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Energy Policy 36 (2008) 673–685

ENERGY POLICY

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America's bottom-up climate change mitigation policy

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Received 2 August 2007; accepted 15 October 2007
Available online 28 November 2007

Abstract

Many diverse actions can be taken to reduce greenhouse gas (GHG) emissions. Increasingly in the United States, policy-makers at sub-national levels are setting emission targets and implementing plans for sector-specific GHG reductions. In this paper, local, state, and regional policy actions in the US are inventoried and analyzed as to their potential effect on national emissions. The realization of all existing sub-national initiatives, as of September 2007, could stabilize US emissions at 2010 levels by the year 2020. The scale of these many decentralized mitigation actions, and their tendency to follow consistent steps, provide a counterpoint to oft-cited drawbacks of decentralized environmental policy. It also indicates that the US has been more committed to climate change mitigation than is generally acknowledged.

Keywords: Climate change; Energy policy; Federalism

1. Introduction

Climate change is often referred to as a global "commons" problem, whereby individuals are unlikely to take responsibility for global accumulation of atmospheric greenhouse gases (GHGs). This "commons" problem implies that top-down international treaties will ultimately be required to achieve substantial climate change mitigation. Yet, increasingly lower-level governments within the US are enacting their own climate change policy targets and mitigation regulations.

Over the past decade, the federal and state governments have diverged in their awareness and willingness to act on climate change in the US. The balance of environmental federalism has shifted decidedly toward lower-level government action on climate change policy. The federal government has focused on research and voluntary programs, while lower-level governments have intensified their emissions mitigation actions. The growing number of local- and state-level actions, including new energy efficiency funding mechanisms, aggressive renewable fuel requirements, and regulatory standards, contrast with the relative inaction at the federal level.

State and local governments are utilizing policy levers available to them to act on climate change and, in part, to help encourage or influence more widespread federal action. The April 2007 US Supreme Court (2007) ruling could put to rest many of the legal challenges against sub-national climate change initiatives. The numerous actions at lower levels of government can now more solidly be considered the first steps of the US toward climate change mitigation. Local, regional, and state governments are now following a prescribed pattern of inventorying their emissions, establishing climate change action plans, setting emission reduction targets similar to those of the Kyoto Protocol, enacting state-level regulations and standards explicitly targeting GHGs, and forging multi-government alliances to reinforce and support their actions. As more climate change mitigation efforts take shape, significant nationwide emission reductions may result. These first steps by governments concerned about climate change provide templates for national initiatives.

2. Literature review and research objectives

We build upon Rabe's (2004) careful categorization and cataloguing of state climate change policy and subsequent

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doi:10.1016/j.enpol.2007.10.018

elaboration since (see e.g., Rabe, 2006; PCGCC, 2007; US EPA, 2007; Byrne et al., 2007) this paper adds a quantification component by estimating the cumulative potential impacts of lower-level government actions in the US. In analyzing the potential impacts of state and local climate change mitigation policy, we examine more broadly the advantages and limitations of this decentralized "bottom-up" approach in the context of environmental federalism.

The relative merits of the power balance of environmental federalism—toward central federal authority or toward lower-level constituent political units—are well discussed in the literature (see e.g. Buzbee, 2005; Adler, 2005). Benefits of more decentralized regulatory action include (1) allowing more experimentation by more policymakers, (2) local tailoring of specific actions to fit more aptly the environmental preferences of constituents of various states and locales, (3) testing the political response of innovative regulatory and policy actions, and (4) gaining the benefit of local expertise and experience in enforcing programs and policies.

However, enactment of state and local environmental policy initiatives may overlap and interact with one another in negative ways: (1) patchwork regulatory programs pose additional administrative burden on industry, (2) duplicative enforcement results in a waste of regulatory resources, and (3) cross-boundary mismatch between pollution sources and impacts. Also, the pitfall of (4) uneven performance by the various jurisdictions can have unintended consequences such as to encourage "shuffling," whereby companies redirect their low-carbon products (such as hydro-electricity) to jurisdictions with stringent rules and high-carbon products (such as coal-based electricity) to areas with weaker or non-existent rules. Finally, the issue of (5) jurisdictional confusion over which level of government is responsible for a given environmental issue can be especially problematic in its potential to encourage inaction by decentralized lower-level governments. This problem is highlighted by Adler (2005): "one cannot reasonably expect states, acting alone, to adopt welfare-enhancing environmental protections as the regulating state will bear a disproportionate share of the costs from such regulation with no guarantee of reaping proportionate benefits."

Considerable criticism has been directed at the current trend of greater lower-level US climate policy. Victor et al. (2005) generally favor the approach of early bottom-up policy action with later cooperation to control emissions, but they downplay these various lower-level actions as lacking the necessary institutional leverage to amount to serious action on climate change. They cite as an example the 10 states with emission targets that only encompass 14% of the US electric sector. Weiner et al. (2006) favor an international cap-and-trade market regime to coordinate all of the local actions, arguing that the ability of bottom-up local policies to move from "uncoordinated autarchy to the accretion of shared norms and informal cooperation" will be difficult and will have little chance of engaging other climate change mitigation partners.

On the other hand, several researchers have underscored the growing importance of lower-level US government action in the formation of federal US climate change policy and on US re-engagement in international climate change policy. Rabe (2004) finds that US state initiatives could help promote the development of federal US climate policy in a bottom-up fashion. Other researchers predict that future US federal climate policy will evolve from and be motivated by major state and regional US climate policy adoption trends (Selin and VanDeveer, 2007). Purvis (2004), on the general practice of the US "to act first at home, and then to build on that approach at the international level," suggests that present environmental developments in the US could eventually spur a new international climate change regime (i.e. non-Kyoto Protocol) in which the US would participate. Bang et al. (2007) find that domestic "push" of lower-level US government actions could offer an alternate path toward international climate engagement for the US; they conclude that two preconditions for US participation in any global climate regime are the gathering of more experience and the crystallization of US policy preferences. Perhaps most importantly, lower-level engagement is key to real, long-term progress. There must be a local commitment, down to individuals, to accomplish the type of economic and societal transformations that will be necessary to achieve very large reductions in carbon. The more engaged and the more powerful the commitment, the more likely it is that actual change will occur.

