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Advancing bipartisan decarbonization policies: lessons from state-level successes and failures

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Abstract

U.S. political polarization is at a high point since the Civil War, and is a significant barrier to coordinated national action addressing climate change. To examine where common ground may exist, here we comprehensively review and characterize successes and failures of recent state-level decarbonization legislation, focusing especially on bipartisanship. We analyze 418 major state-government-enacted bills and 450 failed bills from 2015 to 2020, as well as the political contexts in which they were passed or defeated. We use bivariate analyses and regressions to explore correlations and partial correlations between the policy characteristics and political contexts of bills, and their passage or failure, their bipartisanship, and vote shares they received. Key results include (i) nearly one-third of these state-level decarbonization bills were passed by Republican-controlled governments. (ii) Bipartisan or Republican co-sponsors disproportionately passed financial incentives for renewable energy, and legislation that expands consumer or business choices in context of decarbonization goals; Democrat-only co-sponsors disproportionately passed bills that restricted consumer and business choice, such as mandatory Renewable Energy and Efficiency Portfolio Standards (REEPS) and emissions standards. (iii) Bipartisan bills were disproportionately proposed in "divided" states, did not restrict consumer and business choice, had environmental justice components framed economically, and lacked environmental justice components framed either using academic social-justice jargon or non-neutrally with respect to immutable characteristics such as race. (iv) Bills that expand consumer or business choice were disproportionately enacted. Though climate change is a polarized issue, our results provide tangible insights for future bipartisan successes.

Keywords Political polarization · Climate change · Climate policy · Environmental politics

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1 Introduction

Addressing climate change requires a society-wide effort, sustained over decades. In a democracy, success seems unlikely without public and political unity behind it. Yet, climate change has been one of the most politically polarized issues in recent U.S. history (Iyengar and Westwood 2014; Egan and Mullin 2017), and in other English-speaking countries (Smith and Mayer 2019), with the political left generally showing higher levels of concern, and support for government actions aimed at mitigation (e.g., Mildenberger et al. 2017).

U.S. partisan elites started to polarize on environmental issues as early as the 1970s, but climate change was a low-polarization issue among the U.S. public until the 1990s, with equal fractions of Democrats, Republicans, and Independents reporting being "worried" about it in 1989 (see Egan and Mullin's 2017; Fig. 2A). Public polarization of climate change then steadily increased from 1990 to 2015, but has slightly decreased since 2015 (Egan and Mullin 2017). A majority of Republicans voters now support regulating CO_2 as a pollutant in every state except Wyoming (Mildenberger et al. 2017) and post-2016 polls have found over two-thirds popular support for several specific climate-mitigation policies (Burgess and Marshall 2020). Elite polarization may also be somewhat abating, perhaps in response to popular opinion or perhaps responding to the increasing immediacy and salience of climate-related impacts. For instance, Republicans in the House of Representatives formed the Conservative Climate Caucus in 2021, and the bipartisan Climate Solutions Caucuses formed in both the House (2016) and Senate (2019; Citizens' Climate Lobby 2021). However, lobbying by fossil-fuel industries and other monied interests remains as an elite-level barrier to climate legislation (e.g., Oreskes and Conway 2011; Meng and Rode 2019; Stokes 2020). Moreover, in contrast to climate change polarization, U.S. public polarization on "culture war" issues has sharply increased since 2015, as evidenced, for instance, by sharply diverging opinion trends on racial and gender issues, and on whether universities are beneficial to the country (Pew Research, 2018, 2019a, b, 2021), as well as the election and presidency of Donald Trump.

To shed light on where opportunities for bipartisan cooperation may exist in the current political climate, here we examine climate legislation at the state level. The political heterogeneity of states allows us to observe legislative patterns across varying political contexts, and state-level actions can seed or inspire federal actions, as we discuss in Section 1.1 below. We focus on 2015–2020 legislation, starting in 2015 for reasons discussed above. We analyze 868 major state bills that have a potential effect of decarbonization (418 enacted, 450 failed), and examine which bill characteristics and political contexts correlate with bill success (i.e., whether it was enacted), and support and bipartisanship as measured by the percentage of "yes" votes in a state's lower House or assembly among enacted bills and bill party co-sponsorship.

1.1 Background

An ideological tension—between conservative free-market ideologies and perceptions of climate mitigation requiring large-government solutions—exists at the core of climate change polarization in the U.S. and other English-speaking countries (McCright et al. 2013; Smith and Mayer, 2019). Distrust of scientists by conservatives also contributes to polarization, and is directly related to elite cues (McCright et al. 2013), which can be

especially influential in climate change polarization because understanding it requires scientific literacy (Egan and Mullin 2017). Conservatives' distrust of scientists has been fueled in part by the ideological tension (McCright et al. 2013); in part by misinformation and special-interest-driven efforts to undermine scientific credibility (Mooney 2007); and likely also in part by the fact that climate scientists are overwhelmingly politically liberal (e.g., see Helmuth et al. 2016; Boykoff and Oonk 2018) and sometimes activist or partisan (Boykoff and Oonk 2018; Cologna et al. 2021)—part of a larger pattern in academia (e.g., see Duarte et al. 2015; Cofnas et al. 2018). Declining Republican and Independent opinions of universities since 2015 (Pew Research 2019b) may indicate that this distrust of scientists is deepening.

Broader U.S. polarization is at a high-point since the Civil War, by some measures (Poole and Rosenthal 2001; Paisley 2016). Partisanship has a strong affective dimension (i.e., partisans tribally dislike each other) (Iyengar et al. 2019), and has become a dominant axis of Americans' personal identities (Mason 2016). For instance, only 6% of marriages in the U.S. occur between members of opposite political parties (Fisk and Fraga 2020), and there is widespread opposition to cross-party marriage (Iyengar et al. 2012); experiments and surveys have found members of both parties widely willing to discriminate against each other in school and the workplace (Inbar and Lammers 2012; Iyengar and Westwood 2014); and—alarmingly—a 2019 study (Kalmoe and Mason 2019) found 20% of Democrats and 15% of Republicans respond affirmatively to the question: "Do you ever think: we'd be better off as a country if large numbers of [Opposing party] in the public today just died?". This affective polarization directly influences political support for climate policy and strengthens the influence of elite cues (Ehret et al. 2018; Merkley and Stecula 2020). For instance, Ehret et al. (2018) found that their participants supported a climate policy less if they believed that the other party had proposed it. Conversely, affective mass polarization may also reduce elected officials' incentives to collaborate across party lines. This may be evidenced by, for instance, the increasing partisanship of congressional voting (Paisley 2016), and the increasing use of the filibuster in Congress by the minority party (Klein 2012).

