Promoting Renewable Energy and Demand-Side Management Through Emissions Trading Program Design

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Not regarded as paragons of consistency even at the best of times, some politicians quickly changed their tunes on electricity deregulation after a trying summer in which rolling brownouts and skyrocketing retail electricity prices in parts of California caused a public outcry amongst the unfortunate consumers who bore the brunt of those maladies. Where previously politicians had sung the virtues of competition amongst electricity generators, many in California and beyond have sounded a more wistful tune of late, calling into question the whole deregulation endeavor and recalling fondly the good ol’ days of state regulation. In the search for causes of this summer’s problems, those who would slow the pace of deregulation have managed to draw attention away from the most plausible explanation: that failure to deregulate quickly enough has led to a mismatch between consumers’ demand for electricity and utilities’ capacity to supply it. As economic growth continues to drive new electricity demand, similar problems may emerge in other deregulating states unless effective solutions can be found.

The conventional response to such supply shortages, namely increasing supply by building large new electricity-generating facilities is limited as a short-term solution by the length of time it takes to bring such facilities on-line. Moreover, in the long run this response grows less attractive when one considers the prospect of high fossil fuel prices and the additional air pollutant emissions that would result from a new wave of fossil-fired power plant construction.

Alternative approaches such as expanding renewable energy generation and managing energy demand tend to receive less attention but hold considerable

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promise both as short-term fixes and long-term solutions. In the short-term, renewable energy generating units can be brought on-line relatively quickly since they tend to be smaller and more scalable than conventional plants. Because renewables do not require fossil fuel inputs for production, promotion of renewable generation also constitutes a sound long-term strategic means of reducing exposure to fuel-price fluctuations and oil market manipulation by the Organization of Petroleum Exporting Countries (OPEC). Moreover, renewable generation avoids liabilities associated with the onset of new and more aggressive air emissions regulations aimed at reducing harmful byproducts of combustion such as sulfur dioxide (SO₂), nitrogen oxides (NOₓ), greenhouse gases (GHGs), and others. Demand-side management efforts, which also mitigate the need for additional fossil-fired power generation, yield similar benefits.

Yet despite such benefits, market imperfections prevent these activities from being exploited to their socially optimal level. Public benefits such as greater national energy independence and improved air quality are difficult to account for using existing market pricing methods, and their use is non-excludable, making them susceptible to free-riderism, whereby some of those who enjoy those goods’ benefits are not made to pay for them. A variety of government schemes, such as tax breaks and research subsidies, have been employed over the years to address these imperfections, with some success. A new trend amongst states towards Renewables Portfolio Standards, which mandate that a certain minimum percentage of states’ total energy supply must be generated by renewables, may be particularly effective.

Another promising solution that deserves exploration alongside these other policy measures involves the integration of incentives for renewables generation and demand-side management within the context of emissions trading markets such as the US SO₂ Allowance Program and the emerging market for GHG emissions reductions. As emissions trading’s popularity continues its rapid growth, so also can opportunities for promotion of renewable energy and demand-side management, which undoubtedly contribute to achievement of emissions trading programs’ objectives. But this promise will only be realized if deficiencies in the design of existing trading programs can be rectified, if not within existing programs, then in emerging ones. In this paper, we examine some of these deficiencies and begin the process of formulating effective solutions.

Economics of Emissions Trading

The superiority of emissions trading programs over other air regulation methods derives largely from the compliance flexibility that sources enjoy relative to more
rigid “command-and-control” regulations. Whereas a command-and-control regulation might require, almost without regard for cost, installation of a particular abatement technology or achievement of an emissions reduction from a particular stack, sources affected by an emissions trading program have considerably more options by which to achieve compliance. In such programs, which to-date have been applied mostly to electricity generating facilities, affected sources need only prove that their emissions during a given compliance period did not exceed their holdings of valid emissions permits. Whether sources choose to achieve this balance by installing abatement technology, fuel-switching, by purchasing additional permits from another source, or some other environmentally-sound method is mostly unimportant to the regulatory authority.\(^2\)

