest energy providers. Examples are France, with more than 2 000 obligated entities, and Denmark with more than 400 obligated entities. In cases of large numbers of obligated parties, there is usually a mechanism that streamlines the process of administering the efficiency obligation. In France, most of the obligated parties decided to delegate compliance to an ESCO through a dedicated platform (www.emmy.fr), leaving the administrator with a much smaller number (around 50-100) of interlocutors (Trauchessec, 2017).

For auctions, the degree of fragmentation of the energy market and the number of competitive energy retail companies is less important than for obligations. This is because all of the existing auctions, including capacity market auctions, are funded through a uniformly applied levy (e.g. transmission or capacity charge), through general taxation or hypothecated taxes, and pooled for efficiency purchases through a single buyer. This is not surprising since the mechanics of running an auction are complicated and the burden of participating in multiple auctions would be onerous and potentially counterproductive. At the same time, being able to compare all bids within the same auctions allows the entity running the auction to select the least-cost or most valuable options.

Finally, the institutional capacity of the government agency tasked with setting up and administering the MBI plays an important role in design. For example, if there is ample experience with administering energy efficiency programmes, the mechanism can be much more sophisticated from the start. If experience is more limited, learning processes will take time until the MBI includes a robust set of design features.

Interaction of MBIs with other policies

MBIs do not operate in isolation and are often introduced in an already crowded policy space. MBIs typically involve a financial contribution from the obligated parties or bidder to the overall

[11] There is a large body of analyses on Integrated Resource Planning (see. Hirst, 1992; Harrington et al., 1994).

[12] "Default service" is used generically to refer to the electric service provided to customers who do not choose a competitive electric supplier, or who are not able to obtain service from a competitive supplier.

investment cost of energy efficiency. The remainder is paid by the beneficiary, usually called the "participant" or "participating customer", since in most cases both decisions and investments by these customers are required. Whilst there are exceptions, for example if obligations target low-income customers, most measures delivered are only partly funded by the obligated parties (Rosenow, Platt et al., 2013; Molina, 2014). From the view of the participating customers, obligations provide them with an economic incentive to install energy efficiency measures (Rosenow, Fawcett, Eyre et al., 2016).

While purchase subsidies are almost always the major element of the strategies of obligated parties and auction winners, they will do whatever is cheapest to meet their contractual obligations. This might include advertising campaigns, marketing tie-ins with appliance retailers, helping consumers with a list of approved contractors, and many other programme elements as well as subsidies.[13]

Box 6 • State aid rules and their influence on MBIs

Rules against state aid imposed by the European Union may affect a Member State government's options to support energy efficiency through MBIs. It is interesting to note, for example, that while Portugal and Germany are both EU Member States, their auctions have different provisions. The German programme is based on a simplification of the general guidelines for state aid (General Block Exemption Rules, EU 651/2014). This lessens the administrative burden since the European Commission's approval is not required. However, it also leaves less room for flexibility – the maximum aid intensity is 30% of eligible cost. Portugal has opted to situate its auctioning programme under the *de-minimis* regulation (EU 1407/2013) according to which the funding a company can get is limited to a maximum of EUR 200 000 over a period of three years. Hence, project size is limited in the Portuguese programme.

Interaction of MBIs with public financing programmes

If there are other financing instruments in place for energy efficiency, such as loan programmes, grants or tax rebates that provide funding for the same energy efficiency improvements, there are typically two options for policy interaction:

- Option 1: MBIs provide that energy efficiency measures under the programme must not receive funding from other policy instruments, ensuring that the measures are exclusively supported by the MBI.
- Option 2: Funding from MBIs can be blended with funding from other policy instruments.

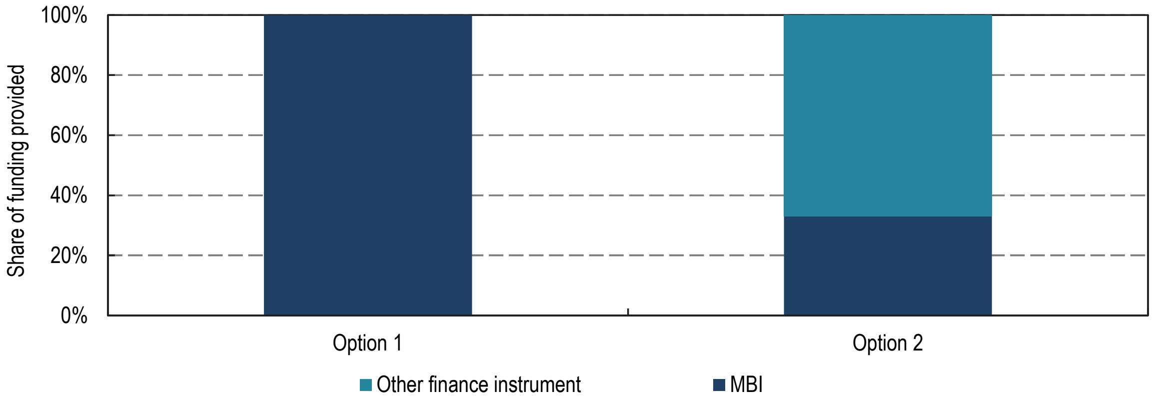
Depending on the financial instrument, there may only be partial overlap (for example, grants only available for low-income households or tax rebates that only apply to people paying tax). For this analysis, overlap was considered to be two or more instruments that fund the same technologies for the same customers and there are examples of both options amongst the case studies.

Option 1 can be found for example in New South Wales, where the Emissions Reduction Fund is used to fund emissions abatement across all sectors of the Australian economy and is supporting energy efficiency activities in New South Wales. To ensure that both schemes deliver the savings set out in their objectives, energy efficiency projects that access the Energy Savings Scheme are not eligible for financial incentives under the Emissions Reduction Fund and vice versa (ESS, n.d.). Similarly, Poland's obligations do not allow for projects to be co-financed by other public subsidies (ENSPOL, 2015). This could lead to competition between different instruments

[13] An example of this is the Danish efficiency obligation, where information provision was the main strategy of the obligated parties in the early years (ENSPOL, 2015).

targeting the same savings opportunities, potentially raising the subsidy level required from obligated parties to persuade customers to participate. Disallowing blended funding also has benefits. For example, it could increase total savings by forcing obliged entities to deliver additional savings that are not being delivered by other governmental programmes, and reduces the issues relating to the attribution of savings to programmes that support the same measures.

Figure 9 • Illustration of the possible blending options of MBIs and other finance instruments



Option 2 can be found for example in France, where funding from tax rebates is blended with funding from the obligation. This lowers the cost of delivering savings through the MBI but risks providing excessive subsidies and double counting savings if not carefully managed (Rhode et al., 2015). In addition, allowing blended funding favours particular measures (those for which other funding is available). This means some technology neutrality is potentially lost. In the United States, obliged entities commonly counsel participating customers to take advantage of federal and State tax rebates offered for high-efficiency heating systems, home insulation and windows, which pay only a portion of measure costs but help to attract customers to obligation schemes. In France, the reporting of savings to the European Commission is handled in such a way that the savings are fully attributed to the obligation and no savings are reported from the tax rebate. Another example is the obligation in the United Kingdom, which was designed so that measures could be part-funded by both the obligation and the Green Deal, an on-bill financing scheme (NAO, 2016).

Combining funding from energy efficiency obligations with additional financial incentives would not increase the savings beyond what would be delivered by the obligations on their own, as the policy design includes capped savings levels (Rosenow, Leguijt, Pato et al., 2016). This assumes that the obligations levels are not influenced by the use of these other policies. If the blending of finance reduces the cost of the obligation, the target size could in theory be increased without adding additional costs to bill payers. However, beneficiaries of the programme may prefer receiving incentives from particular types of funding mechanisms. For example, if the incentive is offered through or in association with a tax rebate or by local government, it may inspire more trust than rebates provided by the utilities (Parag et al., 2009).

On the auction side, Switzerland allows blending of funds from the auction mechanism with other public subsidy programmes up to the 40% maximum contribution compared to investment costs (BfE, 2016). If funding from auction mechanisms can be blended with other public subsidies this would lower the cost of the auction mechanism and, assuming the total amount of funds for the auction does not change, it would allow a larger amount of savings to be delivered. It is questionable though whether such an approach would deliver any benefits in contrast to simply increasing the amount of funds of the auction itself.

An interesting example from the United States is the American Recovery and Reinvestment Act (ARRA), which was introduced in 2009 and provided USD 17 billion specifically for efficiency over a multi-year period (ACEEE, n.d.b). States with obligation programmes used both Option 1 and Option 2, with five allowing the full credit of savings to be attributed to the obligation, three allocating proportional savings credits to the obligation, one strictly separating the two programmes, and two States not having resolved how to approach the matter (Goldman et al., 2011).

The diversity of approaches used among US States for the ARRA programmes is not surprising since there was a similar range of approaches to tax incentives and co-funding measures among the States before the passage of the ARRA. However, unless the parallel programme is clearly responsible for a very large fraction of the savings delivered, the usual approach is to count all of the savings as being delivered by the obligation, or to discount the savings claims to some degree. For the most part, the fact that beneficiaries may receive additional support from a parallel incentive – for example, the tax credit given under the federal income tax code for homeowner investments in efficient windows – does not usually bar an obligated utility from including those measures when claiming credits towards an obligation target. It is understood that the obligations should be leveraging the federal incentive to speed up the pace of change, and to deliver more savings than would occur if the tax credit alone were operating.

In summary, there are examples from successful programmes of both approaches to the interaction with other funding sources. Policy makers should be aware that allowing for overlap between funding sources will incentivise the take-up of particular technologies as well as taking account of the interaction when measuring the overall impact of the programmes.

Interaction of MBIs with capacity markets

Some wholesale power markets have launched capacity markets in recent years, in addition to their markets for energy and ancillary services. The principal purpose of capacity markets is to ensure that adequate capacity will be available to meet load at all times, including peak periods. Forward-looking capacity markets usually procure capacity on a three to five year time horizon. Capacity markets do not purchase energy, but seek to ensure that adequate capacity – the ability to meet energy demand – will be available to serve expected load (generators actually dispatched in future time periods will also be paid in the energy market for the energy they produce and sell). They pay for the value of a service to the system, i.e. to reduce the cost of capacity for a given reserve margin, as well as lowering wholesale energy prices. The amount of capacity that is estimated to be needed in future is set by the system operator based on projected load and the desired reserve margin; for this reason, a committed reduction in future load lowers the amount of generation capacity needed, and helps meet capacity requirements, just as a power plant does.

When these markets were first introduced in New England (United States) in 2006-08, efficiency and demand response advocates rightly pointed out that actions taken on the demand side to lower demand were just as valuable – and sometimes more valuable – than actions that could be taken on the supply side to add new generation capacity to meet load requirements in peak periods or when reserve margins are tight for other reasons, such as an unplanned generator outage.[14] Consequently, some capacity markets have been designed to permit demand response and efficiency assets to compete directly alongside conventional supply-side resources in the auctions set up to procure capacity on a forward-looking basis. The examples in the United States

[14] The topic was evaluated in the New England Demand Response Initiative, a six-state collaborative in 2001-03, leading to numerous recommendations to strengthen energy efficiency and demand response in the New England region (RAP et al., 2003). A description of the early New England market can be found in LaPlante (2007).

are the ISO-New England, PJM and New York-ISO capacity markets, with ISO-New England and PJM having the most experience authorising end-use energy efficiency to bid into the forward capacity markets (Neme et al., 2014).

Box 7 • Demand-side resources in capacity markets

Some capacity markets invite customer-based resources to compete against conventional generation resources in order to assure that there will be adequate reserve margins to meet power system reliability requirements in future time periods. These demand-side resources fall into two categories: demand response and end-use energy efficiency.

Demand response resources are customer-based responses that system operators can call on to improve reliability quickly and over a relatively short period of time – for example, load reduction by turning off equipment, adjusting thermostats in office buildings, or dimming lighting in retail buildings.

Energy efficiency resources are reductions in customer load resulting from improvements in end-use technologies that deliver savings when those technologies are used. While these improvements do reduce aggregate load in various ways, including during peak periods, they are not specifically callable by the system operator. Examples include replacing inefficient chillers and motors with more efficient models, replacing incandescent lighting with LEDs, and substituting high-efficiency heat pumps for traditional resistance electric heating.

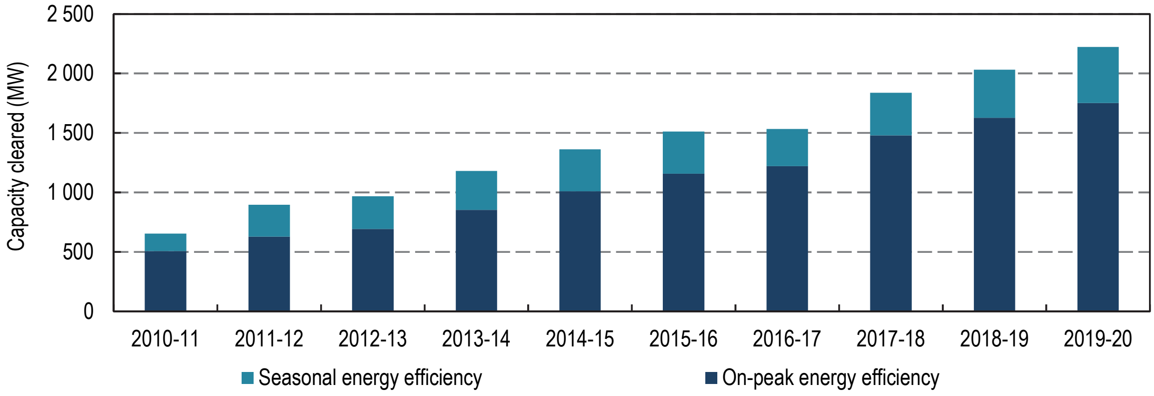
Because demand response and energy efficiency resources have different characteristics and serve to improve reliability in different ways, the rules governing how they can participate in capacity auctions are tailored differently, as they are for generation resources of different types.

The system operator serving New England has substantial experience enrolling efficiency resources in their capacity auctions (Neme et al. 2014). As can be seen in Figure 8, experience has led to an increasing role for efficiency in these markets over time, with 2 224 MW of efficiency clearing the market, for delivery beginning in 2019 – this is 6% of all the supply-side and demand-side capacity resources that cleared in that auction (Liu, 2017). In New England's capacity market, energy efficiency resources are characterised either as "on-peak energy efficiency" or "seasonal energy efficiency" and both types can participate in the auction.[15]

The PJM system operator has also had substantial experience with demand response and energy efficiency bidding into their capacity markets. However, energy efficiency has played a much smaller role in the PJM capacity market than it has in New England. For example, in the most recent auction for delivery in 2018/19, energy efficiency provided just 1% of the cleared bid capacity, while demand response provided roughly 7% (Liu, 2017).

[15] "On-Peak energy efficiency includes measures that will provide demand reductions during peak hours (1 pm to 5 pm) on working days between June and August, and during peak hours (5 pm to 7 pm) on working days in December and January. "Seasonal energy efficiency" includes resources that are defined more by weather conditions (cold winter days, hot spells in the summer) than by average hours of operation. Together these two types will provide 6% of the total capacity cleared for delivery in 2019/20 (Liu, 2017).

Figure 10 • Energy efficiency savings successfully cleared in the ISO-NE capacity market



Source: Liu, Y, 2017.

The striking difference between the proportions of capacity resources supplied by energy efficiency in New England compared to PJM has two main causes. First, a close look at the auction rules reveals that it matters quite a lot how energy efficiency resources are defined, which peak periods are projected by the system operator to be most important to address, and how many years a cleared resource will be paid for reducing load. PJM's rules for energy efficiency bidding in the capacity market are less attractive to energy efficiency providers than those in New England, where efficiency resources are able to bid in for more years of their lifetimes. A second difference is that, on average, the New England States have more ambitious obligations than the States in the PJM market. Since utilities and efficiency entities in New England have strong portfolios of energy efficiency measures to deliver, they have a greater quantity of energy efficiency capacity to bid into the capacity auctions (Neme et al., 2014).

Five important lessons have emerged from these experiences. First, by driving investments in end-use efficiency, obligations demonstrably contribute to lowering peak demands on power systems, and those reductions can lower both the total quantity of supply-side capacity needed to provide reliable service and the clearing price that is paid to all resources through the capacity auction, lowering the cost of resource adequacy to consumers. The main purpose of capacity auctions is to use a market mechanism to drive down the cost of providing projected system capacity needs. By opening the auction to energy efficiency and demand response resources, the cost of meeting system adequacy goals can be substantially lower than it would have been if only supply-side resources were permitted to compete. For example, in the first capacity auction held in ISO New England in which demand-side resources were permitted to bid, it was estimated that demand-side resources lowered total costs by USD 280 million, with energy efficiency alone responsible for approximately one third of the demand-side savings (Jenkins et al., 2009). Following a later auction in PJM, PJM's independent market monitor concluded that demand-side resource participation had reduced total consumer costs for capacity by as much as USD 12 billion in a single auction period. Most of the capacity savings came from the demand response assets, but a meaningful share came from energy efficiency capacity bid into this market.

The second lesson is that there is no single or simple method for including energy efficiency resources in capacity markets. The rules for assigning capacity values to energy efficiency resources, and the terms under which they can be paid, can make a very large difference in how well they will perform in a capacity auction. In addition, climatic and system variables will mean that different capacity markets will require different capacity load profiles.

Third, the prices paid in capacity markets are by themselves insufficient to cover the full costs of the obligations that deliver these benefits. This is not surprising. Resources that clear in a capacity auction are paid only for the capacity (or capacity reduction) that they deliver, not the amount of cost savings that they confer on end-use customers by reducing their energy requirements and lowering clearing prices. Indeed, neither demand- nor supply-side resources rely solely on capacity payments.

Fourth, the rules governing the auctions do not permit pre-existing energy efficiency measures to bid into the forward capacity market – their impact on demand simply shows up as a reduction in the system-wide demand projection, so no payment is made for them. Pre-existing generators, on the other hand, are paid to continue to be available during the period covered by the auction. The decision on whether to include efficiency resources in the baseline forecast (as is the case in the French capacity market, for example), or as resources that can continue to bid into capacity auctions is critical. Both options are possible. It has been argued in the PJM context, that efficiency resources should not be able to bid, since future efficiency is now being included in load forecasts (Monitoring Analytics, 2016). On the other hand, aligning the payment for efficiency services with the beneficiaries, in this case the system operator, better aligns market incentives, as well as making it more likely that efficiency gains will be supported in the long-term, and providing an upfront stream of payments to efficiency aggregators. It is important, however, that if efficiency is allowed to bid in auctions, the amount of capacity procured reflects this.

Finally, it is instructive to note that including energy efficiency in capacity market auctions provides a partial answer to the question “Is efficiency reliable?”. The system operators who administer capacity mechanisms are highly focused on system reliability, and have high standards for resources that will be cleared for payment in a capacity market. Efficiency resources are paid only for demonstrating that they will reliably reduce load during system peak periods. Measurement and verification protocols for capacity programmes are stringent, but efficiency programmes have met these standards and have demonstrated that they deliver capacity savings as well as energy savings in wholesale power markets.[16]

As noted above, the funds that can be earned by energy efficiency resources in all-resource capacity markets are much less than the full cost of delivering those measures, and just a small fraction of the full value that the measures are delivering to participants and society more broadly. In Vermont, where the obligation is adding savings of about 2.1% per year of electricity consumption, the programme’s capacity savings are bid into the New England ISO capacity market, and the net revenues received are equivalent to about 10% of the overall programme costs (Neme et al., 2014). Thus, while it is highly valuable to include energy efficiency and demand response in competitive capacity auctions, it would be unwise to count on the revenues from capacity markets to pay for the efficiency programmes in the first place. In New England and PJM, this is understood. States in these regions rely on their obligation mechanisms to ensure delivery of a growing energy efficiency resource, which can then be bid into the capacity market. Figures from New England show that 99% of capacity from energy efficiency is allocated to utilities with an obligation, suggesting that without obligations energy efficiency would not be able to compete in the current capacity market (ISO-NE, 2015).

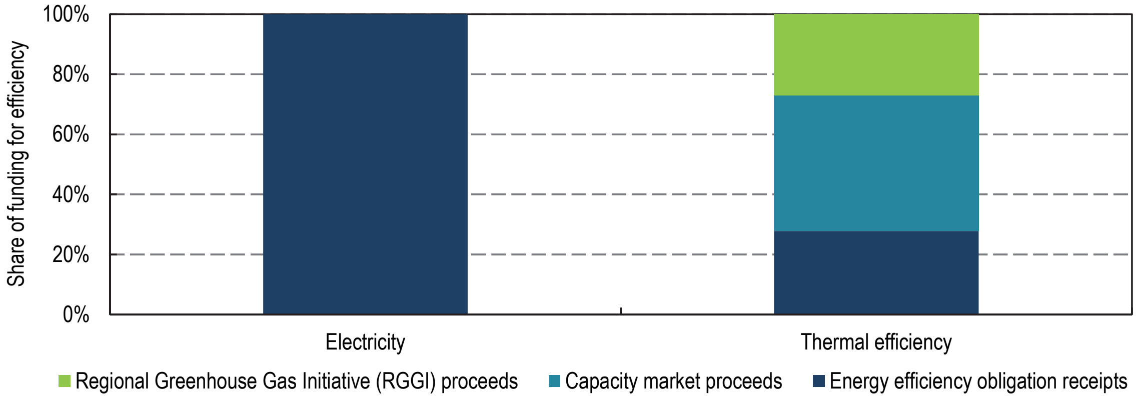
While capacity market revenues are highly unlikely to be sufficient to fund efficiency on their own, they can supplement obligations in at least two important ways:

[16] For example, after ex-post analysis of performance, the New England system operator concluded that for planning purposes efficiency resources will be available on a 100% basis, while real-time demand response is rated at 89% and generation availability is rated at 94.1% on average (Neme et al., 2014).

- They can be used to supplement the obligation spending within the power sector, or even be used to deliver thermal savings outside of the power system; and/or
- The additional funds from the capacity market can be used to lower the consumer bill impacts of obligations.

The first effect is illustrated in Figure 11 using the case of Vermont. Efficiency Vermont, the obligated party, uses the proceeds from the capacity markets to fund thermal efficiency, not electric efficiency. This was purely a policy decision. Because the power sector obligation was well funded, and there was a continuing need for investments in thermal efficiency for homes heated with natural gas and unregulated oil and propane, Vermont policy makers decided to dedicate this new source of revenue to the relatively under-served thermal efficiency needs of State residents. The legislature made a similar decision with respect to the allocation of carbon revenues that Vermont receives as a participant in the Regional Greenhouse Gas Initiative (RGGI), a nine-State cap-and-trade system operating in the northeastern United States.[17]

Figure 11 • Sources of energy efficiency programme funding in Vermont



Source: Neep (2016).

The second option for applying revenues received in the capacity market (offsetting a portion of the efficiency programme costs on consumer bills) was chosen in Massachusetts. One of the aims of the energy efficiency programme administrator in Massachusetts is to "minimise customer rate impacts" through leveraging a range of funding sources including funding from the capacity market (Mass Save, 2012). Since the scheme is already quite ambitious, with a current target of saving over 2.9% per year, devoting capacity market revenue to paying for current measures rather than programme expansion is an understandable choice.

Interaction of MBIs with minimum energy efficiency performance standards

MBIs interact in several ways with standards setting energy performance requirements for equipment, appliances and buildings. First, without standards for measuring the efficiency of energy-using equipment, buildings and building components, most energy efficiency policy instruments would not be able to function. They are therefore not so much complementary as foundational for all MBIs. All of the MBIs reviewed employ technical guidelines setting out which standards have to be followed when installing energy efficiency measures. The absence of such standards would make quality control very difficult.

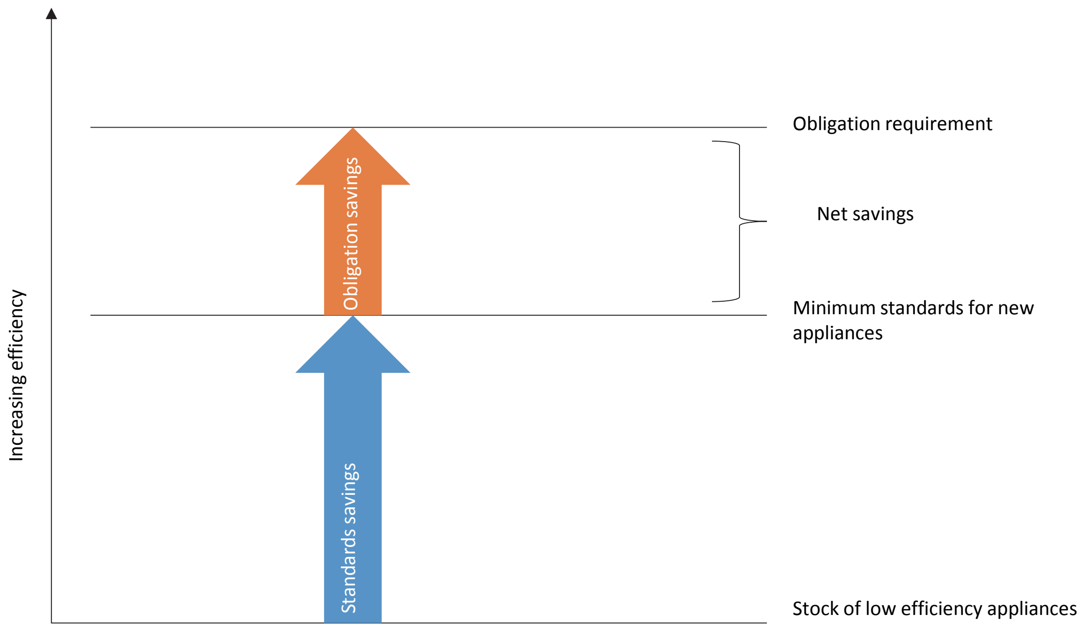
Second, if the energy savings delivered by MBIs are to be additional, they need to support energy efficiency improvements beyond what would happen anyway. For example, in Europe the

[17] For additional discussion of RGGI and the interaction of obligations and carbon markets, see section below.

Ecodesign Directive sets minimum energy performance standards for appliances. MBIs that promote energy efficient appliances need to either a) support appliances that are more efficient than the minimum standards set by the Ecodesign Directive or b) increase the replacement rate of appliances i.e. substitute less-efficient appliances faster than what would happen otherwise. For example, if an appliance with a 20-year lifetime has five years of lifetime left, the additional savings would be the difference between the old and the new appliance over the remaining five years. Such rules exist under the 2012 EU Energy Efficiency Directive and apply to the savings from MBIs and other policies helping to meet the Directive's Article 7 policy savings target (Rosenow, Leguijt, Pato et al., 2016).

Figure 12 illustrates how minimum standards for appliances set by the EU Ecodesign Directive are dealt with in the French obligation programme. Only appliances that are more efficient than the minimum standard can be promoted by the obligation, and only the difference between the minimum efficiency and the actual efficiency of the appliances can be used to calculate savings.

Figure 12 • Interaction of French obligation programme with minimum standards



Source: Osso et al. (2015).

Standards in the transport sector are somewhat different than product standards or building codes. This is because while some countries do have minimum efficiency requirements for individual vehicle types, there are efficiency requirements for the entire fleet of a manufacturer in the jurisdictions with MBIs (e.g. Corporate Average Fuel Economy standards in the United States). Theoretically, an MBI would not generate additional savings because increasing the share of more efficient vehicles would simply allow manufacturers to sell more inefficient ones at the same time. While the indirect effect of this could be that fleet fuel economy standards are increased more quickly over time as the share of more efficient vehicles increases, policy makers have chosen not to reward savings associated with new vehicle purchases in their MBIs. Analyses of obligations and transport sector energy efficiency identified eco-driving training for fleets, tyre pressure optimisation, and energy efficient tyres and lubricants as potential measures (Bertoldi et al., 2011; Lees, 2014). Those measures would work even under a fleet fuel economy standard as fuel economy is typically measured independently of driving behaviour or tyre maintenance.

Interaction with information policies

Information and feedback policy types coupled with MBIs have reinforcing effects as they help facilitate effective implementation. This is because they influence decision making in a different way, using psychology or behavioural economics. For example, an energy label for appliances can be used to promote efficiency appliances, increasing their market share. In the building sector, there are examples where the certification of energy efficient buildings has been introduced successfully (e.g. Germany, Switzerland), sending market signals to consumers. MBIs can promote building projects that result in certification, giving consumers confidence in the quality of the works carried out.

Conversely, where MBIs promote information campaigns on energy efficient behaviour and technology they a) reduce the need to finance those campaigns through other means, and b) support other policies aimed at increased uptake of efficient technologies or behaviour change. MBIs usually do not focus on behavioural measures (although there are examples of relatively large programmes in the United States) so the impact on other policies is likely to be modest.

Interaction with energy and carbon taxes

Energy or CO_2 taxes increase the cost of (carbon-based) energy, internalising the externalities associated with its consumption, and as a result, should make it more likely that efficiency investments take place, assuming some price responsiveness (Kosonen et al., 2009; Lee et al., 2004). Generally, energy and CO_2 taxes are compatible with MBIs as they increase the incentives for people and organisations to reduce their energy consumption and carbon emissions, and to adopt more efficient technologies. In theory, the main effect of taxes on MBIs is that they reduce the need for financial incentives as the energy cost-saving benefits are higher than a situation with no energy taxes. However, a number of market barriers to cost-effective efficiency investments remain even when energy prices rise, such as the landlord-tenant problem, high implicit consumer discount rates, status quo bias, and information barriers. Thus, unless the tax is very high, it is unlikely to stimulate significant efficiency investments on its own (Sorrell et al., 2003).

