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Governing Confusion:
How Statutes, Fiscal Policy, and Regulations Impede Clean Energy Technologies

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INTRODUCTION

The United States shares with many other countries the goal of the United Nations Framework Convention on Climate Change "to achieve … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[1] The critical role of new technologies in achieving this goal is underscored by the fact that most anthropogenic greenhouse gases (GHGs) emitted over the next century will come from equipment and infrastructure that has not yet been built. As a result, new technologies and fuels have the potential to transform the nation's energy system while meeting climate change as well as energy security and other goals.

Many believe that advancing clean energy technologies[2] could significantly reduce the cost of stabilizing greenhouse gas concentrations.[3] Further, if many technologies are successfully developed in parallel with early action to promote deployment, the cost of stabilization could be significantly reduced. The assumed availability of future technologies is a strong driver of stabilization costs in most climate change models.[4] Edmonds et al.[5] studied stabilization of atmospheric CO_2 concentration at 550 ppmv (parts per million by volume) and showed that the accelerated pace of technology improvements and deployment could produce a reduction in costs of a factor of 2.5 in 2100 relative to a baseline incorporating the "business as usual" rate of technical change.

Given the need for large-scale GHG emission reductions, the challenge is to move toward actions that go beyond technology R&D to strategies that target the rapid and large-scale absorption of GHG-reducing technologies into the economy.[6] Most technological innovations do not survive the transition from invention to marketplace success. While they may be technically feasible, various obstacles prevent them from gaining market share. In addition, best practices representing already proven cost-effective approaches to GHG mitigation, are significantly underutilized. The longevity of much of the energy infrastructure from power plants to the building stock, prolongs the operation of obsolete technologies, and other impediments cause suboptimal choices to be made when technologies do finally turn over.

While there are many barriers to the commercialization and deployment of clean energy technologies, those that are imposed by legislatures and regulators are particularly of interest as they operate at cross-purposes with government stated intentions of GHG reductions. This paper focuses on the legal barriers to the deployment of clean energy technologies that come from fiscal policy, regulation and statutes. For each policy realm – fiscal, regulatory, and statutory – distortionary policies are discussed. In some cases these policies are *unfavorable* because they place clean energy technologies at a disadvantage, sometimes by favoring competing technologies. In other cases they are *ineffective* because their intended outcome is undermined by policy design flaws, loopholes, and burdensome procedures that circumvent the policy goal. Still in other instances policies are *uncertain* because of state and local variability, fluctuating short-term policies, and extended debates about alternative future policy scenarios that can forestall commitments to clean energy or accelerate investments in carbon-intensive energy options. In the aggregate, these barriers act to confuse investors, consumers, inventors, and producers in their decisions relative to clean energy technologies.

This assessment of distortionary policies relies on a review of the literature on barriers to clean energy technologies and 27 expert interviews. These interviews with experts from government, national laboratories, industry, universities, and consulting firms provided an up-to-date overview of market and technology conditions and associated barriers, along with substantial detail on the nature of the market imperfections as well as illustrative deployment failures and successes.

I. FISCAL BARRIERS

Fiscal barriers are impediments related to taxation and public revenue and debt policies promulgated by governments that impact markets in which a clean energy technology is expected to compete. They can take many forms such as tax incentives and penalties, liability insurance, leases and land rights-of-way, waste disposal, and guarantees to mitigate project financing or fuel price risk. While fiscal policies are imposed in pursuit of the public good, they can become impediments to innovation and competition, and they can be unfavorable to clean energy technologies. In addition, fluctuating and variable tax incentives as well as the possibility of future tax penalties related to GHG emissions all contribute to fiscal uncertainty, which can undermine marketplace efficiency.

A. Unfavorable Fiscal Policies

Fiscal policies can be used to encourage investment in a particular technology area or to overcome market failures. However, technologies and goals can change quicker than fiscal policy, leading to outdated fiscal instruments, which then incentivize undesired behaviors or technologies. A variety of tax subsidies, differential taxation across capital and operating expenses, unfavorable tariffs, and utility pricing policies illustrate this phenomenon.

1. Tax subsidies. Existing tax subsidies can act as barriers to the commercialization and deployment of GHG-reducing technologies. For example, subsidies for conventional fuels, both implicit and explicit, can significantly lower final energy prices, putting alternative energy options at a competitive disadvantage unless they enjoy equally large tax assistance.

The transportation sector offers examples of policies that provide tax advantages for conventional energy sources and encourage high levels of energy consumption.

- The internal revenue code provides business deductions for the purchase of large light trucks (> 6,000 lbs)[7] that amount to a tax break – encouraging the purchase of large light trucks when they may not be needed.[8] Originally established as a form of tax relief for small business owners, large light trucks (especially, sports utility vehicles – SUVs – which are considered light trucks) are increasingly purchased by families for personal use. This particular issue made waves in the print media in 2003 when the popular luxury vehicle, Hummer H2, was made an example.[9] In October 2004, the allowable first year tax deduction under internal revenue code section 179 was reduced dramatically (from $105,000 to $25,000), but this smaller incentive is still available for large light trucks.[10]

- The gas-guzzler tax on cars (but not on light trucks) has discouraged the purchase of cars and encouraged the purchase of SUVs.[11] This tax was created with the Energy Tax Act of 1978;[12] current taxes, which have been in effect since 1991, range from $1,000 to $7,700 per vehicle depending on the fuel economy of the car beginning at 22.5 mpg.[13] By taxing fuel-inefficient cars, this tax policy has effectively eliminated the mass production of gas-guzzling cars, but it has not reduced energy consumption. Because gas-guzzler taxes have not been applied to trucks, they have created an incentive to produce gas-guzzler vehicles as "trucks."[14]

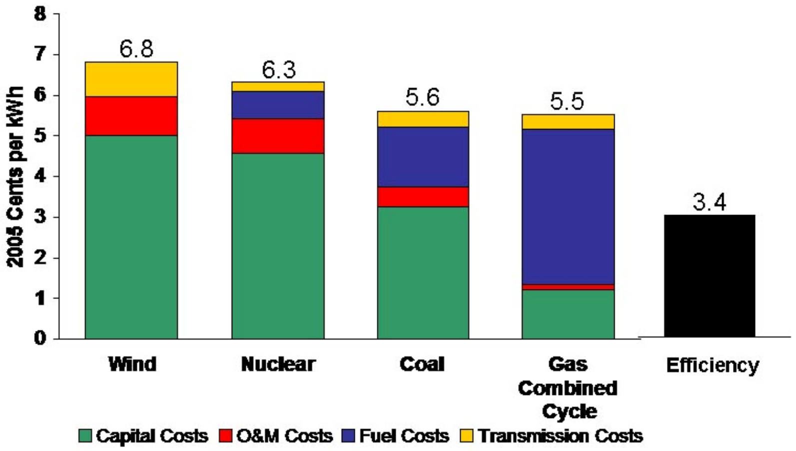
Examples in the realm of energy resource development include oil depletion allowances which allow owners to claim a depletion deduction for loss of their reserves. Specifically, oil and gas wells can claim cost depletion and in some cases percentage depletion.[15] Also, government support for research on the production of liquid fuels from coal and the production of petroleum from shale oil and tar sands can appear as barriers to low-carbon alternative fuels. If successful, this research would promote the continued use of high-GHG transportation fuels. These fiscal incentives exemplify the problem of conflicting social goals. They exist because of the public desire to promote U.S. oil independence and energy security, but they conflict with the goal of stabilizing greenhouse gas concentrations in the atmosphere.

2. Unequal taxation of capital and operating expenses. Tax policies that encourage operating expenses and penalize capital expenses serve to slow capital stock turnover, preclude technological change, and result in the over consumption of energy products and the over production of GHG emissions. Examples of this issue are evident in industry, buildings, and energy supply.

In American industry, the current federal tax code discourages capital investments in general, as opposed to direct expensing of energy costs. In addition, the federal tax code forces firms to depreciate energy efficiency investments over a longer period of time than many other investments (e.g., only five years for a new data center). This is partly because energy-efficient products have long depreciable lives, such as 15 years for a new motor or a new industrial boiler. Interestingly, a new back-up generator would be depreciated over three years while a new combined heat and power (CHP) system would be depreciated over 20 years.[16] The CHP system would provide both reliability and energy efficiency while the back-up generator provides reliability at the expense of energy efficiency and clean air. This is another case of legislation lagging behind (and inhibiting) technological progress. Federal depreciation schedules were put into place more than two decades ago as part of the IRS Reform Act of 1986, and they have not kept up with technological innovations.[17] Modification of depreciation schedules would remove a significant barrier to industrial efficiency investments, but it would require legislative action.[18]

Similarly, as buildings are capital expenses, these fiscal policies retard buildings turnover in all sectors. U.S. tax rules require capital costs for commercial buildings and other investments to be depreciated over many years, whereas operating costs can be fully deducted from taxable income.[19] Since efficient technologies typically cost more than standard equipment on a first-cost basis, this tax code penalizes efficiency.

Fig. 1. Projected Costs of New Generation and Energy Efficiency Improvement



In the electricity supply market, Jenkins et al. have shown that projects with high capital versus expense ratios have higher tax burdens.[20] Interestingly, this is a market in which a mix of capital-intensive and expense-intensive technologies compete. For example, wind and nuclear plants have proportionately high capital costs while natural gas combined cycle and coal plants have proportionately high fuel (i.e., operating) costs (Fig. 1).[21] Reducing the demand for electricity by improving the efficiency of energy use is the least-cost way to deliver new energy services. Because its capital-to-operating ratio is particularly low, energy efficiency is fiscally disadvantaged as an electricity "resource." The problem is that capital and operating costs receive different tax treatment, and these differences result in unequal tax loads between projects built using different technologies.

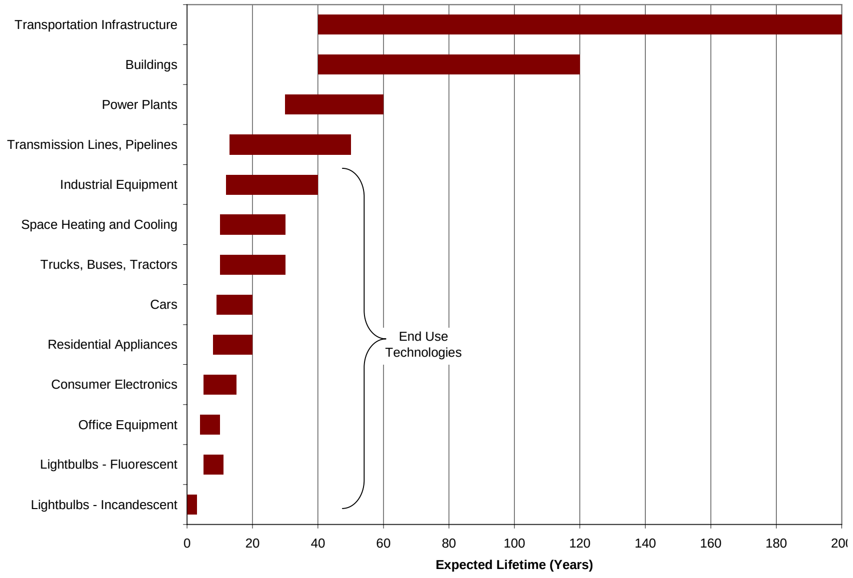
Jenkins et al. compared the tax loads associated with constructing and owning eight different renewable power plants[22] with the tax load of constructing and owning a natural gas-fired generation plant. All but one of the eight renewable projects were found to carry higher tax burdens under the tax codes in place in 1999. Whether or not this remains true today is unclear, given the expanded incentives provided for renewable energy in EPAct and other fiscal policy changes. Assuming capital-intensive technologies still have a differentially higher tax burden than expense-intensive technologies in the electricity generation market, the competitiveness of both renewable and nuclear technologies is reduced as a result.