Profit-maximizing sources use this flexibility to choose the most cost-effective compliance method, enabling sources to reduce their individual costs of compliance as well as the system-wide costs of achieving a given environmental target, relative to command-and-control methods of regulation. In addition, the possibility of financial gain from selling surplus emissions permits to others creates an incentive to develop new, as-yet unknown methods of reducing emissions. This incentive for innovation further amplifies the cost savings that result from emissions trading, and enables air regulators to aim for more aggressive environmental targets than would otherwise be attainable. Unfortunately, however, economic incentives for emissions reduction are limited mainly to entities that directly produce emissions, even though additional cost-effective abatement options may depend on the activities of non-emitters such as renewables generators and electricity consumers.

**Unequal Incentives**

Renewable energy generation and demand-side management both contribute to air quality improvement (and a host of other benefits including some described above) by reducing the need for combustion of fossil fuels to generate electricity.\(^3\) But the design of most existing emissions trading programs does not reward many potential investors who might undertake such activities, leading to under-investment and lost opportunities for cost-effective emissions reductions.

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\(^2\) Shifting production from an affected source to a production facility outside the bounds of the program is one example of a prohibited compliance method.

\(^3\) This is true except where electricity is supplied largely by non-emitting means such as nuclear and hydro-electric generation.
Incentives do exist for owners of emissions sources that already fall under existing emissions trading regulations to invest in renewables and demand-side management. Such investments represent another way for sources to balance their actual emissions and permit holdings. For example, a utility might choose to displace some of its coal-fired generation by investing in a new wind-turbine. In doing so, the utility could maintain its supply of electricity while producing fewer emissions, effectively freeing up permits for sale to others or reducing the number of permits that it must acquire from others to achieve compliance. Likewise, investment in high-efficiency furnaces for residential electricity consumers can potentially benefit generators by helping to fulfill supply obligations without the need for emissions-producing new generation (though this is not likely to be regarded as a preferred means of achieving compliance\(^4\)). Some emissions trading programs, such as the SO\(_2\) Allowance Program, even offered additional incentives for affected sources to undertake such investments by offering bonus permits for certified investments in specified activities (see additional discussion below).

Comparable incentives are absent, however, for independent investors who do not own emissions sources affected by emissions trading restrictions. Independent renewables generators do benefit marginally from the existence of emissions trading programs to the extent that these place a price on emissions, and thus raise production costs for fossil-fuel generators with whom they compete. But an investment in wind-turbine electricity generation equivalent to the one described in the previous paragraph would, for an independent generator, free up no additional permits since non-emitting generators receive no allocation of permits in the first place. Moreover, no mechanisms exist for independent parties to stake legal claim to such permits. In fact, under some circumstances it is affected sources rather than independent investors who ultimately benefit, in a sense, from independent investments. Since renewables generation and demand-side management both provide an emissions-free way of reducing an electricity supply gap, affected emissions sources would benefit from avoiding the cost of acquiring additional permits to cover emissions resulting from new generation (though, it must be noted, they also forego the possibility of earning profits on that new generation).

Early Experience from Precompliance GHG Trading

In recognition of the environmental and economic successes of emissions trading markets in the United States, international negotiators of the Kyoto Protocol, an international treaty that would restrict GHG emissions from industrialized countries, have included three market mechanisms through which countries bound by the treaty could engage in trading to meet their national obligations. Following this lead, many national governments including those of the United Kingdom, Denmark, Germany, Canada, Australia, and others have proposed or are examining ways to establish domestic trading that would apply to sources within their respective countries. Considering the quantity of emissions reductions that will eventually be necessary to achieve the treaty’s objective of preventing dangerous anthropogenic interference with the climate system, and the enormous cost of achieving these reductions without the cost-saving benefits of emissions trading, few would dispute that GHG trading has the potential, at least, to dwarf existing emissions trading markets and to provide incentives for massive flows of investment.