In this research, current trends in US climate change policy actions are reviewed and their effects quantitatively measured. With an eye to what the lower-level government actions could tell us about eventual federal climate change policy, quantification is offered on several questions: Just how committed is the US toward emissions reductions in future years? What percentages of the US population and US GHG emissions are covered by the current lower-level climate policy actions? How much net reduction in national emissions can be gained by fully implemented lower-level GHG mitigation initiatives? Based on this quantitative analysis, we examine the drawbacks of decentralized environmental policy action and assess critiques that current US climate policy does not amount to serious action, that lower-level governments lack sufficient institutional leverage, and that these actions have little potential for wider engagement.

3. Analysis

In the following sections, we investigate three types of GHG policy actions being employed by sub-national US governments. First, we analyze the impacts of "top-down" directives setting state- and city-level GHG emission reduction targets (e.g. reducing state emissions to 1990 level by the year 2020). Second, acknowledging that there is

little guarantee or binding regulation to assure that these top-level targets are achieved, we look at specific "bottom-up" sector-specific GHG mitigation policies (e.g. emission standards for vehicles) that are directed at achieving those targeted reductions. Third, multi-government activities that connect these mitigation efforts are explored.

The quantification of these measures requires the compilation of numerous government data sources, which will be discussed below. To perform these calculations, a database was constructed with baseline characteristics, including GHG emissions, population, number of vehicles, and GHG-related policies, for each state. By inputting which states have adopted given policy actions alongside the emissions characteristics in the database, we have the ability to toggle policy options on and off to examine impacts of "policy" and "no policy" scenarios. In addition, the dates of policy adoption are inputted to graphically analyze trends. The impacts on GHG emissions are explored based on the states' current chosen policies. Expanded state adoption of the policy measures is considered, beyond the states that have currently committed to such policies. Finally, we sum the 50 states' GHG emissions—in varying policy adoption scenarios—to determine the total potential national impact of the GHG mitigation policies.

3.1. Trends in emission reduction target-setting in the US

Regional, state, and local GHG reduction actions have been chronicled by numerous researchers and organizations (Rabe, 2004; US EPA, 2007; PCGCC, 2007; Ramseur, 2007). As late as 2004, US climate change policy efforts could be characterized as an uncoordinated patchwork of disparate initiatives. Now, in 2007, we see a more systematic strategy and a consistent set of actions being undertaken by state governments. States that engage in climate change policy generally follow the steps of inventorying GHG emissions in the state, establishing a GHG registry, formulating a GHG mitigation action plan, and initiating programs and regulations to bring about GHG reductions in future years. Numerous governments are engaged in each of these climate change action steps (PCGCC, 2007; WRI, 2007b). They are guided by a variety of non-government and government agencies (Prindle et al., 2003; US EPA, 2006). States' plans for mitigation steps are routinely following similar paths for mitigation actions. At least 26 states have used, or are using, consistent methods to prioritize similar GHG mitigation actions (CCS, 2007).

Table 1 provides a summary of the current status of state and city climate policy actions with the current (as of April 2007) levels of US involvement, quantified by number of governments and percentages of the population and national GHG emissions associated with each action. In Table 1, US population involvement percentages are calculated, based on which states and cities have undertaken the actions (from PCGCC, 2007; EPA, 2007; US MCPA, 2007), the total population in those jurisdictions (from US Census Bureau, 2006), and the states' GHG emissions (from US EIA, 2006; WRI, 2007a).

Shown in Table 1 are the percentages of the 2007 US population that are in states that are currently GHG

Table 1
Involvement in climate change actions by US states and cities

Climate change action	Description of climate change action	Area represented by climate change action	US representation in climate change action	
			Percent of 2007 US population[a]	Percent of 2007 US GHG emissions[b]
City GHG emission-reduction target	Target to reduce cities' GHG emissions to 7% below 1990 GHG levels by 2012	684 US cities, including Chicago, Dallas, Denver, Los Angeles, New York[c]	26	23[d]
State GHG emission-reduction target	Targets to reduce state GHG to specific emission levels in future years (generally to 1990 GHG levels by 2020)	17 US states: AZ, CA, CT, FL, HI, IL, ME, MA, MN, NH, NJ, NM, NY, OR, RI, WA[d]	45	30
City or state GHG emission-reduction target	Targets to reduce cities' and states' GHG emissions to specific levels in future years	17 states plus the 284 target cities that are *not* in the 17 target-setting states	53	43[d]
State GHG action plan	State plan that identifies and evaluates feasible and effective policies to reduce GHG emissions	30 states[e]	64	53
State GHG inventory	State data collection report that quantifies GHG emissions by states sources and sectors	42 states[e]	96	93

[a]Based on US Census Bureau (2006).
[b]Based on US EIA (2007) and WRI (2007a);
[c]US MCPA (2007).
[d]Based on cities' state average per capita GHG emissions because city-level GHG emissions were not widely available for the 684 initiative-participating cities.
[e]Based on PCGCC (2007) and EPA (2007).

inventoried (96%), have state climate change action plans (64%), and have state-wide GHG emission-reduction goals (45%). The additional impact of the city-level targets (for the 285 cities that are *not* in states with emission targets) is also shown; these city targets increase the proportion of the US population in regions with GHG emission-reduction targets to 53%. Perhaps more important than the population involvement is the representation of those government actions in terms of their portion of US GHG emissions. State-level inventories cover 93% of the nation's GHG emissions; state mitigation plans, 53%; and state GHG emission targets, 30%. In the absence of city-specific emissions data, the impact of the cities' initiative on emissions is estimated based on average GHG-per-person data for each of the respective states, which likely overestimates emissions for larger cities and undercounts for the smaller cities. Also, the US GHG emissions representation percentages in the far right column are lower than percentages for the US population mostly because the more active climate action states tend to have lower GHG-per-person intensities than non-action-taking states.