Interaction of MBIs with emissions trading schemes

The interaction effects of MBIs, and obligations in particular, with emissions trading schemes such as the European Union Emissions Trading System (EU ETS) have been analysed in great detail. In the case of the EU ETS, it has been concluded that "operating in conjunction with the EU ETS, [an obligation] scheme focused solely on electricity efficiency will make no contribution to reducing EU or global carbon emissions unless and until it leads to a tightening of the EU ETS cap" (Sorrell et al., 2009). The reason is that in the short run, any reductions in electricity consumption simply lead to carbon savings by electricity generators, which frees up carbon allowances to be banked for later use or sold to other emitters, without actually reducing the established carbon cap. MBIs that target non-traded emissions (e.g. gas use for heating buildings), have no direct interaction with the EU ETS as such emissions are not covered by the carbon cap (Child et al., 2008). Therefore, most reductions in electric end uses do affect the EU ETS, while most reductions in non-electric energy do not affect the EU ETS (with the exception of reductions in some large energy-intensive industries that are directly covered by the EU ETS).

However, in practice the relationship between MBIs and carbon caps is more complex. Policy makers have linked efficiency and carbon reduction programmes in at least four useful ways:

- Within capped systems, such as a power system under a cap-and-trade scheme, when MBIs deliver efficiency savings, they are delivering carbon savings at relatively low cost – which is the principal goal of a cap-and-trade system. When carbon savings are delivered at low cost, the political will to tighten the cap expands, and it becomes easier to reach later-period carbon goals. During the RGGI's initial phases, participating states devoted about 60% of their carbon auction revenue to end-use efficiency, including obligations operating in those states. These investments lowered both power costs and carbon emissions. When the programme came up for renewal in 2013, governors and legislatures in these States chose to tighten the cap substantially. The reduction target had been 10% from 2005 levels by 2020 and was raised to 50% below 2005 levels by 2020, in large part because the programme was seen by politicians and consumers as enhancing efficiency and lowering consumer costs by "recycling" auction revenue through the region's obligation programmes (Cowart et al., 2015).

- A similar dynamic occurs in systems like the EU ETS with the creation of a market stability reserve, under which the number of allowances to be auctioned in a particular period is tied to an independent factor such as the prevailing market price of allowances, or the number of unused allowances being held for later use.[18] In such systems, if MBIs have the effect of lowering energy demand and demand for allowances, the freed-up allowances can be withdrawn from the carbon market into the stability reserve. Whether this occurs, and whether it leads to a permanent reduction in capped emissions, depends on the rules governing the reserve over time.
- Obligations and other MBIs can be used as a direct complement to cap-and-trade systems, reducing emissions either directly or indirectly, and thus helping to achieve societal greenhouse gas emission targets. For example, the Carbon Emissions Reduction Target (CERT) programme in the UK was a market-based obligation in which the obligated parties were required to meet energy savings goals established explicitly to reduce emissions (Ipsos MORI et al., 2014). Even where obligations are framed in energy-saving terms, they may well complement a cap-and-trade system. Obligations requiring natural gas savings in households and commercial buildings (as in France and 15 US States),[19] are designed in part to reduce emissions from millions of dispersed small sources that normally fall outside cap-and-trade regimes. These regimes have focused on individual large emitters for a variety of reasons.
- Another important relationship between cap-and-trade systems and MBIs builds on the opportunity offered by allowance auction revenues to finance end-use efficiency, thus deepening the MBI regime and delivering low-cost carbon savings. Because the elasticity of demand for electricity is low, moderate price increases due to carbon pricing (or anything else) do little to change consumer behaviour or drive investments in end-use efficiency (Agnolucci, 2009). However, as documented above, well-run efficiency programmes can deliver energy savings at programme costs as low as 2-3 cents per kWh saved. Thus, programmatic energy efficiency can be significantly more effective at delivering efficiency savings than trying to drive efficiency responses through price increases alone.[20] For this reason, there is a powerful opportunity to link MBIs and cap-and-trade schemes by directing carbon auction revenues towards investments in energy efficiency, either through governmental bodies (as in the German Energy and Climate Fund or the Czech Green Savings

[18] The European Commission has proposed the creation of a market stability reserve that would come into effect in 2019. The scheme would withdraw allowances from future auctions when the number of allowances in circulation reaches a defined high point, and would release allowances from the reserve when the number of unused allowances in circulation reaches a set low point (EC, 2015).

[19] Including California, Massachusetts, New York and Vermont among the case study States covered in this paper (Gilleo et al., 2015).

[20] Cowart et al. (2015) conclude that the revenue obtained from a moderate energy price increase can deliver about nine times greater efficiency savings than the consumer price response alone, if the revenue is channeled into programmatic efficiency based on data from obligation programmes in the United Kingdom and well-documented factors for price-elasticity in energy markets.

Programme) that in turn fund energy efficiency programmes[21] or by "recycling" the revenue to obliged entities to enhance the obligation scheme (as in the RGGI). About USD 1 billion in auction revenues has been dedicated to expanding the States' obligation programme in RGGI, which has encouraged additional spending as well. Obligation spending in the nine RGGI States increased from USD 575 million in 2008 (just before the RGGI began) to USD 1.74 billion in 2014 (Ceres, 2016). Analysts have found that the RGGI revenues had added USD 2.9 billion in net economic benefits across the region in its first six years. Consequently, consumers have actually saved money while lowering carbon emissions (Ceres, 2016).

General design features of MBIs

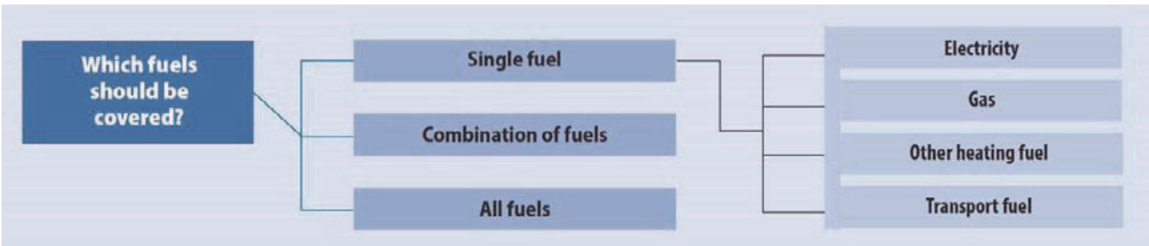
This section focuses on key aspects of MBI design, drawing on the case studies to distil lessons learned, with a view to informing future design of MBIs. There is great variety across the sample of programmes. This is often because the overall objectives of MBIs are heterogeneous: to increase economic efficiency, reduce CO_2 emissions, alleviate fuel poverty, reduce load at peak times, reduce demand in certain locations, encourage innovation, or provide an economic stimulus. In many cases, it is a combination of more than one of the above and which factor is more decisive depends on the context. For example, the issue of fuel poverty is of high importance in the United Kingdom, Vermont and California, and thus those obligations contain specific targets for reducing fuel poverty (Nierop, 2014). In California, Vermont and New York, among other locations, there are well-documented examples where energy efficiency investments were targeted to geographic areas to defer or avoid specific transmission or distribution upgrades that would otherwise have to be made (Neme et al. 2012).

Fuel coverage

A key question for MBIs is the fuels to be covered. For obligations, it is important to note that the fuels covered by the obligation do not necessarily determine where the savings can be achieved and many schemes exist where obligated parties can achieve savings across multiple fuels (e.g. Brazil, China, Italy, South Africa, United Kingdom). However, in the United States, where both electricity and gas are covered, obligations on each fuel are treated separately with electricity distributors obligated to provide electricity savings and gas distributors obligated to provide gas savings. For auctions, fuel coverage determines where the savings have to be achieved rather than who is involved in delivering them.

In principle, all fuels can be covered both by obligations and auctions. Alternatively, only a single fuel or a combination of fuels can be covered (Figure 13).

Figure 13 • Fuel coverage decision tree

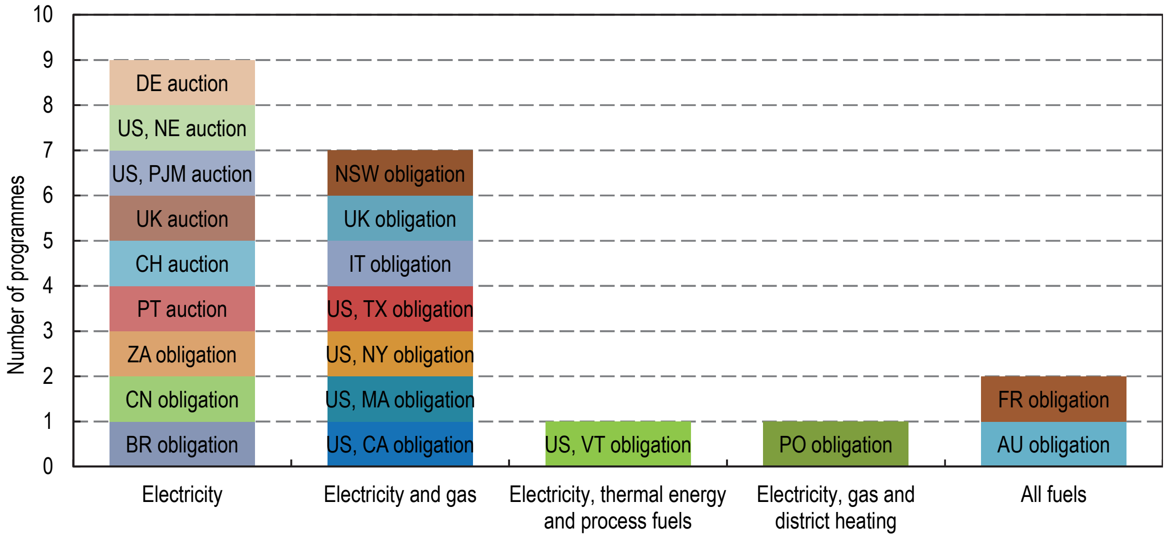


Electricity is the only fuel that is covered by all obligations and auctions around the world (Figure 14). Many MBIs in the United States and the European Union also cover gas, as do all MBIs in

[21] The German energy efficiency auction is funded in this way.

Australia). Only a small number of MBIs cover transport fuels. Where transport fuels are covered by an obligation (France, Ireland), the energy savings in end-use transport have been minimal to date. During the last period of the French obligation (2011-14) only 1.6% of savings were delivered in the transport sector (Deconninck, 2016), although during the current period (2015-2017), savings from transport have risen to 5.2% (MEEM, 2017). In Ireland, energy savings from transport accounted for only 3% of total savings in 2014/15 (Durkan, 2016).

Figure 14 • Fuel coverage



Note: AU = Austria, BR = Brasil, CH = Switzerland, CN = China, DE = Germany, FR = France, IT = Italy, PO = Poland, PT = Portugal, UK = United Kingdom, US = United States, ZA = South Africa, NSW = New South Wales, CA = California, MA = Massachusetts, NE = North England, NY = New York, PJM = Pennsylvania, New Jersey, and Maryland, TX = Texas, VT = Vermont.

Experience shows that in the early years of a new obligation, focusing on one fuel only has the advantage of reducing complexity. Good examples of obligations that focused on one fuel in the beginning and then expanded to other fuels can be found in the United Kingdom, some of the US States and Australia. In the United Kingdom, the first obligation introduced in 1994 only covered electricity. Only in the period 2000-02 did the obligation start to cover gas and it continues to cover both electricity and gas until today (Rosenow, 2012). In Australia, the obligation in New South Wales was extended to include natural gas in 2016 (Crossley, 2015).

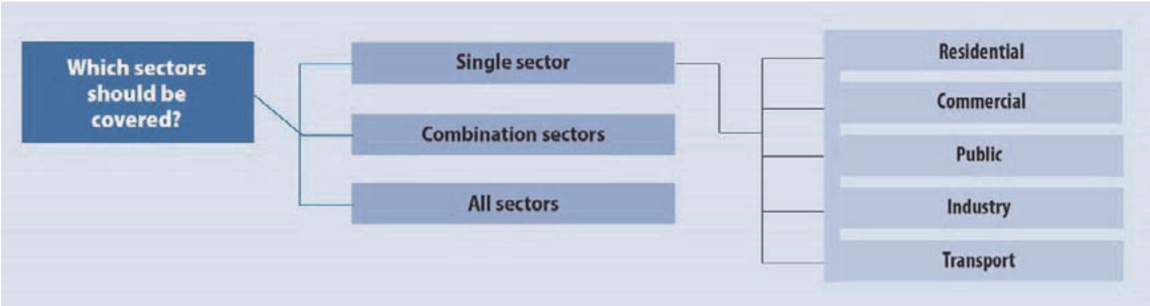
In contrast, most of the auctions analysed are focused exclusively on one fuel - electricity (e.g. Portugal, Switzerland, California, PJM, New England). In the capacity markets in the United States the reason for focusing on electricity only is that the purpose of capacity markets is to ensure future demand can be met through either new supply capacity or load reduction. Energy efficiency improvements focusing on other fuels do not exclusively deliver load reduction, although programmes focusing on building retrofits often affect more than one fuel in the same building. For example, adding insulation, replacing inefficient windows and reducing air infiltration reduces both winter gas heating loads and summer electric cooling loads. Electricity-only auctions can therefore lead to under-investment in cost-effective efficiency by valuing only a portion of the benefits of some efficiency measures. Portugal's auction mechanism Plano de Promoção da Eficiência no Consumo de Energia Elétrica (PPEC) is an example of an auction that started with electricity as the only fuel in 2007 but is likely to include gas sometime in the future, potentially enhancing its cost-effectiveness (AHK Portugal, 2016).

In summary, all MBIs include electricity, many also gas, but fewer schemes focus on other fuels, particularly transport fuels. Where transport has been included, savings are relatively small.

Sectors

Another important design feature to be considered is the sectoral coverage, i.e. in which sector the energy savings can be achieved in order to either contribute to the programmes' targets (energy efficiency obligations) or be eligible for funding (auctions).

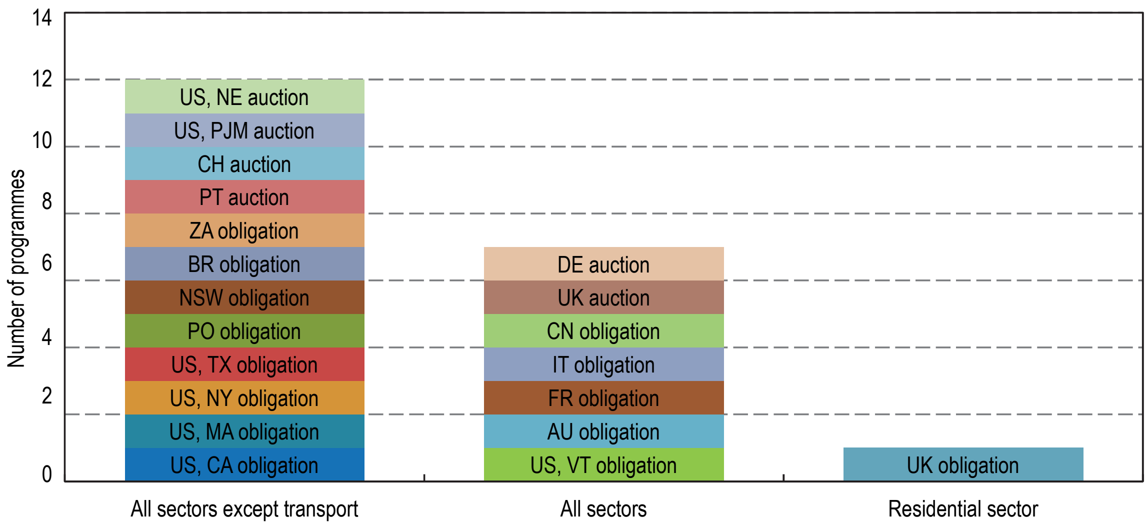
Figure 15 • Sectors decision tree



In principle, all end-use sectors (buildings, industry, transport, agriculture) can be covered by both obligations and auctions. Alternatively, a combination of selected sectors or even a single sector can be covered.

Most obligations analysed apply to all sectors, or all except transport, but some countries restrict the coverage to only one sector. For example, in the United Kingdom and Malta savings can only be delivered from residential buildings, in three of the four Australian obligation programmes (Australian Capital Territory, South Australia and Victoria) only the residential sector and small- and medium-sized businesses are covered. Other countries define the share of the savings to be delivered in specific sectors. For instance, in Ireland 25% of savings have to be generated in the residential sector (including 5% savings in the "energy poverty" sector) and 75% in the commercial sector and industry (Durkan, 2016).

Figure 16 • Sector coverage



Note: AU = Austria, BR = Brasil, CH = Switzerland, CN = China, DE = Germany, FR = France, IT = Italy, PO = Poland, PT = Portugal, UK = United Kingdom, US = United States, ZA = South Africa, NSW = New South Wales, CA = California, MA = Massachusetts, NE = North England, NY = New York, PJM = Pennsylvania, New Jersey, and Maryland, TX = Texas, VT = Vermont.

Even when all sectors are covered by obligations and auctions, the majority of the savings achieved are generated in residential and commercial buildings (almost all programmes) as well as industry (in particular Denmark, Ireland and Italy). Process energy is excluded from most schemes due to the specific nature of interventions and the complexity of estimating and metering the savings. In Europe, inclusion of process energy is further complicated because of potential double counting of savings from obligations or auctions and the EU ETS as discussed earlier.

Most auctions have a wide sectoral coverage and allow savings from a range of sectors (Portugal, Switzerland, PJM, New England, New Jersey, New York, Texas). Where auctions cover a wider range of sectors, they can be effective in delivering savings across the economy (except transport). An example is the Portuguese auction mechanism where the savings are more or less evenly spread across sectors (Table 3).

Table 3 • Share of savings by sector in Portugal's auction mechanism

Sector	Percentage of total savings, 2013-14
All sectors: Information, audits, training	18%
Industry and agriculture	30%
Commercial sector	38%
Residential sector	13%

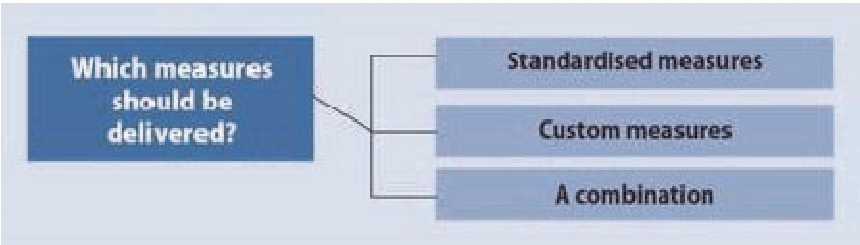
Source: Portuguese Energetic Services Regulatory Authority (2014).

Most MBIs include multiple sectors with some having a narrower focus on just one. Where MBIs cover all sectors most savings are delivered in the residential, commercial and industry sectors.

Eligible measures

Most obligations and auctions impose restrictions regarding the types of measures that can be used to generate savings. Measures can be standardised, custom, or a combination of the two.

Figure 17 • Eligible measures decision tree



In the United States, the regulators of the obligations often review and approve programme proposals out of a portfolio of measures proposed by the obligated utilities. Many obligations and auctions develop catalogues of eligible measures together with deemed savings that are awarded for each measure. Good examples of such catalogues can be found in South Africa, many of the European schemes (e.g. Denmark, France, Ireland, the United Kingdom), the United States (California, Massachusetts, Vermont) and Australia (New South Wales). There are also auction schemes where such catalogues exist, for example in Portugal.

Standardised measures are the most common types of eligible measures and they include for example replacing the heating system, building fabric improvements, lighting, HVAC (heating, ventilation and air conditioning), appliances, and motors. The main reason that such measures are most common is that there is a large potential for replication and the calculation of the savings is straightforward.

Alongside standardised measures, many programmes also allow for custom measures to be delivered. Those are particularly relevant in the commercial and industry sectors, where the savings from an intervention are highly specific and require bespoke calculations. Measures that are process-related are less common within obligations given the complexities involved in metering and estimating their savings. Examples of such measures can be found in the Danish and Italian obligation schemes where more than 40% and 60% of savings respectively are achieved in the industry sector (Togeby, 2015; Stede, 2016). Measures supported include highly specific technologies such as retrofitting kilns to optimise the air flow (Togeby, 2015).

The measures installed vary significantly from one country to another. In the Swiss auctioning scheme 43% of the savings derive from the services and commercial sector, 14% from the public sector, 19% from private households and 24% from the industry. The technologies receiving the highest levels of funding are pumps (12%), lighting (11%) and circulators (11%) (Bühlmann, 2017). In the Italian White Certificate scheme in 2016, 52% of savings were generated in the industry sector (of which thermal energy efficiency comprised 53%, electrical equipment efficiency comprised 26% and layout optimisation comprised 19%), and 41% of savings were generated in the civil sector (of which 47% came from thermal insulation and 43% from high efficiency boilers) (Rotiroti, 2017).

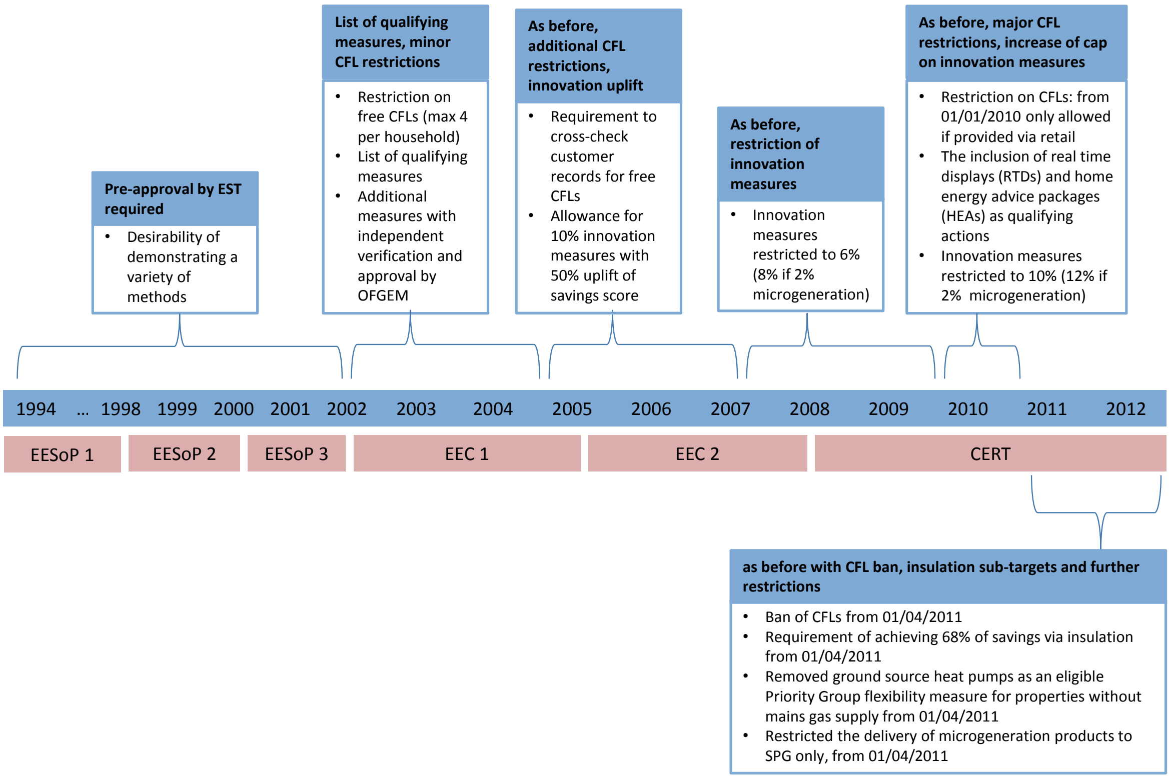
Behavioural measures

Behavioural measures are less common, although there are examples of those being promoted under both obligations and auctions. The Portuguese auction mechanism supports "intangible measures", which include information, training, campaigns and energy audits. In 2013-14, 26% of all savings were achieved by such behavioural measures (Sousa et al., 2015). The United Kingdom's obligations contained provisions for behavioural measures until the end of 2012 including home energy advice packs and visual display units. However, behavioural measures were capped at 2% of a supplier's target (Rosenow, 2013a). In the United States, obligations are often achieved partly by behavioural measures delivered through providers such as Opower and C3 who provide home energy reports to energy customers, e.g. in California and Vermont (Opower 2015; Efficiency Vermont, n.d.).

Deeper energy efficiency improvements

Given the focus on cost-effective energy efficiency measures in the past, there is a question about the ability of MBIs to deliver deeper efficiency improvements. In principle, this can be achieved by a) establishing incentives for deeper energy efficiency improvements and b) limiting the extent to which the most cost-effective measures can be utilised.

Figure 18 • The United Kingdom's restrictions on eligible measures in the obligation programme



Source: Rosenow (2012b).

In the case of obligations, there are examples where the regulator imposes quotas for specific types of measures. For instance, the United Kingdom's efficiency obligations contained a minimum share for insulation measures (Figure 18). As part of the extension of the CERT in 2010 and for the first time since the inception of the obligation, the government decided to set a minimum share for a particular type of measure (Rosenow, 2013a). Suppliers were required to achieve 68% of the CERT target by investing in insulation measures (DECC, 2010). Obligated parties are required to deliver a particular amount of CO_2 savings to be achieved through delivery of solid wall insulation measures (estimated to be equal to at least 100 000 solid-wall insulation installations) over the period January 2013 to March 2017 (Ofgem, 2015). Similar to requiring a minimum share of savings to be achieved by more expensive measures, restrictions can be applied to the amount of low-cost savings. For example, the German auction mechanism only supports measures with lifetimes longer than three years and lighting measures may only contribute up to 30% of savings within a project and make no contribution to aggregated projects (i.e. a number of smaller projects bundled together, BMWI, n.d.b).

Similarly, there are examples of incentives being used to stimulate deeper savings from MBIs. Auctions can use a range of criteria rather than just cost per kWh. One such criterion could be the depth of improvements proposed. Another UK obligation, the Community Energy Savings Programme (CESP), included a carbon scoring system, which acted as the primary mechanism to ensure delivery of expensive measures in a whole-house approach. Incentives to promote more expensive measures functioned (Box 7). The Portuguese scheme does this and takes the following criteria into account: cost-effectiveness, risk, the portion of funds needed compared to investment costs, quality, ability to overcome market barriers and spill over effects, equity, innovation and promoter experience, which vary depending on whether the measures are tangible or intangible (Sousa et al., 2013). To some extent this makes the Portuguese programme closer to a more standard policy programme, in that it uses multi-criteria analysis when distributing funds; other MBIs take account of criteria other than cost in the pre-qualification criteria for bidders, or in the rules governing allowable measures.

Box 8 • Incentives for deeper energy efficiency improvements in the UK's Community Energy Savings Programme (2009-12)

More expensive measures such as solid wall insulation received high carbon score uplifts (i.e. the amount of carbon savings that can be claimed) of up to 200%. Less expensive measures such as microgeneration were subject to a 50% uplift. Typically, cheaper measures such as cavity wall insulation received a carbon "penalty" of -50%. In addition to incentivising the promotion of expensive measures, delivery within the whole-house approach was encouraged: if more than one measure was installed in the same property, an additional uplift was granted for each measure. Again, the carbon score uplift differed from measure to measure. Measures such as solid wall insulation, heat pumps, fuel switching and replacing boilers were rewarded with a 40-50% carbon score uplift. All other measures received a 10% uplift if installed in combination with at least one other measure. The result was that this whole-house bonus was triggered in 60% of the properties treated. However, in only 20% of the dwellings were three or more measures installed. This could be due to the scoring system for multiple measures being perceived as complex, as reported in the final evaluation of the scheme (Ipsos MORI et al., 2014). What the CESP experience shows is that obligated parties do follow such performance incentives in principal but they need to be designed in a way that avoids too much complexity.

Source: Rosenow (2012a).

The standard offer programme for efficiency in New Jersey has a fairly powerful incentive for deeper efficiency investments. The pay-for-performance programme pays for efficiency provided it delivers at least a 15% reduction in a treated location. The rate paid for deeper savings gives providers an incentive to deliver above the minimum: if the programme saves 16% for example, the payment formula gives an additional incentive for *all* of the savings at that site, not just the incremental portion. This pattern continues until a cap is reached, but even with the cap in place, this formula has been a spur to deeper retrofits (New Jersey Board of Public Utterances, 2016).

Including more expensive measures in obligations is not straightforward for a number of reasons. First, the social equity implications of doing so have to be carefully considered. Obligations are funded through energy bills, which means that all customers pay for the programme. If the obligation is limited to fewer more expensive projects, a smaller number of people and organisations benefit whereas everybody still has to pay.

The example of the United Kingdom illustrates this particular point: after requiring the obligated parties in 2013 to carry out costlier measures (such as solid-wall insulation) and a political debate about the cost of energy, a backlash resulted eventually in a less ambitious energy efficiency obligation. This shows that the political dynamics are not trivial.[22] However, there are ways to dampen the effect of concentrated energy saving benefits versus dispersed energy bill costs: in France, many energy efficiency measures are part-funded by obligations and tax rebates, which results in lower costs of the obligation and thus lower bill surcharges (Rohde et al, 2015). In principle, such an approach could be used to employ obligations for the purpose of delivering technologies with higher costs and deeper energy efficiency improvements. The obligation would be the primary delivery mechanism to ensure that energy savings are being achieved. At the same time, funding for less cost-effective measures would be provided by a mechanism funded through general taxation in order to part-fund those measures together with the obligation.