Despite the fact that few, if any GHG sources yet face legally-binding emissions restrictions, some companies have already begun to trade GHG emissions. In contrast to participants in existing legislated emissions trading markets, who trade legal authorizations to emit, participants in this “pre-compliance” emissions trading market exchange only “rights and data associated with verified emissions reductions that may constitute a claim against future compliance requirements”. In other words, a seller transfers to a buyer ownership of the change in GHG emissions resulting from a specific activity, and this carries only a possibility, but not a guarantee, of government recognition under some future regulatory regime. Sellers view early trading as a way to monetize assets (i.e., emissions reductions) that would otherwise be valueless. Buyers view early trading as way to protect against unknown and potentially exorbitant compliance costs associated with future GHG emissions restrictions. Even after accounting for the possibility that some or all of the reductions they acquire may not be recognized by governments as a legitimate offset against their own emissions, buyers regard early trading as a worthwhile insurance policy.

Operating without firm trading guidance from governments, participants in pre-compliance GHG trading have mostly taken their cues from existing emissions markets to predict what sorts of emissions reductions have the highest probability of government recognition. Not surprisingly, would-be participants that invest independently in renewable energy generation and demand-side management face hurdles similar to those present in existing markets. In this context, the main impediment facing such investments can be thought of as a
problem of ownership, along with the related question of quantification. Given the enormous potential of GHG trading, it is particularly important that policymakers understand these problems so that a significant opportunity to create economic incentives for such valuable investments is not squandered. Moreover, it may be easiest to create such incentives in GHG emissions markets, whose rules are not yet written.

Ownership

Buyers in the pre-compliance GHG market typically only purchase emissions reductions that meet a somewhat standardized set of minimum criteria. These include, for example, requirements that reductions be “real,” meaning that they resulted from a specific, identifiable activity, and that reductions be “surplus,” meaning that the reductions are additional to any that might be required by existing law. Additionally, sellers must be able to adequately demonstrate legal ownership of the reductions they wish to sell. In the absence of clear ownership, a buyer may not be confident that a seller can legitimately transfer all legal rights to its reductions.

In many cases, ownership is not difficult to establish. For example, if an electric utility purchases a new technology that directly reduces its emissions, there is little doubt that rights to the resulting emissions reductions belong to the utility. However, when an activity results not in a direct emissions reduction from a particular process, but rather in a displacement of, or reduction in demand for, an emissions-producing process owned by another entity, ownership is less clear. For example, an owner of wind generation might claim an emissions reduction for having displaced existing coal-fired generation. But the existing generator or generators might claim to have generated the same reductions by purposely reducing fossil-fuel combustion, or by some other unspecified means. Knowing that in existing emissions trading markets affected sources generally need not explain nor justify the means by which compliance was achieved, and that determining the exact cause of fluctuations in emissions can be difficult, buyers are worried enough by such potential ownership disputes to avoid these types of reductions.

Quantification

Another essential characteristic of credible early GHG emissions reductions is that they be “measurable,” or quantifiable by a replicable and transparent methodology. When a reduction is generated by directly changing emissions from a particular source, quantification can be simple. However, in the case of
renewables generation and demand-side management, quantification can be a significant challenge since the reductions being claimed from such activities actually occur on the site of the generator or generators whose electricity was displaced or consumed less. The challenge is to set an accurate baseline level of emissions that would otherwise have been emitted if the specified activity had not occurred. Establishment of this baseline requires accurate emissions data from existing generators, who may be reluctant to abet their competitors by delivering the requested data. If the data is somehow acquired, the reduction can be quantified by multiplying the quantity of electricity produced by renewables (or saved by demand-side management) by the baseline rate of emissions that would otherwise have occurred. The result is a quantity of emissions that can be offered for sale.

In a deregulated environment, calculation of baseline emissions rates against which to quantify reductions is complicated by the fact that several different utilities, each using several different generation technologies, might be producing the existing electricity supply. Since it would be impossible to determine exactly which generation technology produced particular electrons, a system average must be used instead. For this information, interested parties must rely on the Independent System Operator (ISO) that maintains the local grid.