Despite these trends, recent signs of U.S. climate change de-polarization—also evident at elite and public levels in Canada (Williams 2021) and the U.K. (Holton and Piper 2021)—suggest that there could be opportunities for common ground, perhaps because the effects of climate change have become impossible to ignore. Moreover, collaboration toward shared goals is a well-known approach to reducing inter-group conflict (Pettigrew 1998). This raises the question of whether successful bipartisan collaborations on climate change might catalyze broader reductions in political polarization.

To explore where opportunities for legislative bipartisanship on U.S. climate mitigation may exist, we examine recent successes and failures of U.S. state-level legislation aimed at reducing greenhouse-gas (GHG) emissions. State actors are key drivers of U.S. climate legislation, and can seed federal legislative proposals. For example, Colorado General Assembly legislators signed a state law in 2019 that directs the state legislative council staff to establish GHG emissions reports to help assess the net impact of proposals on emissions within a 10-year period of enactment (H.R.1188 2019). In June 2020, congressional leaders in the Select Committee on the Climate Crisis released a similar proposal, The Carbon Cost Act (H.R.8613 2020). More broadly, state- and local-level climate action expertise and lessons learned were built into President Biden's "Build Back Better" climate plan and Cabinet (Ricketts et al. 2021). Legislation has been introduced and enacted in various degrees across the fifty state legislatures with differing levels of support from Democrats and Republicans since 2015 (Advanced Energy

Legislation Tracker 2021). While a majority passed in Democrat-controlled state legislatures (Fig. 1A), there are a number of notable exceptions that passed in historically Republican-controlled states (Table S1).

We examine correlations and partial correlations between passage (conditional on being proposed in the first place) and bipartisanship (as measured by co-sponsorship and vote share) of over 860 bills (introduced between 2015 and 2020) aimed at decarbonization, and specific policy function, broad framing components (e.g., does the bill provide a financial incentive or expand/restrict consumer or business choice?), and a state legislature's partisan control. Our analysis builds on previous studies examining state-level Renewable Energy and Efficiency (REEE) policies with a focus on ideological framing (Hess et al. 2016), legislator characteristics (Hess et al. 2015), political conditions in state legislatures (Yi and Feiock 2014; Carley and Miller 2014), and interest group influence (Stokes 2020).

Hypotheses We investigate the following hypotheses: Part a of each hypothesis (and b for Hypothesis 4) explores passage dynamics, which are operationalized through a binary "enacted (1)," or "failed (0)," variable. Part b of each hypothesis (c for Hypothesis 4) explores bipartisanship, which is measured through co-sponsorship of both enacted and failed bills (i.e., is a bill co-sponsored by members of both major parties or not?) and vote share of enacted bills (i.e., what percentage of the lower House or assembly voted "yes" on a bill?). We hypothesize that both elite polarization and public polarization influence which climate policies are politically feasible, and consequently our hypotheses are based on both patterns in public opinion and elite-level behaviors.

Hypothesis 1:

a Decarbonization policies pass more often under Democrat-controlled state legislatures.
b Decarbonization policies pass more often in a bipartisan way in divided or Republican-controlled state legislatures.

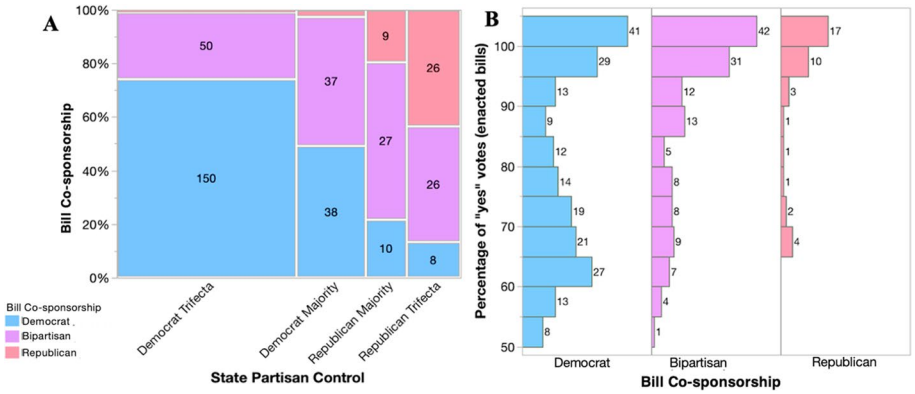

Fig. 1 (Left panel: **A**) Bill co-sponsorship vs. state legislature control. Section widths represent the number of decarbonization bills enacted in the respective legislature control condition. (Right panel: **B**) Percentage of yes votes in the lower House or assembly among enacted bills vs. bill co-sponsorship. Democrat co-sponsored bills generally pass with lower vote shares than Republican and bipartisan co-sponsored bills.

This hypothesis stems from previous research on state-level bills (Hess et al. 2016); and on the pattern of greater support for climate mitigation policies among left-wing parties and voters in English-speaking countries (Mildenberger et al. 2017; Smith & Meyer 2019).

Hypothesis 2:

a Legislation aimed at decarbonization that restricts consumer or business choice will be enacted less frequently than legislation that expands consumer or business choice.
b Legislation aimed at decarbonization that restricts consumer or business choice will pass less often with bipartisan support, and more often with just Democrat support.

This hypothesis stems from the fact that mandates and regulations clash with free-market worldviews (e.g., Smith and Meyer 2019), and are also often vigorously opposed by moneyed interests (Meng and Rode 2019; Stokes 2020). Indeed, a study of pre-2015 state-level bills (Hess et al. 2016) found mandates had lower support.

Hypothesis 3:

a Legislation aimed at decarbonization that includes financial incentives or expanded choice components will pass more often than legislation that restricts or has no effect on individual or business choice or does not have a financial incentive.
b Legislation aimed at decarbonization that includes financial incentives or expands consumer or business choice will pass more often in a bipartisan way.