[22] For a discussion of this matter see Rosenow et al. (2015).

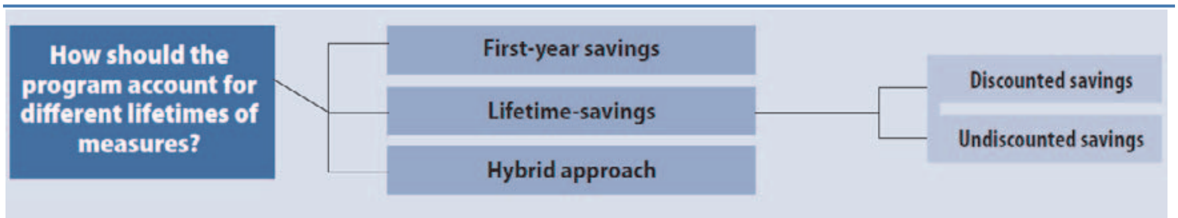
The second consideration with regards to deeper energy efficiency improvements is that the savings from more complex projects are not as easy to predict and obligated parties gravitate to those measures where savings can be clearly determined in advance (by using deemed savings) in order to minimise risk of non-compliance. The experience from the United Kingdom's CESP shows that if the savings calculation for deeper retrofits is too complicated, the obligated parties will continue to focus on single measures and not whole house retrofits. Evidence from the ESCO market also suggests that interventions in complex industrial processes that would potentially deliver much deeper savings are typically not carried out by ESCOs due to the larger investment and the risks involved (IFC, 2011).

In summary, all MBIs deliver savings primarily through standardised measures often in combination with more customised interventions. It is possible to design MBIs in such a way that they deliver more comprehensive energy efficiency improvements beyond single measures.

Lifetimes

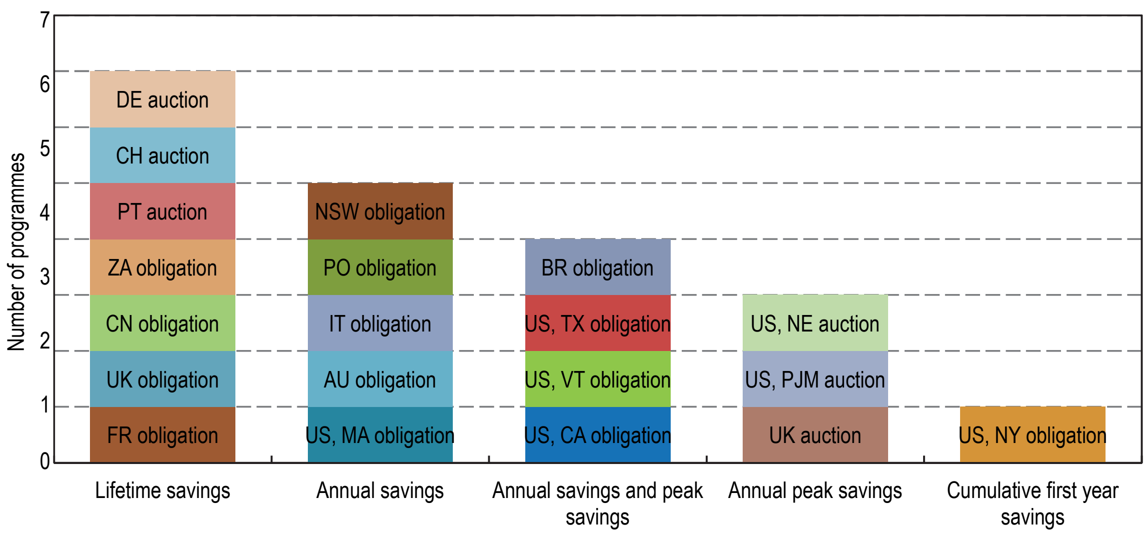
The decision whether to account for the different lifetimes of energy efficiency improvements has a substantial impact on the extent to which bidders and obligated parties are encouraged to focus on longer-lived measures or short-term savings. The principal options consist of accounting for first-year savings, lifetime savings or a hybrid approach (Figure 19).

Figure 19 • Lifetimes decision tree



There is a lot of heterogeneity in how lifetimes are treated. Most obligations assign a one-year lifetime for measures (Figure 20). This potentially underestimates the lifetime savings and prioritises measures with shorter pay-back periods and lifetimes. Examples where only first-year savings are calculated include the obligations in South Africa, Brazil, China and most of the US obligations.

Figure 20 • Treatment of lifetimes in MBIs



Note: AU = Austria, BR = Brasil, CH = Switzerland, CN = China, DE = Germany, FR = France, IT = Italy, PO = Poland, PT = Portugal, UK = United Kingdom, US = United States, ZA = South Africa, NSW = New South Wales, CA = California, MA = Massachusetts, NE = North England, NY = New York, PJM = Pennsylvania, New Jersey, and Maryland, TX = Texas, VT = Vermont.

Some of the Australian obligation programmes such as in New South Wales use lifetime savings. The European obligations experience is very varied in terms of how long the resulting energy savings should be reflected when setting the target. Variation ranges from either annual energy savings (Austria) to lifetime energy savings (France, United Kingdom) or something in between (Denmark).[23] However, there is growing recognition that only counting the first-year energy savings toward a target undervalues savings from those measures with longer lifetimes. In other words, the desired economic outcome is not always achieved by an obligation focusing on first-year savings only, as this favours short-lived measures that do not necessarily bring the greatest long-term economic benefits. This has been recognised in Denmark by the introduction of weighting factors that depend on the lifetime of the energy efficiency measure (ENSPOL, 2015).

In January 2012, Italy also introduced a "tau" coefficient, a multiplier to value longer-lived measures such as insulation and industrial projects (Stede, 2016). This led to a sharp increase in the share of measures delivered in industrial equipment with long lifetimes: total industry savings rose from just 6% in 2007 to 62% in 2015. The key driver was the introduction of the tau coefficient. An interesting side-effect is that compliance rates have increased since its introduction. This is most likely because obligated parties were provided with a larger pool of economically viable savings options (due to valuing the contribution of longer-lived measures in the accreditable savings). This made it easier to "find" new savings options (Stede, 2016). Without recognising the real economic value of the lifetime energy savings, obligated companies with a first-year energy savings target only will naturally focus on the cheaper, short-lived energy efficiency measures. This may not be the desired outcome from a national perspective when taking into account the benefits of longer-lived measures.

For auctions, the situation is also varied. Portugal and Switzerland attribute lifetime savings. The auction scheme in Germany requires a minimum lifetime of ten years and accounts for lifetime savings when calculating the cost-effectiveness of proposed projects. In the capacity markets in New England and PJM, different rules apply. In the New England market, efficiency investments can earn capacity payments over the full lifetime of the measure. In PJM by contrast, efficiency measures can earn capacity payments only for the first four years (Neme et al., 2014). PJM's policy is based on its stated concern that its own load projection methodology is too uncertain over longer periods. But critics point out that certified efficiency measures will still be delivering savings in those later years, regardless of what the market-wide load projections may be from one year to the next.

Besides the variation across schemes regarding first-year and lifetime savings, there are different approaches towards discounting future energy savings. In cost-benefit analysis, it is standard practice for governments to discount the future benefits of any policy at the societal discount rate. It has become standard practice for some MBIs to follow this approach when setting energy savings targets – which of course does not affect those MBIs that only count first-year energy savings. Especially for longer-lived measures, discounting future savings at a relatively high rate can reduce the incentive to invest in such measures. Discounting energy savings is the procedure followed for savings denoted in lifetime energy savings for example in France and in the United Kingdom until 2008. In France, the energy savings from the obligations are discounted with a discount rate set at 4%. In the United Kingdom, a 3.5% discount rate was used until significant changes were introduced after 2008, which led to the abandonment of the use of discount rates in the calculation of lifetime energy savings (Ofgem, 2009).

In conclusion, the approach to lifetimes differs across the MBIs analysed. Whilst evidence suggests that accounting for the whole lifetime of an intervention is more likely to result in more

[23] Denmark provides uplifts for measures with longer lifetimes.

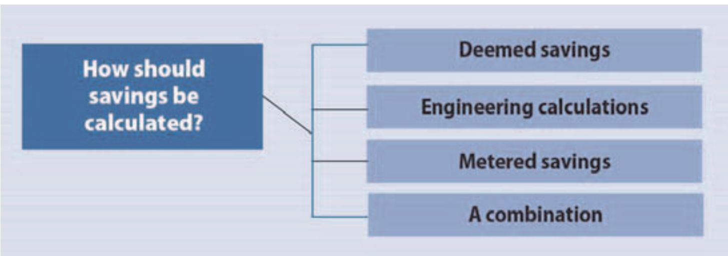
comprehensive and economic measures, many MBIs limit the number of years or only focus on first-year savings. Schemes that count only short-term savings will provide strong incentives for short-lived measures, and little incentive for longer-term, sustainable investments that may be more expensive to install but more cost-effective over the long run. Experience shows that modifying how longer-lived measures are accounted for can have positive effects on investment in more comprehensive measures combined with an increase in compliance rates.

Calculation of savings

There are several approaches to calculating the energy savings from MBIs or energy efficiency programmes in general. The different approaches are often combined in the same programme (e.g. Italy, New South Wales). The principal calculation methods include:

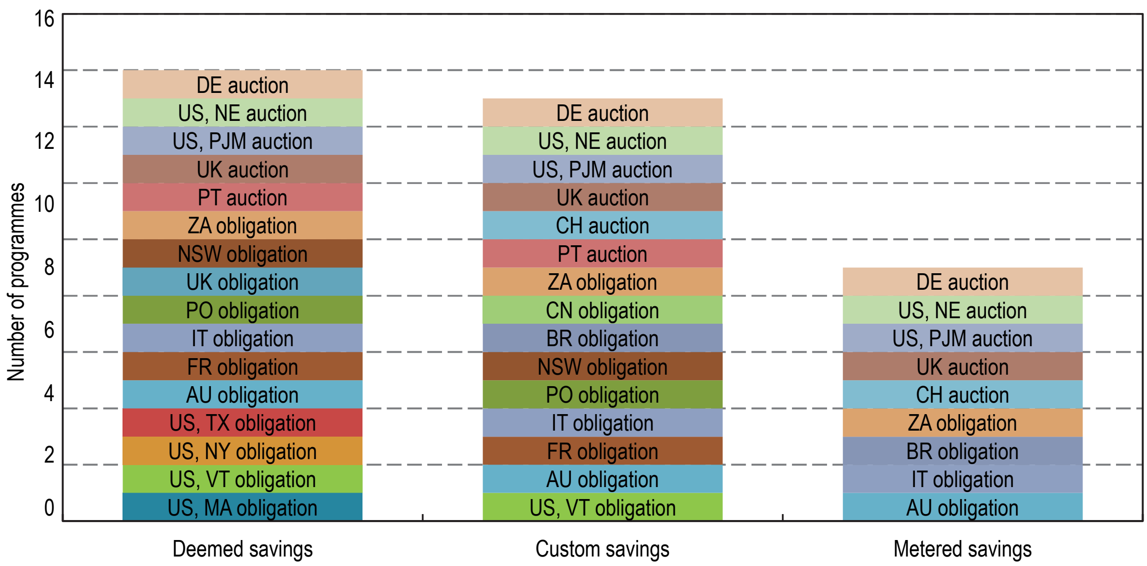
- **Deemed savings**: These are based on the results of previous energy improvements using the same technologies (in the best case independently monitored). Through analysing a statistically representative sample, typical energy savings values for standardised technologies can be established. Such deemed scores are typically published alongside the catalogue of eligible measures (for example in New South Wales, South Africa, the United Kingdom, France, Denmark, Portugal and the United States). In the United Kingdom, there is a high level of granularity in the calculation of deemed savings, with permutations for each measure type based on factors such as the wall type, heating system and property type.
- **Metered savings**: These are based on direct measurement of the actual energy use before and after an intervention. The savings from the installation of a measure or package of measures is determined by taking into account factors such as additionality, occupancy, production levels and the weather, which may affect consumption (see for example Austria, Denmark, New South Wales, South Africa and Switzerland). The digitalisation of the energy sector, including the introduction of smart meters are making metered savings more cost-effective and are leading to their greater use in some jurisdictions.
- **Engineering calculations**: These are based on engineering estimates of savings based on building physics or performance parameters for example. Engineering calculations are typically used where establishing robust measured data for a specific installation is difficult or disproportionately expensive. An example is replacing a compressor or electric motor with a different kWh rating than that for which the information on savings has been independently measured and verified. Engineering calculations are common in many of the MBIs analysed, including most of the US States, China, South Africa, Austria, Denmark, France, Italy, Portugal, Switzerland and New South Wales.

Figure 21 • **Calculation methods decision tree**



One of the reasons deemed savings are used widely (Figure 22) is that they offer certainty as to the energy savings that the energy company or bidder will receive or get funding for provided the measure is correctly installed. The approach also offers easier administration for both the energy company or bidder and the administrator. Finally, all these benefits translate into lower costs for end users. Another reason for the use of deemed savings is that MBIs support a high degree of standardised measures for which deemed savings are most suitable. The main downside associated with deemed savings relates to the perverse incentive it creates for the installation of measures that satisfy the conditions for a deemed score but, in reality, will deliver fewer savings. Experience shows that it is sensible to regularly review the deemed savings estimates to ensure they are still accurate and that the reported savings are a good approximation of the realised savings. In the future, as the costs of metered savings estimates comes down, more and more installations will be able to move away from the deemed approach. In 2015, California moved all of its savings measurement to the metered approach (Box 16).

Figure 22 • Calculation methods



Note: AU = Austria, BR = Brasil, CH = Switzerland, CN = China, DE = Germany, FR = France, IT = Italy, PO = Poland, PT = Portugal, UK = United Kingdom, US = United States, ZA = South Africa, NSW = New South Wales, CA = California, MA = Massachusetts, NE = North England, NY = New York, PJM = Pennsylvania, New Jersey, and Maryland, TX = Texas, VT = Vermont

Box 9 • Adjustment in savings calculations

Exogenous factors: These are factors other than the programme that may affect energy use in the home (e.g. energy price changes). When these act at the same time as the programme, the effect of the programme has to be separated from the effects of these exogenous influences to determine programme impacts.

Rebound effect: The rebound effect describes the phenomenon where consumers increase the level of energy services (e.g. indoor temperature) after an energy efficiency intervention (e.g. insulation). Hence the savings are not as high as those calculated assuming no change in demand for energy services.

Performance gap: The performance gap relates to differences between calculated and actual consumption that can be explained by technical or operational faults in the exacting processes of installing energy efficiency measures or the installed technology itself. In other words, the technology does not deliver the savings estimated based on manufacturers' specifications.

Free riders: Free riders may be defined as those who would have made energy efficiency improvements anyway, with or without programme support. This means the savings due to free riders would happen anyway and cannot be counted towards the programme.

Free drivers: Savings from free drivers result from measures being installed as a result of but not through the programme. This is the case when additional measures are installed over and above the programme's incentives or if non-participants take measures as a result of the programme.

Source: Rosenow and Galvin (2013); Wade et al. (2015).

More complex installations require bespoke calculations or even metering. Metering is typically used for larger projects where the costs of metering can be justified more easily. Some MBIs do not include those methods at all and others rely exclusively on engineering estimates and metering, with the latter being less prominent. Where engineering calculations are used, there is a risk that the estimated savings might not be fully realised if important adjustments are not being made. Best practice for calculating savings includes adjustment for exogenous factors, rebound effects, free riders and drivers, and the performance gap (Staniaszek et al., 2012).

Box 10 • Avoidance of double-counting in France

In France, the energy efficiency obligation has recently been reviewed to adapt it to the requirements of the EU Energy Efficiency Directive (EED). This included an adjustment of the deemed savings used for the catalogue of standard measures eligible under the scheme. For instance, savings that would happen anyway (e.g. due to the Ecodesign Directive) are no longer eligible. The deemed savings for a range of measures falling under EU minimum requirements have been reduced accordingly to reflect the need for savings to be additional to minimum requirements (in this case the baseline is the market average in France).

Additionality of energy savings is an important concern that needs to be addressed in order to ensure that the energy savings would not have happened even in the absence of the programme. At least two factors need to be considered here - the phenomenon of free-ridership and potential double-counting of savings if other programmes are in place. It is not practicable to identify free-riders precisely, so an adjustment needs to be made to the savings estimate in line with estimates of free-ridership. When it comes to other policies and the risk of double-counting, there are several ways this can be addressed. In Germany, an adjustment factor is applied to all energy efficiency policies (including the auction scheme) that accounts for overlap between policy instruments and effectively reduces the energy savings. Austria has chosen a similar adjustment process for its obligation. A well-known example of addressing double-counting is France (Box 10).

A best-practice example of efforts to generate reliable savings estimates is the National Energy Efficiency Data-Framework (NEED) of the United Kingdom. It was set up to provide a better understanding of energy use and energy efficiency in domestic and non-domestic buildings. The data framework matches gas and electricity consumption data with information on energy efficiency measures installed in homes (Department for Business, Energy & Industrial Strategy, 2013). With the type of information available in NEED, one can measure actual performance in control and treated groups, enabling a better-informed approach to the calculation of deemed savings attributed to measures.

Box 11 • Calculation of energy savings in the New England and PJM capacity markets

In the New England and PJM capacity markets, the system operators have created monitoring and verification guideline manuals that provide detailed guidance on how the capacity contribution of efficiency measures should be calculated. Those manuals are consistent with the efficiency industry's International Performance Measurement and Verification Protocols (IPMVP) and include a variety of statistical and engineering approaches (Neme et al., 2014). These standards are conservative and strict, an approach consistent with the system operators' view that their mission is to protect reliability through rigorous standards, whether or not this favours energy efficiency investments.

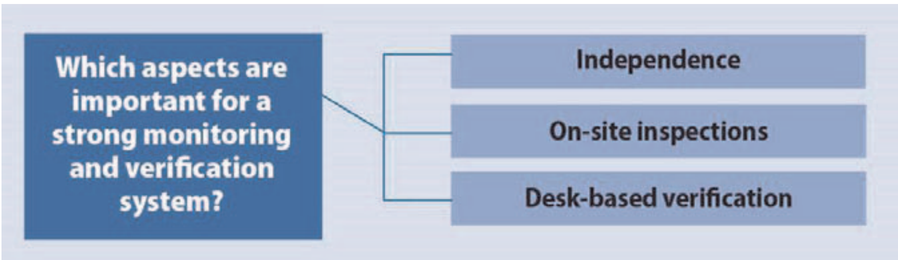
Non-deemed and thus more complex approaches have been used increasingly by some MBIs. For example, in Italy deemed savings projects accounted for 75-90% of annual savings in the period 2006-10, but in recent years, savings from the more challenging monitoring plans usually applied in the industry sector have risen to shares of between 64% and 80% (Stede, 2016).

Most MBIs use deemed savings for the majority of savings as this is relatively low-cost approach to savings calculations, provided that the deemed saving scores are derived through a robust methodology. Where more complex and bespoke interventions take place, metered savings and engineering calculations are used, and California has moved towards the use of metered savings for all measures.

Monitoring and verification

Monitoring and verification is crucial for ensuring that the savings on paper reflect the actual savings achieved. This includes a mechanism that allows the responsible government agency to track progress and get reassurance that the projects supported by MBIs are carried out in accordance with the standards set by the programme. Key aspects of a robust monitoring and verification system are independence, on-site inspections for a sample of the measures, and desk-based verification (Figure 23).

Figure 23 • Key aspects of a strong monitoring and verification system



To minimise bias, it is important to have an independent verifier other than the involved parties. This is the case in many of the MBIs analysed (for example Denmark and the United Kingdom). An open process for reviewing conclusions presented by the verifier is also needed, including the possibility to appeal. Open, public proceedings on such topics are standard practice among utility regulatory commissions in the United States, who are most often responsible for reviewing implementation and cost allocation of obligations. California, Massachusetts, Vermont, New York and several other leading States have opened public dockets to examine programme effectiveness, often issuing corrective orders to help improve programmes going forward.

Globally, there is a growing recognition that independence is important. For example, until recently energy savings from the Chinese obligation programme were self-reported by the grid companies using their own monitoring and verification methodologies. Deemed savings values for some energy efficiency measures were developed by the China Electric Power Research Institute, a subsidiary of State Grid and an obligated party under the obligation. Since 2013, a manual for monitoring and verification provides a framework for independent reporting on the achieved savings (Crossley et al., 2015).

The monitoring and verification system should be developed and adjusted over time to keep up with changes in the programme (including technological performance and cost reductions of the measures) and data availability. Monitoring and verification typically involves site inspections and desk-based audits. Using statistical verification techniques rather than checking every single installation is a sensible approach to minimise administrative cost and to be practicable. In case the system picks up irregularities the depth of controls can be increased.

It is important to keep monitoring and verification systems simple whilst balancing this with the need for a sufficient degree of accuracy. Poland's obligation scheme (pre-2016) was reported to have complex and costly monitoring and verification provisions, leaving much of the requirements to the interpretation of the auditor (ENSPOL, 2015). In the United Kingdom, savings for each measure promoted by the obligation had to be calculated individually for each property using a complex software tool that took into account occupancy and other factors. In the past, simple deemed savings scores were used instead. Recognising the complexity, the government announced a return to deemed savings (DECC, 2016b).

Box 12 • Monitoring and verification in the United Kingdom's obligation programme

In the UK, 5% of each measure type is audited through on-site inspections by independent auditors. In addition, desk-based checks are carried out. This includes monitoring the quality of an installation and the accuracy of reported savings. In addition, the regulator sets up a counter fraud team that works to detect, prevent and deter fraudulent activity. If the technical monitoring failure rate for a particular installer or a measure type installed by a particular installer is higher than 10%, the regulator will require the obligated party in question to conduct additional monitoring. In case of consistently high failure rates the regulator can revoke or refuse the reported savings. In addition, there is also a minimum requirement for a supplier to subject at least 3% of an installer's measures to inspections, to ensure that the 5% is representative of all installers (Ofgem, 2015).

Monitoring and verification is an important component of auction mechanisms to ensure that payments accurately reflect the savings. In the case of the German auction scheme, funds are only paid for the amount of energy saved, measured through metering (BMWI, n.d.b). The Swiss auction programme provides funds for projects after proof of implementation through invoices and updated calculations or metering results. If the energy savings are less than 100% of the initial estimate a proportional reduction of the provided funds takes place. For programmes, funds are also only paid after implementation but there is some flexibility and around 10-20% of the payment can be made upfront (Koenig, 2017).

Box 13 • Monitoring and verification in the New England and PJM capacity markets

Accuracy is particularly important where efficiency resources are enrolled in capacity reliability mechanisms in regional power markets. The system operators managing such systems depend on those resources to ensure reliable supply. For this reason, the monitoring and verification rules governing efficiency and demand response resources are very strict in those markets. In PJM and ISO-New England potential efficiency bidders must be pre-qualified even to participate in the auction. For example, ISO-New England requires bidders to register as market participants, to demonstrate financial capacity to deliver on their bids, and to file for review their detailed plans, including a "critical path" schedule with detailed milestones for delivering the efficiency measures they intend to bid into the system (Winkler, 2016). This process of pre-qualification helps the ISO to better understand the nature of the resources being bid, and to monitor the winning bidders' progress towards delivering cleared resources after the auction, avoiding unwelcome surprises with undelivered savings when the delivery year arrives.

These requirements for demonstrating successful delivery of calculated capacity reductions are substantial. Efficiency Vermont, for example, reports that up to 30% of the revenue received in the ISO-New England capacity auctions is taken up in the administrative costs of participating in the auctions and demonstrating compliance (Gottstein et al., 2010). On a more positive note, the affirmation by system operators, based on rigorous analysis, that end-use efficiency demonstrably reduces critical peak loads and delivers capacity resources at least as reliably as conventional "iron in the ground" generators provides important evidence to those who are measuring the contributions of efficiency resources in many settings, not just capacity markets.

Monitoring and verification practices are very different across the world. There are no binding rules for monitoring and verification at the EU level (Schlomann et al., 2015). While Annex V of the Energy Efficiency Directive sets out the basic requirements for monitoring and verification and the guidance note on Article 7 further explains how the requirements can be addressed, they do not set out the details. As a result, Member States adopt different approaches and report on their methodologies in different ways. This may be well justified, since some calculation approaches are better suited to some policies than others. However, as a result, the energy savings that are notified by Member States, and the information reported on methodologies, are not fully consistent or comparable at EU level (Rosenow, Leguijt, Pato, et al., 2016).

There have been attempts to develop detailed guidance on monitoring and verification elsewhere. For example, the US Environmental Protection Agency has developed draft measurement and verification guidance for demand-side energy efficiency (EPA, 2015). In some countries, the International Performance Measurement and Verification Protocol (IPMVP) is used as a framework for monitoring and verification (EVO, n.d.). IPMVP defines standard terms and suggests best practice for quantifying the results of energy efficiency investments. IPMVP is used in a number of obligations including Brazil, Poland and South Africa.

Box 14 • Monitoring and verification in South Africa

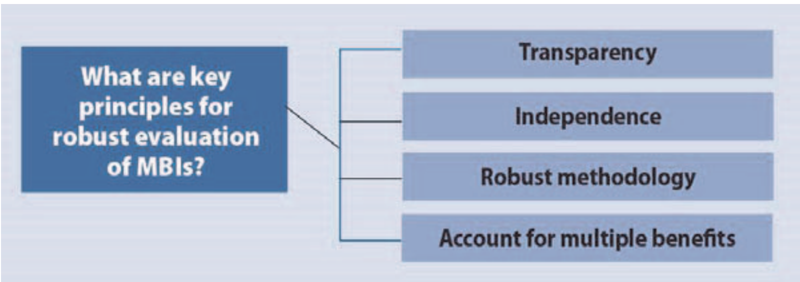
South Africa has developed guidelines for measurement and verification of energy savings: the standard SANS 50010 was developed by the South African Bureau of Standards based on IPMVP and provides a standard approach to measure and verify energy savings and energy efficiency (SABS, 2011). More specific guidelines are developed per programme type or for specific measures. South Africa has an independent professional body, the Council of Measurement and Verification Professionals of South Africa, offering training and certification of professionals.

In summary, all MBIs involve some form of monitoring and verification, and two points stand out in particular: first, robust systems are characterised by a high degree of independence of the agent responsible for monitoring and verification; second, strong monitoring and verification systems involve not only desk-based checks but on-site inspections as a means of verification.

Evaluation

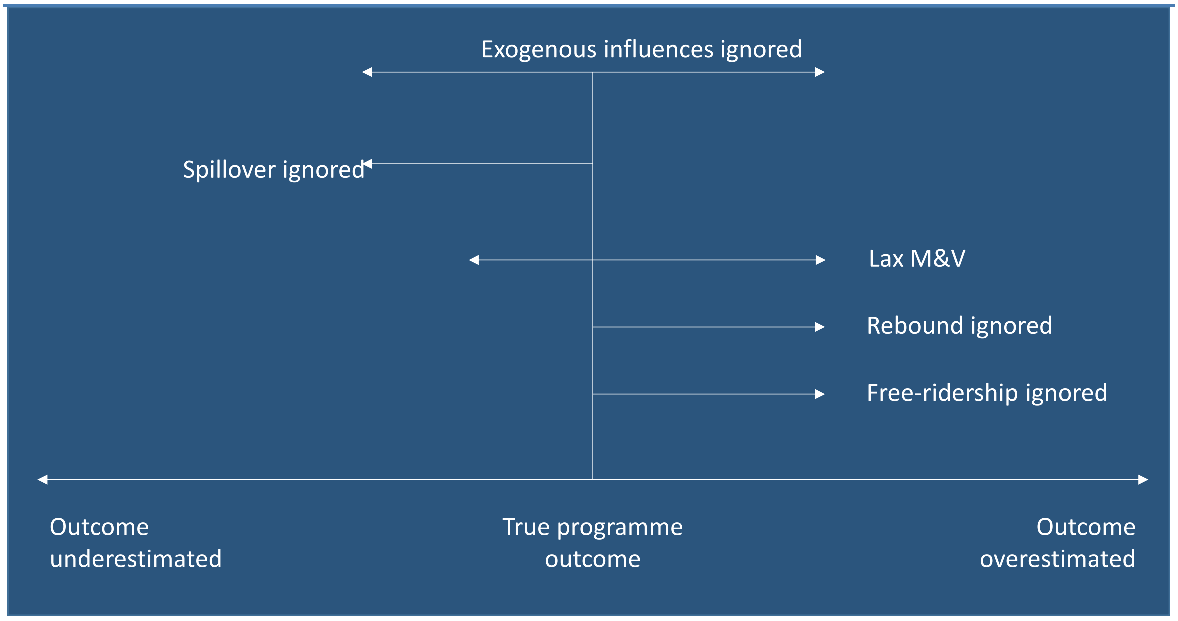
Good evaluation of MBIs is characterised by a number of features. Evaluations need to be transparent, produced independently, use robust methodologies and account for the multiple benefits of energy efficiency (Figure 24).