To date, many buyers potential of reductions generated by renewables or demand-side management have demanded that the quantification methodology also use more than a static rate of emissions per electricity unit displaced or saved. In pursuit of a high degree of accuracy, buyers have demanded that claims of displacement or savings be measured against intra-day and seasonal variations in emissions rates. For example, a photo-voltaic solar generating unit that only produces power during daylight hours would have to measure emissions reductions against an emissions rate based on the mix of baseload and peaking units in use during those daylight hours, instead of the overall system average. Likewise, the quantity of emissions displaced by the photo-voltaic unit would change between seasons, as lower demand in the winter months might require less generation by relatively high-emitting peaking units than in summer months, when demand is high. Though buyers to-date have requested only that emissions data reflect intra-day and seasonal emissions rate variations, theoretically there is no limit to the level of detail at which emissions rate variations might be expressed.

Often such detailed information is unavailable, making quantification extremely difficult, and harming would-be sellers’ chances of executing a transaction. Even
when such information is available, the amount of time and expertise necessary to undertake the appropriate calculations can deter prospective sellers.

### Possible Solutions

Together, the preceding problems prevent some investors in renewables and demand-side management from earning revenue associated with GHG reductions and result in lower overall investment in such activities. Since pre-compliance trading is, by its very nature, undertaken only in preparation for eventual legislated emissions trading programs, it is not the pre-compliance market in particular that requires government solutions. Rather, as governments in the US and elsewhere ponder whether and how to design effective legislated emissions trading markets, they ought to consider what rules will maximize incentives to the broadest range of activities that contribute to overall air quality objectives. In contrast to existing emissions trading programs, whose incentives are mostly limited to owners of affected sources, GHG market rules should attempt to extend these incentives to independent investors in worthwhile emissions-reducing activities. In this section we consider some possible methods of achieving this end.

### Quantification

Quantification is discussed first because its solutions are potentially simpler to formulate than those for ownership. One obvious way of easing quantification difficulties for investors in projects that displace or reduce demand for emitting generation is to require utilities and/or ISOs to compile and distribute accurate and detailed emissions rate data. Such information should be made available continuously, or at least with as much frequency and detail as might be required by quantification rules contained in legislated emissions trading programs. Even with the availability of this data, however, quantification of emissions reductions would remain a time-consuming and complex deterrent to would-be sellers. Since minimizing the burden of this process would ease investors’ ability to generate revenue from the GHG market and make more valuable investments economically viable, governments should consider additional steps to address quantification difficulties. One such step might involve legal establishment and recognition of a standard “benchmark” emissions rate from existing generation that could be applied uniformly as a baseline by those claiming emissions reductions. Benchmarks could be established for individual transmission grids to reflect regional differences in generating mixes, and they could differ depending on season, time of day, or other duration as considered appropriate by regulators.
Whatever rate were set, investors in renewables and demand-side management would be absolved of having to calculate and then justify their chosen emissions baselines.

Benchmarks could also be projected into future years on the basis of historical emissions trends. This would allow project developers to “sell forward” emissions reductions that will occur in the future, as a means of financing current projects. The risk for governments of setting standard benchmarks, especially for future emissions rates, is that any degree of abstracting from or averaging actual emissions rates may lead to a discrepancy between the quantity of emissions actually reduced and the quantity of reductions claimed. This risk can be mitigated by statistical analysis to improve the accuracy of benchmarks, and potentially by applying a discount factor to benchmarks that would reflect estimated uncertainty about their accuracy. These measures could help to reduce the burden of quantification for prospective sellers, while preserving the environmental integrity of their claimed reductions and of emissions trading programs in general.

Ownership

Emissions trading market structures fall broadly into two categories, including baseline-and-credit programs and cap-and-trade programs. On the issue of ownership, the key difference the two structures concerns the nature of emissions restrictions imposed on affected sources. This difference requires that unique solutions to the problems of ownership as described above must be made to fit within the context of each distinct market structure.

