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Contzen, Nadja; Handreke, Annika V.; Perlaviciute, Goda; Steg, Linda

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Original research article

Emotions towards a mandatory adoption of renewable energy innovations: The role of psychological reactance and egoistic and biospheric values

Nadja Contzen [a,b,*], Annika V. Handreke [b,1], Goda Perlaviciute [b], Linda Steg [b]

[a] Eawag Swiss Federal Institute of Aquatic Science and Technology, Department Environmental Social Sciences, 8600 Duebendorf, Switzerland
[b] University of Groningen, Faculty of Behavioural and Social Sciences, Department of Psychology, Grote Kruisstraat 2/1, 9712TS Groningen, the Netherlands

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ABSTRACT

Policies that mandate the adoption of renewable energy innovations could ensure their widespread adoption. Yet, such policies may not be implemented if they face strong opposition from the public, especially when strong negative emotions are at the core of opposition. In a field experiment ($N = 97$), we investigated people's emotional responses to two policy options aimed at increasing the adoption of heat pumps in a neighbourhood in the city of Groningen: a campaign promoting the voluntary adoption of heat pumps versus a regulation that mandates the adoption of heat pumps. In line with reactance theory, the policy option mandating the adoption of heat pumps was perceived to threaten people's freedom more and, in turn, caused stronger negative and weaker positive emotions than the policy option promoting voluntary adoption. Yet, emotions towards the policy options were also related to people's values, providing partial support for the Value-Innovation-Congruence model of Emotional responses. Stronger egoistic values were related with stronger negative emotions, particularly towards the policy option mandating adoption, while stronger biospheric values were related with stronger positive emotions, but only towards the policy option promoting voluntary adoption. Emotions, in turn, were related with acceptability of the policy options. Our findings imply that measures aimed at increasing positive emotions and reducing negative emotions towards policies aimed at increasing the adoption of energy innovations could profit from considering people's core values.

1. Introduction

Renewable energy innovations[2] (hereinafter referred to as energy innovations), such as tidal energy and air-to-water heat pumps (hereinafter referred to as heat pumps), can play an important role in mitigating climate change. Still, their adoption rates are low. For example, in the European Union, renewable energy accounted for only 20% of the energy consumed by households in 2018 [1]. A widespread adoption of energy innovations could be achieved through policies mandating their adoption. However, if such policies are not accepted by the public, they may not be implemented [2–6], and, as a consequence, they would fail in increasing the adoption of energy innovations.

There is initial evidence to suggest that the implementation of environmental policies may fail particularly when strong negative emotions are at the core of public opposition ([5]; see also [7]). Less negative, and particularly more positive emotions might thus be highly relevant for a successful implementation of policies aimed at increasing the adoption of energy innovations. Yet, the question remains what causes emotions towards such policies, and how such emotions are in turn related to the acceptability of the policies. Notably, the literature on emotions towards energy policies in particular and towards (environmental) policies more generally has two major gaps (see also [8]): the evidence on (1) the *causes* of emotions towards (environmental) policies and (2) on the *association* between emotions and policy acceptance is limited (for an exception, see [5]). In this paper, we address these research gaps by investigating in a field experiment the factors underlying people's emotional responses to policies that mandate the adoption of energy innovations (i.e., a regulation that mandates households

* Corresponding author at: Eawag Swiss Federal Institute of Aquatic Science and Technology, Department Environmental Social Sciences, 8600 Duebendorf, Switzerland.
E-mail address: nadja.contzen@eawag.ch (N. Contzen).
[1] Present address: ciT Leipzig GmbH, Lutherstraße 10, 04315 Leipzig, Germany.
[2] We define renewable energy innovations as innovative technologies that produce energy from renewable sources, including sun rays, wind, tide, and earth and air heat, and emit less CO_2 than technologies producing energy from fossil fuels.

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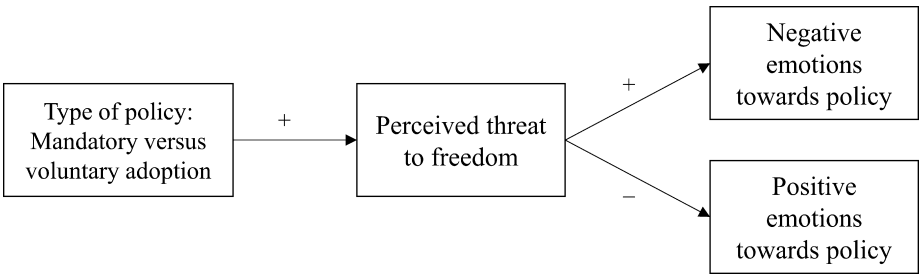

Fig. 1. Conceptual model based on reactance theory [9,10] depicting the associations between type of policy, perceived threat to freedom and emotions.

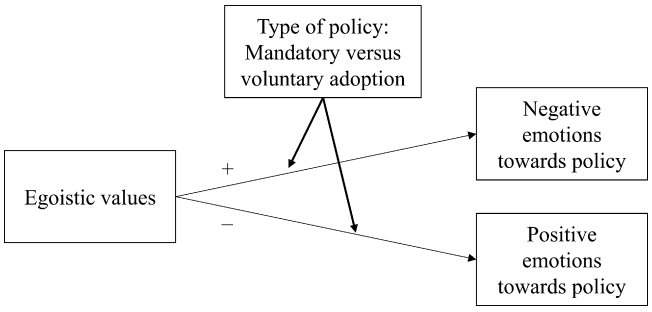

Fig. 2. Conceptual model based on the VICE model [11] with egoistic values explaining negative and positive emotions, moderated by the type of policy. The bold arrows indicate that a mandatory adoption (as compared to a voluntary adoption) strengthens the respective association between egoistic values and emotions.

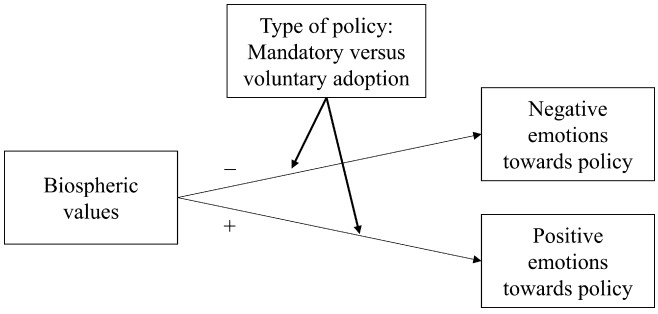

Fig. 3. Conceptual model based on the VICE model [11] with biospheric values explaining negative and positive emotions, moderated by the type of policy. The bold arrows indicate that a mandatory adoption (as compared to a voluntary adoption) strengthens the respective association between biospheric values and emotions.

to adopt heat pumps) compared to policies that promote voluntary adoption (i.e., a campaign that motivates households to adopt heat pumps). We do so based on reactance theory [9,10] and the novel Value-Innovation-Congruence model of Emotional responses (VICE model; [11]; c.f. [12]). Moreover, we examine the associations between emotions towards and public acceptability of these policies.

1.1. Psychological reactance and emotional responses to policies aimed at increasing the adoption of energy innovations

Policies that mandate the adoption of energy innovations are likely to restrict people's freedom of choice regarding their energy supply. According to reactance theory [9,10], such mandates might cause psychological reactance, a motivational state elicited when people feel their freedom of choice is threatened or lost (see also [13–16]). People who experience psychological reactance tend to feel strong negative emotions about the restricted freedom, such as anger [9,10,17,18]. Further, they try to restore their freedom, for example by rejecting the policy that is threatening their freedom (see also [14]). To the best of our knowledge, people's emotional reactions have not yet been studied specifically with regard to environmental policies that mandate adoption of energy innovations versus environmental policies promoting voluntary adoption or more generally with regard to coercive environmental policies (i.e., policies that enforce desired behaviours and choices) compared to non-coercive environmental policies (i.e., policies that promote the voluntary adoption of such behaviours and choices). Yet, in line with reactance theory research shows that people evaluate coercive environmental policies as less acceptable than non-coercive environmental policies [19–22]; c.f. [8]. Based on reactance theory, we hypothesize that policies mandating the adoption of energy innovations lead to stronger negative emotions (H1a) and weaker positive emotions (H1b) than policies promoting their voluntary adoption *because* the former threaten people's freedom of choice more than the latter (see Fig. 1). That is, we hypothesize that perceived threat to freedom mediates the effect of the type of policy on emotions towards the policies (H1c).

1.2. People's values and emotional responses to policies aimed at increasing the adoption of energy innovations

Yet, the emotional responses to policies aimed at increasing the adoption of energy innovations–including policies that mandate adoption–might differ between people, dependent on the implications of the policies for people's values. More specifically, on the basis of the novel VICE model [11]; c.f. [12], we propose that people's emotional responses towards a policy depend on the extent to which a policy is congruent or incongruent with people's core values. Values are general goals people aspire in life that guide the evaluation and selection of behaviour and events, across situations and time [23]; c.f. [24,25]. The VICE model suggests that when a policy is congruent with, that is supports a person's core values, positive emotions are likely to emerge [11]. Equally, a policy that is incongruent with, that is threatens a person's core values, is likely to elicit negative emotions.