Figure 24 • Key principles for robust evaluation of MBIs



The most sophisticated and robust programmes are typically associated with strong evaluation practices. While monitoring and verification is concerned with collecting data on savings from individual sites or projects, evaluation focuses on the MBI itself. Monitoring and verification can be a subset of evaluation and provide data on the number of, and savings from, specific measures implemented under the programme. Also the stringency of calculating savings is important as described in the respective section above. Evaluations typically consist of an impact evaluation part (e.g. how many savings were achieved) and a process evaluation part (e.g. how did the programme deliver the outcome) (Schiller et al., 2011).

Figure 25 • Impact of energy savings estimates for evaluation



Source: Adapted from Wade et al. (2015).

In order to be able to identify weaknesses in a programme, evaluations need to be carried out regularly. Regular evaluation provides a mechanism for constant learning and improvement. A good example is the Californian obligation, which is evaluated annually to agreed protocols. The evaluation reports are published on the CALMAC database so that others can access and scrutinise them (CALMAC, n.d.).

Box 15 • Evaluation in Vermont

Efficiency Vermont (EVT), the State's designated "efficiency utility", is subject to multi-year performance contracts with multiple goals. EVT submits monthly and quarterly progress reports to the Department of Public Service, which monitors that progress on behalf of the public, and to the utility regulator, which has legal responsibility for supervising the overall programme. This leads to regular reviews of EVT's targets, performance and methods of reaching customers and delivering services. A thorough public evaluation, including public hearings conducted by the Board and Department, is done at the end of each three-year compliance period, which feeds into programme revisions for the following performance contract.

Source: Vermont (n.d.).

An important conclusion from this experience over the past decade is that a rigorous and public process of review can drive innovation in delivery routes and build greater public awareness of the services being offered. In addition, obligations are unlikely to meet deeper savings targets over time without the programme reviews.

Another important evaluation practice is to ensure complete independence of the evaluator from the programme administrator, obligated parties or bidders. There are instances where the obligated parties or the administrators themselves are responsible for evaluating the programme. For example, in Switzerland the administrator is responsible for the evaluation of the auction without third-party involvement.[24] This is not necessarily an issue but in principle full independence is not guaranteed under this arrangement. An example where independence is particularly well established is the Californian obligation programme. To avoid conflicts of interest, process and impact evaluations have to be done by different contractors (ENSPOL, 2015).

When carrying out evaluations it is important to make the intervention logic explicit. The evaluation needs to be targeted according to the programme's goals, e.g. "Does the programme reduce consumption in areas at times when and where it matters?", "Does the programme benefit fuel poor households to the extent planned?".

As with any other energy efficiency programmes, MBIs need to be evaluated using robust methodological approaches. In theory, the most robust methods include randomised control trials comparing those who received energy efficiency measures with those who did not (Vine et al., 2014). However, they are rarely used outside of behavioural programmes such as in California and Massachusetts (Steinberg et al., 2014). Reasons for this include reluctance of programme administrators to engage in experimental evaluations due to the higher costs, unfamiliarity with such approaches, and the need for timely results (Wade et al., 2015). Engineering calculations of energy savings are considered to be less robust, although a number of adjustments can be made in order to increase their reliability. Such adjustments account for factors such as rebound, free-ridership or free-drivers/spillover effects (see section on monitoring and verification as well as Wade et al. (2015)). There are good examples of such an approach: the California evaluation framework includes recommendations for making such adjustments and converting gross to net savings (TecMarket Works, 2004). In the United Kingdom, the government regularly reviews and adjusts the assumed savings achieved by specific energy efficiency measures (Rosenow and Galvin, 2013). The latest effort in this regard has been the development of the NEED (see above).

Finally, it is important to note that jurisdictions vary widely in the range of benefits from an MBI they choose to evaluate. The benefits assessed include energy cost savings, carbon emissions reduction, air quality improvements, health impacts, increased comfort, reduced investment in transmission and distribution, etc. Comprehensive evaluations are scarce and not carried out routinely in most of the cases analysed. Regulators in Massachusetts, for example, encourage utilities to report on the multiple benefits of their efficiency programmes but do not require them to do so. Other jurisdictions, including California, collect information on some benefits but not all. For this reason, even in jurisdictions with well-developed energy efficiency obligations, there is often a lack of awareness of the full value of the obligation's effort. This may lead to underinvestment in end-use efficiency and even to the mistaken conclusion that obligations only benefit direct customer participants, or that the only benefit is avoiding short-term marginal energy unit costs. A leading example of more complete analysis is Vermont, where Efficiency Vermont annually reports on a wide range of benefits.[25] The report found that a full accounting of benefits would reveal net benefits, even of aggressive programmes, that are several times higher than their costs. Also in the United Kingdom, the obligation's multiple benefits are evaluated in ex-ante impact assessments covering a wider range than what is typical in other European schemes.

It is noteworthy that evaluation practices are very different across the world. For example, in the United States about 3-6% of programme costs are spent on evaluation, monitoring and verification (State and Local Energy Efficiency Action Network, 2012). In European countries with MBIs the evaluation budget is significantly smaller. There are no EU-wide estimates but we can

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[24] The evaluations are authored by the administrator (BfE, 2014).

[25] A thorough review and summary of those benefits, based on the Vermont data from 2010, is included alongside others of its kind in Lazar et al. (2013).

draw on examples where data on the budget allocated to evaluation has been made public. For example, the obligation operating in the United Kingdom from 2008 to 2012 was evaluated with a budget of around USD 630 000 compared to programme costs of around USD 4.5 billion.[26] This equates to just 0.02% of the programme costs (Ipsos MORI et al., 2014). However, some of the costs are borne by the obligated parties. In the United Kingdom, this cost is estimated to be around 1%. This is based on the requirement that approximately 5% of all measures have to be audited at a cost of approximately 10% of the measure cost. This equates to 0.5% of the total programme cost. In addition, there is a cost to the obligated parties of employing a compliance team of up to 0.5% of programme costs.

Evaluation practices vary significantly amongst the MBIs analysed. Strong evaluative practices feature regular and transparent evaluations that can be scrutinised by all stakeholders. They are based on robust methodologies accounting for factors such as free-riders, free-drivers, rebound effects and technology performance gaps. The best practice of accounting for the multiple benefits of energy efficiency is implemented only in a few programmes.

Box 16 • Best practice in MVE

In California, recent changes to the way that energy efficiency is measured have moved the State away from the *ex ante* deemed savings approach to one based on taking into consideration the overall reduction in normalised metered electricity and natural gas consumption. Driven by the ability to collect and analyse increasingly large digital data sets, the approach will standardise measurement, focussing on the difference between baseline use before efficiency installations and consumption thereafter. Basing incentive payments on measured results will drive continued improvement in the quality of efficiency installations.

Source: Golden (2015).

Evaluation of obligation-specific design features

Obligated parties

One of the most important design features of an obligation programme is the choice of obligated entities. In principle, there are three options available (Figure 26).

Figure 26 • Obligated parties decision tree

For most of the MBIs described in this report, governments have chosen to assign obligations to established energy companies, either retail suppliers or distribution companies. There are reasons for this choice. In the United States, the decision grew out of a utility reform movement called Integrated Resource Planning (York et al., 2012). Integrated Resource Planning recognised that vertically integrated utilities were typically investing in supply-side resources that were more

[26] The final evaluation was budgeted at USD 315 000 according to Data.gov (2013) and given the length and detail of the interim evaluation a similar budget for the interim evaluation is assumed.

expensive than the untapped demand-side resources that could reduce the need for new supply. Therefore, franchised utilities should have an obligation to pursue least-cost solutions for the benefit of their customers. By definition, energy efficiency is then a potential power system resource that should be pursued in a comprehensive fashion alongside generation, power purchases, and transmission and distribution assets. Thus it was logical that energy efficiency services should be part of the utility franchise, not something delivered by governments or other third parties.[27]

Moreover, in many jurisdictions decision-makers were wary of taking complex and costly energy programmes into the government, bringing both new "taxes" and new controversies into state administrations.[28] In the United States, with a strong regulatory system in place in each State, already overseeing the utilities, the responsibility to manage obligations could naturally fall to the energy regulators with the processes and authorities needed to supervise the utilities. Also in Europe, the administration of energy efficiency obligations is sometimes allocated to the energy regulator as is the case in Italy and the United Kingdom. Other common obligation administrators are state agencies, as is the case in Denmark, and government ministries, as is the case in France.

Another reason given for placing the savings obligation on energy companies is that they have direct relationships with customers and this ought to be part of their business. Moreover – and this is an important feature in most jurisdictions – when a performance obligation is placed on a public utility or energy supplier, the costs of achieving the obligation remain outside the governmental system of accounts. In this way, it does not add to the size of the government's budget and does not require annual appropriations through the state legislature or national parliament.

As to the choice between placing the obligation on suppliers versus distributors there are various pros and cons for each option (Table 4).

Table 4 • Pros and cons of placing the obligation on energy suppliers or distributors

	Obligation on distributor	Obligation on supplier
Pros	Stable source of revenue as a regulated monopoly is not subject to market competition Energy regulator is used to dealing with variations in the size of the obligated distributor	Closer contact with end-use customer Still viewed by customers as the place to ask about energy efficiency In a competitive market, suppliers have more marketing skills than regulated monopolies Could encourage an energy service approach Provides a recognised brand that can help overcome some of the concerns in relation to the installation of building fabric measures in homes
Essential requirements	Distributor revenue decoupled from the volume of electricity and gas transported Costs recovered through distribution price control Distribution has infrastructure and systems to manage delivery or procurement of eligible energy savings	Price transparency to government or energy regulator to assure customers that imposition is modest Not a barrier to market entry for new or smaller energy suppliers Reduce conflict of interest if the supplier has an energy efficiency business within the group
Cons	Little contact with end users, especially those with small energy demand Unknown brand to small users for some distributors	Can exert control on supply of energy efficiency Prices may not always be as transparent as government would wish

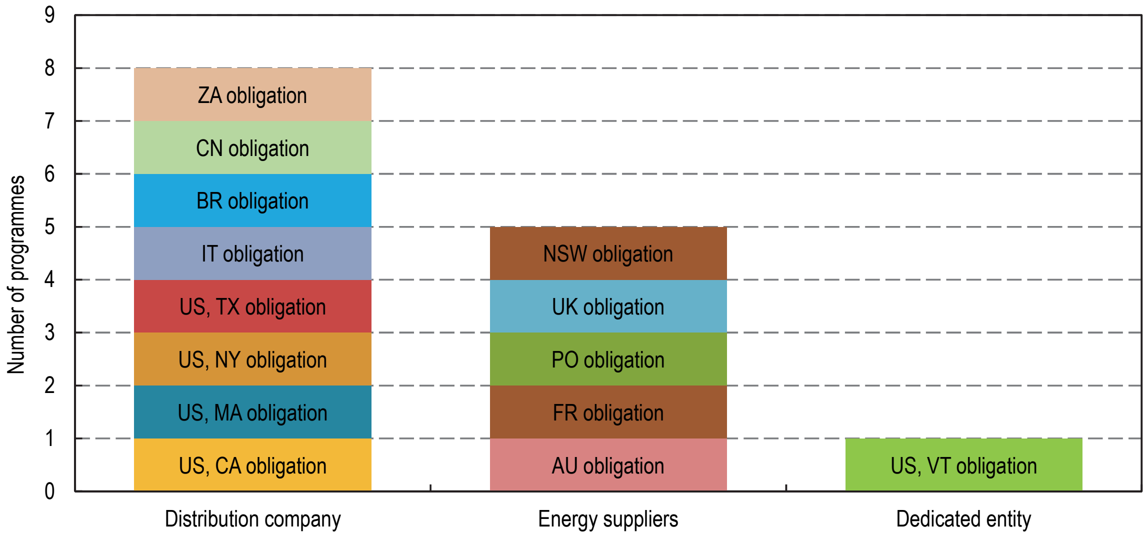
Source: Lees and Bayer (2016).

[27] The same logic has been applied to gas utilities in those jurisdictions that impose an obligation for natural gas.

[28] This was the case for example in the United Kingdom (Rosenow, 2012b). While public utilities and state public utility commissions in the United States have delivered the large majority of obligations, there are a few exceptions. Both New York and California created state energy agencies to deliver some efficiency programmes in addition to their research and renewable power authorities. Vermont, Maine and Oregon created unique delivery entities that channel utility resources through a special statewide entity with its own mandate.

In Europe, the development of the obligation has been somewhat different to the United States. The five obligations in place prior to adoption of the Energy Efficiency Directive had each been created in somewhat unique circumstances, so there was no common model although both the United Kingdom and Denmark's obligations were inspired by Integrated Resource Planning (Rosenow, 2013a; Rosenow, Bayer, Rososińska et al., 2016). Thus when Article 7 of the Energy Efficiency Directive was written, decision-makers judged it important to respect those existing choices and to allow each Member State to choose which path to follow (including the option to meet savings obligations through "alternative measures", or without any obligation on suppliers or distributors at all). Among the 15 obligations now in place and planned in Europe, six (including Italy among our case studies) place the obligation on distributors, and nine (including France, Austria, Poland and the United Kingdom) place the obligation on energy suppliers (Foster et al., 2016) (Figure 25).

Figure 27 • Obligated parties

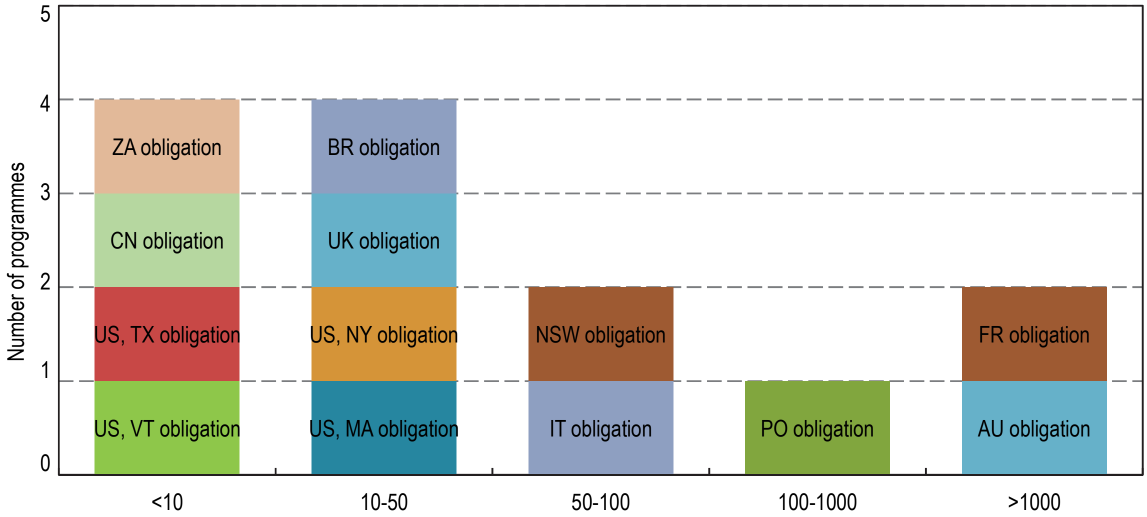


Note: AU = Austria, BR = Brasil, CH = Switzerland, CN = China, DE = Germany, FR = France, IT = Italy, PO = Poland, PT = Portugal, UK = United Kingdom, US = United States, ZA = South Africa, NSW = New South Wales, CA = California, MA = Massachusetts, NE = North England, NY = New York, PJM = Pennsylvania, New Jersey, and Maryland, TX = Texas, VT = Vermont.

China, with an entirely different industry structure, imposes the savings obligation on government-owned grid companies (Crossley, et al., 2015). In New South Wales, as in the other Australian schemes, the obligation has been placed on energy retailers (Crossley, 2008). The significant difference in the number of obligated parties between the schemes analysed is striking (Figure 28).

Wherever obligations are placed, the economic entities are judged to be large enough to carry the burden. As obligated entities must design, implement and comply with a new type of obligation, it necessarily entails transaction costs of enrolling customers, and the complexity of supervising delivery of diverse measures in many distributed locations. For these reasons, some schemes exempt small providers. For example, in France the obligation applies only to electricity, gas, and district heating and cooling retailers selling more than 400 GWh/year or more, to Liquefied Petroleum Gas (LPG) transport retailers selling more than 100 GWh of LPG transport fuel or 7 000 tonnes of LPG heating fuel/year, and retailers selling more than 7 000 m^3 of automotive fuels (Trauchessec, 2017). In a number of US States, municipal utilities and rural electric co-operatives are exempt from regulation, and consequently sometimes not included in the State-wide obligations.

Figure 28 • Number of obligated parties



Note: AU = Austria, BR = Brasil, CH = Switzerland, CN = China, DE = Germany, FR = France, IT = Italy, PO = Poland, PT = Portugal, UK = United Kingdom, US = United States, ZA = South Africa, NSW = New South Wales, CA = California, MA = Massachusetts, NE = North England, NY = New York, PJM = Pennsylvania, New Jersey, and Maryland, TX = Texas, VT = Vermont.

But experience teaches that obligation programmes can be designed to include small distribution companies or smaller retailers. Denmark's programme allocates savings targets to sectors, including electricity, natural gas and district heating, whose trade associations apportion responsibilities among sector participants. However, heating oil distributors, typically smaller companies, participate on a voluntary basis (RAP, 2012).[29] The Vermont scheme collects uniform fees on sales volumes from all electric and gas distribution companies, including municipal and co-operative entities, and pools the funds so they can be spent efficiently.[30] EVT delivers savings to customers in all of these service territories under a performance contract supervised by the state's public utility regulator. EVT can, within broad guidelines, design and deliver programmes as it deems best to meet the overall targets. Incentives are provided for meeting them.[31] Other options, including allowing smaller entities to buy savings certificates or to pool their obligations, are possible.

The most important lesson to draw from the variety of approaches is the possibility of implementing a successful, robust scheme whether the obligation is placed on suppliers, distributors or on a special-purpose entity created for the purpose. In each case, there are other key features of the scheme that will drive success that can be adapted to different obligation routes.

Target

The choice of a target (and sub-targets, where chosen) is another crucial component of obligation programme design.

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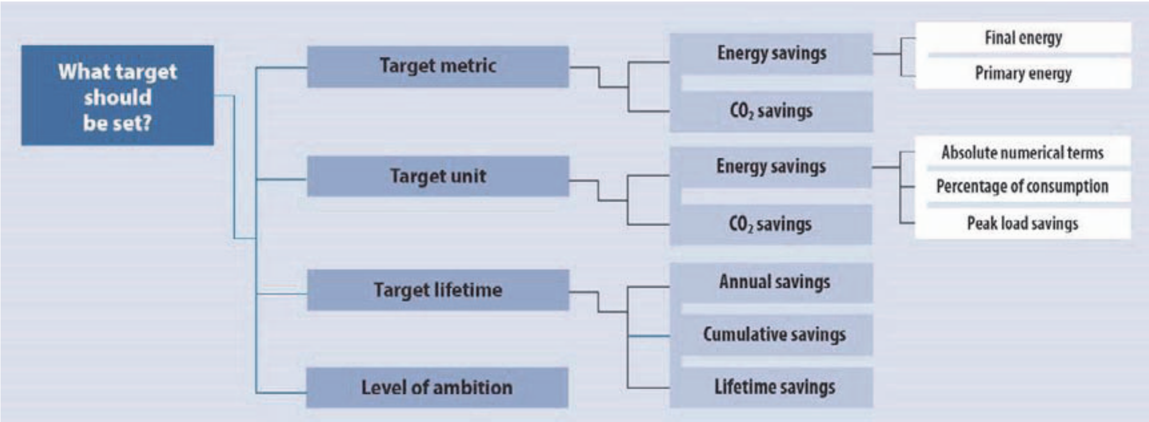
[29] In anticipation of mandatory participation in case they did not participate voluntarily.

[30] The level of the efficiency fee varies by fuel and customer class, but is uniform for electric distributors, large or small, with the exception of the City of Burlington qualifying to deliver its own programmes (Vermont (n.d.) for exact amounts).

[31] An additional feature of the Vermont programme is the fact that the name "Efficiency Vermont" is held by the State. The right to operate the efficiency entity for a period of years is awarded on a competitive basis to a single winning bidder, which is then subject to performance contract for a set period. Initially, the competitive solicitation occurred every three years, but that has since been changed to a 12-year franchise, with performance contracts set and reviewed every three years within that period (NC Clean Energy Centre, 2015).

- The first choice is whether the programme goals will be set in terms of energy savings or emissions reduction (usually CO_2-equivalent) and, if expressed in energy savings, whether it should be primary energy or final energy saved.
- The second question is whether the savings target should be set in absolute numerical terms or as a percentage of consumption, or some other key variable (such as peak load, or load growth).
- The third question is whether the target is set in annual savings (i.e. savings achieved in one year) or lifetime savings (i.e. savings achieved over the lifetime of the delivered energy efficiency improvements).
- Finally, and most importantly, decision-makers have to decide how the savings targets should evolve over time.

Figure 29 • Target setting decision tree



There is a fair degree of variation with respect to all of these variables among the programmes in the sample. The most common practice is for obligation targets to be set in terms of final energy consumption (close to 80% in the sample including Austria, Brazil, California, Denmark, France, Massachusetts, Poland, New South Wales, South Africa, Vermont). In addition, three programmes have set the target both in terms of final and peak load savings (China, South Africa, Texas). While programme designers are aware that end-use efficiency will likely reduce both conventional air pollutants (such as NO_x, SO_2 and particulate matter) and greenhouse gas emissions, obligations have a number of other objectives as well. Most programme designs view the emission savings as a by-product of the instrument, not its principal goal.[32] A few obligations have had targets set in CO_2-equivalent terms, notably the United Kingdom[33] but also the programmes in Victoria and South Australia (Rosenow, 2012b; Crossley, 2008). But the vast majority of programme goals are set in terms of energy consumption.

There is, however, substantially more variation in the way in which the energy savings targets are framed. For example, in New South Wales the target was set as a percentage of final electricity sales, starting at a modest annual rate (0.4% of sales in 2009) but increasing in ambition each year thereafter, up to 4% as of 2014 (RAP, 2012). Several of the US programmes are framed in this general way as well, e.g. New York began at 0.5% of sales in 2008 with incremental savings of 2% per year by 2015 (RAP, 2012). Texas has an escalating target, but it is set in terms of load

[32] It is important to note that cost-effective energy savings are societally important even for power systems that may be increasingly supplied by renewable generation. Aside from the cost considerations, deep decarbonisation is only possible in most regions of the world when renewable energy is used efficiently; wasting renewable power on inefficient end uses would make the energy transition slower, more expensive and technically more challenging.

[33] Alongside fuel poverty related targets.

growth, not total load. It began at 15% of load growth in 2008, growing to 30% of load growth by 2013 (RAP, 2012). In 2011, legislature amended this mandate to one that would require each utility to eventually reduce peak demand by 0.4%. These mandates are of limited ambition, and Texas remains well below the national average in efficiency ambition for States with energy efficiency resource standard programmes (ACEEE, n.d.a).

California has set ambitious targets for both electricity and natural gas utilities, denominated in both capacity and energy terms for power, and in therms of natural gas saved. These targets are set by the public utilities commission on the basis of in-depth potential studies, with an overall goal of capturing 70% of the economic potential and 90% of the maximum practically achievable potential for electric energy savings over a 10-year period (California Public Utilities Commission, 2015).[34] China uses a combination of peak and load reduction per year (Box 17). South Africa follows a similar approach with a dual target of load and peak demand reduction (Eskom, 2015).

Box 17 • Combination of peak and load reduction target in China

The Chinese obligation programme requires the grid companies to produce energy savings equivalent to at least 0.3% of electricity sales in the previous year and to reduce load by at least 0.3% of maximum load in the previous year. The obligation also establishes a sub-target that requires the installation of load monitoring equipment on 70% of the peak load, and load control equipment on 10% of the peak load in any locality.

Source: Crossley et al. (2015).

However differently these programme goals are set, they are to a significant degree translatable – e.g. X% of load growth can be understood as Y% of total sales, or Z GWh. The key question is how ambitious the savings targets are – and of course it has to be considered whether the financial and governance mechanisms are in place to turn the targets into achievable savings. Based on the achievements of the obligations studied, two observations arise. First, among the leading programs in terms of overall ambition, there is normally an *experience curve*: Obliged entities and programme administrators both need time to learn how to enter the market, attract customers, deliver reliable savings, and improve performance with experience. However, with experience and adequate performance incentives, it is quite possible to ramp up annual incremental savings targets (Box 16) although there are practical limits to how quickly the energy efficiency industry can grow in each jurisdiction. The pool of cost-effective opportunities changes over time, both through the depletion of potentials but also the addition of new opportunities through technological innovation and improved consumer awareness.

Box 18 • Examples of target increase

Successful programmes have begun with an initial savings goal of about 0.5% per year, and then raised the target in stages to 1.5%, 2% or more in later compliance periods. In New York, for example, the target was 0.5% of electricity sales in 2008, increasing by 2% per year through 2015. In New South Wales, the target began at 0.4% of electricity sales in 2009, ramping up to 4% in 2014 (RAP, 2012). Targets in Italy (set in terms of Mtoe) and Denmark (set in terms of petajoules) also built in similar learning curves, as did the European Union’s Energy Efficiency Directive.

A second lesson from experience is that when savings targets are set with a view to lifetime savings, not just first-year or immediate savings, programmes will be more effective in meeting national policy goals for lower energy costs, reduced emissions and improved public health. Obligations that count only short-term savings will provide strong incentives for short-lived measures, and little incentive for longer-term, sustainable investments. These may be more

[34] This is based on the presumption that only part of the economic potential is practically achievable.

expensive to install but more cost-effective over the long run. This is especially the case for housing insulation, window and door replacements, and other building shell improvements, where up-front investment costs are high and the pay-back period may be a decade or more.

As a practical matter, designers of energy efficiency obligations have set targets in a number of ways, keeping in mind at least three considerations:

- What is the cost-effective savings potential across the fuels and customer classes we have chosen to target?
- How difficult will it be for the obliged entities we have chosen to launch an effective programme across those targeted end users?
- How much will it cost to achieve these goals, how much will it cost the obliged entities, and in particular, how much of that will show up in delivered energy bills?

Experience in most jurisdictions with obligations is that this third question, on immediate rate impacts, operates to impose a de facto cap on savings rates, regardless of the size of the cost-effective savings potential.[35] Even in the most ambitious programmes in our study, direct bill impacts amount to less than 5% of the cost of delivered energy. In most programmes, the cost of an obligation recovered is less than 2% of the cost of delivered energy (Table 5).

Table 5 • Costs of obligations by country, as share of average energy bill

	Time period	Cost as share of average energy bill		
		Household sector	Industry sector	All sectors
United Kingdom	2008-12	2%	N/A	N/A
Denmark	2015	2%	5%	N/A
France	2011-13	N/A	N/A	0.5-1.0%
Italy	2014	1%	Not available	Not available
Austria	2015	Not available yet	0.9-1.4%	Not available yet
Vermont	2012-14	6%	6%	N/A
California	2009-11	1.5%	1.4%	N/A

Source: Rosenow and Bayer (2016).
Note: N/A = Not applicable.

In some political environments, particularly at times when rising wholesale energy costs are reflected in increases in end-user prices, the programme costs are sometimes considered as bill surcharges that must be reduced. This is short-sighted. Particularly on power systems, reduced demand saves money not only for customers participating in the efficiency programme but for all customers, through reduced market clearing prices, avoided transmission and distribution upgrades, and reduced need for other reliability enhancements. Thus, the apparent direct costs of the obligation programme are in reality offset or even exceeded by bill savings, even in the short term. These effects are not registered on customer bills in any programme studied, while the provider costs of the obligation are included explicitly on customer bills across many schemes.

In summary, there is variety both in the nature and metric of the targets set. Evidence shows that experience and adequate performance incentives enable an increase in targets relatively quickly.

[35] In the early years in the United Kingdom, for example, the regulator was hesitant to increase the target beyond a certain level of energy bill surcharges which has become an important issue in recent years again (Rosenow 2012a).

Customers

When deciding which customers should be able to access measures from an energy efficiency obligation, the two principal groups of customers are all customers and low-income customers.

There is some variation among obligations in their targeting and treatment of different customer classes. Most obligations permit or, in some cases require, savings to be captured across a wide range of customer classes, typically including residential housing, public facilities, commercial buildings and industrial operations. A few of the programmes studied, including Brazil (Box 19), France, New York, California, Massachusetts and Vermont, also include specific sub-targets for low-income or fuel-poor households. This is especially the case in the United Kingdom, where the next version of the obligation will eliminate the requirement to assist "able-to-pay" households, and restrict the delivery of the obligation entirely to fuel-poor households (DECC, 2016b).

Box 19 • Low-income provisions in Brazil

In 2008 a key change was introduced in the Brazilian obligation programme. A minimum of 50% (and since 2010, 60%) of the investments had to be allocated to low-income communities and households on social tariffs. These low-income programmes mainly consist of fully funded compact fluorescent lamps and refrigerators. From 1998 to 2007 only 12.6% of the funds invested through the obligation were supporting low-income households whereas after the change in the law this share has increased to 61.1% in the period 2008 to 2011 (Broc et al., 2012).

The question sometimes arises whether obligated entities should be permitted to deliver eligible savings in fuels that they do not sell, or to customers who are not "their" customers for underlying energy supplies. Where the obligation is imposed on distribution companies, as in many of the US States, the usual practice has been to require that savings be delivered to the obligated company's own customers, in part to ensure that all relevant service territories receive energy efficiency services, and in part because the costs will be recovered in tariffed distribution rates. However, the practice in some other jurisdictions, particularly in Europe, has been more flexible. In Denmark, obligated energy distributors can save any fuel, whether or not they sell that energy form, and in the United Kingdom, obliged retail suppliers can count savings from eligible customers, regardless of where the customer is purchasing its energy supply (Mikkelsen, 2012; Rosenow, 2013a).

