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The durable, bipartisan effects of emphasizing the cost savings of renewable energy

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Effective communication can help increase bipartisan support for renewable energy. Prior research suggests that support for renewable energy may be determined, in part, by which of its benefits are emphasized. Here we use a three-stage, longitudinal experiment ($N = 2,891$) to compare the immediate and over-time effects of three informational frames of renewable energy's benefits (cost savings, economy boost and global warming mitigation). We tested each message's effects on US Democrats' and Republicans' beliefs about and support for renewable energy, and we compared the longevity of these effects over a period of three weeks. We find that cost savings was the most effective frame—both in terms of immediate effect size on beliefs and in the longevity of those effects—with negligible differences between political groups. The durability of all effects exhibited a consistent pattern: an initial steep drop in effect size followed by a plateau.

To avert catastrophic disruption to the world's climate, nations must transform their energy systems to limit CO_2 emissions[1]. The United States plays a particularly important role in this effort, due to its leadership on the global stage, its market power and its substantial contributions to historical and current carbon emissions. Reducing US carbon emissions requires a major transformation of the energy system, and public support is crucial to enacting and sustaining transformative energy policy. While policy design plays an important role in boosting public support and mitigating potential backlash[2–4], communication of the costs and benefits of energy policy also plays an important role. In particular, the way that renewable energy is framed—which characteristics about it are emphasized—shapes public perceptions of renewables and support or opposition for government policies that would either maintain or transform the energy system[2,5–8]. It is thus important to investigate which communication strategies have lasting effects on public beliefs about renewable energy and support for policy to expand it.

Extant scholarship assessing energy policy communication has shown that perceived costs play an important role in shaping public support for energy policy[7]. The concept of framing is a focus of this literature. We refer to frames in communication as the strategic choice to emphasize certain aspects of an issue instead of others to shape the way people perceive the issue[9–11]. Emphasizing different aspects or perspectives of environmental and sustainability issues can (but do not always[12]) influence the attitudinal and behavioural responses of the audience.[8,13–18] In this vein, studies have shown that support for renewables decreases when their costs are emphasized[2,5,19,20] and increases when economic benefits are emphasized.[2,13]

Scholarly understanding of the role of costs in shaping energy policy attitudes lags current energy market realities. Extant research on cost-framing effects have focused primarily on messages emphasizing *increased* household-level energy costs. In recent years, however, renewable energy has become cheaper than coal for electricity generation in many locations.[21,22] This new situation provides new opportunities to build public support for renewables in response to *savings* in household-level energy costs.

We should not assume that messages emphasizing savings will be just as influential as those emphasizing costs but in a positive direction. Instead, people tend to be more motivated to avoid losses than to capture equivalent gains[23,24]. This implies that messages highlighting cost savings (a gain) might not impact support for renewables as much as a message threatening a cost increase (a loss). In the present study, we explore the effects of a cost savings frame on beliefs, attitudes and policy support related to renewable energy, and we compare the effects of a cost savings frame with alternative frames emphasizing other benefits of renewable energy: economic growth and global warming mitigation.

Research also suggests that Democrats and Republicans might react differently to information about these different benefits of renewable energy. Large partisan differences persist in US attitudes about climate change[25,26] and their support for policy proposals that would expand renewable energy in the United States[27]. Democrats and Republicans are differentially sensitive to cost considerations associated with renewable energy policy[28] and to framing effects in the context of climate and energy issues[29], in part because partisan motivations for supporting renewable energy differ. For example, Democrats are probably motivated (more so than Republicans) by a desire to mitigate global warming, whereas Republicans' support for renewable energy is driven (more so than Democrats') by a desire to reduce costs, create jobs and increase energy independence[30]. As such, emphasizing different benefits of renewable energy through framing might have different effects for these political groups. We examine these differences in the present study.

Finally, this study investigates the longevity of these framing effects. The vast majority of research on framing effects has measured the effects at only one time point: moments after exposure to the message. Relatively little is known about the durability of these effects over time. Some recent work suggests that the effect of informational messages might have a persistent effect on public attitudes[31,32]. Building on this work, we explore the durability of framing effects in the context of renewable energy by measuring both the immediate framing effects and the longevity of those effects over a three-week period.

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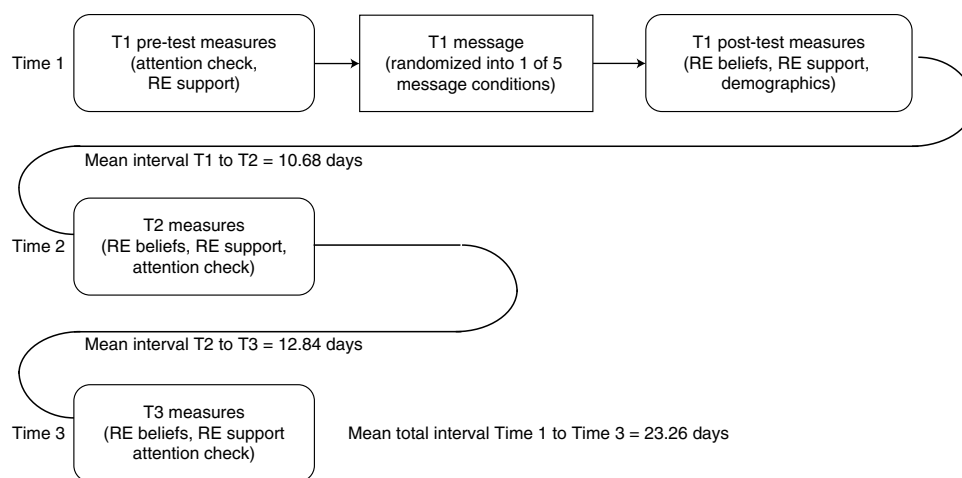
Fig. 1 | The design of the three-stage longitudinal experiment. The design of our study, in which we estimated the effect of different frames on respondents' beliefs and support for renewable energy. RE = renewable energy.

Our study found that emphasizing the cost savings of renewable energy (instead of economic growth or global warming mitigation) was the most effective frame in terms of its immediate effect on beliefs about renewable energy and the longevity of those effects—with negligible differences between political groups. The cost savings frame also had a small effect on support for renewable energy in both political groups. In comparison, the two messages emphasizing global warming mitigation and economic growth, respectively, had smaller initial effects on beliefs and support and exhibited patterns of partisan differences in their immediate effects and potentially in the durability of those effects as well.

Design of the longitudinal experiment

For this study, we conducted a three-stage longitudinal experiment (Fig. 1) to test how messages emphasizing different benefits of renewable energy affect beliefs and policy support regarding renewable energy. This experiment also tested the durability of each of these effects and how the immediate and over-time effects, respectively, compare between Democrats and Republicans. Participants in this experiment were randomly assigned to view different versions of a message about renewable energy. These messages varied with respect to which benefits (cost savings, economy and jobs, global warming or none) were emphasized. The stimuli are available in the online supplementary materials (Supplementary Note 1). For the dependent variables in this study, we measured participants' beliefs about renewable energy (Table 1) and general level of support for it (using a diverse five-item index; Table 2) immediately after the message (Time 1), after a delay of about 11 days (Time 2) and after a delay of another 13 days (Time 3). We chose this interval because longer intervals (a few months) risk high attrition rates but shorter intervals (a few days) cannot assess high durability. Further, Coppock and colleagues[32] found that about 50% of persuasion treatment effects decay after about ten days. We wanted to choose the longest possible interval before complete decay, so we aimed for an average interval of three weeks. Our pre-registered hypotheses, research questions, methods and data are posted on the Open Science Framework platform (https://osf.io/6cf93).