In Fig. 1 the time dimension is added to show adoption trends of GHG inventory completion, GHG action plan formulation, and GHG target-setting. The first two precursors to state GHG mitigation, inventories and climate change action plans, both experience large increases in US population involvement and US GHG coverage from 1994 to 2007. The growth in enactment of emission reduction targets, from about 5% to 53% of the population in less than 6 years, is important for several reasons. Target-setting commits policy-makers to deliver substantive emission reductions, and they provide a firmer framework than plans and mitigation assessment studies.

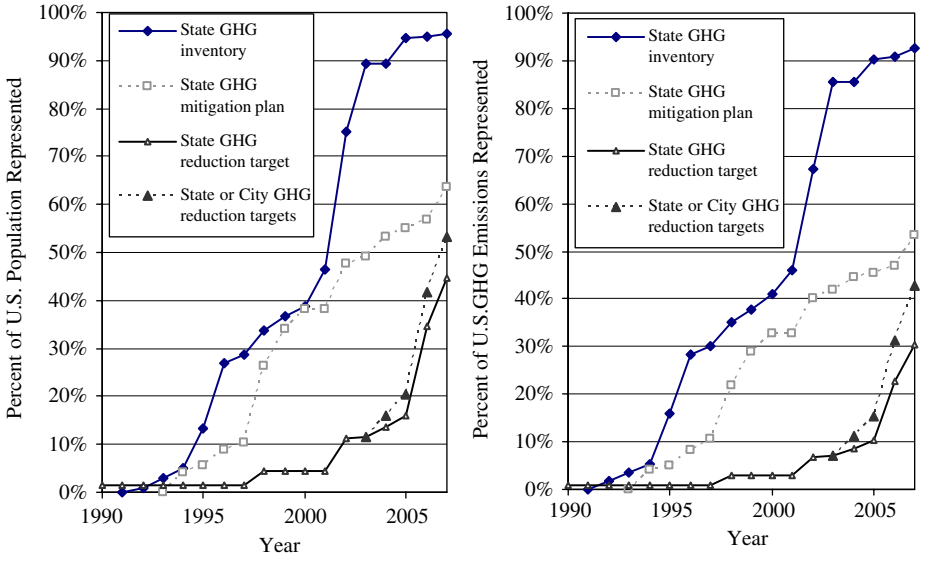

Fig. 1. Trends in US involvement in climate change actions, 1990–2007.

Table 2
Emission-reduction impact of state and local climate policy in the US

Scenario	Areas of GHG reductions	Scenario GHG-reduction impact			
		2020 emissions (MMT CO_2e)	2020 reduction (MMT CO_2e)	Percent reduction from baseline	Percent of reductions to meet 1990 emissions level in 2020
Baseline—no state GHG reduction targets achieved (US EIA, 2007)	None	8146	0	0	0
Target-setting cities reach 7% below 1990 GHG levels by 2012	684 US cities representing 26% of the US population	7549	597	7	27
Target-setting states achieve their target reductions	17 US states representing 45% of US population	7418	728	9	33
Target-setting cities and states reach GHG target reductions	17 states plus the 284 cities that are not in the 17 target-setting states	7168	1041	13	47
US 1990 GHG emissions	–	5910	2237	27	100

Furthermore, the rapid ramp-up of target setting, from 2001 to 2007, for governments serving over half the population, reveals an expanding enthusiasm that may inspire other state policy-makers to proceed beyond simply conducting inventories and mitigation plans.

In Table 2, we assess the overall US impact of the lower-level government target-setting on future US GHG emissions, assuming for now that all target reductions are achieved. The US DOE *Annual Energy Outlook 2007* (US EIA, 2006) forecast is used as a baseline for US energy and emissions characteristics. The states with GHG goals generally aim to reduce emissions to 1990 levels by 2020, and in some cases to 10% below 1990 levels by 2020. Some have more aggressive goals beyond 2020, but only the impact of the 2020 goals is shown. City targets are most commonly set to reduce emissions to the US Kyoto Protocol level of 7% below 1990 levels by 2012, and these cities' emissions are then assumed to hold constant at that level through 2020. All other (i.e. non-target-setting) states and cities are assumed to continue on their general emission growth trends, according to the US EIA (2007) baseline outlook. The current cities' initiative, if all the cities achieved their goals, would equate to a 7% reduction of US emissions from the 2020 baseline. The cities' and states' goals, if both achieved, would reduce US emissions by about 13%. This 13% reduction from the baseline would be equivalent to 47% of the total US emission reduction that would be required to meet the benchmark of the 1990 US emission level. The result of the state and city initiatives would be to approximately stabilize US GHG emissions at their 2010 levels until the year 2020, after which increases resume due to business-as-usual increases in the non-climate-action states' GHG emissions.

3.2. Trends in sector-specific GHG mitigation actions in the US

Many state and city policy-makers have backed up their "top-down" GHG emission target-setting directives by enacting sector-specific policy mechanisms. The largest GHG emissions contributors are power plants and vehicles, which represent 39% and 32% of US GHG emissions, respectively (US EIA, 2007). Many states are now targeting these sources with mitigation policies (PCGCC, 2007; CCC, 2007; Nadel, 2006). Other targets for state actions include residential energy usage (with appliance standards) and agricultural and forestry sequestration. Local mitigation action areas include land use, transportation planning, building codes, and waste reduction policies. This section focuses on the impact of major policies in the two largest GHG sectors and therefore does not comprehensively discuss the full array of GHG policy options being undertaken. For example, this research does not attempt to analyze the potential impacts of the implementation of states' vehicle travel reduction measures.