Policies aimed at increasing the adoption of energy innovations may be (in)congruent with two values in particular: egoistic values (i.e. caring about personal resources) and biospheric values (i.e. caring about nature and the environment; [26]). First, energy innovations may entail major personal costs, including investment costs as well as time and effort required to adopt and (learn to) use the innovation. For example, heat pumps (a renewable energy technology for heating and hot water supply) entail high purchasing costs (approximately €10,000) and a long payback period (approximately 26 years; c.f. [27,28]). Policies to increase the adoption of such innovations are thus likely to be *in*congruent with egoistic values. The value incongruence may be even higher when a policy mandates adoption, as then people certainly have to bear the personal costs that an energy innovation may entail [11]. Voluntary adoption, in contrast, would allow people to choose not to adopt the innovation, thus avoiding the costs, which might reduce the incongruence with egoistic values. Therefore, based on the VICE model [11], we

Table 1
Texts containing the experimental manipulation.

Experimental condition	Manipulation texts
Voluntary adoption	One option could be to launch **a campaign** to **motivate the households in Reitdiep** to **adopt a heat pump** instead of using a central heating (CH) boiler. Such a campaign would include both an information letter, which would be sent to all households, and information meetings in the neighbourhood. In the letter as well as during the meetings, the residents of Reitdiep would receive information about heat pumps … With this campaign, the municipality of Groningen could motivate the residents of Reitdiep to replace their CH boilers with heat pumps.
Mandatory adoption	One option could be a new regulation that **obliges all households in Reitdiep** to **adopt a heat pump** instead of using a CH boiler. If the municipality implemented the new regulation, all households in Reitdiep would be informed about it through an official letter and information meetings in the neighbourhood. In the letter as well as during the meetings, the residents of Reitdiep would receive information about the regulation [and] heat pumps … With this new regulation, the municipality of Groningen could ensure that all households in Reitdiep replace their CH boilers with heat pumps.

Note. Emphasis are presented as in the original text. Text passages that are not relevant for the manipulation are omitted and are indicated through ellipsis points. See Appendix A for the complete information texts.

hypothesize that the stronger people's egoistic values, the stronger negative emotions (H2a) and the weaker positive emotions (H2b) they will experience towards policies aimed at increasing the adoption of energy innovations, especially when a policy mandates adoption (H2c; see Fig. 2).

Second, as energy innovations emit less CO_2 than conventional, fossil fuel based energy technologies, policies aimed at increasing their adoption would have relatively positive implications for nature and the environment. This should be especially the case when policies *mandate* adoption, as then CO_2 emissions are more effectively reduced because everyone has to adopt the energy innovation, even people who would not do so voluntarily (c.f. [19]). As such, policies aimed at increasing the adoption of energy innovations, and especially those that mandate adoption, are likely to be congruent with biospheric values. Consequently, based on the VICE model [11], we hypothesize that the stronger people's biospheric values, the weaker negative emotions (H3a) and the stronger positive emotions (H3b) they will experience towards policies aimed at increasing the adoption of energy innovations, especially when a policy mandates adoption (H3c; see Fig. 3; c.f. [29]).

H3c is based on the assumption that policies mandating the adoption of energy innovations are more congruent with biospheric values than those promoting voluntary adoption because they are more effective in reducing CO_2 emissions. Yet, the question is whether the public actually perceives this difference in effectiveness in reducing CO_2 emissions. Therefore, we test additionally H4: People perceive policies mandating the adoption of energy innovations as more effective in reducing CO_2 emissions than policies promoting voluntary adoption.

1.3. Association between emotions towards and public acceptability of policies aimed at increasing the adoption of energy innovations

Initial evidence suggests that negative emotions towards environmental policies may hamper the successful implementation of such policies because emotions towards such policies may affect their acceptability [5]. Specifically, the stronger negative emotions people experienced towards a policy, in this case a water charge, the less acceptable they evaluated the policy. Reversed, the stronger positive emotions they experienced towards the policy, the more acceptable they evaluated the policy. Similarly, the stronger positive and the weaker negative emotions people experienced towards energy projects, the more acceptable they rated these projects (e.g., [7,30–33]). In line with these findings, we hypothesize that the weaker the negative emotions (H5a) and the stronger the positive emotions (H5b) people experience towards policies aimed at increasing the adoption of energy innovations, the higher the public acceptability of the policies.

2. Materials and methods

2.1. Study location and studied energy innovation

In June 2018, we conducted a field experiment in Reitdiep, a neighbourhood of the municipality of Groningen, the Netherlands, on the acceptability of different policies aimed at increasing the adoption of an energy innovation. The neighbourhood was chosen in consultation with the local authorities, who aimed to replace the gas-based heating systems in the neighbourhood with heat pumps. The adoption of heat pumps was selected as a case in point as heat pumps may have characteristics that are (in)congruent with people's biospheric and egoistic values. First, heat pumps are a renewable energy technology that reduces CO_2 emissions [34]. We thus assume heat pumps to be congruent with biospheric values. Second, they entail high investment costs (approximately €10,000) and a long payback period (approximately 26 years; [27,28]). Additionally, heat pumps emit noise during operation [28]. Due to these personal costs, we assume heat pumps to be incongruent with egoistic values.

2.2. Participants

Participants were recruited door-to-door through a two-stage random sampling procedure. First, all street names of the neighbourhood were ordered randomly. Data collection started in the street at the top of the list and continued in the list order until the required sample size was achieved. Second, for each street we selected randomly whether houses with even or uneven numbers would be approached.

At selected houses, the implementing researcher introduced themselves as a student of the University of Groningen and asked whether the person was interested in taking part in a study on residents' opinion on the adoption of heat pumps. In case of agreement and eligibility[3], a date to pick-up the paper–pencil questionnaire was agreed upon. During the pick-up, participants were debriefed. If no pick-up date could be arranged, a prepaid envelope was provided for returning the completed questionnaire by mail. The house numbers of these households were noted down and the debriefing was put in their letterbox after the data collection had finished. Participation was voluntary, following informed consent, and was not rewarded. The study received ethical clearance by the ethical committee of Psychology at the University of Groningen.

We calculated with G*Power 3.1 [35] the required sample size to detect a medium effect ($d = 0.50$; [36]) at a Type I error probability of 0.05 and a statistical power of 0.80 for the most demanding analysis we had planned, an independent samples *t*-test. A sample size of $N = 102$ was indicated to be sufficient and, taking into account the need to remove inattentive participants or incomplete responses, we aimed at a sample size of $N = 120$.

A total of 365 randomly selected households were approached. Of those, 194 residents were not at home. Another nine were not the owner of their home and therefore not eligible to participate in the study. Of the

[3] A person was eligible when they (a) owned their home, (b) were not a member of the neighbourhoods' sustainability committee as the members had previously been informed about the study, and (c) were the household member who usually decides upon large expenses or the purchase of devices. In case the third criterion was not met, we asked whether the person who usually decides is available and would be willing to participate.

remaining 162 households, 126 returned the questionnaire (response rate: 77.78%). In two cases data was incomplete. Another 26 participants failed attention checks (see section 2.4) and were also removed, resulting in a final sample size of $N = 97$, which was slightly below the required sample size.

Of the final participants, 32 were women (33%), and 62 were men (63.9%); three participants (3.1%) did not indicate their gender. They were between 27 and 86 years old ($M = 43.33$, $SD = 10.05$). The majority of the participants (84.5%) had a bachelor's degree or higher. Of the participating households, 11 (11.3%) had a monthly net income between 1,000 and 3,000 Euros, 36 (37.1%) between 3,000 and 5,000 Euros, and 32 (33%) indicated to earn more than 5,000 Euros per month. Another 18 participants (18.6%) did not indicate their income.

2.3. Design

We applied a between-subjects experimental design with two experimental conditions that manipulated the type of policy, namely a policy promoting the voluntary adoption of heat pumps (voluntary condition) or a policy mandating the adoption of heat pumps (mandatory condition). As a cover story, we told participants that the municipality of Groningen is currently inventorying different policy options to increase the adoption of heat pumps in the neighbourhood. The manipulations took the form of bogus information on one of these policy options the municipality is considering. In the voluntary condition, participants were told that one of the policy options is a campaign aimed at promoting the adoption of heat pumps among the residents of the neighbourhood (see Table 1 for the texts containing the experimental manipulation, and Appendix A for the complete information texts participants received on both heat pumps and the policy options). In the mandatory condition, participants learned about another policy option, namely a regulation that would make the adoption of heat pumps mandatory for all residents of the neighbourhood. For both policy options, participants read they would receive an information letter and information meetings would be organized; these were either only about heat pumps (voluntary condition) or additionally to inform about the regulation (mandatory condition). We randomly assigned participants to one of the two conditions by distributing one of two versions of the questionnaire[4]. The rest of the questionnaire was the same to all participants.