In a first set of analyses, we estimate the effects of each of the three message frames on individuals' beliefs in the factual claim made by the message. We estimate the effect of the savings frame on beliefs about the costs of renewables, the effect of the economy and jobs frame on beliefs about jobs and economic growth associated with renewables and the effect of the global warming frame on

Table 1 | Measures of beliefs about the benefits of renewable energy administered at Time 1 (T1), Time 2 (T2) and Time 3 (T3)

Item	Question stem	Response options
Economy/jobs growth	Overall, do you think that transitioning from fossil fuels (such as coal) to renewable energy sources (solar, wind) as a way to produce electricity:	(1) Reduces economic growth and costs jobs; (2); (3); (4) Has no effect on economic growth or jobs; (5); (6); (7) Improves economic growth and provides new jobs
Cost savings compared to coal	To the best of your knowledge, does electricity produced from renewable energy (solar, wind) cost more, less or about the same as electricity produced from coal power plants?	(1) Renewables cost much more than coal (2) '…somewhat more…' (3) '…slightly more…' (4) '…about the same as…' (5) '…slightly less…' (6) '…somewhat less…' (7) '…much less…'
Reducing global warming	If all nations of the world switched to 100% renewable energy by 2050, *how effective would that be at limiting global warming?*	(1) Not at all effective; (2); (3); (4) Moderately effective; (5); (6); (7) Extremely effective

beliefs about whether switching to renewables would limit global warming. We also estimate the effect of each message on people's general support for renewable energy, operationalized by an index of five measures including support for local development of renewable energy, support for requiring public utilities to use renewable energy and individual purchasing intentions (Methods). These effects are estimated separately for Democrats and Republicans, because partisans differ in their baseline beliefs and motivations for supporting renewable energy. All effects are estimated using ordinary least squares (OLS) regression, with dependent variables standardized within each partisan subgroup.

Table 2 | Items measuring support for renewable energy policies

Item	Question stem	Response options
National priority	How high or low of a priority should the following be for the president and Congress? Developing renewable energy sources, such as solar and wind power.	(1) Extremely low priority; (2); (3); (4) Medium priority; (5); (6); (7) Extremely high priority
Research funding	How much do you support or oppose the federal government funding more research into renewable energy, such as solar and wind power.	(1) Very strongly oppose; (2); (3); (4) Neither support nor oppose; (5); (6); (7) Very strongly support
State-level policy	How much do you support or oppose your state *requiring* that electric utilities produce 100% of their electricity from renewable energy sources (such as wind and solar) by 2050?	(1) Very strongly oppose; (2); (3); (4) Neither support nor oppose; (5); (6); (7) Very strongly support
Local area development	How much do you support or oppose large developments of renewable energy sources (such as wind and solar) in your local area?	(1) Very strongly oppose; (2); (3); (4) Neither support nor oppose; (5); (6); (7) Very strongly support
Individual behavioural intentions	If your local utility company gave you the option to purchase electricity that came from 100% renewable energy sources, how likely would you be to do it?	(1) I definitely would not do it; (2); (3); (4) I might do it; (5); (6); (7) I definitely would do it; (98) N/A: I do not purchase electricity from a utility company; (99) N/A: I already get my electricity from 100% renewable energy sources

We expect that the cost savings and the economy and jobs frames will have positive effects among both political parties. However, the effects of the global warming frame are more difficult to anticipate. Many Democrats already believe that renewable energy helps reduce global warming, so ceiling effects may limit our ability to detect persuasion. Conversely, many Republicans may be resistant to this claim, in part because of its connection to global warming[33,34]. Thus, we do not have clear expectations about the effect of the global warming frame.

We also examine the durability of the framing effects over a three-week period, and we expect that the durability of effects may differ for Democrats and Republicans. Effect durability may depend on how (in)consistent the message is with a person's existing beliefs, ideologies or identity. Canonical research on motivated reasoning suggests that people would be more likely to return to their prior beliefs if the treatment message was inconsistent with those beliefs. This differential decay in effect sizes would be due to a 'disconfirmation bias' in which people counterargue messages that conflict with their prior beliefs[35,36]. However, there is also evidence for a competing perspective. Recent research provides evidence for a Bayesian learning framework in which people update their beliefs in line with a message, regardless of their initial beliefs[37–39]. To explore these competing predictions, we examine differences in the durability of effects across treatments and between partisan groups.

This study examines framing effects on two outcomes: factual beliefs and the composite support variable. Intuitively, factual beliefs about the benefits of renewable energy are the most proximate outcome of our informational messages about the benefits of renewable energy. However, prior research shows that simple informative messages can also lead to changes in other relevant beliefs, attitudes and intended behaviours[2,40,41]. We expect that Republican support for renewable energy will be positively affected by messages emphasizing the economic benefits and cost savings of renewables. But based on prior research showing that global warming can function as a 'polarizing cue'[33,42], we expect that the global warming frame may not affect Republicans' support for renewable energy. For Democrats, we expect that all three frames will increase policy support, although we suspect that ceiling effects may limit the magnitude of the frames' effects on policy support.

Immediate and over-time effects

Figure 2 shows the effect of each of the three framing treatments on beliefs about the costs (Fig. 2a), economic benefits (Fig. 2b) and global warming-related (Fig. 2c) characteristics of renewable energy at time points 1, 2 and 3. Consistent with our expectations, both the

savings and economy and jobs frames had a significant and positive effect on the corresponding beliefs of Republicans and Democrats. We also find a significant positive effect of the global warming frame on both political groups, with the effect (reported here as Cohen's d) significantly larger among Democrats ($d = 0.43$, $P < .001$, 95% confidence interval (0.27, 0.60)) than Republicans ($d = 0.17$, 95% CI (0.00, 0.33)), as determined by a z-test ($z = 2.26$, $P = .012$) (ref. [43]).

The estimates shown in the second and third columns of Fig. 2 support our expectation that the treatment effects would diminish over time. While six of the eight effects remained significant at Time 2, all effects exhibited a substantial initial decrease from Time 1 to Time 2 and then a plateau from Time 2 to Time 3. For the cost savings frame, among Democrats, 49% of the original Time 1 effect remained at Time 2 and 44% remained at Time 3. Among Republicans, 54% of this effect remained at Time 2 and 57% remained at Time 3.

For the economy and jobs frame, among Democrats, about 28% of the original Time 1 effect on beliefs remained at Time 2 and 15% remained at Time 3. However, among Republicans, 71% of that Time 1 effect remained at Time 2 and 66% remained at Time 3.

For the global warming frame, among Democrats, about 57% of the Time 1 effect on beliefs remained at Time 2 and 36% remained at Time 3. However, among Republicans, the global warming frame effect turned negative at Time 2 (a decrease of 147% from the Time 1 effect) and settled near zero in Time 3 (1% of the original effect size).

Figure 3 shows how the durability of the effects on corresponding beliefs varies across messages and between political groups. The cost savings message was the only treatment that had highly durable effects on beliefs within both political groups, and the durability of this effect was about equal for Republicans and Democrats.