This hypothesis is essentially the converse of hypothesis 2. If standard-based decarbonization policies are more frequently opposed by lawmakers (especially Republicans) and moneyed interests than incentives, policies expanding choice might be more frequently supported.

Hypothesis 4:

a Legislation aimed at decarbonization with an environmental justice component will pass less often than bills that lack this component.
b Legislation aimed at decarbonization that includes an environmental justice-component with an economic-justice framing approach will pass more often than bills that include a social-justice framing approach.
c Legislation aimed at decarbonization that includes an environmental justice component will receive bipartisan support more often when it includes economic redistribution opportunities than when it focuses on a social-justice framing approach.

Our analysis defines bills as "social justice" frames if they are either explicitly non-neutral with respect to immutable characteristics such as race, or use specific terminology associated with critical theories in academia (Delgado and Stefancic 2017). We define bills as having "economic justice" frames if they explicitly aim to benefit economically disadvantaged citizens, but lack social justice frames. Hypothesis 4 stems from the fact that the median American voter is relatively economically liberal and socially conservative (Drutman 2017). Thus, we hypothesize that it is easier to build bipartisan coalitions around economic redistribution (e.g., as a recent survey study by Bergquist et al. (2020) found), than around social-justice-framed approaches associated with academia and the left wing of the Democratic party, whose support is more concentrated, even among Democratic voters (see, e.g., Hawkins et al. 2018). Analogously, a recent survey study (English and Kalla

2021) found economic frames garnered larger support for a range of progressive policies than racial frames across a wide range of voter demographics.

2 Methods

2.1 Scope and dataset creation

We focus on 2015–2020 state-level bills aimed at decarbonization, which we define as bills that are intended to have an effect that would clearly result in reducing GHG emissions or the GHG-emission intensity of an economic activity. A number of decarbonization policy types were introduced, as well as policies detrimental to decarbonization, during the 2015–2020 timeframe. We do not include detrimental policies in our analysis (examples include Ohio HB6—see Roberts (2019)—and West Virginia HB2001—see Eik (2015)). We also exclude minor bills whose effects might be considered semantic (e.g., a minor definition change, a small change in legislative language that does not strengthen or retrench the original bill). Thus, we focus on major bills aimed at decarbonization.

We compiled two data sets using policy documents publicly available through the Advanced Energy Legislation Tracker (Advanced Energy Legislation Tracker 2021). We read each bill and cross checked with legislative reports on state government websites and press releases when available. The first dataset, which we use to analyze vote share patterns, includes 393 enacted decarbonization bills from 2015 through 2020 (in all 50 states except for South Dakota and Ohio). The second dataset, which we use to analyze patterns of passage, includes 868 both enacted and failed bills (418 enacted, 450 failed). It includes all enacted bills in the first dataset, plus 25 additional enacted bills without vote share data. In 22 states, we did not find any failed bills, likely because there are hundreds of bills that are in the "introduced" stage in these states (e.g., Texas has introduced 500 bills since 2015, many of which are unlikely to be brought to a vote). We do not include these bills, as we cannot make precise determinations about their likelihood of success. Though some bills that have remained in the introductory stage for a long period of time could be argued as effectively "dead," we include bills in the failed category only if the Advanced Energy Legislation Tracker (AEL) classifies them as such. The AEL records a bill as "failed," based on individual state bill status reports.

We used similar searching criteria and bill categorizations as Hess et al. (2016), with some changes. Hess et al. (2016) focused specifically on renewable energy and energy efficiency (REEE)-related policies. In addition to REEE policies, we included policies relevant to decarbonizing the transportation sector from the perspectives of advanced vehicle adoption incentives, supporting infrastructure, and alternative fueling incentives. We also included GHG emissions standards (separate from renewable energy portfolio standards) and any policies that divest from carbon-intensive energy sources or shut down polluting sources. We use The State Policy Opportunity Tracker from the Colorado State University Center for New Energy Economy (SPOT 2021) as a default to determine classifications for bills that do not cleanly fit into the preexisting categories.

We define bills as "bipartisan" if they attract co-sponsor(s) from the opposing party. Vote shares from roll call offer another measure of bipartisanship from the end of the legislative processes. We record both co-sponsorship and vote share metrics to capture a

broader picture of bipartisanship, including the dimension of cooperation through co-sponsorship as well as the final vote (Harbridge 2015).

2.2 Variable descriptions

Table 1 describes the variables included in our datasets. We only include the percentage of "yes" votes variable in our enacted dataset, because a large majority of the failed bills did not make it to a full vote. All other variables are consistent across both datasets. In addition to the five SPOT tracker categories, and 19 specific bill classifications, we created three additional variables, intended to capture framing components of policies that are present across classifications and directly relate to our hypotheses—the presence or absence of financial incentives, expanded or restricted choice, and environmental justice components. These variables record bill functions that are not fully captured by the classification schemes, but are nonetheless important aspects of a particular bill. We define each of these variables below.

2.2.1 Dependent variables

To test hypotheses 1a, 2a, 3a, and 4a, b regarding correlates of bill passage, we use a binary variable (1 = enacted, 0 = failed). To test hypotheses 1b, 2b, 3b, and 4c regarding correlates of bill bipartisanship, we use three measures: (i) a binary (1 or 0) measure of whether a bill

Table 1 Variable names and descriptions collected in both datasets (except for vote share in the enacted and failed dataset)

Variable	*Independent/ Dependent/ Control*	*Description and operationalization*
State, Bill ID	--	Bill ID: Specific to each bill State: No enacted bills found for OH and SD. No failed bills found for 22 states
Measure of passage	Dependent	Enacted (1), Failed (0)
Measures of bipartisanship	Dependent	1. Bipartisan= (1) 50%-90% co-sponsors from on party, Partisan=(0) 91%-100% co-sponsors from one party 2. Enacted and Bipartisan= (1), Enacted/partisan, Failed/bipartisan, Failed/partisan=(0) 3. Vote share (percentage of "yes" votes in lower House or assembly from both parties among enacted bills, ranges from 51%-100%)
Framing components	Independent	Choice component (expands, restricts, no effect) Financial incentive component (present, not present) Environmental justice component (social justice indicators, economic justice indicators, general progressivism frame, no environmental justice)
State partisan control by session	Independent	Republican: Legislature and Governor are Republican-controlled Democrat: Legislature and Governor are Democrat-controlled Divided: Legislature and Governor are from different parties
Year	Control	2015, 2016, 2017, 2018, 2019, 2020
SPOT Tracker and Classifications	Independent (exploratory analysis Table S7)	5 broad categories of bill function characteristics. 19 classifications of specific bill function. 3 additional classifications—"Authorization", "Other Renewable Energy and Energy Efficiency (REEE)", and "Reduces Regulation"—not shown as they apply to bills in multiple SPOT categories