Many states have similarly uneven sales tax treatment of capital vs. operating expenses. For instance, most states charge sales tax on residential energy-saving devices but not on residential fuels and electricity. Recognizing this disparity, several states now offer periodic sales tax moratoria for the purchase of ENERGY STAR® appliances. Georgia, Florida, and Virginia have adopted temporary (three- and five-day) sales tax holidays for certain energy-efficient products, and Connecticut has an 18-month tax holiday on home weatherization products.[23] Similar holidays are being considered by Illinois, New York, Pennsylvania, Rhode Island, and Vermont.[24]

Clean energy innovations diffuse slowly through the economy in many cases because of the long lifetime of existing productive capital stock, and because of the major investment in hardware and infrastructure that is required for significant market penetration. Power plants may operate for 40 or 50 years, commercial buildings last almost as long, heavy trucks are driven for 28 years, and cars for 17 years.[25] As John Holdren put it: "We've got a $12 trillion capital investment in the world energy economy and a turnover time of 30 to 40 years. If you want it to look different in 30 or 40 years, you'd better start now."[26] To quicken the pace of change, stock turnover must be accelerated by removal of policies that retard capital investments. Policy options for accelerating turnover include taxing consumption instead of income or decreasing taxes on income from capital investments. “Anything that reduces the effective marginal tax rate on capital investments will result in accelerated capital stock turnover.”[27]

Capital stock turnover is obviously paced differently for different technologies, as shown in Fig. 2.[28] The long-lived energy infrastructure systems of highways, buildings, power plants, and transmission lines are distinct from the shorter lifespan of most energy end-use products. This infrastructure longevity contributes to the “lock-in” of incumbent technologies.[29] Companies must take into consideration the risks involved with adopting a new technology, the payback period of a technology, and the appropriate discount rate and transaction costs. Newer, relatively expensive technologies have longer payback periods and represent a greater risk. Thus, “lock-in” not only slows technological change in general but also tends to skew it toward suboptimal choices.[30]

Fig. 2. Examples of Capital Stock Lifetimes



Given that the slow rate of capital stock turnover in many industries has been identified as a key barrier to the introduction of a new generation of carbon mitigation technologies, tax reforms that lower the tax burdens of energy construction projects relative to energy consumption activities warrant consideration.[31]

3. Unfavorable tariffs. Tariffs imposed by government can present a barrier to clean energy technologies. The following examples draw from the markets for alternative fuels and electric power.

The import tariff for ethanol is an example of a policy that raises the cost of ethanol blends produced by domestic refineries. The market for fuel ethanol is heavily dependent on incentives and regulations.[32] In 1980, the U.S. Congress imposed a 54 cent per gallon tariff on imported ethanol to promote energy independence.[33] In addition, the U.S. government provides the domestic ethanol industry with a 51 cent tax credit per gallon,[34] and EPAct 2005[35] requires refineries to use 4 billion gallons of ethanol in 2007, climbing to 7.5 million gallons in 2012. With the refineries choosing to phase-out MTBE in 2007, the demand for ethanol is even greater than expected, and it is not clear if the domestic supply will be able to meet the growing demand. The import tariff prevents refineries from buying ethanol from wherever it is cheapest on the global market, as from Brazil where ethanol production from sugarcane costs are 40 to 50 percent less than U.S. ethanol production from corn.[36]

Independent System Operators (ISOs) also can create tariffs that bar new technologies. These tariffs are effectively connection (market entry) charges although they are not called such. For example, small generators hoping to connect to the grid in the mid-Atlantic area must undergo a review at a cost of $10,000 to the generator before being allowed to tap into the ISO-PJM (Pennsylvania, New Jersey, Maryland) interconnection.[37] Other tariffs levied by individual utilities on customers include standby charges, buyback rates, and uplift fees.

4. Utility pricing policies. Unfavorable electricity pricing policies and rate recovery mechanisms present obstacles for an array of clean energy technologies; these include the regulated rate structure, lack of time-of-use pricing, and imbalance penalties. The origin of many of these policies often is based on historically long-standing practices that have been incrementally modified over years of regulatory oversight.[38]

In traditionally regulated electricity markets, electric utilities face little incentive to promote energy efficiency or non-dispatchable distributed generation because utility company profits are a function of sales. Under current rate designs, companies that own transmission lines also benefit from throughput, and find their profits reduced by energy efficiency programs. As Casten and Ayres explain: “Regulators approve rates that are supposed to provide a ‘reasonable’ return on invested capital. This encourages capital investment, regardless of efficiency…. With approved rates in place, the utility’s profits hinge on throughput – how much electricity flows through their wires. More sales, more profits. Actions that lead to conservation, appliance efficiency gains, and local generation all penalize utility profits.”[39] Fixing the problem of revenue erosion and decoupling profits from sales is critical to incentivizing the efficient use of electricity.

Problems associated with utility ratemaking practices and their disincentives to energy efficiency were a major focus of the *National Action Plan for Energy Efficiency* (NAPEE). Developed by a Leadership Group composed of more than 50 leading organizations representing diverse stakeholder perspectives, the Action Plan was released on July 21, 2006. It focuses on these cost recovery problems, noting that regulatory policies governing utilities have more commonly compensated utilities for building power plants and selling energy, while discouraging energy efficiency even when saving energy costs less than generating energy. Ratemaking practices must be reformed for utilities to remain financially healthy while promoting the efficient use of energy by their ratepayers. Specifically, NAPEE recommends that stakeholders “Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.”[40]

Electricity pricing policies of State legislatures and regulatory commissions also prevent markets from operating efficiently and create obstacles to low-carbon power choices. For example, the price of electricity in most retail markets today is not based on time of use. It therefore does not reflect the time-of-use costs of electricity production, which can vary by a factor of ten within a single day. Because peaking plants are more expensive to run than baseload plants, retail electricity rates are higher during peak times than during shoulder and off-peak times under time-of-use pricing. Yet most customers in traditionally regulated markets buy electricity under time-constant prices that are set months or years ahead of actual use; as a result current market structures actually block price signals from reaching consumers, and consumers are not responsive to the price volatility of wholesale electricity.[41]

Time-of-use pricing would encourage customers to use energy more efficiently during high-price periods. Similarly, the lack of time-of-use pricing and time-of-use (TOU) rates is a barrier to solar photovoltaics (PV) and other generation resources that provide power disproportionately during on-peak periods, because they are not paid for this added benefit but rather are reimbursed at the same price per kWh as an off-peak resource. Widespread time-of-use pricing would provide significant incentives for distributed generation including renewables. When net-metering is used in conjunction with time-of-use pricing, customers who generate electricity during the day (when use is at peak and prices are high) could offset their costs for electricity used off-peak when prices are low.[42]

Imbalance penalties charged by utilities pose challenges to renewable power profitability because of the intermittency of wind and solar PV. Many power markets were set up to bid a day ahead. The utility contracted to provide so many MWs of power generation, committing to certain power output requirements. If power generation deviated from this projection, severe penalties were levied. These penalties reflected the extra cost incurred to have reserve units running and ready to replace the idle load (0.1 to 0.5 cents per kWh). In order to allow renewables to compete more effectively, imbalance payments have evolved in some states, and additional reform is needed.[43] For example, in some parts of California at the end of the month, the scheduled power has to balance out. If the utility is consistently wrong, the imbalance payment has to be paid, but not otherwise.

In sum, because of these utility pricing policies, neither electricity generators, wires companies, nor consumers see the full value of efficiency or distributed generation. Without better price signals, it is challenging for the providers of energy-efficient products and on-site generators to transform consumer markets.

B. Ineffective fiscal policies. Some fiscal policies simply do not meet their intended objective or are at cross-purposes with their stated goal of stimulating the deployment of clean energy technologies. Tax credits for clean energy investments that cannot be claimed and property taxes that encourage deforestation are cases in point.

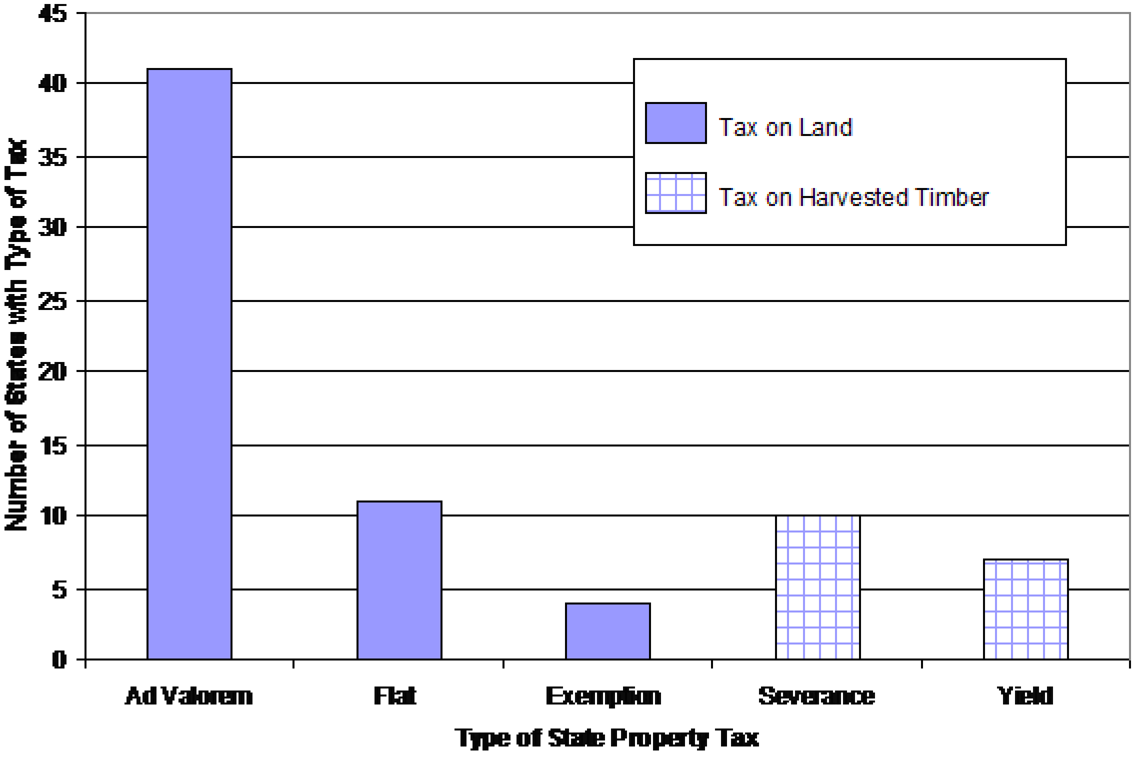
Several tax credits passed in legislation cannot be claimed by the targeted markets and therefore fail to achieve the anticipated market penetration of energy-efficient devices and systems. For instance:

- In 2005, EPAct[44] authorized a tax credit for fuel cells ($1,000/kW or 30 percent of the total cost, whichever is less), and the provision was enacted into law effective January 1, 2006.[45] However, the IRS has yet to establish guidelines that would clarify the eligibility criteria and spell out procedures for claiming the credit.[46] Companies have to spend large amounts of money with consultants to figure out how to use the tax credit. Yet the credit will expire at the end of 2007. Planning cannot be done cost-effectively around two-year tax programs.[47]