In this section, trends in the two foremost climate change action areas—light-duty vehicles and renewable electricity—are investigated for their ability to deliver US GHG emission reductions in future years. Fig. 2 shows the extent of GHG regulations for vehicles and renewable electricity standards by summing the individual states according to when they engaged in the climate actions. Measured in terms of both population and the units that these programs operate on (light-duty vehicle sales and electricity generation), each of these initiatives covers about half of the US. The increased involvement in the California vehicle standard is more abrupt—from 2004 to the present—on

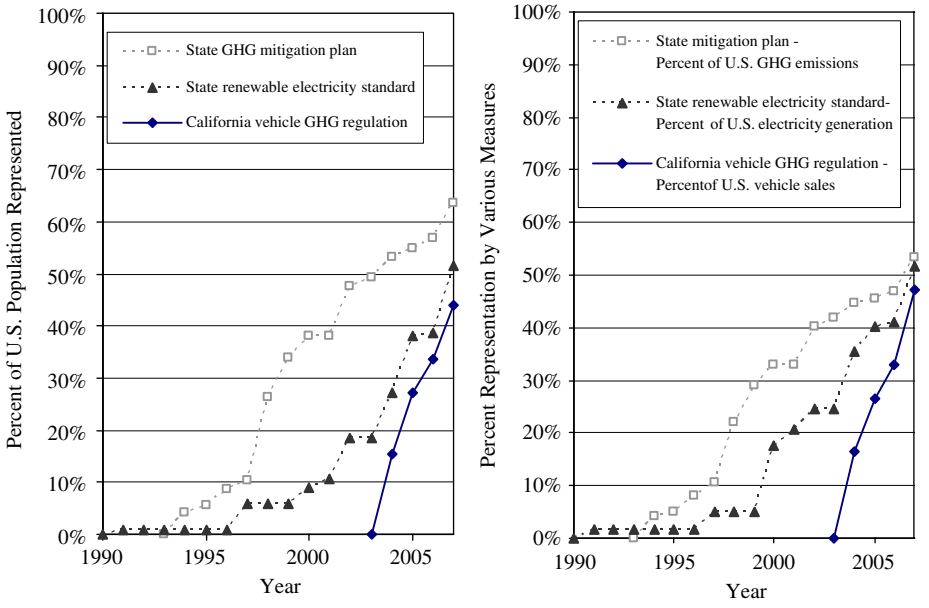

Fig. 2. Trends in US involvement in climate change actions plans, vehicle GHG regulation, renewable electricity standard, 1990–2007.

account of the other (i.e. non-California) states only legally being able to follow California's 2004 regulatory adoption, whereas states have had the ability to adopt renewable electricity targets as they wish since the early 1990s.

Actions to reduce emissions from vehicles, both in the US and globally, historically have originated in California. In 2002, California passed a law to reduce GHG emissions from vehicles, and in 2004 its Air Resources Board promulgated standards that require vehicle makers to reduce average new light-duty vehicle GHG emissions (measured in CO_2-equivalent grams per mile) by 30% by 2016. Implementation is on hold as of mid-2007 as a result of legal challenges and delayed federal approval of a waiver. Since California's 2004 adoption of the regulation, 14 other states have indicated intent to adopt the same rules (CCC, 2007). These 15 states represent 30% of total US GHG emissions, 39% of US motor gasoline usage, and 47% of US light-duty vehicle sales.

California and other states have also adopted an assortment of renewable fuel initiatives that will impact light-duty vehicle GHG emissions. At least 31 states now have mandates and incentives to blend biofuels into their transportation fuels (PCGCC, 2007). These 31 states with biofuel initiatives represent 72% of US GHG emissions and 68% of US motor gasoline usage. The most prominent state actions in this area are Minnesota's 20% ethanol fuel standard for gasoline by 2013 (Minnesota Senate, 2004), Hawaii's alternative fuels standard for 20% renewable content in motor fuel by 2020 (Hawaii, 2006), and California's low-carbon fuel standard to reduce the carbon fuel content of on-road vehicle fuels by 10% by 2020 (California, 2007).

In June 2006, the California Air Resources Board adopted its "low-carbon fuel standard," aggressively championed by Governor Schwarzenegger, and began rulemaking. It is scheduled to take effect in January 2010. Other states are considering it, several leading candidates for the US presidency endorsed it in 2007, the European Union was considering a similar rule, and several bills modeled on the California standard were submitted to the US Congress. This standard is considered here for several reasons: (a) it is a GHG-specific mandate, (b) it has a large effect on GHG reduction, (c) it is a flexible performance target that is relatively attractive to industry because it allows alternative compliance (e.g., corn-based ethanol, cellulosic ethanol, plug-in hybrids), and (d) the California standards have historically been emulated elsewhere.

Estimation of the overall impacts of the state-level mitigation measures for transportation relies heavily on the US Department of Energy's *Transportation Energy Data Book* (Davis and Diegel, 2006). Baseline gasoline and ethanol usage are based on federal motor gasoline receipts (US FHWA, 2006), and baseline data on new light-duty vehicle sales are derived from Polk data (from NADA, 2006).

Scenarios for adoption of California's vehicle and fuel GHG standards by other US states are shown in Table 3. With adoption of the California vehicle regulation by just the 15 interested states, US light-duty vehicle emissions in 2020 would be reduced by 4% from the baseline and 11% of the way toward the sector's 1990 level. If the 31 current biofuel-action states adopted the California low-carbon fuel standard, the effect would be about double that of the 15 vehicle GHG regulation-adopting states. If all of the US states adopted both California's vehicle and fuel programs for GHG mitigation, the US light-duty vehicle sector would experience a 248 million metric ton CO_2e reduction in emissions, or an 18% reduction, from the 2020 baseline.