The results provide suggestive but inconclusive evidence that the durability of the effects of the economy and jobs and global warming frames differed between Republicans and Democrats. Descriptively, the effect of the economic frame appears substantially more durable among Republicans than Democrats. However, z-tests show that these differences are just outside the typical threshold for statistical significance for the effect remaining at Time 2 ($z = 1.81$, $P = .070$) and Time 3 ($z = 1.84$, $P = .066$). This indicates a difference in effect longevity that is not statistically significant due to the uncertainty of the estimates. For the global warming treatment effect, point estimates of effect durability were larger for Democrats than Republicans, with no durability at all among Republicans yet substantial durability among Democrats. Here again, the uncertainty of the estimates—particularly for Republicans—makes it difficult to draw firm conclusions.
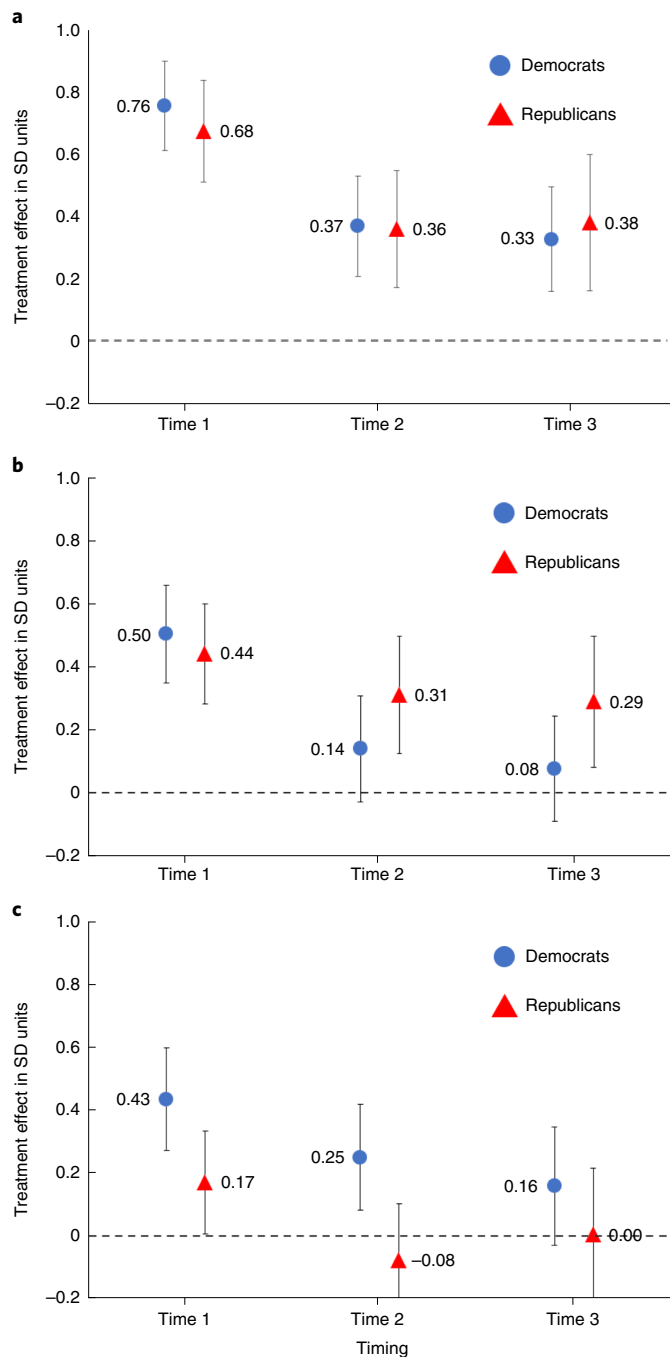
Fig. 2 | Framing effects on corresponding beliefs by political party. a–c, Values represent the standardized effect of each message (cost savings frame (**a**), economy and jobs frame (**b**), global warming frame (**c**)) as compared with the true control condition on its corresponding belief variable at Time 1, Time 2 and Time 3. Error bars indicate 95% confidence intervals around the mean. Dependent variables are standardized within party and reflect respondents' beliefs that renewables are less costly than fossil fuels (**a**), promote job growth and economic development (**b**) and can limit global warming (**c**). Time 1 Republicans $N = 1,403$, Democrats $N = 1,488$; Time 2 Republicans $N = 1,122$, Democrats $N = 1,338$; Time 3 Republicans $N = 893$, Democrats $N = 1,178$.

The extremely wide and unbalanced confidence interval for the longevity of the global warming frame's effect among Republicans (Fig. 3c) is expected for values close to zero, because small absolute differences in values become proportionally massive. Prior work has noted that this is a difficult challenge in estimating differential durability[37], and we are conservative in the conclusions we draw concerning partisan differences in effect durability.

We next turn to the results of the frames on individuals' support for renewable energy (Fig. 4). The savings frame and the economy and jobs frame each had a small but significant positive effect on Republicans' support for renewable energy (Fig. 4a). In contrast, the global warming frame did not significantly affect Republicans' support. This is consistent with our expectation that the effect of a global warming frame might be blunted for Republicans. Only the cost savings frame had a significant positive effect on Democrats' support (Fig. 4a). Consistent with our expectation, the data suggest a potential ceiling effect. Democrats' pre-test scores on the composite support variable were very high (their pre-test unstandardized mean score, an average of the five 'support' items, was 6.07 on the 7-point scale). These small initial effects of these treatments on the support variable do not allow for detecting differences among groups or tracking decay over time (because they are already near zero), so we do not elaborate on those points in this paper but instead encourage future research to investigate this further with larger initial treatment effects.

Figure 4b shows the effect of the savings and economy and jobs frames, compared with the global warming frame, on Republicans' support for renewable energy policy. Building on prior work showing that global warming can serve as a 'polarizing cue'[33,42], we expected that the effect of the global warming frame would be smaller for Republicans than the effect of financial and economic frames. Consistent with this expectation, Republicans' support was higher in response to the cost savings frame condition than the global warming frame (Methods), $d = 0.07$, $P = .006$, 95% CI (0.02, 0.12). While the difference in support between the global warming frame and the economy and jobs frame was not statistically significant, the pattern was in the expected direction and would be significant at $P < .05$ if we had used one-tailed tests (instead of using two-tailed tests as a conservative approach). Regardless, the effect size is extremely small.

Discussion

In this study, we tested the effects of messages emphasizing the cost savings, economic benefits and global warming implications of renewable energy on US beliefs about renewable energy and their support for renewable energy. Thus far, research on the effects of renewable energy communication has tested only immediate effects—with measurements taken moments after exposure to the message. We advance this research by examining the durability of the effects of these communication frames. We also compare the immediate framing effects and the durability of those effects among Democrats versus Republicans.