Emissions, Infrastructure, Grid, and Rate Policies	*Energy Efficiency Policies*	*Financing and other Energy Incentive Policies*	*Transportation Policies*	*Renewable Energy Policies*
Emissions Standard	Building Efficiency	Property Assessed Clean Energy (PACE) laws	Transportation: Electric Vehicles or Zero Emissions Vehicles and supporting infrastructure	Net Metering
Energy Storage	Energy Efficiency Resource Standard	Solar Incentives	Transportation: Alternative Fuels	Renewable Energy Portfolio Standards (REEPS) change/new
Carbon Intensive Energy Divestment		Other Financial Incentives		Renewable energy and efficiency portfolio goal (REEE)
Cap and Trade				Solar carve-out
				Shared Renewables

has bipartisan co-sponsors, regardless of whether it passed or failed; (ii) a binary measure (1 or 0) of whether a bill had bipartisan co-sponsors *and* passed; and (iii) the percentage of "yes" votes from both parties in the lower House or assembly for enacted bills with vote share data (a continuous variable spanning from 51 to 100%).

2.2.2 Independent and control variables

In addition to the SPOT categories and bill classifications (see Table 1 for SPOT categories, see Table S2 for classifications), we include the following independent variables in our analysis:

Financial incentive: includes two levels (yes, no). Bills either introduce an incentive (e.g., renewable energy or alternative fueling tax credit, fee reductions, tax exemptions, PACE laws, and create/disperse funds for renewable energy projects) or they do not (e.g., regulatory adjustments, emissions standards and REEPS without financial incentives, and others).

Expanded choice: includes three levels (expands choice, restricts choice, and no effect). Expanded choice bills either create a positive reinforcement or new options for individuals and businesses that did not exist before. Some bills that expand choice also have financial incentives (e.g., Florida's H.B.195 (2016)) reduces consumer barriers to renewable energy installments by eliminating specific tax burdens) and some only expand choice (e.g., Colorado's law, S.B.167 (2020)), increases consumer access to electric vehicles by allowing manufacturers to sell their own electric vehicles directly to consumers). Second, restricted choice bills do not expand choice, and create penalties, restrictions, and/or new regulations. Lastly, a small amount of bills (approximately 15% of enacted bills and 20% of failed bills) neither expand nor restrict choices and are coded as "no effect." Colorado's H.R.1188 (2019) is an example: it requires GHG reports to help legislative council staff evaluate a policy proposal's net effect on emissions. See Table S3 for more examples of bills that expand, restrict, or have no effect on individual or business choice.

Environmental justice: includes four levels (social justice indicators, economic justice indicators, general progressivism frame, and no environmental justice). "Social justice indicators" bills include phrases such as "environmental justice," "equity," "communities/populations of color," "minorities," and/or specifically focus on the immutable characteristics of race or physical ability in providing benefits. Examples include establishing an environmental justice commission or council (Virginia's H.B.1042 (2020); Illinois' S.B.2920 (2016)) or creating penalties for industry in the face of disproportionate impact of pollution and toxic chemicals on racial minority communities (California's A.B.1132 (2017)). "Economic justice indicators" bills do not include a specific social justice indicator, but include the phrases "low-income," "affordability," or "moderate income," and/or focus specifically on providing benefits for populations based on economic status. Such policies can include shared renewable initiatives (Maryland's H.B.1087 (2015); Utah's H.B.0411 (2019)), and specific tax incentives and rebates for new technologies related to electric vehicles (California's A.B.2885 (2018)), and solar installations (Virginia's H.B.2741 (2019)), to name a few. "General progressivism frame" bills do not include specific economic or social justice indicators, but their intended legislative effects are to advance economic equality goals through incentives, investments, or other forms of benefits. Rhode Island's H.5618 (2017) does not include the above economic or social indicators but expands the state's virtual net metering program under a more inclusive ownership structure.

State partisan control: includes three different subcategories—Republican, Democrat, and divided. If a state government is controlled by Republicans in both executive and legislative branches in a given year, we code the bills that pass in that year as "Republican-controlled," and vice versa for Democrat control. If the legislative and executive branches are split, we code the bills enacted in that particular state and year as "divided." We test the sensitivity of our results to two additional metrics of state partisan control described in Tables S4 and S5.

Year: Bills are recorded between 2015 and 2020. The year variable is controlled for in the analyses to account for potential differences in passage and bipartisanship based on when a bill passed. For instance, years before elections could be a time-specific effect that affects passage and bipartisanship. The year-dummy variable is included in all models to control for year-level factors that might impact the outcome variables.

2.3 Analysis

We use bivariate analysis and multiple regressions to explore correlations and partial correlations between policy characteristics and political contexts of bills using metrics of passage and bipartisanship. Our bivariate analysis explores which bill characteristics are correlated with bipartisanship as measured by vote share and bipartisan co-sponsorship. Our regression analysis focuses on the question of which bill framing components and state partisan control environments (independent variables) partially correlate with each of three binary response variables: "enacted" (did the bill pass?); "bipartisan" (did the enacted or failed bill have bipartisan co-sponsors?) and "enacted and bipartisan" (was the bill passed *and* did it have co-sponsors from both major parties?). We use logit models to measure these correlations—summarized in Table 2. In Table S7, we present several alternate model specifications, such as models including the SPOT categories (models 1 and 3), and omitting the choice component (model 2), due to its covariance with the financial incentive component. Results from additional robustness checks on state classifications and bipartisan co-sponsorship thresholds can be found in Tables S5 and S6, respectively. In Table S8, we separate our dataset according to the state partisan control categories and regress the "enacted" variable on the framing components in each category separately, to see whether effects of framing components on passage varies according to partisan control. We use year fixed effects in all regressions and perform all analyses using JMP software (JMP 2021).

