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Harnessing the opportunities and understanding the limits of state level climate action plans in the United States

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1. Introduction

Climate change is one of the most daunting global problems of our time requiring innovative responses to its causes and consequences. As the world's second-largest emitter of greenhouse gases (GHGs), the United States plays an integral role in global climate action planning. Nevertheless, a strong and consistent federal level climate leadership has been lacking in the U.S., and international agreements have proven hard to reach. Yet, the long absence of federal leadership along with growing public awareness of the reality of the problem created a fertile ground for subnational level (i.e. state, regional, municipal, and community) climate action planning in the United States. In this arena, US states played an integral role. To date, 34 states have adopted climate action plans (CAPs). Climate action plans typically involve an inventory of GHGs from various sectors (e.g. transportation and land-use; energy supply; energy demand in residential, commercial and industrial buildings; agriculture, forestry and waste) as well as strategies to mitigate these emissions. The main question that this paper addresses is: Does state-level climate action in the United States have the potential to reduce carbon emissions significantly? This question was examined by assessing the relationships between CAPs, emissions reduction targets, plan implementation and emissions mitigation.

Empirically speaking, many of the state governments along with their local municipalities have been ready to lead climate action in the United States due to the decentralization of environmental policy resources and regulatory authority from the federal government in the past several decades. In fact, the vast majority of state governments have undergone fundamental changes ever since the first Earth Day in 1970, before which states were deemed “sufficiently lethargic” to require federal level supervision in many of the environmental policy areas (Rabe, 2013). By the 1980s, several states were identified as rising environmental leaders (Bowman & Kearney, 1986; Kane & Anzovin, 1989; Van Horn, 1989). Rabe (2013) documented at least three reasons supported by the literature why commitment to stronger environmental policy may be expanded and accelerated at the state and by extension city levels: 1) broad public concern on environmental issues provides significant momentum for bottom-up policy intervention; 2) the proliferation of environmental professionals, representing industry, advocacy groups, foundations and ultimately state and local agencies provides a considerable base of talent and a fertile ground for policy entrepreneurship; and 3) environmental policy at the state level can be stimulated by direct democracy not possible at the federal level, including promoting initiatives, referendums, and the recall of elected officials.

The majority of state-based initiatives in the United States originated from state climate action plans (CAPs) developed in mid-to-late 1990s (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Wheeler, 2008). During these years, The U.S. Environmental protection Agency made grants available to state governments to prepare an inventory of their GHG emissions and develop emissions mitigation plans (Wheeler, 2008). Although the motivations behind taking action and the focus of CAP strategies varied from state to state, policies targeting alternative fuel fleets (i.e. vehicles utilizing alternative fuels, such as natural gas, methanol or electricity and/or energy efficiency technologies, such as hybrid technology), public transportation, climate-neutral land-use, energy efficiency and renewable energy, waste management and recycling were widespread (Byrne et al., 2007). The state level efforts were accompanied by city level initiatives to mitigate GHG emissions primarily orchestrated by the International Council on Local Environmental Initiatives (ICLEI-Local Governments for Sustainability). Under its Cities for Climate Protection Campaign initiated in 1993, ICLEI shaped the most extensive city level network by providing technical assistance to over 1000 local jurisdictions worldwide and > 200 cities, towns and regional entities in the United States (ICLEI USA, 2019).

It is important to note that despite the conventional propensity within literatures of environmental politics to examine levels of decision-making “as if they were independent” (Adger et al., 2003, p. 1101), ‘global,’ ‘national,’ ‘state,’ ‘regional,’ and ‘city’ environmental policy is not crafted in isolation. There is little questioning of the notion of “nested and discrete scales of political authority over the environment” (Bulkeley & Betsill, 2005, p. 43). Yet, in the case of climate action planning in the United States, analysis of state level actions is achievable and appropriate for several reasons. First, given the federal government's long delay and inconsistent action to address climate change at the national level, state level actions provide most of the information about the successes and failures of various policy

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approaches within the United States. Second, states are the lowest geographical level for which carefully collected and fully comparable energy data is available from the US Energy Information Administration (EIA). Third, due to similar legal authority, the range of potential policy options to mitigate GHG emissions is comparable for all states. Fourth, individual states have selected to develop and implement various types of climate action plans or take no action at all creating an opportunity to compare and contrast these different levels or types of actions. Additionally, several states have reached across borders to collaborate in efforts addressing climate change by creating multi-state initiatives (some with Canadian provinces), and these initiatives are expected to make efforts more effective and efficient by eliminating duplicative processes and providing predictable rules. Lastly, understanding the effectiveness and limitations of state level action is crucial for determining the role of cities and metropolitan regions as well as the federal government in climate action.

This paper is the first evaluation of the current generation of state level CAPs that focuses on implementation and actual reductions in carbon emissions. By focusing on CAP implementation, this evaluation can also provide lessons for subnational entities, such as cities, regional governments and states, about implementing such plans and policies. Wheeler (2008) systematically reviewed the first generation of state-level CAPs in terms of their goals, their basic strength and weaknesses, included or left out measures, and ultimately issues and problems likely to impact implementation. Yet, Wheeler's study did not assess the relationship between CAPs and actual GHG emissions reductions. Drummond (2010) compared states with and without CAPs, asking the question of whether or not these plans have been successful in reducing GHG emissions significantly. While Drummond (2010) identified some of the elements within CAPs that are associated with the greatest reductions, the author did not assess the relationship between implementation and GHG emissions mitigation. Drummond (2010) also focused on carbon energy emissions generated for use in the residential, commercial, and transportation sectors, and excluded the industrial sector of the economy—which is among the most controversial. The scholarly literature does not provide an assessment of possible relationships between variations in climate action plans across the nation, implementation of state CAPs and their effectiveness in reducing GHG emissions, which is one of the goals of this paper.

This paper is part of a two-pronged evaluation of state CAPs with two major components: 1) an assessment of CAP implementation and GHG mitigation potential through a content analysis of plan documents and available information about planning processes; and 2) a panel regression model depicting and assessing the relationships between CAP types based on the stringency of targets, rigor of implementation, and reductions in energy related carbon dioxide emissions from all end-use sectors (i.e. transportation, residential, commercial, industrial, and electric power). The general hypothesis that this phase sets out to investigate is: CAPs result in carbon emissions mitigation beyond the trend.

2. Research methods

2.1. Phase 1: content analysis of state-level climate action plans

The goal of this phase was to systematically assess implementation and GHG emissions mitigation potential of state-level CAPs through a content analysis of plans and publically available information about planning and implementation processes on state websites. The U.S. Environmental Protection Agency (EPA) provided a link to all state level CAPs that were reviewed in this study. Broadly speaking, the content analysis involved four major themes: 1) general information about the CAP and its development and adoption processes; 2) CAP GHG emissions mitigation potential claimed to be achievable through its goals, array of policies, mitigation targets, and adherence to any regional initiative; 3) implementation provisions or conditions that have been suggested by the literature to be linked to successful implementation, such as identification of funding sources and agencies responsible for implementation; and 4) implementation mechanisms, such as voluntary programs, financial incentives, carbon tax or cap-and-trade, recommended and employed by the CAP to reach goals and/or targets.

