



Original research article

## The emotional dimensions of energy projects: Anger, fear, joy and pride about the first hydrogen fuel station in the Netherlands

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## ABSTRACT

Citizens' emotional responses to energy technology projects influence the success of the technology's implementation. Contrary to popular belief, these emotions can have a systematic base. Bringing together insights from appraisal theory and from technology acceptance studies, this study develops and tests hypotheses regarding antecedents of anger, fear, joy, and pride about a local hydrogen fuel station (HFS). A questionnaire study was conducted among 271 citizens living near the first publicly accessible HFS in the Netherlands, around the time of its implementation. The results show that anger is significantly explained by (from stronger to weaker effects) perceived procedural and distributive unfairness, and fear by distributive unfairness, perceived safety, procedural unfairness, gender, and prior awareness. Joy is significantly explained by perceived environmental outcomes and perceived usefulness, and pride by prior awareness, perceived risks, trust in industry, and perceived usefulness. The study concludes that these predictors are understandable practical and moral considerations, which can and should be taken into account when developing and executing a project.

## 1. Introduction

Citizens' emotionally-charged responses can delay or even prevent the introduction of energy projects into society. One well-known example involves a canceled carbon capture and storage project in the Netherlands [1,2]. Many other energy projects, such as wind parks, high-voltage power lines, and nuclear power plants have also been vocally and emotionally opposed by citizens.

Emotions about new technologies have often been viewed negatively. They are said to result from ignorance and to undermine the decision-making process, which should ideally be based in rational weighing of risks and benefits [3,2]. For that reason, emotions have been ignored or taken at face-value by decision-makers [4]. Some scholars have argued, however, that emotions are helpful, valuable, and even necessary for making practical and moral judgments [5,6] and result from, or co-occur with appraisals of the situation (e.g. [7,8]). This claim has been made about energy projects in particular [9,10]. Understanding what underlies citizens' emotions about new energy projects can help developers, policymakers, and industry managers to design better technologies, policies, and communications, and to undertake more ethically acceptable and practically accepted enterprises.

Studies of technology acceptance and risk perception (see for overviews [11,12]) have focused mainly on the positive or negative

valence of feelings measured as affect, and rarely on specific emotions (with the exception of Dohle et al. [13]). Emotion scholars, however, have shown that different emotions of the same valence (e.g. anger and fear) can have different antecedents and lead to different behaviors [14–16]. This suggests that it is valuable to gain more insight into specific emotions towards new technologies.

This paper develops hypotheses about antecedents of specific emotions based on findings from appraisal theory and from technology acceptance studies, and tests these hypotheses for emotions about a local hydrogen fuel station. Two negative emotions (anger and fear) and two positive emotions (joy and pride) are considered. These four distinguishable emotions relate to different appraisals and behaviors [17,15,16,18].

Unlike anger, fear, and joy (e.g. [16,19]), pride has not often been studied; this is particularly true of pride in parties other than oneself or one's offspring [20]. As pride has been shown to motivate people to persevere in a task despite initial costs [21], it is important to understand what generates pride in an energy project.

### 1.1. The case of a Dutch hydrogen fuel station

Hydrogen has the potential to make car use independent of fossil fuels and free from harmful emissions, provided that the hydrogen is produced with sustainable energy sources [22–24]. However, early

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experiences have shown that resistance to HFS projects can arise because of concerns about safety risks, especially when the HFS is located near private residences [25–28].

The current study focuses on an HFS that was placed in the city of Arnhem in 2010. Biogas was purchased for the on-site generation of the hydrogen, making it a low-carbon fuel. The project was initiated and subsidized by regional governmental bodies, and it was owned by a non-profit organization run by industry partners. The HFS was added to an existing petrol station, which was located in an industrial area, close to a residential neighborhood and to the local bus company that would deploy one hydrogen bus. Nearby-living citizens were not involved in decision-making about the project. The official opening generated a few short news items in local newspapers and on national television [29–31].

## 1.2. Theory

Appraisal theory, which assumes that specific emotions are triggered by appraisals of a stimulus [7,8], can shed light on the role of specific emotions in the context of environmental risk perception (cf. [32]). The theory holds that specific emotions are keyed to certain appraisals, such as “novelty, intrinsic pleasantness, certainty, goal significance, agency, coping potential and compatibility with social or personal standards” (the latter including fairness; [7,p. 573]). These appraisals explain not only elicitation of emotions but also differentiation among emotions. For example, events that people feel they cannot cope with are more likely to cue fear, while events that people feel they can cope with are more likely to cue anger [19].

This study focuses on four sets of potential antecedents of specific emotions about energy projects: (1) perceived outcomes, (2) procedural and distributive fairness, (3) prior awareness, and (4) trust. These antecedents are related to several appraisals, namely goal significance, fairness, novelty, agency, control, and coping ability.