3 Results

We have five main results. First, although most decarbonization bills passed in Democrat-controlled state governments, nearly thirty percent (106/385 *100 = 27.5%) passed in Republican-controlled state governments (Fig. 1A). Vote shares show a key related pattern. Enacted bills co-sponsored only by Democrats have a bimodal vote-share distribution, with a sizeable fraction passing narrowly, whereas enacted Republican- and bipartisan-co-sponsored bills nearly always passed overwhelmingly (Fig. 1B). This suggests that Democratic lawmakers often vote for climate-mitigation policies of both parties, while Republicans have a larger voting preference for their own bills. Relatedly, we find types of bills disproportionately supported by Democrats receive lower vote shares, on average (Table S9: Fig. S11). Of the 393 enacted bills from the first data set, 206 had Democrat

Table 2 Results from three logit models where the independent variables include four explanatory variables (framing components and state partisan control) tested in comparison to the omitted subgroup. The second dataset of passed and failed bills is used in these models. Regression coefficients are listed along with standard errors in parentheses and the associated significance levels. Binary dependent variables include "enacted," "bipartisan," and "enacted and bipartisan"

Dependent variables	Enacted	Bipartisan	Enacted and Bipartisan
Intercept	-2.03(1.46)	-3.17(1.42)*	-2.95(1.51)
Financial incentive component			
Financial incentive	-0.30(0.1)**	0.14(0.10)	-0.01(0.11)
Environmental justice vs. none			
Social justice indicators	-0.09(0.27)	-1.29(0.57)*	-0.98(0.58)
Economic justice indicators	-0.01(0.23)	0.66(0.3)*	0.63(0.34)
General progressivism	0.001(0.39)	-0.08(0.48)	-0.35(0.61)
Choice component vs. no effect			
Restricts choice	-0.49(0.12)***	-0.34(0.14)*	-0.63(0.16)***
Expands choice	0.77(0.13)***	0.04(014)	0.47(0.15)**
Democrat and Divided vs. Republican			
Democrat states	0.38(0.10***)	-0.32(0.11)**	-0.48(0.12)***
Divided states	0.25(0.11)*	0.61(0.11)***	0.35(0.12)**
N	860	860	860
Generalized R-square (Nagelkerke)	0.11	0.11	0.11

*$p < 0.15$; **$p < 0.01$; ***$p < 0.001$

co-sponsors, 39 had Republican co-sponsors, and 140 had bipartisan co-sponsors. The remaining 8 bills passed in Nebraska, which is a non-partisan, unicameral legislature. Not surprisingly, bill co-sponsorship was correlated with partisan control (Fig. 1A).

Second, the bill characteristics associated with higher vote shares also tend to be more often bipartisan, even though vote share and bipartisanship do not perfectly correlate with each other. Figure 2 shows the fraction of bills with bipartisan co-sponsors (A) and the mean percentage of yes votes (B) within each framing component and state legislative control category. Both measures show similar patterns: e.g., lower vote shares and less bipartisanship among bills restricting choice, having social justice indicators, and passing in Democrat-controlled states. However, the fact that Republican-co-sponsored bills had higher average vote shares than bipartisan bills (Fig. 1B) illustrates that these two measures are not perfectly correlated with each other. When we regress these two measures on the framing components, we find some slight differences (Table S10). For instance, economic justice indicators are disproportionately bipartisan, but have lower average vote shares than bills lacking environmental justice, though neither of these differences is statistically significant.

Third, bills that expand choice disproportionately pass compared to bills that have no effect on individual or business choices (Tables 2, S5, S7). They are also both enacted and bipartisan more often than bills that have no effect or restrict choice. Bills that restrict choice disproportionately fail and do not have bipartisan co-sponsors compared to the no effect condition (Tables 2, S5, S6, S7). The presence or absence of financial components did not robustly correlate with bipartisan co-sponsorship or passage and

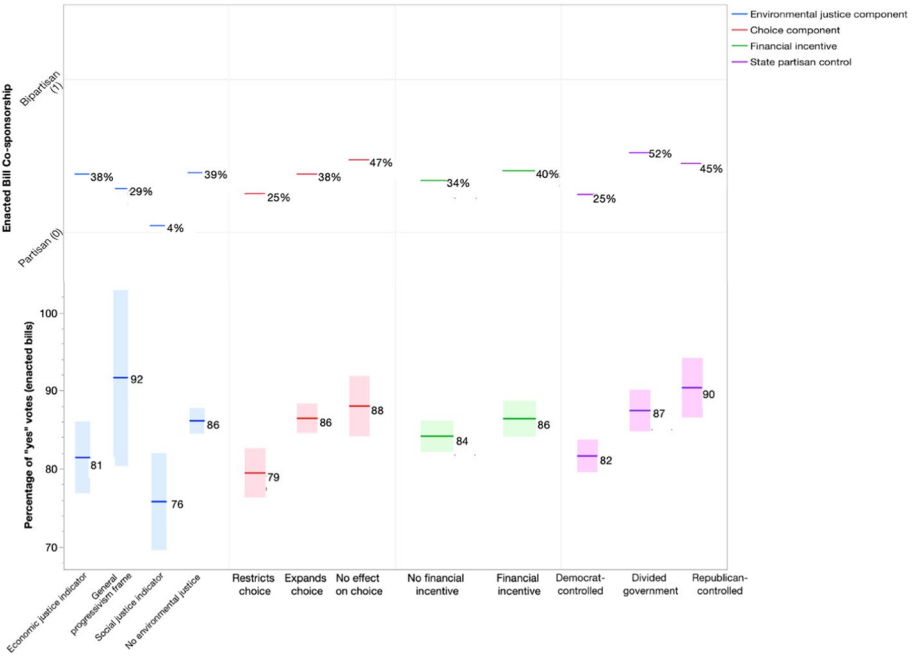

Fig. 2 (Top panel: **A**) Means of the independent variables in relation to bipartisan co-sponsorship. (Lower panel: **B**) Means of the independent variables in relation to the percentage of "yes" votes from both parties in the lower House or assembly (i.e., vote share)

bipartisan co-sponsorship. There is a significant negative partial correlation between bills with financial incentives and passage (Table 2, enacted model). However, in Table S7, model 3, the opposite partial correlation is present where bills with financial incentives are enacted and bipartisan significantly more often than bills without a financial component. Notably, model 3 does not include the choice component variable, which is correlated with both the financial component variable and the response variables. Bills in the "financing and other energy incentives" SPOT category were disproportionately enacted and bipartisan, compared to renewable energy policies, in Table S7, model 4, which does not include the financial component or expanded choice variables. Thus, the estimated model effect of the financial component is sensitive to the inclusion of the SPOT categories and choice component with which it is correlated.