The CAP evaluation framework used for this study was developed in three steps:

1) A preliminary evaluation framework was derived from the literature on plan and policy evaluation and principles of subnational climate action planning. A major part of evaluation methodology focuses on developing general guidelines for evaluation, such as questions, criteria, and indicators of implementation. Surely, in any given situation, evaluation questions, criteria and implications depend on the type of plan, its intentions and timing and purpose of evaluation. Yet, the plan and policy evaluation literature provides a theoretical foundation for developing an appropriate evaluation protocol. For example, Baer (1997) and Berke and Godschalk (2009) proposed lists of criteria that can be used for plan evaluation. These lists include various criteria assessing plan processes, fact base, goal setting, policy scope, implementation and monitoring. For evaluating local CAPs, Bassett and Shandas (2010) stressed the importance of assessing the "depth" of policy actions (i.e. how fully developed, justified, and operationalized each of the plan's proposed policies or actions are) by considering measurable emission reduction targets, identification of actors responsible for implementation and funding sources.
2) The preliminary framework was then validated and improved through three in-depth interviews with climate action planning experts. The semi-structured expert interviews focused on CAP components, characteristics and qualities, processes, signs of implementation success, the usefulness of various implementation mechanisms such as cap-and-trade, carbon tax and voluntary agreements, and common challenges and opportunities involved in implementation. Two open- ended questions provided an opportunity for interviewees to describe their involvement in subnational CAP processes and share other information about CAPs, their implementation and evaluation beyond the specific questions asked. Interviewees were also provided with the preliminary protocol to assess its appropriateness and adequacy.
3) The revised protocol was tested and refined through double coding four plans in two stages—double-coding two plans to test the reliability of the coding instrument and making necessary changes for the clarity of questions; immediately followed by double-coding two additional plans to assure consistency in coding throughout the coding process. After double-coding the first two CAPs, we adjusted the questions for clarification, added explanations for the coders, deleted or modified the questions/sub-questions that could not be answered coherently using information provided in CAP documents, and provided more flexibility by adding answer choices or space for additional explanations—especially when one of the coders could not easily choose among the provided options or there was a clear disagreement between the coders about the answers. Once we revised and improved the CAP assessment protocol, we double-coded two additional plans. The level of agreement between the coders improved significantly after content-analyzing the first two CAPs both due to the improvements made to the protocol and agreements on certain coding procedures (e.g. choosing the answer based on the most current information in case of a disagreement between various CAP documents and explaining the discrepancy in the space provided). Once we independently completed the content analysis of the third and fourth CAPs and compared our results, we found that we agreed on all answers.

The finalized CAP evaluation framework includes four major

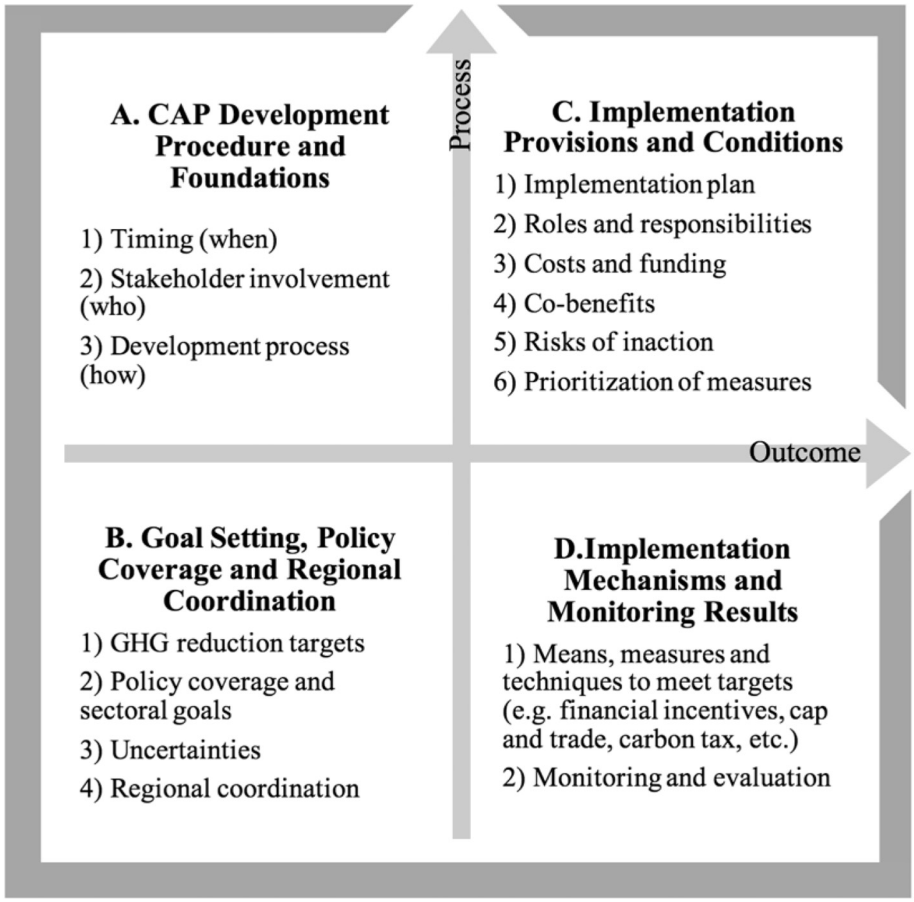

Fig. 1. CAP Evaluation Framework

elements as discussed below and presented in Fig. 1.

A. CAP development procedure and foundations

The first element focuses on three main qualities of the planning process: 1) timing (when): when was the plan developed, adopted and updated; 2) stakeholder involvement (who): a) what agencies and organizations were engaged in the development of the CAP?, b) what entities provided leadership, facilitation, funding and technical support, and c) procedures through which input was received from entities representing government, industry, nongovernmental organizations, academia and the public; and 3) development process (how): what techniques were used to develop a plan and select specific policy recommendations.

B. Goal setting, policy coverage and regional coordination

The second element deals with four key dimensions of CAPs: 1) targets: what are the nearest-term, intermediate and ultimate targets; 2) policy coverage and sectoral goals: what emission sectors have been considered, and what goals have been set for each sector; 3) uncertainties: whether uncertainties in Business as Usual (BAU) emissions and impacts of policies have been considered, and what measures or analyses have been used to take uncertainties into account; and 4) regional coordination: which of the multi-state climate initiatives (if any) has the state participated in.

C. Implementation provisions and conditions

The third element assesses conditions linked to implementation success, according to the evaluation literature. These provisions and conditions are: 1) implementation plan; 2) roles and responsibilities; 3) funding and cost of policy measures; 4) specification and analysis of externalities or co-benefits of each action or the entire CAP; 5) identification and analysis of risks of inaction; and 6) selection and prioritization of policy measures.