Whereas the information we provided was bogus, at the time of data collection the local authorities of Groningen were indeed reflecting on possible policies aimed at increasing the adoption of heat pumps in Reitdiep and had consulted on the topic with the neighbourhood's sustainability committee, which consists of interested residents, and in community meetings. Therefore, we can assume that the provided information was relevant to and realistic for the study participants.

2.4. Measures and variables

Data were collected through a paper–pencil questionnaire in Dutch that took approximately 20 min to complete. The first page included information on the background of the study and an informed consent. Next, we measured people's values and assessed their previous experience with heat pumps. Then, we provided information on the municipality's goal to be "energy neutral" by 2035[5] and how heat pumps could contribute to that (see Appendix A). Thereafter, the experimental manipulation was administered, followed by questions about the respective policy option. The questionnaire concluded with an attention check and some socio-demographic measures. In the following, we present the measures used in the present paper. The means and standard deviations of all variables are presented in Appendix B, Table B1 both for the entire sample and per experimental condition.

Perceived threat to freedom. We measured perceived threat to freedom with four items adapted from [17], namely (1) "The described [campaign/regulation] would threaten my freedom to choose for myself on the adoption of a heat pump"; (2) "The described [campaign/regulation] would try to make the decision on adopting a heat pump for me rather than I deciding for myself"; (3) "The described [campaign/regulation] would try to manipulate me into adopting a heat pump"; (4) "The described [campaign/regulation] would put pressure on me to adopt a heat pump". A fifth item was added for the purpose of this study, namely, "The described [campaign/regulation] would force me to adopt a heat pump". The items were measured on a scale ranging from $-3 = I$ *completely disagree* to $+3 = I$ *completely agree* and were averaged (Cronbach's $\alpha = 0.95$).

Values. Participants' egoistic and biospheric values were measured with the Dutch version of the Environmental Portrait Value Questionnaire (E-PVQ) [38][6]. The items of the E-PVQ consist of descriptions of a person, such as "It is important to this person to prevent environmental pollution".[7] Participants were asked to indicate how much they think the person is like them on a 7-point scale from 1 = *totally not like me* to 7 = *totally like me*. Both value types were assessed with multiple items, which were averaged to form the respective values scale. Biospheric values were measured with four items (Cronbach's $\alpha = 0.90$) and egoistic values with five (Cronbach's $\alpha = 0.75$).

Emotions towards the policy option. Participants indicated how strongly they felt different positive and negative emotions towards the respective policy option on a 6-point scale ranging from 0 = *not at all* to 5 = *very strongly*. The measure was adapted from [11] and included six positive emotions (i.e., comfortable, excited, happy, optimistic, relieved, and satisfied), and seven negative emotions (i.e., afraid, angry, disappointed, disgusted, powerless, upset, and worried). Exploratory factor analysis revealed that the positive and negative emotions loaded on separate factors. We averaged the items accordingly to form a positive emotions scale (Cronbach's $\alpha = 0.93$) and a negative emotions scale (Cronbach's $\alpha = 0.90$).

Perceived effectiveness of the policy option was measured with one item reading "How (in)effective do you think the described [campaign/regulation] would be to achieve Groningen's goal to be energy neutral by 2035?". The response scale ranged from $-3 =$ *very ineffective* to $+3 =$ *very effective*.

Acceptability of the policy option was measured with four 7-point semantic differential scales, ranging from -3 to $+3$, with the following poles: very negative to very positive; very bad to very good; very unnecessary to very necessary; and very unacceptable to very acceptable. The items were averaged (Cronbach's $\alpha = 0.94$).

Attention check. To check whether participants had attentively read [40] and correctly recalled the manipulation texts, we asked participants whether the previously described policy option was (a) a campaign to motivate households in Reitdiep to adopt a heat pump, (b) a new regulation that would oblige all households in Reitdiep to adopt a heat pump, or (c) none of the above. Response (a) was correct for participants in the voluntary condition, response (b) was correct for those in the mandatory condition, while response (c) was incorrect for all participants.

[4] In a street, the two versions were distributed in alternating order and the version the researcher started with was randomly chosen per street.

[5] The municipality of Groningen aims to have phased out of fossil fuels by 2035 [37]. At the time of data collection, this aim was promoted with the slogan "Groningen energy neutral" and is today referred to as "Groningen CO_2 neutral".

[6] The E-PVQ also assesses hedonic and altruistic values [38]. As they are not researched in the present paper, they are not further described here.

[7] The full list of items can be accessed at https://www.epgroningen.nl/epvq/

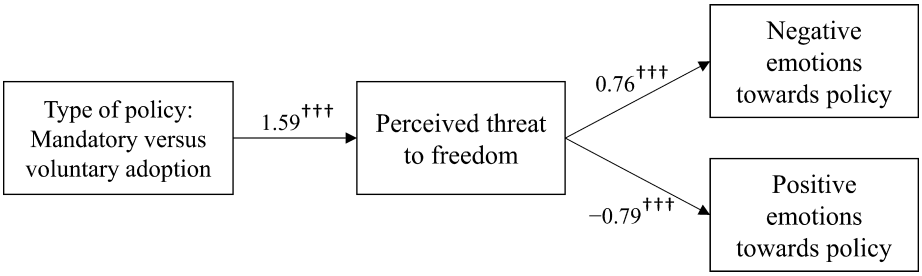

Fig. 4. Effects of type of policy (0 = voluntary adoption and 1 = mandatory adoption) on negative and positive emotions via perceived threat to freedom. (Partially) standardized coefficients presented. ††† $p < 0.001$, one-tailed.

2.5. Data analysis approach

All analyses were performed using IBM SPSS Statistics 25. To test hypotheses H1a to H1c on the effect of type of policy on emotions towards the policy options via perceived threat to freedom, we run mediation analysis with Model 4 of the PROCESS macro [41]. Two analyses were conducted, one testing effects on negative emotions and one testing effects on positive emotions.

We tested H2 on the association between *egoistic* values and emotions towards the policy options, moderated by the type of policy, and H3 on the association between *biospheric* values and emotions towards the policy options, moderated by the type of policy, in separate analyses. This allowed us to (a) test the respective hypothesis in a more controlled manner and (b) maximize the statistical power by considering only the variables relevant for the specific hypothesis. Specifically, for both H2 and H3 we run two moderation analyses, again one analysis testing effects on negative emotions and the other testing effects on positive emotions. The continuous predictors (i.e., personal values) were mean-centred prior to calculating the interaction terms and mean-centred values were used in the respective analyses [42]. Significant interactions were followed up with simple slopes analyses using Model 1 of the PROCESS macro [41].

We tested H4 with a *t*-test comparing the perceived effectiveness of the policy options between conditions. To test H5, we run a multiple regression analysis with negative and positive emotions towards the policy options explaining their acceptability.

When reporting results of our hypothesis testing, we present both significance levels and bootstrap confidence intervals[8,9], using resamples of 5,000 [43]. While the bootstrap confidence intervals computed with the PROCESS macro [41] are percentile confidence intervals, all other confidence intervals are bias-corrected and accelerated (BCA). When reporting on our *directional hypotheses*, we present one-tailed significance levels and 90% bootstrap confidence intervals [44]. For all remaining estimates, two-tailed significance levels and 95% bootstrap confidence intervals are presented. Effect sizes were assessed in line with [36].

3. Results

3.1. Preliminary analysis

Before testing our hypotheses, we first checked whether the participants had attentively read and correctly recalled the information we had provided on the respective policy option (see Appendix C, Table C.1). In the voluntary condition 92% of the participants recalled correctly that they had read about a campaign to motivate the adoption of heat pumps, while in the mandatory condition only 66% recalled correctly that they had read about a new regulation that obliges households to adopt a heat pump. Participants who failed in the attention check were removed from the final sample (see section 2.2) and were not included in any of the further analyses.[10]

Second, we checked whether the randomized allocation of the remaining participants to the experimental conditions had resulted in comparable subsamples. Indeed, there were no significant differences between experimental conditions in socio-demographics (i.e., gender, income, education, and age) and value endorsement (see Appendix C, Tables C.2 and C.3), suggesting randomization had been successful.

The descriptive statistics of and correlations between all study variables are presented in Appendix B both for the entire sample (Table B1) and per condition (Table B2). Compared to participants in the voluntary condition, participants in the mandatory condition perceived a higher threat to their freedom–which indicates that our manipulation had been successful–experienced stronger negative and weaker positive emotions towards the policy option, and evaluated it as less acceptable (see Appendix B, Table B.2). Yet, even the participants in the mandatory condition experienced rather weak negative emotions towards the policy option and rated it as only somewhat inacceptable. These results suggest that even a mandate to adopt heat pumps elicited only limited negative emotions and was not strongly opposed.