Fourth, regarding environmental justice, social justice indicator bills were disproportionately less often bipartisan compared to bills lacking a justice component, whereas economic justice indicator bills were disproportionately more often bipartisan than bills lacking a justice component (Table 2, bipartisan model; Tables S5, S6, S7). We did not find statistically significant partial correlations between the general progressivism frame and passage, bipartisan co-sponsorship, or passage and bipartisan co-sponsorship, compared to the no-environmental-justice condition. Although our bivariate and logit models suggest that social-justice bills may face barriers to bipartisanship, we note that relatively few environmental-justice-related bills have been enacted since 2015 (145, including social justice indicator, economic justice indicator, and general progressivism

classifications combined). Figure 2 shows that social-justice bills receive lower vote shares and have bipartisan co-sponsors less often than the other categories.

Lastly, bills are disproportionately enacted in Democrat-controlled and divided states in comparison to Republican-controlled states based on results from logit regressions on the second dataset of enacted and failed bills (Table 2, enacted model; Tables S5, S6, S7). Bipartisan-co-sponsored bills are found significantly less often in Democrat states and more often in Republican and divided states (Table 2, bipartisan model; Tables S5, S6, S7). The enacted and bipartisan model in Table 2 yields results of the same sign as the bipartisan model with respect to the state partisan control variable.

Interestingly, when we ran separate regressions within each partisan control category, of bill passage on the framing components, we did not find qualitative differences in the results across partisan contexts (Table S8). Most notably, bills restricting choice disproportionately failed—and bills expanding choice disproportionately passed—in Democrat, divided, and Republican states alike. Sample sizes were too small, however, to reliably estimate environmental justice effects in these sub-samples.

4 Discussion

Addressing climate change requires a sustained, society-wide, multi-decadal effort to decarbonize multiple sectors. Achieving this in the U.S. seems likely to require bipartisan cooperation. State and local governments continue to be the primary driving forces of decarbonization policy in the United States (Crew et al. 2020), with some successes of bipartisan cooperation. State-level successes may be instructive to federal efforts. Our analysis examines bill characteristics that correlate with passage and bipartisanship.

4.1 Key takeaways

We comprehensively review recent (2015–2020) state-level decarbonization legislation, with four hypotheses described in the Introduction above. Over two-thirds of the analyzed bills were passed in Democrat-controlled state legislatures, in support of hypothesis 1a (Fig. 1A). However, the fact that nearly one-third of all bills passed in Republican controlled state legislatures suggests there are opportunities for bipartisanship on specific issues. We find statistically significant evidence that bills pass more often with both bipartisan co-sponsors and high vote shares in a state's lower House or assembly in Republican and divided states, in support of Hypothesis 1b (Fig. 2 and Table 2).

We find evidence mostly in support of hypotheses 2–4 as well. The analysis suggests that policies which restrict consumer or business choices like mandatory standards, restrictions, and increased regulations have passed less often and have more rarely been bipartisan (Fig. 2; Table 2)—and received lower vote shares when they did pass (Table S9)—in support of hypothesis 2. Interestingly, we found this pattern in Democrat, Republican, and divided states alike (Table S8). Some of these specific examples include REEPS and emissions standards—both main components of sub-national climate policy to date (Konisky 2020). Similarly, Hess et al. (2016) found, in an analysis of pre-2015 bills, that new or stricter REEPS received the least amount of support from a vote share perspective in comparison to other policies.

Regarding hypothesis 3, bills expanding choice passed disproportionately, and bills with financial incentives passed significantly more often in a bipartisan way in models that do

not include the choice component variable as a covariate (Table S7; model 3 and model 4). These results broadly support hypothesis 3, with some nuances related to patterns of support for various financial policies. Figure S11 shows that some PACE laws and solar incentives are popular with Republican legislators, while a subset of other policies with financial components—including shared renewables—garner disproportionately more support from Democrats. This suggests that some financial incentives do not necessarily align disproportionately with conservative values. For instance, Hess et al. (2016) note that tax credits can be a hit or miss for some Republican representatives in certain political contexts, who believe that no form of energy should be subsidized to promote the free market principle of competition.

Our sample size is too small, and the bill functions are too varied, to make generalizations across all environmental justice bills, but hypothesis 4c is supported in that the analyzed social justice indicator bills were less often bipartisan (Table 2) and received lower vote shares when they passed (Fig. 2). In contrast, bills with economic justice indicators were slightly more often bipartisan relative to the no justice condition (Table 2). However, we did not find statistically significant relationships between environmental justice and bill passage (as expected by hypotheses 4a, b).

4.2 Limitations

The scope of this study is limited to passed and failed legislation, which introduces data gaps from states without bills in these categories on record. This was most often the case with failed bills, where no records existed for 22 states (see Table S4 for full list). These states, which include Texas and Georgia, had hundreds of "introduced," bills that have not been voted on (many likely never will be). While exploring these bills might identify which kinds of policies have enough support to be proposed, there is no distinction between passage or failure, and therefore we consider these bills outside the scope of our analysis. However, we note that keeping bills in their introductory stages is a common stalling tactic (Stokes 2020). Additionally, our analysis does not include ideas that are discussed by stakeholders and policymakers but are never proposed, thus does not speak to the political climates that may prevent ideas from being proposed.

Other limitations exist in data collection. First, The Advanced Energy Legislation Tracker is updated on a rolling basis as staff review new and pending legislation from state data and submissions from the public regarding bills to add. There is a possibility that some bills could have been pending during the time of collection, and therefore not included in our datasets. Second, some stalled introductory bills that have not been categorized as "failed," by state-specific data despite being effectively dead means that LegiScan and AEL do not label them as "failed," either, which could distort the representation of failed bills in select states. Third, 25 enacted bills did not have associated vote share data and are not included in the analyses where vote share is the dependent variable. However, to avoid excluding them entirely, they are included in the second, enacted and failed bills dataset and in those associated regression models.