Fig. 3 shows the trend lines for US light-duty vehicle GHG emissions under varying levels of adoption of the California vehicle GHG regulation and California low-carbon fuel standard. The impact of the vehicle regulation, phased into new vehicles through model year 2016, takes

Table 3
Impact of adoption of California vehicle and fuel GHG standards by other US states on overall US GHG light-duty vehicle emissions

Scenario	Scenario GHG-reduction impact			
	2020 GHG emissions (MMT CO_2e)	2020 GHG reduction (MMT CO_2e)	Percent reduction from baseline	Percent of reductions to meet 1990 emissions level in 2020
US light-duty vehicle baseline (US EIA, 2007)	1408	0	0	0
If 15 US states implement California vehicle GHG standard[a]	1357	51	4	11
If 31 US states implement California low-carbon fuel standard[b]	1311	97	7	21
If all US states implement California vehicle GHG standard	1294	114	8	25
If 15 US states implement CA vehicle standards and 31 US states implement CA fuel standard[a,b]	1264	144	10	32
If all US states implement California low-carbon fuel standard	1262	146	10	32
If all US states implement California vehicle and fuel standards	1160	248	18	55
US 1990 GHG emissions	955	453	32	100

[a]The 15 states that adopted or have expressed interest in adopting California's vehicle GHG regulation (PCGCC, 2007).
[b]The 31 states that have currently adopted biofuel mandates and incentives (PCGCC, 2007).

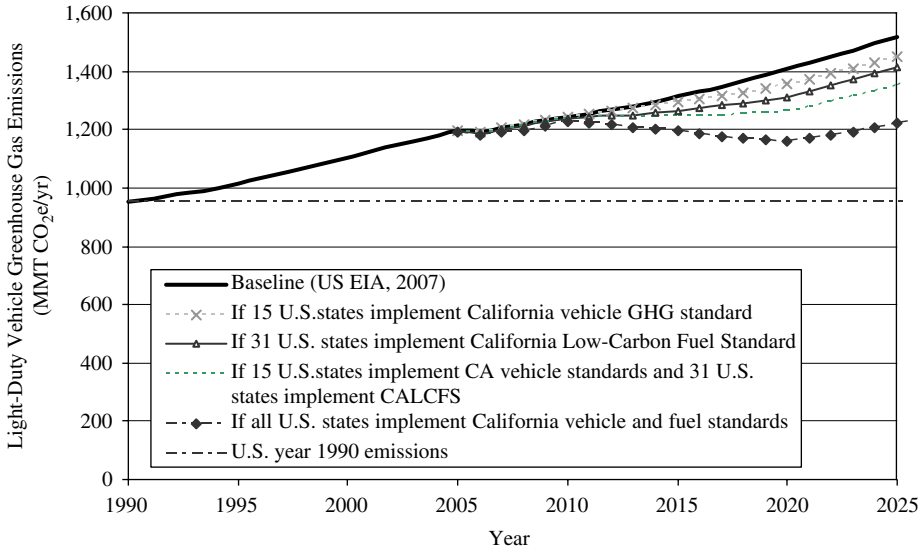

Fig. 3. US light-duty vehicle greenhouse gas emissions with adoption of California vehicle and fuel standards by other US states.

several years after that to impact emissions as older, higher-GHG vehicles gradually retire from the fleet. The low-carbon fuel standard, phased in from 2010 to 2020, has approximately the same effect as the vehicle regulation when fully implemented, if adopted by the same states. Although adoption of the California vehicle standard by the 15 committed states and the fuel standard by the 31 biofuel incentive states have only modest impacts on total US transportation GHG emissions, expanded adoption of these programs yields sizable reductions. If all of the US states adopted both California's vehicle and fuel programs for GHG mitigation, the US light-duty vehicle sector would be 55% of the way from the 2020 baseline to the 1990 level.

A very different but equally effective set of state-level strategies are being undertaken to reduce GHG emissions from the electricity sector. Several states have experimented with power plant regulations for GHG emissions. For example, Massachusetts and New Hampshire have introduced mandated reductions from older plants, while Oregon and Washington implemented regulations for emission levels of new power plant emissions (Ramseur, 2007). In addition, several states have adopted energy efficiency resource standards, which set targets for electricity and natural gas energy savings (Nadel, 2006). The most widespread power sector action is the adoption of renewable electricity portfolio standards, mandates, and goals, now in place in 29 states (plus the District of Columbia). The state renewable electricity programs target increasing amounts of renewable energy to produce electricity.

The states renewable initiatives are diverse (Petersik, 2004). Some states include large conventional hydroelectric power, municipal solid waste, and geothermal electricity generation as acceptable, while others do not. Some mandate particular portions of the renewable electricity from particular sources like solar and wind. Some are voluntary commitments with particular utility companies while some are binding-state mandates. Because of the current popularity of this particular mechanism, representing 52% of US electric sector GHG emissions, 59% of total US GHG emissions, and 59% of US electric power generation, the impact of this measure is investigated for US GHG impacts. The renewable percentage targets range from 2% up to 30% of the states' electricity, and generally have target years between 2015 and 2020. An electricity generation-weighted average of these measures is a 15% renewable portion of these states' electricity by 2017 (not including conventional large hydroelectric power).