Rate-Based Emissions Restrictions. In baseline-and-credit programs, emissions restrictions are expressed as a rate of allowable emissions per unit of input such as fuel or production output such as electricity. For example, some sources participating in markets for “discrete emissions reductions” in select US States are allowed to emit a given quantity of NOx or volatile organic compounds (VOCs) per mmBtu of heat input burned for fuel. Sources who operate more efficiently than this allowed baseline rate may earn permits (known as “credits” in a baseline-and-credit context) for the difference between the baseline and their actual emissions. Baseline-and-credit programs are able to accommodate new emissions sources simply by assigning them baselines equivalent or similar to those of existing affected sources.

However, one consequence of these characteristics is that the overall environmental result of baseline-and-credit systems is neither guaranteed nor easily predicted. It is possible that though sources may reduce their rates of
emissions to comply with their baselines, the addition of new sources and growth in aggregate production may result in an overall increase in absolute emissions levels.

On the other hand, it is also these features that make solving problems of ownership a potentially simpler matter in rate-based programs than in capped ones. Governments could create incentives for investors in renewables generators and demand-side management by assigning standard emissions baselines denominated as allowable emissions per unit of electricity produced or saved. The particular level of baselines for particular generators or types of activities could be equivalent to, or based on regional “benchmarks” described above. Investors in renewable generation and demand-side management would earn credits equivalent to the quantity of electricity produced or saved multiplied by the baseline allowable emissions rate. Recipients could sell the credits to emissions sources needing to demonstrate compliance, and use the revenue to enhance returns on their existing investments or to re-invest in additional projects. Utilities whose electricity production were affected by displacement or reduced demand would not be able to claim or benefit directly from the same reductions, since their allowable emissions too would be based on production levels. Thus a decline in production would authorize them to emit a smaller aggregate quantity of emissions.

**Absolute Emissions Restrictions.** In cap-and-trade programs, such as the US SO$_2$ Allowance Program and the Ozone Transport Commission NOx Budget Program, the regulatory authority begins by establishing an upper limit on overall emissions from a set of affected sources. For example, the SO$_2$ Allowance Program sets a cap on SO$_2$ emissions from certain electric utilities at approximately 9 million tons per year. Then the regulatory authority creates permits (known in a cap-trade context as “allowances”) that authorize emissions equal to the overall cap, distributes these permits amongst affected sources, and allows sources to trade. Cap-and-trade programs are distinct in that their emissions restrictions are expressed as absolute quantities per time, equal to sources’ holdings of valid allowances. For example, a source that owns 50,000 valid SO$_2$ allowances (one allowance authorizes one ton of emissions) at the end of a given year is authorized to have emitted 50,000 tons of SO$_2$ during that year. It is important to note also that increases in production or new market entrants must be accommodated within these absolute limits either by improving the emissions efficiency of production, or by acquiring surplus allowances from another source. Either way, the number of allowances is finite, and the program’s environmental integrity is maintained.
However, this feature complicates the resolution of ownership difficulties for investors in renewables and demand-side management. If governments followed the solution suggested above for rate-based emissions trading programs, a new problem of double-counting would arise, causing inflation of programs’ caps. For example, imagine that renewables generators could earn a quantity of allowances proportional to their production of electricity. Existing trading programs contain no provisions for taking back allowances from utilities whose generation declined as a result of reduced production, and creation of such a provision would be extremely unpopular, and of questionable fairness to affected utilities. So if the utilities maintained their full allowance holdings, and new allowances were granted for renewables, the same emissions reductions would twice contribute to sources’ compliance—once for the utility whose overall emissions (and emissions liability) were reduced by the displacement, and once for the utility that buys the new allowances from the renewable generators. The resulting increase in the total number of available permits would erode cap-and-trade programs’ overall environmental effectiveness. So alternative solutions must be found that create appropriate economic incentives within the confines of absolute emissions caps.

One solution, mentioned above, involves creation of set-aside bonus pool of allowances for approved activities. In the SO2 Allowance Program, 300,000 allowances out of the program’s overall cap were set aside in a Conservation and Renewable Energy Reserve. Between 1992 and the turn of the millennium, these were to be allocated to owners of sources that undertook certified investments in renewable energy and energy conservation. Upon conclusion of the program, just over 10% of the bonus pool had been claimed, apparently because the number of allowances that could be earned per unit of energy generated or saved was not high enough to justify many investments. Also, it is important to be clear that allowances in the reserve were only open to owners of sources already affected by the program’s mandatory emissions restrictions. Independent investors were not able to claim bonus allowances.