Our analysis explores correlations and partial correlations between bill characteristics and bipartisanship and passage, but we do not measure causality. For instance, we find that expanded choice positively correlates with bipartisanship, passage (Table 2), and higher vote share (Table S10); but we cannot necessarily say that these correlations reflect causal relationships.

Lastly, our analysis does not assess the effectiveness of the analyzed bills in reducing emissions. Previous studies aim to quantify the emissions reductions achieved as a result of Renewable Portfolio Standards, since they have been in place in enough states for long enough for researchers to measure their effects on increasing renewable energy generation (Barbose et al. 2016; Greenstone and Nath 2020; Wiser et al. 2016). Our study, in contrast, includes more recent policies dating back to 2015 in addition to a variety of bills whose measured effects on emissions have not been studied yet. Given that all bills are not equally impactful in reducing emissions, bill characteristics that our analysis suggests promoting bipartisanship and passage may not always align with bill characteristics that constitute an ideal climate policy (from the perspective of rapid decarbonization). We briefly discuss this tension—between ambition and consensus/pragmatism—below in the context of Democratic-party politics.

4.3 Policy implications

Each decarbonization policy comes with a story that includes stakeholders, a regulatory climate, political conditions, and spheres of public interest or disinterest. Suggesting that a certain type of policy is best to propose would disregard the high levels of variability and complexity within the policy-making processes and external factors unique to each state government. However, combined with previous literature and illustrative examples, our results provide insights into possibilities for bipartisanship in future climate-mitigation legislation.

4.3.1 Legislative opportunities in red and purple states

Decarbonization bills often pass in blue states and purple states, and states with Democratic-controlled governments. However, we also find that a sizable minority of recent bills passed in purple and red states with Republican-controlled governments. These bills could serve as seeds of future bipartisan action. Examples from press releases and grey literature provide poignant examples that are representative of the statistical patterns we found in these bills—especially the role of expanded choice and some types of financial components in such successes.

For instance, Georgia's solar market is a bright spot among states that are historically controlled by Republican trifectas. In 2015, the Solar Power Free-Market Financing Act lifted restrictions that prevented the solar market from growing (H.B. 57 2015). This new legislation allows businesses and individuals to participate in lease finance agreements. In 2019, Georgia had the fifth largest solar market in the U.S. SEIA (2020) and is making strides in utility-scale solar through projects on farmland and agreements with agricultural leaders (Hsu and Kelly 2019). When the law initially passed, Craig Briscoe, Executive Director of Georgians for Solar Freedom told Atlanta Progressive News:

> "We advocate for solar through free market principles, so anything that introduces a new energy source, creating competition, the result is gonna be costs to be lowered… for the consumers to be the benefit of that occurrence. We advocate for anything that lowers consumer cost," The legislation "benefits the folks who hold those free-market principles and the environmentalist contingency—it's very seldom when it's a win–win… This is good politics, good policy' (Cardinale 2015).

Other bright spots in historically Republican-controlled states include Arkansas' Solar Access Act S.B.145 (2019) and South Carolina's Energy Freedom Act H.3659 (2019). Both include multiple functions to improve accessibility to solar in their respective states, passed with unprecedented legislative support, and included a variety of stakeholder interests in the development stages. The Solar Access Act enables solar leasing and third party purchasing, triples the maximum solar size limit for businesses, and adopts a grandfathering provision to protect solar customers from future rate changes. In a statement from one of the original sponsors,

> "It's a great day for the Arkansas consumer. They will have more choices in the market now" (Moody 2019).

The Solar Freedom Act in South Carolina includes an innovative change in the way utilities measure costs. This policy emphasizes an avoided cost calculation methodology, or "the cost avoided by not building another unit of utility-owned traditional power generation" (Robbins and Mango 2019). This legislation also includes support for battery storage technology and investments in solar energy. These policies highlight clear aspects of expanded consumer choice and financial incentives in context of free market principles.

Our finding that Republican and divided states pass climate legislation with greater bipartisanship and vote shares suggests that Democrats broadly support all kinds of decarbonization policies. From the Republican perspective, this suggests that Republicans could have outsized influence on climate policy, if they embrace the goal of decarbonization.

4.3.2 Non-legislative opportunities in red and purple states

In addition to opportunities for bipartisanship in climate legislation, it is also worth noting opportunities for non-legislative decarbonization initiatives in red and purple states. For instance, Georgia does not have legislated emissions standards or REEPS policies, yet is leading the surge in renewable energy nationwide (Hsu and Kelly 2019). State policies are not driving this adoption in many red states; rather, strong market forces through federal tax credits and the abundance of solar and wind resources are likely to have spurred this trend (Gerdes 2021). As of 2019, Kansas, Iowa, North Dakota, Oklahoma, Wyoming, Nebraska, and South Dakota, made the top ten according to the measure of wind and solar generation as a percentage of electricity consumption (Dutzik et al. 2020).

In the most recent general election, Biden voters made up 70% of the U.S. economy from 477 counties, while Trump voters made up just 29% of the economy from 2497 counties (Muro et al. 2020). Economic activity is concentrated in blue counties, making renewable energy investments a key opportunity for purple and red states and local governments going forward.

> "Wind has been a godsend—it allows flexibility in budgeting by providing a constant source of revenues that you know will be there when you need them." Don Allred, Oldham County, KY judge (Gerdes 2021).

4.3.3 Mandates

Our analysis found that REEPS and emissions standards—which often have farthest-reaching intent regarding decarbonization—were overwhelmingly passed by Democrats; Fig. S11) and received lower vote shares when passed, on average, than other types of policies (Table S9); Hess et al. (2016) found similar results for pre-2015 bills. However, a 2020 study on legislator opinions on renewable energy policies (Lee and Stecula 2020)

found that renewable energy mandates are more popular among subnational policymakers than the other choices provided in 2015 and 2017 surveys—carbon taxes, cap and trade, and emissions standards. This may suggest an opening for bipartisanship on mandates in the future, if public opinion demands one of these options. In such a case, it is possible that combining REEPS and emissions standards with certain framing components that we found to have broader bipartisan appeal (e.g., expanded choice) could broaden the support for REEPS policies. To explore this, Table S12 shows passage rates and mean vote shares (among passed bills) for REEPS bills and emissions standards, grouped by their framing components (expanded choice, financial component, environmental justice). Bills with environmental justice components seemed to receive lower vote shares when passed (with a caveat of small sample sizes), but there are not clear differences in passage rate and vote share across these framing components otherwise (Table S12).