Among both Democrats and Republicans, the cost savings frame was the most effective frame at influencing Democrats' and Republicans' beliefs about renewables and the index of support for renewable energy. The economy and jobs message had a slightly weaker effect on beliefs and support among members of both parties. The effect of the global warming frame on beliefs was weaker for members of both parties, and this effect was substantially smaller for Republicans than Democrats. We did not find differences between parties in the effects of the global warming frame on the support index, probably because the effects among both Democrats ($d = 0.05$) and Republicans ($d = 0.02$) were too small for differences to be detected. Overall, US citizens appear to be particularly sensitive to messages emphasizing the lower costs of renewable energy (as shown in the present study) and emphasizing higher costs (as shown in prior research). Given the rapidly decreasing costs of renewable energy, this suggests that emphasizing lower costs is a promising and widely applicable communication strategy.
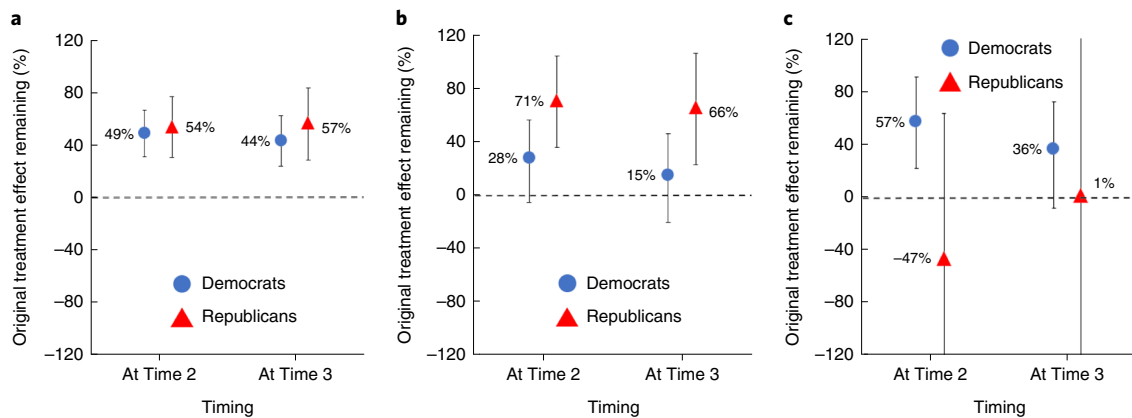
Fig. 3 | Portion of effect remaining by party. a–c, The figure shows the durability of the effects of each of the Time 1 treatment frames (economy and jobs (**a**), cost savings (**b**) global warming (**c**)). Plotted values are the percentage of the initial treatment effect remaining at each time point. Error bars indicate bootstrap 95% confidence intervals around the mean. The 95% confidence intervals in **c** for Republicans are $T2_{lower} = -7.67$, $T2_{upper} = 0.63$; $T3_{lower} = -3.81$, $T3_{upper} = 1.22$. These extremely wide confidence intervals are caused by this measure of durability being a ratio, so small absolute differences become proportionally massive for values close to zero. Time 2 Republicans $N = 1,122$, Democrats $N = 1,338$; Time 3 Republicans $N = 893$, Democrats $N = 1,178$.
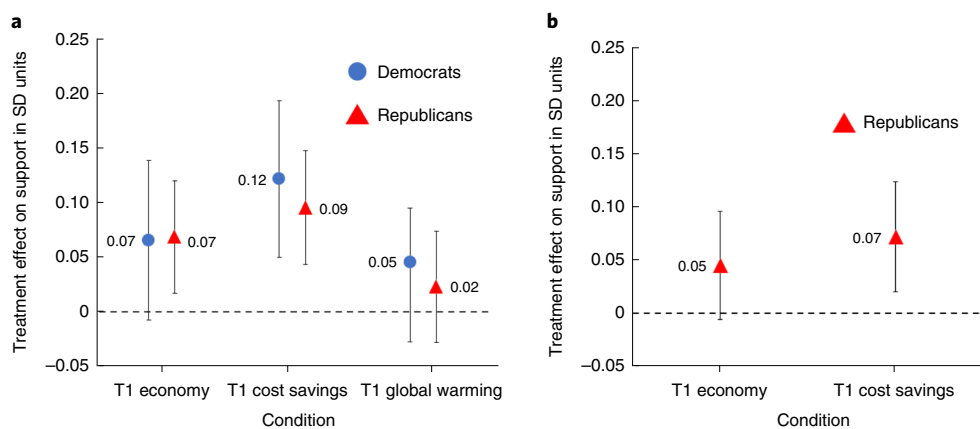
Fig. 4 | Framing effects on support by political party. Values represent the standardized effect of each message on support for renewable energy. SD = Standard deviation. Error bars indicate 95% confidence intervals around the mean. **a**, The immediate (Time 1) effects of the three frames, compared with the true control condition, on support for renewable energy. **b**, The effect of the Time 1 cost savings and economy and jobs frames, compared with the global warming frame, on the composite support variable. Republicans $N = 1,403$, Democrats $N = 1,488$.

We find that all framing effects exhibited an initial steep drop in effect size followed by a plateau. While the initial effect of the economy message frame on beliefs was about equal in the two political groups, this effect decreased to nearly zero among Democrats over the three-week period. The effect of the global warming frame, which was weak among both parties even initially, soon dissipated to zero among Republicans. In contrast, the effect of the cost savings frame proved relatively durable. Nearly half of the immediate persuasive effect of the cost savings frame on beliefs about renewable energy remained after three weeks among both Democrats and Republicans. These findings concerning the durability of effects provide key practical insights for renewable energy communication.

The study opens several opportunities for further enquiry. We find that exposure to a single simple informative message has a substantial effect on beliefs about renewable energy that persists for at least three weeks. The size of the remaining effect at Time 3 varied greatly across message conditions and political groups, and this variation appears to depend on the size of the initial effect. Future research could further investigate how such effects decay over longer time intervals.

Also, future research should test the immediate and over-time effects of other messages and message formats. Our treatments were designed to be brief and scalable, so that the findings can be applied to large-scale communication contexts (for example, social media, advertising). One trade-off associated with this is that brief, simple messages often have small (or non-significant) effects. It is possible that larger effects on support for renewable energy would be found using different treatments, such as messages that spark deeper engagement through longer exposure or a more immersive medium.

Our findings also invite future research about whether the durability of framing effects about sustainable technology differs by political party affiliation. We find suggestive evidence for differential durability. Much of the global warming frame's effect persisted over time among Democrats, but none of the effect persisted among Republicans. Conversely, two-thirds of the economy and jobs frame's effect remained among Republicans after three weeks, but only 15% remained among Democrats. However, the point estimates of proportional effect longevity are highly uncertain. As a result, our (under-powered) statistical tests of differential durability

do not allow us to reject the null hypothesis that effect durability is the same among Democrats and Republicans. While our results are descriptively suggestive, we do not claim these findings to be convincing evidence of differential effect longevity between political groups. Further research—designed with larger cell sizes and stronger treatment effects—could provide more confident conclusions about the differential durability of framing effects between political groups. Yet, regardless of whether political groups differ substantially in the durability of the treatment effects, it is still of practical importance to note that the durability of effect of the cost savings frame did *not* differ between groups. This frame's bipartisan appeal suggests practical value in polarized political environments.

The findings of this study should be interpreted in light of its limitations. One potential limitation is that the economy message discussed both economic growth and job growth, and the measure mentioned both aspects as well. For some participants, this could be a double-barrelled question if they had substantially differing opinions about those two facets. Also, the cost savings belief measure used the clause 'to the best of your knowledge' while the other two belief measures used the clause 'do you think that'. While these phrasings are unlikely to have a meaningful effect on the overall results, they may introduce measurement error in our dependent variables. However, such measurement error would increase the standard errors, biasing the study against finding a significant effect.

Overall, this study identifies the relative advantages of a cost savings frame for shifting public beliefs and support for renewable energy and contributes important evidence about the longevity of message effects over time. Both sets of findings provide actionable insights for scholars and practitioners working in a changing energy landscape. We hope that this study also catalyses additional research on the immediate and over-time persuasive effects of informative messages about renewable energy and other sustainability issues.

Methods

Pilot test. Before the main study, we conducted a pilot test ($N = 549$) to assess whether the framing manipulations embedded in the main study's Time 1 stimulus messages are noticed and correctly interpreted by participants. This is done by measuring the effects of the treatments (messages emphasizing the benefits of renewable energy) on beliefs about the benefits of renewable energy. The results of the pilot test indicated that all three treatments had significant positive effects on the corresponding beliefs about renewable energy (that it increases economic growth and jobs, that it costs less than coal, that it helps reduce global warming). The full methods and results of the pilot test are presented in Supplementary Note 2.