- Several of the tax credits for individuals have limited value because of the Alternative Minimum Tax (AMT),[48] which sets a floor for tax liability and can prevent those subject to AMT from claiming credits.[49] Examples for individuals are the tax credits for hybrid electric vehicles and residential photovoltaic systems.[50] Similarly, more and more of the large industry tax credits are becoming less of a viable strategy because of the AMT. Many large companies already qualify for the AMT so the tax code is not moving industry any further along.[51] The Energy Policy Act of 1992 provided independent domestic oil developers with relief from AMT,[52] but did not do so for renewable generation or energy efficiency technologies.[53]
- The maximum business credit deduction has also reached eligible thresholds for many companies. The internal revenue code requires that in any tax year a company may not reduce its payable taxes by more than 50 percent.[54] Firms can carry unused credits over for five years, but many are still maxed out even with this rollover provision.[55] These companies qualify for more tax credits than they can use, so the credits are often not being fully used. Piling more tax credits on is not effective. When considering EPAct 2005 tax credits, ACEEE reduced the expectation by at least a third because they expect at least a third of the firms will not be able to use them.[56]

Ineffective fiscal policies are not just the purview of the federal government; they also exist at the state and local level. Of particular importance to the viability of biomass as a renewable resource for transportation fuels, electricity, and chemicals is the tax treatment of farmland and forests. Many states have property tax laws that provide incentives for landowners to develop their forestland rather than leave the forest standing.[57] These development incentives are found when forestlands are taxed based on their location (ad valorem), or are not exempted from taxation when the forests are conserved. Almost all states tax property based on ad valorem values while only four offer exemptions for forestlands (Figure 3). These local land values, and corresponding taxes, may rise due to urban sprawl or other drivers of new residential or commercial building in an area, but the value of the timber stand tends not to increase accordingly. A transition in the ownership structure of forests from vertically integrated forest products companies to investment trusts or investment management organizations is also occurring largely due to the double taxation of harvested timber resources. This fiscally driven shift in land ownership may also contribute to reductions in forestland as investment firms search for the “highest or best use” of property.[58] Future cellulosic ethanol production across the country depends upon the maintenance of forest resources and the landowner-to-timber-industry infrastructure.[59]

Figure 3. Differential Property Tax by State



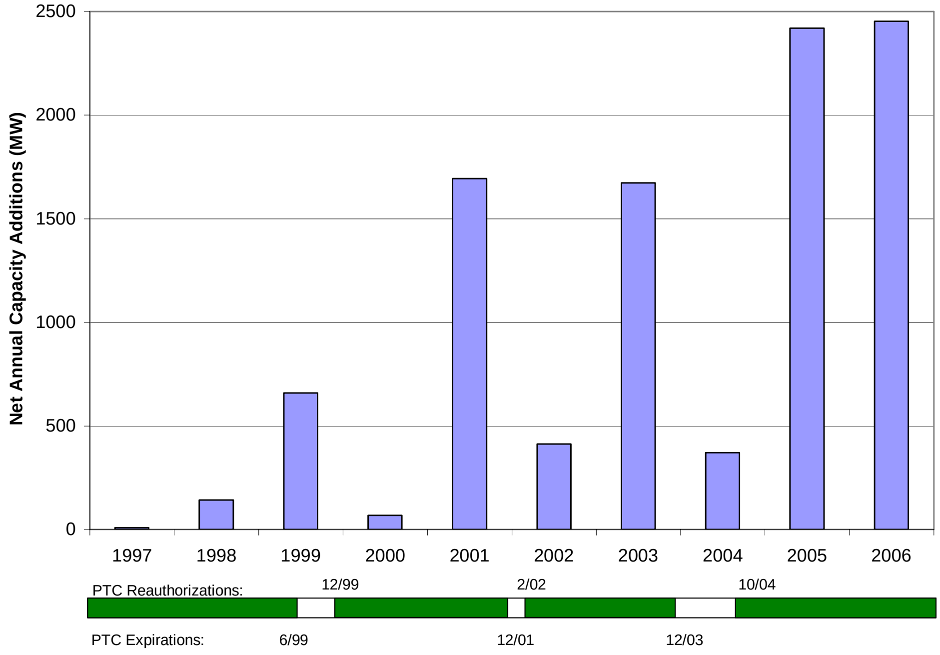
(source of data: http://www.timbertax.org/statetaxes/quickreference.asp)

C. Fiscal Uncertainty

Policies that subsidize energy technologies on an inconsistent and sporadic basis do not motivate rational market behavior. Similarly, future uncertainty related to penalties for GHG emissions also distort investment options.

1. Fiscal incentives. Fluctuating and sporadic fiscal incentives lead to uncertainty as well as abandonment of initiatives before their potential can be realized. This is particularly the case for capital-intensive improvements and technologies that require a large investment for an uncertain return.

Fig. 4. Annual Installed Wind Energy Capacity



(source of data: AWEA Wind Power Projects Database)

One example of this is the renewable production tax credit (PTC), which provides a tax credit for each kWh of electricity generated by qualified technologies.[60] These tax credits were initially made available for the first ten years of operation for all qualifying plants that entered service from 1992 through mid-1999. The subsidy was later extended to 2001, then to 2003, and again with EPAct 2005 to the end of 2007. In 2006, the provisions were extended for an additional two years, ending seven years of on-again/off-again subsidies. Because planning and permitting for new wind turbines takes about two years, expirations of the PTC contribute to investment downturns even if reauthorized shortly afterwards. Fig. 3 shows how PTC reauthorization stimulates market activity, and how PTC expiration is promptly followed by declines in capacity additions.[61] The tax credit has created a sellers market resulting in increased competition for the wind production capacity, which is currently sold out into 2008, raising prices due to “supply and demand” by roughly 50 percent to $1600/KW today. Further, with the sporadic tax credits, production is geared to the short-term, which is not necessarily the most efficient – focusing on an accelerated timetable instead of optimizing production over the long-run by, for instance, investing in longer-term facility needs, systems, and personnel training.

State or local production incentives, similar to the federal PTC, are available in at least five states, adding another layer of geographic diversity and inconsistency. The variability across states for incentives and programs for renewable energy and energy efficiency can be seen using the Databases for State Incentives for Renewables and Efficiency (DSIRE) web data application.[62]

2. Fiscal penalties. Investors must often choose between certain financial gains and uncertain financial penalties when looking at options for the future. When possible taxation or costing for

GHG emissions is unknown, investors may choose to delay adoption of clean energy technologies while their tax treatment is being debated. A clear example of this is the market for CO_2 storage and sequestration, but it also occurs in other climate change technology areas. For instance, Chad Holliday, the C.E.O. of DuPont, told Thomas Friedman that he is reluctant to expand the corporate investment in ethanol because he cannot anticipate what the price of ethanol will be. "What are the regulations going to be? Is the ethanol subsidy going to be reduced? Will we put a tax on oil to keep ethanol competitive? If I know that, it gives me a price target to go after. Without that, I don't know what the market is and my shareholders don't know how to value what I am doing."[63]

Long-term financial uncertainties are particularly relevant to projects that involve carbon sequestration, where issues of liability over the full duration of projects are largely unresolved. During the operational phase of CO_2 storage projects, financial responsibility and liability reside with either the owner of the CO_2 and/or the operator of the storage facility. In the long-term, the turnover of responsible parties poses risk and uncertainty to investors and stakeholders. Success may require the establishment of government bonds or trust funds, privately backed insurance funds, or public-private partnerships.[64] Until such long-term risk management strategies are established through public-private dialogue, the financial uncertainties will hold back carbon capture and storage (CCS) projects.

II. REGULATORY BARRIERS

A regulation is a legal restriction promulgated by government administrative agencies through rulemaking supported by a threat of sanction or a fine. Regulations are imposed in pursuit of the public good to produce outcomes that might not otherwise occur, but they can become impediments to innovation and competition. Common examples of regulation include attempts to control market entries, prices, wages, pollution, and standards of production and performance. Regulatory barriers that arise in the market include unfavorable and ineffective regulatory policies that disadvantage clean energy technologies and impede efficient market functioning. In addition, fluctuating, variable, and unpredictable regulations can undermine marketplace efficiency by introducing policy uncertainty.

A. Unfavorable Regulatory Policies

Regulations are typically seen as instruments of change – encouraging innovation, pollution prevention, safety, and standardization. However, they can also be distortionary, onerous, and barriers to progress when they regulate or unequally impact markets in which a technology is expected to compete. This section describes several distortionary performance and connection standards and burdensome permitting processes that handicap the market penetration of clean energy technologies.

1. Environmental Performance Standards. A number of deeply imbedded regulatory systems favor conventional energy sources and technologies. Examples are drawn from regulations in the electric power sector – new source review and input-based emissions standards.

As part of the 1977 Clean Air Act Amendments Congress established the New Source Review (NSR) program and modified it in the 1990 Amendments, but exempted old coal plants from the New Source Performance Standards (NSPS) to be set. [65] [66] NSPS are standards issued by the Environmental Protection Agency (EPA) to dictate the level of pollution that a new stationary source may produce.[67] These standards are intended to promote use of the best air pollution control technologies, taking into account the cost of such technology and any other non-air quality, health, and environmental impact and energy requirements. These standards apply only to electric generating units that have been constructed or modified since the proposal of the standard. This "grandfathering" has enabled the continued operation of some of the most polluting and highest CO_2-emitting electricity generators in the country far beyond their normal life,[68] and some contend that it has resulted in the underutilization of newer power plants because of their compliance burdens .[69] "NSR thus imposes pollution controls where they are least needed and artificially inflates the value of the dirtiest plants."[70]

Many studies show that several percentage points of efficiency improvement can be squeezed out of the current coal fleet.[71] However, investment in an upgrade could trigger an NSR, and the threat of such a review has prevented many upgrades from occurring.[72] NSR is a preconstruction permitting program that assures the dual goals of maintaining and attaining air quality and providing for economic growth. These goals are achieved through installation of state-of-the-art control technology at new plants and at existing plants that undergo a major modification.[73] However, uncertainty about the scope of such requirements has become a significant disincentive to rebuilding existing generating units that could ultimately result in greater energy efficiency or even lower emissions. Altogether, these effects have led some critics to question whether the NSR program and the NSPS have resulted in higher levels of pollution than would have occurred in the absence of regulation.[74]

On April 2, 2007, the U.S. Supreme Court issued a decision in *Environmental Defense v. Duke Energy Corporation*, that clarifies these requirements. It imposed an annual new source review test on sources unless and until EPA changes its regulations. On April 25, 2007, the EPA proposed further options to change the emissions increase test used to determine if the NSR permitting program would apply when an existing power plant makes a physical or operational change. Under EPA's new option, if a physical or operational change would not increase an electric generating unit's hourly emission, major NSR would not apply. If a generating unit's hourly emissions would increase, then projected annual emissions would be reviewed using the annual emissions increase provisions in the current rules and a generating unit would be subject to major NSR if the annual emissions would increase but not if annual emissions do not increase.[75] The unintended "effect" of discouraging plant upgrades could be heightened by this 2007 U.S. Supreme Court decision and follow-up EPA guidelines by closing loopholes that previously allowed power plants to be expanded and upgraded without triggering NSR reviews.