There are solid reasons to support a flexible, "any eligible customer" approach to energy savings obligations. Neither media markets (promoting energy savings programmes) nor retail supply chains (selling eligible in-programme appliances and equipment) coincide geographically with utility service territories. In competitive energy markets, including liberalised electricity and gas markets, a company's customers don't reside in neat geographic pockets, and they can switch to another supplier at any time anyway. And many customers will be better served by a multi-fuels approach once they are ready to invest in energy savings, making it much more effective to allow a single obliged entity to deliver and claim savings achieved across multiple fuels.

For all of these reasons, flexible programme designs permitting obliged entities to deliver and claim savings across a relatively broad range of customers and fuels has proven to be sound.

Cost recovery

If efficiency obligations are to succeed, quite obviously, the means must be found to pay for costs that must be incurred by obligated entities to overcome the market barriers blocking customers from investing in efficiency on their own. As mentioned previously, across many obligations and different types of customers and end-use savings, it is often the case that about one-third of the cost of installed measures will be paid by the programme administrator or obliged entity (Rhode et al., 2015; Molina, 2014). How these costs are recovered depends on a variety of factors, the most important being the market structure for the energy source involved.

For those where the obligation is placed on retail suppliers and the retail market is competitive, governments usually assume that retailers will recover any obligation costs in their cost of doing business like any other costs. The amount that will be passed through to final customers is, thus, a matter of private decision and competitive pressure. This assumption has been made in the United Kingdom's CERT programme and the energy savings scheme in New South Wales.

Where an obligation is borne by distributors or retailers in a regulated environment, cost recovery is most often assured through regulated rates. This is the case in Denmark, France, Italy, and all of the US States studied. In China, multiple funding streams, including city-wide utility surcharges, electricity tariffs and other funding sources exist (Crossley et al., 2015). Programmes often have unique or additional funding sources as well. For example, some utility obligations in the United States receive additional funding from participation in regional capacity markets.[36] Furthermore, substantial funding is received by some obligation programmes from dedicated carbon auction revenues, as in the RGGI States, including Vermont and Massachusetts (Cowart et al., 2015). As demonstrated in the RGGI and illustrated in Germany, carbon auction revenues provide another possible source of funding for energy efficiency programmes, whether driven by obligations, other MBIs, or by government mandates. Invested in end-use efficiency, carbon revenues could "purchase" low-cost carbon savings while moderating the economic impact of higher supplier costs on business and household customers.

There is an aspect of cost recovery that is sometimes overlooked by efficiency advocates and government, but is rarely out-of-mind for suppliers and distribution companies. In any rate-regulated environment, whether a vertically-integrated supplier, or an unbundled pipes or wires company, the loss of expected sales can impose a disproportionate impact on the profits of the entity losing sales (retailer) or throughput (distributor). For this reason, in the past, obligated entities have been slow to support otherwise sensible energy efficiency programmes, and have not been keen to support them in the political realm. To overcome this problem, regulators have created special rate adjustments in many jurisdictions, termed "net lost revenue recovery" mechanisms, or performance-based rate designs that "decouple" net revenues from total sales levels. The additional costs needed to adjust net utility revenues, not usually very large, will then also be recovered in tariffed rates.[37] Because these adjustments are needed only between rate cases, and because they recover only a portion of the utility's reduced revenues, rate changes to adjust for changes in sales volumes caused by efficiency programmes are usually small and of limited duration, and in any event will be smaller than the bill reductions that result from cost-effective efficiency measures.[38]

Since the inception of the energy efficiency obligation concept, there has been a lively debate over the possible regressive impact of obligation cost recovery mechanisms, whether added to the cost of doing business in competitive environments, or to tariffs in a regulated environment. In particular, there have been concerns about the impact on low-income households (Box 20).

[36] See the discussion on interaction between obligations and capacity markets earlier in this report.

[37] For a thorough explanation of practice in this area, see RAP (2011).

[38] This is because even in the short-run, efficiency programmes lower utilities' costs for fuel or purchased energy, other production costs, line losses, reserves, etc. Revenue recovery mechanisms do not need to recover these avoided costs in order to keep utilities whole after an obligation is put in place. Just a fraction of total costs is returned to the utility (RAP, 2011).

Box 20 • Impact on low-income households

Most economists find that the impact of increased energy costs is (by definition) regressive since lower-income households on average devote a higher percentage of their disposable income to energy costs than higher-income households. If energy efficiency obligation cost recovery is, at least on the surface, adding to the cost of delivered energy, their impact could be regressive (Rosenow, Platt et al., 2013). Efficiency advocates, utilities and programme administrators have responded to these concerns in a variety of ways. First is the recognition that in many jurisdictions, there are parallel programmes for energy bill assistance, so efficiency costs can be offset at least in part through that assistance, especially for those most in need.

More fundamentally, there is the fact that end-use efficiency investments will cost-effectively lower both individual and societal energy bills, and that over time those avoided costs will indirectly benefit everyone, including low-income and fuel-poor households (IEA, 2014). One well-documented study illustrating this point was conducted in Vermont, based on data from EVT's State-wide obligation in 2010. In that year the cost of saved energy incurred by the obligation was USD 39/MWh while the total participant and societal benefits (not including health and amenity benefits) were much higher, just over USD 147/MWh saved. Of those benefits, USD 47/MWh accrued to all power market customers, participants and non-participants alike, through system savings including lower reserve margins, avoided transmission and distribution upgrades, avoided line losses, and avoided environmental costs (Lees et al., 2016). In this instance, even non-participating fuel-poor households received more in savings than they paid in higher rates. While this will vary across programmes, when the full benefits of obligations are carefully considered, it becomes clear that the direct costs of obligations in consumer energy bills may be returned to them in savings even when individual customers do not enroll in programme savings measures.

Low-income consumer advocates are not the only voices concerned about the distribution of costs and benefits of obligation schemes. Industrial customers, particularly those in energy-intensive industries, are also often concerned about the costs of efficiency obligations. Leading programs with long time horizons have most often responded to distributional complaints by a) ring-fencing portions of the revenue and programme work effort according to major customer class categories; b) making sure that over time the programme is broad enough to give a meaningful opportunity to participate to a wide range of those who are paying for the programme; and c) ensuring that direct benefits flow to low-income households, by requiring that a meaningful fraction of total programme is devoted to the most needy customer segments.

In principle, cost recovery is assured through a) regulated rates or b) unregulated cost pass-through to final consumers. The obligations analysed illustrate that often other funding sources are blended to complement programmes' finance. Concerns around regressive impacts on low-income customers can be addressed through programme design and complementary measures.

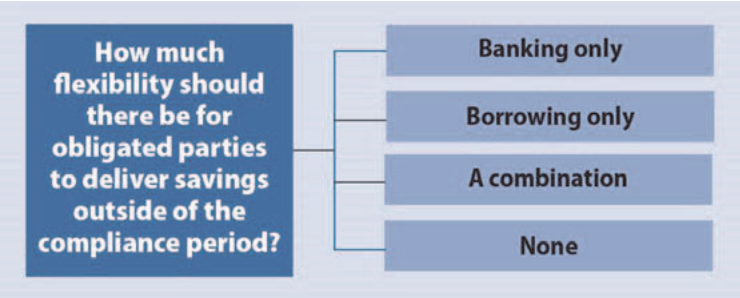
Compliance periods, banking and borrowing

The pace of deployment of energy-saving technologies is driven by a number of factors outside the control of the obligated entities. These include general business cycles, the pace of housing sales, price changes in energy markets, and changes in the availability and prices of efficient appliances and equipment. There are also variations in the success rates of obligated entities due to internal marketing decisions, changes in strategy, financing choices, and so forth. For these reasons, those designing obligations are often urged not to make obligation performance targets too restrictive in time. On the other hand, there is evidence that without strong incentives to deliver savings year after year, and to build programmes over time, consumer awareness is weak and the ability to build up savings over time is undercut.

Among leading programmes, there is good experience in balancing these considerations. First, programme compliance periods should extend across long enough time frames to allow obliged entities to respond to market conditions, monitor their success rates and make programme adjustments. Multi-year compliance periods, often in the range of three years, have been used to good effect in France, and a number of United States and Australian programmes. Borrowing must be treated with caution in order to avoid an untenable challenge in later years for an under-performing obliged entity, and also to ensure that customers receive the benefits of energy efficiency delivery as soon as practicable. Some borrowing, perhaps with modest penalties attached, might be allowed to permit programmes to ramp up at a steady pace. It is also important to avoid a huge spike in programme activity at the very end of a compliance period, which will often be followed by a sharp drop-off at the beginning of the succeeding period. A modest amount of short-term borrowing might help to smooth implementation rates without at the same time encouraging persistent foot-dragging by obliged entities.

It is, within limits, an acceptable practice to bank over-attainment credits from earlier periods and use them to meet obligations for succeeding periods. However, there should be a cap on the amount of excess early savings that can be carried forward to reduce future compliance obligations. It is important to avoid large swings in programme activity (a “start-stop-start” cycle) because this impairs the viability of delivery chains, and the continuous market presence needed to enrol customers when they are ready to buy new equipment or launch a renovation project. As energy service programmes needed to meet long-term energy service needs, obligations work best when they are created and run steadily and accumulate deeper savings over time, while always subject to performance reviews and a process of continual improvement. Figure 30 sets out the design choices regarding the flexibility provisions.

Figure 30 • **Delivery flexibility decision tree**

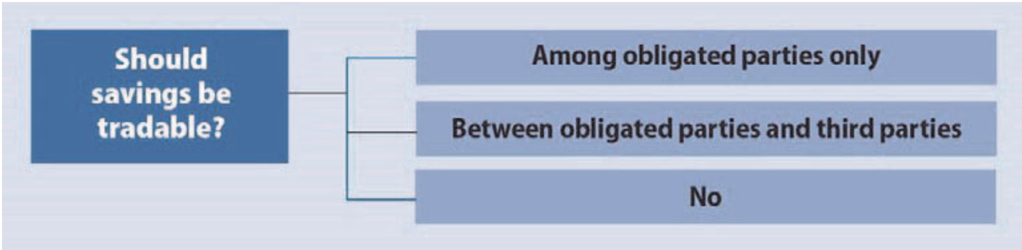


Longer-term programmes (typically three years) offer a higher degree of stability to programme participants. Extensive borrowing can compromise target compliance whereas a modest degree of borrowing or banking can help prevent “start-stop-start” cycles.

Trading

Whether explicitly or implicitly, eligible energy efficiency investments generate compliance credits (sometimes called energy savings certificates) in obligation schemes. With regard to those credits, two different kinds of trading can occur: Trading among obligated parties (horizontal trading), and trading between obligated parties and independent efficiency providers who deliver savings on their own to end-use customers (vertical trading) (Figure 31).

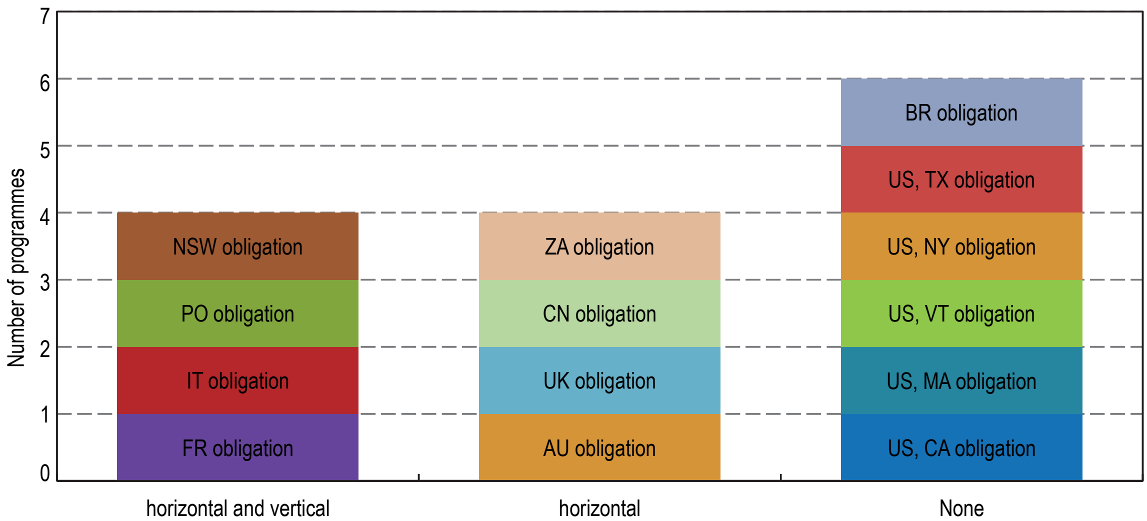
Figure 31 • Trading decision tree



The first kind of trading is not uncommon and is permitted in Denmark, United Kingdom, Italy, France and Ireland. Trades are merely registered with the obligation programme administrator so that compliance credit can be given to the purchasing entity and subtracted from the performance reports of the selling entity (Lees et al., 2016). This is less common in the United States, where regulators seek to ensure that savings are delivered in the same service territories and among the same customers who are paying for the obligation programme through their bills.

The second kind of trading is much less common (Figure 32). The chief examples are the white certificate trading programme in Italy, the system of standard offers operated by the obligation scheme in Texas, the Polish white certificates programme, and the credit purchasing programme in New South Wales (Lees et al., 2016).

Figure 32 • Trading provisions



Note: AU = Austria, BR = Brasil, CH = Switzerland, CN = China, DE = Germany, FR = France, IT = Italy, PO = Poland, PT = Portugal, UK = United Kingdom, US = United States, ZA = South Africa, NSW = New South Wales, CA = California, MA = Massachusetts, NE = North England, NY = New York, PJM = Pennsylvania, New Jersey, and Maryland, TX = Texas, VT = Vermont.

In France, in the early years of the programme, less than 3% of white certificates were traded (Greaume et al., 2011). More recently, the opportunity to earn credits has been restricted to local authorities and social landlords.

Box 21 • White certificate trading in Italy

The white certificates programme in Italy has the longest tenure and is the only programme in Europe where a significant fraction of energy savings from accredited parties who are not also obligated entities exists. About one-third of the white certificates in Italy have been generated by third parties since the programme began in 2005.[39] Most white certificates in Italy are created under bilateral contracts between an energy efficiency company and an obligated energy distributor.

In general, trading programmes have added complexity, and sometimes extra consumer costs to obligation schemes that may well exceed the market efficiency benefits that should theoretically be available from a transparent, fully open market for energy savings.[40] There are at least two major reasons for this. First, on the "supply" side of energy efficiency, potential efficiency providers face a number of market uncertainties. Those who would enter the market to deliver savings need time to create a business, fully understand the rules governing the programme, and then develop marketing and delivery routes to deliver savings, account for them, and get them accredited. They often face markets where there are only a few buyers (a small number of obligated entities), and they do not know in advance what the market value of a white certificate is likely to be.[41] If the government is writing the rules for the programme, they also face the regulatory risk that overall obligation levels and other rules may change at almost any time. This is not a risk limited to trading programmes. Obligation levels and funding levels have seen sharp changes in many jurisdictions, including most recently in the United Kingdom, where changes to the energy company obligation scheme led to a significant drop in the pace of insulation installations, and an economic crisis for the companies that had been doing this work on behalf of obligated energy suppliers.[42] Thus, even though in societal terms investments in energy efficiency are low-risk investments, and it is well understood that the efficiency reservoir is quite large and that obligation programmes *should* continue to build and grow over coming decades, the business model for companies entering a white certificates market is still a risky one.

There is also a trade-off on the purchasing or public side of the white certificates market:

- On the one hand, a certificates market will work best when the attribute being sold is uniform in nature and where compliance with requirements can easily be tracked. In carbon markets, for example, "a tonne is a tonne" and renewable energy certificates represent uniform production quantities, measurable in MWh or therms. If energy savings can be traded via a simply-defined white certificate (e.g. one MWh of reduced consumption = 1 white certificate) an obligation scheme could operate through a comparatively large and liquid market of buyers and sellers.
- On the other hand, if programmes were limited to a single white certificate commodity, it would fall far short of delivering the highest values that efficiency can deliver. Energy

[39] Independent efficiency providers in Italy are often referred to as ESCOs but most do not meet the European definition of ESCO because they usually only install efficiency measures and do not take on on-going energy management responsibilities under a performance contract (Stede, 2016).

[40] Experience from Poland shows that if a market-based instrument is too complex in its design (here it was the overly complex tendering system) the amount of delivered energy efficiency improvements will be limited. Poland launched an obligation based on white certificates trading for the years 2013-16. Trading was only one aspect of the programme's complexity, however. The programme design had many moving parts and sub-categories of savings targets which, together with its short expected life of just three years, challenged its success. Just 3.8% of the savings anticipated was bid into the initial auction for the programme (ENSPOL, 2015).

[41] In New South Wales, for example, there are only three buyers and little price transparency, since most certificate sales occur via bilateral transactions where price is not made publicly available.

[42] By mid-2015 the average delivery rate for loft insulation has dropped by 90%, cavity wall insulation was down by 62%, and solid wall insulation had declined by 57% compared to 2012 (Rosenow and Eyre, 2016).

savings occur in many forms and deliver a variety of values. For example, value could come from savings in locations with distribution grid constraints, or for delivering savings to low-income households, or delivering savings that are highly coincident with peak loads on the grid. Considering the transaction and opportunity costs of many types of efficiency upgrades, it is usually important to recruit deeper savings in a customer location whenever the opportunity arises. Treating all savings as a uniform commodity would wash out those higher values, and providers would face a market that rewards only *low-cost* savings, not *high-value* savings.

For this reason, just as renewable energy certificates programmes often distinguish between photovoltaic renewable energy certificates and wind renewable energy certificates, white certificate programmes face a need to create multiple types of white certificates, or to create bonus schemes to add extra credits to certain types of savings. This has the effect of fragmenting what might be one large white certificate market into multiple white certificate sub-markets, which are smaller, likely to be less liquid, and likely to offer less price certainty to potential energy efficiency providers.

Designers of a white certificate trading system, like designers of renewable energy certificates trading systems, thus face an inherent tension between uniformity, larger scale, and lower-cost savings on the one hand, and diversity, market splitting, and potentially higher-value savings on the other hand.

Programmes that reward all energy savings with the same white certificate, tradable or otherwise, will incentivise the take-up of least expensive measures that are the most profitable and least risky way to earn white certificates. If all savings are paid the same, the least expensive savings are the most profitable, and the least likely to lose money if the clearing price of certificates hovers near to the low cost point. The issue has arisen in a number of programmes, including some of the most well-known white certificate trading regimes. In Italy in 2008, three-quarters of all the white certificates earned for electricity savings came from the use of compact fluorescent light bulbs (Lees et al., 2016). The New South Wales white certificates have been dominated by commercial lighting, which supplied 80% of all the white certificates earned in New South Wales during 2012-13. In Victoria in 2012, more than 80% of the white certificates registered came from standby power controllers (Lees et al., 2016). In all of these cases, the white certificate programme design rewarded the rapid roll-out of simple, relatively inexpensive efficiency measures. This is a good thing if cost-effective delivery of the cheapest possible energy savings is the policy intent. However, policy objectives often tend to be more complex, with policy makers wishing to see efficiency gains made in different parts of the economy and with a variety of technologies, some of which may deliver deeper energy savings. In these cases, policy makers have a number of ways in which MBIs, including white certificates, can be adapted to deliver on a wider set of objectives.[43]

Trading adds an additional layer of complexity, and sometimes extra consumer costs to obligation schemes that may well exceed the market efficiency benefits that should theoretically be available from a transparent, fully open market for energy savings.

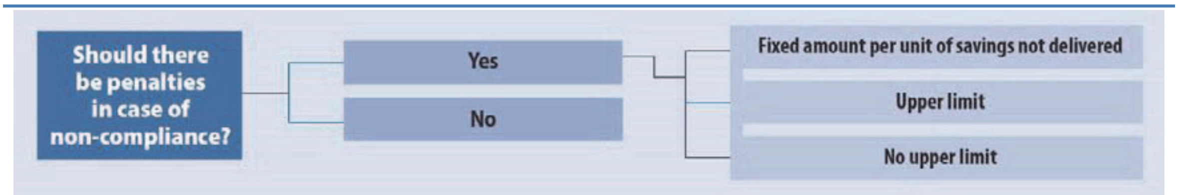
[43] Although not a tradable white certificate programme, the New Jersey pay-for-performance programme offers a good example of the issue. For a standard level of efficiency improvement, the performance programme offers a payment of 0.18 USD/kWh and 1.80 USD/therm of first-year savings for projects that meet a minimum requirement of 15% savings. However, to encourage deeper savings at a site, for each additional per cent of savings, the payment *for all savings* is increased by 0.1 USD/kWh or 0.1 USD/therm. This rewards deeper savings rather well, with deeper savings being paid much more than minimum savings. These earnings are rewarded in money, not in certificates, so the payments are knowable in advance to efficiency providers, and not subject to the market clearing price of white certificates (Neme et al., 2012).

Penalties and performance reviews

In a normal energy market situation, both energy suppliers and efficiency providers can decide how much savings, if any, they will deliver to their customers. Under an obligation scheme, on the other hand, an obligated entity is required either to deliver or to contract delivery of creditable savings from a large number of end-use locations. Ensuring that they do so, within the time frame required, with quality installations and a high degree of customer satisfaction, is a crucial task for programme design and oversight. Experience across numerous obligations reveals that there are three essential aspects of quality control and enforcement: monitoring and verification, non-compliance penalties, and performance reviews.

Monitoring and verification has been discussed above and is clearly the foundation for determining whether programme terms have been satisfied. Non-performance penalties are not the only means of ensuring programme success, but they are a key feature in doing so. Well-designed penalties that are clearly stated in advance, and are enforced transparently and without undue delay, are crucial to effective implementation of obligation schemes.[44] When adopting penalties, policy makers face a choice between setting a fixed penalty (e.g. per unit of savings missed), an upper limit or no upper limit at all.

Figure 33 • Penalties decision tree



As noted earlier, energy efficiency obligation targets need to be designed in such a way as to give obligated entities some flexibility as to when exactly measures will be delivered because underlying market conditions and unanticipated events (e.g. sudden funding shortages, a recession in the buildings industry, a flood in the service territory) can interfere even with well-designed implementation plans, making multi-year compliance periods a good practice. But failure to meet requirements even given adequate flexibility should result in the imposition of non-performance payments.

Several jurisdictions in our study have established pre-defined penalties for under-delivery of efficiency savings, but they have rarely been imposed. In New South Wales the penalty has a 24.86 AUD/tCO_2e shortfall, as of 2012 and adjusted for inflation since then. In Denmark the penalty is 0.1 EUR/kWh of the shortfall, in France the penalty is 0.02 EUR/kWh of lifetime final energy not saved.[45] In contrast, in Italy, Poland and the United Kingdom, the penalties are possibly quite large but intended to be proportionate to the size of the missed savings, and are a matter of judgment by the regulator at the time an issue is raised.

However, whenever penalties are designed and assessed, the programme design should ensure that penalty funds are ultimately spent delivering the savings that have been lost. Since the purpose of the obligation is to deliver savings for defined purposes (e.g. to reduce power bills,

[44] Performance incentives are also useful, and have been used to good effect in the United States (including California, Massachusetts, New York, Texas and Vermont). Denmark and Italy also offer incentives for some aspects of programme implementation. Furthermore, public transparent regulatory inquiries are useful in focusing public attention on those entities who are failing to help customers save on energy bills, or otherwise misdirecting programme efforts. In the programmes in the United States, incentives include an enhanced rate of return on utility capital (New York); allowing the utility to retain a share of the program's calculated net benefits (Texas, Massachusetts, Minnesota); and an opportunity to claim part of a fixed pool of financial benefits on a proportional basis (California, Vermont) (RAP, 2012).

[45] A good overview of these penalty regimes is included in RAP (2012).

fuel imports, emissions, or peak load growth) simply collecting money through penalties is not consistent with the purpose of the program. Assuming that the obligation has been well designed in the first place, it is desirable to build in a requirement that penalties for non-performance be converted to savings, with delivery assured by a contracted efficiency provider, without the funds being taken out of the savings regime. If obliged entities are paying penalties because mandated performance is unrealistic or extremely uneconomic, the problem is the programme design, not the penalty provisions. In this sample no example was identified where this has been the case.

Box 22 • Uncertainty in regimes with well-defined penalties

Uncertainty of one kind or another will arise even when penalties are well defined. For example, France established a clear penalty for each kWh that was missed from an entity's energy savings target, and it was intended to be twice the expected cost of delivery. As it happened, the cost of delivering efficiency turned out to be much lower than expected, so the penalty ended up being as much as five times the cost of compliance (Staniaszek et al., 2012) and ten times the market price in 2016 (Trauchessec, 2017). One side-effect of this approach is that it may give efficiency suppliers some bargaining leverage to raise their prices to obligated entities, since even those higher prices would be less than the price of the penalty. However, considering that in most instances obligated entities are in a strong bargaining position to begin with, this is a matter that regulators should be able to leave to the commercial relationship between obligated entities and the contractors they may work with to secure creditable savings.

In general, programme designers are urged to create clear non-compliance penalties, and to make sure that they significantly exceed the expected cost of delivering savings to customers. This is intended to dissuade obligated parties from simply paying a fee to "buy out" of compliance, whilst failing to deliver savings in the real world. Since the multiple benefits of efficiency can be much greater than the cost of delivering savings, a penalty that matches the lost savings to customers and society is appropriate. This will normally be several times higher than the cost of compliance and, adopted in this manner, would provide a strong incentive to deliver the targeted savings levels.

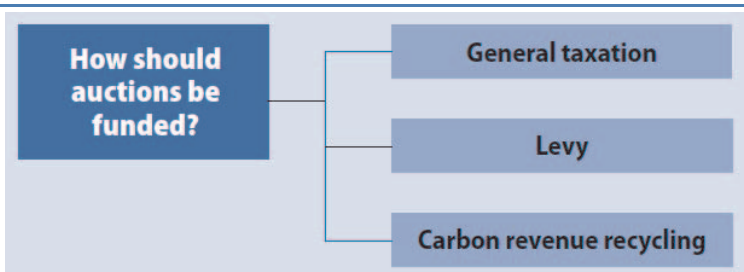
Evaluation of auction-specific design features

Funding source

Auction mechanisms can be funded through a variety of means including (Figure 34):

- **General taxation**: Funds from the public budget are allocated to the auction mechanism.
- **Levy on energy prices**: Auctions can be funded through a predetermined or non-predetermined levy.
- **Carbon revenue recycling**: Finally, auctions may be funded through the recycling of carbon revenues.

Figure 34 • Decision tree auction funding



Examples of all three funding methods are found in the sample. The United Kingdom's auction is funded through general taxation as the auction is currently run as a pilot project rather than integrated with the capacity market which is levy-funded.

The Portuguese scheme is funded through a levy of 0.2% on end-use on end-use electricity prices (EUR 23 million every two years with annual calls) and the Swiss auction funds come from a levy of approximately 0.9 EUR/kWh on energy distributed through transmission lines (Sousa, 2015; BfE, 2015). The two US capacity market auctions analysed are both funded through a market-wide tariff, although the size of the collection for energy efficiency is not predetermined and the price is dependent on the clearing price of the auction. Charges for capacity, including supply-side, energy efficiency and demand response capacity resources, are assigned to power market participants, usually in proportion to their peak system demand, through market-wide tariffs. Demand-side resources are not separately assessed, but are assigned along with charges for supply-side resources.

The German auction is an interesting case as it is financed through the so-called energy and climate fund based partly on carbon revenue recycling (BMWI, n.d.a). This is a funding method unique amongst the sample of auctions.

These funding methods differ in stability of the funds they provide. Arguably, a predetermined levy-funded mechanism provides most stability. Funding through general taxation is more prone to general annual government budget cycles and is usually seen as less stable. In the case of capacity market auctions, even though energy efficiency is funded through a tariffed charge set by a regulated wholesale power market operator, and not via governmental appropriations, the amount of money for energy efficiency is not predetermined. There are uncertainties around the amount of finance that is provided for energy efficiency and it is at least theoretically possible that no funds at all could be allocated it. The funds from carbon revenue recycling can also be volatile as the allowance price varies over time. Shortly after the introduction of the German energy and climate fund permit prices fell below 10 EUR/tCO_2, way below the EUR 17 anticipated when designing the fund (Rosenow, 2013b).

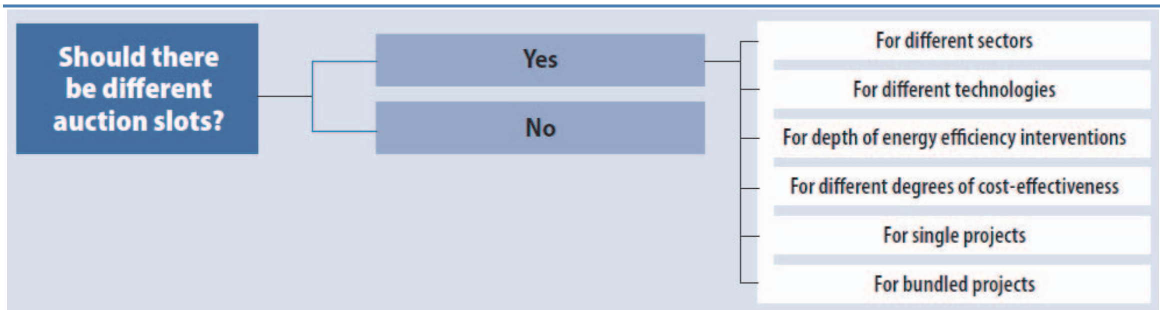
Pricing and payment

Pricing and payment are probably the most critical issues an auction mechanism needs to consider. In theory, an auction could simply encourage bidders to submit bids for savings at the lowest cost per kWh. This would ensure that savings are delivered at the lowest possible cost to society. However, there are several reasons for not pursuing such an approach.