3.2. Psychological reactance and emotional responses to policies aimed at increasing the adoption of heat pumps

In line with H1a and H1b, participants in the mandatory condition experienced stronger negative emotions (total effect: $B = 0.92$, $SE =$

[8] Compared with conventional significance tests, bootstrap confidence intervals quantify the uncertainty as well as the accuracy of estimates and bootstrapping is a more robust approach [43].

[9] For the total effects in mediation analysis and the simple slopes in moderation analysis no bootstrap confidence intervals are presented as PROCESS does not provide bootstrap confidence intervals for these estimates.

[10] We repeated all analyses with the entire sample (i.e., including the inattentive participants). Overall, the results were in line with those presented in the present paper with a few exceptions. First, type of policy, when controlled for perceived threat to freedom, had a significant and–unexpectedly–positive direct effect on positive emotions (see section 3.2 for the respective mediation analysis conducted among the attentive participants). Second, the interactive effects of egoistic values and type of policy on negative emotions and of biospheric values and policy type on positive emotions were not significant (see section 3.3 for the respective moderation analyses conducted among the attentive participants).

Table 2
Moderation analyses with values, type of policy and their interactions explaining emotions towards the policy options.

	Negative emotions					Positive emotions				
		90% CI of B[1]					90% CI of B[1]			
Variable	B	LL	UL	SE	β	B	LL	UL	SE	β
	Regression models testing egoistic values									
Constant	0.36**	0.22	0.51	0.08		2.13***	1.83	2.43	0.14	
Egoistic values	0.19‡	0.02	0.36	0.12	0.17	0.05	−0.22	0.30	0.15	0.04
Type of policy[2]	1.05†††	0.72	1.36	0.21	0.50	−1.17†††	−1.51	−0.81	0.23	-0.48
Egoistic values*Type of policy	0.37†	−0.02	0.74	0.24	0.18	−0.37‡	−0.76	0.05	0.27	-0.16
R^2	0.29***					0.22***				
	Regression models testing biospheric values									
Constant	0.37**	0.22	0.56	0.12		2.10***	1.80	2.40	0.14	
Biospheric values	0.04	−0.06	0.15	0.14	0.03	0.36†	0.11	0.55	0.16	0.25
Type of policy[2]	0.97†††	0.62	1.33	0.19	0.46	−1.11†††	−1.42	−0.83	0.22	-0.45
Biospheric values*Type of policy	0.30	−0.12	0.70	0.24	0.14	-0.71[3]	−1.21	−0.06	0.27	-0.29
R^2	0.23***					0.26***				

Note. $N = 97$. [1] Percentile bootstrap confidence intervals based on 5,000 resamples. For the constant, 95% CIs presented. [2] 0 = voluntary adoption; 1 = mandatory adoption. [3] Based on a one-tailed test, i.e., considering also the *direction* of the coefficient, the interaction is not significant. * $p < .05$, two-tailed. ** $p < .01$, two-tailed. *** $p < .001$, two-tailed. ‡ $p < .10$, one-tailed. † $p < .05$, one-tailed. †† $p < .01$, one-tailed. ††† $p < .001$, one-tailed.

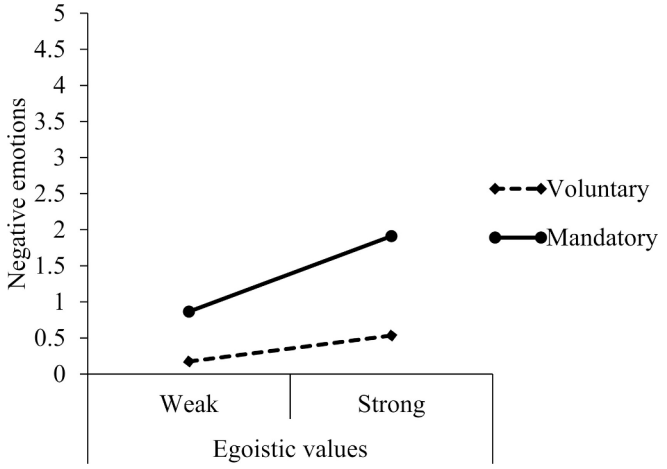

Fig. 5. Moderating effect of type of policy on the association between egoistic values and negative emotions towards the policy options.

0.19, 90% CI = [0.60, 1.24], partially standardized β = 0.89, $p < .001$, one-tailed) and weaker positive emotions (total effect: $B = -1.11$, $SE = 0.22$, 90% CI = [−1.48, −0.74], partially standardized β = −0.91, $p < .001$, one-tailed) than participants in the voluntary condition (for the means per condition see Appendix B, Table B.2).[11]

Supporting H1c, perceived threat to freedom significantly and fully mediated the above effects of type of policy on negative emotions (indirect effect: $B = 1.27$, $SE = 0.26$, bootstrap 90% CI = [0.87, 1.74], partially standardized β = 1.22; remaining direct effect: $B = -0.34$, $SE = 0.27$, 95% bootstrap CI = [−0.96, 0.17], partially standardized β = −0.33, $p = .204$, two-tailed) and on positive emotions (indirect effect: $B = -1.54$, $SE = 0.21$, bootstrap 90% CI = [−1.89, −1.19], partially standardized β = −1.27; remaining direct effect: $B = 0.43$, $SE = 0.31$, 95% bootstrap CI = [−0.18, 0.93], partially standardized β = 0.35, $p = .165$, two-tailed). In more detail, learning that the adoption of heat pumps might become mandatory resulted in higher perceived threat to people's freedom than learning about the potential promotion of voluntary adoption ($B = 3.41$, $SE = 0.27$, bootstrap 90% CI = [2.98, 3.84], partially standardized β = 1.59, $p < .001$, one-tailed; see Fig. 4). In turn, the more participants perceived a policy option to threaten their freedom, the stronger negative emotions ($B = 0.37$, $SE = 0.06$, bootstrap 90% CI = [0.27, 0.48], β = 0.76, $p < .001$, one-tailed) and the weaker positive emotions ($B = -0.45$, $SE = 0.07$, bootstrap 90% CI = [−0.54, −0.34], β = -0.79, $p < .001$, one-tailed) they experienced towards the policy option. Overall, these results suggest that participants in the mandatory condition experienced stronger negative emotions and weaker positive emotions than participants in the voluntary condition, *because* they perceived a higher threat to their freedom.

3.3. Values and emotional responses to policies aimed at increasing the adoption of heat pumps

Next, we tested the associations between values and emotions towards the policy options, dependent on the type of policy option (see Table 2 for the results from moderation analyses). Stronger egoistic values were marginally significantly associated with stronger negative emotions towards the policy options, giving support to H2a. In line with H2c, this association was qualified by a significant and *positive* interaction between egoistic values and type of policy, indicating that the association between egoistic values and negative emotions was stronger in case of mandated adoption than in case of voluntary adoption. Simple slope analyses revealed that while in the mandatory condition egoistic values were significantly associated with negative emotions towards the policy option ($B = 0.56$, $SE = 0.18$, bootstrap 90% CI = [0.26, 0.86], $p = .002$, one-tailed), the association was only marginally significant in the voluntary condition ($B = 0.19$, $SE = 0.12$, bootstrap 90% CI = [−0.01, 0.86], $p = .058$, one tailed; see Fig. 5).

Against our expectations, the association between egoistic values and positive emotions towards the policy options was not significant (H2b) and the interactive effect of values and type of policy on positive emotions, though negative, was only marginally significant (H2c; see Table 2). Simple slope analyses revealed that in the voluntary condition egoistic values were not associated with positive emotions ($B = 0.05$, $SE = 0.15$, 90% CI = [−0.20, 0.30], $p = .370$, one-tailed), while in the

[11] An anonymous reviewer noted that it would be possible that reactance affected the various types of negative and positive emotions we considered in the present study unequally. We investigated this by calculating point-biserial correlations between type of policy and each emotion. Replicating the findings for the negative and positive emotions scales, participants in the mandatory condition experienced each negative emotion significantly more strongly and each positive emotion significantly more weakly than participants in the voluntary condition with one exception: the effect of type of policy on the negative emotion "feeling afraid" was not significant ($r_{pb} = 0.13$, $p = .102$, one-tailed). However, the strength of the effect of type of policy on emotions differed between the emotions, ranging in case of negative emotions from $r_{pb} = 0.30$ for "feeling disgusted" to $r_{pb} = 0.53$ for "feeling angry" and in case of positive emotions from $r_{pb} = -0.31$ for "feeling excited" to $r_{pb} = -0.50$ for "feeling satisfied".