Main study overview. The main study was a survey experiment that spanned three time points (Fig. 1). Time 1 was a survey experiment testing the effects of three frames of renewable energy's benefits on beliefs about those benefits (Table 1) and on general support for renewables (Table 2). After about ten days, all participants from Time 1 were invited to participate in Time 2, which re-assessed beliefs and then also implemented a second experiment for a different study testing the immediate and over-time effects of an animated video emphasizing a social norm of support for renewable energy. This Time 2 treatment does not affect the present study, because Time 2 beliefs were measured before the Time 2 treatment was administered, and random assignment into the Time 2 conditions ensured that all Time 1 conditions contained equal amounts of individuals in the Time 2 treatment and control groups. Further, the Time 2 treatment did not have a significant effect on the Time 3 beliefs about renewable energy. After an additional interval of about ten more days, all Time 2 participants were invited into Time 3, which again assessed beliefs about and support for renewable energy. At all three time points, participation occurred in the Qualtrics online survey environment. In each survey, participants were first informed of their rights and data privacy policies, indicated their consent to participate and then began that portion of the study.

Sample and recruitment at each time point. Participants were recruited from Prolific, a pool of online workers. To ensure a balanced distribution, we used Prolific's preset filters to recruit only self-identified Republicans or Democrats in the United States.

The Time 2 survey was made available only to those who completed Time 1, and the Time 3 survey was made available only to those who completed Time 2. All three study recruitment descriptions made no mention of the study's topic or that it was related to the prior time points. That is, participants opted in to participate in Time 2 and Time 3 without knowing that it was connected to a prior study time

point. This helped to mitigate potential biases resulting from selective attrition between time points. Analyses reported in Supplementary Note 4 indicated that attrition across time points did not substantially affect the composition of the sample and is not a likely explanation for the treatment effects or their pattern of longevity. Additional sample demographics are available in Supplementary Note 3.

In total, 3,010 prospective participants entered the Time 1 portion of the study (1,505 Republicans; 1,505 Democrats). After screening for self-reported political party and removing participants who failed an attention check item, 2,891 valid cases remained for analysis (1,403 Republicans; 1,488 Democrats).

All Time 1 participants were invited to participate in Time 2, which (after removing those who failed an attention check item) had a re-participation rate of 80% among Republicans (1,122/1,403) and 90% among Democrats (1,338/1,488), resulting in a total Time 2 N of 2,460. All Time 2 participants were invited to participate in Time 3, which (after removing respondents who failed an attention check item) had a re-participation rate of 80% among Republicans (893/1,122) and 88% among Democrats (1,178/1,338), resulting in a total Time 3 N of 2,071.

Power calculations for the tests of treatment effects were performed with the pwr package in R. The power analysis calculation that had been stated in the pre-registration documents was misspecified, so an explanation for the revised power analysis is given in Supplementary Note 6 along with the code. Here we report the power analysis results (all at $1 - \beta = 0.80$ and $\alpha = 0.05$) for the treatment effects on beliefs about renewable energy, assuming two-tailed tests (as in the research questions). For Democrats' beliefs about renewables, this study is powered to detect treatment effects on beliefs of $d \geq 0.23$ at Time 1, $d \geq 0.24$ at Time 2 and $d \geq 0.26$ at Time 3. For Republicans, $d \geq 0.24$ at Time 1, $d \geq 0.27$ at Time 2 and $d \geq 0.30$ at Time 3. All of these reflect conservative lower bounds. That is, required sample sizes for sufficient power decrease by approximately 15% when using one-tailed tests (that is, more power for the directional hypotheses) and decrease to an ever greater extent when controlling for pre-test levels of the post-test variables and when using an index of items instead of individual items as we do in the current study for analysing the effects of support[44,45].

Procedure of each time point. Upon entering the Time 1 portion of the study, participants first completed a pre-test containing the five-item index representing support for renewable energy, a measure of their need-to-evaluate (a psychological trait used for a different study) and an attention check measure. Next, participants were randomly assigned into one of five experimental conditions. In each condition, participants read one message corresponding with that experimental condition. Each message was a short infographic designed as a summary from a fictitious publication 'American Technology Report' about new technology trends (Open Science Framework project page provides all stimuli). In the three treatment conditions, each message emphasized a different benefit of transitioning to renewable energy: economic/job growth, cost savings or reducing global warming. In a fourth condition (referred to here as the 'no frame' message), the message did not emphasize any of these benefits and instead only defined renewable energy and described its uses. In a fifth condition (the 'true control'), the message presented information about an unrelated topic—artificial intelligence—while using the same formatting as the other messages. This fifth condition is used to determine the effect of the treatments relative to a true baseline of not reading any message about renewable energy.

Next, to briefly take their mind off of the topic of the message, participants completed a 'distractor' word-sorting task in which they dragged and dropped words into boxes labelled with categories (for example, the word 'yellow' into a box labelled 'colours'). Then, participants responded to the measures of beliefs about the benefits of renewable energy (Table 1) and responded to a post-treatment five-item support measure that was identical to the pre-treatment measure (Table 2). Lastly, participants completed demographic measures.

About 11 days after Time 1 data collection started, the Time 2 survey was made available on Prolific (*Mean* = 10.68, Standard deviation = 1.76). Upon entering the Time 2 portion of the study, participants again completed the measures of beliefs about the benefits of renewable energy (Table 1) to assess how much of the Time 1 treatment effects persisted over time. Then, for the purposes of a different study, participants were randomly assigned either to watch an animated video emphasizing a social norm of support for renewable energy or a control video of similar style and length (1.5 min) that explained an unrelated topic (robotic surgery technology). This component of Time 2 does not affect the present study because the participants in each of the Time 1 message conditions were equally divided by random assignment into the Time 2 conditions. After watching their assigned video, participants completed the measures of support (Table 2).

Main study measures. Beliefs about the benefits of renewable energy were measured with three self-report items. The full text of the questions and response options are displayed in Table 1.

In a pre-test and post-test, five different measures of opinion and intended behaviour regarding renewable energy were measured to comprise a general construct of support for renewable energy: perceived national-level priority, support for research funding, support for state-level policy, support for local area development and individual intentions to purchase electricity from renewable sources if their electricity provider gave the option. The full items are listed in Table 2.

Exploratory factor analyses indicated that within the full Time 1 sample and also within each political group separately, the five support variables represent one latent factor, as evidenced by Kaiser's eigenvalue criterion (>1), the scree plot and factor loadings (Supplementary Note 3 provides complete analyses). Therefore, we created a composite variable to represent general support for renewable energy. This composite variable was a regression-based factor score computed from the five individual items using maximum likelihood. This factor score was then standardized within each political party so that all within-party analyses used a standardized variable. Cases where either 'N/A' option was chosen on the behavioural intentions item (about 4% of the Time 1 sample) were treated as missing data during the calculation of the factor scores and therefore were not included in the analyses. We use the factor score variable in this manuscript as our primary measure of support for renewable energy because the focus of the study is on general support for renewable energy. Supplementary Note 4 reports the treatment effects on each individual item that contributed to the composite measure.

At the end of the Time 1 portion, participants reported their age, highest educational attainment level, race or ethnicity, gender and political party affiliation (Republican, Democrat or Independent). These demographic measures are provided in Supplementary Note 3. Partisan 'leaners' (Independents or non-partisans who say they lean Republican or lean Democratic) were included in the Republican and Democrat groups, respectively.