The nation's current regulatory approach to air pollution – using "input-based emission standards" – is also unfavorable to advancing clean energy technologies. "Input-based emissions standards" assess emissions based on fuel inputs into a power plant, and because they pay no attention to how much electricity or heat is provided by the plant, they fail to reward energy-efficient plants, those producing the same amount or more electricity while emitting fewer pollutants.[76] An "output-based" approach would reward those power generators for producing more useful energy (heat and power) from the same amount of fuel input, while emitting fewer pollutants. Output-based standards could advance an array of innovative power technologies including CHP, which puts to productive use much of the heat that is wasted in conventional power plants. Only output-based measurements can capture the total efficiency provided from a single source of fuel producing both electricity and thermal energy. The EPA has a guidance document on how to promulgate and implement output-based standards, the California Energy Commission and the South Coast Air Quality Management District have adopted output-based standards, and other organizations support them. However, only a few state and local air permitting agencies have adopted them, and EPA's Region 9 refuses to enact them.[77]

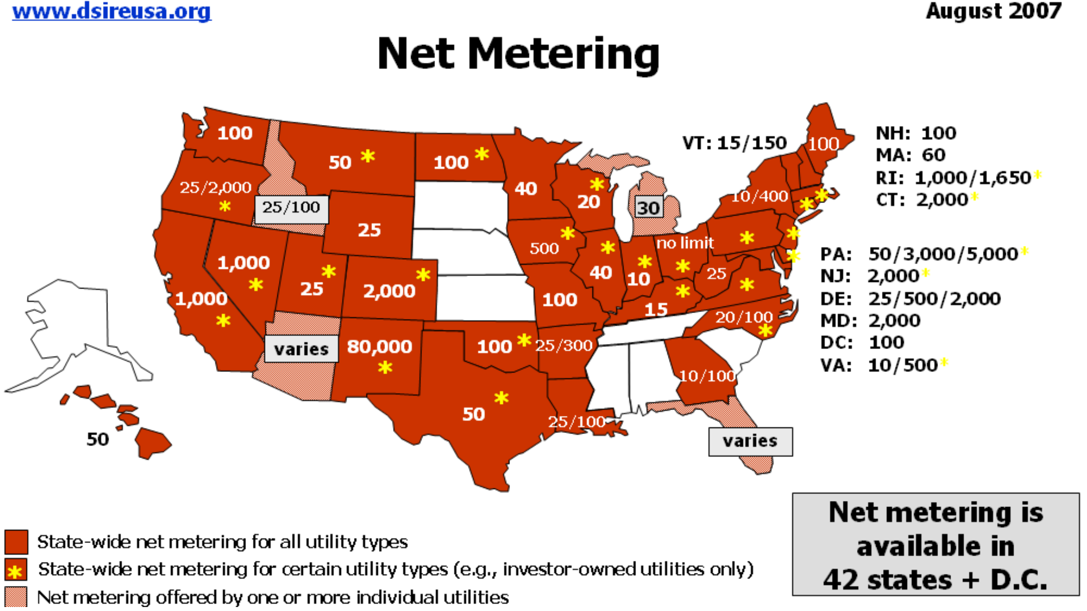
2. Connection Standards

Connection standards are designed to prevent unnecessary fluctuations in the electric system from improperly functioning, or out-of-phase, electric generators. These standards keep the electric system safe from fires, surges, brown-outs, and black-outs; however, in some cases, their application can be seen as onerous rather than due diligence. Distortionary connection standards, like bans on private wires and metering rules, have historically inhibited the installation of distributed generation (DG) systems in the United States.[78]

For example, consider the universal ban on private electric wires crossing public streets. While this ban maintains safety on roadways by preventing the introduction of wires lower than posted height limits, specifications could be designed to permit private wires. This ban forces would-be power entrepreneurs to use their competitors' wires to deliver electricity to their customers. In combination with generally high prices for moving such power, this ban on private electric wires penalizes local generation, which offers the potential for high-efficiency power delivery.[79]

The ability to legally connect DG equipment to the grid depends on federal, state, and local rules and regulations. The legal right to connect to the grid is provided for in federal laws such as the Public Utilities Regulatory Policies Act (PURPA) of 1978 and by state net metering statutes.[80] State-to-state variations in net metering policies cause confusion in the marketplace and raise the cost of completing DG projects. Net metering, an option to overcome barriers caused by variations in metering policies, allows customers with small generating facilities to use a single meter to measure both power drawn from the grid and power fed back into the grid from on-site generation. When a customer installation generates more power than it consumes, power flows into the grid and the meter runs backward. Net metering allows customers to receive retail prices for the excess electricity they generate. When combined with time-of-use pricing, this can result in an attractive value for PV power and other on-site power production.[81] In states that do not have net metering, a second meter must be installed to measure the electricity flowing back to the host utility, and the utility purchases the power at a rate typically much lower than the retail price—which is a disincentive to the development of distributed generation.[82]

Fig. 5. Geographic Variability of Net Metering Rules



Numbers given are the maximum system size, in kW [residential/commercial/industrial]

More than 40 states now have net metering laws, which allow a two-way flow of electricity between the electricity distribution grid and customers with their own generation (Fig. 5[83]). State-to-state variations in regulations impose significant burdens on project developers.[84] Mueller examined the policy instruments in use related to CHP adoption and the actual adoption rates for three types of facilities in Illinois: hospitals, schools, and others.[85] He found that organizations tended to search for CHP to achieve energy savings potential, but they considered regulatory complexity as an obstacle when making the adoption decision.

B. Ineffective Regulations.

Ineffective features of regulations and weak regulatory enforcement can lead to suboptimal outcomes that hinder clean energy technologies. Examples of ineffective regulations include regulatory loopholes, poor land-use planning, and burdensome permitting processes.

1. Regulatory Loopholes. Contained within otherwise effective regulations, one often finds particular clauses and specifications that subvert the goals of the laws. Such is the case with the Corporate Average Fuel Economy (CAFE) standards. Several examples illustrate the ways in which the CAFE standards are ineffective or have been redesigned in conflict with the law's original intent of increasing fuel economy.[86] Specifically, these standards:

- Exempt vehicles over 8500 pounds of gross vehicle weight (e.g., Ford Expedition, Hummer, Lincoln Armada) and ignore large light trucks – such as passenger and cargo vans.
- Preempt states from setting more restrictive fuel economy standards than those in the federal legislation.
- Credit vehicles for flexible fuel (E-85 capability) regardless of how they are fueled after purchase; the National Academies found that "The provision creating extra credits for

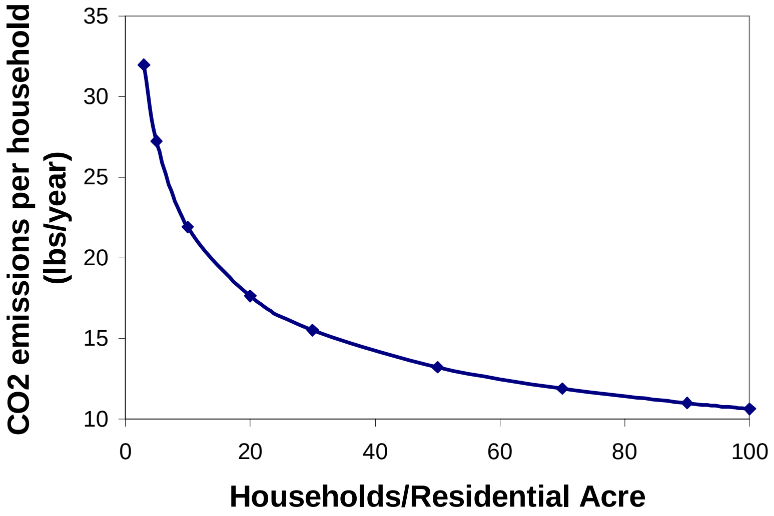
multifuel vehicles has had, if any, a negative effect on fuel economy, petroleum consumption, greenhouse gas emissions, and cost. These vehicles seldom use any fuel other than gasoline yet enable automakers to increase their production of less fuel efficient vehicles."[87]

- Allow car manufacturers to average fuel economies across a broad array of vehicles which creates an incentive for using very efficient smaller vehicles to offset inefficient larger vehicles. For example, trucks are held to a lower CAFE standard than cars, so Chrysler and Dodge benefit from having the PT Cruiser and the Magnum, which are cars in the eyes of consumers, classified as trucks under rules developed by the National Highway Traffic Safety Administration (NHTSA) in 1975.[88]

Such legal loopholes that undermine the goal of fuel economy can be explained in part by the existence of conflicting policy goals. "There is a marked inconsistency between pressing automotive manufacturers for improved fuel economy from new vehicles on the one hand and insisting on low real gasoline prices on the other."[89]

2. Land Use Planning. State and local governmental bodies are responsible for land-use planning in the United States. The planning process involves a mosaic of approaches, often displaying limited sensitivity to environmental goals. The automobile-dominant suburban environment, with its large carbon footprint, is the result of unfettered growth, with limited planning attention given to smart growth characterized by sidewalks and bike paths, rail systems and mixed-use developments that shorten the distance to work and promote the use of mass transit. Indeed, Greene (2006) argues that the main motivation for inefficient modes of travel is the built environment created without integrated land planning strategies.[90] As described by the Department of Energy's Smart Communities website, inefficient sprawling urban environments have been created by a combination of "zoning ordinances that isolate employment locations, shopping and services, and housing locations from each other" and "low-density growth planning aimed at creating automobile access to increasing expanses of land."[91] This urban sprawl leads to higher than necessary energy consumption, due mostly to increased transportation needs. Fig. 6 shows how urban environments compare in terms of transportation CO_2 emissions per household.

Figure 6. Low-Density Zoning Promotes Travel-Related CO_2 Emissions



(source of data: San Francisco League of Conservation Voters calculator, http://www.sflcv.org/density/index.html, December 6, 2004.)

Sprawling urban land use patterns in the U.S. have caused the amount of urbanized land area to grow two to three times faster than the metropolitan area.[92] The result is rapid increases in vehicle miles traveled (VMT) and shrinkage of the forest land available to absorb CO_2.[93] Zoning for low-density urban development contributes to sprawl and locks in dependence on cars by undermining the ability to support transit and to promote walking and cycling. Most subdivision regulations, parking and street design standards also pose barriers to smart growth projects, as do various distortionary fiscal policies such as the link between federal transportation funding and VMT levels.[94] As *Growing Cooler* explains, “the key to substantial GHG reductions is to get all policies, funding, incentives, practices, rules, codes, and regulations pointing in the same direction to create the right conditions for smart growth.”[95]

3. Permitting Processes. The market penetration of many clean energy technologies is hindered by onerous permitting processes. Examples highlighted below cover geological carbon sequestration and the siting of on-shore wind farms.

Carbon capture and storage (CCS) projects are challenged by inadequate regulatory frameworks typical of new products. Currently, there are no uniform guidelines regulating geologic carbon sequestration projects; as a result, regulatory issues are addressed mostly on a case-by-case basis in contracts for a particular project. Applicants prepare individual statements for underground injection of CO_2, and EPA must review each injection well for adequacy.[96] This creates uncertainty and confusion and raises concern about the long-term environmental and economic integrity of the projects.[97] A generic process could streamline these injection projects. Doing “permitting by rule” would be useful. EPA could specify the necessary characteristics in a checklist of requirements so that applications can be more uniform.

Environmental permitting for land-based wind projects falls under the purview of regulations promulgated by a maze of local, county, state, and federal agencies. In addition to the litigation implications of these numerous requirements, each individual permit provides an opportunity for wind projects to be challenged.[98] Permitting processes are also problematic for off-shore wind. In 2005, Minerals Management Services in the U.S. Department of Interior was given authority for offshore wind (and ocean energy) siting. [99] However, the agency has not yet specified its procedures, creating delays in the permitting process.[100] Since success in the marketplace is facilitated by minimizing the risk of litigation and public opposition, wind projects are particularly handicapped by onerous permitting requirements.