Pricing structure

Auctions often feature a range of "slots" differentiating by sector, technology, cost-effectiveness, etc. (Figure 35).

Figure 35 • Pricing structure decision tree



This is a reflection of the multiple objectives of policy makers wanting to support a range of energy efficiency interventions. An auction mechanism will also impose fewer costs on consumers and be most effective in generating savings if its pricing structure differentiates between different types of savings and rewards more comprehensive treatment of efficiency opportunities. The price paid for energy savings should vary by both 1) expected costs of different kinds of measures and 2) the depth of savings achieved. It also may vary to reflect other important values, such as tackling energy poverty, addressing peak loads, improving reliability in congested load pockets, and others. This can be achieved by establishing different auction tranches so that most comprehensive energy efficiency improvements do not have to compete directly against low-cost measures (Box 23).

Box 23 • Auction design in Germany

The German auction features two different types of auction slots: an "open" auction slot, which is technology- and sector-neutral, and a "closed" auction slot, which is sector-, beneficiary- or technology-specific. In addition, the auctions can set minimum requirements for the lifetimes of the supported savings. In the both auction slots only technologies that have a lifetime of at least ten years are eligible for support, which avoids supporting measures that are most cost-effective and have shorter pay-back periods.

Source : BMWI (n.d.b).

The Portuguese scheme PPEC separates bidders into different groups: those with no association with the electricity sector; and those with or without associations with the electricity sector. For the first, bids are ranked altogether, regardless of the consumption segment they address. In the second, bids are ranked within the consumption segment they address. This is to ensure that all sectors benefit and no sector loses out (Sousa et al., 2015).

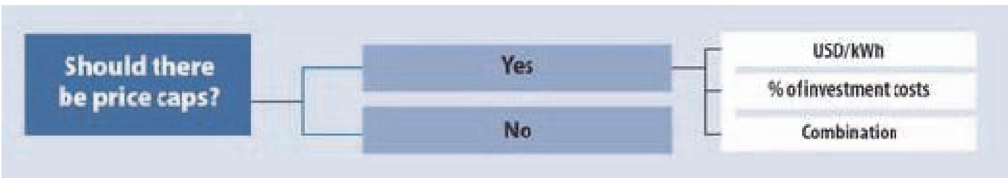
The two capacity market auctions in the United States do not feature different auction slots, meaning that all technologies compete directly with each other, including energy supply technologies (although quotas are defined for each of the resources). The United Kingdom's auction emulates the United States capacity market auctions in that it does not include a range of auction slots either.

Pricing is a key issue for auction mechanisms and addressed differently across the cases analysed. Three out of the six auction mechanisms analysed feature different slots to accommodate for the differences in cost depending on technology and sector. Requiring a minimum lifetime is also used to promote longer-lived measures.

Price caps

In order to ensure that prices paid for energy savings are not spiralling (e.g. where only few very expensive bids are submitted) auctions may cap the maximum amount per kWh paid. The maximum can vary depending on the auction slot.

Figure 36 • Decision tree price caps



In Switzerland, the maximum price paid is 0.08 USD/kWh lifetime savings (BfE, 2017). A similar approach has been followed in Germany where the maximum price paid is 0.11 USD/kWh lifetime savings (BMWI, n.d.b). Depending on the availability of additional funding, the price cap can be tighter or more generous. Another approach is to limit the amount of funding that is paid as a portion of the total capital cost of a project.

Box 24 • Auction design in Portugal

In Portugal, behavioural measures can be fully funded by the auction. The maximum portion of finance provided to non-behavioural measures through the scheme is 80%. In order to ensure a diversity of bidders, sectors and technologies, a ranking approach is used when selecting the successful projects. Some of the key criteria include economic profitability, accessibility to a large diversity of consumers, and innovative characteristics. Behavioural and non-behavioural measures are subject to different sets of criteria with different weights assigned to individual criteria.

Source: Sousa et al. (2015).

Projects bidding into the Swiss auction mechanism can only receive up to 40% funding as a portion of the total investment cost (BfE, 2017). The German auction mechanism, however, only provides up to 30% of the additional cost to deliver savings (cost of efficient technology minus cost of standard technology) (BMWI, n.d.b).

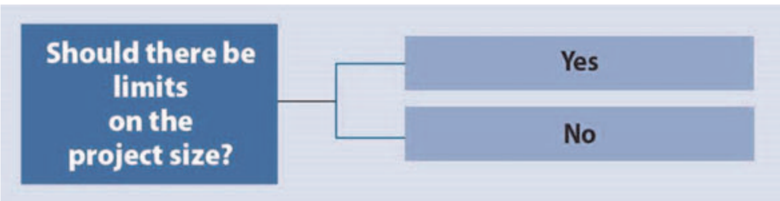
In the PJM and ISO-NE capacity markets, the question of a price cap for efficiency or other demand-side bids has not arisen, for two reasons: First, the bidding regimes are established with an inherent cap for supply-side resources. This is usually the cost of new entry for a newly constructed gas-fired generator, and the auctions are designed to find committed resources at below that cost. Second, adding efficiency and demand response resources to these markets has lowered their clearing prices, with efficiency receiving the same clearing price as supply. There is no separate need to create a special price cap for demand-side resources in such markets.

Price caps de-risk auctions from the perspective of the agency running the auction as they avoid excessive payment for energy savings. Price caps can either be established through a maximum payment per kWh or setting a maximum contribution from the auction to the project costs.

Project size

In many auction mechanisms a minimum size of bids is set to minimise administrative costs. Often, also a maximum size is set to ensure that a variety of bidders can benefit.

Figure 37 • Project size decision tree



Often, larger projects that benefit one end user can bid into auctions as well as programmes where many smaller projects are bundled into a programme. The rationale behind aggregating smaller projects to programmes is that the transaction costs of dealing with multiple small-scale projects are too high to justify their inclusion in the auction on their own. The size of projects and programmes is often different.

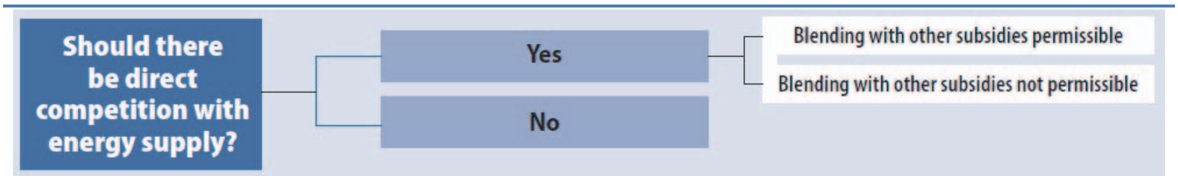
This approach has been followed in the Swiss auction mechanism for example where the size of a project has to be between USD 20 000 and USD 2 060 000 and the size of a programme has to be between USD 150 000 and USD 3 090 000 (BfE, 2017). In the German auction similar restrictions apply, with projects being supported that request funding between USD 30 000 and USD 1 680 000 and programmes of between USD 270 000 and USD 1 070 000 (BMWI, n.d.b). The Portuguese MBI does not feature a distinction between projects and programmes. It is common that bidders submit plans for multiple measures rather than single projects (Sousa, 2017). In the capacity market auctions in the United States bidders can also bundle smaller projects. In the PJM, for example, capacity market bidders can aggregate smaller projects as long as the different resources come from the same distribution company and transmission area (PJM, 2016).

Defining a minimum size for projects that can bid into an auction and allowing multiple smaller projects to be bundled into programmes is commonly used to avoid having to deal with lots of small projects at high transaction costs.

Competition with energy supply

Energy efficiency can compete directly with energy supply technologies if the metric of the outcome to be delivered is not savings but defined in broader energy-related terms (Figure 38).

Figure 38 • Competition with energy supply decision tree



Direct auction-based competition between efficiency measures and energy supply only takes place in the capacity markets auctions conducted by PJM and ISO-NE. There is a lively debate on whether capacity markets are needed at all and on how, if they are pursued, they should be designed to minimise conflicts with efficient energy markets (Borenstein et al, 2015; Bowring, 2013; Spees et al., 2013).[46] At the same time a very important lesson from the PJM and ISO-NE examples is that demand-side resources *can* compete successfully with conventional supply-side resources to deliver highly-reliable capacity resources to power systems. Moreover, including those resources confers great benefits on the market, and on system resource adequacy, and can deliver large consumer savings.

Therefore, one conclusion is that if system operators are creating a capacity market or similar resource adequacy mechanism, it is possible to include demand-side resources in the auction design. However, it would be a big mistake to design those auctions for efficiency in exactly the way they were tailored to the needs of generators. The terms for efficiency and demand-response aggregators to bid into capacity markets are very important. These include the eligibility standards, minimum bid block sizes, monitoring and verification requirements, and time commitment periods. Where there is direct competition with supply options, poor design of auctions can prevent energy savings from even appearing in the auction, creating the impression that efficiency would not be a viable resource to deliver capacity savings. This has happened in the United Kingdom's capacity market (Box 23). This case illustrates that the minimum capacity size needs to be relatively low to allow for demand-side resources to bid in. Furthermore, the contract length and, hence, the period over which rewards are being paid, determines the profitability of demand-side resources. If only the benefits of the first year of a demand-side investment are being rewarded, it is very difficult to see a business case for demand-side

[46] The system operator in ERCOT, serving the US State of Texas, operates a reliability mechanism that does not rely on capacity markets and the question of whether to adopt capacity markets is now the subject of intense debate in several European nations (Hogan, 2016).

investments. It is also notable (as discussed before) that in those capacity markets where demand-side resources provide a visible share of cleared capacity, it is permissible for energy efficiency and demand response to be co-funded by other programmes. Most of the demand-side resources bidding into the capacity markets ISO-NE and PJM are funded through obligations.

Box 25 • Demand-side resources in the United Kingdom's capacity market

The United Kingdom's capacity market is a mechanism designed to ensure that sufficient future capacity will be available to meet the recently adopted reliability standard. Capacity providers can bid in auctions to receive capacity payments, which are based on the auction clearing price. The current design of the capacity market does not result in any energy efficiency projects being supported and only 1% of total capacity in the second auction was awarded to demand response (Nationalgrid, 2015). This is largely because the auction market rules discriminate against demand response (and energy efficiency). The first barrier is the different treatment of demand-side resources: In the four year ahead auction, new generation assets are eligible for capacity contracts extending over more than a decade and up to 15 years, while demand response investments are given only a 1-year capacity contract (PA Consulting, 2016). Since demand response providers must incur the transaction costs of finding and enrolling customers, and installing their technologies, while the benefits of energy efficiency and demand response will accrue over several years, the capacity market rules make these programmes unprofitable for the majority of potential providers. The second barrier is the minimum capacity size in the capacity market: Currently, the minimum capacity size is 2 MW.[47] This is significantly more than in other established capacity markets such as PJM and ISO-NE in the United States where the minimum size is 100 kW (Neme et al., 2014).

Evidence from PJM and ISO-NE also supports two other conclusions: First, direct competition in wholesale energy markets will be possible only if there is a mandate on suppliers or grid operators to design the markets with demand-side alternatives as well as supply-side options in view. This may require a national regulator or regional authority to ensure that the transmission system operators or independent system operators are taking the right steps. Second, since the capacity value of energy efficiency is just one of its values, we should not expect capacity markets to fully support efficiency resource programmes. The efficiency resources that have succeeded in the PJM and ISO-NE auctions are supported mainly through individual state obligations and financed in part through carbon revenues received in nine of the US States. These resources would not even exist reliably in order to bid into the capacity markets without the underlying infrastructure of those energy efficiency obligations and finance programmes.

The only auctions where there is direct competition between supply- and demand-side resources are the capacity markets in the United States. Energy efficiency can compete more effectively against supply-side resources if its long-term benefits are rewarded. Even where this is the case, an additional revenue source that enables efficiency resources to bid into capacity markets at competitive prices may be needed.

Impact of MBIs on the ESCO market

Definition of ESCOs

There is no single definition of what constitutes an energy service company (ESCO). A strict definition of ESCOs focuses on performance contracting:

[47] Note that these values refer to the main capacity auction. In addition to that, there is a small pilot programme in which the United Kingdom reduced the minimum project peak savings from 100kW (2015 auction for delivery in 2015-16) to 50kW (2016 auction for delivery in 2016-18).

"A company that provides energy-efficiency-related and other value-added services and for which performance contracting is a core part of its energy-efficiency services business. In a performance contract, the ESCO guarantees energy and/or dollar savings for the project and ESCO compensation is therefore linked in some fashion to the performance of the project." (Larsen et al., 2012)

This definition excludes installers of energy efficiency equipment who do not enter into a long-term performance contract. For ESCOs satisfying this definition, most activity has been in public and commercial buildings (offices), which offer significant opportunities for replication use of information and communication technologies. In contrast, measuring energy efficiency improvements in process industries is more difficult due to variations in product mix, input materials, age of the plant, production and so forth.

Evidence on the impact of MBIs on ESCOs

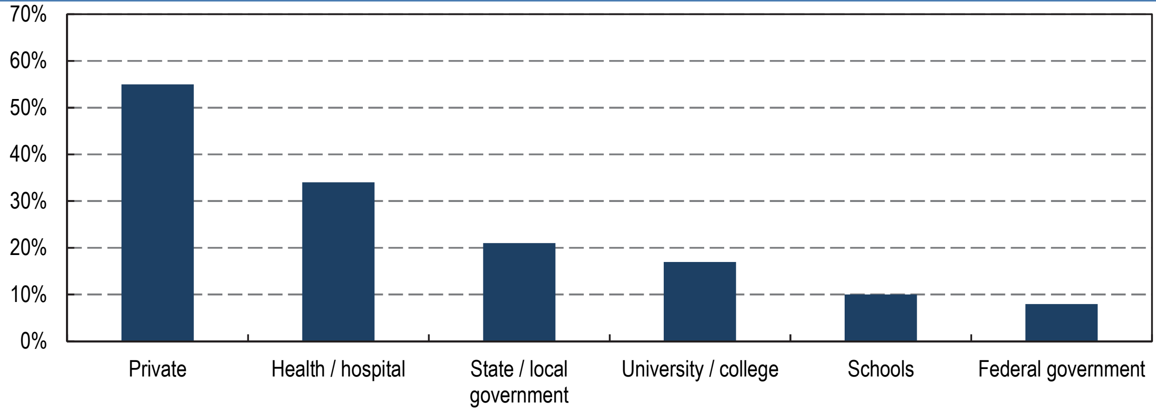
The best available evidence on MBIs and ESCOs can be found in the United States. In other parts of the world the evidence on MBIs is scarce.

United States

In the United States, the five States that are ranked highly in ESCO market activity are also highly ranked in terms of per-capita spending on ratepayer-funded energy efficiency programmes (Larsen et al., 2012). Previous analysis found that energy efficiency obligations have been one of three key drivers for the growth of ESCOs, alongside federal energy efficiency spending and increased interest from customers (Hopper et al., 2007).

In 2006, 3% of ESCO revenues came from residential efficiency programmes funded through obligations. This figure increased to 6% in 2008 (Satchwell et al., 2010). More recent figures indicate that in 2012, 38% of public sector ESCO projects used utility customer-funded incentives or rebates, most of which are provided through obligations (Carvallo et al., 2014). Evidence suggests that a significant share of ESCO project cost is supported by obligations (Figure 38).

Figure 39 • Share of total project cost covered by utility customer-funded energy efficiency programmes



Source: Carvallo et al. (2014).

ESCOs obtain funding directly through obligations, but there is also evidence to suggest that ESCOs can use them to offer additional services to customers (Sedano, 2011). Hence ESCOs play a role both in delivering energy efficiency obligations and in providing services beyond the obligations (Hopper et al., 2007).

European Union

Obligations have played a role in the ESCO market in Italy where investments by obligated parties reached USD 770 million in 2014 (Di Santo et al., 2011; ENSPOL, 2015). Most of the savings have been delivered by "Energy Service Businesses" (*societá di servizi energetici*). These can include ESCOs but many do not feature the key ESCO characteristic of performance contracting. Around 75% of all white certificates are generated by these energy service provider companies (Stede, 2016). No official data exist to assess the extent to which energy efficiency businesses transform into ESCOs. However, the number of ESCOs grew from just 27 in 2012 to 143 in 2016 (Stede, 2016). The recent shift within the Italian obligation programme towards the industry sector (62% of traded certificates in 2015 versus just 6% in 2007) has potentially opened up new opportunities for ESCOs (Stede, 2016).

In the cases of Denmark and France, there is anecdotal evidence that the energy efficiency obligations in those countries support the ESCO market (JRC, 2014a). However, a detailed assessment of this causal link does not exist. In France, the extent to which true ESCO models have been encouraged remains unclear, given that many of the measures have been simple low-cost measures in the residential sector. In Denmark, about 60% of the savings are delivered in the industry sector, which makes it more suitable for an ESCO-type model, and the annual investment by obligated parties was equivalent to USD 200 million in 2015 (Hogh, 2014; Rosenow and Bayer, 2016). There are indications that the obligations have benefited ESCOs and that utilities are starting to diversify their offer by accessing the ESCO market (JRC, 2014a).

In the United Kingdom, it was hoped that energy suppliers would transform into ESCOs delivering energy services when the obligation was introduced. However, this did not happen (Roberts et al., 2014). One reason is that obligations in the United Kingdom focus exclusively on the residential sector where projects are small and thus less attractive for performance contracting. It remains to be seen whether the new German energy efficiency auction mechanism will lead to increased ESCO market activity but the programme allows for collaboration with ESCOs (BMWI, 2016).

China

In response to the obligation programme, State Grid created ESCOs in all 26 provinces within its service territory as subsidiaries of the State Grid-owned provincial grid companies, plus an additional ESCO at the corporate level. Their main roles are implementing energy efficiency projects, delivering specialised energy and consultancy services, and helping to organise workshops and seminars to better engage end users in energy efficiency programmes. By the end of 2014, State Grid had signed 433 energy saving programme contracts, with a total investment of USD 238 million, which was estimated to generate 2.25 TWh annual savings (State Grid, 2014).

Southern Grid established a single ESCO at the corporate level that covers all four provinces within the Southern Grid service territory. Through the Southern Grid ESCO subsidiary, the ESCO successfully helped customers save 6 TWh of electricity from 2010 to 2013 (China Southern Grid Company, 2013).

South Africa

South Africa's obligation programme appears to have supported growth in the ESCO market. The largest utility in South Africa, Eskom, established the Integrated Demand Management division to provide finance for energy efficiency through a range of routes including the ESCO model. The funds provided (USD 44 million in 2013) have been the greatest facilitator of ESCO market activity in the period 2008-13 (Eskom, 2015; JRC, 2014b). More than 500 ESCOs have signed up to the

Eskom DSM register, focusing mainly on the commercial and industrial sectors (JRC, 2014b). Technologies include energy efficient motors and variable speed drives, pumps, HVAC systems, lighting, and hot water and heating systems. However, the ESCO market has been stagnating since September 2013 when Eskom decided to put on hold the finance provided through the Standard Offer programme (JRC, 2014b). Previously, over-reliance on one mechanism had been highlighted as a risk to the long-term stability of the ESCO industry (IDC, 2012).

Brazil

Brazil's energy efficiency obligation played an important role in the development of its ESCO market (JRC, 2014b). In the early phase of the programme, up to 50% of funds made available could be invested in projects suitable for performance contracting, making the obligation the most important source of revenue for the Brazilian ESCO market. There are now more than 50 ESCOs operating in Brazil, of which four are large spin-offs from utilities. The market size is estimated to be around USD 500 million per year (JRC, 2014b). Projects focus primarily on electricity savings, a result of funding from the electric utilities and the low heating requirements in Brazil, and include lighting, motors and HVAC systems. A shift in the programme's focus towards low-income customers resulted in fewer resources being made available for ESCOs after 2008 but modifications to the programme in 2013 provided an additional stimulus for the ESCO market (JRC, 2014b). The funds gathered through the obligation enter a public bidding process and the projects carried out are selected from this process (although not all of the funds generated by the obligation have to be spent). In addition, selection criteria favour proposals that include resources from outside the programme (which increases leverage). These changes all create more opportunities for ESCOs.

Australia

In Australia, the obligations seem to have had little impact on the ESCO market. This may be because the types of energy efficiency improvements "so far mostly consisted of very cheap and easy to implement measures which are not very attractive for ESCO investments" (JRC, 2014b).

Conclusions

The available data suggest that there is a link between MBIs and ESCO market activity. The most detailed data can be found in the United States, Brazil, South Africa and China. Several conclusions can be drawn from the evidence reviewed (Table 6).

Table 6 • Main conclusions from ESCO analysis

Conclusion	Examples
MBIs have been a key driver for ESCOs in several countries.	Brazil, China, Italy, South Africa, United States
A dedicated allowance or funding stream for ESCO-delivered savings can help drive ESCO market activity.	Brazil, South Africa
Where MBIs focus on the industry, commercial and public sectors, it is more likely for ESCOs to participate as the average project size is more attractive, without the need to aggregate multiple smaller projects.	Italy, United States
The wider market conditions such as regulatory settings and the legal establishment of performance contracting as a mechanism are an important prerequisite for a functioning ESCO market.	China, South Africa, United States
Open trading of energy savings can provide access to the market for ESCOs and energy efficiency providers.	Italy

The future of MBIs

The coverage and strength of MBIs is expected to grow. The evidence from global experience over more than two decades, set out in this report, is that end-use energy efficiency remains a low-cost and widely-available resource in all countries. Tapping a greater fraction of this efficiency potential remains an essential foundation for all of the major energy transformation pathways proposed to meet the development and environmental challenges of the current century. Reducing loads through efficiency will lower the cost of bringing electric service to those who cannot now access it. Efficiency also directly reduces emissions, and will over time reduce the total quantity of investments needed to supply reliable power in a low-carbon power system. The world cannot meet the commitments made in the Paris Climate Accord while wasting renewable energy in inefficient end-use applications. More jurisdictions are considering obligations and auctions as ways to engage markets to deliver the efficiency savings needed to meet their policy goals, whether they are energy system adequacy requirements, climate commitments, energy poverty reduction or industrial productivity. In the EU for example, the European Commission has recognised the potential of obligations and promoted them as a way of meeting energy savings targets to 2030.

Meanwhile, technological advances offer new challenges and solutions both on the supply side, (such as rapidly-falling costs of wind and solar generation) and on the demand side (such as advances in lighting, smart appliances, electric vehicles, the "internet of things"). The digitalisation of the energy sector also enables more accurate and granular measurement of energy consumption, providing opportunities for new business models. The evidence set out in this report highlights the importance of monitoring, verification and evaluation in ensuring the integrity of MBIs and demonstrating the cost-effectiveness of the efficiency gains they generate. Developments in the ability of efficiency practitioners to provide more accurate and standardised savings calculations could support increased energy efficiency investment and the trading of efficiency gains through white certificate programmes.

With the likely increase in policy ambition in this area, sharing knowledge across jurisdictions will be central to the success of the next wave of policy development, given the importance of good policy design in this area, and the diversity of experience across the world.

Acronyms, abbreviations and units of measure

Acronyms and abbreviations

ARRA	American Recovery and Reinvestment Act
CERT	Carbon Emissions Reduction Target programme in the United Kingdom
CESP	Community Energy Savings Programme in the United Kingdom
CO_2	Carbon dioxide
DC	Designated Consumer under the PAT scheme
ESCert	Energy saving certificate under the PAT scheme
ESCO	Energy service company
EU	European Union
EU ETS	European Union Emissions Trading System
EVT	Efficiency Vermont
G7	The Group of Seven (G7) countries are: Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.
HVAC	Heating, ventilation and air conditioning
IEA	International Energy Agency
IPMVP	International Performance Measurement and Verification Protocol
LPG	Liquefied Petroleum Gas
MBI	Market-based instrument
MVE	Monitoring, verification and evaluation
NEED	National Energy Efficiency Data-Framework in the United Kingdom
PAT	India’s Perform, Achieve and Trade scheme
PPEC	Plano de Promoção da Eficiência no Consumo de Energia Elétrica
UK	United Kingdom
US	United States

Units of measure

EJ	exajoules
kWh	kilowatt-hour
MWh	megawatt-hour
INR	Indian rupee
MW	megawatt
tCO_2e	tonnes of carbon dioxide-equivalent
USD	United States dollar

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Annex

United States, obligations

Arizona

Date started	2010
Energy savings per year (GWh)	1 190
Incremental energy savings compared to Total Fuel Consumption	0.3%
Programme expenditure (USD million)	125.1
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Include residential lighting, residential swimming pool pumps, appliance recycling, new home construction, HVAC, efficient appliances, behavioural programmes, retrofits, planting shade trees, low-income weatherisation, industrial motors, dynamic tariffs (peak time rebates, time-of-use, and super peak pricing).
Savings metric	% of electricity and gas sales the year before
Calculation method	Includes field metering, on-site inspection, customer surveys, trade ally interviews, focus groups, billing records and analysis, review of implementation tracking databases and documentation.
Monitoring & Verification	Evaluations are conducted by third parties for each of the regulated utilities. Regulated utilities are required to submit annual reports on progress with programmes and measures to the Arizona Corporation Commission for approval.
Target metric	Savings equal to a percentage of the previous year's electricity and gas sales. Up to 2% of the 2020 target for electricity utilities can be met through peak demand reductions (kW) through demand response programmes.
Energy saving target	Electricity (and gas): Cumulative savings equal to 22% of previous year's electricity sales by 2020 (6% for gas). Starting in 2011 with an annual target of 1.25% (0.5% for gas). The annual target increases over time to reach the cumulative goal by 2020.
Obligated parties	Investor-owned electricity utilities. Salt River Project and electric co-operatives also have a (somewhat lower) target. For gas: all gas utilities; gas co-operatives and propane companies must meet a proportion of the standard for regulated gas utilities.
Number of obligated parties	15 electric utilities; 6 gas utilities. Includes all investor-owned and publicly-owned utilities that are regulated by the Arizona Corporation Commission.
Cost recovery	Programme costs are approved by the Arizona Corporation Commission and recovered through bills, often in some combination with an incentive based on the amount of cost-effective energy savings achieved through efficiency programmes. Incentives vary by utility. One obligated party, Southwest Gas, has its revenues decoupled from sales.
Trading	None
Penalties	None, however cost recovery is dependent on programmes and measures being approved by the Commission, implemented in accordance with a commission-approved programme proposal or implementation plan, and monitored and evaluated for cost-effectiveness.
Banking and borrowing	Some credit for "early action"

Arkansas

Date started	2010
Energy savings per year (GWh)	249
Incremental energy savings compared	0.1%

to Total Fuel Consumption	
Programme expenditure (USD million)	83.3
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Education; audits; heating systems; lighting; demand response; insulation; HVAC; motors
Savings metric	Incremental kWh and therm
Calculation method	Deemed savings; metered savings
Monitoring & Verification	All programmes are subject to annual evaluation, measurement, and verification. Each utility employs a third-party contractor to perform company specific evaluation, measurement, and verification. The Commission's General Staff also contracts with an Independent Monitor who evaluates and verifies the work of the third-party contractors. Each utility files an annual evaluation, measurement and verification report with the Commission, and the Independent Monitor also files an annual report with the Commission.
Target metric	kWh and therm savings as a percentage of kWh and therm sales during the base period
Energy saving target	For programme year 2015, the base year for measurement is 2013. The target for electric utilities is 0.90% of 2013 sales, and the target for natural gas distribution utilities is 0.50% of 2013 sales.
Obligated parties	Electricity and natural gas utilities
Number of obligated parties	8
Cost recovery	"Disincentive offset" payment plus a performance incentive relative to achieving certain percentages of its annual targets to manage the lost revenue utilities incur
Trading	None
Penalties	None
Banking and borrowing	None

California

Date started	2004
Energy savings per year (GWh)	6 092
Incremental energy savings compared to Total Fuel Consumption	0.3%
Programme expenditure (USD million)	1 579.5
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Include lighting, advisory, HVAC, appliances, process pumps, air compressors, building retrofits, windows, refrigeration,
Savings metric	Annual MWh, MW (electric); Annual MMTherms (gas)
Calculation method	Deemed savings
Monitoring & Verification	4% of the statewide energy efficiency budget is dedicated to monitoring and evaluation, including M&V of programs implemented under California's obligation. The CPUC oversees monitoring and evaluation of utility programmes.
Target metric	Annual MWh and MW (electricity); Annual MMTherms (gas)
Energy saving target	Efficiency targets for electricity and gas utilities are set based on a legal standard of "all potentially achievable cost-effective" efficiency savings. Current goals: electricity, average goal for IOUs of about 1.15% of retail sales electricity through 2024. Natural Gas: Incremental savings target of 0.56% through 2024. Targets are expected to double as a result of a new law - SB350.
Obligated parties	Electricity and natural gas investor-owned utilities. Publicly-owned electric utilities, accounting for over 25% of overall load in the state, also face statutory energy savings obligations.