### 1.2.1. Goal significance and perceived outcomes

Goal significance or goal relevance distinguishes among the occurrences of specific emotions in appraisal theory. The theory holds that specific emotions are preceded by or co-occur with appraisal of the “extent to which a stimulus or situation furthers or endangers an organism’s survival and adaptation to a given environment, the satisfaction of its needs, and the attainment of its goals” [7,p. 578]. Scherer, in fact, makes goal significance a crucial part of the definition of emotion, which he sees as “an episode of interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event *as relevant to major concerns of the organism*” (Scherer, 1987, 2001 in [60,p. 697] [my emphasis]).

Arguably, having a safe living environment, energy security (including access to useful vehicle fuels), and minimal environmental degradation (e.g. limited air pollution and climate change) is an important goal for many citizens in the context of energy technologies [33]. It can therefore be presumed that the more one believes that an energy technology will positively or negatively affect these goals, the stronger one’s positive or negative emotions respectively will be.

Hydrogen as a fuel for vehicles is often perceived as having environmental benefits and safety risks [34–39]. The more positive environmental outcomes people expect the technology to have, the more joy and perhaps also pride they are likely to report upon the opening of a local HFS; conversely, the more risks people expect the technology to have, the more anger and fear they are likely to report. By the same token, the anticipated usefulness of a local HFS will probably determine the amount of joy and pride people report. While joy may simply be caused by the expectation of a project’s positive outcomes, pride may specifically result from awareness of an outstanding achievement by a party that one feels connected to. Although pride is often associated with personal achievement [15,21], people can also feel pride in the achievements of other community members [20]. It is difficult to

predict which of the outcomes will be considered most outstanding and most linked to local community members, and thus most likely to elicit pride.

### 1.2.2. Fairness: procedural and distributive

Appraisal researchers have found that also perceived unfairness is a strong predictor of specific emotions. For example, Frijda et al. [40] discovered that unfairness cued anger when people recalled their own recent emotions. Scherer [19] demonstrated that perceived unfairness was the second-strongest predictor (after the dimension of agency or causation) of specific emotions that people associated with recent events. Furthermore, Mikula et al. [41] showed that appraisals of an event’s unfairness most strongly induced anger, but also elicited other negative emotions, such as sadness, fear, guilt, and shame. In the context of technology acceptance, Dohle et al. [13] showed that perceived fairness explained the intensity of anger—but not of fear—around mobile phone base stations. These studies, however, did not specify the type of fairness.

Technology acceptance research has determined that both procedural fairness and distributive fairness affect how people evaluate energy technologies [42,12,43]. While procedural fairness relates to how a decision-making procedure takes place (for example, whether citizens’ opinions are being listened to), distributive fairness relates to how the positive and negative outcomes of a technological project are allocated. In the justice literature, procedural and distributive unfairness have been recognized as distinct moral factors; both have been found to cause anger [44]. A study of a hypothetical hydrogen fuel station [45] has confirmed that distributive unfairness explained negative affect, which was measured as the average rating of several negative emotions, including anger and fear. These findings suggest that perceived procedural and distributive unfairness will elicit anger, and possibly also other negative emotions such as fear, when an energy project is developed in one’s vicinity.

### 1.2.3. Novelty and prior awareness

Novelty is one of the appraisal dimensions that predicts which specific emotions arise. Scherer [19], for example, showed that different emotion-eliciting events rate differently in expectedness; unexpected events cued anger, while expected events cued joy.

Citizens living near a new energy project may be more or less aware of it. When asked for their opinion about this project, they may therefore experience novelty to a greater or lesser extent. Thus, prior awareness may influence which specific emotion is felt more strongly. Scherer’s findings on novelty [19] imply that prior awareness elicits more joy and less fear than prior unawareness. Similarly, it may be that pride is higher and fear lower among those who were already aware of the fuel station than among those who were not.

Those with prior awareness of hydrogen as a fuel were more likely to support than to oppose a hypothetical hydrogen fuel station [27]. Similarly, support for the use of hydrogen vehicles in London was higher among citizens who already knew of them [46]. Prior awareness, then, favorably affects how people evaluate hydrogen technologies and leads to more positive and fewer negative feelings about them.

### 1.2.4. Agency, control, coping ability and trust

In different domains, trust plays a very important role in how people evaluate and respond to a situation and its social context (e.g. [47–49]). Specifically, trust seems to shape affective evaluations of potentially risky technologies; trust in three different institutions that were responsible for the use of nanotechnology in the food domain influenced the average affective evaluation of associations with nanotechnology applications [50]. Higher levels of trust in industry and in government engendered more positive and less negative affect regarding carbon capture and storage [51]. For a hypothetical hydrogen fuel station, less trust in industry lead to stronger negative affect, and more trust in the municipality to stronger positive affect [45].

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