C. Regulatory Uncertainty

Energy markets face numerous uncertainties even when operating within stable tax and regulatory framework. Today's markets are particularly unpredictable due to ambiguities about possible future GHG regulations and tax treatments. Investors, electric utilities, vehicle manufacturers, and other key stakeholders who deal with fuel futures must decide what to build as a next generation of power plants and transportation fuels, not knowing if CO_2 and other GHGs will remain unregulated. The 109th Congress processed more than 100 climate change-related proposals,[101] and the 110th Congress appears to be seeing an even greater level of climate policy activity. When the basis for estimating long-term operating costs and competitive advantage is so uncertain, how are consumers to make "rational" choices about the purchase of new energy-using systems and how are producers to decide whether or not to invest in alternative energy technologies? All of the uncertainties associated with the treatment of GHG externalities are impediments to positive action.[102] Examples of regulatory uncertainty impacting clean energy technologies include lack of "waste confidence" for the disposal of spent nuclear fuels; lack of clarity regarding the classification of CO_2; uncertain siting regulations for off-shore wind (see discussion under section "permitting processes"); and uncertain codes and standards for hydrogen storage and transport. These examples are described below, following a broader description of impacts of regulatory uncertainty.

An increasing number of U.S. companies have been participating in voluntary greenhouse gas emission reduction programs and registries to prepare for eventual federal regulations. But whether or not these early actions will receive credit in any future GHG cap and trade program depends on future congressional legislation. To add further complexity to this already uncertain situation, the existing greenhouse gas emissions reduction registries in the United States differ in ways that could affect the provision of credit under future federal legislation.[103] These uncertainties contribute to a "wait-and-see" attitude among many GHG emitters.

The speedy deployment of low-carbon technologies, as with many novel products and systems, can also be inhibited by missing or inadequate regulations, monitoring and verification procedures, and insufficient guidelines, codes and standards necessary for coordinating and interconnecting industry networks. Considering the commercialization and deployment of technology in terms of knowledge imbedded in linked systems and subsystems, it is not surprising that novel technologies face unique systems barriers that incumbent technologies no longer suffer because: the dominant technologies already benefit from mature and well understood regulatory systems.[104] When new technologies are getting ready for commercialization, developers need to know how the technology will be treated by the law. Having codes and standards in place before technologies come to the marketplace can ensure uniformity and safety, and reduces business risk. A compelling example of this need for new codes and standards is hydrogen-based products and systems. Standards will be necessary relative to purity, pressure, material thicknesses, as well as the certification of workers and many other features.[105]

Nuclear power plant operators face uncertainties as to whether or not they will be allowed to construct and operate new nuclear power plants; these uncertainties include the need for 'waste confidence' and a new regulatory regime. New nuclear plants cannot be built until the federal regulating agency, the Nuclear Regulatory Commission (NRC) provides a statement of 'waste confidence'. Power plant operators have no control over this statement, and favorable waste confidence relies upon another federal body – the U.S. Department of Energy (DOE).[106] DOE is responsible for taking ownership of used fuel from nuclear power plants; to date, this has not occurred, so nuclear power plant operators are storing fuel onsite in spent fuel pools and dry storage. The NRC has not stated that onsite storage will be sufficiently permanent to result in 'waste confidence'. The NRC is also working under a new regulatory process for certifying new nuclear power plants through the combined construction and operating license; one investor (NRG) has submitted a request for this new license – testing the process. Investors face considerable uncertainty as to how this new process will impact their construction and operating lead time. In this environment of uncertainty, investors must "get in line" for some products well in advance of knowing whether or not they will ever build the plant.

Various definitional and classification issues regarding CO_2 sequestration remain unresolved, adding uncertainty to the development of CCS projects. CO_2 can either be classified as an industrial product or as a waste product – a distinction that is important because industrial projects are typically subject to less stringent environmental regulations than waste disposal projects.[107] Existing federal air regulations do not define CO_2 as a pollutant, but some states have already defined CO_2 as a waste, an air contaminant, or a pollutant.[108] Classification inconsistencies could negatively impact CCS development because of the added burden associated with waste management.[109] For example, the federal Marine Protection Research and Sanctuaries Act (MPRSA) governs the legality of carbon dioxide sequestration in the subseabed beneath U.S. territorial waters.[110] It specifically prohibits "dumping" industrial waste into ocean waters.[111] Thus, if CO_2 is "industrial waste" and if subseabed carbon dioxide sequestration constitutes "dumping into ocean waters," then it is prohibited. However, there is statutory ambiguity about these terms, which contributes to business risks and impedes investment in this clean energy technology.[112]

In general, regulatory uncertainties keep industry from innovating and deter consumers from purchasing clean energy products. In some cases, regulatory uncertainty comes in the form of conflicting policy priorities. As described by the National Academies, policy inconsistencies limit reductions in fuel consumption, "There is a marked inconsistency between pressing automotive manufacturers for improved fuel economy from new vehicles on the one hand and insisting on low real gasoline prices on the other."[113]

III. STATUTORY BARRIERS

Typically, statutes command, prohibit, or declare policy in pursuit of the public good, but they can become impediments to markets for clean energy technologies. Statutes are written laws set down by a legislature in response to a perceived need to clarify the functioning of government, improve civil order, answer a public need, codify existing law, or provide special treatment for an individual or company. In addition to the statutes passed by the national or state legislature, lower authorities or municipalities may also enact statutes. While these enactments are subordinate to the law of the whole state or nation, they are nonetheless a part of the body of a jurisdiction's statutory law.

Numerous local, state and federal statutes inhibit deployment of clean energy technologies. Some statutes are unfavorable, while others are uncertain. Due to the strong reliance on regulatory agencies for implementing most policies that impact clean energy technologies, there are instances where the line between statutes and regulations is unclear; for this reason, ineffective statutes are difficult to identify separate from ineffective regulation – described above.

A. Unfavorable Statutes

The lack of modern and enforceable building codes acts as a barrier to the deployment of green building technologies. In addition, procurement policies in many states prevent energy saving performance contracting from using private-sector resources to upgrade the energy integrity of state government buildings.

1. Lack of modern and enforceable building codes. There is great variability in the level of energy efficiency required by state building codes. For example, eighteen states have adopted the 2003 International Energy Conservation Code, while nine states have energy codes that are more than a decade old or follow no energy code at all.[114] The dominance of local interests helps explain why there are several thousand different code specifications. These code variations fragment the market and contribute to manufacturing inefficiencies.[115]

Building standards can be distortionary, in spite of their numerous positive influences including the well-known success reducing the energy required by household refrigerators.[116] Because codes and standards take a long time to adopt and modify, they sometimes specify obsolete technologies, thereby inhibiting innovation and encouraging obsolete technology. The RESCHECK code for assisting building code implementation allows tradeoffs between technologies to meet the overall code; in some cases, these tradeoffs lead to distortions when credits are allowed for common practices, preventing improvements in efficiency.[117] For example, in the upper Midwest there is upwards of 80 percent penetration of condensing gas furnaces. The tradeoffs to meet the code allow savings from this now common high efficiency furnace to be used to offset poor envelopes.[118] As a result, this code specification is no longer promoting improved building practices because it has not adapted to technology advances. Codes that are outdated or fail to adapt to changing available technologies can represent lost opportunities to improve energy efficiency.

2. State procurement policies. Over the past decade, energy service companies have become important players in delivering energy-efficiency upgrades to industrial and commercial markets and government facilities through the use of energy-saving performance contracts (ESPCs).[119] Increasingly, this contracting mechanism is being used by state and federal government agencies to upgrade the energy efficiency of government-owned buildings. Recognizing the value of this funding mechanism, EPAct 2005 extended the authority of the federal government to engage in ESPCs.

Many state constitutions, however, do not allow the obligation of funds in advance of their being appropriated. In some of these states, this requirement is seen as prohibiting multi-year contracting with energy services companies. Another barrier to third-party financing is the scoring practices of the Congressional Budget Office (CBO). The CBO scores the costs and not the savings of ESPC contracts. The costs are real because they are in the contract, but the savings are not scored because they do not yet exist. There are similar problems with lease-purchases, where the lease payments incorporate the added first cost of the more expensive energy-efficient product, but the scoring does not include the savings.[120]

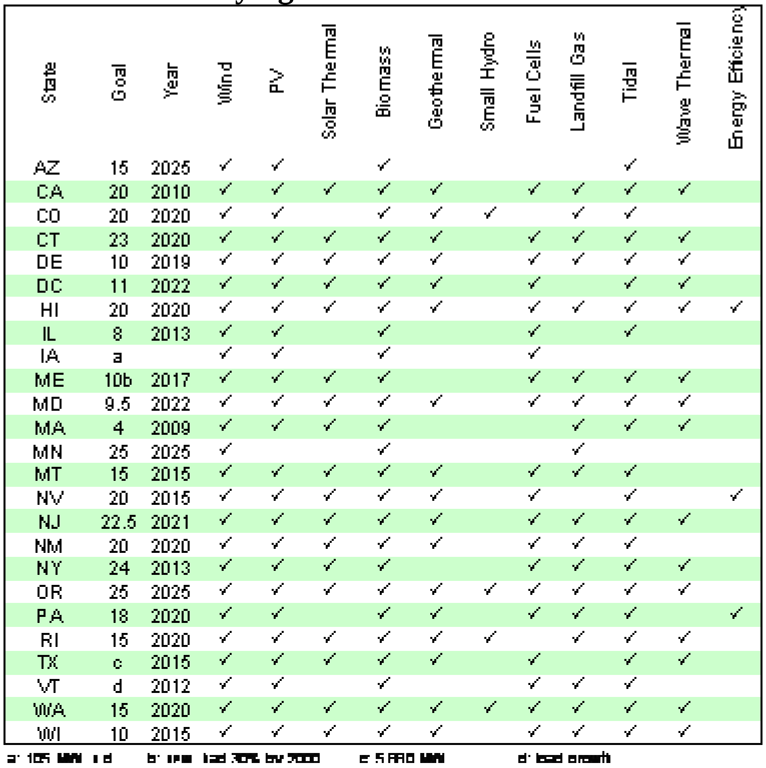
B. Statutory Uncertainty

The expectation of a stream of immediate and future benefits drives most investment and consumption decisions. Uncertainty is a deterrent to investment and it is particularly problematic when new clean energy technologies are being launched into a market where codes and standards have not been developed, policies are expected, statutes fluctuate over time, and “the rules” vary from place-to-place.

1. Mosaic of Clean Energy Portfolio Standards. Differences across state laws add confusion in the marketplace for clean energy technologies. They also thwart the economies of scale that can result from national markets.