Because bonus pools represent a portion of programs’ aggregate caps, they have the advantage of preserving trading programs’ environmental effectiveness, and they could also be made open to both affected sources and independent investors. Though double counting might still arise, at least the overall cap would not be inflated. However, since the quantity of allowances placed in the bonus pool is limited by policymakers’ initial allocation, the total value that investors could potentially earn from the pool is also limited, though at an unknown quantity which depends on the market price for allowances. This value would be distributed on a first-come-first-served basis, with no opportunity for earning additional allowances except by regulatory decree.
Another means of addressing ownership issues within capped programs concerns programs’ basic method of allowance allocation. The SO₂ Allowance Program, whose widely-acknowledged success often makes it a model for design of other programs, allocates allowances to sources according to a formula that assigns a given number of allowances per mmbtu of fuel input, and which is then “ratcheted down,” or discounted to ensure that the overall quantity allocated stays within the program’s aggregate cap. For example in the program’s Phase II that began in 2000, affected sources received an allocation of allowances equivalent to 1.2 pounds of SO₂ emissions per mmbtu of fuel input, discounted to stay within the program’s cap of 8.95 million tons of SO₂ per year. Individual sources’ average fuel input data from the years 1985 to 1987 is used as the basis for allocations. The program’s overall cap is made more stringent over time by reducing the allowable quantity of emissions per fuel input.

Allocating allowances on the basis of output instead of input would level the playing field between affected sources and independent investors in renewables (though not demand-side management, which does not produce per se). Program designers could use a benchmark rate of emissions per unit of electricity produced, discounted to achieve overall target emissions reductions, as a means of allocating allowances. As another variation on the SO₂ Program’s allocation methodology, new market entrants could be accommodated by making the allocation formula dependent on a rolling average of output such as the three most recent years rather than on a static year or group of years.

Together these solutions would address issues of ownership and, compared to bonus pools, would provide a more flexible incentive structure for renewables investments whose upper limit would be determined only by investors’ ability to generate electricity. However, this and the other solutions explored in this section on capped trading programs all essentially consist of a transfer of finite allowances from utilities who possess the allowances now (or would, if existing conventions are followed in future programs) to their competitors. What we have not explored in this discussion are the arguments in favor of the status quo. Issues of fairness to utilities, who already face a difficult challenge to achieve existing emissions reduction targets, and the value of regulatory simplicity, which might be compromised by these solutions, should not be dismissed lightly. In addition, a rolling allocation, in particular, would diminish source’s ability to predict their future emissions allocations, and to take cost-effective business decisions in accordance with those plans. A significant loss of regulatory predictability could diminish cost savings and potentially outweigh the benefits of creating new incentives for independent investors.
Conclusion

Expansion of renewable energy generation and demand-side management efforts contribute positively to the achievement of several worthy objectives, such as reducing electricity supply shortages, increasing energy independence, and reducing harmful air emissions. Existing emissions trading programs, despite their indisputable success at reducing the costs of environmental protection, provide unequal incentives for owners of renewables and demand-side management projects. The inadequacy of incentives for independent investors in these activities constitutes a lost opportunity for promoting such activities and correcting market failures that result in under-investment. Though designs of most existing emissions trading programs fail to provide adequate incentives for independent investors, the nascent market for GHG reductions provides perhaps the best context for refining our understanding of these issues. In this context, the two main impediments to creation of incentives for renewables and demand-side management can be thought of as problems of quantification and ownership. While the former issue can be resolved without a great deal of difficulty, solutions to the latter are more elusive. These must be tailored to the structures of the markets in which they would operate, and none is without shortcomings and tradeoffs. Nevertheless, the potential benefits of promoting renewables and demand-side management through emissions market design undoubtedly justify at least a further exploration of these and other possible solutions.