To quantify the emissions impacts of the state renewable initiatives, baseline state-by-state electricity characteristics were taken from the US DOE (2006) data tables that quantify electricity by state and by source. Several assumptions are made to estimate the impact of the renewable electricity policies on US electric sector emissions. The fossil fuel-related carbon intensity (GHG emissions per kWh electricity generation) of each state is assumed to improve at the same rate as the national average, based on the US EIA (2007) forecast. New renewable electricity is assumed not to be from large conventional hydroelectricity (per general stipulation of state renewable electricity standards). A wide range of studies (e.g. Norton, 1999; Mann and Spath, 2002; Bergerson, 2005) suggest that renewable electricity from biomass, wind, solar, and hydro plants offer a 90% to greater than 100% reduction in GHG emission rates from baseline non-renewable (i.e. from present mix of fossil fuel and nuclear generation). We assume a 95% GHG reduction from renewable electricity generation, as compared with non-renewable generation. After renewable percentages are entered for given target years for each

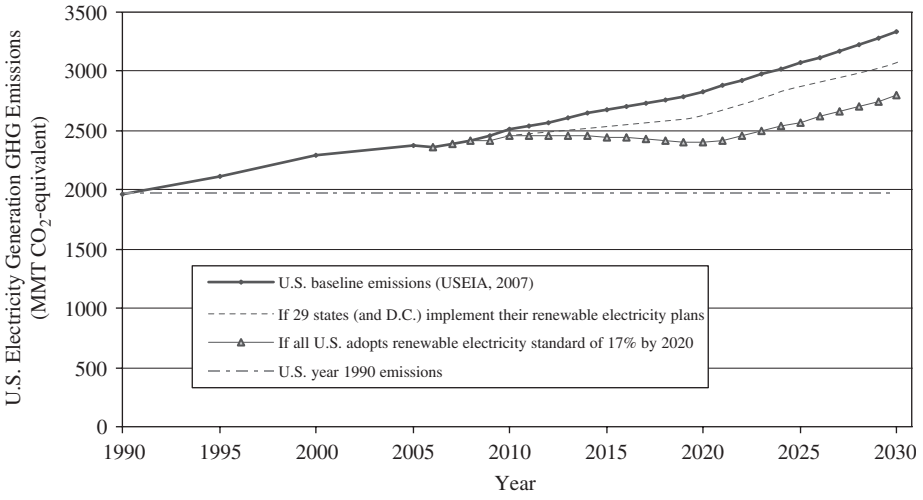

Fig. 4. Impact of state renewable electricity plans on US electricity GHG emissions.

state, the trends from 2006 to the target years are estimated as linear.

Fig. 4 shows the resulting US electric power sector emissions under the baseline, and for 29-state (plus DC) adoption of renewable electricity programs and full 50-state US adoption. Here we follow the general convention applied by states that large hydroelectric is not counted toward the renewable portfolio standards. The combined impact of the state measures is equivalent to a 9% national renewable electricity target in 2020, assuming that large conventional hydroelectric power is not included (this equates to 17% total renewable if large hydroelectric is included in the calculation). The national emission trend is only modestly disrupted by the implementation of the 30 renewable electricity programs, with a 6% reduction in electric sector GHG emissions in 2020. Extending the renewable introduction beyond those 30 programs to the entire US would more than double the emissions impact. If the average 17% renewable electricity standard was adopted across all 50 states (equivalent to 24% renewable electricity if large hydroelectric is included), the impact would reduce baseline 2020 emissions from the electricity sector by 18%. Extending renewable electricity goals to other states has a greater (i.e. non-linear) impact because the states in 2007 that do not have such programs have greater carbon intensities than those states with renewable electricity standards.

3.3. Trends in multi-government climate change coordination

Local and state governments in the US are expanding their multi-government alliances to develop emission-tracking systems and trading systems. As introduced in the literature review, state-level actions are often confounded by lack of policy expertise in these areas and their inability to deal with cross-boundary jurisdictional issues. To address these limitations, hundreds of dispersed city governments have joined together in information-sharing alliances, states are engaging in cross-sector cooperation and developing emissions trading mechanisms to connect and incentivize actions across state lines, and some states are even forging alliances with other countries. This section investigates these multi-government trends.

Table 4 summarizes the scale and coverage of major multi-government climate mitigation alliances in the US. These initiatives are listed chronologically in order of their particular statements or commitments that relate specifically to GHG mitigation. The alliances engage in standardization of emissions inventories and tracking, development of region-specific energy and emissions technologies, and development of emissions trading or cap-and-trade mechanisms to integrate the diverse mitigation programs of the participants. Two important features in these multi-government developments are (1) the mandatory aspect of the cap-and-trade system for participants of the Regional Greenhouse Gas Initiative and (2) the setting of a specific time (i.e. August 2008) for establishment of a multi-sector market-based emissions trading system in the Western Climate Initiative.

The time trend of the US multi-government climate policy cooperation is shown in Fig. 5. Most growth in multi-government coordination has occurred since 2002. Comparing these trends with the very similar trends in Figs. 1 and 2 for state action plans, it would appear that states are becoming increasingly concerned about climate change and are recognizing the importance of allying with other states to coordinate, collaborate, and integrate their emission-reduction initiatives. When including all of the states (and the cities not in those states) that are involved in the six major climate-mitigation coordination efforts, approximately 90% of population and GHG emissions of the US are involved in mid-2007 in actions to coordinate sub-national climate change mitigation.

Table 4
Multi-government climate change coordination involvement in the US

Government partnership	Current US participation (involvement initiation)	Selected climate change coordinating actions	Percent US population	Percent US GHG emissions
New England Governors and Eastern Canadian Premiers[a] (NEG/ECP)	6 states: CT, MA, ME, NH, RI, VT (2001)	Standardize inventories, coordinate reduction plans, create uniform regional registry to form basis for emissions banking and trading	5	3
West Coast Governors' Global Warming Initiative[b] (WCG GWI)	3 states: CA, OR, WA (2003)	Inventory update, protocol establishment, research collaboration, establish a market-based carbon allowance system	16	10
US Mayors' Climate Protection Agreement[c] (US MCPA)	684 cities (2004–2007)	Urge state and federal governments to enact climate policy and establish an emissions trading system	26	23
Regional Greenhouse Gas Initiative[d] (RGGI)	10 states: CT, DE, MA, ME, NH, NJ, NY, RI, VT, MD, also DC and PA observing (2005–2007)	Develop cap-and-trade program for GHG emissions, first for power plants. Accommodate diversity in participant states' programs, later expansion to other sources, states	16	10
Western Governors' Association[e] (WGA)	19 states: AK, AZ, CA, CO, HI, ID, KS, MT, NE, NV, NM, ND, OK, OR, SD, TX, UT, WA, WY (2006)	Coordinate on development of renewable energy, energy efficiency, and carbon sequestration, and support market-based policy to reduce GHGs	34	35
Powering the Plains[f] (PTP)	5 states: IA, MN, ND, SD, WI (2006)	Develop efficiency, renewable energy, and carbon sequestration technologies; develop renewable energy credit-tracking and trading system	5	7
Southwest Climate Change Initiative[g] (SWCI)	2 states: AZ NM (2006)	Collaborate on GHG mitigation strategies, develop consistent forecasting, reporting, and crediting practices	3	2
Western Climate Initiative[h] (WCI)	5 states: AZ, CA, NM, OR, WA (2007)	Establish registry and tracking systems, regional emissions target, and by August 2008, multi-sector market-based system	19	13
The Climate Registry[i] (CR)	40 states (2007)	Collaboration to develop a common system for reporting greenhouse gas emissions	83	73
Total US involvement in multi-government coordination initiatives (through September 2007)			94	89