D. Implementation mechanisms and monitoring results

The final element of the CAP evaluation framework is implementation mechanisms recommended or employed by the CAP to reach its goals and targets. In contrast to the previous element that solely relies on the content of the CAP to assess its implementation potential, this step also includes an analysis of other available evidence regarding the implementation of the plan. More specifically, evidence of CAP implementation or the lack thereof was found through searching the websites of governmental agencies or other organizations and entities that have either developed or published the CAP or are identified in the CAP as the responsible entity for implementation. This information was then crosschecked with state-specific data available through U.S. EPA, Center for Climate and Energy Solutions (C2ES) and the Center for Climate Strategies websites.

Implementation is defined as specific commitments made by the state to carry out policy actions recommended by the CAP, such as legislation to mitigate climate change. Implementation mechanisms are means, measures and techniques through which the state plans to reach CAP targets or goals. These include: voluntary and negotiated agreements; technical assistance, financial incentives; targeted spending (e.g., on public transportation); codes and standards; cap and trade; carbon tax; pilots and demos; information, education and outreach; research and development; emissions reporting and disclosure; and any hybrid combination of these mechanisms. In addition to implementation evidence, this step includes examining methods used to monitor and evaluate CAP implementation, such as progress reports, and plan and emissions inventory updates.

Once I completed the CAP evaluation form for each state, I then organized the collected data into four tables corresponding to the four elements of CAP evaluation framework described above. The analysis of these tables revealed that while state CAPs vary in the details of their processes, components and characteristics, they can be classified into six major types based on their targets and implementation. The findings section explains in detail what these CAP types are. These 6 types were not predefined; instead, they emerged from the analysis of collected qualitative data. The CAP types were used as an input to the regression model of the second phase to assess the potential impacts of targets and implementation on emissions reductions. There were several reasons to focus on these two variables. First, there is a gap in the literature about the relationship between targets, implementation and emissions mitigation. Second, the plan evaluation literature stresses the importance of goal-setting (i.e. targets) and implementation (see, for example, Baer, 1997; and Berke & Godschalk, 2009). Third, interviews with experts in the field indicated that targets are important as they serve as "the starting point," "the vision," "a motivational factor," "guide to achieving the objectives" and "[a] link between scientific [mitigation] requirements and planning." Implementation, on the other hand, is "extremely" important according to the experts interviewed because "the plan is not the end goal, but a way to actually achieve the emissions reductions," and "[implementation is] the area that almost every place falls down on." Finally, comparing targets and implementation is realistically achievable, whereas details about the CAPs (e.g. the specific combination of policy packages) and planning processes (e.g. rigor of stakeholder engagement) cannot be practically reduced to simplified yet valid categories.

2.2. Phase 2: state-level CAPs and energy-related carbon dioxide emissions

The second phase builds upon the data and analysis of the first phase. After assigning each state a CAP type based on the rigor of targets and stringency of implementation, I used a panel regression model to isolate and assess the impact of state level CAPs on carbon emissions. The regression coefficients, if statistically significant, show a reduction in per capita energy-related CO_2 emissions, holding all other variables constant. The specific regression model that I have used is random-effects Generalized Least Squares (GLS) regression model for panel (time-series) data. This model is appropriate when there is reason to believe that differences across entities have some influence on the dependent variable. Random-effects GLS model is suitable in this case because specific characteristics of states are most likely related to their energy-related CO_2 emissions. Another advantage of this model is that one can include time-invariant variables, such as geographic location.

The panel regression model includes 48 continental states and years 1990 to 2013, yielding a dataset of 1104 observations. I excluded Alaska, Hawaii and Washington, DC due to lack of data for a number of independent variables and uniqueness of circumstances of these entities. Year 1990 was selected because it is the most common baseline year adopted by state level CAPs. This is because the Kyoto Protocol used 1990 as its base year, and because most states adopted the Kyoto goal or its revised versions, they also picked 1990 as their baseline year (Wheeler, 2008). Table 1 lists the dependent and independent variables as well as variable explanations, expected sign of regression, and data sources.

The dependent variable measure is derived from EIA State Energy Data System (SEDS) that is annual time-series data extending back to 1960. Emission estimates are based on energy consumption data from EIA's State Energy Consumption, Price, and Expenditure Estimates (SEDS). The dataset includes energy-related emissions for five energy-use sectors (i.e. transportation, residential, commercial, industrial, and electric power) and emissions from all sectors combined.

Several changes were made to the combined emissions to develop an appropriate dependent variable. First, I divided emissions by population to obtain per capita emissions. By doing so, I normalized emissions between small and large states and controlled for possible effect of population increase or decrease (e.g. in-migration vs. out-migration) on emissions. Second, I calculated change in emissions as a measure of progress towards emissions reductions. The change was calculated compared to most popular baseline year emissions (i.e. year 1990) because the baseline year is what plans compare their progress with. Furthermore, this controls for the effect of historic dependency on coal for producing electricity (coal-fired power plants). If I were to use emissions as opposed to change in emissions, I would have to control for differences in initial energy endowments (e.g. coal-fired power plants, hydroelectric power, and nuclear power).

The model involves a number of independent variables to explain part of changes in emissions. Potential impacts of CAPs, their targets and implementation on emission changes are the specific focus of this paper. I treated state level CAPs–categorized into 6 types–as a nominal variable. Thus, the model compares each category to a No-CAP alternative. I assigned the appropriate CAP category to each state the year the plan was adopted. Thus, the model also compares each state before and after the adoption of the CAP.

Another independent variable that is particularly important for cities and regions is urban compactness as opposed to sprawled development. There is considerable evidence in the literature that sprawl is linked to higher levels of emissions when compared to a more compact development pattern (see for example, Ewing, Bartholomew, Winkelman, & Walters, 2008, pp. 107–111; Ewing & Rong, 2008; Glaeser & Kahn, 2008; and Randolph & Masters, 2008, among others). The compactness variable is derived from a multi-factor sprawl index published by the Metropolitan Research Center at the University of Utah in April 2014 and later in the year by Smart Growth America. This research is an update and refinement of a sprawl measure released in 2002. Using the refined method of 2014, sprawl indices are calculated for years 2000 and 2010. The average compactness score is 100, and greater values indicate that an area is more compact. I used the county-level sprawl indices to compute average state-level compactness for years 2000 and 2010. I interpolated sprawl indices for the missing years. Because sprawl indices changed slightly between 2000 and 2010 (with the same most compact, most sprawled or average areas in both years), linear interpolation is an appropriate method.

It is also important to control for other variables that can potentially be correlated with the dependent variable, and thus, can provide a plausible alternative explanation for reductions in emissions. Change in energy prices, unemployment, income, and industrial mix are the most important of these variables. The logic behind including these variables comes from the potential relationship between the economy and changes in emissions. Explanation of these variables is provided in Table 1, but two of them require further clarification. Following Drummond (2010) I used change in regional energy prices as opposed to state-level energy prices because change in energy prices is one of the major effects of CAP implementation. If I were to use change in state-level energy prices, this could have dramatically underestimated the impact of the CAPs. One limitation of this method, however, is the potential autocorrelation problem. I controlled this effect by adding the regions–where the states were assigned to in the regional consumer energy prices dataset–to the model. Regions are also considered geographic variables, and therefore also control for the potential relationship between location and emission changes.