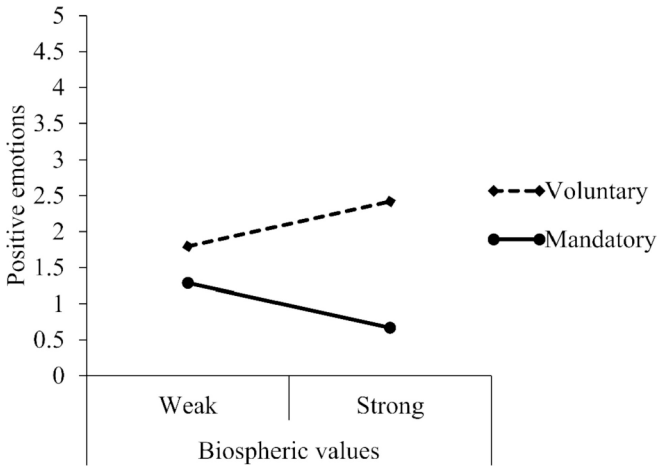

Fig. 6. Moderating effect of type of policy on the association between biospheric values and positive emotions towards the policy options.

Table 3
Multiple regression results of negative and positive emotions on acceptability of the policy options.

		90% CI of B[1]				
Variable	B	LL	UL	SE	β	R^2
Constant	−0.13	−0.57	0.38	0.25		0.65***
Negative emotions	−0.71†††	−0.86	−0.59	0.12	−0.44	
Positive emotions	0.65†††	0.49	0.79	0.10	0.47	

Note. $N = 97$. [1] BCA bootstrap confidence intervals based on 5,000 resamples. For the constant, 95% CIs presented. *** $p \leq 0.001$, two-tailed. ††† $p < .001$, one-tailed.

mandatory condition, as expected, stronger egoistic values were associated with weaker positive emotions towards the policy option, but the association was only marginally significant ($B = -0.32$, $SE = 0.22$, 90% CI = [−0.68, 0.05], $p = .074$, one-tailed). In other words, stronger egoistic values were not *significantly* associated with weaker positive emotions towards the policy options, irrespective of the type of policy.

Both the association between biospheric values and negative emotions towards the policy options and the interactive effect of biospheric values and type of policy on negative emotions were not significant (see Table 2). That is, stronger biospheric values were not significantly associated with weaker negative emotions towards the policy options (against H3a), irrespective of the type of policy (against H3c).

However, supporting H3b, stronger biospheric values were associated with stronger positive emotions towards the policy options (see Table 2). Yet, against H3c, we did not find a significant *positive* interaction between biospheric values and type of policy; that is, the association between biospheric values and positive emotions was not stronger in case of mandated than in case of voluntary adoption. On the contrary, there was a significant *negative* interaction between biospheric values and type of policy ($B = -0.71$, $SE = 0.27$, bootstrap 95% CI = [−1.29, 0.04], $p = .010$, two-tailed), suggesting that the association between biospheric values and positive emotions towards the policy options was stronger in case of *voluntary* adoption rather than in case of mandated adoption. In fact, simple slope analyses revealed that only in the voluntary condition were biospheric values significantly and *positively* associated with positive emotions towards the policy option ($B = 0.36$, $SE = 0.16$, 90% CI = [0.09, 0.62], $p = .014$, one-tailed). In the mandatory condition the association was negative and non-significant ($B = -0.35$, $SE = 0.22$, 95% CI = [−0.79, 0.08], $p = .109$, two-tailed; see Fig. 6).

The assumption underlying H3c, namely that policies mandating the adoption of energy innovations are more congruent with biospheric values than those promoting voluntary adoption because they are more effective in reducing CO_2 emissions, was not supported. Specifically, and against H4, participants who had learned that the adoption of heat pumps might become mandatory did not perceive the respective policy option to be more effective in reducing CO_2 emissions ($M = 0.57$, $SE = 1.60$) than participants who had read about a promotion of voluntary adoption ($M = 0.60$, $SE = 1.49$; M diff = −0.02, BCA 90% CI [−0.50, 0.57]; $t(95) = 0.07$, $p = .473$, one-tailed).

3.4. Acceptability of the policy options

Finally, we examined the associations between negative and positive emotions, respectively, and acceptability of the policy options.[12] Both negative and positive emotions were significantly associated with acceptability (see Table 3). As expected, the weaker the negative emotions (H5a) and the stronger the positive emotions (H5b) participants experienced, the more acceptable they considered the policy option to be. The associations between emotions and acceptability were somewhat stronger for the policy option that mandated adoption than for the one promoting voluntary adoption (see Appendix B, Table B.2).

Paralleling the effects of policy type on emotions, participants who had learned that the adoption of heat pumps might become mandatory evaluated the respective policy option as significantly less acceptable ($M = -0.44$, $SD = 1.62$) than participants who had read about the promotion of voluntary adoption ($M = 1.03$, $SD = 1.41$; M diff = −1.47, BCA 95% CI [−2.10, −0.86]; $t(95) = -4.76$, $p < .001$, two-tailed).

4. Discussion

Integrating reactance theory [9,10] and the novel VICE model [11], we investigated in a field experiment the causes of people's emotional responses to two policy options aimed at increasing the adoption of heat pumps. The policy options were a campaign promoting voluntary adoption of heat pumps and a regulation that mandates their adoption. As predicted based on reactance theory, the policy option mandating the adoption of heat pumps evoked stronger negative emotions and weaker positive emotions compared to the one promoting voluntary adoption and these effects were mediated by perceived threat to freedom. Specifically, participants who learned that adoption might be mandated experienced stronger threat to their freedom than those who learned

[12] As noted by an anonymous reviewer, we had the option to test whether acceptability of the policy options depends on the type of policy and values, respectively, and whether emotions mediate these effects. We ran the respective analyses and report them in Appendices D and E. In short, participants who had learned that the adoption of heat pumps might become mandatory, experienced stronger negative emotions and weaker positive emotions towards the policy option, and, in turn, rated the policy option as less acceptable than participants who had read about the promotion of voluntary adoption. Next, in case of mandated adoption–but not in case of voluntary adoption–the stronger people's egoistic values were, the stronger negative emotions they experienced towards the policy option and, in turn, the less acceptable they rated the policy option. In a similar vein, in case of voluntary adoption–but not in case of mandatory adoption–the stronger people's biospheric values were, the stronger positive emotions they experienced towards the policy option and, in turn, the more acceptable they rated the policy options.We do not report these findings in the main manuscript because of two reasons. First, the main focus of our paper was on researching potential causes of *emotions* towards policies aimed at increasing the adoption of energy innovations. We focus on emotions as research indicates that negative emotions may be a crucial barrier to the implementation of such policies (c.f. [5]) and because such emotional reactions are–despite their practical relevance–understudied. Second, while we assume that emotions and acceptability are highly intertwined, we do not make any assumptions on the causality, whereas mediation analysis implies such an assumption. Importantly, given that we did not experimentally manipulate emotions, we are not able to conclude, based on our data, on the causal relationship between emotions and acceptability.

about the potential promotion of voluntary adoption, which, in turn, was related with stronger negative emotions and weaker positive emotions towards the policy options. In sum, our results parallel research on for example coercive health messages and indicate that people generally prefer voluntary measures to measures that force them to act in a predefined way (e.g. [17]).

Partially supporting the VICE model [11], participants' emotional responses towards the policy options also depended on their egoistic and biospheric values, contingent on the type of policy. Specifically, and as expected, the stronger participants' egoistic values, the stronger negative emotions they experienced towards the policy options. As hypothesized, this was particularly the case regarding the policy option mandating the adoption of heat pumps, probably because this policy option would force people to adopt an energy innovation that involves personal costs and would thus be particularly incongruent with egoistic values.

In a similar vein, the stronger participants' biospheric values, the stronger positive emotions they experienced towards the policy options, probably because the policy options would help in reducing CO_2 emissions and are thus congruent with biospheric values. Yet, this association was only found in case of voluntary adoption of heat pumps but not in case of mandated adoption, which is in contrast to our expectations. Specifically, based on the VICE model [11], we had hypothesized that the positive association between biospheric values and positive emotions would be even stronger in case of policies *mandating* adoption compared to policies promoting voluntary adoption. This hypothesis was based on the assumption that the congruence with biospheric values would be higher when adoption would be mandated (as a mandate would result in higher reductions of CO_2 emission as all people would have to adopt the innovation) than when a voluntary adoption would be promoted (see section 1.2).