Number of obligated parties	Three electric IOUs; three natural gas IOUs; 39 POUs
Cost recovery	All electric and natural gas IOUs are decoupled. Performance incentives for IOUs are also available.
Trading	No
Penalties	None
Banking and borrowing	None

Colorado

Date started	2007
Energy savings per year (GWh)	673
Incremental energy savings compared to Total Fuel Consumption	0.16%
Programme expenditure (USD million)	111
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Large variety of measures including lighting; motors; drives; heating systems; HVAC; insulation; refrigeration; showerheads; social norms
Savings metric	Incremental GWh
Calculation method	For prescriptive products: deemed savings, for custom projects: scaled savings, for pilot projects: metered savings
Monitoring & Verification	Evaluation of ratepayer-funded energy efficiency programmes in Colorado relies on regulatory orders; evaluations are administered by the utilities; audits of sample of measures to ensure quality and performance.
Target metric	Incremental GWh and spending as % of revenue
Energy saving target	2016: electricity savings target of 1.42% of sales = 441 GWh and natural gas savings target commensurate with spending targets (at least 0.5% of prior year's revenue)
Obligated parties	Investor-owned electric and natural gas utilities
Number of obligated parties	Two
Cost recovery	
Trading	None
Penalties	None
Banking and borrowing	None

Connecticut

Date started	2007
Energy savings per year (GWh)	577
Incremental energy savings compared to Total Fuel Consumption	0.26%
Programme expenditure (USD million)	224
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Demand-side measures, including, but not limited to, energy efficiency, load management, demand response, combined heat and power facilities, distributed generation and other emerging energy technologies
Savings metric	Deemed energy (kWh) and demand (kW), and natural gas (Ccf) savings that would occur at a customer's meter
Calculation method	Deemed savings

Monitoring & Verification	Connecticut has established formal rules and procedures for evaluation, which are stated in Public Act 11-80 and Evaluation Rules and Roadmap. Statewide evaluations are conducted.
Target metric	Incremental savings as a percent of sales
Energy saving target	Requirement for acquisition of all cost-effective efficiency resources, equivalent to yearly incremental electricity savings targets of ~1.51%, natural gas savings of 0.61% through 2018.
Obligated parties	Electric distribution utilities, natural gas companies, and municipal electric utilities
Number of obligated parties	Five utilities plus municipal utilities: Connecticut's electric distribution companies (Connecticut Light & Power and United Illuminating Company), natural gas investor-owned utilities (Connecticut Natural Gas Corporation, Southern Connecticut Gas Company, and Yankee Gas Services Company), and municipal electric companies
Cost recovery	Connecticut's electric energy efficiency programmes are funded by a monthly system benefits charge on customers' electric bills. Connecticut Energy Efficiency Fund ("CEEF") electric programmes are also funded through the revenues the electric utilities receive from the ISO-New England Forward Capacity Market ("FCM"). CEEF will also be supplemented with funds the electric utilities receive from the Regional Greenhouse Gas Initiative (RGGI). Natural gas energy efficiency programmes are funded by a monthly charge established in the companies' Plan plus funding based on the difference between the imposed tax and the approved tax. Municipal electric utilities are required to create a fund to support energy efficiency and renewable energy programmes. This fund is supported by a surcharge of 0.22 USD/kWh.
Trading	None
Penalties	None
Banking and borrowing	None

Hawaii

Date started	2004
Energy savings per year (GWh)	144
Incremental energy savings compared to Total Fuel Consumption	0.18%
Programme expenditure (USD million)	33
Fuel coverage	Electric utilities. Hawaii uses very little natural gas and does not have any energy efficiency programmes for natural gas
Sector coverage	All sectors
Eligible energy efficiency measures	Heat pump water heating, ice storage, ratepayer-funded energy efficiency programmes, and use of rejected heat from co-generation and combined heat and power systems
Savings metric	% of net electricity sales; % of forecast electricity sales, or % annual savings
Calculation method	Deemed savings
Monitoring & Verification	The evaluation of ratepayer-funded energy efficiency programmes in Hawaii relies on legislative mandates (HRS § 269-124(7)). Evaluations are administered by Hawaii Public Utilities Commission. Hawaii has established formal rules and procedures for evaluation. Statewide evaluations are conducted.
Target metric	Cumulative electricity savings in GWh
Energy saving target	Cumulative electricity savings of 4 300 GWh by 2030 (equal to approximately 30% of forecast electricity sales, or 1.4% annual savings).
Obligated parties	Electric utilities
Number of obligated parties	Two
Cost recovery	Costs are recovered by utility rates
Trading	None
Penalties	None

Banking and borrowing	None

Illinois

Date started	2007
Energy savings per year (GWh)	1 513
Incremental energy savings compared to Total Fuel Consumption	0.13%
Programme expenditure (USD million)	395
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Large variety of measures that save electricity and/or natural gas including, but not limited to, lighting; motors; drives; heating systems; HVAC; refrigeration; CHP
Savings metric	Annualised First-Year Incremental Net Savings. Lifetime savings may be reported for informational purposes in reporting and planning documents.
Calculation method	Deemed savings and customised
Monitoring & Verification	Evaluation contractors are managed by the utilities and The Department of Commerce and Economic Opportunity with ICC oversight authority. Illinois has established formal rules and procedures for evaluation. An independent evaluation of the utilities and Department of Commerce & Economic Opportunity's energy efficiency programmes is performed annually.
Target metric	Incremental % of energy delivered
Energy saving target	2015: electricity savings target of 2% of energy delivered and gas savings target of 1% of gas sales
Obligated parties	Investor-owned electric and natural gas utilities. Department of Commerce and Economic Opportunity is responsible for 25% of the spending by administering public programmes through a dedicated fund.
Number of obligated parties	Six
Cost recovery	Automatic adjustment of tariff subject to approval by the regulator
Trading	Obligated parties may outsource part of their programme development and implementation
Penalties	USD 100 000 per day of non-compliance for failing to file plan by deadline specified; failing to meet energy efficiency goals requires a utility contribution to low-income energy efficiency programmes (value determined by the size of the utility) and may, for utilities or DCEO, result in efficiency programmes being transferred to a third party or the Illinois Power Agency for administration.
Banking and borrowing	Within one period: utilities can also meet annual incremental savings goals by showing that the total cumulative annual savings within a 3-year planning period (beginning in PY 2015) were equal to the sum of each annual incremental savings requirement.

Iowa

Date started	2009
Energy savings per year (GWh)	796
Incremental energy savings compared to Total Fuel Consumption	0.18%
Programme expenditure (USD million)	154
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Include energy audits, education, rebates and other financial assistance, research projects, time-of-use-rates, tree planting, hot water insulation
Savings metric	% reduction in sales (electric and gas) and demand reduction (MW) (electric)

Calculation method	No standard method
Monitoring & Verification	There are no specific legal requirements for M&V. Details of M&V approach are included in utility plans and approved by the IUB as part of the plan approval process.
Target metric	% of MWh sales (electric); % of Mcf sales (gas)
Energy saving target	Targets vary by utility. Utilities were required to consider a 1.5% annual savings target; however, the target approved by the IUB is lower to stay within the cost cap set for the obligations. The average target for electric utilities is annual incremental savings of 1.2% of sales per year; and for gas utilities, of between 0.7% and 1.2% of retail sales per year.
Obligated parties	Rate-regulated electricity and gas utilities. Municipal and co-operative utilities are required to establish, report on, and meet their own efficiency goals.
Number of obligated parties	Two (electric IOUs); four natural gas
Cost recovery	Cost are passed directly through to customer bills. The Iowa Utilities Board can disallow recovery of costs deemed to not have been "reasonable" or "prudent."
Trading	None
Penalties	Disallowance of costs deemed to have not been "reasonable" and "prudent."
Banking and borrowing	None

Maine

Date started	2009
Energy savings per year (GWh)	145
Incremental energy savings compared to Total Fuel Consumption	0.12%
Programme expenditure (USD million)	23
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	
Savings metric	Incremental GWh
Calculation method	Deemed savings
Monitoring & Verification	The independent evaluation of ratepayer-funded energy efficiency programmes in Maine is required by statute (Title 35a Section 10104 subsection 10). Evaluations are administered by Efficiency Maine.
Target metric	Incremental % of energy delivered
Energy saving target	~1.6% for electric and 0.2% for natural gas
Obligated parties	Third party (Efficiency Maine)
Number of obligated parties	Three
Cost recovery	Costs are recovered through transmission and distribution utility rates.
Trading	None
Penalties	None
Banking and borrowing	None

Maryland

Date started	2008
Energy savings per year (GWh)	792
Incremental energy savings compared to Total Fuel Consumption	0.19%
Programme expenditure (USD million)	337

Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Appliances; HVAC; lighting; building fabric; CHP; smart meters; new buildings
Savings metric	Cumulative MWh
Calculation method	
Monitoring & Verification	Each utility directs its own primary evaluation and verification activities through its EM&V Contractor, with an independent evaluator providing independent analysis and due diligence of the EM&V process, and evaluation of broad policy issues, such as impacts on the environment, jobs, price mitigation, reliability for each of the utilities.
Target metric	% of per capita electricity consumption
Energy saving target	"Post-2015: electricity: 2% of the utilities weather normalised gross retail sales
Obligated parties	Investor-owned electric and natural gas utilities
Number of obligated parties	Four
Cost recovery	Three of Maryland's investor-owned electric utilities (DP&L, Pepco and BGE), as well as one gas utility (Washington Gas Light) have their revenue separated from their sales through the use of a full revenue decoupling mechanism.
Trading	None
Penalties	None
Banking and borrowing	None

Massachusetts

Date started	2009
Energy savings per year (GWh)	2 177
Incremental energy savings compared to Total Fuel Consumption	0.52%
Programme expenditure (USD million)	675
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Plans may include (but are not limited to) the following programmes: energy efficiency and load management; demand response; innovation; efficient appliances, heating, air conditioning, lighting; public education; programmes providing support for energy use assessment, real time monitoring systems, engineering studies and services related to new construction or major renovation;
Savings metric	% of electricity and gas sales
Calculation method	Deemed savings, based on the technical reference manual
Monitoring & Verification	The budget and approach to M&V are set forth in the utility three-year plans and approved by the Department of Public Utilities (DPU). Programme administrators must report quarterly to the "energy efficiency advisory council" (EEAC). The EEAS is an official body, appointed and convened by the DPU by law. The EEAC provides an annual report on progress with utility 3-year plans to the Department of Public Utilities and joint committee on telecommunications, utilities and energy.
Target metric	% of electricity and gas sales
Energy saving target	Electric: Yearly incremental savings targets began at 1.4% in 2010, ramping up to 2.94% by 2016. Natural Gas: Targets began at 0.63% in 2010, ramping up to 1.24% by 2016. Targets are set every three years for a three-year period, based on the legislatively mandated obligation to acquire all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply.
Obligated parties	Electric and natural gas distribution companies
Number of obligated parties	Four (electric); six (natural gas)

Cost recovery	Cost recovery is permitted. (25 M.G.L. §21). It occurs through a systems benefit charge. Additionally, energy efficiency programmes are funded through revenue from the Forward Capacity Market, the Regional Greenhouse Gas Initiative, and other outside funds. (Docket Nos. 09-116 thru 09-120).
Trading	None
Penalties	None
Banking and borrowing	None

Michigan

Date started	2008
Energy savings per year (GWh)	2 852
Incremental energy savings compared to Total Fuel Consumption	0.34%
Programme expenditure (USD million)	251
Fuel coverage	Electricity; gas
Sector coverage	All sectors
Eligible energy efficiency measures	Varies. See www.michigan.gov/mpsc/0,4639,7-159-52495_55129---,00.html
Savings metric	% of total annual retail sales
Calculation method	Deemed savings
Monitoring & Verification	According to statute, energy optimisation plans shall include a process for obtaining an independent expert valuation of the actual energy optimisation programmes to verify the incremental energy savings from each energy optimisation programme (MCL 460.1071).
Target metric	% of total annual retail sales
Energy saving target	Electric: 1% of annual retail sales in megawatt hours for 2012 and thereafter; Natural gas: 0.75% of annual retail sales in MCF's for 2012 and thereafter
Obligated parties	All electric and natural gas utilities
Number of obligated parties	64
Cost recovery	Statute states that Energy Optimisation Plans should include provisions for cost recovery (MCL 460.1089; MI PSC, Docket U-15800, Order on 12/4/08). Rates typically include energy efficiency riders representing volumetric charges for residential customers and monthly per meter charges for commercial and industrial customers. Spending for each utility is capped at 2.0% of total sales revenues.
Trading	None
Penalties	None
Banking and borrowing	Each MWh of savings achieved by a utility in a given year qualifies for one energy optimisation credit. Excess credits can be banked, i.e. used to meet up to one-third of the required energy savings in the year following the year in which they were achieved. Excess credits cannot be banked if a utility has opted to receive incentive payments for exceeding its savings targets in a particular year.

Minnesota

Date started	2007
Energy savings per year (GWh)	1 611
Incremental energy savings compared to Total Fuel Consumption	0.29%
Programme expenditure (USD million)	182
Fuel coverage	Electricity; gas
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Heating systems; HVAC; refrigeration; building fabric; lighting; audits; motors;

	drives
Savings metric	Incremental MWh and Dekatherm
Calculation method	Deemed savings, metered and scaled savings
Monitoring & Verification	Minnesota has developed the Energy Savings Platform (ESP) to track and report the energy savings for all 187 utilities that participate in CIP. Evaluations are mainly administered by the utilities. The Division of Energy Resources and staff from Minnesota Department of Commerce also assist in the evaluation administration. Approximately 10% of custom projects are reviewed for quality.
Target metric	Incremental MWh and Dekatherm and spending as % of revenue
Energy saving target	2015: electricity savings of 1.5% and gas savings of 0.5% of previous year's consumption; largest electric utility has a 2% savings goal due to using a nuclear power plant; electricity utilities need to spend 0.2% of gross operating revenue on low-income customers and gas utilities need to spend 0.4% of gross operating revenue on low-income customers
Obligated parties	Investor-Owned Utilities, Retail Suppliers
Number of obligated parties	187
Cost recovery	Automatic adjustment of tariff subject to approval by the regulator
Trading	None
Penalties	None
Banking and borrowing	Energy savings achieved in excess of 1.5% may be carried forward for up to three years, except in the case of savings from infrastructure projects, which may carry over for five years.

Nevada

Date started	2005
Energy savings per year (GWh)	195
Incremental energy savings compared to Total Fuel Consumption	0.10%
Programme expenditure (USD million)	49
Fuel coverage	Electricity. Sierra Pacific Power and Southwest Gas offer natural gas efficiency programs, but natural gas energy efficiency programmes are not required under the state EERS.
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Energy efficiency measures qualify if they are subsidised by the electric utility, reduce demand (as opposed to shifting peak demand to off-peak hours), and are implemented or sited at a retail customer's location after 1 January 2005. Examples include: air conditioner retrofits, efficient lighting purchases, refrigerator recycling, and solar thermal water heating
Savings metric	% total electricity sold
Calculation method	No specific methods could be identified.
Monitoring & Verification	The evaluation of ratepayer-funded energy efficiency programmes in Nevada relies on regulatory orders (NAC 704). Evaluations are mainly administered by the utilities and are conducted for each programme. There are no specific legal requirements for these evaluations in Nevada.
Target metric	% of energy savings as percentage of Renewable Portfolio Standard
Energy saving target	25% renewable energy by 2025. Energy efficiency may currently meet 20% of the standard in any given year, but phases out of the RPS over time.
Obligated parties	Investor-owned utilities
Number of obligated parties	Two
Cost recovery	Energy efficiency programmes that are funded by rate adjustments noted on customer bills. Nevada utilities can recover lost revenues that result from successfully conducting energy efficiency programmes.
Trading	The Public Utilities Commission of Nevada established a programme to allow energy providers to buy and sell portfolio energy credits (PECs) in order to meet

	energy portfolio requirements. The number of kWh saved by energy efficiency measures is multiplied by 1.05 to determine the number of PECs. For electricity saved during peak periods as a result of efficiency measures, the credit multiplier is increased to 2.0. PECs are valid for a period of four years.
Penalties	None
Banking and borrowing	None

New Mexico

Date started	2008
Energy savings per year (GWh)	124
Incremental energy savings compared to Total Fuel Consumption	0.06%
Programme expenditure (USD million)	25
Fuel coverage	Electricity
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Deemed savings, metered and customised
Savings metric	Cumulative
Calculation method	Deemed savings
Monitoring & Verification	Annual reports must be submitted by each utility and a comprehensive M&V report must be conducted by an independent evaluator every three years. Typically, a subset of programmes is independently evaluated every year. New programmes are independently evaluated in their first year and every year the two programmes with the highest projected energy savings are evaluated.
Target metric	Cumulative % of electricity sales
Energy saving target	5% of 2005 electricity retail sales by 2014 and 8% of 2005 retail sales by 2020
Obligated parties	Investor-owned utilities
Number of obligated parties	Three
Cost recovery	Automatic adjustment of tariff subject to approval by the regulator
Trading	None
Penalties	None
Banking and borrowing	None

New York

Date started	2008
Energy savings per year (GWh)	1 339
Incremental energy savings compared to Total Fuel Consumption	0.12%
Programme expenditure (USD million)	493
Fuel coverage	Electricity and gas
Sector coverage	Residential, multi-family, low-income, commercial/industrial, and research and development programmes
Eligible energy efficiency measures	
Savings metric	Electric: cumulative utility savings. Gas: incremental savings
Calculation method	Deemed savings
Monitoring & Verification	The evaluation of ratepayer-funded energy efficiency programmes in New York relies on regulatory orders Case 07-M-0458 and Case 07-G-0141). Both utilities and the New York State Energy Research and Development Authority (NYSERDA) administer the evaluation of programs. New York Evaluation Plan Guidance for EEPS Programme Administrators is established for conducting evaluations. Statewide evaluations and evaluations for each utility are

	conducted.
Target metric	Cumulative % first year savings
Energy saving target	Electric: Under current Reforming the Energy Vision (REV) proceedings, utilities have filed efficiency transition implementation plans (ETIPS) with incremental targets varying from 0.4% to 0.9% for the period 2016–2018. NYSERDA's Clean Energy Fund (CEF) Framework outlines a minimum 10-year energy efficiency goal of 10.6 million MWh measured in cumulative first year savings (approximately 0.7% incremental annual savings). Some degree of overlap of programme savings is anticipated between utility targets and NYSERDA CEF goals. Natural Gas: Utilities have filed proposals for varying incremental targets averaging incremental savings of 0.28% for the period 2016–2018.
Obligated parties	Utilities, NYSERDA, independent parties
Number of obligated parties	16 plus NYSERDA
Cost recovery	Starting in 2007, New York required its utilities to propose full revenue decoupling mechanisms in each succeeding rate case. As a result, all of New York's rate-regulated electric and gas utilities operate with their revenues decoupled from their sales. In addition, utility-specific incentives are on a sliding scale based on achievement of between 80% and 100% of individual goals. Utility incentives will not be calculated until 2016, when the 2015-16 period is complete.
Trading	None
Penalties	No penalties are specifically stated. However, incentives for utilities are based upon meeting 80% and 100% of individual goals. Falling short of this means the utility won't receive the incentive payment.
Banking and borrowing	None

North Carolina

Date started	2007
Energy savings per year (GWh)	855
Incremental energy savings compared to Total Fuel Consumption	0.11%
Programme expenditure (USD million)	107
Fuel coverage	Electricity
Sector coverage	All sectors except transport
Eligible energy efficiency measures	CHP
Savings metric	First year savings
Calculation method	Deemed, metered savings and engineering calculations
Monitoring & Verification	The utilities are responsible for M&V and may use an independent third party. The utilities must describe the industry-accepted methods and methodologies and identify any third party as well as provide a schedule for reporting savings to the regulator.
Target metric	Cumulative % of sales
Energy saving target	Equivalent to 0.25% incremental savings; public electric utilities must obtain renewable energy power and energy efficiency savings of 3% of prior-year electricity sales in 2012, 6% in 2015, energy efficiency is capped at 25% of the 2012-18 targets.
Obligated parties	Investor-owned utilities
Number of obligated parties	Three
Cost recovery	Annual rider up to an annual cap to recover costs
Trading	None
Penalties	None
Banking and borrowing	None

Oregon

Date started	2010
Energy savings per year (GWh)	767
Incremental energy savings compared to Total Fuel Consumption	0.27%
Programme expenditure (USD million)	183
Fuel coverage	Electric; natural gas
Sector coverage	Residential; commercial; industrial
Eligible energy efficiency measures	To be eligible for funding under the obligation (that is, funding from the Energy Trust), measures must generally meet two cost-effectiveness tests -- Utility Cost Test and Total Resource Cost Test. Measures for buildings must meet Energy Trust energy efficiency specifications. Measure categories in 2015 included: existing buildings (C&I, residential multi-family, new buildings, production efficiency (industry and agriculture), existing and new homes, products.
Savings metric	Average MW (1 aMW = 8 760 MWh); therms
Calculation method	
Monitoring & Verification	Statute requires independent review of the public purpose charge to develop recommendations for the legislature. A report was released in 2006 that recommended developing more consistent M&V procedures for public purpose charge funds. M&V is done by the Energy Trust of OR. The Energy Trust of OR has a robust programme for process and impact evaluations and a robust quality control and quality assurance process to make sure M&V is done well.
Target metric	Average MW (1 aMW = 8 760 MWh); therms
Energy saving target	55.1 average megawatts of electricity in 2016; save at least 6 million annual therms of natural gas in 2016. For 2015-19, save 240 aMW of electricity and 24 million annual therms of natural gas.
Obligated parties	Investor-owned electricity companies (retail) (SB 1149, Sec. 1.11)
Number of obligated parties	Four
Cost recovery	Costs of energy efficiency are recovered the same as costs for supply-side investments - through a regulated rate of return on revenues.
Trading	None
Penalties	None
Banking and borrowing	None

Pennsylvania

Date started	2004
Energy savings per year (GWh)	867
Incremental energy savings compared to Total Fuel Consumption	0.08%
Programme expenditure (USD million)	198
Fuel coverage	Electricity
Sector coverage	Residential; commercial; industrial
Eligible energy efficiency measures	HVAC equipment – ranging from room air conditioners to large centrifugal chillers – as well as lighting, energy management controls upgrades, drives and motors, and food service equipment; also appliances, lighting, motors and drives, HVAC, compressed air, and refrigeration measures
Savings metric	Cumulative savings and incremental savings
Calculation method	Deemed and metered savings
Monitoring & Verification	The evaluation of ratepayer-funded energy efficiency programmes in Pennsylvania relies on both legislative mandates and regulatory orders. The order follows the legislation. Evaluations are mainly administered by the Pennsylvania Public Utilities Commission, but there are no specific legal

	requirements for these evaluations in Pennsylvania. Evaluations are conducted for each of the utilities.
Target metric	Cumulative savings and incremental savings
Energy saving target	Phase II of the EE&C Program, establishing electricity savings targets for the three-year period from FY2014-16. The targets amount to 2.3% cumulative savings over the three-year period. Phase III is a five year period running from 2016-20. Targets vary by utility, but total 5 710 487 MWh over the phase, equivalent to about 0.77% incremental savings per year through 2020.
Obligated parties	Major electric distribution companies
Number of obligated parties	Seven
Cost recovery	Under Act 129, the electric distribution companies' energy efficiency and conservation plans propose a cost-recovery tariff mechanism to fund the energy efficiency and conservation measures and to ensure recovery of reasonable costs. The utilities can also recover the costs through a reconcilable adjustment mechanism.
Trading	None
Penalties	None
Banking and borrowing	None

Rhode Island

Date started	2006
Energy savings per year (GWh)	389
Incremental energy savings compared to Total Fuel Consumption	0.65%
Programme expenditure (USD million)	101
Fuel coverage	Electricity; gas
Sector coverage	All gas and electric customers
Eligible energy efficiency measures	Lighting; building fabric; heating system; HVAC; new construction; appliances; process improvements; motors; drives
Savings metric	Both lifetime savings and 1st year savings depending on programme
Calculation method	Based on a combination of metered consumption and engineering estimates.
Monitoring & Verification	Usually studies are done on a programme-specific basis. RI piggybacks on MA studies and contracts out with third parties. Periodic overall studies are done specific to RI.
Target metric	Incremental % of sales, MWh and decatherm
Energy saving target	2015: electricity savings of 2.5% of 2012 sales (193 603 MWh) and gas savings of 1.0% of 2012 gas sales (376 915 MMBtu)
Obligated parties	Investor-owned utility
Number of obligated parties	One
Cost recovery	Surcharge per kilowatt-hour and decatherm delivered determined by regulator
Trading	None
Penalties	None
Banking and borrowing	None

Texas

Date started	1999
Energy savings per year (GWh)	728
Incremental energy savings compared to Total Fuel Consumption	0.02%
Programme expenditure (USD million)	201

Fuel coverage	Electricity
Sector coverage	Residential and commercial electricity customers, except large industrial users connected to the transmission grid. These customers do not pay for electric utility efficiency programmes and therefore cannot participate in them.
Eligible energy efficiency measures	Equipment, materials and practices (including behavioural or operational changes) implemented in a customer's site on the customer's side of the meter that result in a reduction at the customer level or on the utility's system in electric energy consumption, measured in kWh or peak demand. May include thermal energy storage and appliance removal.
Savings metric	MW, MWh
Calculation method	Deemed savings (technical reference manual)
Monitoring & Verification	Each standard offer, market transformation, and self-delivered programme shall include use of an industry-accepted evaluation or measurement and verification protocol, such as the International Performance Measurement and Verification Protocol (IPMVP) or a protocol approved by the commission, to document and verify energy and peak demand savings. A utility shall not provide an energy efficiency service provider final compensation until the provider establishes that the work is complete and evaluation or measurement and verification in accordance with the protocol verifies that the savings will be achieved. The Commission also selects an EM&V contractor to verify uility efficiency programmes and programme portfolios.
Target metric	% of annual incremental load growth; summer peak demand reduction (MW)
Energy saving target	Obligated utilities must offset 30% of incremental load growth annually through end-use energy efficiency, subject to cost caps. If this goal is equivalent to at least 0.4% of a utility's summer weather-adjusted peak demand for the combined residential and commercial customers for the previous programme year, the utility shall acquire four-tenths of 1% of its summer weather-adjusted peak demand for the previous programme year.
Obligated parties	All electric transmission and distribution utilities (does not include electric co-operatives or municipally owned utilities).
Number of obligated parties	Five
Cost recovery	An Energy Efficiency Cost Recovery Factor (EECRF) rate schedule is included in tariffs and permits utilities to recover the costs of providing energy efficiency programmes. The commission also has the option of approving an energy charge or a monthly customer charge for the EECRF.
Trading	None
Penalties	The commission may impose an administrative penalty or other sanction if the utility fails to meet a goal for energy efficiency.
Banking and borrowing	% of annual incremental load growth; summer peak demand reduction (MW)

Vermont

Date started	2000
Energy savings per year (GWh)	103
Incremental energy savings compared to Total Fuel Consumption	0.25%
Programme expenditure (USD million)	48
Fuel coverage	Electricity; thermal energy and process fuels
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Lighting; HVAC; industrial process equipment; CHP; appliances; thermal renovation
Savings metric	MWh, MW, MMBtu
Calculation method	Vermont employs a technical reference manual to determine the calculation methods for savings. Includes deemed savings.
Monitoring & Verification	Evaluations are mainly administered by the Energy Efficiency Utility (EEU). The "Process and Administration of an Order of Appointment" sets forth details for monitoring and verification, and requires verification of the reported energy and capacity savings and cost-effectiveness of programmes delivered by EEU

	implementers by an independent auditor.
Target metric	MWh, MW, MMBtu
Energy saving target	2015 - 2017 goals: electricity – 321 800 MWh and 41 300 kW peak reduction (summer), 53 700 kW (winter); thermal energy and process fuels – 235 000 MMBtu
Obligated parties	Vermont Energy Investment Corporation (VEIC), the state's "efficiency utility", is obligated to meet targets, as well as Burlington Electric Department and Vermont Gas Systems. Revenues for VEIC's programmes come from electric and natural gas utilities (except the two mentioned above, who administer their own programmes), as well as heat, propane, kerosene and coal dealers.
Number of obligated parties	Three
Cost recovery	Utility costs are recovered via rates. Vermont's two investor-owned utilities have decoupled revenues from sales.
Trading	No
Penalties	No explicit penalties. A proportion of the compensation to VEIC is contingent on meeting stated goals, subject to an M&V process. If goals are not met, the state withholds compensation and the administrator can potentially be replaced at the end of the contract period.
Banking and borrowing	MWh, MW, MMBtu