Change in industrial mix is another variable that can potentially impact emission changes. For example, a shift in industrial output from energy- or carbon-intensive products (e.g. steel) to low-energy products (e.g. computer equipment) can result in emissions reductions. It is very difficult, if not impossible, to track industries within states to know whether a switch in industrial output is responsible for emissions changes. However, it is possible to measure the dependency of a state's

Table 1
Variables.

Variable	Explanation	Expected sign of regression coefficient	Source & date downloaded
Change in emissions per million persons (DV)	Energy CO_2 emissions for current year minus same for 1990	Not applicable	U.S. Energy Information Administration
Climate action planning (CAP types)	Categorical variable for state climate action planning efforts	Negative, since climate action planning is meant to reduce emissions through a wide array of policy options and increasing awareness	U.S. Environmental Protection Agency (EPA) list of states with CAPs; and Data collected through Phase 1 of this study
Change in unemployment rate	Unemployment rate (%) for current year minus same for previous year	Negative, due to decreased economic activity, and by extension, emissions	Bureau of Labor Statistics (BLS)
Change in per capita income	Per capita income for current year minus same for previous year	Positive, since states with higher income tend to consume more energy	Bureau of Economic Analysis (BEA)
Change in regional energy prices	Change in regional energy prices for current year minus same for previous year	Negative, since higher prices reduce consumption	Bureau of Labor Statistics. Consumer price indices program.
Democratic presidential vote %	% of vote for Democratic presidential candidate in nearest election	Negative, since states with higher percentage of democratic vote tend to be more concerned about the environment	Presidential Elections Data extracted from UC Santa Barbara's The American Presidency Project
Heating degree days (HDDs)	Annual heating degree days weighted by population as a measure of heating energy demand	Positive, since greater number of HDDs means greater demand for energy	National Climatic Data Center
Cooling degree days (CDDs)	Annual heating degree days weighted by population as a measure of cooling energy demand	Positive, since greater number of CDDs means greater demand for energy	National Climatic Data Center
Change in percent GDP from carbon-intensive manufacturing industries	GDP from carbon-intensive manufacturing divided by the size of the economy for current year minus same for previous year	Positive, since states with larger share of carbon-intensive industries relative to the size of their economy tend to consume more energy	Bureau of Economic Analysis (BEA) NAICS
Change in percent GDP from carbon-intensive non-manufacturing industries	GDP from carbon-intensive manufacturing divided by the size of the economy for current year minus same for previous year	Positive, since states with larger share of carbon-intensive industries relative to the size of their economy tend to consume more energy	Bureau of Economic Analysis (BEA) NAICS
Compactness index	State level average compactness calculated from county level composite sprawl score that considers density, land use, activity centering and street connectivity	Negative, since urban compactness reduces VMT and thus transportation emissions	Smart Growth America Measuring Sprawl 2014
Interstate energy trades	Controls for the effect of interstate electricity trades by creating a credit for electricity exporting states and debit for importing states	Positive, since energy exporting states emit carbon for producing electricity	U.S. EIA
Regions	Regions as defined by BLS consumer energy price indices	–	Bureau of Labor Statistics (BLS)

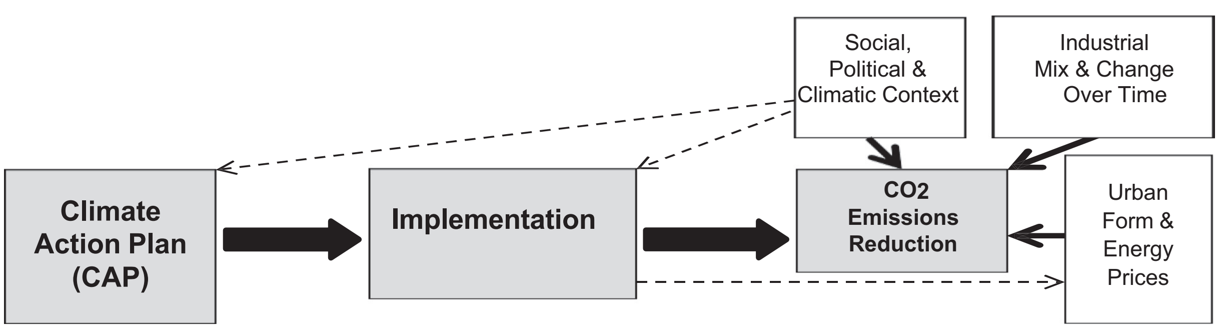

Fig. 2. Conceptual model.

economy on carbon-intensive industries and its changes over time. To control for potential effects of industrial mix changes, I calculated change in percent Gross Domestic Product (GDP) from carbon intensive industries. I included two variables related to change in industrial mix in my model: change in percent GDP from carbon-intensive manufacturing and non-manufacturing industries. Generally, carbon intensive industries emit large amounts of GHGs per unit of good produced, and their energy costs are a large portion of their total costs (Zabin, Buffa, & Scholl, 2009). According to the most recent U.S. EPA inventory of GHGs, which is based on an analysis of EIA energy consumption data, several industrial activities consume a lot of energy and emit large amounts of GHGs. Within manufacturing activities, the most carbon-intensive industries are: Petroleum refineries; primary metals (e.g. iron, steel, and aluminum); chemicals; pulp and paper; non-metallic mineral products (e.g. cement and glass); and food (EPA 430-R-15-004, 2015; Zabin et al., 2009). Among non-manufacturing industries, construction, mining, and agriculture are considered energy and carbon-intensive (EPA 430-R-15-004, 2015).

In my models, I also included two climatic variables: heating degree days and cooling degree days that show heating or cooling fuel demand on a state-wide basis. The logic behind including these two variables is that greater number of heating or cooling degree days result in greater demand for energy consumption.

Lastly, I controlled for the effect of interstate electricity trade using U.S. EIA data. In most states, electric power generation is the largest source of CO_2 emissions from fossil fuel combustion. Because some states are net exporters of electricity and others are net importers of electricity, it is important to control for interstate electricity trade for a fair evaluation.

Fig. 2 offers a conceptual model showing the possible relationships between the independent variables explained above and change in per capita CO_2 emissions. The *direct* way that CAPs can result in carbon emissions reduction is through implementation of CAP policies and measures. Yet, there are a number of *indirect* ways that CAPs can lead to reductions in carbon emissions. For example, state level CAP development processes might inspire city level action that can further reduce emissions.