About 13 days after Time 2 data collection started, the Time 3 survey was made available on Prolific (interval $M = 12.84$ days, $SD = 1.20$). In Time 3, the same measures of beliefs and support were repeated to observe longevity of Time 1 and Time 2 treatment effects.

Hypotheses. We pre-registered a series of hypotheses, which formalize the expectations we report in the main text.

First, we examine three hypotheses about the effects of each of the three message frames on individuals' beliefs in the factual claim made by the message. We expect that for both Republicans and Democrats:

Hypothesis 1 (H1): An economy/jobs frame will have a positive effect on the belief that renewable energy improves economic growth and creates jobs.

Hypothesis 2 (H2): A cost savings frame will have a positive effect on the belief that renewable energy costs less than coal.

However, the effects of the global warming frame are more difficult to anticipate. Many people may already believe that renewable energy helps reduce global warming, so ceiling effects may limit our ability to detect persuasion. Conversely, many Republicans may be resistant to this claim, in part because of its connection to global warming[33]. Absent confident expectations, we investigate:

Research question 1 (RQ1): For (a) Democrats and (b) Republicans, how does the global warming frame affect beliefs about the degree to which transitioning to renewable energy would help reduce global warming?

We also examine the effects of the frames on renewable energy policy support. While factual beliefs are the most proximate outcome of factual information about the benefits of renewable energy, prior research shows these informative messages can indeed influence people's level of support for policy and local development[2,40]. However—as in the Gateway Belief Model[41]—effects on support may be smaller than effects on the more proximate construct of factual beliefs. Here we offer separate hypotheses and research questions for Republicans and Democrats due to evidence (noted above) of partisan differences in the effects of renewable energy messages. We expect that:

Hypothesis 3 (H3): Republicans' support for renewable energy will be positively affected by messages emphasizing (a) the positive impacts of renewable energy on economic growth and job creation and (b) the cost savings of renewable energy compared with coal.

In contrast, prior research has demonstrated that global warming can function as a 'polarizing cue', such that using it as the value proposition can result in negative responses among Republicans[33-42]. Therefore, we expect that:

Hypothesis 4 (H4): Among Republicans, a message that emphasizes the positive impacts of renewable energy on economic growth and job creation will result in stronger support for renewable energy than a message emphasizing that renewable energy helps reduce global warming.

Hypothesis 5 (H5): Among Republicans, a message emphasizing the cost savings of renewable energy relative to coal will result in stronger support for renewable energy than a message emphasizing that renewable energy helps reduce global warming.

Among Democrats, however, the potential for ceiling effects makes it unclear whether the global warming frame will significantly affect support for renewable energy—as nearly all Democrats already have strong support for it[30]. It is also unclear whether, among Democrats, the cost savings frame would have different effects than the global warming frame because there is no reason to expect Democrats would be adversely affected by mentioning global warming. Due to this uncertainty, we explore:

Research question 2 (RQ2): Among Democrats, how will the economy and jobs frame, the cost savings frame and the global warming frame, respectively, affect support for renewable energy?

Finally, we examine a series of hypotheses regarding the durability of effects. A small review of a handful of longitudinal framing experiments found that a

portion of the effect often remains past the immediate setting[31]. Additional insights are provided by recent work by Coppock et al.[32], who found that in diverse topics, about 50% of the effect of informational messages remained after 30 days. To contribute insights on persuasion durability in the context of renewable energy, our study measures both the immediate framing effects and the longevity of those effects over a three-week period. We expect that:

Hypothesis 6 (H6): The framing effects on beliefs about renewable energy will be still present after a period of 10–15 days but will be reduced.

Another important open question is whether effect longevity is dependent on how (in)consistent the message is with a person's existing beliefs, ideologies or identity. To our knowledge, this has not been investigated in a longitudinal experimental design, and relevant theory and research point to two competing perspectives.

Widely cited research on motivated reasoning suggests that people would be more likely to return to their prior beliefs if the treatment message was inconsistent with their prior beliefs due to a 'disconfirmation bias' in which they counterargue messages that conflict with their prior beliefs[35,36].

In contrast, Coppock et al.[37,38] argue for a Bayesian learning framework in which people update their beliefs in line with a message, regardless of their initial beliefs. Similarly, a series of 59 political advertising experiments[39] found only partial and weak support for the idea that people are more likely to be persuaded by advertisements that align with their political identity.

Given these competing perspectives about differential longevity of effects, we ask:

Research question 3 (RQ3): Do some of the Time 1 belief effects have greater longevity than others?

Research question 4 (RQ4): Do Republicans and Democrats differ in the longevity of the Time 1 belief effects?

Main study analyses. The Time 1 treatment effects on beliefs about renewable energy among Republicans and Democrats (H1, H2 and RQ1) were tested with a series of OLS regression models, with the dependent variable in each model being a belief variable (economy and jobs, cost savings, global warming), standardized within each political subgroup. We created dichotomous indicators of each experimental condition to use as independent variables, with the 'true control' condition (the message about an unrelated topic) set as the reference group. We report the results as Cohen's d effect sizes, which express the effect of each treatment in standard deviation units. The full regression models for all analyses are displayed in Supplementary Note 5. The pre-registration planned to use ANCOVA for the analysis of treatment effects, but we ultimately used OLS regression for simplicity and ease of interpretation. The results are identical either way.

Like the tests of H1, H2 and RQ1, the effects of the Time 1 treatments on support for renewable energy among Republicans and Democrats (H3, H4, H5 and RQ2) were tested using OLS regression, in which dichotomous variables indicated each experimental condition. The dependent variable was the Time 1 post-test composite support variable, and we included pre-test support as a covariate to increase measurement precision and statistical power. The 'true control' condition was the reference group when testing the effects of the three benefit frames on support. The global warming condition was the reference group when comparing Republicans' responses across the three Time 1 frames (H4 and H5).

H6, RQ3 and RQ4 concern the amount of longevity in treatment effects over time. For H6, we test whether treatment effects decrease over time by inspecting effect sizes and their confidence intervals[46] immediately after the treatment, again at Time 2 (an average of about 11 days later) and again at Time 3 (an additional 13 days after Time 2). For RQ3 and RQ4, we examine whether the proportion of the initial message effects (on beliefs) that persists at later time points is different for Democrats than Republicans. We explore these differences by calculating the proportion between the treatment effects observed at later time points and the immediate treatment effects (that is, T2 effect/T1 effect; T3 effect/T1 effect). Put simply, these proportions represent the percentage of the initial treatment effect that persists at Time 2 and Time 3. To estimate uncertainty around these proportions (that is, standard errors and confidence intervals), and to facilitate comparisons across Republicans and Democrats, we use a non-parametric bootstrapping procedure[37].

Ethics. This study was reviewed and approved by the Yale University Institutional Review Board. All participants gave informed consent before participation and were compensated for their participation at an average hourly rate greater than the US minimum wage.

Reporting summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability
The datasets used for this study (all three time points) are available on the Open Science Framework (https://osf.io/6cf93/) as Statistical Package for the Social Sciences (SPSS) data files (.sav). Alternative data formats are available from the corresponding author upon reasonable request.