There are two potential, complementary explanations of the finding that the positive association between biospheric values and positive emotions towards the policy options was not stronger in case of mandatory adoption, and was even found only in case of voluntary adoption. First, it is possible that particularly in case of mandatory adoption the influence of psychological reactance on positive emotions may have been larger than and may have overridden the influence of biospheric values. Our findings point indeed in this direction. Perceived threat to freedom was strongly correlated with positive emotions towards the policy options, and particularly towards the one mandating adoption, while the correlation between biospheric values and positive emotions was only of small to medium effect size (even in case of the policy option promoting voluntary adoption). This suggests that in case of mandated adoption the positive emotions that may have been elicited–particularly in people with stronger biospheric values because of the policy's congruence with these values–were overridden by the negative emotions elicited by psychological reactance. In other words, even people who may support, based on their values, the aim of an (energy) policy (such as the reduction of CO_2 emissions) may be unfavourable towards the policy, if the policy restricts their freedom of choice. Reactance seems thus more decisive for people's emotional responses–and probably their decision-making–than their value-considerations, which would be in line with both reactance theory [9,10] and value approaches [25,45]. Specifically, and as pointed out by an anonymous reviewer, core values have been conceptualized as distal predictors of (pro-environmental) decision-making. They mostly affect decisions indirectly through a chain of more proximal cognitions, including beliefs and norms, e.g., [25,45]. Reactance, in contrast, has been conceptualized as a proximal predictor of decision-making, namely a motivational state in which people tend to decide and act in favour of restoring their freedom of choice [9,10].

Noteworthy, research indicates that negative reactions caused by psychological reactance are largest when a restriction of freedom is non-absolute in the sense of uncertain or negotiable, such as a policy *option* that a municipality is considering [46,47]; see also [48]. Yet, an absolute restriction, which is certain and non-negotiable, such as a policy a municipality has already *decided* to implement, has been found to evoke comparatively positive reactions. Our study, by presenting policy *options* the municipality of Groningen was allegedly considering, confronted participants with a non-absolute restriction of their freedom. If instead we had confronted our participants with an absolute restriction, such as bogus information on a *decision* already taken by the municipality, participants might have experienced less psychological reactance and reacted more positively to the mandate. While scholars have interpreted these comparatively positive reactions to absolute restrictions as rationalizations (i.e. a positive (re-)interpretation of the restriction to justify it [46,47]), the positive reactions might additionally be driven, at least in part, by people's core values. In more detail, it is possible that when matters are decided and psychological reactance thus fades into the background, people (re-)evaluate the absolute restriction in light of their values, thus giving more way to the (positive and negative) influence of values on emotions. Future research could compare the influence of psychological reactance, rationalization *and* values on emotions towards a mandate to adopt an energy innovation dependent on whether the restriction is non-absolute, such as a policy *option*, or absolute, such as a policy *decision*.

A second and complementary explanation of the finding that the positive association between biospheric values and positive emotions towards the policy options was not stronger in case of a mandatory as compared to voluntary adoption is related to perceived value congruence. Specifically, it is possible that participants did not perceive the policy option mandating adoption to be more congruent with biospheric values than the policy option promoting voluntary adoption. Our findings on the perceived effectiveness of the policy options in reducing CO_2 emissions point indeed in this direction. Against our expectations, on average participants perceived the policy option mandating the adoption of heat pumps to be equally effective in reducing CO_2 emissions–and thus probably equally congruent with biospheric values–as the policy option promoting voluntary adoption. Yet, if participants had perceived the policy option mandating the adoption of heat pumps to be more effective in reducing CO_2 emissions, as we had expected, participants with stronger biospheric values might have experienced stronger positive emotions towards this policy option; cf. [29]. However, it should be mentioned that the measure we used to assess the perceived effectiveness of the policy options in reducing CO_2 emissions was phrased rather broadly, namely referring to the effectiveness of the respective policy option "to achieve Groningen's goal to be energy neutral by 2035". It is possible that we would have found differences in the perceived effectiveness of the two policy options if we had applied a more precise measure, for example on the effectiveness of the policy option in reducing the CO_2 emissions among the residents of the neighbourhood. Future research could include more precise measures of policy effectiveness to further probe the congruence between policies aimed at increasing the adoption of energy innovations and biospheric values. Moreover, the present study did not include any measures to investigate the policies' characteristics that cause incongruence with egoistic values, such as personal costs people associate with policies that

either mandate adoption of energy innovation or promote their voluntary adoption. This could be done in future studies. Furthermore, while we assumed that emotions towards policies aimed at increasing the adoption of energy innovations depend on the policies' (in)congruence with egoistic and biospheric values, respectively, we did not measure whether people actually perceived the assumed value (in)congruence. Future studies could include such measures to compare the perceived value (in)congruence of policies that mandate adoption as compared to those that promote voluntary adoption, which would help in specifying the role of value *(in)congruence* for emotional responses.

In contrast to what was assumed based on the VICE model [11], egoistic values were only significantly associated with negative but not with positive emotions, and biospheric values were only significantly associated with positive but not with negative emotions. The effects of value (in)congruence on people's emotions towards policies aimed at increasing the adoption of energy innovations thus seem to be more selective than expected: value incongruence seems to affect particularly negative emotions, while value congruence seems to affect mainly positive emotions. More research is needed to test this further.

Finally and as expected, participants' emotional responses to the policy options were associated with acceptability of the policy options. In more detail, weaker negative and stronger positive emotions towards the policy options were related with higher acceptability of the policy option (c.f. [11;5,7,30–33]). These findings indicate that people's emotional reactions to policies aimed at increasing the adoption of energy innovations in particular and to environmental policies in general are critical to understand public acceptability of such policies (c.f. [5,8]).

4.1. Practical implications of our findings

If the public experiences negative emotions towards and opposes policies that mandate the adoption of energy innovations, these policies might not be implemented and would thus fail in increasing the adoption of energy innovations. Our results indicate indeed that people–and even those with stronger biospheric values–react with stronger negative emotions towards a mandate to adopt energy innovations and accept it less than a promotion of voluntary adoption. Yet, despite the comparatively more negative reactions to the policy option mandating an adoption of heat pumps, negative emotions and opposition to this policy option were rather low: participants who evaluated the mandate experienced only weak negative emotions and perceived the mandate on average as only somewhat inacceptable. These results are promising for practice as they suggest that rather than experiencing strong negative emotions towards and strongly opposing policies that mandate the adoption of energy innovations, the public might accept such policies at least 'reluctantly' [49]. What is more, based on the literature it seems plausible that if we had confronted our participants with absolute restrictions (such as bogus policy *decisions*), rather than with non-absolute restrictions (i.e., bogus policy *options*), the comparatively more negative reactions to a mandatory adoption of heat pumps might have been even lower, for example due to rationalization [46,47]. Yet in practice, politicians may be reluctant to decide on implementing a policy option that is, at least at the beginning, not fully supported by the public, even if the public might fully support it after implementation; c.f. [50], see also [51].

Therefore, it is essential to consider how to develop policies that evoke more positive and less negative emotions from the beginning. Our study provides some insights on potential measures to achieve this. First, our results highlight that policies promoting the *voluntary* adoption of energy innovations may elicit positive emotions among people with stronger biospheric values, probably because such policies, by contributing to reduced CO_2 emissions, may be congruent with these values. To reduce negative and increase positive emotions towards policies that *mandate* the adoption of energy innovations, especially among people with stronger biospheric values, public outreach could highlight the congruence between such mandates and biospheric values. For example, communication could highlight that *especially* policies that *mandate* rather than propose the voluntary adoption of energy innovations will be effective in reducing CO_2 emissions to fight climate change, because they secure widespread adoption. Second, our results highlight that when the adoption of an energy innovation implies personal costs, policies aimed at increasing adoption may elicit negative emotions among people with stronger egoistic values, probably because such policies, due to the personal costs they imply, may be incongruent with these values. Thus, to reduce negative emotions towards policies that mandate the adoption of energy innovations, especially among people with stronger egoistic values, the incongruence between such policies and egoistic values could be minimized. For example, the implementation of such policies could be accompanied by subsidies that compensate at least a part of the investment costs for the installation of energy innovations. Additionally, developers of energy innovations could aim to reduce investment costs as well as any other personal costs of energy innovations, thus reducing the incongruence with egoistic values, or try to make them personally even more beneficial than conventional energy technologies, thus increasing congruence with egoistic values.

Current political decision-making considers mainly *negative* emotions, probably because of their obstructive potential for the implementation of policies; c.f. [11,12]. In contrast to current practice, our findings emphasize the need to consider both negative *and* positive emotions towards policies aimed at increasing the adoption of energy innovations in particular and environmental policies in general. First, in our study, stronger egoistic values were associated with stronger negative emotions towards the policy options, but egoistic values were not associated with positive emotions. Stronger biospheric values, in contrast, were associated with stronger positive emotions, but biospheric values were not associated with negative emotions. If only negative but not positive emotions are considered in decision-making about policies aimed at increasing the adoption of energy innovations, only the responses of people with stronger egoistic but not the responses of people with stronger biospheric values are included, which implies that people's different motives are not equally considered in decision-making. Second, in our study positive and negative emotions explained acceptability of the policy options to a similar degree, which suggests that not only negative but also positive emotions towards energy policies can play a role in acceptability of the policies. Interventions to increase the acceptability of policies that mandate the adoption of energy innovations could thus aim equally at reducing negative *and* increasing positive emotions.