3. Findings and discussion

3.1. Phase I findings

3.1.1. CAP types

Broadly speaking, there are two major types of CAPs based on targets: 1) CAPs that set a GHG emissions reduction target—often following an executive order from state governor that sets such targets or appoints a climate change sub-cabinet or advisory group to do so; and 2) CAPs that do not set any emissions reduction target. The vast majority of state level CAPs (30 out of 32) set at least one target for GHG emissions reduction within their jurisdiction; however, sometimes the targets are tied to multi-state climate change planning commitments. For example, the states that partnered in The Western Climate Initiative (WCI), Midwest Greenhouse Gas Reduction Accord (MGGRA) and Pacific Coast Collaborative (PCC), to name a few, agreed to collectively set a regional emissions target. This resolution is either based on targets originally established by participating states or otherwise are reflected in state level plans, with states proposing to either meet or exceed the regional target. Several states have also chosen to join such multi-state initiatives as observers. Observer states often set matching or comparable reduction targets, but normally do not commit to the implementation mechanism set by the regional initiative—such as a regional cap-and-trade program.

State CAPs have set targets that may be single-step, two-step or multiple-step. Typically, CAPs with two- or multiple-step targets set a long-term goal to be reached by 2050 with a midterm target to be achieved by 2020 or 2025.2050 marks the middle of the century; it is a date often used—in addition to the end of century mark–in scientific scenario analyses to illustrate the impacts of climate change and/or define necessary reductions to possibly avoid the most catastrophic impacts. A number of states also set interim target(s)—to help them make progress towards the midterm target. For example, New Hampshire sets a midterm goal of reducing emissions 20% below 1990 levels by 2025 and specifies five interim targets to reach the 2025 goal. Following the Kyoto Protocol, the most common baseline year is 1990 for state level CAPs, with some states setting emissions of the year 2000, 2005 and 2006 as their baseline. Thus, the first step commonly involves either going back to 1990 emissions levels or lower than that (e.g. 5%, 10% or 20% lower).

I define long-term ambitious target as: aiming at or close to scientific requirements for emission reductions in the United States by midcentury as interpreted by the CAPs. It is important to note that scientific requirements vary based on different targets for stabilization of atmospheric GHG concentrations. In other words, emission allowances for all industrialized nations (including the U.S.) are different for various GHG concentration levels. Therefore, scientists have developed several scenarios for stabilization levels and mitigation requirements. Gupta et al.'s (2007) systematic analysis of the literature suggests that under low and medium stabilization levels, developed nations would need to cut their emissions substantially (i.e. 40% to 95% below 1990 levels), even if developing nations achieve significant reductions. Nonetheless, virtually all states with an ambitious target have interpreted scientific requirements for emission reductions as approximately 75% to 85% below 1990 levels in the long run (around 2050).

A short-term target (e.g. 2020), on the other hand, does not meet the requirements of a long-term ambitious target. A short-term target does not preclude a state from adopting rigorous policy measures or developing an ambitious target in the future. Yet, in and of itself a short-term target is insufficient to guide the state emissions reduction efforts in the long run to meet the scientific requirements. In other words, a short-term target lacks a long-term vision. Additionally, since state level short-term targets tend to be low (as opposed to ambitious targets based on scientific requirements), having a short-term target only can imply elimination of rigorous policy options from consideration. For instance, South Carolina set a target to reduce emissions to 5% below 1990 levels by 2020; no long-term goal was set.

In addition to the targets, CAPs differ in terms of the stringency of their implementation. I classified a CAP in the “strong evidence of rigorous implementation” group if: there is stringent state level legislation governing the implementation of the CAP with lead or other responsible agencies identified and clear monitoring and evaluation mechanism, or otherwise, there is evidence of extensive programmatic interventions with progress towards goals clearly documented in some type of a progress report, implementation plan, updated inventory or online tool. I classified a CAP in the “some evidence of implementation” group if: there is some evidence of early actions or programmatic interventions; yet, there is evidence of stopped funding, discontinued or sporadic climate council or advisory group meetings or documents clearly showing that the state is not on track to reach its goals although some programs have been implemented. I classified a CAP in the “no or limited implementation” group if: I found no evidence of implementation whatsoever, insufficient evidence of implementation, or evidence of lack of implementation—meaning that it is clearly stated on the relevant state agency website that the state has stopped the CAP process after its adoption. I considered evidence of implementation insufficient if: there were either very limited information provided and/or I found a few programs that seemed relevant but these were not tied to the CAP or its other documents whatsoever. Considering the type of CAP targets and the rigor of their implementation, plans can be broadly categorized into 6 groups described above and illustrated in Table 2.

3.1.2. Limitations and opportunities for improving CAPs

3.1.2.1. Near-term targets are low and CAPs rely on major technological

Table 2
A summary of CAP types.

CAP type	Key identifiers		States with a CAP (total analyzed: 32)
	Target(s)	Implementation	
Type 1	No target	No or limited evidence of implementation	4 CAPs: Missouri, Nevada, Ohio, Utah
Type 2	A short-term target only	No or limited evidence of implementation	5 CAPs: Arkansas, Illinois, Kentucky, North Carolina, South Carolina
Type 3	A long-term ambitious target	No or limited evidence of implementation	5 CAPs: Arizona, Iowa, Montana, New Mexico, Wisconsin
Type 4	A short-term target only	Evidence of some implementation	3 CAPs: Florida, Pennsylvania and Virginia
Type 5	A long-term ambitious target	Evidence of some implementation	7 CAPs: Maine, Michigan, New Jersey, New York, Rhode Island, Vermont, Washington
Type 6	A long-term ambitious target	Stronger evidence of rigorous implementation, monitoring and evaluation	8 CAPs: California, Colorado, Connecticut, Maryland, Massachusetts, Minnesota, New Hampshire, Oregon

innovations to achieve long-term targets. Regardless of the differences in CAP targets across the nation, near-term targets are low compared to long-term targets, and especially the most rigorous CAPs rely on major technological innovations to reach their long-term targets. It is very typical of CAPs to set a rather achievable target to be reached by say, 2020. This is not intrinsically problematic, provided that we understand that simply continuing the trend of emissions reductions will not get us close to meeting the long-term targets. In other words, after meeting the near-term target, we need measures that sharply reduce emissions. By setting a near-term target, many CAPs have analyzed feasibility of their policy options. Yet, when it comes to the ultimate target, tools, techniques and mechanisms to reduce emissions dramatically to meet the long-term targets are unknown. To some degree, this is inevitable. Due to their long time span (i.e. more than forty years from the development of the plan), CAPs deal with numerous uncertainties. However, major lifestyle changes and technological innovations are needed to reach long-term targets that meet the scientific requirements.

Designing a path that links CAP measures and long-term ambitious targets is a crucial aspect of climate planning. The states that carefully monitor and evaluate their progress towards their targets have recently started to plan for emissions reduction beyond 2020. One approach that is common among these states is setting an interim target (e.g. 2030) that guides emissions reduction actions towards the 2050 goal. Massachusetts Clean Energy and Climate Plan for 2020 (updated in 2015), for example, begins to look more closely to longer term targets, includes scenario analyses for 2030 and 2050 emissions, and examines viable paths to deep reductions needed to meet the state's ambitious long-term target.

3.1.2.2. CAPs typically lack dedicated or sufficient funding sources for implementation. Most CAPs include a relatively detailed cost analysis using techniques such as net present value (NPV) and cost-effectiveness calculations. Whereas many selected policy options are claimed to be cost-effective and a worthwhile investment, initial costs may still hinder implementation. This is more than serious in economic downturns, when CAP implementation competes with other pressing issues. Therefore, identification of funding sources and analysis of potential funding problems early on in the CAP development process is rather important.