[a]NEG/ECP (2001).
[b]WCG EC (2004).
[c]US MCPA (2007).
[d]RGGI (2005).
[e]WGA (2006).
[f]GPI (2007).
[g]New Mexico (2006).
[h]WCI (2007).
[i]CR (2007).

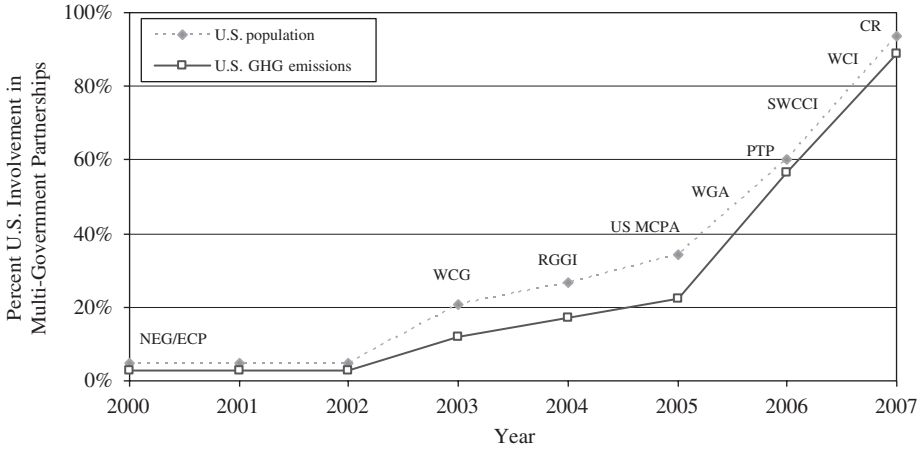

Fig. 5. Trends in US involvement in multi-government cooperation in climate change mitigation.

4. Discussion

The benefits of decentralized sub-national government action can be substantial. There are many circumstances and cases where locally led initiatives are quite compelling. For example, local governments can be more innovative and more responsive to local environmental preferences and economic circumstances. In the case of the US, where the federal government has been reluctant to lead efforts to reduce GHG emissions, efforts by lower-level governments take on added weight. It may make sense for more resource-constrained or less innovative local and state governments to learn from, or emulate, others' actions in a cascading process.

In many cases, however, national initiatives are far more compelling than a patchwork of local initiatives. Vehicle emission standards are a good example, since standardization and mass production leads to lower technology costs. In the case of global pollutants, the case is even more compelling than with local pollutants, where the value and importance of reductions varies greatly depending on the severity of the problem in any particular locale.

The critique that states do not have sufficient leverage on climate change—an example of the well-known "commons" problem in environmental policy—is undermined by the expanding initiatives by lower-level governments in the US. Victor et al. (2005) commented that state-level actions like emission target-setting, which at that time involved 10 states with 14% of US electricity generation, lacked the necessary leverage for serious impacts. Earlier statements such as this did not anticipate the snowball effect now underway or the creative use of a variety of policy levers to effect change. The state renewable electricity standards cover more than half of US electricity generation, and states representing about half of US vehicle sales are poised to adopt the California GHG regulation for vehicles. A pivotal US Supreme Court (2007) ruling opens the door for more state and regional initiatives, including vehicle regulation.

The overall US GHG emissions effect of the state and city emission targets could, if realized, stabilize US emissions at 2010 levels by 2020. The two major sector-specific mitigation efforts, those targeting vehicles and electricity, could put modest dents in national GHG emissions for their sectors with the current level of state involvement—and substantial reductions if extended to the entire US. Although these reductions are nowhere near the deeper longer-term reduction that would be required for climate stabilization, they are nonetheless substantial and significant relative to federal inaction.

Lower-level US governments are learning to avoid the problem of creating a patchwork of diverse regulations for industry. They are accomplishing this by following consistent sets of mitigation actions prescribed by state policy innovators and adopting approaches that do not dictate particular technologies. Government action on climate change mitigation is generally following the steps of establishing an emissions inventory, developing a mitigation action plan, setting an emission reduction target, enacting sector-specific policies, and partnering with other governments to integrate their efforts and leverage their reductions. To accommodate further adoption by other states, principles of flexibility and incentives are being widely adopted. The California vehicle GHG regulation, the California low-carbon fuel standard, and renewable electricity standards are all performance standards that allow individual states (and industries in those states) the flexibility to choose the emission-reduction technologies that suit local circumstances.

The "commons" problem is falling away as more sub-national governments learn to work together. Early pioneering state actors saw themselves as models and leaders to be followed by others. For example, the first state-level emission target-setting, by Vermont, was advanced with a stated objective to demonstrate that "there are things individual Vermonters, the state and the nation can do" (Vermont, 1989). When California was developing its vehicle GHG regulations and later its low-carbon fuel standard, state leaders very deliberately watched and coordinated their efforts with other governments, within and outside the US. The vehicle regulatory report cites the importance of the combined impact of the adoption of similar mitigation measures for vehicles in other US states and other countries (Canada, Japan, and in Europe) (CARB, 2005), and the low-carbon fuel standard was developed through continuing discussion with leaders in other US states and the European Union, which proposed to adopt a standard nearly identical to California's just weeks after California's initial announcement (EU, 2007; California, 2007).