4.2. Strength, limitations and directions for future research

To the best of our knowledge, our study is the first to integrate reactance theory [9,10] *and* a value-based approach (c.f. [25,45])–namely the novel VICE model [11]–to investigate the factors underlying people's emotional responses to environmental policies. Further, it is the

only study testing in a field experiment the influence of policy type on emotions, and how these in turn relate to policy acceptance. Therewith, the study contributes substantially to the literature on the causes of emotions towards (environmental) policies and on the association between emotions and policy acceptance; c.f. [5,8].

Next, because of the experimental design, our study has high internal validity, allowing conclusion about the causal effects of a mandate versus voluntary adoption on emotions as well as acceptability. Further, by focusing on the adoption of a real-life innovation among the residents of a neighbourhood that may in fact have to adopt the innovation, the study is also of high external validity. This is particularly true since at the time of data collection the local authorities of Groningen were reflecting on different policy options to increase in the coming years the adoption of heat pumps in the neighbourhood and had consulted on the topic with residents of the neighbourhood.

Yet, our study is not exempt of limitations. First, we had to balance the aspired sample size to the feasibility of door-to-door data collection, which is very time- and resource-consuming. Therefore, we aimed for a sample size to detect medium rather than small effects. Nevertheless, since small effects have only limited practical relevance, the achieved sample size seems sufficient to draw relevant practical conclusions on the importance of values, type of policy, as well as their interactions for understanding public emotions towards and acceptability of policies aimed at increasing the adoption of energy innovations.

Next, the residents of the studied neighbourhood were mostly highly educated and their income was above the Dutch average. While our sample is thus not representative of the Dutch public, it is representative of the target group of our study, Dutch home owners, which would also be the primary target group of the policies we researched. While our findings may thus not be generalizable to the Dutch public, they seem generalizable to the target group of home owners.

Further, attention checks revealed that the vast majority of participants in the voluntary condition correctly recalled the information we had provided on the respective policy option, whereas a substantial proportion of participants in the mandatory condition did not (34%) and were thus removed from the analyses. Future research could try to optimize recall and thus intervention effects through extensive piloting of the manipulation texts.

While we assumed that policies aimed at increasing the adoption of energy innovations are especially (in)congruent with egoistic and biospheric values, they may also be (in)congruent with other values, such as altruistic or hedonic values. These values could be considered in future studies.

Finally, while our research strongly suggests that values influence emotions towards policies aimed at increasing the adoption of energy innovations, we did not experimentally vary the salience of values or value strength. Therefore, we are not able to formally conclude on whether values indeed caused emotions. Also, while we found emotions and acceptability to be closely related, we cannot draw conclusions on their causal relation. Still, the study adds to the literature that emotions and public acceptability, for example of policies or innovations, are closely intertwined (c.f. [5,31,52]) and that values are at their basis (c.f. [11]).

5. Conclusions

In a field experiment, we found support for two theories explaining people's emotional responses to policies aimed at increasing the adoption of an energy innovation. In line with reactance theory [9,10], we found that people experienced stronger negative emotions and weaker positive emotions towards a policy option that mandates the adoption of energy innovations and accepted it less than a policy option promoting voluntary adoption. Additionally, though to a lesser extent, people's emotions towards the policy options were explained by their values. Specifically, stronger egoistic values were related with stronger negative emotions, particularly towards the policy option that mandated adoption, while stronger biospheric values were related with stronger positive emotions towards the policy option that promoted voluntary adoption, which partly supports the VICE model [11]. Weaker negative emotions and stronger positive emotions were in turn related to higher acceptance of both policy options. Our findings imply that measures aimed at increasing the public support of policies aimed at increasing the adoption of energy innovations could profit from considering people's core values.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Information on heat pumps and policy options provided to study participants

Heat pumps

Below you will find information on the goal of the city of Groningen to be energy neutral by 2035 and how the adoption of heat pumps in Reitdiep could contribute to this end. In addition, you will find information on heat pumps. **Please read the information carefully. Later we will ask you several questions about your opinion on heat pumps.**

The municipality of Groningen wants to be energy neutral by 2035, which means that fossil fuels will no longer be used, but only clean and sustainable energy sources. To succeed in this sustainable energy transition, sustainable technologies must be adopted on a large scale and in a timely manner. For example, to become less dependent on natural gas, more sustainable heating methods must be adopted.

Due to differences in capacities and possibilities to apply new energy types, every neighbourhood in Groningen needs a different strategy. For households in the neighbourhood of Reitdiep the use of heat pumps could be a suitable option (as previously mentioned, heat pump means an air to water heat pump).

What is a heat pump?

A heat pump is a sustainable alternative to heating a house (and producing hot tap water) with gas. A heat pump extracts heat from the air and converts it into energy to heat the house, thus making a central heating (CH) boiler superfluous. If you would like to know more about how a heat pump works, you will find more information on the next page.

A heat pump consists of two parts: one located indoors and one located outdoors. The indoor part is placed where the CH boiler is usually placed; the outdoor part, which is around 1.5 m^2, is placed for example on the roof or next to the house. During the placement, it should be taken into account that the outdoor part can cause noise nuisance. Most heat pumps emit about 50 dB of noise, which is slightly louder than the noise of a modern fridge freezer. You can prevent noise nuisance by placing the outdoor part smartly (e.g. not near to windows) and/or using a soundproof casing.

Why are heat pumps sustainable?

Heating with a heat pump is environmentally friendly. While a heat pump needs electricity to operate, it generates up to four times more heat energy than the electrical energy it needs. When combined with sustainably produced electricity, it generates heat energy without using any fossil fuels, thus substantially reducing CO_2 emissions. Overall, heat pumps contribute to a sustainable energy transition, which is essential to combat climate change.

More information: How does a heat pump work?

Extracting heat from the environment through low pressure

A refrigerant circulates in the heat pump system. By means of the refrigerant, the heat pump extracts heat from the outside air. In the outdoor part, the pressure is low and under low pressure, the refrigerant evaporates into gas form. Through evaporation, the refrigerant extracts heat from the outside air. The refrigerant has the special property that it already evaporates at a very low temperature. This allows a heat pump to absorb heat from the outside air even at very low outside temperatures.

Increase temperature through high pressure

Next, the gaseous refrigerant, which has still a rather low temperature, is pumped to the indoor part of the heat pump system and is exposed to higher pressure. Due to the higher pressure, the gas condenses and becomes liquid again. As a result, heat is released. This heat is transported to the radiators and/or underfloor heating of the house and the house is heated.

Reduce pressure and the cycle repeats

Then the pressure is reduced again and the refrigerant is transported back, in liquid form, to the outdoor part. There, the refrigerant absorbs new energy from the outside air. And the cycle of the heat pump repeats itself over and over again.

Adoption of heat pumps in Reitdiep

Below you will find information on one of the possible options the municipality of Groningen has to stimulate the adoption of heat pumps in Reitdiep. **Please read this information carefully. We will ask various questions about this later.**

The municipality of Groningen is currently inventorying the possible options for increasing the adoption of heat pumps in Reitdiep. Additionally, the municipality is exploring possible funding structures and/or subsidy schemes to make investments possible.

Information provided in the non-coercive condition

One option could be to organize **a campaign** to **motivate the households in Reitdiep** to **adopt a heat pump** instead of using a CH boiler.

Such a campaign would include both an information letter, which would be sent to all households, and information meetings in the neighbourhood. In the letter as well as during the meetings, the residents of Reitdiep would receive information about…

Information provided in the coercive condition

One option could be a new regulation that **obliges all households in Reitdiep** to **adopt a heat pump** instead of using a CH boiler.

If the municipality implemented the new regulation, all households in Reitdiep would be informed about it through an official letter and information meetings in the neighbourhood. In the letter as well as during the meetings, the residents of Reitdiep would receive information about the regulation, …

… heat pumps, the benefits and costs, available financing options and subsidies, and the implementation process. Moreover, the residents would have the opportunity to ask all their questions.

To facilitate the installation of a heat pump, there would be the option to make an appointment with "Groningen lives SMART", an advisor on sustainable living, who can give advice on how to optimally install a heat pump in the specific household.

Information provided in the non-coercive condition

With this campaign, the municipality of Groningen could motivate the residents of Reitdiep to replace their CH boilers with heat pumps.

Information provided in the coercive condition

With this new regulation, the municipality of Groningen could ensure that all households in Reitdiep replace their CH boilers with heat pumps.

Appendix B. Descriptive statistics and intercorrelations of all study variables

Table B1
Descriptive statistics and intercorrelations of all study variables for the entire sample.