Evidence from this study suggests that although funding options have been discussed one way or another in most CAPs, many lack dedicated or sufficient funding sources. Some CAPs mention identification of funding sources for implementation a challenge, whereas others leave this step (i.e. funding identification) to be dealt with at a later time.

Exceptions do exist. California's Assembly Bill 32 (i.e. the California Global Warming Solutions Act of 2006), for example, is funded through a number of mechanisms that are discussed in detail in the Scoping Plan (updated every five years). A fee is collected from large sources of GHGs in the state annually that is used for covering annual expenses for state agencies to implement AB 32. Aside from regulatory and market-based programs aimed at reducing GHG emissions, investments from various sources provide incentives for industries to reduce emissions. The Greenhouse Gas Reduction Fund (GGRF)—which comes from auction proceeds as a part of Air Resources Board's (ARB) cap-and-trade program—is set to be used for a wide range of projects that can result in long-term reductions in GHG emissions. ARB's Investment Plan evaluates GHG reduction alternatives and prioritizes promising investments that bring about co-benefits in addition to emission reductions.

3.1.2.3. Dealing with uncertainties is a challenge and scenario analysis is rare. Findings also show that CAPs, in general, have not accounted for uncertainties through sophisticated methods, such as scenario development. Scenario development comes from systems science. It is a method facilitating recognition and exploration of uncertainty and complexity in the decision-making process, as opposed to limiting or simplifying the context into a single forecast (Van Der Sluijs, 2005; Vervoort et al., 2014). In the context of the United States, with public confusion about the reality of climate change coupled with lack of steady and sufficient federal level support, decision-makers involved in CAP processes have often chosen to simplify rather than further complicate the situation. This is understandable, especially because most of the current generation of CAPs have been developed years ago and/or with limited resources. Future CAPs or CAP updates, however, would benefit greatly from improved decision pathways that take uncertainties into account.

Most CAPs have either ignored uncertainties altogether or have identified it as a challenge. More research and better data are required to develop sophisticated scenario analyses to enhance decision-making. Evidence from the content analysis of state level CAPs shows that accounting for uncertainty in business-as-usual (BAU) emissions, policy designs and/or impacts of individual policies is rare. Although, exceptions exist. For instance, Massachusetts' plan has considered three levels of BAU emissions (i.e. high; middle; low) and three levels of policy impacts. When it comes to uncertainties as they relate to climate change impacts, scenario development is again uncommon. For us to calculate a more accurate cost-benefit analysis of CAP implementation, we need to draw a better picture of climate change impacts and risks. States have struggled to link implementation benefits to climate change risks in their CAPs.

Cost-benefit analyses conducted for state level CAPs did not typically take into account costs avoided due to alleviated climate change risks. Stakeholders involved in state CAP processes have often considered co-benefits of specific measures, but these co-benefits are not quantified in most cases as discussed earlier. One example of an effort to integrate the avoided costs is Connecticut's CAP that estimate avoided health costs due to reductions in criteria air pollutants benefits. However, the cost of adapting to climate change impacts (assuming that adaptation is possible) is much higher than health costs alone in monetary terms only and notwithstanding potential devastating community and intergenerational costs.

Projection of local impacts may involve a greater degree of uncertainty. Nevertheless, states that have developed an adaptation plan, as a part of their climate action planning efforts, have started to look more closely into these impacts. For example, New York's The Community Risk and Resiliency Act (CRRA) proposed sea level rise projections that are based on detailed analyses conducted by Horton, Bader, Rosenzweig, DeGaetano, and Solecki (2014). This report, also known as the ClimAID report, is prepared for the New York State Energy Research and Development Authority, and its projections are based on the outputs of over 20 global climate models, downscaled to New York. Integrating the costs associated with these projected impacts into CAP financial analyses can provide justification for actions that are not otherwise advisable. In other words, access to sophisticated analyses of climate change risks can impact decision making.

3.1.2.4. Implementation mechanisms are weak. Most CAPs lack regulatory teeth, and by extension, a direct way to enforce implementation. Even the CAPs in the rigorous implementation group, do not necessarily have a comprehensive program to reduce GHG emissions from all sources throughout the state. Additionally, carbon pricing mechanisms (i.e. carbon tax and/or cap and trade) are relatively uncommon. Carbon pricing is deemed as a necessary and effective policy step to address climate change in the United States (Metcalf, 2008; Nordhaus, 2007). However, many CAPs rely merely on programmatic incentives or voluntary mechanisms to achieve their goals. These programmatic smaller scale interventions are likely insufficient to meet the deep reduction targets set for 2050. Achieving ambitious 2050 targets is inherently complicated, involving many factors, such as personal lifestyle choices and preferences. While it is unlikely that an individual “silver bullet” implementation mechanism exists to meet these ambitious long-term goals, an

Table 3
Descriptive statistics for independent variables.

Variable	Mean	Standard deviation	Minimum	Maximum
Cooling degree days (CDDs)	1071.74	804.68	42.00	3827.00
Heating degree days (HDDs)	5243.83	2085.25	430.00	10,810.00
Change in % GDP from carbon-intensive manufacturing	0.00	0.01	−0.05	0.07
Change in % GDP from carbon-intensive non-manufacturing	0.00	0.01	−0.08	0.05
Change in regional energy prices	6.23	15.43	−45.84	34.31
Democratic presidential vote %	0.46	0.09	0.25	0.68
Compactness	95.07	11.24	64.29	129.03
Change in per capita personal income	1081.94	953.06	−5781.00	7527.00
Change in average unemployment	0.05	0.99	−2.54	5.51
Change in interstate energy trade	1008.41	3,928,213.00	−25,200,000.00	26,600,000.00

approach that combines a wide and diversified range of strategies is more likely to yield success (Yang, McCollum, McCarthy, & Leighty, 2009). Yet, many states have opted out of carbon pricing options, choosing a shorter list of implementation mechanisms instead.

3.2. Phase 2 findings

3.2.1. CAPs and change in energy-related carbon dioxide emissions

This section focuses on findings from the second phase of the study: Analyzing the relationship between state level CAPs and change in energy-related carbon dioxide emissions from all sectors (i.e. dependent variable). Sectors that contribute to energy-related carbon dioxide emissions include commercial, industrial, residential, transportation and electric power. Based on findings from the first phase, I examined the relationship between six types of CAPs and change in energy-related carbon dioxide emissions controlling for other economic, climatic, geographic and political variables. Table 3 provides descriptive statistics for the independent variables.