The tacit agreements between individual states are steadily giving way to formalized agreements between sub-national US governments. The US partnerships of western states, mid-western plains states, northeastern states, and cities across the map now represent over 80% of the US population and GHG emissions. These partnerships bind their climate-mitigation efforts with coordinated research into mitigation technologies, work toward consistent emissions inventory protocols, and seek to ultimately merge those emission-reduction sub-markets. This trend toward committed partnerships, often involving emissions trading, offers the prospect of overcoming cross-boundary jurisdiction issues (e.g. electricity generated in one state is consumed in another), and also cross-sectoral issues (e.g. farm-grown ethanol blended in gasoline in other states).

Furthermore, US multi-government initiatives are even creating bridges with countries *outside* the US. New Jersey and the Netherlands signed a letter of intent to develop joint mitigation initiatives and establish a framework for a crediting and trading system for GHG emissions (New Jersey, 1998). The US states and Canadian provinces are forming alliances to permit emissions trading between electricity plants and perhaps other sectors (WCI, 2007; RGGI, 2007; NEG/ECP, 2001). California and Canada

policy-makers had numerous discussions on the stringency and consistency of their vehicle GHG programs as they both broke from federal US vehicle emissions policy (NRCan, 2005; CARB, 2004). The agreement between the governments of California and the United Kingdom to collaborate on climate change mitigation even aspires to work with other countries like China and India for further reductions outside their borders (California, 2006). While these agreements and discussions may be hampered or even stopped by constitutionality questions, these pacts between US state governments and foreign governments challenge the conventional wisdom that state-level action is incompatible with international involvement, and at a minimum facilitate later agreements between the national governments.

In the end, though, the fact remains that about half the US states have not yet meaningfully engaged in climate change mitigation. The implications of this uneven environmental performance are uncertain. In some cases, as with renewable electricity targets, national rules are not critical and may even be undesirable. For example, setting renewable electricity standards and their allowable criteria may very well depend on each state's particular available resources. In other cases, as with vehicle emissions, it is desirable to develop a single approach in dealing with automakers. Given that GHGs are a global concern and that the cost of mitigation can vary dramatically across regions and industries, it is important that local and state governments gain more experience and expertise. At some point they will likely be confronted with national initiatives. Some states, such as California, will be well prepared, as will some companies and industries (and may even resist being subsumed into national initiatives). Others will not be well prepared. The surge in local and state activity will play a crucial role in the formation of multi-government compacts to develop emissions trading systems across sectors and political jurisdictions.

5. Conclusions

US climate change policy is far more complex and rich than what is commonly thought. A wide variety of sub-national initiatives are underway. Many are leading to direct and significant emission reductions. Others are setting the stage for future incentives and enforceable policies and rules.

Out of the soup is emerging a consistent US policy structure. States (and cities) inventory their emissions, investigate GHG mitigation action plans, and commit to future emission reductions. These governments then choose from a menu of available policy alternatives, such as vehicle GHG standards, fuel standards, appliance efficiency standards, and renewable electricity portfolio standards, and innovate with particular policy instruments that are tailored to their specific locale. State governments cooperate and coordinate their actions via multi-state regional initiatives, which appear to be on the way to eventually establishing emission-trading markets. These actions are beginning to add up to a sizable portion of US population and GHG emissions and substantial potential GHG emission reductions.

The commitments of lower governments on climate action are steadily amounting to substantial emission-reduction commitments. Sub-national US mitigation efforts represent engagement by 43–89% of the affected populations and responsible parties—including 53% coverage of GHG emissions by state climate change mitigation action plans; 43% coverage of emission sources by state or city emission-reduction targets; 58% coverage of US electricity production by state renewable electricity standards; 47% coverage of US vehicle sales by state vehicle GHG regulations; and 89% coverage of US GHG emissions by multi-government partnerships supporting the establishment of GHG market mechanisms. If the 17 states that have set their own GHG emission-reduction targets (generally to 1990 levels by the year 2020) in fact were to achieve those targets, nationwide US GHG emissions would be stabilized at 2010 levels by 2020—without any serious mitigation action taken by over half the states.

Governments have largely overcome the "commons" problem in dealing with climate change, with a broad range of effective state- and city-level policy mechanisms being put in place. They are gaining much experience about what works, how to leverage each others efforts, and how to link across jurisdictions and sectors.

Of course, governments (and industry) are still at the bottom of the learning curve, though now perceptibly moving up that curve. Even so, these efforts should not be overstated. The adoption and pursuit of targets, goals, and potential reductions should not be confused with actual mitigation performance, and what has been accomplished still falls far short of the much deeper longer-term cuts that will be needed for global climate stabilization. Moreover, even the best intentions of multiple multi-government partnerships developing consistent emission-tracking systems does not ensure that a cross-jurisdiction and cross-sectoral emissions trading mechanism will come to fruition anytime soon, never mind function well.

What is clear, though, is that lower-level government policy structure need not preclude, and can certainly advance, federal policy in the area of climate change. Broad efforts of states and cities are so pervasive at this point that future federal policy will benefit by adopting the most popular and best functioning GHG mitigation programs and by coordinating the many existing initiatives. Whether and how nationwide and worldwide emissions markets evolve remains highly uncertain. All this experimentation may well result in an assortment of diverse markets and policies, though founded on common metrics and protocol. That may turn out to be the best approach of all. We will see.

Acknowledgments

The authors are grateful for funding from the University of California, Davis Sustainable Transportation Center,

established through a University Transportation Centers Program grant of the US Department of Transportation and the California Department of Transportation. The authors appreciate the critical feedback from anonymous peer reviewers.

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