Many states have recently adopted Renewable Portfolio Standards (RPS) or Sustainable Energy Performance Standards (SEPS) requiring that a portion of electricity sold by utilities in a state come from particular renewable sources or be avoided through improvements to energy production and energy end-use efficiencies. Because electricity providers

Table 1. Varying Renewable Portfolio Standards



State	Goal	Year	Wind	PV	Solar Thermal	Biomass	Geothermal	Small Hydro	Fuel Cells	Landfill Gas	Tidal	Wave Thermal	Energy Efficiency
AZ	15	2025	✓	✓		✓					✓		
CA	20	2010	✓	✓	✓	✓	✓		✓	✓	✓	✓	
CO	20	2020	✓	✓		✓	✓	✓		✓	✓		
CT	23	2020	✓	✓	✓	✓	✓		✓	✓	✓	✓	
DE	10	2019	✓	✓	✓	✓	✓		✓	✓	✓	✓	
DC	11	2022	✓	✓	✓	✓	✓		✓		✓	✓	
HI	20	2020	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
IL	8	2013	✓	✓		✓			✓		✓		
IA	a		✓	✓		✓			✓				
ME	10b	2017	✓	✓	✓	✓			✓	✓	✓	✓	
MD	9.5	2022	✓	✓	✓	✓	✓		✓	✓	✓	✓	
MA	4	2009	✓	✓	✓	✓				✓	✓	✓	
MN	25	2025	✓			✓				✓			
MT	15	2015	✓	✓	✓	✓	✓		✓	✓	✓		
NV	20	2015	✓	✓	✓	✓	✓		✓		✓		✓
NJ	22.5	2021	✓	✓	✓	✓	✓		✓	✓	✓	✓	
NM	20	2020	✓	✓	✓	✓	✓		✓	✓	✓		
NY	24	2013	✓	✓	✓	✓			✓	✓	✓	✓	
OR	25	2025	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
PA	18	2020	✓	✓		✓	✓		✓	✓	✓		✓
RI	15	2020	✓	✓	✓	✓	✓	✓		✓	✓	✓	
TX	c	2015	✓	✓	✓	✓	✓		✓		✓	✓	
VT	d	2012	✓	✓		✓			✓	✓	✓		
WA	15	2020	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
WI	10	2015	✓	✓	✓	✓	✓		✓	✓	✓	✓	

a: 105 MW [illegible] b: new [illegible] 30% by 2000 c: 5,880 MW d: load growth do not reside completely within the bounds of states (electricity is an interstate product), variation in these laws can be costly and onerous for utilities. These laws vary not only by their percentage goals and timelines for renewable energy, but also by the renewable resources and technologies that are eligible (see Table 1[121]).[122]

2. Uncertain property rights. Uncertainty about property ownership is a barrier for several clean energy technologies including carbon capture and storage (CCS), coal bed and coal mine methane, and wind generation.

For CCS, the three main areas of property rights are surface (rights pertaining to the location of CO_2 injections), sub-surface (rights associated with underground reservoirs), and rights to the CO_2 itself.[123] The surface and gas rights are generally not under question, but the deep subsurface property rights are not established or not applied consistently. When CO_2 is injected underground, it is not clear who needs to be paid and who has the right of refusal. Existing sub-surface rights are not uniform: for oil, the rights are attached to the surface, and the mineral rights are owned separately based on sub-surface rights; water is treated differently. It is unclear how large-scale CO_2 injection will be treated. Can the surface owner deny rights? If the injected fluid goes beyond the surface boundaries, the floor space a mile deep in adjacent lots may or may not be available to that well. There is one case that provides a precedent for broad property rights. DOE's FutureGen project has assumed that the well owner must own the entire land footprint over the impacted floorspace. Resolution of the ownership of CO_2 storage rights (reservoir pore space) is needed before CCS approaches can proliferate.[124]

Ownership issues similarly impede the recovery of methane from coal beds and coal mines. If the coal mine draws methane from under properties owned by others, land ownership can be unclear. Ownership of the gas also could raise reporting issues for the mine owner. Statutory uncertainty is created because there is variability among states as to the legal ownership of resources, land, and gas. Owners of the coal, surface land, coalbed methane, and mineral rights may be different entities, complicating negotiations for recovery of the gas and access to the land. The Supreme Court found that federal coal leases granted under the 1909 and 1910 Coal Lands Acts did not include coalbed methane as part of the coal lease, impeding potential recovery.[125] The Bureau of Land Management (BLM) is involved in resolving this property rights issue; separate leases may need to be negotiated. EPAct 1992[126] attempted to resolve the issue, providing model legislation, but many states did not adopt it. Mine-by-mine solutions are being developed for a small number of mines.[127]

For wind technologies, Wilson notes a pressing problem related to wind rights contracts for small landowners.[128] Wind rights are generally recognized under two common law doctrines: the united fee ownership rule (the idea that a landowner's property rights extend to everything from the center of the earth to the sky, such as rainfall from clouds over their property) dictates a legal right to harvest the wind that blows across one's land, in contrast, traditional mineral rights doctrine (which establishes that surface rights may remain in the possession of one person or entity, while the right to extract various minerals lies with another) suggests that wind, like oil and natural gas, is a resource that can be sold.

CONCLUSIONS

The “market-failure model” guiding public policy debates today suggests that markets should be left alone by government unless market failures exist.[129] In competitive and efficient markets, suppliers produce what consumers want and are willing to pay for. However, when market failures exist, prices do not accurately reflect total costs, and it is legitimate to consider public intervention. This rationale has led to the creation of large-scale government involvement in energy markets in an attempt to fix or compensate for voluminous market failures. [130]

This paper has shown that these interventions have produced an array of “public failures”[131] that now need to be reformed. They are of special interest because they are imposed by legislators and regulators through tax laws, regulations and statutes. By hindering the deployment of clean energy technologies, they are at cross-purposes with U.S. government intentions to reduce GHG emissions.[132] This paper describes more than 30 of these barriers and it characterizes them as distortionary because of their unfavorable, ineffective, or uncertain features that slow or block the market uptake of clean energy technologies (Table 2).

Numerous *unfavorable* policies place clean energy technologies at a comparative disadvantage. Sometimes this is done by favoring competing technologies or by precluding technological change and thereby supporting incumbent technologies. Environmental standards enable the continued operation of some of the most polluting generators in the country far beyond their normal life and perversely disincentivize investing in plant upgrades. Conflicting social goals often explain these public failures: cheap energy is preferred over clean energy, and the desire to promote U.S. oil independence trumps the goal of mitigating greenhouse gases. Legal inertia is another cause: laws often trail behind and thereby inhibit technological progress, as is true of building codes, CAFE standards, and tax depreciation schedules.

Various *ineffective* policies exist which have design flaws that undermine their intended outcomes. Sometimes these occur in the form of loopholes as is the case with the fuel-economy standards for the nation’s vehicles. In other instances, tax credits for investments in clean energy technologies are authorized but they cannot be claimed. Burdensome procedures add unnecessary sluggishness to the process of technological change. Property taxes for forest land promote deforestation, and land-use planning continues to foster urban sprawl with its expanding carbon footprint.

Policy *uncertainty* is pervasive in today’s energy markets. Investors and consumers face numerous uncertainties and ambiguities about possible future GHG regulations and tax treatments. These uncertainties contribute to a “wait-and-see” attitude among GHG emitters. Uncertainty results from state and local variability, fluctuating short-term policies, and extended debates about alternative future policy scenarios can preempt commitments to clean energy and investments in carbon-intensive energy options. Net-metering, environmental permitting, Renewable Portfolio Standards and many other “crazy-quilt” state-by-state policies hinder the development of national markets and the resulting economies of scale so necessary for new technologies to become cost-competitive.

These distortionary policies create confusion in the marketplace for energy technologies. A vigorous campaign of policy reform is needed to create a consistent, effective, and predictable policy environment where clear and reinforcing signals encourage the infusion of clean energy technologies to prevent large-scale global climate disruption.

Table 2. Fiscal, regulatory, and statutory impediments to clean energy technologies

Unfavorable Fiscal Policies	**Tax subsidies**	The internal revenue code provides business deductions for the purchase of large light trucks.
		The gas-guzzler tax on cars (but not on light trucks) has discouraged the purchase of cars and encouraged the purchase of SUVs.
		Oil and gas depletion allowances allow owners to claim a depletion deduction for loss of their reserves.
		Government support for research on the production of liquid fuels from coal and the production of petroleum from shale oil and tar sands promotes carbon-intensive fuels.
		The link between federal transportation funding and vehicle miles traveled rewards the growth of transportation energy use.
	Unequal taxation of capital and operating expenses	The federal tax code discourages capital investments in general, as opposed to direct expensing of energy costs.
		The federal tax code forces firms to depreciate energy efficiency investments over a longer period of time than many other investments.
		Capital-intensive technologies (e.g., renewables and nuclear power plants) have a differentially higher tax burden than expense-intensive technologies (e.g., coal and natural gas plants).
	Unfavorable tariffs	The import tariff for ethanol raises the cost of ethanol blends produced by domestic refineries.
		Utilities impose tariffs (including standby charges, buyback rates, and uplift fees) on small generators seeking to connect to the grid.
	Utility pricing policies	Unfavorable electricity pricing policies present obstacles for an array of clean energy technologies; these include the regulated rate structure, lack of real-time pricing, and imbalance penalties.
		In traditionally regulated electricity markets, electric utilities face little incentive to promote energy efficiency or non-dispatchable distributed generation because utility company profits are a function of sales.
Ineffective fiscal policies		The IRS has yet to establish guidelines that clarify the eligibility criteria and spell out procedures for claiming tax credit for fuel cells authorized in the Energy Policy Act of 2005.
		Tax credits intended to promote the purchase of hybrid electric vehicles and residential photovoltaic systems have limited value because of the Alternative Minimum Tax, which sets a floor for tax liability.
		The internal revenue code requires that in any tax year a company may not reduce its payable taxes by more than 50 percent, which prevents many firms from benefiting from tax deductions for clean energy investments.
		Many states have property tax laws that provide incentives for landowners to develop their forestland for higher use rather than leave the forest standing or continue timber production.
Fiscal Uncertainty	**Fiscal incentives**	Financial incentives, like the production tax credits, that vary over time increase investment uncertainty.
	Fiscal penalties	Investors face uncertain costs for GHG emissions; when these possible future costs are weighed against certain higher capital costs for cleaner technologies, cleaner technologies are not likely to win.

Unfavorable Regulatory Policies	**Performance Standards**	Exempting existing facilities from strict emissions requirements placed on new plants discourages what would be naturally occurring technological progress.
		Emissions standards that are input based rather than output based discourage process improvements that would result in lower emissions.
	Connection Standards	The ban on private electric wires crossing public streets penalizes local generation of electricity, which could reduce transmission losses and increase overall efficiency.
Ineffective Regulations	**Regulatory Loopholes**	Federal CAFE standards exempt vehicles over 8500 pounds gross vehicle weight, encouraging automakers to make heavier – rather than more efficient, trucks.
		States are prevented from setting more restrictive fuel economy standards than those in the federal CAFE legislation, so state policy innovation is limited.
		Federal CAFE standards also credit vehicles for flexible fuel (E-85 capability) regardless of how they are fueled after purchase or their fuel mileage.
	Poor land-use planning	Zoning for low-density urban development contributes to sprawl and locks in dependence on cars rather than multi-user transit.
	Burdensome permitting processes	Several clean energy technologies, such as carbon capture and hydrogen, are challenged by inadequate regulatory frameworks.
		Environmental permitting for land-based wind projects falls under the purview of regulations promulgated by a maze of local, county, state, and federal agencies, while off-shore wind faces a lack of permitting procedures.
Regulatory Uncertainty		Regulatory uncertainty – regarding whether or not GHG will be regulated or how current technologies will fare under new regulatory processes – impedes rational investment decisions.
Unfavorable Statutes	**Lack of modern and enforceable building codes**	Building codes that are not enforced, are based on outdated technology, or allow tradeoffs that mitigate use of existing technology discourage adoption of clean energy technologies.
	State procurement policies	When state agencies cannot contract over more than one fiscal year, they are unable to take on capital improvements that are cost-effective in the long-run.
Statutory Uncertainty	**Variable Clean Energy Portfolio Standards**	Many states have adopted renewable or efficiency portfolio standards for electric generation, but these vary greatly – making it difficult for utility investors to reduce emissions or improve efficiency through the most cost-effective means.
	Uncertain property rights	Property rights for subsurface and above-surface areas are unclear. In some cases, particularly coal-bed methane, geologic storage of carbon dioxide, and wind energy, property rights for these areas must be defined to provide investment certainty.

REFERENCES

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[1] United Nations Framework Convention on Climate Change art. 2, May 9, 1992, S. Treaty Doc. No. 102-38, 1771 U.N.T.S. 107.