My goal with this model was to explain variations in emissions with CAP types as well as a set of control variables. The direct way that CAPs can result in carbon emissions reduction is through implementation of CAP policies and measures. I collected information about implementation of state level CAPs in the first phase. CAP types include information about implementation. For example, I found evidence of rigorous implementation for type 6 CAPs. However, implementation is only one way that CAPs can impact carbon emissions. There are a number of indirect ways that CAPs can lead to reductions in carbon emissions. Perhaps the most important of these indirect mechanisms is the planning process. Altschuler argued that “planning is more important than any plan” (quoted in Baer, 1997, p. 336; and in Drummond, 2010, p. 416). The planning process, especially when various interest groups and the public are actively involved, can yield outcomes. Innes and Booher (1999) argued that a good consensus building process can have outcomes beyond the immediate and/or identifiable results at the end of the project. These outcomes, according to Innes and Booher (1999), can appear after the completion of the plan development process or outside its boundaries in the form of new collaborations, new discourses, learning that extends into the community, and so forth. In the case of state level CAPs, this means that the planning process can indirectly yield outcomes outside the boundaries of the plan in the form of other relevant policies or programs that reduce carbon emissions. Indeed, analyzing these indirect mechanisms is beyond the scope of this study. Yet, acknowledging the possibility of these indirect effects can help us understand why a CAP may result in carbon emissions reductions even the implementation has quickly faded away after the plan development process, or there is no evidence of direct implementation whatsoever.

Table 4 shows the results of the regression model. Total number of observations are 1104, and the number of groups, which is the number states included in the model, is 48. The overall R2 is a reasonable 0.25, meaning that the model explains a quarter of the variations in state level energy related carbon emissions.

Table 4
Effects of state CAPs on per capita CO_2 energy emissions.

Variables	Coefficient
CAP Type 1. No target; no or limited implementation	−2.738705**
CAP Type 2. Short-term target; no or limited implementation	−1.160499**
CAP Type 3. Ambitious target; no or limited implementation	−0.8332563*
CAP Type 4. Short-term target; some implementation	−2.36251**
CAP Type 5. Ambitious target; some implementation	−1.546992**
CAP Type 6. Ambitious target; rigorous implementation	−1.096547**
Cooling degree days (CDDs)	−0.0004712
Heating degree days (HDDs)	0.0001331
Change in % GDP from carbon-intensive manufacturing	−4.979222
Change in % GDP from carbon-intensive non-manufacturing	12.54649*
Change in regional energy prices	0.010386
Democratic presidential vote %	1.108312
Compactness	−0.0602424**
Change in per capita personal income	0.0002443*
Change in average unemployment	0.1368203ᵠ
Change in interstate energy trade	0.000000043**
Region-West	−2.791596**
Region-South	−0.8061115
Region-Northeast	−0.6447329
Region-Midwest	0
Constant	5.765357

Number of observations = 1104 Overall R2 = 0.25
** $P < 0.01$.
* $P < 0.05$.
ᵠ $P < 0.10$.

All CAP types are statistically significant at the 0.01 level ($p < 0.01$) except for type 3 CAPs (long-term ambitious target, and no or limited evidence of implementation), which is significant at the 0.05 ($p < 0.05$) level. Coefficients are negative for all CAP types indicating that, in the years since 1990, all state level CAPs reduced emissions compared to the states without CAPs, holding all other variables constant. CAP coefficients for all groups range from −0.83 to −2.74. This means that, in the years since 1990, on average states with a CAP reduced per capita emissions by about 1.79 metric tons, when compared to the states without CAPs and controlling for other economic, climatic, geographic and political variables.

Ironically, what this model shows is that CAPs, regardless of their targets and implementation, result in carbon emissions reduction. Nevertheless, the model does not reveal mechanisms through which these CAPs work. In other words, the model does not show how exactly CAPs with no or limited evidence of implementation lead to carbon reductions. Although causal mechanisms between types 1, 2 and 3 CAPs (with no or limited evidence of implementation) and emissions reductions are uncertain and unknown, there are a number of possible explanations. One explanation for the statistical significance of the relationship between all types of CAPs, including the ones with no sign of implementation (i.e. types 1, 2 and 3), is the possibility of indirect effects of the planning process on carbon emissions reduction. State level climate action planning is typically a complex process involving numerous stakeholders. It is likely that these CAPs have resulted in other environmental policy measures or programs with similar carbon reduction benefits. Considering that most state CAPs have benefitted from fairly extensive consensus-building processes, the possibility of indirect effects should not be disregarded.

One surprise is that type 6 and 5 CAPs, which have an ambitious long-term target and stronger evidence of implementation, have a slightly smaller coefficient than the type 1 CAPs with no specified emissions target and no or limited evidence of implementation. One possible explanation is that the states with a types 6 or 5 CAP had already achieved lower carbon emissions through other environmental policy measures with emissions reduction benefits, making it difficult to reduce emissions after the adoption of the CAP. Another possible explanation is related to a general critique of state level CAPs: low short-term targets. Because of these low 2015 or 2020 targets, it is possible that implementation of the CAPs have not yet resulted in reductions significant enough to reveal potential strengths of types 6 and 5 CAPs. The effects may appear later, if these states continue to rigorously implement the ambitious long-term goals set by the CAPs. Ultimately, the reason behind these findings may simply be a lag between implementation of measures and appearance of results.

Interestingly, type 4 CAPs, with a short-term target and some evidence of implementation, have the second largest coefficient (after type 1 CAPs). This suggests that CAPs with a short-term target may also be successful in reducing emissions—at least in the short run. Again, the possible advantage of having an ambitious long-term target may not be apparent yet—especially because CAPs with a stringent long-term target still have a weak near-term target.

Compactness, a variable especially important for cities and regions, is also statistically significant at the 0.01 level ($p < 0.01$). Its negative coefficient is indicative of an inverse relationship between compactness and emissions, or a positive relationship between sprawl and emissions. The sprawl measure used in this model is a composite measure involving many variables combined into four major factors: 1) development density; 2) land use mix; 3) activity centering; and 4) street accessibility (Ewing & Hamidi, 2014). This means that the development decisions of communities can have measurable impacts on emissions. The most relevant type of emissions related to urban compactness (or sprawl) is transportation sector emissions. This is because sprawled areas are associated with higher levels of vehicle ownership and vehicle miles traveled (VMTs) per capita and traffic delay per capita (Ewing, Pendall, & Chen, 2003).

From the set of economic variables, year-to-year changes in per capita personal income and energy interstate trade are statistically significant at the 0.01 level ($p < 0.01$). The positive coefficient of these two variables indicates that increases in per capita personal income and energy interstate trade are associated with greater energy related emissions. Because per capita personal income is a measure of personal wealth, this means that, when all other variables are held constant, increase in personal wealth results in greater contribution to emissions through increased consumption of energy. Energy interstate trade is a measure of interstate electricity exports and imports. For net exporters of electricity, this variable is positive; and for net importers, it is negative. This is because in the process of electric power generation, producers of electricity emit carbon dioxide.