References

1. IPCC *Climate Change 2021: The Physical Science Basis* (eds Masson-Delmotte, V. et al) (Cambridge Univ. Press, 2021).
2. Stokes, L. C. & Warshaw, C. Renewable energy policy design and framing influence public support in the United States. *Nat. Energy* **2**, 17107 (2017).
3. Rabe, B. G. *Can We Price Carbon? American and Comparative Environmental Policy* (MIT Press, 2018).
4. Stokes., L. C. The politics of renewable energy policies: the case of feed-in tariffs in Ontario, Canada. *Energy Policy* **56**, 490–500 (2013).
5. Bayulgen, O. & Benegal, S. Green priorities: how economic frames affect perceptions of renewable energy in the United States. *Energy Res. Social Sci.* **47**, 28–36 (2019).
6. Bolsen, T., Druckman, J. N. & Cook, F. L. How frames can undermine support for scientific adaptations: politicization and the status-quo bias. *Public Opin. Q.* **78**, 1–26 (2014).
7. Ansolabehere, S. & Konisky, D. M. *Cheap and Clean: How Americans Think about Energy in the Age of Global Warming* (MIT Press, 2014).
8. Scrase, J. I. & Ockwell, D. G. The role of discourse and linguistic framing effects in sustaining high carbon energy policy—an accessible introduction. *Energy Policy* https://doi.org/10.1016/j.enpol.2009.12.010 (2010).
9. Chong, D. & Druckman, J. N. Framing theory. *Annu. Rev. Political Sci.* **10**, 103–126 (2007).
10. Druckman, J. N. The implications of framing effects for citizen competence. *Political Behav.* **23**, 225–256 (2001).
11. Entman, R. M. Framing: toward clarification of a fractured paradigm. *J. Commun.* **43**, 51–58 (1993).
12. Bernauer, T. & Mcgrath, L. F. Simple reframing unlikely to boost public support for climate policy. *Nat. Clim. Change* **6**, 680–683 (2016).
13. Bain, P. G., Hornsey, M. J., Bongiorno, R. & Jeffries, C. Promoting pro-environmental action in climate change deniers. *Nat. Clim. Change* **2**, 600–603 (2012).
14. Clarke, C. E. et al. Public opinion on energy development: the interplay of issue framing, top-of-mind associations, and political ideology. *Energy Policy* **81**, 131–140 (2015).
15. Feinberg, M. & Willer, R. Apocalypse soon? Dire messages reduce belief in global warming by contradicting just-world beliefs. *Psychol. Sci.* **22**, 34–38 (2011).
16. Myers, T. A., Nisbet, M. C., Maibach, E. W. & Leiserowitz, A. A. A public health frame arouses hopeful emotions about climate change. *Climatic Change* **113**, 1105–1112 (2012).
17. Nisbet, M. C. Communicating climate change: why frames matter for public engagement. *Environment* **51**, 12–23 (2009).
18. Dixon, G., Hmielowski, J. & Ma, Y. Improving climate change acceptance among U.S. conservatives through value-based message targeting. *Sci. Commun.* **39**, 520–534 (2017).
19. Andre, H. Value orientation and framing as determinants of stated willingness to pay for eco-labeled electricity. *Energy Effic.* **4**, 185–192 (2011).
20. Mills, S. B., Rabe, B. G. & Borick, C. *Widespread Public Support for Renewable Energy Mandates Despite Proposed Rollbacks* (Center for Local, State, and Urban Policy, 2015); https://closup.umich.edu/issues-in-energy-and-environmental-policy/22/widespread-public-support-for-renewable-energy-mandates-despite-proposed-rollbacks
21. Gray, M., Ljungwaldh, S., Watson, L. & Kok, I. *Powering Down Coal: Navigating the Economic and Financial Risks in the Last Years of Coal Power* (Carbon Tracker Initiative, 2019); https://carbontracker.org/reports/coal-portal/
22. *Renewable Power Generation Costs in 2019* (International Renewable Energy Agency, 2020); https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019
23. Tversky, A. & Kahneman, D. The framing of decisions and the psychology of choice. *Science* **211**, 453–458 (1981).
24. Tversky, A. & Kahneman, D. Loss aversion in riskless choice: a reference-dependent model. *Q. J. Econ.* **106**, 1039–1061 (1991).
25. McCright, A. M. & Dunlap, R. E. The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *Sociological Q.* **52**, 155–194 (2011).
26. Guber, D. L. A cooling climate for change? Party polarization and the politics of global warming. *Am. Behav. Sci.* **57**, 93–115 (2013).
27. Bergquist, P., Konisky, D. M. & Kotcher, J. Energy policy and public opinion: patterns, trends and future directions. *Prog. Energy* **2**, 032003 (2020).
28. Bergquist, P., Mildenberger, M. & Stokes, L. C. Combining climate, economic, and social policy builds public support for climate action in the US. *Environ. Res. Lett.* **15**, 054019 (2020).
29. Benjamin, D., Por, H.-H. & Budescu, D. Climate change versus global warming: who is susceptible to the framing of climate change? *Environ. Behav.* **49**, 745–770 (2017).
30. Gustafson, A. et al. Republicans and Democrats differ in why they support renewable energy. *Energy Policy* **141**, 111448 (2020).
31. Lecheler, S. & De Vreese, C. D. How long do news framing effects last? A systematic review of longitudinal studies. Ann. Int. Commun. Assoc. https://doi.org/10.1080/23808985.2015.11735254 (2016).
32. Coppock, A., Ekins, E. & Kirby, D. The long-lasting effects of newspaper op-eds on public opinion. *Q. J. Political Sci.* **13**, 59–87 (2018).
33. Feldman, L. & Hart., P. S. Climate change as a polarizing cue: framing effects on public support for low-carbon energy policies. *Glob. Environ. Change* **51**, 54–66 (2018).
34. Schuldt, J. P., Konrath, S. H. & Schwarz, N. "Global warming" or "climate change"?: whether the planet is warming depends on question wording. *Public Opin. Q.* **75**, 115–124 (2011).
35. Edwards, K. & Smith, E. E. A disconfirmation bias in the evaluation of arguments. *J. Personal. Soc. Psychol.* **71**, 5–24 (1996).
36. Taber, C. S. & Lodge, M. Motivated skepticism in the evaluation of political beliefs. *Am. J. Political Sci.* **50**, 755–769 (2006).
37. Coppock, A. E. *Positive, Small, Homogeneous, and Durable: Political Persuasion in Response to Information.* PhD thesis, Columbia Univ. (2016).
38. Guess, A. & Coppock, A. Does counter-attitudinal information cause backlash? Results from three large survey experiments. *Br. J. Political Sci.* **50**, 1497–1515 (2020).
39. Coppock, A., Hill, S. J. & Vavreck, L. The small effects of political advertising are small regardless of context, message, sender, or receiver: evidence from 59 real-time randomized experiments. *Sci. Adv.* **6**, 40–46 (2020).
40. Bayer, P. & Ovodenko, A. Many voices in the room: a national survey experiment on how framing changes views toward fracking in the United States. *Energy Res. Soc. Sci.* **56**, 101213 (2019).
41. van der Linden, S., Leiserowitz, A. & Maibach, E. The gateway belief model: a large-scale replication. *J. Environ. Psychol.* **62**, 49–58 (2019).
42. Hart, P. S. & Feldman, L. Would it be better to not talk about climate change? The impact of climate change and air pollution frames on support for regulating power plant emissions. *J. Environ. Psychol.* **60**, 1–8 (2018).
43. Paternoster, R., Brame, R., Mazerolle, P. & Piquero, A. Using the correct statistical test for the equality of regression coefficients. *Criminology* **36**, 859–866 (1998).
44. Broockman, D. E., Kalla, J. L. & Sekhon, J. S. The design of field experiments with survey outcomes: a framework for selecting more efficient, robust, and ethical designs. *Political Anal.* **25**, 435–464 (2017).
45. Gerber, A. S. & Green, D. P. *Field Experiments: Design, Analysis, & Interpretation* (WW Norton, 2012).
46. Cumming, G. Inference by eye: reading the overlap of independent confidence intervals. *Stat. Med.* **28**, 205–220 (2009).