[2] For the purposes of this paper, we use the term “clean energy technologies” to refer to technologies that reduce GHG emissions. These include technologies covered by the 15 sectors contributing to four goals of the U.S. Climate Change Technology Program: reducing emissions from energy end use and infrastructure, reducing emissions from energy supply, capturing and sequestering carbon dioxide, and reducing emissions of non-CO_2 GHGs. These technology sectors and CCTP goals are described in greater detail in the *CCTP Strategic Plan* (U.S. Climate Change Technology Program (CCTP). 2006. *Strategic Plan*. Washington, DC: U.S. Department of Energy, DOE/PI-0005, http://www.climatetechnology.gov, accessed 7/3/07).

[3] Hoffert, Martin I., Ken Caldeira, Gregory Benford, David R. Criswell, Christopher Green, Howard Herzog, Atul K. Jain, Haroon S. Kheshgi, Klaus S. Lackner, John S. Lewis, H. Douglas Lightfoot, Wallace Manheimer, John C. Mankins, Michael E. Mauel, L. John Perkins, Michael E. Schlesinger, Tyler Volk, Tom M.L. Wigley. 2002. “Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet,” *Science*, Vol. 298, pp. 981-987. Grubb, M., C. Carraro and J. Schellnhuber. 2006 "Technological change for atmospheric stabilization: Introductory overview to the innovation modeling comparison project." *The Energy Journal* Special Issue: Endogenous technological change and the economics of atmospheric stabilisation (1-16). Montgomery, W. David. 2006. Prepared statement for hearing on "The Role of Science in the Asia-Pacific Partnership" before the Committee on Commerce, Science and Transportation Subcommittee on Global Climate Change and Impacts. United States Senate. Washington DC.

[4] Nakicenovic, N. and K. Riahi. 2003. *Model Runs with MESSAGE in the Context of the Further Development of the Kyoto-Protocol* (Berlin, Germany: WBGU). Weyant, John P. (ed.). 2004. “Special Issue EMF 19 Alternative technology strategies for climate change policy.” *Energy Economics* 26(4). To clarify, “stabilization costs” refers to the cost of achieving stabilization of GHG at some level.

[5] Edmonds J.A., J.F. Clarke, J.J. Dooley, S.H. Kim, and S.J. Smith. 2004. “Modeling Greenhouse Gas Energy Technology Responses to Climate Change.” *Energy* 29 (9-10) (Special Issue):1529-1536.

[6] ..

[7] 26 USC § 179 “Election to expense certain depreciable business assets” provides for depreciation of large trucks.

[8] Greene, David. 2006. Personal communication (telephone interview) Corporate Fellow, Center for Transportation Analysis, Oak Ridge National Laboratory. 10/31.

[9] Wong, B. 2003. “It's not just a Hummer, it's a tax break.” *Seattle Post-Intelligencer*, January 17. Kamen, A. 2003. A Hummerdinger of a Tax Loophole. *Washington Post*, p. A25, September 26.

[10] 26 USC § 179, supra note 8 amended in 2004 with P.L. 108-357 § 910(a) to reduce deductions for SUV’s (which are specifically defined in the section) to a maximum of $25,000.

[11] Current taxes in effect since 1991: Gas Guzzler Tax is in the Code of Federal Regulations 40CFR600.513-91. This regulation creates a tax rate that is based on an equation. Thus, as the EPA determines the fuel economy of a car, that economy is an input into the equation to determine the rate.

[12] Energy Tax Act of 1978: P.L. 95-618, 92 Stat. 3174, enacted November 9, 1979

[13] More information about the gas guzzler tax and lists of cars subject to the tax can be found at http://www.epa.gov/fueleconomy/guzzler/420f06042.htm

[14] Greene, supra note 8.

[15] 26 USC §§ 611, 613, and 613(A); for more information, see Internal Revenue Service (IRS). 2006. *Publication 535: Business Expenses, Chapter 9: Depletion.* http://www.irs.gov/publications/p535/ch09.html#d0e7114, accessed 7/26/07. Cost depletion refers to depletion based on the basis cost and resource amounts extracted and sold whereas percentage depletion refers to depletion based on income from sales of particular resources.

[16] Combined heat and power (CHP) refers to methods that utilize just one fuel source to provide both electric and heat energy needs – usually by circulating “waste steam”. For more information, see U.S. EPA http://www.epa.gov/chp/

[17] P.L. 99-514

[18] Elliott, Neal. 2006. Personal communication (telephone interview). Industrial Program Director, American Council for an Energy Efficient Economy. 10/27.

[19] Non-residential buildings have a life of 39 years in the schedule; 26 USC § 168

[20] Jenkins, Alec, Richard Chapman, & Hugh Reilly. 1999. Tax barriers to four renewable technologies. California Energy Commission. www.energy.ca.gov / papers/ CEC-999-1996-003, accessed 8/14/07.

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[21] EIA does not provide a breakdown of cost categories for energy efficiency; however, other studies have shown that energy efficiency is labor- and not capital-intensive. U.S. Energy Information Administration (EIA). 2007. *Annual Energy Outlook 2007 with Projections to 2030 – Overview*, DOE/EIA-0383(2007), Figure 56. http://www.eia.doe.gov/oiaf/aeo/index.html, accessed 7/16/07. Kushler, Martin, Dan York, and Patti Witte. 2004. *Five Years In: An Examination of the First Half-Decade of Public Benefits Energy Efficiency Policies*. Washington, DC: American Council for an Energy Efficient Economy, Table 5.

[22] The renewable projects included current and advanced solar central receiver plants, biomass-electric, and flash and binary cycle geothermal projects. Jenkins et al., supra note 21.

[23] Federation of Tax Administrators (FTA). 2006. State Tax Holidays. http://www.taxadmin.org/fta/rate/sales_holiday.html#chart, accessed 11/28/06.

[24] Alliance to Save Energy. 2005. Sales Tax Holiday for Energy-Efficient Products. http://www.ase.org/content/article/detail/2643, accessed 11/29/06.

[25] Cars sold in 1990 had a median lifetime of 17 years, and heavy trucks last longer, with an estimated life of 28 years. Davis, Stacy C. and Susan W. Diegel. 2007. *Transportation Energy Data Book: Edition 26*. http://cta.ornl.gov/data/index.shtml, accessed 7/17/07, Tables 3.8 and 3.10.

[26] Holdren, John P. 2006. Quoted in the *New York Times*, 10/30 “Budgets Falling in Race to Fight Global Warming,” p. A14.

[27] Lane, Lee. 2006. Personal communication (telephone interview) Director, Climate Policy Center, 11/16.

[28] revised from http://www.calchamber.com/NR/rdonlyres/F7F36D4B-44DB-4545-AE54-59AB8FF72A7C/0/ACCPstudy.pdf, Figure 5.

[29] Unruh, G. 2002. “Escaping Carbon Lock-in.” *Energy Policy*, 30: 317-325.

[30] Cowan, R. 1990. “Nuclear Power Reactors: A Study in Technological Lock-in.” *Journal of Economic History*, 50(3), pp. 541-567. Unruh, supra note 30.

[31] Ruth, M. 1995. “Technology change in the US iron and steel production,” *Resources Policy*, 21:3 199-214. Worrell, E. and G. Biermans. 2005. “Move over! Stock turnover, retrofit and industrial energy efficiency,” *Energy Policy* 33:7 949-962.

[32] Yacobucci, Brent D. 2007. “Fuel Ethanol: Background and Public Policy Issues.” Congressional Research Service (CRS) Report for Congress, RL 33290, http://www.nationalaglawcenter.org/assets/crs/RL33290.pdf, accessed 7/9/07.

[33] Omnibus Reconciliation Act of 1980. P.L. 96-598

[34] Volumetric Ethanol Excise Tax Credit (VEETC) as part of American Jobs Creation Act of 2004 (P.L. 108-357).

[35] P. L. 109-58

[36] Yacobucci, supra note 32.

[37] Sovacool, B. and R. Hirsch. 2007. *Energy Myth Seven- The Barriers to New and Innovative Energy Technologies are Primarily Technical: The Case of Distributed Generation* in Sovacool, B. K. and Brown, M. A. (eds.) *Energy and American Society – Thirteen Myths*. New York: Springer Publishing Company, pp. 145-169.

[38] Tempchin, Rick. 2007. Personal Communication (in person interview) Director of Retail Distribution Policy, Edison Electric Institute, 7/23.

[39] Casten, T.R. and R.U. Ayres. 2007. *Energy Myth Eight - Worldwide Power Systems are Economically and Environmentally Optimal* in Sovacool, B. K. and Brown, M. A. (eds.) *Energy and American Society – Thirteen Myths*. New York: Springer Publishing Company, pp. 201-237.

[40] Leadership Group. 2006. *National Action Plan for Energy Efficiency*. Washington, DC: U.S. Department of Energy and U.S. Environmental Protection Agency. http://www.epa.gov/cleanrgy/pdf/napee/napee_report.pdf, accessed 7/16/07.

[41] Cowart, Richard. 2001. “Efficient Reliability: The Critical Role of Demand-Side Resources in Power Systems and Markets.” Report to the National Association of Regulatory Utility Commissioners, Regulatory Assistance Project, p. vii. http://www.raponline.org/Pubs/General/EffReli.pdf, accessed 11/9/06.

[42] With net-metering, the customer is only charged for “net” consumption (Pew Center, http://www.pewclimate.org/what_s_being_done/in_the_states/net_metering_map.cfm, accessed October 26, 2007). Net-metering is also discussed separately in this paper, section II.A.

[43] Thresher, Robert. 2006. Personal communication (telephone interview). Director, National Wind Technology Center, National Renewable Energy Laboratory. 11/3. Beck and Martinot, supra note 44.

[44] Energy Policy Act of 2005 (P.L. 109-58)

[45] 26 USC § 25D “Residential Energy Efficient Property”