	Type of policy[1] *r*	Perceived threat to freedom *r*	Perceived policy effectiveness *r*	Egoistic values *r*	Biospheric values *r*	Negative emotions *r*	Positive emotions *r*	Acceptability of policy option
Perceived threat to freedom	0.79***							
Perceived policy effectiveness	−0.01	−0.22*						
Egoistic values	−0.15	0.05	−0.06					
Biospheric values	−0.13	−0.14	−0.02	0.05				
Negative emotions	0.44***	0.64***	−0.42***	0.20	0.06			
Positive emotions	−0.45***	−0.66***	0.49***	0.02	0.13	−0.55***		
Acceptability of policy option	−0.44***	−0.63***	0.57***	−0.01	0.05	−0.70***	0.72***	
M	–	−0.15	0.59	3.87	5.62	0.76	1.68	0.42
SD	–	2.14	1.53	0.91	0.84	1.04	1.22	1.66

Note. $N = 97$. [1] 0 = voluntary; 1 = mandatory. * $p < .05$, two-tailed. ** $p < .01$, two-tailed. *** $p < .001$, two,tailed.

Table B2
Intercorrelations of all study variables for the voluntary condition (above the diagonal) and for the mandatory condition (below the diagonal) and descriptive statistics per condition.

	Perceived threat to freedom *r*	Perceived policy effectiveness *r*	Egoistic values *r*	Biospheric values *r*	Negative emotions *r*	Positive emotions *r*	Acceptability of policy option *r*
Perceived threat to freedom		−0.29*	0.22	−0.12	0.52***	−0.52***	−0.44**
Perceived policy effectiveness	−0.47**		0.00	0.14	−0.55***	0.51***	0.70***
Egoistic values	0.40*	−0.15		0.00	0.27*	0.04	0.11
Biospheric values	0.08	−0.28‡	0.11		0.05	0.28*	0.10
Negative emotions	0.61***	−0.42**	0.37*	0.22		−0.33*	−0.50***
Positive emotions	−0.62***	0.60***	−0.25	−0.27	−0.57***		0.55***
Acceptability of policy option	−0.67***	0.55***	−0.39*	−0.18	−0.75***	0.79***	
$M_{voluntary}$	−1.56	0.60	3.99	5.71	0.38	2.14	1.03
$SD_{voluntary}$	1.45	1.49	0.98	0.88	0.71	1.13	1.41
$M_{mandatory}$	1.86	0.58	3.71	5.49	1.30	1.03	−0.44
$SD_{mandatory}$	1.12	1.60	0.79	0.78	1.19	1.03	1.62

Note. $n_{\text{Voluntary}} = 57$. $n_{\text{Mandatory}} = 40$. ‡ $p < .10$, two-tailed. * $p < .05$, two-tailed. ** $p < .01$, two-tailed. *** $p < .001$.

Appendix C. Attention and randomization checks

Table C1
Remembered information across experimental conditions: Number of cases, percentage within condition, and standardized residuals.

	Condition: Adoption is …						
	… voluntary			… mandatory			
Policy option is …	*n*	% in condition	SR[1]	*n*	% in condition	SR[1]	$\chi^2(df)$
… a campaign	**57**	**91.93**	**3.44**	15	24.59	−3.47	$\chi^2(2) = 61.99$***
… a regulation	1	1.61	−4.33	**40**	**65.57**	**4.36**	
… neither nor	4	6.45	−0.46	6	9.83	0.47	

Note. [1] Standardized residual. Cases that remembered the information correctly are in bold. *** $p < .001$

Table C2
Distribution of gender, income, and education level across experimental conditions: Number of cases, percentage per condition, and standardized residuals.

Socio-demographic	Condition: Adoption is …						
	… voluntary			… mandatory			
	n	% in condition	SR[1]	*n*	% in condition	SR[1]	$\chi^2(df)$
Gender							$\chi^2(2) = 0.40$ [t]
Man	35	61.40	−0.24	27	67.50	0.28	
Woman	20	35.09	0.28	12	30.00	−0.33	
No disclosure	2	3.51	0.18	1	2.50	−0.21	
Income per month							$\chi^2(5) = 5.65$ [t]
< 1000€		3.51	0.76	0	0.00	−0.91	
1000€-2000€	5	8.77	−0.13	4	10.00	0.15	
2000€-3000€	16	28.07	0.51	8	20.00	−0.60	
3000€-4000€	6	10.53	−0.40	6	15.00	0.47	
4000€-5000€	15	26.32	−0.88	17	42.50	1.05	
>5000€	13	22.81	0.74	5	12.50	−0.89	
No disclosure	2	3.51	0.76	0	0.00	−0.91	
Education level							$\chi^2(2) = 2.50$ [t]
Lower	0	–	–	0	–	–	
Medium	11	0.19	0.93	3	0.08	−1.13	
Higher	46	0.81	−0.39	36	0.92	0.47	

Note. [1] Standardized residual. [t] $p > .10$.

Table C3
Means and standard deviations in age, and biospheric and egoistic values across experimental conditions.

	Condition: Adoption is …						
	… voluntary			… mandatory			
Variable	*n*	*M*	*SD*	*n*	*M*	*SD*	*t*(*df*)
Age	56	44.04	9.62	39	42.31	10.69	$t(93) = 0.82$ [t]
Biospheric values	57	5.71	0.88	40	5.49	0.78	$t(95) = 1.29$ [t]
Egoistic values	57	3.99	0.98	40	3.71	0.79	$t(95) = 1.47$ [t]

Note. [t] $p > .10$.

Appendix D. Testing emotions as mediators of the effects of type of policy on acceptability

Using Model 4 of the PROCESS macro in SPSS [41], we tested whether type of policy affects acceptability of the policies aimed at increasing the adoption of heat pumps, and whether this effect is mediated by negative and positive emotions. Type of policy had a strong effect on acceptability of the policy options (total effect: $B = -1.47$, $SE = 0.31$, 95% CI = [−2.09, −0.86], partially standardized $\beta = -0.89$, $p < .001$, two-tailed). Specifically, participants who had learned that the adoption of heat pumps might become mandatory evaluated the respective policy option as significantly less acceptable than participants who had read about the promotion of voluntary adoption. This effect was significantly mediated by both negative emotions (indirect effect: $B = -0.64$, $SE = 0.17$, bootstrap 95% CI = [−1.03, −0.33], partially standardized $\beta = -0.38$) and positive emotions (indirect effect: $B = -0.70$, $SE = 0.17$, bootstrap 95% CI = [−1.04, −0.38], partially standardized β = -0.42). The remaining direct effect of type of policy on acceptability was not significant ($B = -0.13$, $SE = 0.24$, bootstrap 95% CI = [−0.55, 0.30], partially standardized $\beta = -0.08$, $p = .581$. two-tailed), indicating that the effect was fully mediated by negative and positive emotions. This suggests that participants who had learned that the adoption of heat pumps might become mandatory rated the policy option as less acceptable than participants who had read about the promotion of voluntary adoption *because* they experienced stronger negative emotions and weaker positive emotions.

Appendix E. Testing the association between values and acceptability, moderated by policy type, and mediated by emotions

Using Model 1 of the PROCESS macro in SPSS [41], we tested whether egoistic and biospheric values were associated with acceptability of the policies, dependent on the type of policy. Further, using Model 7 of the PROCESS macro in SPSS, we tested whether these associations were mediated by negative and positive emotions.

Egoistic values were not significantly associated with acceptability of the policy options ($B = 0.16$, $SE = 0.20$, 95% bootstrap CI = [−0.28, 0.60], $p = .413$, two-tailed). However, the interactive effect of egoistic values and type of policy on acceptability was significant ($B = -0.96$, $SE = 0.35$, 95% bootstrap CI = [−1.65, −0.24], $p = .008$, two-tailed). Simple slope analyses revealed that in the voluntary condition egoistic values were not associated with acceptability ($B = 0.16$, $SE = 0.20$, 95% CI = [−0.23, 0.56], $p = .413$. two-tailed). Yet in the mandatory condition stronger egoistic values were significantly associated with lower acceptability of the policy option ($B = -0.80$, $SE = 0.29$, 95% CI = [−1.38, −0.21], $p = .008$), and this association was significantly mediated by negative emotions (indirect effect: B = −0.42, SE = 0.17, bootstrap 95% CI = [−0.80; −0.12]). In sum, in

case of mandated adoption but not in case of voluntary adoption the stronger people's egoistic values were, the stronger negative emotions they experienced towards the policy option and, in turn, the less acceptable they rated the policy option.

Biospheric values were not significantly associated with acceptability of the policy options either ($B = 0.17$, $SE = 0.23$, 95% bootstrap CI = [−0.19, 0.47], $p = .471$, two-tailed), nor was the interactive effect of biospheric value and type of policy on acceptability significant ($B = -0.53$, $SE = 0.38$, 95% bootstrap CI = [−1.29, 0.34], $p = .171$, two-tailed). Still, in the voluntary (but not in the mandatory) condition biospheric values had a significant indirect effect on acceptability of the policy option via positive emotions ($B = 0.23$, $SE = 10$, bootstrap 95% CI = [0.02, 0.41]). That is, in case of voluntary adoption but not in case of mandatory adoption the stronger people's biospheric values were, the stronger positive emotions they experienced towards the policy option and, in turn, the more acceptable they rated the policy option.

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