Author contributions

A.G. conceptualized the study and methodology. M.H.G., P.B., K.L., S.A.R. and A.L. advised on the study's concept, design, measures and stimuli. A.G. and M.H.G. collected the data. A.G., M.H.G. and P.B. analysed the data. A.G. wrote the original draft, with contributions and revisions from M.H.G., P.B., K.L., S.A.R. and A.L. A.L. obtained funding for the project.

Competing interests

The authors declare no competing interests.

Additional information

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Software and code

Policy information about availability of computer code

Data collection	Participants were recruited via Prolific, an online worker pool. The data collection and experimental procedure was performed in Qualtrics, an online survey environment. Participants entered Qualtrics, gave informed consent, answered survey questions, and viewed stimulus messages all within the Qualtrics environment.
Data analysis	Power calculations were performed in R (v. 4.0.2) and the analyses informing the study's research questions and hypotheses were performed in SPSS (v. 26).

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Behavioural & social sciences study design

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Study description	This study tested the immediate and over-time persuasion effects of different message variations in the topic of renewable energy. The analyses estimate the quantitative effect of each treatment message and the longevity of that effect over a period of 3 weeks.
Research sample	Participants were recruited from Prolific, a diverse pool of online workers. This sample source was chosen because it contains a diverse collection of U.S. adults, which satisfied our goal of obtaining a sample that was similar to the U.S. adult population (although not perfectly representative). The final Time 1 sample used for analysis was 51% female and 49% male, with a mean age of 35.35 (SD = 13.4; min = 18, max = 84). The most common level of educational attainment was a Bachelor's degree (40%), followed by some college or Associate's degree (30%), graduate or professional degree (20%), high school diploma (10%), and less than high school diploma (<1%). The sample was mostly White (76%), followed by Asian-American (11%), Latinx (8%), Black or African-American (6%), and other groups each totaling less than 1%.
Sampling strategy	Prolific participants see a list of available studies, and they opt in to participate. To ensure a balanced distribution, we used Prolific's preset filters to make the Time 1 study available to only self-identified Republicans or Democrats in the U.S. To obtain reparticipation from participants for Time 2, we made the Time 2 study available on Prolific only to participants who completed Time 1. Similarly, we made the Time 3 study available only to participants who completed Time 2. The study description at each time point did not mention that it was related to a prior study, in order to avoid biases in attrition or self-selection. Power calculations for the tests of treatment effects were performed with the pwr package in R. Here, we report the power analysis results (all at 1-B = .80 and α = .05) for the treatment effects on beliefs about renewable energy, assuming two-tailed tests (as in the research questions). For Democrats' beliefs about renewables, this study is powered to detect treatment effects on beliefs of d ≥ .23 at Time 1, d ≥ .24 at Time 2, and d ≥ .26 at Time 3. For Republicans, d ≥ .24 at Time 1, d ≥ .27 at Time 2, and d ≥ .30 at Time 3—all reflecting conservative upper bounds (see Note below). Note: Required sample sizes for sufficient power decrease by approximately 15% when using one-tailed tests (i.e., more power for the directional hypotheses) and decrease to an ever greater extent when controlling for pre-test levels of the post-test variables and when using an index of items instead of individual items as we do in the current study for analyzing the effects of support (Broockman et al., 2017; Gerber & Green, 2012).
Data collection	Data was collected by recording responses to survey items in the Qualtrics online survey environment. These self-report data were then downloaded from Qualtrics for analysis. Participants were automatically randomly assigned to experimental conditions without any input from the researchers (to avoid any source of influence or bias from the researchers). The researchers were not blind to the study's hypotheses, but the analyses were preregistered.
Timing	Data collected at three time points. In Time 1, participants responded to survey measures and viewed their assigned experimental stimuli. About 10 days after Time 1 data collection started, the Time 2 survey was made available on Prolific (interval mean = 10.68, SD = 1.76). About 10 days after Time 2 data collection started, the Time 3 survey was made available on Prolific (interval mean =12.84 days, SD = 1.20). effects. The interval between time points varies between participants because on Prolific participants are able to choose when, or if, they participate in available studies. The earliest Time 1 data collection was June 3, 2020, and the latest Time 3 data collection was June 30, 2020.
Data exclusions	Participants were excluded from analyses if they failed an "attention check" item (which asked them to select a specific response on a question), or if their self-reported political party affiliation was neither Democrat nor Republican. This exclusion protocol removed less than 2% of cases at each time point.
Non-participation	For Time 1, non-participation rates are unknown because we cannot determine how many members of the Prolific pool saw the Time 1 study but declined to participate. Of those invited to participate in Time 2, the re-participation rate was 85%. Of those invited to participate in Time 3, the re-participation rate was 84%.
Randomization	At Time 1, participants were randomly assigned to 1 of 5 experimental conditions, which corresponded with 5 different messages. The random assignment was performed by the Qualtrics software. The remaining two time points did not involve further group allocation, but instead consisted of further measurement of the groups that had been created at Time 1.

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☒	☐ Animals and other organisms
☐	☒ Human research participants
☒	☐ Clinical data
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Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Human research participants

Policy information about studies involving human research participants

Population characteristics	The final Time 1 sample was 51% female and 49% male, with a mean age of 35.35 (SD = 13.40; min = 18, max = 84). The most common level of educational attainment was a Bachelor's degree (40%), followed by some college or Associate's degree (30%), graduate or professional degree (20%), high school diploma (10%), and less than high school diploma (<1%). The sample was mostly White (76%), followed by Asian-American (11%), Latinx (8%), Black or African-American (6%), and other groups each totaling less than 1%. Political ideology was measured on a five-point scale from "(1) very liberal" to "(5) very conservative" (M = 2.84, SD = 1.34). To measure political party affiliation, respondents were asked "Generally speaking, do you think of yourself as a..." with response options of "Republican," "Democrat," "Independent," "Other," and "No party/not interested in politics." Participants who responded "Independent" or "Other" were asked "Do you think of yourself as closer to the..." (response options of "Republican party," "Democratic party," and "Neither"). Those who responded "Republican party" and "Democratic party" to the follow-up question (i.e., the "leaners") were combined with those initially responding "Republican" and "Democrat," respectively. The Time 1 sample was 49% Republicans and 51% Democrats. Attrition between time points did not substantially affect the demographic or political composition of the sample.
Recruitment	Participants were recruited from Prolific, a diverse pool of online workers. Prolific participants see a list of available studies, and they opt in to participate. To ensure a balanced distribution, we used Prolific's preset filters to make the Time 1 study available to only self-identified Republicans or Democrats in the U.S. To obtain repartication from participants for Time 2, we made the Time 2 study available on Prolific only to participants who completed Time 1. Similarly, we made the Time 3 study available only to participants who completed Time 2. At each time point, participants opted in to participate in this study. This type of opt-in sample from an online panel is not perfectly representative of the general population, and is subject to self-selection biases. To mitigate biases in self-selection and attrition, we did not mention the specific topic of the study (renewable energy) in the recruitment material, and the study description at Time 2 and Time 3 did not mention that it was related to a prior study that participants had completed.
Ethics oversight	Yale University Institutional Review Board

Note that full information on the approval of the study protocol must also be provided in the manuscript.