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[46] U.S. Fuel Cell Council. 2007. *Federal Fuel Cell Tax Incentives; An investment in clean and efficient technologies.* www.usfcc.com/resources/, accessed 7/14/07.
[47] Logan, Sam. 2007. Personal communication (telephone interview). CEO, Logan Energy. 1/29.
[48] 26 USC § 55 "Alternative Minimum Tax Imposed"
[49] Logan, supra note 47.
[50] A new tax credit created under P.L. 109-58, §§1341-1342 replaced the existing Clean Fuel Tax Deductions under 26 USC § 179A that were terminated in 2005; these credits that include hybrid electric vehicles are codified in 26 USC § 30B. Tax credits for residential photovoltaic installations are up to 30% of the cost, with a $2000 cap for individuals- 26 USC § 25D.
[51] The AMT limits the ability of investors and individuals to shelter income from federal taxes. Elliott supra note 19.
[52] Energy Policy Act of 1992 (P.L. 102-486)
[53] Jenkins, Alec, Richard Chapman, & Hugh Reilly. 1999. Tax barriers to four renewable technologies. California Energy Commission. www.energy.ca.gov / papers/ CEC-999-1996-003, accessed 8/14/07.
[54] Elliott, Neal. 2001. *Federal tax strategies to encourage the adoption of Combined Heat and Power*. Washington, DC: American Council for an Energy Efficient Economy (ACEEE), Report No. ACEEE-IE015.
[55] Elliott, supra note 18.
[56] Elliott, supra note 18.
[57] Murray, Brian. 2006. Personal communication (telephone interview). Director for Economic Analysis, Nicholas Institute for Environmental Policy Solutions, Duke University 11/7.
[58] Hickman, Cliff. 2007. *Restructuring of US Industrial Timberland Ownership - REITS and TIMO's*. Retrieved on October 26, 2007 from http://64.226.56.33/documents/TIMO_REIT_Paper_PDC.pdf
[59] Reisert, Roger. 2006. Personal Communication (interview). President, C2 Biofuels. 11/28.
[60] Production Tax Credits are defined in 26 USC § 45. EPAct 2005 (P.L. 109-58 § 1301) amended 26 USC § 45; Section 1301 also modifies the definition of "qualified energy resources" in Code section 45(c)(1)
[61] American Wind Energy Association (AWEA). 2007. *U.S. Installed Wind Capacity, 1981 to 2006*. http://www.awea.org/projects/, accessed 7/12/07.
[62] DSIRE – http://www.dsireusa.org/, accessed 7/31/07.
[63] Friedman, Thomas. 2007. "The Power of Green," *New York Times Magazine*.
[64] Bliss, Kevin. 2005. *Carbon Capture and Storage: A Regulatory Framework for States Summary of Recommendations*. Oklahoma City, OK: Interstate Oil and Gas Compact Commission, pp. 5-6.
[65] 42 U.S.C. §§ 7401-7671 (2006).
[66] Clean Air Act Amendments of 1977 (P.L. 95-95; 91 Stat. 685) and of 1990 (P.L. 101-549)
[67] "Standards of Performance for New Stationary Sources" 40 CFR 60
[68] Braitsch, Jay. 2007. Personal Communication (telephone interview). Director of Strategic Planning, Fossil Energy, U.S. Department of Energy. 2/5.
[69] Stavins, Robert N. 2006. "Vintage-Differentiated Environmental Regulation," 25 STAN. ENVTL. L.J. 29.
[70] Gremillion, T. 2007. "Case Comment: Environmental Defense V. Duke Energy Corporation," *The Harvard Environmental Law Review*, 31 Harv. Envtl. L. Rev. 333.
[71] Climate Change Technology Program. 2005. *U.S. Climate Change Technology Program: Technology Options for the Near and Long Term*. A compendium (dated September 2005) of technology profiles and ongoing research and development at participating Federal agencies http://www.climatetechnology.gov/library/2005/tech-options/tor2005-212.pdf

[72] Braitsch, supra note 68.
[73] Stole Rives Environmental Group, http://www.stoel.com/showalert.aspx?Show=2281, accessed 7/31/07.
[74] Gremilion, supra note 70.
[75] EPA's Fact Sheet on *New Source Review: Emission Increases for Electric Generating Units* can be found at http://www.epa.gov/nsr/fs20070424.html
[76] Freedman, S. and S.Watson. 2003. *Output Based Emissions Standards: Advancing Innovative Technologies*. Washington, DC: The Northeast Midwest Institute.
[77] Brent, Richard. 2006. Personal communication (telephone interview). Vice President, Solar Turbines, Inc. 11/8.
[78] Distributed generation is modular electric power located close to the energy consumer, including photovoltaics, gas turbines, fuels cells, and combined heat and power. Alderfer, R. Brent and Thomas J. Starrs. 2000. "Making Connections: Case Studies of Interconnection Barriers and Their Impact on Distributed Power Projects." National Renewable Energy Laboratory Report NREL/SR-200-28053. Golden, CO: NREL. Mueller, Steffen. 2006. "Missing

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the spark: An investigation into the low adoption paradox of combined heat and power technologies," *Energy Policy* 34: 3153-3164. Sovacool and Hirsh, supra note 38.

[79] Casten and Ayres, supra note 39.

[80] P.L. 95-617

[81] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (DOE/EERE). 2003. The Green Power Network, Green Power Markets, "Net Metering Policies" webpage, http://www.eere.energy.gov/greenpower/markets/netmetering.shtml, accessed 7/17/07.

[82] Many states do not have net metering programs. Other states require net metering only for investor-owned utilities. In a few states, the Public Utilities Commission has mandated net metering programs for all utilities. There are also state-by-state variations in the types of on-site power that are eligible for net metering – photovoltaics and wind almost always qualify, but fuel cells are rarely covered by net metering legislation (DOE/EERE, supra note 85).

[83] Database of State Incentivies for Renewables & Efficiency (DSIRE). 2006. *Net Metering Rules.* http://www.dsireusa.org/, accessed 11/9/06.

[84] Alderfer and Starrs, supra note 73.

[85] Mueller, supra note 78.

[86] Energy Policy and Conservation Act of 1975 (P. L. 94-163) established corporate average fuel economy (CAFE) standards for new passenger cars

[87] National Academies Press. 2002. *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*. Board of Energy and Environmental Systems (BEES), p. 111.

[88] Csere, C. 2004. "Saving gas through semantic definitions." *Car and Driver*.

[89] National Academies, supra note 91, p. 113.

[90] Greene, supra note 8.

[91] http://www.smartcommunities.ncat.org/landuse/luintro.shtml

[92] Fulton, W., R. Pendall, M. Nguyen, and A. Harrison. 2001. *Who Sprawls Most? How Growth Patterns Differ Across the U.S.* Washington, DC: Brookings Center on Urban and Metropolitan Policy, 2001.

[93] Ewing, R., K. Bartholomew, S. Winkelman, J. Walters, and D. Chen. 2007. *Growing Cooler: The Evidence on Urban Development and Climate Change.* Chicago, IL: Urban Land Institute.

[94] An overview of the apportionment of funds from the Federal Highway Trust Fund can be found in the GAO 2006 report available at http://www.gao.gov/new.items/d06572t.pdf.

[95] Ewing et al, supra note 92, p. 10.

[96] Hovorka, Susan. 2006. Personal Communication (telephone interview). Research Scientist, Bureau of Economic Geology, University of Texas. 11/14.

[97] Robertson, Kate, Jette Findsen, and Steve Messner. 2006. *International Carbon Capture and Storage Projects—Overcoming Legal Barriers*. National Energy Technology Laboratory, DOE/NETL-2006-1236.

[98] Koehler, Mike. 2007. "Developing Wind Power Projects in Massachusetts: Anticipating and Avoiding Litigation in the Quest to Harness the Wind," *Suffolk Journal of Trial and Appellate Advocacy, 12 Suffolk J. Trial & App. Adv.*

[99] Authority granted in EPAct 2005 (P.L. 109-58)

[100] Thresher, supra note 43.

[101] The Pew Center on Global Climate Change, 109th Congress Proposals, http://www.pewclimate.org/what_s_being_done/in_the_congress/109th.cfm (last visited Aug. 10, 2007).

[102] Newell, Richard. 2006. Personal communication (telephone Interview). Gendell Associate Professor of Energy and Environmental Economics, Duke University. 11/21.

[103] DiMascio, Nicholas. 2007. "Credit Where Credit is Due: The Legal Treatment of Early Greenhouse Gas Emissions Reductions." Duke Law Journal, 56 Duke L.J. 1587.

[104] Unruh, G. 2000. Understanding carbon lock-in. *Energy Policy, 28*, 817-830.

[105] National Renewable Energy Laboratory (NREL). 2002. Proceedings of the 2002 U.S. DOE Hydrogen and Fuel Cells Annual Program/Lab R&D Review, May 6-10, 2002, Golden, Colorado. Golden, CO, NREL/CP-610-32405. http://www.nrel.gov/docs/fy02osti/32405.pdf, accessed 7/16/07.

[106] Rushton, Jim. 2006. Personal communication (telephone interview). Director of Nuclear Science and Technology, Oak Ridge National Laboratory. 11/8.

[107] Robertson, Findsen, and Messner, supra note 97.

[108] Existing regulations under the Clean Air Act provisions 42 USC §§ 7401-7671

[109] Bliss, supra note 64.

[110] 33 U.S.C. §§ 1401-1445 (2000).

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[111] Id. §§ 1412(a).

[112] Weeks, Ann Brewster. 2007. “Subseabed Carbon Dioxide Sequestration as a Climate Mitigation Option for the Eastern United States: A Preliminary Assessment of Technology and Law,” *Ocean and Coastal Law Journal, 12 Ocean & Coastal L.J. 245.*

[113] National Academies, supra note 91, p. 113.

[114] Brown, Marilyn A., Frank Southworth and Therese K. Stovall. 2005. “Towards a Climate-Friendly Built Environment,” Pew Center on Global Climate Change. http://www.pewclimate.org/docUploads/Buildings%5FFINAL%2Epdf, accessed 11/9/06.

[115] Hirst, Eric, and Marilyn A. Brown. 1990. “Closing the Efficiency Gap: Barriers to the Efficient Use of Energy,” *Resources, Conservation and Recycling,* 3: 267-281.

[116] National Academies. 1998.

[117] An “envelope” refers to the exterior of a building – i.e. walls, windows, roofing, foundation, and associated insulation.

[118] Harris, Jeff. 2006. Personal Communication (telephone interview). Vice President for Programs, Alliance to Save Energy. 11/17.

[119] An energy service company (ESCO) is a business that develops, installs, and finances projects designed to improve the energy efficiency and maintenance costs of facilities. ESCOs generally act as project developers for a wide range of tasks and assume the technical and performance risk associated with the project (source: http://www.naesco.org/, accessed 7/17/07).

[120] Harris, supra note 127.

[121] Rabe, Barry G. 2006. *Race to the Top: The Expanding Role of U.S. State Renewable Portfolio Standards,* Pew Center on Global Climate Change, http://www.pewclimate.org/global-warming-in-depth/all_reports/race_to_the_top, accessed 7/31/07, and dsireusa.org.

[122] Cooper, Christopher and Benjamin Sovacool. 2007. “Renewing America: The Case for Federal Leadership on a National Renewable Portfolio Standard (RPS),” Network for New Energy Choices, Report No. 01-07. http://www.newenergychoices.org/dev/uploads/RPS%20Report_Cooper_Sovacool_FINAL_HILL.pdf, accessed 6/7/07. Brown, M.A., Dan York, Martin Kushler. 2007. “Are RPS Ready for the National Stage?” *the Electricity Journal*, Vol. 20, Issue 4, 62-72.

[123] Robertson, et al. supra note 103.

[124] Hovorka, supra note 96. Bliss, supra note 64.

[125] Sabino, A. M. (2007). “Supreme court distinguishes “Coal” from “gas” in Amoco.” *Natural Gas* 16:1 1-6.

[126] P.L. 102-486

[127] Kruger, Diana and Paul Gunning. 2006. Personal Communication (telephone interview). Non-CO2 Programs Branch, Environmental Protection Agency. 11/8.

[128] Wilson, 2004

[129] Taylor, Jerry and Peter Van Doren. 2007. *Energy Myth Five – Price Signals are Insufficient to induce Efficient Energy Investments,* in Sovacool, B. K. and Brown, M. A. (eds.) *Energy and American Society – Thirteen Myths,* New York: Springer Publishing Company, 125-144.

[130] Brown, M.A. 2004. “Obstacles to Energy Efficiency,” *Encyclopedia of Energy* 4, 2004, 465-475. Prindle, B. 2007. *Quantifying the Effects of Market Failures in the End-Use of Energy* (Washington, DC: American Council for an Energy-Efficient Economy), ACEEE Report Number E071, http://www.aceee.org/energy/IEAmarketbarriers.pdf, accessed 8/5/07, Brown, Marilyn A. 2001. “Market Failures and Barriers as a Basis for Clean Energy Policies,” in *Energy Policy,* 29 (14): 1197-1207.

[131] Bozeman, Barry. 2002. “Public-Value Failure: When Efficient Markets May Not Do,” *Public Administration Review*, 62(2), 134-151.

[132] The George W. Bush administration in 2002 announced a national goal of reducing GHG intensity (that is, emissions per dollar of real GDP) by 18% from 2002 to 2012.