Two other economic variables, percent GDP from carbon-intensive manufacturing and non-manufacturing, are measures of dependency of a state's economy on industries that emit large quantities of GHGs per unit of goods or services produced. The first of the two, percent GDP from carbon-intensive manufacturing is not statistically significant in explaining variation in per capita carbon emissions. However, the second variable–percent GDP from carbon-intensive manufacturing–is statistically significant at the 0.05 level ($p < 0.05$), and its coefficient is 12.55. Thus, a 1% increase in GDP from carbon-intensive manufacturing leads to an increase of 12.55 metric tons of carbon emissions per capita. This means that the higher the dependence of a state's economy on the three carbon-intensive nonmanufacturing industries–construction, mining, and agriculture—the greater their energy-related carbon emissions would be, when all other variables are controlled for. From a policy perspective, this could also represent an opportunity for significant emissions reduction, for example, through encouraging the use of efficiency measures in these industries.

The remainder of economic variables–namely changes in average regional energy prices, and average unemployment–are not significant at the 0.05 level. The two climatic variables–heating degree days and cooling degree days–as measures of need for energy consumption to air condition buildings are not statistically significant either. Among regions, being geographically located in the West Region is negatively correlated with changes in per capita carbon emissions ($p < 0.01$). Lastly, percent democratic vote in the nearest presidential elections is not statistically significant in the model.

4. Conclusions, implications for climate action planning and directions for future research

Across the United States, states have taken a range of approaches to mitigate GHG emissions within their boundaries and beyond. Findings from this study show that all types of CAPs, regardless of the targets and status of their implementation, result in measurable yet modest reductions in carbon emissions, when a set of economic, climatic, political, and geographic variables are controlled for. This can be explained by the fact that climate action planning is a complex process, and can yield outcomes beyond implementation of policy measures specified in the CAP. Mechanisms such as learning that extends into the lower levels of government (e.g. cities and regional governments) as a result of the involvement of the public and various interest groups in the planning process, or the development of other related plans, policies or frameworks (with the potential to reduce emissions) that can emerge from a CAP process. Analysis of these mechanisms including the dynamics between CAP processes and indirect outcomes is beyond the scope of this study, but the findings suggest that this can be an interesting topic for future research. One limitation of CAP content analysis is that data about stakeholder processes are limited to what is provided in the plan, and there is a wide variation in the breadth and depth of information included in different CAPs. In-depth interviews with stakeholders involved in CAP processes would enhance our understanding of CAP dynamics beyond what is publically available through documents.

Another limitation of the model presented in this study is that it does not include a local climate action variable. Municipal and community level CAPs may or may not be an extension of the state level CAP. In California, for example, many cities adopted a CAP due to state level regulation. For instance, because the environmental review process of development projects can be streamlined if a city adopts a CAP, cities in California have been incentivized by the state to develop and implement CAPs. In Ohio, on the other hand, the two cities of Cleveland and Akron adopted a CAP in 2009, two years before the state of Ohio released its first CAP. Unlike Ohio's CAP, Cleveland's plan set two goals for GHG emissions reduction, and provides evidence of progress. Regardless of their relationship with the state level CAP, these local plans can be successful in reducing emissions. Future research can assess the potentials, effectiveness, strengths and weaknesses of these local CAPs. Collecting comparable monthly or annual emissions data at the city and metropolitan levels can provide an opportunity for evaluation of these CAPs.

Currently, state CAPs with an ambitious target and evidence of implementation have not proven greater emissions reductions than those with a short-term target and limited evidence of implementation. As explained earlier, this can be due to weak short-term targets, a lag between implementation and results becoming visible, the possible effect of indirect CAP processes, and/or the difficulty of emissions reductions beyond what has already been achieved through other actions by the states with a type 5 or 6 CAP. This finding is another evidence that CAPs are very complex involving many factors, and their success in significantly reducing emissions can be influenced by various dynamics. It is important to note that the regression model presented in this study is exploratory. Better understanding of possible mechanisms that link CAPs to emissions reductions are needed to develop an improved model.

Evidence from the content analysis of state CAPs shows that climate action is a heterogeneous phenomenon within various jurisdictions across the nation—ranging from no action at all to rigorous implementation of stringent climate regulations. This is also true for city and regional level action in the United States. This heterogeneity, in and of itself, irrespective of potentials and constraints of individual action taking jurisdictions, can be problematic and highlights the importance of federal level action. This is not only because of carbon leakage potential, but also due to sending mixed messages about the United States' stance on climate action as a nation—which can hinder global efforts to mitigate emissions. Lack of strong federal leadership on climate planning has created an opportunity for innovative bottom-up climate action; however, this has also resulted in a patchwork of climate action across the nation. A robust federal leadership on climate protection can level the playing field for all jurisdictions, diminish possible carbon leakage to the states and cities with minimal regulations, support the implementation of lower-level CAPs, and finally enhance chances of global cooperation against the threat of climate change.

Nevertheless, state level CAPs illustrate important potentials of subnational climate action. Through CAP development and implementation, U.S. states have acted as laboratories of democracy and incubators of innovation and collaboration. The detailed analysis of co-benefits of climate action conducted through CAP development of many states shows a more holistic view of planning practice and policy implementation. Robust financial analyses, such as cost-effectiveness analysis and NPV, indicate that through climate action, states can undertake worthwhile investments benefitting the economy, the environment, and the community. State level CAPs can also influence city and metropolitan level action both *directly* (e.g. through emission reduction mandates) and *indirectly* (e.g. by offering incentives, technical support, community engagement activities, etc.).

Additionally, sub-national level action in the United States and elsewhere can send positive signals to higher levels of government as well as global entities that significant climate action can and should be taken at all levels, most importantly including city and regional levels. Evidence from state-level CAPs in the U.S. suggests that communities have taken action despite inconsistent support, lack of strong leadership and even withdrawal from global agreements by their federal government. This is in contradiction with the common argument that because local and regional entities are often removed in time and space from root causes of climate change, they should be reluctant to take action against it. In fact, because climate change adverse impacts as well as climate action planning co-benefits (e.g. clean air, walkable and healthy communities, better public and active transportation infrastructure, green jobs, etc.) will be observed locally, cities, regions and states have a tremendous incentive and a vested interest in developing and implementing CAPs. Thus, higher levels of government and global organizations should empower and support rather than undermine or discourage sub-national level action.

Lastly, we should move beyond energy efficiency measures to be able to reduce emissions sharply. Findings from this analysis show that CAPs are reducing energy-related carbon emissions in a measurable but modest amount. Continuing the current trend of emissions reductions is insufficient to reduce emissions dramatically to meet the long-term targets. Achieving greater reductions involves major technological and policy innovations as well as lifestyle changes. It is impossible to illustrate what future innovations will exactly entail or what can be achieved through major technological advancements. However, planning and policy tools and techniques that involve wide stakeholder participation and scenario planning that challenges current thinking, can be used as a framework to create an ecosystem amenable for innovation. Through these techniques, various decision-making alternatives–ranging from urban development decisions to lifestyle choices—are converted into dynamic stories that analyze external forces and policy responses. Stakeholders involved in the visioning process are likely to find that some outcomes or processes represent a future or a situation that is more desirable than others. And then the question is: how do we get from the present to the desired situation. The excitement about climate action planning simply begins there.

CRediT authorship contribution statement

Serena E. Alexander:Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Writing - original draft, Writing - review & editing.

Declaration of competing interest

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