4.3.4 Debate among Democrats on bipartisanship

As mentioned above, our findings that certain types of bills pass less often, receive lower vote shares, and/or are less often bipartisan do not necessarily imply that these policies (e.g., REEPS, social justice indicators) are not worth pursuing in contexts (e.g., some Democrat-controlled states) where they can pass. Indeed, given that Democrats (both voters and lawmakers) broadly favor a wider range of climate policies than Republicans, there is a current debate in the public square over whether Democrats should unilaterally push climate legislation through when the opportunity arises, or if they should prioritize bipartisan efforts to reduce the chance that any of their actions would be undone by the next administration.

One hypothesis related to this debate, that recent history seems to support, is that actions with broad popularity among voters can be successfully pursued unilaterally, even if politics and lobbying prevent bipartisan cooperation on these actions legislatively. The rationale is that undoing a popular policy—even if it was passed into law by only one party—is difficult politically, and thus a party can win both politically and in terms of their policy goals by pushing through popular policies unilaterally. The Affordable Care Act (Obamacare) may provide an example of such an initiative—now broadly popular, passed unilaterally by Democrats, and not easily reversed (Norman 2017).

Recent polls and local developments may suggest ambitious renewable energy targets might be an example of a broadly popular policy, even though we find it has recently been disproportionately passed in a uni-partisan (Democrat) manner. As of December 2020, 254 cities, 10 states, and 12 tribes had committed to achieve the U.S. climate targets set in the Paris Climate Accord through signing the "We Are Still In" declaration (We Are Still In 2020). A 100% renewable energy target or goal has been set by at least 170 cities and 11 counties (Sierra Club 2020), and governors of 25 states have joined the U.S. Climate Alliance with a commitment to take actions that will advance the GHG reduction goals of the Paris Agreement. A recent October 2020 poll from Yale Climate Change Communication also shows that 82% of Americans say 100% clean energy should be the U.S. energy goal (YPCC 2020).

The Green New Deal (GND)—another often-debated proposal backed by many Democrats—includes far-reaching action in environmental and social justice along with financial incentives and new opportunities for renewable energy jobs, among other actions (H.R.109 2019). Recent 2019 polls from Data for Progress reveal that 59% of U.S. voters support the GND, though this support is overwhelmingly Democratic (Data

for Progress 2019). The full passage of a GND type of policy may be less likely due to high levels of partisanship and some level of division even among Democrats (Gardner 2018), though a new report from Evergreen Action and polling from the Yale Program on Climate Change Communication shows that a federal Clean Electricity Standard is within reach in the coming years through possible budget reconciliation measures (Stokes and Ricketts 2021).

4.4 Future research

Our analysis focused on specific characteristics of bills. Future research should explore the effects of bundling multiple policies together in single legislation, as legislation becomes increasingly complex. One recent example is the national December 2020 COVID-19 relief bill that included multiple actions related to renewable energy incentives and pollution prevention, with the most significant action being the phaseout of hydrofluorocarbons (HFC) by 2035 that could result in 0.5C of avoided warming (Pilkington 2020). In a recent December 2020 report from the Center for New Energy Economy, bills with multiple functions (coined as omnibus bills) increased nationally from 2016 to 2019 (Crew et al. 2020). Examples in this analysis include Vermont's H.40 (2015), which uses a mix of both a standard and on-bill financing for homeowners to improve energy efficiency and New Mexico's Energy Transition Act (S.B.489 2019), which establishes both a new renewable electricity standard and economic relief for affected coal communities.

A recent study of 2476 Americans by Bergquist et al. (2020) evaluated the marginal impact of 40 climate, social, and economic policies on the overall support for climate action and reform. Interestingly, they found that a coalition building approach that couples certain economic and social policies including affordable housing, a $15 minimum wage, or a job guarantee with climate policy makes climate action more popular especially among people of color (Bergquist et al. 2020). The policies evaluated by Bergquist et al. (2020) are similar to our economic justice indicators classification of environmental justice components in decarbonization legislation. Indeed, we found economic justice bills passed in a bipartisan way significantly disproportionately, compared to no justice, in our logit models. However, environmental justice policies with social justice indicators (i.e., invoking academic jargon or non-neutral with respect to immutable characteristics) were not evaluated by Bergquist et al. (2020). These findings raise the question of how voters might respond to different combinations of economic justice indicators, social justice indicators, and other kinds of climate-mitigation policy. More broadly, future research should assess how combining various climate and non-climate policies affect support.

Another important future research objective is comparing the effectiveness of climate-mitigation policies, especially in combination with assessment of political feasibility. A particularly important question is whether and to what extent there is a tradeoff between political feasibility and ambition. RPS is arguably the policy type that has been researched the most in terms of its effectiveness (e.g., see Barbose et al. (2016), Greenstone and Nath (2020), Wiser et al. (2016), and refs. therein), though newer programs like PACE (one recent study on PACE program impacts on California's economy—Rose and Wei 2020), shared renewable projects, and an assortment of financial incentives have not been heavily studied from a state or national level relating to estimated emissions reductions. Additionally, future research on this topic could gauge whether preliminary policies such as task forces, studies, and pilot programs are developed into long-lasting policies and programs.

5 Conclusion

Bipartisanship may be key to sustained climate mitigation on decadal scales in the U.S. Though bipartisanship faces documented challenges related to increasing tribalism, inherent ideological clashes, and monied special interest group influence, our analysis shows that there are opportunities to enact certain state-level decarbonization policies with both legislative and popular support. We found that a number of bills pass in Republican-controlled state legislatures, certain characteristics are associated with bipartisan co-sponsorship and higher vote share totals, and some pass more than others. Bipartisan bills since 2015 take on different characteristics and are intended to serve a variety of functions, but are disproportionately present in divided states, and are likely to include expanded choice and economic justice indicators, and lack social justice indicators (though exceptions to these patterns exist). Our results show what types of bills have passed in different political and partisan contexts, which could inform efforts to scale up climate mitigation nationally.

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Data availability Raw data used in our analysis are available as Supplementary Material.

Materials availability N/A.

Code availability JMP Journals used to run analyses are available from the corresponding author on request.

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