Washington

Date started	2006
Energy savings per year (GWh)	947
Incremental energy savings compared to Total Fuel Consumption	0.16%
Programme expenditure (USD million)	280
Fuel coverage	Electricity
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Any reduction in energy consumption resulting from increases in the efficiency of energy use, production, or distribution. Includes end-use energy efficiency, high-efficiency customer-side co-generation for own use; transmission and distribution system efficiency; production efficiency.
Savings metric	MWh
Calculation method	Deemed savings, unless a utility can demonstrate that a company-developed savings value is more appropriate than a regional value
Monitoring & Verification	Obligated parties report to Regulator on goals and savings achieved, and are audited for compliance by the Washington State Auditor. Savings must be measured using the Northwest Power and Conservation Council's deemed savings database, unless the utility can demonstrate that that a company-developed savings value is more appropriate than a regional value.
Target metric	MWh
Energy saving target	Utilities establish five- and ten-year outlooks, and two-year targets to meet "all cost-effective electricity conservation." Average of about 1.4% incremental electricity savings per year. Conservation target for 2014-15 for all 17 obligated utilities amounted to 1 480 450 MWh over two years.
Obligated parties	Public, municipally owned and investor-owned utilities with more than 25 000 customers in Washington must meet "all cost-effective electricity conservation."
Number of obligated parties	17. This is the number of public (14) and investor-owned (3) utilities that meet the 25 000 customer threshold.
Cost recovery	Investor-owned utilities may recover all "prudently-incurred costs" related to energy conservation.
Trading	No trading; but up to 25% of excess savings in a two-year compliance period can be carried over to the following two-year compliance period.
Penalties	Utilities pay a penalty of USD 50 for each MWh of shortfall, adjusted annually (since 2007) to account for inflation and GDP. The utility has three months to notify customers of the fined amount and reasons for missing the target. Pass-

	through of penalty cost to consumers is subject to administrative approval. Penalties are collected into a special fund, and can only be spent on renewable energy development and conservation at public facilities, local government facilities, community colleges, or state universities.
Banking and borrowing	MWh

Wisconsin

Date started	2011
Energy savings per year (GWh)	1 063
Incremental energy savings compared to Total Fuel Consumption	0.19%
Programme expenditure (USD million)	94
Fuel coverage	Electricity; gas
Sector coverage	All sectors
Eligible energy efficiency measures	The current number of energy efficiency measures in Focus is 1 071. In addition there are 15 renewable energy measures. The current listing of those measures is in the TRM, which includes many but not all measures.
Savings metric	kWh first year energy savings, focus on energy has a lifetime savings metric
Calculation method	Deemed savings
Monitoring & Verification	Statewide energy efficiency programmes are evaluated by an independent third party hired by the Commission to evaluate programmes by measuring their impact and cost-effectiveness. Utility programs beyond the statewide requirements are also required to be independently evaluated.
Target metric	Wisconsin
Energy saving target	Energy efficiency obligation
Obligated parties	2011
Number of obligated parties	1 063
Cost recovery	0.19%
Trading	94
Penalties	Electricity; gas
Banking and borrowing	All sectors

United States, auctions

PJM

Date started	2012
Energy savings per year (GWh)	Not available
Incremental energy savings compared to Total Fuel Consumption	Not available
Programme expenditure (USD million)	55-110
Fuel coverage	Electricity
Sector coverage	Residential, commercial and industry
Eligible energy efficiency measures	Variety of measures with efficiency ratings higher than replaced equipment or relevant regulation or standard practices
Savings metric	Average demand reduction over system peak hours (MW)
Calculation method	Combination of deemed, metered and modelling in accordance with IPMVP
Monitoring & Verification	For prescriptive measures, regularly updated secondary sources (e.g. technical Reference Manual) can be used. For custom measures or projects, metering and/or modelling based on appropriate sampling (with statistical precision

	requirements) are typically needed

New England

Date started	2008
Energy savings per year (GWh)	Not available
Incremental energy savings compared to Total Fuel Consumption	Not available
Programme expenditure (USD million)	55
Fuel coverage	Electricity
Sector coverage	Residential, commercial and industry
Eligible energy efficiency measures	Variety of measures with efficiency ratings higher than replaced equipment or relevant regulation or standard practices
Savings metric	Average demand reduction over system peak hours (MW)
Calculation method	Combination of deemed, metered and modelling in accordance with IPMVP
Monitoring & Verification	For prescriptive measures, regularly updated secondary sources (e.g. Technical Reference Manual) can be used. For custom measures or projects, metering and/or modelling based on appropriate sample (with statistical precision requirements) are typically needed

EU, obligations

Austria

Date started	2009 (voluntary), 2014 (mandatory)
Energy savings per year (GWh)	1 578
Incremental energy savings compared to Total Fuel Consumption	0.5%
Programme expenditure (USD million)	106
Fuel coverage	All fuels
Sector coverage	All sectors
Eligible energy efficiency measures	Any measure that saves energy and is additional
Savings metric	First year savings
Calculation method	In principle: a combination of deemed, scaled and metered savings. Also surveyed savings are permissible. There is a large catalogue of deemed savings values (mainly for the household sector) that is updated regularly.
Monitoring & Verification	A monitoring body has been appointed for M&V. Reporting via an online portal. All data is processed electronically. Three main pillars of M&V: plausibility checks (all measures), desktop check of detailed documentation of measures and on-site checks (both for representative samples of measures).
Target metric	Cumulative final energy savings (PJ) and % of energy sales
Energy saving target	2014-20: 159 PJ cumulative final energy, 0.6% of energy sales/year, minimum share for residential sector of 40% of savings
Obligated parties	All retailers of energy - excluding small retailers (<25 GWh)
Number of obligated parties	>4 000
Cost recovery	Unregulated cost pass-through
Trading	Bilateral trading between obligated parties
Penalties	Option to pay 0.20 EUR/kWh not delivered. If target not delivered and buy-out mechanism not used penalty of up to EUR 100 000 per obligated party.
Banking and borrowing	An overachievement of the annual target can be transferred to the following years.

Bulgaria

Date started	2008
Energy savings per year (GWh)	807
Incremental energy savings compared to Total Fuel Consumption	0.8%
Programme expenditure (USD million)	283
Fuel coverage	Electricity, heat, natural gas, liquid and solid fuel
Sector coverage	All sectors
Eligible energy efficiency measures	Measures that save energy in energy generation, transmission and distribution or final consumption; training; audits; energy efficiency management; awareness
Savings metric	Cumulative (ktoe)
Calculation method	Engineering calculations; metered savings
Monitoring & Verification	Annual reports submitted to regulator; audits
Target metric	Annual final energy savings (ktoe)
Energy saving target	2014-20: 69.38 ktoe final energy per year
Obligated parties	Energy suppliers (electricity, heat, gas, other fuels)
Number of obligated parties	52 (expected to increase to 80)
Cost recovery	Unregulated cost pass through
Trading	No
Penalties	Yes - BGN 1 000-5 000 or BGN 5 000-500 000
Banking and borrowing	No

Denmark

Date started	1995
Energy savings per year (GWh)	3 384
Incremental energy savings compared to Total Fuel Consumption	2.2%
Programme expenditure (USD million)	207
Fuel coverage	Electricity; gas; district heating; oil for heating
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Heating system; building fabric; ventilation; lighting; process equipment; cooling; compressed air; pumps; motors; drives; appliances, distributions systems, collective solar installations in connection with district heating supply
Savings metric	First year savings
Calculation method	Deemed savings for most household measures; scaled and metered savings for most industry projects
Monitoring & Verification	The obligated companies are responsible for M&V. They shall have quality control system in place. As part of this assurance, obligated companies must each year carry out an audit to ensure and demonstrate that the notified savings have been realised and documented in accordance with the agreement and the Order. In alternate years, the audit may be carried out internally by the company itself, with intervening audits being carried out externally by an independent auditor. An independent random control is made annually by the Danish Energy Agency.
Target metric	Annual final energy savings (PJ)
Energy saving target	2015-20: 12.2PJ final energy per year
Obligated parties	Electricity, gas and heat distributors. Oil companies on a voluntary basis
Number of obligated parties	465
Cost recovery	The obligated parties can recover the cost by the tariffs. It is regulated as a non-

	profit activity.
Trading	No – but allow between the obligated parties
Penalties	Yes, but amount not specified
Banking and borrowing	Only banking and with limitations

France

Date started	2006
Energy savings per year (GWh)	12 210
Incremental energy savings compared to Total Fuel Consumption	0.7%
Programme expenditure (USD million)	437
Fuel coverage	All fuels
Sector coverage	All sectors except facilities subject to the ETS
Eligible energy efficiency measures	Standardised and non-standardised measures plus contributions to programmes targeting fuel poverty, education, or innovation
Savings metric	Lifetime final energy savings (TWh)
Calculation method	Deemed savings and engineering estimates
Monitoring & Verification	Deemed savings for standardised measures; ministerial approval required for others
Target metric	Lifetime final energy savings (TWh)
Energy saving target	2015-17: 700 TWh lifetime final energy + 150 TWh lifetime to be implemented for the exclusive benefits of fuel poor households
Obligated parties	All LPG suppliers with a turnover >100 GWh, suppliers of electricity, gas and district heating with a turnover >400 GWh, distributors of automotive fuels
Number of obligated parties	2009
Cost recovery	Electricity and gas prices are regulated for domestic consumers buying their energy from historic suppliers: EDF or Engie (ex-GDF). Regulated prices are decided by the Regulator (CRE) and the Government. Other obligated parties can pass on the costs at their own discretion.
Trading	Vertical trading via trading platform and bilateral trading
Penalties	Yes, buy-out of 0.02 EUR/kWh
Banking and borrowing	Yes, savings can be banked for up to nine years

Ireland

Date started	2012
Energy savings per year (GWh)	449
Incremental energy savings compared to Total Fuel Consumption	0.4%
Programme expenditure (USD million)	48
Fuel coverage	All fuels
Sector coverage	All sectors (non-residential, residential and energy poor residential)
Eligible energy efficiency measures	Pre-approved list of measures with deemed energy saving values for residential (including energy poor) sector. In the non-residential a wide range of energy efficiency measures are eligible, assessed on a case-by-case basis with savings determined on a metered or scaled basis.
Savings metric	First year savings (kWh)
Calculation method	Deemed savings, metered savings and engineering and scaled savings
Monitoring & Verification	Regulator audits a statistically significant sample of credits, between 5% and 10% of all works submitted by obligated parties. The works audited must approximate 20% of the obligated party's savings and must include a

	representative sample of project types, sizes, sub-sectors and locations, as well as considering any risk factors. Audits of all non-deemed measures.
Target metric	Annual primary energy savings (GWh)
Energy saving target	2014-20: 550 GWh primary energy per year (there is a consultation underway at the moment and this annual target may change)
Obligated parties	Energy suppliers that sell more than 600 GWh per year; importers of road transport fuel (there is a consultation underway at the moment and this threshold may change)
Number of obligated parties	10. One obligated party fell below the threshold sales level in 2015 and is no longer obligated. Also, one of the obligated parties, Enprova, is an umbrella organisation for a number of obligated oil parties.
Cost recovery	Unregulated cost pass-through
Trading	Bilateral trading between obligated parties and vertical trading via trading platform is allowed but not yet prevalent
Penalties	Yes, penalty set at multiple of 1.25 of the buyout price across all sub-sectors. An obligated party may buy out up to 30% of their sectoral targets in any year, penalties are applied to any deficit remaining.
Banking and borrowing	Unrestricted banking of savings possible

Italy

Date started	2005
Energy savings per year (GWh)	5 815
Incremental energy savings compared to Total Fuel Consumption	0.4%
Programme expenditure (USD million)	784
Fuel coverage	Electricity; gas
Sector coverage	All sectors
Eligible energy efficiency measures	Pre-approved list of measures with deemed and engineering estimates (scaled) energy saving values plus other measures assessed on a case-by-case basis as metered savings
Savings metric	Annual primary energy savings (Mtoe)
Calculation method	Deemed savings, scaled savings, metered savings
Monitoring & Verification	Deemed savings, on-field measurement, or measures subject to preapproval
Target metric	Annual primary energy savings (Mtoe)
Energy saving target	2016: 7.6 Mtoe primary energy
Obligated parties	Electricity and gas distributors having more than 50 000 end users
Number of obligated parties	61
Cost recovery	Surcharge on energy delivered approved by regulator
Trading	Vertical trading via spot market and bilateral trading
Penalties	Penalty is due if compliance is less than 60% of obligation; set depending on the market price
Banking and borrowing	Certificates multiplied by a number greater than 1 (penalties in 2014: EUR 2 500 and EUR 65 000)

Luxembourg

Date started	2015
Energy savings per year (GWh)	214
Incremental energy savings compared to Total Fuel Consumption	0.5%
Programme expenditure (USD million)	28

Fuel coverage	All fuels
Sector coverage	All sectors
Eligible energy efficiency measures	All energy efficiency measures with few exceptions
Savings metric	Savings are calculated on a first year savings basis, but the lifetime of the measures are taken into account (for actions with a lifetime going until 2020 or beyond, the whole first-year saving can be accounted; for actions with a lifetime ending before 2020 only a proportion of the first year savings can be accounted).
Calculation method	Deemed savings and scaled savings
Monitoring & Verification	Obligated parties have to report annually on the energy savings achieved during the preceding year. Supporting documentation regarding the savings declared will have to be retained for ten years by the obligated parties and produced in the event of a control or verification.
Target metric	Annual final energy savings (MWh)
Energy saving target	2016: 285 381 MWh final energy per year
Obligated parties	All suppliers of electricity and natural gas serving residential, service sector and industrial customers
Number of obligated parties	Theoretically 35, but in practice only 12
Cost recovery	Unregulated cost pass-through
Trading	No, but bilateral cession is allowed between obligated parties
Penalties	2 EUR/MWh with obligation to realise the missing savings during the next calendar year
Banking and borrowing	Savings exceeding the target can be carried over to the previous four years or to the next three years

Malta

Date started	2014
Energy savings per year (GWh)	4
Incremental energy savings compared to Total Fuel Consumption	0.1%
Programme expenditure (USD million)	1
Fuel coverage	Electricity; gas
Sector coverage	Residential
Eligible energy efficiency measures	Smart meters; rising block tariffs
Savings metric	Cumulative final energy savings (GWh)
Calculation method	Not clear
Monitoring & Verification	Not clear but appears to be top-down evaluations of energy consumption before and after measures
Target metric	Cumulative final energy savings (GWh)
Energy saving target	2014-20: 111.6 GWh final energy
Obligated parties	Enemalta Corporation (monopoly distributor)
Number of obligated parties	1
Cost recovery	No information
Trading	No
Penalties	Up to EUR 100 000 or EUR 600 for each day of non-compliance
Banking and borrowing	No

Poland[48]

Date started	2013
Energy savings per year (GWh)	6 155
Incremental energy savings compared to Total Fuel Consumption	0.9%
Programme expenditure (USD million)	808
Fuel coverage	Electricity; gas; district heating
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Long list of eligible measures based on Annex of Energy Services Directive (e.g. building fabric; heating system; appliances; lighting; waste heat recovery) excluding behavioural measures
Savings metric	Final energy first year (toe)
Calculation method	Deemed savings and scaled savings
Monitoring & Verification	Energy savings accomplished in energy efficiency projects with average annual energy savings that exceed 100 toe shall ex-post be verified by an energy audit. The audit must not be conducted by the same auditor who carried out the initial audit for the project. Projects that fall below the 100-toe threshold are subject to random sampling verification.
Target metric	Cumulative final energy savings (Mtoe)
Energy saving target	2016-20: 2 645 Mtoe
Obligated parties	Electricity, natural gas and district heating companies selling to final consumers; members of a commodities exchange; commodity brokerage houses
Number of obligated parties	>500
Cost recovery	Unregulated cost pass-through
Trading	Yes, certificates can be traded via Polish Power Exchange
Penalties	Up to 10% of the revenue of the obligated party, may not exceed PLN 3 000 000 (approximately EUR 750 000)
Banking and borrowing	Yes

Slovenia

Date started	2014
Energy savings per year (GWh)	131
Incremental energy savings compared to Total Fuel Consumption	0.2%
Programme expenditure (USD million)	13
Fuel coverage	All fuels
Sector coverage	All sectors
Eligible energy efficiency measures	Technologies determined by legislation including building fabric; heating system; district heating; measures in the transport sector, energy management
Savings metric	First year savings (kWh)
Calculation method	Deemed savings
Monitoring & Verification	The Energy Agency verifies at least a statistically significant proportion and representative sample of measures. Obligated parties have to report annually.
Target metric	Cumulative savings (GWh)
Energy saving target	2014-20: 4 263 GWh cumulative savings

[48] While the information in this table is based on Poland's information to the European Commission. The number of issued white certificates given by the Energy Regulator Office for the tenders announced and completed is different as well as the associated administrative cost may be different.

Obligated parties	Suppliers of electricity, heat, gas and liquid and solid fuels to final customers
Number of obligated parties	161
Cost recovery	Unregulated cost pass through
Trading	No
Penalties	EUR 15 000-EUR 250 000
Banking and borrowing	No

Spain

Date started	2014
Energy savings per year (GWh)	2 640
Incremental energy savings compared to Total Fuel Consumption	0.3%
Programme expenditure (USD million)	346
Fuel coverage	Electricity; gas; oil products; LPG
Sector coverage	All sectors
Eligible energy efficiency measures	Wide range of measures including energy management; energy audits; process improvement; carpooling; car sharing; promotion of cycling; building fabric; heating systems; HVAC; lighting
Savings metric	Information not available
Calculation method	Information not available
Monitoring & Verification	No provisions yet as compliance will be achieved through payments into the National Energy Efficiency Fund
Target metric	ktoe (cumulative)
Energy saving target	6 356 ktoe over 2014-20
Obligated parties	Suppliers of electricity and natural gas, and wholesale retailers of oil products and LPG; small supplies and retailers exempt
Number of obligated parties	Information not available
Cost recovery	Information not available
Trading	Certificates will be tradable but unclear whether only bilaterally or also vertically
Penalties	Yes, level to be specified in future
Banking and borrowing	No

United Kingdom

Date started	1994
Energy savings per year (GWh)	922
Incremental energy savings compared to Total Fuel Consumption	0.1%
Programme expenditure (USD million)	1 035
Fuel coverage	Electricity and natural gas
Sector coverage	Residential
Eligible energy efficiency measures	Building fabric and heating systems improvements, including district heating system connections and microgeneration
Savings metric	Lifetime CO_2 savings ($MtCO_2$) and lifetime space and heating cost savings (GBP millions)
Calculation method	Deemed savings
Monitoring & Verification	Monthly reports by obligated parties; technical monitoring of 5% of all measures; monthly assessment of eligibility of newly notified measures; structural processes to ensure additionality, eligibility and accuracy, plus further checks in

	case of reported non-compliance
Target metric	Lifetime CO_2 savings ($MtCO_2$) and lifetime space and heating cost savings (GBP billions)
Energy saving target	2015-17: three sub-targets: Carbon Emission Reduction Obligation (CERO): 12.4 $MtCO_2$ (lifetime). Carbon Saving Community Obligation: 6 $MtCO_2$ (lifetime) Home Heating Cost Reduction Obligation (HHCRO): GBP 3.7 billion lifetime space and heating cost savings
Obligated parties	Energy suppliers who have more than 250 000 domestic customers and provide more than 400 gigawatt hours of electricity or more than 2 000 GWh of gas
Number of obligated parties	12
Cost recovery	Unregulated cost pass-through
Trading	Horizontal trading only
Penalties	Up to 10% of global turnover
Banking and borrowing	Unlimited banking

EU, auctions

Germany

Date started	2016
Energy savings per year (GWh)	Not available
Incremental energy savings compared to Total Fuel Consumption	Not available
Programme expenditure	EUR 50 million in 2016, EUR 100 million in 2017, EUR 150 million in 2018
Fuel coverage	Electricity
Sector coverage	All sectors
Eligible energy efficiency measures	Any technologies that reduce electricity consumption
Savings metric	Lifetime savings (kWh)
Calculation method	Engineering estimates; deemed savings; metered savings
Monitoring & Verification	Successful bidders need to prove that the technologies have been installed. For single projects requirement of meter readings to prove energy savings, for aggregated projects deemed savings are used

Portugal

Date started	2007
Energy savings per year (GWh)	117
Incremental energy savings compared to Total Fuel Consumption	0.06%
Programme expenditure (USD million)	13 million
Fuel coverage	Electricity (gas planned)
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Large variety of measures + information, training, audits
Savings metric	Lifetime savings
Calculation method	Deemed savings and engineering estimates
Monitoring & Verification	Selected projects must submit reports semi-annually, and the PPEC administrator audits the projects to confirm achievement of savings targets

Switzerland

Date started	2010
Energy savings per year (GWh)	50
Incremental energy savings compared to Total Fuel Consumption	0.02%
Programme expenditure (USD million)	23 million
Fuel coverage	Electricity
Sector coverage	All sectors except transport
Eligible energy efficiency measures	Appliances; heating systems; motors; lighting; cooling
Savings metric	Lifetime savings (kWh over a standard utilisation period of 15 years)
Calculation method	Engineering estimates and metered savings
Monitoring & Verification	The project/program managers report of the achieved savings (measured or calculated), which need to be plausible and comprehensible. Inspections are being conducted be the Federal Office

Australia, obligations

Country/region	Australian Capital Territory	New South Wales	South Australia	Victoria
Date started	2013	2003 (as part of an emissions trading scheme); 2009 (as a stand-alone energy efficiency scheme)	2009	2009
Energy savings per year (GWh)	Not available	237	Not available	324
Incremental energy savings compared to Total Fuel Consumption	Not available	0.1%	Not available	0.1%
Programme expenditure (USD million)	9	52	11	71
Fuel coverage	electricity; gas	electricity; gas	electricity; gas	electricity; gas
Sector coverage	Residential and small-to-medium enterprises	Residential, commercial and industrial	Residential and small businesses	Residential and small businesses
Eligible energy efficiency measures	Not applicable	Annual incremental savings from measures implemented in 2015	Not applicable	Annual incremental savings from measures implemented from 1 June 2015 to 31 May 2016
Savings metric	Specified small-scale energy saving measures with deemed energy saving values	Specified small-scale energy saving measures with deemed energy saving values; large-scale measures with direct calculation of savings	Specified small-scale energy saving measures with deemed energy saving values	Specified small-scale energy saving measures with deemed energy saving values; large-scale measures with direct calculation of savings
Calculation method	Deemed savings values	Deemed savings values; direct calculation of savings for large-scale	Deemed savings values	Deemed savings values; direct calculation of savings for large-scale

		measures		measures
Monitoring & Verification	Random audits of energy saving projects	Random audits of energy saving projects	Random audits of energy saving projects	Random audits of energy saving projects
Target metric	% of energy sales	% of annual liable electricity and gas purchases by retailers for supply to end-users in New South Wales	Lifetime final energy savings (GJ)	Victorian Energy Efficiency Certificates; each certificate is equivalent to one tCO_2e
Energy saving target	8.6% of electricity and gas sales in the Australian Capital Territory. 20% of energy savings must be achieved in low-income households.	7% of annual liable electricity and gas purchases by retailers, increasing each year to reach 8.5% in 2019, after which it will remain steady until 2025. After deductions in respect of exempt supplies to entities in emissions-intensive and trade-exposed industries, the effective target is reduced by about 1%.	Total energy efficiency targets for primary and secondary retailers: 1 200 000 GJ in 2015, 1 700 000 GJ in 2016, and 2 300 000 GJ in 2016. Primary retailers must achieve the following amounts of the total targets through energy savings in priority low-income households: 230 769 GJ in 2015, 326 923 GJ in 2016, and 442 308 GJ in 2017.	5.4 million Victorian Energy Efficiency Certificates per annum; equivalent to 5.4 million tCO_2e per annum
Obligated parties	Tier 1 electricity and gas retailers with more than 5 000 customers and 500 000 MWh annual sales; Tier 2 electricity and gas retailers that do not meet the thresholds for Tier 1	Electricity retailers; electricity generators that supply customers directly; and customers who purchase electricity directly from the wholesale National Electricity Market. Electricity retailers are responsible for acquiring gas savings.	Primary retailers with 5 000 or more electricity or natural gas residential customers in South Australia; secondary retailers with annual electricity purchases greater than 27 000 MWh, or annual gas purchases greater than 100 000 GJ.	Energy retailers that have 5 000 or more customers in Victoria, or that make annual purchases of 30 000 MWh or more of electricity or 350 000 GL or more of gas for on-sale to prescribed customers in Victoria.
Number of obligated parties	One Tier 1 retailer is obligated to undertake eligible energy saving activities. Four Tier 2 retailers pay a contribution fee of AUD116/tCO_2e.	57	7 primary retailers and 2 secondary retailers	22

Cost recovery	Cost of acquiring energy savings is treated as a cost of doing business in a competitive retail electricity market	Cost of acquiring energy savings is treated as a cost of doing business in a competitive retail electricity market	Cost of acquiring energy savings is treated as a cost of doing business in a competitive retail electricity market	Cost of acquiring energy savings is treated as a cost of doing business in a competitive retail electricity market
Trading	Purchase by obligated parties of energy savings from specialist third party providers via private bilateral contracts. No white certificates.	Purchase by obligated parties of white certificates from specialist third party certificate providers via private bilateral contracts and public spot market	Purchase by obligated parties of energy savings from specialist third party providers via private bilateral contracts. No white certificates.	Purchase by obligated parties of white certificates from specialist third party certificate providers via private bilateral contracts and public spot market
Penalties	AUD 300 per tCO_2e shortfall	AUD 27.03 per notional MWh energy saving shortfall	Base penalty of AUD 10 000 for failing to meet a target; and AUD 70 per tCO_2e shortfall	AUD 45.44 per tCO_2e shortfall
Banking and borrowing	Unlimited banking	Unlimited banking	Unlimited banking from 1 January 2015	Unlimited banking

Rest of the world, obligations

Country/region	Canada, Ontario	Brazil	Uruguay
Date started	2011	1998	2016
Energy savings per year (GWh)	1 231	620	437
Incremental energy savings compared to Total Fuel Consumption	0.18%	0.02%	0.94%
Programme expenditure (USD million)	364	191	3
Fuel coverage	Electricity	Electricity	Electricity; natural gas; “burnable” fuels and other hydrocarbon derivatives
Sector coverage	Programmes required to serve all sectors (residential, low income, small business, commercial, agricultural, institutional and industrial – distribution and transmission connected)	All sectors except transport	All sectors
Eligible energy efficiency measures	Lighting, non-lighting (all major end-uses), direct-install, custom projects, behind-the-meter, engineering studies, audits, monitoring and targeting, home energy reports, etc.	Appliances; lighting; heating systems	
Savings metric	Incremental annual savings (GWh)	Incremental annual savings (MWh)	
Calculation method	Annual net verified savings through third party Evaluation, Measurement &	Estimates of savings are based on the IPMVP	Engineering calculations

	Verification (EM&V) (sampled, metered)		
Monitoring & Verification	Distributors are responsible for the measurement and verification of projects within their service territory. Programmes are evaluated on an annual basis by independent third party EM&V consultants to determine annual net verified savings. EM&V reports on each programme are published annually on IESO website.	Utilities send reports to regulator which are checked by the regulator regarding the estimated energy savings and the respective investments. The regulator does not perform ex-post verifications. The utilities are responsible for monitoring and evaluating their own projects. In practice there is no independent verification of the programmes.	Energy savings certified by an IPMVP certified professional.
Target metric	Cumulative annual (GWh)	% of expenditure	% of sales
Energy saving target	7 TWh persisting energy savings from 2015 to 2020 for distribution connected programmes; 1.7 TWh persisting energy savings from 2015 to 2020 for transmission connected customers	0.5% of revenues to be allocated to energy efficiency measures	0.13% of sales to be allocated to energy efficiency
Obligated parties	Local electricity distributors	Electricity distributors	Energy utility companies
Number of obligated parties	75	49	4
Cost recovery	Regulator approves cost recovery through tariffs	regulator approves cost recovery through tariffs	0.13% levy on total sales from energy suppliers
Trading	None	None	None
Penalties	Graduated administrative and financial remedies (e.g. set-offs on payments) based on proportion of planned savings achieved and LDC cost effectiveness.	Yes, penalties that are defined case-by-case	
Banking and borrowing	Targets are for a multi-year period (2015-20)	None	

Country/region	China	South Korea	South Africa
Date started	2010	1995	2008
Energy savings per year (GWh)	14 578	331	816
Incremental energy savings compared to Total Fuel Consumption	0.04%	0.20%	0.05%
Programme expenditure (USD million)	448	128	44
Fuel coverage	Electricity	Electricity; natural gas; district heat	Electricity
Sector coverage	All sectors	Commercial, industrial, educational, and residential customers	All sectors except transport
Eligible energy efficiency measures	Not specified	Energy efficient products	Lighting; shower heads; heat pumps;

			compressed air; drives; motors; ventilation; process optimisation
Savings metric	Annual incremental energy savings (GWh) and load reduction (GW)		Annual incremental energy (GWh) and peak demand savings (MW)
Calculation method	Engineering estimates		Engineering estimates; deemed savings; metered savings
Monitoring & Verification	100% of savings can only be claimed if audited by third party or recorded by equipment	Verification of actual energy savings by an independent third party	Eskom administrates M&V process and its Energy Audit Division contracts with universities across South Africa to conduct independent M&V assessments. Standard guidelines of measurement and verification of energy savings are given by SANS 50010, which was developed by SABS based on the IPMVP.
Target metric	% of electricity sales and load	Not existent	MW load reduction and incremental annual savings (GWh)
Energy saving target	0.3% of electricity sales in the previous year and load reduction by at least 0.3% of maximum load in the previous year	Not existent	2015: 294 MW and 1 204 GWh
Obligated parties	Government-owned grid companies	Public utilities	Electricity public utility
Number of obligated parties	2	3	1
Cost recovery	City utility surcharge, revenue from differential electricity prices, and other funding sources	Customer charge for electricity and from energy utility revenues for gas and district heating	Costs collected through tariffs after approval by regulator
Trading	Obligated parties may purchase savings from customers and ESCOs under bilateral contracts	None	None
Penalties	No financial penalties but general rules of compliance apply	None	Tbc
Banking and borrowing	No	None	Tbc

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